AMERICAN FEDERATION OF MINERALOGICAL SOCIETIES

Future Rockhounds of America Badge Program

Fourth Edition

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This packet is available on-line on the AFMS website: www.amfed.org

AMERICAN FEDERATION OF MINERALOGICAL SOCIETIES
Future Rockhounds of America Badge Program

MISSION STATEMENT

Future Rockhounds of America is a nationwide nonprofit program within the American Federation of Mineralogical Societies that develops and delivers quality youth activities in the earth sciences and lapidary arts in a fun, family environment. Our underlying goals are to foster science literacy and arts education through structured activities that are engaging and challenging and by which kids—and the adults who mentor them—learn while having fun.

INTRODUCTION

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Philosophy behind the FRA Badge Program & Suggestions on Using It

I've developed this manual so as to enable the American Federation of Mineralogical Societies to sponsor a youth program via Future Rockhounds of America, a program that rewards kids on an on-going basis as a means of encouraging and cultivating their interest in the earth sciences and lapidary arts. Through this, each of our individual clubs and societies will uphold our chartered goals as nonprofit, educational organizations by actively seeking to foster and develop science literacy and arts education amongst our youngest members.

My guiding philosophy has three underpinnings. They come from both my own values as a person invested in the positive development of young people and from a wealth of academic research indicating that if one wants to design and deliver programs that effectively promote positive development among young people, three steps are crucial to enact. First, we must provide young people opportunities to learn important skills. Second, we must provide these opportunities in the context of positive and continuing youth-adult relationships. Third, once youth have these skills, we must give them the opportunity to participate in, as leaders of, the programs we present to them.

So first step: we learn by doing. Book knowledge is great, but reading 1,001 books won't craft a cab. You've got to roll up your sleeves, slice a rock, and watch your thumbnails disappear as you shape and grind that first special gem! Second point: we are motivated by goals that are attainable and that offer tangible rewards and recognition, especially if we're given a clear roadmap and consistent support and guidance toward reaching those goals. With kids, this means encouraging supportive adult-youth relationships through adult mentors who pledge a relatively long-term commitment. The best program would be one in which children, youth, and adults work, learn, and grow together. The importance of fostering—and *maintaining*—supportive relationships cannot be stressed enough. A basic expectation of clubs enrolling kids in FRA should be genuine, active, and sustained commitment on the part of the individual youth leaders and the entire club in order to foster strong relationships between adults and young people and between young people and their peers. Third step: kids are motivated the most when they participate the most, both in choosing the activities they'd like to engage in and in helping to shape those activities. In this regard, I'm especially proud to note that one of our badge units, Reaching Across Generations, was proposed and developed by a junior member, Erica Nathan, who—as of this writing—is a college student pursuing her dreams. Another junior member—Jem Burch—suggested the "Elements" activity now included within our Rocks & Minerals badge for this Fourth Edition of the manual.

It's with these thoughts in mind that I've developed an AFMS/FRA series of guided activities modeled after the Boy and Girl Scouts Merit Badge™ systems. In the following pages, I describe clusters of activities children and youth could do either on their own or at club meetings or workshops and the badges they can earn as a result. For instance, one is a Rocks & Minerals cluster that involves building one's own mineral ID kit with readily available tools then demonstrating how to use it to identify several common minerals. Another cluster revolves around Lapidary Arts and requires planning and crafting a project such as a cab, wire-wrapped necklace, or soapstone sculpture while learning the basics of shop tools and safety.

In this packet, I lay the groundwork for twenty badges covering the full spectrum of our hobby, including:

Rocks & Minerals	Earth in Space
Earth Resources	Gold Panning & Prospecting
Fossils	Gemstone Lore & Legend
Lapidary Arts	Stone Age Tools & Art
Collecting	Rocking on the Computer
Showmanship	The World in Miniature
Communication	Special Effects
Field Trips	Fluorescent Minerals
Leadership	Reaching Across Generations
Earth Processes	Maps

Local youth leaders are encouraged to adjust the level of each activity to match the age range of the kids involved. Take, for instance, the mineral identification project (Activity 1.2). Very young children might be taught only the basics of color and hardness, and the youth leader could guide them through a hands-on session with just a few very common minerals that are easily identified, such as quartz, calcite, sulfur, malachite, galena, mica, pyrite, and hematite. Older kids might be given more of a challenge, using a wider range of characteristics to identify a wider range of minerals on their own or in teams after a basic overview. Don't take the activities at face value; adjust as necessary!

You'll also find some activities overlap and can be used to help earn more than one badge at the same time. For instance, among the activities for the Rocks & Minerals and Fossils badges, kids are encouraged to collect rocks, minerals, and fossils, thus simultaneously fulfilling the requirements of Activity 5.1 for the Collecting badge. These aren't intended to be isolated, individual activities but part of an integrated whole that ultimately will help kids earn a "Rockhound" badge as a mark of significant achievement after earning a minimum of six of the twenty badges and a "Rock Star" pin if completing all twenty. On the "Kids Corner" section of the AFMS web site, we publish "Honor Roll" listings of kids who have diligently worked their way to becoming Rockhounds and Rock Stars.

Youth should become a central part of our efforts in order to best ensure that we are providing activities our kids find engaging and worth their time. Thus, I welcome suggestions from both local youth leaders and kids themselves. How can existing activities be improved? What new activities can we add? In addition, please alert me to websites that are no longer be active. For our 2016 Fourth Edition, I have checked every website and have removed those that are no longer in service, but that's a never-ending battle as websites come and go, and I can use all the help I can get to continue monitoring and updating any websites recommended within these pages. I envision this as an evolving program that grows, adapts, and improves with time and use and with the help of all who use it. It's also with youth voice and commitment in mind that I developed the Leadership badge with activities that encourage our more enthusiastic and ambitious junior members to take charge of selecting and organizing activities for their peers.

Kids should have choices about which activities they participate in, and they should have a chance to help shape those activities. It's through youth voice and participation that we engender empowerment and a social commitment and sense of belonging. It's often said that our clubs and societies are declining and, therefore, that we need to attract more young people in order to keep our clubs alive. But saying it in this way puts the cart before the horse. Instead, the focus needs to be on what is best for our youth. Only then will we fire the interest of kids in ways that engender a sense of belonging, with meaningful opportunities from which a lifelong interest and commitment will emerge naturally. Let us not put our clubs first—let us put kids first! If we can find ways to make youth responsible and fully engaged participants, not just recipients, the long-term health of our clubs will follow as a natural result.

Suggestions on Forming a New Youth Group in Your Club

I'm often approached via email or phone by a member of a local society that would like to use this Badge Program but doesn't have a youth group in place. How, they ask, can we get started? Here are seven general suggestions I've developed as a result of talking with folks who have taken the initiative to begin one:

1. ***Go to where the kids are.*** Based on a survey conducted by a natural history museum, the age group with the most kids interested in rocks is 5 to 10, or the elementary school bracket. It's with that group you'll likely find most success. Work with local school teachers and youth groups (Boy and Girl Scouts, Big Brother/Big Sister, 4-H, Boys and Girls Clubs, YMCA, summer camps, etc.) and volunteer to give earth science related talks to them in ways that are relevant and that benefit their goals—for instance, by helping teachers cover curricular

guidelines in the sciences, or by helping a scout leader complete a geology badge. Have a Kids Booth at your annual show with sign-up sheets for parents whose kids have a fascination with rocks and fossils and who would like more information about your club and its activities. Arrange to set up a club booth or table at community events and festivals. In other words, sketch out and implement a proactive plan to raise your profile within the community and to let everyone know what you can offer in helping to educate and cultivate kids with an interest in our hobby. And if you have just one child in your club, encourage that child to bring a friend. Then provide fun activities that catch their attention in ways that will bring them back month after month, along with still more friends.

2. ***Capitalize on your existing pool of talent.*** Every successful youth group I've observed has one "champion"—one committed individual who brings it all together and "makes it happen." But don't depend on just one person. It's hard to find someone who knows everything about every facet of rockhounding, but in most clubs you find an amazingly diverse storehouse of individual knowledge. One person has an intense love of fossils, another is an expert cab crafter, while yet another has an amazing mineral collection. Start by identifying adults within your club's ranks and their individual strengths. Then gather commitments! Just one member a month committing to help with a presentation or activity will carry you through your first year. Make it clear that this needs to be a *club* commitment, not the project of any single individual. And while I note a key element is that central "champion" who then recruits volunteers, equally important is training those volunteers. Provide support and delineate expectations. What's the time limit for a presentation? Do you have a general outline that a program provider can follow? Do you want samples to distribute to kids and/or hands-on activities and of what sort? Don't just call for volunteers; assist, guide, and support them.

3. ***Plan before you start.*** How will your activities be organized? You should have procedures spelled out, and they should be more-or-less consistent from meeting-to-meeting so expectations are clear for everyone involved and to create a familiar sense of rhythm for the kids. You might choose to devote 10 to 20 minutes of your usual club meeting to a Pebble Pup Presentation; or you might choose a monthly activity or workshop at a member's home. Whatever you choose, keep the structure and expectations more-or-less consistent. In addition to planning the structure of a typical meeting, you should plan your entire first year's calendar in advance, gathering commitments from club members to take on specific months. Then, publicize the schedule in your club bulletin and elsewhere so everyone knows what's coming and appropriate preparations can be made well in advance rather than moving from meeting to meeting in a last-minute rush to find a new topic, activity, or speaker.

4. ***Center meetings around an activity and topics of interest and appeal.*** Most adult meetings are centered around a lecture or presentation, and during these, you'll observe kids a) sleeping or b) running the hallways. (I know this based on

first-hand experience with my own kids!) The best way to channel kids' curiosity and energy is through hands-on activities. There should be a *brief* presentation to set the stage, but the bulk of your meeting should be activity-oriented. For instance, in introducing fossils, you very briefly should give kids the utmost basics on what a fossil is and on the fossilization process and then move quickly to just a few high impact and sturdy specimens kids can see and touch, perhaps with a couple large-format picture books, posters, or dinosaur models as illustrations—or with a laptop computer hooked to a large monitor and keyed into relevant websites or images. Then move on to the main event: an activity making clay and plaster casts so kids can walk away with their very own plaster fossil at the end of the night. Get kids learning by doing, and they'll want to come back for more. In addition, pitch each talk to things you know kids will be interested in. Mark Uhran, a director at NASA, once noted in a presentation to fellow scientists about how to get more young people into science, "Space and dinosaurs are the two things that turn kids on more than anything else. If we could grow dinosaurs on the space station, we'd have this thing nailed." What topics, samples, and hands-on activities will nail the interest of *your* club's kids?

5. ***Reward kids with something tangible after each meeting.*** Kids like to collect, so one goal should be to help them build a basic collection. In addition to whatever they may end up with from the activity session of each meeting (like the fossil cast described above), you might also open each meeting with a raffle where every kid is a winner. Spread out a selection of rocks, minerals, and fossils, and give each child a raffle ticket and let them pick from the selection when their numbers are called. Or give each child the same sort of specimen. (Encourage adult members, when going on field trips, to stockpile and bring home a supply of whatever they're seeking for the kids, whether quartz crystals, fossil shark teeth, agates, or barite roses.) Whatever route you choose to go, label specimens with info on what they are and where they came from to begin teaching kids the basics of documenting their collections to add both personal and scientific value.

6. ***Involve parents.*** A youth program should not turn into a babysitting service. Kids have a lot of energy (my own energy was constantly getting me into trouble when I was in elementary school, as my second-grade "D" in conduct will attest…), and parents should be expected to help channel that energy in positive, productive directions and to lend their support. The larger the youth group, the more important it is that a number of adults are on hand to provide individual attention and to prevent the inevitable tendency toward chaos. As an added benefit, getting parents involved in running your activities will help in cultivating future youth leaders for your club, thus avoiding the common problem of burn-out if a single individual is asked to run the youth program year after year.

7. ***Safeguard children.*** Finally, I need to emphasize a point I wish we didn't have to go into, but it is absolutely vital to raise and to underscore, namely, having youth leaders who are well known by all in the club for sound moral values and having multiple adults on hand when working with kids. There are, unfortunately, some

who would abuse the natural trust of children. My home state of California has Megan's Law, which requires registration of sex offenders on a public web site with photos and information about offenders. Some societies require background checks for any club members volunteering to work with juniors, and this is a good policy to explore with your own club board. Always have multiple adults working with the kids, and prevent any sort of abuse, whether physical, sexual, mental, emotional, or verbal. In addition, safeguard children from fellow children by making clear that any sort of hazing or bullying among kids is wrong and is never permitted. The Houston Gem & Mineral Society has developed an official "HGMS Policy on Children" that outlines policies, procedures, and expectations on the parts of children, parents, and club members to ensure a safe, enjoyable environment for children while engaged in any HGMS functions. Consider putting a similar policy in writing for your society. For guidance on this issue, I recommend all youth leaders within AFMS-affiliated societies read the excellent and thorough materials entitled "Youth Protection" contained on the web site of the Boy Scouts of America: http://scouting.org/Training/YouthProtection.aspx **The safety of our youth is paramount, and any obvious or even suspected abuse should be reported and dealt with through proper legal authorities.**

A terrific source filled with other ideas on forming a youth group is *Working With Young People*, by Mabel Kingdon Gross. This manual was prepared for and published by the Eastern Federation of Mineralogical and Lapidary Societies. It's an excellent guide to starting a juniors' program from scratch as well as a resource of activity tips.

Rewarding Kids for their Work: Beyond the Badges

Our AFMS/FRA Badge Program offers tangible rewards for kids to work toward in the form of the badges they can earn as outlined in this Badge Manual. But sometimes it may take a while for kids to work through all the activities required earn a particular badge. Motivating pebble pups and junior members is a continuous effort. To keep them coming back, offer other rewards along the way. Above, I've suggested providing rocks, minerals, or fossils at each and every meeting. Another idea provided by Jim Urbaniak of the Oregon Agate & Mineral Society is "Rock Bucks." OAMS has printed its own currency. Junior members receive one Rock Buck for each scheduled Juniors Meeting they attend, for each FRA badge they earn, and for other activities. Accumulated Rock Bucks may be spent just like real cash at the club's spring and fall silent auctions. Another club has adopted this idea for what they call their "Learn & Earn" program.

Acknowledgements for Editions 1 through 3

Building this badge program has been a long but enjoyable labor of love, a labor made all the more enjoyable by the help received along the way. I'd like to thank all prior AFMS Juniors Program Chairs who blazed the trail and upon whose shoulders I've stood these many years. I'd like to thank the youth leaders—along with two junior members—from local clubs who have offered ideas for new activities and refinement of existing activities. We saw many additions to the 2012 revision of the badge manual thanks to their fine

suggestions emerging from their work with kids. I acknowledge each within the revised activities where I've incorporated their suggestions. They come from states East, West, North, South, and all points in between—thank you, all! I'd like to thank the officers and members of the California Federation of Mineralogical Societies who got me started on my path in appointing me CFMS Junior Activities Chair in 1998. I'd like to thank the officers and members of the American Federation of Mineralogical Societies who have whole-heartedly supported the idea of this Badge Program from its inception in 2003 and who have so generously funded it so that it can be provided completely free to all kids within our affiliated clubs and societies. And I'd like to thank the good folks at AB Emblem in Weaverville, North Carolina, who have manufactured the badges for the fun, colorful rewards we offer to kids. I also thank Darryl "Diamond Dan" Powell for his support and ideas through the years, and I thank Todd Maurer for assistance proofreading the Third Edition of the manual and for his recommendations to underscore safeguarding of children. Finally, we should all give thanks to those brave individuals who roll up their sleeves and really make it all come together. A resource like this badge program is just an inert tool, a collection of words on a page. It only achieves its true potential in the hands of a dedicated person who takes it up and makes something inspirational happen with a group of kids or even a single child. So here's to all those who make it happen: the youth leaders at all the local gem and mineral clubs and societies across America!

Acknowledging Those Who Helped with this Fourth Edition

When I began developing this Badge Manual more than 12 years ago, my goal was to bring out revised and expanded editions every four years. Hard to believe it is already time for a Fourth Edition. Thank you to all who have helped with this latest iteration! These include the following (with apologies to anyone I may have inadvertently overlooked):

Alice Kozanecki (Illinois) provided a nice link on mineral identification geared to kids for our Badge 1 – Rocks & Minerals. Jesse and Jem Burch (California) provided ideas for "The Elements" activities now incorporated as unit 1.8 for the Rocks & Minerals badge. Jim Urbaniak (Oregon) also suggested ideas for "The Elements" activities. In addition, Jim provided for an update on Oregon's State Mineral and suggested the "Rock Bucks" reward I include above in the Introduction. Thank you to Beth Simmons (Colorado) who provided a suggestion for a contest that led to our new "Name that Mineral" activity (1.9). Susie Harlow (California) gave me uses of the mineral Trona for Badge 2 – Earth Resources. Terry McMillin (California) suggested adding Latin and Greek roots in how dinosaurs and other fossils were named. That suggestion, along with websites about dinosaur names and meanings listed by Merrill Dickinson in his September 2015 President's Message for the Eastern Federation, now appear as our new unit 3.8 for the Fossils badge. Larry Knapton (California) provided the matrix recipe for the activity on excavating a fossil as part of Activity 3.2 in Badge 3 – Fossils. Terry McMillin (California) suggested adding a beading unit, which is now included in Badge 4 – Lapidary Arts. Louisa Carey (California) suggested adding something on pearls. I've taken that idea and have created an entirely new activity on gemstones (both inorganic and organic) for our Lapidary Arts badge. Pete Levinthal (Washington) alerted me to a free software program for cataloging mineral collections (Activity 5.2). Tina Lubin (California) recommended adding more on safety in Badge 8 – Field Trips. Mike Havstad (California) suggested a "Recruiter" patch for kids who bring in new members; his idea has been incorporated into Badge 9 – Leadership. Jim Urbaniak (Oregon) provided the link for making 3D paper models of landforms now included with the Earth Processes (Badge 10). Marci Revelli (Washington) suggested adding measuring out distances in the solar system using toilet paper for our Earth in Space Activity 11.1. Jim Roberts (Mississippi) provided great suggestions, as well, on adding to activities for Badge 11 – Earth in Space. David Skrupky (Wisconsin) suggested the metal detecting activity now incorporated into Badge 12 – Gold Panning & Prospecting. Brett Johnson (California) has helped with our listing of websites for our Rocking on the Computer badge (Activity 15.2). Darryl "Diamond Dan" Powell also provided great website suggestions in the Eastern Federation Newsletter of March 2012 that you'll now see in the Rocking on the Computer unit. The Delaware Valley Earth Science Society provided several mineral-related websites that I've included from their "Websites of the Month" feature in their July 2015 newsletter. Dennis Gertenbach (Colorado) suggested adding info on how kids can take digital photos through a Dyno-Lite Digital Microscope for our World in Miniature unit (new Activity 16.8), and he noted how they added "singing rocks" to the Special Effects unit (Activity 17.7). Marci Revelli (Washington) also suggested adding to Special Effects by including effervescence (Activity 17.7). Holly McNeil (Maryland) noted how her club's kids put together a booth at their annual club show to provide the "Amazing Mineral Magic Show" (Activity 17.8) to show attendees throughout the day, so I've added that suggestion at the end of 17.8. Karen Nathan (Florida) shared her hands-on project for creating fluorescent minerals with paints for Badge 18 – Fluorescent Minerals. In all, this new edition is expanded to 255 pages (from 223 in the Third Edition), with 86 pages that are revised or totally new.

To one and all who have taken an active interest in using, improving, and expanding the range of our Badge Program: my sincere gratitude and thanks on behalf of all the kids who stand to benefit. More ideas are welcomed as we now embark on our Fifth Edition!

In Closing…

I hope this program will accomplish two things at the same time:

1) support junior leaders at local Federation-affiliated societies by giving them a variety of proven, organized activities that offer their kids challenging educational and artistic opportunities on an on-going basis, and

2) provide motivation for pebble pups and junior members to work toward earning tangible rewards and recognition and learning satisfying lifelong skills, knowledge, and friendships while—as always—having fun!

Jim Brace-Thompson, AFMS Juniors Program Chair
July 2004, updated February 2008, March 2012, August 2016

HOW TO USE THIS MANUAL

1. How it Works

Welcome to the AFMS Future Rockhounds of America! We wish to help you as the youth leader of your local club by providing the series of guided activities that follow.

We offer a total of 20 badges. To earn a badge, kids must complete at least 3 of the designated activities for that badge. Talk with the kids in your club and involve them in deciding which activities to do. In addition, we encourage you to adapt the level of each activity to best match the ages of the kids in your club. You don't need to follow the activities exactly as laid out; rather, you should feel free to improvise to make any activity as accessible as possible for the kids with whom you're working. It's the concept that matters! As long as you are helping your kids master a general concept, we're not overly concerned about the specific steps or techniques employed along the way.

Sheets are provided where kids can check off the activities as they complete them. Once 3 or more are checked, both the kids and their youth leaders should sign and date the checklist and the youth leader should send it to the AFMS Juniors Program Chair (Jim Brace-Thompson, 7319 Eisenhower Street, Ventura, CA 93003) to receive the badge to award to youth members during club meetings. This information can also be phoned, (805) 659-3577, or emailed (jbraceth@roadrunner.com) to speed processing time.

There is also a master checklist following this introduction that kids can use to keep track of their overall progress. Once they've earned 6 badges, they may receive a Rockhound badge, signifying a graduation from "pebble pup" to official "rockhound." Juniors earning all 20 badges receive an AFMS cloisonné pin and graduate to "Rock Star" status. We suggest awarding these in a special ceremony at your club, perhaps at the end of the year when you hold your installation of new officers and/or at mid-year, perhaps during a club picnic or at a club show. It is up to the local juniors leader to keep track and notify Jim when a junior member has achieved either Rockhound or Rock Star status.

2. The Structure of This Manual

In the pages that follow the master checklist, for each badge you'll find:

a) a brief introduction/overview followed by a list of activities and their basic requirements (we encourage you to copy and distribute this to your kids);

b) an activity checklist for signature by kids and leaders to send to the AFMS Juniors Program Chair to receive badges (again, you ought to copy and distribute this to your kids); and

c) back-up resources for youth leaders (some is background material for your own information; some is to share with your kids to help them with their projects).

Achievement Checklist

To keep track of your achievements, put a checkmark in the boxes next to each activity. To earn a badge, you should complete at least 3 activities for each category and then have your leader send a signed notice to the AFMS Juniors Activities Chair. You become a "Rockhound" after earning 6 badges and a "Rock Star" if earning all 20!

1. Rocks & Minerals **Date badge earned:____________**

□ 1.1 Learning the characteristics of minerals.
□ 1.2 Making and using a mineral ID kit.
□ 1.3 Building a mineral collection.
□ 1.4 The three rock types.
□ 1.5 Crystal shapes.
□ 1.6 Growing crystals and making geodes.
□ 1.7 State rocks, minerals, and gemstones.
□ 1.8 The elements.
□ 1.9 Name that mineral!

2. Earth Resources **Date badge earned:____________**

□ 2.1 Everyday uses of rocks and minerals.
□ 2.2 Minerals in the home.
□ 2.3 Collecting everyday objects and the minerals that went into them.
□ 2.4 Field trip to a mine or quarry.
□ 2.5 Field trip to a hardware store.
□ 2.6 Careers in the earth sciences.

3. Fossils **Date badge earned:____________**

□ 3.1 The geological time chart.
□ 3.2 Types of fossilization and making or excavating fossils.
□ 3.3 The forms of life.
□ 3.4 Collecting fossils.
□ 3.5 A fossil-collecting field trip.
□ 3.6 Your state fossil.
□ 3.7 Dinosaurs.
□ 3.8 Fossil and dinosaur names.

4. Lapidary Arts **Date badge earned:____________**

□ 4.1 Learning about lapidary rocks.
□ 4.2 Choosing a lapidary project.
□ 4.3 *Workshop safety and maintenance* (required to earn this badge).
□ 4.4 *Completing a lapidary project* (required to earn this badge).
□ 4.5 Sharing your lapidary project.
□ 4.6 Gemstone minerals.

5. Collecting **Date badge earned:____________**

□ 5.1 Building a collection.
□ 5.2 Cataloging and labeling your collection.
□ 5.3 Storing a collection.
□ 5.4 Displaying your collection.
□ 5.5 Reporting about your collection.

6. Showmanship **Date badge earned:____________**

□ 6.1 Techniques for effective displays.
□ 6.2 Holding a workshop on display ideas.
□ 6.3 Observing and evaluating displays.
□ 6.4 *Making your own public display* (required to earn this badge).
□ 6.5 Entering competition.

7. Communication **Date badge earned:____________**

□ 7.1 Oral report.
□ 7.2 Written report or newsletter article.
□ 7.3 Bulletin board or poster board displays.
□ 7.4 Corresponding with experts.
□ 7.5 Holding a symposium.
□ 7.6 Writing a field trip guide.

8. Field Trips **Date badge earned:____________**

□ 8.1 *Field trip etiquette, safety, & AFMS Code of Ethics* (required to earn this badge).
□ 8.2 Field trip planning.
□ 8.3 *Taking a field trip* (required to earn this badge).
□ 8.4 Record keeping.
□ 8.5 The indoor field trip.

9. Leadership **Date badge earned:____________**

□ 9.1 Becoming a youth officer.
□ 9.2 Organizing a group display.
□ 9.3 Leading a show-and-tell session or presentation.
□ 9.4 Planning and leading a field trip.
□ 9.5 Overseeing a newsletter column or an entire youth newsletter.
□ 9.6 Managing a youth activity booth at a local gem show.
□ 9.7 Mentoring.
□ 9.8 Recruiting.
□ 9.9 Fundraising.

10. Earth Processes **Date badge earned:____________**

□ 10.1 What is a rock?
□ 10.2 Plate tectonics and the rock cycle.
□ 10.3 Igneous rocks.
□ 10.4 Sedimentary rocks.

□ 10.5 Metamorphic rocks.
□ 10.6 Making 3D models of geologic features related to plate tectonics.
□ 10.7 Earthquakes.

11. Earth in Space **Date badge earned:____________**
□ 11.1 Modeling the solar system.
□ 11.2 Learning about visitors from space.
□ 11.3 Effects of meteorites and famous craters.
□ 11.4 Collecting meteorites and tektites.
□ 11.5 Collecting meteorite dust.
□ 11.6 More fun measuring impact cratering.

12. Gold Panning & Prospecting **Date badge earned:____________**
□ 12.1 Gold as a mineral.
□ 12.2 Uses of gold.
□ 12.3 Gold throughout history.
□ 12.4 Gold resources in your own state or region.
□ 12.5 Field trip to a gold mine.
□ 12.6 Panning for gold.
□ 12.7 Metal detecting for gold, coins, and other artifacts.

13. Gemstone Lore & Legend **Date badge earned:____________**
□ 13.1 Anniversary stones.
□ 13.2 Birthstones and the Zodiac.
□ 13.3 Fabled gemstones.
□ 13.4 Gems in religion.
□ 13.5 Mysticism and minerals.

14. Stone Age Tools & Art **Date badge earned:____________**
□ 14.1 Rocks and minerals used as tools.
□ 14.2 Making stone tools.
□ 14.3 Making stone tools and art from clay.
□ 14.4 Making rock art.
□ 14.5 Recording and interpreting rock art.
□ 14.6 Visiting a museum or Native American cultural center.

15. Rocking on the Computer **Date badge earned:____________**
□ 15.1 *Exploring the web safely and securely* (required to earn this badge).
□ 15.2 Reporting on favorite websites.
□ 15.3 Making presentations with the computer.
□ 15.4 Cataloging your collection electronically.
□ 15.5 Maps and GPS to find your way.
□ 15.6 Joining an online community.

16. The World in Miniature **Date badge earned:____________**
□ 16.1 Collecting, preparing, and storing miniature minerals.

□ 16.2 Collecting, preparing, and storing thumbnail minerals.
□ 16.3 Collecting, preparing, and storing microminerals.
□ 16.4 Collecting, preparing, and storing miniature fossils.
□ 16.5 Collecting, preparing, and storing thumbnail fossils.
□ 16.6 Collecting, preparing, and storing microfossils.
□ 16.7 Collecting and classifying sand.
□ 16.8 Drawing or photographing microminerals, microfossils, or sand.

17. Special Effects **Date badge earned:____________**
□ 17.1 Magnetism.
□ 17.2 Triboluminescence.
□ 17.3 Birefringence, or double refraction.
□ 17.4 Chatoyancy: cat's eye and asterism.
□ 17.5 Natural fiber optics, or "TV stone."
□ 17.6 Phantoms and inclusions.
□ 17.7 Other special effects.
□ 17.8 The amazing mineral magic show!

18. Fluorescent Minerals **Date badge earned:____________**
□ 18.1 *What is "fluorescence" and why do some minerals fluoresce?* (required)
□ 18.2 Famous fluorescent mineral localities.
□ 18.3 Collecting fluorescent minerals.
□ 18.4 Creating a fluorescent display case and exhibiting your collection.
□ 18.5 *Safety with fluorescent lamps.* (required to earn this badge)
□ 18.6 Special effects of some fluorescent minerals.
□ 18.7 Making fluorescent minerals with glow-in-the-dark paints.

19. Reaching Across Generation **Date badge earned:____________**
□ 19.1 *Spending six hours with a senior member* (required to earn this badge).
□ 19.2 Five things you learned from a senior member.
□ 19.3 The best time you spent with your senior member.
□ 19.4 Finding, taking, or drawing a picture of your senior member.
□ 19.5 A specimen that is special to your senior member.
□ 19.6 Making a memory box.

20. Maps **Date badge earned:____________**
□ 20.1 Learning about the different sorts of maps and how to read them.
□ 20.2 Sources of paper maps.
□ 20.3 Making maps.
□ 20.4 Using GPS.
□ 20.5 Maps on the Web.

To earn your Rockhound badge, you need to earn 6 or more of the 20 badges. Check off activities you've completed. When you have earned 6 or more badges, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair to receive your Rockhound badge.

Similarly, once you've earned all 20 badges, you should forward the completed sheets to receive an AFMS cloisonné pin as a "Rock Star."

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Youth Leader's address for receiving the Rockhound badge or Rock Star pin:

____

____

____

Future Rockhounds of America Membership Badge

All kids belonging to clubs affiliated with Future Rockhounds of America automatically receive the FRA Membership Badge. The youth leader of the local FRA-affiliated club should contact the Juniors Program Chair of the AFMS to receive these badges. Because our budget is modest and we hope to maintain this program cost-free to local clubs and individual kids, our annual supplies are limited. Thus, we ask that local youth leaders help us keep this program free by being judicious and only requesting necessary minimum quantities on an as-needed basis for the kids actually signed up in your club.

1. Rocks and Minerals

To earn this badge, you should demonstrate how to identify many of the most common minerals and learn the basic rock types. Other activities you might choose involve learning about crystals and growing crystals and your State Rock, State Mineral, or State Gemstone. This unit also helps you start building, curating, and maintaining your own rock and mineral collection.

Activity 1.1: Learning the characteristics of minerals.
Buy a book or pick one up at the library or turn to websites to learn all about minerals. Make a chart of common minerals and their characteristics in terms of things such as color, streak, cleavage, fracture, luster, hardness, crystal shape, and weight (or specific gravity). In your chart, list various common minerals down the first column, then have separate columns to note characteristics of each mineral.

Activity 1.2: Making and using a mineral ID kit.
Make a mineral ID kit that will allow you to demonstrate familiarity with characteristics of minerals such as color, streak, hardness, relative weight, reaction to a weak acid solution such as vinegar, etc. Using your mineral ID kit, along with a chart of mineral characteristics, successfully identify at least a half dozen minerals presented by your youth leader.

Activity 1.3: Building a mineral collection.
Build a collection of 10 to 20 minerals. Some collectors focus on a single mineral with specimens from around the world to show different forms. A quartz collection might include amethyst from Brazil, clear crystals from Arkansas, smoky quartz from Pikes Peak, cairngorm from Scotland, and rose quartz from South Dakota, California, or Switzerland. Other collectors concentrate on a local area and collect all the minerals that might be found in one quarry, city, county, or state. Still others focus only on self-collected minerals. Most of us opt for variety and collect a little bit of everything. Whichever form you choose for your collection, be sure to follow the basics of good curation: label each specimen and keep a catalog with key information about what it is and where it came from. (See Badge 5: Collecting.)

Activity 1.4: The three rock types.
Learn about and describe the three basic rock types (igneous, sedimentary, and metamorphic) and build a collection with samples of each type. (See Badge 10: Earth Processes.)

Activity 1.5: Crystal shapes.
Draw crystal shapes and/or make crystal models with blocks of styrofoam or with styrofoam balls and dowels, with construction paper or cardboard or other materials, or with a 3D printer, which you can sometimes find in a library. Some common crystal shapes are cubic, hexagonal, orthorhombic, monoclinic, triclinic, tetragonal, and trigonal. Construct as many different varieties as you can.

Activity 1.6: Growing crystals and making geodes.
Using a material that dissolves in water like sugar, table salt, borax, or Epsom salts, grow different forms of crystals, create an "eggshell geode," or craft a stalagmite.

Activity 1.7: State rocks, minerals, and gemstones.
Just as each state has its own flag, many have a State Mineral, a State Gemstone, and/or a State Rock. Find out what your state rock, mineral, or gemstone is and write a report about it for your club newsletter or talk about it at one of your club meeting. If your state doesn't have an official mineral or rock, write to your governor and state legislature to nominate one!

Activity 1.8: The elements.
Learn what an element is and about the periodic table of chemical elements and how each element is classified into different groups (transition metals, halogens, etc.). Then pick one of the following activities to complete: 1) pick an element and write about its traits and properties; 2) write about what makes each group of elements different than the others and the properties of the elements in that group; or 3) make a collection of "native element minerals." If you choose to make a collection, be sure to follow the basics of good curation. Label each specimen and keep a catalog with information about what it is and where it came from. Identify on your label what the atomic number and chemical symbol are for each native element mineral in your collection. (See Badge 5: Collecting)

Activity 1.9: Name that mineral!
With your youth leader serving as the moderator, participate with fellow club members in a panel like a TV game show. The moderator will describe characteristics of rocks and minerals and their uses. The participant who can name the most correctly wins! To prepare, review Activity 1.1 on the characteristic of minerals and Activity 2.1 on everyday uses of minerals.

1. Rocks & Minerals

□ 1.1 Learning the characteristics of minerals

□ 1.2 Making and using a mineral ID kit

□ 1.3 Building a mineral collection

□ 1.4 The three rock types

□ 1.5 Crystal shapes

□ 1.6 Growing crystals and making geodes

□ 1.7 State rocks, minerals, and gemstones

□ 1.8 The elements

□ 1.9 Name that mineral!

To earn your Rocks & Minerals badge, you need to complete at least 3 of the 9 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 1.1: Learning the characteristics of minerals.

Definition: A **mineral** is a solid chemical element or compound which:

1) occurs naturally;
2) is inorganic (not a product of biological or life forces);
3) has a definite chemical composition; and
4) has an orderly atomic structure often expressed in a crystal form.

For instance, graphite and diamonds (made of carbon) are considered minerals but coal (also made of carbon) is not because coal is an organic product that formed from fossil remains of plants, or once-living organisms.

Kids should learn to identify several common minerals using simple tests of physical properties such as color, streak, luster, crystal shape, cleavage, fracture, hardness, chemical reactivity, and weight, or specific gravity. To help them, you should direct them to a rock and mineral guidebook and encourage them to buy at least one for their own reference. Many good ones are available to purchase at all levels of pricing or to borrow from a library. Here's just a sampling from the seemingly endless supply:

- Bonewitz, *Smithsonian Rock & Gem* (2005)
- Chesterman, *National Audubon Society Field Guide to North American Rocks & Minerals* (1978)
- Cook, *Minerals & Gemstones: 300 of the Earth's Natural Treasures* (2007)
- Eid & Viard, *Minerals of the World* (1995)
- Farndon, *The Complete Guide to Rocks & Minerals* (2006)
- Farndon & Parker, *The Complete Illustrated Guide to Minerals, Rocks & Fossils of the World* (2012)
- Fuller, *Pockets Rocks & Minerals* (2003)
- Hurlbut, *Dana's Manual of Mineralogy* (1971—or any recent edition or reprint)
- Jackson, *What's that Rock or Mineral? A Beginner's Guide* (2014)
- Korbel & Novák, *The Complete Encyclopedia of Minerals* (1999)
- Lagomarsino, *A Pocket Guide to Rocks & Minerals* (2008)
- Peck, *Mineral Identification: A Practical Guide for the Amateur Mineralogist* (2007)
- Pellant, *The Complete Book of Rocks & Minerals* (1995)
- Pough, *Rocks & Minerals: Peterson Field Guide* (1996)
- Roots, et al., *The Nature Companion's Rocks, Fossil & Dinosaurs* (2002)
- Schuman, *Handbook of Rocks, Minerals, & Gemstones* (1993)
- Simon & Schuster's *Guide to Rocks & Minerals* (1978)
- Zim & Shaffer, *Rocks, Gems, & Minerals: A Golden Guide, Revised* (2001)

The "official" book for use in naming and labeling minerals entered into Federation-sponsored competitions is *Fleischer's Glossary of Mineral Species* (from The Mineralogical Record, www.mineralogicalrecord.com). For one-stop shopping, distributor Gem Guides Book Company (www.gemguidesbooks.com) offers a whole range of books on all topics rock-related, as does the annual Lapidary Catalog of Kingsley North, Inc. (www.kingsleynorth.com).

Farndon's *e.guides Rock and Mineral* (2005) combines the traditional print content of a book with links to websites offering interactive multimedia, games and quizzes, and downloadable images. And since I've now transitioned to websites, any number of them have sprung up to assist with mineral ID. One fun one is "Yup…Rocks," www.yuprocks.com. Another one geared specifically to kids is "Mineralogy4Kids" at www.mineralogy4kids.org/mineral-identification. In addition to providing an interactive way for kids to identify a mineral by going step-by-step through a series of questions, this website also has sections on crystals, the rock cycle, uses of minerals, etc. Another site geared to kids and to interactive learning is "The Learning Zone" from the Oxford University Museum of Natural History: www.oum.ox.ac.uk/thezone/minerals/. Finally, the mineral identification website that has become a standby for rockhounds young and old is the Mineral Database, www.mindat.org. (Guide your kids to these and other websites when working on Badge 15: Rocking on the Computer.)

Here are some basics of mineral identification:

- ***Color*** can be the most striking aspect of a mineral, and some can be identified by color. For instance, malachite is always green, azurite is blue, realgar is red. But color alone is usually not enough. For example, quartz occurs in many colors caused by minute impurities and may be clear, cloudy (milky quartz), yellow-orange (citrine), purple (amethyst), pink (rose quartz), a sparkly green (aventurine), etc.
- ***Streak*** is the color left when a mineral is scratched on an unglazed porcelain tile plate. This can surprise you in that it is sometimes very different from the mineral's outward color. For instance, silvery gray hematite leaves a red streak and golden pyrite a green-black streak.
- ***Luster*** is a reflective property of mineral surfaces. The way a mineral reflects light may make it look hard and shiny or dull or waxy. A mineral may be metallic (pyrite), adamantine (sparkling like a diamond), vitreous or glassy (quartz), silky (gypsum), waxy (jade), resinous, pearly, earthy, greasy, etc.
- ***Crystal shape*** is the characteristic appearance of a crystal, usually determined by the underlying atomic structure. Crystal shape may be cubic (pyrite or galena), octahedral (fluorite), rhombohedral (calcite), hexagonal (quartz), etc. For more on crystal shapes, see Back-up page 1.5: Crystal Shapes.
- ***Cleavage*** is the tendency of some minerals to split or break along characteristic planes corresponding to directions of minimum cohesion. For instance, mica cleaves in thin sheets, a form known as basal cleavage. Other common forms of cleavage include rhombohedral (calcite), cubic (galena), and octahedral (fluorite).
- ***Fracture*** is the manner in which a rock or mineral breaks if it doesn't exhibit cleavage. For instance, a break may be conchoidal (curved like a clam shell, as in breaks on obsidian), uneven (with a rough surface, e.g., lepidolite), or fibrous (splintery, e.g., ulexite).

- ***Hardness*** is the resistance of a mineral to scratching. The Mohs' scale is a relative measure of this property, comparing the hardness of ten different minerals from softest to hardest: 1 – talc, 2 – gypsum, 3 – calcite, 4 – fluorite, 5 – apatite, 6 – feldspar, 7 – quartz, 8 – topaz, 9 – corundum, 10 – diamond. To arrive at approximate hardness, you can use some common tools: a fingernail is hardness 2.5, a penny is 3, a pocketknife blade or steel nail is 5, glass is 5.5, a steel file is 6.5.
- ***Chemical reactivity*.** Some minerals will chemically react. For instance, a good test for carbonates (calcite, limestone, dolomite, etc.) is a drop of acetic acid, or vinegar. If it fizzes, it contains calcium.
- ***Weight, or Specific Gravity*.** To determine the weight, or specific gravity, of a mineral requires special equipment. Specific gravity (SG) is technically defined as the density of a mineral compared to the density of water. The light mineral borax has SG 1.7, whereas the heavy mineral gold has SG 19.3. For most purposes, kids can just judge the relative weight, or heft, of a mineral, whether heavy, light, or in-between.

Darryl Powell (aka "Diamond Dan") has prepared a wonderful variety of mineral identification resources you may wish to purchase to use with your club's kids in learning about minerals. These include *The World of Minerals & Crystals* (a coloring book introducing minerals from A to Z, with commentary on physical properties, forms, and uses in everyday life) and *Earth Digger Clubs* (a series of mineral-identification exercises in kits of one-hour activities, complete with patches as rewards for kids who complete an activity; kids learn about individual minerals such as calcite, pyrite, quartz, gypsum, or fluorite, as well as about properties of minerals such as hardness, color, crystal formation, etc.). These resources may be purchased from Diamond Dan Publications, c/o Darryl Powell, phone 585-278-3047, email diamonddan@rochester.rr.com, web address www.diamonddanpublications.net.

Another helpful partner in educating kids about the earth sciences is Myrna Martin, who began a home-based business called Ring of Fire Science Company LLC in Oregon (www.RingofFireScience.com). Inspired by the eruption of Mount Saint Helens 90 miles from her home, she crafted a set of lesson plans on volcanoes that grew into a whole "Hands-on Science" series. These include *Minerals: Hands-on Science,* which is beautifully designed and illustrated with easy-to-follow instructions for each activity along with "Teacher's Notes" that fill you in on lesson objectives, how the activity fulfills National Science Education Standards, and vocabulary with definitions.

For those who like to play games that also educate, check around for the Smithsonian Institution's *What Do You Know About Rocks, Minerals, and Gems? Quiz Deck.* It's a deck of cards, each with a colorful photograph and question on one side and answers on the back. It's published by Pomegranate Communications, Inc., www.pomegranate.com.

The following table provides you with a "cheat-sheet" of a wide variety of minerals and their various characteristics. In addition, we've provided a blank table you can copy and give to kids to fill in with different minerals they wish to test.

Back-up page 1.1: Table for Mineral Identification

MINERAL	COLOR	STREAK	CLEAVAGE	FRACTURE	LUSTER	HARDNESS	SHAPE	WEIGHT
Apatite	Brown, yellow, green	White	Basal, imperfect	Conchoidal	Vitreous, greasy	5	Hexagonal	3.1-3.3
Azurite	Blue	Light blue	Perfect	Conchoidal	Earthy/dull	3.5-4	Monoclinic	3.8
Barite	Light blue, brown, yellow	White	Basal, perfect	Uneven	Glassy/pearly	3-3.5	Orthorhombic	4.4
Beryl	Clear, green, blue, golden	White or colorless	Basal, poor	Conchoidal	Glassy	7-8	Trigonal / hexagonal	2.6-2.9
Borax	Clear, white	White	Perfect	Conchoidal	Vitreous, dull, resinous	2-2.5	Monoclinic	1.7
Bornite	Bronze	Gray-black	None	Uneven	Metallic	3	Isometric (rare)	5
Calcite	Clear, white, yellow, blue	White	Rhombohedral perfect	Conchoidal	Glassy	3	Trigonal / hexagonal	2.7
Chrysocolla	Sky blue, green	White	None	Conchoidal	Glassy or waxy	2-4	Monoclinic	2-2.3
Cinnabar	Red, red-brown	Red-brown	Perfect in 3 directions	Uneven	Earthy	2-2.5	Hexagonal	8-8.2
Copper	Copper	Shiny brown	None	Hackly	Metallic	2.5-3	Isometric / Cubic	8.9
Corundum	Red (ruby), Blue , etc.	White	None; basal parting	Conchoidal	Glassy	9	Trigonal / hexagonal	4
Diamond	Clear & many colors	White	Perfect, 4 directions	Conchoidal	Adamantine to greasy	10	Isometric / cubic	3.5
Dolomite	White, gray, pink	White	Rhombohedral	Conchoidal & uneven	Vitreous	3.5-4	Hexagonal	2.8-2.9
Feldspar	White, yellow, pink, gray	White	2 perfect cleavages	Uneven	Glassy or pearly	6-6.5	Mono- or triclinic	2.5-2.7

Back-up page 1.1: Table for Mineral Identification (cont.)

MINERAL	COLOR	STREAK	CLEAVAGE	FRACTURE	LUSTER	HARDNESS	SHAPE	WEIGHT
Fluorite	Clear, yellow, green, blue	White	Octahedral, perfect	Uneven, subconchoidal	Glassy	4	Cubic or isometric	3.1
Galena	Silver-gray	Gray	Cubic, perfect	Conchoidal	Metallic	2.5	Cubic	7.4-7.6
Garnet	Red, green, black, brown	White	None	Conchoidal	Glassy	6.5-7.5	Isometric	3.5-4.3
Gold	Golden	Yellow-golden	None	Hackly	Metallic	2.5-3	Isometric / cubic	15.6-19.3
Graphite	Black, dark gray	Gray-black	Basal, perfect	Fibrous	Shiny, metallic	1-2	Trigonal / hexagonal	1.9-2.3
Gypsum	White, yellow, brown, clear	White	Perfect	Conchoidal or splintery	Pearly, glassy	2	Monoclinic	2.3
Halite	White, pink, blue, clear	White	Cubic, perfect	Conchoidal	Glassy	2-2.5	Isometric / cubic	2.1-2.2
Hematite	Black, steel-gray	Red-brown	None	Uneven	Metallic	5.5-6.5	Trigonal / hexagonal	4.9-5.3
Jade	Green, white, black, purple	White	None	Uneven, difficult	Waxy or pearly	6.5-7	Monoclinic	3.2-3.5
Kyanite	Blue to white	White	Good, two directions	Splintery	Vitreous	5.5-7	Triclinic	3.5-3.7
Magnetite	Black	Black	None	Semi-conchoidal	Metallic	5.5-6.5	Isometric / cubic	4.9-5.2
Malachite	Green	Light green	Perfect, one direction	Conchoidal or splintery	Silky, dull	3-4	Monoclinic (rare)	3.9-4
Mica	Black-brown, clear	Gray-brown or white	Basal, perfect	Uneven	Pearly	2.2-3	Monoclinic	2.8
Olivine	Green-yellow, brown	White	Indistinct	Conchoidal	Glassy, vitreous	6.5-7	Orthorhombic	3.3-4.3

Back-up page 1.1: Table for Mineral Identification (cont.)

MINERAL	COLOR	STREAK	CLEAVAGE	FRACTURE	LUSTER	HARDNESS	SHAPE	WEIGHT
Opal	White, varicolored	White	None	Conchoidal	Glassy, pearly	5.5-6.5	None	2
Pyrite	Brassy yellow	Greenish-black	Cubic & octahedral	Uneven	Metallic	6-6.5	Cubic / isometric	4.9-5.2
Quartz	Clear, pink, black, purple	White	None	Conchoidal	Glassy, vitreous	7	Trigonal / hexagonal	2.65
Serpentine	Green, black	White	Basal, perfect, or fibrous	Uneven or splintery	Waxy, silky	3-5	None	2.3-2.6
Silver	Silver, black	White, silvery	None	Hackly	Metallic	2.5-3	Isometric (rare)	10.1-11.1
Smithsonite	Green, brown, yellow	White	Perfect, rhombohedral	Uneven	Vitreous	4-4.5	Trigonal (rare)	4.3-4.5
Sodalite	Azure-blue	White	6 directions, poor	Uneven to conchoidal	Vitreous	5.5-6	Cubic (rare)	2.3
Sphalerite	Yellow, red, brown, black	White/yellow or pale brown	Dodecahedral	Conchoidal	Submetallic, greasy	3.5-4	Cubic / isometric	3.9-4.1
Sulfur	Yellow	Yellow	None	Conchoidal	Waxy, resinous	1-2.5	Orthorhombic	2-2.1
Talc	White, green, yellow, pink	White	Perfect, one direction	Uneven	Earthy, dull or greasy	1	Monoclinic (rare)	2.7-2.8
Topaz	Yellow, brown, pink, green	White	Basal	Uneven, subconchoidal	Vitreous	8	Orhorhombic	3.4-3.6
Tourmaline	Black, red, green, golden	White	None	Conchoidal	Glassy, vitreous	7-7.5	Hexagonal	3-3.3
Turquoise	Light blue, blue-green	Pale blue-green or white	None	Uneven or conchoidal	Waxy, earthy, or dull	5-6	Triclinic	2.6-2.8
Wulfenite	Orange-yellow, brown	White	Pyramidal	Subconchoidal	Resinous, adamantine	3	Tetragonal	6.5-7

Back-up page 1.1: Sample Table to Use for Mineral Identification (**Note:** not important that every box be filled for every mineral.)

MINERAL	COLOR	STREAK	CLEAVAGE	FRACTURE	LUSTER	HARDNESS	SHAPE	WEIGHT

Back-up page 1.2: Making and using a mineral ID kit

Following is the Moh's Scale and examples of some common tools kids can use to help judge the relative hardness of different minerals by creating their own mineral ID kit:

Moh's Hardness	Mineral	Common Tools
1	Talc	easily scratched by a fingernail
2	Gypsum	fingernail (hardness 2.5)
3	Calcite	copper penny (3 to 3.5)
4	Fluorite	easily scratched by a knife
5	Apatite	knife blade/steel nail/steel washer (5)
6	Feldspar	glass/a glass marble (5.5); steel file (6.5)
7	Quartz	easily scratches glass
8	Topaz	easily scratches glass
9	Corundum	easily scratches glass
10	Diamond	scratches all other materials

In addition to the tools noted in the above table, a mineral ID kit might include an unglazed porcelain tile for checking the streak of a mineral and a small bottle of acetic acid (vinegar) to test whether a mineral contains calcium carbonate.

See the table accompanying Back-up page 1.1 for info about various characteristics for a number of common minerals. A similar blank table is provided for you to copy and give to kids to use to complete a mineral identification exercise, or you can encourage them to create their own table listing just the characteristics they wish to test.

A good selection of minerals to present to juniors to demonstrate ability to identify minerals might include sulfur, pyrite, fluorite, quartz, hematite, galena, mica, and calcite. There are a number of ways of testing a kid's ability to identify minerals. The most basic is to provide kids individually with an assortment of minerals and to ask them to apply various tests. You might also create a bag of sand and gravel. "Salt" it with some of the minerals noted above and ask kids to screen out various minerals to identify. To make it challenging, include two specimens that look similar (for instance, a clear piece of quartz and a clear piece of topaz).

An even more fun activity is the "Mineral Identification Game." At a club meeting, have an assortment of a dozen to two dozen minerals spread out on a table, each with a number. Give kids sheets of papers with numbers down the side and ask them to go around the table identifying and writing down the names of each mineral matched to the appropriate number. Give them perhaps 15 minutes to do this before discussing the answers. This could be done individually, or kids could be divided into teams and this could be made into a contest to see which team gets the most correct answers.

In another version of the Mineral Identification Game, different mineral specimens might be put on a table along with mineral identification books. The first kid to identify a particular "mystery mineral" correctly gets to keep it. This is a definite motivator! Anyone winning a mineral steps out of the contest so that one child doesn't end up walking away with all the specimens.

Back-up page 1.3: Building a mineral collection.

Back-up pages for Badge 5 on Collecting provide information on building a collection. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 1.3. For instance, there you'll find information about how to organize a catalog or logbook for an entire collection, how to create labels for individual specimens within a collection, and how to store a collection.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 1.4: The three rock types.

In this activity, kids would be expected to

a) explain the differences among the three basic rock types of igneous, sedimentary, and metamorphic and how these different rock types typically form;

b) identify specific examples of each rock type; and

c) build a small collection of representative samples.

The three basic rock types are:

- ***Igneous.*** Igneous rocks are formed by crystallization of magmas, either deep within the earth (intrusive igneous rocks: granite, gabbro, diorite, granodiorite) or extruded onto the surface (basalt, andesite, dacite, rhyolite, obsidian, pumice, scoria, ash).

- ***Sedimentary.*** Sedimentary rocks are formed by clastic sediments such as gravel, sand, or mud created by the eroding actions of wind, water or ice breaking down older rocks (examples: conglomerate, breccia, sandstone, siltstone, mudstone, shale) or chemically by minerals precipitating out of water (limestone, dolomite, evaporates such as gypsum, anhydrite, or halite). They might also be biologic in origins (coal, diatomaceous earth, chert).

- ***Metamorphic.*** Metamorphic rocks have been changed by heat and/or pressure and other earth forces and are classified as foliated (slate—formed from shale; schist—formed from shale that's been more intensely altered; gneiss—formed from granite) or non-foliated (quartzite—formed from sandstone; marble—formed from limestone).

Abdo Publishing provides three little books from their Core Library Rocks and Minerals series geared to kids in grades 3-5: Lisa Owings' *Igneous Rocks* (2015), Rebecca E. Hirsch's *Sedimentary Rocks* (2015), and Jennifer Swanson's *Metamorphic Rocks* (2015). The series includes still more books on crystals, fossils, gems, and the rock cycle. Each book includes glossaries, "Learn More" references to other books and websites, and links to more info on the publisher's website. It's a great basic series for both kids and adults!

For this activity, you might provide kids with the following fill-in-the-blank page to use.

Note: *Kids can use this activity toward satisfying requirements for the Earth Processes badge simultaneously (Activities 10.1, 10.3, 10.4, and 10.5)*

.

The Three Rock Types & My Collection

Igneous rocks are defined as_______________________________________

____

____

My collection includes the following igneous rocks:_______________________

____

____

Sedimentary rocks are defined as___________________________________

____

____

My collection includes the following sedimentary rocks:____________________

____

____

Metamorphic rocks are defined as___________________________________

____

____

My collection includes the following metamorphic rocks:___________________

____

____

Back-up page 1.5: Crystal shapes.

Crystals come in wonderful and amazing shapes that are based upon their underlying chemical structure. Some common forms are cubic, tretragonal, monoclinic, triclinic, hexagonal, trigonal, and orthorhombic. The shape of a crystal is an important trait that can help you identify a mineral, so you should familiarize kids with these basic crystal forms. Here are brief descriptions of each:

- Cubic: very symmetric and orderly, shaped like a square cube, with 6 faces, or sides (note, however, that some are shaped like octahedrons—or diamond-shaped—with 8 faces, and still others are shaped like dodecahedrons, with 10 faces)

- Tetragonal: shaped like cubic crystals that have been stretched out along one axis.

- Monoclinic: these are shaped like tetragonal crystals that have been skewed or tilted in one angle.

- Triclinic: triclinic crystals are similar to monoclinic ones but aren't usually symmetrical from one side to the other; they can look like monoclinic crystals that someone stepped on and squished!

- Hexagonal: these crystals look like six-sided prisms; viewed from the top, they look like hexagons.

- Trigonal: similar to hexagonal, but possessing a 3-fold axis of rotation instead of the 6-fold axis of hexagonal crystals.

- Orthorhombic: these crystals look like two elongated pyramids stuck together, but they're skewed at a bit of an angle.

Because it can be difficult to visualize these systems using words alone, you should get a book illustrating different crystal forms and bring in pictures and samples of minerals that illustrate each (for instance, a cubic pyrite or fluorite crystal; a hexagonal quartz crystal).

A couple of activities provide kids with hands-on fun in learning about these shapes. In one, build crystal shapes using tinker toys or dowels and Styrofoam balls or gum drops and toothpicks. (Kids especially like the last option because they get to eat the results!)

Another way to illustrate crystal shapes in hands-on fashion is through making models by folding colorful construction paper, cardstock, or thin cardboard and pasting or taping them together. Darryl Powell (aka "Diamond Dan") has prepared a couple of great resources you may wish to purchase to use with your club's kids. These include *Corundum Carl's Great Crystal Adventure* (introduces crystallography and includes 13 crystal models that can be cut out and folded into 3-dimensional crystal shapes, along with a recipe for growing crystals) and *Crystal Clips V* (a CD-ROM holding over 900 mineral and crystal drawings in both color and black-and-white in TIFF and JPEG formats). These resources may be purchased from Diamond Dan Publications, c/o Darryl Powell, phone 585-278-3047, email diamonddan@rochester.rr.com, web address www.diamonddanpublications.net.

The following website from the California Department of Conservation has links to a number of really neat masters you can download and print for free to then copy on paper or cardstock for kids to craft cut-and-fold 3D models of different crystal shapes: http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx.

Finally, another nice resource is Rebecca Hirsch's book *Crystals* (2015), a part of a whole series from Abdo Publishing called the Core Library Rocks and Minerals series geared to kids in grades 3-5.

Back-up page 1.6: Growing crystals and making geodes.

Growing Crystals.

Some minerals grow into crystals in water solutions. This process can be observed using readily available materials, such as sugar, salt, alum, and Epsom salts dissolved into a **saturated solution** in boiling hot water. A saturated solution contains the maximum amount of salt that will dissolve in a given amount of hot water.

Materials.

- Crystal-building material: sugar, table salt, Epsom salts (from a pharmacy), or powder alum (from the grocery store spice section). Other materials you might use include borax, photographic fixer, or saltpeter. Copper sulfate (from pool supply or hardware stores) is used to create blue chalcanthite crystals. With young kids, though, it's probably best to stick with basics, such as table salt or sugar.
- Water
- Measuring cups
- Spoon
- Cooking pan
- Glass jars
- Pebbles
- Stick or pencil
- String (cotton twine), cut into small lengths, with a paperclip tied to one end
- (optional) food coloring

Procedure.

1. Heat water to a boil, then turn off the heat.
2. If using table salt, mix one-half cup of salt into three-quarters cup of hot water. If using Epsom salts, mix one-half cup Epsom salts into one cup of water. If using alum, mix one-quarter cup alum into one cup of water.
3. Stir your solution. If all of your mineral dissolves, the solution is not yet saturated, and you should add a bit more mineral until no more will dissolve. (Note: you can make colorful crystals by adding a couple drops of food coloring.)
4. Place a few pebbles in the bottom of a glass jar and pour your solution over the pebbles. Or, tie string to a stick or pencil, pour your solution into a glass jar, and dip the string into the solution with a paperclip to weigh the string down, and leave it hanging there from the pencil.
5. Set your jar aside in a spot where it won't be disturbed and don't bump or bounce it. Check every so often the next few days. As water evaporates, you'll see crystals forming on your pebbles or string.

Assign different salts to different kids, and at your next monthly meeting, have everyone bring their jars to compare the different forms of crystals each produced.

In addition to home-made crystals, you can grow crystals using commercial crystal-growing kits. Check places like Ward's Natural Science (order their Earth Science and Geology catalogs; phone 1-800-962-2660 or check their web site at www.wardsci.com). Another source is Edmund's Scientific (1-800-728-6999; www.scientificsonline.com). Or check in toy stores, nature stores, or stores specializing in teacher supplies.

Making Geodes.

Geodes are round or elliptical rocks with an outer shell and a hollow interior lined with crystals, often quartz or calcite. With this fun crystal-growing activity, kids can make their own geodes using eggshells or walnut shells.

If using eggshells, carefully crack eggs and pick out the best halves, choosing ones that don't have any long cracks in them. Carefully peel away the "skin" on the insides of the shells with tweezers or by rubbing with your fingers. If using walnut shells, crack a number of walnuts in half, clean out the meat, and choose shells lacking any long cracks.

Next, set your eggshell or walnut shell halves in egg cartons, where they'll be stable and secure. Using the same recipes described earlier for growing crystals, prepare a crystal-growing solution and pour or spoon a little into each egg- or walnut shell. Set the egg carton aside in a warm, dry spot where it won't be disturbed for the next week or more as the water evaporates, leaving you with sparkling geode halves.

The Women in Mining (WIM) Educational Foundation also provides a neat geode activity wherein you split a coconut, clean out the meat, drill a hole in one half, and lacquer the outside of both halves. Once all has dried, glue the two halves back together with silicone and pour a crystal-growing solution into the hole. A week or two later, pour out any remaining solution and cut open the coconut along the seam to reveal a sparkling interior.

Growing Stalactites, Stalagmites, and Towers.

Stalactites, stalagmites, and towers grow in caves by the steady drip-drip of mineral-laden groundwater oozing from a cave ceiling. Usually that water is laden with calcium carbonate (calcite and limestone). With this activity, kids can grow their own stalactites, stalagmites, and towers with a powder you can find with the detergents and washing supplies at your local grocery store.

<u>Materials</u>.

- 10 tablespoons of borax (washing soda)
- 24 ounces of hot water
- Measuring spoon and cup
- Stirring spoon or stick
- Cookie sheet

- 2 pint-size glass jars + 1 jar lid
- Strip of old towel (1X18 inches)

Procedure.

1. Place a cookie sheet in an area where it will be undisturbed for several days or even a couple weeks.
2. Place 2 jars on the cookie sheet next to each other and separated by the jar lid.
3. Measure out and fill each jar with 12 ounces of hot water and 5 tablespoons of borax then stir until the borax is fully dissolved in each jar.
4. Place one end of the towel in each jar with a dip in the center between the jars.
5. Exercise patience! Now it's time to let nature take its course, so sit back and observe.

The borax/water solution will travel along the towel. At the dip you created in the center, the solution will build up then drip down into the jar lid and the water will evaporate, leaving behind the borax that was held in solution. Drop-by-drop, it should create a stalactite hanging from the towel and a stalagmite growing up from the jar lid. If let go long enough, the stalactite and stalagmite eventually will meet and grow together to create a tower. All three features are common in limestone caves.

By the way, for those like me who always get confused as to which is which, here's an easy mnemonic for remembering the distinction between a stalactite and a stalagmite. The word "stalactite" has a "c" in the middle. Let that stand for "ceiling." A stalactite grows down from the ceiling of a cave. The word "stalagmite" has a "g" in the middle. Let that stand for "ground." A stalagmite grows up from the ground of the cave. (Now if someone would only come up with a mnemonic for helping me remember how to spell "mnemonic"!)

Popcorn or Bubble Rock.

For about five bucks, you can purchase what's packaged and sold as "Popcorn Rock" or "Bubble Rock." Both are billed as "the rock that grows." Basically, these are small chunks of gray limestone from Utah. As you soak them for 1 to 3 weeks in a bowl of distilled white vinegar, you'll see white popcorn-like "rock bubbles" grow as the vinegar evaporates and aragonite crystals form atop the rocks.

Note: *Kids can use this activity toward satisfying requirement for the Earth Processes badge simultaneously (Activity 10.4.a. – A).*

Back-up page 1.7: State rocks, minerals, and gemstones.

The following table lists the officially designated rock, mineral, and/or gemstone for each state in the U.S. Have your kids to learn why their particular rock, mineral, or gemstone was selected. Some were selected because the rock or mineral was especially important to the economy of the state. For instance, limestone is the state rock of Indiana because of the contribution of limestone quarries to the state's economy. Indiana limestone helped to rebuild Chicago after its big fire in the nineteenth century and has been used in such historic buildings as the Washington Monument and the Empire State Building. Other state emblems were selected because they are unique to that particular state. For instance, benitoite was chosen as the state gemstone of California because it's only found in California. Kids can check with the state geological survey to learn the details behind their state rock, mineral, and/or gemstone, or they might try to unearth the original legislation that designated the official rock.

If you don't see a rock, mineral, or gemstone for your state, encourage your pebble pups and junior members to organize a letter-writing campaign to your state governor and legislature to nominate one! In organizing such a campaign, they should tell why the rock, mineral, or gemstone has special significance for the state. They might also write to rock clubs across the state to encourage others to join in their effort.

State	Rock	Mineral	Gemstone
Alabama	Marble	Hematite	Star Blue Quartz
Alaska		Gold	Jade
Arizona	Petrified Wood	Fire Agate	Turquoise
Arkansas	Bauxite	Quartz	Diamond
California	Serpentine	Gold	Benitoite
Colorado	Yule Marble	Rhodochrosite	Aquamarine
Connecticut		Garnet	
Delaware		Sillimanite	
Florida	Agatized Coral		Moonstone
Georgia	Quartz	Staurolite	Amethyst
Hawaii			Black Coral
Idaho			Star Garnet
Illinois		Fluorite	
Indiana	Limestone		
Iowa	Geode		
Kansas			
Kentucky	Kentucky Agate	Coal	Freshwater Pearl
Louisiana	Petrified Palmwood	Agate	
Maine		Tourmaline	
Maryland			Patuxent River Stone
Massachusetts	Roxbury Pudding Stone (Jasper)	Babingtonite	Rhodonite

State	Rock	Mineral	Gemstone
Michigan	Petoskey Stone		Chlorastrolite
Minnesota		Iron	Lake Superior Agate
Mississippi	Petrified Wood		
Missouri	Mozarkite (Chert)	Galena	
Montana		Agate	Sapphire
Nebraska	Prairie Agate		Blue Chalcedony
Nevada	Sandstone	Silver	Black Fire Opal & Turquoise
New Hampshire	Conway Granite	Beryl	Smoky Quartz
New Jersey	Unofficially, brownstone, known as Stockton Sandstone.	As of 2016, Franklinite & Prehnite are being debated.	
New Mexico			Turquoise
New York		Hematite	Garnet
North Carolina	Granite		Emerald
North Dakota			
Ohio			Flint
Oklahoma	Barite Rose		
Oregon	Thunder Egg	Oregonite & Josephinite	Sunstone
Pennsylvania			
Rhode Island	Cumberlandite	Bowenite	
South Carolina	Blue Granite		Amethyst
South Dakota		Rose Quartz	Fairburn Agate
Tennessee	Limestone	Agate	River Pearl
Texas	Petrified Palmwood		Blue Topaz
Utah	Coal	Copper	Topaz
Vermont	Marble, Slate, Granite	Talc	Grossular Garnet
Virginia			
Washington			Petrified Wood
West Virginia			Chalcedony Coral
Wisconsin	Wausau Red Granite	Galena	Ruby
Wyoming			Nephrite Jade

Note: *Kids who write a paper or give an oral report for this activity can also use it to satisfy requirements toward earning the Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 1.8: The elements.

Chemists have identified 118 elements. They have been called "the universe's building blocks" in that, individually or combined, they form all matter (except for so-called "dark matter"). Use this activity to help kids learn about the periodic table and how each element is classified into different groups (transition metals, halogens, noble gases, etc.). Then encourage them to write about what makes each group different than the others and the properties of the elements in that group. Or, after studying the elements, have kids pick one of their favorites and write about its unique traits and properties.

Two great reference books in large, colorful formats are:

- Theodore Gray, *The Elements: A Visual Exploration of Every Known Atom in the Universe,* 2009.
- Image Publishing, *How It Works Book of the Elements,* 2015.

It's fairly unusual to find a mineral consisting purely of a single element. More often, an element is combined with others into a compound. For instance, iron (Fe) can be found on its own but is more often found in iron oxide minerals like hematite (Fe_2O_3) or magnetite (Fe_3O_4). Lead (Pb) also can be found on its own but is more often found as galena (lead sulfide, PbS). However, some elements do occur in relative abundance in nature in uncombined forms with distinct mineral structures. They are called "native element minerals." Encourage your kids to build a collection of some of the more common and readily available ones, such as copper, sulfur, and carbon (as graphite). You also see iridescent hopper crystals of bismuth sold at gem and mineral shows, but these are lab-grown. We don't encourage kids to try collecting all 30 native element minerals given that some are toxic (for instance, arsenic, lead, mercury). Following are some common native element minerals that would make for an interesting collection:

Element	**Symbol**	**Atomic Number**	**Atomic Weight**
Bismuth (usually as lab-grown crystals)	Bi	83	208.98038
Carbon (as Graphite or Diamond)	C	6	12.0107
Copper	Cu	29	63.546
Gold	Au	79	196.96655
Silver	Ag	47	107.8682
Sulfur	S	16	32.065

Another fun activity might be to work with kids to draw up a list of 10-20 elements and everyday objects that contain them; for instance, an incandescent tungsten lightbulb, neon signs, nickel-cadmium rechargeable batteries, car bumpers decked out with chrome, copper pipes or electrical wire. The two books noted above are filled with examples.

Note: *Kids who build a collection of native element minerals can use this activity to satisfy requirements toward earning the Collecting badge (Activity 5.1). Those who write a paper for this activity can also use it to satisfy requirements toward earning the Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 1.9: Name that mineral!

Here's your chance to be a TV game show host! Review back-up pages for Activities 1.1 and 2.1 and prepare questions to test your kids' knowledge of mineral characteristics and uses. Then, as in a game show, stand behind a podium with your questions (and their answers) on large cards. Have participating kids lined up and seated behind a table with name cards in front of each or with name tags on their shirts. Then let the contest begin!

Award five points for each correct answer. You might award partial points if kids come up with an answer than is justifiably close but not exactly what you were looking for. (For instance, if the hints are that the mineral is blue with a light blue streak and soft hardness of 3.5-4.0 Mohs and the answer is "azurite," but someone answers "aquamarine", you might award partial points. Aquamarine is a blue form of beryl, but it leaves a colorless or white streak and is much harder at 7-8 Mohs. Still, it is blue!)

Have a really nice mineral specimen as a prize for the winner with the most points. You might also have second and third place prizes, ribbons, a little trophy, cash, or whatever prizes your society decides is best. The main thing is to have fun! You might do this as a program at one of your monthly meetings. (Adults are not allowed to shout out hints!)

Here are some examples of questions you might ask:

- **Question:** This mineral has a distinctive blue color. In fact, its name even means "blue." It leaves a light blue streak and is fairly soft on the Mohs scale at 3.5-4. *Name that mineral!* **Answer:** azurite.

- **Question:** This is the hardest of all minerals. In fact, it's 10 on the Mohs scale. Many married women wear it on a finger. *Name that mineral!* **Answer:** diamond.

- **Question:** This mineral has one name if it's red but a different name if it's blue or other colors. It's very hard; in fact, it's the mineral for 9 on the Mohs scale. It's a precious gemstone and is faceted for jewelry. Cabbed forms can exhibit asterism, or a star effect. *Name that mineral!* **Answer:** corundum (ruby and sapphire).

- **Question:** This mineral has a shiny pinkish-red or orange-brown color with metallic luster. It is soft and malleable. You might find it in your home's plumbing or in your electrical wiring. *Name that mineral!* **Answer:** copper.

- **Question:** This mineral forms very soft crystals that are clear or white and that leave a white streak. You may find it in your laundry detergent. Large quantities of it are mined in Boron, California. *Name that mineral!* **Answer:** borax.

- **Question:** You might find yourself sprinkling this salty soft and cubic mineral on your dinner or on an icy sidewalk. *Name that mineral!* **Answer:** halite.

2. Earth Resources

These activities introduce the practical side of minerals, or how rocks and minerals are used in everyday life. We are surrounded by our mining heritage, from gypsum in walls to brass knobs on doors or clay in flowerpots and on pages of glossy magazines. Mineral resources may be divided into three classes: metals (iron, copper, nickel, etc.), nonmetals (sand, clay, limestone, salt), and fossil fuels (coal, oil, natural gas). The following activities will help you appreciate the role mining and minerals play in day-to-day life.

Activity 2.1: Everyday uses of rocks and minerals.
In a group, circle around a flipchart, chalkboard or white board. Look around and list everyday things and the rocks and minerals you think went into them. (If using a good old black chalkboard, you can start with the chalk itself and the slate of the chalkboard.)

Activity 2.2: Minerals in the home.
Write a report or make a poster about at least 10 rock and mineral products in your home or in a particular room in your home: your bedroom, bathroom, kitchen, living room, etc.

Activity 2.3: Collecting everyday objects and the rocks and minerals that went into them.
Build a collection of everyday objects and minerals that went into them. You can get specimens by collecting them in the field, trading with other club members, or purchasing them at nature stores, museum gift shops, rock shops, or gem shows. Here are examples to get you started: a penny and a copper nugget; a nail and a piece of hematite; a tube of fluorinated toothpaste and a fluorite crystal; laundry detergent and a borate mineral; a fishing weight and a galena crystal. Display your collection of everyday objects and their source minerals at a local gem show, the library, during show-and-tell at school, at one of your club meetings, or wherever else a public display might be possible.

Activity 2.4: Field trip to a mine or quarry.
Take a field trip to a mine or quarry. Afterwards, write a report for your Youth Leader or make a presentation at the next club meeting describing what was being mined, how it was being mined, and how it's ultimately used. If you were able to get a sample of what was being mined, bring it to your next meeting and show-and-tell everyone about it.

Activity 2.5: Field trip to a hardware store.
Take a "field trip" or "scavenger hunt" to a local hardware store or home building supply store. List things you see there and their source rocks and minerals.

Activity 2.6: Careers in the earth sciences.
Learn about careers in the earth sciences (mining, teaching, gemology, the jewelry business, seismology, etc.). Maybe even interview someone in such a job, such as a local jeweler. Write a brief paper imagining yourself in such a career and some adventure you might undertake in that job. For instance, an oil geologist might be taking a boat ride to an off-shore oil platform. A paleontologist with a museum or university might be prospecting for fossils in the Gobi Desert. A gemologist might be cutting the world's largest blue diamond. What would be an interesting job to you?

2. Earth Resources

□ 2.1 Everyday uses of rocks and minerals

□ 2.2 Minerals in the home

□ 2.3 Collecting everyday objects and the rocks and minerals that went into them

□ 2.4 Field trip to a mine or quarry

□ 2.5 Field trip to a hardware store

□ 2.6 Careers in the earth sciences

To earn your Earth Resources badge, you need to complete at least 3 of the 6 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 2.1, 2.2, 2.3: Everyday objects and the minerals that went into them.

You could conduct Activity 2.1 as a single group activity or make a competition of it, dividing the kids into two or more teams and seeing who can make the longest list in 10 minutes. To conclude the activity, you might unveil a collection of mineral specimens, revealing the actual raw materials that went into some of the things in the room.

Sitting at my computer when I first considered Activity 2.1, I quickly saw a brass lamp, windows made of silica, all sorts of things made of plastic derived from petrochemicals, bricks in the fireplace derived from clay, an old tin cup holding my graphite pencils, a gold wedding ring on my finger, walls made of plasterboard comprised of gypsum, steel nails in the furniture, and paint on the walls containing diatomite as filler. In fact, the television off to the corner contains no less than 35 different metals and the telephone handset has no less than 42 different minerals! To get kids primed to think about what things are made of, you might hold up a couple common items that serve as good teaching examples:

1) an old watch you can take apart (especially one with luminescent hands) has a glass/silica top, a metal body made of brass, aluminum, etc., interior parts that might include gemstones, radioactive minerals for luminescence, etc.
2) a salt shaker with an aluminum top and glass body, filled with salt (halite) crystals.
3) an incandescent light bulb with glass exterior (made from silica, soda ash, lime, coal, and salt), brass or aluminum screw-in base, tungsten filament, copper and nickel lead-in wires, molybdenum tie and support wires, aluminum heat deflector, etc.
4) a pencil may have a wooden body, but it's filled with a rod composed of graphite mixed with kaolinite and has an eraser that may hold pumice for grit and that is held in place with a band of metal that may be aluminum (bauxite) or brass (copper and zinc/sphalerite). Wow! As many as 5 or 6 rocks and minerals in a common pencil!

There are several good web sites you can consult that provide handy lists and tables linking minerals to everyday objects. Two particularly good ones are the Minerals Education Coalition (www.mineralseducationcoalition.org) and Women in Mining (www.womeninmining.org). (The Minerals Education Coalition web site provides a nice graphic illustrating all the minerals going into a light bulb; the ones I've described above are just a few on their list.) Our U.S. Geological Survey (USGS) has a website for the National Minerals Information Center (http://minerals.usgs.gov/minerals/) that provides statistics and information on minerals essential to the economy. The American Geosciences Institute publishes a digital-only book called *The Consumer's Guide to Minerals.* You can purchase it for a very reasonable price ($4.99 as of January 2016) by going to www.agiweborg/pubs. It explores the myriad uses of minerals in scientific research, manufacturing, medicine, and commercial applications. Following are samples from this book and these websites:

Rock or Mineral	Everyday Object
Barite	Glass; paints; textiles; toothpaste; green color in fireworks
Bauxite (aluminum ore)	Cans & other containers; aluminum foil; autos; airplanes; building components like aluminum siding, window frames

Rock or Mineral	Everyday Object
Borax	Laundry detergent
Calcite	Cement; plaster; glass; steel; toothpaste
Cassiterite (tin ore)	Cups, plates, & cans; coinage; opalescent glass; enamel; weather-resistant vinyl siding; solder
Celestite	Fireworks; caustic soda
Chalk	Chalk; quicklime; mild abrasive; fingerprint powder
Cinnabar (mercury ore)	Batteries; thermometers; barometers
Coal	A "fossil fuel for heating; generating electric power
Copper	Coinage; electrical wiring; electronics; plumbing pipes; brass
Corundum	Ruby & sapphire gemstones; abrasives
Diamond	Jewelry; abrasives; cutting tools and drills
Diatomite	Swimming pool and other filters; toothpaste; metal polishes
Dolomite	Magnesia for medical/industrial uses; crushed road stone
Feldspar	Clay products (pottery; ceramics); glass; gemstones
Fluorite	Toothpaste; hydrofluoric acid; steelmaking; nonstick pans
Galena (lead ore)	Fishing weights; car batteries; machine parts; solder; linings for radiation protection; bullets
Garnet	Sandpaper and other abrasives; jewelry
Gold	Jewelry; dentistry; electronic components; coinage; astronaut face masks are gold-coated to protect against solar radiation!
Granite	Ornamental building stone; monuments; gravel
Graphite	Dry lubricant; brake linings; molds in foundries; pencil lead
Gypsum	Plaster-of-Paris; wallboards; fertilizer
Halite (salt)	Food; highway de-icing; chemicals; source of chlorine
Hematite (iron ore)	Nails & screws; steel; machine parts; tools; chains and fences; bikes; cars; bridges; building frames
Kaolinite (clay)	Tiles; kitty litter; bricks; dinnerware and other ceramics; toilets, sinks & bathtubs; glossy paper; fiberglass; stomach medicines; pencil lead; chimney liners
Kyanite	Sparkplugs; electrical insulators; porcelain products
Limestone	Cement; crushed road stone; building stone; steel making
Lepidolite (lithium ore)	Rechargeable batteries; electric car batteries; ornaments
Malachite	Ornamental stone & jewelry; copper; green pigment
Manganese	Used in making steel
Marble	Architectural & ornamental purposes; statuary
Mica	Electronic insulators; joint compounds; paints; plastics; rubber products; toothpaste; Christmas tree "snow"
Nickel	Coinage; alloys; nickel steel (stainless steel); magnets; electroplating; rechargeable batteries; electric guitar strings
Phosphate	Fertilizer; animal feed supplements
Pumice	Concrete blocks; abrasives; Lava-brand soap; cosmetic stone to rub away dead skin
Pyrite	Sulfuric acid; decorative rock sometimes used in jewelry
Quartz (silica)	Glass; gemstones; spectrographic lenses; clocks & watches; also, quartz sand has many uses when mixed with other substances as in cement
Rutile (titanium ore)	Ore of titanium—used in jetliners & artificial hips & knees
Sand & gravel	Concrete; asphalt; road fill; blocks; bricks

Rock or Mineral	Everyday Object
Silver	Jewelry & ornaments; silverware utensils; coinage; mirrors; photography; solar cells; batteries; photosensitive glass
Slate	Roofing shingles; blackboards; patio slabs; the beds on high-quality pool & snooker tables
Sphalerite (zinc ore)	Metals & alloys (brass); rust-proof coating on other metals; nails & screws; batteries; water & gas valves; paint; pigments in rubber; skin creams
Sulfur	Sulfuric acid; fertilizer; gunpowder & other explosives; rubber
Talc	Talcum powder; cosmetics; ceramics; rubber; plastics; paper
Trona, or Soda Ash (sodium carbonate)	Glass containers (such as light bulbs); fiberglass; detergents; medicine; food additives; photography; pH control of water
Tungsten	Filament in light bulbs
Vermiculite	Insulation
Wolframite (tungsten)	Light bulb filaments; cemented carbides; steel additive
Zircon (zirconium ore)	High-temperature ceramics; nuclear reactors; abrasives

Activity. To illustrate a practical use, get diatomite from the swimming pool supply area of a hardware store. Poke a number of holes in the bottom of a large, sturdy paper cup. Line the bottom of the cup with a few layers of cheesecloth. Fill the cup a quarter- to half-full with a mixture of diatomite and pea gravel. Cut the top off a plastic water bottle and insert your cup on top. Pour muddy water into the cup and allow it to sit. You should end up with more-or-less clear water at the bottom of the water bottle (it will still be a little muddy, but not nearly as muddy as it began) as a result of the filtration properties of diatomite, which is composed of microscopic silica "skeletons" or tests of fossil diatoms that are peppered with tiny holes. The porous nature of these tests makes diatomite a perfect filter.

Note: *Kids who write a report about minerals in the home for Activity 2.2 can simultaneously satisfy requirements toward earning their Communication badge (Activity 7.2).*

Back-up page 2.3: Collecting everyday objects and the minerals that went into them.

For pointers on building a collection, see back-up pages for Badge 5 on Collecting.

To help your kids in collecting common minerals, start by approaching your fellow club members to see if they might have supplies of minerals they've collected over the years that they would be willing to donate to the cause (quartz crystals, fluorite, galena, gypsum, hematite, etc.). Also, many common minerals are inexpensive and readily available from show dealers, and sometimes show dealers will offer special bulk discounts if you approach them about your project.

In the retail arena, various nature stores sell common minerals (pyrite crystals, tumble-polished pieces of quartz or hematite, etc.). Toy stores and crafts stores are other spots to try, as well as stores selling teaching supplies and the gift shops of natural history museums.

If you have active mines in your area, they may be willing to donate samples. For instance, the vast borax mine in Boron, California, is happy to lead tours and provide free samples of various borate minerals.

Still other sources (although more expensive) are the various scientific supply houses, such as Ward's, Edmund Scientific's, etc.

Note: *Kids can use this activity to satisfy requirements toward earning their Collecting badge simultaneously (Activity 5.1). And those who put together a public display can use it toward satisfying requirements for earning the Showmanship badge (Activity 6.4).*

Back-up page 2.4: Field trip to a mine or quarry.

There's nothing like showing your kids nature's bounty first-hand and where it originates. Arranging tours at quarries and mines can be a fun adventure. Many mining companies are happy to provide educational tours if contacted well in advance so that appropriate arrangements can be made.

In my home state of California, opportunities abound with inactive and active gold mines, Wild West silver towns like Calico, the borax mine in Boron, diatomite mines near Lompoc, a limestone quarry near Davenport, tourmaline mines near San Diego, gypsum mines near Ocotillo, etc. Growing up in Illinois, I was often taken on organized field trips sponsored by the Illinois Geological Survey to operating limestone quarries, coal mines, and lead mines for fossil and mineral collecting. Later in Maryland, I often searched for petrified wood as well as minerals like garnets in sand and gravel quarries, and I found an abundance of active and inactive coal mines and limestone quarries when I lived in Pennsylvania.

How do you find out about local quarries and mines? One possibility is the Yellow Pages. For instance, in my local phone book, I found Best Rock Mining Company listed under "Mining Companies." Look under "Mining," "Rock," "Quarries," etc. Try the local Chamber of Commerce. Other good bets are state geological surveys, which maintain lists of mineral resources and active mining companies. You can locate your state survey via a Google search on the computer or by looking in the phone book "Blue Pages" under State Government listings, where it might be included under the Department of Conservation or Geological Survey. On the web site of the United States Geological Survey (http://www.usgs.gov/) a handy map of the U.S. allows you to click on your state for regional geologic information.

After a field trip to a mine or quarry, have kids prepare written reports or make individual or group presentations at the next club meeting describing what was being mined, how it was being mined, and how it's ultimately used. They can also bring and share samples collected at the mine (some mines allow this; others don't) and perhaps use the experience as the basis for an educational display case at your next show or to share at their school or a science fair.

If you can't make it to a mine or quarry, never fear! The World Wide Web comes to the rescue. Check out "Virtual Quarry Interactive" (www.virtualquarry.co.uk), which offers a simulated field trip to a rock quarry and, under "Teacher's Desk," 20 lesson plans related to quarrying and rock products used in everyday life. It's a British site, so the narrator has an accent and some of the terminology may be unusual for American students (e.g., "lorry" instead of "truck"), but it's a fun, informative site, nonetheless.

Note: *Kids can use this activity toward satisfying requirements for the Field Trips badge simultaneously (Activity 8.3). Also, kids who write a report or give a talk about their trip can simultaneously satisfy requirements toward earning the Communication badge (Activities 7.1 and 7.2).*

2.5 Field trip to a hardware store.

A home building supply or hardware store, especially one that also has a garden center, is a great place to vividly underscore just how much that's all around us derives from rocks and minerals. This makes for a great indoor field trip that can be turned into a scavenger hunt to see which kids (or teams of kids) can come up with the biggest list of everyday items and the rocks and minerals that went into them. If doing an activity like this with a fairly large group of kids, contact the store manager in advance to ensure a warm welcome. You may find they're willing to help in the hunt!

To get you started, here are a few things that come immediately to my mind as to what you can find in your local hardware store derived from common rocks and minerals:

- electrical wiring, pipes, and plumbing fixtures (made from copper)
- steel and iron nails (made from iron ores such as hematite and magnetite)
- aluminum and tin siding and roofing (made from bauxite and cassiterite)
- brass screws and ornamental plates (brass is an alloy of copper and zinc)
- lead solder (made from galena)
- diamond on drill bits and saw blades used for cutting title, concrete, etc.
- diatomaceous earth for swimming pool filters
- plaster and plasterboard or drywall (made from gypsum)
- sandpaper (several varieties: garnet, silicon carbide, and corundum, or emery)
- glass (made from silica sand)
- crushed stones for ornamental use (red or black volcanic cinders or scoria, limestone, marble, etc.)
- sand
- bricks and ceramic products (made from fired clay, or kaolinite)
- salt (or halite) for melting icy buildup on sidewalks
- slate slabs for high-priced shingles and flagstones
- slabs of various sorts for ornamental use, as in kitchen countertops (made from granite, marble, labradorite, etc.)

Using this list as a starting point, see what else your kids can find. Again, this can make for a really fun event if you turn it into a competitive scavenger hunt with prizes at the end.

Back-up page 2.6: Careers in the earth sciences.

As a multi-disciplinary science, geology draws from and applies chemistry, physics, biology, mathematics, and engineering. Subfields include geophysics, hydrogeology, oceanography, paleontology, environmental engineering, mining and mineral resources, and more. Geology students learn about earth processes and their effects on the general environment and life. Well-trained geologists help in charting pathways that are both environmentally and economically sound in addressing issues related to human interaction with both resources and hazards, crafting solutions to benefit the general public. In addition to geology, gemology is a career direction for kids interested in minerals and gemstones, whether as a miner seeking new sources of rough gemstones, a distributor in the wholesale business, a retailer, or an artisan crafting fine jewelry.

Great resources to help kids learn about such careers are web sites for the Minerals Education Coalition and Women in Mining: www.mineralseducationcoalition.org and www.womeninmining.org. You and your kids can also explore the web site of the U.S. Geological Survey: www.usgs.gov. And there are the American Geosciences Institute (AGI, www.americangeosciences.org) and the Gemological Institute of America (GIA, www.gia.edu). If you live near a college or university that has a geology department, you might contact the department because they will often have information about careers in geology for advising their students. Here are just a few ideas:

- college or university professor of geology or paleontology
- laboratory research worker and technician
- natural history museum curator
- petroleum geologist
- staff geologist or field geologist for a mining company
- mining engineer
- geophysicist
- planetary geologist for NASA
- surveyor
- cartographer
- independent consultant assessing geological hazards for the construction industry
- seismologist for the United States Geological Survey (USGS)
- metallurgist
- environmental scientist conducting environmental impact studies and remediation
- marine geologist
- hydrogeologist or hydrologist evaluating and developing groundwater resources
- gemologist
- independent fossil or rock and mineral dealer
- professional jewelry designer and craftsperson
- jewelry store owner

Encourage kids to read about—or even interview someone in—one of these careers.

Note: *Kids who write a paper for this activity can use it toward satisfying requirements for the Communication badge simultaneously (Activity 7.2).*

3. Fossils

Fossils represent a merger between the sciences of geology and biology. They are at the core of the science of paleontology, or the study of past life. To study fossils, you need to learn about different forms of life on earth, the history of that life, and the geological processes that preserve life's record. The following activities will assist you. As a start, you should get a book. There are many good, basic guidebooks at reasonable prices, such as Rhodes, Zim, and Shaffer's *Fossils: A Guide to Prehistoric Life*, Palmer's *Pockets Fossils*, Walker and Ward's *Smithsonian Handbooks: Fossils*, and more. You can also find many good books like these in your public library.

<u>Activity 3.1: The geological time chart</u>.
Memorize the geological eras and periods and some key facts about each one. Then make a geological time line showing all the geological periods on a long sheet or roll of paper. Illustrate it with drawings of fossils and prehistoric plants and animals that are characteristic of each period.

<u>Activity 3.2: Types of fossilization and making or excavating fossils</u>.
Explain the different types of fossilization (e.g., carbonization, mineralization, molds and casts, etc.). Then do one of the following. Make a "fossil" with clay and plaster, make paper or cardstock cut-and-fold fossil models, bake a Tri-lo-"Bite," make a sponge fossil bone, make artificial amber with insects, or excavate a real or plastic fossil.

<u>Activity 3.3: The forms of life</u>.
Demonstrate knowledge of the major groups of invertebrates, vertebrates, and plants.

<u>Activity 3.4: Collecting fossils</u>.
Build a fossil collection of 10 to 20 specimens. Some collectors concentrate on a single sort of plant or animal (for instance, trilobites) and try to collect a wide range of species. Others concentrate on one locality or formation and build an array of all the plants and animals that locality has to offer. Still others opt for diversity, trying to collect a little bit of everything (clams, brachiopods, corals, shark teeth, trilobites, etc.). Whichever form you choose, be sure to follow the basics of good curation, labeling each specimen and keeping a log book with key information (what it is, where it came from, age of the fossil, etc.). (See Badge 5: Collecting.)

<u>Activity 3.5: A fossil-collecting field trip</u>.
Learn and demonstrate knowledge of the AFMS Code of Ethics and the rules of field trip etiquette (as well as the laws of your state or region), then head out on a fossil-collecting trip. (See Badge 8: Field Trips.)

<u>Activity 3.6: Your state fossil</u>.
Just as each state has its own flag, many have an official state fossil. Find out what your state fossil is and write a report about it for your club newsletter or talk about it at one of your meetings. If your state doesn't have a state fossil, discuss what would be a good fossil to nominate, and then write to your governor or local state legislature to suggest it!

Activity 3.7: Dinosaurs.
Everyone loves one particular fossil: dinosaurs! With your fellow club members, take part in a dinosaur identification game or other dinosaur-related activities, such as crafting cut-and-fold paper or cardstock dinosaur models.

Activity 3.8: Fossil and dinosaur names.
Fossils, including dinosaurs, often have long names that seem impossible to pronounce. Sometimes, they were built around the name of a person (for instance, a famous paleontologist or the person who first discovered the fossil). Other times, they are named for the place where they were found or for some characteristic. The names are then put into Latin or Greek form. Pick your favorite fossils or dinosaurs and learn how its name came about and what it means. Or develop a new dinosaur name built around the name of your society or town. Or create a whole new fossil animal and give it a name!

3. Fossils

□ 3.1 The geological time chart

□ 3.2 Types of fossilization and making or excavating fossils

□ 3.3 The forms of life

□ 3.4 Collecting fossils

□ 3.5 A fossil-collecting field trip

□ 3.6 Your state fossil

□ 3.7 Dinosaurs

□ 3.8 Fossil and dinosaur names

To earn your Fossils badge, you need to complete at least 3 of the 8 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page for Fossils badge: Reference books.

Following are some books kids might buy or seek in the library for learning about fossils:

- Horenstein, *Familiar Fossils*, the Audubon Society Pocket Guides (1988)
- Ivanov, et al., *The Complete Encyclopedia of Fossils* (2001)
- Mehling, *Fossils: 300 of the Earth's Fossilized Species* (2007)
- Palmer, *Fossils*, Pockets Series (2004)
- Rich, Rich, Fenton & Fenton, *The Fossil Book: A Record of Prehistoric Life* (1997)
- Rhodes, et al., *Fossils: A Guide to Prehistoric Life*, Golden Guides Series (1962)
- Thompson, *The Audubon Society Field Guide to North American Fossils* (2002)
- Walker & Ward, *Fossils*, Smithsonian Handbook Series (2002)

The little paperback by Rhodes and the much bigger book by Rich, Rich, Fenton & Fenton are classics that were standards way back when I was a kid! In addition to these, I encourage you to check out three other books that tell all about fossils and how to become a fossil detective, one geared to very young children, another to kids in grades 3-5, and the other to still older kids:

- Aliki's *Fossils Tell of Long Ago* (1990) is a story book that introduces young children to fossils: what they are, how they formed, how they are found, what they tell us, and how to make a fossil of your own.
- Jenny Fretland VanVoorst's *Fossils* (2015) is part of Abdo Publishing's Core Library Rocks and Minerals Series geared to kids in grades 3-5.
- Peter Larson and Kristin Donnan teamed to write *Bones Rock! Everything You Need to Know to Be a Paleontologist* (2004). This is a fantastic, beautifully illustrated introduction for somewhat older kids. Paleontologist Robert Bakker says it best on the back cover of the book: "A wonderfully generous invitation to the joys of paleontology! This is the book I wish I had when I was ten. And fifteen. And in college. And when I got my first job teaching paleontology. *Bones Rock!* tells you how to be a dino detective. Listen carefully."

You can find these and other guidebooks in the Science, Nature, and Field Guide sections of bookstores. You can sometimes get guidebooks like these at a discount if ordering in bulk and if your club has a nonprofit, educational tax ID number and you let the distributor know you're purchasing for educational purposes.

Finally, many interesting websites help you explore fossils with kids, like the following:

- National Park Service Junior Paleontologist Program
  http://nature.nps.gov/geology/paleontology/jr_paleo.cfm
- "The Learning Zone," Oxford University Museum of Natural History
  http://www.oum.ox.ac.uk/thezone/fossils/index.htm
- University of California Museum of Paleontology
  http://www.paleoportal.org

Back-up page 3.1: The geological time chart.

It took humans a long, long time to fully appreciate the long, long history of our planet Earth. As that appreciation dawned, scientists began constructing stratigraphic and geologic time scales and charts. Today, an International Commission on Stratigraphy researches official names, dates, and ages to set a consistent and uniform chart that serves as the go-to reference source for academic and professional researchers and students. Work with your kids to learn about the geological time chart and the different plants and animals that lived during the different eras and periods.

A basic geologic time chart, with examples of common fossils from each period, is provided on the next page as a reference. In addition, a similar table with blank spaces is provided for kids to fill in the era, period, and epoch names.

Alternatively, you can encourage your kids to create their own timeline in whatever way they like. For instance, some kids prefer a horizontal timeline, illustrating it to show different creatures that supplanted one another through time. If you get a long roll of large paper, this also makes a neat group activity. Roll the paper the entire length of a room and divide it up into the geological time scale. Then pass out pencils, colorful markers and crayons, and assign kids to different periods to illustrate with fossils and reconstructions of plant and animal life of those periods.

Finally, another neat activity for illustrating the vast scale of geologic time is to make a timeline in chalk on a sidewalk with one inch equaling one million years. (Thus, to go from the beginning of the Cambrian Period to the present, your time line would stretch 544 inches, or more than 45 feet! And that's ignoring the preceding four *billion* years of earth history—for that, you'll need a bigger piece of chalk!) Give kids pieces of colored chalk to draw pictures of appropriate fossils at different spots along the timeline, with trilobites in the Cambrian, dinosaurs in the Jurassic, and so forth.

A website related to the geological time scale, along with some animations, has been put together by the Planet Habitability Laboratory of the University of Puerto Rico:
http://phl.upr.edu/library/notes/thedistributionofcomplexlifeinthelast540millionyears

<table>
<tr><th>ERA</th><th colspan="3">PERIOD/EPOCH</th></tr>
<tr><td rowspan="7">Cenozoic
“recent life”
dinosaurs dead / mammals ahead

mammals diversify

first humans</td><td colspan="2" rowspan="2">Quaternary
(modern humans appear; mastodons & mammoths & other Ice Age mammals)</td><td>Holocene
11,000 years</td></tr>
<tr><td>Pleistocene
1.6 million years</td></tr>
<tr><td rowspan="5">Tertiary
(by the Eocene, many modern types of mammals appear, including whales; large running mammals appear in Oligocene; large carnivores and grazing mammals are abundant starting in the Miocene; earliest hominids appear in late Miocene or early Pliocene)</td><td rowspan="2">Neogene</td><td>Pliocene
5.2 million years</td></tr>
<tr><td>Miocene
23 million years</td></tr>
<tr><td rowspan="3">Paleogene</td><td>Oligocene
35 million years</td></tr>
<tr><td>Eocene
56 million years</td></tr>
<tr><td>Paleocene
65 million years</td></tr>
<tr><td rowspan="3">Mesozoic
“middle life”
dinos rule / mammals drool

first dinosaurs & first mammals appear toward end of Triassic

Era ends in great mass extinction (end of dinosaurs) likely caused by asteroid impact</td><td colspan="3">Cretaceous
(earliest placental mammals; earliest flowering plants; bony fish proliferate; dinosaurs and ammonites proliferate but become extinct by the end of the period)
145 million years before present</td></tr>
<tr><td colspan="3">Jurassic
(dinosaurs are abundant on land and ammonites in the sea; earliest birds)

208 million years before present</td></tr>
<tr><td colspan="3">Triassic
(earliest dinosaurs & mammals; cycads & conifers diversify)
245 million years before present</td></tr>
<tr><td rowspan="8">Paleozoic
“ancient life”
invertebrates reign supreme

Cambrian “explosion” ushers in complex multicellular life

First land plants as early as Ordovician

First land vertebrates and rise of seed plants toward end of Devonian

Era ends in largest mass extinction in earth history; cause still unknown</td><td colspan="3">Permian
(mammal-like reptiles emerge; largest mass extinction event on earth)
290 million years before present</td></tr>
<tr><td colspan="3">Pennsylvanian
(great coal-forming forests of scale trees & seed ferns; abundant insects)
323 million years before present</td></tr>
<tr><td colspan="3">Mississippian
(abundant sharks & amphibians & crinoids; earliest reptiles)
362 million years before present</td></tr>
<tr><td colspan="3">Devonian
(fish become abundant; extinction of armored fish; earliest amphibians and ammonoids)
408 million years before present</td></tr>
<tr><td colspan="3">Silurian (great diversity of ostracods; earliest land plants and insects)
439 million years before present</td></tr>
<tr><td colspan="3">Ordovician
(graptolites abundant; invertebrate marine animals proliferate, especially coelenterates, mollusks, brachiopods, bryozoans, and arthropods)

510 million years before present</td></tr>
<tr><td colspan="3">Cambrian (appearance of burrowing animals and most contemporary forms of complex multicellular life; trilobites common)
544 million years before present</td></tr>
<tr><td rowspan="2">Pre-Cambrian
Divided into Proterozoic Eon (2.5 to .54 billion years ago), Archean Eon (3.8 to 2.5 billion years ago), and Hadean Eon (starting 4.6 billion years ago, when earth formed)</td><td colspan="3">Vendian or Ediacaran (enigmatic soft-bodied Ediacaran fossils appear shortly before the Cambrian)
600 million years before present</td></tr>
<tr><td colspan="3">(Single-celled life emerges and proliferates: bacteria, algae, stromatolites)

4.6 billion years before present</td></tr>
</table>

ERA	PERIOD/EPOCH		
		—	

Back-up page 3.2: Types of fossilization and making or excavating fossils.

Forms of Fossilization.

Fossils are the preserved remains or evidence of past life, both plant and animal, microscopic and macroscopic. These include actual remains of the plant or animal (such as teeth), carbonized impressions, molds and casts of shells and other body parts, etc., as well as evidence of an organism's activity, such as chemical traces, burrows, footprints, or coprolites (known as trace fossils). Following are some of the most common forms of fossilization.

- ***Molds and casts.*** Calcareous shells may dissolve, leaving a cavity in a rock that is later filled with sediment or minerals, forming a mold and cast of the original organism. Only the general shape and form of the original organism is left.
- ***Mineralization, replacement, or petrification.*** Original shell, bone, or wood may be infiltrated or totally replaced by a mineral that seeps into pores via mineral-laden groundwater. When this happens, scientists can observe even tiny details of cell structure in bones and the cells and growth rings in petrified wood.
- ***Re-crystallization.*** Shells may re-crystallize, leaving original shell material but in a different mineral form. For instance, many shells are formed from calcium or aragonite, which changes to calcite during fossilization.
- ***Carbonization.*** Between layers of finely bedded shale, original organic material may be compressed and distilled away, leaving only a thin film of carbon on a bedding plane, as often happens with leaves and insects that fossilize.
- ***Original remains.*** Sometimes, animal or plant remains may undergo little to no alteration at all. Such is often the case with fossils such as teeth that are resistant to decay. Or an animal like an insect may be captured in sap, which hardens into amber, creating a natural time capsule that preserves the original organic material. (Scientists have been able to extract bits of ancient DNA from such insects!) In Siberia, creatures such as woolly mammoths have been found locked in ice that has remained frozen since the Ice Ages.

Making a Fossil Using Clay and Plaster.

This activity simulates how fossils in the forms of molds and casts are created.

Materials.

- Plaster of Paris
- Jug of water
- Modeling clay
- Vegetable oil
- Paintbrush (1-inch wide)
- Paper cups
- Dowels or sticks
- Small cardboard containers
- Shells, leaves, or fossil models
- Paper towels
- Masking tape
- Pen or marker
- Roll of large paper/newspapers
- (optional) paints and paint brushes

Procedure.

1. This can be a messy procedure, so start by protecting your tabletop or other work surface by spreading out a roll of paper, newspaper, or some sort of drop cloth.
2. Place a chunk of modeling clay into the bottom of a small cardboard container (the cut-off bottoms of individual-serving milk cartons, paper cups, or Pringles potato chip cans work well) and press into a flat, smooth surface.
3. With your 1-inch wide paintbrush, brush a light coating of vegetable oil across the surface of the clay. This is to make it easy to remove your fossil model and, later, the plaster cast. Otherwise, the clay will stick.
4. Have kids select the fossil they wish to make. Use real leaves or seashells or plastic models of fossils. Such models often may be found in museum gift shops. Ward's Natural Science (www.wardsci.com) also sells a set of plastic fossil models. Ones that seem to be most popular with kids are trilobites, ammonites, and shark teeth.
5. Press the fossil model or seashell into the clay and then remove it to create a mold.
6. Mix and stir plaster and water in a paper cup with a dowel or stick to the consistency of a thick milkshake. Pour it into the mold created in the clay. Use the dowel to get all the plaster out, and if you're making a number of fossils and will need to re-use the dowel, wipe it clean right away with paper towels before the plaster hardens on it.
7. Gently tap the bottom of your container with the clay and plaster several times against the tabletop to ensure that the plaster completely fills the mold and to remove any air bubbles in the plaster.
8. It takes about 15 to 20 minutes for the plaster to dry enough to complete this project, and if you're working with a lot of kids, it's easy to mix up which fossil belongs to whom. Have kids write their names on small strips of masking tape with pens or markers and affix them to their fossil containers. Set all the containers aside to dry. During this drying period, you should have another activity; otherwise, you'll hear "Is my fossil ready yet?" about 200 times. This is a nice activity to do prior to a meeting; once the meeting is over, before everyone goes home, you can return to the fossils. Or, after setting everything aside to dry, you might show a video about fossils and cap it off by having everyone unveil and share their newly minted fossils.
9. Once the plaster has dried, tear the cardboard container and peal the cardboard away, leaving a layer of clay attached to a layer of plaster. This gives you a chance to talk about layers of sediment and to show kids how fossil-bearing sediments usually (but not always) form in discrete layers.
10. Peal the clay away, and your kids will find a cool fossil in their slab of plaster. Many kids then write their names on the backs of their fossil slab.
11. Optional. Have kids paint their fossils. Glossy or flat enamel paints (the kinds used with plastic model airplanes and cars) work well in shades of black, gray, brown, or beige. Craft stores often carry textured "sand" paints, so kids can paint the surface around the fossil to resemble a real matrix. I've also found a pearly coating at one craft store. I painted it over an ammonite cast that I had painted a brassy brown. The pearl coating gave a glossy, iridescent sheen just like real mother-of-pearl. Experiment with different sorts of paints and coatings like these.

I've also been told about a fossil-making activity that calls for mixing together one cup of used coffee grounds, one-half cup of cold coffee, one cup of flour, and one-half cup of salt in a mixing bowl. Knead this into a dough, flatten it on a sheet of waxed paper, and cut out small squares or circles. Press objects such as scallop, snail, or clam shells into the dough, remove the object, and either allow the dough to harden for a day or two or bake it briefly in an oven. The resulting items have the look and feel of a real fossil in matrix. Or, for yet another, simpler process to make fossils using just self-hardening clay, see the back-up page for 10.4.b) Sedimentary rocks: Making fossils.

Note: *You can use any of the activities described above to help kids satisfy requirements toward earning both their Fossils and Earth Processes (Activity 10.4.b) badges simultaneously.*

Making Cut-and-Fold Models of Fossils Using Cardstock.

The following website has links to a number of really neat masters you can download and print for free to then copy on paper or cardstock for kids to craft cut-and-fold 3D models of fossils: http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx

Making Tri-lo-"Bites" and Other Delectable Fossil Treats.

Even more fun than making plaster fossils—especially for younger kids—is making Tril-o-"Bites." Dennis Gertenbach of the Flatirons Mineral Club in Colorado sent this activity. Haul out your grandma's Christmas cookie recipe, gather kids in the kitchen, and work with them to fashion, bake, and decorate cookies with frosting in the forms of trilobites, ammonites, star fish, dinosaurs, and other fossil creatures. In the process, they'll be learning about the names and shapes of different fossils in a way that should leave a good taste in their mouths when everyone gets to eat their fossil creations!

The Kentucky Geological Survey website has a Trilobite Cookie recipe as well as recipes for "Prehistoric Appetizers". Go to www.uky.edu/KGS/education/trilobitecookies2.htm and www.uky.edu/KGS/education/cookbook.htm. Those appetizers include Ammonites-in-a-Blanket, Cephalopods-in-a-Blanket, and Cephalopod Celery. Yummy!

Making Fossil Bones from Sponges.

Cut sponges into the shapes of bones and set them in a pan or tray. Pour a saturated solution of hot water and Epsom salts into the pan and over your sponges then set the pan aside for a week or so until all the water has been absorbed into the sponges or has evaporated and the sponges have dried. You should end up with stiff sponges with pores holding crystals of Epsom salts, just as petrified dinosaur bones turn rock-hard from the minerals that flowed through their cells.

Making Artificial Amber with Insects.

Amber is resin from trees that has hardened over the ages. Basically, it's fossilized tree sap. It is often sought after by lapidary artists to be crafted into lightweight jewelry with beautiful golden transparency. In fact, amber is considered an "organic" gemstone. It is also sought after by fossil collectors because that same sap that results in amber also sometimes trapped insects, bits of leaves, or other critters when it was still gooey and sticky. These make for some of the best fossils around in that every detail of the insect is preserved in three dimensions, right down to antennae and the tiniest hairs on an insect leg. It's literally like a window into ancient life!

Help your kids make artificial amber using dead and dried insects and polyester or epoxy casting resins. Such resins usually come in a kit along with a hardener. Look in craft stores like Michael's or Ben Franklin. I've also run across instructions on a website called RockHoundBlog for making amber using clear nail polish colored with yellow food coloring (along with a drop of red): http://rockhoundblog.com/regular-postings/how-to-make-amber/

While the activity above results in some great paperweights, another activity results in great snacks! The "ehow" website offers recipes for creating edible "jello amber" and "amber brittle," both embedded with gummy insects. For the full recipes, see http://www.ehow.com/how_8347295_make-amber-fossils.html

Excavating a Fossil.

This activity gives kids a fun way to learn about the basics of fossil excavation without leaving home! Mix together a scant quarter cup of plaster of Paris, a generous cup of coarse-grained washed plaster sand (available in bags at hardware stores) that has been thoroughly dried, and, optionally, a bit of diatomite (available with swimming pool supplies in hardware stores). Add water to this mixture to the consistency of pancake batter. You may need to experiment a bit to get the right proportions and consistency.

Pour the wet matrix you've just made into three fist-sized containers or cups. Set a fossil into this matrix in each container. Lightly spraying the fossil with a vegetable oil like Pam will make it easier to chip out. You might use a real fossil (a crinoid stem fragment, a brachiopod, a shark tooth, etc.) or a small plastic dinosaur skull or skeleton from a toy store. (I've obtained some at our local 99¢ Store.) Pour more matrix to cover the fossil. Keep a tip of the fossil emerging from the top so kids will know where to begin their excavation.

Once the matrix has hardened, it can be removed from the container to dry thoroughly. Make one for each kid in your group, and give everyone a nail to "excavate" fossil treasures. You can also use wooden skewers as excavating tools. Because bits of matrix may go flying as kids chip away, eye protection is recommended. Once all fossils have been chipped out into the open, have your junior paleontologists learn about the fossil that each has just excavated.

In addition to mixing up your own chunks of sedimentary rocks for excavation, you can also find pre-made kits containing blocks, digging tools, and a brush. Look for these in museum gift shops, stores catering to teachers, and similar venues.

Back-up page 3.3: The forms of life.

The AFMS publishes the *AFMS Fossil List*, which represents the approved reference list of classifications and common names of fossils used in judging competitive exhibits of fossil collections. This highly detailed list serves as an invaluable reference tool. You can receive information about obtaining a copy by contacting the AFMS central office at the following email address: central_office@amfed.org. Or you can download a copy yourself from http://www.amfed.org/rules/rules.htm. Once in the site, click on "AFMS Approved Reference List of Classifications and Common Names for Fossils," and then make sure you have a good supply of paper in your printer because the document is over 20 pages long.

In addition to the *AFMS Fossil List*, you'll find classifications provided in the many fossil guidebooks listed above on the first back-up page for the Fossils badge. And you might check out the website "Yup…Rocks" (www.yuprocks.com), which features a photo gallery of fossils from the major phyla.

How much detailed knowledge kids should have of the different forms of life will vary with the ages of the kids with whom you're working. For younger kids, it's enough that they learn to use common names and to distinguish among, say, clams, starfishes, sponges, etc. The older the kids, the more detail they should be expected to learn, moving from common names to scientific nomenclature, using Bivalvia (previously called Pelecypoda), Asteroidea, Porifera, and so on.

On the next page, you'll find a general listing of the major fossil taxa most often included in the collections of amateur fossil hunters.

Representative Phyla of the Animal Kingdom
Invertebrates:

Porifera (sponges)
  Representative classes: Calcarea, Demospongia, Hexactinellida

Cnidaria (corals, jellyfish, sea pens, sea anemone)
  Representative classes: Protomedusae (jellyfish), Hydrozoa, Anthozoa (corals)

Bryozoa (bryozoans, or "moss animals")
  Representative classes: Stenolaemata, Gymnolaemata

Brachiopoda (brachiopods)
  Representative classes: Inarticulata, Articulata

Mollusca (mollusks)
  Representative classes: Gastropoda (snails), Bivalvia or Pelecypoda (clams, oysters, scallops), Cephalopoda (cephalopods: ammonites, nautiloids, squid, octopi), Scaphopoda (scaphopods)

Annelida (worms)
  Representative classes: Polychaeta (marine worms), Oligochaeta (earthworms)

Arthropoda (arthropods)
  Representative classes: Trilobita (trilobites), Ostracoda (ostracods), Insecta (insects), Crustacea (crabs, shrimps, lobsters), Cirripedia (barnacles)

Echinodermata (echinoderms)
  Representative classes: Blastoidea, Crinoidea, Asteroidea (starfish), Ophiuroidea (brittle stars), Echinoidea (sea urchins, sand dollars), Holothuroidea (sea cucumbers)

Vertebrates:

Chordata (vertebrates)
  Representative Classes:
  Chondrichthyes (cartilagenous fishes: sharks, skates, rays, guitarfish)
  Osteichthyes (bony fishes)
  Teleosteri (ray-finned fishes)
  Amphibia (amphibians)
  Reptilia (reptiles: lizards, turtles, crocodiles, dinosaurs, flying reptiles, marine reptiles)
  Aves (birds)
  Mammalia (mammals)

Representative Classes and Orders of the Plant Kingdom

Sphenopsida (horsetails)
Filicopsida (ferns, tree ferns)
Pteridospermales (seed ferns)
Cycadales (cycads)
Glossopteridales (glossoperid)
Ginkgoales (ginkgoes)
Cordaitales (cordaites)
Coniferales (conifers: pines, spruce, etc.)
Magnoliopsida (dicotyledon angiosperms, or flowering plants)
Liliosda (monocotyledon angiosperms, or flowering plants)

Back-up page 3.4: Collecting fossils.

Back-up pages for Badge 5 on Collecting provide information on building a collection. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 3.4. For instance, there you'll find information about how to organize a catalog or logbook for an entire collection, how to create labels for individual specimens within a collection, and how to store a collection.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 3.5: A fossil-collecting field trip.

Back-up pages for Badge 8 on Field Trips provide information on organizing and taking a field trip. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 3.5. For instance, there you'll find the AFMS Code of Ethics, general rules of field trip etiquette, and suggestions on organizing and conducting a field trip and the tools and supplies you'll need.

Note: *Kids can use this activity toward satisfying requirements for the Field Trips badge simultaneously (Activity 8.3).*

Back-up page 3.6: Your state fossil.

A terrific book to share with your kids is Stephen Brusatte's *Stately Fossils: A Comprehensive Look at the State Fossils and Other Official Fossils* (2006). Brusatte provides background about each fossil and how it came to be the designated state fossil.

Alabama – *Basilosaurus cetoides* (Eocene whale)
Alaska – *Mammuthus primigenius* (Pleistocene woolly mammoth)
Arizona – *Araucarioxylon arizsonicum* (Triassic petrified wood)
Arkansas – none
California – *Smilodon (californicus) fatalis* (Pleistocene saber tooth cat)
Colorado – *Stegosaurus stenops* (Jurassic dino)
Connecticut – *Eubrontes giganteus* (Triassic/Jurassic dinosaur footprint)
Delaware – *Belemnitella americana* (Cretaceous cephalopod, or belemnite)
District of Columbia – *Capitalsaurus* (dinosaur)
Florida – *Eupatagus antillarum* (Eocene heart urchin)
Georgia – Tertiary Shark Teeth
Hawaii – none
Idaho – *Equus simplicidens* (the "Hagerman horse" from the Pliocene Epoch)
Illinois – *Tullimonstrum gregarium* (Pennsylvanian "Tully Monster")
Indiana – none
Iowa – none
Kansas – none
Kentucky – Paleozoic Brachiopod
Louisiana – *Palmoxylon* (Oligocene petrified palm wood)
Maine – *Pertica quadrifaria* (Devonian plant)
Maryland – *Ecphora gardnerae* (Miocene marine gastropod) + a state dinosaur, *Astrodon johnstoni* (Cretaceous dinosaur)
Massachusetts – Jurassic Dinosaur Tracks
Michigan – *Mammut americanum* (Pleistocene mastodon); also, the state rock is a fossil, *Hexagonaria percarinata* (a Devonian coral called "Petoskey Stone")
Minnesota – *Castoroides ohioensis* (Pleistocene giant beaver; this is the "unofficial" state fossil)
Mississippi – *Basilosaurus* and *Zygorhiza kochii* (Eocene whales)
Missouri – *Delocrinus missouriensis* (Pennsylvanian crinoid) + a state dinosaur, *Hypsibema missouriensis*
Montana – *Maiasaurus peeblesorum* (Cretaceous dinosaur)
Nebraska – Pleistocene Mammoth
Nevada – *Shonisauris ichthyosaurus* (Triassic ichthyosaur, a marine reptile)
New Hampshire – none
New Jersey – *Hadrosaurus foulkii* (Cretaceous dinosaur)
New Mexico – *Coelophysis* (Triassic dinosaur)
New York – *Eurypterus remipes* (Silurian sea scorpion)
North Carolina – none
North Dakota – Teredo Petrified Wood (Paleocene wood bored by shipworms)
Ohio – *Isotelus* (Ordovician trilobite)
Oklahoma – *Saurophaganax maximus* (Jurassic dinosaur)
Oregon – *Metasequoia* (Eocene dawn redwood)
Pennsylvania – *Phacops rana* (Devonian trilobite)
Rhode Island – none
South Carolina – none
South Dakota – *Tricerotops prorsus* (Cretaceous dinosaur)
Tennessee – *Pterotrigonia thoracica* (Cretaceous bivalve)
Texas – *Pleurocoelus* (Cretaceous dinosaur)
Utah – *Allosaurus fragilis* (Jurassic dinosaur)
Vermont – *Delphinapterus leucas* (Pleistocene beluga whale)
Virginia – *Chesapecten jeffersonius* (Pliocene pecten, or scallop)
Washington – *Mammuthus columbi* (Pleistocene Columbian mammoth)
West Virginia – none (but the state gem is a Mississippian fossil coral, *Lithostrotionella*)
Wisconsin – *Calymene celebra* (Silurian trilobite)
Wyoming – *Knightia* (Eocene herring) + a state dinosaur, *Tricerotops* (Cretaceous dinosaur)

Note: *Kids who write a paper or give an oral report for this activity can also use it to satisfy requirements toward earning the Communication badge (Activities 7.1 and 7.2).*

Back-up page 3.7: Dinosaurs.

Dinosaurs exert an almost universal pull on kids. It's as if dinosaur fascination is built into kid DNA! Younger kids especially love reading stories about dinos, playing with dinosaur toys, and learning their long, complicated scientific names. Here are a few activity suggestions revolving around dinosaurs to help you capitalize on that fascination:

- Test dinosaur identification skills with flashcard games or plastic models. Dinosaur cards are commercially available, or you can make your own by cutting pictures of dinosaurs from books, magazines, or web sites. If using plastic models, you can reward kids who come up with the right name by giving them the model—one model per child in your group. You can also give kids pages from a dinosaur coloring book, with each child coloring a different dinosaur and sharing—and naming—the results with the group. And for yet another activity for testing dino-ID skills, construct crossword puzzles with names of dinosaurs.

- Use "dino eggs" to test dinosaur identification skills. You can make eggs by inflating and coating balloons with paper mache made from strips of newspaper soaked in water and flour. Once the paper mache has dried, use a pin to pop the balloon inside, cut a slit, insert a plastic dinosaur model, then paper mache over the slit. Once dry, paint the egg. Or, for a simpler process, just buy big plastic eggs that show up at stores prior to Easter that can be opened to insert candy. Instead of candy, insert small dinosaur models of different species. Give each junior member an egg to crack open and have them identify the dinosaur inside.

- Draw and color dinosaur murals or timelines on a long sheet of paper, incorporating dinosaur stickers. Sheets of dinosaur stickers can be found in party or gift-wrapping sections of stores, in craft stores, bookstores, etc.

- Create dino-dioramas with models in shoe boxes. Talk with your kids about which dinosaurs in the diorama are plant eaters versus meat eaters and who's hunting whom.

- Make dinosaur masks on cardboard sheets using templates available from web sites or from books such as Shaffer's *Cut & Make Dinosaur Masks* or Smith's *Dinosaur Punch-Out Masks.* You can also make 3-D masks by coating large inflated balloons with papier-mâché and building out snouts or using grocery bags, cardboard, glue, colorful markers, and other readily available materials.

- Make dinosaur hand puppets by following the directions at www.bgs.ac.uk. Select Discovering Geology, then Time, and finally Prehistoric Puppets and Models, and you'll be led to a site offering cut-out models for crafting Pterosaur, Styracosaur, and T. rex puppet heads, as well as orthoceras nautiloids and trilobites. Fun!

- Craft cut-and-fold 3D models of dinosaurs using free templates from this website: http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx.

- Assemble dinosaur skeletons from chicken bones (see Chris McGowan's books, *Make Your Own Dinosaur out of Chicken Bones* and *T-Rex To Go: Build Your Own from Chicken Bones*). Commercial kits are available from places like Edmunds Scientific for "excavating" bones and/or building skeleton models with wooden or plastic bones. A fun group activity for assembling a 6-foot dino skeleton involves cutting large bones out of cardboard and hiding them around a room. Then hold a scavenger hunt. Once all bones have been found, assemble them with brass fasteners.

- Hold a fact-or-fiction quiz contest game. A site devoted to "Dinosaurs: Facts & Fiction" is on the USGS web site: http://pubs.usgs.gov/gip/dinosaurs/ There's also the book by Scotchmoor, et al., *Dinosaurs: The Science behind the Stories*, 2002.

- Make collections of fossils from the age of dinosaurs. Some parts of the U.S., like Texas, the Dakotas, the Rocky Mountain states, and the West in general, abound in marine and land fossils from the Mesozoic Era, and localities with Cretaceous marine fossils are common on the East Coast and Southeast.

- Make dinosaur footprint molds and casts with clay and plaster and the feet of plastic dinosaur models.

- Simulate the sounds of dinosaurs! Hadrosaurs had large, hollow crests on their heads. Paleontologists believe they used these to "honk" to one another. Using two 3- or 4-foot lengths of PVC pipe joined by a U-shaped connection, you can craft a simulated hadrosaur crest. With a big breath, blast into it as you would with a tuba, blowing air through pursed lips, and the honk of a hadrosaur will fill the air, some 65 million years after the last hadrosaur honk blasted across the land.

- Visit a museum that has dinosaur skeletons or go on a dinosaur-related field trip to a place like a dinosaur track-way park. Daniel and Susan Cohen have written a handy book whose title says it all: *Where to Find Dinosaurs Today* (1992). It's a state-by-state listing with descriptions of museums with dinosaur fossils.

- Send kids on a "Dino Scavenger Hunt." At a monthly meeting, ask them to come to next month's meeting with a list of places they saw dinosaurs. For instance, I've seen them on cereal boxes at the grocery store, on TV cartoons, on lunch boxes, on T-shirts, on gift-wrapping paper, and in the toy store. Did dinosaurs really go extinct 65 million years ago? Hard to tell, given that they still seem to surround us!

- You can find dinosaur activities, quizzes, and more on museum web sites. For instance, enter "Dinosaur Dig" into the search box of the San Diego Natural History Museum web site, www.sdnhm.org. Check for similar sections on the web sites of major museums around the country, such as the Chicago Field Museum, American Museum of Natural History in New York City, Natural History Museum of Los Angeles County, Smithsonian Natural History Museum in Washington, DC, etc.

- A web site offering things like dinosaur trading cards, colorable posters, and craft projects is "Dino Dan," at www.nickjr.com/dino-dan. (We were alerted to this neat web site by Daniel Jones of the Midland Gem & Mineral Society of Texas.)

- To access many dinosaur facts, games, activities, printables, coloring pages, and more, go to "The Teacher's Guide" at http://theteachersguide.com, and enter "Dinosaurs" into the search box.

- In addition to the websites already noted above, one book offers one-stop shopping for all sorts of dino-related sites: R.L. Jones and Kathryn Gabriel's *Dinosaurs On-Line: A Guide to the Best Dinosaur Sites on the Internet* (2000).

- One book with all sorts of dinosaur facts and trivia is Rachel Firth's *Dinosaurs* (2001), in the Usborne Discovery Internet-Linked Series. It offers links to recommended web sites to extend learning beyond the pages of the printed book via the Usborne Quicklinks Website at www.usborne-quicklinks.com, where you enter the keywords "discovery dinosaurs." The featured web sites offer further information, animations, games, activities, and more, including pictures kids can download and use in reports.

In addition to these activities, there's no end of dinosaur activity books geared to every age level. One example is Janice VanCleave's *Dinosaurs for Every Kid.* Another is *Mryna Martin's Dinosaurs: Hands-on Activities*. Myrna Martin began a home-based business called Ring of Fire Science Company in Oregon (www.RingofFireScience.com). Inspired by the eruption of Mount Saint Helens 90 miles from her home, she crafted a set of lesson plans on volcanoes that grew into a whole "Hands-on Science" series. These include her dinosaurs book, which is nicely illustrated with easy-to-follow instructions for 15 fun activities related to dinosaurs.

Check Amazon.com, the kids' sections of bookstores, teacher supply stores, and the web. Just type "dinosaur" into a search engine like Google, and thousands of possibilities spring up! Pick one or more to do a dinosaur activity with your club's kids—and thank Mitty Scarpato (of the Conejo Gem and Mineral Club in California) for suggesting that we include Dinosaur activities in the FRA Badge Program.

Back-up page 3.8: Fossil and dinosaur names.

Fossils, including dinosaurs, often have long names that seem impossible to pronounce but that, somehow, kids seem to master with ease. These names may look strange to English readers because they are often put into Latin or Greek forms.

Teach how dinosaurs and other fossils were named by exploring Latin and Greek root words. Fossils are sometimes given Greek or Latin names for where the fossil was found. For instance, the dinosaur *Utahraptor*, stands for "Utah predator" for a meat-eating dinosaur that was discovered in the state of Utah. Or a fossil is sometimes named in honor of a significant person. For instance, *Darwinius masillae* is a fossil primate named for a Latinized version Charles Darwin as well as for the Latinized place it was discovered: Messel, Germany. Or the fossil may be described—in Latin or Greek—for its characteristics. Thus, *Tyrannosaurus rex* stands for "king of the tyrant lizards" and *Titanosaurus*—the largest of all dinosaurs—stands for the Titans of Greek mythology.

Two websites contain good information on dinosaur names, in particular:

- www.Kidsdigdinos.com/dinosaurnames.htm
- www.bing/images/search?q=%22dinosaur+names*%22&FORM=HDSC2

Myrna Martin's book *Dinosaurs: Hands-on Activities* has a nice table on page 9 showing root words from Latin or Greek and their meanings in English, such as *alto* (high), *cephalo* (head), *crypto* (hidden), *echino* (spiny), *nano* (dwarf), *rex* (king), etc.

As one activity, suppose your junior members discover an entirely new dinosaur and get to name it after your society. For instance, my society's juniors might name it *Venturasaurus* ("Ventura lizard") after the Ventura Gem & Mineral Society. In fact, there already exists a fossil sand dollar called *Dendraster venturaensis*! What would your club's new dinosaur be named?

As an alternative activity, challenge kids to create a new dinosaur or other fossil creature and draw pictures of this new animal or plant. Then have them name it and explain why they gave it that name.

Or, instead of creating and naming an entirely new fossil, ask kids to select a fossil and explore its scientific name. What is the origin of that name? Has it been translated into Greek or Latin? Why was the fossil given that name? Perhaps assign them to write an article about the name for your society newsletter or to give a report at a club meeting.

As a reward, you might give each child a piece of genuine dinosaur bone or a sample of whatever fossil you were using for a naming exercise (a trilobite, crinoid stem, brachiopod, sea urchin, coral, etc.).

Note: *Kids who prepare an oral or written report can use this activity toward satisfying requirements for the Communication badge simultaneously (Activities 7.1 and 7.2).*

4. Lapidary Arts

Many rocks that look dull and uninspiring on the outside harbor a gem within. Lapidary arts allow you to unlock the gleaming beauty. As with any art, successfully completing a lapidary project requires planning, guidance by an experienced mentor, and practice, practice, and more hands-on practice! To start, you should read an illustrated guidebook, such as James Mitchell's *The Rockhound's Handbook* or Pansy Kraus's *Introduction to Lapidary* to learn about the various lapidary arts and to pick a project that interests you. In addition, learn about safety in the workshop. Then jump in and practice, practice, and practice some more—it's fun, and the outcome can be a thing of beauty forever!

<u>Activity 4.1: Learning about lapidary rocks</u>.
Different rocks have different characteristics. Some are hard, some soft. Some are uniform in color, others are banded. Still others are mottled and mixed in color. Learn the qualities of different rocks for lapidary projects, such as soft soapstone or hard agate. List several different rocks and the sorts of lapidary projects they may be good for.

<u>Activity 4.2: Choosing a lapidary project</u>.
Buy or borrow a book on lapidary arts and read about one or more of the arts you would like to try, be it cabbing, faceting, inlay, wirewrapping, silver smithing, beading, carving, and/or rock tumbling. Work with your youth leader to determine the materials and equipment you'll need. Then outline the steps for your project.

<u>Activity 4.3: *Workshop safety and maintenance</u>.*
Note: ***This activity is required to earn this badge*.**
Make a list of safety rules to follow in completing your lapidary project and demonstrate your knowledge of safety in a workshop.

<u>Activity 4.4: *Completing a lapidary project</u>.*
Note: ***This activity is required to earn this badge*.**
Complete your lapidary project.

<u>Activity 4.5 Sharing your lapidary project</u>.
A thing of beauty is a thing to be shared! You can do this in several ways. Bring your finished project to a club meeting to share with friends and explain the steps that went into its creation. Or write an article for your club newsletter describing your project and outlining the steps you took in making it. Or display your work at a club gem show.

<u>Activity 4.6: Gemstone minerals</u>.
Learn about the rarest, most valued of lapidary materials: the precious and semi-precious gemstones. Then write a report about your favorite gemstone for your society newsletter. If you have access to the machinery and a skilled mentor to train you, consider faceting a gemstone crystal or cabbing a star garnet, ruby, or sapphire.

4. Lapidary Arts

□ 4.1 Learning about lapidary rocks.

□ 4.2 Choosing a lapidary project.

□ 4.3 *Workshop safety and maintenance* (required to earn this badge).

□ 4.4 *Completing a lapidary project* (required to earn this badge).

□ 4.5 Sharing your lapidary project.

□ 4.6 Gemstone minerals.

To earn your Lapidary Arts badge, you need to complete at least 3 of the 6 activities. (Please note that successfully completing Activities 4.3 and 4.4 are required to earn this badge.) Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

______________________________ ______________________________
My signature | Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 4.1: Learning about lapidary rocks.

The goal of this activity is to orient and familiarize kids with the most commonly used lapidary materials. For beginners, you should focus on the more inexpensive and commonly available forms such as agate, jasper, onyx, and soapstone.

- Agate (a hard stone that is easy to work and to polish; good for cabbing)
- Jasper (similar to agate in taking an easy polish; good for cabbing)
- Flint (good for knapping to make arrowheads and spear points, utilizing proper safety precautions; also good for cabbing)
- Petrified Wood (good for cabbing, book ends, specimens for display; one problem, though, is that petrified wood has a tendency to split or flake)
- Soapstone (a very soft rock especially good for beginners to rock carving)
- Travertine Onyx (a soft rock good for carving)
- Alabaster (another soft rock good for carving)
- Marble (a bit harder than travertine onyx or alabaster but still excellent for rock carving; takes a good polish)

Except for quartz and garnet, the following stones are much more expensive and/or require more skill to work:

- Opal
- Jade
- Lapis
- Amber
- Stones for faceting and/or cabbing: varieties of quartz (clear, rose, amethyst, smoky, citrine), topaz, tourmaline, emerald, aquamarine, peridot, garnet, corundum (ruby and sapphire), diamond

Encourage adult club members to bring in examples of finished cabs, carvings, faceted stones, and other projects they've done. They also should bring examples of the rough material from which the finished stones were crafted to show your kids "before" and "after" pieces. Give kids a good, well-rounded look at the variety of lapidary rocks, from those most readily available and relatively easy to work (agate, marble, etc.) to the most precious and expensive of stones requiring great skill on the part of the lapidary artist (rubies, sapphires, emeralds, and diamonds). Keep the focus, though, on the more common stones suitable for those just beginning in the lapidary arts. Use Activity 4.6 to take kids into the more rarified part of the hobby with precious gemstones. After presenting rocks various sorts, quiz the kids about what rocks they think might work best for different sorts of projects.

Back-up page 4.2: Choosing a lapidary project.

Types of Lapidary Projects to Choose From.

The choice of a lapidary project should be matched to the age level and abilities of your club's kids and youth. Following are some sample projects, starting from simpler ones appropriate for younger members and progressing to more difficult ones that would challenge even your adult club members:

- **Rock painting.** Paint designs or pictures on flat, smooth rocks, or transform round stones into bugs, turtles, bunnies, etc., with enamel, acrylic, or tempura paints.

- **"Pet Rocks" & "Rock Critters."** Stack and glue small stones together like snowmen to make animals and people; use tempora paints, incorporate glue-on "google" eyes, pipe cleaner arms and legs, feathers, and other ornaments, then make up a story about your pet or critter.

- **Light-catchers.** Glue tumble-polished agates or beach glass onto translucent plastic container lids and insert a wire or fishing line to hang the creation against a window using a plastic suction cup and hook sold at many craft stores.

- **Sand art.** Colored sands (available with aquarium supplies), white glue, and cardboard or small plywood sheets can be used to make sand art pictures and designs.

- **Wind chimes.** Starting with 8- to 15-inch wooden rods or driftwood limbs, space screw eyes 1- to 1.5-inches apart. Attach varying lengths of fishing line or base metal chain to each eye. Then attach agate slabs, seashells, or obsidian needles with bellcaps or glue-on leaf bails and jump rings.

- **Rock tumbling and "free-form" jewelry.** Tumble small agates and jasper and top the best pieces with bell caps and jump rings to make necklaces and dangling pieces for bracelets or key chains. You also can insert tumbled stones into "wire cages." These are pre-made oval-shaped spirals of wire (available from dealers selling findings and other jewelry supplies) into which you can slip a tumbled stone to craft a pendant in no time. Or kids can wire-wrap tumbled stone using cooper, brass, or silver-plated wire.

- **Other tumbled stone projects.** The easiest way to turn tumbled stones into art is to pile them in a bowl or glass vase to decorate a tabletop. Or glue them, along with seashells, in the shapes of flowers or other designs to the backing of a picture frame. You also can coat a flower pot with wet plaster of Paris or self-hardening clay and press tumbled stones into the plaster or clay before it sets for a mosaic or inlay effect. If you have a club member with a drill who can drill a large number of tumbled stones for you kids, you can teach them to make bead necklaces with free-form tumbled stones. The more you experiment, the wider range of projects you'll find for turning tumbled stones into lapidary art!

- **Polishing soft stones by hand.** Relatively soft stones (opals, Petoskey stones, alabaster, or travertine onyx) can be sanded and polished by hand with wet-or-dry emery sandpaper in coarse, medium, and fine grits. You can purchase 8.5X11-inch sheets of sandpaper and cut them into quarters for each child. After working through the three grits, kids coat a square of leather with a polishing compound like aluminum oxide and water to work up a final polish. This process is easier if you first cut small cabs and mount them on dop sticks for each child in your group.

- **Cabbing.** Create domed cabs for brooches, belt buckles, necklaces, and bolo ties.

- **Flat-lapping.** Create bookends or polished agates, geodes, and thunder egg halves.

- **Beading.** Craft wire-wrapped rings, bracelets, brooches, ear rings, or necklaces with natural and synthetic beads and supplies purchased from a bead store. Learn pearl knotting, proper ways of attaching clasps, and how to size a bead or cabochon.

- **Wirewrapping.** With brass or copper wire, turn fossil shark teeth into necklaces or wrap a cab to hang from a necklace.

- **Gemstone trees.** Small, polished gemstone chips from a tumbler can be transformed into leaves when glued onto tree limbs swirling out of twisted copper wires.

- **Carving and sculpting.** Soft rocks like soapstone or alabaster can be carved and shaped fairly easily with metal awls, files, and sandpaper.

- **Knapping.** Turn flint, agate, or obsidian into arrowheads and knife blades. Knapping, though, can lead to nasty cuts, so appropriate training and precautions, along with eye protection, are mandatory!

- **Scrimshaw.** Sales of ivory have been banned in the U.S., but one way to continue the long New England tradition of scrimshaw is by inscribing and inking scenes onto tagua nuts. You can also use materials such as antler or bone.

- **Intarsia, inlays, and mosaics.** This craft required much precision and patience.

- **Sphere making.** You'll need an expensive machine and a lot of saw cuts!

- **Faceting.** This requires expensive machinery and a lot of time and patience.

- **Forging glass beads.** Due to the fire hazard, this is for your oldest juniors.

- **Metal smithing.** Due to working with torches, this, too, is for your oldest juniors.

Resources to Guide You in Choosing and Practicing a Lapidary Art.

Many magazines and books provide good ideas for lapidary projects, and don't overlook your own fellow club members!

Magazines:

- *Rock & Gem*
- *Lapidary Journal Jewelry Artist*
- *Gems & Gemology*

Books:

- Ann Benson's *Beadwork Basics* (Sterling Publishing Company)
- Jack R. Cox's *Cabochon Cutting* (Gem Guides Book Company)
- Henry C. Dake's *The Art of Gem Cutting* (Gem Guides Book Company)
- Pansy D. Kraus's *Introduction to Lapidary* (Krause Publications)
- Tim McCreight's *The Complete Metalsmith* (David Publishing, Inc.)
- Jinks McGrath's *Jewelry Making* (Chartwell Books, Inc.)
- James R. Mitchell's *The Rockhound's Handbook* (Gem Guides Book Company)
- Edward J. Soukup's *Facet Cutters Handbook* (Gem Guides Book Company)
- J. Wexler's *How to Tumble Polish Gemstones* (Gem Guides Book Company)

Web sites:

The Rio Grande company (suppliers of lapidary materials) allows you to access free how-to video clips on varied lapidary projects. Go to their web site, www.riogrande.com, and click on "Learn with Rio."

Your Own Local Experts:

In addition to books and videos, draw from the experience of your own adult club members in helping kids learn about the various lapidary arts they might try. Many clubs have an expert in cabbing, another in faceting, another in metal smithing, etc. In the Ventura (California) Gem and Mineral Society, member Wayne Ehlers would sponsor cab-making workshops for kids and adults alike, and he prepared a set of handouts. In basic, step-by-step fashion, these included instructions for making a cab, useful hints, and a glossary of lapidary terms (what's a cab? a blank? a preform?). Who are the most experienced lapidary artists in your club? Work with them to prepare a set of handouts with simplified instructions and guidelines to distribute to your junior members, with emphasis on one or two basic arts (e.g., cutting and shaping a cab, wirewrapping, soapstone carving, rock tumbling and making freeform jewelry) to get kids' feet wet.

Back-up page 4.3: *Workshop safety and maintenance.*

Note: ***This activity is required for kids to earn the Lapidary Arts badge.***

Before kids are allowed to flip on a single power switch in a workshop, they should be required to read and sign a sheet outlining workshop safety rules and learn about all equipment. Machinery can be dangerous. Help kids learn how to operate rock saws, grinding wheels, and other tools safely, and make sure experienced adults are present in helping them through their projects. Whether working with kids or adults: safety first!

There are all sorts of lapidary arts, each requiring different materials, tools, and procedures. Also, according to Murphy's Law, anything that can go wrong will go wrong. Thus, no listing of safety rules can ever be complete, and any listing that tried would end up filling several volumes. There are, however, some basic safety rules. Kids should be encouraged to create their own set to match the project they undertake. Here are a few examples:

- Always have at least two people in the shop when equipment is in operation.
- Keep your workspace neat and organized and your equipment clean and in good condition; clean up equipment immediately after each use.
- Learn about equipment before flipping the "on" switch; know your equipment: read manuals and take note of manufacturers' safety precautions and warnings.
- Stock a first-aid kit in your workshop, along with an emergency phone number.
- Keep a fire extinguisher in your workshop and be sure it is in good working order.
- Decide what you need for your project ahead of time, and then have all necessary materials and equipment close at hand.
- Don't walk away and leave running equipment unattended; turn off machines if not being used.
- Wear safety glasses or goggles when hammering, sawing, grinding, etc.
- Keep a workplace thoroughly ventilated to avoid breathing rock dust or fumes from adhesives and, if necessary, wear a facemask to protect your lungs.
- If dry sanding, check frequently to make sure your stone does not overheat, and wear a facemask and/or work with a suction ventilating device.
- Diamond saw blades should not be run dry because the heat generated will ruin them; always use a lubricating coolant with a diamond saw blade.
- Don't overload electrical circuits.
- Make sure any belts connecting grinding wheels or saws to motors are shielded.
- Don't wear loose sleeves when working with saws or grinding wheels and tie back long hair.
- Keep electric motors and switches dry and grounded to prevent electric shocks.
- Don't allow grinding wheels to soak up water while idle to avoid unbalanced wheels.
- When grinding small stones or grinding without a dop stick, you can protect your fingers by wrapping the tips in tape or bandages.
- Don't use too much pressure when sawing or grinding stones; let the blades and grinding stones to the work.

Back-up page 4.4: *Completing a lapidary project.*

Note: ***This activity is required for kids to earn the Lapidary Arts badge.***

Your club should prepare a good supply of agate and jasper slabs, chunks of soapstone, petrified wood, onyx, and other rough materials. These should be on hand along with spools of wire, bell caps, etc., to give kids a plentiful supply of material with which to experiment and practice in crafting lapidary projects. Wire, bellcaps, and other lapidary mountings, findings, and materials may be purchased from dealers at gem and mineral shows or at rock shops, bead shops, variety hobby stores such as Michael's or Ben Franklin, or via cataloguers such as Rio Grande, Kingsley North, Diamond Pacific, Fire Mountain Gems and Beads, and others.

Then, you should schedule and sponsor several supervised sessions with as many adults assisting to give kids as much one-on-one guidance as possible, with parental attendance required as well. Don't leave kids on their own to satisfy the requirements for this badge. As with any art, successfully completing a lapidary project requires training and planning, and then practice, practice, and more practice, under the watchful eye of an experienced mentor.

Cabbing Without a Workshop.

Relvan Zeleznik of Stamford, Connecticut, shared this activity for those juniors groups not allowed to work in the adults' workshop or for those whose societies lack workshop facilities altogether. If you're facing such a challenge, you can turn to other activities described in Activity 4.2 (rock tumbling, beading, wirewrapping, etc.). Still, there is a way, described by Relvan, for kids to learn the basic principles of cabbing and producing a nice, finished cabochon. For this, you'll need someone in your club who can slab and cut soft stones (opals, common opal, Petoskey stone, alabaster, travertine onyx, etc.) as small, thumbnail-sized preforms. If you don't have a club member who can prepare these, you might approach a dealer for a supply.

Dop the stones atop nail heads with dop wax and give one to each child, along with small square sheets of coarse, medium, and fine wet-or-dry emery. Start with the coarse emery. Placing the sheet in your palm, add a few drops of water and begin grinding the stone against it using a rocking, twisting, circular motion. Grind, adding drops of water as necessary, until the cab is domed and smooth. Then rinse the stone and wipe it clean and repeat with medium and then fine emery. For a final polish, give each child a small leather pad dabbed with a light frosting of aluminum oxide polish mixed with water on the rough side of the pad. (This can also be done on the back of one of the emery paper sheets.) To remove the stone from the nail, place it in a freezer for just a few minutes; it should pop right off with gentle pressure. While the results may not be as shiny and even as if done with an expensive Genie, this "poor man's Genie" ain't bad for a first-time cabbing experience.

Back-up page 4.5: Sharing your lapidary project.

Encourage kids to bring a finished lapidary project to a club meeting to share with friends and to explain the steps that went into its creation. Or you might have them write brief articles for the club newsletter to describe their projects and to outline the steps taken in making them. Finally, as a third possibility, you might help them create an exhibit for your local gem show. Such an exhibit could be devoted to a single lapidary art, showing all the steps that went into crafting the finished item (for instance, showing how a rough rock was slabbed, preformed, ground, polished, and then set in a finding), or it might be an exhibit showcasing a variety of finished works crafted by a number of the club's kids.

Note: *Kids who prepare an oral or written report can use this activity toward satisfying requirements for the Communication badge simultaneously (Activities 7.1 and 7.2). Those who display their lapidary work in a case at a gem show or some other public venue can use this activity toward satisfying requirements for the Showmanship badge (Activity 6.4).*

Back-up page 4.6: Gemstone minerals.

Activity 4.1 introduces kids to a full range of lapidary rocks with emphasis on the most readily available and affordable stones that are relatively easy to cut and work. These include materials like agate, jasper, marble, or soapstone. Activity 4.6 shifts to the true rarities of the lapidary world: the precious and semi-precious gemstones.

The term "gemstone" can be applied not only to minerals but also to certain rocks and organic materials. The common denominators are that they tend to be colorful and rare and can be polished and/or cut to be used for jewelry or other ornamental purposes. Once cut and polished, they are referred to as gems. Gemstone rocks include charoite, lapis lazuli, and jade. Organic gemstones include pearls, jet, ivory, coral, and amber (all produced by once-living organisms).

Although certain rocks and organic materials have been classified as gemstones, most commonly we associate minerals as gemstones, and mineral gemstones are divided into two groups: precious and semi-precious. Precious gemstones are the most rare, beautiful, and durable. They are hard on the Mohs scale (7.5-10). All experts categorize three minerals as precious gemstones: diamond, corundum (varieties sapphire and ruby), and beryl (variety emerald). Some also include pearl, jade, beryl (variety aquamarine), topaz, and opal. Value increases with size, color intensity, clarity, and perfection of a stone. Semi-precious gemstones, while still rare, are usually more abundant and include such minerals as garnet, zircon, peridot, quartz (varieties amethyst and citrine), and tourmaline. They tend to be softer than precious gemstones (around Mohs 5-7).

Precious and semi-precious gemstones vary from transparent to translucent or even opaque. If transparent, they are usually faceted. If translucent to opaque (like jade, jet, turquoise, star rubies, or star sapphires), they are usually cut as cabochons or carvings.

Whether precious or semi-precious, clear or opaque, if it's rare, beautiful, and highly desirable for jewelry, it's a gemstone! Enlist adult members of your society who have both natural and faceted or cabbed specimens to do a show-and-tell presentation on precious and semi-precious gemstones and gems for your society's kids. Then encourage each junior member to select a favorite and to write a brief article for your newsletter. Encourage them to illustrate the articles with drawings or photographs of the gemstones they've selected.

If you have access to the machinery and a skilled and willing mentor within the ranks of your adult members, consider giving faceting classes to your more advanced juniors who seem up to the task, or assist them in cabbing a star garnet, star ruby, or star sapphire.

Note: *Kids who write a report about gemstones for Activity 4.6 can simultaneously satisfy requirements toward earning their Communication badge (Activity 7.2).*

5. Collecting

Kids of all ages love to collect, and most rockhounds are pack rats at heart. We like nothing better than to assemble an assortment of rocks found on our journeys, traded with fellow collectors, or purchased at gem shows and rock shops. A proper collection, however, is more than a bunch of rocks and/or fossils tossed into a box. The value of a collection lies in its "curation," or in the information included with your specimens: what it is, where it came from, who collected it, and other unique information. The collection also should be properly organized and stored so individual specimens can be cared for and retrieved easily. Curating your treasures provides an opportunity to learn about the specimens you've collected while improving both the scientific and economic value of your collection. Here are some activities toward these goals:

<u>Activity 5.1: Building a collection</u>.
Build a rock, mineral, fossil, and/or lapidary art collection with at least 10 to 20 specimens. A collection can focus on just one sort of thing (a collection of minerals, a collection of fossils, a collection of jewelry), or it can be a mixture of all these things. Some people get very specialized, collecting, for instance, different kinds of shark teeth or different forms of quartz. Ultimately, a collection reflects the interests of the collector.

<u>Activity 5.2: Cataloging and labeling your collection</u>.
Take care to curate your collection. Number your specimens and, for each one, include a label and keep a logbook or catalog with key information. For rocks and minerals, this includes what it is and where it came from. For fossils, you should include both those facts as well as information about the age of the fossil. Labels for a lapidary project might include what it is, what it's made from, when it was made, and who made it.

<u>Activity 5.3: Storing a collection</u>.
Store your collection. Each specimen should be in its own small box or baggie. The small boxes might then be kept in trays, shoe boxes, cigar boxes, shallow shelves, soda flats, or whatever works best for you and the space you have to store your collection.

<u>Activity 5.4: Displaying your collection</u>.
Prepare a display to exhibit to your fellow pebble pups at a club meeting or to show to the public in a club show. In this display, you should include not just your specimens but also labels to tell your viewers what it is they're seeing. (See Badge 6: Showmanship.)

<u>Activity 5.5: Reporting about your collection</u>.
Give a presentation or write an article for your club newsletter or a report for your youth leader about your collection. For instance, what do you like to collect and why? Do you have any special stories to tell about 2 or 3 of the specimens in your collection? If you have a mineral collection, what's your most valuable mineral and why? If you have a fossil collection, what's your oldest fossil? Youngest? Most interesting? If you have a collection of lapidary arts, describe how a particular piece was made. (See Badge 7: Communication.)

5. Collecting

□ 5.1 Building a collection

□ 5.2 Cataloging and labeling your collection

□ 5.3 Storing a collection

□ 5.4 Displaying your collection

□ 5.5 Reporting about your collection

To earn your Collecting badge, you need to complete at least 3 of the 5 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

______________________________ ______________________________
My signature Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

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Back-up page 5.1: Building a collection.

Collections come in many sorts. Some people try to collect as many different minerals or fossils as possible to create a "reference or species collection." Because it's nearly impossible to collect a sample of every mineral of fossil in existence, most choose to specialize with a "specialty collection" focusing on just one or more areas, for instance, fluorescent minerals, trilobites, agates, ore minerals, etc. Then there's a "locality collection" with specimens from just one area or country, or even just one quarry. Some opt for a "self-collected collection" of minerals or fossils they have personally found on field trips. A "gem collection" consists of precious and semi-precious stones that are used for jewelry. There are also historical collections, native element collections, type locality collections, systematic or Dana collections, and more. The collection, ultimately, reflects the interests of the collector. A couple nice reference books are Krause's *Mineral Collector's Handbook,* 1996, and Currier's *About Mineral Collecting*, 2008/2009.

To help illustrate the range of collectibles, have adult members of your club bring in examples from their collections. For instance, in my own club we have one member who specializes in trilobites and has a collection of literally thousands of the little bugs. Another member loves petrified wood and has assembled a collection of beautifully polished rounds from around the world. Yet another only self-collects and has an array of natural mineral specimens he's found in the deserts of California and Nevada. Yet another member loves to self-collect agates and jasper in their many forms and to craft what he finds into cabochons; he's got a great collection of cabs in all the colors of the rainbow along with samples of the rough from which they were made. Still others have colorful collections of polished banded agates, personally faceted gemstones, an assortment of fossil insects, and so on.

Adult members sharing samples from their collections will illustrate to kids the range of possibilities for creating their own collections. It's also neat for kids to hear stories from adults of their adventures as kids (especially any funny stories and misadventures) and what got them started in collecting the things they do.

In encouraging kids to collect, also teach responsibility. For instance, discourage "over-collecting" in the field. We should take only what we need and can reasonably use and leave some for those who might follow us. We should respect private property and protected items and report any rare or especially unusual items to a museum or other authority. Federal and state laws protect some items, for instance, vertebrate fossils or Native American artifacts. Refer kids to the AFMS Code of Ethics included with Back-up page 8.1. Finally, kids should strive to learn about the items they collect and should record observations and notes about what they've collected (see Activity 5.2) to turn the activity of collecting into an educational opportunity.

Note: *Because several other badges involve building a collection, kids can work toward earning their Collecting badge and other badges simultaneously. For instance, see Activities 1.3 and 1.4 (Rocks & Minerals), 2.3 (Earth Resources), 3.4 (Fossils), 10.1, 10.3, 10.4, and 10.5 (Earth Processes), 11.4 and 11.5 (Earth in Space), 12.6 (Gold Panning & Prospecting), 14.1 (Stone Age Tools & Art), 16.1 through 16.7 (The World in Miniature), and 18.3 (Fluorescent Minerals).*

Back-up page 5.2: Cataloging and labeling your collection.

Properly caring for, or curating, a collection greatly improves both its scientific and economic value. Kids should be taught how best to curate the rocks, minerals, and fossils they collect and the lapidary works they create. Detailed information about the collection as a whole and the specimens contained within it should be kept in a logbook or catalog using 3X5 or 5X7 notecards, a notebook, a loose-leaf binder, etc., or in an electronic database. Then, for each specimen, a label should be created.

The Logbook or Catalog.

A logbook or catalog provides a systematic resource for recording and retrieving information about the contents of a collection. Collectors are generally encouraged to number their specimens, placing a dab of white paint or typist's correction fluid in an inconspicuous spot that won't show if the specimen is exhibited, and writing a specimen number in black India ink. Sometimes you can write directly on the specimen without the use of paint. Once the ink has dried, you might coat it with clear nail polish.

There's no one, universal way to number a collection, and each collector must choose a system that works best for his or her collection and preferences. The simplest method is starting with the first specimen you've collected and consecutively numbering each subsequent specimen: 1, 2, 3, 4, etc. However, it's more useful to use a number system that incorporates descriptive information. For instance, I've organized my fossil collection by geological period or epoch and then by locality. So I have trays for the Eocene Epoch that are subdivided by localities. All fossils collected from the Eocene Epoch are given a number starting with "E" for Eocene. Then they're given a locality designation: "O" for Ojai, California, "P" for Pender County, North Carolina, "K" for Kemmerer, Wyoming. Then each fossil from a specific locality is numbered starting with "1." Thus, my Eocene fossils from Kemmerer, Wyoming, are numbered EK1, EK2, EK3, etc., and my Eocene fossils from Ojai, California are numbered EO1, EO2, etc.

A mineral collection might be numbered by a specific locality, county, state, or country. Thus, all your minerals from Brazil might be labeled B1, B2, B3, etc., with "B" standing for Brazil. Or you might choose to number by type of mineral. Thus, all your quartz specimens might be numbered Q1, Q2, Q3, etc., where "Q" stands for quartz, while your fluorite specimens are numbered F1, F2, F3, etc.

A collection of lapidary arts might be numbered by the sort of artwork (grouping all cabs together under "C," all faceted stones under "F," etc. Whether the simple system of just 1, 2, 3, 4, 5, etc., or a more complex system incorporating locality and age information, the important things are to pick a system that proves most useful to you and that records essential information that it's all-too-easy to forget years down the road.

Once you've settled on a system and have begun to attach numbers to your specimens, the number for each should be recorded in the logbook or catalog along with other key information. For rocks and minerals, this includes what it is and where it came from. If the specimen is self-collected, you should record detailed information about the collecting site, including written directions and a map for how to get to it. If you purchase a specimen, you should get as much information as you can from the dealer about where the mineral came from, including, if possible, a specific location or mine. (This is one way to separate truly excellent dealers who are interested in the scientific value of minerals from those who are in it just to make a buck and who don't take the care to record and keep such information.) You might also record when you collected or purchased the specimen.

A complete catalog entry for a mineral might include the following fields:
- Specimen number assigned to the mineral.
- Common name of the mineral, along with variety.
- Locality where the mineral was found.
- An indication as to whether it was self-collected, traded, purchased, or a gift.
- Name of the person who collected it.
- Date it was collected, purchased, traded, or given as a gift.
- If purchased, name of the dealer and the price and any info about previous owners.
- Miscellaneous notes, including directions and map to the locality if self-collected, and notes about the collecting site.

For fossils, you should include all of the above as well as information about the scientific name of the fossil and its geological age:
- Specimen number assigned to the fossil.
- Common name of the fossil.
- Taxonomic information, including the scientific name of the fossil. (You may get as detailed as you like with this, but most include at least the Genus and Species.)
- Age of the fossil. (The more detail, the better. At the very least, you should record the geological Period or Epoch; at best, you should include the Formation and even the specific horizon within a Formation.)
- Locality where the fossil was found.
- Name of the person who collected it.
- Date it was collected or purchased.
- If purchased, name of the dealer and the purchase price.
- Miscellaneous notes, including directions and map to the locality if self-collected, and notes about the collecting site.

An entry for a lapidary project might include a specimen number, what it is, what it's made from (and the purchase price of the individual components, or information about where you collected or purchased the rough material to use in your project), when it was made, who made it, and estimated value. You might also include notes about any special techniques and equipment used to create your project.

It is seldom that any of us are compulsive enough to record all the information I've indicated, but the effort is worth it for enhancing the ultimate value of a collection, and you should encourage kids to make cataloging a routine part of their collecting activity.

Labels.

A label is simply an abbreviated version of the full catalog entry, capturing only a few key points that will fit on a card small enough to store with a specimen or to show alongside a specimen in a display. For a mineral, at the least you should include the common name of the mineral and its locality. For a fossil, you should include the common name, scientific name (Genus and Species), locality, and age (period or epoch). For a lapidary project, you might include what it is, what it's composed of, and who made it (e.g., a Jade Vase, created by Jane Doe.) While the above may be fine for most purposes, if entering competition in an AFMS or a regional federation show, you'll find specific requirements for labeling contained within the AFMS Uniform Rules, which should be consulted for different categories of displays: www.amfed.org/rules/rules.htm.

Electronic Data Keeping.

As a collection grows, it can become increasingly difficult to remember and keep track of your specimens, even if recorded in a handwritten logbook. Also, a handwritten logbook can prove inflexible to use. One invaluable alternative is the computer. You can use the database or spreadsheet functions that come packaged with most computers to create your own electronic catalog, or you can turn to commercially available software. For instance The Fredrick Group sells "TFGCollector" custom-made software for cataloging facts about a rock or fossil collection. (The Fredrick Group, Inc., P.O. Box 1698, Cumming, GA 30028, phone 866-679-9284, www.fredrickgroup.com.) Also, Carles Millan has created free software for cataloguing mineral collections that can be downloaded at http://carlesmillan.cat/min/main.php.

Advantages of a computerized database are the ability to easily edit information and to quickly and easily pull up information about a specific desired field. For instance, if you have a quartz collection from around the world, you might want to pull up the records for just your amethyst specimens. Or perhaps you're putting together a display of quartz specimens from a single country or region. A computerized database makes it relatively easy to pull up related files like these. With digital photography, some collectors even incorporate photos of collecting sites and their individual specimens into their databases to make it even easier to match an entry in a catalog with a specimen in a drawer.

Cataloging and Labeling Group Activity.

Turn cataloging and labeling into a group activity! Have kids bring parts of their collections to a meeting and work with them to devise numbering systems. Then work further to identify, label, and store specimens, thus giving them hands-on experience before going home to catalog and label the rest of their collections.

Note: *Kids who create an electronic catalog can use this activity to satisfy requirements for earning the Rocking on the Computer badge simultaneously (Activity 15.4).*

Back-up page 5.3: Storing a collection.

Just as there are many individual ways to catalog a collection depending upon the nature of the collection and the preferences of the collector, so there are different sorts of storage methods and containers. The methods and containers tend to evolve with a collection, progressing from cardboard boxes to fine cabinetry with shallow trays and drawers.

As young children, many of us began with simple egg cartons, which are actually perfect for holding and sorting small specimens. Individual cups separate each mineral or fossil. And that's the main thing in choosing a storage method: keeping individual specimens separate from one another so that labels don't get mixed up. Actually, this isn't a problem if you've affixed a number to each specimen and have kept a record of that number in a catalog, but you still want to make sure minerals or fossils don't rub against one another, causing unwanted scratches, chips, or dings. So you want a system like an egg carton with its individual cups. A similar, sturdier option is the plastic box with hinged lid and square compartments sold in crafts stores for beads or with fishing tackle.

Lapidary supply houses and dealers at some shows sell fold-up cardboard boxes in a variety of sizes. You should also collect small cardboard containers whenever you can. For instance, the cardboard boxes that hold greeting cards, match boxes, or even the cut-off bottoms of milk cartons make great specimen containers. You might also store specimens in small plastic baggies. Your boxes or baggies with individual specimens and their labels can then be organized and stored in cardboard soda flats to hold a whole collection. Get soda flats of two slightly different sizes so that one can serve as a top to protect a collection from dust and so that you can stack a collection as you fill more and more boxes. Shoeboxes and cigar boxes also work well for holding various specimens. Also, boxes that hold reams of typing paper can make great flats by trimming the bottom down to match the top to create a perfect storage box with lid.

A nice container for both storing and displaying a collection is a Riker mount. This consists of a sturdy cardboard bottom filled with cotton. Specimens are arranged in the cotton. Then a top with glass is fitted over and held in place with pins.

The most sophisticated and permanent way of storing a collection is in a unit of wooden shelves or trays kept in a cabinet. I've built several of my own and found it to be a lot easier than I initially imagined. Or, if you can afford it, you can buy shallow shelves meant for storing maps or art supplies or wooden or metal shelves built for mineral and fossil collections from scientific supply houses, like Ward's. But such professionally produced units can easily run into the thousands of dollars—not an option for the budget of 99.9 percent of the kids I've ever worked with!

As an activity, bring in a variety of shoeboxes, cigar boxes, cardboard flats with lids, plastic fishing tackle and crafts boxes, and small boxes and baggies to talk about organizing a collection with hands-on examples. Follow this up at your next meeting by having kids bring in examples of how they've decided to store their collections.

Back-up page 5.4: Displaying your collection.

Back-up pages for Badge 6 on Showmanship provide information on where and how to display. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 5.4.

Note: *Kids can use this activity to satisfy requirements toward earning the Showmanship badge simultaneously (Activity 6.4).*

Back-up page 5.5: Reporting about your collection.

Back-up pages for Badge 7 on Communication provide information on preparing an oral or written report. You should refer to those back-up pages for reference in assisting kids in satisfying Activity 5.5.

Note: *Kids can use this activity toward satisfying requirements for the Communication badge simultaneously (Activities 7.1 and 7.2).*

6. Showmanship

A fun part of collecting and the lapidary arts is sharing what we've found or made. When displaying at a local gem show, we not only get to "show off" our own collections but also to learn from others, getting advice, sharing tips, and forging bonds of friendship through mutual interests. But building an effective display involves more than getting a glass-fronted box and throwing in a bunch of rocks. Before you enter an exhibit into a show, county fair, or elsewhere, you should learn the rules of effective showmanship.

<u>Activity 6.1: Techniques for effective displays</u>.
Learn the techniques of assembling an effective display, such as balance, color coordination, labeling, and lighting. List them from memory.

<u>Activity 6.2: Holding a workshop on display ideas</u>.
Hold a workshop with fellow club members to discuss display ideas. Have a display case at hand and see what happens when you use various types of materials as background liners (light versus dark materials; plain versus patterned cloth; etc. What happens when you vary the lighting or use risers or stands to raise display specimens?

<u>Activity 6.3: Observing and evaluating displays</u>.
Either alone or with a group, visit a museum with rock displays or a gem show with exhibits. Carefully observe the displays, taking note of what catches your eye as being effective or not so effective. Make a checklist of techniques for effective displays and judge the displays you see against the checklist. Then hold a discussion about what works and what doesn't in a display. How could the displays you saw be improved?

<u>Activity 6.4: *Making your own public display</u>.*
Note: ***This activity is required to earn this badge.***
Gather together the best of your rock, mineral, or fossil collection or your lapidary artwork and prepare a display for public exhibit. Good settings for displays include your school, county fairs, libraries, a local museum, a rock club show, or a science fair. Such a display might be done individually or collectively. If collectively, your club might approach a public library about doing a display for a month. Libraries like to do this, and they often use it as an opportunity to highlight their books on that particular topic.

<u>Activity 6.5: Entering competition</u>.
Enter into competitive display at your regional show, at a county fair, or elsewhere. Competitions usually have very specific sets of rules or guidelines that all entrants must follow. Work with your youth leader to make sure you understand whatever rules may be in place for the competition you enter.

6. Showmanship

□ 6.1 Techniques for effective displays

□ 6.2 Holding a workshop on display ideas

□ 6.3 Observing and evaluating displays

□ 6.4 *Making your own public display* (required to earn this badge)

□ 6.5 Entering competition

To earn your Showmanship badge, you need to complete at least 3 of the 5 activities. (Please note that successfully completing Activity 6.4 is required to earn this badge.) Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____

Date completed

__________________________________ ____________________________________

My signature | Youth leader's signature

____

Name of my club

Leader's preferred mailing address for receiving badge:

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Back-up page 6.1: Techniques for effective displays.

For detailed background on displays, you might purchase Patricia Mummert and William Shelton's *Exhibiting: The Show Biz Aspect of the Hobby*, available from the Eastern Federation of Mineralogical and Lapidary Societies. Help your kids develop a "tip list" of do's and don'ts of effective displaying. For instance, kids should learn such rules as:

- *use neutral liners to highlight, not detract from, specimens*

Display cases often look best when lined with cloth wrapped tightly around sheets of cardboard or plywood cut to fit snuggly along the case sides and bottom. Two rules govern choice of cloth. First, you want the viewer's eye to focus on your specimens, not the background; choose a cloth that's neutral in appearance. Avoid patterns (spots, checkers, paisley, stripes) and avoid cloth that's glossy and reflects light or that's garish in color. Plain linen, canvas, or burlap in a neutral color usually works best. Second, choose a color that will highlight your specimens. Dark specimens can get lost against a dark liner; instead, use pastel shades of light blue, tan, eggshell white, etc. If displaying light-colored specimens, a dark liner (black, navy blue, dark olive green) may be more appropriate. Choose a color that enables your specimens to "pop" in the viewer's eyes.

- *use balance (in size of specimens, colors, and arrangement) to guide the viewer's eye across a display in an aesthetically pleasing way*

Choose specimens that compliment one another in size and shape and arrange them symmetrically around a center. A large specimen shoved to the side of a case can make a display look lopsided. However, a single large piece placed in the center and surrounded by smaller pieces can provide a pleasing effect. If using risers, place larger specimens toward the bottom of the case and smaller ones toward the top to lend a sense of "gravity" to the display. If displaying colorful minerals, arrange the colors in a way that provides interest to the viewer; for instance, alternate dark and light colored minerals.

- *use neat, clear labeling that's both precise and concise and large enough to read*

Handwritten labels with spelling errors on jaggedly cut pieces of paper leave a bad impression. If possible, you should use labels that are typed in large, bold print that is easily read from a distance, and labels should be uniform in size. Keep information on a label to a minimum; the centerpiece of a display should be the rocks, minerals, fossils, or lapidary pieces, and the labels should provide back-up info but shouldn't steal the show.

- *use lighting that's neither too bright nor too dim and that shines evenly across a case*

Most cases include lights, which is essential to best highlight your display. At most federation-sponsored shows, no more than 150 watts of lighting is usually recommended. Light should fall evenly throughout the case, with no round spotlights or shadows.

- *finally, consider using a theme or story to tie a display together*

This is especially effective for educational displays that illustrate a process; for instance, the steps in how to make a cab, moving from rough material at one end of the case to stones that are polished and set in a mounting at the other end. Or you might display a grouping of minerals or fossils from one locality or formation; or one sort of rock (for instance, an agate collection) or fossil (a collection of trilobites).

Back-up page 6.2: Holding a workshop on display ideas.

Once your kids are familiar with the basics of assembling an effective display, hold a seminar at one of your monthly meetings to review those basics in an interactive manner. Such a seminar should be hands-on, with a display case front-and-center to vividly illustrate display techniques.

For instance, bring in different sorts of liners to show how specimens can get lost against a "busy" background of plaid or paisley versus how they can be highlighted against a neutral background. Demonstrate how dark specimens "pop" more effectively to the eye against a background of beige, eggshell white, or light blue but get lost against a black background. Conversely, show how light-colored specimens are enhanced against that same black background.

Show the difference that lighting can make, starting with no light at all, and then illustrating problems of high-wattage light bulbs that glare or bulbs that are too small and that create "spotlighting" effects within a case.

Demonstrate appropriate use of labeling. Show labels that are too large and too crammed with dense text versus those that are small, simple, and convey "just the facts, ma'am." Illustrate the difference between hand-written labels cut out jaggedly with scissors versus typed or printed labels measured for uniformity and sliced evenly with a paper cutter. Show labels printed on thin paper that ends up curling at the edges versus labels printed on stiff card stock.

Illustrate effects that risers or glass shelves or acrylic display stands can have by adding depth to a display. For instance, show an assortment of rocks lined up in rows in an unlined case. Then show that same assortment in a case that's been lined, that has tiered risers, and that includes stands beneath the specimens.

In a display, especially one entered into a competition, all specimens should be free of dust, dirt, and fingerprints. Leave a cluster of clear quartz crystals outside for several weeks and bring it in along with a pan of water and a toothbrush to illustrate the dramatic effect a simple scrubbing can have on specimens. (But don't try this with your halite!)

After reviewing general display techniques, let the kids themselves play around with a case. You can bring in materials yourself for them to experiment with, or you can have them bring in their own collections. Don't just lecture and distribute a list of "do's" and "don't's." Let the kids see for themselves what happens when they try different arrangements and display techniques. If you have members who have taken slides or prints of displays at various shows, a nice touch is a brief slide show or photo album of award-winning cases to show how it can all come together.

The Geo-Juniors of the Summit Lapidary Club (Ohio) have prepared a nice worksheet you might copy and distribute to help your juniors work through an evaluation session as shown on the next page.

WORKSHEET FOR EVALUATING DISPLAYS

(courtesy of the Summit Lapidary Club Geo-Juniors of Ohio)

Display background:

Plain, neutral color:_____ Dark colors:_____ Patterned background:_____
What stands out? The liner:______ The items being displayed:______
Are the case and items clean? ______

Balance of display:

How is the display arranged? By color:_____ By size:_____ By shapes:_____
Do colors coordinate or contrast?_____________________________________
Do large items balance nicely with smaller ones?_____
Does the display have a balanced look?_____ Or is it heavy in one area?_____
Is this display pleasant to view?_____
How might you change the balance?__________________________________

____

Labeling:

Are labels easy to read?_____
Are labels typed _____ or handwritten _____?
Do you understand what the labels say?_____
Are all words spelled correctly?_____
Do the labels overwhelm the display?_____

Lighting:

Is there enough light to clearly see all the items being displayed?_____
Is the light too bright _____ or too dim _____ or just right _____?
Does the light fall evenly all across the case?_____

Theme:

Is there a theme or story? An example would be if there is one type of rock or fossil; or a "how to" focus for creating a lapidary project. Is there such a theme?_____
If yes, is that theme clearly displayed and conveyed?_____
Is there an overall "title label" expressing the theme?_____
What suggestions do you have to change or improve the display around a theme?

____

____

____

Back-up page 6.3: Observing and evaluating displays.

To satisfy the requirements for this activity, have kids write a brief written evaluation of three or four cases they've seen at a rock show or displays they've viewed at a museum or in a jewelry store window or elsewhere. As a start for gathering information for their report, they might use the worksheet contained with Activity 6.2.

In their report, they should illustrate a basic awareness of the techniques for effective displays and they should provide recommendations for ways in which the displays they viewed might be improved, whether through more effective lighting, better labels, a different arrangement of specimens, or a simple dusting of the display case. (You'd be surprised how many cobwebs you can find in some museum displays!)

Back-up page 6.4: *Making your own public display.*

Note: ***This activity is required for kids to earn the Showmanship badge.***

A fun and rewarding aspect of our hobby is sharing what we've found, collected, and learned about with others. Collections aren't meant to be hoarded and hidden away. Kids should be encouraged to share their collections in a public display. The best venue for that is your own club's annual rock show or a rock show held by a neighboring club or society.

If you club doesn't hold a show and if neighboring clubs are simply too far away to conveniently attend, other options to explore include a display at a county fair, in a lobby or library window display case at elementary or secondary schools, or at a science fair. Opportunities abound. For instance, my local public library has a display case in its foyer and welcomes individuals and nonprofit organizations installing educational displays for a month at a time. Regional museums sometimes also provide a display case for a temporary rotating display. These often must be reserved months in advance, so do some early legwork to locate such public spaces.

Check for opportunities like these within your community. Then assist your kids in taking advantage of them!

Note: *Because several other badges involve making a public display, kids can work toward earning their Showmanship badge and other badges simultaneously. For instance, see Activities 2.3 (Earth Resources), 4.5 (Lapidary Arts), 5.4 (Collecting), 7.3 (Communication), 9.2 (Leadership),17.8 (Special Effects), and 18.4 (Fluorescent Minerals) .*

Back-up page 6.5: Entering competition.

Each year, each of the seven regional federations of the AFMS holds a show and convention that includes the opportunity to enter a display into competition to earn ribbons and plaques. Junior members can even win a financial reward! The AFMS holds a joint show and convention with one of the regional federations, rotating over the years to each region. The juniors case earning the most points at an AFMS-affiliated show wins the AFMS Lillian Turner Award, which includes a certificate, a mineral specimen, and a $100 Series "E" Bond. Thus, it really can "pay" to enter!

Over the years, the AFMS has devised a detailed system of rules for all the different sorts of displays that represent the varied aspects of our hobby. Categories range from all manner of lapidary arts (sphere-making, cabbing, faceting, beading, intarsia, etc.) to mineral collecting and fossil collecting (with categories for micromounts, thumbnail specimens, and larger specimens; for self-collected fossils and purchased specimens; for materials from a single locality and those collected from around the world; and so on). Each category comes with its own requirements and rules, and—in order to ensure uniformity in judging—these rules have been collected together in a rather thick packet.

The junior program leader should obtain a copy of the AFMS Uniform Rules, read through it, and be on hand to help guide kids who wish to enter a competitive display. The rules can be complex and difficult for even an adult to follow, and entering competition can be daunting for anyone, young or old. While you shouldn't construct your kids' displays for them, you should be on hand to provide support, pointers, and advice based on a full knowledge of the AFMS rules for exhibiting.

The AFMS Uniform Rules may be purchased through the American Federation of Mineralogical Societies or your regional federation, or it may be downloaded free from the AFMS web site at http://www.amfed.org/rules/rules.htm. (It's a long document, so make sure you have plenty of toner and paper in your printer!)

Within the Uniform Rules are sheets that explain at a glance the things to be judged within specific categories and the number of points allocated to each thing. You should copy these sheets to share with kids entering a particular category.

These Federation-sponsored shows aren't the only opportunities for kids to enter competitions. Check around your local area. County fairs often sponsor competitions for hobbies and collections. Schools sponsor science fairs. If you come up dry, hold your own competition for your junior members and pebble pups at your club's annual show utilizing the AFMS Uniform Rules or developing rules of your own, such as the ones on the next few pages sent in by Audrey Vogelpohl of the West Seattle Rock Club.

JUNIOR DISPLAY EDUCATION

(courtesy of Audrey Vogelpohl, West Seattle Rock Club of Washington)

Assisting junior members to display what they have collected, whether self-collected or purchased from commercial dealers, can be accomplished with this simple set of guidelines designed specifically for juniors. These guidelines are meant to be used at the club level for local show displaying.

Any junior can participate. The guidelines are designed with display categories, age grouping, judging, points, and ribbons. Displays must be a junior's own work and effort, with coaching from a parent, guardian, or sponsor. Rules of participation are kept simple and aimed at the Junior level. These guidelines are not intended to distract or prohibit any junior from entering formal Federation show competition under the AFMS Uniform Rules but to provide a somewhat more simplified introduction to competing at the local level.

Ribbons only will be awarded. There will be no trophies unless a junior is participating in competition under the AFMS Uniform Rules at a regional or national Federation show. The points used for this local program are for training only and are not equivalent to the points system used with AFMS Uniform Rules.

Judging will be education-centered in order to provide the junior with helpful, constructive written feedback for any points taken off. Literally all judging criticisms need to be fully explained so the junior will have a primer to work from and improve. The goal should be to build confidence in the junior exhibitor to move to the next step of entering competition at a Federation level.

A NOTE TO PARENTS

It is very important to have your support. We hope that you will work with your child or children if they have an interest in displaying their material. These guidelines are to assist you in understanding the process of juniors entering a display in our own local club show. Please ask questions of the Juniors Chair and other fellow club members and learn basic steps that will help your own child create an excellent display for the public to appreciate.

RULES FOR JUNIOR DISPLAYING

PART 1. GENERAL GEM & MINERAL SHOW DISPLAY GUIDELINES

1.1 Decide what you want to display

a. What do you like to collect?
b. Specimens from a special field trip?
c. What is the show subject or theme?
d. What will make your display *special?* (unique, best quality, complete collection, dramatic specimen, favorite)
e. Examples of your lapidary skills? (carving, cabs, faceting)
f. Have you made jewelry or gem trees?

1.2 Communications from your display

a. Present your display as if you are speaking to a new friend that you have not met yet.
b. Purpose of your display is sharing the art of nature, public education, and promoting your interests and club hobby.
c. Keep it simple without too much wording.
d. Coordinate colors that are pleasant to your eye and that highlight the specimens.
e. Avoid use of excess “props” (feathers, sticks, photos, glass, wood, metal) in your case because they steal attention from specimens.

1.3 Specimens you decide to display

a. All same material or different types of gems, minerals, or fossils.
b. Size may be large or small, uniform or mixed.
c. Quality should always be the very best you can provide.
d. Number of specimens should be just enough to make your display easy to view and not look too “busy” or overfilled.
e. Large specimens in back of display case, smaller in front.
f. Always wash/clean your specimens before placing in the case.

1.4 Labeling your display

a. Always have accurate names, correct spelling, punctuation, and information. To help avoid mistakes, proofread twice, then ask someone else to read the labels.
b. Use uniform size of lettering on the labels and make letters large enough to read at about two feet from the front of the case.
c. Individual labels for each specimen should include, at a minimum, correct name of mineral or fossil and origin, or where found.
d. If all material in a case is the same sort of material (all calcite; all trilobites), identify on a single label at the back or floor of the case.
e. Lettering should be typed or laser-printed on durable cardstock (not

paper) than handwritten. Plastic covered labels are too reflective.

f. Prepare a label with your name and age, but only place it into the case after judging is over.

1.5 Display case for your specimens

a. Good display cases are hard to find so begin by borrowing a case for the show.
b. Typical cases are "Federation Style," which are about two feet high, two feet deep, and four feet wide, with a glass front. Dimensions usually vary slightly because there are different builders.
c. Your case should always have a liner that is lighter color (white or pastels are best) than the dominant colors of your specimens. Dark or "flashy" liners will usually distract from the color effects of the displayed specimens.
d. Wash hands before installing liners in the case to prevent smudging with finger prints.
e. Best lighting is clear, incandescent bulbs or tube fluorescent bulbs that are "cool white" type, not to exceed 150 watts total per case.
f. After you have arranged and labeled the specimens, be sure to clean the inside of the front glass before securing to the front of the case.

PART 2. DISPLAY AGE GROUPS

For AFMS and Regional Federation competitions, juniors are defined as having reached the 8th birthday and not yet having reached the 18th birthday as of the opening date of the show. But for local shows, you might consider a wider range of ages, broken up into several groups, for instance:

Age Group 1: ages 4 through 7
Age Group 2: ages 8 through 11
Age Group 3: ages 12 through 15
Age Group 4: 16 through 17

Having a wider range allows for fairer groupings and also for awarding more prizes. For more experienced kids who have exhibited before, particularly those in Age Group 4, you might consider applying the AFMS Uniform Rules when judging to prepare them for that next step in competitive exhibiting.

PART 3. DISPLAY CATEGORIES

Adapt categories to your own local club interests, but these may include:

3.1 Self-Collected Specimens

Any type, size, or location. Labels must include the specimen name and location where specimen was found. Date it was found is helpful, if available.

3.2 Minerals
Any size, type, or location. Must include accurate mineral names and locations on labels.

3.3 Educational
Any topic or theme relevant to rockhounding or rock uses. Brief, to-the-point wording is best on all labels.

3.4 Lapidary
Tumbling, polishing, faceting, carving, etc. On the labels, must include names of lapidary materials used.

3.5 Gem Trees
Must name stones, enamels, and/or metals used.

3.6 Fossils
Any type, size, or location. On labels, identify common names, genus and species names, locations, and geological age (period or epoch).

PART 4. JUDGING CATEGORIES AND POINTS

Points will be allotted out of an overall total of 100 as follows:

4.1 Showmanship: 30 points.
Overall appearance, detail, arrangement. Does the display stand out amongst the others?

4.2 Workmanship: 20 points.
Quality of lapidary and jewelry work or mineral and fossil cleaning and preparation. How neat and distinct is the work?

4.3 Labeling: 10 points.
Individual and group labels. Judges will evaluate accuracy only. Other aspects of the labels, such as whether handwritten or printed or whether done on paper versus cardstock, will be evaluated under Showmanship. Deductions of 2 points per error to a maximum of 10 points.

4.4 Quality: 20 points.
Color, size, rarity, definitive/classic specimen. Are your specimens the best you can reasonably find?

4.5 Educational Value: 20 points.
Use of maps, graphs, print, historical background, photos, etc. Will the viewer learn something from your display?

PART 5. AWARDS

5.1 Blue Ribbon for 90-100 points
5.2 Red Ribbon for 80-89 points
5.3 White Ribbon for 70-79 points
5.4 Certificate for Participating for under 70 points

The points used for this program are for training only and are not equivalent to the point system used with AFMS Uniform Rules. Remember, this program is designed for beginners training, so when you enter your display in competition at a Federation show to compete for Federation trophies, be sure you ONLY use the current updated AFMS Uniform Rules that are available from your regional Federation publications office or from the AFMS website, www.amfed.org.

PART 6. REFERENCE SOURCES FOR LABELING

In addition to the AFMS Uniform Rules, several other resources are contained on the AFMS website (www.amfed.org) to be used in properly labeling mineral, lapidary, and fossil specimens. These include:

6.1 AFMS Mineral Classification List
This lists the most current names used for properly identifying minerals based on *Fleischer's Glossary of Mineral Species*. It also lists names that have been replaced or that are now considered obsolete.

6.2 AFMS Approved Reference List of Classifications and Common Names of Fossils
This list of over 20 pages helps exhibitors place fossils within their taxonomic context, within their phyla, classes, orders, and subclasses.

6.3 AFMS Approved Reference List of Lapidary Material Names
A lapidary material sometimes goes by a different name than would be used if the same specimen was entered as a mineral or fossil. For instance, "Turritella Agate" is an accepted lapidary name, but if the same material were entered as a fossil, it would be called *Goniobasis* sp. The AFMS list provides accepted lapidary names to use in competition.

JUNIOR DISPLAY APPLICATION

Exhibitor's Name or #:_____________________________________Age:____

Place an "X" next to the number of the category for your display:

____ 1. Self-Collected Specimens	**____ 4. Lapidary**
____ 2. Minerals	**____ 5. Gem Tree**
____ 3. Educational	**____ 6. Fossils**

--------------------------------Do No Write Below This Line---------------------------------

For Judges: Judging Categories & Points

Please provide explanations for any and all points deducted, along with helpful suggestions. Add comments to the back of the sheet as necessary.

Showmanship – 30 points possible **Points awarded:_____**

Overall appearance, detail, arrangement.

Comments:

Workmanship – 20 points possible **Points awarded:_____**

Quality of lapidary and jewelry work or mineral and fossil cleaning and preparation.

Comments:

Labeling – 10 points possible **Points awarded:_____**

Accuracy only. Other aspects of the labels (handwritten; printed on paper; etc.), to be evaluated under Showmanship. Deductions of 2 points per error to a maximum of 10 points.

Comments:

Quality – 20 points possible **Points awarded:_____**

Color, size, rarity, definitive/classic specimen. Are specimens the best one can reasonably find?

Comments:

Educational Value – 20 points possible **Points awarded:_____**

Use of maps, graphs, print, historical background, photos, etc.

Comments:

7. Communication

Part of enjoying a hobby is sharing it with others. They say you don't truly "know" something until you're able to teach it to another. Learning to communicate effectively is an important skill. If you go on to become a geologist or paleontologist, you'll discover that science isn't complete until your findings are written up and shared with colleagues, either in a public address or in a journal article or a book. If you go on to become a lapidary artist, you'll find great enjoyment in sharing your skills and techniques with others as an informal mentor or in formal workshop settings. You'll find lifelong benefit to learning the basics of effective communication, both within the hobby and beyond.

Activity 7.1: Oral report.
Give a talk to your club or to your class at school about a trip you took, a project you did, a special rock or fossil you've collected, etc. In preparing your presentation, consider the key questions that all reporters ask: Who? What? Where? When? How? Why?

Activity 7.2: Written report or newsletter article.
Write a 250- to 500-word article for your club newsletter. Follow the news reporter's questions of who, what, where, when, how, and why.

Activity 7.3: Bulletin board or poster board displays.
Prepare a bulletin or poster board display for your show, library, or school on rocks, fossils, minerals, or the lapidary arts. Use pictures to convey most of your information, with writing kept to a minimum, mostly in the form of banners and headlines.

Activity 7.4: Corresponding with experts.
A great way to learn is by corresponding with experts who have made a career out of gemology, paleontology, or geology. Write or email a local jeweler, a paleontologist in a museum, a geology professor at a university, etc. These people are usually very busy, so you should briefly tell them who you are and what you're interested in. Then ask something very specific you'd like to know about their work. Share their answers with your fellow club members at your next meeting or in a report for your club newsletter.

Activity 7.5: Holding a symposium.
Geologists and paleontologists often get together in meetings to exchange ideas, give lectures, and hold symposiums. A symposium is a series of 3 or 4 brief talks organized around a specific topic. Each speaker presents, and then there's an opportunity for questions and discussions. Come up with a topic and hold your own symposium.

Activity 7.6: Writing a field trip guide.
Write a guide to your favorite collecting locality. Provide a brief overview of what's to be found; how to get to the site, with written directions and a map; and the tools you'll need and how to go about collecting. (Are the specimens on the surface? Do you need to dig for them with a shovel?) If several members of your club write guides to different sites, you can put them together into a local guidebook for your club and school.

7. Communication

□ 7.1 Oral report

□ 7.2 Written report or newsletter article

□ 7.3 Bulletin board or poster board displays

□ 7.4 Corresponding with experts

□ 7.5 Holding a symposium

□ 7.6 Writing a field trip guide

To earn your Communication badge, you need to complete at least 3 of the 6 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 7.1: Oral report.

Every aspiring journalist is taught to answer six essential questions in covering a story: Who? What? Where? When? How? Why? You should teach your kids to consider these questions in delivering an oral report. This handy list helps them both to organize the report and to come up with ideas about what to say.

For instance, if they wish to tell about a field trip adventure, who went on the trip? What were they hoping to find, and what did they actually find? Where did they go? When did they go there? How did they find out about the collecting spot and/or how did they go about collecting there? And why might they recommend this site to others?

Or, a talk might be organized like a story, with a beginning, middle, and end. For instance, in describing a field trip, they might tell how they got the idea to visit a specific locality, then describe the trip itself, and end by showing what they found there. In telling how to do a particular lapidary project, they might describe the necessary tools, go through each step in the process, and end by unveiling the finished product.

In giving an oral report, it's important that the audience be engaged in ways that capture and hold attention. Good public speakers incorporate jokes to bring out smiles. In fact, they often begin their talks with a joke or an amusing anecdote to begin in an entertaining way. And, just like in a book, good illustrations can spice up the presentation, so kids should be encouraged to show or pass around specimens, to include maps, pictures or posters, or to otherwise visually reinforce what they'll telling the audience.

Finally a good way to end a talk is with questions and answers, so time should be left for the audience to ask questions or to share their own experiences.

Note: *Because several other badges involve giving an oral report or presentation, kids can work toward earning their Communication badge and other badges simultaneously. For instance, see Activities 1.7 (Rocks & Minerals), 2.4 (Earth Resources), 3.6 (Fossils), 4.5 (Lapidary Arts), 5.5 (Collecting), 9.3 (Leadership), 12.2, 12.3, and 12.4 (Gold Panning & Prospecting), 13.3, 13.4, and 13.5 (Gemstone Lore & Legend), 14.1 and 14.5 (Stone Age Tools & Art), 15.2 and 15.3 (Rocking on the Computer), 17.8 (Special Effects), and 19.5 (Reaching across Generations).*

Back-up page 7.2: Written report or newsletter article.

At regional and national federation levels, awards are given for best articles published in club newsletters, with a category for articles by kids. Encourage your kids to contribute to your club's newsletter, or, if you don't have one, to write up a brief report to share with you and the other kids in your club. Learning to write a good report is a skill that will benefit kids in school and beyond. In teaching your kids to write an article, you should use the same six key questions noted for Activity 7.1: Who? What? Where? When? How? Why? This handy list helps them both to organize the report and to come up with ideas for what to say in their article.

In addition, encourage kids to try different "genres" or types of articles. One genre is the **anecdote**, or story. Kids might write about a specific memorable event that happened while on a collecting field trip that, at the same time, packs in useful information about where they went and what could be found there. For instance, I vividly remember reading one field trip article that told the story of an encounter with a wild burro that ransacked a campsite near the Mojave mining town of Darwin. The central focus was the encounter with the burro. But in telling the story, the author provided readers with a lot of history about past mining days in the desert, minerals that collectors can find in the old mine dumps, and the wonderful wildlife and colorful characters living in the region. Another genre is the **technical article**. Such an article is more scientific in nature and usually involves some background reading and research. A technical article might describe how a geode or petrified wood forms. It might describe the different classifications of crystal structures. In writing a technical article, kids should end with a list of the books they consulted for their information. Yet another genre describes a **process**, or provides a set of **directions**. An example of such an article would be one that describes in detail the steps for completing a lapidary project, such as crafting a cab. These articles usually begin with a brief overview of what is being made. Then, the necessary tools and materials are listed. Finally, each step in the process is described in numbered or outlined form. For examples of such an article, see Back-up page 1.6 on "Growing Crystals" or Back-up page 3.2 on "Making a Fossil." Still another genre is the **tall tale**, or the humorous story that conveys information or expresses an opinion in a way that elicits a laugh. The perfect example is Mark Twain.

Encourage kids to write several articles, trying different styles (funny/serious; technical/informal) until they find a style that fits them best. Publish as many as you can in your club newsletter. Seeing their names in print can be a big boost for kids' self confidence and—as noted above—could lead to recognition by a regional federation and the AFMS if your newsletter editor submits articles into consideration for annual federation awards.

Note: *Because several other badges involve writing a paper, kids can work toward earning their Communication badge and other badges simultaneously. For instance, see Activities 1.7 (Rocks & Minerals), 2.2, 2.4, and 2.6 (Earth Resources), 3.6 (Fossils), 4.5 (Lapidary Arts), 5.5 (Collecting), 8.4 (Field Trips), 9.5 (Leadership), 11.3 (Earth in Space), 12.2, and 12.3 (Gold Panning & Prospecting), 13.3, 13.4, and 13.5 (Gemstone Lore & Legend), 14.5 (Stone Age Tools & Art), 15.2 (Rocking on the Computer), and 19.3 and 19.5 (Reaching across Generations).*

Back-up page 7.3: Bulletin board or poster board displays.

Bulletin boards are found in many locations: in your local schools, in public libraries, in homes for senior citizens, in local and county government centers, etc. Explore options within your community and make arrangements for providing educational displays on rocks, fossils, minerals, or the lapidary arts (or on all these aspects of the rockhounding hobby). You might assign this to individual kids within your club, or you might make this a group activity involving everyone.

With a bulletin board display, your audience is usually passing by and isn't likely to stand still and read a great deal of text. You need to grab attention quickly and to get your message across efficiently. As with billboards along a highway, vivid and memorable pictures should do most of the talking and supporting text should be kept to a minimum, mostly in the form of headlines and brief captions.

For instance, a bulletin board about rockhounding in general might ask the question, in large, colorful print: "WANT A NEAT HOBBY?" At the bottom, in equally large print, you might write "TRY ROCKHOUNDING!" These two large banner headlines very quickly broadcast the main message of the bulletin board. Then the middle of the bulletin board can be filled with large photographs, drawings, and other visual images about various aspects of the hobby. Each might be provided with a small caption where you can go into a bit more information. But remember, unlike an article in a newspaper or newsletter, folks will be reading this while standing up and usually while on their way elsewhere, so each caption should be as brief and to-the-point as possible and in print that's large and easily read at a distance.

Junior leader Sandra Corry of the Tennessee Valley Rock & Mineral Club worked with her juniors to present a "Geology Science Fair" to their club. They created tri-fold poster boards on different topics and, at the end of the day, they had a nice supply of "traveling posters" they could take to other public education events around town. The Carmel Valley Gem & Mineral Society (California) has a similar supply of tri-fold poster boards (one on fossils, one on dinosaurs, one on mineral identification, one on earth processes, etc.) that are set up on tables around the kids' booth at their annual show and that are taken to schools for educational talks and programs. Tri-fold poster boards provide a great way for kids to make more-or-less permanent educational displays about our hobby that can be conveniently stored, then transported and set up in all sorts of venues.

Note: *Kids can use this activity to satisfy requirements toward earning the Showmanship badge simultaneously (Activity 6.4).*

Back-up page 7.4: Corresponding with experts.

In encouraging kids to correspond with experts, you may want to do some advance legwork to make sure that they'll get a timely response. It would be a shame to build up a child's expectations and enthusiasm only to see a letter, email, or phone message go unanswered.

Start by asking kids what it is they'd like to learn about. Then decide who might be a good expert to address their questions. For instance, a child might want to know where all those diamonds come from in the jewelry store windows downtown or in the mall. Or they may want to know how a particular dinosaur got its name. The first question would be appropriate to address to a local jeweler and the second to a museum paleontologist or a university professor. You should help decide who would be the best person to address the question and to track that person down and see in advance if they would be willing to help in your project.

Here are examples of different experts you might contact and how to track them down:

- **Local jewelers.** Check your yellow pages under "Jewelers" or "Jewelry." They usually have a number of different categories: Jewelers-Manufacturers, Jewelers-Retail, Jewelers-Wholesale, Jewelry Buyers, Jewelry Designers, Jewelry Engravers, Jewelry Repairing, etc. Other categories to try include "Gemstones," "Appraisers," or "Lapidaries."
- **College professors.** Check the web site of the nearest college or university to connect with academic geologists and paleontologists. Once on a university web site, check under "Geology" or "Earth Sciences" to get to the department site. Such department web sites usually have a listing of all faculty on staff, with brief descriptions of their areas of expertise. Someone there may be able to help you or to give you the name and contact information of a colleague at another college or university.
- **Museum curators or researchers.** Call up the closest natural history museum to see if they have a staff geologist or paleontologist.
- **Professional geologists and other earth scientists.** The U.S. Geological Survey web site has a link to the "Earth Science Information Center" to address earth science questions via the USGS education web site: http://www.usgs.gov/education/.
- **Mining experts.** Two groups have web sites that provide much educational information on mining and mineral resources, along with links to ask questions. One is the Minerals Education Coalition (http://mineralseducationcoalition.org) and another is Women in Mining (http://www.womeninmining.org).

Back-up page 7.5: Holding a symposium.

Because it's a group event involving several presenters, not just one, organizing a symposium takes special advance planning. First, you need to select a topic that will be of interest to a number of people in your group and about which people may have differing but equally useful opinions and experiences to relate. The goal of a symposium isn't to come to a single correct answer to a question. Instead, it's to share information and tips that a variety of people have formulated in tackling the question at hand, thus giving everyone involved new insights and ideas to consider.

For instance, one good topic for a symposium is how to catalog a collection. Everyone seems to have a different system (see Back-up page 5.2: Cataloging and labeling your collection). It can be useful to hear how different people have organized their collections in different ways and can give kids a number of useful ideas for deciding how they may wish to catalog their own collections.

Another helpful symposium topic might be on cabbing and how to bring out the best shine in a cab. Different minerals have different characteristics, and some—such as jade—can prove difficult to polish. What sorts of techniques have different club members developed over the years? What sorts of polishing compounds would they recommend? What sorts of techniques have they used with different minerals? Etc.

Usually, a symposium has three or four presenters, along with a host or moderator. The moderator introduces the topic and then introduces each speaker in turn and makes sure they stick to their allotted time. Each person might talk for 10 or 15 minutes. At the end, the moderator summarizes, followed by opportunities for the audience to pose questions or to share their own thoughts, experiences, and insights in a follow-up discussion.

Kids themselves might organize, run, and participate in their own symposium. Or, they might come up with the topic, make the plans, and then invite adult members to serve as speakers, followed by questions from the kids.

Back-up page 7.6: Writing a field trip guide.

The best model to provide to kids for writing a field trip guide to their favorite local collecting site is one of the many published field guides. The geological surveys of some states publish rockhounding guidebooks you can use as models, and two publishing companies publish guides covering many states.

Gem Guides Book Company publishes the "Gem Trails" series. In these guidebooks, the first paragraph for a particular locality tells what can be collected there. This is followed by directions for how to get to the site and instructions for how to collect (for instance, by searching the surface of the ground, by digging in specific layers, by splitting shale, etc.). Then there's usually a photograph of the locality and people collecting there, followed by a map. They also often give special words of advice or warning. For instance, there may be special issues regarding status of ownership of the land and needs for making advance arrangements or getting special passes or paying fees. There may be warnings about hazards such as rattlesnakes, open mine pits, extreme heat in the summer, etc.

Falcon Press Publishing Company publishes "The Rockhound's Guide" series. In the one for California, the author starts with a listing of the Land Type (desert versus coastal versus mountain, etc.), Best Season to visit, Tools, Material to be collected, Special Attractions, Vehicle Type needed to reach the site, etc. This list is followed by directions, or "Finding the Site," and then "Rockhounding," or paragraphs describing what you'll find and how best to collect it. A map and a photo of the site then usually follow.

Any of these can provide helpful and useful models for your kids to follow.

8. Field Trips

The ultimate hands-on activity is a field trip! Little can replace the thrill of discovering a precious gemstone or a fossil first-hand. Also, a lapidary project has a lot more personal value and meaning if you collected the rough material yourself. But before you start down the road, you need to know the laws of your state and rules governing proper behavior for collectors and respecting private property. You also need to consider what you'll be collecting and how you'll collect it and then make plans and gather together the proper equipment. The follow activities will help you get the most out of your field trip adventure.

Activity 8.1: *Field trip etiquette, safety, & AFMS Code of Ethics.*
Note: *This activity is required to earn this badge.*
Learn and demonstrate knowledge of the AFMS Code of Ethics. Make a permission release form. Demonstrate field trip etiquette on your next trip. If the trip was on private land, did you first gain permission? Did you provide the owner with a release form? Did you fill in any holes you made? If at a road cut, did you keep rocks off the roadway?

Activity 8.2: Field trip planning.
Choose a locality for a field trip from a guidebook or from suggestions by adult members in your club. Draw a map and directions to your site. List what you expect to find, then list the tools and supplies you'll need to collect and transport your finds home.

Activity 8.3: *Taking a field trip.*
Note: *This activity is required to earn this badge.*
Take a field trip to a collecting locality. Be sure to follow proper field trip etiquette during the trip—and have fun!

Activity 8.4: Record keeping.
Start and maintain a "field journal" of what you did and what you found during your field trips in a composition or spiral-bound notebook, three-ring binder, or other record book or on the computer. Take notes while in the field and later write up a formal report including observations about the locality and specimens. Pinpoint where you found your rocks, minerals, or fossils, so that others could locate the spot. Was there a specific layer containing the fossil or mineral deposit? If so, how could others locate and identify that layer? If you have a camera, illustrate your field journal with photos, or provide drawings that may prove useful to others wishing to visit the site.

Activity 8.5: The indoor field trip.
Organize a field trip to a college geology department or to a museum, calling in advance to arrange a tour not just of the exhibitions on public display, but the treasures behind the scenes.

8. Field Trips

□ 8.1 *Field trip etiquette, safety, & AFMS Code of Ethics* (required to earn this badge)

□ 8.2 Field trip planning

□ 8.3 *Taking a field trip* (required to earn this badge)

□ 8.4 Record keeping

□ 8.5 The indoor field trip

To earn your Field Trips badge, you need to complete at least 3 of the 5 activities. (Please note that successfully completing Activities 8.1 and 8.3 are required to earn this badge.) Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

Date completed

My signature

Youth leader's signature

Name of my club

Leader's preferred mailing address for receiving badge:

Back-up page 8.1 *Field trip etiquette, safety & AFMS Code of Ethics.*

Note: ***this activity is required to earn this badge*.**

Before setting foot in the field, kids should be taught proper field trip etiquette. This includes the do's and don'ts governing proper—and legal—behavior when collecting natural resources. It also includes safety to ensure everyone comes home unharmed.

If organizing a group field trip, as the group leader, it's your responsibility to teach by example. First and foremost, be aware of the laws of both the U.S. and your state government regarding fossils. Some areas, and some types of fossils, are regulated and, if anything, such regulations will only increase in coming years. Here are just a couple examples. While common invertebrate and plant fossils are usually okay to collect, no vertebrate fossils may be collected on federal lands without special permits, which are usually only granted to scientists conducting a formal research study. Also, while plant fossils are usually okay to collect, no more than 25 pounds of petrified wood, plus one piece, may be collected in a single day, up to a limit of 250 pounds per year. No collecting of any sort is allowed within National Parks.

Whether searching for fossils, rocks, or minerals, always secure necessary permits and be aware of regulations. For instance, if collecting in a National Forest (as distinct from a National Park), you're not allowed to do more than surface collect (no digging or disturbing the natural features of the land) and you may need to purchase an "Adventure Pass" to park on national forest land. (Keep up-to-date on this because regulations for National Forest lands have recently been in flux.)

To collect on private property, obtain permission and make arrangements with landowners well in advance of your trip. With a large group, you'll likely be required to sign a waiver or liability release form promising not to damage property and absolving property owners of any responsibility for accidents. In fact, you're likely to get a better reception if you approach a property owner with such a waiver already in hand and with evidence of insurance coverage through your regional Federation. (See Back-up pages for Activity 8.3 for sample liability release forms.)

Here is some general advice for the adult field trip leader regarding safety precautions. In selecting your field trip site, avoid areas with obvious hazards (high-traffic road cuts, steep bluffs with loose material likely to result in slumping or landslides, clumps of poison oak, etc.). Remind kids to dress in appropriate outdoor clothing, sturdy shoes or (better still) hiking boots, a hat or hardhat, and—if they will be chipping away with rock hammers and chisels—work gloves and eye protection such as shatter-proof goggles or safety glasses. Before departing, make sure your car, truck, or van is in good shape and has a full tank of gas. You or another adult in the group should know basic first-aid and should have a fully and freshly stocked first-aid kit at hand, with a cell phone and directions to the nearest hospital in the event of an emergency. On arrival at the site, be sure you are fully off the pavement if parking near a road. Have a signal to conclude the field trip or to bring the group together (for instance, three blasts of the car horn). Also, always tell someone where your group is going and how long you anticipate being away so if the group does get lost, rescue parties know where to start.

Before you embark on the field trip, explain any ground rules. Then, remind kids of those rules once you arrive. Kids have boundless enthusiasm and energy, especially if they've been cooped up in a bus or car. Don't let them just leap from the car and run helter-skelter. Gather everyone around to talk about what you'll be collecting, to provide collecting tips, and to repeat **ground rules and safety tips.** These might include:

- Pair up with a buddy and stay close to one another so if an accident happens, there's someone who can lend immediate assistance and get help.
- Don't wander off alone; stay within view of the group at all times.
- Have some sort of safety signal (for instance, three sharp blasts on a whistle) to use in case anyone gets separated and lost or urgent help is needed for any reason. (If using a whistle, make sure everyone uses it *only* for emergencies.)
- No rushing up steep slopes of loose talus that could cause a slip and a broken ankle or that might send rocks rolling toward those behind and beneath you.
- Don't toss rocks onto a roadway—or toward other field trippers.
- Don't try lifting or rolling overly heavy rocks alone.
- Don't undermine overhangs since that can lead to a deadly cave-in.
- Don't leave unfilled holes that people or livestock might trip in.
- If using a rock hammer, wear goggles or safety glasses to avoid eye damage from flying rock chips.
- Don't enter mine shafts due to dangers of cave-ins, unseen deep holes, bad air, etc.
- Stay away from any wild animals; even a cute one is still wild and can give a nasty scratch or bite or, worse yet, transmit rabies.
- Be aware of any venomous or other nasty creatures in the collecting area (rattle snakes, water moccasins, scorpions, black widow spiders, wasps, ticks, chiggers, etc.) and how to avoid them. Use bug spray in buggy areas with mosquitoes, midges, etc.
- Know how to recognize plants to avoid, like stinging nettles, poison oak or ivy, etc.
- Remind everyone to keep hydrated and—if collecting in a hot, sunny area, to wear a brimmed hat. Two of the most common maladies among field trippers and hikers are dehydration and heat stroke.
- Watch the weather and be ready to leave in the event of thunderstorms and lightning.
- While most of our collecting is done in warm-weather months, if doing "polar bear collecting" in the winter, watch for hypothermia and frostbite.

The AFMS has devoted a section of its website to safety tips like these and more, with reprints of articles that go into detail. Go to http://www.amfed.org/safetytips.htm

Before leading kids on a field trip, I suggest making a list of safety rules tailored to the locality where you'll be collecting and printing and distributing it in advance. Then review those rules upon arriving at the locality.

In addition to safety tips and rules, all your club members—adults and juniors—should have a copy of and should be intimately familiar with the AFMS Code of Ethics:

American Federation of Mineralogical Societies

Code of Ethics

- I will respect both private and public property and will do no collecting on privately owned land without permission from the owner.
- I will keep informed on all laws, regulations or rules governing collecting on public lands and will observe them.
- I will, to the best of my ability, ascertain the boundary lines of property on which I plan to collect.
- I will use no firearms or blasting material in collecting areas.
- I will cause no willful damage to property of any kind such as fences, signs, buildings, etc.
- I will leave all gates as found.
- I will build fires only in designated or safe places and will be certain they are completely extinguished before leaving the area.
- I will discard no burning material - matches, cigarettes, etc.
- I will fill all excavation holes which may be dangerous to livestock.
- I will not contaminate wells, creeks, or other water supplies.
- I will cause no willful damage to collecting material and will take home only what I can reasonably use.
- I will practice conservation and undertake to utilize fully and well the materials I have collected and will recycle my surplus for the pleasure and benefit of others.
- I will support the rockhound project H.E.L.P. (Help Eliminate Litter Please) and will leave all collecting areas devoid of litter, regardless of how found.
- I will cooperate with field-trip leaders and those in designated authority in all collecting areas.
- I will report to my club or federation officers, Bureau of Land Management or other authorities, any deposit of petrified wood or other materials on public lands which should be protected for the enjoyment of future generations for public educational and scientific purposes.
- I will appreciate and protect our heritage of natural resources.
- I will observe the "Golden Rule," will use Good Outdoor Manners, and will at all times conduct myself in a manner which will add to the stature and Public Image of Rockhounds everywhere.

Revised July 7, 1999 at the AFMS Annual Meeting

Back-up page 8.2: Field trip planning.

Choosing a Field Trip Locality

It's best for juniors leaders to get together with the club field trip chair in January for a Field Trip Planning Meeting to schedule trips for the entire year so that everyone can work them into their calendars. In choosing a locality, select sites relatively rich in minerals or fossils. By nature, kids are impatient and will want to start finding "stuff" right away. Your goal, after all, should be to foster enthusiasm, not to tax their patience. If you don't know of suitable exposures in your area, ask around at a local college. Many geology departments have road logs for earth science field trips. Three publishers have guidebook series covering many states in the U.S.: Mountain Press publishes the Roadside Geology Series; Gem Guides publishes the Gem Trails series; and Falcon Press publishes The Rockhound's Guide series. In addition, state geological surveys often have guidebooks to their states or individual educational reports and road logs on specific mineral or fossil localities. The U.S. Geological Survey web site (http://www.usgs.gov/) has a handy map that allows you to click on your state for regional geologic information.

Field Trip Supplies

Different localities have different materials and, therefore, different requirements in terms of the tools and supplies necessary for collecting. Select the materials appropriate to the site you'll visit. The following list is meant to be representative, not exhaustive:

- Protective clothing (durable long-sleeved shirt and long pants)
- Sturdy hiking boots (preferably steel-toed) and heavy work gloves
- Hard hat if in a quarry or elsewhere with a danger of falling rocks
- Wide brimmed hat and sunscreen to protect against sun exposure
- Shatterproof goggles or safety glasses if hammering rocks
- Detailed area maps, compass, GPS unit
- Backpack, rucksack, and/or 5-gallon bucket to carry supplies and specimens
- Rock hammer, rock pick, sledge hammer, along with chisels, gads, pry bar
- Shovel, trowel, hand rake
- Sifting screens
- Pocket knife
- Hand or whisk broom, paint brushes, toothbrushes
- Toilet paper, paper towels, newspapers, bubble wrap for wrapping delicate specimens
- Masking tape
- Small storage boxes, ziplock baggies
- Cardboard flats or other boxes or containers for transporting specimens
- Cards for writing locality info to wrap in the field with your specimens
- Magnifying glass, hand lens, or loupe
- Spray bottle of water to check for potential lapidary material
- Field notebook and pencils/pens to record info about a site
- Camera to keep a visual record of a site and specific collecting horizons
- First aid kit (fully stocked with fresh materials)
- Plenty of water in canteens or bottles, food, and—if going overnight—camping gear
- Cell phone or 2-way radio and a field companion or "buddy" in event of an accident

Back-up page 8.3: *Taking a field trip.*

Note: ***this activity is required to earn this badge*.**

The first step in taking a field trip is planning. You should follow the recommendations in Back-up page 8.2 for selecting a field trip site and choosing the appropriate supplies. You should make a map and write out clear directions to the site, along with a list of recommended tools and materials to bring, and distribute this to field trip participants.

And you should know how many people you'll be leading on the trip. A trip with just a few participants is a lot less intrusive—especially on a rancher's private land—than a trip with 30 or 40 participants. The larger the group, the more management concerns to consider, and the more adults you'll need to help chaperone. So get a clear idea as to the size of your group by circulating a field trip sign-up sheet. (See example within the following pages.)

It's usually a good requirement to have one or both parents accompany their kids on a field trip. If they can't, any absent parents should sign a permission slip and liability release, providing phone numbers where they may be reached during the time you'll be on the trip, and you should let them know when you'll return and where to call in case of questions. Everyone (kids and adults) participating in a field trip should also sign a personal injury and liability release form. Finally, during the trip itself, it's best to use the buddy system with two kids always together in case one is injured.

Following is a series of forms to assist you in planning and conducting a group field trip. These are provided as examples only, and you should modify and adapt them for your own, individual needs and purposes.

Note: *Because several other badges involve taking a field trip, kids can work toward earning their Field Trips badge and other badges simultaneously. For instance, see Activities 2.4 (Earth Resources), 3.5 (Fossils), 9.4 (Leadership), 11.4 (Earth in Space), 12.5 and 12.6 (Gold Panning & Prospecting), 14.5 and 14.6 (Stone Age Tools & Art), and 20.4 (Maps).*

FIELD TRIP SIGN-UP SHEET

Trip location:________________________________ **Trip date:**_____________

NO.	NAME (PLEASE PRINT)	HOME PHONE
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(This form courtesy of Richmond Gem & Mineral Society)

PERSONAL INJURY & LIABILITY RELEASE FORM

TO:____

Name of Company, Quarry, Mine, or Property Owner

SUBJECT: Release of the above named from any responsibility should personal injury or property damage occur while visiting, collecting, or otherwise being on the property owned or operated by the above.

INSURANCE: The____

Name of Club or Society

is covered by a blanket policy issued to the California Federation of Mineralogical Societies that covers Bodily Injury and/or Property Damage. A copy of said policy can be made available upon request.

We the undersigned hereby waive any right to make claim against the host for any injury or property damage that may occur while a guest on property owned or operated by the host company or landowner.

________________________________ ________________________________

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________________________________ ________________________________

(This form courtesy of Richmond Gem & Mineral Society)

LIABILITY RELEASE

(Place the name of your club here)

To whom it may concern:

I, the undersigned parent or guardian, do hereby give permission for ______________________________ to participate in the events as scheduled by the youth advisors of the (insert the name of your club here).

It is understood that any personal loss or injury, should such occur to ______________________________ while a participant in the scheduled activity remains our responsibility and that no claim may be made against either the advisors or the (insert the name of your club here).

It is further understood that the blanket insurance policy for the society covers the third party (i.e., host or property owner) should damage occur while a guest on said premises during a scheduled field trip by (insert the name of your club here).

Should emergency first aide or medical attention be needed while ______________________________ is participating in the scheduled activity, permission is granted to attend to the need. Our own health and accident insurance is carried with____.

(name of insurer)

and the policy number is____.

I/we can be reached by telephone at ____________home or___________office.
If unable to reach anyone, a third party may be called____________________.

(name and phone number)

Signing this release signifies validation for as long as the above named child remains a member in good standing of the (insert name of your club here).

____
Print name of Parent(s) or Guardian

____
Signature of Parent(s) or Guardian

____
Date

(This form courtesy of Richmond Gem & Mineral Society)

(name of club here)

A Member Society of the California Federation of Mineralogical Societies
Educational Nonprofit Tax Exempt Organizations

INFORMED CONSENT * ASSUMPTION OF RISK * WAIVER OF LIABILITY

for (name of club here) Field Trips & Activities

Trip/activity host:____

Trip/activity date/s:____

Trip/activity Location/s:____

Attendee's name:____

Attendee's address:____

Please read the following information before beginning the field trip or activity. **Sign and date this form to acknowledge you have read and understand the information presented below.**

I understand that the field trip activity that I am participating in, of the above named Society, may include one or more of the following hazard(s) that may result in personal harm:

> Unpredictable and dangerous environmental conditions/hazards, including but not limited to snow, rain, wind, very cold and very hot temperatures, lightning, altitude, loose rock, falling rock, rock slides, avalanche, river hazards, mud slides, mud, ice, other slippery conditions, and contact with poisonous reptiles, wild fauna and toxic plants.____ (initial)
>
> I understand the risks inherent in all outdoor activities existing in the environment, either natural or man-made.____ (initial)
>
> I understand that I am required to use appropriate safety equipment pertinent to the field trip activity in which I will be participating. I accept full responsibility for my actions and accept liability for any resulting damages or injuries.____ (initial)

By participating, I am assuming the risks inherent in this field trip or activity and am releasing the above named societies, their officers, directors and individual members, from any liability for claims or lawsuits by the undersigned participant, his or her heirs or assignees, arising out of this field trip activity. I have read all of the aforementioned information and the list of safety rules accompanying this form and understand any and all of it. Any questions which have occurred to me have been answered to my satisfaction. I am participating in these activities of my own free choice.

If the participant is under 18 years of age, this form must be read and signed by a parent or legal guardian before participation in this field trip or activity.

____ ____________________
Signature of Participant Date

____ ____________________
Signature of Parent/Legal Guardian Date

(This form courtesy of the California Federation of Mineralogical Societies)

Back-up page 8.4: Record keeping.

Much of the value of a mineral or fossil lies in its context: where did it originate, and what might that tell us about its formation and about its place within the overall geology of a region and its geologic history? While a gemstone may hold intrinsic value and economic worth even if its ultimate source is unknown, a fossil that lacks context lacks scientific value and becomes a mere curiosity or a purely commercial object. Even a gemstone is further enhanced if it has a story behind it—if it's the "Moguk Ruby" or a "Virgin Valley Opal." Whether it's minerals, gemstones, or fossils, kids should be encouraged to look beyond economic value and the "gee whiz" factor of a neat object and to consider the scientific and educational value of what they collect.

Thus, kids should be taught to maintain a field journal of what they did and what they found during their trips in a notebook, three-ring binder, or on the computer. I do both. I've bought a small, sturdy, bound diary in which I can jot notes, make sketches, and rough out maps while in the field. Once home, I transfer the info in a more organized fashion on the computer to print and maintain on three-hole punched sheets that can be inserted into a binder or manila folders for easy storage and easy reorganization as additional sheets accumulate. These records are used to pinpoint where rocks, minerals, or fossils were found so others could locate the spot—or so I can find it again years later as memory fades. They also augment sheets containing catalog information about each specimen (see Back-up pages for Activity 5.2 on cataloging and labeling a collection), additional information I find and photocopy about the geology or paleontology of a particular site, and sheets of slides or prints that I've photographed of a locality.

Kids should be as specific as possible in record keeping. What are the directions to the site? What distinguishing permanent landmarks might mark the site? (For instance, "a 30-foot red boulder" is much more likely to be around 40 years from now as opposed to "a small, rotting log.") In this day-and-age, they can provide GPS data. Was there a specific layer containing the fossil or mineral deposit? If so, how could others locate and identify that layer? What did they find, and was it abundant or scarce? Did they notice anything unique, such as certain minerals or fossils occurring together with other sorts of specimens, or on their own? The more detail, the better. Once in the field, the impulse is to collect, collect, and collect some more. But while collecting the rocks, kids should take the time to carefully collect information to accompany those rocks. These written records of their adventures can often be even more interesting than the rocks themselves!

Encourage kids to augment written entries with drawings, maps, and photos. I always make a camera an essential part of my collecting tools. In recording info about a locality, a picture really can be worth a thousand words. Plus, they come in useful in other ways, as in preparing a slide show, illustrating a bulletin board display, or providing visual relief and support in an article. (Most professional magazines require contributing authors to provide visually interesting photos if submitting an article for consideration.)

Note: *Kids who write trip reports can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activity 7.2).*

Back-up page 8.5: The indoor field trip.

Not all field trips need to be out into the field. In some places, all the hard work of searching, collecting, and cleaning rocks, minerals, and fossils has already been done, and the results are just waiting for you to see! Take your kids on a trip to one such locality, i.e., a college geology department or a science or natural history museum.

Many college geology departments have teaching collections, and—given that they are educational institutions—most are happy to oblige in guiding your kids through their collections if given sufficient advance notice. You should also try to arrange a question-and-answer session with one or more of the faculty on staff. Some departments have active public outreach efforts, so while visiting, you should strive to forge a long-term relationship with receptive faculty members who may be able to help you in an on-going manner with additional activities for your kids.

Museums—both the large, world-class varieties like the American Museum of Natural History and smaller, regional ones like the Santa Cruz City Museum—are terrific places to take kids. It's probably childhood trips to the Field Museum in Chicago along with field trips sponsored by the Illinois State Geological Survey that fanned my interest in the earth sciences. The most memorable visit, however, was one in which I was invited to tour not just the exhibitions on public display, but the treasures behind the scenes in none other than the Smithsonian. I vividly remember seeing tray after tray of shark teeth of all manner and variety being pulled and stacked in front of me until the stack was taller than I was. A mile-high row of such trays stretched down an aisle as far as the eye could see, or so it seemed. However large it really was, an impression was indelibly made!

Call in advance to arrange a group tour of a museum and most will assign a specific guide or docent to escort you and your kids. When calling, be sure to check into the possibility of a "behind the scene" tour in addition to the public displays.

The web is a great place to locate the nearest natural history museum. For instance, just a few seconds after typing "Natural History Museums" into the Google search engine, I found a long list of sites, with four that I explored in more detail. Each offered excellent and thorough listings of museums around the U.S. and the world, complete with links that take you to the museums' own web site. Unfortunately, in the crazy and temporary world of the World Wide Web, most of those have gone "extinct" since I wrote the third edition of this manual. Still, for now anyway, a very good one remains on the web site of the University of Washington library:

http://www.lib.washington.edu/sla/natmus.html

9. Leadership

Learning to lead is an important skill that benefits you far beyond our hobby. As you learn from your youth leader, we hope you will be inspired to take the initiative to become a leader yourself. As you develop and deepen your knowledge and skills gained through FRA activities, assist in teaching your fellow youth members and in helping your youth leader to decide which activities to pursue with the group. The following are intended to help you assume and develop a leadership role within your club.

Activity 9.1: Becoming a youth officer.
Become an officer within your youth group and help decide what topics and activities your group will do this year.

Activity 9.2: Organizing a group display.
Take charge of organizing a group pebble pup display at your club show or at another venue, such as a library display window.

Activity 9.3: Leading a show-and-tell session or presentation.
Lead a group show-and-tell session, presentation, or symposium to adult members of your club.

Activity 9.4: Planning and leading a field trip.
Plan and lead a field trip.

Activity 9.5: Overseeing a newsletter column or an entire youth newsletter.
Oversee a monthly column for a year in your club's newsletter or start and edit your own junior members' newsletter.

Activity 9.6: Managing a youth activity booth at a local gem show.
Either on your own or working with adult members of your club, help to decide on activities to include in a Kids' Activity booth at your local gem show, and then help to run the booth during the show.

Activity 9.7: Mentoring.
Become a mentor to younger or less experienced members of your club, sharing your knowledge and experience with them in a specific project, such as how to craft a cab, how to build and curate a collection, etc.

Activity 9.8: Recruiting.
Help grow your club by bringing in a new member who attends at least three meetings—and, hopefully, ends up joining!

Activity 9.9: Fundraising.
Just as Girl Scouts sell cookies to help support their activities, work with your youth leader to come up with ways to raise funds to help support your club.

9. Leadership

□ 9.1 Becoming a youth officer

□ 9.2 Organizing a group display

□ 9.3 Leading a show-and-tell session or presentation

□ 9.4 Planning and leading a field trip

□ 9.5 Overseeing a newsletter column or an entire youth newsletter

□ 9.6 Managing a youth activity booth at a local gem show

□ 9.7 Mentoring

□ 9.8 Recruiting

□ 9.9 Fundraising.

To earn your Leadership badge, you need to complete at least 3 of the 9 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 9.1: Becoming a youth officer.

Building leaders is essential to the future of our clubs, providing the guidance, ideas, and inspiration that keep us all going. It's never too early to start cultivating the leaders of tomorrow! You should think about assigning or electing youth officers, especially if you have older kids within your group. The overall structure might mirror the offices of your adult club, but with fewer positions and fewer demands. Adjust the type and number of offices to the ages and abilities of the kids in your group and the size of your group.

If you have a large number of older kids who prove enthusiastic and ambitious, some basic offices to consider might be a youth group President to oversee meetings and to help decide what topics and activities to pursue for the coming year. A Recording Secretary would keep notes from meetings to outline, distribute, and archive and to include in the regular club newsletter. A Treasurer could help lead efforts to raise funds to be used for special youth events and might help run the youth activity booth at your local gem show (see Activity 9.6). A Newsletter Editor might oversee constructing a youth newsletter or a youth section of your club's regular newsletter (see Back-up page for Activity 9.5). A Field Trip coordinator could help decide on two or three special trips for the kids in your club to organize and to take over the course of a year (for instance, an outdoor collecting trip during warmer weather and an indoor visit to a museum for the colder or rainier seasons).

If you have a small group with mostly young kids, you may end up appointing a single Youth Assistant from among the older, more mature kids within the group. Such an assistant might help give advice about activities to try in a group setting that he or she believes would be the most interesting to his/her friends and could help you come in early to do any advance preparations and set-up.

With all the demands kids have on their time today, however, don't overload them. This should be an enjoyable, rewarding experience, not a burden or a drudge.

Back-up page 9.2: Organizing a group display.

One thing I always look for at a local gem show—and more and more often am disappointed not to find—is a Pebble Pups group display. Frequently, members of neighboring clubs band together and enter a club display at shows of neighboring clubs, and the combined efforts and materials make for truly outstanding exhibits.

Similarly, while a single young child just starting out in the hobby may not have many pieces in his or her collection, the combined efforts of all the kids in a club can result in a great display that illustrates the range of individual interests and the overall scope of the hobby. The kids in any club should always be encouraged to put together such a group display—and it's even better if the kids themselves take charge of organizing and arranging it.

For any kids who volunteer to oversee such an effort, you should lend advice and assistance as requested and should the need become apparent. Hold a meeting with the kid/s organizing the effort to discuss how to go about it and share the Back-up pages for Badge 6 – Showmanship, especially Activity 6.1 on techniques for effective displays. Among the procedures they'll need to consider are:

- Should we have a theme (for instance, fossils, or the many varieties of quartz, or local rocks and minerals)?
- How and when will we gather together material from our fellow club members?
- Where and when will we all meet to talk about how best to arrange our display?
- Where will we get our case and when will we set it up?
- What will we need for set-up (e.g., liners, risers, display stands, etc.)?
- Will we make uniform labels or ask that everyone bring their own labels?
- How will we keep track of everyone's individual specimens?
- How and when we will return everyone's specimens?

The easiest place to assemble such a group display is at the club's annual show. However, search out other public spots within the community, as well, such as the local library, public schools, local museums, or perhaps a friendly jewelry or crafts store owner.

Note: *Kids who participate in constructing a group display can use this activity toward earning their Showmanship badge simultaneously (Activity 6.4).*

Back-up page 9.3: Leading a show-and-tell session or presentation.

Kids expressing an interest in leading a group show-and-tell session, presentation, or symposium should be provided with the Back-up pages for Badge 7 – Communication, especially for Activity 7.1 – Oral report and Activity 7.5 – Holding a symposium.

Show-and-tell sessions are the easiest to arrange and ought to be organized around a theme. Here are just a few ideas:

- Things I collected on our most recent club field trip.
- Things I purchased at our annual club show.
- What I've made at our club workshop.
- My most valuable specimen and why I like it.

While a free-flowing show-and-tell session can more-or-less run itself once it gets going, a full-scale symposium can take a great deal more planning. If your junior member chooses to go this route, be sure to take the time to review Back-up page 7.5, and then—have fun!

Note: *Kids who participate in a group show-and-tell session or presentation can use this activity toward earning their Communication badge simultaneously (Activities 7.1 and 7.5).*

Back-up page 9.4: Planning and leading a field trip.

A youth member expressing a desire to plan and lead a field trip should first exhibit complete familiarity with Badge 8 on Field Trips and should have earned that badge before undertaking this activity. Share all Back-up pages from Badge 8.

Note: *Kids who participate in a field trip as part of this badge activity can use this toward satisfying requirements to earn the Field Trip badge simultaneously (Activities 8.2 and 8.3).*

Back-up page 9.5: Overseeing a newsletter column or an entire youth newsletter.

When I belonged to the Carmel Valley Gem and Mineral Society in California, we had one youth member who was dinosaur crazy. It was the same time that *Jurassic Park* hit the scene, and you couldn't round a corner, walk into a grocery store, or turn on the TV without seeing a dinosaur. "Dinosaur Bob," as he came to be known, took the initiative to start his own "Fact of the Month" column in the club newsletter, a column devoted solely to the topic of fossils (usually dinosaurs) and graced with his own dino drawings. Encourage a similar child or youth with a passionate interest in the hobby to do the same.

You could either have a single youth correspondent who pens a monthly column or you could establish a Youth Column and encourage kids to take turns contributing to it. To make the column stand out, you should place it at the same spot in each issue of the newsletter, where it's easy to flip to—such as the last page or a middle fold.

Dinosaur Bob had a theme going for him, making it easy to come up with topics each month. His columns usually started with a simple question that grew into a short essay: What color were dinosaurs? Were dinosaurs warm-blooded or cold? How did the dinosaurs die? A year-long series of mineral columns can evolve from focusing on the birthstone of the month. A lapidary column might take the form of a Dear Abby column, addressing such vexing questions as, "One writer asks, 'Why won't my jade take a decent polish?'" "How do you avoid flat spots on a cab?" You might establish themes like these, or simply allow kids to write what tickles their fancy at the time.

Caution: *Don't undertake the following unless you're willing to commit a great deal of time!* If you have a truly enthusiastic bunch of kids, including some real wordsmiths, a great project is pulling together a full-scale juniors newsletter—a newsletter by and for junior members. A terrific model is the "Mineral Mites Bulletin" inaugurated by Ismael Sanchez, Advisor to the Bakersfield Mineral Mites of California. Their newsletter consists of the Advisor's Report (written by the adult youth leader), the Assistant Advisor's Report, juniors officers contributions, an events calendar, a "Mineral of the Month" column, clippings from articles in other rock club newsletters, jokes, poems, games, juniors activities (for instance, learning about mining with a chocolate chip cookie), notice of awards for Mineral Mites accomplishments, and Federation reports. In addition to contributions from the Mineral Mites officers, all junior members are encouraged to become involved in the publication. It's printed in 4-color and includes clip art and photos. A truly outstanding effort! However, if you have just a small group and limited resources, even a much smaller effort can prove to be a lot of fun and a great learning experience for your kids. You could put together a single-page monthly flyer or fold a sheet of paper and create a four-page mini-newsletter. But for even a modest newsletter, heed the warning posted above! A monthly newsletter just simply takes time and effort, no matter how long or short, and no two ways about it.

Note: *Kids who work on this activity can use it to work toward earning the Communication badge simultaneously (Activity 7.2).*

Back-up page 9.6: Managing a youth activity booth at a local gem show.

Every show should have a youth activity booth, and it's even better if youth are actually running it! One thing my own kids often eagerly volunteered for—even after they grew older and began to tire of the old man's fascination with rocks and fossils—was helping to run the youth activities booth at our annual show. They especially liked the part where you take money and spin the spinning wheel or sell a grab bag.

You should hold a meeting with kids to decide on what sorts of activities they'll want to sponsor and how much space they'll need. Here are examples of fun activities often seen at gem shows:

- A "Wheel of Fortune" spinning wheel, where every spin wins a rockhound prize of a mineral specimen, crystal, polished slab, fossil, etc., donated by club members. If you don't have a spinning wheel, a variation is to have kids draw a numbered ticket from a hat or a bowl and match it to numbered specimens on a prize table.
- Grab bags filled with tumbled stones.
- Making fossils (see Activity 3.2).
- Sand-sifting with a screen or colander for small fossils and gemstones in a box of sand.
- A "Pirate's Treasure Chest" filled with tumbled stones from which kids get to pick an assortment.
- Black Sand Fun, where a container is filled with magnetic sand and a series of magnets.
- Making rock critters by gluing together flat or round stones and attaching eyes, pipe cleaner arms or antennae, feathers, etc., to make snowmen, caterpillars, bugs, etc.
- Rock painting, creating lady bugs, fat cats, and other creatures by painting on large, smooth flat or round stones with tempura.
- Coloring and drawing with coloring book pages of earth science scenes (available at children's bookstores, teaching stores, etc.) or on large sheets of paper rolled out on a table. (This activity should be free. In addition to having activities that kids pay for at a show, you should always have a few that any child can do free-of-charge, such as coloring and drawing or the Black Sand Fun.)

More activities may be found on the AFMS web site: http://www.amfed.org. Tab on "Kids Show Activities" within the Kids Corner section of the web site.

In addition to deciding on what activities to sponsor, kids should determine a budget, help get the supplies they'll need (relying as much as possible on donations from adult members and sympathetic local store owners within the community), and work on the layout and set-up of the Kids Activities Booth. They'll also need to draw up a work schedule so that all kids get a chance to rotate through overseeing various activities while still allowing time to enjoy the show themselves.

Back-up page 9.7: Mentoring.

Actually, if any of your kids have been taking the lead on the various activities outlined above, they've already most likely been mentoring!

Becoming a mentor means helping younger or less experienced club members, sharing one's knowledge and experience with them in a specific project, such as how to craft a cab, how to build and curate a collection, how to identify a mineral or fossil, etc. A mentor is someone who is always on hand, ready and willing to lend help and advice as a friendly and sympathetic colleague, someone who has already been through the ropes and who can share from experience.

As new kids join the club, you might consider formally assigning a "buddy" to them from among your more experienced club members—a mentor who shares whatever interest the new club member arrives with and who can help channel and cultivate that interest.

Back-up page 9.8: Recruiting.

One thing is as certain as night following day: kids grow up! And when they do, they often head off in directions that lead them away from an early interest in rocks. That happened in my own life. After collecting fossils since I was knee high to a grasshopper and enrolling in college as a geology major, I switched to humanities, got a job in publishing, and only many years later returned to my early passion.

From my experience (and from some survey work with a local natural history museum), it is mostly kids in the elementary school age bracket who are fascinated and even infatuated with rocks, minerals, and fossils. By junior and senior high school, many things compete for their interest: computers, cell phones, and social media, extracurricular activities (sports, music, drama, etc.), cars, the opposite sex, etc., etc., etc.

The only way to maintain a vibrant youth program is to continually bring in new recruits. For that, turn to your own junior members! This activity is considered accomplished if a youth member brings in a friend who attends at least three meetings.

But a true recruiter does more than just bring a friend along. Anyone working on this activity should also serve as a host or hostess and mentor to introduce the friend to the hobby and to the club in ways that will spur interest and a desire to become a fellow rockhound.

Back-up page 9.9: Fundraising.

Kids should learn where money comes from and the effort it takes to earn it, how to manage it wisely, and how to save for things of value. The following four suggestions for a fundraising activity are intended to help in this effort.

1. Decide how to spend your money. The first step in a fundraising project is determining what you need or want, then finding out how much it will cost. If your club holds a local show, you might take the kids around to the various dealers to see what sorts of things are out there before meeting as a group to decide what to buy. Guide kids to think in terms of things that will benefit the most club members while remaining within a reasonable budget. This could be a piece of lapidary equipment like a rock tumbler that could be filled with stones provided by each child. Or perhaps they'd like to start a library with how-to lapidary books geared to kids. With everyone gathered around a flipchart or whiteboard, toss around and list ideas and take a vote.

2. Set fundraising goals. Once you know what your kids want, you'll be able to determine a target dollar amount to raise. Raising the necessary amount could be a long-term project, with various fundraising activities held over the course of a year. Teach the kids to track their fund via simple, basic accounting. Make a large poster-board thermometer calibrated with dollar amounts leading to their goal, and use it to motivate the kids by keeping both their goal and their progress literally in sight.

3. Determine fundraising activities. In addition to involving kids in decisions about *what* to buy, involve them in decisions about *how* to buy it. After holding a brainstorming session and a vote on what to buy, hold another session on fundraising activities everyone can participate in. For instance: running a Kids' Booth at your local club show; running a Kids Silent Auction; making and selling lapidary crafts; garage, lemonade, and bake sales. To motivate potential customers, kids might make a poster showing what they're planning to purchase with their money and asking customers for help in reaching their goal, showing folks how the money is going to a good cause.

4. Help "give back" to the AFMS.   Our AFMS/FRA Badge Program is provided free of charge to participating clubs, but it's not without costs; for instance, mailing badges and materials to all the clubs using the program and—most significantly—manufacturing the badges. I'm happy to provide Certificates of Merit to any clubs contributing to the Badge Program to instill a sense of belonging among youth members.

Teaching the value of money and the long-term vision and patience to save for something worthwhile will help kids learn lessons that will benefit them all their lives.

10. Earth Processes

While the ground beneath our feet may seem stable, our Earth is actually an amazingly dynamic and fluid planet. Huge sections of crust called “plates” are always on the move, spreading apart from each other at some places like under the Atlantic Ocean, sliding past each other at other places like the San Andreas Fault, crashing together at still other places to lift mountains like the Himalayas. Here you will learn about such processes, the definition of a rock, and how rocks of different sorts are formed by earth processes.

Activity 10.1: What is a rock?
Learn the definition of a rock and the three rock types (igneous, sedimentary, and metamorphic). Collect at least one of each of the three rock types.

Activity 10.2: Plate tectonics and the rock cycle.
Our earth is made of huge segments, or plates, that are constantly on the move. They recycle rocks and create processes and conditions that lead to igneous, sedimentary, and metamorphic rocks. Make a poster showing the rock cycle. Include specific examples of the different sorts of rocks you might find along different parts of the rock cycle.

Activity 10.3: Igneous rocks.
Learn about different sorts of igneous rocks, how they formed, and how they differ from one another, such as granite versus basalt versus obsidian versus pumice. Then do one of the following activities: a) use a sugar candy recipe to demonstrate the effects of quick versus slow cooling and gas bubbles in forming the texture of an igneous rock; b) make a plaster or clay volcano and set it off for your fellow club members; or c) make an igneous rock collection of 3 or more different types.

Activity 10.4: Sedimentary rocks.
Learn about wind and water erosion and deposition and chemical precipitates and evaporates in order to understand how sedimentary rocks form. Then do one of the following activities: a) make a precipitate or sandstone, conglomerate, and breccia and create a geologic column of these in a milk carton or observe sedimentary processes in nature or in the lab; b) make fossils with clay and plaster; or c) make a sedimentary rock collection of 3 or more different types.

Activity 10.5: Metamorphic rocks.
Learn about “parent rocks” and the formation of metamorphic rocks due to heat and pressure. Then do one of the following activities: a) using clays of different colors as your “parent rocks,” make a metamorphic rock with pressure and heat by twisting and rolling the clays together and then baking them in an oven; or b) make a metamorphic rock collection with 3 or more different types.

Activity 10.6: Making 3D models of geologic features related to plate tectonics.
Understanding some earth processes can be hard without visualizing them. Craft 3D paper models to illustrate geologic features related to plate tectonics.

Activity 10.7: Earthquakes.

Somewhere in the world, an earthquake is happening even as you read this sentence. Explore how and why by researching major earthquakes throughout history, exploring the underlying causes of earthquakes, or modeling their effects.

10. Earth Processes

□ 10.1 What is a rock?

□ 10.2 Plate tectonics and the rock cycle

□ 10.3 Igneous rocks

□ 10.4 Sedimentary rocks

□ 10.5 Metamorphic rocks

□ 10.6 Making 3D models of geologic features related to plate tectonics.

□ 10.7 Earthquakes.

To earn your Earth Processes badge, you need to complete at least 3 of the 7 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

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Back-up page 10.1: What is a rock?

Minerals ***are inorganic substances with unique chemical compositions created in nature.*** "Inorganic" means they're not alive. Minerals often produce crystals, and a particular type of mineral always has the same chemical make-up that gives it a distinctive crystal form and color/s. Minerals are the individual units or building blocks that, brought together, make up a rock. **Rocks** ***are inorganic solids from the earth's crust that are made up of one or more minerals***. To provide a comparison for kids, you might say that everyone in your club represents an individual mineral. You have boy minerals, girl minerals, mother and father minerals, etc. Scattered around town, each is an individual, but when you bring them together in the same room, the individual boys and girls and parents become something new: a rock club. Just so, when individual minerals come together in a group, they create a rock.

Granite is a good example for showing how rocks are made of collections of minerals because crystals of the individual minerals making granite are especially large and visible as compared to some other types of rocks. Although different types of granite will have different combinations of minerals, most granite is made of the minerals feldspar, quartz, mica, and hornblende. The quartz will tend to be clear or milky and shiny like glass. The feldspar might be white, gray, or pink and somewhat dull. The mica will appear as silver or black glittery flakes. And the hornblende will appear as black specks. Have your kids examine a specimen of granite under a magnifying glass to see the different types of minerals in order to gain an appreciation of how a rock is made up of different minerals that have grown together.

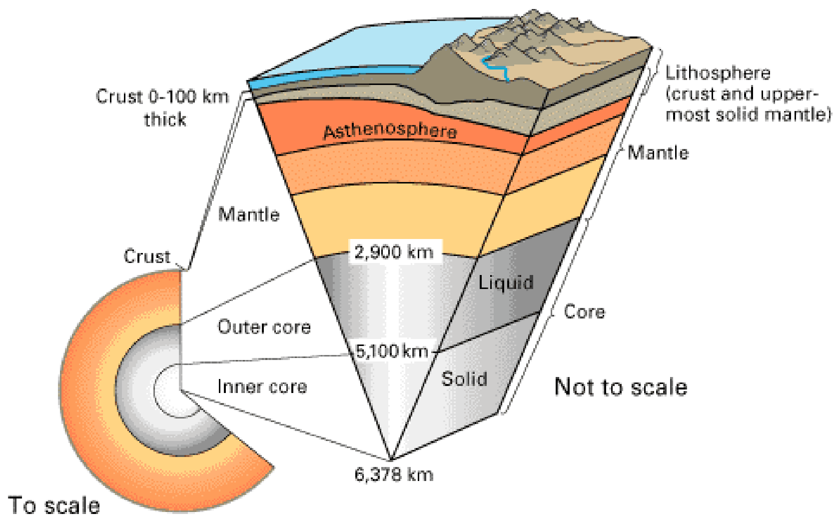
Rocks are divided into three groups:

1. **Igneous rocks** cooled and crystallized from hot, molten magma, either on the surface of the earth or deep below ground. "Igneous" is derived from the Latin word *igneus*, meaning "fire." Examples of igneous rocks your kids might collect include granite, basalt, rhyolite, obsidian, gabbro, tuff, andesite, pegmatite, or pumice.
2. **Sedimentary rocks** formed by gravel, sand, or mud that got buried and hardened due to pressure from overlying rocks. Sedimentary rocks start by processes of erosion that create gravel, sand, or mud that settles to the bottom of a basin (ocean, lake, or river valley) in layers. These layers eventually harden to become conglomerate, sandstone, or shale. "Sedimentary" is derived from the Latin word *sedimentum*, which means "to settle or sink down." Sedimentary rocks also include those that precipitate out of water, either through chemical action or evaporation, such as limestone, gypsum, or halite (salt). Examples of sedimentary rocks your kids might collect are shale, sandstone, breccia, conglomerate, limestone, coquina, diatomite, dolomite, travertine, or gypsum.
3. **Metamorphic rocks** are pre-existing rocks that have been altered by extreme heat and/or pressure to create a rock with a new form and mineral structure. "Metamorphic" is derived from the Greek word *metamorphōsis*, which means "to change" or "to transform." Examples of metamorphic rocks are marble, gneiss, slate, schist, quartzite, soapstone, greenstone, and serpentine.

Note: *Kids can use this activity to satisfy requirements toward earning their Rocks & Minerals badge (Activity 1.4) and Collecting badge (Activity 5.1) simultaneously.*

Back-up page 10.2: Plate tectonics and the rock cycle.

Some have described our Earth as a round soft-boiled egg with a partly solid/partly liquid hot **core** surrounded by a syrupy hot layer of soft rock known as the **mantle**, both contained within a thin and brittle outer **crust** of hardened rock.



Source: *United States Geological Survey website, "Education" link.*

On Earth, the rocks making up the crust are constantly moving through a cycle of formation and change through processes involved with **plate tectonics**. The thin, brittle crust of the Earth is not an even shell, as with our soft-boiled egg example, but rather, is cracked and divided into a number of plates that float and travel over the more fluid mantle. Much of the earth's seismic activity (earthquakes, volcanic eruptions, mountain building) occurs at the boundaries of these plates, where plates collide (as in the Himalaya Mountains), diverge (as along the mid-Atlantic ridge), slide past one another (as at the San Andreas fault), or where one overrides another (as along the east coast of Japan). Several web sites offer animations and/or instructions on making "earthquake models" so that you can demonstrate their effects and illustrate the different sorts of plate boundaries. For instance, see:

- "How to Make an Earthquake Model for Kids" www.ehow.com/how_5347246_make-earthquake-model-kids.html
- "USGS Science Fair Project Ideas" http://earthquake.usgs.gov/learn/kids/sciencefair.php
- "Earth Science 3D Paper Models and Toys" www.consrv.ca.gov/cgs/information/Pages/3D_PaperModels.aspx#heading

For photos of various earthquake events, you might check out the web site "Yup…Rocks," www.yuprocks.com.

As a result of these tectonic processes, with plates colliding, diverging, overriding, or sliding past one another, new rock is formed, old rock is worn down and re-deposited as sediment, and other rocks are changed through heat and pressure. You can use various types of rocks to illustrate this **rock cycle**.

- **Igneous rocks** formed from hot, molten magma, either deep underground (e.g., ***granite***) or extruded onto the planet's surface (e.g., ***basalt***). Igneous processes can form volcanoes and mountains that lift land up and create new land.
- **Sedimentary rocks**, on the other hand, result from processes that wear the earth down. Gravity, combined with the weathering properties of wind, rain, and freezing, disintegrates rocks, breaks them into smaller components, and transports them into valleys and basins as gravel, sand, or mud, where they pile up in layers and eventually harden into the sedimentary rocks known as ***conglomerate***, ***sandstone***, and ***mudstone*** or ***shale***. Sedimentary rocks also form chemically, as when calcium carbonate precipitates out of tropical seas to form ***limestone*** or when seas or lakes evaporate, leaving behind deposits of ***halite*** or ***gypsum***.
- Sometimes, igneous and sedimentary rocks get buried under other rocks and get caught up into immense forces involved in plate tectonics and mountain building. When this happens, these rocks get heated and squeezed, and the pressures can change their structures and transform them into whole new rocks, known as **metamorphic rocks**. These include rocks such as ***gneiss***, ***schist***, ***slate***, or ***marble***.

Here are some illustrations of how rocks move through a "rock cycle." Granite is an igneous rock that hardened and crystallized from molten magma deep beneath the earth. You'll see bits of crystallized quartz in granite. When granite weathers, these quartz crystals get worn down into grains of sand. When deposited in a valley, lakebed, or ocean, sand can harden into the sedimentary rock called sandstone. If the sandstone is buried and subjected to heat and pressure, it will transform into the metamorphic rock called quartzite.

Granite → Sandstone → Quartzite
igneous sedimentary metamorphic

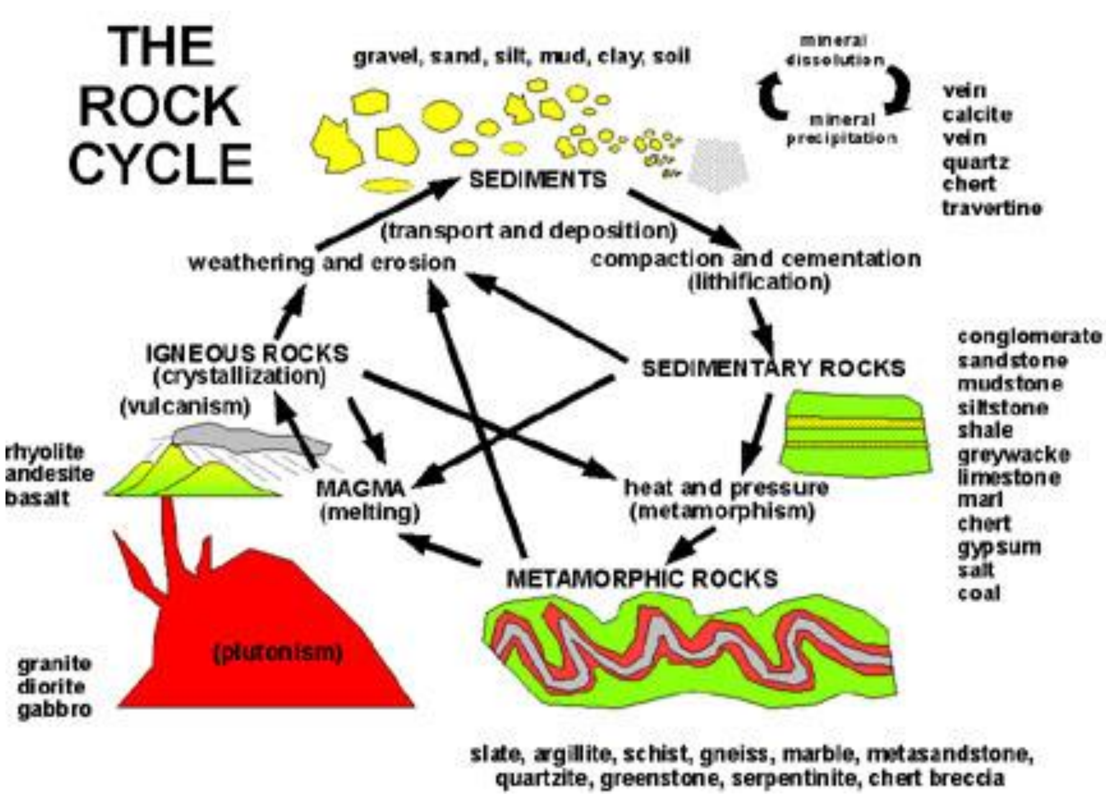
The mica and feldspar in igneous granite can get worn down into silt and clay. When that hardens, it becomes sedimentary shale. And when shale is subjected to heat and pressure, the original mica re-crystallizes to form flat, platy layers of metamorphic slate or schist.

Granite → Shale → Slate or Schist
igneous sedimentary metamorphic

To illustrate these processes, Abdo Publishing provides four great little books from their Core Library Rocks and Minerals series geared to kids in grades 3-5: Rebecca E. Hirsch's *The Rock Cycle* (2015), Lisa Owings' *Igneous Rocks* (2015), Rebecca E. Hirsch's *Sedimentary Rocks* (2015), and Jennifer Swanson's *Metamorphic Rocks* (2015). Check for details on these and other books at www.mycorelibrary.com. Oxford University Museum of Natural History has put together "The Learning Zone" website: www.oum.ox.ac.uk/thezone/rocks/index.htm. It provides fun sections geared to interactive learning as kids follow "Rocky" through the rock cycle.

Another helpful partner in educating kids about the earth sciences is Myrna Martin, who began a home-based business called Ring of Fire Science Company LLC in Oregon (www.RingofFireScience.com). Inspired by the eruption of Mount Saint Helens 90 miles from her home, she crafted a set of lesson plans on volcanoes that grew into a whole "Hands-on Science" series. These include *Rock Cycle: Hands-on Science*, which is beautifully designed and illustrated with easy-to-follow instructions for activities directly related to the rock cycle and the three rock types along with lesson summaries, quizzes, and vocabulary with definitions provided in an end-of-book glossary.

Here's a simplified diagram of the rock cycle. Your kids should be able to find other diagrams in geology books that they can get from the library or a bookstore or from sites on the World Wide Web. Have them create a large poster of the rock cycle in which they list different sorts of rocks they might expect to find at different points along the cycle. To create a three dimensional poster, they might glue small specimens of some of the different types of rocks alongside their lists.



Source: *United States Geological Survey.*

Back-up page 10.3.a) Igneous rocks: Demonstrating effects of cooling and gases.

Igneous rocks form from molten magma from inside the earth that cools and solidifies as it nears or reaches the surface. To show kids how a hot, liquid substance can become rock hard when it cools, here are a couple easy demonstrations.

A. Fast cooling versus slow cooling. As molten magma cools, crystals form. If the magma cools very slowly, those crystals have a chance to grow large. This is what happens in **granite**, an **intrusive igneous rock** that generally forms deep underground and takes an extremely long time to cool. If magma cools more quickly, crystals don't have a chance to grow as large, so the resulting rock has a smaller crystal structure. This is seen in **basalt**, an **extrusive igneous rock** formed from magma that rose to the surface of the earth where it cooled more quickly in the air. Sometimes magma cools super-fast, and when that happens, crystals may not have a chance to form at all, as seen in smooth **obsidian**.

If you have some available, use specimens of granite, basalt, and obsidian to illustrate this difference in rock texture and crystal size. Have kids examine each closely with a magnifying glass to see the differences and have them use their sense of touch to feel the different textures. **You can illustrate how crystals grow to different sizes depending upon how quickly they cool with the following experiment:**

Materials.

- Cooking pan with a half-cup of water
- Hotplate or stovetop
- Spoon and ladle
- Two and one-half cups of sugar
- Empty bowl chilling inside a larger bowl half-filled with ice cubes

Procedure.

1. Bring the water to a boil and slowly stir in sugar until you form hot syrup.
2. Ladle just a small bit of your syrup into the empty chilled bowl to cool quickly as a thin film on the bottom of the bowl.
3. Leave the rest of your syrup in the original cooking pan to cool slowly.

Once both mixtures have cooled, you should observe that the mixture in the chilled bowl is very clear and smooth, with only tiny sugar crystals having formed, whereas the mixture that cooled more slowly in the hot pan is coarser and lumpier and cloudy or milky looking. Similarly, magma that cooled quickly as lava on the surface of the earth tends to have smaller crystals and a more finely grained texture whereas granite, which cooled much more slowly as magma deep beneath the earth, tends to have large crystals and a very lumpy texture.

B. Quick cooling and the effects of gas bubbles. If magma cools super-fast, no crystals may form at all, and you end up with volcanic glass, or obsidian. **While we usually think of volcanic glass as being smooth and shiny, as you'll see in this demonstration, a little gas can make a big difference in texture and appearance.**

Materials.

- 3 cups of sugar
- 3/4 cup of light corn syrup
- 3 tablespoons of white vinegar
- 1/3 cup of water
- Butter or margarine
- Spoonful of baking soda
- Cooking pan and wooden spoon
- Candy thermometer
- Cookie sheet or shallow brownie pan
- Stove or hotplate

Procedure.

1. Grease the cookie sheet or shallow brownie pan with your butter or margarine and chill it in a refrigerator or over ice cubes.
2. Stir your sugar, corn syrup, vinegar, and water together in a cooking pan over high heat. Stirring constantly, cook to 302° F (150° C) on the candy thermometer, or "hard crack" stage. (Some candy thermometers will have this spot marked and labeled.) The ingredients should end up forming a hot, syrupy liquid.
3. Pour the thick syrup onto the chilled, greased cookie sheet or brownie pan and smooth it into a thin layer.
4. When the syrup mixture cools, it will become a hard lump. (In this case, it's a hard-candy lump that should be edible.)

Likewise, hot, soft, liquid molten magma solidifies into a hard igneous rock when it cools. In this instance, you will have created a smooth, clear "rock" with a texture somewhat like **obsidian**. Obsidian is lava that cooled very quickly, so quickly that crystals didn't have a chance to grow, thus resulting in smooth volcanic glass.

Another volcanic rock that cools to a glassy state is **pumice**, but unlike smooth obsidian, pumice is rough and porous. It's shot through with thousands of tiny bubbles from gases. These gases whipped up a volcanic "froth" that cooled quickly in the air. To illustrate this effect, you can follow the very same recipe outlined above but with the following twist. After pouring just half of your syrup into one chilled and greased pan or cookie sheet, set your cooking pan down and quickly stir a spoonful of baking soda into the remaining half of your mixture. The baking soda will react with the vinegar to release carbon dioxide bubbles throughout your mixture, which you should now pour into a second chilled and greased pan.

When both mixtures have cooled, shatter both into smaller pieces and have your kids compare pieces side-by-side along with specimens of obsidian and pumice.

Back-up page 10.3.b) Igneous rocks: Making a volcano.

The classic earth science project is making a model volcano that erupts with fluid lava. Here's how!

Materials.

- A 2-foot square sheet of poster board or plywood
- A small can (empty tomato paste or small mushroom cans work well)
- Newspaper, foil, or wire mesh
- Plaster of Paris, mixing bowl, spoon
- Water
- Paint, spray adhesive, sand, lacquer (optional)
- Baking soda
- Vinegar
- Red and yellow food coloring
- Dishwashing liquid
- Measuring cups
- Plastic film canister with a snap top
- Alka-Seltzer or denture cleanser
- Water
- Newspapers or drop cloth

Procedure.

1. On your poster board or plywood base, make a mound or cone shape from damp and wadded newspapers, wadded foil, wire mesh, or other suitable material.
2. At the very top, wrap this material around a small can or bottle.
3. Mix plaster of Paris (two parts plaster, one part water), and coat your mound with it, leaving the can open at the top. Then set it aside to let the plaster dry.
4. You can either use the volcano the way it is, or you and your kids can paint the volcano whatever colors you prefer or, for a realistic touch, apply a spray adhesive and sprinkle your volcano with sand (or glitter, for an artistic touch).
5. If you plan on re-using the volcano many times, you should coat the finished work with a lacquer so that it may be easily wiped clean.

You now have a dormant volcano. Here's how to make it active and ready to erupt in ways that will simulate two types of volcanic eruptions.

A. Lava flow eruption. Some volcanic eruptions are relatively mild. Rather than a single, massive explosion, they issue a flow of hot, basaltic lava, like we see with lava flows on the Hawaiian Islands or with the extinct cinder cone volcanoes and lava fields in the American West. Here's how to simulate this sort of eruption:

1. Place your volcano on newspapers or a drop cloth.
2. Fill the can at the top of your volcano one-third with baking soda.
3. In a separate cup, mix one-third cup of vinegar with a couple drops of red and yellow food coloring and two drops of liquid detergent.
4. Pour this mixture into your volcano with the baking soda to creating a sudden eruption and lava flow!

If you have specimens available, show kids samples of **basalt, pahoehoe**, or **a'a**. These are the sorts of igneous rocks formed in a lava flow like the one you've just demonstrated.

B. Explosive eruption. Other volcanic eruptions involve massive, violent explosions, like that which blew the top off of Mount Saint Helens in 1980. Here's how to simulate this sort of eruption:

1. Fill a plastic film canister three-fourths with water or vinegar.
2. Drop in an effervescent tablet (Alka-Seltzer or denture cleanser work well).
3. Quickly snap on the canister lid, give it a hard shake, and quickly place the canister into the mouth of your volcano, with the lid of the canister pointing up.
4. Keep kids back from the volcano as they wait. After just a second or two, the lid of the canister will pop several feet into the air along with a quick squirt of foamy water. (This works *very* quickly if using vinegar along with Alka-Seltzer, but may take a bit longer if using water with a denture cleanser tablet.)

If you have specimens available, show kids samples of **rhyolite** and **andesite**. These are the sorts of igneous rocks formed during an explosive eruption.

Making a plaster volcano can be time-consuming and involved and may require several days to complete in stages. It requires time for the plaster to dry, for decorating or painting the plaster, then for coating the volcano with a protective layer of lacquer and allowing that to dry. Here's an easier way for individual kids or pairs or teams of kids to make small erupting volcanoes of their own much more quickly.

Materials.

- Square-foot sheet of stiff cardboard (1 for each child or team of kids)
- Test tubes or small bottles (1 for each volcano being made)
- Clay or Play-Doh
- Baking soda
- Vinegar
- Red and yellow food coloring
- Dishwashing liquid
- Measuring cups
- Newspapers or drop cloths

Procedure.

1. With the cardboard as a base, kids position a small bottle or test tube in the middle.
2. Kids fill their bottles/tubes half full of baking soda, then pile modeling clay around the bottle in the shape of a volcano cone, leaving the top of the bottle open.
3. Mix vinegar with drops of red and yellow food coloring and a drop or two of dishwashing liquid.
4. Pour your vinegar solution into the baking soda to watch the volcano erupt!

For a wealth of information all about volcanoes, centered on the sorts of questions kids ask, a great resource is the little paperback book *101 Questions About Volcanoes* by John Calderazzo (Western National Parks Association, 1994, www.wnpa.org).

Back-up page 10.3.c) Igneous rocks: Collecting igneous rocks.

Following are igneous rocks kids may be able to collect if they live in the right area of the country, or that they may be able to purchase from rock dealers or to trade through the mail via the AFMS Patricia Egolf Rock Pals program as a club project with kids in other AFMS/FRA clubs who live in areas where igneous rocks are common:

- **Andesite** is a gray to black volcanic rock with a high silica content that commonly erupts as thick, sticky lava flows from stratovolcanoes, such as those in the Andes Mountains, which gave this igneous rock its name.
- **Basalt** is generally a hard, dense, heavy, dark gray or black rock formed from magma that flowed out of a volcano or vent in thick streams or sheets. Basalt can come in a variety of forms. **A'a** (pronounced "ah-ah") is variety that cooled with a jagged, rough and rubbly surface. **Pahoehoe** (pronounced "pah-hoi-hoi") cooled with a glassy smooth hummocky or ropy texture.
- **Gabbro** is a dark (often black), coarse-grained, intrusive igneous rock chemically equivalent to basalt but that cooled deep beneath the Earth's surface, resulting in large crystal structures within the rock that sparkle in the light.
- **Granite** cooled from magma deep under the earth and as a result usually has large mineral crystals all grown together. Depending on the type of granite, these minerals might include quartz, feldspar, mica, olivine, etc.
- **Obsidian** is a heavy, smooth, and shiny volcanic glass rich in iron and magnesium that cooled very quickly during an eruption, so quickly that crystals didn't have time to grow, thus resulting in glass. Chemically, it's often identical to pumice, which makes it terrific to use for compare-and-contrast with pumice.
- **Pegmatite** is a very coarse-grained igneous granite consisting of quartz, feldspar, and mica and commonly also containing large gemstone crystals such as tourmaline, aquamarine, and kunzite. Pegmatites form as a magma that cools quickly after intruding as a dike or sill into other rock.
- **Pumice** is formed from magma that shoots out during a particularly violent, explosive eruption. Gases dissolved in liquid magma expand rapidly during the eruption, making pumice extremely frothy (like froth created when you shake a soda can and open it). Millions of tiny gas bubbles leave cavities shot through pumice, making it extremely light—so light that it can often float on water!
- **Rhyolite** is often a banded light-colored, fine-grained rock that formed when thick, sticky lava flowed for relatively short distances.
- **Scoria** is similar to basalt, but whereas basalt usually flows in a thick, fluid layer from a volcano, scoria is shot into the air as a cinder during explosive eruption events. Thus, like Swiss cheese, it's peppered with holes from gas bubbles, making it much lighter than basalt.
- **Tuff** is volcanic ash and cinder that settles while still quite hot and becomes welded and compacted into layers of coarse, often lightweight rock that's usually white or gray or cream in color.

Note: *Kids can use this activity toward satisfying requirements for other badges, too: Rocks & Minerals (Activity 1.4) and Collecting (Activity 5.1).*

Back-up page 10.4.a) Sedimentary rocks: Making sedimentary rocks.

Sedimentary rocks start by processes of erosion that create boulders, cobbles, gravel, sand, mud, or clay. These settle to the bottom of a basin (low-lying land or an ocean, lake, or river valley) in layers. These layers eventually harden to become what are called "clastic" sedimentary rocks: conglomerate, sandstone, or shale. Sedimentary rocks also include those that precipitate out of water either through chemical action or evaporation, such as limestone, gypsum, or halite. These are "nonclastic" sedimentary rocks, or precipitates and evaporites. Via the following activities, kids can make artificial sedimentary rocks, including evaporites, sandstone, conglomerate, and breccia.

A. Creating precipitates and evaporites. Some sedimentary rocks, such as **limestone** and **gypsum**, chemically precipitated out of minerals in water or were left behind when water in a lake or sea evaporated. You can demonstrate this process using water solutions created with readily available materials.

Materials.

- Table salt, Epsom salt, or alum
- Water
- Measuring cups
- Spoon
- Cooking pan
- Glass jars
- Pebbles
- Stick or pencil
- String (cotton twine), cut into small lengths and dampened
- Food coloring (optional)

Procedure.

1. Heat water to a boil, then turn off the heat.
2. If using table salt, use ½-cup salt with ¾-cup hot water. With Epsom salt, use ½-cup salt with 1-cup water. If using alum, use ¼-cup alum with 1-cup water.
3. Slowly add and stir salt into the hot water until it becomes a "saturated solution." A saturated solution contains the maximum amount of mineral that will dissolve in a given amount of water. If all of your salt dissolves, the solution is not yet saturated, and you should add a bit more salt. Stop when no more salt will dissolve.
4. Optional: You can make colorful crystals by adding a couple drops of food coloring.
5. Place a few pebbles in a glass jar and pour your solution over the pebbles. Or, tie a piece of string to a stick or pencil. Dampen the string with your solution and roll it in salt to provide "seed crystals." Then pour your solution into a glass jar, and dip the string into the solution. Leave it hanging there from the stick or pencil.
6. Set your jar aside in a spot where it won't be disturbed and don't bump or bounce it. Check every so often the next few days. As water evaporates, you'll see crystals forming on your pebbles or string.

Assign different salts to different kids. Once everyone's water has evaporated, bring their jars together to compare the different forms of crystals each produced.

You can also grow crystals using commercially available crystal-growing kits from places like toy and craft stores, museum gift shops, or scientific supply houses. Two reliable supply houses are Ward's Natural Science (order their Earth Science and Geology catalogs; phone 1-800-962-2660; web site www.wardsci.com), or Edmund's Scientific (phone 1-800-728-6999; web site www.scientificsonline.com).

Note: *Kids can use this activity for satisfying requirements toward earning the Rocks & Minerals badge simultaneously (Activity 1.6).*

B. Creating sandstone. **Sandstone** forms when sand is buried and mineral-rich groundwater flows through it. Minerals in groundwater act as cement to glue sand grains together while overlying layers of sediment exert pressure to compact it. Your kids can simulate sandstone formation with an easy activity to make their own artificial sandstone.

Materials.

- Paper cups
- Sand (from beach or hardware store)
- Epsom salt, sodium silicate solution (also called water glass), or plaster
- Water
- Pan or Pyrex measuring cup
- Spoon, dowel, or popsicle stick
- Food coloring (optional)
- Paper towels

Procedure.

1. Fill the bottom of a paper cup with a layer of sand about an inch deep.
2. Make a solution of mineral-rich "groundwater" in a pan or Pyrex measuring cup by dissolving Epsom salt in boiling hot water (keep stirring in salt until no more will dissolve). An alternative to Epsom salt is a sodium silicate solution (water glass) diluted with water. (As an option, have different kids add drops of different food colorings to their solutions to make sandstones of different tints.)
3. Pour the "groundwater" into the sand and stir it all together with a spoon, dowel, or popsicle stick to make sure all the sand is wet. However, you don't want to make soup, so don't pour in too much water!
4. Lightly tap the bottom of the cup on a countertop or desktop to settle the sand.
5. Set the cup, uncovered and undisturbed, in a sunny, warm open spot to evaporate the water. If you poured in too much solution, you may find you need to soak up excess water with wadded paper towels after you've allowed the mixture to sit for awhile.
6. After about a week, the mixture should have completely dried. When it has, tear off the paper cub, and you should end up with a rock that looks and feels similar to the sandstone in your sedimentary rock box.

I've had mixed success with using these Epsom salt and water glass solutions. They took a long time to dry, and Epsom salt often produced just a thin crust at the top of the sand. Here's an alternative that's worked with greater consistency. Fill cups with an inch-thick layer of sand and add a heaping tablespoon of plaster of Paris. Have kids add different food colors to different cups, and then add water and mix the sand and plaster together. This variation also tends to dry more quickly than Epsom salt or water glass solutions. In yet another variation, use two parts white glue to one part water. Mix this together with the sand in the bottom of your paper cup and allow to dry, then peel off the cup.

Kids will notice that the artificial sandstone is softer, crumblier, and not as heavy as the real thing. Ask if they can think of why. (Answer: the real sandstone not only has been cemented together by minerals in groundwater but also has been compacted when it was buried beneath other rocks. The weight of overlying rocks and earth pressures squeezed sand grains together as much as possible, forcing out air pockets and making the real sandstone much denser than our artificial sandstone.)

If you have specimens of real sandstone, you might notice that it comes in different colors, from yellow or brown hues to bright reds, grays, greens, etc. The color of sandstone may have two explanations:

i) Sometimes, sand grains are made of different minerals, and the color of the sandstone is caused by the color of the sand grains themselves. For instance, black sand beaches in Hawaii are derived from the dark basaltic lavas. White sand dunes covering an extensive area of New Mexico were derived from the mineral gypsum.
ii) Other times, the color of sandstone may be due to the color of the minerals deposited around sand grains by the groundwater. For instance, some groundwater holds iron oxide in it, and this will often cause a rusty color, "painting" the sandstone red.

Many times, the color of a piece of sandstone represents a combination of colors derived from the sand grains themselves along with the color/s of any minerals that were deposited around those sand grains to glue them together. You can demonstrate the coloring effect of minerals in groundwater by having different kids add different colors of food coloring to their ground water solutions. Have some add a couple drops of red, have others add a couple drops of blue, and have others use no food coloring and compare the resulting sandstones when all have dried.

C. Creating conglomerate and breccia. **Conglomerate** is a clastic sedimentary rock formed by the cementing of rounded cobbles and pebbles that have been worn smooth during transport in streams, rivers or ocean shores. The individual cobbles and pebbles (or "clasts") get compacted and cemented together in the same manner as sand grains in sandstone. **Breccia** is basically the same thing as conglomerate except that its cobbles and pebbles are sharp and angular, indicating that the rock fragments had not been transported very far before being deposited and buried. To make a conglomerate or breccia, you can follow a similar procedure as that used to make sandstone and just add pebbles to your sand mixture:

Materials.

- Paper cups
- Sand (from beach or hardware store)
- Gravel (both smooth and rough pebbles from a beach or river bed, or purchase bags of smooth and rough pebbles at aquarium supply stores or hardware stores)
- Sodium silicate solution (also known as water glass) or plaster of Paris
- Water
- Pan or Pyrex measuring cup
- Spoon, dowel, or popsicle stick
- Paper towels

Procedure.

1. Fill the bottom of a paper cup with a layer of sand and gravel about an inch thick. (Give half your kids rounded pebbles and the other half the rougher, angular pebbles.)
2. If using sodium silicate (water glass), make a solution of mineral-rich "groundwater" in a pan or Pyrex measuring cup by diluting the sodium silicate in water.
3. Pour the "groundwater" into the sand and gravel mixture and stir it all together with a spoon, dowel, or popsicle stick to make sure all the sand and gravel is wet. However, you don't want to make soup, so don't pour in too much water!
4. Alternatively, if using plaster of Paris, put a heaping tablespoon of dry plaster into each kid's cup of sand and gravel and then add just enough water to be able to stir and mix everything together. (Again, don't make soup!)
5. Lightly tap the bottom of the cup on a countertop or desktop to settle the sand, gravel, and water mixture.
6. Set the cup, uncovered and undisturbed, in a sunny, warm open spot to help the drying process. If you poured too much solution, you may find you need to soak up excess water with wadded paper towels after you've allowed the mixture to sit.
7. Once, the mixture has completely dried, tear off the paper cub, and you should end up with a rock that looks and feels similar to the conglomerate or breccia, especially if you break your artificial specimens in half.

Those kids who used the smooth, water-worn pebbles will have created artificial **conglomerate**. Those who used the rougher pebbles with sharp edges, on the other hand, will have created artificial **breccia**.

D. Creating a geologic column. The geologic column is the sequence of rocks that document the earth's ancient history. For instance, a layer of **limestone** that's capped by a layer of **shale** that's capped by a layer of **sandstone** might tell of a time when a sea began to retreat. When the sea was deep and clear, it left a deposit of limy, fossil-filled sediments that would eventually become limestone. But as the sea began to retreat and shrink away from its original banks, the floor of the sea would grow muddier from dirt washing in from the land and from swamps and estuaries advancing at the edge of the sea. This mud would eventually become a layer of shale. As the land continued its advance and the sea continued to retreat, a layer of sand from a beach might be deposited over the older layers of limestone and shale and eventually become sandstone.

Geologists study sequences of sediments like this from all around the earth. By studying sedimentary layers, they tease out stories each layer tells about earth history, and they assemble and organize various layers by time into the "geologic column," which is like assembling pages in a history book that progresses from ancient history to modern time.

You and your kids can create a small geologic column as follows:

Materials.

- Several cupfuls of sand and gravel
- Small seashells and thick leaves

- Petroleum jelly
- Waxed paper
- Plaster of Paris
- Water
- Food coloring (red, blue, green)
- Half-gallon cardboard milk carton
- Bowl or large plastic cups
- Spoon, dowel, or sticks
- Apron and paper towels

Procedure.

1. Cut the top off a half-gallon rectangular cardboard milk carton.
2. Spread your seashells and leaves across a sheet of waxed paper and lightly coat one side of each seashell and leaf with petroleum jelly.
3. Mix equal amounts of sand and plaster of Paris (about a half to one cup of each) in a bowl or large cup.
4. Add a few drops of red food coloring and water and stir to a thick, smooth consistency.
5. Pour this colored sand/plaster mixture into your milk carton.
6. Take some seashells and/or leaves and gently press them atop your sand/plaster layer with the oiled sides up. (Don't bury them completely into the sand/plaster layer; just nudge them in a bit, with the oiled tops showing.)
7. Repeat this process using sand/plaster layers colored by different food colorings (with some layers of no food coloring, just natural sand and plaster), placing oiled seashells or leaves between each layer as you build up a multi-colored "layer cake" inside the milk carton. For variation, in some of the layers you might mix in some pea-sized gravel along with the sand and plaster. Continue adding different colored layers until the milk carton is filled to the top.
8. Once the milk carton is full, let everything harden for a day or so.
9. When all is dry, peal off the milk carton to reveal your layers of sediment.
10. By tapping between layers with a hammer and chisel, you should be able to split your sedimentary rock into layers to reveal fossils and their impressions in the form of the seashells and leaves you dropped between layers.

E. Observing sedimentation in action. Rather than making artificial examples of sedimentary rocks, send kids outdoors to observe sedimentation in action. For example, they might see:

- rocks chipping off and piling up at the base of a cliff;
- a tree with roots growing into and cracking rocks and boulders at an outcrop (or buckling and cracking a cement sidewalk in their neighborhood);
- a gully cutting into a hillside and carrying away soil, sand, or gravel;
- sand bars and cobbles piling up in bars along a river bank.

Have kids look around and bring back lists of what they see in the natural environment, including these and any other examples.

F. Observing sedimentation in the lab. Kids can observe sedimentation in “the lab” with the following activities:

- Fill a large glass jar or water bottle one-third to one-half full of a mixture of gravel, sand, and dirt. Pour in water to the top of the jar and screw on the cap. Shake vigorously with up-and-down and circular motions. Then set the jar down and allow the mixture to settle. If all goes well, the sediments should have settled in clear layers by weight, with gravel on the bottom, mud on top, and sand in between.

- Fill a large pan with dirt and tilt it with a brick or wood block under one end. Using a gardener’s water can, rain water down from the high end to show how erosion occurs on hillsides, carving gullies and transporting sediment downhill with gravity. You might also plant stones in the dirt to show how such obstacles affect the flow of water and erosion.

- To illustrate the destructive power of water and how—given enough time—water can break down rocks as it expands and contracts between its frozen and liquid states, get a water bottle with a cap. Fill it one-third with cinders (available from the garden supply section of a hardware or garden store) and the rest with water. Cap it and pop it into the freezer. Over the course of several weeks, allow it to freeze and thaw a number of times. Finally, pour the contents into a bowl or pan. What began as cinder rocks should now be a combination of mud, sand, and cinders.

Back-up page 10.4.b) Sedimentary rocks: Making fossils.

Fossils are the remains of past life that got buried within sediments that turned into sedimentary rocks. This includes remains of animals (bones, teeth, shells) or plants (impressions of leaves or stems or petrified wood) or even imprints such as footprints that a dinosaur left on a beach or tubes that worms burrowed through mud.

Kids can make fossil imprints with clay and organic materials they bring in themselves, such as flowers, leaves, ferns, chicken bones, or seashells. Here's what they'll need:

Materials.

- Self-hardening clay
- Paper plates or sheets of waxed paper
- Rolling pin (optional)
- Seashells, leaves, chicken bones, flowers, ferns, or other organic materials
- Vegetable oil or talcum powder
- Paint (optional)

Procedure.

- Give each child a sheet of waxed paper or a paper plate and a lump of self-hardening clay.
- Either with their palms or with a rolling pin, have kids flatten their clay into a thin, even layer about a half-inch thick on the waxed paper or paper plate.
- Have your kids press their flower, leaf, fern, chicken bone, or seashell gently into the clay and lift it out. (With seashells that have deep ridges or indentations, they first may need to coat the shell lightly with vegetable oil or talcum powder to be able to lift it out of the sticky clay with ease.)
- Let the clay dry and harden, and each of your kids will have a fossil impression.
- For a realistic touch with impressions of ferns or other leaves, students can paint the impression with black, brown, or gray paint after the clay has dried. Most plant fossils are carbonized films, and the paint will replicate the film of carbon left on the impression.

Note: *For other, somewhat more involved projects to make fossils using clay and plaster, see the back-up page for Activity 3.2. You can use any of these activities to help kids satisfy requirements toward earning both their Earth Processes and Fossils badges simultaneously.*

Back-up page 10.4.c) Sedimentary rocks: Collecting sedimentary rocks.

Following are sedimentary rocks kids may be able to collect if they live in the right area of the country, or that they may be able to purchase from rock dealers or to trade through the mail via the AFMS Patricia Egolf Rock Pals program as a club project with kids in other AFMS/FRA clubs who live in areas where sedimentary rocks are common:

- **Breccia** is a clastic sedimentary rock composed of cobble- and pebble-sized rock fragments that are sharp and angular, indicating that the rock fragments had not been transported very far before being deposited and buried.
- **Coal** originated from compressed vegetation, often derived from swamps, that was buried rapidly in thick masses. High in combustible carbon content, coal-burning facilities are the largest source for generation of electricity.
- **Conglomerate** is a clastic sedimentary rock formed by the cementing of rounded cobbles and pebbles that have been worn smooth during transport in streams, rivers or ocean shores.
- **Coquina** is similar to conglomerate, but rather than being formed by rounded cobbles and pebbles, it's formed by masses of broken seashells, coral fragments, and other biologically-derived materials that are poorly cemented together.
- **Diatomite**, a soft chalk-like sedimentary rock, is composed primarily of silica from the fossilized shells of billions and billions of microscopic diatoms, which are algal-like organisms at the base of the ocean's food chain. It has many industrial uses as a filter (you'll see it in hardware stores with pool supplies), a mild abrasive, and as filler (as in house paints); under high magnification, the individual diatom shells look like snowflakes.
- **Gypsum** is a chemical sedimentary rock precipitated from highly saturated salt waters that left behind thick deposits of sulfate hemihydrate. Gypsum is the main ingredient in plaster of Paris and is also used in drywall, so you may well be surrounded by gypsum at this very moment.
- **Limestone** is a type of non-clastic, chemical sedimentary rock also called calcium carbonate because of its high content of calcium. It generally forms as a limy ooze precipitated on the ocean floor and includes shells from marine animals.
- **Sandstone** is a clastic sedimentary rock formed from the cementing of sand-sized grains, often from minerals in groundwater, along with pressure.
- **Shale** is one of the most common sedimentary rocks. It's composed of silt, mud, or clay that has been compacted to form a solid rock.
- **Travertine** is a form of calcium carbonate (like limestone) deposited through the action of water, such as mineral-rich springs. It's often soft and beautifully banded, making it a favored sculpting stone. It's also sometimes called onyx and alabaster.

Note: *Kids can use this activity toward satisfying requirements for other badges, too: Rocks & Minerals (Activity 1.4) and Collecting (Activity 5.1).*

Back-up page 10.5.a) Metamorphic rocks: Making a metamorphic rock with clay.

Metamorphic rocks are formed when pre-existing rocks (referred to as "parent rocks") are altered by extreme heat and/or pressure. This often creates a whole new sort of rock with a new form and mineral structure.

To illustrate how pressure along with heat can change a rock into something new, you can do a demonstration with clay that Lowell Foster of the Ventura Gem and Mineral Society of California has shared:

Materials.

- Bars of clay of various colors: red, blue, yellow, white, etc. (**Caution:** Use clays that may be baked hard in an oven. Be careful in selecting your clay because not all clays are suitable for baking, and some synthetic varieties might actually catch on fire! That's because some synthetics are made from petroleum products. Most clays available in craft stores indicate on their labels whether or not they may be fire-hardened.)
- Baking tray or pan
- Toaster oven or your home oven

Procedure.

1. If kids twist and press together a bar of blue clay with a bar of red clay with a bar of white clay, the pressure and the twisting make a new clay with a swirl pattern. (Before they start twisting, have them break off and set aside small pieces of their original clay for comparison at the end of this activity.)
2. The more you continue twisting and mixing, the more the pattern and color may change, with blue and red combining to purple in places, or red and white turning pink.
3. If you now add heat to the equation by baking your new clay, you'll get a hard ceramic-like rock with a swirl pattern. You can bake specimens in your own home oven or in a small, portable toaster oven if it's capable of baking at 265° F for 30 minutes or so.

The tough new rock that comes out of the oven will be very different in color, pattern, and texture from the three individual soft pieces of clay your kids began with. In a similar manner, metamorphic rocks end up changed in color, pattern, and texture from their parent rocks by the combined effects of pressure and heat. Have kids compare pieces of their original red, blue, and white clay alongside the lump of twisted, mixed, and baked clay.

To conclude this activity, you can use thin strips of clay of many different colors stacked atop one another and apply pressure from the sides and/or twist and turn to make wavy patterns, or press holes into yellow clay and insert small balls or squares of red or blue clay to see what happens to their shapes when you then press down. Give clay to your kids, and let them get creative!

Back-up page 10.5.b) Metamorphic rocks: Collecting metamorphic rocks.

Following are metamorphic rocks kids may be able to collect if they live in the right area of the country, or that they may be able to purchase from rock dealers or to trade through the mail via the AFMS Patricia Egolf Rock Pals program as a club project with kids in other AFMS/FRA clubs who live in areas where metamorphic rocks are common:

- **Gneiss** (pronounced "nice") is a "high grade" metamorphic rock derived from various sources (e.g., granite, shale, conglomerate, etc.) that were subjected to intense heat and pressure, heat so high that the rock nearly melted to a magma, resulting in minerals that drew together in distinct banding patterns under the high pressure.
- **Greenstone** is a fine-grained massive metamorphic rock with a dull luster that comes in varying shades of green; in California, it's associated with gold-bearing veins in the Mother Lode mining country.
- **Marble** is limestone that has been altered through metamorphic action. Soft, easily carved, semi-translucent, and capable of taking a polish, it's often used by sculptors and builders. Marble comes in various forms, depending on the elements contained in its parent rock. For instance, **limestone marble** contains mostly calcium carbonate and may have interesting veining (or "marbling") with colors due to different mineral impurities. **Dolomite marble** had a parent rock of dolomite, which is similar to limestone, but with magnesium in addition to calcite as a constituent mineral. And **mariposite** (named after Mariposa, California, where it occurs in abundance) is a form of dolomite marble with a high green chromium muscovite mica content that gives it a distinctive green marbling.
- **Quartzite** is a massive, medium-grained metamorphic rock with a sugary texture often derived from sedimentary sandstone.
- **Serpentine** is a fairly soft metamorphic rock that may be waxy to the touch and has apple-green to black, mottled coloring that can look like serpent scales. It's the official California State Rock.
- **Slate** is a "low grade" metamorphic rock (meaning it was subjected to only low heat and pressure) formed from sedimentary shale; it splits, or cleaves, in flat surfaces, and has been used as roofing shingles and blackboards.
- **Soapstone** consists mostly of an impure, massive variety of talc. Soft, with a pearly sheen, it's a popular sculpting material, but has many other uses, such as in the manufacture of laboratory tabletops, firebricks, and electrical apparatus due to its resistance to heat, electricity, and acids.

Note: *Kids can use this activity toward satisfying requirements for other badges, too: Rocks & Minerals (Activity 1.4) and/or Collecting (Activity 5.1).*

Back-up page 10.6: Making 3D models of geologic features related to plate tectonics.

It can be hard to fully understand some earth processes without visualizing them. The California Department of Conservation has stepped in to help in a hands-on way! Quite a number of folks and associations have come up with designs for crafting cut-and-fold 3D paper models to illustrate geologic features related to plate tectonics, including volcanoes, seafloor spreading and subduction, earthquake features and different types of faults (normal, reverse or thrust, strike-slip or lateral, transform, oblique, etc.), landforms and structural geology (synclines and anticlines, unconformities, etc.), and much more.

The California DOC has conveniently compiled these all together on a single website that describes each model then provides a direct link to the source where you can download and print masters for free to make copies for your club's kids. They note that the models exhibit better structure and stability when printed on cardstock. Here's the link:

http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx

This great resource provides cut-and-fold models you might use for still other badges. For instance, you'll find models illustrating the different crystal shapes of minerals for the Rocks & Minerals badge (Activity 1.5), models of a variety of fossils and dinosaurs that can be used when working on the Fossils badge (Activities 3.2 and 3.7), and models of the Earth and other planets that can be used when working on the Earth in Space badge (Activity 11.1).

Cutting out, folding, and gluing or taping engages kids in a hands-on way that provides a lot of fun while crafting a finished product that educates in the process!

Back-up page 10.7: Earthquakes.

Some parts of our continents are stable and the earth seldom moves under our feet. But at places like my home state of California along the edge of two major tectonic plates (the North American plate and the Pacific plate), the earth is anything but stable! Earthquakes are a daily occurrence somewhere in the state. Most are small-scale and go undetected except by monitoring stations with sensitive seismometers. But others can level entire cities. Here are some activities you can select from to do with your kids to explore earthquakes and their effects. Or, come up with earthquake activities of your own!

- **Modeling liquefaction.** When an earthquake hits an area that is sandy or covered with fine-grained soils or landfill, the effects can be devastating. To show why, fill a bowl with sand and set rocks on top. Flood the bowl with water then, very gently but rapidly, tap the edges of the bowl repeatedly. You'll see the rocks sink out of sight. Similarly, during an earthquake sand particles become suspended in water. The result is a lack of strength in the ground that allows buildings to subside and collapse.

- **Modeling effects on tall buildings versus short buildings.** Embed flexible metal rods of varying lengths into a section of 2X4 wood—for instance, a 6-inch rod, a 12-inch rod, and a 36-inch rod. Top each rod with a bolt or other heavy object. Then start shaking the 2X4. Notice the effects on the tallest rod versus the shortest rod. Similar effects happen with high-rise buildings versus low-rise homes. Which do you think will sustain the most damage during an earthquake?

- **Making models of different sorts of faults.** Construct 3D paper models of faults and other earthquake structures by going to the following website to get templates: www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx. You can also make models with thin stacked layers of play dough of different colors. Slice it at an angle and slide two blocks past one another or push together to see the results as one block rides up over the other. What are the underlying geologic forces and structures that cause earthquakes of different sorts and what are the effects?

- **Monitoring and reporting earthquakes.** With the Internet, everyone can help advance the science of earthquake monitoring and reporting. For instance, the U.S. Geological Survey (USGS) allows folks to go online and share information about the effects of any earthquake they experience to help create a map of shaking intensities and damage. Check it out on the web page called "Did You Feel It?" at http://earthquake.usgs.gov. On it, you'll be asked to rate earthquakes by answering such question as whether only dishes rattled or if heavy furniture overturned.

- **Major earthquakes throughout history.** Have kids select and research major earthquakes such as the San Francisco earthquake of 1906, the New Madrid earthquakes of 1811-1812, the Lisbon, Portugal earthquake of 1755, the Sumatra earthquake of 2004, or the Kobe, Japan earthquake of 1995. What caused each and what were the effects? How did they compare against other earthquakes? Can those areas expect still more earthquakes any time soon? If so, why?

11. Earth in Space

While we usually keep our eyes on the ground when rockhounding, geology isn't only underfoot. The earth is like a little blue marble floating among other marbles and big gassy balls, accompanied by metallic BBs and splinters of ice in the form of meteors and comets. On a clear night, look to the sky, and you'll occasionally see streaks left by meteors burning up in our atmosphere. Sometimes, though, they make it to the earth's surface, where we can collect them and hold a piece of space in our hands. This unit will teach you about such visitors from space.

<u>Activity 11.1: Modeling the solar system</u>.
Check out a book or explore websites to learn about the earth and its fellow planets. Then use materials like marbles, balls, and similar round items to make a model of our solar system. You can also make paper or cardstock cut-and-fold models of the Earth and other planets. Or draw a colorful poster of our solar system on long paper or a big sheet of poster board.

<u>Activity 11.2: Learning about visitors from space</u>.
In addition to planets, our solar system is filled with "cosmic debris" in the form of meteors, an asteroid belt between Mars and Jupiter, and the Oort cloud of comets. Read about our solar system and learn the definitions of a.) meteorite, b.) tektite, c.) asteroid, and d.) comet. If someone in your club has a collection of meteorites or tektites, invite them to show-and-tell so that you can hold a space rock in your hand.

<u>Activity 11.3: Effects of meteorites and famous craters</u>.
Most meteors are tiny and burn up in our atmosphere, creating bright streaks in the night sky that we often call "shooting stars." But some bigger meteors make it to the earth's surface. If they're big enough, they can create craters and shoot out glassy fragments called tektites when they melt rock from our earth's crust on impact. Make a crater by dropping or tossing marbles or ball bearings into flour, wet sand, or mud. Find pictures of meteor craters in a book or on a web site. Then pick one crater and learn everything you can about it and write a report on it for your club newsletter.

<u>Activity 11.4: Collecting meteorites and tektites</u>.
If you happen to be lucky enough to live near a known "strewn field" where a meteor exploded and left fragments over a wide area and you have club members with metal detectors, organize a field trip to search for a meteorite. However, meteorites are very rare and hard to identify in the field. So if you want to add a meteorite or tektite to your rock collection, your best bet will be to purchase one at a rock shop, gem show, museum gift shop, or through a meteorite dealer on the web.

<u>Activity 11.5: Collecting meteorite dust</u>.
While large meteorites are rare and hard to find, a constant "rain" of meteorite dust falls through our atmosphere. By some estimates, 30,000 to 90,000 tons of such dust falls every year! Work with your youth leader to develop a way to collect such dust to examine under a hand lens or a microscope.

Activity 11.6: More fun measuring impact cratering.

Activity 11.6 is an extension of 11.3, where you were able to learn the effects of meteorites via impact craters. This new activity provides a more detailed exercise by which you can see and measure the effects of multiple impacts and how they might be used to date the surfaces of planets and moons.

11. Earth in Space

□ 11.1 Modeling the solar system

□ 11.2 Learning about visitors from space

□ 11.3 Effects of meteorites and famous craters

□ 11.4 Collecting meteorites and tektites

□ 11.5 Collecting meteorite dust

□ 11.6 More fun measuring impact cratering.

To earn your Earth in Space badge, you need to complete at least 3 of the 6 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

______________________________ ________________________________
My signature Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

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Back-up page 11.1: Modeling the solar system.

When I was a kid, modeling our solar system was easy. We just memorized this little ditty: "My very earnest mother just served us nine pizzas." The first letter of each word represents the first letter of each planet in order from the sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.

Since that simple time, we've filled our solar system with an asteroid belt between Mars and Jupiter, an Ort cloud of comets surrounding our solar system along with a Kuiper belt and Centaurs, and a host of interesting moons we've begun exploring via spacecraft. Plus, most scientists have kicked poor Pluto out of the family of planets, demoting it to a mere "dwarf planet"! Others have added a planet or two in the form of icy bodies like Xena, larger than Pluto, that have been found in the outer reaches of our solar system.

Even as I type this 2016 update to our Badge Manual, the newspaper has announced a potential ninth planet to replace Pluto, a hypothetical planet 5,000 times bigger than Pluto (or nearly as large as Neptune) that is so far out in the solar system, it would take 10,000-20,000 years to circle the sun! So far, it's just being called "Planet 9" but stay tuned! We'll see if this "predicted" planet proves real. Meanwhile, use this as an example of how science is always changing and incorporating new theories, data, and information.

Work with kids to **create a model of our solar system** or to draw and color it on a long sheet of paper or poster board. The easiest is a model of the planets. You might choose marbles and balls of varying sizes to show how big different planets are relative to one another (from tiny, pea-sized Pluto to giant basket-ball sized Jupiter), and you might include a lamp to represent the sun. If you spread planets across a room, the heat emitted by a light bulb can illustrate how the sun's warmth that nurtures us on Earth makes for broiling conditions on Mercury yet barely reaches poor, maligned Pluto. You can also purchase models or posters of the solar system.

The California Department of Conservation provides a page on their website with links to a number of really neat masters you can download and print for free to then copy on paper or cardstock for kids to craft cut-and-fold 3D models of the Earth and other planets: http://www.conservation.ca.gov/cgs/information/Pages/3d_papermodels.aspx.

To vividly illustrate the long distances between planets and the length of the solar system as a whole, one club has taken their kids outside and has used a roll of toilet paper for measuring out distances from the sun to Pluto. Yet another club uses a very long roll of brown wrapping paper and marking each planet's position using a scale of one inch for every 10 million miles. They then made a model of each planet's relative size using a 6-foot beach umbrella for the sun and scaling down from that.

Before setting kids loose to make models or posters of the solar system, a fun activity to teach the names of our planets is via **flashcards**. You can make your own set by cutting planet photos from old astronomy or *National Geographic* magazines and pasting them to cardboard. Or you can go to web sites to download and print images of each planet onto cardstock and print or write the name of the planet on the back. See http://pds.jpl.nasa.gov/planets/ for terrific NASA photos.

To return to the fate of Pluto, the International Astronomical Union's 2006 revised definition of a planet demoted Pluto with this resolution: "(1) A 'planet is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighborhood around its orbit. (2) A 'dwarf planet' is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, (c) has not cleared the neighborhood around its orbit, and (d) is not a satellite. (3) All other objects, except satellites, orbiting the Sun shall be referred to collectively as 'Small Solar System Bodies.'"

Use Pluto as an example for talking about how we define a planet versus a moon, a dwarf planet, and small solar system bodies such as asteroids, comets, or mere celestial debris. Kids should learn that science isn't always fixed or definitive. Definitions change, and scientists often debate and challenge one another and don't always come to a consensus as new discoveries come to light.

Back-up page 11.2: Learning about visitors from space.

Here are some basic definitions for four visitors from space:

meteorite: a particle from space (rocky or metallic in composition, or both) that reaches the surface earth without totally burning up in the atmosphere. (While still in space, it's referred to as a **meteor**.) Cordelia Tomasino (Michigan) points to the NASA web site http://www.nasa.gov/centers/jpl/education/ediblerocks.html where you enter "Edible Rocks" to get a ready-made activity teaching kids about the characteristics of different sorts of meteorites using common candy bars.

tektite: a glassy body that forms when a meteor or asteroid crashes into earth, melting rocks below it during an explosive impact and blasting them into the atmosphere or even outer space. On their return to earth, they cool and harden during their fall through the air into round, oblong, or pear-shaped glassy rocks often pock-marked with tiny pits.

asteroid: celestial bodies larger than meteors but smaller than planets, most often found in our solar system between the orbits of Mars and Jupiter. It's believed they represent debris formed from colliding planets or material that failed to form into planets during the creation of our solar system. They sometimes cross earth's orbit, and some are believed to have caused spectacular explosions, such as the one that may have exterminated the dinosaurs 65 million years ago.

comet: a celestial body of ice, dust, and other compounds that circles the sun in a looping, eccentric orbit (as opposed to the more uniform circular orbits of planets). As its orbit nears the sun, particles burn off and form a long tail pointing away from the sun.

To help your kids learn more about these visitors from space, you might direct them to books and websites like these and others:

- Carman, *Collecting Meteorites: Starting in Your Own Back Yard* (1995), 78 pages. Although focused on Australia, this is a great, handy introduction for the beginner anywhere on earth.

- McSween, *Meteorites and Their Parent Planets, Second Edition* (1999), 310 pages. Written by a past-president of the Meteoritical Society, this is a somewhat more technical book describing the nature of meteorites, where they come from, and how they get to Earth.

- Norton, *Rocks From Space: Meteorites and Meteorite Hunters, Second Edition* (1998), 447 pages. This is considered one of the best all-round meteorite books for a general audience. It is a must on the shelf of anyone who gets seriously interested.

- Smith, *The Meteor Crater Story* (1996), 79 pages. The story of one meteor crater near Winslow, Arizona, this book ends with a handy appendix listing known impact sites throughout the world.

- Notkin, *Meteorite Hunting: How to Find Treasures from Space* (2011), 84 pages. Written by the host of the TV series *Meteorite Men*, this brief guide is filled with color photos and info written in accessible language.

- *Meteorite Times* (www.meteorite-times.com). A free monthly online magazine.

- The UCLA Meteorite Gallery. http://meteorites.ucla.edu. UCLA is home to one of the largest meteorite collections in the U.S., and they've set up a website to showcase a gallery they've opened to the public. The website includes a wonderful pamphlet all about meteorites that you can download and print for free.

Back-up page 11.3: Effects of meteorites and famous craters.

While most meteors simply burn up on hitting the atmosphere, some meteorite, asteroid, and comet impacts have had profound effects on our earth. For instance, it is now generally accepted that an immense impact off Mexico's Yucatan Peninsula 65 million years ago was responsible for the extinction of the dinosaurs and many other creatures. It has recently been postulated that a comet exploding over North America did in large Ice Age mammals like woolly mammoths, giant ground sloths, and saber-toothed cats as recently as 10,000 years ago. In 1908, in a remote spot of Siberia, an enormous explosion known as "the Tunguska event" flattened trees in every direction over 770 square miles and could be heard over a 500 mile radius. (That's 800,000 square miles!) On a smaller scale of destruction, a couple of cars and a mailbox have been hit by small meteorites, and one even crashed through an Alabama woman's home to bounce off her hip, leaving a nasty bruise and a very surprised woman. (That meteorite is now in the Smithsonian.)

The most visible and obvious effect of a large meteorite strike is a scar or crater on the ground. **As an activity to show kids how craters form, have them create small craters by dropping or tossing marbles, ball bearings, golf balls, rocks, or other objects into wet sand or mud or a tub of dry white flour whose surface has been dusted with dry powdered paint or a similar powder like cocoa.** See if it makes a difference in crater size and shape by how hard the object impacts, whether it drops straight or from an angle, or whether you use a large, small, heavy, or light object.

As a follow up to this activity, particularly with older kids in your group, the web site www.lpl.arizona.edu/impacteffects lets you calculate the destructive power of meteorites of different sizes and trajectories.

Assign craters to kids in your group to research all they can about them. Have them report back to the group and/or write articles for the club newsletter. Some include:

- Campo del Cielo (Argentina)
- Chicxulub (Yucatan, Mexico)
- Henbury Craters (Australia)
- Manicouagan Crater (Canada)
- Meteor Crater (Arizona, USA)
- Monturaqui Crater (Chile)
- Odessa Crater (Texas, USA)
- Sikhote-Alin strewnfield (Siberia)
- Whitecourt Crater (Canada)
- Wolf Creek Crater (Australia)

Have kids pick a crater from this list, or let them read books or surf web sites to find craters of their own to explore. For instance, they may want to find out about a crater closest to their own homes. Dean Smith's brief book *The Meteor Crater Story* ends with a handy appendix listing known impact sites throughout the world and O. Richard Norton's *Rocks From Space* has a similar list in an appendix. In addition to books like these, here's a web site you might direct kids toward to find more famous meteor craters: http://geology.com/meteor-impact-craters.shtml. Using satellite images, this site includes a Meteor Crater Map of the world that allows you to click on a highlighted spot and zoom in with the "+" button for close-up views of 50 selected craters. The Planetary and Space

Science Centre of the University of New Brunswick (Canada) manages the Earth Impact Database listing all known craters and crater fields. Finally, Wikipedia has an article all about impact craters, as well as a table of known craters on Earth. You can access these at the following web addresses:

- http://en.wikipedia.org/wiki/Impact_crater

- http://en.wikipedia.org/wiki/List_of_impact_craters_on_Earth

Note: *Kids who write a report about a famous meteor crater can use this toward satisfying requirement toward earning their Communication badge simultaneously (Activity 7.2).*

Back-up page 11.4: Collecting meteorites and tektites.

Given their extraterrestrial origins and rarity, meteorites have a lot of appeal. Once bitten by the meteorite bug, it's easy to get hooked into seeking a specimen of your own. However, this is no easy task, both because of the rarity of meteorites (for those seeking to collect one in the field) and their price (for those seeking to purchase one). If you're fortunate to live near a "strewn field" where a meteorite is known to have exploded into hundreds or thousands of fragments (as near Odessa, Texas), your chances of collecting one on your own are greatly increased. O.R. Norton's book *Rocks from Space* includes lists of strewn fields, and the Meteoritical Bulletin Database is an online resource listing all known and classified meteorite falls. But getting to a strewn field is the easy part. You then have to be able to pick out a rock that may look like every other rock on the ground. Because some meteorites have a high nickel-iron content, collectors use metal detectors or magnets attached to strings or a walking stick. One famed meteorite hunter, H. H. Nininger, used to drive through the desert towing a magnetic rake!

Still, even experienced meteorite hunters consider it a lucky day when they make a find. Thus, your most effective way of digging up a meteorite for your collection is with the "silver pick," or reaching for your wallet to buy one from a dealer. The most reasonably priced pieces for a child's budget are Nantan meteorites from China and small, black, pear-shaped tektites from Southeast Asia. I've seen these at almost every show I've attended. (Caution, though! I've heard that artificial tektites are now being produced in China from black glass and entered into the gem and mineral market as the real deal.) Encourage kids to check with dealers at rock and gem shows, rock shops, and museum gift stores, or to write or email for catalogs from such companies as:

- *The Universe Collection* (www.universecollection.com, Bethany Sciences, P.O. Box 3726-T, New Haven, CT 06525-0726, phone 203-393-3395). Write or call for their annual catalog, but be warned: this is a high-end enterprise, with prices to match. Most specimens are priced by the gram, and meteorites tend to be very, very heavy!
- *Meteorite Central* (www.meteoritecentral.com). Log onto this web site and get a password to join "The Meteorite Mailing List" and join over 1,300 members with an interest in collecting meteorites who exchange information to learn about, discuss, and purchase meteorites.
- *The Meteorite Exchange Network* (www.meteorite.com). This site has info about meteorites and the community of meteorite enthusiasts and dealers. In fact, it links to dozens of dealers, web sites, and eBay auctions and eBay stores.
- *Aerolite Meteorites, LLC* (www.aerolite.org). Geoffrey Notkin, host of the TV series *Meteorite Men*, started this company and website, which has meteorites, meteorite photos, expedition reports, science articles, and more.
- *Club Space Rock* (www.meteorites.ning.com). An online "meteorite community."

Note: *Kids can use this activity toward satisfying requirements for the Collecting badge simultaneously (Activity 5.1). Those who seek meteorites in the field can apply this toward earning the Field Trips badge (Activity 8.3). Kids who join "Club Space Rock" can use that toward earning the Rocking on the Computer badge (Activity 15.6).*

Back-up page 11.5: Collecting meteorite dust.

Kids who really get into meteorites will itch to collect their own. However, they run into two problems. First, even professional meteorite hunters have a hard time finding and collecting meteorites in the field. They are rare and elusive and hard to identify by scanning the ground. Second, although you can sometimes find small Nantan meteorites from China and little black tektites from Southeast Asia at reasonable prices at gem shows and rock shops, most meteorites are priced, well, out of this world.

What to do to get a meteorite into a kid's collection? *Think small!* A couple neat websites provide instructions on how to collect "micrometeorites" or meteorite dust:

- http://www.pbs.org/wgbh/nova/teachers/activities/3111_origins.html
- http://starryskies.com/Artshtml/dln/6-00/dust.html

Most meteors burn up in our atmosphere, but as they do, they leave a trail of dust. That dust, along with micrometeorites and other solar debris is constantly raining down. By some estimates, tens of thousands of tons of extraterrestrial material falls on earth each year! The web sites I've referenced give instructions on how to collect micrometeorites. Essentially, you need to create a "meteorite trap." Suggestions include: keeping a bucket under a down-spout during a rainstorm to collect dust in runoff water from a roof; placing a water-filled bucket on a rooftop or other elevated spot for 4 weeks (checking periodically to refill the water as it evaporates); and laying a large plastic sheet (like a shower curtain) in an open spot or at the bottom of a wading pool and collecting residue from the sheet every two days for a little over a week. Another technique involves placing a strong magnet in a paper cup and tapping the cup on the ground around downspouts. Black specks will attach themselves to the bottom of the cup until you remove the magnet and tap them loose over a sheet of white paper. Examine the flecks under a microscope, searching for ones that are spherical and pitted.

With all these techniques, most of what you'll collect will be ordinary earthbound dust and dirt. You'll need to collect, concentrate, and dry the residue, sort out the dead insects, leaves, and other big things, and then use magnets to separate potential meteorite dust from earth dust. Viewed under a microscope, meteorite dust is often rounded and may have small surface pits. Perhaps the most amusing or quirky incidence regarding meteorite dust comes from Norway, where Ragnar Martinsen, sitting in the outhouse of his cabin, heard an explosion and later found tiny grains of rock in aluminum pans he had left in his yard. Scientists reported these to be pieces of only the 14th recorded meteorite landing in Norway.

At best, you're not likely to get more than a piece the size of a sand grain or smaller, but a meteorite is a meteorite, and how many people can claim to have collected one on their own? This fun activity also vividly illustrates how the earth we're on is part of the larger universe, floating through space with cosmic debris that sometimes pays a visit.

Note: *Kids can use this activity toward satisfying requirements for the Collecting badge simultaneously (Activity 5.1).*

Back-up page 11.6: More fun measuring impact cratering.

Activity 11.3 explores effects of meteorites with craters made by dropping marbles or other objects into tubs of flour, sand, or mud. This new activity provides a more detailed exercise by which you can see and measure effects of multiple impacts and how they might be used as a relative means of dating surfaces of planets and moons.

Via plate tectonics, Earth continually recycles its crust. Plus, we have an atmosphere with dynamic weather that creates erosion and moves sediments around, and that atmosphere is relatively thick, causing smaller meteors to burn up before they might hit the surface. For all these reasons, we don't see as many craters on the surface of Earth as we see on other planets and moons within our solar system, such as Mercury, Mars, or our own moon. Basically, on planets and moons with little-to-no atmosphere and that are tectonically inactive, the older the planet, the more meteorite craters it will contain. And older craters will be degraded by subsequent crater formation. The number of craters might also tell us, on an otherwise heavily cratered planet, if an area experienced volcanic activity and flooding, creating one spot less heavily cratered than elsewhere.

To illustrate these points, fill two large petri dishes or similar containers with very fine-grained sand, much finer than typical beach sand (check at a pet shop with aquarium supplies). Place a dish on the floor on top of a drop cloth or newspaper. Fill an eyedropper with water from a small cup or bowl. Hold the eyedropper at chest level and hold a piece of fine mesh window screen about a foot beneath the eyedropper and above the dish of sand. Now, one drop at a time, drip just a couple drops from the eyedropper. The mesh screen will break the water drops into smaller droplets. Let these fall onto the surface of the sand. Move the screen around so that drops from the eyedropper keep hitting dry screen to break into droplets. You should see several craters formed atop your sand. Pick up and set your dish aside. Then repeat with a second dish of sand, but this time rain several drops.

Count the number of craters in each dish. Which has more? Look at the condition of the craters in each dish. You should notice in the dish that was rained on longer, not only are there more craters, there also are more craters that overlap and degrade one another. Similarly, one way scientists date surfaces of extraterrestrial bodies is by looking at the number of craters and the conditions of craters. Take your first dish and simulate an outpouring of volcanic lava by pouring a little sand to cover over the craters at the top of the dish. Return the dish to the floor and rain a couple drops, then compare the appearance of the top of the dish to the bottom. What was the effect of your simulated volcanic activity?

This exercise is derived from a 1998 NASA publication entitled *Planetary Geology: A Teacher's Guide with Activities in Physical and Earth Sciences.* For this and other helpful resources for exploring space, go to the following link on the NASA website: http://www.nasa.gov/audience/foreducators/index.html.

12. Gold Panning & Prospecting

Gold has been highly valued throughout human history as a precious metal. This unit will teach you why. You can learn about gold as a mineral, its uses and history, and even how to become a prospector to find a gold flake or nugget of your own. In addition to gold, modern-day prospectors use metal detectors to find not just gold but also coins, artifacts, and other metal objects.

Activity 12.1: Gold as a mineral.
Buy a book on minerals or pick one up at the library to learn about the properties of gold as a mineral: its color, streak, cleavage, fracture, luster, hardness, crystal shape, and weight or specific gravity. Compare all these to properties of pyrite, or "fool's gold."

Activity 12.2: Uses of gold.
Write a report about why gold is considered valuable and the many ways it's used. Publish your report in your club newsletter or present what you've learned at a club meeting.

Activity 12.3: Gold throughout history.
Gold has been valued, sought, and fought over throughout history. Learn about a historical event involving gold and either write a report about it for your club newsletter or prepare a presentation about it for your fellow club members.

Activity 12.4: Gold resources in your own state or region.
Where has gold been found near you? From your library, from adult members of your club or society, or from your state geological survey, learn and then report to your fellow club members about areas closest to you where gold has been found. Show locations on a map. Gold is rare, so the closest spot may be in a neighboring state or region.

Activity 12.5: Field trip to a gold mine.
If there are any active gold mines within a convenient drive of your hometown, work with your youth leader to see if they would allow a group visit. Then go and see for yourself how gold is mined.

Activity 12.6: Panning for gold.
If there are streams in your area that are known to hold gold, arrange a field trip and pan for some gold of your own. If the nearest gold streams are too far away, you can still pan for gold in your own backyard. Some companies sell bags of "gold concentrate," or gravel from gold-bearing streams that you can buy and pan through in a tub of water. See if you can add a gold flake—or even a nugget!—to your rock collection.

Activity 12.7: Metal detecting for gold, coins, and other artifacts.
Learn how to use a metal detector, then take one to a beach, park, playground or other area where many people have been to see if you can dig up any lost coins, jewelry or other objects. First, though, learn about the "Code of Ethics" for metal detecting and respect all laws and property rights whenever you go treasure hunting.

12. Gold Panning & Prospecting

□ 12.1 Gold as a mineral

□ 12.2 Uses of gold

□ 12.3 Gold throughout history

□ 12.4 Gold resources in your own state or region

□ 12.5 Field trip to a gold mine

□ 12.6 Panning for gold

□ 12.7 Metal detecting for gold, coins, and other artifacts

To earn your Gold Panning & Prospecting badge, you need to complete at least 3 of the 7 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

______________________________ ______________________________
My signature Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 12.1: Gold as a mineral.

Gold is popular! You'll be able to find any number of books about it in a bookstore or at your local library to recommend to your juniors for learning about gold as a mineral. One example from my own home library is Joseph Petralia's *Gold! Gold! A Beginner's Handbook & Recreational Guide*. Also the U.S. Geological Survey distributes a free pamphlet written by Harold Kirkemo, William L. Newman, and Roger P. Ashley and entitled simply *Gold.*

Or direct kids to a general rock and mineral identification book, such as:

- Pellant, *The Complete Book of Rocks & Minerals*
- Zim & Shaffer, *Rocks & Minerals: A Golden Guide*
- Fuller, *Pockets Rocks & Minerals*
- Simon & Schuster's *Guide to Rocks & Minerals*
- Pough, *Rocks & Minerals: Peterson Field Guide*
- Chesterman, *National Audubon Society Field Guide to North American Rocks & Minerals*

A neat little book especially suitable for younger kids is Darryl Powell's *Gold! A Coloring and Activity Book for Young Prospectors.* In it, "Nugget the Gold Prospector" tells kids where gold is found, what it looks like, and why it's so valuable, all with large-format illustrations for kids to color and a quiz, crossword puzzle, and other activities at the end. You can get copies and current pricing by contacting Diamond Dan Publications, c/o Darryl Powell, (585) 278-3047, email diamonddan@rochester.rr.com, web site: www.diamonddanpublications.net.

Another golden mineral is iron pyrite, or "fool's gold." Here's how gold compares to iron pyrite by a variety of common mineral properties:

Property	Gold	Pyrite, "Fool's Gold"
Color	golden-yellow	brassy-yellow
Streak	gold-yellow	greenish-black
Cleavage	none	cubic & octahedral
Fracture	hackly	uneven
Luster	metallic	metallic
Hardness	2.5 – 3.0	6.0 – 6.5
crystal shape	isometric/cubic	isometric/cubic
specific gravity	15.6 – 19.3	4.9 – 5.2

Gold is one of the basic elements in chemistry: atomic number 79. In the periodic table, it's listed as Au, from the Latin word for gold, *aurum*. It's a "noble" metal, meaning it doesn't oxidize under normal conditions. By contrast, iron pyrite is a compound (iron disulfide, or FeS_2) made from the elements iron and sulfur. In the air, pyrite tends to decompose over time, reacting with oxygen and water to form sulfuric acid. While gold has many uses (see Back-up page 2.2), pyrite has just a few, such as the manufacture of sulfuric acid and sulfur dioxide, as an aid in the recovery of other metals (iron, gold, copper, cobalt, nickel, etc.), or to make inexpensive costume jewelry.

Back-up page 12.2: Uses of gold.

Gold has a pleasing heft to it and a brilliant shiny color that doesn't tarnish, corrode, or rust. It's a rare mineral (known as a "precious mineral"), and that rarity along with its shiny beauty gives it value. It's also a soft mineral. The most malleable and ductile of our metals, it can be beaten into sheets as thin as a few microns thick. Because it's so easy to work with, it has many uses, which further adds to its value. It also conducts heat and electricity very well. Have kids learn why gold is considered valuable and explore its many uses. Then encourage them to publish their findings in the club newsletter or give a presentation at a club meeting.

A good resource for this assignment is the web site of the Minerals Education Coalition, or MEC (http://mineralseducationcoalition.org). MEC is a nonprofit organization that provides educational programs to teach kids about the importance of natural resources, how we use them in everyday life, and where they come from.

To give you a start, here's a partial listing of some of gold's many uses:

- economics (gold is melted and formed into bricks or ingots and held in gold reserves by many nations, like the supply the U.S. keeps at the Fort Knox Bullion Depository)
- jewelry (this is where most gold ends up)
- medallions and coins (some medallions used as awards—such as Olympic Gold Medals or the Nobel Prize—are crafted from gold, and although we no longer do so, for thousands of years many countries used precious metals such as gold and silver in making their coins; the U.S. stopped using gold in common coinage in 1933)
- architecture (you'll see "gold leaf" on the domes of many state capitol buildings)
- dentistry (nearly 50 pounds of gold are used in dental work *every day* for procedures such as crowning teeth or for permanent bridges)
- medicine (a radioactive isotope of gold is used in some cancer treatments, and another variety has been used to treat rheumatoid arthritis)
- scientific and electronic instruments (gold has a pure, stable nature and seldom oxidizes or combines with other elements; due to this, as well as a good capacity for conducting electricity, gold is a key part of semiconductor circuits)
- the space program (for electronic components and to reflect heat off satellites and space capsules)
- the electro-plating industry (as an electrolyte)
- photography (gold toners shift black-and-white tones to brown or blue, and on sepia-tone prints, gold toners produce red tones)
- glass and acrylic coating (gold-coated acrylic windows are used in the cockpit of some airplanes to keep windows clear of frost and fogging and to help maintain temperatures in the cabin; it also coats visors in astronaut helmets; and the world's largest telescopes have mirrors coated with pure gold)

Note: *Kids who give a presentation or write an article can use this activity toward earning their Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 12.3: Gold throughout history.

Gold has been valued, sought, and fought over throughout history. Help your kids pick a specific event to research. Then have them share what they've learned with one another, give a presentation to the club, and/or write a brief report about it for the club newsletter. The Minerals Education Coalition (MEC) has a terrific little packet all about gold on their web site (http://mineralseducationcoalition.org) that you can download for free. It includes a timeline about gold through recorded history, as well as all sorts of other facts about gold, and even a coloring page of a prospector panning for gold in a stream alongside his trusty burro. Here are a few historic events you may wish to pick from to assign a topic, or you can let kids explore and find an event on their own:

- In the 14th century B.C., Tutankhamun ("King Tut") was pharaoh of Egypt, and when Howard Carter and Lord Carnarvon discovered his tomb in 1922, they found spectacular gold items that have come to be known as the "Treasures of Tutankhamun." Have kids find out what's included among those treasures.
- Have you heard the story of the Golden Fleece of Jason and the Argonauts in Greek mythology? The story is believed to have its roots in the practice of using sheepskin to recover gold dust from river sands feeding into the Black Sea in 1200 BC.
- In 300 BC, the Greeks and Jews of ancient Alexandria started the practice of alchemy, or the effort to turn common metals like lead into precious gold. The quest continued and intensified—to no avail—with Medieval alchemists.
- The lure of gold is said to have been one cause of the Second Punic Wars between the Roman Empire, which had few gold resources, and Carthage, which was expanding its colonial empire in Hispania, or gold-rich Spain, around 200 BC.
- In 1511, King Ferdinand of Spain launched massive expeditions of Conquistadores to bring back all the gold to be found in the New World; most was obtained by plundering Aztec and Inca treasuries of Mexico and Peru. It also led to quests for the mythical country of El Dorado, where the streets were said to be lined in gold.
- A gold rush started in North Carolina in 1803, sparked in part by the 1799 discovery of a 17-pound nugget by a 12-year-old boy in Cabarrus County. Before the discovery of gold in California, North Carolina had become known as the "Golden State," and prior to 1829, all the gold coined at the Philadelphia mint was from North Carolina.
- The Forty-Niner Gold Rush that brought so many adventurers to California and eventually led to California statehood started when flakes of gold were found in 1848 during construction of a sawmill for John Sutter along a river near Sacramento.
- The impact of gold discoveries in the Black Hills of South Dakota in the 1860s and 1870s led, among other things, to Custer's Last Stand.
- Another gold rush was sparked with discoveries in Cripple Creek, Colorado, in 1892.
- The discovery of gold by two prospectors in the Klondike of Canada's Yukon Territory sparked a rush into the cold regions of Western Canada and Alaska in 1898.

A couple of neat books geared to kids are Kalman's *Life in the Old West: The Gold Rush* and Diamond Dan Publications' *Gold! – An Activity Book for Young Prospectors.*

Note: *Kids who give a presentation or write an article can use this activity toward earning their Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 12.4: Gold resources in your own state or region.

Help kids learn about gold resources that may be found in them-thar hills of their own home state or region. Use the U.S. Geological Survey web site (www.usgs.gov) to guide you to information about mineral resources in your state.

Check bookstores and outdoor or camping supply stores for guides and maps to gold regions in your state. In bookstores, these are often found in sections selling field guides or regional books. In camping supply stores, these are often found in the maps and publications section. While most guides focus on gold-rich states like Alaska, Nevada, or California, you can find guides to many other states and regions. Wherever there's gold, there seems to be a book about it. For instance, here's a partial selection:

- Koschmann, *Principal Gold Producing Districts of Alabama, Georgia, Virginia, Pennsylvania, and Tennessee*
- Wendt, *Where to Prospect for Gold in Alaska Without Getting Shot!*
- Preston, *Arizona Gold and Gem Maps*
- Toole, *Where to Find Gold in California*
- Voynick, *Colorado Gold: From Pike's Peak Rush to the Present*
- Dwyer, *Lake Superior Gold: An Amateur's Guide to Prospecting*
- Stevens, *Memoirs of a Maine Gold Hunter* and other books by Stevens
- Klein, *Where to Find Gold and Gems in Nevada*
- Preston, *Nevada Gold and Gems Maps: Then & Now*
- Wilson, *Gold Panning in New Mexico: From Map Reading to Staking the Claim*
- Koschmann, *Principal Gold Producing District of New Mexico*
- Knapp & Glass, *Gold Mining in North Carolina: A Bicentennial History*
- Gerrick, *Gold Prospecting in Ohio*
- Beydler, *Virginia Gold Mines: The Golden Piedmont*
- Battien, *Gold Seekers: A 200 Year History of Mining in Washington, Idaho, Montana and Lower British Columbia*

Joseph Petralia's *Gold! Gold! A Beginner's Handbook & Recreational Guide: How & Where to Prospect for Gold* talks about the history of gold and prospecting methods, and then includes a chapter that gives a general idea as to where gold has been found in the Southeast, Rocky Mountain states, and the West.

In addition, look in back issues of *Rock & Gem* magazine. They publish an annual issue devoted to gold, and for a long time, they've been including as a regular feature maps to specific gold-panning locations at various accessible spots across the country. Check around for publications like these, whether in your local library, bookstores, camping supply stores, or your state geological survey or division of mines.

Note: *Kids who give a presentation on where gold can be found can use this activity toward earning their Communication badge simultaneously (Activities 7.1).*

Back-up page 12.5: Field trip to a gold mine.

We have approximately 30 major gold mines operating in a big-scale sort of way in our country, with most of today's U.S. gold coming from the states of Alaska and Nevada. But gold deposits have been found coast-to-coast, and there are a lot of smaller operations scattered across the country. Because it's so valuable, great efforts are made to recover even small amounts. Every time the price of gold spikes, new mines seem to sprout.

Check with your state geological survey or division of mines for any operating gold mines in your state and try to arrange a field trip to one if the mine owners will allow such a visit. You might need to go outside your own state and venture further into your general region, thus making for a longer two- or three-day field trip.

There are two major types of gold deposits, each requiring different mining techniques to retrieve the gold within: 1) **lode or vein deposits** in which gold is found where it precipitated along cracks and veins in the bedrock, and 2) **placer deposits** where gold has weathered out of its original lode or vein deposit and is often found mixed with sand and gravel laid down by stream channels and rivers.

In a lode deposit, mining involves blasting ore and crushing huge amounts of it to recover small amounts of gold. The crushed ore is heated or "smelted" to melt and release the gold, which is usually poured into bar shapes. In placer deposits, huge quantities of sand and gravel must be sorted and screened with the help of running water to retrieve gold nuggets. Gold is very heavy, with a density of 16 to 18 as compared to a density of about 2.5 of "waste rock" (the sand and gravel). This difference in density means that miners can use gravity to help separate gold from gravel by devices that agitate the rocks and collect the gold. Such devices include hand-held gold pans, rockers, and sluice boxes.

Gold is also recovered using various chemical procedures, such as amalgamation (where mercury, or quicksilver, bonds with gold from ore) or the cyanide process (where potassium cyanide is used to dissolve and recover gold from low-grade ore).

Note: *Kids can use this activity toward satisfying requirements toward earning their Field Trip badge simultaneously (Activity 8.3).*

Back-up page 12.6: Panning for gold.

See suggestions provided in Back-up page 12.4 on how to locate gold fields nearest you to arrange a panning trip with your club's juniors. You might need to go outside your own state and venture further into your general region, thus making for a longer, more ambitious two-, three-, or even four-day field trip adventure. ***A reminder:*** **always obtain permission from landowners before undertaking any field trip, especially when prospecting for a valuable resource like gold, and check to make sure the spot you're panning or prospecting is not under a claim.**

However, no matter how hard you look for a good local gold-panning locality, the unfortunate reality is that not every state is rich in gold resources. If the search for a gold-panning site within reasonable proximity for your kids comes up dry, a good alternative is to set up tubs of water on a backyard patio and pour in bags of gold concentrate. You can order these from many places through the web. In a search engine, just enter "gold panning concentrate" and a host of commercial sites pop up, many from California and Alaska. Prices ranges from "practice" bags at 2 pounds for around $15.00 to super-deluxe 20-pound bags at over $400. (I recommend the practice bags…) Here are just a few examples of the many sources you can find on the web to purchase gold panning concentrate, along with gold pans and other equipment:

- Minerals Education Coalition (http://mineralseducationcoalition.org). Click on the tab for the "MEC Store." They sell a "Gold Panning Kit" with gold concentrate, pan, instructions, etc., that was going for $15 when I last checked, as well as individual pans and individual bags of concentrate at reasonable prices.

- Gold Fever Prospecting (http://store.goldfeverprospecting.com/goldpanning.html). Get a variety of equipment, books, and concentrates from the California Motherlode.

A warning, though: these companies and offers seem to come and go. When I prepared the last edition of this AFMS/FRA Badge Manual, I listed four such sources. Half of those are no longer to be found on the web, so be prepared to do some web surfing for new companies and new sources of supplies.

At a recent gem show, I picked up a "Gold Panning Kit" in a little box being sold by a dealer specializing in educational specimens and kits, DVDs, books, and the like. This particular product is put out by GeoCentral of Mason, Ohio, www.geocentral.com. It's geared to ages 8 and above and includes everything you need: a seven-inch gold pan, bag of pay dirt, magnifying glass, pipet, tweezers, storage flask, and a panning guidebook with instructions. Best of all, when I checked it out, the whole kit was selling for just $10.00!

Some companies selling concentrate also sell equipment or provide a beginner's package like the one described above with concentrate, a pan, and instructions. Panning equipment usually includes a gold pan, hand lens, magnet, eyedropper (for picking up tiny gold flecks), vial, and a long screwdriver or other rod to dig out sediment in crevices.

Basically, gold panning involves combining sand and gravel with water in a gold pan and swirling and shaking so that the heavier grains of gold settle to the bottom while lighter sand and gravel is removed from the pan.

Here are just a few of the many good resource books about gold panning and prospecting:

- Butler, *Recreational Gold Prospecting for Fun and Profit* (1998)
- Koch, *Gold Prospecting and Placer Deposits: Finding Gold Made Simpler* (2013)
- Lagal, *The New Gold Panning is Easy: Prospecting and Treasure Hunting* (2003)
- Petralia, *Gold! Gold! A Beginner's Handbook and Recreational Guide* (1992)
- Walsh, *Treasure Hunter's Handbook* (2014)

Note: *Kids who go into the field to pan can use this activity toward satisfying requirements for their Field Trip badge simultaneously (Activity 8.3), as well as the Collecting badge (5.1).*

Back-up page 12.7: Metal detecting for gold, coins, and other artifacts.

People lose things all the time. Whether at a beach, park, playground, school yard, fairgrounds, sports grounds, or anywhere else where many people congregate, coins fall out of pockets, rings or earrings fall off, and other metal objects mysteriously disappear and fall to the ground to be buried in the sand or soil. Also, around especially old houses and fence lines people sometimes had trash heaps in the days before garbage trucks rolled up on a weekly basis. These are all great areas for kids to go out equipped with metal detectors to find man-made treasures. And they may want to go out to known gold fields for natural treasures. Using a metal detector, Australian Kevin Hillier found a 61-pound gold nugget that sold for over a million dollars!

Before kids pick up a metal detector, they should learn the "Code of Ethics" for detecting and respect all laws and property rights. A code has been developed by The Task Force for Metal Detecting Rights Foundation. Among other things, it states: "I will follow all laws relating to metal detecting on federal and state lands as well as any laws pertaining to the local areas I may be searching; I will respect private property and attain the owner's permission before metal detecting; I will recover targets in a way that will not damage or kill vegetation and I will fill in holes completely, leaving the area looking as it was; I will use common courtesy and common sense at all times." In just a few short months after I learned of this organization and code, however, their web site seemed to have disappeared. I did find it again by searching "metal detecting code of ethics." The code popped up on several sites, including http://www.whiteselectronics.com/the-hobby/knowledge-base/code-of-ethics.

A number of great websites introduce folks to metal detecting. Here are just a couple:

- http://gometaldetecting.com
- http://metaldetectingworld.com/how_to_metal_detect_p1.shtml

Just how expensive are metal detectors? I've found many models in the range of $400-$750. Those with more power and features tend to be in the $1,000 range, and professional grade models can be $2,000 or more. But don't despair! I did find one model that seems perfect for kids. The "Bounty Hunter® Junior Metal Detector" was listed (in January 2016) at just $69.99 and was on sale at Cabela's for nearly half that. So reasonably priced models do exist—you just need to shop around! A good website to help you is Metal Detector Reviews, a site devoted to listing, comparing, and reviewing metal detectors of all grades and brands: http://metaldetectorreviews.net.

A nice reference book for kids to read is Liza Gardner Walsh's *Treasure Hunter's Handbook* (2014). A good reference for adults is Garret Romaine's *The Modern Rockhounding and Prospecting Guide* (2014), which has a solid chapter on detecting supplemented with many good website recommendations. This book covers the whole rockhounding hobby, not just detecting, so it's great for your overall reference shelf.

13. Gemstone Lore & Legend

Because they're so rare and beautiful, gemstones and precious metals have always fascinated people. We give them as gifts to mark special occasions, like a diamond ring for an engagement or a gold watch for retirement. And many cultures have invested gems with mystical, magical powers and legends. These units let you explore gemstone lore and legend, and to compare legend against what contemporary science says.

Activity 13.1: Anniversary stones.
A 25th anniversary is considered a silver anniversary and a 50th anniversary is golden. Construct a list of all the gemstones and precious metals used to mark anniversaries from 1 to 100.

Activity 13.2: Birthstones and the Zodiac.
Each month is marked by its own "modern" or "traditional" birthstone or a "zodiac" stone. List birthstones for all the months of the year and find out as much as you can about your own birthstone.

Activity 13.3: Fabled gemstones.
Some especially large and valuable gemstones have been lost, stolen, and/or vested with supernatural powers or curses. Pick a famous gemstone and explore its history and any legends associated with it.

Activity 13.4 Gems in religion.
Whether the religion is Christianity, Judaism, Islam, Hinduism, Buddhism, or others, you're sure to find gemstones and precious metals mentioned in its holy books, including the Bible, Koran, Torah, etc. Pick a religious text and see what gemstones are mentioned and their significance.

Activity 13.5: Mysticism and minerals.
Many gemstone minerals have important scientific, economic, medical, nutritional, and artistic uses and value. In addition to valuing them for such practical uses, some people and cultures have assigned mystical or magical properties to certain minerals and gemstones. Pick a mineral or gemstone and explore what legend and lore says about its mystical uses and properties. Then compare that to what contemporary science says about the mineral.

13. Gemstone Lore & Legend

□ 13.1 Anniversary stones

□ 13.2 Birthstones and the Zodiac

□ 13.3 Fabled gemstones

□ 13.4 Gems in religion

□ 13.5 Mysticism and minerals

To earn your Gemstone Lore & Legend badge, you need to complete at least 3 of the 5 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

Date completed

My signature

Youth leader's signature

Name of my club

Leader's preferred mailing address for receiving badge:

Back-up page for Gemstone Lore & Legend badge.

A good general-purpose guidebook for your kids in exploring gemstone lore and legend is Emma Foa's *Pockets Gemstones* (DK Publishing: New York, NY, 2003). Part of the Dorling Kindersley Pockets Full of Knowledge series, this particular book has several advantages:

- At $6.99, it's inexpensive and thus a good match for a child's budget.

- It's written to a wide, general-purpose audience, so it's clear and easy to read, with information appearing in brief overview paragraphs and captions. Each two-page spread is a self-contained unit on a particular topic or gemstone.

- It's heavily illustrated with beautiful color photos, each supported by surrounding text.

- In addition to talking about gemstones as ornaments of beauty, it goes into other uses of gems, their formation and crystal structure, gemstone mining, and their appearance in myth and medicine.

- It includes a section on famous and legendary gems.

- It has a nice reference section talking about gem care and jewelry making, as well as a section on how gems are cut and polished.

- It includes a glossary of terms and a table of the basic mineralogical properties of 53 gemstones.

- It concludes with a list of resources, including major museums with gemstone collections and organizations such as the Gemological Institute of America, followed by a comprehensive index.

- All this is contained in a small, compact book just 5-inches by 3-3/4-inches and 128 pages long that slips easily into a pocket.

For all these reasons, this handy little volume is highly recommended as a resource for all kids working on earning their Gemstone Lore & Legend badge.

Back-up page 13.1: Anniversary stones.

Kids can obtain lists of anniversary stones from jewelry shops, web sites, or books about gems and jewelry. The lists vary—sometimes considerably—and there are actually two different lists, "traditional" and "modern." Following is what I've been able to find, but you're likely to find some lists that differ:

Anniversary	Traditional	Modern
3rd		crystal or glass
5th		silverware
6th	iron	
7th	copper or brass	
8th	bronze	
10th	tin or aluminum	diamond jewelry
11th	steel	fashion jewelry & accessories
12th		pearls or colored gems
14th	ivory	gold jewelry
15th	crystal or glass	
16th		silver hollowware
19th		bronze
20th		platinum
21st		brass or nickel
22nd		copper
23rd		silver plate
25th	silver	sterling silver
30th	pearl	diamond
33rd		amethyst
34th		opal
35th	coral or jade	jade
37th		alabaster
38th		beryl or tourmaline
40th	ruby or garnet	ruby
45th	sapphire	sapphire
50th	gold	gold
55th	emerald or turquoise	emerald
60th	diamond or gold	diamond
75th	diamond or gold	
80th		diamond or pearl
85th		diamond or sapphire
90th		diamond or emerald
95th		diamond or ruby
100th		10-carat diamond

Back-up page 13.2: Birthstones and the Zodiac.

You can obtain lists of birthstones from jewelry stores or from books on gems and jewelry. The lists often vary (by one count, there are nearly 50 different lists!) but the following table shows commonly accepted birthstones, along with some backups:

Month	Modern or Traditional Birthstones	Mystical Birthstones
January	garnet (or tanzanite or rose quartz)	emerald
February	amethyst (or tourmaline or onyx)	bloodstone
March	aquamarine (or bloodstone)	jade
April	diamond (or nephrite jade or quartz)	opal
May	emerald (or agate or chrysoprase)	sapphire
June	pearl (or alexandrite or moonstone)	moonstone
July	ruby (or onyx or carnelian)	ruby
August	peridot (or sardonyx)	diamond
September	sapphire (or malachite or lapis)	agate
October	opal (or tourmaline)	jasper
November	topaz (or citrine or rubellite)	pearl
December	turquoise (or blue topaz, zircon, lapis lazuli, tanzanite, or coral)	onyx

When it comes to Zodiac Stones, lists vary tremendously. In fact, for each sign of the Zodiac, some ascribe a whole range of stones: a birthstone, a zodiac stone, a talisman stone, a mystical stone, a planet stone—even a lucky charm stone! This only adds to the confusion when it comes to ascertaining just what is supposed to be one's birth stone. While I've seen lists of all sorts, the following is what I've settled on. Be aware, though, that kids in your club may very well come up with different lists.

Zodiac or Birth Stones			
amethyst **(also, garnet)** Aquarius (Jan. 20-Feb. 19)	**emerald** **(also, sapphire)** Taurus (April 20-May 20)	**ruby** **(also, onyx)** Leo (July 23-Aug. 22)	**topaz** **(also, beryl)** Scorpio (Oct. 24-Nov. 22)
sapphire **(also, amethyst)** Pisces (Feb. 20-March 20)	**moonstone** **(also, agate)** Gemini (May 21-June 20)	**peridot** **(also, carnelian)** Virgo (Aug. 23-Sept. 22)	**turquoise** **(also, pearl)** Sagittarius (Nov. 23-Dec. 21)
diamond **(also, bloodstone)** Aries (March 21-Apr. 19)	**pearl** **(also, emerald)** Cancer (June 21-July 22)	**opal** **(also, peridot)** Libra (Sept. 23-Oct 23)	**garnet** **(also, ruby)** Capricorn (Dec. 22-Jan. 15)

Back-up page 13.3: Fabled gemstones.

Many especially large and valuable gemstones have been lost, stolen, and/or vested with supernatural powers or curses. One of the most famous is the Hope Diamond, currently residing under heavy protection in the Smithsonian. According to legend, it was stolen from the eye of a Hindu idol, and various owners have suffered ignoble fates ever since: being torn apart by wolves, beheadings, suicide, even death by starvation! Thus, it's become legendary for bringing misfortune to those who would possess it.

Below, I've listed a number of prominent gemstones with interesting histories, stories, or legends behind them. Some of these fabled gemstones are famous merely for being the biggest or best of their kind (for instance, the largest yellow diamond, the most flawless emerald, etc.). Others are famous for their long histories and owners who have included sultans and slaves, kings and queens, industry titans and movie stars. Still others are infamous for legendary curses and daring thefts. Assign a different stone to each of your kids to research. Then at your next meeting or gathering, have them sit in a circle to report back to the group what they've discovered, or have them prepare articles for the club newsletter. Pick from the list, or have kids find famous stones on their own.

- The Hope Diamond
- The Blue Diamond of the Crown
- The Koh-i-Noor (Mountain of Light)
- The Shah Diamond
- The Regent Diamond
- The Braganza Diamond
- The Cullinam I & II Diamonds (aka, "The Great Star of Africa" and "The Lesser Star of Africa")
- The Tiffany Diamond
- The Sancy Diamond
- The Duke of Devonshire Emerald (aka, "The Duke's Diamond")
- The Chalk Emerald
- The Mogul Emerald
- The Hooker Emerald
- The Mackay Emerald
- The Andamooka Opal (aka, "The Queen's Opal")
- The Aurora Australis Opal
- The Black Prince Opal (aka, "The Harlequin Prince")
- The Empress of Australia Opal
- Fire Queen Opal ("Dunstan's Stone")
- The Pride of Australia Opal (aka, "The Red Emperor")
- The Flame Queen Opal
- The Olympic Australis Opal
- The Pearl of Lao Tzu (aka, "The Pearl of Allah")
- The DeLong Star Ruby
- The Hixon Ruby Crystal
- The Midnight Star Ruby
- The Neelanjali Ruby
- The Rajaratna Ruby
- The Rosser Reeves Ruby
- The Black Prince's Ruby
- The Timur Ruby
- The Samarian Spinel
- The Logan Sapphire
- The Queen Marie of Romania Sapphire
- The Ruspoli Sapphire
- The Star of Asia Sapphire
- The Star of Bombay
- The Star of India
- The Stuart Sapphire
- The American Golden Topaz

Note: *Kids who give a presentation or write an article can use this activity toward earning their Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 13.4: Gems in religion.

Gems and precious metals are mentioned in many holy books and have places in various religious and cultural traditions. Have your kids pick a religion or native culture and research mention of gems in religious texts or traditions. One helpful reference work you may be able to find in the library is R.V.S. Wright and Robert L. Chadbourne's *Gems & Minerals of the Bible: The Lore & Mystery of the Minerals & Jewels of Scripture, from Adamant to Zircon* (Keats Publishing, 1988). Here are a few examples to start things off:

Judeo-Christian:

- In Exodus 28:17-21, the gold filigree breastplate of the high priest is described as adorned with four rows of three stones each: sard, topaz, and carbuncle; emerald, sapphire, and diamond; ligure (jacinth, or hyacinth), agate, and amethyst; and beryl, onyx, and jasper. Each of the stones represents one of the twelve tribes of Israel.
- The Twelve Apostles have corresponding gemstones: Andrew – sapphire, Matthias – chrysolite, Bartholomew – peridot, Peter – jasper, James – chalcedony, Philip – carnelian or sardonyx, James bar Alpheus – topaz, Simon – zircon, John – emerald, Thaddeus – chrysoprase, Matthew – amethyst, and Thomas – beryl.
- In Revelation 21:18-21, we see a vision of the New Jerusalem in which the foundations of the walls of the heavenly city are adorned in twelve layers of precious stones. From bottom to top, these are jasper, sapphire, chalcedony, emerald, sardonyx, sard, chrysolite, beryl, topaz, chrysoprase, jacinth, and amethyst.
- The prophet Ezekiel wrote: "Then I looked, and, behold, in the firmament that was above the head of the cherubim there appeared over them as it were a sapphire stone, as the appearance of the likeness of a throne."

Buddhism:

- Buddhist monks in India are said to have used amethyst to help in meditation.
- For Tibetans, chalcedony symbolizes the purity of the Lotus flower.
- Garnet is considered a holy stone bringing enlightenment and wisdom.

Islam:

- In Arab countries, moonstone is often given as a gift and blessing for a large family.

Native American:

- Jade was revered by many cultures in Central and South America. For Mayans, jade preserved love, and nephrite jade was believed to stave off wounds.
- For some Native American tribes, jasper is a magical rain stone.
- Some North American Indians believe jet to be a protective stone that can bring comfort after the death of a relative.
- According to legend, when Apache warriors leapt from a mountain to their death rather than being captured by enemies, tears of their families hit the ground and, as signs of enduring sorrow, they're now found as Apache tears obsidian.
- Turquoise has long been considered a holy stone by American Indians; for some, it provides protection against harm.

Note: *Kids who give a presentation or write an article can use this activity toward earning their Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 13.5: Mysticism and minerals.

From time immemorial, human eyes have been captivated by the color and sparkle of gemstones, and we've come to invest some with mystical, magical powers. To put my cards on the table, I don't put much stock in mysticism. Still, it's fascinating stuff, especially when viewed from a cultural or historical angle, which is the perspective I encourage taking in exploring this activity with kids. To get you started, here's just a brief sampling of some classic gems and a couple beliefs associated with each:

- **Amethyst:** Amethyst is supposed to ward off evil thoughts and drunkenness and, so doing, induce a sober mind. The Chinese ground it to cure bouts of bad dreams.
- **Aquamarine:** Called "the sailor's gem," aquamarine was believed to have originated in a mermaid's jewelry box and provides safe passage on stormy seas. It was also thought to make soldiers invincible and to bring pure love.
- **Diamond:** Diamond has long been valued and has been viewed as a symbol of wisdom and enlightenment, self-confidence and power. While Greeks believed it protected against poisons, Hindus believed a flawed stone could invite misfortune.
- **Emerald:** Emeralds were believed to restore failing eyesight. Related to this, they were also believed to provide clairvoyance, or an ability to see into the future.
- **Garnet:** Garnets were thought to protect against depression and to deter liver disease and problems with blood circulation, perhaps because of their blood-red color.
- **Opal:** Opal was considered an unlucky stone in Europe and was even believed to have caused The Plague. By contrast, it's a stone of eternal hope in Asia.
- **Ruby:** Rubies were once thought to counteract poison and the plague and, rubbed on the skin, were supposed to restore youth and vitality.
- **Sapphire:** Sapphire has been considered a powerful protective stone. Some thought rays reflected from it could kill poisonous creatures. Persians believed the Earth itself rested on a giant sapphire that reflected the blue of heaven into our sky.
- **Topaz:** Once thought to be a cure for bad moods and madness, topaz has also been thought to bestow wisdom and to help ascertain the truth.

To guide your kids to more info about a greater variety of gems, you can find any number of books in New Age sections of a bookstore or library, like Peschek-Böhmer and Schreiber's *Healing Crystals & Gemstones: From Amethyst to Zircon*. Check also Foa's *Pockets Gemstones*. This handy, inexpensive pocketbook has two pages each devoted to 27 different gems. For each, it includes a small box entitled "Myth & Magic" with two or three beliefs about that particular gemstone through the ages. See also Knuth's *Gems in Myth, Legend, & Lore* or Kunz's *The Curious Lore of Precious Stones*.

Let your kids pick gems of special interest to them, and have them explore associated myths and legends and supposed mystical powers each stone possesses. But don't end there. Have them compare what modern science has to say about their gemstones. Or let them test a gem's power for themselves. For instance, it's said an emerald will melt the eyes of any snake that gazes upon it. Have an emerald? Have a young boy with a snake in your group? I see potential for an experiment!

Note: *Kids who give a presentation or write an article can use this activity toward earning their Communication badge simultaneously (Activities 7.1 and 7.2).*

14. Stone Age Tools & Art

Rocks have different properties and textures. For instance, obsidian is smooth and makes flakes with razor-sharp edges, kaolin (clay) is soft and moist and easily shaped when first dug from the ground, and granite is coarse and heavy. Early humans and stone-age cultures have taken advantage of the properties of different rocks to make tools and art from them. These activities will guide you in making your own stone tools and art.

Activity 14.1: Rocks and minerals used as tools.
Make a list of rocks and minerals that have been used as stone tools and art. Describe the properties of each one on your list that made them useful to stone-age cultures. Collect some of the rocks or minerals on your list and show them to fellow club members.

Activity 14.2: Making stone tools.
If you have a source for rocks such as basalt or granite in the form of large, rounded cobbles, work with your youth leader to craft clubs, tomahawks, or a grinding stone. Or watch a master flint knapper craft an arrowhead.

Activity 14.3: Making stone tools and art from clay.
Try one or both of these activities. a) Roll clay into long ropes and coil it to make pots, cups, and other vessels. You can press patterns into the outside surface of your pot with your fingernails, feathers, or twigs and then bake it hard in an oven. b) Fashion beads from clay and bake them hard. Combine them with other natural materials such as wood, seeds, shells, and feathers and string them together to create necklaces and bracelets.

Activity 14.4: Making rock art.
Pick one of these art projects to try: a) Some cultures have left paintings in caves showing animals they hunted, their own hand prints, and mysterious zig-zags and squiggles. They made paints from ground minerals mixed with water, grease, or oil. Make your own paint and create a cave painting on a large, flat stone. b) Other cultures left behind petroglyphs, or images chipped into stone. Make your own petroglyph, using a hard, pointed rock to chip images onto the flat surface of a softer rock. c) Use sands of different colors to craft a temporary design on a sidewalk or floor, or make a more permanent artwork by making a design with white glue on plywood or cardboard and sprinkling sands of different colors into your pattern.

Activity 14.5: Recording and interpreting rock art.
If you live near a painted cave or a petroglyph site, visit it and photograph or sketch the patterns you see. Try to determine what the rock art may be telling of how Indians lived—the animals they kept and hunted, the ways they dressed, ceremonies they held, etc. Write your thoughts in your club newsletter or give a presentation at a club meeting.

Activity 14.6: Visiting a museum or Native American cultural center.
Take a trip to a museum, Native American cultural center, or college archeology department that has artifacts and learn about tools that Indians fashioned and the rocks and minerals they used.

14. Stone Age Tools & Art

□ 14.1 Rocks and minerals used as tools

□ 14.2 Making stone tools

□ 14.3 Making stone tools and art from clay

□ 14.4 Making rock art

□ 14.5 Recording and interpreting rock art

□ 14.6 Visiting a museum or Native American cultural center

To earn your Stone Age Tools & Art badge, you need to complete at least 3 of the 6 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 14.1: Rocks and minerals used as tools.

Here are some examples of rocks and minerals that have been used by indigenous cultures around the world in crafting tools or making artworks:

- **Flint:** flakes easily, with sharp edges, making it good for knapping into arrowheads, spear points, and knives.
- **Obsidian:** another source for knapping into arrowheads, spear points, scrapers, and knives.
- **Agate and jasper:** two more sources of stone suitable for flaking and knapping.
- **Kaolin, or clay:** soft and malleable but bakes rock-hard when heated, thus making it perfect for crafting cups, bowls, and other vessels and for making beads.
- **Granite:** heavy and coarse, and thus good as a grinding stone or for making tomahawk or club heads.
- **Basalt:** also heavy and coarse and good as a grinding stone.
- **Tar:** at places with oil seeps, native cultures have exploited tar for things such as caulking boats or waterproofing bowls (note: tar is technically not a mineral, but it is a natural resource that has long been exploited by people).
- **Hematite:** ground to make red paint.
- **Azurite or lapis:** ground to make blue paint.
- **Malachite:** ground to make green paint.

An interesting book that goes into all sorts of materials used by stone-age peoples to craft tools for survival is David Wescott's *Primitive Technology: A Book of Earth Skills* (Gibbs Smith, Publisher, 2001). The materials he discusses include stone, wood, bone, natural fibers, fire, etc. He even includes a chapter on primitive art and music.

Note: *Kids who make a collection of rocks and minerals used to make stone tools can use this activity toward satisfying requirements for earning the Collecting badge simultaneously (Activity 5.1). If they give a presentation to share their collection and talk about how these rocks have been used as tools, they can also use that presentation toward earning their Communication badge, as well (Activity 7.1).*

Back-up page 14.2: Making stone tools.

a) ***Tomahawks & Grinding Stones.*** For tomahawks and grinding stones, seek heavy rocks that have been rounded and smoothed in a river bed, along an ocean beach, or in a deposit of glacial till. Tomahawks can be made by cutting a foot-long section of a tree branch, notching one end, inserting an oval or oblong stone, and securing it in place by wrapping and tying a length of thick leather string. For a grinding stone, seek a well-rounded, coarse-grained rock (granite, basalt, etc.) that will fit comfortably in the palm of your hand. Match this with a large, flat slab of rough rock (perhaps a foot in diameter), and set your kids to work grinding hard kernels of corn.

b) ***Arrowheads & Spear Points.*** Stone-age peoples craft arrowheads and spear points from rocks such as flint, agate, jasper, and obsidian. There are various techniques for crafting a point, from hard- and soft-hammer percussion to pressure flaking. Percussion involves striking flint or obsidian with antler, bone, or another rock. Pressure flaking involves poking at the flint or obsidian with the pointed end of an antler segment or other tools to chip off small flakes along the edges of an arrowhead or spear point.

WARNING!! Do not do a knapping exercise with kids! Knapping produces razor-sharp edges (sharper than scalpels) and can send sharp shards flying through the air. Eye protection is a must, as are thick leather gloves. Even then, one guarantee is that knapping will lead to cuts—and sometimes very nasty ones! Thus, this isn't the sort of exercise you want to do with young kids. Instead, this is better left as a demonstration performed by a trained expert well versed in the craft. I recommend you get a master knapper from your own club or a nearby club to provide a demonstration. Thousands of Americans practice this art form, connecting via newsletters and the Internet and gathering at regional "knap-ins" to share techniques and materials. You can get a sense of "who's who" in this community in John Whittaker's book *American Flintknappers: Stone Age Art in the Age of Computers* (2004). If you can't find a local knapper, you can still provide a demo for your kids via a video: "Flintknapping with Bruce Bradley, Ph.D." This terrific 45-minute video may be purchased on-line from the web site of the Mammoth Site of Hot Springs, South Dakota, through their on-line store at http://www.mammothsite.com.

Again, I stress the warning not to do knapping with kids! Even for adults, thorough preparation and great care is required in pursuing a knapping project, as emphasized in the safety chapter of any one of the several books that have been published on the art of knapping. You may wish to purchase one of these as a reference for your club library:

- Gravelle, *Early Hunting Tools: An Introduction to Flintknapping* (1995)
- Hellweg, *Flintknapping: The Art of Making Stone Tools* (1984)
- Patten, *Old Tools – New Eyes: A Primal Primer of Flintknapping* (1999)
- Waldorf, *Art of Flint Knapping, Fourth Edition* (1993)
- Waldorf & Martin, *Getting Started in Flint Knapping* (1998)
- Whittaker, *Flintknapping: Making & Understanding Stone Tools* (1994)

Back-up page 14.3: Making stone tools and art from clay.

Clay is the mineral kaolin, and it's been used throughout human history and prehistory because it's soft and easily shaped when moist yet bakes rock hard to create water-tight vessels and other tools. Using designs you find in books on North American Indians, lead your kids in fun activities fashioning pots, vessels, and beads from clay.

a) ***Pots and Vessels.*** In leading kids in this activity, first stock up on a big supply of modeling or pottery clay that's either self-hardening or that may be fire-hardened in a standard oven (or, if you have one available, a potter's kiln). Have kids start by flattening a circle of clay for a base, using their hands or a rolling pin. Next, have them make long "ropes" of clay by rolling a lump of clay between their palms. They then coil their clay rope around the base, building upwards and making and adding new lengths of clay rope as needed until they have a pot or vessel of just the right size they want.

Your kids then have several options. They can leave the pot just as it is. Or they can make hash-mark (///////) or X (XXXXX) patterns or other interesting designs all around their clay ropes by pressing into the clay with their fingernails, feathers, or twigs. Or they might massage the sides of their pots smooth with their fingers and paint a design on the outside. Then bake the pots hard in an oven or let them self-harden.

If you have pottery artists in your club, get together with them for more creative ideas and for more sophisticated techniques.

b) ***Beads.*** Have kids roll clay into small balls, ovals, cylinders, etc., for beads, and pierce holes in each bead with kabob sticks before baking them hard. Combine them with other natural materials such as wood, seeds, shells, and feathers and string them all together to create necklaces and bracelets.

Note: *You might consider applying this activity toward the Lapidary Arts badge, as well (Activity 4.4).*

Back-up page 14.4: Making rock art.

a) ***Cave painting.*** Near my home in southern California are cave paintings, or pictographs, left by Chumash Indians. The primary colors are red from hematite, black from charcoal or burnt manganese, and white from clay or diatomaceous earth. Indians ground such materials with mortars and pestles, then mixed the resulting powdery pigments with a binder (water, grease from animal fat, or oil from crushed seeds). Paint brushes were crafted from feathers, coarse hair or fur, or vegetable fibers bound together or inserted into cane tubes. Paint also was applied simply by finger. Work with your kids to make paint and use it to decorate large, flat rocks. Here are some minerals that have been crushed, mixed with oils or animal fats, and used in paints over the ages (as an alternative to oils or animal fats, you can use white glue diluted in water as your binder):

- green clay
- yellow clay
- yellow limonite
- brown clay
- red clay
- white clay
- white chalk
- white gypsum
- black charcoal
- blue azurite
- green malachite
- an earthy variety of red hematite

WARNING!! In some books, you may read that yellow and red paint pigments can be ground from **orpiment** and **realgar**. While this is true, **both are sulphides of arsenic and can be dangerous and even toxic.** ***Don't use these with your club's kids!***

b) ***Petroglyphs.*** Petroglyphs are images that have been chipped into stone and are often seen at cliff sites or covering large boulders in the American Southwest. In deserts, rocks often get coated with a dark crust called **desert varnish**. Native Americans chipped though this coating to create their petroglyph artworks, sometimes creating huge murals stretching across a cliff face. To help kids make their own petroglyphs, provide soft, flat rocks such as slabs of shale or sandstone. (If you don't have a source readily available that you can collect from the field, try a building supply store for flagstones. See if they have any broken ones they may be willing to donate for free.) You also can make a soft, flat surface with plaster. Lightly coat the surface of your rock or plaster slab with a red-brown or black paint to simulate desert varnish. Then give kids small, pointed rocks to chip images into the desert varnish.

c) ***Sand painting.*** The Navajo, Tibetan monks, and Australian Aborigines are just some cultures that craft intricate patterns using colored sands. These are not usually meant to be permanent artworks but instead living, flowing works, just as sand blows across the landscape in the wind. Your kids could make similar, temporary works by drizzling sand in desired patterns onto a sidewalk or a sheet of cardboard. Or, for a permanent work of sand painting, you can give them sheets of cardboard or plywood and have them make patterns with white glue over which they sprinkle sands of different colors. If you have a nearby source from gullies, beaches, or river beds, you can use natural sands, or you can purchase a variety of vividly colored sands from aquarium supply stores.

Back-up page 14.5: Recording and interpreting rock art.

If you live near a rock art site, organize a field trip. Make sure kids are respectful of the rock art and do nothing to deface it. These spots are sacred to Native Americans, and many have survived centuries in the elements. Help preserve them for centuries to come! If you don't have a spot near you, show kids a photo gallery of rock art sites from around the world at this web site: http://www.bradshawfoundation.com. If visiting a site, have kids bring sketch pads to copy their favorite images. They might also take photos, but nothing beats sketching in your own hand to get a true feel for the art and to force you to make a careful examination. Then hold a discussion with your kids about what they think various images and symbols left by the Indians may mean. The meanings behind most cave and cliff paintings and petroglyphs have been lost and may never be understood, but some images are clear and paint vivid stories, such as hunting for bighorn sheep or bison.

While most books about rock art focus on the Southwest, ancient rock art has been found throughout America. Here are some guidebooks that talk about rock art from coast to coast and that provide directions to rock art localities. See if you can find one near you.

- Arnold & Hewitt, *Stories in Stone: Rock Art Pictures* (Houghton Mifflin, 1996), images from the Coso Range of the California Mojave; for ages 12 and up.
- Coy, et al., *Rock Art of Kentucky* (University of Kentucky Press, 2004).
- Duncan, *The Rock-Art of Eastern North America* (University of Alabama Press, 2004), covers from the Atlantic Coast to the Ozarks, MN, IA, and MO.
- Farnsworth & Heath, *Rock Art Along the Way* (Rio Nuevo, 2006), covers UT, NM, CO, NV, AZ, CA.
- Francis & Loendorf, *Ancient Visions: Petroglyphs & Pictographs of the Wind River & Bighorn County, Wyoming & Montana* (University of Utah Press, 2002).
- Keyser, *Art of the Warriors: Rock Art of the American Plains* (University of Utah Press, 2004).
- Keyser, *Indian Art of the Columbia Plateau* (University of Washington Press, 2003).
- Keyser & Klassen, *Plains Indian Rock Art* (University of Washington Press, 2003).
- Lenik, *Picture Rocks: American Indian Rock Art of the Northeast Woodlands* (University Press of New England, 2002).
- Loendorf, Chippindale, & Whitley, *Discovering North American Rock Art* (University of Arizona Press, 2005).
- Patterson, *A Field Guide to Rock Art Symbols of the Greater Southwest* (Johnson Books, 1992), covers AZ, CA, NV, CO, UT, NM, TX.
- Sanders, *Rock Art Savvy: The Responsible Visitor's Guide to Public Sites of the Southwest* (Mountain Press, 2005), covers AZ, CA, CO, NV, NM, TX, UT.
- Sullivan & Sullivan, *Roadside Guide to Indian Ruins & Rock Art of the Southwest* (Westcliffe Publishers, 2006).
- Sundstrom, *Storied Stone: Indian Rock Art in the Black Hills Country* (University of Oklahoma Press, 2004).
- Whitley, *A Guide to Rock Art Sites* (Mountain Press, 1996), southern CA, NV.

Note: *This activity can be used to satisfy requirements toward earning the Field Trip badge (Activity 8.3) and the Communication badge (Activities 7.1 & 7.2) simultaneously.*

Back-up page 14.6: Visiting a museum or Native American cultural center.

Take your clubs' kids to a museum, Native American cultural center, or college archaeology department. Here, kids can see actual tools, artwork, and other artifacts crafted from rocks and minerals and other natural materials. By calling in advance to make arrangements, you may be able to have knowledgeable experts guide your group and—in museums and archaeology departments—perhaps even give a peak at research collections in back rooms not normally open to the public. Surf the web or check with your town's visitor center or chamber of commerce to explore possibilities, then call to see what sorts of collections are in your area and what arrangements might be made. For instance, spending less than two hours surfing the web on my computer this morning, I found the following that offer good possibilities for either brief morning or afternoon adventures or day trips within easy access of my hometown of Ventura, California, which for centuries has been inhabited by Chumash tribes.

For a brief morning or afternoon trip:

- The Museum of Ventura County, located in the heart of downtown, has exhibits of early Chumash culture from the time when Ventura was a village called Shisholop.
- The Albinger Archaeological Museum, located across the street from the Museum of Ventura County, displays Native American stone relics from 1600 to 100 BC.
- The Robert J. Largomarsino Visitor Center at Channel Islands National Park includes artifacts and publications about seafaring Chumash from our offshore islands.
- Our local community college, Ventura College, offers courses on archaeology and has knowledgeable experts who would be worth calling to see if they might meet with a group of kids and/or offer advice about other area resources.

For a longer day trip still within easy driving distance of Ventura:

- Chumash Painted Caves State Historic Park, near the San Marcos Pass above Santa Barbara, preserves fine examples of pictographs in a rock shelter.
- More pictographs can be viewed along trails in the Santa Monica Mountains National Recreation Area, which even offers third and fourth graders a program on the Chumash in their Satwiwa Native American Cultural Center.
- Oakbrook Regional Park Chumash Interpretive Center to my south provides an artifact exhibit, a rock art exhibit, and ongoing events and activities.
- Both the Santa Barbara Museum of Natural History and the Museum of Natural History of Los Angeles County offer great Native American displays.
- The Anthropology Department at the University of California, Santa Barbara, holds the Repository for Archaeological & Ethnographic Collections.
- UCLA has several relevant programs—an Anthropology Department, American Indian Studies Center, and an Institute of Archaeology—as well as their Fowler Museum of Cultural History with artifacts from native cultures worldwide.

Check your community for similar opportunities for an adventure with your club's kids!

Note: *This activity can be used to satisfy requirements toward earning the Field Trip badge simultaneously (Activity 8.3).*

15. Rocking on the Computer

Are you "wired to learn"? The computer offers all sorts of fun, from video games to chat-rooms and instant messaging to websites where you can meet new people and learn about new things. The activities in this unit will help you use the computer to learn more about the hobby of rockhounding, to create presentations, to organize your collection, to find your way to collecting sites, and to connect with fellow collectors.

<u>Activity 15.1: *Exploring the web safely and securely</u>.*
Note: *This activity is required to earn this badge.*
Gather around a computer with your youth leader and other members of your club to explore the web via search engines like Google, Yahoo, Bing, or Ask.com. Learn "safety tips" for things to beware of when exploring the web. Then come up with topics (like quartz, or dinosaurs, or gem cutting) to see what you can find.

<u>Activity 15.2: Reporting on favorite websites</u>.
Explore the web on your own to find two or three websites related to your own areas of interest (minerals, fossils, geodes, meteorites, lapidary arts, natural history museums, etc.). Write down the web address of each site and a brief description of what you found on the site to share with your fellow club members.

<u>Activity 15.3: Making presentations with the computer</u>.
Create a PowerPoint presentation about your favorite minerals, fossils, or collecting site using images from the web or from pictures taken with a digital camera and show it to your fellow club members. If you have the right equipment and skills, try incorporating video clips. (See Badge 7: Communication.)

<u>Activity 15.4: Cataloging your collection electronically</u>.
Create an electronic catalog or list of your rock, mineral, or fossil collection that includes the name of each specimen and its locality and any other information you would like to remember about the specimen. For instance, if you bought it, you may want to record where you bought it and how much you paid for it. If it's a fossil, you should record the age of the fossil and the period or formation that it's from. (See Badge 5: Collecting.)

<u>Activity 15.5: Maps and GPS to find your way</u>.
Learn about different types of traditional paper maps (roadmaps, topographic maps, geological maps, etc.). Then explore mapping resources that are on the web, such as MapQuest or Google Earth or maps available via the websites of geological surveys. Learn about GPS and how it can help you find collecting spots. (See Badge 20: Maps.)

<u>Activity 15.6: Joining an online community</u>.
See if there's an online community focused around your particular area of interest, whether it be fossils, rock tumbling, meteorites, or minerals. Then, being mindful of safety tips from Activity 15.1, explore the site and report back to your juniors group about why you would—or would not—recommend it.

15. Rocking on the Computer

□ 15.1 *Exploring the web safely and securely* (required to earn this badge)

□ 15.2 Reporting on favorite web sites

□ 15.3 Making presentations with the computer

□ 15.4 Cataloging your collection electronically

□ 15.5 Maps and GPS to find your way

□ 15.6 Joining an online community

To earn your Rocking on the Computer badge, you need to complete at least 3 of the 6 activities. (Please note that successfully completing Activity 15.1 is required to earn this badge.) Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

Date completed

My signature

Youth leader's signature

Name of my club

Leader's preferred mailing address for receiving badge:

Back-up page 15.1: *Exploring the web safely and securely.*

Note: ***This activity is required to earn this badge.***

Gather your kids around a computer with an Internet connection to explore the web via search engines like Google, Yahoo, MSN, or Ask.com. Start by showing kids how to access a search engine. Then show them procedures for conducting a basic search, as well as how to conduct a somewhat more refined search to narrow down the number of resulting websites that will pop up. Finally, brainstorm with your kids to come up with rock-related topics of interest to them for exploration, like quartz crystals or dinosaurs or gem cutting. Type in the topic to see what you can find.

A good setting for an exercise like this is **your local public library**, providing of course you don't suddenly surprise the staff there with a flood of 20 noisy kids! In fact, your local librarians most likely would be thrilled to help in organizing and leading such a session. Stop in and talk with them and see what might be arranged. In one of my old day jobs at a publishing company, I interacted a lot with librarians when I signed and developed library reference books. Librarians are extremely bright and knowledgeable people engaged in a service profession. Thus, as a general rule they love to help people and are trained to help you find the information you need that's useful and reliable.

Safety and Security.

Librarians are able to provide your juniors with warnings about the dangers of the online environment. While I don't want to overstate such dangers, "on-line predators" do exist, as well as an unfortunate overabundance of websites of a less than savory nature that you want kids to avoid, not to mention the potential for getting "tagged" by spammers or by warped individuals who get a cheap thrill sending around digital worms and viruses if you open the wrong sort of document. One of the benefits of conducting a workshop like this in your public library—in addition to the safe and friendly community environment it provides—is that their computers generally do include firewalls and screens that prevent access to less desirable sites.

Here are some **safety tips** to pass along to kids when plugging into the online environment:

- Seek parents' permission before exploring websites.
- Refrain from giving out personal information should a particular site ask for names, addresses, phone numbers, etc.
- Avoid sites that require you to log in or to register, and seek advice from parents before taking any action like that on the web.
- Open attachments or downloads only from trustworthy sources.

Your local librarians will likely have additional safety tips to offer, so visit your local librarians, utilize their expertise, take advantage of computers set up and meant for public access, and arrange a web workshop for your club's kids!

Back-up page 15.2: Reporting on favorite web sites.

Activity 15.1 brings your kids together as a group to learn how to explore the web and see the sorts of things they can find related to our hobby while doing so with safety and security in mind. Activity 15.2 now sends them off to explore the web on their own and to report back. Each junior member should surf the web to explore his or her own area of interest, be it rocks, minerals, fossils, geodes, meteorites, dinosaurs, famous gemstones, lapidary arts, museums, field trips, etc. Have kids settle on the two or three websites related to their topic that they find the most interesting. They should thoroughly explore the sites and then do a brief write-up to report back that includes: 1) the web address of each site and its title, if it has one; 2) a brief description of what's to be found on each site; and 3) a conclusion about why they would recommend each site to other club members. You can let kids explore totally on their own, or you can provide suggestions as starting points. Here are some specific websites you might recommend:

General Information:

- http://www.google.com Google is a search engine that connects to anything and everything on the web. The only problem is that when you enter a search term, you could end up getting tens of thousands of results or "hits." Teach kids to use the advanced search features to attempt to narrow a search to more relevant sites.
- http://en.wikipedia.org Wikipedia has become an all-purpose "crowd-sourced" font of knowledge covering any and all topics. It's often a good first stop. Then follow up by pursuing links and references that conclude Wikipedia articles.
- www.YouTube.com YouTube is filled with all manner of video clips, both silly and serious. Search such topics as "mineral collecting" or "collecting rocks and minerals" and see what comes up.
- http://earth.google.com From Earth to the moon to Mars, Google Earth lets you explore it all with ever-increasing detail.
- http://education.usgs.gov The Education section of the United States Geological Survey website provides links to maps, images, videos and animations, online lectures, and more, with sections geared appropriately for primary, secondary, and undergraduate education. See what your tax payer dollars have provided!
- www.earthsciweek.com Earth Science Week is sponsored by the American Geological Institute with varied cosponsors such as the USGS, National Park Service, and more.

Minerals and Earth Resources:

- http://education.usgs.gov   The "Education" link of the U.S. Geological Survey web site is filled with activities and even links to experts who will answer kids' questions.
- http://mineralseducationcoalition.org The Minerals Education Coalition provides a wealth of info and resources on minerals, their uses, and careers in the earth sciences.
- www.womeninmining.org Women in Mining also provides good info and resources on minerals and their uses, along with links to other interesting earth science sites.

- www.theimage.com This Mineral Gallery shows gorgeous gemstones with info on the properties of nearly 200 different types of minerals; it also provides tips on shooting mineral photos with digital cameras.
- www.zacksrocksandminerals.com Zack's Rocks & Minerals is a nice all-purpose rock-and-mineral web site that was initially designed when Zachary was a teenage junior member of the Lynchburg (Virginia) club. He has continued to update and expand the site. This provides an inspiring illustration of where a junior's interest might take him or her!
- www.mindat.org The Mineral Database is a mineral-by-mineral treasure trove of information on mineral compositions, descriptions, localities, etc. It is said to have become the world's largest database of mineral information.
- www.minrec.org Website of *Mineralogical Record* magazine, the most authoritative mineral collector's journal in the world. This web site upholds that tradition.
- www.webmineral.com Web Minerals is a mineralogy database of 4,714 mineral species with a vast image library and links to other resources.
- www.the-vug.com I found The Vug to be a little confusing but to offer many interesting resources. Especially check out their section on "Fakes & Forgeries."
- www.rockhounds.com Bob's Rock Shop is the first "Zine" devoted to rocks and minerals! It's run by a "regular rockhound" and continues to provide a fine service.
- www.e-rocks.com eRocks is more of a commercial site with ongoing online auctions, which can help provide estimated value to your mineral collection.
- www.njminerals.org/ Chris's Mineral Collecting includes info on identifying minerals, how-to-do micromounting, and more.
- www.minsocam.org/msa/collectors_corner/MineralCollecting.htm The Mineralogical Society of America provides a complete primer on mineral collecting. Also see their page www.mineralogy4kids.org/games.html

Fossils:

- http://www.nature.nps.gov/geology/paleontology/jr_paleo.cfm The National Park Service "Junior Paleontologist Program" site helps kids explore how paleontologists work, along with links to still more sites, activities, and resources.
- www.paleoportal.org The Paleontological Portal of the University of California Museum of Paleontology is an entry point to fossil resources for all age levels.
- www.fossilmuseum.net The "Virtual Fossil Museum" is an educational resource welcoming contributions by educators, scientists, and amateur fossil enthusiasts. It includes pictures and photos, fossil sites, geological history, paleobiology and more!

Lapidary Arts:

- www.rockhounds.com "Bob's Rock Shop" teamed with *Rock & Gem* magazine to provide a first-class resource on topical information for hobbyists.
- www.gemsociety.org/reference-library/ This web site of the International Gem Society has a great "Jewelry & Lapidary" section that aids in learning all about gemstones, gemology, jewelry making and the lapidary arts.

- www.bwsmigel.info/ A complete—and free—gemology course with links to dozens of lessons.

Museums:

- www.lib.washington.edu/sla/natmus.html Rated a "Top Site" by Education Index, here you'll find links to museums and university collections worldwide.
- http://paleo.cc/kpaleo/museums.htm "Kuban's Guide to Natural History Museums" features annotated links to larger museums with fossil displays.
- www.amnh.org/education/resources/ The American Museum of Natural History provides on-line activities and resources specifically for kids.

Note: *Kids can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activities 7.1 or 7.2).*

Back-up page 15.3: Making presentations with the computer.

Among the things I enjoy most about belonging to a rock club (okay, I belong to *five* rock clubs, but that's a different story…) are the presentations made by fellow club members. These most often are slide shows of a collecting trip or a trip to a big show like Tucson or Denver, but they also include show-and-tell presentations of a member's collection or demonstrations and instructions on a particular lapidary skill.

With the widespread use of digital cameras, these presentations increasingly are being augmented by or given entirely off a computer through a digital projection system which beats the old slide projector in any number of ways. Gone is the whir of an overly loud fan cooling your bulb, the jammed slide that brings a temporary pause to the presentation, and the occasional upside-down or backward slide, which is especially embarrassing when it turns out *all* the slides are that way! In addition to avoiding those pitfalls, now you can enhance a presentation by digitally inserting labels or arrows highlighting special features in a particular photo, combining photos for panoramic views, adding PowerPoint slides with brief snippets of animated text or outlines to guide your audience through key points of your talk, and even adding a musical background or just the sound of the wind across the desert.

My own son and daughter were given occasional assignments in high school to create PowerPoint presentations as group homework projects. If you have kids with such abilities and proclivities in your club, encourage them to prepare a PowerPoint presentation or a digital slide show about their favorite rocks, minerals, fossils, or collecting sites using images plucked from the web or from pictures taken with a digital camera. If they have the right equipment and skills, they can even incorporate video clips and/or sound. This works especially well as a group project, with kids converging on the home of the one with the most sophisticated computer equipment and with the more knowledgeable kids sharing computer know-how and savvy with the less knowledgeable (I include myself in the latter category) and with everyone contributing ideas toward producing a final product for presentation at a club meeting.

At a simpler level, encourage kids with digital cameras to take photos on their collecting trips showing the surrounding countryside, the specific locality and any identifying landmarks, and samples of what they found there. They then can pick out the best shots to burn to CDs to copy and share with other kids in the club or to start storing in a club library as a digital archive of collecting localities. See how far your kids' computer skills can take them as they apply those skills toward rockhounding. Who knows? You might be providing training for your future club web master!

Note: *Kids can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activity 7.1).*

Back-up page 15.4: Cataloging your collection electronically.

When I was a kid, I used a composition book to catalog my fossil collection, listing new fossils as I got them, and supplementing that master list with a collection of 4X6 index cards where I scribbled locality info, with data about the formation and the sorts of fossils I had collected. The card system made it easy to find my locality info: it was all stored alphabetically by the name of the locality (most often the name of the closest town, like "Stockton Bryozoan Patch" or "Braidwood Concretions" or "LaSalle Crinoid Quarry"), and new cards could be inserted easily in their alphabetical place. The whole system worked fine while my collection was small and manageable, but the larger it grew, the more difficult it was to leaf back through my master list in that composition notebook, in which fossils were listed as they were acquired rather than by some more logical system, such as class or family of fossil, geological age, locality, etc. Eventually, I found faults in my index card system, as well. For instance, instead of grouping by locality name, would it make more sense to group all the cards together by geological time period in case I wanted to find all the Ordovician localities represented in my collection? So I made divider cards for each major period and then organized localities alphabetically within each period. But then, what if I specifically wanted to find all localities holding a specific type of fossil, like trilobites? How would I easily find those?

The advent of the computer made such questions moot. Collectors (both kids and adults) have access to intuitively easy-to-use database and spreadsheet software programs that come already loaded on new computers when purchased. You can now set up master fields. For fossils, these might include things such as specimen number, common name, taxonomic information, period and/or formation, and locality. For minerals: specimen number, common name, locality, etc. Once master fields are set up and data for each specimen entered, it's easy to reorganize your list and pull up just the things you want, for instance, all my fossil fish from the Eocene Epoch, or all my fossil crinoids regardless of locality or time period, or all my specimens of quartz crystals.

An easier alternative to creating your own database from scratch is purchasing software packages expressly designed to help rockhounds catalog their collections. These often have blank fields that simply need to be filled in, and the program does the rest of the work, even allowing you to print custom labels. Two examples are "TFGCollector" (The Fredrick Group, Inc., P.O. Box 1698, Cumming, GA 30028, www.fredrickgroup.com, phone 866-679-9284) and Carles Millan's free software for cataloguing mineral collections (http://carlesmillan.cat/min/main.php).

For more about cataloging a collection and electronic data keeping, see Back-up page 5.2: Cataloging and labeling your collection, in the Collecting Badge unit. Work with your kids to come up with the best system for cataloging their collections and encourage those who are technologically proficient to make full use of the computer.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.2).*

Back-up page 15.5: Maps and GPS to find your way.

Use this activity to show kids the different types of maps they'll find useful in pursuing our hobby, from traditional guidebooks, road maps and geographic/political maps showing locations of towns, county borders, etc., to topographic maps showing the ups and downs of our landscape and geological maps revealing the formations under our feet in colorful patterns. With that background under their belts, then turn to digital maps.

Maps have come a long way since the days we stopped at gas stations to get the bulky fold-out variety to distract us as we drove and that never seemed to fold back the way they folded out. Those maps still exist and still serve a purpose. Good sources for roadmaps continue to be gas stations, along with drug stores and variety stores, AAA offices, etc. More detailed maps and atlases are available through companies like **DeLorme**, **Rand McNally**, and **Thomas Guides** and can be found in variety stores, bookstores, or outdoor supply stores. To get topographical and geological maps, turn to the geological survey of the state you're planning to visit. Most will have a catalog or online listing of maps they offer. To find a link to your state geological survey, go to the web site of the **U.S. Geological Survey**: http://www.usgs.gov.

The most exciting development with maps is how getting from Point A to Point B has been transformed in the digital age. Show your kids how they can enter start and end points into **MapQuest** (http://www.mapquest.com) or similar services and get directions, driving distances, and estimated travel time, along with a color map highlighting their route. In fact, skip MapQuest! Cars increasingly are equipped with built-in navigation systems that will even talk to you and tell you when you've gone a road too far. On the web, mapping services such as **Google Earth** (http://earth.google.com) combine traditional maps with satellite images that allow you to zoom in for a close-up look at your destination. Gather kids around a computer and explore these neat features, picking destinations the kids throw out.

Finally, the **Global Positioning System (GPS)** has truly transformed how we might go about finding our old-time favorite collecting spots, even in those desert localities where the unmarked fork in the road turns out to be three or four forks, none seeming to line up exactly with the guidebook in our lap. In fact, those guidebooks increasingly include GPS coordinates for collecting spots. Some now consist purely of coordinates, entirely forgoing the traditional maps and directions, for instance, David A. Kelty's *GPS Guide to Western Gem Trails*. Other guidebooks are popping up, like Delmer G. Ross's *Rockhounding the Wiley's Well District of California: The GPS User's Guide*. If you or other adult members of your club or society have GPS devices, give your kids a demo of GPS in action, perhaps by doing a "geocache," or treasure hunt: hide a container or bag with enough crystal or fossil specimens for each of the kids in your group and plant it in a field or park, noting its GPS coordinates. And then play GPS hide-and-go-seek with your kids, and give each a rocky reward once the cache has been located.

Note: *Kids can use this activity to satisfy requirements toward earning the Maps badge simultaneously (Activities 20.4 & 20.5).*

Back-up page 15.6: Joining an online community.

Being mindful of the "safety tips" noted on Back-up page 15.1 (required to earn this badge), you might encourage your older, more computer-savvy kids to join an online community in an area of specific interest. Such communities can put them in touch with knowledgeable hobbyists and experts around the world with like-minded interests, offering blogs, message and bulletin boards, discussion groups, news updates, photo galleries, and more. Kids can find answers to their questions, suggestions and tips, leads to further resources, and even opportunities to trade specimens through the mail.

The downside is that discussions held on such sites don't always proceed in a grown-up manner as the occasional "flame war" erupts in part as a result of misunderstandings arising from the nature of online communication, where, for example, an effort at humor may get interpreted as an insult. You'll also find people engaging in fatuous ego trips now and then, painfully and embarrassingly reminiscent of recent candidates for the U.S. Presidency. Still, the benefits outweigh the occasional downside, and online communities can be both educational and fun if you look past the banter and egos that sometimes go off track.

I recommend consulting your local librarian to help discover good, established, reputable groups. Fellow club members also might be able to advise. To give you a flavor, here are a few I'm aware of:

- LA-Rocks, an on-line group of Southern California rockhounds who share information on gems and minerals, collecting sites, shows, and field trips. http://groups.yahoo.com/group/LA-Rocks/

- Rock Tumbling Hobby, a site for over 4,000 rock tumbling enthusiasts to trade tumbling tips, share photos, and arrange swaps of tumbling rough. www.rocktumblinghobby.com

- Club Space Rock, a site which bills itself as "the world's largest meteorite community," with folks ranging from rank amateurs to world-class scholars. www.meteorites.ning.com

- Bob's Rock Shop, billed as "the Internet's First 'Zine for Rockhounds," this includes a "Rock Talk" discussion group and message forum, along with all sorts of other information, photo galleries, links, and more. www.rockhounds.com

16. The World in Miniature

When we collect, we usually seek the biggest rock on the ground. But you may be surprised at what you'll find within the world in miniature! Step through the magnifying glass and learn to collect, clean, and store the smaller wonders of the mineral and fossil world and discover great specimens most people walk right over. Many people focus on **cabinet specimens** (ones that are fist-sized). Here, you'll learn about **miniatures** (a specimen small enough to fit in the space of a 2-inch cube), **thumbnails** (fits within the space of a 1-inch cube) and **micromounts** (specimens so small as to require magnification with a hand lens or microscope to identify and evaluate). Learn not only how to collect micromounts but also how to capture images to share with others via drawing or photographing your specimens. You'll find one thing for certain: these small specimens sure are easy to store!

Activity 16.1: Collecting, preparing, and storing miniature minerals.
Except for their size, miniatures aren't a lot different from larger specimens you may have collected, but you may need to use special techniques to trim and store a small mineral. Learn those techniques and make a collection of at least 10 miniature minerals.

Activity 16.2: Collecting, preparing, and storing thumbnail minerals.
You might extract thumbnail minerals from a cavity in a rock, sift them from soil, or carefully split one away from a larger mass of crystals. Learn special techniques to collect, mount, and store thumbnail minerals, and make a collection of at least 10.

Activity 16.3: Collecting, preparing, and storing microminerals.
Microminerals are a special class requiring extra special care and materials. Because they are so very tiny, they're easily lost or destroyed. Learn what special efforts to take to collect, mount, and store them, and make a collection of at least 10 microminerals.

Activity 16.4: Collecting, preparing, and storing miniature fossils.
Sometimes you'll find small fossils in mint condition sitting right on the surface. More often, you'll need special techniques to collect, trim, and store a small fossil without damaging it. Learn those techniques and collect at least 10 different miniature fossils.

Activity 16.5: Collecting, preparing, and storing thumbnail fossils.
Learn how to use small chisels, saws, and nippers to trim matrix from around thumbnail fossils. Also learn how to safely store your small treasures so they aren't lost or destroyed. Then make a collection of at least 10 different thumbnail fossils.

Activity 16.6: Collecting, preparing, and storing microfossils.
You can find microscopic fossils loose in the dirt at a fossil site. Learn about graduated screens for sifting sediment to retrieve tiny fossils. Also learn how to store your tiny treasures so they aren't lost or destroyed, then collect of at least 10 different microfossils.

Activity 16.7: Collecting and classifying sand.
A heap of sand is basically a collection of microminerals and microfossils. Form a sand collection and explore the world of sand grains with sand samples from at least five very different locations. Explain why your samples may look different from each other.

Activity 16.8: Drawing or photographing microminerals, microfossils, and sand.
In order to better share your micromineral, microfossil, or sand collection with others, make drawings or take photographs to magnify your specimens.

16. The World in Miniature

□ 16.1 Collecting, preparing, and storing miniature minerals

□ 16.2 Collecting, preparing, and storing thumbnail minerals

□ 16.3 Collecting, preparing, and storing microminerals

□ 16.4 Collecting, preparing, and storing miniature fossils

□ 16.5 Collecting, preparing, and storing thumbnail fossils

□ 16.6 Collecting, preparing, and storing microfossils

□ 16.7 Collecting and classifying sand

□ 16.8 Drawing or photographing microminerals, microfossils, or sand

To earn your World in Miniature badge, you need to complete at least 3 of the 8 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page for the World in Miniature badge.

Let’s start with some definitions…

- A **cabinet** specimen fits within the confines of a 5-inch cube. These are the sorts of specimens we often see on display at gem and mineral shows. They’re generally no bigger than fist-sized and would fit comfortably within the palm of your hand. But that’s not what this unit is about…
- A **miniature** is a specimen that fits within the confines of a two-inch cube.
- A **thumbnail** is a specimen that fits within the confines of a one-inch cube.
- A **micromount** is a specimen so small that it requires a hand loupe (generally 10X or 20X) or a microscope to identify and appreciate it. It’s also usually permanently glued and mounted in a small box or slide.

It’s probably best to start kids exploring smaller specimens with “minatures.” The smaller you get on the scale presented above, the more complicated and expensive it can become to build and maintain a collection, and micromounts are pursued primarily by “connoisseurs” of the mineral and fossil world. These tiny specimens often represent the pinnacle of perfection. Many of those stunningly perfect crystals you see featured in colorful magazine photo spreads are actually micromounts; take a close look at the captions, and you’ll often see measurements expressed in terms of millimeters.

Still, it doesn’t necessarily have to be complicated nor expensive to make a start with even a micromount collection. In this unit, we won’t try to be comprehensive but instead will focus on simple, inexpensive basics while providing recommended resources for anyone wishing to go into more depth, particularly with microminerals and microfossils.

Smaller specimens provide a great way to get kids started in collecting. For one thing, such specimens are often a lot kinder to a child’s budget if purchasing specimens at a gem show. While perfect crystals of precious gemstones such as rubies, sapphires, diamonds, or emeralds are going to cost a bundle no matter what the size, many common specimens of such minerals as quartz, calcite, or pyrite, or of fossils like brachiopods, horn corals, or ammonites usually cost a whole lot less the smaller they are.

Kids are also more likely to find “mint” condition fossils or crystals of smaller sizes when collecting in the field. They just need to be trained to look for and appreciate these smaller specimens. When I was a child, I was on the lookout for the twelve-foot long petrified log or the *T. rex* skull—perhaps somewhat unrealistically, given that I grew up in Illinois….I haven’t done a formal count, but I’d safely wager that the vast majority of my own self-collected fossils fall within the categories of miniatures and thumbnails.

A miniature or thumbnail collection certainly takes a lot less space to store. While those fist-sized cabinet specimens could fill up shoebox after shoebox in a child’s closet or under the bed, over 100 thumbnail mineral specimens can easily fit in a space just one foot by two feet and literally thousands of microfossils mounted on slides can be tucked compactly into a space no bigger than a breadbox. Finally, as a fringe benefit, working with small specimens refines hand-eye coordination and helps a child in developing concentration, patience, and focus.

Back-up page 16.1: Collecting, preparing, and storing miniature minerals.

Collecting miniatures. One good way to start kids collecting miniature minerals is in the backyard of a willing club member who has a 40-year accumulation of rock sinking into the ground, with small chips and pieces scattered all about. Let kids know they won't be seeking a spectacular giant hunk but instead rejects and cast-offs: the quartz or calcite-filled geode that shattered under a hammer blow and now sits in unwanted pieces. On close inspection, and with a little scrubbing, these pieces may yield perfect miniatures. Encourage kids to get up-close-and-personal with the rocks. Other sources of miniatures include gem shows, swaps with fellow club members, and—of course—field trips to mines and mineral localities listed in guidebooks for self-collecting.

Tools for field collecting miniatures will be the same as those used for collecting bigger specimens (see Back-up page 8.2): a rock hammer and chisel, goggles for eye protection, work gloves to protect hands, a roll of toilet paper for wrapping specimens so crystal tips and faces don't get chipped or scratched, zip-lock baggies for transporting specimens safely home in buckets, knapsacks, or soda flats, and masking tape, markers, and notebooks for recording locality and other field information for each specimen.

Preparing miniatures. Preparing miniatures basically involves trimming away matrix and unwanted damaged crystals. Kids shouldn't try to trim excess matrix in the field but rather at home, where they can better control the trimming. Basic supplies needed include lapidary hammers and small chisels (along with eye protection), rock or tile nippers and/or special vice-like rock trimmers to snip away pieces of matrix, a small rock saw, a hack saw fitted with a grit-edge or tungsten carbide blade rod, and a regular hand magnifying glass or, better, a bench magnifier that allows one to work with both hands free. Small sand bags are also helpful to secure a specimen and to absorb the shock of any hammer-and-chisel blows, which should be administered with a light touch.

For sturdier, non-soluble minerals and crystals, cleaning often involves nothing more than a scrubbing with soapy water and a toothbrush. I've also used steel dental picks and a dental water pick to get at stubborn dirt packed within tiny crevices.

Storing miniatures. Miniatures may be stored in egg cartons, small fold-up cardboard specimen boxes, or compartmentalized plastic storage boxes with fold-top lids sold with fishing tackle or in bead-supply stores. A more expensive option is the 2-inch Perky box, named after its creator, Willard Perkins of Burbank, California, who was known to friends as "Perky." For use with miniatures, these come in two sizes: medium (1-3/8"X2"X2") and large (2.25"X2.5"X2.5"). These small plastic boxes, available from mineral suppliers, usually have a black bottom lined with Styrofoam and a clear plastic top. Specimens can be pushed into the Styrofoam or held in place with a dab of mineral- or poster-tack. These Perky boxes, in turn, can be stored in soda flats or small cabinets.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.2: Collecting, preparing, and storing thumbnail minerals.

Collecting thumbnail minerals. See Back-up page 16.1 on ways to collect miniatures. It'll be much the same when approaching thumbnails. However, the "tools of the trade" get a little more specialized. You'll need the same tools used for collecting miniatures, augmented with a loupe, flat screwdrivers and ice picks, and chisels of various sizes but especially small ones. The screwdrivers and ice picks can be used to probe small crystal-lined pockets and to remove mud and clay from cavities. If trying to chip out a little crystal-lined vug, stuff bits of rags (or shaving cream) into the cavity, both to protect crystals from shocks of hammer blows and to keep them in place so they don't go flying. In areas where small crystals may be loose in the dirt or gravel or when searching through mine tailings, your best tools are hand rakes, small shovels or trowels, and quarter-inch mesh screens in wooden frames. This is how many fee dig sites operate, with a pile of earth from mine tailings to be dumped into screens and sifted in water for quartz crystals, tourmalines, garnets, etc. Also handy: a supply of small zip-lock baggies to store finds.

Preparing thumbnail minerals. For thumbnails, as with miniatures, the goal is to reduce larger rock blocks with hammers and chisels if the crystals can take the shock of blows being delivered around them. You want to trim away as much matrix as possible without damaging the crystals, switching to increasingly delicate techniques the closer you get. Instead of delivering sharp blows with a standard rock hammer and chisel, you'll switch to small chisels and deliver delicate blows with small lapidary hammers (while wearing eye protection). You can also use rock or tile nippers and vice-like rock trimmers. For especially stubborn matrix, you may need to use a trim saw lubricated with water rather than oil, but most collectors prefer a "natural" edge on matrix as opposed to the straight edge of a saw cut. One way to create a natural edge is to saw a shallow groove from below and then tap with a small chisel and hammer from above. When using hammers and chisels to remove matrix close to your specimen, place your rock on a sand bag to cushion blows, and use a bench magnifier to leave both hands free. Two other important tools are tweezers and glue should a crystal in a cluster pop loose.

Storing thumbnail minerals. Thumbnails are best stored in 1-inch Perky boxes, which are actually 1.25"X1.25"X1.25". These small acrylic boxes, available from mineral suppliers, have a black bottom lined with Styrofoam and a clear top. Specimens can be glued onto or pushed into the Styrofoam or attached with tack. Instead of Styrofoam, you can also use 1-inch acrylic squares that make it easy to remove a specimen from the Perky box for display in an exhibit. For kids just beginning and on a budget, matchboxes will also do, or—as with miniatures—plastic boxes with compartments and fold-top lids sold in bead stores or with fishing tackle. The bottom of each compartment should be lined with cotton to keep specimens from rolling about. Basically, use anything that's enclosed so as to contain the small specimen securely and to keep out dust.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.3: Collecting, preparing, and storing microminerals.

Collecting microminerals. What does a chunk of rotting granite shedding flakes of mica, quartz, and feldspar have in common with a freshly cracked geode with interior crystals speckled with black dots? On close inspection, both may yield perfect microminerals. In collecting microminerals, kids need to dive in nose-first and really get up-close-and-personal with the rocks. It's not enough to scan the ground from above. Kids need to get on hands and knees or even their bellies when searching through gravel or over matrix likely to hold tiny crystals, and they'll definitely need to bring their 10X or 20X loupes to look closely at what they spy. I've found perfect little "Pecos diamond" quartz crystals while lying on the ground, picking through the sandy ruble of an ant hill in New Mexico.

Preparing microminerals. Preparing microminerals involves trimming away matrix, very carefully, very slowly, just a little at a time. Basic supplies include hammers and small chisels (along with eye protection), nippers and/or special vice-like rock trimmers, a small rock saw, Dremel-type grinding and cutting bits, dental picks, pointed-nose pliers, tweezers of various sorts, glue, and a bench magnifier that allows for hands-free work or even better, a binocular stereomicroscope, commonly called a dissecting microscope.

Storing microminerals. Microminerals are usually permanently glued into a protective container and are then referred to as **micromounts**. Micromount boxes with a black bottom and clear, snap-on lid can be purchased from mineral supply stores, or you can use those small plastic boxes with snap-on magnifier lids. There are many sophisticated techniques for gluing microminerals onto tiny rods and mounting them in display boxes. But for kids just beginning, it's probably best to use pedestals of tiny corks painted black. They can be handled more easily, both for gluing on the specimen and for positioning and gluing the pedestal into the box. Trim down the pedestal to keep the top of a mineral specimen just under the upper lip of the box so the lid never comes in contact with the mineral. If possible, the pedestal should not be visible beneath the mineral when viewed from above. Have kids practice with less desirable specimens until they acquire patience and skill at gluing and positioning with tweezers. For practice, they should start with larger specimens with flat bottoms to glue to larger pedestals. Great attention is needed, with a steady hand, to place and glue a micromineral to a pedestal. Also, work should be done on a tray under good lighting so tiny specimens don't get dropped and lost.

Sauktown Sales (Mill Creek, Indiana) specializes in micromount specimens and supplies. On their website www.sauktown.com, they provide not only supplies but much useful information and links to nearly two dozen web sites related to micromounts. Although pitched toward an adult audience, a couple reference books and a web site also provide fine information for you to consult in working with kids on this activity:

- Milton Speckel, *The Complete Guide to Micromounts* (1965, 1980; out of print?)
- Quintin Wight, *The Complete Book of Micromounting* (1993). Available through the Mineralogical Record, www.minrec.org

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.4: Collecting, preparing, and storing miniature fossils.

Collecting miniatures. Kids will find miniature fossils as they seek other, larger fossils during your regular field trips. In fact, a great many common invertebrate fossils fall within the size range of one- to two-inches and are often found weathered free at an outcrop: sea urchins and small sand dollars, small clams and snails, "Devil's toenail" oysters, a great many brachiopods, crinoid stem fragments, twiggy bryozoan, trilobites, horn corals, and more. You should also encourage kids to make trades with fellow collectors since they'll often bring home multiple examples of a fossil species. Encourage them to trade duplicate specimens from their collections with duplicates in other kids' collections to more quickly expand the variety of their holdings at no cost—while at the same time making friends within the hobby. Finally, they'll discover true bargains at gems shows for fossils that fall within the one- to two-inch size range, specimens that are *a lot* more affordable than big flashy fish fossils from Wyoming or two-foot limestone slabs with whole crinoids from Morocco.

Preparing miniatures. Preparing miniatures involves trimming away as much unnecessary matrix as possible without damaging the fossil. Basic supplies needed include hammers and small chisels (along with eye protection), rock nippers and pliers and/or special vice-like rock trimmers to snip away pieces of matrix, a small rock saw, and a regular hand magnifying glass or, better, a bench magnifier that allows you to work with both hands free. With a miniature fossil, you usually want to remove all the matrix, if possible, and Dremel-type bits and brushes and dental picks can help in removing final specks of dirt or matrix from small nooks and crannies. If the fossil has been silicified and is in a limestone matrix, soaking in vinegar (acetic acid)—followed by a vigorous brushing—can also help dissolve, loosen, and remove matrix. (Afterwards, soak the fossil in water and baking soda to neutralize any remaining acid from the vinegar.)

If a specimen is delicate or can really only be exhibited in matrix, as much matrix as practical should be removed. If a specimen is in hard limestone or shale, a small rock saw or a hack saw fitted with a grit-edge or tungsten carbide blade rod is often used. However, many collectors prefer a "natural" edge to the matrix rather than the flat edge that a saw produces. One way to create a natural edge is to saw a groove from below and then tap with a small chisel and lapidary hammer from above. When hammers and chisels are being used to remove matrix that's very close to a specimen, the rock should be placed on a sand bag to cushion blows.

Storing miniatures. Miniatures may be stored in egg cartons, small fold-up cardboard boxes, or in 2-inch Perky boxes, named after their creator, Willard Perkins. These small plastic boxes, available from mineral suppliers, usually have a black bottom lined with Styrofoam and a clear plastic top. These Perky boxes, in turn, can be stored in soda flats or small cabinets.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.5: Collecting, preparing, and storing thumbnail fossils.

Collecting thumbnail fossils. Small thumbnail fossils might be found right on the surface of a fossil locality, having weathered free and mixed in with surrounding soil. To increase the odds of finding specimens, take screens to sift through such soil at the base of a fossil outcrop. You'll also find many thumbnail fossils embedded in limestone, sandstone, or shale. Rather than trying to remove fossils from hard matrix in the field, kids should bring those specimens home to work in a more controlled setting with an assortment of tools at hand.

Preparing thumbnail fossils. As with miniatures, preparing thumbnail fossils involves trimming away matrix. Basic supplies needed include: rock- or lapidary hammers and small chisels (along with eye protection); pliers or nippers to snip away pieces of matrix and/or special vice-like rock trimmers; a small rock saw; a regular hand magnifying glass or, better, a bench magnifier that allows you to work with both hands free; Dremel-type bits, saws, and brushes; dental picks; tweezers; and glue. Some small silicified fossils embedded in limestone may be freed in acid baths using acetic acid (vinegar) or muriatic acid (often sold with swimming pool supplies).

Caution: *Working with acid should always be done by an adult exercising great precautions with long rubber gloves and aprons, eye protection, and a high quality respirator mask in well ventilated areas, with any open containers kept away from areas where pets might be or where fumes might cause damage to paints, pipes, etc. We do not recommend that kids work with acid of any sort, and any adults electing to do so should first thoroughly familiarize themselves with all procedures and precautions.*

Storing thumbnail fossils. Thumbnails are best stored in 1-inch Perky boxes, named after their creator, Willard Perkins. These small plastic boxes, available from mineral suppliers, usually have a black bottom lined with Styrofoam and a clear plastic top. Specimens are often pushed into the Styrofoam or attached to it with a dab of tack. Instead of Styrofoam, you can also use 1-inch acrylic squares that make it easy to remove a specimen from the Perky box for display in an exhibit. For kids just beginning and on a budget, matchboxes will also do, or plastic boxes with compartments and fold-top lids of the sort sold in bead stores or with fishing tackle. The bottom of each compartment should be lined with cotton to keep specimens from rolling about. Basically, use anything that's enclosed so as to contain the small specimen securely and to keep out dust.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.6: Collecting, preparing, and storing microfossils.

Collecting microfossils. In areas of recent marine deposits, microfossils might be mixed loose with soft sediments (sand and mud), requiring only that you scoop up a sample and sift it through a screen. Or microfossils might be embedded in limestone, sandstone, or shale. To check sediment or rock samples, take a 10X or 20X loupe into the field. If you detect small fossils in a sediment sample, take home a supply in zip-lock baggies; if in matrix of hard rock, take several hand pieces home. Use the same tools already listed in Activities 16.4 and 16.5, but add sifting screens of various mesh sizes. You can purchase stackable graduated screens from geological supply houses such as Ward's, or you can do like I did and make your own with wooden frames and screens of various sizes purchased from a hardware store, starting with quarter-inch down to window screen and smaller. Small trowels and hand rakes are handy for sifting through soft sediments and dirt containing fossils that may have weathered out of a limestone, sandstone, or shale bank. It's always a good idea to sift through dirt surrounding such "hard rock" outcrops.

Preparing microfossils. For microfossils in soft sediment and for those that are weathered free in the dirt around hard sediments, all that's required is sifting away the sediment with a series of graduated screens. You'll also want a bench magnifier that allows for hands-free work or even better, a binocular stereomicroscope, commonly called a dissecting microscope, along with stick pins and tweezers. Work should be done on a tray under good lighting so tiny specimens don't get dropped and lost. (Microfossils embedded in limestone may be freed in acid baths and those in shale can sometimes be freed by soaking samples in kerosene, but those techniques are best reserved for adults exercising due precautions; see the references listed below for specific techniques.)

Storing microfossils. Microfossils can be prepared as "micromounts" in the same manner as microminerals, within small micromount boxes (see Activity 16.3). Alternatively, professional geology supply houses, such as Ward's, sell small slides made especially to hold microfossils. These are made of two layers of cardboard, a glass top, and an aluminum frame to hold the glass atop the cardboard. Specimens may be glued in with a small dab of white glue or a droplet of gum tragacanth or gum arabic.

Although most reference books published about microfossils are pitched to an adult audience, they provide fine reference for any adult working with kids on this activity:

- Brasier's *Microfossils* (1980). This one is detailed and technical!
- MacFall & Wollin's *Fossils for Amateurs: A Handbook for Collectors* (1972). Now out of print, this was a longtime standard for amateurs and is in many libraries or used book shops. Chapter 12 overviews microfossil collecting.
- Margaret Kahrs (editor), *Microfossils: M.A.P.S. Digest Expo XXI Edition* (Mid-America Paleontological Society, Vol. 22, No. 4, 1999).
- Jim Brace-Thompson, "Microfossil Techniques: Tools & Methods for All Budgets," in Kathleen Morner (ed), *Paleotechniques: M.A.P.S. Digest Expo XXVI Edition* (Mid-America Paleontological Society, Vol. 27, No. 2, 2004). (Call me for reprints.)

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.7: Collecting and classifying sand.

A **psammophile** is a sand collector (*psammo* = sand; *phile* = lover of). And a heap of sand is basically a collection of microminerals and microfossils. Help your juniors become psammophiles by forming sand collections and exploring the world of sand grains with samples from at least five very different locations. Explore samples under 10X or 20X loupes or microscopes and discuss why they may look different. For instance, sand that has been transported a great distance and ends up along a beach or in an area of sand dunes is often **well sorted**; that is, it often consists of grains that are rounded and of relatively uniform size and composition. This is the case with nearly pure white quartz sands found in areas around the Monterey Peninsula in California or white carbonate beaches in parts of Florida. Sand that hasn't been transported far (as along a stream in a mountain valley) may have rough, angular grains of all sizes and may consist of a wide variety of rocks and minerals (**poorly sorted**). The color of the sand is due to the color of its constituent minerals. For example, White Sands National Monument in New Mexico holds vast fields of pure white sand composed of gypsum, whereas Papakōlea Beach in Hawaii has green sand due to the mineral olivine. Work with your kids to explore the differences in the shape, size, texture, color, and other characteristics of sand samples and encourage them to speculate about what caused those differences.

In building their collections, kids can conveniently store samples in small baggies, bottles with lids, or stoppered test tubes. This is one hobby involving little or no expense. Many great books have been published all about sand. As a reference in working on this activity, you may want to purchase these or see if your library has them:

- Gary Greenberg, *A Grain of Sand: Nature's Secret Wonder*, 2008. This is both a font of information about the diversity of sand and a gorgeous coffee table book filled with wonderful close-up photos. My top choice for a book that inspires!
- Gary Greenberg, et al., *The Secrets of Sand*, 2015. Greenberg teams up with coauthors for another informative, fun, well-illustrated look at sand.
- Ellen J. Prager (author) & Nancy Woodman (illustrator), *Jump Into Science: Sand*, 2006. This book, published by National Geographic, is aimed squarely at kids, with a fun "sandpiper sleuth" seeking answers to what sand is, where it comes from, and how it gets to the beach. My top choice for young readers.
- Michael Welland, *Sand: The Never-Ending Story,* 2010. A university press book for advanced readers, this is still a great read with interesting facts and surprises.
- Bagnold, *The Physics of Blown Sand & Desert Dunes*, 2005. A reprint of a classic text first published in 1954, this advanced tome is for the true scientist among us.

Anne Lowe-Salmon in Connecticut pointed me to the International Sand Collectors Society (www.sandcollectors.org) that publishes a quarterly newsletter called *The Sand Paper*. They've sold an educator's kit for about $30 that included sand samples and a CD of sand-related activities. Check them out! This is the best resource I've seen, with great info telling all about sand, the hobby, and how to become a psammophile.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 16.8: Drawing or photographing microminerals, microfossils, and sand.

Microminerals, microfossils, and sand are best appreciated under the lens of the microscope, but we don't always have a microscope on hand to share the intricate details of our tiny specimens with others. In order to better share them, help your kids make drawings or take photographs to magnify their specimens.

Such illustrations or photos can come in handy in displaying tiny specimens. For instance, at a club show, a county fair, science fair, etc., it can make for an interesting display to have a tiny specimen atop the head of a pin side-by-side with a close-up drawing or photo. These illustrations or photos also can be used to accompany an article about the specimen. With sand, such illustrations help vividly show the difference between well sorted and poorly sort sand samples, or showing the tiny foraminifera that make up some sands from tropical beaches.

Work with kids to make drawing of specimens observed under a microscope. Or, if you have access to one, use a digital microscope such as a Dyno-Lite Digital Microscope hooked up to a computer to photograph specimens.

17. Special Effects

To earn this badge, you'll need to learn about what causes certain "special effects" in some rocks and minerals. For instance, what causes "cat's eye" effect and what rocks or minerals typically exhibit that effect? These are fun rocks to share with friends, so you should also start a collection of these special minerals and maybe hold an Amazing Mineral Magic Show!

Activity 17.1: Magnetism.
What is magnetism and what causes it? Name the two basic types of magnetism, and name at least three magnetic minerals. Provide a demonstration of magnetism.

Activity 17.2: Triboluminescence.
Learn to pronounce the long word "triboluminescence" and explain what it means. Demonstrate triboluminescence in a darkened room with two quartz crystals and with Wint-o-Green Life Savers candy.

Activity 17.3: Birefringence, or double refraction.
What is birefringence and what causes it? Name one common mineral that causes birefringence, or double refraction, and provide a demonstration of it to your fellow club members.

Activity 17.4: Chatoyancy: cat's eye and asterism.
What causes chatoyancy? Explain it to your fellow club members and show them how it works with a common spool of sewing thread under a bright light. Name at least three minerals that are often cut into cabs exhibiting cat's eye and/or asterism.

Activity 17.5: Natural fiber optics, or "TV stone."
A mineral called ulexite, when cut and polished on top and bottom, can magically lift words from a page and display them on its surface. How does it do that? Amaze your friends by demonstrating this for them.

Activity 17.6: Phantoms and inclusions.
Explain how phantoms and inclusions form. What is an enhydro? Show your fellow club members an example of a crystal with a phantom or inclusion.

Activity 17.7: Other special effects.
Learn about other special effects not listed above. How many others can you name and explain?

Activity 17.8: The amazing mineral magic show!
Either with fellow club members or on your own, host a "magic show" at one of your meetings to highlight special effects of some of these amazing minerals.

17. Special Effects

□ 17.1 Magnetism

□ 17.2 Triboluminescence

□ 17.3 Birefringence, or double refraction

□ 17.4 Chatoyancy: cat's eye and asterism

□ 17.5 Natural fiber optics, or "TV stone"

□ 17.6 Phantoms and inclusions

□ 17.7 Other special effects

□ 17.8 The amazing mineral magic show!

To earn your Special Effects badge, you need to complete at least 3 of the 8 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

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Back-up page 17.1: Magnetism.

We've all had fun with magnets: those little bars that stick to refrigerators and pick up paperclips. Place one near an iron or steel surface, and it will literally jump out of your hand and stick to the surface. They also attract and repel other magnets, letting you flip and push one around with another without them touching. Magnets perform these fun stunts because they produce a field of force—a magnetic field—caused by movement of electrons.

Some minerals react when placed near a magnetic field. Such minerals are referred to as **magnetic minerals**. They have one common denominator: **iron**. A simple test will help you identify a magnetic mineral. Pass it over a compass, and the compass needle will move.

Magnetic minerals come in two basic sorts. Most common are those attracted to a magnet, either strongly or weakly. The most strongly magnetic is magnetite (iron oxide), but there's also pyrrhotite (iron sulfide), ilmenite (titanium-iron oxide), hematite (another iron oxide), and franklinite (zinc-iron oxide). Some, such as limonite (hydrated iron oxide) or siderite (iron carbonate), may become weakly magnetic if heated.

A second sort of magnetic mineral is one that is naturally magnetized. That is, it's a magnet itself, generating a magnetic field that will attract iron to it. There's just one mineral of this sort, a specific variety of magnetite called lodestone.

You can enjoy fun activities with kids seeing how lodestone picks up paperclips or how magnets stick to magnetite and other magnetic minerals. For another fun activity, fill a plastic tub with **black sand** (often found in association with placer deposits while gold panning) and drop in a few strong magnets. Magnetic minerals in the black sand will clump around the magnets like frizzy hair on a bad hair day.

Magnetism has long fascinated people. For centuries, ships carried lodestones to magnetize compass needles for navigation. Magnetism has helped prospectors distinguish iron ore look-alikes; for instance, magnetite and chromite are outwardly similar, but magnetite is much more strongly magnetic.

The word "magnet" comes from Magnesia, an area in Greece where lodestone was discovered long ago. It was called *magnítis líthos*, or "magnesian stone." According to another, more interesting legend, a Greek shepherd boy named Magnes discovered lodestone when iron nails in his shoes stuck to a rock. Sounds like a good excuse for being late to school!

Back-up page 17.2: Triboluminescence.

Triboluminescence is quite a word! Kids (and adults!) may need help pronouncing it: tri´-bō-lu-mə-nə´-səns. The ***tribo*** part comes from the Greek word meaning **"to rub."** ***Luminescence*** is derived from the Latin word for **"light"** and is defined as low-temperature emission of light. Thus, triboluminescence is low-temperature light produced between two materials rubbed together.

In a darkened room, triboluminescence can take the form of tiny spark-like flashes observed in some minerals, like sphalerite or corundum, when a hard point is dragged across the surface. It can also occur when a mineral (or other material, like hard sugar or Wint-o-Green Life Savers) is crushed, ripped, scratched, or rubbed. Scientists still haven't fully explained this optical phenomenon, but they believe it to be caused by separation and reunification of electrical charges at a molecular level when bonds are broken by the rubbing or scratching. (Note that this is different from the high-temperature sparks generated when rocks and minerals like flint or pyrite are struck.)

Triboluminescence has been observed by diamond cutters, who sometimes see a diamond begin to glow while a facet is being ground. Since diamonds can be a little hard to come by, you may want to demonstrate the effect by rubbing together two large quartz crystals in a darkened room. This works best with pretty big, palm-sized specimens. You can simply rub two faces together or, to produce more light, rub the prism edge of one crystal back and forth along the prism face of the other crystal. (A prism face is one of the flat sides of the quartz crystal; the prism edge is where two flat sides come together.)

Interestingly, flashes of light have sometimes been observed during earthquakes. Some believe these "earthquake lights" may be related to triboluminescence when rocks high in quartz content get rubbed and rendered apart during the quake.

Back-up page 17.3: Birefringence, or double refraction.

Birefringence is one long, fancy word! A simpler term is **double refraction**. Take a piece of paper and draw a single line on it. Place a certain kind of clear crystal over the line, gaze through the crystal, and you'll see two lines! How does that happen?

When we direct our eyes at a line on a piece of paper, light is bouncing off the paper and into our eyes, allowing us to perceive the line on the paper. When light travels through certain crystals, the structure of the crystal causes the light to split into two rays traveling in slightly different velocities. When they bounce into our eyes, we perceive a double image. What is actually a single line, when viewed through the stone, appears as two lines.

Refraction, by the way, can occur in air when its density varies. You may have noticed this when gazing down a roadway on a hot summer day or across the basin of a desert, where hotter, less dense air radiates off the surface beneath somewhat cooler, denser air above. Light is refracted. The result? A mirage! Or, something your eyes see, even though your mind knows it's not really there.

The mineral most commonly associated with double refraction is **calcite**, particularly clear rhombohedral calcite crystals known as **Iceland spar**. Nice specimens from Mexico are on sale at nearly every gem and mineral show and are also often sold in museum gift shops.

Back-up page 17.4: Chatoyancy: cat's eye and asterism.

Cat lovers should enjoy **chatoyancy**. It's from a French word, *chatoyer*, meaning to shine like a cat's eye. Chatoyancy is commonly called **cat's-eye effect**. In bright light, a cat's pupil narrows to a vertical slit. When some gemstones are rounded and polished, bright light will be reflected as a single thin ray, looking very much like a cat's eye.

Chatoyancy is caused by inclusions, or minerals enclosed within another mineral. Light entering the host mineral reflects off included minerals. When inclusions are fibrous and run parallel to one another, they produce a single line of reflected light running perpendicular to the direction of the fibers. You can illustrate this effect for kids using a spool of sewing thread. Hold it under a light, and they'll see a vertical line running perpendicular to the wound thread. Chatoyancy is enhanced if the stone is rounded into a cabochon or sphere, concentrating the light, just as with our rounded spool of thread.

Chatoyancy can be produced by many minerals and inclusions. Yellow cymophane, or chrysoberyl containing rutile or tube-like cavities, is highly valued. A golden cat's-eye quartz contains rutile, while a gray-green variety contains amphibole asbestos. A gray-blue quartz containing partially silicified crocidolite (blue asbestos) is called hawk's eye. The popular tiger's eye quartz forms when crocidolite fibers are replaced by silica along with iron oxides, producing a silky golden color. Then there's actinolite, apatite, beryl, tourmaline, scapolite, moonstone, and more. You can even observe chatoyancy with common, non-precious minerals such as satin-spar gypsum or ulexite.

Minerals producing a chatoyant effect are found worldwide, but some places are especially famous: Sri Lanka and Brazil for cat's-eye chrysoberyl and quartz; South Africa and Australia for tiger's eye; California, for cat's-eye tourmaline. In addition to appreciating the beauty of cat's-eye gemstones, some cultures consider them good-luck charms with the ability to counteract an "evil eye."

The Greek word *aster* means "star," and **asterism** refers to a luminous star-like figure appearing on the face of a gemstone as a result of reflected light. Asterism is similar to cat's eye. Like cat's eye, it's caused by included fibers that run parallel to one another, producing a single line of reflected light. If bundles of such fibers are oriented in two directions, they'll produce two intersecting eyes, resulting in a four-rayed star. Oriented in three directions at 120 degrees to each other, as may happen within hexagonal crystals of corundum or quartz, rutile bundles will create three eyes, or a six-rayed star.

Cabbing focuses and concentrates light to produce the star effect, but much can go wrong in the process. The gem cutter must orient the base of the stone parallel to the plane of the inclusions, or the star may be off-centered. Another decision: how high to dome the stone? A higher dome channels light more effectively, creating a sharper star. But if the dome is too steep, rays get cut off and don't wrap around the surface of the dome. A dome cut too flat produces a fuzzy, ill-defined star. Gemstones most associated with asterism are star rubies and sapphires. However, Idaho produces star garnets. Quartz, diopside, and spinel can also exhibit asterism.

Back-up page 17.5: Natural fiber optics, or "TV stone."

Near the town of Boron, California, is an immense open-pit mine where truckload after huge truckload of borate minerals have been dug for generations for commercial applications; for instance, to produce borax for laundry detergent. These minerals were concentrated in a closed basin as ancient lakes dried up in the desert. One of those borate minerals is call **ulexite**, for the German chemist who first discovered it in the 1800s, Georg L. Ulex.

Ulexite is composed of long, thin crystals that might grow as fluffy, cotton-like puffballs or, more commonly, as compact, blocky masses of fibrous veins, with crystals tightly aligned side-by-side. The fibrous crystal bundles give blocky masses of white ulexite a soft, satin luster.

To demonstrate a truly neat special effect, use a rock saw to cut a chunk of ulexite perpendicular to those crystal bundles at top and bottom. Then polish both top and bottom. (You can often find small specimens of ulexite in rock shops and museum gift shops already cut and polished.) Now have your kids place that chunk onto the words in a book or atop a colorful drawing on the comics page of the Sunday newspaper. The words or picture will seem to be sucked up and will appear at the top surface of the ulexite, just like an image on a television screen!

The individual crystals making up the block of ulexite act like fiber-optic cables. Each transmits light from the bottom surface of the stone to the top surface, thus producing the unique optical property that earned ulexite its nickname of **"TV stone."**

Back-up page 17.6: Phantoms and inclusions.

We're all familiar with quartz crystals that appear clear through-and-though, like clean window glass. But sometimes when you look into a quartz crystal, you might see the clear or fuzzy outline of another quartz crystal! This crystal-within-a-crystal is referred to as a **phantom**. A phantom is created when crystal growth is interrupted and later resumes. It's similar to looking at the rings of a tree trunk, which record periods of active growth and dormancy. Essentially, when looking at a phantom, you're seeing a smaller, younger version of the bigger crystal you're holding.

Phantoms can be seen in almost any type of mineral that produces a transparent or translucent crystal, such as quartz, calcite, fluorite, or tourmaline. But the phantoms you see most commonly sold on the market are in quartz. With quartz, you may see nearly clear, almost indistinguishable phantoms from different growth phases. But many times, between growth phases, the crystal termination faces may be lightly etched or may collect gas or liquid bubbles. When that happens, the phantoms are a ghostly white. Other times, the termination faces may be lightly dusted by a coating of a different mineral, creating phantoms of different colors. Green phantoms are created by thin layers of chlorite, reddish-brown phantoms from iron minerals like hematite, and blue phantoms result from the mineral riebeckite.

Phantoms are found in many quartz crystal deposits. The Brazilian gemstone districts are especially famous for them. Arkansas has yielded its fair share of white phantoms, and Peterson Peak (or Hallelujah Junction) on the border between California and Nevada is famous for its smoky quartz phantoms. Crystals containing phantoms are also called "shadow crystals," "ghost crystals," or "specter crystals." While the names may sound like something from a spooky nightmare, the effects are like a beautiful dream!

In addition to phantoms, you occasionally see **inclusions** in quartz crystals or other mineral crystals. An inclusion may be any material—solid, liquid, or gaseous—found inside a mineral. I mentioned light dustings of chlorite that might form in a quartz phantom. Sometimes rather than just a light dusting, a larger mineral crystal will form and will then get engulfed in the growing quartz crystal. In my collection, I have quartz crystals containing tiny garnets and others containing tiny pyrite crystals. Clusters of needlelike rutile crystals frequently appear as inclusions in minerals like quartz or corundum. A variety of gypsum known as "hourglass selenite" from Oklahoma is well known for inclusions of clay and sand in the form of an hourglass figure.

One really cool type of inclusion is when an air pocket forms within a crystal and contains a little drop of water. Tilt the crystal this way and that way, and you'll see the water droplet move up and down, as with a carpenter's level. Such a crystal is referred to as an **enhydro**.

Back-up page 17.7: Other special effects.

Here, in brief, are a few other special effects not already described that some of your juniors may wish to explore. See if they can discover the reasons behind one or more of these special effects:

- *Opalescence, fire-and-flash, or play-of-color*. These terms all describe the vivid multicolored dance you see in an opal as you twist and turn it under the light.

- *Adularescence*. When turned in the light, minerals like labradorite and moonstone feldspars exhibit a milky, bluish luster that's been compared to the moon's reflection on water. This is also sometimes called "moonstone effect."

- *Iris or rainbow effect*. Some banded agates, when sliced thin and held to the light, exhibit all the colors of the rainbow in a gorgeous, iridescent display.

- *Phosphorescence*. Some fluorescent minerals momentarily holding a faint glow after a fluorescent lamp has been switched off, with the glow gradually fading away in the dark. It's especially noticeable in pink calcite rhombs from Nuevo Leon, Mexico. This also sometimes is called "afterglow. (See the back-up page for Activity 18.6.)

- *Thermoluminescence*. This is a faint glow, similar to phosphorescence, created when a mineral like fluorite is just mildly heated, well below the point of incandescence.

- *Pleochroism or change-of-color*. "Pleochroism" means "many colored." Some minerals (alexandrite, sapphire, tourmaline, benitoite, etc.) may change colors when viewed from different angles. For instance, some benitoite crystals may be blue viewed from above yet colorless viewed from the side. Dichroic minerals will show two colors; trichroic minerals show three.

- *Tenebrescence*. Some minerals, like hackmanite, change color after exposure to ultraviolet light, then fade under daylight, only to regain brighter colors with a little more UV exposure. This property of reversing color with changes in light radiation is called tenebrescence. (See the back-up page for Activity 18.6.)

- *Shooting sparks*. Striking a pyrite or flint against a piece of steel will create sparks. It's thanks to this that our caveman ancestors were able make fire to stay warm!

- *Aventurescence and schiller*. Particularly when polished, aventurine (massive quartz or feldspar filled with tiny plate-like inclusions of mica, rutile, or hematite) glistens as if filled with metallic confetti frozen in mid-air.

- *Floating rocks***.** Obsidian and pumice are both volcanic glass, but one sinks in water while the other floats. Ask you kids why. Give them magnifying glasses to look closely at the structure of pumice and all those tiny holes that were created by gas bubbles when the pumice was a hot, frothy lather.

- *Singing rocks.* Zeolite minerals have microscopic pore spaces. This makes them highly effective for water filtration and purification and other industrial and medical uses. It also makes them great singers! When placed in a bowl with a little water, chunks of rocks containing certain zeolite minerals like clinoptilolite crackle, hum, and soon begin to whine. If the pieces you use are small, you'll need to hold the bowl close to your ear. After a while, the rocks become waterlogged and need to be dried to sing another day. Tiny pea-sized pebbles of clinoptilolite are sold with aquarium supplies as an ammonia remover in fish tanks. I was also able to secure gravel-sized pieces via eBay. These produced much better effects although I still needed to hold the bowl close to my ear.

- *Fizzing & bubbling rocks.* Carbonated beverages release bubbles of carbon dioxide. Similarly, carbonate rocks like limestone (calcium carbonate) fizz and release carbon dioxide when you put a drop of acetic acid (vinegar) on them. This is known as ***effervescence.*** To help enhance the fizzing, scratch the limestone with a nail to create a little heap of limestone dust before applying the acid.

- *Expanding minerals.* Vermiculite is a layered mica-like mineral. Water resides between the layers and, when the mineral is heated, that water converts to steam and vermiculite expands—just like popcorn. This is called ***exfoliation.*** You can find vermiculite in a gardening store since it's often used in hydroponics and as a soil amendment to help retain moisture and improve aeration; however, the bag I bought didn't really produce good results. The vermiulate was chopped fine and it had already been thoroughly dried. To be successful with this demo, you apparently need to secure big "fresh" pieces.

Most popular guidebooks about rocks and minerals, aimed at kids and adults, have a section or chapter devoted to special effects. For example, here are a few I know about:

- Bonewitz, *Smithsonian Rock & Gem*, 2005.
- Farndon, *The Complete Guide to Rocks & Minerals*, 2006. See the section "Mineral Properties: Optical."
- Symes, *Eyewitness Rocks & Minerals*, 2004.
- Ward, *Phenomenal Gems*, 2008. This great little book is filled with colorful photos showing gems that glow, shimmer, and change color, along with explanations.

Steer kids to books like these and have them explore even more special effects above and beyond those listed here.

Back-up page 17.8: The amazing mineral magic show!

For a presentation at one of your society's monthly meetings, help your kids host "The Amazing Mineral Magic Show!" They can demonstrate many of the effects described in this unit, as well as others they might discover by reading on their own. For instance:

- Lodestone magnetite can be used to show a rock that pushes magnets around, flips them over, and picks up paperclips. When placed alongside "black sand" or iron filings, you have a rock that suddenly grows "hair." Put filings into a plastic pan, hold your lodestone under the pan, and you can pull the filings all around.

- Transform ugly, dull fluorescent rocks and minerals into ones that turn bright, vivid colors and suddenly glow from within when you turn out the lights and turn on an ultraviolet lamp.

- Turn out the lights, turn on a UV lamp over a piece of fluorescent calcite from Mexico, then switch off the lamp to show a fluorescent mineral that holds a glow for awhile, before gradually fading to black.

- With the lights still out, show how two pieces of quartz can create spark-like flashes of light when simply rubbed together.

- Keep those lights out to show rocks that shoot real sparks by striking steal against chunks of flint or pyrite.

- Illustrate how ulexite is a "TV stone" that can "lift" images from printed pages.

- Reveal how a calcite rhomb doubles an image by holding it over a piece of white cardboard that has a single black line drawn down the middle.

- With a slice of iris agate and a flashlight, show how a rock can capture a rainbow.

- Show how a domed cab of Idaho garnet, rose quartz, ruby, or sapphire can capture a star, or how domed tiger-eye quartz or satin-spar gypsum winks like a cat's eye.

- Drop a piece of volcanic glass (obsidian) into a clear container of water to show how—as we all know—rocks are heavy and sink. Then, take a piece of volcanic glass known as pumice and drop it in to show a rock that floats!

What other magic effects can your kids come up with? This can be a presentation that's great fun for the entire club. In fact, the kids might ask the adults to come prepared to bring a "magical" rock or two of their own to join in the show. One club's kids hosts a booth at their annual show to demonstrate special effects to visitors throughout the day.

Note: *Kids can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activity 7.1).*

18. Fluorescent Minerals

In Unit 17, we learned about all sorts of special effects. In this unit, we'll explore one special effect more deeply. To earn your Fluorescent Minerals badge, you should be able to define "fluorescence" and explain why some minerals fluoresce and then name some common fluorescent minerals. You might also learn about famous localities for fluorescent minerals, collect examples and create a fluorescent display case, and learn about safety when it comes to working with ultraviolet lamps.

<u>Activity 18.1: *What is "fluorescence" and why do some minerals fluoresce</u>?*
Note: *This activity is required to earn this badge.*
Define "fluorescence" and explain why some minerals fluoresce.

<u>Activity 18.2: Famous fluorescent mineral localities</u>.
Some fluorescent mineral localities have become world famous. Name at least three localities and some of the fluorescent minerals to be found at each.

<u>Activity 18.3: Collecting fluorescent minerals</u>.
Build a collection of 6 to 10 fluorescent minerals and make a list or table telling what color they are under normal lighting, short-wave ultraviolet lighting, and long-wave ultraviolet lighting. Be sure to follow the basics of good curation in building your collection: label each specimen and keep a catalog with key information about what it is and where it came from. (See Badge 5: Collecting.)

<u>Activity 18.4: Creating a fluorescent display case and exhibiting your collection</u>.
Building a fluorescent case requires more effort and parts than a normal mineral display case. Build or buy your own and exhibit your collection at a gem show, county fair, school science fair, in class at school, or elsewhere. (See Badge 6: Showmanship.)

<u>Activity 18.5: *Safety with fluorescent lamps</u>.*
Note: *This activity is required to earn this badge*.
Fluorescent lamps, particularly those emitting shortwave ultraviolet light, can "sunburn" skin and eyes. Don't look directly into a fluorescent lamp when it's turned on, and limit the time you spend working under ultraviolet lighting. Learn what other precautions you should take when working with fluorescent lamps.

<u>Activity 18.6: Special effects of some fluorescent minerals</u>.
In addition to changing color and glowing, some minerals show other special effects under fluorescent lighting. Name at least two other special effects and the minerals that produce them.

<u>Activity 18.7: Making fluorescent minerals with glow-in-the-dark paints</u>.
Make your own simulated fluorescent minerals using ordinary non-fluorescent rocks and dabbing them with paints that glow under a black light. Name actual fluorescent minerals that glow the same colors as your simulated minerals.

18. Fluorescent Minerals

□ 18.1 *What is “fluorescence” and why do some minerals fluoresce?* (required to earn this badge)

□ 18.2 Famous fluorescent mineral localities

□ 18.3 Collecting fluorescent minerals

□ 18.4 Creating a fluorescent display case and exhibiting your collection

□ 18.5 *Safety with fluorescent lamps* (required to earn this badge)

□ 18.6 Special effects of some fluorescent minerals

□ 18.7 Making fluorescent minerals with glow-in-the-dark paints.

To earn your Fluorescent Minerals badge, you need to complete at least 3 of the 6 activities. (Please note that successfully completing Activities 18.1 and 18.5 are required to earn this badge.) Check off all the activities you’ve completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader’s signature

____
Name of my club

Leader’s preferred mailing address for receiving badge:

____

____

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Back-up page 18.1: What is "fluorescence" and why do some minerals fluoresce?

Light moves in waves and comes in different forms depending on the wavelength. Some of these forms are **infrared**, **visible**, and **ultraviolet (UV)**. We humans are most familiar with visible light. UV light moves in waves too short for human eyes to detect, but we can see the effects with certain minerals. What appears to be a gray rock in visible light may glow orange or green under UV light. Or a mineral of one bright color under visible light may appear a different color under UV; for instance, purple fluorite may turn green or blue. Still other minerals may stay the same color but appear more vivid, as with red ruby. In all these cases, under UV light the minerals seem to glow from within.

The first person to describe this phenomenon was English scientist Sir George Stokes in 1852. He worked with fluorite, so he called the effect **fluorescence**. Some minerals containing impurities called **activators** will absorb UV light, then emit longer, visible light waves which we see as colors. At the atomic level, UV light causes electrons in some molecules from the "activators" to jump to a higher energy level. In falling back to their normal level, they give off the extra energy in the form of visible light. UV light is usually divided into **short wave (SW)** and **long wave (LW)**. Most fluorescent minerals are sensitive to SW. Some will change color as you switch from SW to LW. Fluorescent lamps, especially SW, are very expensive, but you can use a less expensive alternative for LW with a black-light tube readily available at hardware stores—the kind of light tubes gardeners use as grow-lamps for plants and that teenagers use to make posters of their favorite rock stars glow.

What I've provided above is an extremely brief and simplistic explanation of fluorescence. Some great books for teaching kids more about fluorescence and fluorescent minerals are:

- Stuart Schneider, *Collecting Fluorescent Minerals*, 2004. Not only does this book have great opening chapters about fluorescent minerals in general and collecting them, it also serves up a feast for the eyes with a colorful photographic atlas of fluorescent minerals from around the world filling most of the pages.
- Stuart Schneider, *The World of Fluorescent Minerals*, 2006. Schneider picked up from his earlier book with even more colorful photos in this follow-up volume.
- Manuel Robbins, *Fluorescence: Gems & Minerals under Ultraviolet Light,* 1994. Robbins describes fluorescence, overviews significant localities, and provides full chapters devoted to individual minerals, as well as a chapter on the activators that cause fluorescence of different colors. While not as colorful as the Schneider books (it contains a small color insert), it's still chock full of good information.
- Harry Wain, *The Story of Fluorescence*, 1965. This little paperback has been around for decades. The Raytech company manufactures fluorescent lamps and packages a copy with each lamp they sell.

Finally, you can also get great information from the web site of the Fluorescent Mineral Society, www.uvminerals.org.

Back-up page 18.2: Famous fluorescent mineral localities.

The Schneider and Robbins books listed on Back-up page 18.1 provide information about fluorescent mineral localities around the world. For this activity, I encourage you to point kids toward those books or the web. Here are just a few famous spots:

The Franklin & Sterling Hill zinc mines of northern New Jersey are probably the most famous localities in the U.S. with brilliant yellow-green willemite, calcite in shades of pink and orange-red, pectolite that glows purple, and many more minerals and vivid colors. Most fluorescent mineral collectors started with minerals from these areas.

St. Lawrence County in north-central New York once hosted major mines, many now closed with the land being reclaimed, but you can occasionally still go on club-organized trips to mine dumps for sphalerite, calcite, diopside, fluorapatite, norbergite, and more.

Arizona has more mines than can be succinctly listed that have been prime producers of fluorescent minerals of all sorts.

The Terlingua area of Texas is home to mercury mines famous for "Terlingua calcite," which glows blue in SW and pink in LW UV, with a high degree of phosphorescence.

Sweetwater County, Wyoming, yields gray Sweetwater agates speckled with black dots. While drab in regular lighting, they glow vivid apple-green under UV.

Mont Saint-Hilaire in the province of Quebec, Canada, is an important mining and mineral locality where over 270 minerals have been collected. One authority has catalogued over 60 fluorescent minerals from this region.

The Bancroft District of Ontario is another important Canadian mineral area, featuring a mineral museum, an annual mineral show, and dig sites yielding such fluorescents as feldspar, scapolite, calcite, zircon, sodalite, hackmanite, fluorite, scheelite, apatite, etc.

Mexican mines have produced some great fluorescent minerals from such places as Mapimi in Durango County and Cerro del Mercado.

Durham, England, has mines with some of the most spectacularly fluorescent fluorite.

Greenland may be a bit out of the way for most of us but is making a name for itself as a source of fluorescent minerals from what's known as the Ilimaussaq Complex.

Afghanistan, particularly the Sar-e-Sang district along the Kokcha River in Badakhshan Province, is well known for tenebrescent sodalite known as hackmanite, which shows up at a lot of gem shows. It also has fluorescent fluorapatite, calcite, scapolite, etc.

Pakistan, particularly northern Pakistan, is a great source of fluorescent minerals, along with a wonderful variety of gemstone minerals.

Back-up page 18.3: Collecting fluorescent minerals.

Most minerals do not fluoresce. In fact, according to one report, only about 500 out of some 3,600 named minerals fluoresce, and not even all of them fluoresce all the time. It depends on whether they contain the necessary activators. Some are truly exotic minerals that are difficult to collect because of their scarcity or the few places they may be found. But others are fairly common, either if you are personally collecting in the field or if you are buying from a mineral dealer. Here are some that kids might consider as they build their own fluorescent collections. These are sure to please! Keep in mind that colors may vary from what's presented in this chart, depending on the locality.

Mineral	Natural Color	SW UV Color	LW UV Color
Agate (esp. Sweet-water agates)	varies: clear, white, gray, blue, etc.	green, yellow-green	faint green
Albite	White	velvet red, purple-red	purple
Aragonite	white or yellow	white, yellow, green	cream
Barite	varies: many colors	Creamy white	bright creamy white
Calcite	varies: clear, white, pink, yellow, etc.	varies: white, red, orange, etc.	varies: white, red
Chalcedony geodes from Mexico	White	bright green	faint green
Celestite	colorless, blue, yellow	faint blue	faint blue
Corundum, var. Ruby	red, purple-red		bright cherry red
Fluorite	varies: purple, yellow, blue, pink, clear, etc.	blue-green	violet blue, purple
Halite	varies: white, pink, blue, etc.	pink, bright orange	
Hardystonite	white, gray, tan	purple-blue	weak purple-blue
Hyrdozincite	White	bright blue-white	dark blue
Opal (common)	White	bright green	
Pectolite	Clear	weak pink, purple	orange-pink, lavender
Scapolite, var. Wernerite	yellow or greenish-yellow	dull yellow	intense yellow
Scheelite	creamy white, yellow	blue-white	cream yellow
Selenite	golden-yellow	pale blue	
Sodalite	Blue	orange, red	bright orange
Sphalerite	black, brown, yellow, reddish	yellow-orange, blue	yellow-orange, blue
Willemite	varies: white, gray, red, yellow, brown	Green	green, brown-yellow
Wollastonite	gray or white	Bright orange, yellow	weakly yellow
Zircon	often dark brown	yellow-orange	brown-yellow

Help kids build a collection with some of these minerals that glow with dramatic brilliance. Kids who become especially fascinated by fluorescent minerals might be encouraged to join the Fluorescent Mineral Society, www.uvminerals.org.

Note: *Kids can use this activity to satisfy requirements toward earning the Collecting badge simultaneously (Activity 5.1).*

Back-up page 18.4: Creating a fluorescent display case and exhibiting your collection.

Building a fluorescent case requires more effort, parts, and expense than a normal display case. Suggestions for crafting a fluorescent display are included on the Fluorescent Mineral Society (FMS) website: http://uvminerals.org/fms/display-techniques. If you plan to work with your juniors to build a case, I recommend contacting members of FMS. Here are some basic suggestions and tips:

- Fluorescent displays require darkness: a darkened room, or a display case within a drape or a black tent, or an enclosed display case with a small "viewing port."

- I've been frustrated trying to find blueprints for a basic UV display case, and I've ended up using my regular display case with a modified top that has extra openings: one for regular lamps and one for my fluorescent lamp. I have separate plugs for each lamp, with on/off switches. (If you're into electrical wiring, you can figure a way to put these on timers so that viewers don't have to flip switches themselves to switch from white light to UV light.) Then, I created a frame with a curtain to drape over my case, creating a darkened booth.

- Protect the eyes of viewer from shortwave UV light. Position the lamp so that people won't look directly into it. (I hang my lamp at an angle, facing away from the viewer.) Ordinary types of glass will stop shortwave UV light almost completely, so place a glass front between the specimens and viewer.

- Be careful in your choice of liners, risers, or stands. Many fabrics and papers and some woods fluoresce. Same thing with many plastics, so avoid using plastic stands or risers that might show beneath your mineral specimens. Best choices for liners are dull black fabric, paper, or cardstock, or wood painted dull black. (Test a dab of the paint first to make sure it doesn't fluoresce.)

- For labels, use "reverse printing" with your computer to bring white letters against a black background; otherwise, your labels will glow brighter than many of your specimens and will detract attention from the specimens.

- If using black fabric liners and/or risers, clean the liners and risers with tape or a lint roller before placing specimens into the case. Otherwise, small flecks of lint and dust will show up like stars when the fluorescent lights are turned on.

Help kids build their own fluorescent mineral collections and encourage them to exhibit on their own or in a group case at a show, county fair, school, etc. Raytech sells the "Raytech View Box" that you can also use for looking at individual specimens or a small collection, and they sell a variety of fluorescent lamps: www.raytech-ind.com.

Note: *Kids who publicly exhibit a fluorescent collection can use this activity to satisfy requirements toward earning the Showmanship badge simultaneously (Activity 6.4).*

Back-up page 18.5: Safety with fluorescent lamps.

Note: *This activity is required for kids to earn the Fluorescent Minerals badge.*

No one should look directly into a fluorescent lamp when it's turned on. While long-wave ultraviolet light (LW UV) is relatively harmless, short-wave ultraviolet light (SW UV) can "sunburn" skin and eyes and cause irritation, especially for people with sensitive skin. Although protective glasses can shield eyes from harm, kids should be advised to limit time spent with UV light of any sort.

Teach kids to be safe, not sorry! They should learn to observe the following precautions in working with fluorescent lighting:

- To prevent "sunburn" on skin, limit exposure by limiting the time spent with fluorescent lighting, particularly SW UV, and limit the amount of exposed skin by wearing long-sleeved shirts, museum gloves, etc.

- Never look directly into an ultraviolet lamp when it's turned on, just as you should never stare directly into any light source. Eye irritation and damage can result. Always keep the light aimed away from your face.

- Be aware that even if the lamp is pointed away from you, if it's aimed at a reflective surface, UV light can still be reflected back at you.

- To further help prevent eye irritation when working with fluorescent lamps, wear protective eyeglasses, such as regular laboratory-style safety glasses, goggles, or even regular eyeglasses, and—again—limit time spent working with a fluorescent lamp turned on. The best sorts of glasses to use are those offering 99.9% UV protection.

- If building a fluorescent mineral display case, tuck or angle fluorescent lamps where people can't look directly into them.

- Have a glass front between the lamp and the viewer in a fluorescent mineral display case. Ordinary types of glass are usually effective at blocking some, but not all, SW UV light.

Back-up page 18.6: Special effects of some fluorescent minerals.

In addition to changing color and glowing as if lit from within, some fluorescent minerals exhibit still more special effects. These include *phosphorescence* and *tenebrescence*.

Phosphorescence.

Kids today might not have experienced this, but folks from my generation will recall turning off the television in a darkened room late at night and watching the screen slowly fade to black. Some fluorescent minerals do the same thing, momentarily holding a faint glow after a fluorescent lamp has been switched off, in a phenomenon known as phosphorescence. It's especially noticeable in pink calcite rhombohedrals from Nuevo Leon, Mexico, often sold at gem and mineral shows. A large chunk makes a great addition to Activity 17.8, The Amazing Mineral Magic Show. It is truly neat to watch as the calcite continues glowing in the dark after fluorescent lights are switched off, with the glow gradually fading away. Phosphorescence, or "afterglow," is also observed in scapolite, some celestine and barite, gypsum, hydrozincite, Terlingua calcite from Texas, and other minerals.

Tenebrescence.

I learned about tenebrescence at one of those gem shows that take place in the rooms of a big hotel. My wife and I entered Room 204, whereupon an elderly man from Afghanistan waved a pale purple crystal in our faces and urged us to join him in the bathroom. Our hesitation when he closed the door turned to alarm when he switched off the lights to total darkness. Then, with a "click," we saw his bright smile illuminated by a fluorescent lamp and the crystal glowing bright apricot orange. I was ready to buy it then and there, but the show wasn't over. When we emerged back into the light of the hotel room, I saw that the formerly pale crystal was now a vivid raspberry color! The man's smile grew even larger as I reached for my wallet. Later at home, we saw that the color of our wonderful new acquisition had reverted back to pale purple when we left it exposed to daylight. Thus, my first-hand lesson about tenebrescence, a property by which a mineral can change color when exposed to UV light (particularly SW UV), then fade under daylight, only to regain its brighter colors with a little more UV exposure. This color reversal can be repeated indefinitely. The property of reversing color with changes in light radiation has been called *reversible photosensitivity* or *reversible photochromism*, or more commonly, *tenebrescence*. Hackmanite (a variety of sodalite) is the mineral perhaps most well known for exhibiting this special effect. You can show the same effect with "photosensitive eyeglasses" that self-darken into sunglasses on exposure to strong sunlight and then turn clear again indoors. Other minerals that can exhibit tenebrescence include tugtupite, spodumene, "chameleon diamonds," and some barites.

Back-up page 18.7: Making fluorescent minerals with glow-in-the-dark paints.

This activity, sent in by Karen Nathan (Florida), teaches about fluorescence in a fun, hands-on way. To begin with, she scheduled the fluorescence unit to coincide with Halloween. Rocks that glow in the dark—just like those glow-in-the-dark skeleton costumes! What could be more appropriate and attention-grabbing for kids? After a brief talk to educate everyone about fluorescence, a display with sample specimens under a fluorescent lamp, and a video from the Sterling Hill Museum website in New Jersey at http://sterlinghillminingmuseum.org/visitor/mineralcollect.php, Karen concluded with an activity that is quick and simple: painting simulated fluorescent minerals with glow-paints then tagging the colors to minerals that cause fluorescence in those colors.

You'll need the following materials:

- non-fluorescent rock samples (preferably dark)
- glow-paints from a craft store (yellow, green, orange, pink, blue)
- paper plates
- sponges cut into small square pieces
- recycled applesauce containers (for display and transport home)
- an ultraviolet light

Place a small dab of each glow-paint on a paper plate for a palette. Have kids gently dab sponge squares into the different paints then onto their rocks. Turn out the lights and use a UV flashlight or a black light to see the newly created fluorescent rocks glow! (Remember SAFETY when viewing with a UV lamp and tell kids not to look directly into the light.) Have kids identify the minerals from a key provided, such as the following:

A KEY TO FLUORESCENT MINERAL COLORS	
Color	**Likely Fluorescent Mineral/s**
Green	Willemite
Orange-Red to Red	Calcite, Sodalite
Bright Cherry Red	Corundum variety Ruby
Pink	Calcite
Blue	Hydrozincite, Diopside
Powder-Blue	Microcline
Yellow	Norbergite
Pale Yellow to Blue	Scheelite, Powellite
Violet to Purple	Hardystonite
Orange, Yellow, & Blue	Sphalerite

Remind kids that this is a general guide and that colors and minerals may vary. In fact, you might give an assignment for them to augment and add to the table. Then encourage them to explore and learn more on websites, in books, at museum displays, and elsewhere.

19. Reaching Across Generations

This badge and its activities were developed by Erica Nathan of the Coquina Kids of Florida after senior member John Withey of their host club, the Tomoka Gem & Mineral Society, passed away. Older members in your club may seem unapproachable, but if you get to know them, you'll find they are a wealth of knowledge, experience, and fun stories, just as Erica discovered. To earn this badge, strike up a friendship with a senior member in your club and get to know more about him or her by completing activities below. **Erica dedicates this badge to the memory and honor of John Withey.**

<u>Activity 19.1: *Spending six hours with a senior member</u>.*
Note: ***This activity is required to earn this badge.***
Along with your parents, spend at least six hours with a senior member. You might talk about rocks or minerals. You might seek help identifying fossils in your collection. Perhaps you could go on a club field trip. Maybe, providing they hold an officer position, you could help do their position or ask them to tell you about it. For example, you can assist the editor with the next issue of the society newsletter or the membership chair in preparing and mailing a new member packet. As a conclusion to this activity, you should write a thank-you note or create a card for the time spent together.

<u>Activity 19.2: Five things you learned from a senior member</u>.
Make a list of the five most important things your senior member taught you. These might relate to mineral identification, lapidary arts, organizing your collection, etc., or they might not relate to rocks at all—for instance, patience or curiosity or responsibility.

<u>Activity 19.3: The best time you spent with your senior member</u>.
Write a paragraph about the best moment you had with your senior member. Share your paragraph with your senior member before turning it in to your junior leader. With your senior member's permission, see if your newsletter editor will publish it.

<u>Activity 19.4: Finding, taking, or drawing a picture of your senior member</u>.
A picture is a great way to remember special times. Take a picture of your senior member, or have your parents take a picture of the two of you together, or you might draw a picture and present it to your senior member at the next club meeting.

<u>Activity 19.5: A specimen that is special to your senior member</u>.
Find out about a specimen that is special to your senior member. Write a paragraph describing the specimen and tell why it is special, or give a presentation about it at one of your club meetings. You may want to take a picture of this specimen if you write about it, or have your senior member bring it to the meeting if you talk about it.

<u>Activity 19.6: Making a memory box</u>.
Find a box or frame and decorate it with things related to rocks and minerals. You can find logos for your club, regional federation, rockhounding, etc., online. Place anything from your previous activities (19.1-19.5) in the box. Show the memory box to your junior leader before gift-wrapping it to present to your senior member at a club meeting.

19. Reaching Across Generations

□ 19.1 *Spending six hours with a senior member* (required to earn this badge)

□ 19.2 Five things you learned from a senior member

□ 19.3 The best time you spent with your senior member

□ 19.4 Finding, taking, or drawing a picture of your senior member

□ 19.5 A specimen that is special to your senior member

□ 19.6 Making a memory box

To earn your Reaching Across Generations badge, you need to complete at least 3 of the 6 activities. (Please note that successfully completing Activity 19.1 is required to earn this badge.) Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

General Back-up Page for Badge 19: Reaching Across Generations.

The vast majority of adults are moral, reliable, responsible, and eager to help as best they can in efforts to educate and nurture our kids in a positive, wholesome environment.

Regrettably, though, as noted in the Introduction to this FRA Badge Program Manual, one very unfortunate aspect of the world in which we live is that, sadly, there are some adults who should not be left alone with kids. To repeat that section of the Introduction:

Safeguard children. *Finally, I need to emphasize a point I wish we didn't have to go into, but it's absolutely vital to raise and to underscore, namely, having youth leaders who are well known by all in the club for sound moral values and having multiple adults on hand when working with kids. There are, unfortunately, some who would abuse the natural trust of children. My home state of California has Megan's Law, which requires registration of sex offenders on a public web site with photos and information about offenders. Some societies require background checks for any club members volunteering to work with juniors, and this is a good policy to explore with your own club board. Always have multiple adults working with the kids, and prevent any sort of abuse, whether physical, sexual, mental, emotional, or verbal. For further guidance on this issue, I recommend all youth leaders within AFMS-affiliated societies read the excellent and thorough materials entitled "Youth Protection" contained on the web site of the Boy Scouts of America: http://scouting.org/Training/YouthProtection.aspx* ***The safety of our youth is paramount, and any obvious or even suspected abuse should be reported and dealt with through proper legal authorities.***

Thus, as with all other activities recommended within this manual, kids should not be left alone, one-on-one, with an individual adult. Parents should accompany their kids in working on the activities for this and other badges.

Back-up page 19.1: *Spending six hours with a senior member.*

Note: ***This activity is required to earn the Reaching Across Generations badge.***

One of the most memorable assignments I had in high school was when our American History teacher had us each find and interview someone who had been our age during the Great Depression of the 1930s. I remember very little else specifically about that class and its assignments—other than that Mr. Bernota always tossed back and chewed on two dry aspirins to kick off the daily lecture—but that one assignment has always stuck with me, when Dad drove me across town and our interviewee poured out stories of growing up and day-to-day incidents that mirrored some of my own. The dry textbook pages in our history book were coming alive in ways I could directly relate to, and this "old person" didn't seem so very old and history didn't seem so very remote anymore. (And when I do the math, that person who seemed so "old" probably wasn't much older than I am today!)

Along with their parents, kids should spend at least six hours with a senior member, either visiting them for a whole day, or spread out in one-, two-, or three-hour segments. Try to **match kids and senior members with similar interests**, whether it be minerals, fossils, field trips, fluorescent rocks, lapidary arts, natural history museums, gem shows, or what have you.

Encourage kids to decide in advance what they would most like to talk about, but don't be overly prescriptive. A lot of the best stories and advice arises naturally in the course of everyday conversation. But to kick off that conversation and to prime the well, so to speak, it helps to have topics prepared and at hand that might be of mutual interest to the kids and their "mentors."

Or, even better, arrange for some specific activity, such as the junior member seeking the senior member's help identifying rocks or classifying fossils in the junior's collection, or help in cleaning and curating specimens, or a workshop and tips on crafting a cab or faceting a gemstone, or providing display tips for preparing an exhibit at the next club show or for a competitive exhibit at a federation show. Or turn the tables and have the junior member assist a club officer in his or her club duties. For example, the junior might assist the newsletter editor with the next issue of the society bulletin or the membership chair in preparing and sending a new member packet. Another possibility is for the junior and senior member to enjoy the next club field trip together, or for the junior to assist the senior member at the next club show at the kids' booth, snack bar, admission and welcome table, raffle station, or silent auction.

Be sure that, as a conclusion to this activity, kids send a thank-you note or card for the time spent together. Karen Nathan (mother of Erica, the junior member who created this badge unit) has worked with the juniors of Coquina Kids to create hand-made cards related to our hobby, with messages like "You're a Gem!" or "You Rock!" along with stick-on plastic rhinestones. Encourage your kids to craft similar handmade cards; they'll mean a whole lot more to the person receiving them.

Back-up page 19.2: Five things you learned from a senior member.

So that you'll be sure kids really interact with their senior members, tell them in advance that you'll expect them to come back with a list of the five most important things their senior member taught them. In fact, you might even give kids a numbered sheet, with space for them to fill in, as shown on the next page.

And their list doesn't have to be restricted to just things about rocks, fossils, or lapidary arts. Perhaps the senior member taught patience, or a sense of responsibility, or caring for others, or a sense of fun, humor, and curiosity. It's hoped kids will come away from this experience having learned not just stone-cold facts, but values and interpersonal skills, as well.

What I Learned from____

name of my senior member

1. ____

2. ____

3. ____

4. ____

5. ____

Back-up page 19.3: The best time you spent with your senior member.

Have kids write a paragraph about the best time they had with their senior members. This could be a laugh over a special memory the senior member shared from his or her own childhood or a special treat like cookies or cobbler that the senior member shared from an old family recipe. It might be a story from the "old days" of the club. Or it may be a special fossil or mineral discovery they made together on a club field trip.

Have junior members share their paragraphs with their senior members before turning it in to the junior leader. With the senior member's permission, the junior member might see if the society newsletter editor will publish the paragraph to share the experience with all the society members.

Note: *Kids whose paragraphs are published in the society newsletter can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activity 7.2).*

Back-up page 19.4: Finding, taking, or drawing a picture of your senior member.

A picture is a great way to remember special times, so accompanying parents should be sure to have a camera handy when junior members and senior members get together. Encourage junior members to take pictures of their senior members, or have parents take photographs of the juniors and seniors together. Or encourage junior members to draw pictures of their senior members and present the drawings (framed, if possible) to the senior members at the next club meeting.

Kids who complete activity 19.3 and submit their paragraph to the society newsletter should also submit their picture to go along with the paragraph. If you do this, though, be sure to get the senior's signed permission to publish the picture. If the picture includes the junior, as well, you should have signed permission from the junior's parents before publishing in a newsletter.

Back-up page 19.5: A specimen that is special to your senior member.

In every senior's collection is a specimen (or two or three or four) that is extra special to him or her. It could be a specimen that a parent or grandparent gave to them when they were kids, the very first rock or mineral they ever collected, a spectacular fossil they discovered during a field trip, the first cabochon they crafted or the first pendant they wire-wrapped themselves, a stone they found on a trip to another country, or perhaps a ring or necklace containing a precious gemstone that their spouse gave to them on a special occasion.

For instance, I have an inkwell that's kind of beat up. It's adorned with different minerals from Colorado (amazonite, pyrite, galena, etc.) that have been glued to the inkwell. It's perpetually dusty, most of the minerals are dinged, and some are even missing, but I keep it proudly out on display. Why? Well, it was a gift from my grandfather, who received it from his grandfather, who participated in the Colorado Gold Rush of the late 1850s. I always saw it on display in my grandparents' home, and it's always on display now in my home.

Have junior members find out what specimens are extra special to their assigned senior members. Then have them write a paragraph describing the specimen and telling why it's special. Or have them give presentations about it at a club meeting. If the junior members write about it, have them accompany their paragraphs with photos or drawings of the specimens. If the junior members give oral presentations at one of your club meetings, have the senior members bring those specimens to the meeting to accompany the talks.

Note: *Kids who give an oral presentation to the club or whose paragraphs and/or pictures are published in the society newsletter can use this activity to satisfy requirements toward earning the Communication badge simultaneously (Activities 7.1 and 7.2).*

Back-up page 19.6: Making a memory box.

A memory box contains objects of special significance and sentimental value to serve as private reminders of treasured moments. Memory is fickle, and while we may think we'll remember a particular moment forever, it's surprising how quickly our frail brains forget details. Memory boxes store things neurons might someday lose, so encourage juniors to get a box and decorate it with things related to rocks and minerals and the moments spent with their senior member from any of the previous activities in this badge unit.

Memory boxes can be as simple or complex as imagination and budget allow. At the simplest level, it may consist of a shoe box containing pictures, letters, cards, and other precious objects. Or you can progress all the way to fancy oak shadow boxes with cubbies, shelves, and a glass front to hang on a wall. From shoebox to shadow box, here are a few ideas:

- A simple, unadorned shoe box storing pictures, letters, cards, or objects.
- That same shoebox, but with the outside painted or covered with wrapping paper that's been glued on and decorated with ornaments like stickers or plastic stick-on rhinestones. The top might be held shut with colored shoelaces, yarn, or ribbons.
- A top-hinged box available from stores like Target. Some of these have little compartments on the lid to slide in a photo or a label.
- Top-hinged wooden boxes available from craft stores like Michaels or Ben Franklin. The exterior might be painted with bright and colorful scenes or stained and lacquered, and the interior might be lined with felt.
- A printer's tray from an antique store. However, these usually have very small and shallow compartments, limiting what they can hold.
- A shadow box with cubbies and a glass top. These can be mounted on a wall or placed atop a shelf.

Here are a few ideas for materials to decorate the memory box:

- Colorful markers and crayons.
- Gift-wrapping paper.
- Ribbons, yarn, and/or string.
- Materials from the scrapbooking section of a crafts store.
- Rubber stamps and ink.
- Rock, mineral, and/or fossil pictures cut from rock and gem magazines.
- Logos downloaded from your club and federation websites.
- Most importantly, items from time spent with the senior member, including photos, any letters or notes exchanged, perhaps a mineral, crystal, or fossil the senior member gave the junior member, etc.

Once the memory box is complete, kids should share it with their senior member and junior leader, explaining why they've chosen to include what they have.

20. Maps

Our world is a complex, three-dimensional sphere. Maps "translate" our three-dimensional world into a flat, two-dimensional portrait, and different types of maps have been created to help us understand different things about our complex world. To earn this badge, you should demonstrate your knowledge of maps of different types, what each type tells us, and how to use them. You might also go on to learn about making a map, where maps may be found, and how to use electronic techniques involving GPS for finding your way around the world.

<u>Activity 20.1: Learning about the different sorts of maps and how to read them</u>.
Most of us think of maps in terms of taking us from Point A to Point B, but that's only one sort of many maps. Different sorts of maps tell different stories. There are roadmaps, geographic maps, geologic maps, topographic maps, weather maps, and others. Buy a book or pick one up at the library to learn about different sorts of maps and what each one tells us, or explore the Internet to learn about maps and mapping. Make a chart of common sorts of maps and their characteristics.

<u>Activity 20.2: Sources of paper maps</u>.
Learn about the different places where maps of different sorts may be found, then go out and get the map of your choice and demonstrate how to read and use it. Also, find out what companies and agencies publish maps.

<u>Activity 20.3: Making maps</u>.
Make a map of your choice. This could be a simple street map of your neighborhood, a roadmap showing how to get to a mineral or fossil site from your home, a topographic map showing the hills and valleys of a nearby park, or even a map of a room in your own home. How about a treasure map showing where you buried a can of crystals or tumbled stones? In crafting your map, keep in mind such considerations as orientation, scale, symbols, legend, and labels.

<u>Activity 20.4: Using GPS</u>.
What do the words "GPS" stand for? Find out, and learn how to use it. See if your club leader might take your group on a "geocaching" adventure!

<u>Activity 20.5: Maps on the Web</u>.
The World Wide Web has become a wonderful source for maps of all sorts, including ones that allow you to change angles of view, zoom in or out, fly around the world, and otherwise have fun in two and three dimensions. Explore the Web and report on what sorts of maps you can find there.

20. Maps

□ 20.1 Learning about the different sorts of maps and how to read them

□ 20.2 Sources of paper maps

□ 20.3 Making maps

□ 20.4 Using GPS

□ 20.5 Maps on the Web

To earn your Maps badge, you need to complete at least 3 of the 5 activities. Check off all the activities you've completed. When you have earned your badge, sign below and have your FRA leader sign and forward this sheet to the AFMS Juniors Program chair.

____
Date completed

____
My signature

____
Youth leader's signature

____
Name of my club

Leader's preferred mailing address for receiving badge:

____

____

____

Back-up page 20.1: Learning about the different sorts of maps and how to read them.

Maps are two-dimensional representations of different aspects of our world. Kids should learn about the different sorts of maps and what kind of information each conveys. For instance, here are a few types of maps kids are likely to encounter:

- *Roadmaps* show how to get from point A to point B on streets, roads, or highways. These are what most folks think of when hearing the word "map."
- *Political maps* show borders of countries, states, and regions, locations of capital cities, etc. Kids will see these in political science and history textbooks.
- *Geographic maps* may show both natural features (rivers, mountains, lakes) and manmade features (cities, roads, railroads), as well as artificial, political features (borders between countries and states).
- *Geologic maps* show the underlying geology of a region, highlighting different types of rocks and formations. These are very colorful, for a very practical reason. The colors have been standardized to tell readers specific information about the type of rocks and their ages. Geological time periods are further delineated by letter codes, for instance, capital J for Jurassic, with lowercase letters indicating formations.
- *Topographic maps* with concentric lines allow you to "read" the landscape. Each line corresponds to a different elevation and once you become adept at reading these, you can "see" the landscape in three dimensions. Many hiking maps are topographic maps so that hikers will know just how steep the trail ahead will be.
- *Weather maps* show weather patterns across geographic areas, with symbols indicating wind patterns, storms, high pressure and low pressure systems and fronts. Kids just need to tune into the local news report to see these, and they're also often seen on the back page of the newspaper.

Help kids learn more about maps by directing them to books about mapping and bring in different sorts of maps to show how they vary. (Back-up page 20.2 has sources of maps.) Many good books are available to purchase or to borrow through the library. Some can get fairly technical, but you can also find age-appropriate books at stores that cater to school teachers and sometimes at more general bookstores. Check with the store clerk to direct you to books about geography. Following are some I've found.

More advanced, technical books:

- Barnes & Lisle's *Basic Geological Mapping*, 2004.
- Maltman, *Geological Maps: An Introduction*, 1990.
- McClay, *The Mapping of Geological Structures, Second Edition*, 2003.

Books aimed at kids:

- Richard Panchyk, *Charting the World: Geography & Maps from Cave Painting to GPS with 21 Activities,* 2011. (Ages 9-12.)
- Tish Rabe, *There's a Map on My Lap! All About Maps*, 2002. Cat in the Hat's Learning Library (Ages 4-8.)
- Scott Ritchie, *Follow That Map! A 1st Book of Mapping Skills,* 2009. (Ages 4-8.)
- Sharon Thompson, *Map Skills*, 2003. (Grade 5.)

Back-up page 20.2: Sources of paper maps.

It used to be, you got your map at your corner gas station. But different places specialize in maps of different sorts. One of the biggest places folks turn to nowadays is the Internet, but we'll cover that in Activity 20.5. In this activity, the focus is on traditional paper maps. Here are a few places you can point kids:

- *Libraries*. The library can be your one-stop shop for maps of all sorts. Just ask at the front desk!

- *Geological Surveys*. The office of your state geological survey or department of conservation will contain geological and topographic maps, as well as maps showing mines and natural resources, and more. They usually have a catalog of maps of your state and its counties and townships, and you can often purchase them online or by mail or, if you're lucky enough to live close to the survey office, you can often buy them right there. Our national United States Geological Survey (USGS) is another source. In fact, on the opening page of its website, www.usgs.gov, is a map of the U.S.; click on your state, and you'll be led to local resources.

- *American Association of Petroleum Geologists.* AAPG offers geological maps including cross sections, tectonic maps, landform maps, and more; www.aapg.org

- *University Geology Departments*. If you have a nearby college or university with a geology department, see if they'll let you look through their large, oversized geological maps that are often stored in big, flat drawers.

- *Outdoors & Camping Supply Stores*. These stores often have maps of major parks and trails, including topographic maps, hiking maps, etc.

- *Bookstores*. Here's where you're most likely to find geographic and roadmaps, including the Thomas guide series, atlases, etc.

- *Gas stations & Convenience Stores*. Yes, you still can get roadmaps at the corner gas station, as well as at convenience stores, drugstores, and elsewhere.

A number of publishers and organizations specialize in making maps. These include:

- *National Geographic*. http://maps.nationalgeographic.com/maps

- *Rand McNally*. http://store.randmcnally.com

- *Thomas Guides*. http://www.thomasmaps.com (now owned by Rand McNally)

- *DeLorme*. http://delorme.com

- *American Automobile Association*. http://www.aaa.com

Back-up page 20.3: Making maps.

Host a map-making workshop with your juniors to make maps of different sorts. You might start by asking them to sketch a simple map of the room they're in, as if they were on the ceiling of the room looking down. Sounds simple, doesn't it? But wait! Here are some questions to pose and to consider:

How do they want to orient the room on the map? Where will north be? What features of the room do they wish to highlight? For instance, do they only want to highlight permanent features, such as doors, windows, closets, etc., or also temporary, moveable features, such as tables and chairs? What sort of scale do they want to use to convey the size of the room to someone who might read their map? That is, will one foot of the actual room be translated as one inch, a half inch, or a quarter inch on the map? Or, for the true scientists among us, will one meter be translated as one centimeter? If including things like chairs in the map, will they actually draw little chairs, or will they use a symbol like this, Ħ, to represent each chair in the room? If so, they'll need to craft a legend to tell readers what each symbol stands for. At the bottom of that legend, they also should indicate the scale used for the map; for instance, "Scale: 1 inch = 1 foot." Finally, they'll need to consider labels, both a large label for the map as a whole to tell readers what room this map represents and possibly small labels within the map identifying major features of the room, like a closet or a fireplace. Begin familiarizing kids with mapping terms like **orientation**, **scale**, **symbols**, **legend**, and **labels**.

From this exercise of mapping their meeting room, expand out. For instance, you might lead them in making a geographic map of their own neighborhood highlighting various features of particular interest to the kids (Timmy's yard or apartment, MacDonald's, the ice cream shop…). Or, as a group, make a roadmap showing how you'll be getting to your next field trip collecting locality. Make a miniature hilly landscape out of moist sand in a large tub and insert rows of toothpicks at different levels, with all the toothpicks of specific levels joined together by different colored yarn or string to give kids a better appreciation of what the lines on a topographic map help us visualize. Then have them sketch a 2-dimensional topographic map using the toothpicks and strings on your miniature 3-dimensional landscape to guide them.

But don't confine the kids' imaginations. Let them determine the type of map they want to make, be it a "treasure map" to a tin can filled with tumbled stones buried in the backyard, a roadmap showing how to get to a mineral or fossil site from their homes, a topographic map highlighting the hills and valleys of a nearby park, etc.

The U.S. Geological Survey has neat, helpful sections all about maps and map making that you may want to explore. Go to http://www.usgs.gov and click on the "Education" link and start exploring all the resources they have to offer for free!

Note: *Kids who make a map to a collecting locality as part of planning for a field trip can use this activity to satisfy requirements toward earning the Field Trips badge simultaneously (Activity 8.2).*

Back-up page 20.4: Using GPS.

"GPS" stands for "Global Positioning System," a satellite-based navigation system operated by the U.S. Department of Defense. It allows for determining accurate positioning on the earth's surface in latitude and longitude coordinates aided by some two dozen satellites in space. Initially reserved for military and government use, a part of the system known as the Standard Positioning System, has become readily available for civilian use and now appears in navigation systems for cars, for general aviation pilots, for recreational hikers, and more.

You can use GPS to find your way around with a handheld GPS receiver device or even a smartphone, and learning to use GPS is an important skill in today's world. In fact, most gem, mineral, and fossil guidebooks are now including GPS coordinates along with basic roadmaps, and some books are entirely geared to GPS, such as David A. Kelty's *The GPS Guide to Western Gem Trails.* Keep in mind, though, not all published coordinates are precise, and I've been warned by Christina Morrissey of the Northwest Federation that there are three formats for coordinates. That is, the numbers can be expressed in three different ways, and they do not mean the same location. For instance, see coordinates of Delorme Gazetteers versus Benchmark Maps. Every GPS unit can be set to express each of these three formats, but the fact that they exist is rarely discussed.

One fun way to learn how to use GPS is geocaching, which has become an increasingly popular pastime. It's basically a treasure hunt or a variation on hide-and-go-seek. People all across the world (even Antarctica!) have hidden waterproof containers, called geocaches, and they've posted coordinates so that others can locate the hidden caches. When players find a cache, they'll often enter the date and their own "code" into a logbook in the container. Sometimes the caches also contain little trinkets for players to trade. Players then share their experiences online.

Dennis Gertenbach, leader of the Junior Geologists of the Flatirons Mineral Club of Colorado, recommended this activity to me. He has taken kids geocaching to an area where he also demonstrates how to use a topographical map. For more information on geocaching, Dennis refers us to the following website: http://www.geocaching.com. A good article entitled "GPS and Geocaching in Education" provides a nice, clear overview and introduction to this fun activity, along with some how-to video slide shows. Created by professors and graduate students at San Diego State University, it used to be available on the web, but I wasn't able to find it on my most recent search.

In addition to exploring the geocaching website, you might encourage kids to read Donald Cooke's book, *Fun with GPS* (2005). Written specifically for kids and illustrated with hundreds of pictures, it explains what GPS is and how they can use it. It's also filled with fun activities for kids to gain hands-on experience. As one way of fulfilling this badge unit, you might encourage them to try one of those activities.

Note: *Kids can use this activity to satisfy requirements toward earning the Rocking on the Computer badge simultaneously (Activity 15.5). If they go on a geocaching trip, they can apply that toward the Field Trip badge (Activity 8.3).*

Back-up page 20.5: Maps on the Web.

The World Wide Web has become a rich trove of increasingly sophisticated maps, from **MapQuest** programs that give driving directions and roadmaps and estimated drive times between destinations, http://www.mapquest.com/, to Google Earth, and more.

In particular, take your juniors to a computer terminal to explore the possibilities afforded by **Google Earth** at http://earth.google.com. This amazing tool combines the power of Google Search with satellite imagery, maps, terrain, and 3D buildings. Among the range of possibilities suggested on the web site: "fly" to one of your junior member's homes by typing in the address and pressing "search" to zoom right in. Get driving directions to a park or natural history museum. Tilt and rotate the view on a Google Earth map to see terrain and buildings in 3D. We've truly come a long, long way from the roadmaps—which I always found impossible to refold—at the corner gas station!

Another really neat website sponsored by the U.S. Geological Survey is **EarthNow!** Visit it at http://earthnow.usgs.gov. It consists of real-time, bird's-eye images of the Earth's surface being beamed down from Landsat satellites. You actually feel like you're in a spaceship, with the surface of the Earth scrolling away beneath you. To orient you, city and town names appear in blue text.

You can pursue this activity as a group exercise, or you can encourage kids to explore for maps of their own. Whichever way you go, have them each prepare a brief oral or written report about what they found. Their report should include: 1) the web address of the site and its title, if it has one; 2) a brief description of what's to be found on the site; and 3) a conclusion about why they would recommend the site to other club members.

Note: *Kids can use this activity to satisfy requirements toward earning the Rocking on the Computer badge simultaneously (see Activities 15.1, 15.2, 15.5), as well as the Communication badge (Activities 7.1 or 7.2).*

Rockhound Badge

Once you've completed six or more of the twenty FRA badges, you will be eligible to receive an official "Rockhound Badge." This signifies your graduation from a Pebble Pup or Junior Member to a true, blue Rockhound.

Send a copy of your Achievement Checklist, signed by you and your youth leader, to the AFMS Juniors Chair, indicating the activities you've completed and the badges you've earned. Your Rockhound Badge will then be processed and approved and forwarded to your youth leader to award in a special ceremony. Plus, you name will be posted to an "Honor Roll" list on the Kids Corner section of the AFMS web site.

If you wish to earn all twenty badges, by all means, please proceed! The more you learn, the better. It will make you more fully versed in the hobby, and the more knowledge you gain in life, in general, the better. Plus, there's a special award should you earn all twenty badges (see the next page).

In earning at least six of the twenty badges, you will have demonstrated a well-rounded knowledge of the many facets of our hobby. We hope that, along the way, you will have picked up knowledge and skills you will enjoy for the rest of your life—all while having fun!

On behalf of the American Federation of Mineralogical Societies, congratulations!

AFMS Cloisonné Pin for Rock Stars

Once you've completed all twenty FRA activity badges, you will be eligible to receive an official AFMS cloisonné pin and your name will be posted to a "Rock Stars" list on the Kids Corner section of the AFMS web site.

Send a copy of your Achievement Checklist, signed by you and your youth leader, to the AFMS Juniors Chair, indicating the activities you've completed and the badges you've earned. Your Rock Star award will then be processed and approved and forwarded to your youth leader to award in a special ceremony.

As with earning your Rockhound Badge, the American Federation of Mineralogical Societies offers special congratulations upon entering the elite ranks of the Rock Stars!