AMERICAN FEDERATION OF MINERALOGICAL SOCIETIES

Future Rockhounds of America Badge Program

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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, we'll uphold our chartered goals as nonprofit, educational organizations by actively seeking to foster and develop science literacy and arts education among 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 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. We much provide young people opportunities to learn important skills. We must provide these opportunities in the context of positive and continuing youth-adult relationships. And, 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, 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, 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 young people

and their peers. Third, 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.

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 and 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, soapstone sculpture, etc., while also learning the basics of shop tools and safety.

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

- Rocks & Minerals
- Earth Resources
- Fossils
- Lapidary Arts
- Collecting
- Showmanship
- Communication
- Field Trips
- Leadership
- Earth Processes
- Earth in Space
- Gold Panning & Prospecting
- Gemstone Lore & Legend
- Stone Age Tools & Art
- Rocking on the computer

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, 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.

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 fifteen badges.

Youth should become a central part of our efforts in order to best ensure that we are providing activities that our kids find engaging and worth their time. Thus, I welcome feedback and suggestions from both local youth leaders and kids themselves. How can the existing activities be improved? What new activities can we add? I envision this as

an evolving program that grows, adapts, and improves with time and use. 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's not put our clubs first—let's 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

If your local society or club doesn't already have a youth group in place, here are five general "rules" I've learned as a result of talking with folks who have taken the initiative to begin one:

- ***Capitalize on your existing pool of talent.*** 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, another has an amazing mineral collection. Start by identifying adults within the ranks of your club's members 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.

- ***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.

- ***Center meetings around an activity.*** Most adult meetings are centered around a lecture or presentation, and during these, you'll observe kids a) sleeping or b) running the hallways. 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 sturdy specimens kids can see and touch, perhaps with a couple large-format picture books and dinosaur models as illustrations. 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.

- ***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—whether quartz crystals, fossil shark teeth, agates, or barite roses—for the kids.) 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.

- ***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. This also brings up a point I wish we didn't have to go into, but it's important to raise, namely, the importance of having youth leaders who are well known by all in the club and of having multiple adults on hand when working with kids. The safety of our youth is of primary importance. Finally, 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.

A terrific source filled with other ideas 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 up a juniors' program from scratch, as well as a resource of activity tips.

Acknowledgements

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 the prior AFMS Juniors Program Chairs who blazed the trail and upon whose shoulders I've stood these many years. I'd like to thank all the individual youth leaders from all the local clubs who have offered ideas for new activities and refinement of existing activities. 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 and who have so generously funded it so that it can be provided completely free to all kids within our affiliated clubs. And I'd like to thank the good folks at AB Emblem in Weaverville, North Carolina, who have helped to craft and manufacture the badges into the fun, colorful rewards we can now offer kids. 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 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 clubs and societies across America!

In Closing…

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

1) support junior leaders at local clubs 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 and knowledge while—as always—having fun!

Jim Brace-Thompson
AFMS Juniors Program Chair
July 2004, updated February 2008

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 15 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.

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 (jbaceth@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." 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.

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 information 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 as you complete them, 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. To earn the Rockhound badge, you need to earn at least 6 of the 15 badges.

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.
□ 1.7 State rocks, minerals, and gemstones.

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 a fossil.
□ 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.

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.

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 display.
□ 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 and 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.

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.

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.

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.

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.
□ 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.

To earn your Rockhound badge, you need to earn 6 or more of the 15 badges. Check off the 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 Activities chair to receive your Rockhound badge.

_____
Date completed

_____ _____
My signature Youth leader's signature

_____
Name of my club

Youth Leader's preferred mailing address for receiving the badge:

_____
_____
_____

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 Activities 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 be judicious and only request necessary minimum quantities on an as-needed basis.

1. Rocks and Minerals

To earn this badge, you should demonstrate how to identify common minerals and learn the basic rock types. Other activities involve learning about crystals and your state rock or mineral. This unit also helps you start building your own rock and mineral collection.

Activity 1.1: Learning the characteristics of minerals.
Buy a book or pick one up at the library to learn about different minerals and their characteristics. 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, and 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 (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, and smoky quartz from Pikes Peak. 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 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.
Describe the three basic rock types (igneous, sedimentary, and metamorphic) and build a collection with samples of each type.

Activity 1.5: Crystal shapes.
Draw crystal shapes and/or make crystal models with blocks of styrofoam or with styrofoam balls and dowels, with cardboard, etc. Some common crystal shapes are cubic, hexagonal, orthorhombic, monoclinic, triclinic, tetragonal, and trigonal.

Activity 1.6: Growing crystals.
Using a material like sugar, table salt, or Epsom salts, grow different forms of crystals.

Activity 1.7: State rocks, minerals, and gemstones.
Just as each state has its own flag, many have a State Mineral or 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!

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

□ 1.7 State rocks, minerals, and gemstones

To earn your Rocks & Minerals 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 Activities 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.

Kids should learn to identify several common minerals using various 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. Many good ones are available to purchase or to borrow through the library. Some include Pellant's *The Complete Book of Rocks and Minerals*, Zim and Shaffer's *Rocks and Minerals: A Golden Guide*, Fuller's *Pockets Rocks & Minerals*, Simon & Schuster's *Guide to Rocks and Minerals*, Pough's *Rocks and Minerals: Peterson Field Guide*, Chesterman's *National Audubon Society Field Guide to North American Rocks and Minerals*, or Roots, Willis, and Brett-Surman's *The Nature Companion's Rocks, Fossil and Dinosaurs*.

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 tile plate. This can surprise you in that it is sometimes very different from the mineral's outward color. For instance, gray hematite leaves a red 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), vitreous or glassy (quartz), silky (gypsum), waxy (jade), resinous, pearly, earthy, 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. For most purposes, you just need to judge the relative weight 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, P.O. Box 143, Manchester, New York 14504 (phone 585-289-4936; email diamonddan@rochester.rr.com; web address www.diamonddanpublications.com).

See the accompanying chart that provides you with a "cheat-sheet" of a wide variety of minerals and their various characteristics. In addition, we've provided a blank chart 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, blue-green, golden	White or colorless	Basal, poor	Conchoidal	Glassy	7-8	Trigonal / hexagonal	2.6-2.9
Borax	Clear, white	White	Perfecdt	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, tgreen	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	Mettalic	2.5-3	Isometric/Cubic	8.9
Corundum	Red (ruby), Blue (sapphire)	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, blue	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, etc.	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	Submettalic, greasy	3.5-4	Cubic/isometric	3.9-4.1
Sulfur	Yellow	Yellow	None	Conchoidal	Waxy, resinous, greasy	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, etc	White	Basal	Uneven, subconchoidal	Vitreous	8	Orhorhomic	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	
2	Gypsum	Fingernail (hardness 2.5)
3	Calcite	Copper Penny (3 to 3.5)
4	Fluorite	
5	Apatite	Knife Blade/Steel Nail
6	Feldspar	Glass (5.5); Steel File (6.5)
7	Quartz	
8	Topaz	
9	Corundum	
10	Diamond	

In addition to the tools noted in the above table, a mineral ID kit might include an unglazed 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 chart accompanying Back-up page 1.1 for info about various characteristics for a number of common minerals. A similar blank chart 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 chart 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 minerals might be put on a table along with mineral identification books. The first kid to identify a particular specimen, or "mystery mineral," correctly gets to keep it. This is a definite motivator!

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 crystalization of magmas, either deep beneath the surface of the earth (granites) or extruded (lavas, obsidian, ash). Examples: granite, basalt, rhyolite, obsidian, pumice, scoria, diorite, gabbro, andesite, tuff.

- *Sedimentary.* Sedimentary rocks are formed by sediments (gravel, sand, mud, etc.) created by the eroding action of wind, water, or ice breaking down older rocks or by minerals precipitating out of water. Examples: mudstone, shale, sandstone, conglomerate, limestone, dolomite, coquina, gypsum, diatomaceous earth, coal.

- *Metamorphic.* Metamorphic rocks have been changed by heat and/or pressure and other earth forces. Examples: slate (formed from shale), schist (formed from shale, more intensely altered than slate), quartzite (formed from sandstone), marble (formed from limestone), serpentine, hornfels, gneiss.

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).

Activity 1.4: The three rock types.

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. Cut-out patterns for making such models may be found on the following web site: http://www.geocities.com/CapeCanaveral/Hall/1410/mobile.html

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, P.O. Box 143, Manchester, NY 14504 (phone 585-289-4936; email diamonddan@rochester.rr.com; web address www.diamonddanpublications.com).

Back-up page 1.6: 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: table salt, Epsom salts, or alum. (Other materials you might use include borax, photographic fixer, sugar, or saltpeter.)
- Water
- Measuring cups
- Spoon
- Cooking pan
- Glass jars
- Pebbles
- Stick or pencil
- String (cotton twine), cut into small lengths
- (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 a piece of string to a stick or pencil, pour your solution into a glass jar, and dip the string into the solution, 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 or nature stores.

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
Michigan	Petoskey Stone		Chlorastrolite
Minnesota		Iron	Lake Superior Agate

Mississippi	Petrified Wood		
Missouri	Mozarkite (Chert)	Galena	
Montana		Agate	Yogo Sapphire
Nebraska	Prairie Agate		Blue Chalcedony
Nevada	Sandstone	Silver	Black Fire Opal & Turquoise
New Hampshire	Conway Granite	Beryl	Smoky Quartz
New Jersey	Stockton Sandstone		
New Mexico			Turquoise
New York		Hematite	Garnet
North Carolina	Granite/Unakite		Emerald
North Dakota			
Ohio			Flint
Oklahoma	Barite Rose		
Oregon	Thunder Egg		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).

2. Earth Resources

This set of activities introduces the practical side of minerals, or how rocks and minerals are used in everyday life. We are surrounded by evidence of our mining heritage, from gypsum in our walls to brass knobs on doors and clay in our flowerpots and on the pages of glossy magazines. 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 or a chalkboard or white board. Look around the room and draw up a list of everyday things and the minerals you think went into them. (If using an old-fashioned 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 about minerals 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 minerals that went into them.
Build a collection of everyday objects and specimens of the minerals that went into them. You can get specimens by collecting them in the field, trading with other members in your club, or purchasing them at nature stores, museum gift shops, rock shops, or gem shows. Here are some examples to get you started: a penny and a copper nugget; a nail and a piece of iron ore or hematite; a tube of fluorinated toothpaste and a fluorite crystal; laundry detergent and a borate mineral; a fishing weight and a galena (lead) 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" to a local hardware store or home building supply store. List some of the things you see there and their source minerals.

Activity 2.6: Careers in the earth sciences.
Learn about careers in the earth sciences (mining, teaching, gemology, the jewelry business, seismology, etc.). 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 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 Activities 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 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. 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) a light bulb with its glass exterior (made from a combination of 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.

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 Mineral Information Institute (www.mii.org) and Women in Mining (www.womeninmining.org). (The MII 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.) Following are samples from those web sites:

Everyday Object	Mineral
Pennies; copper wiring; electronic parts; plumbing	Copper nugget
Nails; steal	Iron ore or hematite
Toothpaste; hydrofluoric acid	Fluorite
Laundry detergent	Borate minerals
Fishing weights; batteries; TV screen	Galena (lead)
Cans; autos; airplane; building components	Bauxite (aluminum)
Tiles; kitty litter; bricks; dinnerware and other ceramics; glossy paper; fiberglass	Koalin or clay
Fertilizer; animal feed supplements	Phosphate
Swimming pool and other filters; toothpaste; metal polishes; insulators	Diatomite
Rechargeable batteries	Cobalt or lithium
Food; highway de-icing; chemicals	Halite (salt)
Cement	Limestone

Pottery	Feldspar
Concrete; asphalt; road fill; blocks; bricks	Sand & gravel
Metals & alloys; paint; rubber; skin creams	Zinc
Used in making steel	Manganese
Talcum powder & cosmetics; ceramics; rubber; plastics; paper	Talc
Sandpaper & other abrasives; jewelry	Garnet
Jewelry; dentistry; electronic components	Gold
Lubricant; brake linings; molds in foundaries; pencils	Graphite
Plaster-of-Paris; wallboards	Gypsum
Sparkplugs	Kyanite
Batteries; thermometers; barometers	Mercury
Electronic insulators; joint compounds; paints; plastics; rubber products; toothpaste	Mica
Concrete blocks; abrasives	Pumice
Sulfuric acid; fertilizers; chemicals; gunpowder & other explosives; rubber	Sulfur
Glass; gemstones; spectographic lenses	Quartz (silica)
Lightbulb filaments; cemented carbides; an additive to steel	Tungsten
Jewelry & ornaments; silverware utensils; coinage; photography; solar cells	Silver

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 (tumble-polished pieces of quartz, hematite, pyrite crystals, 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 kids first-hand nature's bounty 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.

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).

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.

2.5 Field trip to a hardware store.

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 or home building supply store derived from common minerals and rocks:

- copper wiring, pipes, and plumbing fixtures
- steel and iron nails
- aluminum and tin siding
- brass screws and ornamental plates (brass is an alloy of copper and zinc)
- lead solder
- diamond on some drill bits and saw blades (for cutting title, concrete, etc.)
- diatomaceous earth for swimming pool filters
- plaster and plasterboard (made from gypsum)
- sandpaper (several varieties: garnet, silicon carbide, and corundum, or emery)
- glass (made from silica sand)
- various 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 kaolin)
- 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!

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.

A couple of great resources for helping kids learn about careers in the earth sciences are web sites for the Mineral Information Institute (MII) and Women in Mining (WIM): www.mii.org and www.womeninmining.org. For additional ideas, you and your kids can explore the web site of the United States Geological Survey: www.usgs.gov.

If you live near a college or university that has a geology department, you might also 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
- surveyor
- cartographer
- independent consultant assessing geological hazards for the construction industry
- seismologist
- 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

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. A couple of good, basic guidebooks at reasonable prices are Rhodes, Zim, and Shaffer's *Fossils: A Guide to Prehistoric Life* and Palmer's *Fossils*.

Activity 3.1: The geological time chart.
Memorize the geological eras and periods and some key facts about each one. Then make a geological time line showing all the geological periods. Illustrate it with drawings of fossils and prehistoric plants and animals characteristic of each period.

Activity 3.2: Types of fossilization and making a fossil.
Explain the different types of fossilization (e.g., carbonization, mineralization, molds and casts, etc.). Make a "fossil" by making imprints of leaves, shells, or fossils models in clay and pouring in plaster to show how casts and molds are formed.

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

Activity 3.4: Collecting fossils.
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 Activity 5: Building a Collection.)

Activity 3.5: A fossil-collecting field trip.
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 Activity 8: Field Trips.)

Activity 3.6: Your state fossil.
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 activity.

3. Fossils

□ 3.1 The geological time chart

□ 3.2 Types of fossilization and making a fossil

□ 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

To earn your Fossils 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 Activities 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:

- Paolo Arduini and Giorgio Teruzzi, *Simon & Schuster's Guide to Fossils* (A Fireside Book, Simon & Schuster, Inc.)
- Sidney Horenstein, *Familiar Fossils*, the Audubon Society Pocket Guides (Alfred A. Knopf)
- Martin Ivanov, Stanislava Hrdlickova, and Ruzena Gregorova, *The Complete Encyclopedia of Fossils* (Rebo International)
- Richard Moody, *Fossils: How to Find and Identify Over 300 Genera*, Macmillan Field Guides Series (Collier Books, Macmillan Publishing Company)
- Douglas Palmer, *Fossils*, the Pockets Series (Doris Kindersley, Ltd.)
- Giovanni Pinna, *The Illustrated Encyclopedia of Fossils* (Facts on File)
- Frank H. T. Rhodes, Herbert S. Zim, & Paul R. Shaffer, *Fossils: A Guide to Prehistoric Life*, the Golden Guides Series (Golden Press)
- Ida Thompson, *The Audubon Society Field Guide to North American Fossils* (Knopf)
- Cyril Walker and David Ward, *Fossils*, the Eyewitness Handbook Series (Doris Kindersley, Ltd.)

In addition to these, I encourage you to check out two other books that tell all about fossils and how to become a fossil detective, one geared to very young children, the other to older kids:

- Aliki's *Fossils Tell of Long Ago* (HarperCollins, 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.
- Peter Larson and Kristin Donnan teamed to write *Bones Rock! Everything You Need to Know to Be a Paleontologist* (Invisible Cities Press, 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 your local bookstore. 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 publisher or distributor know you're purchasing for educational purposes. With a resource like this at hand, you're ready to lead kids into any number of activities to learn about fossils and life of the past.

Back-up page 3.1: The geological time chart.

A geologic time chart, with examples of common fossils from each period, is provided below 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.

One superb web site that guides kids interactively through the whole of geological time has been put together by the Smithsonian Institution's National Museum of Natural History. It may be found at http://www.nmnh.si.edu/paleo/geotime. The site spotlights the geological events and their associated biological organisms throughout the different eons, eras, periods and epochs of earth's history. It's packed full of info, including backgrounders on dating techniques scientists use.

ERA	PERIOD/EPOCH		
Cenozoic "recent life" dinosaurs dead / mammals ahead mammals diversify first humans	**Quaternary** (modern humans appear; mastodons & mammoths & other Ice Age mammals)		**Holocene** *11,000 years*
			Pleistocene *1.6 million years*
	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)	**Neogene**	**Pliocene** *5.2 million years*
			Miocene *23 million years*
		Paleogene	**Oligocene** *35 million years*
			Eocene *56 million years*
			Paleocene *65 million years*
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	**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*		
	Jurassic (dinosaurs are abundant on land and ammonites in the sea; earliest birds) *208 million years before present*		
	Triassic (earliest dinosaurs & mammals; cycads & conifers diversify) *245 million years before present*		
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	**Permian** (mammal-like reptiles emerge; largest mass extinction event on earth) *290 million years before present*		
	Pennsylvanian (great coal-forming forests of scale trees & seed ferns; abundant insects) *323 million years before present*		
	Mississippian (abundant sharks & amphibians & crinoids; earliest reptiles) *362 million years before present*		
	Devonian (fish become abundant; extinction of armored fish; earliest amphibians and ammonoids) *408 million years before present*		
	Silurian (great diversity of ostracods; earliest land plants and insects) *439 million years before present*		
	Ordovician (graptolites abundant; invertebrate marine animals proliferate, especially coelenterates, mollusks, brachiopods, bryozoans, and arthropods) *510 million years before present*		
	Cambrian (appearance of burrowing animals and most contemporary forms of complex multicellular life; trilobites common) *544 million years before present*		
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)	**Vendian** or **Ediacaran** (enigmatic soft-bodied Ediacaran fossils appear shortly before the Cambrian) *600 million years before present*		
	(Single-celled life emerges and proliferates: bacteria, algae, stromatolites) *4.6 billion years before present*		

ERA	PERIOD/EPOCH		
		—	

Back-up page 3.2: Types of fossilization and making a fossil.

Forms of Fossilization.

Fossils are the preserved remains or evidence of past life (plant and animal). 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 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 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.
- Recrystalization. Shells may recrystalize, 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 plan, 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.

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 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.

Note: For another, simpler process to make fossils using just self-hardening clay, see the back-up page for 10.4.b) Sedimentary rocks: Making fossils. You can use either of these activities to help kids satisfy requirements toward earning both their Fossils and Earth Processes badges simultaneously.

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 is a highly detailed list that 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 in the first back-up page for the Fossils badge.

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* (published by Fossil News, 1185 Claremont Drive, Boulder, CO 80305; www.fossilnews.com). 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.)
- Draw and color dinosaur murals or timelines on a long sheet of paper, incorporating dinosaur stickers. Sheets of dino stickers can be found in party or gift-wrapping sections of stores, in craft stores, bookstores, etc.
- Create dinosaur dioramas with models in shoe boxes and talk with your kids about which dinos in the diorama are plant eaters versus meat eaters and who would be hunting whom.
- Make dino 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 or using grocery bags, cardboard, glue, colorful markers, and other readily available materials. A nice web site showing how to convert grocery bags into dinosaur masks is http://www.miamisci.org/avacado/projects/dinos/masks.html
- 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 dinosaur skeleton involves cutting large bones out of cardboard and hiding them around a room. Then hold a scavenger hunt. Once all bones have been located, assemble them with brass fasteners.
- Hold a dinosaur facts and myths quiz. A site devoted to "Dinosaurs: Facts & Fiction" is on the USGS web site: http://pubs.usgs.gov/gip/dinosaurs/
- 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.

In addition to these activities, there's no end of dino activity books geared to every age level. Just one example is Janice VanCleave's *Dinosaurs for Every Kid.* Check Amazon.com, the kids' sections of bookstores, teacher supply stores, and the web. Just type "dinosaur" into a search engine like Google, and thousand of possibilities spring up! Pick one or more to do a dinosaur activity with your club's kids.

4. Lapidary Arts

Many rocks that look dull and uninspiring on the outside actually harbor a gem within. The lapidary arts allow you to unlock that gleaming beauty. As with any art, successfully completing a lapidary project requires training and 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 forms of lapidary arts and to pick a project that interests you. In addition, learn about safety in the lapidary workshop. Then jump into the workshop and practice, practice, and practice some more—it's fun, and the outcome can be a thing of beauty forever!

Activity 4.1: Learning about lapidary rocks.
Different rocks have different characteristics. Some are hard, some soft. Some are uniform in color, others are banded, while 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.

Activity 4.2: Choosing a lapidary project.
Buy or borrow a book on lapidary arts and read about one or more of the various arts that you would like to try. Among the many activities practiced by rockhounds are cabbing, faceting, inlay, wirewrapping, silver smithing, beading, carving, and rock tumbling. Work with your youth leader to determine all the materials and equipment you'll need. Then outline the steps for your project.

Activity 4.3: *Workshop safety and maintenance.*
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.

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

Activity 4.5 Sharing your lapidary project.
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 all the steps that went into its creation. Or write a brief article for your club newsletter describing your project and outlining the steps you took in making it. Or display your lapidary work in a case at your club's annual gem show.

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.

To earn your Lapidary Arts badge, you need to complete at least 3 of the 5 activities. (Please note that successfully completing Activity 4.3 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 Activities 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 flint knapping to make arrowheads and spear points; also good for cabbing)
- Petrified Wood (good for cabbing, book ends, specimens for display; one problem is that petrified wood has a tendency to split or flake)
- Soapstone (a very soft rock especially good for beginners to rock carving)
- Onyx (a soft rock good for carving)
- Alabaster (another soft rock good for carving)
- Marble (a bit harder than 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: varieties of quartz (clear, rose, amethyst, smoky, citrine), topaz, tourmaline, emerald, aquamarine, peridot, garnet, corundum (ruby and sapphire), diamond

Encourage other adult club members to bring in examples of finished cabs, carvings, faceted stones, and other projects they've done. They also should bring along with examples of the rough material from which the finished stones were crafted to show your kids "before" and "after" pieces.

Back-up page 4.2: Choosing a lapidary project.

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:

- 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.)
- "Rock Critters" (Stack and glue small stones together like snowmen to make animals and people; incorporate "google" eyes, pipe cleaner arms and legs, feathers, and other ornaments.)
- 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 pane.)
- Rock tumbling and "free-form" jewelry. (Tumble small agates and jasper and top the best pieces with bell caps to make necklaces and dangling pieces for bracelets.)
- Cabbing (to create brooches, belt buckles, necklaces, and bolo ties).
- Flat-lapping (to create bookends or to polish agates, geodes, and thunder egg halves).
- Making bead bracelets and necklaces.
- Wirewrapping.
- Gemstone trees.
- Scrimshaw.
- Flint knapping.
- Intarsia, inlays, and mosaics.
- Sphere making.
- Carving and sculpting.
- Forging glass beads.
- Metal smithing.
- Faceting.

There are a variety of projects you can do with simple tumbled stones for very young kids. I noted "free-form" jewelry and light-catchers, above. In addition, kids can glue seashells and tumbled stones against a framed background in the shapes of flowers. Or they can coat a simple clay flowerpot with plaster or self-hardening clay and press in tumbled stones for an 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.

Many books and magazines provide good ideas for lapidary projects. Some include:

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)

In addition to books, draw from the experience of your own adult club members. 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 sponsors cab-making workshops for kids and adults alike, and he's prepared a set of handouts. In basic, step-by-step fashion, these include 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 an experienced adult is 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:

- 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 accompanying 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.
- 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.
- If dry sanding, wear a facemask and/or work with a suction ventilating device.
- 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.

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.

Back-up page 4.5: Sharing your lapidary project.

Note: Kids who bring a finished lapidary project to a club meeting to share with friends and to explain the steps that went into its creation, or those who write a brief article for the club newsletter describing a project and outlining the steps taken in making it 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).

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:

Activity 5.1: Building a collection.
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.

Activity 5.2: Cataloging and labeling your collection.
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.

Activity 5.3: Storing a collection.
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.

Activity 5.4: Displaying your collection.
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 Activity 6: Showmanship.)

Activity 5.5: Reporting about your collection.
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 Activity 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 Activities 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.

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 jasper in its 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 crafted facted 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.

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), and 14.1 (Stone Age Tools & Art).

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. 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 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.

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.

Thus, a complete catalog entry for a mineral might include the following fields:

- Specimen number assigned to the mineral.
- Common name of the mineral.
- Locality where the mineral was found.
- An indication as to whether it was self-collected, traded, or purchased.
- 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.

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, with information about Kingdom, Phylum, Class, Family, etc. 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's seldom that any of us are compulsive enough or make the time to record all the information I've indicated above, but the effort is well worth it in terms of 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.

Electronic Data Keeping.

As a collection grows, it can become increasingly difficult to remember and keep track of all your specimens, even if recorded in a handwritten logbook. Also, a handwritten logbook can sometimes 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, Inc., sells "TFGCollector" custom-made software for cataloging facts about a rock or fossil collection. (The Fredrick Group, Inc., 100 Colony Park Drive, Suite 303, Cumming, GA 30040, phone 678-947-1355, Ext. 500.)

The great advantages of a computerized database are the ability to easily edit and change information and the ability 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. In this day-and-age of digital photography, some collectors even incorporate photos of collecting sites and their individual specimens into their electronic databases to make it even easier for a person to match an entry in a catalog with a specimen in a drawer.

Cataloging and Labeling Group Activity.

You can 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 or chips. 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 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 most 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.

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

Activity 6.2: Holding a workshop on display ideas.
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?

Activity 6.3: Observing and evaluating displays.
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?

Activity 6.4: *Making your own public display* (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.

Activity 6.5: Entering competition.
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 Activities 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't's 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.

Finally, 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.

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. 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), and 9.2 (Leadership).

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.

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 display.
Prepare a bulletin board display for your annual show, a library, or your 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 display

□ 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 Activities 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), and 15.2 and 15.3 (Rocking on the Computer).

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), and 15.2 (Rocking on the Computer).

Back-up page 7.3: Bulletin board display.

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.

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."
- Geologists and paleontologists: check the geology department web site of the nearest college or university. (A listing of all colleges in the U.S. is available through a web site maintained at the University of Texas: http://www.utexas.edu/world/univ) 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.
- Geologists and paleontologists: call up the closest natural history museum to see if they have a staff geologist or paleontologist.
- 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 U.S.G.S. education web site: http://ww.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 Mineral Information Institute (http://www.mii.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 usually 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, 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 & AFMS Code of Ethics* (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* (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 and 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 Activity 8.1 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 Activities 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 & AFMS Code of Ethics*

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

Before ever setting foot in the field, kids should be taught proper field trip etiquette and the do's and don'ts governing proper—and legal—behavior when collecting natural resources. 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 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 special 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 otherwise disturbing the natural features of the land) and you need to purchase an "Adventure Pass" to park on national forest land. 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.)

In selecting your field trip site, avoid areas with obvious hazards (high-traffic road cuts, steep bluffs, thick clumps of poison oak, etc.). Remind kids to dress in appropriate outdoor clothing, sturdy shoes, and a hat, and before you go, 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. If parking near a roadway, be sure your car is fully off the pavement when you arrive, then watch out for kids rushing up steep slopes of loose talus. Don't let rocks get tossed into a roadway—or toward other kids! Don't undermine overhangs, and don't leave unfilled holes. Do make sure an adult in the group knows first-aid and has a fully stocked first-aid kit close at hand, with a cell phone and directions to the nearest hospital in the event of an emergency.

Before leading kids on a field trip, inform them of rules like these and also distribute and ask them to learn the A.F.M.S. 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

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 immediate area, ask around at a local college. Many college geology departments have road logs for earth science field trips. Three publishers have extensive series of guidebooks covering many states in the US: Mountain Press of Missoula, Montana, publishes the Roadside Geology Series; Gem Guides of Baldwin Park, California, publishes the Gem Trails series; and Falcon Press of Helena, Montana, 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 and sturdy hiking boots
Detailed area maps and compass
Backpack or rucksack
Rock hammer, rock pick, sledge hammer
Chisels, gads, pry bar
Shovel, trowel, hand rake
Sifting screens
Pocket knife
Paint brushes and toothbrushes
Hard hat if in a quarry or elsewhere with a danger of falling rocks
Wide brimmed hat to protect against sun exposure
Heavy work gloves
Shatterproof goggles if hammering rocks
Toilet paper, paper towels, newspapers, bubble wrap for wrapping delicate specimens (the toilet paper comes in handy for other reasons while in a remote field location…)
Masking tape
Small storage boxes and 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 or hand lens
Spray bottle of water to check for potential lapidary material
Field notebook and pencils/pens to record info about a site
Camera and film to keep a visual record of a site and specific collecting horizons
First aid kit
Plenty of water and food and, if going overnight, camping gear

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.

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), and 14.5 and 14.6 (Stone Age Tools & Art).

FIELD TRIP SIGN-UP SHEET

Trip location:_____ Trip date:_____

NO.	NAME (PLEASE PRINT)	HOME PHONE
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2		
3		
4		
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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.

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

(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).

_____

_____
Signature of Parent(s) or Guardian

_____
Date

(This form courtesy of Richmond Gem & Mineral Society)

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:

http://www.lib.washington.edu/sla/natmus.html
http://www.ucmp.berkeley.edu/subway/nathistmus.html
http://members.aol.com/fostrak/museums.htm
http://dir.yahoo.com/Society_and_Culture/Environment_and_Nature/Natural_History_Museums/

9. Leadership

Learning to lead is an important skill that will benefit you far beyond this hobby of rockhounding. 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.

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

To earn your Leadership 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 Activities 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 "Mineral Mites" of the Kern County Mineral Society in Bakersfield, 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 the KCMS club and 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.)

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.

10. Earth Processes

While the ground beneath our feet may seem solid and stable, our Earth is actually an amazingly dynamic and fluid planet. Huge sections of the crust, called "plates," are constantly 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, and crashing together at still other places to lift up mountains like the Himalayas. This unit will teach you 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, 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, and as they move about, they help to recycle rocks and to create the processes and conditions that lead to igneous, sedimentary, and metamorphic rocks. Make a poster showing the rock cycle. In the poster, 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; 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.

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

To earn your Earth Processes 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 Activities chair.

_____
Date completed

_____ _____
My signature Youth leader's signature

_____
Name of my club

Leader's preferred mailing address for receiving badge:

_____

_____

_____

Back-up page 10.1: What is a rock?

A mineral is an inorganic chemical substance created in nature. "Inorganic" means it's 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.

On Earth, rocks are constantly moving through a cycle of formation and change through processes involved with **plate tectonics**. The crust of the earth is divided into a number of plates that float and travel over the mantle. Much of the earth's seismic activity (earthquakes, volcanic eruptions, mountain building) occurs at the boundaries of these plates, where plates collide, diverge, slide past one another, or where one overrides another. In the process, 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***.
- 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":

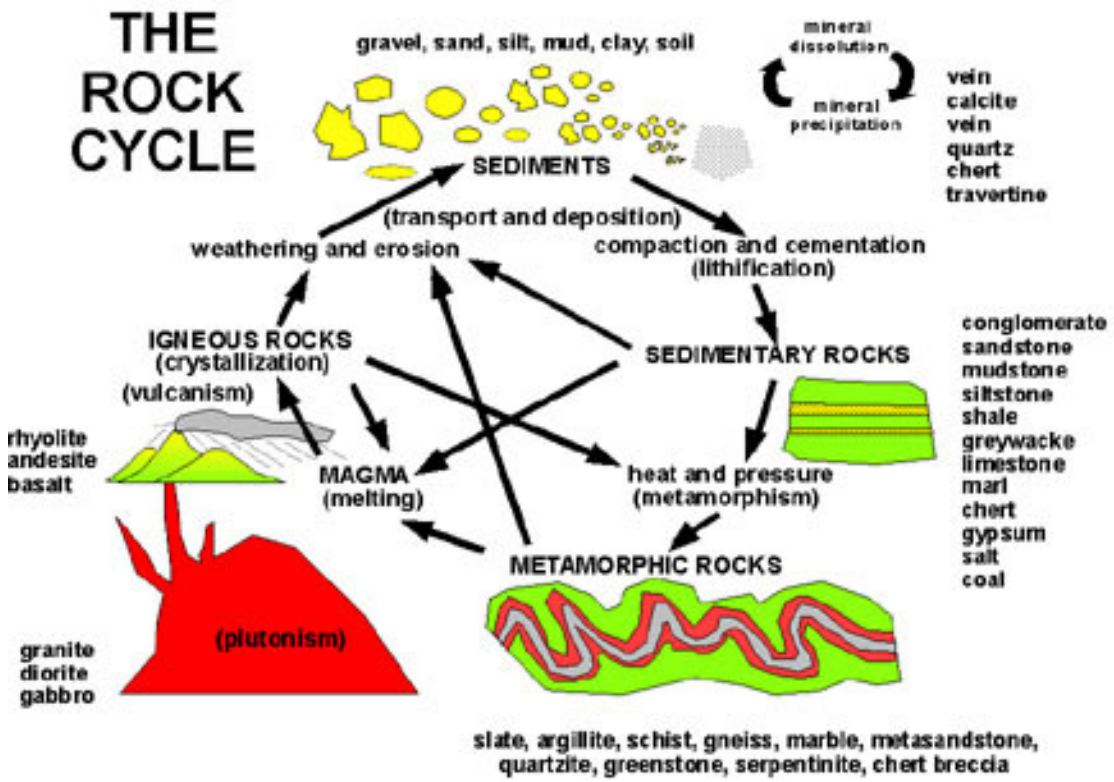
Granite is an igneous rock that hardened and crystallized from molten magma deep beneath the earth. You'll see bits of crystallized quartz in granite. When granite weathers, these quartz crystals get worn down into grains of sand. When deposited in a valley, lakebed, or ocean, sand can harden into the 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

Also, the bits of flaky mica and the 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

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: *This image is a work of a United States Geological Survey employee, made during the course of the person's official duties. As a work of the United States Government, the image is in the public domain.*

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
- 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.
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 place the canister into the mouth of your volcano, with the lid of the canister pointing up.
4. Keep kids back from the volcano and patiently wait. After a few seconds, the lid of the canister will pop several feet into the air along with a quick squirt of foamy water.

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!

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

Following are common igneous rocks that 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 that they may be able to trade through the mail 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 gravel, sand, or mud. These settle to the bottom of a basin (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.

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.

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 another, somewhat more involved project to make fossils using clay and plaster, see the back-up page for Activity 3.2. You can use either one 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 common sedimentary rocks that 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 that they may be able to trade through the mail as a club project with kids in other AFMS/FRA clubs that 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:

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 common metamorphic rocks that 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 that they may be able to trade through the mail as a club project with kids in other AFMS/FRA clubs that 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).

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 meteorites and comets. On a clear night, look to the sky, and you'll occasionally see streaks left by meteorites 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.

Activity 11.1: Modeling the solar system.
Check a book 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. Or draw a colorful poster of our solar system on long paper or a big sheet of poster board.

Activity 11.2: Learning about visitors from space.
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.

Activity 11.3: Effects of meteorites and famous craters.
Most meteorites are tiny and burn up in our atmosphere, creating bright streaks in the night sky that we often call "shooting stars." But some bigger meteorites 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 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.

Activity 11.4: Collecting meteorites and tektites.
If you happen to be lucky enough to live near a known "strewn field" where a meteorite 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.

Activity 11.5: Collecting meteorite dust.
While large meteorites are very rare and hard to find, a constant "rain" of meteorite dust falls through the air all the time from all those meteorites that burn up in 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.

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

To earn your Earth in Space 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 Activities chair.

_____
Date completed

_____ _____
My signature Youth leader's signature

_____
Name of my club

Leader's preferred mailing address for receiving badge:

_____

_____

_____

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 corresponds to the first letter of each planet, laid out in order from the sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and 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 remote spacecraft. Plus, we've kicked poor Pluto out of the family of planets, demoting it to a mere "dwarf planet"! At least, *some* scientists have. Others have added a planet or two in the form of icy bodies even larger than Pluto that have been found in the outermost reaches of our solar system.

Work with your 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 just 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 your planets across a room, the heat emitted by the light bulb can be used to 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 commercial models and posters of the solar system from museum gift shops, nature stores, toy stores, etc.

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, if you have a computer and color printer, 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. Check http://pds.jpl.nasa.gov/planets/ for terrific NASA photos.

Another neat web site at http://seds.lpl.arizona.edu/nineplanets/nineplanets is Bill Arnett's "The ~~Nine~~8 Planets". This site includes a link to the International Astronomical Union's 2006 revised definition of a planet that 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 argue with one another and don't always come to a consensus.

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 of the earth without totally burning up or vaporizing in the atmosphere. (While it's still in space, it's referred to as a "meteor.")

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 high into the atmosphere, or even into outer space. On their return to the earth's surface, they cool and harden during their fall through the air into round, oblong, or pear-shaped glassy rocks that are 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 may 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 consisting 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 from the comet 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 like these and others:

- Hugh Carman, *Collecting Meteorites: Starting in Your Own Back Yard* (Hill of Content Publishing Co.: Melbourne, Australia, 1995), 78 pages. Although focused on Australia, this is a great, handy introduction for the beginner anywhere on earth.
- Harry Y. McSween, Jr., *Meteorites and Their Parent Planets, Second Edition* (Cambridge University Press: Cambridge, UK, 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.
- O. Richard Norton, *Rocks From Space: Meteorites and Meteorite Hunters, Second Edition* (Mountain Press Publishing Co.: Missoula, Montana, 1998), 447 pages. This is considered one of the best all-round meteorite books for a general audience. It's a must on the shelf of anyone who gets seriously interested.
- Kathy Sawyer, *The Rock from Mars: A Detective Story on Two Planets* (Random House: New York, NY, 2006), 394 pages. Sawyer weaves the fascinating story of a meteorite from Mars discovered in Antarctica and the controversy it created when some scientists speculated that it held fossils of ancient Martian microbes.
- Dean Smith, *The Meteor Crater Story* (Meteor Crater Enterprises, Inc.: Flagstaff, Arizona, 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.

Back-up page 11.3: Effects of meteorites and famous craters.

While most meteorites simply burn up on hitting the atmosphere, some meteorite, asteroid, and comet impacts have had profound effects on our earth. For instance, it's now commonly 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's 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 squre 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 a 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 or ball bearings into wet sand or mud.** See if it makes a difference in crater size and shape by how hard the marble impacts, whether it drops straight or from an angle, or whether you use a large, small, heavy, or light marble.

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. A few of the more famous meteor craters include:

- Campo del Cielo (Argentina)
- Chicxulub (Yucatan, Mexico)
- Haviland (Kansas)
- Henbury Craters (Australia)
- Meteor Crater (Arizona)
- Odessa Crater (Texas)
- Manicouagan 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. Finally, Wikipedia has an article all about impact craters, as well as a table of known craters on Earth at:

- 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 and littered the landscape with hundreds or thousands of fragments (as near Odessa, Texas), your chances of collecting one on your own are greatly increased. O. Richard Norton's book *Rocks from Space* includes lists of known strewn fields. But getting to a strewn field is the easy part. You then have to be able to pick out a rock that, at a glance, may look like every other rock on the ground. Because meteorites usually have a high nickel-iron content, collectors use metal detectors or magnets attached to strings or at the end of a walking stick. In fact, one famed meteorite hunter, H. H. Nininger, used to drive through the desert towing a magnetic rake. One web site gives advice to novice meteorite seekers: www.novaspace.com/METEOR/Find.html.

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 that might be within a child's budget and that are common on today's market are small Nantan meteorites from China and small, black, pear-shaped tektites from Southeast Asia and Australia. I've seen these at almost every show I've attended.

Encourage your 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-R, 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 850 members with an interest in collecting meteorites who exchange information to learn about, discuss, and purchase meteorites.
- *The Meteorite Exchange, Inc.* (www.meteorite.com). This site has info about meteorites and the community of meteorite enthusiasts and dealers. In fact, it links to over 30 dealers, web sites, and eBay auctions and eBay stores.
- *Meteors.com* (www.meteors.com). Although this site includes an odd mishmash (music downloads, health and beauty aids, and Washington Mutual Credit Cards??), it also has a "Meteorites for Sale" link.

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).

Back-up page 11.5: Collecting meteorite dust.

Kids who really get into meteorites and tektites will soon be itching to collect some of their own. However, they immediately 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 or Australia 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!* Some neat web sites provide instructions on how to collect "micrometeorites" or meteorite dust:

- http://www.pbs.org/wgbh/nova/teachers/activities/3111_origins.html
- http://www.teachersource.com/micrometeorites.htm
- http://starryskies.com/Artshtml/dln/6-00/dust.html

Most meteorites burn up in our atmosphere, but as they do, they leave a trail of dust. That dust, along with micrometeorites, bits of comets, and other solar debris is constantly raining down on us. In fact, by some estimates, tens of thousands of tons of extra-terrestrial material falls on earth each year! The web sites I've referenced above give specific instructions on how to collect micrometeorites and cosmic dust. 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 3 or 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.

With all these techniques, most of what you'll collect will be ordinary earthbound dust and dirt (spiced with the occasional bird dropping). 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 few pieces 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).

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 find a gold flake or nugget of your own.

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.

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

To earn your Gold Panning & Prospecting 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 Activities 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 a popular mineral, and 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 by writing to Diamond Dan Publications, c/o Darryl Powell, P.O. Box 143, Manchester, NY 14504. Email diamonddan@rochester.rr.com for current pricing or check the Diamond Dan web site: http://home.rochester.rr.com/diamonddan

Here's how gold compares to iron pyrite by a variety of common mineral properties:

Property	Gold	Pyrite
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	cubic/isometric
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 Mineral Information Institute, or MII (http://www.mii.org/). MII 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 Mineral Information Institute (MII) has a terrific little packet all about gold on their web site (http://www.mii.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.

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 info on mineral resources in your state. It also will guide you to your state's geological survey or division of mines. Simply click on your state on the map that appears on the opening pages of the USGS web site and then follow the links.

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.

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:

- Mineral Information Institute (http://www.mii.org/panforgold.html) They sell a "Gold Panning Kit" with gold concentrate, pan, instructions, etc., as well as individual pans and individual bags of concentrate at reasonable prices.
- The Lifestyle Store (http://www.lifestylestore.com/ls_gold_practice.html) You can get a practice supply of drywasher concentrate from the California Mojave Desert.
- Felix Paydirt's Gourmet Gold (http://www.felixpaydirt.com/dirt.html) From the Fairbanks, Alaska, mining district, you can get bags ranging from 2 to 51 pounds.
- Gold Fever Prospecting (http://store.goldfeverprospecting.com/goldpanning.html) Get a variety of equipment, books, and concentrates from the California Motherlode.

Some companies selling concentrate also sell equipment or provide a beginner's package with concentrate, a pan, and brief instructions. Basic gold-panning equipment 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:

- Angier, *Looking for Gold: The Modern Prospector's Handbook*
- Butler, *Recreation Gold Prospecting for Fun and Profit*
- Lagal, *The New Gold Panning is Easy*
- Von Lusch, *Gold Prospecting*

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).

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 25^{th} anniversary is considered a silver anniversary and a 50^{th} 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 Activities 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)	Emerald
February	Amethyst (or Tourmaline)	Bloodstone
March	Aquamarine (or Bloodstone)	Jade
April	Diamond (or Nephrite Jade)	Opal
May	Emerald (or Agate)	Sapphire
June	Pearl (or Alexandrite or Moonstone)	Moonstone
July	Ruby (or Onyx)	Ruby
August	Peridot (or Sardonyx)	Diamond
September	Sapphire (or Malachite)	Agate
October	Opal (or Tourmaline)	Jasper
November	Topaz (or Citrine or Rubellite)	Pearl
December	Blue Topaz (or Turquoise, Zircon, Lapis Lazuli, or Tanzanite)	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 razer-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 Activities 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 primitive 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.

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.

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 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 45-minute video may be purchased on-line for $24.99 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 any 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.

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.

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
- brown clay
- red clay
- white clay
- white chalk
- 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 of the 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 goats 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 web sites 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, and to find your way to collecting sites.

Activity 15.1: Exploring the web.
Gather around a computer with your youth leader and other members of your club to explore the web via search engines like Google, Yahoo, MSN, 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.

Activity 15.2: Reporting on favorite web sites.
Explore the web on your own to find 2 or 3 web sites 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.

Activity 15.3: Making presentations with the computer.
Create a PowerPoint presentation about your favorite rocks, minerals, fossils, or collecting site using images from the web or from pictures taken with a digital camera. If you have the right equipment and skills, you can even incorporate video clips.

Activity 15.4: Cataloging your collection electronically.
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.

Activity 15.5: Maps and GPS to find your way.
Learn about different types of traditional paper maps (roadmaps, topographic maps, geological maps, etc.). Then explore mapping features 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.

15. Rocking on the Computer

□ 15.1 Exploring the web

□ 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

To earn your Rocking on the Computer 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 Activities 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.

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 web sites 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 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 my day job at a publishing company, I interact a lot with librarians. They're 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.

Librarians also would be 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 web sites 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 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 web sites.
- 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 up 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. This activity now sends them off to explore the web on their own and to report back. Each should surf the web to explore his or her own area of interest, be it minerals, fossils, geodes, meteorites, dinosaurs, famous gemstones, lapidary arts, museums, etc. Have kids settle on the two or three web sites related to their topic that they find the most interesting. They should thoroughly explore the sites and then do a brief write-up 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 web sites you might recommend:

Fossils:

- www.isgs.uiuc.edu/dinos/ "Dino Russ" provides info on dinosaur digs, exhibits, societies, publications, dinosaur artwork, and more.
- 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.

Minerals and Earth Resources:

- www.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.
- www.mii.org The Mineral Information Institute 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 A Mineral Gallery shows gorgeous gemstones with info on the properties of nearly 200 different types of minerals.

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.
- http://Socrates.berkeley.edu/~eps2/ A professional gemologist and a college professor team to provide lessons on gems, gem material, and lapidary skills.
- www.tradeshow.com/gems/ A comprehensive introduction to gemology and the lapidary arts for the general public.

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 the 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 view, 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 often 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 (albeit more expensive) alternative to creating your own database from scratch is purchasing any of several software packages now on the market expressly 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. One example is TFGCollector, custom-made software for cataloguing facts about a rock or fossil collection (available from The Fredrick Group, Inc., 100 Colony Park Drive, Suite 303, Cumming, GA 30040, phone 678-947-1355, Ext. 500; web site http://www.fredrickgroup.com).

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 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 big, 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 their 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, outdoor supply stores, etc. 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, though, is how getting from Point A to Point B has been transformed with the arrival of the digital age. Show your kids how they can enter start and end points into MapQuest (http://www.mapquest.com) or similar services on the web and get specific directions, driving distances, and estimated travel time, along with a color map highlighting their route, all at the click of a mouse. 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 road maps with satellite images that allow you to zoom in for a real-time 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.

Rockhound Badge

Once you've completed six or more of the fifteen 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.

If you wish to earn all fifteen 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.

In earning at least six of the fifteen 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!