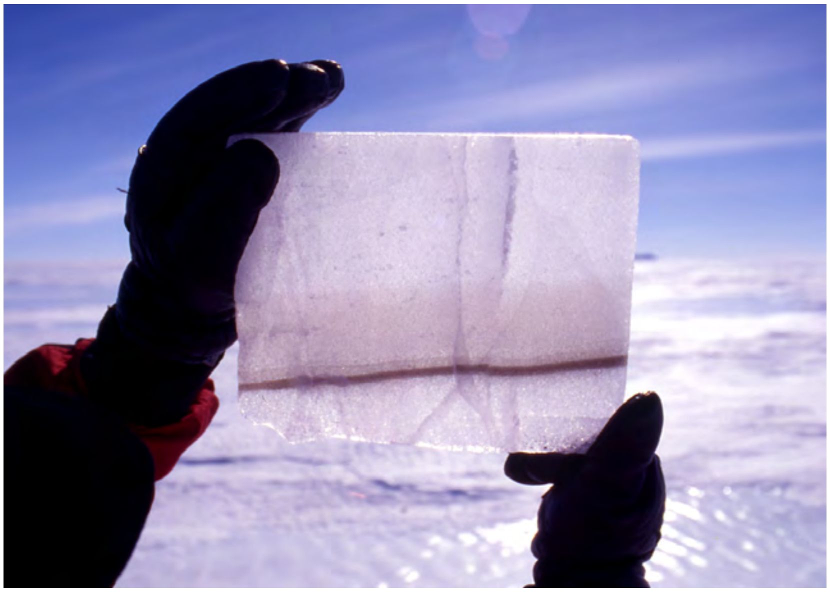
Lite Geology

EARTH BRIEFS

FALL 2009 ISSUE 26

How Can Popcorn Help Us Understand Climate?



The dark band in this picture is a layer of volcanic ash trapped in ice from the East Antarctic ice sheet. The ash was deposited on snow on the surface of the ice sheet, which was then buried and compressed over time to form ice. Determining the age of the ash layer will reveal the age of the ice adjacent to the ash layer.

Climate change is an increasingly critical issue across the globe, and many countries are poised to spend enormous sums of money in an effort to prevent or minimize the negative effects that most scientists predict will occur in the coming years. But what are these predictions based on? Reliable temperature and other climate records only go back about 200 years, but the earth's climate has been changing for its entire 4.5-billion-year history. Identifying long-term temperature swings and variations in the composition of the atmosphere are critical to understanding what causes global climate change and to making accurate predictions of what the future holds.

Ice Cores: Windows into the Earth's Past

How can we determine the earth's temperature trends in the past, and what caused these episodic periods of relative warmth and cold? Clues can be found in rocks, sediments, tree rings, and cave formations. One of the best sources of this information is actual samples of air and precipitation from the geologic past that have been preserved in layers of snow and ice that have accumulated in glaciers and ice sheets. Virtually all of Greenland and Antarctica are covered by ice sheets, which are more than 10,000 feet thick in places. This ice has been accumulating for hundreds of thousands of years. It contains air bubbles that were included with the snow as it fell, preserving samples of the atmosphere at that

In This Issue…

Lite Geology was first published in the fall of 1992. This is the first issue using a new electronic format. The articles and features still focus on current events and issues related to earth science and are written in a less technical style primarily for students and teachers in grades 7–12. Each issue will include articles and classroom activities, plus regular features, teachers' resources, Web links, and upcoming geological and scientific events.

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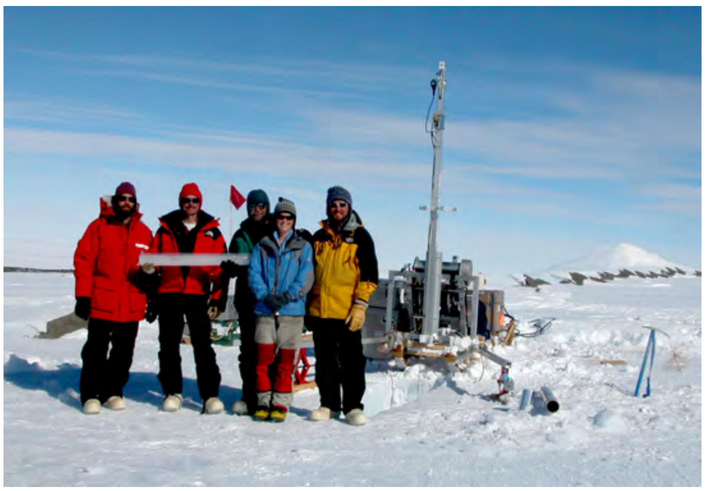
time. The chemical composition of the ice itself reveals past temperature. Data from these tiny time capsules allow us to identify global temperature trends and to measure past levels of carbon dioxide and other greenhouse gases. Correlating prehistoric temperatures with greenhouse gas levels in the atmosphere helps us to create climate models that predict how current and future atmospheric greenhouse gas concentrations will contribute to climate change and global warming. Thanks to ice cores extracted from the Greenland and Antarctic ice sheets, we now have climate data for the past 400,000 years. But how do we know the age of individual layers of ice? Counting annual layers of ice like rings in a tree just isn't accurate enough for older ice in many ice cores.



Ice coring on the summit of Mount Moulton, in West Antarctica. A portable drill rig is shown, and scientists hold a segment of ice core retrieved by the drilling operation. A thick ash layer is visible in the background (dark band) at the base of the source volcano, Mt. Berlin.

Geologists take advantage of the decay of natural radioactive elements to determine the age of rocks. But they must look for deposits that contain these elements. When volcanoes erupt, they deposit ash over the surface of the ice sheets, which is then covered by later snows and preserved. Even minute quantities of dust and volcanic ash from distant eruptions can be dated through geochemical and isotopic analyses. One rock dating method, called potassium-argon (K–Ar) geochronology, analyzes crystals in volcanic ash to help determine the age of ash-bearing horizons in ice cores.

K–Ar geochronology, and a related, higher-precision technique called $^{40}Ar/^{39}Ar$ geochronology, rely on the principle that radioactive elements decay over time, with a parent isotope of potassium (K) decaying to form the daughter isotope argon (Ar). The daughter isotope, being a gas, does not start to accumulate until a volcanic eruption takes place, and the molten rock cools, at which point the radioactive decay clock starts. At this point the system becomes effectively closed, and the ratio between parent and daughter isotopes begins to change. Over a very long period of time, almost all of the radioactive K will decay to form Ar. The time that it takes for half of the potassium to turn into argon is called the "half-life," which in this case is 1.25 billion years. In the first 1.25 billion years after the eruption, half of the potassium will decay into argon. In the next 1.25 billion years, half of the remaining potassium will decay (leaving one-fourth of the original potassium), and so forth. By precisely measuring the ratio of potassium to argon in feldspar crystals in ash from a volcanic eruption, the age of the eruption, and therefore the age of the ice adjacent to the ash layer, can be determined.

Popcorn Activity (grades 6–12)

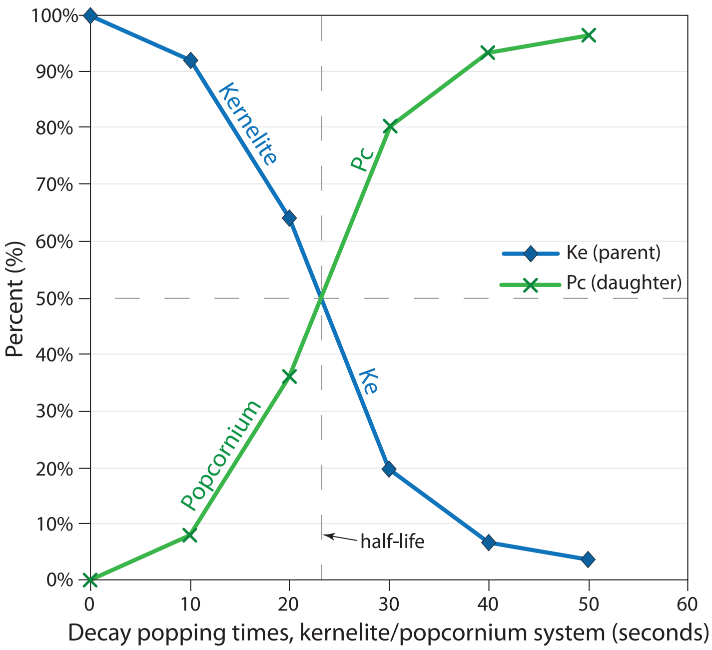
Understanding how radioactive decay works, and how long it takes for a specific element like potassium to decay, is critical to being able to date rocks using the K-Ar geochronology. A simple way to simulate radioactive decay is by making popcorn. Popcorn starts out as unpopped "parent" kernels we'll call "kernelite" (Ke). Heating starts the radioactive decay clock, and the "kernelite" begins to decay to a new daughter product of popped kernels we'll call "popcornium" (Pc). Just like radioactive decay, this process is irreversible, and with enough cooking time almost all the kernelite will decay to popcornium. The "half-life" of kernelite is the amount of time it takes for half of the kernels to pop, transforming them into popcornium.

Bag #	Pop time	Stopwatch time	Ke	Pc	% Ke	% Pc
Bag 1						
Bag 2						
Bag 3						
Bag 4						
Bag 5						
Bag 6						
A						
B						
C						
D						

Record the data generated from the popcorn exercise on this data sheet. These can then be used to calculate the percentages of each element (Ke and Pc). Use these percentages to plot the decay and accumulation curves of kernelite and popcornium.

The following experiment using the "kernelite/popcornium" system can help us understand radioactive decay. Pop several bags of popcorn, keeping them in the microwave for different amounts of time, and then count the pieces of kernelite and popcornium in each bag. After acquiring the data, the next step is to plot the "decay" curve of kernelite and the "accumulation" curve of popcornium.

Next use these curves to establish the "half-life" of kernelite. Then you will use the curves to determine the "age" (popping time) for bags of popcorn for which the age is unknown. The experiment involves several steps as described below. Data sheets and graph pages for use with this activity can be found at: **http://geoinfo.nmt.edu/education/exercises.**



This sample graph shows the decay curve of kernelite and accumulation curve of popcornium through time. The "half-life" of kernelite is determined by the point where the two curves cross. In this example, the half-life is expressed in seconds of popping time (decay) and is shown by the dashed vertical line.

Materials:

- 10 mini-bags of microwave popcorn
- one large roll of craft or parchment paper
- pens and markers
- master data sheets for recording popping times and kernel counts **http://geoinfo.nmt.edu/education/exercises**
- graph paper

1. Using a microwave oven, pop six bags of popcorn one at a time. Label the six bags with six different predetermined popping times (0 seconds, 10 seconds, 20 seconds, 30 seconds, 40 seconds, and 50 seconds). Preset the microwave time for 2 minutes. Keep in mind that some time will elapse as the popcorn heats up before it begins to pop. Do not count this time before the popping begins. The "radioactive decay" timing begins when you hear the first kernel of popcorn pop. Use the microwave timer or a stopwatch to then measure the popping time. Turn the microwave off and remove the bag as soon as the predetermined (decay) popping time is reached.

2. Label the remaining four bags A, B, C, and D. Pop each for time intervals between 10 and 50 seconds. Secretly record the time for each of the bags. These are the unknown samples for which the "age" (popping time) will be determined later.

3. Divide the class into ten groups. Each group will open a bag of popped corn, spread the contents on a large sheet of parchment paper, and carefully count and record the number of kernelite and popcornium pieces. Record your results on the data sheet.

4. Plot the results from bags with known popping time intervals on the graph with time (t) on the horizontal axis, percent of kernelite (parent) on the vertical axis (0–100% scale). On the same graph, also plot the percent of popcornium (daughter). You can now determine the "half-life" of the kernelite/popcornium system by finding the point where both the percent of kernelite and the percent of popcornium are 50% (i.e., where the two plotted lines cross) and then reading the time from the horizontal axis.

5. Find the % Ke values from "unknown" bags (A–D) and plot where they intersect your decay curve. Now, determine the unknown "age" (popping time) for each bag by reading the time from the X-axis that corresponds to the measured % Ke. Compare your results to the mystery popping times that were secretly recorded.

6. Discuss the ways in which experimental errors can affect your results. How might your experimental kernelite/popcornium decay system differ from a natural radioactive decay process, such as occurs in volcanic ash layers in ice cores? How else might scientists use radioisotopic dating to study climate history and other geologic records?

The popcorn exercise was created by Susan Welch, Nelia Dunbar, Bill McIntosh, Douglas Bland, and Lynn Heizler at the New Mexico Bureau of Geology and Mineral Resources. Special thanks to Matteo Cattadori, a teacher from Italy who inspired this exercise.

Through The Hand Lens

Profile of a New Mexico Earth Science Teacher

Carla Burns, a science teacher at Ruidoso High School, has been an active participant in teacher programs at the New Mexico Bureau of Geology and Mineral Resources for many years. She has served as a facilitator at Rockin' Around New Mexico teacher workshops and also has attended several earthquake education workshops. Carla's enthusiasm for geology is contagious, and her rock collection grows with every locality she visits. Here is a summary of Carla's teaching background and favorite earth science resources.

Ruidoso High School science teacher Carla Burns at Dry Falls in the Channeled Scablands of Washington State.

Grade Level and Subjects Taught

Pre-AP (Advanced Placement) Chemistry, AP Chemistry, Pre-AP Physics, and Astronomy/Geology

Education

B.S. from Utah State University with a Biology major, Chemistry, Math, Secondary Ed minors; M.S.T. in Chemistry/Biology from New Mexico Tech.

Professional Achievements

- Presidential Award for Science Teaching
- Outstanding Science Teacher
- Outstanding MESA (Mathematics, Engineering and Science Achievement) Advisor
- Past president and board member (20 years) for New Mexico Science Teachers Association
- Reviewer for science adoption materials with the New Mexico Public Education Department (2005)

Why is it Important for Students to Learn About Earth Science?

Earth science is critical to understanding the cycles on our planet, how our raw materials are obtained, and why geology is important to our way of life.

Advice or Suggestions for Other Earth Science Teachers

Make it fun and relevant to your students. Do local geology field trips and help them become interested in the richness of the geology of our state.

Favorite Lesson in Earth Science

Carla's favorite lesson in earth science is one that she offers during the first week of her geology class:

Local Geology Rock Lab
What is the local geologic history for where we live?

I ask students to collect five local rocks from the area where they live. The major stipulation is that the rocks must be indigenous to the area—no landscaping rocks, gravel, asphalt, etc. All students must bring their rocks to school at the beginning of the geology class. We then spend a class period or two looking at the rocks and keying them out as much as possible. Sometimes we are only able to identify them as igneous, sedimentary, or metamorphic.

Next, we spend some time learning or reviewing the rock cycle. We work on our rock identification skills. We then categorize our rocks and determine the percentage of each type of rock.

Students will then use their books, the internet, and other resources to determine the environment for the various rock types. They must always be asking themselves, "Why are we finding this type of rock in this location?" At the end of their investigation, students in groups create a geologic history of our area and do a presentation for the class.

Carla Burns' Favorite Resources and Web Links

New Mexico Bureau of Geology materials and publications geologic maps, (including the New Mexico Geologic Highway Map) DVDs about geology, and the Earth Science Week planning toolkits for teachers.

- Geology.com is a comprehensive Web site for earth science news, maps and images, geology careers, and links to resources. **http://www.geology.com**
- The United States Geological Survey provides science information on biology, geography, geology, geospatial data, and water. **http://www.usgs.gov**
- The Hawaiian Volcano Observatory Web site features reports on current eruption activity and past eruption histories for the Hawaiian volcanoes. **http://hvo.wr.usgs.gov**
- The New Mexico Bureau of Geology and Mineral Resources serves as the state geological survey and provides earth science information about New Mexico. **http://geoinfo.nmt.edu**

Favorite Geologic Feature in New Mexico

Volcanoes! And the Rio Grande rift valley.

Rockin' Around New Mexico 2009

Our Annual Teachers' Workshop

Each year, *Rockin'* teachers have the opportunity to explore the geology of a unique location of the state. A combination of in-class instruction and field trips gives participants background in basic geology concepts, in addition to geologic hazard risks and school safety instruction. Curriculum materials are provided to support teachers in using the lessons in the classroom. Graduate credit for participating in the workshop is available through the Masters of Science for Teachers (MST) program at New Mexico Tech.

The 2009 *Rockin' Around New Mexico* workshop was centered in Grants, New Mexico, and began with an overview of local geology including Mt. Taylor, East Grants Ridge, and the Grants uranium district. A special lesson on radioactivity and radiation safety provided the foundation for understanding uranium geology and mining issues as well as radiometric dating of rocks. Field trips to local uranium mills under reclamation and the Mt. Taylor uranium mine allowed for discussions on the history of mining, reclamation, and future potential for uranium production in the Grants uranium district.

During the field trip to the volcanic deposits of East Grants Ridge, teachers examined the eruptive sequence visible at several outcrops. Teachers collected obsidian and rhyolite samples and were given pumice and lava rock samples from other local deposits to use in their classrooms. Following the field trip, teachers participated in discussions on earthquake and volcanic hazards in New Mexico, as well as classroom safety practices.

Bureau of Geology economic geologist Virginia McLemore (left) and New Mexico Tech geology professor Bruce Harrison (right) describe reclamation activities from the top of the Homestake uranium mill tailings pile. Evaporation ponds used for treating contaminated water can be seen in the distance.

Teachers learn about volcanic structures at East Grants Ridge on the western flank of Mt. Taylor. The black outcrop on the skyline is a basaltic volcanic plug, and the white rocks to the left are pumice deposits formed at an early stage of the eruption.

Wanted: Science Teachers for a 3-day Summer Geology Field Experience

The workshop is conducted each summer by the New Mexico Bureau of Geology and Mineral Resources with the support of other agencies and organizations. If you are a K–12 educator and would like to increase your knowledge in earth science, consider attending the next *Rockin' Around New Mexico* summer geology workshop for teachers. For information about participating in the 2010 session of *Rockin' Around New Mexico*, contact Susie Welch at the New Mexico Bureau of Geology by e-mail at susie@nmt.edu or call 575-835-5112. Teachers who are actively in the classroom or pre-service teachers are welcome to apply. Dates are usually the first or second week in July. Applications will be available online or by mail in February 2010.

Rockin' 2009 Was Sponsored By:

New Mexico Bureau of Geology and Mineral Resources

New Mexico Department of Homeland Security and Emergency Management

New Mexico Institute of Mining and Technology

New Mexico Geological Society

New Mexico's Enchanting Geology

Where Is This?

Soda Dam is a rock structure formed by hot springs from geothermal activity. Ground water is heated by hot volcanic rocks deep beneath the Valles caldera in the Jemez Mountains, then travels along a fault and surfaces at Soda Dam. The hot water carries dissolved minerals and deposits them at the surface in thin layers of finely crystalline calcium carbonate, called travertine. These spectacular travertine formations began forming hundreds of thousands of years ago.

Twenty-five years ago, water discharged from a fissure along the axis of the dam, and the dam was actively growing. Unfortunately, the New Mexico State Highway Department, in trying to repair a hump on New Mexico State Highway 4, damaged the plumbing system of the dam, and since then Soda Dam has been slowly eroding away. A new travertine mound is forming on the west side of the highway.

Soda Dam is located 0.4 miles north of the Jemez Springs Ranger Station on New Mexico State Highway 4, about an hour north of Albuquerque.

The GPS location is:

UTM: Zone 13
13S 347630E 3961900N (NAD27)
Coordinates:
35° 47' 28" N 106° 41' 11" W

Short Items of Interest to Teachers and the Public

The Mineral Museum on the campus of New Mexico Tech in Socorro, New Mexico

Hours:

8 a.m. to 5 p.m., Monday through Friday
10 a.m. to 3 p.m., Saturday and Sunday
Closed on New Mexico Tech holidays

Web page:

http://geoinfo.nmt.edu/museum/

The Mineral Museum is located in the Gold Building on the campus of New Mexico Tech in Socorro. The bureau's mineralogical collection contains more than 16,000 specimens of minerals from New Mexico, the United States, and around the world, along with mining artifacts and fossils. About 2,500 minerals are on display at a time.

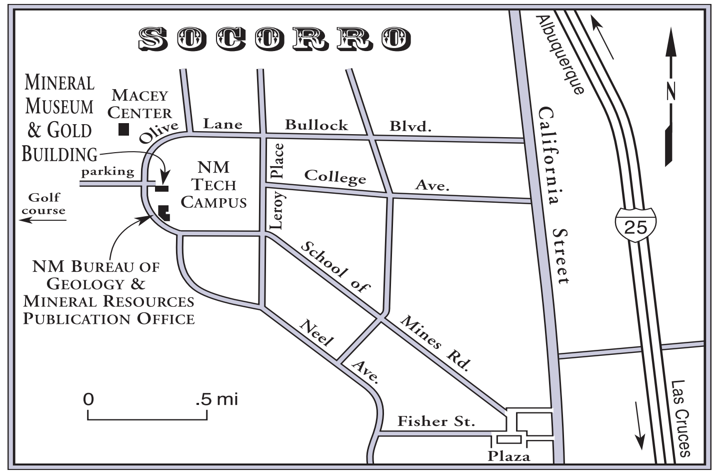
For teachers and other groups, we offer free tours of the museum. We like to show off our home state minerals, as well as give students an idea of how minerals end up in products we use every day. Museum staff can also identify rocks or minerals for visitors. Please call ahead to ensure someone will be available. For more information on the museum, please visit our Web site at: http://geoinfo.nmt.edu/museum/

Dr. Virgil Lueth
Senior Mineralogist and Curator
vwlueth@nmt.edu
575-835-5140

Bob Eveleth
Senior Mining Engineer and Associate Curator
beveleth@gis.nmt.edu
575-835-5325

To schedule a tour, contact:

Susie Welch
Manager, Geologic Extention Service
susie@nmt.edu
575-835-5112



The Publication Sales Office at the New Mexico Bureau of Geology and Mineral Resources on the campus of New Mexico Tech

Open 9 a.m. to 4 p.m. (closed for lunch from 12 to 1), Monday through Friday.

Call 575-835-5490 for phone orders or information, or visit our Web site at:
http://geoinfo.nmt.edu/publications/home.html

The Publication Sales Office has many resources for teachers, including publications on New Mexico's geology, many meant for the amateur geologist and general public.

We offer:

- Topographic maps for the entire state of New Mexico
- Geologic maps for selected areas of New Mexico
- U.S. Forest Service maps
- A 20% discount for teachers

Our Newest Publications Include:

Water, Natural Resources, and the Urban Landscape: The Albuquerque Region, edited by L. Greer Price, Douglas Bland, Peggy S. Johnson, and Sean D. Connell, Decision-Makers Field Guide 2009. The 2009 field guide provides a broad overview of geologic and resource management issues related to the rapidly growing Albuquerque metropolitan area. The 23 papers, written for a general audience, discuss the most critical of these issues, including water supply strategies for the future, geologic hazards, saline waters and deep, non-potable aquifers, and flood control challenges.

The book includes full color photographs, maps, illustrations, diagrams, tables, and a fold-out map of the drainage facilities in Albuquerque. Available for sale or online at: **http://geoinfo.nmt.edu/publications/decisionmakers/2009/home.cfm**

New Mexico Earth Matters, Summer 2009, ***The New Mexico Library of Subsurface Data*** by Ron Broadhead and Peter A. Scholle. This summer ***Earth Matters*** takes readers behind the scenes at the bureau to explore our subsurface data collection. Learn how and where core samples are collected, how they are stored, and why they are important.

You can sign up for a free subscription to ***Earth Matters*** if you live in the state of New Mexico. Call 575-835-5302 or e-mail us at pubsofc@gis.nmt.edu. If you prefer to get your information online, all of our ***Earth Matters*** issues can be found on our Web page at:

http://geoinfo.nmt.edu/publications/periodicals/earthmatters

Previous issues include many topics on New Mexico's geology including volcanoes, hydrology, caves, energy resources, climate change, earthquakes, geologic mapping, and more.

Upcoming Events for Teachers and the Public

Earth Science Week, October 11–17, 2009

The American Geological Institute designates one week each year as Earth Science Week, and each year has a different theme. This year it is October 11–17, 2009, and the theme is "Understanding Climate." More information about the activities, events, and materials planned for Earth Science Week can be found at the Earth Science Week Web site: **http://www.earthsciweek.org/**.

Related links include:

- American Geological Institute: **http://www.agiweb.org**
- Earth Science Week toolkit and classroom materials: **http://www.earthsciweek.org/materials**
- Earth Science Week contests: **http://www.earthsciweek.org/contests**
- National Academy of Sciences on climate change: **http://nas.edu/climatechange**
- Earth science education and outreach: **http://www.agiweb.org/geoeducation**
- National Oceanic and Atmospheric Administration education programs on weather and climate: **http://www.education.noaa.gov**

For ideas on classroom activities or planning an event near you, check out the Earth Science Week Web site: **http://www.earthsciweek.org/**.

A helpful planning toolkit for teachers can be ordered online. Governor Bill Richardson has proclaimed October 11–17, 2009, as Earth Science Week in New Mexico. See a copy of the proclamation on the Earth Science Week Web site.

Soar to Greater Heights: Professional Development for Our Sustainable Future, New Mexico Science, Math and Environmental Education Conference, October 22–24, 2009

This conference will be held in Ruidoso, New Mexico. Online registration for the conference is at: **http://nmteach09.eventbrite.com**

Open House at the New Mexico Bureau of Geology and Mineral Resources November 7, 2009

10 a.m. to 2 p.m. on the campus of New Mexico Tech in Socorro, New Mexico

As part of Exploration Day at New Mexico Tech, the Bureau of Geology, Mineral Museum, and Publication Sales Office are sponsoring an open house. New Mexico Tech students and families, and the public are welcome to browse the new publications, enjoy refreshments, and see what is new at the museum.

Online Resources for Teachers and Students

The EPA Student Center is a Web page for kids to learn about the environment. It is a good starting place for science projects, helping out the planet, or exploring possible careers in environmental science. Kid Friendly!
http://www.epa.gov/students/

USGS Earthquakes for Kids is a student Web page with easy access to latest quakes, cool earthquake facts, activities, games, science project ideas, etc. Kid Friendly!
http://earthquake.usgs.gov/learning/kids/

The Bureau of Land Management hosts a Web page called Just for Kids: Soil Biological Communities that contains where students can have fun learning all about the importance of soil to the living creatures who depend on it, including us! Kid Friendly!
http://www.blm.gov/nstc/soil/Kids/knowmore.html

The City of Albuquerque's Web page offers information on supporting a sustainable environment for its citizens. Learn about the steps Albuquerque is taking to improve the quality of life through its Green Goals program such as the recycling and waste reduction, public transportation, alternative fuels, the San Juan–Chama drinking water project, and more.
http://www.cabq.gov/albuquerquegreen

Credits for Lite Geology

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