2003 EARTH SCIENCE WEEK FIELD TRIP

October 18 and 19, 2003

Get Out, Stay Out, and Stay Alive!

This year's Earth Science Week public field trip is designed to encourage people to get out into the backcountry surrounding the Reno-Sparks area to explore and appreciate our rich geologic history and mining heritage, while at the same time educating people to "Stay Out and Stay Alive" when it comes to abandoned mine workings. It is for anyone who wants to find out more about local geology, abandoned mine safety, and Nevada mining and environmental concerns. It is also for anyone who wants to collect a variety of volcanic rocks, the ore minerals pyrite and enargite, and 16 million-year-old leaf fossils in diatomite, a sedimentary rock. Local geoscientists will accompany you on the trip to answer questions on any of these topics.

In keeping with the theme of National Earth Science Week 2003, "Eyes on Planet Earth: Monitoring Our Changing World," we will learn about some of the ways earth scientists monitor changes in the earth's crust-measuring the pH of stream water, testing for dissolved solids in mine drainage water, observing groundwater-monitoring wells, looking at water chemistry data from a mined area, and discussing how GPS satellite data can help us monitor tectonic changes in the Earth's crust.

This approximately 60-mile round trip will take us to sites located 20–25 miles north of Reno near the Pyramid Lake Highway. The first two stops will require only high-clearance vehicles, but the last stop will be on a very rough road up Perry Canyon probably requiring a four-wheel-drive vehicle.

Field trip participants will meet at 8:30 A.M. at Washoe County's **Lazy 5 Regional Park** located on the east side of the Pyramid Lake Highway about 5 miles north of North McCarran Boulevard. We will depart the park at 9 A.M.

Road Log:

Odometer mileage

cumulative

0.0 **Lazy 5 Washoe County Regional Park;** restrooms, water, playgrounds
Depart parking lot and turn right (north) on the Pyramid Lake Highway.

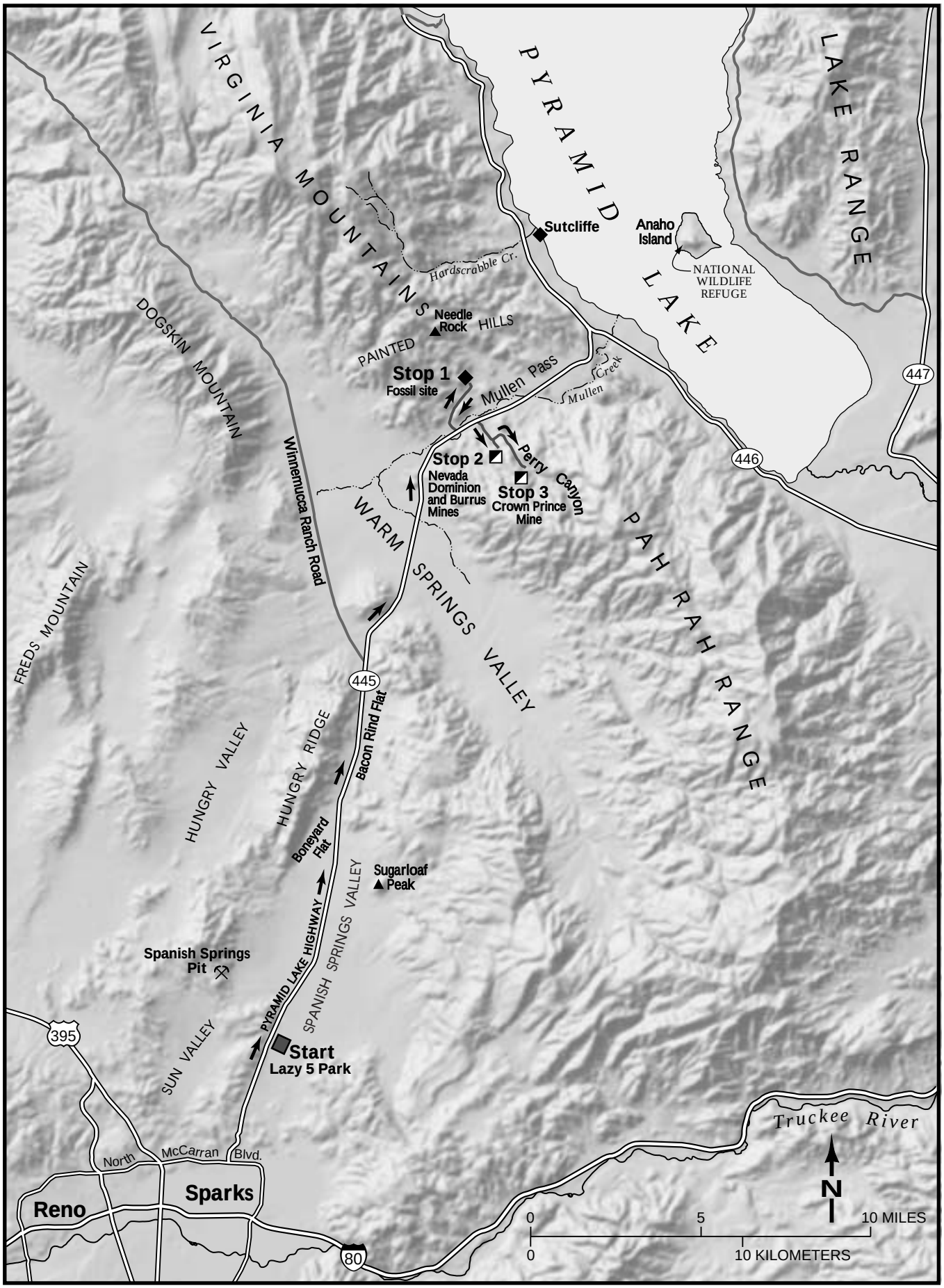
1.2 Pass La Posada on right. Spanish Springs High School is visible near the base of the mountains on the left, where 4 inches of rainfall on June 20–21, 2002 triggered a flood and debris-laden mudslide that caused more than a million dollars worth of damage. Detailed mapping of the sediments on alluvial fans before building on them can help direct development to areas less susceptible to flooding and help design debris detention basins that work.

3.7 Pass Sha Neva Road on the left, which leads to the Spanish Springs aggregate quarry to the west, where Martin Marietta Corporation mines and crushes granodiorite (an igneous rock similar to granite) for use in construction projects in the Reno-Sparks area. A range front fault at the base of the mountain has crushed the rock and allowed it to weather into "DG" or "decomposed granite," which is also mined and sold for construction and landscape use.

9.6 The hills on the right are capped by west-dipping Oligocene ash-flow tuffs, volcanic rocks that are 25–30 million years old.

10.7 Pass Winnemucca Ranch Road. Dogskin Mountain, the prominent peak at 10 o'clock, is composed mainly of gray and black speckled intrusive igneous rock called quartz monzodiorite.

For the next few miles, we will be crossing the Warm Springs fault zone, one of many northwest-trending fault zones that make up the Walker Lane fault zone, which runs parallel to the Nevada-California border and extends as far south as the


VIRGINIA MOUNTAINS
PYRAMID LAKE
LAKE RANGE
Sutcliffe
Anaho Island
NATIONAL WILDLIFE REFUGE
Hardscrabble Cr.
Needle Rock
HILLS
PAINTED
DOGSKIN MOUNTAIN
Stop 1
Fossil site
Mullen Pass
Mullen Creek
447
446
Stop 2
Nevada Dominion and Burrus Mines
Stop 3
Crown Prince Mine
Perry Canyon
Winnemucca Ranch Road
WARM SPRINGS VALLEY
PAH RAH RANGE
FREDS MOUNTAIN
445
Bacon Rind Flat
HUNGRY VALLEY
HUNGRY RIDGE
Boneyard Flat
Sugarloaf Peak
SPANISH SPRINGS VALLEY
Spanish Springs Pit
PYRAMID LAKE HIGHWAY
395
SUN VALLEY
Start
Lazy 5 Park
Truckee River
North McCarran Blvd.
Sparks
Reno
80
N
0 5 10 MILES
0 10 KILOMETERS

Death Valley area. GPS technology allows us to measure the actual movements of the earth's crust in response to the movement of the underlying tectonic plates. Recent measurements indicate that the interaction between the Pacific plate on the west and the North American plate on the east is expressed not only by movement along California faults like the San Andreas, but also by strike-slip movement along the Warm Springs fault zone and other parallel faults farther inland. The rocks bordering such faults are being mapped in detail to better understand the nature of this movement.

12.2 On the right is the Wild Horse and Burro adoption facility operated by the U.S. Bureau of Land Management.

13.0 Entering Palomino Valley, still crossing the Warm Springs fault zone. The brightly colored volcanic layers at 11 o'clock are called Incandescent Rocks.

17.0 Pass access road to Washoe County shooting facility on the left. **Begin to slow down here to make a left turn**.

17.8 Turn left over cattle guard.

18.0 Bear right at fork in dirt road by gravel pit.

18.1 Bear right at fork in dirt road.

18.3 Bear left at fork in dirt road.

18.6 Bear right at fork in dirt road.

19.0 At crest of hill, bear right at fork in dirt road.

19.2 Bear right at fork in dirt road.

19.8 Park on the left side of the road where white rock is visible.

STOP 1. The Miocene Fossil Lake Beds in Mullen Pass

Within 100 feet or so of the road you will find shallow trenches that have been dug to expose the plant-fossil-bearing horizon in the diatomite unit of the Pyramid sequence. Basalt rocks that are interbedded with the ancient diatomaceous lakebeds have been radiometrically dated at 15.6 million years old. Leaf impressions are faint, white-on-white, so look carefully at broken rock surfaces to find them.

The Pyramid Sequence fossil-plant site was discovered in 1951 by Dr. Ira La Rivers of the Biology Department, University of Nevada, Reno. Initial collections were made by Dr. Daniel I. Axelrod (then at the University of California, Los Angeles) in 1952. Later, in 1965 Professor Axelrod and Howard Schorn collected most of the 1,414 fossils recorded, of which the best preserved are now housed at the Museum of Paleontology, University of California, Berkeley. Professor Axelrod published a monograph on the fossil flora in 1992.

Dr. Axelrod recognized a total of 41 different species at this site, of which five types of plants account for more than 80% of the total specimens. The five most abundant species, in order of their abundance, are: **evergreen oak** (Quercus), 27%; **birch** (Betula), 20%; **2 species of alder** (Alnus), 28%; and **maple** (Acer), 6%. Dr. Axelrod's abundance counts tell us what types of fossil plants we are most likely to collect at this site.

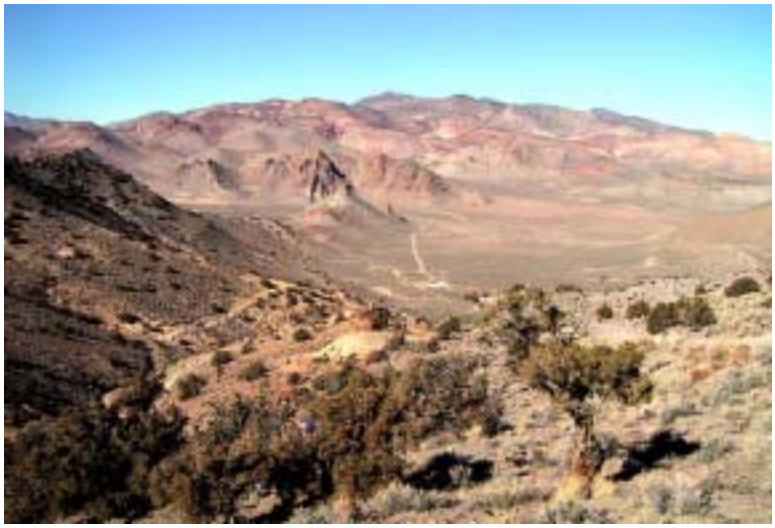
Digging for fossils in diatomite at Mullen Pass.

Fossil leaves in diatomite.

The numerical abundance of the collected specimens does not necessarily mean that those species were present in these percentages in the Miocene forest. Many factors determine which leaves or other plant remains are preserved, such as the distance the tree lived from the lake, the size and weight of the leaf, and the durability or fragility of the leaf. These and many other factors of the deposition, burial and finally our finding the fossils determine the numerical abundance of species in a fossil flora.

The fossil flora represented here are generally made up of six conifers and 25 hardwood species. The conifer species include pine, spruce, hemlock, fir, and swamp cypress. Both evergreen and deciduous hardwood trees and shrubs grew around the relatively small (a few square miles) lake. The abundant oaks, alders, birches, cottonwoods, willows, sycamore, rose, mountain-ash, and swamp cypress probably grew close to the lake and the streams coming into the lake. The species composition and physical nature of the leaves indicate that the fossil forest lived where the mean annual temperature was about 45°F and annual precipitation was about 35 inches evenly distributed throughout the year. It is quite striking to compare the estimated temperature and precipitation of the Pyramid fossil flora to that of the present-day Reno area, where the mean annual temperature is about 50°F and the annual precipitation of about 7.5 inches occurs mainly in the winter months. Recent work by Wolfe and others (1997) suggests that this region, and thus the ancient lake, stood at an elevation of about 10,000 feet in the middle Miocene 16.5 million years ago, and that the valleys have since dropped some 5,000 feet, contributing to the change from the somewhat cooler Miocene mean annual temperatures to the present warmer mean annual temperature.

A large variety of volcanic rocks is exposed in the hills surrounding the fossil-leaf site. The massive cliff-forming rocks to the north of this site are for the most part rhyolitic to dacitic rocks called flow-domes. The brightly colored layered rock that was visible to the north for the last mile or so as we drove here is known as the "Tuff of Incandescent Canyon." The rocks in the two hills to the south between us and the Pyramid Lake Highway are composed of the upper unit of a dark, glassy dacitic rock called the Tuff of Mullen Pass, which probably slid down as a landslide block from the hills to the east.



View from Burris Mine area looking north at the colorful volcanic rocks of the Painted Hills north of Pyramid Highway.

Leave the fossil site and retrace the route back to the Pyramid Lake Highway.

21.7 Turn left (north) onto Pyramid Lake Highway.

22.8 Turn right onto dirt road at black mailbox labeled "Chaplin."

22.9 Note rock outcrop on right side of the road: a tufa-encrusted rhyolite dome. Tufa is calcium carbonate that is typically deposited on the rocks along the shoreline of a playa lake; you can see it forming today at Pyramid Lake. Its presence here is evidence of a higher stand of lake water during late Pleistocene time. Look for tufa encrustations elsewhere in the valley. Continue along the dirt road to the east, past buildings, noting orange "Stay Out and Stay Alive" signs on fenced old mine workings.

24.0 Park along roadside.

STOP 2: Nevada Dominion Mine and Burrus Mine.

Walk to Nevada Dominion Mine on the southwest side of the road to observe secured workings and discuss the Abandoned Mine Lands (AML) program of the Nevada Division of Minerals.

"Stay Out and Stay Alive," the motto of the Nevada Division of Minerals' Abandoned Mine Lands Program.

These mines are located in the Pyramid mining district. The first mining claims were located here about 1863, on gold, silver, and copper prospects not long after the earliest discoveries on the Comstock Lode in Virginia City in 1859. By 1876, shafts and adits had been developed on at least ten different veins in this district. Most production from the mines was during the period from 1881 to 1890, but miners continued to work the veins intermittently for gold, silver, and copper until World War II and sporadically after that until the mid-1960s. Uranium mineralization was discovered here in the 1950s and a small amount of uranium ore was produced. As a result of many years of mining, the area is pockmarked with old mine shafts, adits, stopes, and drifts, many of which have caved, but some of which remain open to the surface, like the Nevada Dominion Mine.

The Nevada Division of Minerals began a program in 1987 to identify and rank hazardous abandoned mine workings and secure them from entry, and to educate the public about the dangers in and around such sites. This is one of their secured sites. NDOM staff members take the AML education program into the schools of Nevada with a minerals presentation and a video to impress upon students the importance of staying out of and away from abandoned mine workings. Some Eagle Scouts have secured hazardous abandoned mine openings as their community service projects. The complete 2002 annual report on the AML program is available at: http://minerals.state.nv.us/forms/aml/amlreport2002.pdf.

Walk to lower adit of the Burrus (Burris) Mine

The lower adit of the Burrus Mine is used as a mining laboratory for teaching, training, and research of UNR's Mackay School of Mines students and faculty. It is a work-in-progress utilizing mainly student volunteer work, volunteer mining community expertise, and donated funds and materials. Mineralization at the Burrus Mine occurs in northwest-striking almost vertical veins containing the mineral enargite (copper arsenic sulfide) and sporadic precious metals. The veins are in a volcanic tuff.

Some of the underground workings on the property may date from the 1860s but the most recent work, prior to University acquisition, was probably about 1960. There is now a 223-foot shaft, two shallower minor shafts, and three adits that total about 700 feet in length. The original workings were narrow and unsuitable for modern mining equipment, and part of the volunteer work of the students has been to enlarge and stabilize the old mine workings.

Burrus Mine, lower adit.

The ultimate vision for the Burrus is to serve as a fully developed mining laboratory with facilities for both track and rubber-tired drifting, including power, compressed air, water, haulage, and ventilation systems. Support facilities such as shops, warehouse, offices, classrooms, bunkhouse, and watchman's quarters are planned. The upper Burrus adit will be enlarged to 5 feet wide by 7 feet high for track haulage and the lower MP&H adit (this one) will be enlarged to 10 by 10 feet for rubber-tired haulage.

Explore area around the mine to see country rock that hosts the ore deposits. Then reboard vehicles and head back down the road.

The remainder of the field trip up Perry Canyon will be on rougher, rockier and steeper roads that should not be attempted by vehicles without 4WD, high clearance, and sturdy tires.

24.3 Turn right on dirt road towards hills and cross gully carefully avoiding washed-out areas.

24.4 Continue straight, do not turn right.

24.8 Keep to left on main road heading up the canyon ahead.

25.1 Take right fork up Perry Canyon.

25.2 Note monitoring well on the left side of the road (capped yellow cylindrical pipe).

25.7 Note a second monitoring well on the left side of the road.

25.8 Note mine dumps on right from lower workings of the Jones Kincaid Mine. You may want to stop here on your return trip to look for sulfide minerals on the mine dumps.

25.9 Take right fork and cross the creek by old stone building.

26.1 Turn right and park along road below the mine dumps.

Old stone building in Perry Canyon, probably dating from the early mining days of the Pyramid district.

STOP 3: Adit and mine dump of the Crown Prince Mine.

On the flanks of the mine dump, we will look for the minerals pyrite and enargite. Pyrite, sometimes called "fool's gold," has the chemical formula FeS_2, and is recognized by its brassy metallic luster and hardness of 6–6.5, hard enough to scratch glass. Enargite is an ore of copper with the chemical formula Cu_3AsS_4 and is recognized by its metallic luster, gray-black "gun-metal" color, and hardness of only 3—easily scratched with a steel nail or pocketknife.

Waste-rock pile of the Crown Prince Mine in Perry Canyon, with yellow-capped groundwater monitoring well in foreground.

Pyrite and enargite from the waste-rock pile of the Crown Prince Mine.

We will walk up the dirt road to the right of the dump to the caved adit of the mine. Here we have collected some of the water standing in the adit. Acid Mine Drainage (AMD) forms when pyrite in rocks is oxidized by oxygen in air with water to form iron(III) sulfate and sulfuric acid:

$$4FeS_{2\,(s)}\ \text{(pyrite)} + 2H_2O_{\,(l)} + 15O_{2\,(g)} \rightarrow 2Fe_2(SO_4)_{3\,(aq)}\ \text{(iron(III) sulfate)} + 2H_2SO_{4\,(aq)}\ \text{(sulfuric acid)}.$$

Similarly, copper minerals in the rock are changed through the action of the acid, water, and oxygen to soluble copper(II) sulfate, $CuSO_4$. The water flowing from the mine thus contains soluble iron(III) sulfate and copper(II) sulfate, plus sulfuric acid.

We will also do a test for dissolved metals in the mine water by mixing it with ordinary household ammonia (ammonium hydroxide, NH_4OH). When acidic water draining from the mine is mixed with ammonium hydroxide, the iron ions precipitate out as a rust-colored iron oxide, and the copper ions are complexed by the ammonium ion to form a blue solution. The appearance of the blue solution indicates the presence of copper ions in the original mine water.

Precipitate of melanterite, a hydrated iron sulfate that forms from acid mine drainage.

$$Fe_2(SO_4)_{3\,(aq)} + CuSO_{4\,(aq)} + H_2SO_{4\,(aq)} + 12NH_4OH_{\,(aq)} \rightarrow$$

$$2FeO(OH)_{(s)}\ \text{(goethite)} + Cu(NH_3)_4^{2+}{}_{(aq)}\ \text{(deep blue solution)} + SO_4^{2-}{}_{(aq)} + 4(NH_4)_2SO_{4\,(aq)} + 8H_2O_{(l)}$$

Scientists at NBMG and elsewhere have done additional testing of both the surface waters downstream in Perry Canyon and of the groundwater in the monitoring wells located here and elsewhere in Perry Canyon. We will discuss the results of monitoring here in Perry Canyon. We will also discuss how modern mining companies avoid acid mine drainage (AMD) and what is being done to remediate AMD at old mine sites.

This is the last stop on our trip. Retrace the route back to the Pyramid Lake Highway and south to the Reno-Sparks area.

Thank you for helping us celebrate Earth Science Week, designated the second full week of October by the Governor of Nevada, the U.S. Congress, American Geologic Institute, and the Association of American State Geologists to recognize the importance of geology and other Earth sciences to society. If you have questions about Nevada geology, natural hazards, mineral or energy resources, please contact the Nevada Bureau of Mines and Geology by telephone (784-6691), by e-mail (info@nbmg.unr.edu), on the Internet (www.nbmg.unr.edu). Our offices on the UNR campus are open weekdays, 7:30 a.m. to 4:30 p.m.

This field trip is made possible by volunteers from the Nevada Bureau of Mines and Geology; Nevada Division of Minerals; Nevada Paleontological Society; W.M. Keck Museum, Mackay School of Mines, University of Nevada, Reno; Geological Society of Nevada; American Institute of Professional Geologists; U.S. Bureau of Land Management, and Nevada Mining Association. This field trip guide was prepared by D.D. LaPointe and Jon Price, Nevada Bureau of Mines and Geology, with input from James Firby and Howard Schorn, Nevada Paleontological Society; Bill Durbin and Alan Coyner, Nevada Division of Minerals; and Beth Price, Truckee Meadows Community College.

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