Guide for Earth Science Week Field Trip, October 20 or 21, 2007
Nevada Bureau of Mines and Geology Educational Series E-46

Taking the Pulse of the Earth

Slide Mountain, Steamboat Geothermal Area, and Rilite Aggregate Quarry in the Virginia Foothills

If snow prevents us from driving our intended route to the top of Slide Mountain we will still meet at the Mount Rose Summit Rest area to discuss local geology, and then reconvene at Galena Creek Park, picnic area, north entrance as an alternative Stop 1. If the Mount Rose Highway itself is closed because of snow, we will meet at 9:00 a.m. at Galena Creek Park. Hard hats and closed-toe shoes (no sandals or clogs) will be required at the final stop at the Rilite quarry. We will lend hard hats to those who don't have them.

This year marks the tenth annual Earth Science Week (ESW) public field trip to help promote public and professional awareness of the status of Earth science in society. The 2007 ESW field trip theme is "Taking the Pulse of the Earth" and will focus attention on geoscience research associated with the EarthScope Program, a major geophysical experiment funded by the National Science Foundation that is designed to investigate the structure, dynamics, and evolution of the North American continent. The research is helping us understand the physical processes that control earthquakes and volcanic eruptions. Earth scientists are using seismometers, state-of-the-art drilling equipment, satellites, and GPS receivers to "take the pulse of the Earth."

Many scientists in our area are participating in EarthScope, including teams of geodesists, geologists, and seismologists at the University of Nevada, Reno. Some of those scientists will accompany us on our field trip today to describe some of their scientific instruments, what kind of data they collect with those instruments, how they interpret that data to find out more about the interior of the Earth. Following this theme, the 2007 ESW trip will visit three areas south of Reno where we will see how geoscientists obtain information about the Earth and use that information to mitigate hazards, build a sustainable base of energy and mineral resources, and to further our general understanding of how the Earth works. A generalized map of our major field trip stops is shown on page 4.

8:30 AM: Earth Science Week field trip participants meet at the Mount Rose Summit rest area (on State Highway 431, 16.6 miles west from South Virginia Street). Those without 4WD will need to carpool with participants who have room in 4WD vehicles, as the road to the first stop is steep and parking is limited. We would like to reduce the number of vehicles to a minimum.

At Mount Rose Summit rest area: (elevation 8,933 feet above sea level). Mount Rose (elevation 10,778 feet) lies to the north, capped by Miocene (24 to 5 million-year-old) volcanic rocks (andesite lava flows). On the south side of the highway, Slide Mountain (elevation 9,694 feet) is underlain by Cretaceous (144 to 65 million-year-old) igneous rock (granodiorite, similar to granite, but with less silica) that was part of the core of a volcanic arc, similar to the Andes of South America or the Cascade Range today.

Cumulative
Mileage**:**

0.0 Exit the rest area parking lot at 9 AM and turn left onto the Mount Rose Highway, (headed back toward Reno) and immediately take your first right onto a gravel road. Please follow the lead vehicle.

0.1 Pass through normally locked gate onto private road. We have permission from the Slide Mountain Users Association to guide today's field trip along this road, but typically access is restricted. Turn right at the first fork just past the gate and drive up a steep segment of road. Please allow plenty of space for the vehicle ahead of you to make it up the slope.

0.4 Turn right at fork. Road will make a few switchbacks on the way to the top.

1.1 Junction of several dirt tracks at top; bear right (do not take sharp right) and go past the old gray building.

1.2 Bear left at fork.

1.4 Turn right at "Wildcard" ski run sign, making a loop to the left, returning to road you came in on.

1.6 Pull far over to the right side of the road by the ski lift building and park vehicles. **DO NOT BLOCK MAIN ACCESS ROAD**.

Exit vehicles and walk to the GPS satellite receiver and seismic relay station. At these installations, seismologist Ken Smith (Nevada Seismological

Laboratory) and geodesist Bill Hammond (Nevada Bureau of Mines and Geology) will talk about the instruments, technology, and some of their recent research on earthquakes near Lake Tahoe and related magma movement that caused an increase in elevation at Slide Mountain.

GPS location for the geodetic GPS receiver on Slide Mountain: N 39° 18.855' W 119° 53.059'

The Global Positioning System (GPS) geodetic station on Slide Mountain is one of a series of similar high-precision instruments that are used to measure motion of the surface of the Earth, both horizontally and vertically. These stations, partly funded by the National Science Foundation through its EarthScope Program, have recorded some exciting phenomena. Specifically, we know from these GPS stations that about 20 to 25% of the motion between the Pacific Plate and the North American Plate, most of which is accommodated on the San Andreas fault in California, is taking place on strike-slip faults in western Nevada and eastern California. In addition, this particular GPS station was key to understanding an unusual swarm of small, deep earthquakes that occurred in 2003. Researchers from Nevada Seismological Laboratory and Nevada Bureau of Mines and Geology detected that Slide Mountain moved up and to the northeast approximately 1 centimeter during the earthquake swarm, implying that magma was injected in the lower crust near the state line at the north end of Lake Tahoe.

Of the three major types of faults (strike-slip, normal, and reverse or thrust faults), Nevada's active faulting is dominated by two (strike-slip faults and normal faults). The normal faults are largely responsible for the basin-and-range topography of Nevada and for the presence of Lake Tahoe as a deep basin. Nevada is one of the most seismically active states in the U.S.—second only to California among the lower 48 states. Historically, we have experienced a magnitude 7 or greater earthquake about once every 30 years somewhere in Nevada. The last ones were in 1954 near Fallon. The Reno-Sparks-Carson City area ranks among the 30 urban centers in the nation with the highest estimated potential earthquake loss, according to the Federal Emergency Management Agency (FEMA).

The Nevada Seismological Laboratory is one of the world's most respected seismology research and earthquake engineering teams. It has overall responsibility for instrumental studies of earthquakes throughout Nevada. This laboratory serves as a repository of information and a resource for the public on earthquake activity, risks and safety measures in Nevada and adjoining states. The Nevada Seismic Network's 200 stations locate over 7,000 earthquakes per year. The relay station on the top of Slide Mountain helps transmit some of this earthquake data to the Laboratory at UNR.

At the summit we will also have the opportunity to collect specimens of granodiorite, a salt-and-pepper-speckled rock with crystals, each a few millimeters in diameter, of white feldspar, clear quartz, and black biotite and hornblende; pegmatite, a coarse-grained granite, with crystals up to a few centimeters of salmon-colored feldspar, white quartz, and black biotite; diorite (finer grained than the granite and with more dark minerals). We will look for inclusions of magnetite-rich rocks in the granite and copper stain on some rocks. You may eat lunch at the summit and have some time to explore and learn about GeoCaches and EarthCaches.

Return to vehicles at about 12:30 PM and retrace route back down to the Mount Rose Highway.

2.8 Turn right onto Mount Rose Highway.

17.9 Turn right onto Wedge Parkway.

18.0 Turn left into UNR Redfield Campus at 18,600 Wedge Parkway, and immediately left into first parking lot opposite the Nell Redfield Building A. Here we will meet geologist Stuart Johnson with Ormat Nevada, Inc.

We will carpool into as few vehicles as possible for a tour of Steamboat Geothermal Area.

Here we will learn about the operation of the geothermal power plants that extract and re-inject naturally occurring hot waters from the ground to produce one of the cleanest and most environmentally friendly kinds of renewable electrical power available anywhere. Geothermal activity in the region is dominantly associated with circulation of groundwater along faults that penetrate deep into the crust, picking up heat from the Earth's interior. Some chemical data suggest that there may be a connection between geothermal activity and magma at depth at Steamboat Springs, but the magma is probably now solidified. Ormat Nevada, Inc. is constructing the Galena Geothermal Project, which, when completed, will bring the total production capacity from existing Steamboat geothermal plants to over 100 megawatts of electricity. One megawatt of electricity can supply energy for approximately 700 to 1,000 typical homes in the area, so the total generating capacity of the Steamboat geothermal area will be enough to power about 75,000

homes, enough to meet most of the residential electrical needs of the Reno-Sparks population. The electricity produced at the plant is under contract to Sierra Pacific Power Company. Ormat owns and operates four other geothermal plants at Steamboat, the oldest of which has been in operation since 1986. Completion of this project in late 2008 will make the Reno-Sparks area the first geothermal powered city in the U.S. (Stuart Johnson, 2007 – Nevada Petroleum Society field trip road log).

We will begin the tour in the parking area to north of Nell J. Redfield Building A on the Redfield campus. The campus area is on lands donated to the University System by the Nell Redfield Trust. This trust administers the Redfield land holdings that at one time consisted of a swath of alternate sections of land extending from the south Truckee Meadows to Lake Tahoe. Some of the geothermal leases within the developed geothermal area are on Redfield lands. In the Steamboat geothermal area, we should have the opportunity to collect basaltic andesite, a normally dark gray to black volcanic rock, much of which has been hydrothermally altered, meaning that hot water circulating though fractures in the rocks has changed some of the minerals to clay and silica and bleached the color of the rocks to light gray or white. Bright yellow native sulfur is often found coating fractures in the altered rock, and cinnabar (mercury sulfide) colors some of the altered rock and soil pink. Clear, glassy crusts of silica are also deposited in holes and fractures in the basaltic andesite.

After our tour of the geothermal area, return to vehicles, exit the Redfield parking lot, turn right onto Wedge Parkway, and rezero odometers at the intersection of Wedge Parkway and the Mount Rose Highway.

0.0 Turn right on the Mount Rose Highway

1.3 Cross U.S. 395 (South Virginia Street) continue straight, east on Geiger Grade Road (Nevada Route 341).

2.0 Turn left at the first stop light, onto Equestrian Road.

2.3 Turn left (northeast) at STOP sign onto Western Skies Drive.

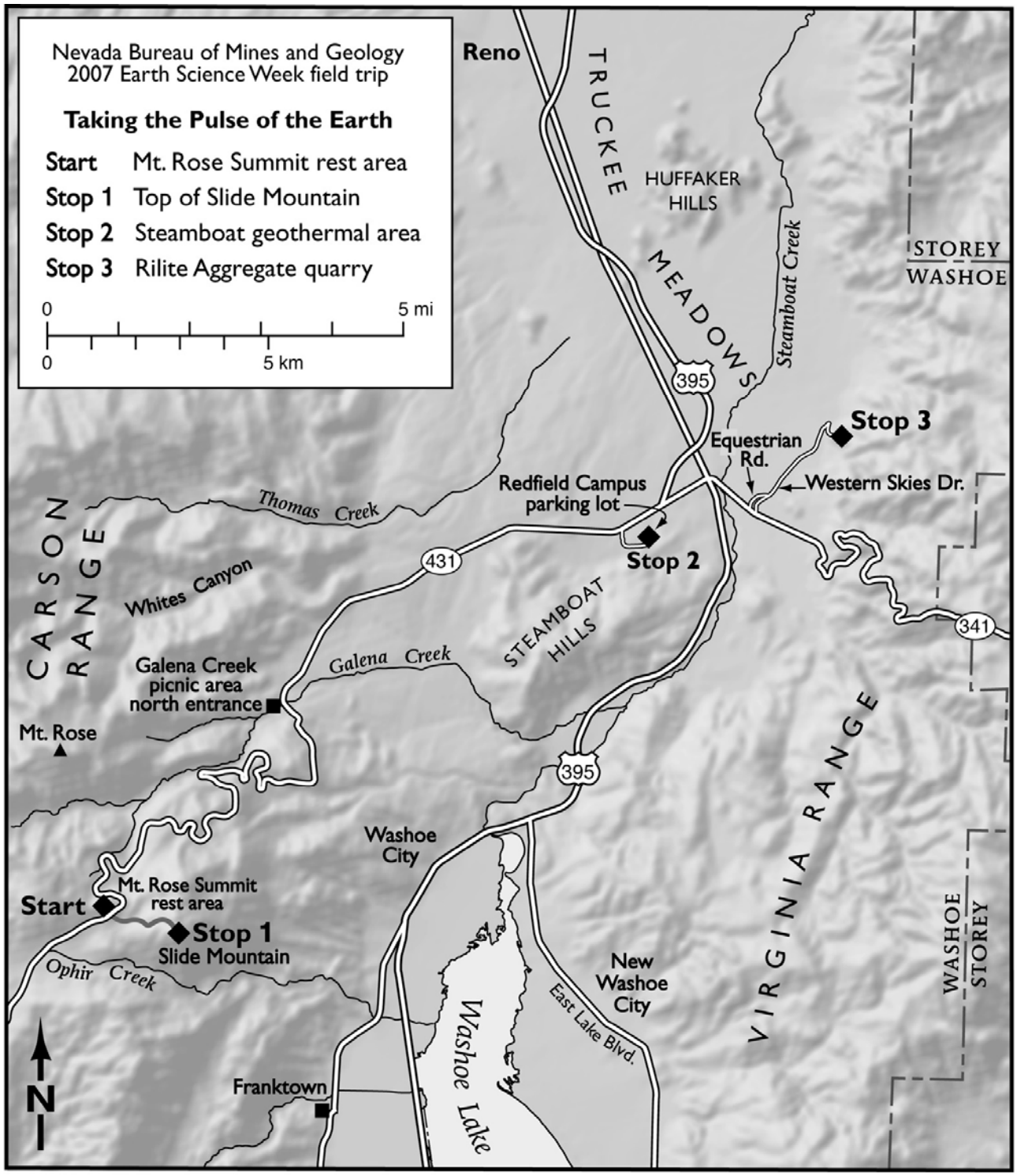
3.6 Turn right into Rilite Aggregate property and proceed through gate. Permission from the quarry owner is required to enter this property, which is normally gated and locked.

4.1 Stop in quarry. GPS location within the quarry: N 39° 24.799’ W 119° 42.632’

The Reno-Lake Tahoe area is well known to have active faulting, but few people think of active volcanoes here. The nearest active volcanoes are at Lassen Peak, which last erupted in 1915, and north of Mammoth Mountain, where rhyolite lava domes like the one at the Rilite quarry are thought to have erupted as recently as 600 years ago. But the area from Lake Tahoe through Reno to Fallon has lots of Quaternary (less than 1.8 million years old) volcanic rocks. Most are either basalt, which mostly formed lava flows and cinder cones, or rhyolite, which formed short, thick lava domes. Both rocks have been locally mined for aggregate, and, fortunately for us, most of these rocks are young only by geologic standards. The rhyolite lava dome here at the Rilite quarry is 1.2 million years old, as are similar rhyolites in the Virginia Foothills neighborhood and in the western part of the Steamboat Hills. The lava dome used to form a hill that rose several hundred feet above the Truckee Meadows. Quarrying for all the growth around Reno has removed a lot of the rhyolite, and the quarry is now a moderately deep hole. Basalts that are common between Lake Tahoe and Interstate 80 are also only as young as 1.2 million years. These include several cinder cones and lava flows that make up Bald Mountain south of Truckee, east of California Highway 89, and at the basalt quarry easily visible just south of I-80 near Hirschdale. However, younger volcanic eruptions have happened near Fallon. Soda Lake just northwest of Fallon is a maar, a volcanic crater formed when basalt magma contacts ground-water and blows up like a steam explosion. The exact age of the Soda Lake maar is not known but is younger than about 10,000 years because it cut through sedimentary layers deposited by the last remnant of Lake Lahontan. A similar explosion crater, although probably related to geothermal steam rather than magma, is visible in the Steamboat geothermal area near the Redfield campus. NBMG geologist Chris Henry will tell us about radiometric dating of these and other rocks and what this information tells us about the significance of the rocks for geothermal energy and volcanic hazards.

Rocks that you should be able to collect in the Rilite quarry area include rhyolite, a light gray to pink volcanic rock with flow banding, which is crushed and used in construction and as decorative rock, and perlite, a hydrated volcanic glass. When heated above 1600ºF (870ºC), perlite “pops” much like popcorn, expanding to 20–30 times its original volume. Expanded perlite is used as a soil conditioner in agriculture, in construction, and in many industrial processes.

This concludes the field trip. 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, the 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 (775 682-8767) or on the Internet (www.nbmg.unr.edu). This field trip guide was prepared by D.D. LaPointe, Jon Price, Christopher Henry, and Bill Hammond, Nevada Bureau of Mines and Geology, and by Ken Smith, Nevada Seismological Laboratory (http://www.seismo.unr.edu/), Mackay School of Earth Sciences and Engineering at the University of Nevada, Reno, and by Elisabeth Price.



View toward Lake Tahoe from Slide Mountain.

Geodetic GPS receiver on Slide Mountain.

Aplite vein in granodiorite on Slide Mountain.

Diorite inclusion in granodiorite on Slide Mountain.