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To: Center for Faculty Development

From: Deborah A. Ragland, Ph.D., Adjunct Professor of Geology, University of New Mexico – Taos

Subject: Summary of the 2007 New Mexico Geological Society Field Conference

Dear Colleagues,

Once again, I would like to thank the Center for Faculty Development and UNM-Taos for granting my request for funding to attend the 2007 New Mexico Geological Society Field Conference. The 2007 conference was held in northern New Mexico in a volcanic region to which most students taking geology at the Taos campus can relate. I have been very fortunate in that three of the last four annual field conferences have been held in northern New Mexico. As with the previous NMGS trips, we participants had the opportunity to be in the field with geologists who have spent years researching the geology of the areas in and around Los Alamos.

The 2007 field conference originated in Los Alamos; most of the conference concentrated on the Jemez Mountains and the Valles Caldera. The content of the trip covered the stratigraphy, sedimentology, and paleontology of the Paleozoic, Mesozoic, and Cenozoic Eras (roughly 540 million years), the geomorphology developed on the Cenozoic strata, and the volcanic geology leading to the present Valles Caldera. We also learned about the ecosystems within the caldera and the current methods of preservation and restoration on the Preserve.

Summary of the 2007 New Mexico Geological Society Field Conference

Day One: The first day of the field seminar began our exploration of the outer rim of the Valles Caldera. This area of north-central New Mexico is characterized by an important juxtaposition of the Colorado Plateau and the Rio Grande Rift. The Colorado Plateau is a broad area of gently uplifted sedimentary rocks which show little deformation whereas the Rio Grande Rift is a geologic province marked by innumerable faults and relatively recent volcanic fields. The Cañones fault zone which can be viewed from the picnic area on U.S. Highway 84 north of Abiquiu is the contact between the Colorado Plateau and the Rio Grande Rift. Several fragments (splays) of the fault offset sedimentary strata distinctly showing the movement along the fault.

Of special interest is reactivation of the Cañones fault during the formation of the Rio Grande Rift. The original faulting occurred during the Laramide Orogeny, approximately 65 million years ago, and was then reactivated when stress fields were reoriented several million years later. Stress fields during the Laramide Orogeny were compressional (i.e., squeezing together) but the stress fields reversed during the formation of the Rio Grande Rift (i.e., the Rift is a "pull-apart" basin).

As we made our way toward the outer edge of the Valles Caldera, we traveled through the sedimentary beds on the edge of the Colorado Plateau progressing from the Paleozoic to the

Cenozoic. To the northwest, Permian (Paleozoic) to Cretaceous (Mesozoic) rocks are exposed while the Caldera rim began to make its appearance to the south.

The last stop on the first day was our first view of the Valles Caldera. And what a remarkable view! After a short hike we found ourselves on the north rim of the Caldera. Rainy skies cleared to give us a spectacular 360˚ view of the entire caldera with the resurgent and ring-fractured rhyolitic domes piercing the Valles floor. It was at this stop that we saw the first evidence of environmental restoration within the Valles Caldera preserve and the environmental damage outside the preserve. The meadow where we stood was composed of short, straggly grasses with many bare patches, clear evidence of overgrazing. On the other side of the fence, tall grasses covered meadows as far as we could see.

Day 2: We spent the second day of the field conference entirely within the confines of the Valles Caldera Preserve. Our first view from within the Caldera was absolutely surrealistic. Heavy cold mist filled the floor of the Caldera as one of the Preserve officials spoke to us about the ecology of the Valles and their plans to restore and maintain the preserve. The Valles Caldera Preservation Act of 2000 authorized the purchase of the Baca Ranch which occupies the center of the Jemez Mountains Volcanic Field of northern New Mexico. 88,900 acres of mountain grassland and forests with prime wildlife habitat are included in the preserve. The Valles is, eventually (by the year 2015), supposed to become a self-supporting, working ranch, recreation area, and scientific field laboratory, while at the same time, restoring and preserving an environmental and geologic treasure. Revenue-generating programs include public recreation (e.g., hiking), elk hunts, trout fishing, livestock grazing, and special events (such as our geology field seminar). The Preserve encompasses almost the entire Valles Caldera, the world's type resurgent caldera. Geologists from all over the world have access to the caldera for scientific study. New geologic maps have already been produced which will provide interpretative, land use, resource management, conservation, and volcanological information.

As we listened to the Preserve scientist, the mist slowly started rising and in the background the incredible panorama of the Valles emerged. Redondo Peak, a resurgent dome composed of tuffaceous material, at an elevation of over 11,000 feet peaked through the mist to the southeast. As we scanned the horizon, other resurgent domes (Cerro del Medio, Cerro del Abrigo, Cerro la Jara, South Mountain) dotted the Caldera floor. All of these are rhyolite domes that occupy the caldera moat, the region between the caldera walls and the resurgent dome.

The Valles Caldera was formed about 1.25 million years ago (not that long ago, in geological perspective) during a catastrophic eruption of approximately 70 cubic miles of ignimbrite. The floor of the caldera collapsed along a system of ring fractures creating a giant depression about 10 miles in diameter. Sediments and a small lake filled the collapsed caldera with resurgent domes soon emerging.

The rest of the second day was spent within the caldera studying the various rock types and trying to decipher the sequence of events that led to the caldera formation. One stop in the center of Valles Grande displayed an incredibly interesting cross-section through lake sediments attesting to a change in either topography or climate or both that allowed the floor of the caldera to be filled or partially filled with water during one or more time periods.

One of the most interesting stops led by Fraser and Kathy Goff was the site of the aborted development of hydrothermal power. In the 1960's, Unocal drilled exploratory wells in the Valles looking for petroleum. Instead, they hit hot water at about 220°C. In the 1970's, Unocal started to look for economic geothermal in the Valles. After sinking considerable money into exploration and drilling, Unocal announced that they could produce 400 megawatts of power by exploiting the Valles Caldera geothermal sources. Unocal went so far as to begin building infrastructure, the remains of which are still visible today. In the end, Unocal admitted that only 20 megawatts of power could be expected from the Valles, at the time (and even now) economically unfeasible. Huge turbines specifically designed for Unocal's geothermal plant were sold for a fraction of their cost to Mexico. Recent studies have shown that had geothermal been developed, downstream supply problems would have occurred at Soda dam in San Diego Canyon.

Our second day ended with a barbeque at the ranch headquarters where we enjoyed a spectacular sunset and watched as hundreds of elk roamed across the Valles Grande.

Day 3: Day 3 was spent studying the more recent geologic environment of the Los Alamos area and the implications for human habitation. Los Alamos is basically built on the Bandelier Tuff, a fact made painfully evident at the first stop. Very deep, steep-sided canyons dissect the plateau on which Los Alamos sits; high-dollar homes are built on the very edges of the precipices, areas which, in the end, could be extremely unstable if (when) the local climate changes. An example of the extreme instability came at a later stop where a landslide had occurred the year before, cutting back into a slope nearly to an apartment complex. A walk to the bottom on one of the canyons illustrated the unstable nature of the tuff – the walls of the canyon could be scraped away by hand, with no tools.

A later stop at the Pajarito Fault illustrated the rather tenuous position in which Los Alamos (a major science lab involved with radioactive materials) sits. Three known earthquakes greater than 6.5 in magnetude occurred in the Holocene at approximately 9,000 years ago, approximately 5,000 years ago, and at approximately 1.5 thousand years ago. Los Alamos is far from quiet.

Our day and trip ended with a view of the Cerro Grande fire-scar terrain. In May, 2000, the Cerro Grande fire burned 43,000 acres resulting in a complete loss of vegetative cover and many homes. The intense heat and loss of vegetative cover reduced the soil's ability to absorb moisture and have resulted in increased runoff with significant erosion of sediment. Storm water flows have increased dramatically in the canyons, which will, in time, contribute to increased erosion, undercutting, and eventual damage to structures in the Los Alamos area.

How Will This Field Conference Benefit Students?

Many students take Physical Geology, Earth History, Geological Catastrophes, the Geology of New Mexico, and Geological Field Seminars simply for pleasure; others take the courses to fulfill science and science with laboratory requirements in their programs. A few students

actually are geology majors and need the first two courses to start their degree programs in their field of study, then continue by taking the remaining courses to enhance their geological knowledge. In order to bring the broad subjects of these courses into an arena that makes sense to all of these students, the instructor must become familiar with the geology of north-central New Mexico and the Taos area. The more the very general subjects in the sciences can be related to the personal lives of the students, the more likely the students will understand and use the subject. Field seminars led by experts in the geology of New Mexico help any instructor at UNM-Taos better instruct her/his students. That was the case with the 2007 field seminars as I learned more about the geology of New Mexico.

The Valles Caldera is particularly significant to those of living in the western United States. Much work is currently being conducted at Yellowstone National Park as the area is beginning to show signs of increased volcanic and seismic activity. The Yellowstone volcanoes are classified as Super Volcanoes – so is the Valles Caldera. The more we learn about the Valles and the processes that led to its explosion, the better we will be able to prepare our students for the aftermath of a volcanic super-eruption, no matter where in the world it occurs. These studies are not to make the students or general public fearful, but to make certain they are concerned, informed, well-educated citizens who are able to make rational decisions regarding their environment.

With regard to more current, more immediate events, studying the use and misuse of the land is an extremely important aspect of geological studies. The folly of the Unocal venture as they tried to gain support for drilling the Valles Caldera for geothermal sources is a painful lesson in money lost and environment negatively altered. Students need to learn to separate good science from bad science and be able to make informed, intelligent decisions. Every new bit of information that can link the past with the present will give the students a much better chance of making informed decisions in their future lives. The Cerro Grande fire points out that one aspect of the environment cannot be separated from another. Unstable geological conditions are now exposed and may affect the future of the Los Alamos community.

Most students do not realize how much the landscape in northern New Mexico (and indeed, on the entire planet) has changed through time. It is important for anyone living in the area to appreciate how many changes the thin crust of the Earth has undergone in order to anticipate future changes that can, and will, occur. Unlike some parts of the country, our current landscape in northern New Mexico is extremely varied resulting in many biozones and microclimates. If students learn how the processes that produced this topography relate to the biozones and microclimates, they will gain a much better understanding of how to live in harmony with their surroundings. Study of the formation of the Valles Caldera and Los Alamos area with the volcanic terranes, faults, earthquakes, potential geothermal sources, etc., will prepare them to live anywhere in a more educated, environmentally friendly manner.

Conclusion

Again, I would like to thank the Center for Faculty Development and UNM-Taos for granting my request for funding to attend the 2007 New Mexico Geological Society Field Conference.

Every new fact that I can learn about the geology of New Mexico is passed on to my students. I would encourage all faculty members to take advantage of Faculty Development funding to enhance not only their knowledge of the specific fields, but also to better pass on that information to their students.

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Clarification of Terminology

Caldera: roughly circular depression at the summit of a volcano (or where a volcano existed) resulting from the collapse of the roof of the magma chamber.

Cenozoic Era: On the geologic time table, the Era from 65 million years ago to present, the era when mammals began to proliferate.

Fault: A fracture in a rock body that has shown visible displacement.

Geomorphology: the study of landforms and the interrelationships between topographical features at the surface of the Earth.

Ignimbrite: poorly-sorted rock body resulting from a fiery flow down the sides of a volcano.

Mesozoic Era: On the geologic time table, the Era from 250 million years ago to 65 million years ago. Commonly known as the "Age of the Dinosaurs."

Paleozoic Era: On the geologic time table, the Era from 540 million years ago to 250 million years ago. Although life appeared in the PreCambrian Era (prior to 540 million years ago), the Paleozoic is known for its explosion of life forms.

Pleistocene: On the geologic time table, the Epoch from approximately 1.8 million years ago (dates vary by author from 2 million years ago to 1.6 million years ago) to 10,000 years ago (this date can also vary significantly); the Pleistocene is part of the Cenozoic Era and Quaternary Period and is famous for its glacial and interglacial intervals.

Quaternary: On the geologic time table, the Period from approximately 1.8 million years ago to the present; the Quaternary is the latest part of the Cenozoic Era.

Resurgent dome: an upward intrusion of magma usually occurring after a caldera collapse.

Rhyolite: An igneous rock extruded by a volcano or fissure; the eruption is often moderately explosive because the silica content is higher than basaltic lavas.

Rio Grande Rift: a narrow, elongate valley generally following the Rio Grande; the rift was formed by a series of down-drop fault blocks starting roughly in the area of Leadville, CO, continuing through the entire length of New Mexico, and apparently ending near Chihauhua, Mexico. The rift is still active today and is the subject of many research projects.

Sedimentology: the study of sedimentary rocks, the depositional environments in which they formed, and the subsequent diagenetic alteration of said rocks.

Stratigraphy: that branch of geology which combines the study sedimentology with the sequence of deposition and correlation of layered rocks.

Structural Geology: study of the deformation of rocks (folding, faulting) and interrelationships of deformed rock bodies.

Tuff: A rock formed of compacted volcanic fragments; the fragments are generally less than 4 mm in size.