THE GUFFEY VOLCANIC CENTER AND SURROUNDING AREAS OF THE THIRTYNINE MILE VOLCANIC FIELD, CENTRAL COLORADO

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The Guffey Volcanic Center and Surrounding Areas of the Thirtynine Mile Volcanic Field, Central Colorado

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In the southern Rocky Mountains the Thirtynine Mile volcanic field is second in volume of extrusives, with the Mid-Tertiary San Juan volcanics, located nearly 100 miles to the southwest, clearly being the largest. During the first summer of Keck-funded research projects, a month-long effort was mounted by nine students and three faculty members to effectively map and sample roughly one-third to one-half of the area immediately adjacent to Guffey, Colorado, a small village in close proximity to the largest of the volcanic centers in the field. Based on this original work a research paper in Geology was accepted and published (Wobus and others, 1990). However, at least one salient question had been left unanswered by this Keck I effort; namely, is the "Guffey caldera" a true caldera or rather a fortuitous quirk of erosional processes. In the design of the Keck IV project, this was clearly one of the top two or three research questions we wanted to address.

To that end, Dr. Glenn Kroeger of Trinity University, in conjunction with two students, Mark Tinker and Greg Wimpey who are also from Trinity , designed a set of gravity traverses to answer this caldera question. The gravimetry study however required precise elevation control. This necessitated a substantial time investment in surveying the proposed gravimetry traverse lines using EDM (electronic distance measurement) equipment. All of us at one time or another spent a day with the geophysics crew to get a flavor of what it actually means to run a modern surveying profile and to gather meaningful gravity data. The results of these research endeavors will be highlighted by Mark's and Greg's presentations.

Dr. Bud Wobus of Williams College and three students, George Booth and Andrew Tittler, both from Williams and Lisa Dameron from Wooster focused their efforts on the Thirtyone Mile volcanic center which is located a few miles south of the Guffey center. Their goals were to establish the eruptive history of this volcano in as much detail as possible through detailed field mapping and collecting representative samples from each rock unit for whole rock chemistry. George focused on the main volcanic edifice while Andrew concentrated on the basaltic dikes which cut many of the stratigraphic units. Lisa fixed her attention on the silicic ash-flow and tuffaceous units which lie stratigraphically below the Thirtyone Mile lavas.

Bill Burris of Wooster, Chris Roessler of W&L, and David Coler and Elizabeth Shawkey, both from F&M worked with my supervision. Bill and Dave mapped and collected samples from adjacent areas on the northwest and west margins of the Guffey volcanic center. Elizabeth worked immediately north of the Guffey intrusive area to the summit of Thirtynine Mile Mountain while Chris focused on an area east-northeast of Guffey immediately south of the Four Mile Creek road centering on Witcher Mountain. In each of these projects detailed field mapping was a prerequisite to collecting representative samples from each rock unit for subsequent petrographic study and whole rock chemical analysis.

Each of the seven students who was focused on a volcanic petrology project soon was enmeshed in working out the gory details of volcanic stratigraphy. The only absolute chronology available at the time was an age of 36 Ma for the Wall Mountain tuff, a datum upon which all the Thirtynine Mile volcanics rested, and an age of 35 Ma from a mafic lava flow 2/3 of the way up the south side of Thirtynine Mile Mountain (Epis and Chapin, 1974). A clear need for additional absolute age dates was evident early on in this project. As serendipity occasionally camps at my doorstep, Hilary Eppley,

presently a senior chemistry major at F&M who had taken my introductory geology course several semesters before, walked into my office and inquired about a possible one-semester research project which would introduce her to the world of geochemistry. It didn't take long for our conversation to turn to the exciting possibility of applying K/Ar geochronology to the Thirtynine Mile volcanic field. Twelve samples was a number we settled upon because the Ar mass spectrometer at Case Western Reserve University, in the lab of Dr. James Aronson can be loaded with six samples at a time. Hilary and I spent six days in October, 1990 at Case Western Reserve doing the actual data collection; all twelve samples analyzed extraordinarily well (see Eppley, 1990 for all the details). Ten of the twelve samples produced K/Ar dates between 35.8 and 32.0 Ma with a 2σ error of approximately 0.5 Ma for each date. However, the last two dates were most revealing. One, from a hornblende andesite dome or flow which had been mapped as part of one of the lowest stratigraphic units, produced an age of 38.3 Ma, an age clearly older than the Wall Mountain tuff. This structure must have stood as part of an island-like feature (kipuka) which the Wall Mountain tuff went around as it filled in the topographic lows during its extrusion. Volcanism in the Thirtynine Mile field preceded as well as postdated the Wall Mountain tuff event; the relative importance of this early phase of volcanism is presently not known. The second unexpected K/Ar date was from a sample collected by Ed Venzke during Keck I from a pyroxene diorite intrusive body which constitutes the core area of the Guffey volcanic center. These intrusive bodies and the domes and flows (?) they cut were thought to be very closely aligned in age and represent a resurgent doming phase associated with the development of the Guffey caldera, following the model that is so evident in the nearby San Juan volcanic field. The age of this intrusive sample (45.3 Ma) which does not correspond at all to the age of the surrounding volcanics, was completely unexpected. Also, data from Mutschler and others (1988) indicate this was a very quiet period of time (Middle Eocene) with little igneous activity across the state of Colorado. Pandora's box had been opened!

Based on our previous results, I returned to Case Western Reserve in late December, 1990 to do another batch of six samples, selecting and preparing them with even greater care than usual. With the exception of one fiasco on my part, five quality K/Ar age dates resulted. Two corroborated the Middle to Late Eocene plutonic activity, one substantiated the 38 to 39 Ma period of activity, and a fourth provided an insight into the waning stages of volcanism in the Thirtynine Mile volcanic field. Examining all the K/Ar ages <36 Ma provides a pattern of volcanism becoming more mafic with decreasing age, a pattern clearly substantiated by this high-alumina basaltic lava, from the northwest flank of Thirtynine Mile Mountain, whose age was 29.7 Ma. The fifth and last date from the batch was, once again, completely unexpected. This sample is a hornblende andesite from what is likely a dome structure from the intrusive central area of the Guffey volcanic center. The K/Ar date for this sample is 58.5 ± 0.9 Ma, an age which reflects latest Paleocene-earliest Eocene volcanism and is likely related to traditional Laramide activity! The magmatic activity associated with the Guffey "center" has turned out to be more complex than anyone dared imagine, spanning nearly 30 Ma. A few precise, but currently unanswered, petrologic questions which result from this geochronologic data base include the following:

1) Is the same upper mantle/lower crust source region being partially melted to generate the magma involved in each phase of activity?

2) What evolutionary path does each magma batch follow once it is formed? How are these paths similar? How are they different?

3) Are there any clear compositional changes in the igneous activity as a function of geologic time?

4) In terms of plate tectonics, what is going on to produce this pattern of episodic magmatic activity at the Guffey center?

Given the insight from the K/Ar geochronology, several key areas need to be re-mapped, carefully looking for intrusive contacts and the like. In addition the chemical variation within each of these magmatic pulses needs to be fully characterized. Clearly, more work is needed before a complete picture of the igneous activity at the Guffey center can be fully described. To that end I hope to spend March 22-25 at Case Western Reserve doing one last batch of six samples, which I hope to report on at our Keck IV symposium.

References

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