VOLCANOLOGY

Project title: Contemporary Surface Deformation of the Yellowstone Caldera

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Objective: Every few years, we will conduct precise leveling surveys along the roads of Yellowstone National Park to assess the character of vertical deformation within and around the caldera system. These surveys began in 1983 and will continue as long as funding is available. The next survey is likely in the summer of 2003.

Findings: No work completed during 2001 calendar year.

Project title: Monitoring Caldera Unrest at the Yellowstone Caldera: A Global Positioning System (GPS) Crustal Deformation Study and Hot Springs Temperature Study by the Eastern Illinois University Geology Field Camp

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Objective: The purpose of our study is to monitor caldera unrest at the Yellowstone Caldera by annually collecting GPS data and hot springs temperatures from a network of data collection points. Although the data collected in this study can contribute to more detailed monitoring efforts of the caldera, the primary goal of this project is to provide an ongoing, hands on field experience for undergraduate geology majors at the Eastern Illinois University Geology Field Camp.

Findings: During our third annual GPS survey on June 27–28, 2001, we deployed three Trimble 4000 Ssi receivers at pre-determined GPS control stations in the park. These stations are located along a NW-SE traverse across the western part of the Yellowstone Caldera. Each year, data is col-

lected continuously for 48 hours from eight control stations. The GPS team sets up each station and trains two students in overall instrument monitoring before leaving them with the receivers for four-hour intervals.

A comparison between our 2000 and 2001 data indicates that uplift has resumed across the western region of the Yellowstone caldera. Uplift ranged between one and eight cm along our traverse, generally increasing northward. Subsidence ranging between 3 and 10 cm occurred across our network between 1999 and 2000. This shift from subsidence to uplift is consistent with the preliminary results reported by Robert Smith, University of Utah. However, the magnitude of our vertical deformation rates across the network is markedly higher than those reported by Smith.

The 2000 to 2001 horizontal displacements along our traverse ranged from a few mm's to three cm. Overall displacement direction was to north, varying between NNE and NNW. The largest horizontal displacements occurred at stations with the smallest uplift. Between 1999 and 2000, horizontal displacements were mostly westerly with a southern component. This shift to northerly movement contrasts with the southwesterly displacement defined by the regional deformation model across the Yellowstone Plateau. If our data are applied to this model, the axis of "rising and stretching" is located south or southwest of the present-day caldera. Our working group continues to examine the reliability of our results in view of the regional deformation patterns. A more detailed report of this study, including data tables and a map is available at: http://146.94.14.10/yellowstone.

A second component of our study is monitoring hot springs temperatures at selected thermal areas within the Yellowstone Caldera. Our study area consists of three separate thermal areas in the Lower Geyser Basin located along Rabbit Creek, White Creek, and Sentinel Meadows. Data is collected by small groups of students led by a faculty member who evaluates each thermal feature for safety and the best location to measure its temperature. Students measure the temperature of each hot spring using thermocouples and record the highest temperature obtained. The location of each measurement point is determined precisely in terms of latitude and longitude using a roving GPS unit carried by another student. Baseline data for our study was collected on June 28–29, 2000 when over 100 thermal springs were measured.

On June 27–28, 2001 we revisited the study areas and collected temperature and location data on 146 hot springs. Temperatures recorded at hot springs in Sentinel Meadows were essentially unchanged from 2000, measuring mostly in the 90°s, with several as high as 94°C. At least three new pools have become active south of Sleep Cone north of the main trail. The consistently high temperatures qualify Sentinel Meadows as the overall hottest of our three study areas. Although most hot springs in the Rabbit Creek area remained unchanged, significant increases of 4–19°C occurred at multiple pools in three separate hot spring clusters. Thus, Rabbit Creek qualifies as an area with an overall temperature increase. Data collected from White Creek was more difficult to evaluate because many of the 2001 locations were new, or did not correlate with the 2000 locations. Hot springs that did correlate between the data sets were essentially unchanged. Rabbit Creek and White Creek thermal features were more variable than Sentinel Meadows, with temperatures ranging from about 38–94°C. Maps and data tables for this study can be viewed at: http://oldsci.eiu.edu/geology/camp/YNP/ynpres.htm.

Project title: Physical Volcanology of the Huckleberry Ridge Tuff

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Objective: The objective of the research is to collect detailed quantitative information on the internal physical and chemical stratigraphy of the Huckleberry Ridge Tuff, from representative sections within and beyond Yellowstone National Park. This information will be used to enhance understanding of the vent locations and their evolution, the timing and development of caldera collapse, the transport and emplacement of the ash flows, and the overall time-scales of the parental eruption.

Findings: A total of 13 field days were spent working in Yellowstone National Park, accessing easily-reached areas around Mammoth, Mount Everts, and the Blacktail Deer Plateau north to the Yellowstone River. Work within the Park forms part of a much broader study of the Huckleberry Ridge Tuff (HRT), and the work in 2001 was intended as a reconnaissance to acquaint myself with features of the tuff. This aim was accomplished, but in addition several new discoveries were made that extend the pre-existing understanding of the stratigraphy and distribution of the tuff. These are as follows: 1) A new basal locality with fall deposits preserved below the tuff has been found at a site north of Yellowstone River, about 400 m west of Little Cottonwood Creek. This and other sites at Mount Everts indicate the HRT eruption started with only-weak, 'sputtery' explosive activity before escalating into the large-scale ash-flow producing activity. 2) Study of the basal fall deposits exposed on Mount Everts has shown that ash flows were being emplaced nearby for some significant time period prior to the level represented by the onset of ash-flow deposition at the preserved sites. This implies that the onset of ash-flow deposition of HRT Member A is diachronous, and that earlier portions of the tuff were coeval with, not following, fall deposition. Thin surge and flow deposits found at the northern tip of Mount Everts thin southwards over 2–3 km to vitric ash fall, implying the coeval flows were emplaced nearby, in a now lost paleovalley through the Mammoth–Gardiner area. 3) New localities were found that exposed crystal-poor tuff that is equivalent to Christiansen's (2001) HRT Member C just west of Mammoth, specifically, on the southern slopes of Terrace Mountain and the ridge east of Clematis Creek. Although stratigraphically equivalent to Member C (i.e. overlying the visually distinctive top to Member B with a clear welding [hence cooling] discontinuity), this newly discovered material is different in appearance to the archetypal Member C material at Huckleberry Ridge and the Red Mountains (near South Entrance) and their genetic relationships require clarification. 4) Comparison of sections within and outside the park have shown that the distribution of indentifiable sub-units ('facies') within the HRT members is more complex than previously thought. For example, crystal-poorer parts of HRT Member A form only thin (dm to m-thick) basal and top parts of the member where exposed on Mount Everts, but appear to form the bulk of Member A where exposed in the Madison River valley west of the park.

I greatly appreciate the opportunity to undertake work in the park, and am encouraged by the findings to date that information from the park will be of importance in my overall study of the HRT. No material has been prepared for publication from 2001 efforts, due to the preliminary nature of the findings and the need for more detailed future sampling and documentation.

Project title: Eruption Observation of Selected Remote Geysers

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Objective: To obtain eruption interval and duration measurements of selected remote geysers at Shoshone Geyser Basin (Double Geyser, Frill Spring), Heart Lake Geyser Basin (Glade Geyser), Lone Star Geyser Basin (Buried Geyser, Unnamed geyser SW of Lone Star-Shoshone trail bridge), Gibbon Geyser Basin (Phoenix Geyser).

Findings: Shoshone Geyser Basin: Double Geyser erupted every 4,300–5,643 seconds (mean of 35 intervals = 4,664 seconds); Frill Spring was dormant. Heart Lake Geyser Basin: Glade Geyser erupted every 2–5 days. Gibbon Geyser Basin: Phoenix Geyser erupted every 15,280–19,387 seconds (mean of 48 intervals = 17,794 seconds) for durations of ~1 hour.

Project title: Volcano Emissions

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Objective: Research on various gas emissions from fumaroles, soils, and other sources within Yellowstone National Park for the purpose of defining a background level of emissions to which future measurements of anomalous degassing during volcanic or tectonic unrest could be compared.

Findings: Project is ongoing. Results to date indicate that gas measurements can be made in the air

above the park from an airborne platform.

Project title: Chloride Flux Monitoring

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Objective: To secure a long-term database of thermal activity in YNP.

Findings: Nineteen years of data on the chloride flux exiting YNP (which proxies for heat flow out of the Park) shows a decline of thermal discharge from the park of 10–12% over this time period. We believe that this decline may be related to the documented deflation of the Yellowstone caldera.