

# **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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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 on-going, hands-on field experience for undergraduate geology majors at the Eastern Illinois University Geology Field Camp.

During our fourth annual GPS survey on June 26-27, 2002, we deployed 3 Trimble 4000Ssi 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 collected continuously for 48 hours from 8 control stations. The GPS team sets up each station and trains students in overall instrument monitoring before leaving them with the receivers for 4 hour intervals. The 2002 survey results indicate a change from uplift in 2001 to subsidence in 2002. Subsidence across the network ranges between 2.4 and 5.7 cm with a general decrease from north to south. There is no apparent relationship between the pattern of subsidence in the 2002 data and the caldera structure. Over the past 3 years, our deformation results show that the western region of the Yellowstone caldera has subsided, uplifted, and then subsided. Horizontal displacements ranged from a few mm to 2cm. Overall displacement direction is southerly and contrasts with the general northerly direction of the previous year. At the northern end of the network, horizontal movement is more westerly. Relatively large horizontal displacements occurred at stations with relatively small subsidence values. There is no clear spatial relationship between displacement direction and proximity to the caldera axis. This deformation pattern is consistent with southwesterly displacement as defined by the regional NE-SW deformation model across the Yellowstone Plateau. A more detailed report of this study, including data tables and a map is available at: <http://spruce.gis.wilkes.edu/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 3 separate thermal areas in the Lower Geyser Basin located along Rabbit Creek, White Creek, and Sentinel Meadows. Students measure the temperature of each hot spring using thermocouples and determine its location using a GPS unit. Baseline temperature data for our study was collected on June 28-29, 2000. In 2002, we began collecting pH data and digital imagery of each thermal feature. On June 26-27, 2002 we revisited the study areas and collected data on about 150 hot springs. Springs in Sentinel Meadows Thermal Area are consistently the hottest of all the study areas, with temperatures typically ranging from 85-96°C. In general, springs have either remained stable or shown temperature increases of 3-4°C since 2000. A few new springs may have developed in this area. The pH ranged from 6.2-8.7 in Sentinel Meadows and exhibited a positive correlation with temperature. There was no correlation between pH and location or pool size at Sentinel Meadows. The Rabbit Creek thermal area exhibited the greatest range in

temperatures of the 3 study areas, 40-95°C. Overall, about 60% of the springs showed modest temperature increases since 2000, typically between 3 and 7°C. Rabbit Creek has the widest variance in pH of the 3 study areas (6.0-9.5), but there is no correlation between temperature and pH. Larger pools tend to have higher pH values than smaller pools and there appears to be a geographic pattern of water pH at Rabbit Creek. Thermal features in the White Creek Group range in temperature from 53-95°C. In this group, more springs have shown temperature decreases than increases, although most have remained unchanged since 2000. Temperature decreases range up to 10°C whereas increases were as high as 7°C. The White Creek Group has pH values between 6.3 and 8.9, but most are above 7.5. There appears to be no relationship between pH and temperature, geographic distribution, or pool size. Maps and data tables for this study can be viewed at: <http://oldsci.eiu.edu/geology/camp/YNP/ynpres.htm>