Helium Isotope Ratios in South Sister Volcano Vicinity, Cold Springs

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RESEARCH OBJECTIVES

As part of a geochemical monitoring project at Oregon's South Sister volcano—a volcano that is undergoing strong uplift (Wicks et al., 2002)—we are carrying out a detailed study of helium isotope ratios in cold and hot springs in the Separation Creek drainage area. Through this study, we hope to determine the occurrence of any changes in spring chemistry that could be related to the ongoing uplift.

APPROACH

Helium isotope ratios ($^3He/^4He$) in fluids from volcanic areas are useful indicators for the presence of a magmatic component in those fluids. Moreover, in combination with other geochemical indicators, these ratios are indicative of a magma source and subsequent chemical processing of the fluids. The approach of this project was two-fold: (1) to establish a baseline of helium isotope ratios for springs within the zone of uplift and the surrounding area, and (2) establish a chemical and isotopic monitoring program for selected springs within the area.

ACCOMPLISHMENTS

Helium isotope data from the Three Sisters area are shown in Figure 1a. All the springs in the area, hot or cold, show a significant magmatic helium component. The most remarkable results are that two cold springs with a free gas phase, one close to the center of the uplift zone and the other close to the volcanic edifice itself, gave helium isotope ratios that are indistinguishable from pristine upper-mantle-derived helium (8 ± 1 times RA, where RA is the ratio in air and used for normalization). For the rest of the area, the data show a general trend of decreasing helium isotope ratios with distance from the zone of uplift (Figure 1b). This trend reflects dilution of the magmatic helium component with crustal fluids that typically are rich in radiogenic ^4He ($^3He/^4He$ ~ 0.02 RA).

During the time this study was conducted, none of the monitored springs showed any significant changes (Figure 1a) in helium isotopic composition. To further understand the system, we are continuing the monitoring program.

SIGNIFICANCE OF FINDINGS

Geochemical explorations for deep hot fluids, of economic interest as a potential energy source, generally focus on hot springs to the exclusion of nonthermal waters. The surprisingly very high helium isotopic compositions observed in two of the cold springs suggests that cold springs should not be overlooked, because they may contain helium isotope signatures reflecting deep processes, such as magma intrusion, that precede thermal and/or chemical pulses at the surface.

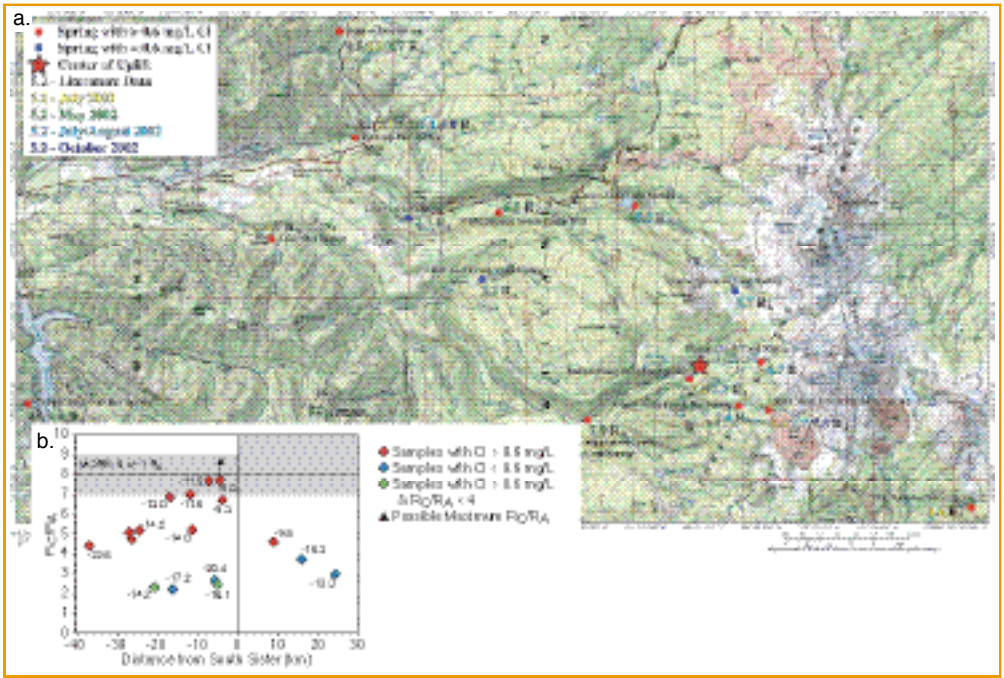

Figure 1(a). Overview map of the Three Sisters area, central Oregon, with sample locations and helium isotope results, using color coding for sampling date and general spring chemistry indication; (b) Plot of helium isotope ratio vs. distance from the volcano, with $\delta^{13}C$ values next to each data point showing a similar trend.

RELATED PUBLICATIONS

Wicks, C., Jr., D. Dzurisin, S.E. Ingebritsen, W. Thatcher, Z. Lu, and J. Iversen, Magmatic activity beneath the quiescent Three Sisters volcanic center, central Oregon Cascade Range, Oregon. Geophysical Research Letters, 29, 26-1–26-4, 2002.

ACKNOWLEDGMENTS

We would like to acknowledge UNOCAL for allowing us access to the data collected during their geothermal exploration studies. The principal author (van Soest) acknowledges Pat Dobson for his assistance with the literature search. This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Technology Department, Office of Geothermal Technologies, of the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.