Mantle volatiles in groundwaters near the San Andreas Fault

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Groundwater samples were collected from 19 wells along the San Andreas Fault (SAF) in the Cuyama, Cuddy, and Mil Potrero Valleys in southern California, USA. Previous work has shown leakage of mantle He via the SAF indicative of a focused mantle contribution to the surface. In this study, we assess the relation between He, a major volatile phase, and CO_2, the hypothesized carrier of the helium from the mantle.

The isotopic composition and concentrations of dissolved gases were determined. Measured $^3He/^4He$ ratios were compared to the $^3He/^4He$ ratio of air = 1.4 x 10^{-6} = Ra, to determine whether groundwaters were enriched in crustal (0.02Ra) or mantle (8Ra) helium. Concentrations of ^4He, corrected for air-bubble entrainment, varied from 3.0 to 58.1 x 10^{-8} $cm^3STP\ g^{-1}H_2O$. $^3He/^4He$ ratios varied from 0.46 to 3.58 Ra, consistent with mantle He in all samples (up to ~50%). A subset of 10 samples were analyzed for CO_2 and $\delta^{13}C$; concentrations of CO_2 varied from 0.059 to 0.223 $cm^3STP\ g^{-1}H_2O$, and the $\delta^{13}C$ of the CO_2 varied from -21.50 to -11.87‰. In groundwater, $\delta^{13}C$ ratios of ~-6‰, and elevated CO_2 concentrations may indicate the presence of mantle volatiles, particularly when they co-occur with high $^3He/^4He$ ratios. Measured $CO_2/^3He$ ratios varied from 64.1 to 1632 x 10^9 (mantle $CO_2/^3He$ = ~1.5 x 10^9).

Samples were collected from Quaternary alluvium filled valleys formed by motion along the northwest-trending, right-lateral strike-slip SAF. The flux of deep mantle fluids to the seismogenic zone at high hydrostatic pressure may cause fault rupture, and transfer volatiles into the shallow crust. $^3He/^4He$ and $\delta^{13}C$ ratios, and ^4He and CO_2 concentrations are highest in the wells located in the Cuddy and Mil Potrero valleys, which are closest to the SAF. Samples with the highest $^3He/^4He$ ratios also had the lowest $CO_2/^3He$ ratios. However, the eight wells sampled in the Cuddy and Mil Potrero valleys were located <1km from the SAF, yet their $^3He/^4He$ and $CO_2/^3He$ ratios varied by up to an order of magnitude suggesting heterogeneous fluxes of mantle volatiles along this 40 km section of the SAF.

Biological precipitation of calcite in stalagmites

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In recent years, spleothems have become an important archive for paleoclimate studies. To deduce paleoclimatic information from carbonate deposits, which is precipitated under non-equilibrium-conditions, it is important to improve the understanding of biological calcite precipitation.

In this study, laboratory experiments were conducted with calcium carbonate precipitating bacteria isolated from stalagmite deposits collected from Krem Syndai in Meghalaya, India. The medium used to culture these bacteria was designed in accordance to the drip water composition. We have isolated a new strain S4 that has been partially identified by 16S rDNA sequencing. The strain shows less than 95% similarity with any of the existing *Bacillus* stains involved in bio calcification. SEM and AFM studies are being carried out to understand the tomography of S4 strain.

Biocalcification rate of this strain was studied at regular intervals by studying the change in optical density, pH and calcite (wt%) precipitated in the medium. There is a positive correlation (r =0.925) between optical density and pH implying increased precipitation over the 40 day period. XRD was done to identify the minerals in the microbial precipitate. In addition the precipitate was analyzed for the isotopic composition of $\delta^{13}C$ and $\delta^{18}O$.