Triple Oxygen Isotopic Systematics of Meteoric Hydrothermal Systems and Implications for Paleoaltimetry

C. PAGE CHAMBERLAIN[1]*, DANIEL E. IBARRA[1,2], MAX K. LLOYD[2], TYLER KUKLA[1], ZACHARY D. SHARP[3], DEREK SJOSTROM[4]

[1] Geological Sciences, Stanford University, Stanford, California 94305, USA (*correspondence: chamb@stanford.edu)
[2] Earth and Planetary Sciences, UC Berkeley, Berkeley, California 94709, USA
[3] Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131, USA
[4] Geology Program, Rocky Mountain College, Billings, Montana 59102, USA

We use triple oxygen isotopes of mineral separates from altered granitic rocks to determine the isotope composition of meteoric waters in a fossil hydrothermal system, the low-$\delta^{18}O$ Eocene Idaho Batholith, originally studied by Criss and Taylor [1]. In doing so we: 1) test whether meteoric water values determined from previous $\delta^{18}O$ and δD analyses on quartz, feldspar and biotite [1] are robust; and 2) determine the paleoelevation of the Eocene highlands that are presently constrained primarily by the $\delta^{18}O$ and δD of paired muscovite and quartz from core complexes [2].

Our analyses of paired plagioclase feldspar and quartz samples range in $\delta^{18}O$ from -3.3‰ to 9.0‰, and 5.7‰ to 10.8‰, respectively, with a strong negative correlation in feldspar $\Delta^{17}O$ ($\lambda = 0.528$) ranging from -0.014 to -0.117. Exploiting this correlation, we derive an empirical mixing slope ($\delta'^{17}O$ vs. $\delta'^{18}O$) of 0.525 and calculate a meteoric water composition of $\delta^{18}O$ = -12.1‰ (-14.7 to -9.1‰), based on a mixing regression to the meteoric water line. Our results have important implications for future paleoaltimetry studies. First, our calculated $\delta^{18}O$ value of meteoric waters is slightly higher than combined $\delta^{18}O$ and δD measurements in these hydrothermally altered granites (-15‰; [1]) and δD values from muscovite in nearby core complexes (-15.6‰; [2]), suggesting some post crystallization exchange of hydrogen. Second, our results are consistent with a high elevation (3 to 4 km) Eocene highland in the north-western U.S. Cordillera, yet lower than these estimates based on hydrogen isotopes.

[1] Criss & Taylor (1983) *Geological Society of America Bulletin*, **94**, 640-663. [2] Mulch *et al.* (2007) *Tectonics*, **26**, TC4001.