B, Li, and Cl systematics in the Yellowstone hydrothermal system

JEFFREY T. CULLEN[1], SHAUL HURWITZ[2], JAIME D. BARNES[1]

[1]Department of Geological Sciences, University of Texas at Austin, Austin, Texas, 78712, USA (*correspondence: jcullen@utexas.edu)

[2]U.S. Geological Survey, Menlo Park, CA 94025, USA

Thermal waters were collected from six thermal areas in Yellowstone National Park, USA and analyzed for their major and trace element concentrations and boron and chlorine isotope compositions to better constrain the controls on the distribution of B, Li, and Cl in the Yellowstone hydrothermal system.

Neutral chloride-type waters, predominatly in Yellowstone's geyser basins, are characterized by a narrow range of Cl/B (20.0 to 27.3 by mass), whereas acid sulfate-type waters, mainly in the eastern part of the park and in Norris Geyser Basins, have lower ratios and span a larger range of Cl/B (0.1 to 19.6). The Cl/Li and B/Li of neutral chloride and acid sulfate type waters are indistinguisahable (5.7 to 50.9 and 0.44 to 12.2, respectively) and do not correlate with other chemical parameters. Lithium concentrations in neutral chloride-type waters correlate well with estimated reservoir equilibration temperatures based on SiO_2 geothermometry, documenting enhanced Li mobility with increasing temperature as has been reported in thermal well waters elsewhere [1]. Variations of Cl and B concentrations correlate poorly with estimated reservoir temperature, demonstrating their conservative behavior.

Waters from the travertine depositing Mammoth Hot Springs north of the Yellowstone caldera have $\delta^{11}B$ values of -8.5 and -8.7‰, suggesting interaction with underlying carbonates. $\delta^{11}B$ values of waters from the Yellowstone caldera and Norris Geyser Basin range between +4.2 and -5.7‰ (n = 20), mainly clustered around -4‰, indicating interaction with host rhyolites, consistent with previous work [2]. $\delta^{37}Cl$ values of thermal waters from within, and outside the Yellowstone caldera (Cl <798 ppm) range between -0.2 to +0.8‰ (n = 21), extending the range of previously reported $\delta^{37}Cl$ values in Yellowstone thermal waters (-0.13 to +0.42‰) [3]. A preliminary $\delta^{37}Cl$ value of a representative host rhyolite is -0.2‰, which is at the lower end of thermal waters and identical to the value of the upper mantle [4]. Thermal waters from Mammoth Springs have $\delta^{37}Cl$ values of -0.2 to +0.1‰ (n = 5), indistinguishable from the rhyolite-hosted springs. Overall, the Cl isotope data suggest that Cl behaves as a conservative tracer.

[1] Millot et al., 2007, *Appl. Geochem.*, 22, 2307-2325. [2] Palmer and Sturchio, 1990, *GCA*, 54, 2811-2815. [3] Zhang et al., 2004, Water-*Rock Interact.*, 1, 233-236. [4] Sharp et al., 2013, *GCA*, 107, 189-204.