Evaluation of volcanic rock as a source for indium in hydrothermal environments

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Indium is an integral element used in LCD, LED, and solar cell technology. Despite its importance in emerging technologies, little is known about its behavior in hydrothermal systems. Experimental studies on the geochemistry of indium may provide information useful in the development of exploration vectors. In this study, our aim is to estimate the efficiency with which indium can be removed from volcanic rocks by hydrothermal alteration by studying the extent to which indium partitions between an aqueous solution and products of hydrothermal alteration. To evaluate the magnitude of this efficiency, experiments were performed using a 1 M HCl aqueous solution containing ~370ppm indium and a 3 mm diameter basalt sphere. A subset of experiments included additional 0.5 M NaCl and 0.5 M KCl. Water/rock ratios in the experiments were set at either 1 or 2 (by mass). Experiments were then run at 500°C and 50 MPa for two weeks. Basalt run products consisted of an altered rim and a comparatively less altered core. The altered rim consistently had indium concentrations above detection (~25ppm), whereas the core tended to have lower indium concentrations, frequently below detection, demonstrating that alteration minerals can sequester indium in a hydrothermal system. In the run products from experiments without added NaCl+KCl, indium concentrations ranged from an average (n=10) of bd-65ppm in the comparatively unaltered core, and 42-176ppm in the altered rim. In the experiments with added aqueous HCl+NaCl+KCl solutions, indium concentrations ranged from an average of 42-106ppm in the interior and 58-106ppm in the rim. Therefore, the heavily altered rim of the basalt exhibited higher indium concentrations than the relatively unaltered core. Furthermore, preliminary results suggest that the water/rock ratio exerts significant control over the sequestration of indium in the altered rock. Experiments with a water/rock ratio of ~1 had average indium concentrations ranging from 65-106ppm in the interior and 106-176ppm in the rim. Experiments with water rock ratios of ~2 had average indium concentrations ranging from bd-50ppm in the interior and 42-115ppm in the rim. These data suggest that a larger quantity of indium will partition into the altering fluid relative to solid alteration products, and can therefore serve as a more potent ore fluid when alteration occurs at a higher water/rock ratio. Further work is required to explore how additional conditions might contribute to the availability of indium during alteration.