Selective Adsorption of Rare Earth Elements from Geothermal Brines

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Rare earth elements (REE) are critical materials for developing clean energy-, strategic defense-, and consumer technologies. Mining, which is expensive and laborious with a significant environmental burden, is currently the economically preferable method of extracting and harvesting these elements. Previous research has shown that fluids generated through geothermal energy production may be enriched with REE and represent a potentially untapped source of these critical materials. This research details the development and performance of ligand-functionalized adsorbents designed to selectively uptake REE from heterogeneous aqueous mixtures. Batch experiments resulted in adsorption yields of up to 99.4% for lanthanides in synthetic geothermal brines. A suite of ligands and adsorbent supports were tested under various reaction conditions, and their capacity, selectivity, and uptake kinetics were compared directly. The synthesized materials demonstrated robustness and retained their adsorptive capacity after exposure to elevated temperatures (100°C) and acid/base solutions. A bench-scale column system was developed and packed with functionalized supports to simulate potential geothermal fluid treatment scheme. Results from flow-through column experiments were compared with those anticipated from mathematical model simulations.