Thermodynamic Stability of Rare Earth Carbonates

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Abstract:

Rare earth elements (REEs) are strategic materials important for technology, modern electronics, and energy. However, unstable supply chains have intensified global demand. A promising alternative source of REEs is recycled waste sludges generated during aluminum production. To understand and model fractionation and mobility of REEs and to improve extraction processes, it is essential to develop robust thermodynamic models of REE-H_2O-CO_2 interactions. This requires reliable thermodynamic data on rare earth carbonates.

There are five important phases in the REE-H_2O-CO_2 system at low temperature hydrothermal conditions (<250 °C). An amorphous phase initially precipitates from carbonate solutions but transforms into lanthanite, tengerite, kozoite, or bastnaesite as a function of temperature and heating time. Enthalpies of formation for these compounds were measured using high temperature drop solution calorimetry and room temperature acid solution calorimetry. Absolute entropies were obtained from low temperature heat capacity measurements. Trends in thermodynamic stability show that the phase formation is highly dependent on temperature, ionic radius of the REE, and kinetics.