Rare Earth Element ore genesis: The Great Unknown

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Economic or potentially economic REE deposits are hosted by or genetically associated with alkaline igneous rocks and carbonatites. Primary REE enrichment in silicate magmas depends on the highly incompatible nature of the REE, may be facilitated by fluoride complexation, and occurs at late stages of magma evolution through crystal settling and crystallisation of residual, fluid-saturated liquids including immiscible fluoride melts. Carbonatite magmas likely owe their REE enrichment to the high solubility of the REE, and their preference for the LREE to the similar ionic radii of Ca^{2+} and Ce^{3+}; HREE are smaller.

Hydrothermal mobilisation may be essential to the economic viability of many REE deposits. Indeed, the World's largest deposit, Bayan Obo, China, is dominantly hydrothermal. Although aqueous fluoride complexes are widely thought to be the main agent of REE transport, modelling of natural systems suggests that this is not the case. Instead, chloride complexes appear to be responsible for REE transport. Moreover, experiments suggest that REE chloride complexes can cause the observed preferential LREE mobility. Hydrothermal concentration of REE occurs when interaction of acid REE-Cl-bearing fluids with pH-buffering rocks, or mixing with neutral fluids, and/or decreasing temperature, induces REE mineral deposition.

LA-ICPMS^2: Laser ablation sampling with combined ICP-Q-MS and MC-ICP-MS detection for simultaneous trace elemental and isotope ration analyses

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In situ analysis by laser ablation offers significant advantages to users in a range of applications including geochronology but interrogating the sample for all of the information required may not be possible in a single measurement. Laser ablation is a destructive sampling technique and while many samples are large enough to allow for multiple analyses on a range of instruments, geochronologically relevant samples are often so small as to preclude multiple analyses. These samples are often unique and once sampled by laser ablation, they are lost and no further information can be extracted.

In this presentation, a system for the simultaneous isotopic and elemental characterization of zircon (ZrSiO4) is described. A high performance 193nm excimer laser (Photon Machines Analyte G2) is used to sample ~50 μm diameter pits in the zircon, and the He carrier gas containing the entrained sample is split between ICP-Q-MS and MC-ICP-MS systems. A new high performance ICP-Q-MS system (Thermo Scientific iCAP Q) is used for the quantification of trace elements (both transition metals and rare earth elements) and MC-ICP-MS (Thermo Scientific Neptune Plus) is used for high precision Pb and Hf isotope ratio measurements.

The advantages afforded by such combined, simultaneous isotopic and elemental analyses of growth zones of minerals will be highlighted in the presentation

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