Three PhD positions at New Mexico Tech in molecular complexation of rare earth elements (REE) in high temperature and pressure supercritical geologic fluids

We seek motivated candidates with a strong interest in high-temperature hydrothermal experimental geochemistry, EXAFS and Raman/UV-Vis spectroscopy, chemical thermodynamics and computational geochemistry. These positions are part of the new collaborative **U.S. geoscience critical minerals experimental – thermodynamic research hub** between New Mexico Tech (NMT), Los Alamos National Laboratory (LANL), and Indiana University Bloomington (IUB), which is a Department of Energy (DOE), Basic Energy Sciences, funded project (https://www.energy.gov/articles/doe-awards-30m-secure-domestic-supply-chain-critical-materials).

The 3-years funded PhD projects (Graduate Research Assistantships, RA) will **start in Spring 2022** at the Department of Earth and Environmental Science (https://nmt.edu/academics/ees/) and the New Mexico Bureau of Geology and Mineral Resources (https://geoinfo.nmt.edu/) at New Mexico Tech. The main advisors for theses PhD projects are Dr. Alexander Gysi, Dr. Nicole Hurtig and Dr. Laura Waters. These projects consist of high-temperature solubility and speciation experiments and aim at determining thermodynamic properties of REE aqueous complexes in supercritical fluids relevant to the formation of magmatic-hydrothermal critical mineral deposits.

We are seeking expertise for the following three projects (please contact the respective faculty):

- Project 1 (Gysi, alexander.gysi@nmt.edu): This project involves *in situ* spectroscopy (UV-Vis and Raman) experiments focused on determining REE complexation in hydrothermal solutions. The PhD student will be part of Dr. Alexander Gysi's Ore Deposits and Critical Minerals research group and design a new type of experimental flow-through cell and learn spectroscopic and analytical techniques for determining the formation constants of REE in supercritical hydrothermal aqueous fluids. This research also includes collaborative work on the MINES thermodynamic database and development of an internally consistent experimental and thermodynamic databases using modern computational optimization techniques together with the GEMS development team (https://gems.web.psi.ch) and Dr. Chen Zhu at IUB.
- Project 2 (Hurtig, nicole.hurtig@nmt.edu): This project focuses on batch-type reactor hydrothermal solubility experiments at 350 – 500 °C and pressures up to 1 kar for determining the solubility and speciation stoichiometry of REE complexes. The PhD candidate will work with a new type of high-temperature Inconel reactors from Parr Instruments that will allow measuring pressure for determining volumetric properties of supercritical fluids.

- Project 3 (Waters, laura.waters@nmt.edu): This project aims to generate a comprehensive set of solubility measurements of REE phosphates usings synthetic REE end-member crystals, which will be equilibrated with a variety of neutral and acidic solutions between 500 – 700 ºC and pressures of 0.5 to 2 kb, in cold seal pressure vessels. The PhD will gain expertise in creating precious metal capsules for housing experimental run products, expanding a cold-seal pressure line, improving a methodology for solution capture, designing kinetic tests for solubility experiments and analyzing run products using ICP-MS and ICP-OES, electron microprobe analyzer and scanning electron microscope.

While the positions are hosted at NMT, collaboration opportunities will be provided through the research hub to conduct experimental research internships at LANL with our collaborators Dr. Artas Migdisov and Dr. Pavel Dub, and participate in thermodynamic data analysis and code development with our collaborators Dr. Chen Zhu at IUB.

Prospective PhD students are expected to have a MSc degree in geochemistry, chemistry or Earth science related fields and an interest in thermodynamics, laboratory experiments, analytical geochemistry, and numerical modeling. Hands-on experience with solution ICP-MS and ICP-OES, and mineral analysis techniques such as XRD, EMPA, LA-ICP-MS and SEM are beneficial. A background in aqueous geochemistry and/or thermodynamics is preferred. Proficiency in English is required. The PhD positions are funded for a period of three years through research assistantships that cover stipend and tuitions to study at NMT, research costs and attendance to conferences for networking opportunities.

For additional questions about this project please email alexander.gysi@nmt.edu with your CV and a short cover letter. The letter should explain your previous research experience, career goals, and your interest in these position. Applications will be reviewed starting immediately until positions are filled. Prospective candidates will be further invited to submit their full application directly to the Office of Graduate Programs at NMT using the following link: http://gradcas.liaisoncas.org/apply/. Applicants are expected to submit a CV, academic transcripts, a letter of introduction and obtain three reference letters. A TOEFL is required for non-native English speakers. For questions about the admission process at New Mexico Tech please contact graduate@nmt.edu. **The deadline for Spring applications is September 25, 2021.**