Sm-Nd and Lu-Hf geochronology of ultramafic dykes from the Malanjkhand porphyry copper mine, India

A Munro, A Bouvier

Department of Earth Sciences, University of Western Ontario, Ontario

Ultramafic igneous rocks are relatively difficult to date due to a lack of incompatible elements, and therefore U-rich minerals, which are necessary for the traditional U-Pb radiometric dating method. When igneous rocks are subsequently metamorphosed and altered, which can affect radiochronometric age determination, dating becomes even more challenging. This study aims to date the formation of the ultramafic dyke swarm that cross-cuts the Malanjkhand porphyry copper mine located in the Dongargarh Kotri Belt, India. The deposit is estimated to contain 789 million tonnes of ore averaging 0.83wt% Cu, 0.004wt% Mo, 0.2 g/T Au, and 6 g/T Ag. The granitic porphyry body has been dated to ~2.5 Ga with syngenetic mineralization of sulphide ore minerals. The dykes have the potential to be future economic prospects if their relationship with the mineralization event can be determined. The dyke swarms have been characterized using geochemistry and field observations. Previous attempts to date the ultramafic dykes using more conventional radiometric methods, such as the K-Ar and Rb-Sr systems, were unsuccessful, providing inconsistent ages because K and Rb are large ion lithophile elements, which are known to be susceptible to mobilization during metamorphism and alteration events. As an alternative method, the Sm-Nd (^{147}Sm-^{143}Nd, half-life = 106 Ga) and Lu-Hf (^{176}Lu-^{176}Hf, half-life = 37 Ga) radiogenic systems will be used as to date two selected dyke samples. These two radiogenic pairs are based on refractory elements (rare-earth and high field strength elements), which fractionate between silicate minerals in ultramafic igneous rocks (e.g., olivine, pyroxene and plagioclase). By producing Sm-Nd and Lu-Hf isochrons, we will determine the igneous crystallization ages of the dykes. Comparing the records from two chronometers with different geochemical behaviors within the same minerals, evaluates potential disturbances. Mineral separates of pyroxene and plagioclase and whole-rock powders of two gabbroic pyroxenite rock samples (>90% pyroxene, 5-10% plagioclase and accessory minerals of amphiboles, biotite, chromite and pyrite) were prepared for acid washing, dissolution, and Sm-Nd and Lu-Hf isotopic dilution methods in the GEOMETRIC Laboratory at the University of Western Ontario. The isotopic compositions of purified elements will be measured using high precision Multi-Collector ICP-MS. Obtaining the formation ages of the ultramafic dykes has the potential to link the dyke swarming event to either the porphyry intrusion itself or to younger catalogued tectonic disturbances in the Dongargarh Kotri Belt, which will assist in future exploration for similar sites.