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Monazite-xenotime Y+REE partitioning as a marker of ancient metamorphic conditions

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Early Earth metamorphic conditions (P, T and fO_2) are elusive to qualification because mineral phases used in thermobarometry are susceptible to weathering and alteration. Moreover, combined mineral oxy-thermo-barometers that can be confidently geochemically dated, rarely exist. The difficulty compounds if one wishes to explore the characteristics of extinct metamorphic fluids. This is apparent when qualifying the metamorphic conditions experienced by Archean and Eoarchean metasediments and supracrustal sequences [1-3]. Most metamorphic environments have monazite-xenotime pairs that might potentially record metamorphic information. We present an experimental calibration where we quantify the exchange of Ce and Y between monazites and xenotimes that we synthesized in equilibrium by combining Ce, Y, Sm, Eu, Gd, Dy and P. Based on preliminary results, we observe that the cation exchange is a function of P (1 & 0.7 GPa) and T (1200 -700 °C). Moreover, the partitioning of Ce into xenotime is affected by fO_2 (where fO_2 ranges from FMQ+0.5 to FMQ–5). We also measured the Eu anomaly in monazite-xenotime pairs and have found that there is systematic change in the Eu anomaly of both phases as a function of fO_2. Our results show that the monazite-xenotime system holds significant potential to reveal P, T, and fO_2 of metamorphic systems. These two phases also incorporate U and Th – generally at the exclusion of Pb – meaning that they can be U-Th-Pb dated [4, 5]. We have discovered these phosphate phases as inclusions in Jack Hills zircons and in rocks from the Inukjuak domain which are excellent targets for our results. Moreover, given the ubiquity of these two phases, our calibrations may be applied to many metamorphic terranes.

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