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A monazite oxygen isotope thermometer

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ABSTRACT

A quartz-monazite oxygen isotope thermometer was calibrated based on $\delta^{18}O$ measurements of mineral separates from monazite-bearing rocks and on piston cylinder calcite-monazite oxygen exchange experiments. The oxygen isotope composition of monazite was measured using secondary ion mass spectrometry (SIMS) and multiple fluorination techniques. The results of these measurements suggest that (1) differences in Th content of monazite can cause the instrumental mass fractionation in an ion microprobe to vary by at least 4‰; (2) the oxygen isotope compositions of chemically distinct zones in the monazite grains analyzed are probably similar; and (3) $\delta^{18}O_{mnz}$ is most accurately determined by extracting oxygen via fluorination in nickel vessels. Comparing the oxygen isotope fractionation between quartz and monazite with independently derived temperature estimates suggests that (1) the coefficient of fractionation between quartz and monazite ($a_{qtz\text{-}mnz}$) equals 2.2 ± 0.6, and (2) ~100 μm monazite grains in a multiply metamorphosed, granulite facies orthogneiss from the Wind River Range record the high-temperature history of this rock, whereas other isotopic thermometers suffered retrograde oxygen exchange. This evidence indicates that monazite might be used to constrain peak metamorphic temperatures, which may correlate with the ages recorded by the same mineral.

Keywords: Monazite, oxygen isotope, thermometry, ion probe, Wind River Range