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LETTER

High-precision oxygen isotope analysis of picogram samples reveals 2 μm gradients and slow diffusion in zircon

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ABSTRACT

Ion microprobe analysis with a sub-micrometer diameter spot reveals a sharp, 2 μm gradient in oxygen isotope ratio proving that oxygen diffusion in zircon is slow even under prolonged high-grade metamorphism. The data are consistent with an oxygen diffusion coefficient of $10^{-23.5\pm1}$ cm^2/s. Furthermore, this gradient is found in a zircon that contains clear textural evidence of recrystallization in nearby regions. This finding shows that through careful textural and chemical analysis, primary information can be extracted from a zircon that has also undergone partial recrystallization. The oxygen isotope ratios found in zircon have been used to infer magmatic and pre-magmatic histories, including the presence of liquid water on the surface of earliest Earth. Recently, these interpretations have been questioned with the assertion that zircon may not retain its primary oxygen isotope signature through metamorphism. The slow diffusion confirmed by these results supports interpretations that assume preservation of magmatic compositions.

Keywords: Ion microprobe, SIMS, zircon, diffusion, oxygen isotopes, stable isotopes, granulites facies, migmatites