

# Zirconium isotope tracing of the magmatic-hydrothermal transition

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Zirconium (Zr) isotopes have significant potential for tracing magmatic processes, particularly late-stage fractionation involving fluids. However, the fractionation of Zr isotopes between magma and fluid is still unclear. In-situ Zr isotope analyses of zircons from three granite-pegmatite suites in the Tibetan plateau show a wide range of  $\delta^{94/90}\text{Zr}$  values (IPGP-Zr) between  $-0.23\text{‰}$  and  $1.38\text{‰}$ , with the highest values in hydrothermally altered zircons from pegmatites. A coupled dissolution-reprecipitation process of zircons in a fluid-rich magma is the most plausible mechanism to explain the strong enrichment of heavy Zr isotopes in hydrothermally altered zircons. During the formation of granitic pegmatite, exsolution of F-Na-Si-bearing fluids can enhance zircon solubility and is capable of significant removal of Zr from the melt. Faster diffusion of  $^{90}\text{Zr}$  into the fluid channel will result in preferential accumulation of light Zr isotope in the fluid, and drive heavy Zr isotope enrichment in the residual melt under disequilibrium conditions. Later reprecipitated zircons will inherit the heavy Zr isotope composition of the melt. Rayleigh fractionation models suggest fluid-melt fractionation factors for Zr isotope of about 0.99911–0.99930. The results show the major controls of fluid on Zr isotope fractionation during crystal-magma-fluid differentiation. Zr isotope can be a powerful tracer for the magmatic-hydrothermal transition.

