Pulsed degassing of magma recorded by water concentration in zircon

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Quantifying H_2O concentration in magmas is critical for understanding their generation, differentiation or eruption, because H_2O has profound effects on melting temperatures, crystallizing pathways, and volcanic explosivity. Nominally anhydrous minerals (NAMs) can incorporate minor H_2O, in equilibrium with magmas from which they crystallize, prior to emplacement/ eruption. Zircon, a common accessory mineral widely used for U-Pb-Hf-O isotope studies, is also a NAM that accommodates hydrogen in concentrations of up to thousands of wt. ppm H_2O. Here we report SIMS analytical results on water concentration in zircons separated from a gabbroic diorite and a basaltic andesite. The former was collected from a Carboniferous stock within the Palaeozoic Lachlan Orogen of Eastern Australia, known as TEMORA 2, widely used as U-Pb-O reference zircon for SIMS analysis. The latter came from a Quaternary volcanic rock in Tengchong, China (13TC06E). Our results show that both samples have two zircon groups with consistent oxygen isotopes but distinguishable water contents. TEMORA 2 has water concentrations at 100-300 ppm and 600-700 ppm, and 13TC06E has that at 200-300 ppm and 500-700 ppm. Multiple analyses along profiles of a single zircon grain show limited water concentration variations, suggesting that zircon crystal has a good capacity to keep H_2O after crystallization. The clear variations in water concentrations is interpreted as that these crystallized zircons were equilibrated with H_2O-saturated melt at two different depths, with pulsed degassing events. This interpretation is also supported by Ti-in-zircon temperature data for the samples.