Effects of deep degassing on H_2O/Ce in Ocean Island Basalts

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The degree of water recycling to the deep mantle during subduction is unclear. Low H_2O/Ce ratios in EM-type glasses (Societies, Pitcairn) suggest efficient water removal during subduction. However, HIMU H_2O/Ce estimates are variable, ranging from >250 (melt inclusions from Mangaia) to <100 (submarine glasses from Tuvalu seamount). Because H-diffusion in cpx is slower than in olivine, cpx phenocrysts provide an additional means of constraining pre-eruptive magma water contents. We examined water and trace element concentrations in cpx phenocrysts from HIMU basalts from the Austral Islands. Calculated melt water contents (up to 2.5 wt.%) and H_2O/Ce ratios (average ~250) are systematically higher than in olivine-hosted inclusions from the same samples, suggesting that post-entrapment water loss for melt inclusions is common.

H_2O/Ce ratios in submarine quenched glasses are typically considered to be robust proxies of source H_2O/Ce. However, most OIBs to span a limited range in water content (~1-1.5 wt.%), and low H_2O/Ce ratios are primarily observed in melts with unusually high [Ce] (up to 350 ppm). In addition, water content and H_2O/Ce in some sample suites correlate with entrapment pressure despite having formed at pressures above where open- or closed-system degassing should produce significant water loss (~500 bars). We suggest that polybaric "sparging", whereby low-P melts re-equilibrate with CO_2-rich volatiles exsolved at higher pressure, may result in degassing trends that approach CO_2-H_2O isopleths rather than open- or closed-system degassing paths. As a result, both the primary water and CO_2 contents of many OIBs, and therefore the extent of water recycling via subduction, may have been significantly underestimated.