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ABSTRACTS

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Are melt inclusions a robust tool for understanding H2O content of deep hydrous arc magmas?

Dissolved in magma, H2O plays a significant role in generation, evolution, and eruption of arc magmas. Estimating pre-eruptive H2O content is challenged by near-surface H2O degassing during ascent and eruption. Currently, the 'gold-standard' for determining pre-eruptive volatile contents in magmas is the study of mineral-hosted glassy melt inclusions (MIs). They act as tiny pressure capsules potentially preserving maximum dissolved water contents, while the matrix melt degasses on ascent and gets modified by mixing and differentiation processes. Despite the widespread use of glassy MIs, it has yet to be tested whether they underlie a systematic maximum limit resulting in potentially biasing the inferred magmatic H2O budget in subduction zones. Natural glassy MIs have been found to contain no more than ~8-9 wt.% of dissolved H2O, and the question remains, is this limit representing a natural limit or a preservation limit? Here we explore the limits of mineral hosted glassy MIs as hydrous magma recorders based on an experimental study of quenching water-bearing silicate melts and show that 9 wt.% of dissolved H2O is a physical limit that quenched melt inclusions cannot exceed, while still quenching to a single-phase glass. Our results demonstrate that the maxima of 8-9 wt.% H2O from glassy MIs studies is linked to the ability of quenched glass to incorporate H2O/OH– in its structure, while excess water exsolves as bubbles and/or promotes devitrification through crystallization of quench crystals or hydrous alteration of the glass. Hydrous melts with H2O >9% will not form glassy MIs. As a result glassy MIs are only faithfully recording magmatic pre-eruptive H2O contents in the upper-most part of the Earth's crust where H2O-solubility is below 9 wt.%. They have no sensitivity to estimate volatile budgets neither in deep/primitive arc magmas nor in mid-crustal evolved magmas. Such magmas may contain much larger amounts of water than currently recognized imparting also additional buoyancy on ascent. For dense primitive magmas this may solve a conundrum often found in convergent margins; the fact that such magmas can reach the surface despite a low-density filter in the form of evolved magmas and crust in their path. These results show that we might be drastically underestimating the volatile budgets in subduction zones and they highlight the necessity of using and developing alternative methods for estimating pre-eruptive H2O contents.