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The process of volatile species accumulation in magmas: storage timescales, migration rates, and hints for short warning times of explosive eruptions

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Volatile species (e.g., H_2O, CO_2, etc.) play a significant role in magma genesis, evolution, ascent and, finally, eruption. Despite the recognized crucial function of volatile species, there are still several problems that continue to blur our view about their role in key processes occurring in volcanic plumbing systems. Key questions still open are: 1) what are the timescales of H_2O accumulation in crystallizing magmas? 2) What are the ascent rates of volatile-rich residual melts leading to eruptions?

Also, at depths where the magmatic pressure is below the saturation threshold, volatile species can exsolve quickly, potentially causing crystal mush remobilization, and triggering higly-explosive eruptions. Finally, the vigor of volatile exsolution can be strongly affected by the ascent rate of volatile-rich magmas, ultimately exerting a significant role in modulating the eruptive style.

We study the timescales of water accumulation in residual melts resulting from crystallization of a hydrous CO_2-bearing magmatic mass stored at mid- and deep-crustal levels in subduction-related settings.

Our calculations indicate that, after repose periods ranging from few to several kilo-years, volatile-rich melts with water concentrations larger than 6–9 wt.% can migrate towards the Earth surface in very quick timescales (i.e., days or even hours), possibly triggering explosive eruptions with short warning times and devoid of long-term geophysical precursors.