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Time and tempo of melt segregation from a magma mush: evidence from the Takidani pluton (Japan)

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The Takidani pluton is a Pleistocene intrusion representing a nearly 2 km-thick shallow level magma reservoir located in the Central Japan Alps. The pluton, which is associated with caldera-forming eruptions, is vertically zoned and composed of six distinct lithological units ranging from hornblende-bearing granodiorite to biotite granite, with silica content varying from ca. 65 to 76 wt.%. In its upper part, the intrusion is characterized by the gradual transition between equigranular and porphyritic granodiorites. Textural and geochemical evidence indicates that the porphyritic unit represents a lens of residual melt extracted from the underlying equigranular granodiorite (Hartung et al., 2017).

The time and tempo of melt extraction is determined using both high precision and high-spatial resolution U-Pb zircon geochronology, performed by CA-ID-TIMS and SIMS respectively. High precision ²⁰⁶Pb/²³⁸U zircon ages for the two units are similar, with grains from both rocks exhibiting an age spread as large as 200-300 kyr, from ca. 1.2 to 1.5 Ma. In-situ U-Pb dating obtained by SIMS using a spot size of 20 µm reveal systematic age difference between cores and rims, highlighting two events of zircon crystallization with no substantial difference between the two units. Zircon cores from the porphyritic and equigranular granodiorites give identical ages at ca. 1.45 ± 0.06 Ma. Spot U-Pb ages from magmatic rims range between 1.29 and 1.07 Ma, with a peak of the distribution density at around 1.20 Ma.

This information, combined with Zr saturation temperatures and phase equilibria modelling, suggests that zircon cores crystallized from the magma reservoir before rheological locking and melt segregation were achieved. The segregation of the interstitial melt from the mush took place in the ca. 250 kyr between the two events of zircon crystallization. The extracted residual melt was depleted in Zr and carried entrained crystals of plagioclase and zircon from the mush. The low Zr content of this melt hindered zircon crystallization that was only possible after a time lag of 250 kyr. The youngest event of zircon crystallization at ca. 1.2 Ma was contemporaneous in the segregated melt and in the underlying mush.

Reference: Hartung, E., Caricchi, L., Floess, D., Wallis, S., Harayama, S., Kouzmanov, K., Chiaradia, M., 2017. Evidence for residual melt extraction in the Takidani Pluton, Central Japan. *J. Petrol.* 58, 763–788.