Small-scale zircon age variability in the Monte Capanne pluton revealing the timescale of crustal melting and melt extraction

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The shallow level Monte Capanne monzogranite (Elba Island, Italy) is formed by three facies which have been interpreted, based on textural and chemical arguments, to represent distinct magma batches emplaced by under-accretion[1]. Recently, high-precision U-Pb zircon ID-TIMS geochronology for the pluton has documented zircon crystallization ages spanning ca. 0.55 My, from 7.568 to 7.007 Ma[2]. Individual rock-samples from the facies show 0.3-0.5 My of dispersion in U-Pb zircon ages. Numerical thermal simulation considering a three-batch emplacement scenario has predicted a maximum zircon crystallization time <70 ky for the lowermost and most voluminous facies and only ca. 1 ky for the uppermost. Such a short time interval can only account for 1-10% of the entire age variability observed in the zircon record. Therefore, it has been suggested that most of the zircon grains crystallized in a magma reservoir at depth and were successively recycled[2].

In this study, we explore the possibility that the 500 ky of magmatic evolution recorded by the pluton reflects the stepwise extraction of relatively small batches of new magma produced by the progressive melting of the crustal source. Modelling performed using the R-crust phase-equilibrium programme[3] demonstrates that magma generation from any likely source for the pluton will be delivered in several discrete pulses. Assuming bleed-off of any melt volume >1 vol%, the source undergoes substantial periods of heating with little magma production, interspersed with significant magma production over relatively narrow intervals of temperature increase. This is in good agreement with the multimodal distribution of zircon ages showing prominent peaks at 7.50, 7.40 and 7.25 Ma, with these ages corresponding to the main periods of magma production.We conclude that the zircon age variability exhibited by the pluton may reflect the duration of the melting event and melt extraction from the source.

[1] Farina et al., 2010. GSA Bulletin, 122, 1463-1479. [2] Barboni et al., 2015. EPSL, 432, 436-448. [3] Mayne et al., 2016. JMP, 34, 7, 663-682.