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Trace element, Sr and Pb isotopic zoning in K-feldspar megacrysts from the Monte Capanne monzogranite (Elba, Italy): evidence for a multi-stage crystallization history

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Zoned K-feldspar megacrysts from the Monte Capanne pluton (7 Ma) display indented resorption surfaces near their rims, which result from crystal dissolution and subsequent regrowth following magma mixing. Ion microprobe profiles reveal complex zoning in Ba, Rb, Sr and P. The rims and the outer cores of the megacrysts generally have higher Ba, lower P and lower Rb/Sr ratios compared with the inner cores, although the zoning is often more complex especially in megacrysts with several resorption surfaces (e.g., reverse Ba zoning, low Rb/Sr).

Trace element zoning correlates with Sr isotopic zoning obtained by microdrilling. Initial ^{87}Sr/^{86}Sr ratios decrease from core to rim, although the variation is very variable. Inner core analyses define a mixing trend in an isochron diagram extending towards a high$I_{Sr} -$ ^{87}Rb/^{86}Sr melt component, while the outer core and rims display a more restricted range of isotopic variation, but a large range of ^{87}Rb/^{86}Sr.

In situ Pb isotopic analyses by Laser Ablation MC-ICPMS also reveal zoning in ^{208}Pb/^{206}Pb and ^{207}Pb/^{206}Pb that is sympathetic with Pb elemental variations. The core regions display a common rimward decrease in ^{208}Pb/^{206}Pb and ^{207}Pb/^{206}Pb, while the rims have higher ^{208}Pb/^{206}Pb and ^{207}Pb/^{206}Pb.

The isotopic and trace element profiles are the result of growth-zoning in melts

of varying composition, instead of secondary diffusive equilibration, as shown by concentration-weighted isotopic diffusion modelling. Early megacryst growth (i.e. the inner core region) occurred in magmas contaminated by crust (high $^{87}Sr/^{86}Sr$ and $^{208}Pb/^{206}Pb$) and refreshed by influx of silicic melts (intermediate $^{87}Sr/^{86}Sr$ and low $^{208}Pb/^{206}Pb$), while later stages (i.e. the rim and outer core) record recharge with mantle-derived magmas (low $^{87}Sr/^{86}Sr$, high $^{208}Pb/^{206}Pb$), and crystal fractionation, with possible interaction with hydrothermal fluids. This model reconciles observed geochemical and isotopic whole-rock patterns, as well as the extensive field occurrence of mafic enclaves and metasedimentary xenoliths.