EGU22-1195
https://doi.org/10.5194/egusphere-egu22-1195
EGU General Assembly 2022

Annealing experiments on zircons: influence of lattice orientation and metamictization.

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Zircon derived from crustal rocks can survive dissolution into basic melt during rock assimilation and magma hybridization if shielded in mafic phenocrysts or minerals from non-disaggregated xenoliths. Under these conditions, zircon can be subject to thermal shock that triggers recrystallization of metamict domains and reaction with its hosted mineral inclusions. In this work, we simulate this process by performing thermal annealing experiments on zircon grains with a variable degree of metamictization. The results show recrystallization of metamict domains, melting of multi-phase mineral inclusions, nanopores formation, and microcracking propagation by thermo-elastic stress. Highly metamict zircon with elevated common-Pb and radiogenic-Pb loss, which were impossible to date with SHRIMP, lost all their common-Pb and some radiogenic-Pb upon annealing, producing well-fitted discordias with significant upper intercept age. The porosity enhances intracrystalline melt mobility, leaching out impurities. Baddeleyite was formed at temperatures below the thermal decomposition of pure zircon by two mechanisms: (1) incongruent zircon dissolution into molten mineral inclusions with a high CaO/SiO_2 ratio (2) recrystallization of metamict domains aided by silica migration from the reaction site.