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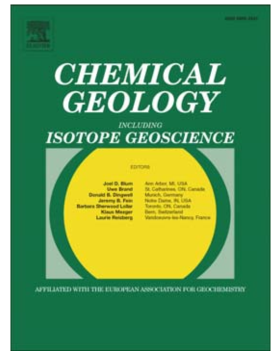

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The effect of crystal-plastic deformation on isotope and trace element distribution in zircon: Combined BSE, CL, EBSD, FEG-EMPA and NanoSIMS study

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Abstract

Plastically-deformed zircon grains from granulite-facies (Ivrea-Verbano Zone, Southern Alps, Italy) and amphibolite-facies (Tauern Window, Eastern Alps, Austria) shear zones have been investigated. The main focus was on the effects of crystal-plastic deformation on the distribution of trace elements and their isotopes. Zircon grains reveal crystal-plastic deformation patterns in form of (I) gradual bending of the lattice (high density of free dislocations), (II) highly-deformed margins revealing a combination of low- and high-angle boundaries and gradual bending of the lattice, and (III) a low-angle boundary (LAB) network. Chemical and isotopic maps and profiles show that trace elements in zircon are re-distributed in all plastically-deformed domains. Changes in trace element composition along LABs are sometimes revealed by brighter CL and darker BSE signal. LABs and domains of high free-dislocation density have depletion in U, Y, Yb and enrichment in Ce, La and Nd, while Ti and P are either enriched, depleted or remain unaffected, and Hf demonstrates stability. Y and Yb are decreased in concentration across LABs, and have oscillating concentration in domains of high free-dislocation density. Our observations confirm that crystal-plastically deformed domains in zircon act as effective pathways for trace cations.

The Pb isotopic system is disturbed by crystal-plastic deformation microstructures, as indicated by relative $^{207}Pb/^{206}Pb$ ages showing significant discordance in plastically-deformed zircon domains. In deformed domains, a positive correlation between dislocation density and the degree of isotopic age distortion is observed. Fractured or porous domains and domains with high density of (sub)grain boundaries are enriched in common Pb from the matrix, and thus show significantly older relative $^{207}Pb/^{206}Pb$ ages than pristine domains. In contrast, Pb loss occurs in domains with high free-dislocation