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Rejuvenation effects during plastic deformation of Zircon: geochronological implications

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Zircon is one of the most stable accessory minerals known on the Earth; it was believed that zircon isotopic ages mostly record primary igneous crystallization events. It is true until the mineral is not affected by plastic deformation or other disturbing events during its life after crystallization. Zircon may deform by the recovery/subgrain rotation recrystallisation that indicates formation and migration of dislocations under crustal conditions. Deformation occurs at depth due to stresses associated with collision of the phases, and forms such microstructures as low-angle boundaries (Reddy et al., 2007).
Low-angle boundaries act as fluid migration paths and elements diffusion paths. Facilitating Pb, Ti, U, Th and trace elements mobility in the crystalline zircon, these structures can change chemical, REE and isotopic composition of certain grain's parts (Reddy and Timms, 2010) and lead to isotopic resetting in the mineral domains. Since the isotopic age of the domains of single crystal can vary, it should be possible to recognize and interpret this variation and distinguish the timing of different high-temperature deformation events. Zircon can preserve low-angle boundaries and associated age disturbance under lower-crust temperatures for billions of years (Moser et al., 2009).
Electron backscatter diffraction (EBSD) allows us to make microstructural-crystallographic analyses in order to measure the crystallographic orientations in crystalline material. EBSD mapping is supposed to be able to constrain potential diffusion pathways in minerals. It can indicate areas of damaged crystalline structure, helps to examine substructures of minerals used in radiometric dating and to assess the potential for resetting of ages by deformation events (Reddy et al., 2007).
In this research we are trying to answer a list of questions, related to isotopic resetting due to deformation:
What is the behavior of zircons which were plastically deformed during metamorphic-deformation events and hosted by the shear zones? How to evaluate the significance of isotopic-system resetting in deformed domains? How to estimate the possibility of dating the deformation events and what is the reliability of such dating?
A complex of methods is used for this research: transmitted and reflected light microscopy, CL (cathode luminescence) imaging for growth history, BSE (backscattered electrons) imaging for orientation and chemical contrast, SE (secondary elements) pictures for surface relief, SHRIMP (Sensitive High Resolution Ion Microprobe) for age dating, EBSD for crystallographic orientations. We suppose that careful combination of all these methods will lead to better understanding of some internal processes which happen with mineral during its evolution in host rocks.
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