The magmatic-hydrothermal evolution of A-type granite recorded in zircon

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Zircon is a common accessory mineral in granitic rocks. It is chemically resistant, relatively insoluble and refractory, and can withstand weathering and recycling, as well as high temperature metamorphism and anatexis. It is widely accepted that zircons can provide reliable and robust estimates of age, compositions of coexisting minerals and melts, and constraints on the genesis and origin of host rocks.

Here we present a comprehensive investigation on three types of natural zircon that formed from early- to late-stage of granitic system in Xiangshan, north China. Zircon structures were analyzed by XRD, cathodoluminescence and Raman spectroscopy. Major and trace element compositions of zircon were measured by EMPA and LA-ICPMS.

Prismatic and oscillatory zoned zircon grains (Type-1A), crystallized early in the paragenesis at high temperatures in a volatile-undersaturated environment, have the smallest lattice parameters (a=6.603Å, c=5.971Å) and low U and Hf contents. Prismatic and altered zircon grains (Type-1B), formed under volatile-saturated conditions and in the presence of a F-rich fluid with numerous thorite and xenotime inclusions, have intermediate lattice parameters (a=6.649Å, c=6.020Å) and obviously high Th, U, Hf, La, Pr and Nd contents. Pyramidal zircon grains (Type-2), formed in a subsolvus granite system at relatively low temperatures and coexisted with fluid inclusions, have the biggest lattice parameters (a=6.677Å, c=6.010Å) and the highest Th, Hf, Y, and REE contents. The occurrence of the three zircon types in the Xiangshan A-type granite is interpreted to reflect progressive fractionation of granitic melt from hypersolvus to subsolvus conditions. During the evolution the A-type granitic melt enrich in Th, Hf, Y, and REE. Zircon lattice expansion in this study is resulted from chemical incorporation of trace element and volatile components, during the magmatic to hydrothermal evolution of granitic magma. The formation of the Type-1B zircons suggests they formed during the magmatic-hydrothermal transition stage of the evolution of granitic magma. Therefore, the evolution of zircons in both textures and compositions can be used as efficient indices for the differentiation and evolution of A-type granitic system.