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Editorial

Editorial for the Special Issue "Isotopic Tracers of Mantle and Magma Evolution"

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Over the past few decades, an increasing number of isotopic studies (Re–Os, Lu–Hf, Sm–Nd, etc.), coupled with other geochemical research, have been carried out on igneous, sedimentary, and metamorphic rocks, with the aim of understanding their mantle or crustal source characteristics, provenance, metamorphic evolution, and metallogenesis. In addition, whole-rock isotopic studies have also shed light on magma evolution, e.g., magma mixing, fractional crystallization, and crustal contamination. Zircon is a conspicuous component of mafic–felsic igneous rocks, clastic rocks, and their corresponding metamorphic equivalents. Zircon U–Pb geochronology, using the LA–ICP–MS, SHRIMP, or SIMS techniques, can provide precise ages of igneous emplacement or eruption, the maximum depositional age, as well as ages of metamorphism and ore formation. Combining U–Pb dating with the in situ Lu–Hf–O–Zr isotopic analysis of zircon grains, researchers can provide more detailed insights into magma genesis and crust–mantle interaction, as compared to whole-rock isotopic methods alone.

The contributions in this Special Issue of *Minerals* clearly demonstrate that complex investigations based on a combination of different isotopic methods will have the greatest potential for the successful resolution of open geological questions. The nine articles in this Special Issue address igneous rocks (four articles), metamorphic rocks (two articles), sedimentary rocks (one article), and metallogeny (two articles).

The first part of this volume includes papers on the petrogenesis and tectonic settings of the igneous rocks. Based on zircon U–Pb ages, Lu–Hf isotopes, and major and trace element whole-rock compositions for granitoid intrusions in the Yanbian–Dongning region, Northeast China, Wang et al. [1] propose that the Early Jurassic monzogranite is derived from the partial melting of the Neoproterozoic–Paleozoic continental crust in a continental arc setting related to the Paleo-Pacific subduction. The Early Cretaceous granodiorite, on the other hand, originated from the partial melting of both the mantle wedge and the overlying continental crust, most likely caused by the dehydration and metasomatism of the subducted Paleo-Pacific slab.

A second case study from Northwest China by Xia et al. [2] focuses on granite and diorite dykes in the southern part of the Altay orogenic belt. From the perspectives of zircon U–Pb dating, Lu–Hf isotopes, and geochemistry, the authors document their shared features, including enrichment in LREEs and LILEs and depletions in HFSEs. The results demonstrate that the granitic and diorite dykes formed via the mixing of mantle magma and crustal materials to varying degrees, and that the diorite dykes are more clearly contaminated by the lower crust.

The article by Zhu et al. [3] describes investigations of petrology and zircon U-Pb geochronology and an in situ mineral major and trace element analysis of the Gaositai Paleoproterozoic hornblendite in northern Hebei, northern North China Craton. The authors conclude that the generation of hornblendite was likely the product of a post-collisional extension related to collision between the eastern and western North China blocks.

Pan et al. [4] report on their systematic petrological, geochemical, zircon U-Pb geochronology, and zircon Hf isotope studies of the Triassic volcanic rocks in the Ela Mountain Area

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of East Kunlun Orogen, China. Their results indicate that these rocks were formed in an environment of slab failure in the late stage of syn-collision.

The second part of this Special Issue is dedicated to metamorphic evolution and geochronology. Liu et al. [5] sampled biotite two-feldspar gneiss from Hongtoushan in the Qingyuan area and undertook petrography, mineral chemistry, phase equilibrium modeling, and monazite dating analyses, revealing a vertical sagduction process to be responsible for the metamorphic evolution.

Also in the North China Craton, Duan et al. [6] investigated Neoarchean granitoid gneisses and supracrustal rocks in Eastern Hebei through systematic zircon U–Pb geochronological and whole-rock geochemical analyses. Their results are helpful for further constraining Archean vertical tectonism in the North China Craton.

The third part of this Special Issue is dedicated to studies of provenance and tectonic setting. Yu et al. [7] report the results of a combined zircon U–Pb dating and Lu–Hf isotope study of the Paleoproterozoic Gaixian Formation in the southeastern part of Liaodong Peninsula, also drawing on previously published data. They conclude that the Jiao-Liao-Ji belt underwent a successive process of rifting–subduction–collision, and a major crustal growth event occurred at 2.9–2.5 Ga.

Studies of mineralization genetically related to magmatic rocks can help us to understand the role played by tectonic setting in metallogenesis and thus contribute to explorations for additional ore deposits. The study conducted by Feng et al. [8] combined zircon U–Pb dating and fission-track data for the Dongping and Xiaoyingpan gold deposits in the North China Craton, and the authors suggest that the Yanshanian gold mineralization is coeval with the thinning of the North China Craton during the Late Jurassic–Early Cretaceous.

Along the southern peripheral area of the Songliao Basin, North China, Deng et al. [9] provide a detailed investigation of the geology and geochemistry of outcropping shales belonging to the Lower Jurassic Beipiao Formation in the Jinyang Basin. The results indicate that magmatic-hydrothermal activities in the Wolong area promoted the formation of organic-rich source rocks and the hydrocarbon generation process.

The articles collected in this Special Issue contribute to the fields of petrology, mineralogy and economic geology. We hope that some of the methods (e.g., geology, geochemistry, and geochronology) proposed and the findings obtained will inspire future research in geosciences. Future articles on topics related to this Special Issue are welcomed.

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