

Editorial

Editorial for Special Issue “Distribution of Major- and Trace-Elements in Igneous Minerals”

José F. Molina 

Departamento de Mineralogía y Petrología, Facultad de Ciencias, Campus de Fuente Nueva, Universidad de Granada, 18071 Granada, Spain; jfmolina@ugr.es

Since the pioneering work of Goldschmidt [1], there has been important progress in understanding the principles that govern the distribution of major- and trace-elements in minerals (e.g., see [2–4]). They provide the foundations for applying mineral chemistry to the estimation of environmental conditions (pressure, temperature, and fugacity of volatile components) at which magmas generate and crystallize, and to the understanding of the kinetic factors that control igneous processes (rates of mineral crystallization and melting, atomic and molecular diffusion, and heat dissipation and heating rates). Mineral-melt and mineral-fluid major- and trace-element partition coefficients also make it possible to use mineral chemistry for inferring the composition of melts and fluids released from residual magmas, which can have a large capacity for hydrothermal ore generation.

In this Special Issue, Svetov et al. [5] discuss the mechanisms of generation of variolitic and massive picrobasalts from the Paleoproterozoic Suisaari Formation, Karelian Craton, Eastern Fennoscandian Shield, and evaluate the contribution of magma mixing, contamination, and fractional crystallization to the formation of zoning patterns in clinopyroxene phenocrysts. For this purpose, they use constraints from major- and trace-element zoning patterns and crystal size distribution of clinopyroxene phenocrysts, clinopyroxene-melt Fe-Mg partition coefficients, and clinopyroxene-only thermometry.

Zandomeni et al. [6] discuss the petrogenesis of metaluminous to peraluminous Cambrian granitoids from the Pampean magmatic arc, Sierra de Guasayán (Argentina). They study the plutons of La Soledad, Guasayán, El Escondido El Martirizado, and Alto Bello. The authors use a large variety of thermobarometric methods for determining the P–T conditions of magma crystallization, including calibrations of the Al-in-titanite, Al-in-biotite, Al-in-hornblende and amphibole-plagioclase barometers and the amphibole-plagioclase and Ti-in-amphibole thermometers. They emphasize that mineral chemistry can reveal the hybrid nature of some facies of the Guasayán pluton. This work reports the first mineral data set for granitoids of the Pampean magmatic arc that is accessible to the international geology community.

Cambeses et al. [7] provide textural and phase relationship constraints on magma hybridization in the Valencia del Ventoso Plutonic Complex that was generated during the Variscan intra-orogenic extensional magmatism of the Ossa-Morena Zone (SW Iberia). The authors determine the P–T conditions of magma crystallization using Al-in-hornblende barometry and amphibole-plagioclase thermobarometry. This work also discusses the origin of antecrysts incorporated in hybrid calc-alkaline magmas using amphibole and biotite compositions and estimating the alkalinity of interstitial melts saturated in amphibole employing amphibole-melt K_2O and Na_2O/K_2O partition coefficients reported in Molina et al. [8].

Madon et al. [9] analyze the genetic links between hydrothermal gold deposits and syntectonic magmatism in the Neoproterozoic Abitibi Greenstone Belt, Superior Province, Canada. They study five plutons from the Chibougamau area (Anville, Saussure, Chevrillon, Opémisca, and Lac Line) that are representative of the chemical diversity of synvolcanic, with TTG affinity, and syntectonic, with sanukitoid and alkaline affinity, magmatism. The



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authors determine oxygen fugacity, and water, chlorine, and sulfur contents in the magmas using zircon REE and zircon-melt Ce partitioning oxy-barometry, amphibole hygrometry, and apatite-melt chlorine and sulfur partitioning; temperatures were also estimated using Ti-in-zircon thermometry. The work provides a methodological basis for the determination of volatile components in residual magmas. These results are used to evaluate the economic potential of the studied intrusions.

The works by Uchida et al. [10,11], relevant for hydrothermal systems related to the later stages of crystallization of felsic magmas, present experimentally determined simultaneous partition coefficients of divalent cations between sphalerite [10] and alabandite [11] with supercritical hydrothermal chloride fluids (500–800 °C and 100 MPa). The authors discuss the relationships between partition coefficient and ionic radius, analyzing the importance of electronegativity and strength of covalent bonds.

Finally, structural factors that control cation substitution (size and charge of ions, coordination number and size of lattice sites in minerals and melts, and nature of atomic and molecular bonds) explain the similar geochemical behavior of isovalent ion pairs, such as Y^{3+} – Ho^{3+} , Zr^{4+} – Hf^{4+} , Th^{4+} – U^{4+} , and Nb^{5+} – Ta^{5+} , in many igneous systems. However, the Th/U ratio can be significantly fractionated in oxidizing aqueous environments in which the dominant uranium species is U^{6+} , which is highly soluble due to the formation of uranyl ions. In relation to this issue, Regelous et al. [12] analyze the relationships of Th and U in the S- and I-type granites from the Variscan West Bohemian Massif (Germany) and in the Neoproterozoic A-type granites from the Malani province (India). The authors reveal a systematic fractionation of the Th/U ratio that is explained in terms of heterogeneities of the source and mobilization of U.

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