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Editorial

Editorial for Special Issue "Arctic Mineral Resources: Science and Technology"

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The Arctic zone of the Earth is a major source of mineral and other natural resources for the future development of science and technology. It contains a large supply of strategic mineral deposits, including rare earths, copper, phosphorus, niobium, platinum-group elements, and other critical metals. The continuing melting of the sea ice due to climate change makes these resources more accessible than ever before. However, mineral exploration in the Arctic has always been a challenge, due to the climatic restrictions, remote location and vulnerability of Arctic ecosystems. This Special Issue covers a broad range of topics related to the problem of Arctic mineral resources, including geological, geochemical and mineralogical aspects of their occurrence and formation, chemical technologies, environmental and economic problems of mineral exploration. The contributions can be broadly classified into four major types: geodynamics and metallogeny, mineralogy and petrology, mineralogy and crystallography, and mining and chemical technologies associated with exploration of mineral deposits and the use of raw materials for manufacturing new products.

The issue opens up with a review on the relations between geodynamics and oil and gas potential of the Yenisei-Khatanga Basin (Polar Siberia, central part of the Russian Arctic) provided by Vernikovsky et al. [1]. The main oil and gas generating deposits of the basin are Jurassic and Lower Cretaceous mudstones, and the latter contain 90% of known hydrocarbon reserves. The article by Kozlov et al. [2] is devoted to the Western part of the Russian Arctic and examines the interplay between geodynamic evolution and metallogeny of the region, which is extremely rich in unique and rare mineral deposits. The distribution of the latter is investigated in several subsequent papers. Kalinin et al. [3] reports on gold prospects in the region with special focus on regional metallogeny and distribution of mineralization, whereas the article by Kompanchenko et al. [4] focuses on vanadium mineralization. Uranium mineralization and the age of its formation is the subject of the paper by Kaulina et al. [5]. The region is also famous for its platinum-group-element (PGE) deposits, which are investigated by Bayanova et al. [6], who provides a comprehensive overview on the mechanisms of their formation and time evolution associated with long-lived plume activity. In a companion paper, Groshev and Karykowski [7] report on the results of the study of the main anorthosite layer of the West-Pana intrusion (Kola peninsula), which hosts the PGE mineralization. The Cu-Ni productive suite of the Pechenga structure on the Russian-Norway border is considered by Zhamaletdinov [8]. The idea of the study initiated back in Soviet time was to estimate the prospects for discovery of Cu-Ni deposits in northern Norway by means of single electric pulses generated by the 80 MW magneto-hydrodynamic (MHD) generator "Khibiny". The conclusion of the study is that the most promising potential for Cu-Ni deposits Pil'gujarvi formation of the Northern wing of the Pechenga structure is rather quickly wedged out in Norway, while the conductive horizons of the Southern part of Pechenga, which have a weak prospect for Cu-Ni ores, continue into Norway nearly without a loss of power and integral electrical conductivity.

The understanding of the structure, origin and evolution of mineral deposits is impossible without the use of comprehensive information on the geochemical and petrochemical features of their rocks and minerals. Thus, the second part of the issue contains a collection of articles on mineralogical and petrological characterization of mineral deposits and its use in petrogenetic models. Khibiny (Kola peninsula, Russia) is one of the world largest peralkaline intrusions that hosts giant apatite deposits, which are mined by the "PhosAgro" company. Kogarko [9] reports on the results of detailed chemical studies of apatite in the Khibiny apatite-nepheline deposits, which prompted her to conclude that the main mechanism for their formation was the gravitational settling of large nepheline crystals in the lower part of the magma chamber, while small apatite crystals were concentrated in its upper part. The formation mechanisms of zeolite deposits in carbonatites and their geochemical and mineralogical constraints are examined by Zozulya et al. [10] using the Breivikbotn deposit (Northern Norway) as an example. Three following papers of the issue [11–13] are devoted to 3-D mineralogical mapping of the Kovdor phoscorite-carbonatite complex (Kola peninsula, Russia). On the basis of detailed mineralogical studies (including crystal-structure analysis) of forsterite [11], sulfides [12] and pyrochlore-supergroup minerals [13], the authors construct a 3-D model of the deposit and try to decipher major features of its genesis and evolution. Zircon macrocrysts from the Drybones Bay kimberlite pipe (Northwest Territories, Canada) are the subject of a detailed study of Reguir et al. [14], who, on the basis of a high-resolution trace element and geochronological study, provide strong evidence that the macrocrysts are the products of interaction between a shallow (<100 km) mantle source and transient kimberlitic melt.

Descriptive mineralogy and crystal chemistry provide an essential fundamental basis for our understanding of mineral matter and basic characteristics of their formation and behavior under changing chemical and physical parameters. The third part of the issue includes three papers on rare minerals from Kola peninsula. The review of Lyalina et al. [15] concentrates on beryllium mineralization. Twenty-eight different mineral species of Be have been found on the Kola peninsula, and their chemistry, crystallography and geological and mineralogical occurrences are reviewed in detail. The paper by Selivanova et al. [16] reports on the compositional and textural variations in hainite-(Y) and batievaite-(Y), two rare-earth-containing minerals from the Sakharjok Massif, Keivy alkaline province (Eastern part of the Kola peninsula). Zolotarev et al. [17] provides the first crystal-structure data on shkatulkalite, a rare mineral from the Lovozero massif that was discovered in 1996, but could not be structurally characterized until now.

The last part of the issue is devoted to technological problems associated with the exploration of mineral deposits and the use of the raw materials. Chanturiya et al. [18] review advanced techniques of saponite recovery from diamond processing plant water and the areas of saponite application, including modified saponite-based products. The Arkhangelsk-area diamond deposits are considered as an example. Masloboev et al. [19] provide a timely and comprehensive analysis of hydrometallurgical processing of low-grade sulfide ore and mine waste in the Arctic regions. The paper presents perspectives and challenges for heap leaching of sulfide and mixed ores from the Udokan (Russia) and Talvivaara (Finland) deposits, as well as technogenic waste dumps such as the Allarechensky deposit dumps (Russia). Antigorite is an important constituent of mining wastes and can be used in production of alkaline-activated binders, which is the subject of the report by Kalinkina et al. [20]. Finally, Gerasimova et al. [21] show how titanite ores such as those found in the Khibiny deposit can be used for industrial production of nanostructured and microporous titanosilicates that can be used as sorbents for the extraction of radionuclides from liquid radioactive wastes.

In total, the issue contains three reviews and eighteen full research articles on various problems associated with investigation of Arctic mineral resources. As Arctic issues become more and more relevant, we hope that the issue provides a useful overview of a broad range of topics related to the geological and technological exploration of the Arctic.

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