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Editorial

Editorial for Special Issue "New Mineral Species and Their Crystal Structures"

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Mineralogy is the oldest and one of the most important sciences of the geological cycle. Minerals, the basis of overwhelming mass of solid matter in the universe, are direct subjects of investigation in mineralogy. Minerals, or mineral species, are generally solid crystalline substances. Their definition indicates that, they are: (1) naturally occurring; (2) belonging to the distinct structural type; (3) stable, varying merely in the relatively small limits of chemical composition. If a given mineral differs from other known species in its structure (2) and/or composition (3) then it can be considered as a new mineral species.

According to the data of the Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association (IMA) (http://nrmima.nrm.se/), there are currently about 5600 known mineral species. The number of minerals increases steadily year by year. Before the 2000s the number of minerals approved by the IMA Commission varied from 50 to 70 species per year. In 2010s this number reached 100–160 species per year, and at present we observe an increasing tendency again, i.e., in 2018, almost two hundred new mineral species were approved by the IMA CNMNC. Is it a lot? It depends on what one compares it to. For instance, the number of biological species known at present is close to two million, and the number of synthetic chemical compounds, including organic substances, comes nearer to ten million. In comparison with these numbers, the species diversity of the Mineral Kingdom is relatively small, so a discovery of every new mineral species is a significant event in science. Investigation of new minerals, many of which possess a unique crystal structure and unusual properties, has a great significance for the understanding solids' structure and processes in the interior of the Earth, on the Earth's surface and in the Universe.

Articles submitted to the Special Issue of *Minerals* effectively demonstrate the great chemical, structural and genetic diversity of new mineral species of the present time, as well as the geography of discoveries and the variety of analytical methods used in studies of new minerals. Recently an increasing number of new mineral species discovered in volcanic fumaroles has been observed [1]. In the present issue, there are two articles devoted to the two new volcanic minerals: Verneite, $Na_2Ca_3Al_2F_{14}$, described simultaneously from Eldfell and Hekla volcanoes in Iceland and Vesuvius in Italy [2], and thermaerogenite, $CuAl_2O_4$, from the Tolbachik volcano at Kamchatka, Russia [3]. In these articles, readers could not only find the high level of the analytical investigation, but also the authors' imagination with regards to the choice of names for the new minerals:

- "Verneite is named after Jules Verne (1828–1905). In his novel Voyage au centre de la Terre (1864), Verne describes a group of characters descending through a crater of a quiescent volcano in Iceland (Snæfell) and, after an adventurous journey through exciting Earth's underground, finally being ejected in South Italy with the eruption of a volcano (Stromboli). Therefore, we consider the name verneite appropriate for a mineral found and described by the same team of researchers on the best-known Icelandic and Italian volcanoes [2]".

- "The name thermaerogenite (spinel group member) is constructed based on the combination of Greek words θερμός, hot, αέριον, gas, and γενής that means "born by". Thus, in whole it means *born by hot gas*, that reflects the fumarolic origin of the mineral" [3].

The next two new minerals, sharyginite, $Ca_3TiFe_2O_8$ (perovskite supegroup member) [4] and nöggerathite-(Ce) $(Ce,Ca)_2Zr_2(Nb,Ti)(Ti,Nb)_2Fe^{2+}O_{14}$ (zirconolite-related mineral) [5], were discovered in the Eifel region, Rhineland-Palatinate, Germany. Volcanic rocks of Eifel are a unique source of new minerals: more than fifty mineral species were discovered there [6]. In Germany local collectors of minerals provide substantial assistance in collecting of specimens and so they are rightly the co-authors of the new mineral descriptions (Christof Schäfer, Bernd Ternes, and Willi Schüller). New data on the composition and structure of rusinovite $Ca_{10}(Si_2O_7)_3Cl_2$, found in altered xenoliths of Eifel and Southern Ossetia, are presented by Środek et al. [7]. Until now rusinovite was known only from xenoliths within ignimbrites of the Upper Chegem Caldera at Northern Caucasus, Russia [8].

More than twenty new mineral species were discovered in pyrometamorphic rocks of the Hatrurim Complex in the Dead Sea rift in the last eight years [9]. In this issue the new mineral ariegilatite, $BaCa_{12}(SiO_4)_4(PO_4)_2F_2O$ (with intercalated antiperovskite structure) is described [10]. It was collected from spurrite rocks in the Negev Desert, Israel and has also been found in several localities in the Palestinian Autonomous Territory and Jordan [10]. Previously, barioferrite, $BaFe_{12}O_{19}$, a new mineral of the magnetoplumbite group, was described in rocks of the Hatrurim Complex. However, due to the small size of crystals, its structure could not be studied [11]. Krzątała with co-authors reported the structure of barioferrite in a different article [12].

Pieczka and co-authors described the Ca-Mn-ordered new mineral of the apatite supergroup, parafiniukite, $Ca_2Mn_3(PO_4)_3Cl$, from the Szklary pegmatite in Lower Silesia, Poland. Szklary is the type locality for previously discovered lepageite, nioboholtite, titanoholtite and szklaryite [13].

Ore minerals in this Special Issue are represented by gold amalgam aurihydrargyrumite, Au_6Hg_5, found on gold particles in the Iyoki deposit at Shikoku Island, Japan [14]; oyonite, $Ag_3Mn_2Pb_4Sb_7As_4S_{24}$, a new sulphosalt of the lillianite homologous series from the Uchucchacua deposit in Oyon district, Peru [15]; and cerromojonite, $CuPbBiSe_3$, a new selenide of the bournonite group from the El Dragón mine in Potosí, Bolivia [16].

Some new supergene minerals were reported from Italy. Demartin and co-authors present fiemmeite, $Cu_2(C_2O_4)(OH)_2{\cdot}2H_2O$, from Val di Fiemme in Trentino. It occurs in coalified woods which were permeated by mineralizing solutions containing Cu, U, As, Pb and Zn. The oxalate anions have originated from altered plant remnants included in sandstone [17]. Biagioni with co-authors studied Si-analogue of chalcophyllite from the Cretaio Prospect in Grosseto, which was named tiberiobardiite in the honour of Tiberio Bardi, a mineral collector who found a specimen which became the holotype of tiberiobardiite with the simplified formula $Cu_9Al(SiO_3OH)_2(OH)_{12}(H_2O)_6(SO_4)_{1.5}{\cdot}10H_2O$ [18].

Repeated studies of early investigated mineral species using modern analytical methods to clarify their formal position in the actual mineralogical classification is an important aspect of modern mineralogy. Pankova with co-authors reported the results of a structural investigation of kurchatovite and clinokurchatovite, two modifications of $CaMgB_2O_5$, from their type localities: Solongo in Buryatia, Russia, and Sayak-IV in Kazakhstan, respectively [19]. As a conclusion of the comparative study of kurchatovite and clinokurchatovite, the authors stated: "kurchatovite and clinokurchatovite are not polytypes, but polymorphs, and therefore re-consideration of their status as of separate mineral species is not warranted. However, the structures of the two minerals are closely related: the crystal structure of kurchatovite may be considered as a derivative of clinokurchatovite through the modular approach".

We hope that the present Special Issue presents an interesting read not only for mineralogists and geochemists but also for scientists who work in the fields of crystallography, chemistry, solid-state physics and materials science, on synthesis and on crystal chemical studies of novel technological materials related to minerals. We also hope that research articles on new mineral species attract the attention of museum curators and mineral collectors.

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