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Editorial

Editorial for the Special Issue "Innovative and Applied Research on Platinum-Group and Rare Earth Elements"

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This Special Issue "Innovative and Applied Research on Platinum-group and Rare Earth Elements" is dedicated to the work and memory of Demetrios Eliopoulos, IGME (Institute of Geology and Mineral Exploration), Greece who passed away on 19 April 2019.

Demetrios Eliopoulos (1947–2019) started his research work (nearly 40 years ago) on base and precious metals with his Master's thesis (Western University, Canada) and Ph.D thesis (Southampton, UK). Over the course of his career at IGME (Greek Institute of Geology and Mineral Exploration), Demetrios was the IGME representative of R&D, European Commission Projects, Head of Economic Geology, and a contributor to numerous fundamental research reports and publications. His main distinctions include: his membership on the Editorial Board of Mineralium Deposita, being a Fellow of the SEG (Society-Economic-Geologists) and SGA (Society for Geology Applied to Mineral Deposits), and the Award from the Academy of Athens (discovery of palladium in a porphyry-Cu deposit of Greece). Demetrios was the chairman of the Organizing Committee of the 7th Biennial SGA Meeting, held in Athens, Greece, August 24–28, 2003. He was involved in fruitful scientific collaboration over the years with his wife and colleague Maria Economou-Eliopoulos. Their work was recognized by the international community, and the IMA has adopted a new mineral name in honor of Demetrios and Maria (Eliopoulosite, IMA 2019-96, this volume). This Special Issue contains a series of papers, including two reporting on the finding of new minerals—Grammatikopoulosite, NiVP, a new phosphide, and Eliopoulosite, V_7S_8, a new pyrrhotite like mineral—both from chromitites of the Othrys ophiolite complex, approved by the Commission of New Minerals, Nomenclature, and Classification of the International Mineralogical Association (IMA 2019-090 and 2019-96) [1,2]. The geological environment, mode of the occurrence, physical and chemical properties, and crystallographic data are provided. Problems concerning the distribution, mineralogy and field relationships of PGE-enriched ores, which are important for our understanding of the metallogenic controls on the concentration of PGE in ophiolite complexes and their exploration, are addressed in three papers. Kiseleva et al. [3] present the first detailed data on the chromitites and PGE mineralization in the Ulan-Sar'dag ophiolite located in the Central Asian Fold Belt (East Sayan, Russia), and propose a scheme for the sequence of the formation and transformation of the PGM at various stages of the evolution of that ophiolite complex. Kravtsova et al. [4] present the peculiarities of the distribution and binding forms of PGE in the arsenopyrites and pyrites of the Natalkinskoe gold ore deposit in NE Russia. They conclude that the possibility of their extraction from that type of ore may significantly increase the quality and value of the extracted materials at the Natalkinskoe deposit. Zaccarini and Garuti [5] describe the occurrence of zoned laurite found in the Merensky Reef of the Bushveld layered intrusion, South Africa. Specifically, zoned laurites from the Merensky Reef are characterized by textural position, composition, and zoning—suggesting that they are "hydrothermal" in origin, having crystallized in the presence of a Cl- and As-rich hydrous solution, at temperatures much lower than those typical of the precipitation of magmatic laurite. The paper by Sadeghi et al. [6] deals with the study of the rare earth elements (REE) in till and bedrock, as well as in mineral deposits associated with apatite-iron oxide mineralizations, various skarn deposits, hydrothermal deposits, and alkaline-carbonatite intrusions in Sweden. In this study, analytical data of samples collected from REE mineralizations during the EURARE (www.eurare.org) project are compared with bedrock and till REE geochemistry—both sourced from databases available at the Geological Survey of Sweden (www.sgu.se). These results are useful in the assessment of REE mineral potential in areas where REE mineralizations are poorly explored or even undiscovered. The paper by Stouraiti et al. [7] presents the effect of mineralogy on the beneficiation of REE from heavy mineral sands from Nea Peramos, Kavala, northern Greece. They provide the characterization of the fractions separated by a magnetic separator using X-ray powder diffraction (XRD) and bulk Inductively Coupled Plasma and Mass Spectrometry(ICP-MS) chemical analyses, and show that at high intensities of magnetic separation, they were strongly enriched in Light Rare Earth Elements (LREE) compared to the non-magnetic fraction. This new information can contribute to the optimization of the beneficiation process, that can be applied for REE recovery from Heavy Mineral (HM) black sands. A group of papers deal with the genetic significance of a spectrum of trace elements and stable chromium isotopes in chromitites. The paper by Economou-Eliopoulos et al. [8] on the factors controlling the chromium isotope compositions in podiform chromitites is an application of Cr stable isotope ($\delta^{53}Cr$ values) compositions to the investigation of magmatic and post-magmatic effects on chromitites associated with ophiolite complexes. Chromitites from the Balkan Peninsula depict a wide range of $\delta^{53}Cr$ values. Signatures range from positively to slightly negatively fractionated $\delta^{53}Cr$ values—even in individual relatively large deposits. Positively fractionated $\delta^{53}Cr$ values of all chromitite samples from Othrys and of high-Al chromitites from Skyros, coupled with a negatively correlated trend between $\delta^{53}Cr$ and Cr/(Cr + Al), may reflect the control of $\delta^{53}Cr$ by degree of partial melting and by magma fractionation. This is best exemplified by high-Al chromitites from the cumulate sequence of the Vourinos complex. The paper by Eliopoulos and Eliopoulos [9] on the factors controlling the gallium preference in high-Al chromitites presents geochemical—including Ga—and mineral chemistry data on chromitites associated with the ophiolite complexes of Greece and elsewhere. Potential factors controlling the lower Ga contents in high-Cr chromitites compared to high-Al ones are the composition of the parent magma, temperature, redox conditions, the disorder degree of spinels, and the ability of Al^{3+} to occupy both octahedral and tetrahedral sites, in contrast to the competing Cr^{3+} that can occupy only octahedral sites (due to its electronic configuration) while the Ga^{3+} shows a strong preference on tetrahedral sites. The paper by Eliopoulos and Economou-Eliopoulos [10] on the trace element distribution in magnetite separates of varying origin and genetic/exploration significance provides SEM/EDS and ICP-MS data on representative magnetite samples covering various geotectonic settings and rock-types, such as calc-alkaline and ophiolitic rocks, porphyry-Cu deposits, skarn-type, ultramafic lavas, black coastal sands, and metamorphosed Fe–Ni-laterites deposits. They concluded that, despite the potential re-distribution of trace elements—including Rare Earth Elements (REE) and Platinum Group Elements (PGE) in magnetite-bearing deposits—the data may provide valuable evidence for their origin and exploration. In particular, the trace element content and the presence of abundant magnetite provide valuable evidence for discrimination between Cu–Au–Pd–Pt- porphyry systems and those lacking precious metals. The paper by Gray and Van Rythoven [11] deals with a comparative study between porphyry-Cu deposits of the Western Cordillera, using portable X-ray fluorescence analysis (pXRF) and optical microscopy. Although the proposed research methodology cannot reach the levels of precision and accuracy required to meet standards for mineral resources, the combined use of pXRF in the field with optical microscopy provides a fast and cost-effective method for the exploration of large unexplored porphyry intrusions characterized by extensive haloes of alteration. The application of the proposed methodology to porphyry intrusions can influence decisions regarding geological mapping, cross-sections, and the selection of samples for a more detailed petrographic and geochemical investigation of porphyry-type deposits, as well as influence exploration for potential sources of Cu, Mo and precious metals (Au and platinum-group elements). The paper by Eliopoulos et al. [12] is focused on sulphides of both Cyprus-type and Fe-Cu-Co-Zn sulphides associated with magnetite within gabbro, close to its tectonic contact with serpentinized harzburgite of the Pindos ophiolite complex. The higher Zn, Se, Mo, Au, Ag, Hg, and Sb contents and lower Ni contents in the Pindos compared to the Othrys sulphides may reflect inheritance of a primary magmatic signature. Relatively high Cu/(Cu+Ni) and Pt/(Pt+Pd), and low Ni/Co ratios for sulphides from the deeper part of the complex suggest either no magmatic origin, or a complete transformation of preexisting magmatic assemblages. However, the recorded textural and mineralogical features of both sulphide types from Pindos resemble the Fe-Cu-Zn-Co-Ni mineralization reported in other mafic–ultramafic-hosted VMS deposits, which have shown mineralogical, compositional and textural analogies with present-day counterparts on ultramafic-rich substrate seafloor VMS deposits formed by hydrothermal processes.

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References

1. Bindi, L.; Zaccarini, F.; Ifandi, E.; Tsikouras, B.; Stanley, G.; Garuti, G.; Mauro, D. Grammatikopoulosite, NiVP, a New Phosphide from the Chromitite of the Othrys Ophiolite, Greece. *Minerals* **2020**, *10*, 131.
2. Bindi, L.; Zaccarini, F.; Bonazzi, P.; Grammatikopoulos, T.; Tsikouras, B.; Stanley, C.; Garuti, G. Eliopoulosite, V_7S_8, A New Sulfide from the Podiform Chromitite of the Othrys Ophiolite, Greece. *Minerals* **2020**, *10*, 245.
3. Kiseleva, O.N.; Airiyants, E.V.; Belyanin, D.K.; Zhmodik, S.M. Podiform Chromitites and PGE Mineralization in the Ulan-Sar'dag Ophiolite (East Sayan, Russia). *Minerals* **2020**, *10*, 141.
4. Kravtsova, R.G.; Tauson, V.L.; Makshakov, A.S.; Bryansky, N.V.; Smagunov, N.V. Platinum Group Elements in Arsenopyrites and Pyrites of the Natalkinskoe Gold Deposit (Northeastern Russia). *Minerals* **2020**, *10*, 318.
5. Zaccarini, F.; Garuti, G. Zoned Laurite from the Merensky Reef, Bushveld Complex, South Africa: "Hydrothermal" in Origin? *Minerals* **2020**, *10*, 373.
6. Sadeghi, M.; Arvanitidis, N.; Ladenberger, A. Geochemistry of Rare Earth Elements in Bedrock and Till, Applied in the Context of Mineral Potential in Sweden. *Minerals* **2020**, *10*, 365.
7. Stouraiti, C.; Angelatou, V.; Petushok, S.; Soukis, K.; Eliopoulos, D. Effect of mineralogy on the beneficiation of REEs from heavy mineral sands: the case of Nea Peramos, Kavala, northern Greece. *Minerals* **2020**, *10*, 387.
8. Economou-Eliopoulos, M.; Frei, R.; Ioannis, I. Factors Controlling the Chromium Isotope Compositions in Podiform Chromitites. *Minerals* **2020**, *10*, 10.
9. Eliopoulos, I.P.D.; Eliopoulos, G.D. Factors Controlling the Gallium Preference in High-Al Chromitites. *Minerals* **2020**, *9*, 623.
10. Eliopoulos, D.G.; Economou-Eliopoulos, M. Trace Element Distribution in Magnetite Separates of Varying Origin: Genetic and Exploration Significance. *Minerals* **2020**, *9*, 759.
11. Gray and Van Rythoven. A Comparative Study of Porphyry-Type Copper Deposit Mineralogies by Portable X-ray Fluorescence and Optical Petrography. *Minerals* **2020**, 10, 431.
12. Eliopoulos, D.G.; Economou-Eliopoulos, M.; Economou, G.; Skounakis, V. Mineralogical and Geochemical Constraints on the Origin of Mafic–Ultramafic-Hosted Sulphides: The Pindos Ophiolite Complex. *Minerals* **2020**, *10*, 454.