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Trace element geochemistry, mineralogy and texture of the Ermioni VMS mineralization host volcanics, and new insights on the geotectonic setting of volcanism, Argolis, Greece

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Introduction

Several studies have been performed on the trace element geochemistry of the mafic volcanics of the "Ermioni Complex" (Bortolotti et al., 2002; Robertson et al, 1987) in order to clarify the geotectonic setting of the Southeast Argolis Peninsula. Yet, the complex lithology and tectonism of the "Ermioni Complex" combined with the diversity in the geochemical character identified, including both Island Arc Tholeiites (IAT) and Mid-Ocean Ridge Basalts (MORB), create significant issues in providing solid results on the distinction of the geotectonic setting of the Southeast Argolis area. This study is focused on the volcanic rocks that host the Ermioni VMS mineralization in an attempt to specify the geotectonic setting of volcanism and the corresponding type of mineralization.

Sampling – Analytical methods

Samples were collected from the most important mine sites, Karakasi and Roro, and were primarily screened for the exclusion of the highly altered ones. The remaining were crushed, pulverized and homogenized, and were commercially analyzed by ICP-AES and ICP-MS for major, minor and trace elements (84 in total). The host rock mineralogy and texture was determined by combination of transmitted and reflected light optical microscopy, Raman Spectroscopy, X-ray Diffractometry and Scanning Electron Microscopy carried out at the Laboratory of Mineralogy, Petrology and Ore Deposit Geology, Section of Geological Sciences, School of Mining and Metallurgical Engineering, National Technical University of Athens.

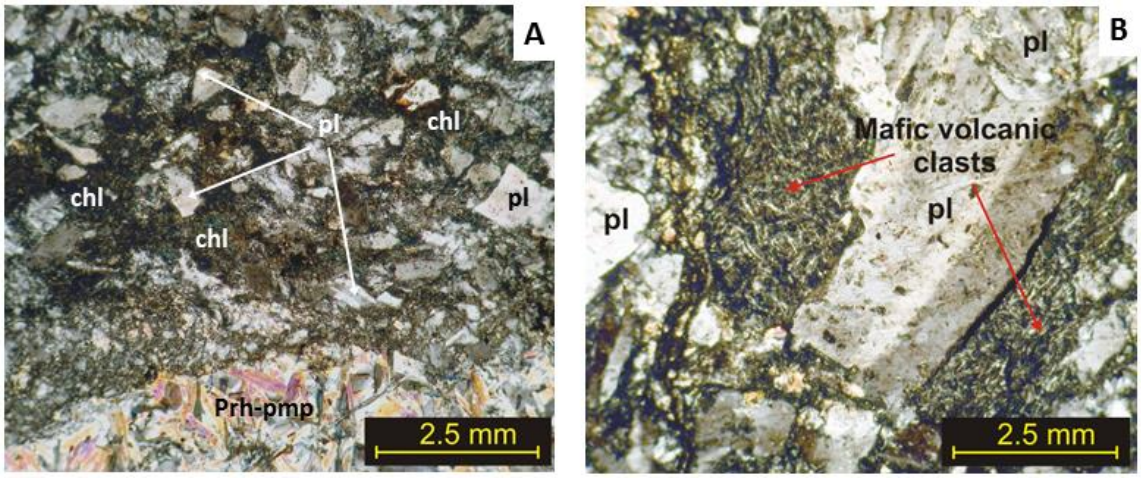

Figure 1. Transmitted light optical microscopy images of the Ermioni VMS mineralization host volcanics. A. Propylitized mafic volcanic tuffs with angular to sub-angular Ca-plagioclase (pl) fragments altered to albite, in a ground mass dominated by chlorite (chl) ± quartz (qz). Late stage prehnite (prh)-pumpellyite (pmp) ± quartz (qz), and quartz veins and veinlets cut the propylitized rock. B. Mafic volcanic clasts with plagioclase microlaths between coarse-grained plagioclase crystals within the host volcanic tuffs. Abbreviations after Whitney and Evans (2010).

Results and discussion

The Ermioni VMS mineralization is hosted in mafic volcanic tuffs and terrigenous turbidites of the "Ermioni Complex. The host mafic volcanics are gray-green in color, cohesive, indurated and massive, and geochemically range between basalts and andesites. The mineralogy of the Ermioni host volcanics is rather monotonous, with predominant angular to subangular coarse-grained albite crystals after hydrothermal alteration of primary Ca-plagioclase (Figure 1). The size of the albite crystals ranges from several μm to a few mm, and their angular shape indicates small-scale transportation of detritus. Primary mafic phases are highly altered and the matrix is dominated by fine-grained chlorite, epidote, prehnite – pumpellyite and minor quartz (Figure 1). Scarce Ti phases include rutile/anatase, sphene and ilmenite. Angular to subangular clasts of mafic volcanics with plagioclase microlaths are also observed within the Ermioni host volcanics, indicating limited transportation of volcanic material (Figure 1B). Hydrothermal propylitic alteration is evident by the presence of prehnite – pumpellyite ± quartz (Figure 1A), and quartz – epidote veins and veinlets that cut the host volcanics, which in turn are cross-cut by late stage coarse-grained quartz and quartz – calcite veins.

Examination of the trace element geochemistry of the Ermioni VMS host mafic volcanics indicates a calc-alkaline to tholeiitic, and subduction related character (Figure 2). The geochemistry of the host mafic volcanics at Karakasi and Roro is characteristic of a supra-subduction zone setting in close proximity to the continental margin, as identified by the high

silica content of the Ermioni host turbidites (Triantafyllidis and Diamantakis, 2018). The Ermioni host volcanics show similar trend to island arc volcanic rocks, with moderate LREE and relatively constant HREE values. Moreover, the Ermioni volcanics show enrichment in LILs and depletion in HFS (e.g. Ti, Y and Zr), although depletion in K and Rb is also observed, most probably related to hydrothermal alteration phenomena that have affected the footwall host volcanics (Misra, 2012). A negative Nb-Ta anomaly is observed and considered as subduction-related magma signature, and the trend is typical for subduction zone related volcanics, and in particular calc-alkaline volcanic arc basalts (Pearce et al., 1984).

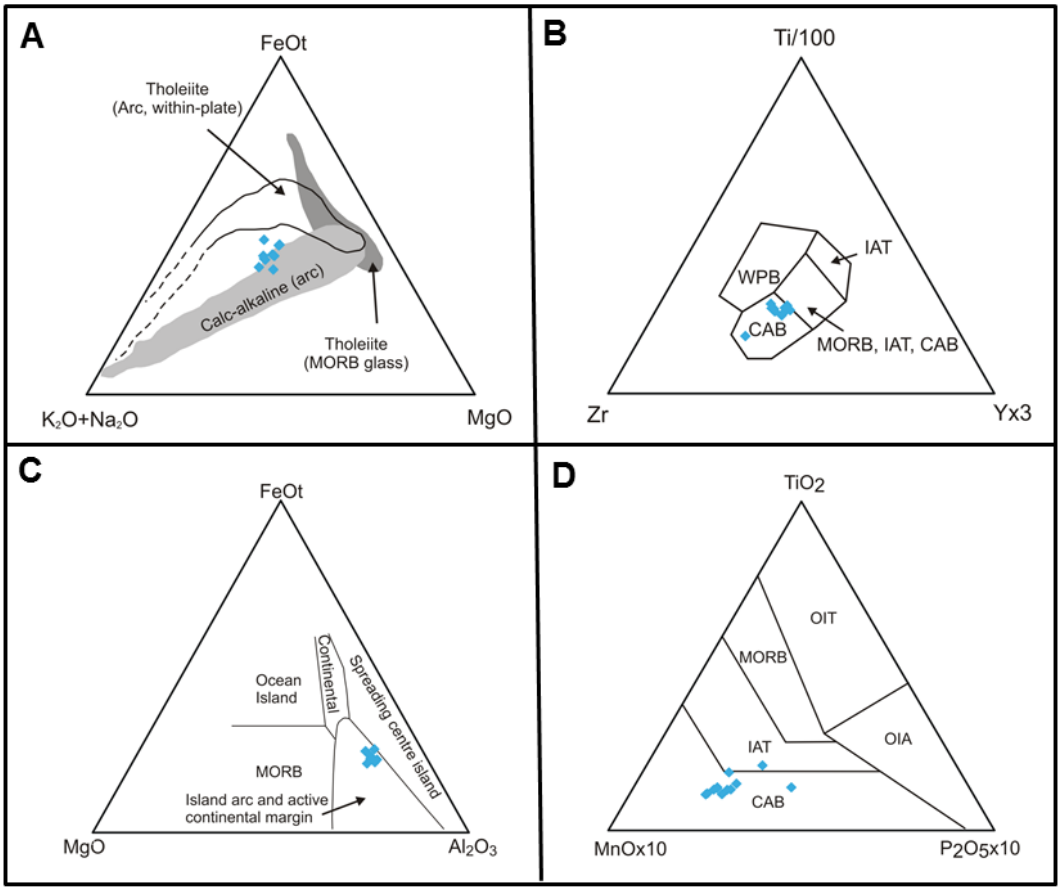

Figure 2. Major and trace elements ternary diagrams from the Ermioni VMS host mafic volcanics. A. AFM diagram. B. Ti-Zr-Y diagram. C. FeOt-Al_2O_3-MgO diagram. D. TiO_2-P_2O_5x10-MnOx10 diagram.

Concluding, the trace element geochemistry, texture and alteration of the Ermioni VMS host volcanics indicates a different geotectonic setting of volcanism relative to the typical geotectonic setting of ophiolites that host Cyprus-type mineralizations, as formerly proposed for the Ermioni VMS ore (Robertson et al., 1987). Based on the results of this study related to host rock lithology, mineralogy, texture and geochemistry, there are strong arguments for classification of the Ermioni VMS mineralization as "Besshi-type" (Höy, 1991). Yet, due to the complex tectonism and deformation of the Southeast Argolis Peninsula only geochronological data may provide solid arguments on the geotectonic setting and age of the "Ermioni Complex" volcanism, as well as the type of the Ermioni mineralization.

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