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Physicochemical conditions of the evolution of the volcanic-hosted Zn-Pb ± Cu epi-mesothermal vein-type deposit and its contribution to the understanding of western Anatolian metallogeny, NW Turkey

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ABSTRACT

This study focuses on the evolution of the Kirazlıyayla volcanic-hosted Zn-Pb ± Cu epi-mesothermal vein-type deposit and its relationship to volcanism in NW Turkey. The Kirazlıyayla area has an extensive variety of geological formations, including the Karakaya, Yenipazar, Fındıcak, Sarısu Volcanics, and Mesudiye. The mineralization that formed within the Sarısu Volcanics at Kirazlıyayla mine area exhibits distinctive features, including the occurrence of crosscutting quartz and sulfide veins and veinlets, forming a network of sulfide-bearing stockworks with locally banded/bedded massive sulfide. Three mineralization phases occur across the alterations. Pyrite crystallization and silicification alteration occurred during the first phase. In the next phase, sphalerite develops with the deposition of the first generation of galena and chalcopyrite occurs along with sericite, kaolinite, and quartz in the phyllic alterations. Dolomite and calcite minerals dominate carbonatization in the third phase, with the second generation of galena and chalcopyrite with tennantite. The $\delta^{34}S$ of the sulfides exhibited a range of values from 0.7 to 6.8 $‰_{VCDT}$, with an average value of 2.13 $‰_{VCDT}$. The presence of igneous rocks in the study area provides evidence for a uniform sulfur source having magmatic signature. The variability in sulfur isotope composition can be observed in intermediate and high-sulfidation ore minerals. The use of oxygen isotope analysis has the potential to facilitate the identification of hydrothermal fluids involved in the formation of ore deposits, which often exhibit a combination of magmatic and metamorphic fluids. The fluid inclusion investigations have shown two-phase liquid-vapor inclusions in both the sphalerite and quartz minerals, which could be categorized as both primary and secondary varieties. The indication of these fluid inclusions inside sphalerite and quartz implies a potential meteoric source and may be attributed to the gradual mixing of fluids responsible for ore formation, which is facilitated by the influx of meteoric water along the pathway of fluid flow. Therefore, these fluid inclusions show magmatic-meteoric mixing, resulting in the creation of low-salinity ore-forming fluids due to the interaction between magmatic fluid and diluted meteoric water, resulting in further mineralization at the late stage of mineralization. Zinc, lead, and copper in hydrothermal fluids may supersaturate under fluid mixing conditions, producing Zn-tennantite and second-generation galena minerals.

In conclusion, the Kirazlıyayla deposit is influenced by a variety of physicochemical conditions associated with volcanism and the transportation of hydrothermal fluids. These fluids penetrate the crust, dissolving metals from nearby rocks, and may circulate and flow towards the surface via the NE-trending faults and fractures in the study area. When these hydrothermal fluids reach zones of lower pressure or temperature, mineralization often occurs, allowing dissolved metals to precipitate out of the fluid and create mineralized veins. Therefore, the volcanism played a significant role, both as a heat source and a mechanism for mobilizing hydrothermal fluids, enhancing the understanding of metallogenesis in NW Turkey.

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