Ore Mineralogy of Kirazlıyayla (Yenişehir-Bursa-Turkey) Mesothermal Zn-Pb-($\pm$ Cu) Deposit: Preliminary Results

F. Javid and E. Çiftçi^(✉)

Department of Geological Engineering, Faculty of Mines, ITU, 33469 Maslak,
Istanbul, Turkey
eciftci@itu.edu.tr

Abstract. The Kirazlıyayla deposit is one of Pb-Zn ($\pm$ Cu) deposits associated with andesitic volcanism cutting through the metamorphics of Karakaya complex. It is a structurally controlled, vein-stockwork style, mesothermal ore deposit. Replacement, brecciation, vein/veinlets, carries, sea-island, and dissemination textures were identified. Pyrite, sphalerite, chalcopyrite, galena, tennantite, and covellite constitute the ore mineral paragenesis. Quartz, calcite and dolomite with kaolinite account for the gangue minerals. Supergene stage is insignificant. The Kirazlıyayla mineralization is a Zn-Pb ($\pm$ Cu) mineralization hosted by tectonically controlled andesitic volcanism within the Karakaya metamorphics and has common features with the other occurrences in the western Anatolia.

Keywords: Kirazlıyayla · Mesothermal · Lead · Zinc · Karakaya complex · Structurally controlled

1 Introduction

Turkey hosts noteworthy variety of mineral deposits owing to its geological evolution within the Alpine-Himalayan orogenic belt and its complex tectonic setting. Mineral deposits of Turkey are better understood through the understanding tectono-magmatic evolution of Turkey. Within this framework, there are a number of various ore deposits disseminated throughout the country including the Kuroko-type VMS deposits (strictly in the Eastern Pontides tectonic belt), Cyprus-type VMS deposits (along the Bitlis-Zagros suture zone in SE Anatolia and Küre-Kargı trend in the Central Pontides), Besshi-type VMS deposits (in the Central Pontides and along the Bitlis-Zagros suture zone), epithermal deposits of both LS and HS type (mostly in western Anatolia) and significant number of IS type with noteworthy lead and zinc presence, and carbonate-hosted sulfidic and nonsulfidic Pb-Zn deposits (along the Tauride Belt). In addition, skarn-type (mainly Fe producing) deposits (disseminated throughout the country), porphyry Cu-Mo (disseminated throughout the country), mesothermal cupriferous Pb-Zn mineralizations (along the Eastern Pontide belt), and podiform chromite deposits (along the suture zones throughout the country) are also important part of the metallogeny of Turkey.

Although Turkey produces zinc and lead concentrates, due to the lack of smelters, about 1.5 billion dollars each year paid for the import of those metals. In the recent years, the government is in an attempt to revive the sector through various incentives.

The western Anatolia is host to great number of mineral deposits. As for the lead-zinc occurrences, it can be summarized in 3 types in terms of their genesis in the region: (I) distal skarn occurrences associated with the carbonates of the metamorphic basement; (II) structurally controlled veins within the basement metamorphics and the overlying volcanics or along their contacts; and (III) replacements along the mafic dykes.

The study area is located in one of the tectonic elements of Turkey – the Sakarya terrane, which is an elongate crustal ribbon extending from the Aegean in the west to the Eastern Pontides in the east. It is consisted of sandstones of Lower Jurassic age, which sits on a fairly complex metamorphic basement that contains a high-grade Variscan basement metamorphics of Carboniferous age (Topuz et al. 2004, 2007; Okay et al. 2006), Paleozoic granitoids (Delaloye and Bingöl 2000; Okay et al. 2002, 2006; Topuz et al. 2007), and a low grade metamorphic complex - the Lower Karakaya Complex constituted by Permo-Triassic metabasite with lesser amounts of marble and phyllite. The Lower Karakaya Complex represents the Permo-Triassic subduction-accretion complex of the Paleo-Tethys as indicated by the presence Late Triassic blueschists and eclogites (Okay and Monié 1997; Okay et al. 2002), accreted to the margin of Laurussia during the Late Permian to Triassic. The complex is overlain by a thick series of strongly deformed clastic and volcanic rocks with exotic blocks of Carboniferous and Permian limestone and radiolarian chert. This complex basement was overlain unconformably in the Early Jurassic by a sedimentary and volcanic succession. The Early Jurassic is represented by fluvial to shallow marine sandstone, shale and conglomerate in the western part of the Sakarya Zone. The metamorphic basement is cut by Eocene volcanisms.

The Kirazliyayla Zn-Pb ore deposit is spatially and temporally related with Eocene intermediate extrusive rocks - andesite and trachyandesite with NE-SW extension and covered by clastic and carbonate rocks. The main purpose of the investigation is to determine the genesis of Kirazliyayla Zn-Pb ore deposit and its place in the metallogenic evolution of the region to contribute the understand of the metallogeny of Turkey. In that, geochemical characteristics, mineralogy of both host rocks and ore minerals, its tectonic setting are the main issues are covered.

2 Methods and Approaches

A total of 30 samples representing the ore deposit from open pit – main production step and from the boreholes were taken, from which polished sections were prepared and Nikon Eclipse LV100 reflected light microscopy integrated with a CITL MK5 Cathodoluminescence system was employed for mineralogical examination. The ore minerals and the paragenesis were identified on the basis of their petrographical features and their textural relationships, respectively. Electron Probe Micro Analysis (EPMA) and Secondary Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) were routinely used for confirming the minerals and chemistry of sulfide minerals when needed.

Fig. 1. (A) sphalerites and carbonates are partially replaced by late stage galena; (B) chalcopyrite and pyrite are partially replaced by late stage galena; (C) galena replaces coarse sphalerite; (D) galena replaces coarse sphalerite and also carbonate gangue; (E) large cataclastic pyrite veined by sphalerite and late stage galena; (F) large cataclastic sphalerite with replacing galena and chalcopyrite, all in silicic matrix; (G) Large sphalerite grains with late stage galena, chalcopyrite and tennantite veins; (H) large pyrite and chalcopyrite veined by late stage galena; (I) Euhedral quartz, large sphalerite grains with late stage galena; (J) sphalerite veined by late stage chalcopyrite and pyrite; (K-L) Late carbonates veining sphalerite (Py: pyrite; Ccp: chalcopyrite; Sp: sphalerite; Gn: galena; Tn: tennantite; Cal/Dol: calcite/dolomite)

Fig. 1. (continued)

3 Results and Discussion

Field observations indicated that kaolinitization with silicification is pervasive alterations indicating low pH hydrothermal activity resulted in the mineralization. The mineralization is associated with andesitic volcanics in that vein/veinlets, replacement in places, stockwork, and breccia ore structures are prevalent. Thickness of veins may reach to 1 m in rare occasions. Samples were collected from the production steps in the open pit and from the boreholes cutting the mineralized zones.

Based on the studies of the ore samples, the major ore minerals are sphalerite and galena as zinc and lead carrier. Pyrite is a ubiquitous. Chalcopyrite is a minor to trace

sulfide phase along with trace tennantite (Fig. 1K–L). Most of the samples indicate that the mineralization is medium to high grade. Sphalerite and galena occur as large grains (sometimes up to mm size) in most of the samples, indicative of being precipitated out of supersaturated fluids within narrow spaces. Both are also fairly inclusion-free (clean). When not, galena occurs with tennantite, sphalerite with pyrite and chalcopyrite. Galena has also chalcopyrite encapsulation in places.

Interpretation of the intergrowth ore textures suggests that mineralization started with pyrite crystallization then a brief precipitation of first generation of chalcopyrite, then followed by major sphalerite crystallization, which is followed by a major carbonatization, followed by a brief tennantite and second generation of chalcopyrite formation. In the final stage of the ore mineralization a major galena precipitation took place. Figure 2 summarizes the mineralization event. Ore deposit experienced very weak supergene stage in which only traces of covellite formed.

Fig. 2. Proposed ore mineral paragenetic sequence for the Kirazlıyayla Zn-Pb mineralization

4 Conclusions

Major ore minerals include sphalerite and galena. Chalcopyrite is minor while tennantite is trace. Pyrite is always present, but not as much as sphalerite and/or galena. Tennantite is the only fahlerz that occurs in some ore zones, overall in trace quantities. Sphalerite and galena occur as large grains in most of the samples. Both are also fairly inclusion-free (clean). When not, galena occurs with tennantite, sphalerite with pyrite and chalcopyrite. Galena has also chalcopyrite encapsulation in places. Paragenetic succession for the ore minerals appear to be (from early to late):

Pyrite-Chalcopyrite (I)-Sphalerite-Chalcopyrite (II)-Tennantite-Galena

Calcite/dolomite and quartz account for the gangue minerals. Kaolinite is the major clay mineral. Sericite also locally become significant.

Coarse nature of the major minerals (majority of the galena and sphalerite is larger than 100 microns) suggests high liberation (>90%). Small size occurrences (<10%) are mostly in the form of veinlets within each other, so during milling, most of that size range may be liberated.

Sulfosalts or fahlore are represented only by tennantite ($\text{Cu}_6[\text{Cu}_4(\text{Fe},\text{Zn})_2]\text{As}_4\text{S}_{13}$).

Preliminary results show that the Kirazlıyayla mineralization is a Zn-Pb ($\pm\text{Cu}$) hosted by andesitic volcanics whose emplacement within the metamorphic complex should be tectonically controlled.

Acknowledgements. The authors would like to acknowledge support received from Meyra Mining company for their courteous support during the field work.

References

- Delaloye M, Bingöl E (2000) Granitoids from western and northwestern anatolia: geochemistry and modeling of geodynamic evolution. *Int Geol Rev* 42:241–268
- Okay AI, Tüysüz O, Satır M, Özkan-Altın S, Altın D, Sherlock S, Eren RH (2006) Cretaceous and Triassic subduction-accretion, HP/ LT metamorphism and continental growth in the Central Pontides, Turkey. *Geol Soc Am Bull* 118:1247–1269
- Okay AI, Monié P (1997) Early Mesozoic subduction in the Eastern Mediterranean: evidence from Triassic eclogite in northwest Turkey. *Geology* 25:595–598
- Okay AI, Monod O, Monié P (2002) Triassic blueschists and eclogites from northwest Turkey: vestiges of the Paleo-Tethyan subduction. *Lithos* 64:155–178
- Topuz G, Altherr R, Schwarz WH, Dokuz A, Meyer HP (2007) Variscan amphibolite facies metamorphic rocks from the Kurtoğlu metamorphic complex (Gümüşhane area, Eastern Pontides, Turkey). *Int J Earth Sci* 96:861–873
- Topuz G, Altherr R, Kalt A, Satır M, Werner O, Schwartz WH (2004) Aluminous granulites from the Pulur Complex, NE Turkey: a case of partial melting, efficient melt extraction and crystallisation. *Lithos* 72:183–207

Open Access This chapter is licensed under the terms of the Creative Commons Attribution 4.0 International License (<http://creativecommons.org/licenses/by/4.0/>), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.