Fluid inclusion and S isotope systematics of some carbonate-related Pb-Zn-Cu mineralizations in NW Anatolia, Turkey

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The studied Pb-Zn-Cu deposits are located between Çanakkale and Balıkesir in NW Anatolia. Two ore deposits are investigated here, in Lapseki-Çataltepe to the northwest and in Yenice-Kalkım to the southeast of Çanakkale. The host rocks in both areas are represented, from the bottom to the top, by lense- and/or band-shaped recrystallized limestones, and/or marble-intercalations bearing Permo-Triassic metamorphic rocks. Eocene granitoids and subvolcanics are found in Lapseki area, whereas Oligo-Miocene aged granitoids and Middle Miocene subvolcanic rocks are found in Yenice area. The Pb-Zn-Cu mineralizations in these areas are observed at and around the carbonates and along fractures in the metamorphic rocks. The sulfide minerals comprise mainly galenite, sphalerite, chalcopyrite, pyrite and arsenopyrite, whereas the gangue minerals in the ore zones are represented by garnet, epidote, quartz and calcite. In addition to these minerals, manganiferous hedenbergitic pyroxene and hematite have been detected in the ore zones of Kalkım area.

Fluid inclusion studies of Kalkım area (Handeresi, Bağırkaç and Fırıncıkdere mineralizations) revealed that fluids in pyroxenes have salinities of 5.4 to 8 wt.% NaCl equiv., and the homogenization temperatures (Th) range between 290 and 430°C. The salinities of sphalerites are around 11 wt.% NaCl equiv., and the Th vary from 272 to 338°C. The fluids during quartz formation stand out with the salinities of 1.4 to 2.6 wt.% NaCl equiv., and Th of this stage is 157-267°C. On the other hand, the Th of the fluids during calcite formation ranges between 68 and 75°C. The salinities of this stage could not be measured. The fluid inclusion measurements of Lapseki area (Çataltepe mineralizations), showed that the fluids in garnets have salinities of 0.7 to 1.4 wt.% NaCl equiv., and their Th range between 310 and 353°C. Sphalerites have salinities of 0.5 to 1.2 wt.% NaCl equiv., and Th of 220 to 300°C. The salinities of fluids related to the quartz formation vary between 0.5 and 1.1 wt.% NaCl equiv., and their homogenization temperatures from 200 to 310°C. Because the system was open, based on the fact that both liquid and gaseous phases could be observed at the same fluid inclusions in both areas, sphalerite homogenization temperatures could be evaluated as formation temperatures varying between 220 and 340°C.

In Kalkım area, the sulfur isotope compositions of the sulphide minerals are: $\delta^{34}S_{PbS}$ = -1.1 to 1.5 ‰ with a mean around -0.2 ‰, $\delta^{34}S_{ZnS}$ = -0.7 to 2.1 ‰ with a mean around 0.7 ‰, and $\delta^{34}S_{CuFeS2}$ = -0.6 to 1.5 ‰ with an average around 0.4 ‰. The sulfur isotope composition of the sulphide minerals in Lapseki area are characterized by $\delta^{34}S_{PbS}$ = -0.5 to 0.0 ‰ with an average around -0.25 ‰, $\delta^{34}S_{ZnS}$ = 0.8 to 1.3 ‰ with a mean around 1.03 ‰, $\delta^{34}S_{CuFeS2}$ = 0.9 to 1.5 ‰ with an average around 1.2 ‰, and $\delta^{34}S_{FeS2}$ = 0.0 to 1.0 ‰ with a mean around 0.5 ‰. The $\delta^{34}S$ values of sulfide minerals in both areas show a narrow range near 0 ‰ which can be interpreted as indicating magmatic sources and the sulfur isotopes are very similar to $\delta^{34}S$ values of skarn deposits.