Vein-type copper mineralization associated with the Arakawa magmatic-hydrothermal system in Akita, Japan

*Shota Satori[1], Yasushi Watanabe[1], Takeyuki Ogata[2], Yasutaka Hayasaka[3]

1. Graduate School of International Resource Sciences, Akita University, 2. International Center for Research and Education on Mineral and Energy Resources, Akita University , 3. Graduate School of Sciences, Hiroshima University

The Neogene Northeast Japan arc yields many vein-type copper deposits associated with felsic intrusive rocks. This study investigated copper mineralization associated with a magmatic-hydrothermal system in the Arakawa area in Akita Prefecture, Japan, to discuss the evolution of the hydrothermal fluid from magmatic exsolution stage to late epithermal stage.

In the center of the Arakawa area, there are dacitic intrusive rocks represented by the Ushizawamata intrusion, of which zircon age is determined to be 8.10 ±0.30 Ma by U-Pb method by laser ablation-inductively coupled plasma-mass spectrometry.

The Ushizawamata dacitic intrusion and host sedimentary rocks were subjected to hydrothermal alteration, which are classified into four alteration zones. Biotite and chlorite alteration, illite alteration, chlorite alteration and smectite alteration are distributed in zoning from the Ushizawamata intrusion to around area.

Many copper-bearing quartz veins are present in the Arakawa area. Those veins are sub-parallel and strike NE. Those veins are hosted in the sedimentary rocks and lavas of the Neogene. The ores are composed mainly of chalcopyrite, pyrite, Fe chlorite, hematite and quartz. Copper ore mainly consists of chalcopyrite was formed in the early mineralization stage, and barren comb-shaped quartz was formed in the late stage in the copper-bearing quartz veins.

The fluid inclusions in quartz of the copper-bearing quartz veins are all liquid-rich two-phase. Homogenization temperature and salinity are 268.5-276.6 ℃ and 5.7-7.5 wt. % in the early stage quartz and 256.7-269.4 ℃ and 2.7-2.9 wt. % in inner part of comb-shaped quartz of the late stage, and 207.0-250.0 ℃ and 2.7-3.7 wt. % in marginal part of comb-shaped quartz of the late stage, respectively.

All fluid inclusions in quartz phenocrysts in the Ushizawamata intrusion are secondary in origin. Those are classified into two different assemblages. One is a pair of halite bearing poly-phase inclusions and vapor-phase inclusions or vapor-rich two-phase inclusions. The other assemblage consists only of liquid-rich two-phase inclusions. Homogenization temperature and salinity in poly-phase inclusions are 465.7- >487.2 ℃ and 55.2- >58.0 wt. %, and those in vapor-rich two-phase inclusions are 393.0-419.4 ℃ and 2.6-3.7 wt. %. Homogenization temperature and salinity in liquid-rich two-phase inclusions are 344.1-403.0 ℃ and 8.0-9.3 wt. %.

The spatial and temporal proximity between the Ushizawamata intrusion and hydrothermal veins suggest a genetic link between the intrusive dacitic magma and copper mineralization.

The overlap of the two different fluid inclusion assemblage in the Ushizawamata intrusion is similar to that in the porphyry-type copper deposit system, where a high temperature / high salinity fluid associated with low-density vapor in the early hydrothermal stage is replaced by a lower temperature / lower salinity fluid

in the late hydrothermal stage.

The ore forming fluid of the early mineralization stage at Arakawa is about 50 ˚C lower in temperature and about 0 to 2 wt. % lower in salinity than the late hydrothermal fluid of the Ushizawamata intrusion. This relation suggests that the late hydrothermal fluid in the intrusion was responsible in the formation of illite alteration zone and copper-bearing quartz veins, and copper precipitation was caused by the decrease in temperature of the ore forming fluid. The abundant occurrence of chamosite in and around the mineralized veins are attributed to the buffering by the host rock under a low water / rock ratio in the lower part of the ore horizon. The ore forming fluid of the late mineralization stage shows a salinity range of 2.7 to 4.2wt. %. This suggests that the fluid was mixed with seawater.

It is concluded that the hydrothermal fluid from late stage of magmatic exsolution with dacitic magma was the source of copper mineralization in the Arakawa deposit about 8 Ma.

Keywords: Cu mineralization, magmatic-hydrothermal system, fluid inclusions, hydrothermal alteration

