

DAIRI: THE ONLY AVAILABLE EXAMPLE OF GIANT SEDEX Zn-Pb-Ag DEPOSIT IN SUMATRA, INDONESIA

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The Dairi SEDEX Zn-Pb-Ag deposit (Sumatra, Indonesia) lies within the succession of black shales and dolostones of the Lower Carboniferous Kluet-Kuantan Formation that has undergone sub-greenschist to greenschist metamorphism. This deposit is host to 25.1 Mt ore at 10.2% Zn, 7.3% Pb, and 8.4 g/t Ag, making the mineralization one of giant SEDEX deposits across the globe. More than 90% of the metal resource in Dairi is hosted by stratiform orebodies, whereas the rest occurs in discordant orebodies that conceptually represent the feeder for the overlying stratiform mineralization. Sphalerite and galena are present as principal ore minerals, coexisting with minor tetrahedrite, tennantite, and chalcopyrite, as well as trace arsenopyrite, acanthite, pyrrhotite, boulangerite, freieslebenite, and diaphorite. Pyrite is the dominant iron sulfide phase in the stratiform and discordant orebodies, marking three paragenetic stages: (1) diagenetic, (2) hydrothermal, and (3) metamorphic. In contrast, pyrrhotite is confined to the lowest horizon of the stratiform orebodies. Fluid inclusions in the discordant orebodies homogenize at 116.8°-195.2°C which may reflect the original trapping temperatures; those in the stratiform orebodies have a wider range of homogenization temperatures (109.8°-349.5°C) which reinforce the premise that the orebodies, along with their host rocks, have been metamorphosed. Salinity inferred from fluid inclusion microthermometry polarizes into the ranges of 18-25 wt.% NaCl equiv. and 3-7 wt.% NaCl equiv. suggesting the dilution of a saline ore-forming fluid by seawater as the primary driving force that leads to the sulfides-sulfosalts precipitation. $\delta^{34}\text{S}$ in the discordant orebodies ($4.6\pm 0.6\text{‰}$) is in contrast to that in the stratiform orebodies ($21.6\pm 10.0\text{‰}$), signifying a dual source of reduced sulfur in the Dairi deposit. Hydrothermal sulfur is likely to be responsible for metal fixing during the in-fracture precipitation resulting in the discordant orebodies since the ore-forming fluid may have formed from the formational water equilibrated within the reduced rift-fill sequence. On the other hand, reduced sulfur involved in the formation of stratiform orebodies is supplied from bacteria reduction of the Carboniferous seawater sulfate. Its heavy $\delta^{34}\text{S}$ is thought to be a product of anoxia development in a restricted basin. The Dairi deposit was discovered in the 1990s and no other SEDEX deposits containing significant metal repositories has been discovered throughout Sumatra ever since. Therefore, this deposit-scale mineralization study in Dairi is expected to guide exploration of SEDEX Zn-Pb-Ag deposit in the island.

Keywords: Dairi, SEDEX, Zn-Pb-Ag, Mineralization, Exploration, Metal deposit