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The Relationship between Pb/Zn Mineralization and Salt Diapir Illustrated by the Case of Bou Grine Deposit, Tunisian and Jinding Deposit, SW China

WANG Hongyan, XUE Chuandong and TANG Liang

Department of Earth Sciences, Kunming University of Science and Technology, Kunming 650093, China

The close relationship between some lead and zinc concentration and salt- bearing diapirs had caused extensive concern by the end of 19th century (Levat, 1894). Bou Grine Zn/Pb ore deposits in Tunisia of North Africa is the best example to understanding the close relationship between lead-zinc mineralization and salt diapirs. And recent years, some experts put forward that the giant Jinding Zn/Pb deposit also formed by halokinesis with evaporite salt dome (Dong, 2012; Li, 2012; Leach et al., 2013).There are some common features present both in salt diapirs deposits in Jinding and Bou Grine. This paper concerns about describing and summarying up the typical characteristics, geological background, temporal and spatial distribution of the diapirs related Zn/Pb ore deposits, and then discusses the genetic model foundation for further study.

1 Geological Characteristics of Salt Diapirs Related Deposits

1.1 Geological setting and Mineralization features

The Bou Grine Zn/Pb deposit is located in the Domes area at the northern extremity of Jebel Lorbeus diapir, which is oriented SW-NE. This area extends over 8000 km^2 between the "nappes" area and Medjerda Neogene subsident basin to the north and the Tertiary garben area of the central Tunisian platform to the south (Montacer et al., 1987). The ore- bearing formation is brecciated dolostone. The types of sulfide mineralization include banded, layered like and massive mineralization (Lattar, 1980; Rouvier et al., 1985). The main minerals including sphalerite, galena, pyrite, and calcite, is the principal gangue mineral with quartz, celestite. In banded mineralization, the sphalerite is always colloform and occasionally in individual crystals. The host rocks either carbonate or sandstone are crosscut by mineralized fissures, containing sulfides as the stratiform deposits. In veins, Pb-Zn-bearing minerals are well crystallized, locally the mineralization becomes of stockwork type. Sedimentary rocks often show recrystallization and high fracture phenomenon, mineralization generally appear at two sides of diapir. Bitumen and native sulphur are locally found throughout the deposit (Charef and Sheppard, 1987). Sulfide minerals occur mainly as open- space fillings in a variety of rock porosity and fractures and detrital grains in internal sediments.

Jinding Pb/Zn deposit in Lanping Mesozoic-Cenozoic basin is very famous for its ultra-large scale polymetallic mineralization and complicated genisis. In Jinding ore district, there are favorable thrusted nappe structures, strike- slip faults, and salt diapirs duing to its complicated regional geological setting. There exsits a series of salt dome sturctures mostly consisted of gypsum and minor halite, pyrite and auphalt, intruding into the sandstone and limestone of the Jingxing Fm (K_1j), Maichuqing Fm (T_3m), and Sanhedong Fm (T_3s). Salt diapirs experienced two stages at least, parts of which have developed into the piercement phase, accompanying with strong pyritization and Pb-Zn mineralization. And at the top of the salt domes, there often occures massive pyrites and veined Pb-Zn orebody. Galena, sphalerite and pyrite which form the mineral association in the sandstone- hosted deposit all perform fine grained and replace calcite cements between detrital quartz grains, taking on colloform texture, disseminated, and spotted ores. The limestone breccia-hosted type consists of galena, sphalerite, pyrite and celestite, which formed by filling the crack and opening space.

1.2 Temporal and spatial distribution

The salt diapirs related metal deposits are distributed in specific geological background and metallogenic environment. Bou Grine deposit are in a subsiding basin in an orogeny foreland, and Jinding deposit in a foreland

* Corresponding author. E-mail: 644202577@qq.com

basin under continental collision orogenic setting, mineralogenetic epoch are concentrated in Meszoic and Cenozoic, especially most common in the Triassic and Cretaceous.

The mineralization associated with salt diapirs are usually distributed spatially in diapir zone, on the top of the diapiric structure or adjacent to the site, and the contact with the diapirs is the main belt. Salt diapirs influence mineralization and alteration zoning, ore features and mineral assemblages, changing regularly from the center of the salt diapris to the surrounding rocks (Li, 2012).

1.3 Ore-bearing strata

The ore- bearing strata of salt diapirs in the base metal deposits are generally dolomite, limestone, sandstone and mudstone, which show characteristics of brecciated, rich in organic matter and high porosity. This type of deposits show some stratabound ore deposit characteristics.

2 Favorable Effects of Salt Diapirs on the Pb-Zn Mineralization

From Bou Grine to Jinding deposits, we can see the favorable effects of salt diapirs on Zn-Pb mineralization are as follows: (1) Salt diapirs provide a reservoir for hydrocarbons and reduced sulfur. Biodegradation of hydrocarbons and microbial sulfate reduction contribute to the formation of high- grade mineralization at the contact with the salt dome cap rock (Bechtel et al., 1996). (2) Halokinesis will intensively change the occurrence and the thickness of the sedimentary masses, leading the preexisting structures more complex and disordered. Salt layers act as a lubricant in deforming sediment masses. And it is easy to form conduits for metal- bearing brines to transport during this process. (3) Salt diapirs provide a chemical trap for hydrocarbons ascending Zn- and Pb- rich sedimentary brines (Leach et al., 2013). Salt rocks can be a good seal for its impermeability and good compactness. (4) Halokinesis provides the driving force for migration of basin fluids. (5) Salt diapirs are ideal environment for biogenic sulfate reduction reactions when organic-rich sediments fluids and near-surface sulfate-rich brines mixed, and metal precipitated if a source of metals is available. The peridiapiric region is the place where pulsations of a variety of different fluids pass through and mix along themselves and/or woth surface waters (Sheppard S.M.E et al., 1996; Bechtel A et al., 1996).

3 Metallogenic Model

The metals dispersed in sedimentary strata probably were leached and upward migrated by hot hypersaline basinal brines. When the metalliferous brines migrated up around the diapirs, finally mixed with near- surface, sulfate- rich brines in the roof zone. And the dissolved sulfate was reduced by the sulfate- reducing bacteria (Bechtel, 1996). This mechanism will be ongoing if freshwater has concentrated to where it mixed with the underlying brine. With the dropping of fluid salinity, temperature and pressure, the metal- saturated brine and surface water mixed, leading to metal deposited. Several features or necessary conditions should be present in the salt diapirs related base metal deposits: (1) The thick evaporite layers at the base of the sedimentary sequence act as uplift indicators. (2) There presents evaporite minerals, dominating by gypsum and halite. (3) The mineralization shows metallogenic characteristics of open space filling and replacement, belonging to the post ore formation. (4) The succession in the same zone of tectonic or epirogenic movements that facilitate remobilization (Rouvier et al., 1985). (5) Already existing faults or fractures act as the channel to the fluid upward through series of interactions with salt diapirs.

4 Conclusion

Salt diapirs metal deposits are a different deposit from the existing sediment- hosted base metal deposits, which can not be explained by the present genetic model. Further study should be emphasized on sedimentary basin development and diapirism, basin fluid evolution and migration, role of organics, basement tectonics and the interaction between the salt flow and basin fluids.

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