Mineralization stages and fluid processes in the giant Jinding deposit, western Yunnan, China

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Abstract. Jinding is the largest Zn-Pb deposit in China, and also the youngest sediment-hosted super-large Zn-Pb deposit in the world. The Jinding mineralization processes are discussed in this paper based on the investigations of the mineral intergrowth. The hydrothermal mineralization experienced three stages: the stage of quartz-sphalerite- galena, the stage of sphalerite-galena-celestite and the stage of galena-calcite-celestite-gypsum. Fluid inclusions in sphalerite and associated gangue minerals show that the homogenization temperatures range from 54° to 309°C and cluster around 110°~150°C, with salinities of 1.6~18.0 wt% NaCl equivalent. The temperature increased and the salinity decreased during the early stage, the temperature was stable and the salinity decreased during the main stage, and both temperature and salinity decreased during the final stage. This temperature-salinity trend probably resulted from mixing of a high- temperature, low-salinity fluid with a low- temperature, high-salinity fluid during mineralization.

Keywords. Jinding deposit, sandstone-hosted, mineralization stages, mineralization fluid processes, fluid inclusions

1 Introduction

The Jinding deposit was discovered in 1960 in the Lanping Basin, SW-China (Fig. 1). Hosted in Cretaceous and Palaeocene terrestrial sandstones, the Jinding deposit is the largest Zn-Pb deposit in China. The Jinding Deposit is related to continental crust movement during the collision of the Indian and Eurasian plates, and is the youngest sediment- hosted super large Zn-Pb deposit in the world (Xue et al. 2003). The genesis of the deposit has been a subject of debate and controversy since the 1980's, and the mineralization fluid process is the key.

In this paper, we investigate the mineral intergrowth, mineralization stage, fluid flow and reveal the mineralization fluid process in the Jinding Deposit. Our results suggest the mixing of mantle- and crust-derived fluid during the Jinding mineralization.

2 Regional geology

The Lanping Meso-Cenozoic Basin is an intracontinental basin developed on the Changdu-Lanping-Simao microplate between the Yangtze Plate to the east and the Tibet-Yunnan Plate to the west, separated by the Lancangjiang and Jinshajiang-Ailaoshan faults (Fig.1). The basin basement is the Palaeo-Tethys marine and terrestrial carbonates, volcanic rocks, and clastic rocks. The Meso-Cenozoic System consist of, in ascending order, the Upper Triassic, Middle-Upper Jurassic, Lower Cretaceous, Upper Cretaceous, Tertiary, and there are several terrestrial gypsum-salt sequences and sedimentary gaps in the basin column. The main fault cuts deeply into the lower crust and upper mantle. In addition, some EW-trending blind structures are also recognizable. Tectonic evolution of the Lanping Basin shows as the Indosinian remained basin, the Yanshanian depression basin and the Himalayan pull-apart basin (Xue et al. 2002).

Himalayan alkali intrusions of mantle-source or mantle-crust mixed sources occur along the margin- and the central-faults of the basin. Some mantle rock xenoliths occur in these alkali intrusions. Several isolated circular structures observed by remote sensing suggest the presence of some thermal anomalies and magma at depth.

The thermal metamorphism developed along the Lanping-Simao fault could result from both deep faulting and heat-driven upwelling along the faults (Luo et al. 1994). High temperature bodies with low seismic velocity and distinct rises of the asthenosphere occur under the Jinding Deposit (Bian 2000).

Deep faulting, magmatism, upwelling of mantle fluid, discordances in the stratigraphic column, and interaction between the crust and the mantle, are the basic geological characteristics of the Lanping Basin and stem from collision of Indian plate and Eurasian plate, This sort of geodynamics is favorable for the material exchange to result in large scale mineralization.

3 Ore geology and mineralization stage

The Jinding ore district has undergone sedimentation, thrusting, heat doming and dome collapse. The mineralization accompanied the local extension and the heat flow upwelling. Ore bodies are usually tabular in shape, distinctly structure-controlled (Fig. 2), and no obvious sedimentary features can be recognised. The cement texture resembles that of typical ores formed when sulfide minerals replace the cement in the highly permeable clastic rocks.

The Jinding hydrothermal mineralization is separated into three stages based on paragenetic studies and min-

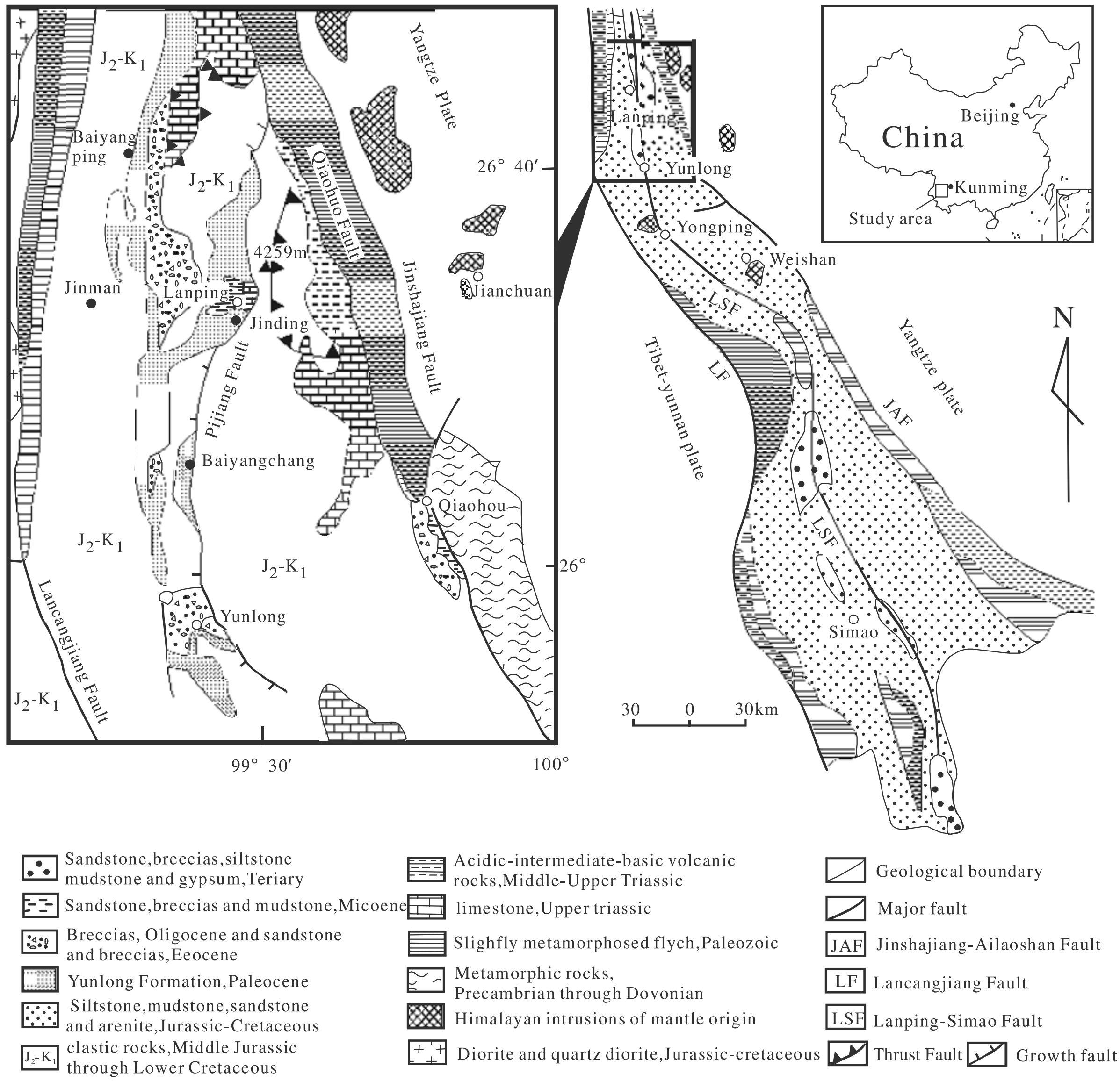

Figure 1: Location of the Jinding Deposit and a simple geology of the Lanping Basin.

eral intergrowth in the ore. They are the stage of quartz-sphalerite-galena, the stage of sphalerite-galena-celestite and the stage of galena-calcite-celestite-gypsum. The galena of the third stage is coarse grained and associated with calcite in veins and vugs, whereas the galena of the earlier stages is fine-grained and disseminated. The celestite of the third stage occurs in veins and associated with the remobilized bitumen, which is different from the sedimentary celestite in strata and the disseminated hydrothermal celestite in the ore. Pyrite occurs in every stage, but most commonly in the second and the third stages. Disseminated bitumen formed before Zn-Pb mineralization and was hydrothermally matured during the mineralization.

4 Jinding mineralization fluid process

Fluid inclusions have been found in sphalerite and associated quartz, celestite, calcite and gypsum in the Jinding ores. Fluid inclusions show a variation in size 3~20 microns (Fig. 3). Fluid inclusions distributed in healed fractures were not studied. The results of 73 melting- temperature and 94 homogenization- temperature have been obtained.

The homogenization temperatures range 54°~309°C with the average 182°C in quartz, 154°C in sphalerite, 140°C in celestite, 126°C in calcite and 98°C in gypsum. 3 homogenization temperature peaks are revealed in the

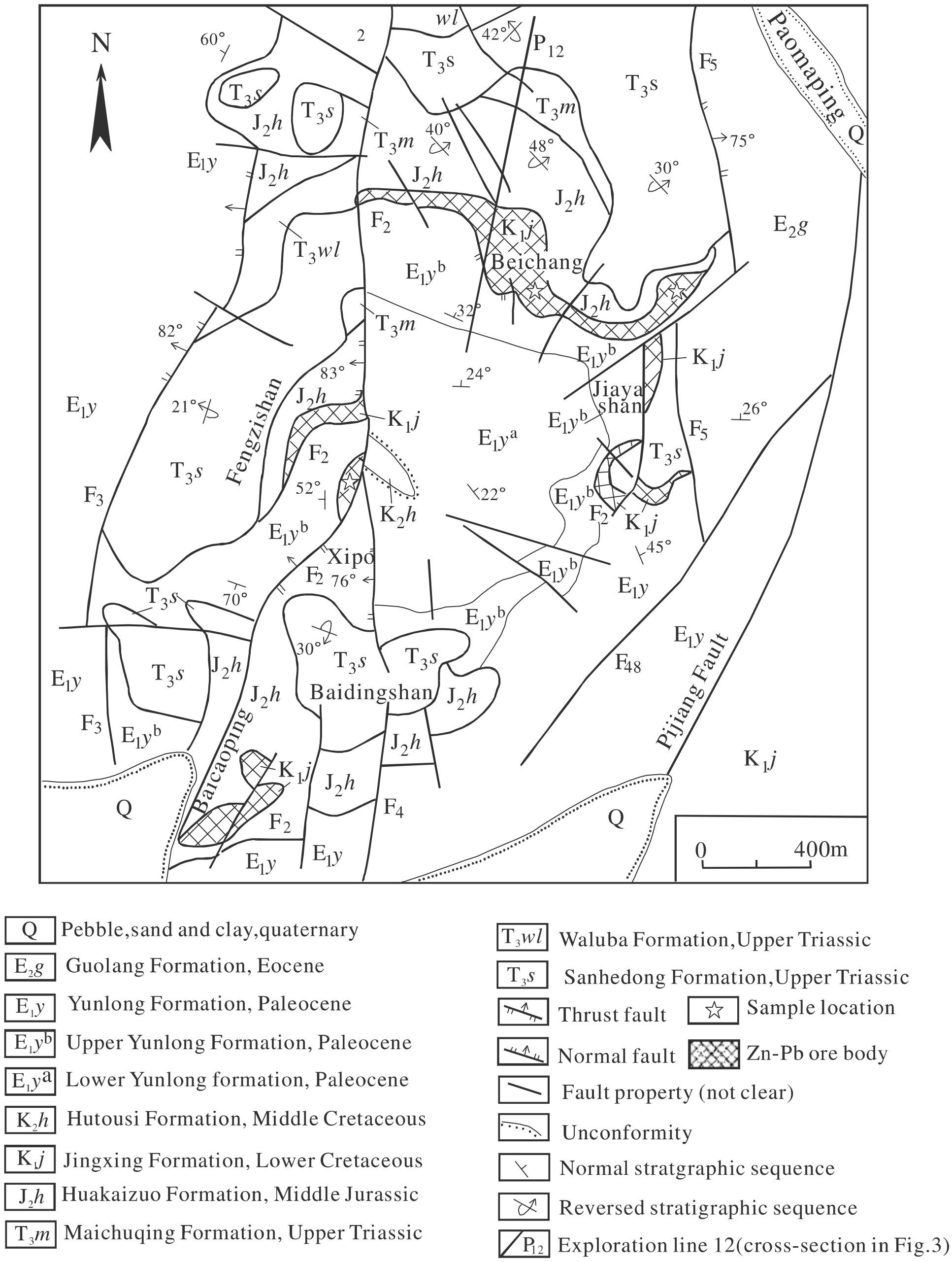

Figure 2: A geological map of the Jinding Deposit (after Third Geological Team 1984).

stacked histogram, i.e., a 170ºC~190ºC peak mainly consisting of quartz, sphalerite and celestite, a 110ºC~140ºC peak of sphalerite, celestite and calcite, and a 80ºC~100ºC peak of calcite and gypsum. These peaks broadly correspond to the three hydrothermal stages recognized by ore petrography and mineralparagenesis. There is a general trend of westward decrease in homogenization temperatures in the Jinding ore district.

Salinities of fluid inclusions range from 1.6 to 18.0 wt% NaCl equivalent, with an average of 6.1 wt% and a mode around 4~5 wt% NaCl equivalent. The average salinity is 8.7 wt% NaCl equivalent for fluid inclusions in quartz, 10.5 wt% in sphalerite, 10.0 wt% in celestite, 5.2 wt% in calcite, and 3.6 wt% in gypsum. Salinity values show a systematic increase from east to west in the ore district.

The westward decrease in homogenization temperatures and increase in salinity indicate a negative correlation between temperature and salinity, which is also reflected in the temperature-salinity diagram, especially for data from sphalerite, celestite and quartz (Fig. 4).

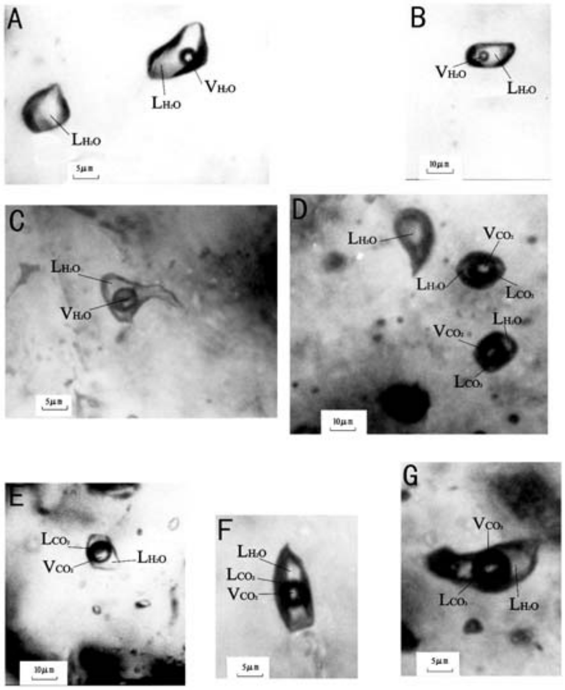

Figure 3: Photomicrographs of the fluid inclusion types from sphalerite and associated quartz, celestite, and calcite in the Jinding ores (room temperature). (A) a single-phase liquid H_2O inclusion (left) and a two-phase vapor-liquid H_2O inclusion (right) in celestite; (B) a two-phase vapor-liquid H_2O inclusion in calcite; (C) a two-phase vapor-liquid H_2O inclusion in quartz; (D) a single-phase liquid H_2O inclusion (upper) in quartz and two three-phase liquid H_2O-liquid CO_2-vapor CO_2 inclusions (the other two on right) in sphalerite; (E) a three-phase liquid H_2O-liquid CO_2-vapor CO_2 inclusion in quartz; (F) a three-phase liquid H_2O-liquid CO_2-vapor CO_2 inclusion in celestite; (G) a three-phase liquid H_2O-liquid CO_2-vapor CO_2 inclusion in celestite.

5 Conclusions

The temperature increases and the salinity decreases during the early stage, the temperature is stable and the salinity decreases during the main stage, and both of temperature and salinity decreases during the later stage.

The negative temperature-salinity trend probably results from mixing of a high-temperature and low-salinity fluid with a low-temperature and high-salinity fluid during the main stage of mineralization.

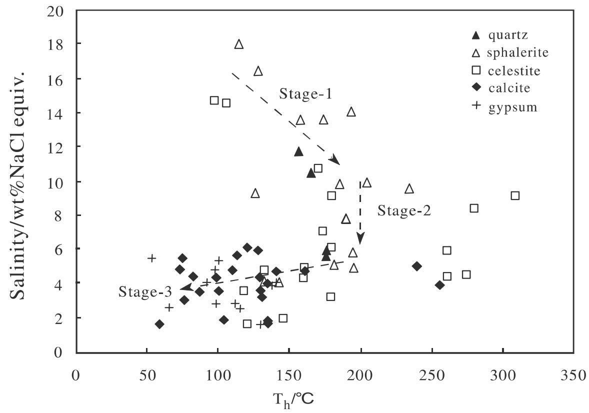

Figure 4: Homogenization temperature vs. salinity, the Jinding mineralizing fluid.

Acknowledgements

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