HAN Fengbin, CHEN Zhengle, SUN Yue and WU Yu, 2014. Sediment-Hosted Pb–Zn Deposits Related to the Reduction of Oil and Gas: A Sample from the Wulagen Lead-Zinc Deposit, China. *Acta Geologica Sinica* (English Edition), 88(supp. 2): 158-159.

Sediment-Hosted Pb–Zn Deposits Related to the Reduction of Oil and Gas: A Sample from the Wulagen Lead-Zinc Deposit, China

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1 The Relationship between Ores Deposit and the Reduction of Oil and Gas

The co-existence relationship in space between oil and gas and metal ore deposits are not uncommon. Metal content is higher in some of the reservoir, such as the mercury content in the oil and gas fields can be up to 4000-5000t in the north German, the equivalent of a big mercury deposit (China standard for the large mercury deposit 1000t), the gold content of the Shengli oilfield in China is up to $1\sim2x10^{-6}$. Some metal deposits itself produce a large number of asphalt, liquid oil and other organic matter such as Jinding Lead-Zinc ore deposit. The carbonate formation of strata-bound ore deposits in south China are rich in organic matter.

Nearly 30 years, with the progress of geological science interdisciplinary and test means, the relationship between metal elements in ore-forming process and oil and gas have been confirmed for many researchers.

Metal ore deposit related to oil and gas has the following characteristics: 1) The metallogenic elements is also Cu, Pb, zinc, and chemical properties of active metal elements such as U, Au; 2) The times of strata-hosted is more newer formation, mostly in the Cenozoic sedimentary basin; 3) The rock-hosted is given priority to with clastic sedimentary rock and carbonate rock; 4) Orebody and ores are visible in hydrocarbon residues, asphalt and other organic matter. For example，the Guizhou Tongren - Hunan Fenghuang mercury - oil and gas belt, the main ore-bearing bed is both the source bed, hydrocarbon generation, the time of mercury migration accumulation is near the early time of oil generation and migration.

2 A sample Study from the Wulagen Lead-Zinc Deposit

The Wulagen lead-zinc deposit, located at Kashi Sag in northwestern margin of the Tarim basin, western Xinjiang, China, is hosted in Mesozoic-Cenozoic sandstones and conglomerates, and a typical sediment-hosted Pb–Zn deposit where lots of organic matters are widely spread, such as residues of oil & gas and dry asphalt. Recent studies and prospecting have confirmed that the geologic condition of this deposit is favorable for mineralization, and the mineral potential should be very large. However, its genesis remain controversial for long time.

Our analyses showed that the value of sulfur isotopic compositions from ore-bodies changed from -27.9% to +15‰ with a wide distribution and two-terminal element, suggesting the sulfur probably from the marine sulfate thermal and chemical reduction. The lead isotopic ratios were 17.771~18.721, 15.402~15.748, and 37.92~39.103, respectively. The value of lead isotopes concentrated near the orogenic-belt evolution curve on the Pb-Pb diagram, suggesting a Proterozoic strata source. Lots of organic matters and petroleum and gas inclusions in ores were found. Measurements of mineralization fluids yielded the homogenization temperature varying from 78 ℃ to 369 ℃, concentrating temperature on 100~220℃, implying the ore-forming fluids was not a typical single basin cryogenic fluids, but mixed fluids probably experienced for many times thermal activitives. The salinity was mostly lower than 8 wt% NaCl. Geochemical analysis indicates that the provenance of the ore bearing sedimentary rocks is mainly terrigenous. The total amount of rare earth of mineralization of sandstone and conglomerate is obviously higher than that no mineralization, suggesting that the ore-forming process has certain adsorption of rare earth elements.The content of organic carbon in ores varied from 0.02 to 12.43%, but that in no ore-bearing or organic remainder rocks was ranging from 0.02 to 0.1%. The average content of total silfur in ores was 3.56%. The content of organic carbon and ∑S was positively correlated with the lead-zinc mineralization intensity, suggesting that the lead-zinc mineralization process was accompanied with the transformation from original

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oxidation to reduction in ore-hosted rocks, and that the oil&gas be worked as reducing agent. The Fe2+/ Fe3+ value in ore-bearing and oil&gas remainder-bearing sandstones was close to 1, indicating that the environment was tend to be neutral or reduction as response to the reduction. The content of chloroform bitumen "A" changed from 0.004 to 0.025 wt%. The ration of total hydrocarbons was 46.22% in average, and that of "non-hydrocarbon+ asphaltenes" was 53.77%, and the average of saturated hydrocarbons to aromatic hydrocarbons was 9.59, showing the organic matter was similar to I-type parent material, suggesting the organic matter be from the marine algae. The ration of Pr/Ph varied from 0.41 to 1.84, indicating a deoxidization environment for the organic matter. Odd-even predominance index was from 0.75 to 1.07, suggesting that the maturity of organic matter should be relatively high. Carbon preference index was from 1.03 to 1.30, indicating a higher degree in thermal evolution. Finally, a new metallogenic model of the deposit, oil and gas reduction mineralization model, was proposed, suggesting that ore-forming material deposited and accumulated during the reduction of oil and gas with well permeability, original oxidation sandstones and conglomerates when the lead-zinc-bearing fluids flowed through Mesozoic to Cenozoic strata.

Acknowledgements

The authors are grateful to Senior Engineer Liu Zengren and Engineer Ye Lei from Xinjiang Geological Survey, China Non-ferrous Metals Resources Geological Survey for offering help in fields.

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