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The Discovery of a Paleo-oil Reservoir and a Study on the Relationship between Ore Formation and Hydrocarbon Accumulation in the Qinglong Antimony Deposit, Guizhou China

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The Qinglong antimony deposit is located in the Southwestern Guizhou depression of the South China fold system and to the southwest of the Yangtze platform. Fifteen bitumen layers have been found in five drill holes and with ca. 0.37 Mt bitumen resources calculated for the deposit in 2012. The bitumen mainly occurs in fissures and pores in the Permian Emeishan basalt, Dachang tuff and Maokou limestone. Some minerals such as pyrite, chalcopyrite and bornite but no antimony minerals are found in the bitumen layers.

Asphalt in the paleo-oil reservoir contains 86.67% carbon, 3.32% hydrogen, 0.27% nitrogen and 3.52% oxygen. The ratios of H/C and O/C are 0.46 and 0.03 respectively (n=12). The reflectivity of bitumen reaches 2.57% (n=6), indicating that the asphalt formed during the beginning of the dry gas stage. The asphalt in this paleo-oil reservoir have high average copper contents of 528.27μg/g and low average antimony contents of 0.635μg/g (n=4).

The homogenization temperatures were determined to be 121.7-156.1 ° C with a mean of 139 °C (n=16) in the paleo-oil reservoir. These temperatures may record the generation of condensate oil and wet gas. Raman Spectroscopy reveals that organic inclusions are made of bitumen, methane and ethane, indicating the paleo-oil reservoir is highly evolved. The same gases are also found in the inclusions of the antimony deposit.

The $\delta^{13}C$ of asphalt in the Qinglong paleo-oil reservoir is -28.1‰ (n=9), which is very close to other Permian paleo-oil reservoirs in the Nanpanjiang basin[1]. This value is also closer to the Devonian source rocks, suggesting that the asphalt was derived from these rocks. The biomarker parameters also reveal a genetic relationship between the asphalts and Devonian source rocks.

Five bitumen samples yield an isochron with an age of 254.3±2.8 Ma and an initial $^{187}Os/^{188}Os$ ratio of 0.531±0.02. The large variation in the $^{187}Re/^{188}Os$ ratios and small mean square of weighed deviation (MSWD=0.56) suggest that this Re-Os isochron is reliable. This age is earlier than ore forming age with 142 Ma or 148Ma, as determined by Sm-Nd method in fluorite[2].

The Qinglong antimony deposit and paleo-oil reservoir have a close spatial relationship, the former occurring in the centre and the latter in the western wing of the Dachang anticline. Ore bodies in the antimony deposit occur mainly in the Dachang volcanic rocks. The crude oil passed through growth faults and unconformity surfaces to the Emeishan basalt in the Dachang anticline and formed an oil reservoir at 254.3±2.8Ma. With the constant burial of the oil-bearing strata, the oil reservoir gradually

evolved to a gas reservoir and the gas migrated to the core of Dachang anticline. Hydrocarbon gases would reduce SO_4^{2-} to S^{2-} and prompt the formation of the antimony deposit. These reactions are as follows: $SO4^{2-}+CH_4=S^{2-}+CO_2+2H_2O$ and $3S^{2-}+2Sb^{3+}=Sb_2S_3$. The paleo-oil reservoir would immediately provide S^{2-} for ore formation, because pyrite is common in the Qinglong paleo-oil reservoir.

References

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