Genetic relationship between hydrocarbon system evolution and Carlin-type gold mineralization: Insights from Re-Os pyrobitumen and pyrite geochronology in the Nanpanjiang Basin, South China

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Liquid oil and bitumen are found in Carlin-type gold deposits of the Carlin Trend, Nevada, USA, and the Lannigou deposit, Nanpanjiang Basin, South China. However, the temporal and genetic associations of hydrocarbons, especially pyrobitumen, and gold mineralization are poorly understood. Previous studies have highlighted the possibility of hydrocarbons being the source of ore metals. To this end, using rhenium-osmium (Re-Os) geochronology of pyrobitumen and gold-bearing pyrite from the Laizishan and Banqi reservoirs, and the Yata Carlin-type gold deposit in the Nanpanjiang Basin, we show that hydrocarbons played a critical role in the mineralization process.

A Re-Os age of 228 ± 16 Ma obtained for highly mature pyrobitumen suggests that this pyrobitumen formed by thermal cracking of oil during the Late Triassic in the Laizishan and Banqi reservoirs. This age is in agreement with the modelled thermal history of the Nanpanjiang Basin, which indicates that liquid oil thermally cracked to pyrobitumen and gas (methane) during the Triassic. Moreover, the oil cracking timing is similarly constrained to a Re-Os age of 218 ± 25 Ma determined on gold-bearing pyrite from the Yata deposit. This Re-Os pyrite age is in agreement with ages reported for other Carlin-type gold deposits in the Nanpanjiang Basin. Collectively, the timing of gold mineralization suggests that the auriferous Carlin-type systems of the Nanpanjiang Basin formed during the Late Triassic.

Integrating the Re-Os pyrobitumen and gold-bearing pyrite ages, the initial osmium isotope compositions (ca. 0.6) and published fluid inclusion data both the reservoir and gold deposits, a methane (CH_4)-triggered thermochemical sulfate reduction (TSR) process is considered to be the genetic link between of pyrobitumen formation and gold-bearing pyrite mineralization.