Oil-cracking gas accumulation history recorded by fluid inclusions

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Gases from oil cracking may accumulate in the same traps that originally accommodate oils. Vomumetric expansion during the conversion of oil to gas usually results in overpressure if traps are kept intact and no additional reservoir space is newly developed. However, the present pressure system of the giant oil-cracking gas pool in the Sinian carbonate reservoirs in central Sichuan Basin is almost hydrostatic. In this study, integrated microscopic laser raman and microthermometry were integrated to investigate the character of gaseous fluid inclusions (GFIs) in the Sinian carbonate reservoirs, based on which gas accumulation and pressure evolution history are proposed. Three types of methane-domianted gaseous fluid inclusions were identified in terms of their petrological occurrence, chemical composition, methane density, and the homogenization temperatures (Ths) of coeval two-phase aqueous fluid inclusions. Type I GFIs contain abundant pyrobitumen whose thermal maturity is similar to that of reservoire probitumen and the high denisty of methane (average 0.272 g/cm^3), indicating their origin of early oil inclusions that have been thermally converted to gas inclusions. Compared with type I GFIs, type II GFIs accomadate notably less pyrobitumen with average methane density of 0.249 g/cm^3. Considering that the aqueous fluid inclusions coeval with type II GFIs have Ths of 20–40 ºC higher than those coeval with type I GFIs, type II GFIs are probalby formed from original wet gas or volatile oil inclusions. Type III GFIs, hosted in quartz and fluorite, contain no pyrobitumen and their gases are dominated by methane with minor CO_2 and H_2S, indicating that they are newly formed during oil cracking and may record the PVTX of reservoired gases at that time. The Raman shifts of methane in these inclusions vary from 2911.16 to 2912.43 cm^{-1}, indicating an average methane density of 0.253 g/cm^3. Integrated with regional burial and thermal evolution history, the fluid inclusions data illustrate that the present gas reservoirs were first charged with oils and even wet gas during Permian to late Triassic; then the oils were cracked into gases forming strongly overpressurized gas pools during Jurassic to late Cretaceous, after which the gas pools were partly destroyed and adjusted by tectonic uplift during late Cretaceous, ultimately forming the present gas pools with almost hydrostatic pressure systems.

Supported by NSFC (Grant No. 41072095and41522302).