Abiogenic Fischer-Tropsch synthesis of methane at the Baogutu reduced porphyry Cu deposit, western Junggar, NW-China

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Methane is widely developed in hydrothermal fluids from reduced poprhyry copper deposits (RPCDs; proposed by Rowins, 2000), but its origin remains enigmatic. The occurrence of methane in fluids at the Late Carboniferous Baogutu RPCD in western Junggar, Xinjiang, NW-China (our unpublished data; Shen *et al*., 2010), presents an excellent opportunity to address this problem. A systematic study including fluid inclusion microthermometry and Laser-Raman, hydrothermal mineral H-O isotope analyses was conducted to constrain the origin of CH_4 and CH_4-rich fluids.

The wide range of δD values (-86.7±11.2 ‰, n = 21) and $\delta^{18}O$ (+3.8±1.4 ‰, n = 21) for water within quartz most likely results from water-rock interaction with water/rock ratios (wt% in O) ranging from 0.25~3 and 0.2~1 for a closed system and open system, respectively, but not from mixing with meteoric water. Detailed Laser-Raman analyses indicate CO_2 in apatite included in granodiorite porphyry phenocrystic biotite records the early stage magmatic stages, whereas later hydrothermal fluids containing CH_4 with trace CO_2 are found in inclusions in vein quartz.

We propose that the magmatic CO_2 was reduced to CH_4 by Fischer-Tropsch type (FTT) reactions in the presence of H_2, which was probably generated during the early Ca-Na hydrothermal alteration with hydration of hornblende + clinopyroxene to actinolite + magnetite + sphene + albite. Therefore, the methane of fluids at the Baogutu RPCD was not produced via thermogenesis or bacteriogenesis but instead formed during late hydrothermal alteration by FTT reactions.

[1] Rowins S. M. (2000) *Geology* **28**, 491–494. [2] Shen *et al*. (2010a) *Chem. Geol*. **275**, 78–98.

Molecular geochemistry as indicators of seal integrity and relevance to shale oil exploration

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Recent development in unconventional shale petroleum production in North America has led to significant changes in the global energy outlook. Production of shale oil from organic rich source rocks has brought complex geochemical, geological and engineering challenges which are distinct from those related to conventional systems. This study compares the marine petroleum systems in the Devonian-Mississippian Bakken Formation of the Williston basin in North America and the lacustrine petroleum systems in the Eocene-Oligocene Shahejie Formation in the Zhanhua Depression of Bohai Bay Basin, China, to identify key geological controls for viable shale oil plays. In particular, we pay attention to the role of seal integrity in the retention of petroleum fluids within the mature source rock systems. In the Williston basin there are two opposing schools of thought that infer either the Bakken Formation or the Lodgepole Formation as the primary source rock for the Madison-reservoired oils in the Canadian Williston Basin. While there is geochemical evidence for significant mixing of Bakken and Lodgepole oils in the Madison reservoirs, multivariate statistical analysis of a large geochemical data set indicating that oil mixing appears to be geographically dependent and restricted by a northeast-southwest–striking zone, where fracture or fault systems are inferred to have provided high permeability zones allowing Bakken-derived oil to migrate upward across the Lodgepole Formation. The areas without significant fault or fracture systems favour either lateral oil migration along porous beds in the middle Bakken reservoirs or oil retention within the Bakken source rocks leading to overpressure zones. In the Zhanhua Depression, in contrast, molecular geochemical data suggest two contrasting hydrocarbon migration scenarios: dominant short-distance lateral migration in over-pressured central sag areas, and vertical migration along fault and fractures to the shallow reservoirs in the Guantao Formation. As oil production from the shale dominated intervals in the Zhanhua Depression show clear relationship between the production locations to the proximity of regional fault systems, delineating the relationship holds the key in the target selection of shale oil exploration.

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