

## Origin of the bitumen in Xiamaling Formation

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A lot of bitumen with or without siliceous shell were found in unit 3 of the Xiamaling Formation (1.39 Ga) in the Xihuayuan district, Hebei province, northern of China. Most of the bitumen or bitumen concretions occurred at low angle or parallel to the depositional plane, embedded in the surrounding black shale or green chert, without any signs of diagenetic alternation. The bitumen concretions found both in the black shale and green chert in the unit 3 of Xiamaling Formation have almost same morphological structure and chemical composition suggesting similar formation pathways and timing.

Fresh bitumen and surrounding rocks, including the black shales and green cherts, were sampled, crushed and prepared for biomarker analysis. All of the analyses were performed at Key Laboratory of Petroleum Geochemistry, China National Petroleum Corporation, China. Saturated hydrocarbon fractions were analyzed by GC-MS.

In the chromatograms of  $m/z$  191, all of the  $C_{18}\sim C_{24}$  tricyclic terpanes,  $C_{24}$  tetracyclic terpane ( $C_{24}TT$ ),  $18\alpha(H)$ - $17\alpha$ -methyl- $22,29,30$ -trisorhopane (Ts),  $7\alpha(H)$ - $22,29,30$ -trisorhopane (Tm), and  $C_{29}\sim C_{34}$  hopanes could be detected in the bitumen and surrounding rocks. However, the  $C_{19}\sim C_{22}$  long chain alkyl tricyclic terpanes ( $*C_{19}\sim *C_{22}$ ),  $C_{29}$  pre-eluting, and the diahopanes of  $*C_{29}$ ,  $C_{29}Ts$  and  $*C_{30}$  showed similar distribution features in the bitumen and black shale, while green cherts has no this kind of diahopanes. Furthermore, the main advantage peaks of tricyclic terpanes were  $C_{19}$  and  $C_{20}$  in the bitumen and black shales, different with that of  $C_{21}$  and  $C_{23}$  in the green cherts.

In the chromatograms of  $m/z$  217, partial spectrum peaks of  $C_{27}\sim C_{29}$  steranes could be checked out in the green chert, while they were both below the detection limits in the bitumen and black shales.

Therefore, the biomarker distributions in the fresh bitumen were similar with those in the surrounding black shale, different with those in the surrounding green chert. Thus, the bitumen appears to have originated locally from the black shales of Xiamaling Formation.