Formation conditions and geological and geochemical characteristics of the largest tight gas area in central China

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The central China mainly consists of two gas-bearing basins, i.e. Ordos and Sichuan basins, which have been the two ever-found largest tight gas areas in China. They are tectonically located in the transition area between the eastern extensional tectonic area and the western reducing extruding tectonic area, and are characterized by stable structure, gentle paleo-geomorphology, vertical movements, and weak hydrodynamic intensity. It develops large-scale delta sedimentary system and the sediment separation is poor. Coal measure gas source rocks and sandbodies are widely distributed. The formation of large-scale heterogeneous tight sandstone reservoirs is due to the sour water medium of coal measure strata in the two basins, burial depth more than 4000 m during the early stage, and selective dissolution resulting from the integral uplift of 1000-2500 m of the basin in the late stage. Sedimentary reservoirs are slightly different in the two basins.

The Upper Paleozoic strata in the Ordos basin belong to marine-terrestrial depositions after craton. Coal measures with relatively high maturity are widely developed. The Upper Paleozoic strata of the Ordos basin are tight sandstones with low permeability (averagely <8%) and low porosity (averagely $<0.5\times10^{-3}\mu m^2$). However, effective reservoirs with porosity of 8-14% and permeability of $0.5\sim10\times10^{-3}\mu m^2$ are also developed under such background. Tight gases from different strata are all of typical coal-derived gas, while there exist some differences of the geochemical compositions.

The Upper Triassic Xujiahe formation in the Sichuan basin is a gentle large slope of the foreland basin. The effective source rocks are coal measure dark mudstones with low maturity. The source rocks and reservoirs are distributed with a type of 'sandwich' and the distribution area is more than $10\times10^4 km^2$. The tight sandstone reservoirs have porosity of 3~% and permeability less than $0.5\times10^{-3}\mu m^2$. It is determined as coal-derived gas with relatively low maturity.

Both basins have great potential of tight gas resources and are becoming of important large gas areas with rapid development of natural gas in China.

Paleoclimate, nutrient supply and lacustrine source rocks formation in Songliao Basin, China

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The Songliao Basin is the biggest terrestrial oil-bearing basin in China. The oil source rock is the Upper Cretaceous lacustrine mudstone and oil-shale with a thickness of ~ 120m through the Member 1 (K_2qn^1) into the lower Member 2+3 (K_2qn^{2+3}) of Qingshankou Formation, underlaid by the fluvial-delta red-green silty mudstone and sandstone of the Upper Cretaceous Quantou Formation.

Maturity parameters show that the source rocks are matured with litlle variation. The ratios of C_{21}-/C_{22}+ and $(C_{21}+C_{22})/(C_{28}+C_{29})$ are greater than 1.2 and 2.0, respectively, indicating the organic matter mainly from algal input. However, TOC (1-6%) is gradually decreased from the bottom of K_2qn^1 to the lower K_2qn^{2+3}, coinciding with the variation trend of nutrient elements (e.g. Fe^{2+}). The black carbon concentration is higher within Quantou Formation than Qingshankou Formation, indicating paleoclimate during Qingshankou Formation depositing is relatively warm, arid and might have more wildfires. The compound-specific stable carbon isotopic compositions of leaf-wax HC (*n*-C_{27}, *n*-C_{29}, *n*-C_{31}) demonstrate a heavy carbon isotope plateau within Quantou Formation and a less heavy long-term trend with a short-tern positive excursion torwards the lower Member 2+3 of Qingshankou Formation, suggesting that during Qingshankou Formation deposition, the stable carbon isotopic composition of atomospheric CO_2 is heavy and very like to be associated with the Cenomanian-Turonian Oceanic Anoxic Event (OAE2).

The oil source rock in the Songliao Basin is deposited at post-OAE2 stage during the decreasing atmospheric CO_2 under relatively humid paleoclimate condition. The weathering under relatively warm and less humid climate of Quantou Formation supplys much nutrient for lacustrine algal bloom, TOC is decreased as nutrient is consumed.

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