Gas geochemical constraints on the origins of shale gas in Longmaxi formation, Sichuan Basin, China

MINGJIE ZHANG[1], QINGYAN TANG[1] CHUNHUI CAO[2] ZONGGANG LV[3] LI DU[2] ZHONGPING LI[2] YANG YANG[1]

[1] School of Earth Sciences, Lanzhou University, Gansu 730000, China. (mjzhang@lzu.edu.cn)

[2] Lanzhou Centre of Oil & Gas Resource Research, Chinese Academy of Sciences, Gansu 730000, China

[3] Shu'nan Gas-mine Field, PetroChina Southwest Oil & Gas Field Branch Company, Luzhou 648000, China

The Longmaxi formation in the southern Sichuan Basin shows good geological conditions for the shale gas reservoirs, and has produced commercial shale-gas reservoirs. In present study, chemical composition,and C-He isotopic compositions for the Longmaxi shale gas in Weiyuan and Changning areas, Sichuan Basin, China were measured using an integrated method of GC- mass spectrometry to evaluate gas sources, and physical and geochemical processes.

The results show that Longmaxi shale gas after hydraulic fracturing are dominated by methane (94.0-98.6%) with low humidity (0.3-0.6%), and minor non-hydrocarbon gases, which are mainly CO_2 and N_2, and trace He. $\delta^{13}C_{CO2}$ =-2.5- -6.0‰, $^3He/^4He$ =0.01-0.03Ra. They display reversal pattern of carbon isotopes with carbon number ($\delta^{13}C_1 > \delta^{13}C_2$). Meanwhile shale gas in the Weiyuan has lighter $\delta^{13}C_1$ (-34.5--36.8‰), $\delta^{13}C_2$ (-37.6- -41.9‰) and $\delta^{13}C_{CO2}$ (-4.5- -6.0‰) than those in Changning ($\delta^{13}C_1$=-27.2- -27.3‰, $\delta^{13}C_2$=-33.7- -34.1‰, $\delta^{13}C_{CO2}$ =-2.5- -4.6‰).

The Longmaxi shale was thermally high or over mature stage of organic matter with good seal condition. The shale gas after hydraulic fracturing is a dry gas dominated by CH_4. It could be originated from the thermal decomposition of kerogen Type I and II, and the secondary cracking of liquid hydrocarbons which caused the reversal pattern of carbon isotopes. Some CO_2 could be derived from decomposition of carbonate. The differences in carbon isotopes between Weiyuan and Changning areas could be caused by different proportion of mixed gas from the secondary cracking of liquid hydrocarbons at the specific geological and geochemical conditions.

Acknowledgements: This study was supported by "973 Program" of China (2012CB214701), NSF of China (Grant No. 41472070, 41372095, 41502143), Key project of China MOE (311010), China Postdoctoral Science Foundation (2015M572612).