Mantle-origin CO₂ gas pools in petroliferous basins, Eastern China

D. Jinxing

Faulting and magma activities frequently occurred in Eastern China since Jurassic Period. This create favourable conditions for discharge of mantle-origin gas. Springs and volcanic lakes after Quaternary volcanic period in Wudalianchi volcanic area, Heilongjiang Province and Tianchi, Changbai Mountain, Jilin province, contain a large amount of CO₂. CO₂ content amounts to 77.80%-99.45%, and δ¹³C_{CO₂} value is -3.83 to -7.50, and δ³He/⁴He of gas seeps is (1.67 ± 0.07) x 10⁻⁶~8.24 x 10⁻⁶, namely R/Ra is 1.19~5.89. According to gas flux statistics of 3 m² water area of Keyan Spring in Wudalianchi volcanic area, 279.3 m³ gas is discharged daily. Volcanic rock and deep faults are generally distributed in juncture of Jiangxi Province, Guangdong Province. There are many gas seeps in hot spring in Zhegulong, Pingyuan, Guangdong Province and Xunwu, Jiangxi Province. Their CO₂ content varies from 96.7% to 99.96%, and δ¹³C_{CO₂} value is -3.39 to -5.62‰, δ³He/⁴He of gas seeps is (1.90 ± 0.06) x 10⁻⁶~(3.09 ± 0.09) x 10⁻⁶, namely R/Ra is 1.36~3.21. The above δ¹³C_{CO₂} is -3.39 to -7.50‰, which shows that CO₂ is of mantle-origin; the R/Ra of 1.19~5.89 shows that helium gas contains a large amount of mantle-origined ³He. This shows that the discharge of mantle-origin CO₂ and helium is widespread in volcanic area and outcrop area of igneous rock in Eastern China.

The discharge of mantle-origin gas is also widespread in rift petroliferous basin of Eastern China. 24 CO₂ gas pools(fields) has been discovered in Songliao Basin, Bohai Bay Basin, Northern Jiangsu Basin and Sanshui Basin, and East China Sea Basin, Zhujiangkou Basin. CO₂ content of these gas pools is 72.5 to 99.76%, and CO₂ content of most CO₂ gas pools is over 92%, with also hydrocarbon gases(C₁₋₄). δ¹³C_{CO₂} value of gas pools is -3.47~ -5.90‰, which suggest that CO₂ is derived from mantle. δ³He/⁴He is (2.80 ± 0.08) x 10⁻⁶ (6.94 ± 0.20) x 10⁻⁶, namely R/Ra is 2.00~4.96. This shows that helium gas contains a large amount of mantle ³He. 11~56% of helium is derived from mantle helium. But the light δ¹³C₁ of CO₂ gas pools (< -30) along with carbon isotope series of δ¹³C₁< δ¹³C₂< δ¹³C₃< δ¹³C₄ show that hydrocarbon gas is organic origin. Hydrocarbon gases mixed with mantle-origin gas that migrates and accumulates into petroliferous basins.

The occurrence of mantle-origin CO₂ gas pools is related to area with R/Ra>2, also associated with traps close to deep faults and intrusive rocks. The magnitude of mantle-origin CO₂ flux is quite large, for example, CO₂ reserves of Huangqiao Gas Field in the North Jiangsu Basin is estimated up to 624 x 10⁸ m³.