Study on the volcanic lithofacies and controls on volcanic reservoir quality of Yingcheng Formation in Shengping Gas Field, Song-liao Basin, China

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Study on lithology and petrography of volcanic rocks from Yingcheng Formation of the Lower Cretaceous in Shengping Gas Field, Songliao basin, indicates that the major volcanic rocks include pyroclastics and lava with a small part of pyroclastic lavas, sedimentary pyroclastics, pyroclastic sedimentary and sub-volcanic rocks. Rhyolite is dominated in lava, with a small amount of dacite and andesite. The four volcanic eruption cycles for the Yingcheng Formation, and the four sub- volcanic eruption cycles in the major gas-bearing Ying-3 member of the Yingcheng Formation have been identified. The volcanic activities are characterized by high frequency with rapid eruptions and short intermittent phases, quick condensation and consolidation, alternating of intensive central explosion and quiet fissure effusion. Five lithofacies of the explosive, effusive, extrusive, volcanic conduit and volcanic- sedimentary facies, and six sub-facies of splash fall lava, pyroclastic, lava flow, volcanic gravity flow, volcanic neck and sub-volcanic can be recognized. Major controlling parameter for the volcanic reservoir quality is the rock types and lithoficies and their spatial distributions. Reservoir property is also impacted by characteristics of volcanic activity, paleomorphology, diagenesis, tectonic evolution and structural processes. Wells with high gas flow production are mainly located in areas where the volcanic explosive facies is developed, as well as explosive facies and effusive facies are alternatively occurred. Excellent volcanic reservoir maily occurred in palaeo-highs and in neighbouring transitional areas where the rocks experienced a relatively entense weathering and structural stress and resulted in enhanced reservoir properties.

Geochemical characters and geological settings of abiogenic gases in Songliao Basin, China

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The Songliao Basin is an intracratonic rift basin which has developed various types of faults. Many abiogenic gases according to the criteria proposed by Jenden [1] have been found including high CO_2 content gases (CO_2: 70.14-98.52%, CH_4: 0.88-16.85%, N_2:0.61-5.58%,He:0.018-1.288%, H_2:0.00-0.04%) and alkane gases (CH_4: 69.44-97.92%, CO_2: 0.02-25.25%,He: 0.02-0.24%,H_2:0.00-0.84%,N_2:0.00-8.50%).The characteristics of isotopic ratios of above gases are that carbon isotopic ratios of carbon dioxide ranging from -3.9‰ to -8.4‰ , the distinct carbon isotopic reversal trend among C_1-C_4 alkanes whose carbon isotopic ratios range from -16.7 ‰ to -29.5‰, from -19.2‰ to -33.2‰, from -24.3 ‰ to -34.3‰ and from -30.9‰ to -36.0‰ for the CH_4,C_2H_6,C_3H_8,C_4H_{10} respectively, the heavier carbon isotopic ratio which is heavier than -30‰ for the CH_4 and the high R/Ra values (R/Ra >0.5, where Ra is the atmospheric value of $^3He/^4He$).

Geological settings of Songliao basin are advantages for abiogenic gases formation. The first is high paleo and current temperature which were up to 6.0°C and shallow buried depth for the Moho-discontinuity which is at the depth of ~29-31km giving the better environment for the magma uprising. The second is that different types of faults are well developed in the basin. The regional and detail distributions of abiogenic gases are controlled by the translithospheric faults and crust faults respectively. Also, the existences of shear fracture in middle-lower crust and a layer with low density, low velocity and a thickness of 3-6 km at a depth of ~20km under the Basin may provide migration pathway and chamber of magma from mantle. The third is that multiphasic volcanic eruption and frequent earthquakes in Songliao basin providing good geological environment for the abiogenic gases formation.

[1] Jenden *et al.* (1993b) Abiogenic hydrocarbons & mantle helium in oil & gas fields. In *The Future of Energy Gases*, Vol. **1570** (ed. D. G. Howell) pp. 31-56. U.S. Geological Survey Professional Paper.