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Biogenic Gas Resource and Exploration Directions in China

Zhang Ying[1,2], Li Jian[1,2], Wang Xiaobo[1,2], Li Jin[1,2]

[1]Research institute of petroleum exploration and development-Langfang, Langfang City, Hebei Province, China
[2]The key laboratory of gas reservoir formation and development, CNPC, Langfang City, Hebei Province, China

Based on the biogenic methane producing simulation experiment and combinated pervious experimental research results, the biogenic gas producing potential of different types of organic matter are discussed and the biogenic methane producing models are preliminary established. By analyzing the relationship between biogenic gas source rock and biogenic gas reservoir, it is considered that the high quality biogenic gas source rock is favorable for big gas fields formation and the large area distribution, high organic organic matter abundance and great thickness of low mature-immature source rock is the chief primary condition. The water-soluble phase is an important existing form of organic matter in biogenic gas source rock. It is proposed that large scale biogenic gas accumulation should be focused on big sedimental basins with high quality source rock, the Quteranry in east of Qaidam basin and the upper Ceratuous in Songliao basin are the most important exploration areas.

Biogenic gas are origatied from anaerobic degration of organic matter in geological sediments, the formation of large scale bigenic gas field is closely related to biogenic methane producing ability of different types organic matter. Evalting the biogenic methane producing ability of different type's organic matter correctly and studying the reationship between the source rock and biogenic gas resrvior are of great guding effect for biogenic gas exploration.

1. Results of biogenic methane producing simulation experiment on different types of organic matter

Protein, carbohydrate, lipoid compound, lignin and tannin are the main component of natural organism. Animal, plant and bacteria are different kind of organisms which are rich different componets. In animal ,bacteria and algae, the content of protein are high, the carbohydrate and lipoid compound relative high, no lignin and tannin; In plant the carbohydrate is the highest and relative high ignin and tannin partly(1). Because different original organic matter have different component, the biogenic degradation and methane producing ability are distinggushed.

The results of biogenic mathe procucing simulation experiment form this paper and Chen Anding in 1991(2) are listed in Table 1. The biogenic methane producing ability of algaes is larger than 700 ml/gTOC; the highest can reach 948.2ml/gTOC. The biogenic methane producing ability of aquatic herbal plant and terrestrial herbal plant is from 266.9 to 463.2ml/gTOC. The woody plant has the lowest biogenic methane producing potential, the gas producing rate of mangrove root on behalf of woody plant in Hainan is 178.3ml/gTOC, the sludge on behalf of

woody plant in Qinnan harbor in Hainan provine is only 41.8ml/gTOC. And that the tribution of some algae may partly contribute to sludge and mangrove root can not be removed.

Tab.1 The amount of producing biogenic methane from different original organic matter

sample	Amount of producing biogenic methane (ml/gTOC)	Data sources
Chlorella	948.2	this paper
spiral seaweed	736.1	this paper
algae	706.7	this paper
aquatic herbal plant	463.2	this paper
terrestrial herbal plant	266.9	this paper
Sludgein Dian Lake of Yunnan province	228.1	reference [2]
mangrove root in Hainan island	178.3	reference [2]
Sludge in Qinglan harbor in Wenchang city , Hainan province	41.8	reference [2]

Based on the experiment data, and combining the precess of organic matter evolution in geological sediments and temperature condition needed by methane bacteria, the biogenic methane producing model for different type of original organic matter preliminarily established (Figure 1). The maximum methane producing amount of type Ⅰorganic matter of behalf of algae is about 1000ml/gTOC, The maximum methane producing amount of type Ⅱ organic matter on behalf of aquatic herbal plant is about 500ml/gTOC. The maximum methane producing amount of type $Ⅲ_1$ organic matter on behalf of terrestrial herbal plant is about 300ml/gTOC, and the maximum methane producing amount of type $Ⅲ_2$ organic matter on behalf of higher plant is about 180ml/gTOC. Diffeernet types of organic matters have large difference in methane producing abiity.

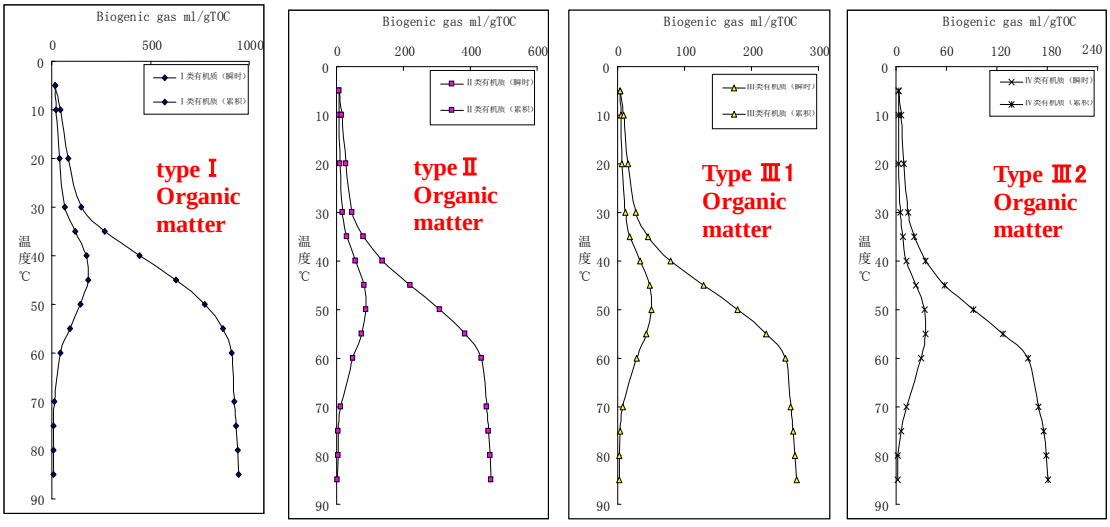

Fig.1 Biogenic methane producing model of different type of organic matter

2 .The relationship between biogenic gas source rock and resevior formation

2.1 The excellent biogeneic gas source rocks are favorable for big gas field formation

The distribution of biogenic gas reservoir accords with the “source control theory”. No matter what in vertical or in horiztonal, biogenic gas reservoir always locates near the source rock. Large area excellent biogenic gas source rock is the material base for large-scale biogenic gas accumulation. The result of biogenic methane simulation experiment show that the gas producing amount of algae and hydrobios are higher than terrestrial plant, the biogenic gas producing amount of algae is five times than that of the higher plant. The source rock which is rich in algae and low grade hydrobios should be paid more attention. The source rocks of biogenic gas in china usually are Lake Facie mudstone which is rich in algae and low grade hydrobios. The components of orgnic matter in lake are complex, the remains of phytoplankton (the common are blue-green algae, chrysophyceae, green alga, diatom, dinoflagellate and Euglena etc.) and animal plankton (anhistozoa, wheel animalcule, crustacean, etc.) are the main component of biogenic organic matter.(2)

2.2 Water solube phase is an important exsiting form for organic matter in biogenic gas source rock

During biogenic gas generation, the molecular weight of organic matter are grandually reduced and water soluble ability enhance. With the biogenic degradation advanced, more and more organic matter are transformed into water soluble phase. For example, most of amino acid and nucleic acid are water soluble, monosaccharide and low sugar in saccharides are water solube. When engaging in biogenic gas resource evaluation, the amount of water soluble organic matter in biogenic gas source rock should be paid more attention and can not be igored.

The organic exsiting form of Quternary lake facie mudstone in Qaidam basin is good example(3).The mudstone sample with burial depth from 100 to 1800m (Figure 2), the content of total organic carbon ranges from0.22 to 1.68%, and the average value is 0.82%, most can reach the low limit of effective source rocks abundance (0.4%), and half can reach the standard of good source rock . In total organic matter abuandce, the insoluble part is 0.23%, and the average of water soluble prat is 0.59% which account for more than 70%. If only evaluating the insoluble organic matter, the reconginition that the organic matter abundance of source rock is low is easily obtained, it is not favorable for exactly evaluating the resource of biogenic gas.

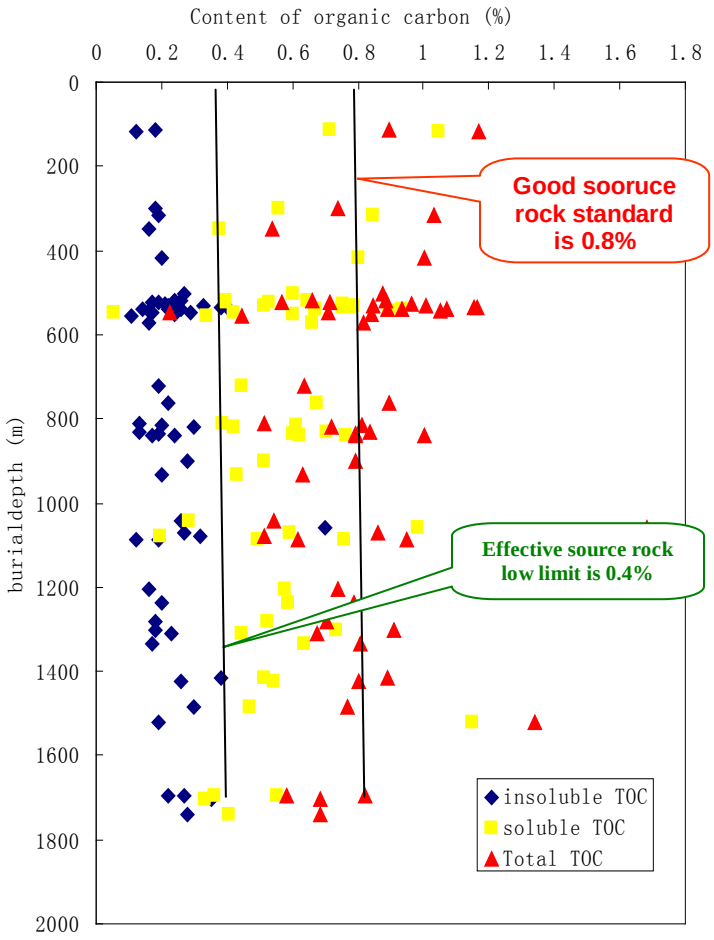

Fig.2 Oraganic matter abundance of Quteranry mudstone in Qaidam basin

3. The discussion on exploration directions of biogenic gas fields in china

The formation of large biogenic gas field need sufficient source supplies, enough reserevior space, good preservation condition, favorable coordination for source-reservior-caprock, etc. Most of the discovered biogenic gas fields and gas showings locate in Mesozonic and Cernozoic sedimental basin. The scale of gas resevior is closely related to the oraganic matter type, quality and area of the source rock. It is proposed that large scale biogenic gas accumulation should be focused on big sedimental basins with high quality source rock. The Quaternary in Qaidam basin and Creteacous in Songliao basin are the most important exploration domains for biogenic gas.

3.1 The Quaternary in eastern Qaidam basin

Controlled by distribution of source rock and tectonic conditions, the deep sag area and northern slope area in Sanhu depression are the most important exploration directions for tectonic gas reservoirs. With the exploration gradually going into deep degree, the lithologic gas reservoirs probably take more and more important position. The seismic identification and hydrocarbon detection technique for tectonic and lithologic traps, and the logging identification technique for low saturation thin gas bearing formation are the key problems to settle for biogenic gas exploration.

3.2 The shallow layer in Songliao basin

The sediment eviromnent, geochemical and geologic condition of the shallow layer in upper createacous of Songliao basin are favorable for the biogenic gas generation and resevior formation. The biogenic gas mudstone source rock are developed in second, third, forth section of Nenjiang formation and Mingshui formation, the fluvial facies sandstone of third section in Nenjiang formation –Mingshui formation can be as good reservoir. At present, some biogenic gas fields such as Aonan, Honggang are discovered. It has great potential to form large scale biogenic gas reservoir. Enhancing seismic and logging identification on shallow gas reservoir are effective technical methods for shallow gas exploration. And also, identificating and developing the shallow gas reservoirs are of great significances for safety producing deep oil and gas in oil fields.

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