TAN Fengqi, JU Yiwen and XU Houwei, 2015. Present Situation and Technical Developing Tendency of Shale Gas Development in China . *Acta Geologica Sinica* (English Edition), 89(supp.): 409-411.

Present Situation and Technical Developing Tendency of Shale Gas Development in China

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1 Introduction

American shale gas production in 2005 year is 194×10^8 m^3 and it rapidly growth to $2600\times10^8m^3$ in 2014 year, the successful development of shale gas change American energy supply pattern and make important influence to global energy supply and geopolitics (Daniel et al., 2007). At present China is a country with rich coal, lack oil and less gas, the main energy structure is what coal resource is percent 70, plus petroleum resource is percent 20 and natural gas resource is percent 5, the energy structure is not very reasonable. So natural gas development, especially the effective development of unconventional natural gas will can optimize China's energy structure. Preliminary evaluation shows that the amount of China's shale gas resource is about $100^{12}m^3$ and is much higher than amount of conventional natural gas resource (Zhang et al., 2008; Jia et al., 2012). So far in 2013 year, the production of coal gas and shale gas respectively exceed 30^8m^3 and 10^8m^3. Expected to 2025 year, the production of natural gas and petroleum can respectively share half of energy consumption, in which the shale gas production can highly improve. In the industry, the exploration and development of unconventional natural gas continue to make a breakthrough in 2014, the new capacity of shale gas is 20^8m^3 in Fuling area and the predictive annual production achieve 10^8m^3 for Sinopec company. In addition, shale gas production in Changning-weiyuan area and Fushun-yongchuan area also make a breakthrough for PetroChina Corp.

2 Problems in Shale Gas Development

Although China's shale gas industry obtain success in stage, we must wake up to some objective problems in development process (Kent et al., 2007; Zou et al., 2010; An et al., 2010; Kang et al., 2012; Ju et al., 2014), main problems are show as following points: ① The amount and distribution of shale gas resource are not clear, oil and gas content of mud and shale in different basins has not been a common standard and the difference is various, so we must take a deep step to determine resource situation. ② The lithofacies of continental mud and shale change faster and formation burial is deep, the reservoir characteristics such as multiple pore types and strong heterogeneity lead to complex oil and water relationship, besides the occurrence state of shale gas is not also clear. ③ Because geological tectonic is much too complex for shale gas basins in China, a lot of mud and shale formations are all reformed by multiple tectonic movement and more kinds of geological movement include to fault, magma and fold etc are strong, above geological characteristics add difficulty for shale gas exploration and development (Table. 1). ④ Study on occurrence mechanism, seepage theory and accumulation law for shale gas reservoir must continue to improve deeply. ⑤ The technology of shale gas exploration and development need to make breakthrough, especially the geophysical prospecting technique, drill-horizontal well-fracturing technique and solid fracturing of well company system have been more difference than foreign progressive company. ⑥ The governmental supporting systems which include to environmental projection-mange-policy need to improve and strengthen as soon as possible. With deep researching of above problems, geologists generally recognize that complex geological tectonic in China is an important influence factors of shale gas occurrence and accumulation, multiple times' tectonic deformation and erosion & uplift of mud and shale formation become necessary condition whether shale gas can successfully preserve. For example, the tectonic deformation effect can change micro-nano pore structure type and specific surface area of clay particles, and take

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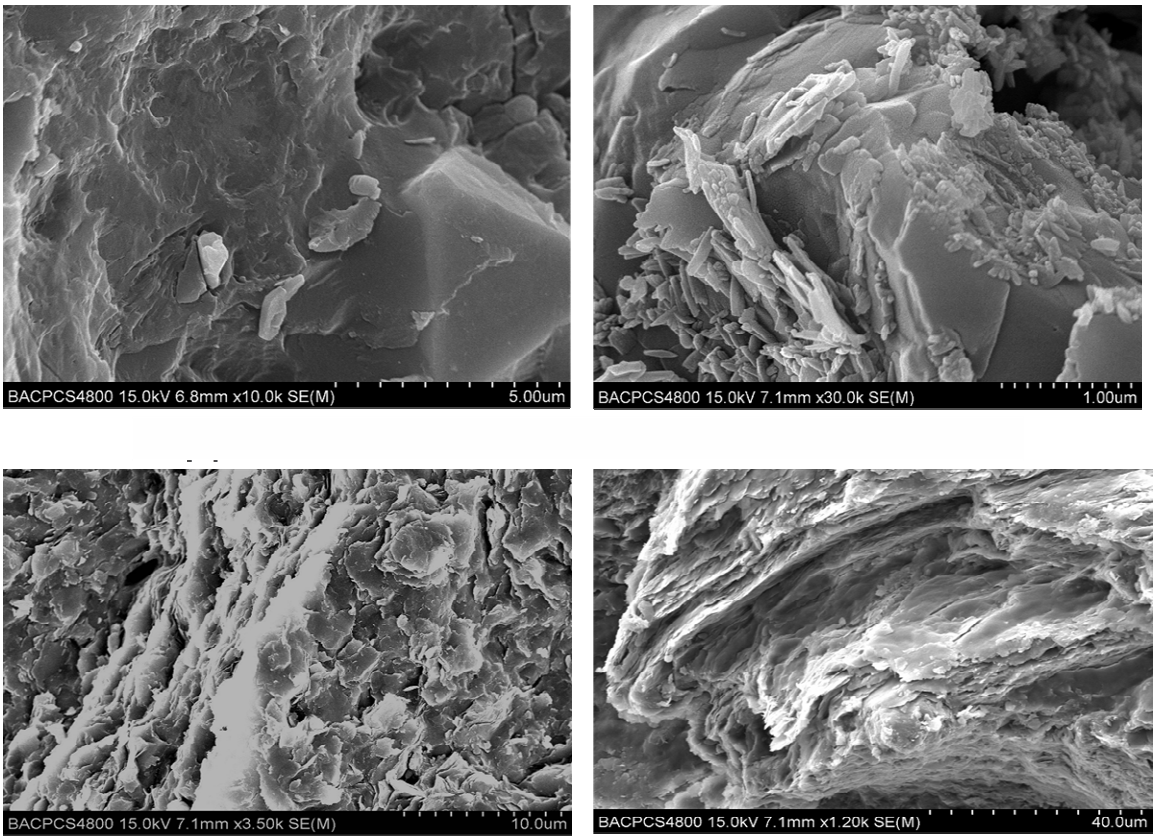

Fig.1 Scanning electron microscope of shale tectonic deformation
(a), Shale weak deformation; (b), Shale brittle deformation; (c), Shale brittle-ductile deformation; (d), Shale ductile deformation.

influence in occurrence situation and accumulation amount of shale gas (Fig. 1). On the other hand, the erosion and uplift of shale formation can produce more micro fractures and regional cracks, for one thing these kinds of fractures give more pore space for free gas accumulation, on the other hand these facture system also give good migration way for shale gas lose. Based on above analysis, the tectonic deformation effect has two side of role for shale gas rich accumulation and high production, so we must pay more attention to this problem, and also need to deep research to solve important theoretical problems of basic geology.

3 Technical Developing Tendency

The geological condition in China's shale gas is very complex, most sedimentary basins were reformed by different period, different direction and different characteristic's tectonic movement and finally have been formed different type of tectonic deformation area. In addition, the palaogeographic environment of shale clastics deposition is also complex, the reform intensity in later stage is more stronger. Above geological characteristics cause that China's shale gas development technology features is what the replication ability and referential nature are poor. Therefore, if China's shale gas wants to realize large-scale industrial development, we must take following overall idea which is exploration and development, geology advance, development verification to full implementation. Firstly, the geological situation must be researched clearly, take the demonstration projects to drive development of advanced technology and take the technological progress to improve demonstration projects implementation. Above research results can guide development program's optimization and finally to realize double harvest of technology and production. For complex geological difficult, the developing trend of shale gas exploration and development technologies mainly show following points (Ambrose et al., 2010; Curtis et al., 2012; Gale et al., 2007; Ross et al., 2009): (1) Evaluation technology of cross-scale characterization and combination relationship for shale geological characteristics. (2) Geological and mechanical characteristics of nonlinear combination for multiple reservoirs and its forecast technology. (3) Fine characterization of water dynamic field and its analysis technology of influence mechanism for shale gas development. (4) Multiple scale flow mechanism of shale formation and evaluation technology of interference. (5) Random control mechanism and forecast technology of

Table 1 The accumulation features and differences of marine, paralic and lake facies' shale gas

Facies	Marine shale	Paralic shale	Nonmarine shale
development scale and distribution range	relative large	relative small	relative small
rock componet	dolomite、quartz sandstone、blcak shale	mudstone、silty shale、coal bed	mudstone、silty shale、coal bed
controlling factors	sea level、terrigenous supply	sea level、terrigenous supply、structure、climate	terrigenous supply、structure、climate
comparability	good	relative bad	bad
distribution in China	Yangtze region and Tarim basin etc from The lower Paleozoic to low Three Triassic formations	North China and northewst region from Late Paleozoic to Cenozoic formations	North China and northewst region from Mesozoic erathem to Cenozoic formations
thickness	large monolayer thickness	single monolayer thickness、significant mutual layer	single monolayer thickness、significant mutual layer
age	Paleozoic erathem-Mesozoic erathem	Late Mesozoic erathem-Early Cenozoic	Mesozoic erathem-Cenozoic
sedimentary facies	deep sea facies	deep lake facies and swamp facies	deep lake facies
depositional environment	especial position	relative deep water	relative deep water
kerogen types	Type Ⅰ、Ⅱ	Type Ⅱ、Ⅲ	Type Ⅲ
degree of thermal evolution	over maturity	low-high maturity	low-high maturity
gas types	Pyrolysis gas、Secondary bacterial gas	Bacterial methane gas、Pyrolysis methane gas	Bacterial methane gas、Pyrolysis methane gas

artificial fractures under multiple field coupling effect. (6) Quantitative description of reservoir pore and fracture system and its numerical simulation technology. (7) Basic geological theory and key technology of three kinds of natural gas's common development which are shale gas, coal gas and tight gas.

Acknowledge

This research was supported by Young Teacher's Research Starting Foundation of University of Chinese Academy of Sciences and National Natural Science Foundation of China (No. 41372213).

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