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下扬子皖东南地区二叠系页岩储层特性及甲烷吸附能力

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Characterization of Pores and Methane Sorption Capacity of Permian Shales in Southeast Anhui, Lower Yangtze Region

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摘要/Abstract

摘要 :

为深入研究皖东南地区二叠系页岩储层微观特征及其储气能力,选取2口钻井岩心样品进行负离子抛光—场发射扫描电子显微镜、氮吸附/脱附实验、甲烷吸附能力测定以及相关地球化学分析。结果表明,二叠系富Ⅱ—Ⅲ型有机质泥页岩石英等脆性矿物含量较高,存在晶间孔、粒间孔以及粒内孔、次生溶孔、有机质孔及微裂缝、构造缝等多种储集空间类型。采用He气法所测孔隙度为2.15%~6.10%、渗透率平均值为 $0.00257 \times 10^{-3} \mu\text{m}^2$ 。该页岩以中孔为主,含少量大孔和微孔,大多数的孔径分布在2~50nm之间。BJH孔容为 $3.30 \sim 11.23 \text{mm}^3/\text{g}$,其中,中孔和大孔孔容约占总孔容的80%;BET比表面积介于 $3.91 \sim 20.84 \text{m}^2/\text{g}$ 之间。T-图法计算微孔比表面积介于 $1.015 \sim 4.053 \text{m}^2/\text{g}$ 之间,中孔和微孔是页岩比表面积的主要贡献者。大量纳米级孔隙的发育及具有较大的比表面积,为页岩储层提供了良好的吸附聚气能力,实验模拟地层温压测定页岩甲烷最大吸附量达 $2.3 \sim 3.2 \text{m}^3/\text{t}$ 。说明研究区二叠系页岩具有良好的储集性能及甲烷吸附能力。

关键词: 皖东南, 二叠系页岩, 页岩储层特征, 孔隙结构, 氮吸附/脱附, 甲烷吸附能力

Abstract:

To investigate pore characteristics and methane sorption capacity of Permian shale reservoir in Southeast Anhui, Lower Yangtze region, eight core samples were selected for test including Ar-ion milling-field emission scanning electron microscope, N₂ adsorption-desorption and methane sorption experiments and related geochemical analysis. The results show that the shales contain multi-types of pores including inter-granular pore, intra-granular pore, intra-crystalline pore, dissolved pore, organic pore and micro-cracks. The total porosity of our samples ranges from 2.15% to 6.10% and average permeability is $0.00257 \times 10^{-3} \mu\text{m}^2$. The nanoscale pores mainly consist of meso-pores and small parts of micro- and macro-pores. The pore diameters mostly range from 2 to 50nm. The pore volume counted by BJH equation ranges from $3.30 \sim 11.23 \text{mm}^3/\text{g}$ and the total surface area calculated by BET equation ranges from $3.91 \sim 20.84 \text{m}^2/\text{g}$. The micropore surface calculated by T-method ranges from $1.015 \sim 4.053 \text{m}^2/\text{g}$. Meso- and micro-pores mainly contribute to the surface areas. These nanopores and large surface area in the Permian organic-rich shales could provide good conditions for shale gas storage. The methane adsorption capacity is up to $2.3 \sim 3.2 \text{m}^3/\text{t}$ at 27MPa. This indicates that the Permian shales have relatively favorable storage condition for shale gas.

Key words: Southeast Anhui, Permian shale, Total porosity, Pore structure, N₂, adsorption-desorption, Methane adsorption capacity

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