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川西中侏罗统致密砂岩次生孔隙成因分析

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摘要：

基于岩石学观察,运用铸体薄片鉴定、扫描电镜分析、矿物烃类包裹体成分分析,结合储层特征,研究了川西中侏罗统致密砂岩次生孔隙的形成机制。结果表明,川西中侏罗统为典型的无生烃能力的红色碎屑岩地层,上沙溪庙组砂岩气藏气源主要来自纵向上距该气藏约1000~3000m的下伏上三叠统须家河组含煤层系,储层平均孔隙度9.6%,平均渗透率0.177×10^{-3}μm^2,为远源致密砂岩气藏。次生溶蚀孔隙对储层总面孔率的贡献达60%,其对砂岩面孔率的贡献大于原生孔隙。砂岩中沥青的分布及高岭石的分布、地层水的证据以及次生矿物烃类包体成分等表明,次生孔隙主要由有机酸对长石溶蚀形成,有机酸主要有3种来源,一是下伏须家河组烃源层生烃过程中排出的有机酸沿断裂和裂缝向上运移进入上沙溪庙组,二是从须家河组运移上来的烃类与上沙溪庙组储层中的氧化剂反应生成的有机酸,三是上沙溪庙组泥岩脱水形成的有机酸。其中以前两种有机酸形成的溶蚀孔隙最为重要,而第三种来源的有机酸由于其形成的孔隙少且保存下来的很少,对储层的意义不大。区域流体势、断裂和裂缝的发育都为下伏上三叠统须家河组有机酸进入上沙溪庙组储层提供了有利条件。控制次生孔隙形成和分布的主要地质因素是砂岩中受物源控制的易溶组分含量、沉积相、储层所处的古构造位置以及断裂、裂缝的发育情况。

英文摘要：

The Middle Jurassic in western Sichuan is typically a red clastic bed without hydrocarbon generation capacity. Composed by four sandstones of Js_2^1, Js_2^2, Js_2^3 and Js_2^4 from top to bottom, the reservoir of the Upper Shaximiao Formation in Xingchang gas field is tight sandstone reservoir with average porosity of 9.6% and average permeability of 0.177×10^{-3}μm^2. The source rock of the gas pool is 1000~3000m underlain Xujiahe Formation, which makes the Upper Shaximiao Formation a distal gas pool. Secondary porosity that was created dominantly by the dissolution of feldspar grains was markedly developed in the reservoir sandstone and has greatly enhanced the tight sandstone reservoir property. Secondary porosity made much higher contribution to reservoir than primary porosity. It accounts for proximately 60% of thin-section point counted porosity. Several lines of evidence from bitumen occurrence and dissolved minerals of the sandstone, the distribution of kaolinite, the composition of formation water, and component of hydrocarbon inclusions in authigenic minerals suggest that the second porosity of the Upper Shaximiao Formation tight sandstone was created by the dissolution of organic acid from three sources. The first source of organic acid is from the underlain Xujiahe Formation consists of very thick organic-rich coal beds with III-type kerogen that expelled organic acid during hydrocarbon generation which was transported upwards through faults and fractures. The second source is a result of reaction of oxidant in the reservoir sandstone with hydrocarbon transported from deep beds, and the less important third source comes from dehydration process of the mudrock of the Shaximiao Formation. The first two sources of organic acid are responsible for most of the secondary porosity formation, while those created by organic acid from the third source are trivial due to their very small amount and failure in preservation. Regional water potential difference in the fifth member of the Xujiahe Formation during Jurassic and faults and fractures provide the conditions needed for organic acid transportation from the underlain Xujiahe Formation up into the Shaximiao Formation. The content of soluble components of the sandstone, paleotectonic location of the reservoir, and the degree of fault and fracture development and their distribution are major controlling factors for the forming and distribution of dissolved porosities.

关键词：川西 上沙溪庙组 致密砂岩储层 次生孔隙 有机酸

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