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四川盆地东部石炭系古岩溶储层成岩流体: 来自流体包裹体、微量元素和C、O、Sr同位素的证据

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摘要:

相当Moscovian阶的石炭系黄龙组古岩溶储层是川东地区最重要的天然气储层类型之一。通过对石炭系古岩溶储层岩石结构、成岩演化序列以及铁锰锶微量元素、碳氧锶稳定同位素和流体包裹体综合研究, 可将川东石炭系古岩溶型碳酸盐岩划分为古风化壳岩溶岩和埋藏岩溶岩两种成因类型, 成岩流体可划分为三种类型: ①古表生期大气水渗流-潜流成岩环境下的强氧化性低温大气水, 流体具有富Fe和Mn、极低Sr含量、 $\delta^{13}\text{C}$ 和 $\delta^{18}\text{O}$ 值弱负偏以及极高 $^{87}\text{Sr}/^{86}\text{Sr}$ 比值的性质; ②中-深埋藏成岩环境下的强还原性深部混合热流体, 属富Mn和Fe、贫Sr、 $\delta^{18}\text{O}$ 值明显负偏性质的中-低温、含 $\text{MgCl}_2\text{-H}_2\text{O}$ 、 $\text{NaCl-MgCl}_2\text{-H}_2\text{O}$ 体系流体; ③深埋藏成岩环境下的酸性压释水, 属富Mn和Fe、 $\delta^{13}\text{C}$ 值明显负偏性质的中-高温、含 $\text{Na}_2\text{SO}_4\text{-H}_2\text{O}$ 、 $\text{Na}_2\text{CO}_3\text{-H}_2\text{O}$ 、 $\text{NaHCO}_3\text{-H}_2\text{O}$ 体系流体。各成岩流体对古岩溶储层发育具有重要的控制和影响作用, 其中经强氧化性低温大气水的淋滤溶蚀形成孔、洞、缝非常发育的古风化壳型岩溶储层叠加后期的酸性压释水的溶蚀再改造, 可大大改善储层的孔渗性, 并在喜山期构造破裂作用下, 最终形成川东石炭系规模性裂缝-孔隙型古岩溶储层。

英文摘要:

The Paleokarst reservoirs of the Carboniferous Huanglong Formation (equivalent to Moscovian) is one of the most significant natural gas reservoirs in eastern Sichuan Basin, China. Based on the comprehensive study of the rock fabric of paleokarst reservoirs, the diagenetic sequence, the trace element (e.g. Fe, Mn and Sr), and the stable isotopes (e.g. C, O and Sr), as well as fluid inclusion, paleokarst carbonatites in Carboniferous from eastern Sichuan Basin could be divided into two types: the ancient weathered crust karst rock and the buried karst rock. At the same time, three types of diagenetic fluid are identified: ①Cool meteoric water with strong oxidizing properties that lives in the vadose to phreatic diagenetic environment of ancient supergene stage, of which owns high Fe and Mn, very low Sr, slightly negative  $\delta^{13}\text{C}$  &  $\delta^{18}\text{O}$  and strongly high  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio; ②Deep mixed thermal fluid with strong reducing properties that lives in the middle-deep buried environment, of which owns high Fe and Mn, poor Sr, obvious negative  $\delta^{18}\text{O}$  (reflect middle-low temperatures), and of  $\text{MgCl}_2\text{-H}_2\text{O}$ ,  $\text{NaCl-MgCl}_2\text{-H}_2\text{O}$  system; ③Compaction released water with acidic properties that lives in the deep buried environment, of which owns high Fe and Mn, obvious negative  $\delta^{13}\text{C}$  (reflect middle-low temperatures), and of  $\text{Na}_2\text{SO}_4\text{-H}_2\text{O}$ ,  $\text{Na}_2\text{CO}_3\text{-H}_2\text{O}$ ,  $\text{NaHCO}_3\text{-H}_2\text{O}$  system. All diagenetic fluids played important roles in controlling and influencing the paleokarst reservoirs development, of which the ancient weathered crust karst reservoir would develop a large amount of holes, pores and seams after cool meteoric water with strong oxidizing properties leaching. And it would get a secondary modification and a better pore ratio and permeability after acidic compaction released water's corrosion. At last, eastern Sichuan Basin formed a scale of ancient crack-hole karst reservoir in Carboniferous system, under the impact of Himalayan tectonic fracture.

关键词: [古岩溶储层](#) [地球化学](#) [成岩流体](#) [黄龙组](#) [石炭系](#) [四川盆地](#)

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