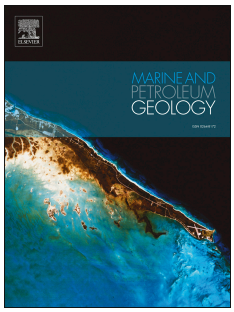
Accepted Manuscript



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PII: S0264-8172(17)30430-0

DOI: 10.1016/j.marpetgeo.2017.10.029

Reference: JMPG 3122

To appear in: *Marine and Petroleum Geology*

Received Date: 5 June 2017

Revised Date: 27 October 2017

Accepted Date: 30 October 2017

Please cite this article as: Jiang, L., Worden, R.H., Cai, C., Shen, A., He, X., Pan, L., Contrasting diagenetic evolution patterns of platform margin limestones and dolostones in the Lower Triassic Feixianguan Formation, Sichuan Basin, China, *Marine and Petroleum Geology* (2017), doi: 10.1016/j.marpetgeo.2017.10.029.

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ABSTRACT

Deeply-buried carbonate-reservoirs from the Lower Triassic Feixianguan Formation in the Sichuan Basin of China host extensive natural gas resources. These reservoirs are predominantly found in oolitic shoals, with the reservoir quality of dolomitized zones being higher than that of undolomitized limestone counterparts. Here we present a combination of petrographic, isotopic, fluid inclusion, and quantitative porosity data in order to understand and predict the diagenetic processes that have impacted the reservoir quality of dolostones and limestones. The porosity of limestones has been reduced to ~7.5% due to calcite cementation, whereas the porosity in oolitic dolostones is not cemented with calcite and typically has ~23.5% porosity. Dolomitization and concurrent early-diagenetic gypsum growth played crucial roles on the development and preservation of high porosity in the oolitic dolostone, first by stabilizing the rock fabric to inhibit loss of porosity during burial, and secondly through the generation of new porosity by dissolution of carbonate and anhydrite. A negative shift of $\delta^{18}O$ and salinity values (<3.5 wt. %) measured from fluid inclusions in diagenetic calcite cement in limestones suggest that diagenesis associated with meteoric water played a key role in destroying limestone reservoir quality. Early oil charge seems to have had a positive effect on carbonate reservoir quality in the dolostones, since oil emplacement inhibited calcite cementation. Subsequently, thermochemical sulfate reduction (TSR) occurred, predominantly in the dolostones, as shown by TSR calcite cement with highly negative $\delta^{13}C$ values (~ -20 ‰ VPDB) and $\delta^{18}O$ (~ -10 ‰ VPDB) together with elevated calcite precipitation temperatures (> 110°C). It is likely that TSR was responsible for the formation of enlarged dissolution vugs that increased porosity by ~2% in dolostones due to: i) anhydrite dissolution, ii) production of significant amounts of water resulting in formation water undersaturated with respect to calcite and dolomite, iii) generation of H_2S,