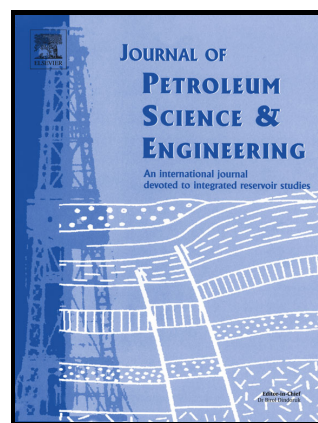


## Author's Accepted Manuscript

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PII: S0920-4105(15)30150-9  
DOI: <http://dx.doi.org/10.1016/j.petrol.2015.10.024>  
Reference: PETROL3217

To appear in: *Journal of Petroleum Science and Engineering*

Received date: 20 May 2015  
Revised date: 13 August 2015  
Accepted date: 16 October 2015

Cite this article as: Jianying Yuan, Chenggang Huang, Fan Zhao and Xing Pan, Carbon and oxygen isotopic compositions, and palaeoenvironmental significance of saline lacustrine dolomite from the Qaidam Basin, Western China, *Journal of Petroleum Science and Engineering*, <http://dx.doi.org/10.1016/j.petrol.2015.10.024>

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# Carbon and oxygen isotopic compositions, and palaeoenvironmental significance of saline lacustrine dolomite from the Qaidam Basin, Western China

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## ARTICLE INFO

Article history:

Received

Accepted

Available online

**Keywords:** lacustrine dolomite; penecontemporaneous; intergranular pore; carbon and oxygen isotopes; Qaidam Basin

## ABSTRACT

Recently, significant progress has been made in tight reservoir exploration of petroleum in the western Eocene Qaidam Basin in Western China. Among these rocks, there are high-quality dolomite reservoirs, of which we studied the petrological, mineralogical, and geochemical characteristics. These analyzes revealed that the dolomite structures are mainly micritic, with a widely developed intercrystal pore. The pore radius measured less than 1  $\mu\text{m}$  and the micritic dolomite  $\delta^{13}\text{C}_{\text{PDB}}$  values ranged from -4.5 ‰ to 0.2 ‰, with an average value of -2.4‰. These values are negatively  $\delta^{13}\text{C}$  biased when compared to other lacustrine carbonate rock in China, indicating that the braided delta supplies light carbon-rich surface water. Over time, the dolomite carbon isotopic composition changed due to dissolved carbon from organic matter, which produced  $\text{CO}_2$  via oxidation disintegration. In the case of light carbon, the rich organic matter resulted in a lighter isotopic composition of the dissolved carbon and modified the lacustrine deposit dolomite carbon isotopic composition indirectly. In addition, the micritic dolomite  $\delta^{18}\text{O}_{\text{PDB}}$  values ranged from -6.1‰ to 0.4‰, with an average value of -2.6‰. This value is positively  $\delta^{18}\text{O}$  biased compared to other lacustrine carbonate rock in China and was affected by the saline lacustrine environment. The oxygen and carbon isotope correlation, salinity, and temperature data reflect that the dolomite micritic formed in both a semi-open and semi-closed saline environment on a penecontemporaneous stage via calcite metasomatism in the sediment interface under a low-temperature. This type of penecontemporaneous metasomatism dolomite is widely distributed throughout the study area, and the intergranular pores possess a strong anti-compaction ability. This critical discovery of the plane distribution of the tight dolomite in the Qaidam Basin has provided multiple novel avenues of study within the field.

## 1. Introduction

Carbonate oil and gas reservoirs are characterized by large-scale reserves and high productivity. For example, the North Field dolomite gas field in the Arabian Basin has recoverable reserves of up to 22.01 billion tons of oil equivalent (Xie et al., 2009). Under certain geological conditions, lacustrine carbonate rocks are not only important source rocks, but also crucial reservoir rocks. Examples include the lacustrine carbonate reservoirs in the Rift Basin in the Congo (Africa), the Campos Basin in Brazil (South America), and the Utah Basin in the U.S. (North America) (Cohen and Thouin, 1987; Benson, 1993; Bustillo et al., 2002; Tueher and Wright, 1990). The development of lacustrine carbonate deposition in China primarily occurred during the Permian, Cretaceous, and Paleogene periods (Jia et al., 2012). The Permian lacustrine carbonate rocks are predominantly distributed in the Junggar and Santanghu Basins, with the dominant rocks in the saline lacustrine basins consisting of sedimentary dolostone and dolomitized rocks (Kuang et al., 2012). The Jurassic lacustrine carbonate rocks are largely distributed in the Sichuan and Ordos Basins and are comprised of shell limestone in the Da'anzhai Member of the Lower Jurassic Ziliujing Formation (Ding et al., 2013). The Cretaceous lacustrine carbonate rocks are chiefly distributed throughout the Songliao and Jiuxi Basins and are composed of biolithite limestone in the Cretaceous Qingshankou and Quantou Formations within the Songliao Basin (Han et al., 2012), as well as dolomite in the Cretaceous lacustrine hydrothermal sedimentation of the Qingxi Depression in the Jiuquan Basin (Wen et al., 2014). The development of Paleogene lacustrine carbonate rocks reached its peak in the Third Member of the Paleogene Shahejie Formation of the Huanghua Depression (Pu et al., 2011), the biolithite limestone in the Funing Formation of the Subei Basin (Wang et al., 2013), and the Eocene carbonate rocks in Western Qaidam Basin (Tang et al., 2013). Overall, there is a widespread development in the above regions and basins. Moreover, development was also discovered in the Hengyang, Sanshui, and Baise Basins in the south of China. By the end of 2012, there was a total of 63 lacustrine carbonate oil and gas fields discovered in the Sichuan, Bohai Bay, and Qaidam Basins (in addition to others), with geological petroleum grossing  $5.97 \times 10^8$  t.

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