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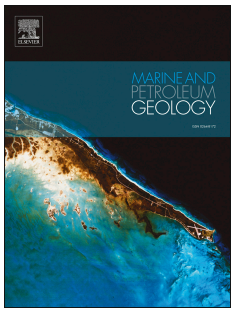

Different formation mechanism of quartz in siliceous and argillaceous shales: A case study of Longmaxi Formation in South China

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Different formation mechanism of quartz in siliceous and argillaceous shales: a case study of Longmaxi Formation in South China

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Abstract: Brittle mineral, especially quartz, exert significant effect on the development of shale gas, however, the formation mechanism of quartz in shale is still unclear. Here, we present X-ray diffraction data, scanning electron microscopy (SEM) determination, cathodoluminescence and geochemical data to investigate Longmaxi Formation, which is a key target for shale gas exploration and development in China recently. Siliceous and argillaceous mudstones were recognized from 5 outcrops of Longmaxi Formation, which were examined with respect to the formation mechamism of quartz. Three different types of quartz (silt-size detrital grain with bright luminescence, micro-sized grains and quartz overgrowths with bright luminescence) were identified by SEM/EDS/CL both in the argillaceous and siliceous shale. Siliceous shale deposited by suspension sediment settling with high sea level because of anoxia condition indicated by lower Th/U and higher V/Cr ratios. The quartz in siliceous shale display a positive covariation with Ba_{bio}, as well as a good correlation between TOC and quartz, suggesting biogenic-quartz is an important constituents. Argillaceous shale was likely dominated by suspension alternate with gravity current in consideration of the mixing of clay- and silt- laminae, there is no correlation between quartz and TOC, and positive correlation between excess silica and Zr, indicating terrestrial quartz in argillaceous is more important relative to siliceous shale. Additionally, reorientation of phyllosilicate particles and positive correlation between KI and quartz contents (R^2=0.57) suggest the indispensable diagenetic-quartz (illitization of smectite), near or far from the clay minerals, both in siliceous and argillaceous shales. This process also result in high quartz saturation in silt-rich laminae, thus that quartz overgrowths encased in dolomite cements is common in argillaceous shale. Based on the geochemical analysis, the argillaceous shale contains 86% detrital-silica, 14% digenetic-silica. However, the siliceous shale approximately contains 33% detrital-silica, 11% digenetic-silica and 56% biogenic-silica. Occurrence and origin of quartz are of great significance for physical properties of shale and hydraulic fracturing during the development of shale gas.

Key words: Quartz; Siliceous shale; Argillaceous shale; Longmaxi Formation

1 Introduction

Mudstone and shale are generally consist of grains<63μm in diameter, loosely comprising a mixture of lath-shaped clay minerals and more equidimensional grains such as quartz and feldspar (Andrew C. A et al., 2006). Shale gas, as well as the deposition and diagenesis, has attracted an increasing interest to the sedimentary geologists and petroleum over the past decades. For example, the Upper Ordovician-Lower Silurian succession in south China contains thick, organic rich (up to 10% total organic carbon) black shales and mudstone, which comprise the major source rocks for