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Characteristics of Biogenic Silica and Its Effect on Reservoir in Wufeng-Longmaxi Shales, Sichuan Basin

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Further researches of shale petrology indicate that clay minerals are not the dominant mineral in most shale reservoirs. Depending on the reservoir, shales are typically dominated by quartz, calcite, or mixtures of these minerals and the quartz content is usually more than 30%. Besides the detrital quartz, biogenic silica is also an important part of shale reservoir. In order to analyze the genesis of quartz in gas shale and its effect on the reservoir quality, shales from Wufeng Fm.-Longmaxi Fm. in Sichuan Basin were studied. Based on X-diffraction analysis (XRD), scanning electron microscope (SEM) combined with cathodeluminescence (CL), energy spectrum analysis (EDS) and major elements test, detrital quartz and biogenic silica were identified. Biogenic silica occurs as irregular shape with relatively large aggregates of crypto- or microcrystalline and macrocrystalline and monochromatic CL of these silica with less intensity, typically displays CL-peak close to wavelengths of about 620nm and some of them displays another CL-peak centered close to 370 nm，which is interpreted as being remnants of the CL-properties of opal-A/opal-CT inheritance from the biogenic precursor material. Biogenic silica is interpreted to have been re-crystallized locally during progressive burial from a biogenic precursor most likely of pelagic organisms like radiolarians and sponge spicules. There are numerous residual siliceous fossils such as radiolarian, sponge spicule in thin sections which can provide abundant materials foundation for biogenic silica in Wufeng Fm.-Longmaxi Fm.

The major elements analysis shows that shale rich in biogenic silica characterizes with high Si/Al ratio and high content of SiO_2, P_2O_5, Fe_2O_3 and with low Al_2O_3, TiO_2, FeO, MgO. The ratio of Al/(Fe+Al+Mn) is 0.58–0.76 and the Si/(Si+Al+Fe) has a high value which is over 0.75. Biogenic silica mainly distributes at Wufeng Fm. and the lower part of Longmaxi Fm. The results of XRD represent that quartz content decreases from bottom to top and the amount of siliceous fossils also decreases in the thin sections, indicating that from bottom to up the biogenetic quartzes decrease and detrital quartzes increase. Al is considered to be the principal conservative proxy for clay mineral flux in fine-grained clastic deposits, whereas Si is mainly present in both siliciclastic and biogenic fractions. When Si normalized to Al can provide useful information about changes in fluxes derived from detrital non-aluminosilicate sources. In the A well, Al displays a general stepwise increase upward and Si/Al ratio decrease upward, indicating that terrigeous clasts increase and the biogenic silica decrease. Geochemistry results show that TOC of Wufeng-Longmaxi shales in Well A is 0.3%–4.23% with 2.28% in average and the TOC has a positive correlation with quartz content. Siliceous plankton is the main provider for ocean primary productivity whose content is closely related to the biology prosperous degree in surface waters. It can not only reflect the change of productivity in the past but also can improve the content of organic matter in the shale. Shales rich in biogenic silica indicate high ancient oceanic productivity and luxuriant parent material of hydrocarbons, which were beneficial to the enrichment of organic matter and reservoir fracturing.

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