Quartz types, origins in the Lower Cambrian Niutitang Formation, Middle Yangtze platform, China: insights into the role of quartz cementation on porosity development in shales

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Summary

Quartz in shales is critical to shale reservoir properties, including porosity, pore structure and geomechanical properties. Due to the small size of constituting components, our understanding on quartz types and origins in shales is still unclear. Recently, the application of high resolution scanning electron microscope (SEM) combined with cathodoluminescene (CL) technique has enabled major advances in our understanding of quartz cementation in shales. A suite of the Lower Cambrian Niutitiang shale samples were selected to study quartz types, origins and the effect of quartz cementation on porosity development by integrating geochemical analysis, nitrogen adsorption, SEM and SEM-CL imaging analysis.

Theory / Method / Workflow

Seventy-five shale samples were selected from the Niutitang Formation, and these samples were subjected to TOC content, XRD mineralogy, Major and trace elements, nitrogen adsorption, thin section image, SEM, EDS, and SEM-CL images analysis.

Results, Observations, Conclusions

The results show that quartz primarily exists as five forms: silt-size/sand-size detrital quartz, siliceous skeletons, overgrowth nucleated around detrital quartz, matrix-dispersed microcrystalline quartz, and aggregates of euhedral quartz. Detrital quartz is characterized by angular shape, and bright luminescene. Quartz overgrowth can be easily identified by the characteristic non to low luminescene, indicative of authigenic origin. Matrix-dispersed microcrystalline quartz is typically less than 5 microns, and co-existed with clay minerals. Quartz aggregates are primarily composed of equate-sized euhedral quartz. The ternary diagram of Fe-Al-Mn, the cross-plot of SiO_2 versus Zr, and thin section observations suggest that dissolution

and re-precipitation of siliceous skeletons provides the major silica source for authigenic quartz (defined as quartz formed during diagenetic processes) in the Niutitang Formation. The distribution of secondary organic matter, primarily including residual bitumen and pyrobitumen, is always associated with aggregates of euhedral quartz, because the micrometer-scale and well-connected interparticle pore spaces between euhedral quartz crystals provide important storage sites for secondary organic matter, and abundant organic matter-hosted pores (organic pores) are generated during the thermal cracking of residual oil and bitumen to gas.

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