Laser ablation in situ U-Pb dating in constraining the diagenetic history and porosity evolution of ancient marine carbonate reservoirs

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Understanding diagenetic controls on porosity evolution is critical for carbonate reservoir evaluation, while the dating of carbonate diagenetic mineral may provide vital constriants. This presentation demonstrates a method of in situ U-Pb dating for carbonate, combining laser ablation (LA) and multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS), which successfully overcomes the difficulty in sampling and dating ancient marine carbonates with low Uranium and Plumbum contents. A new carbonate standard, the calcite cement with an age of 209 Ma in the Xiaoerblak Formation, Lower Cambrian at Tarim Basin, China, has been used successfully in this study. We report here a successful application of the proposed method in the study of diagenesis-porosity evolution of the Sinian Dengying Formation, Sichuan Basin in southern China. Here, the host rocks display ages around 584±26 Ma and 592±24 Ma, approaching their stratigraphic ages, indicating early dolomitization. Through dating the dolomitic cements from vugs, matrix pores and fractures in the Sinian Dengying Formation, three stages of cements were identified, corresponding to the ages of 466-557 Ma, 223-303 Ma and 20-91 Ma respectively, indicating three stages of filling process occurred in early Caledonian, late Hercynian-early Indosinian and late Yanshanian-Himalayan respectively. This revealed that the burial and diagenetic process of dolomite reservoirs in Sinian Dengying Formation was characterized by progressive filling-up of primary pores and dissolution vugs formed by epigenic karstification. Based on the dating results and statistics of dolomitic cement distribution, a quantitative model was established to reflect the diagenetic history and porosity evolution of the Sinian Dengying Formation, where the effective porosity of the rocks were around 15%, 12% and 8-10% during the Late Silurian, Early Triassic and Yanshanian periods.