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1 Late leaching under deep burial conditions causing reservoir porosity: a case study from the Miocene Zhujiang carbonates, China

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The importance of secondary porosity for hydrocarbon reservoirs in carbonate rocks is widely recognized. Subaerial exposure and related corrosion creating secondary porosity have been the subject of many previous studies whereas the impact of late leaching under deep burial conditions might have been underestimated in the past.

We investigated the Miocene Zhujiang carbonates, which are the hydrocarbon-reservoir rock of the Liuhua-11-1 field in the South China Sea and comprise reservoir porosity of up to 50%. Porosity data collected from three wells reveal six stratigraphic units (zones F through A). Porous zones F, D and B are intercalated with tight zones E, C and A. Detailed thin-section and cathodoluminescence studies suggest that the vast majority of pores in the Zhujiang carbonates was generated or overprinted after stylolitisation, which requires deep burial settings. Zones C and E, however, lack this late-leached porosity. Carbon and oxygen-isotope data, together with petrographic studies, suggest that zone C was tightly cemented due to meteoric diagenesis. Therefore this interval was impermeable to later corrosive fluids in deep burial settings. Zone E, containing micrite-rich layers, was more prone to pressure solution. Compaction and associated calcite precipitation probably caused low porosity in this zone. We propose that migrating corrosive fluids were diverted along flow baffles (zones

E and C) parallel to bedding, leaching the intervals in-between (zones F, D and B) and emphasized the depositional pattern. This was observed on the scale of tens of meters, producing porous zones F, D, B between tight zones C and E. At the meter scale, the alternation of tight and porous layers within zone E can be interpreted in a similar manner. Even at a micro-scale, late-leached pores are often oriented along bedding-parallel stylolites.

In conclusion, although the main porosity of the Zhujiang carbonates is of late-diagenetic origin, its distribution is influenced by a depositional pattern. 2-D and 3-D seismic data confirm that zones A to F reflect depositional events.

The case study of the Miocene Zhujiang carbonates demonstrates that leaching under deep burial conditions can cause porosity at reservoir-scale, and its role in hydrocarbon geology might have to be re-evaluated. Furthermore it shows how depositional facies, early diagenetic and earlier burial processes can influence the spatial distribution of late-leached porosity.