Hydrothermal Processes and Reservoir Quality in Carbonate Reservoirs: Good, Bad or Ugly?

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ABSTRACT

In the last decade, there has been significant, often acrimonious, discussion as to the role of hydrothermal processes on controlling reservoir quality in carbonate rocks. For example, there are many examples of non-stratabound dolomitisation that apparently formed from hot, saline brines (so-called hydrothermal dolomite). However, the actual mechanism for dolomitisation is controversial and it is unclear whether such dolomite bodies genuinely improve reservoir properties or not. Similarly, models of porosity enhancement in the burial realm by hot, fault-derived fluids have been both championed and condemned in the literature. Often there is often good evidence for porosity modification and permeability enhancement after chemical compaction and fracturing, but the source and drive mechanism for fluids responsible for this change have not been adequately explained. This presentation aims to look objectively at the evidence for porosity modification within carbonate systems using a range of outcrop and the subsurface case studies from Europe, North Africa and the Middle East. In some cases, hydrothermal processes result in localised diagenetic modification that can be mapped and modelled as discrete, non-stratabound geobodies. In these cases, diagenesis has not just altered the matrix pore structure but also influenced the geomechnical properties of the reservoir. Elsewhere the influence of hydrothermal fluid flux may be more nebulous and diffuse. In the worst case, seal breach can occur, compromising reservoir quality entirely. This leads to three considerations: 1) The importance of basin-scale tectonics, since many apparent products of hydrothermal processes are linked to zones of structural complexity and elevated heat flow. 2) Likely fluid sources and mechanisms for fluid migration. Although hot, saline (crustal) brines characterise many apparent products of hydrothermal processes, this is not always the case. There is also often an intimate link between faults, diagenetic modification and hydrocarbon emplacement, but this relationship has not been fully constrained. 3) The role of prior sedimentary architecture in controlling fluid and diagenetic pathways Ultimately, it is clear that the spatial and temporal relationship between fault-controlled fluid flux and diagenesis can be play a key role in modification of reservoir properties, but we are still some way from understanding how, where and when these processes occur.