TG04

Micro-quartz Grain Coatings: Do they help in Tight Gas Sandstones?

S. Shammari* (Saudi Aramco)

SUMMARY

Exploration for so-called “tight-gas sandstones” has increased significantly in recent years due to technological advances in drilling and fracturing treatments. Tight gas sands are those with very low porosity and permeability that cannot be economically produced without stimulation or horizontal drilling. It is well known that zones of higher porosity/permeability, “sweet spots”, within otherwise tight sandstones can greatly enhance their economic viability.

Exploration for so-called “tight-gas sandstones” has increased significantly in recent years due to technological advances in drilling and fracturing treatments. Tight gas sands are those with very low porosity and permeability that cannot be economically produced without stimulation or horizontal drilling. It is well known that zones of higher porosity/permeability, “sweet spots”, within otherwise tight sandstones can greatly enhance their economic viability.

Quartz cement commonly is one of the most significant diagenetic minerals filling pore spaces in tight gas sandstones. With increasing depth and temperature, quartz overgrowths gradually fill the pore spaces until potential reservoirs retain only a few percent porosity and less than a millidarcy permeability—i.e. a tight sandstone.

Microquartz cement is one factor that can inhibit quartz overgrowth cementation and preserve porosity in such deep, tight sandstones. Coatings of microquartz crystals on the surfaces of detrital grains can inhibit the development of normal quartz overgrowths, creating “sweet spots” in an otherwise tight sandstone. This has been observed in the Permian-Carboniferous Unayzah sandstone reservoir of Saudi Arabia where coatings consist of euhedral microquartz crystals (~2-10 µm in diameter or prism length) that appear to be in crystallographic continuity with the detrital grains. Computer modeling of quartz cementation (Lander et al., 2008) suggests that microquartz which is not in crystallographic continuity with detrital quartz grains is more effective in slowing normal quartz overgrowth development than microquartz that is in crystallographic continuity, due to interference of growing crystals in the former.

In the Unayzah, microquartz coatings are often associated with pedogenesis (in association with early illuviated clay coatings) and/or late diagenetic fibrous illite clays. Nucleation of microquartz crystals on the surface of detrital grains indicates high concentrations of silica in the pore water. Potential sources of silica are interbedded siliceous soil horizons (silcretes/silica nodules), dissolution of detrital feldspars, and weathering of clay minerals.

Unlike normal quartz-overgrowth cementation that can be successfully modeled pseudo-kinetically with commercial modeling software such as Touchstone™ or Exemplar™ using various input parameters (e.g., detrital mineralogy, grain size, grain coatings, temperature and time-temperature history), the occurrence of microquartz coatings presently is difficult to predict or model. Because of the inferred association with paleosols, detailed work on the paleopedology of the Unayzah reservoir is essential for a better understanding of microquartz distribution. It is possible that microquartz cemented zones of higher porosity/permeability can be detected by seismic inversion methods as sweet reservoir spots.