AP22

Fracture-controlled Dolomite Reservoirs in Late Cretaceous Carbonates of the Sarvak Formation, Anaran Anticline, Islamic Republic of Iran

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SUMMARY

Late burial dolomite of hydrothermal origin replaces Cretaceous carbonate shelf sediments of Albian to Turonian age (Sarvak Formation) in the NW closure of the Anaran Anticline, Zagros Mountains, Simply Folded Belt, Iran. The outcrops, spectacularly exposed along deep river canyons, offer the possibility for a 3D reconstruction of the geobodies, combining both field data (sedimentary logs, cross sections and samples for diagenetic and petrophysical studies) and LIDAR derived photorealistic model of the most representative dolomite bodies. The aim is to quantify the impact of hydrothermal dolomitisation on the reservoir quality.

The hydrothermal origin of the dolomitising fluids will be discussed integrating different geochemical data (fluid inclusions, stable and radiogenic isotopes, minor and trace elements). Dolomite replaces carbonate rocks characterised by different facies, showing different geometries: 1) massive plus stratabound (Lower Sarvak); 2) pipes (Upper Sarvak). Dolomite distribution decreases vertically with at least three discrete breaks corresponding to two main aquitard intervals: 1) Ahmadi Shales, separating massive dolomite form from plume-like bodies; 2) Turonian Mudstones; 3) Surgah Fm., above, which no dolomite has been observed. Fractures and faults play a major role in controlling the distribution of the dolomite bodies, in particular the ENE-WSW and WNW-ESE conjugate fault systems, which are often associated with dolomitic halos. A geological conceptual model is built taking into account different fracture and matrix porosity models for limestone and dolomite.

Spectacularly exposed late burial dolomite bodies of hydrothermal origin replace Cretaceous carbonate shelf sediments of Albian to Turonian age (Sarvak Formation) of the Anaran Anticline, in the Simply Folded Belt of the Zagros Mountains, Islamic Republic of Iran. The outcrops have been mapped, logged and sampled in order to evaluate the effect of hydrothermal dolomitisation process on the reservoir characteristics. In addition, a LIDAR photorealistic model of the representative dolomite bodies has been interpreted (geobody shape and size, fault interpretation, fracture analyses) and the data incorporated into a 3-D outcrop model.

Dolomite replaces carbonate rocks characterised by different facies. The typical dolomite geometries are massive (600 m thick x 1,500 m long), domal and pipe-like bodies (150 m diameter x 200 m thick), usually associated with highly fractured and faulted zones, and stratabound bodies (30–50 m thick x 300 m long), which emanate from the massive dolomite body and follow permeable layers or are located beneath cycle-capping mudstones.

Typical petrographic associations consist of abundant void-filling saddle dolomite phase and a more volumetrically important matrix-replacive finer grain dolomite phase. Preservation of precursor sedimentary structures (i.e. bedding planes) is in general poor in the “core” of the dolomite bodies, but variable, with primary facies and fabrics identifiable locally in clean river sections. Fabric preserving dolomite is more prevalent towards the edges of dolomite bodies. Development of vuggy porosity is also variable and typically facies controlled. Preferential development of vuggy porosity below cycle-capping mudstones is typical in platform top facies. Breccia-type textures associated to fault zones are also common and testify to a complex dissolution/cementation fluid flow and diagenetic history. Crackle, mosaic and chaotic fabrics are common.

Field evidence points to a strong control of ENE-WSW and WNW-ESE fault systems on the dolomitisation fluid flow. These structures are related to the pre- to syn-folding phase of the Zagros and are often associated with a dolomitisation halo.

The distribution of dolomite decreases vertically with three major discrete breaks corresponding to three main aquitard intervals: (1) the early Cenomanian basinal micritic limestones and shales of the Ahmadi Member, which marks the transition between Lower (massive plus stratabound dolomite) and Upper Sarvak Formation(pipes); (2) the Middle Turonian basinal micritic limestones and shales of the Ghir-ab Member, which mark the Cenomanian – Turonian boundary; (3) Coniacian Surgah Formation claystones, above which no dolomite has been observed.

Extensive systematic sampling across the different dolomite body types (stratabound, massive, pipes) and adjacent undolomitised precursor facies has been also carried out in order to capture lateral and vertical variation in the poro-permeability values and quantify the impact on the reservoir quality. In general, porosity values are low to moderate in both dolomite and limestone, with the dolomitised grainy facies of the Lower Sarvak Formation showing better reservoir quality. Permeability is also moderate but distinctly higher in the dolomitised lithologies when compared to the undolomitised counterpart, implying a redistribution of the pore system network related to dolomitisation. Fractures seem to have a major control in the highest permeability values. Different fracture and matrix porosity models for dolomitised and undolomitised lithologies are applied and incorporated in 3-D geological conceptual model.