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High resolution chemostratigraphy: a new method for geosteering in clastic reservoirs at the wellsite: a case study of a recent well drilled in the TAG-I reservoir in Algeria.

Triassic Argilo Gréseux-Inférieur (TAG-I) fluvio-lacustrine sandstones of the Berkine Basin, in Algeria, form a significant hydrocarbon reservoir. The TAG-I sequences are of Middle to Late Triassic age and unconformably overlie a Devonian to Carboniferous subcrop and is in turn overlain by claystones of the Triassic Carbonate, a shallow marine claystone, limestone and evaporite sequence. The TAG-I accumulated in a semi-arid conditions in a fluvial system that occupied a NE-SW trending valley system, formed in response to syn-rift basin subsidence. The TAG-I sandstones were deposited by braided and low to moderately sinuosity fluvial channels (Figure 1), which are concentrated into fluvial fairways separated by floodplain fines with extensive palaeosol developments.

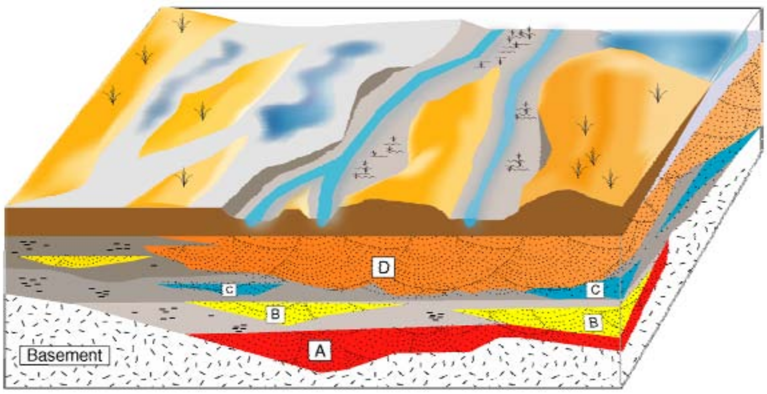

Figure 1. Schematic TAG-I palaeo-environmental reconstruction.

Detailed reservoir-scale sandstone correlation is hampered by marked vertical and lateral facies variations, plus the sequences are biostratigraphically barren. However, chemostratigraphy has produced a four-fold regional zonation for the TAG-I (Figure 2), with a more detailed field-scale zonation (Martin *et al*. 2004) based on the analysis of over 500 conventional core samples. These zonations are based on geochemical variations that reflect changes in provenance and the depositional environment (Ratcliffe *et al.* 2002) and this corresponds well to the established TAG-I Sequence Stratigraphy scheme of Turner et al, 2001.

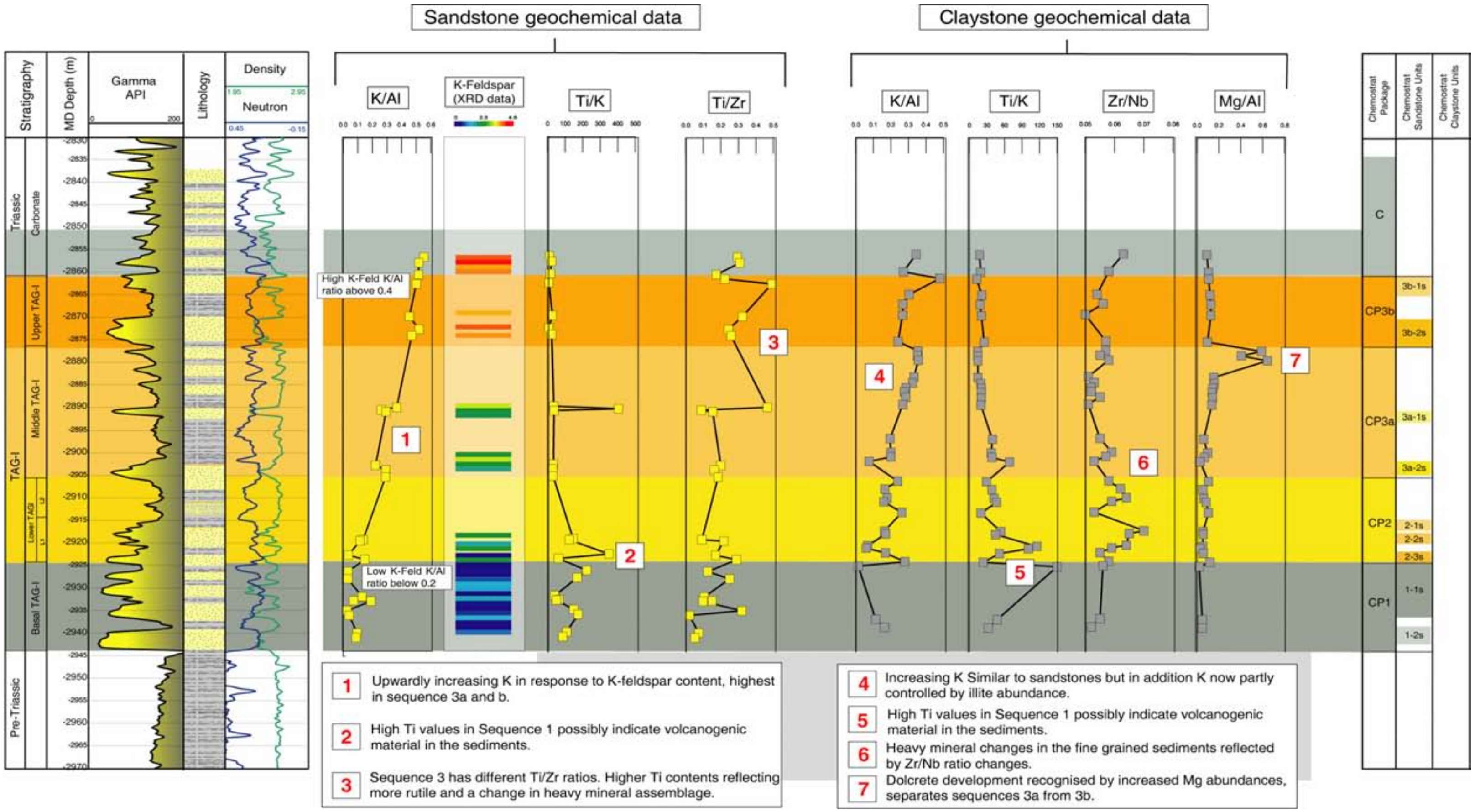

Figure 2. Chemostratigraphic zonation criteria used to establish a four fold reservoir of the TAG-I.

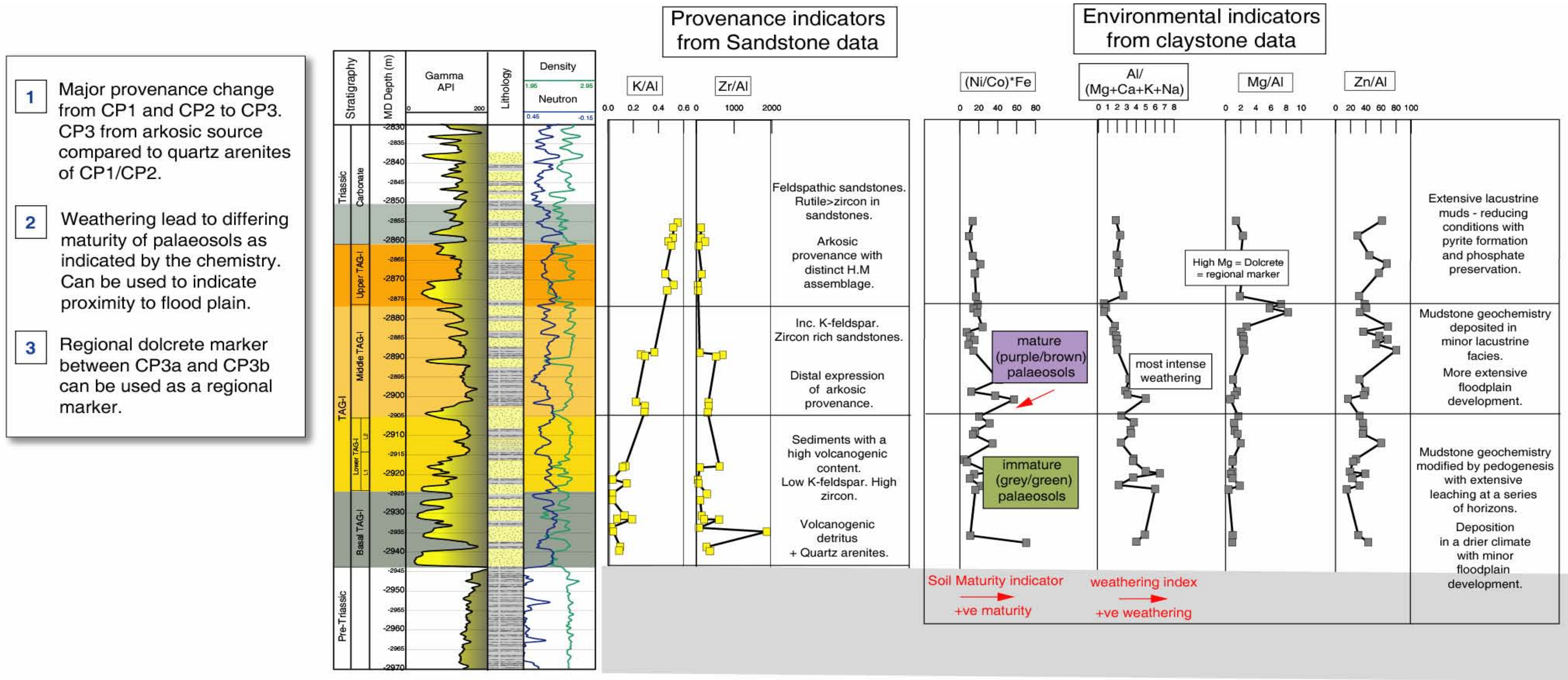

Figure 3. The modelling of the relationships between sediment geochemistry, provenance and palaeo-eironment in TAG-I.

During the drilling of a sinusoidal well on the Rhourde Oulad Djemaa (ROD) Field (Block 402), real-time geochemical analyses of cuttings were undertaken by laser-induced breakdown spectrometry (LaserStrat®). The resultant geochemical data and the field-scale zonation were then used together to modify and geosteer the well successfully along the optimum pathway down through the overlying Triassic Carbonate, then guiding the well bore through three passes of the Upper and Middle TAG-I (Figure 4). This trajectory then avoided the re-entry of the geomechanically weak Triassic Carbonates (above) and water bearing/pressure separated Lower TAG-I sands (below), thus preventing additional well bore stability problems and extra completion requirements.

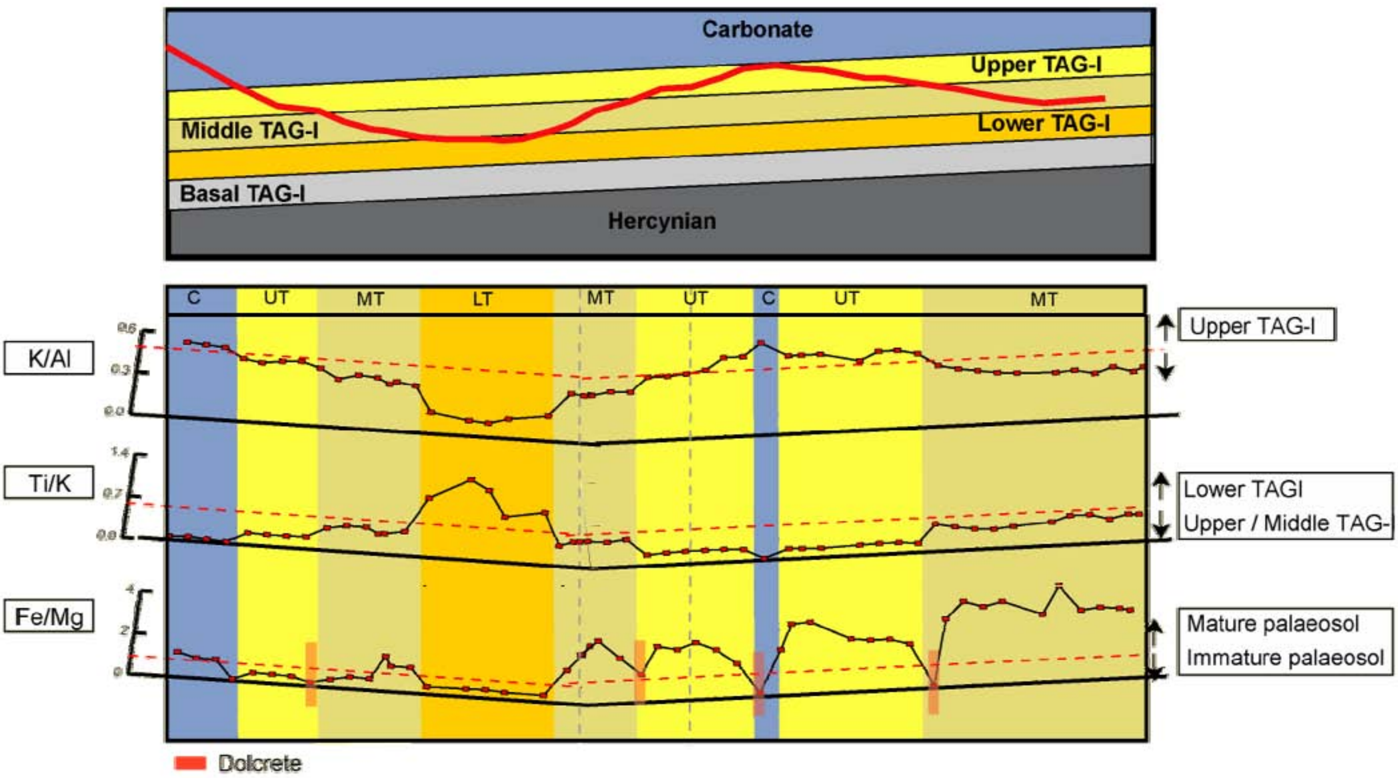

Figure 4. The Chemostratigraphic zonation recognised during the drilling of the sinusoidal well through the TAGI. The stratigraphic of reservoir was constrained using E-log and chemostratigraphic data.

The geochemical data (Al/(Ca+Mg+K+Na), (Ni/Co)*Fe, Fe/Mg ratios) corroborated by sedimentological data have been used to model palaeosol types and maturity, which resulted in the mapping of channel pathways and mature floodplain fairways (Figure 5). Key palaeosol geochemical parameters were also acquired real-time, potentially enabling wells to be geosteered away from floodplain successions, that contained few sandstones. High-resolution chemostratigraphy provides the framework for constraining wellsite deployments and enables wells to be drilled closer to their optimum field development programme.

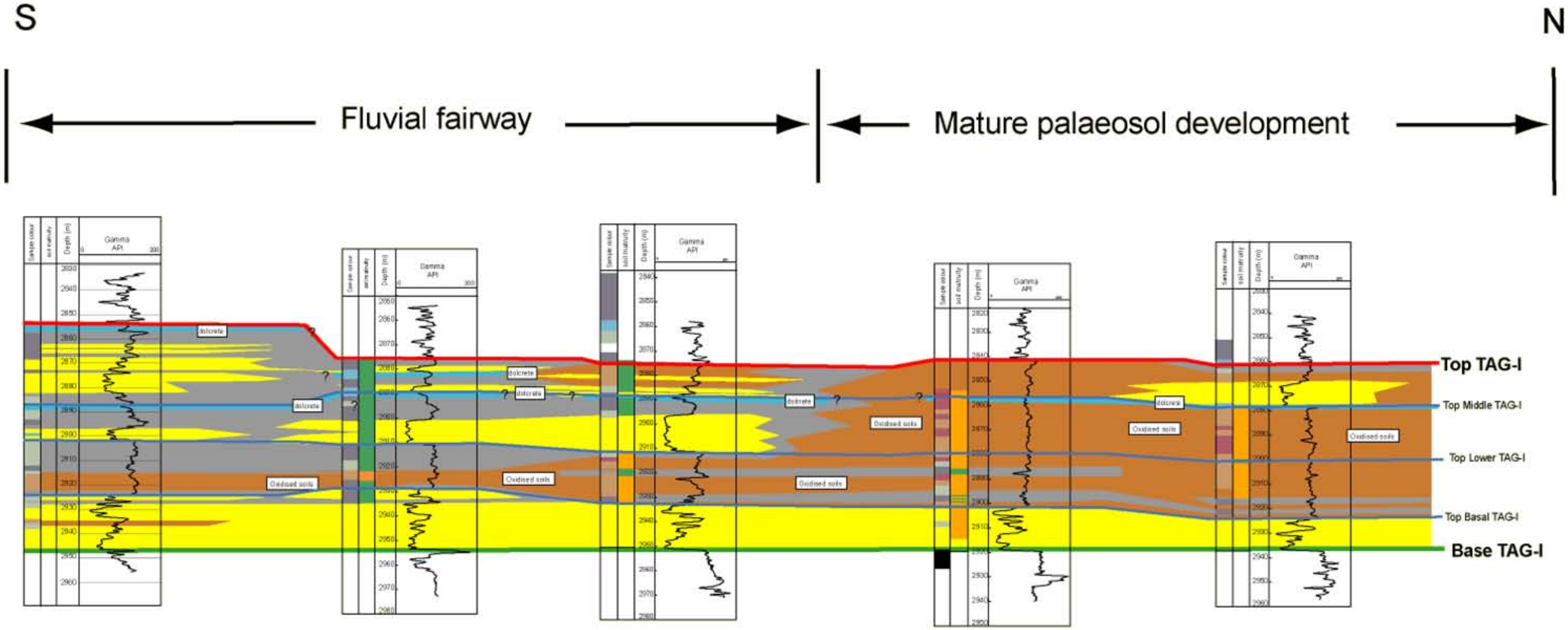

Figure 5. The modelling of sedimentological facies based on the geochemical data (from core and cuttings samples) and sedimentological data enabling the differentiation of channel prone and floodplain fairways in the TAG-I.