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Charge Modelling in the Ahnet-Timmimoun Basin, Algeria - Timing of Gas Generation and Migration

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The Ahnet and Timmimoun basins of District 3, Algeria contain a large number of relatively dry gas discoveries. These largely Paleozoic basins contain two world-class oil-prone Silurian and Devonian source rocks. The presence of dry gas is thought to be linked to the thermal history of the basin especially the extent of pre-Hercynian Carboniferous burial.

The basins have experienced a complex thermal history with several possible thermal events. The Hercynian uplift and erosion has resulted in relatively little Mesozoic and Tertiary section being preserved. Vitrinite reflectance data in District 3 wells has proven to be misleading and unreliable, especially in the pre-Carboniferous sections of many wells. Other techniques have been investigated in order to attempt to calibrate the thermal history. Biomarker data have been used to help calibrate the thermal history and an example is shown from well data.

Pre-Hercynian Carboniferous thicknesses in District 3 have been estimated using a variety of techniques. These methods appear to consistently show that substantial Carboniferous burial took place prior to uplift and erosion with a minimum of 2 km of Late Carboniferous being deposited across the region. 1D thermal modelling shows that this extent of burial pre-Hercynian was sufficient to cause the source rocks to enter the gas window and much the oil and gas would have been generated before many of the traps were formed.

Zircon fission track data have been used by several investigators to define heating events in District 3. ZFTA data have been cited as being indicative of a 200Ma thermal event resulting in post-Hercynian oil and gas generation. ZFTA data collected in District 3 are shown to be ambiguous and do not clearly show this 200Ma event with nearby wells showing both 200Ma and 300Ma maximum heating events. It is believed that 300Ma was the age of maximum burial related to pre-Hercynian Carboniferous burial.

Temispack 2D modelling has been used to demonstrate that remobilisation of gas during Hercynian uplift and structuration can account for the apparent mismatch between the timing of generation and migration, which is pre-Hercynian, and the timing of structuration which is Hercynian. Source rocks are into the gas window pre-Hercynian and gas remigrates into structures during uplift and erosion.

Many of the gas-filled structures have a low degree of fill with present-day column heights being less than structural closure. Although it has proven difficult to develop a model that can accurately predict this degree of fill, there some relationship between the degree of fill in a reservoir and the depth of burial of the crest of each structure at the end of Hercynian structuration. If the top seal of these structures is less than 1000m below the surface, then they are likely to be less than full to spill. This is probably related to leakage of gas through the top seal during the uplift phase. A remarkable feature of these gas accumulations is the lengthy period (200-300Ma) over which gas has been preserved.

The carbon isotope gas data from District 3 are unusual. The isotope data indicate high thermal maturity and yet the methane isotope values are heavier than ethane and propane values. It is believed that these unusual values are in response to extreme thermal stress resulting from oil to gas and late stage gas-to-gas cracking and confirm the high thermal maturity experienced by the source rocks.