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GEOCHEMICAL EVALUATION OF TAYARAT'S PROSPECTIVITY IN BURGAN FIELD

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The Tayarat Formation of the Aruma Group is part of a shallow-water carbonate platform complex deposited across the interior of the Arabian Shield during the Maastrichtian Stage of the Cretaceous System. The Tayarat carbonates span the depositional spectrum from subtidal marine to lagoonal, with the dominant reservoir facies being developed within dolomites deposited in a subtidal setting. The Tayarat (-2700 TVDSS), which is roughly 800 feet thick in the area, can be sub-divided into lower and upper carbonate units separated by an intervening shale. The upper unit has generally better reservoir characteristics.

As an on-going project Kuwait Oil Company's – Greater Burgan Studies Team is conducting a comprehensive geochemical studies of the Tayarat Formation in selected wells. The objective is to assess the chemical and physical properties of the fluids that are present in the Tayarat Formation. Geochemically, the results to date suggest that there are two types of hydrocarbons found in the Tayarat Formation: (1) very heavy/ viscous indigenous oil and (2) more recently re-migrated medium gravity oil from underlying lighter oil reservoirs.

Very heavy/ viscous indigenous oil (API 3-17°):

The degradation of the hydrocarbon's physical and chemical properties is as a results of on-going secondary processes such as water washing, biodegradation and loss of volatiles. The extent of these secondary effects varies with aerially and with depth. The hydrocarbons found on the northern side of Burgan Field has been severely degraded (API 3-10°). Whereas, the southern side shows only moderate to extensive alteration of the oils (API 10-17°). These observations have been supported by the absence of *n*-alkanes, and the presence of a distinctive hump on the finger print analyses. As a consequence, Tayarat oils are relatively rich in sulphur, yielding an average sulphur content of 5% by weight. In addition, the SARA analyses of the severely degraded oils show the abundance of resins and aromatics at the

expense of the asphaltenes and saturates. Therefore, it is believe that the physical properties of Tayarat oils are probably controlled jointly by the presence of polars and sulfur.

Re-charged medium gravity oil (API ~26°):

An east-west trending deep seated fault in the south of Burgan Field might be the conduit for on-going re-migrating of lighter hydrocarbons from the deeper reservoirs such as the Wara and/or Burgan. The volumetric contribution of this fault in bringing lighter oil to shallower depths until recently was poorly understood. Unfortunately, recent well data suggests that the fault's contribution is minor. Here, finger print analyses illustrate the recharging and removal of the lightest *n*-alkane ends (gasoline group). The *n*-C_7/ MCH vs. *n*-C_7 ratio demonstrates the presence of on-going evaporative fractionation process which is responsible for preferential migration of the lightest species. SARA results show the dominance of saturate and aromatic fractions at the expense of NSO's. Finally, the sulfur content is notably lower than in the indigenous Tayarat heavy oil.

Generally, the pristane/ phytane ratios of both types of oils found in the Tayarat Formation are < 1, a characteristic generally indicative of oils generated from a source rock deposited in an anoxic environment. An oil-oil correlation was made for the different gravity oils based on finger-printing, biomarkers for saturates and aromatics, and carbon isotopic compositions. The results of this study are in agreement, suggesting that both types of oil are source related and may have been generated from marine shale/ carbonate source rock rich in sapropelic organic matter (Type II kerogen), deposited in anoxic-dysoxic environment.

Finally, the PY-GC results for the heavy, altered Tayarat oils are believed to show a reasonably good correlation with the unaltered oils found in the Burgan Formation.