C-08 THE GEOLOGICAL EVALUATION OF CONCESSION 9 AREA IN NORTHWEST LIBYA

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Summary

A study of the geological history and hydrocarbon prospectivity of Concession 9 and its surrounding area in northwest Libya (fig 1), has been undertaken, based on the interpretation of about 1000 km of seismic reflection data and information from 15 wells. One third of the seismic coverage is onland and ties to a well to the south of the Concession. The remaining coverage is offshore and ties to two wells to the north of the Concession. The study area is situated in the northern part of the onshore Jeffara Basin and extends northward across the Libyan continental shelf into the southern flank of the offshore Gabes-Tripoli-Misurata Basin.

Six seismic reflection horizons ranging in age from Carboniferous to Upper Miocene were mapped. The interpretation suggests that east-west striking normal faults, which throw both to the north and south, controlled the geological development of the area from the Palaeozoic to Mesozoic and gravity driven listric faulting, limited to the southern flank of the Gabes-Tripoli-Misurata Basin, occurred in the Cenozoic. Previously the geological evolution of the region was only thought to be dominated by north throwing east-west basement faults.

A model for the geological evolution of the region is presented. During Carboniferous to Triassic time a major east-west striking, southward dipping fault (fault A in this study) controlled sedimentation in the northern part of the Jeffara Basin Jurassic extension produced new faults and reactivated the old ones. On the southern flank of the Gabes-Tripoli-Misurata Basin a set of these faults acted as a hinge zone, which accommodated subsidence northwards. Cenozoic extension in Miocene times resulted in the development of listric faults offshore, which detach within Triassic – Jurassic evaporites, above this hinge zone.

An assessment of the hydrocarbon potential of the Concession is undertaken and several prospects identified. Onshore, Carboniferous to Triassic reservoir rocks trapped against fault A form a potential prospect. Offshore, traps developed during the Cenozoic listric faulting, Upper Cretaceous carbonate build ups and a canyon-fill sand are of most interest.

Introduction:

Libya, situated on the Mediterranean forehand of the African plate encompasses the stable Saharan platform. The palaeo-geographic evolution of Libya is directly connected with the Caledonian, Hercynian and Alpine orogenies (Goudarzi, 1980). North-west Libya was part of the Saharan platform which was tectonically stable for the much Palaeozoic Era. Prior to the Carboniferous, the region was only affected by epeirogenic movement. Hercynian movements in Late Carboniferous to Early Permian times resulted in an eastwards trending uplift and steep faulting in a belt that extends eastwards into Tunisia causing the area to the north of the Jeffara

fault system to subside. This subsidence was the first step in the development of the Tethys Trough.faulting in a belt that extends eastwards into Tunisia causing the area to the north of the Jeffara fault system to subside. This subsidence was the first step in the development of the Tethys Trough.

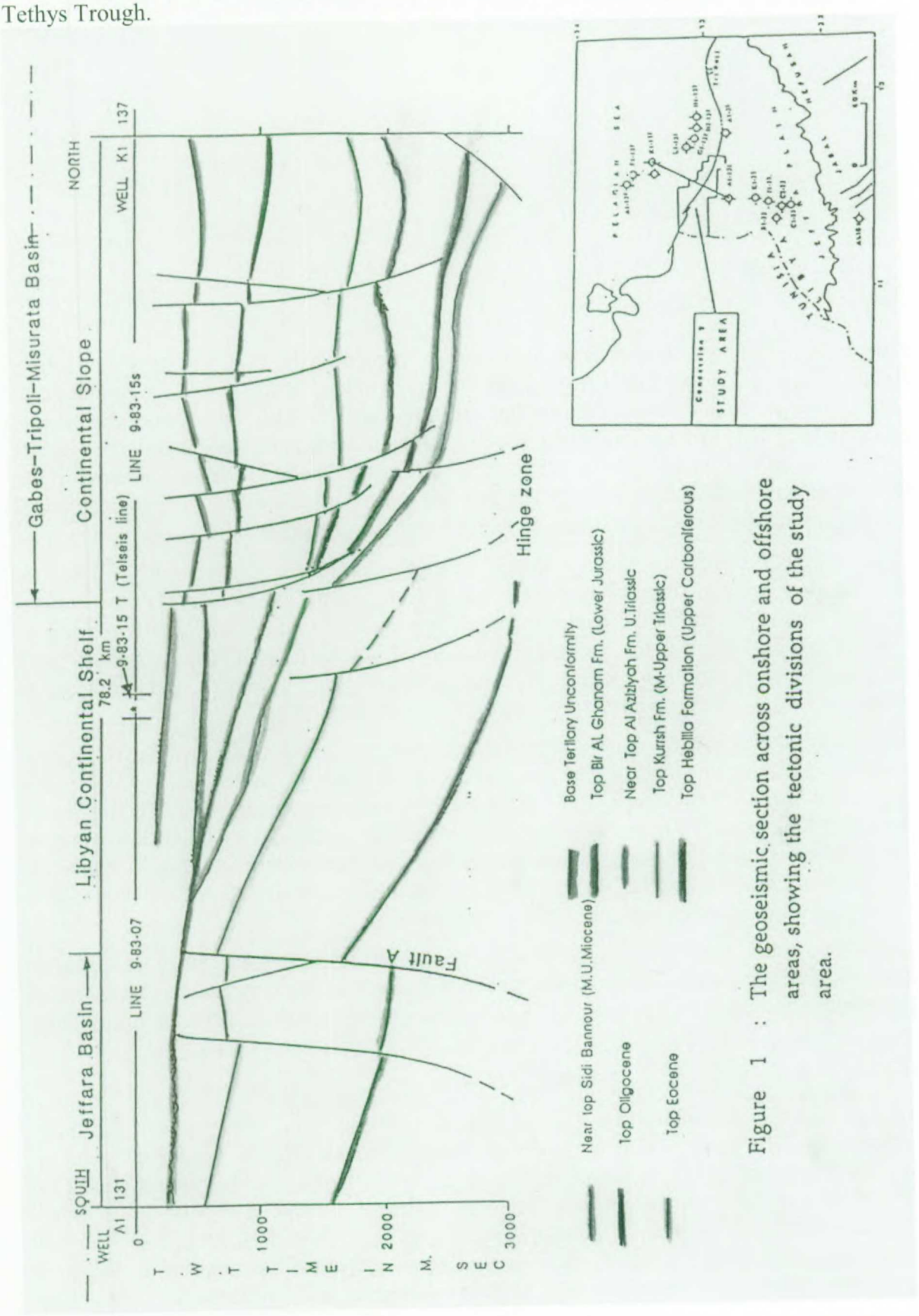


Figure 1 : The geoseismic section across onshore and offshore areas, showing the tectonic divisions of the study area.

The regional tectonic framework proposed by different workers for the evolution of the central Mediterranean basins is interpreted as being mainly controlled by the relative movements of Africa to Europe. This lateral movement could be transtensional, with development of pull-apart basins, or transpressive producing structural inversion within already formed basins. Characteristic features of strike-slip tectonics such as flower structures, reverse faulting and variation in thickness across faults are not evident on the seismic data of the study area. Further more, en echelon faults and folds which usually characteristic strike-slip tectonism are however not evident on the structure contour maps. The variation in thickness across faults is interpreted in terms of growth faulting in this study. Although strike-slip tectonism cannot be ruled out, the faults in this study were interpreted to have mainly extensional component.

There is no direct borehole information on the subsurface stratigraphy in Concession 9. The stratigraphy information are inferred from the well-data of surrounding areas and the literature (El Hinnawy et al., 1975; Bishop, 1976; Burollet et al., 1978 and Hammuda et al., 1985). This study follows the stratigraphic nomenclature of Hammuda et al. 1985 from Late Carboniferous and for older strata the nomenclature of Veba oil co. (1976) is used (fig 1). Precambrian rocks form the basement of the region in Tunisia and the Ghadames Basin to the south of the study area. They are gentle folded metamorphosed rocks and granites with east-west and northeast-southeast alignment. There are no brothels in north-west Libya that reach the Pre-Cambrian.

Deposition of the Early Paleozoic was controlled by regional folds in the Precambrian (Bishop, 1975). The sediments are of shallow marine to glacial origin. The onset of the Caledonian orogeny (Late Devonian) resulted in a marine transgression and the area was covered by epicontinental seas. Deposition of thick sequences of shale (Tanezzuft shale) occurred and was accompanied by gentle subsidence. A progressive progradation of Silurian and Devonian strata from the south to the north, which could be due to increasing uplift resulting from the Caledonian orogeny in the north. In the Carboniferous, the area was uplifted leading to the erosion of the older strata, as a result of which Hebelia Formation (Late Carboniferous) rests unconformably on the top of the Tanezzuft shale of Early Silurian age. In the Perm-Carboniferous time the subsiding Jeffara Basin appeared to the north of the Nafusah uplift.

The Mesozoic lithologies are well controlled by the land borehole information and outcrops in the Nafusah area. Boreholes in the offshore have not reached the pre- Jurassic strata with the exception of L1-137 well, which penetrates the top of the Upper Triassic Abu Shaybah Formation at depth of 3800 m.

The Cenozoic rocks are thin in the onshore wells, where they unconformably overlay older strata ranging in age from the Triassic to the Cretaceous. The Cenozoic is missing in the Jeffara Plain and Jabal Nefusah to the south of Concession 9 (e.g. the youngest rocks in well A1-131 are Cretaceous). Well J1-23 is the southernmost well that contains Cenozoic rocks. To the south of this, The Jeffara Plain must have been a high since the Cretaceous. At this time Jabal Nefusah was subjected to a major uplift, resulting in outcrops of strata ranging in age from the Triassic to the Cretaceous. Subsidence in the offshore area led to the accumulation of thick sequence north to present shoreline.

Two onshore and four offshore seismic reflection horizons ranging in age from Carboniferous to Upper Miocene were mapped. The interpretation of the Carboniferous to Upper Triassic formations was mainly based on the onshore data, because these stratigraphic units are deeply buried north of the present shoreline. The Jurassic does not show a complete succession in the study area. Other than the Lower Jurassic Bir Al Ghanam Formation, these reflections were not correlated across the study area because they pinch out southwards before reaching the main

seismic grid. The Cretaceous is missing in the onshore area and has a patchy distribution around the hinge zone with thicker distribution in the north in the offshore area. The succession shows an unconformable relationship at both its top and bottom. Multiple Unconformities and isopach changes did not allow direct correlation of the Cretaceous horizons throughout the seismic grid. The entire succession belonging to the Cenozoic is not always encountered in the onshore area and does not show a complete succession in the offshore area either.

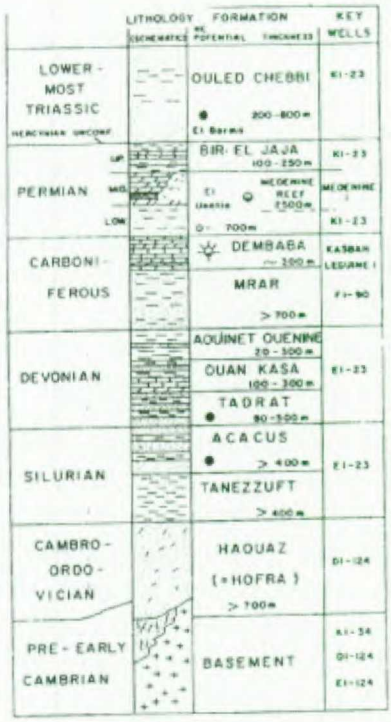
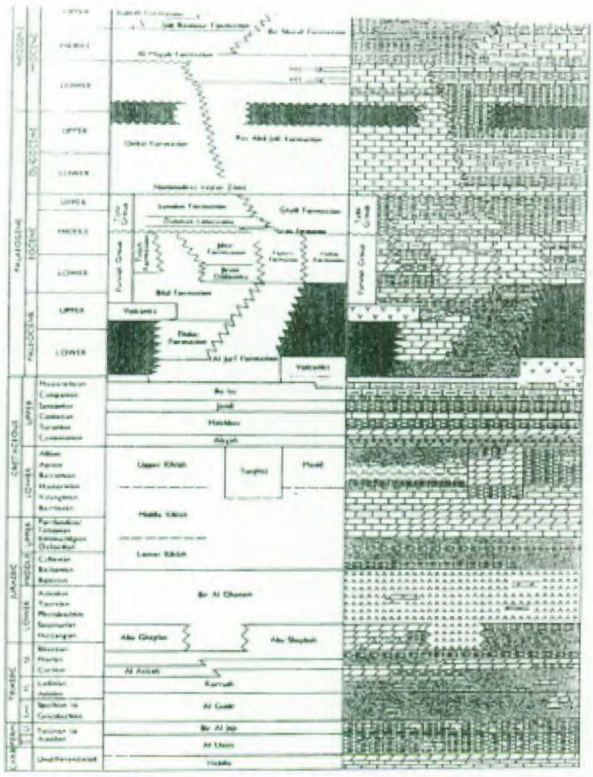


Figure 2 : Generalised stratigraphic nomenclature and lithologies from Cambrian to Lower Triassic (Veba Oil Co. 1976).



: Generalised stratigraphic nomenclature and lithologies for the Late Carboniferous to Recent (after Hammuda et al 1985).

Conclusion:

Northerly throwing east-west trending basement-controlled faults have been previously regarded as the dominant tectonic style of the region. A major Palaeozoic growth fault has been identified (named here fault A), which controlled the northern margin of the Jeffara Basin and throw to the south rather than the north. The present interpretation of the seismic data does not appear to support the idea that a basement controlled tectonic style is the only tectonism in the study area. A set of Cenozoic listric faults of the coastal fault system (offshore Concession 9) detached within Jurassic-Triassic evaporites and is associated with a different tectonic style. These faults are interpreted to be gravity-driven growth faults, within the sedimentary succession, on the southern flank of the Gabes-Tripoli-Misurata Basin. These Cenozoic faults occur immediately above the shelf break slop which developed in Triassic to Jurassic times into a hinge zone controlled by basement faults. The evaporites decouple these two fault system.

References:

Eblaou, A., 1992 : Seismic interpretation of the geological evolution of Concession 9 NW Libya; Mphil thesis, university of Leeds,uk.,pp.136.