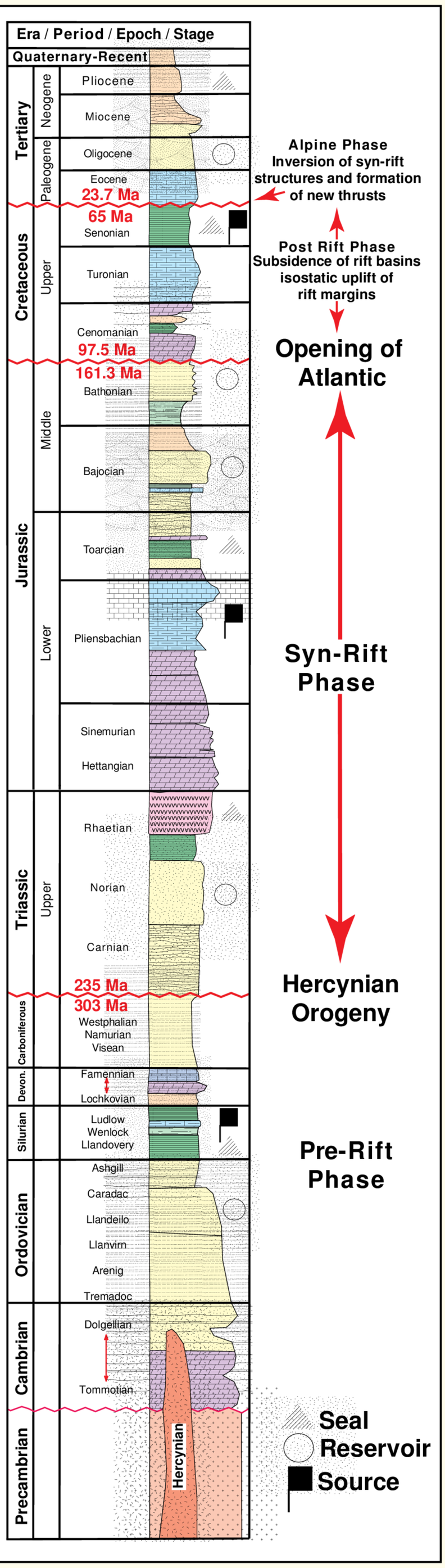
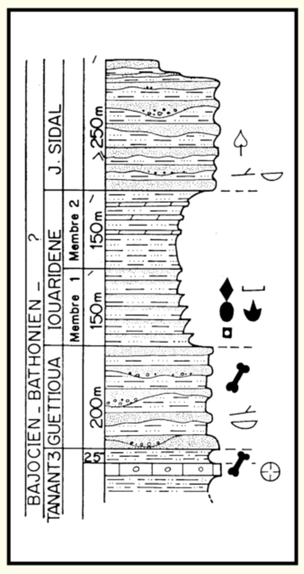
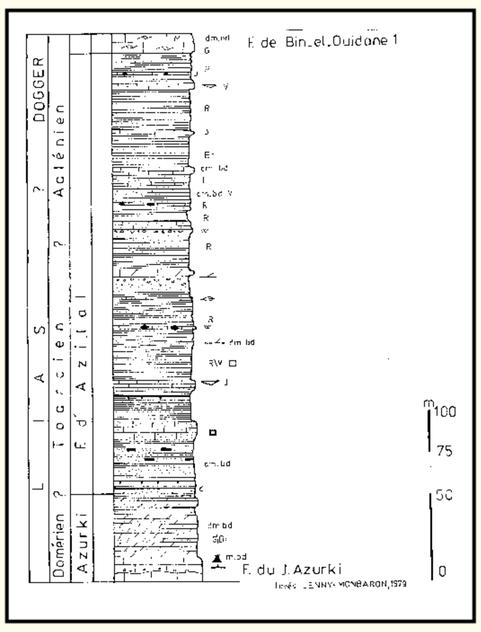
Stratigraphy of the High Atlas:
Potential reservoirs, source rocks and seals.



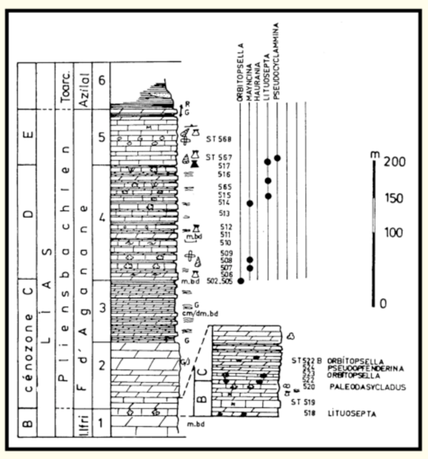
Above) Composite stratigraphic column for the High Atlas mountains of Morocco. This section was derived from detailed measured sections in the High Atlas, Anti-Atlas and well data.



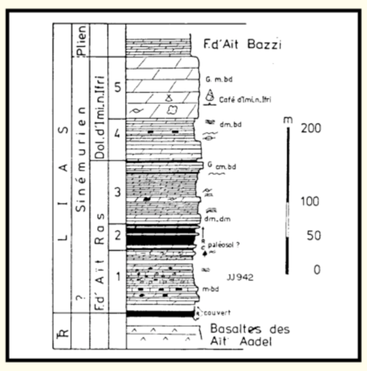
Above) The Bajocian-Bathonian strata of the High Atlas are composed of thick sandstone intervals. These sands offer excellent reservoir potential. These sandstones are equivalent to the "Dogger" sands of the North Sea.



Above) Measured section of the "Liassic" from the Azilal region of the High Atlas. The Toarcian is composed of sandstones interbedded with thick shale intervals.



Above) The "Liassic"of the High Atlas along transect A-A' is often composed of thick dolomites and limestones. These Pleinsbachian-Hettangian carbonates form many of the ridges and mountains of the High Atlas.



Above) The Sinemurian (Lower Jurassic) of the High Atlas lie above the basalts of the Upper Triassic. The Sinemurian is characterized by thick dolomites and shales.

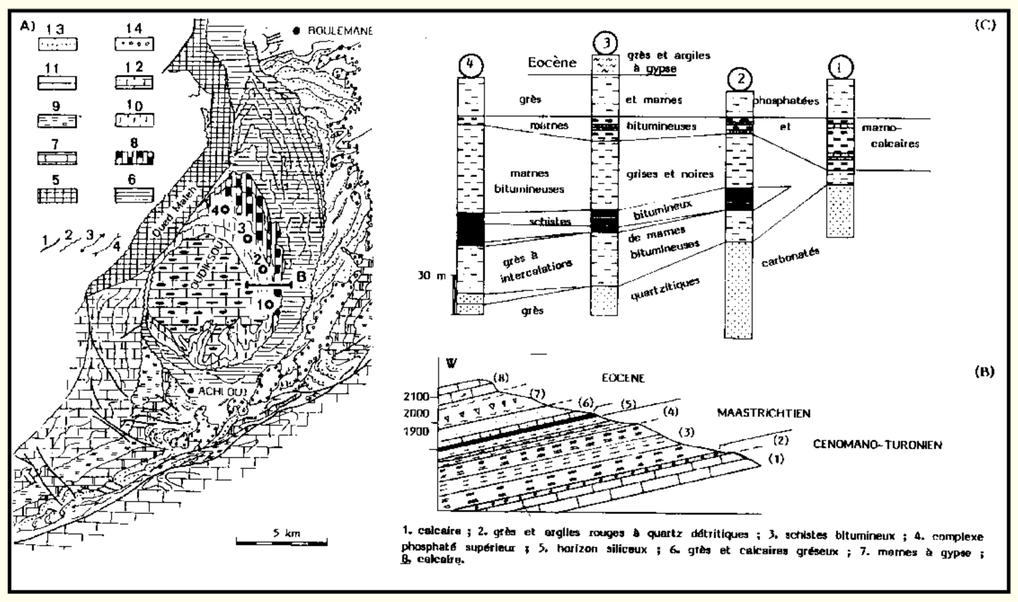
Middle Atlas Mountains									
Latitude	Longitude	TOC	S1	S2	S3	Tmax	HI	OI	Age
33°25.46N	4°20.65W	3.87	0.81	2.5	0.96	437°C	323	2	U. Pliensbachian
33°25.66N	4°20.65W	1.66	6.61	8.4	0.23	421°C	506	14	U. Pliensbachian
33°08.53N	5°09.48W	18.12	6.21	117.4	2.22	419°C	648	12	Maastrichtian

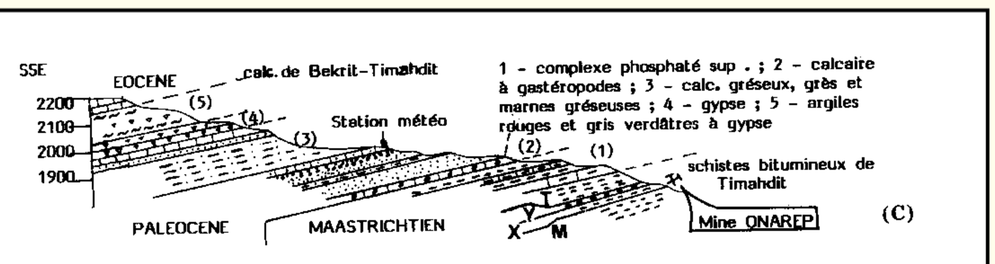
OSD-1										
Latitude	Longitude	Depth	TOC	S1	S2	S3	Tmax	HI	OI	Age
33°11.24N	3°48.12.5W	1768m	1.92	0.09	0.27	0.23	474°C	14	11	Westphalian
33°11.24N	3°48.12.5W	2066m	1.64	0.01	0.43	0.14	452°C	26	8	Westphalian
33°11.24N	3°48.12.5W	2401m	11.44	0.52	18.7	0.62	439°C	163	5	Namurian
33°11.24N	3°48.12.5W	2556m	1.28	0.04	0.52	0.15	453°C	40	11	Namurian

TOC = weight % organic carbon
S1,S2 = mg hydrocarbons/g rock
S3 = mg carbon dioxide/ g rock

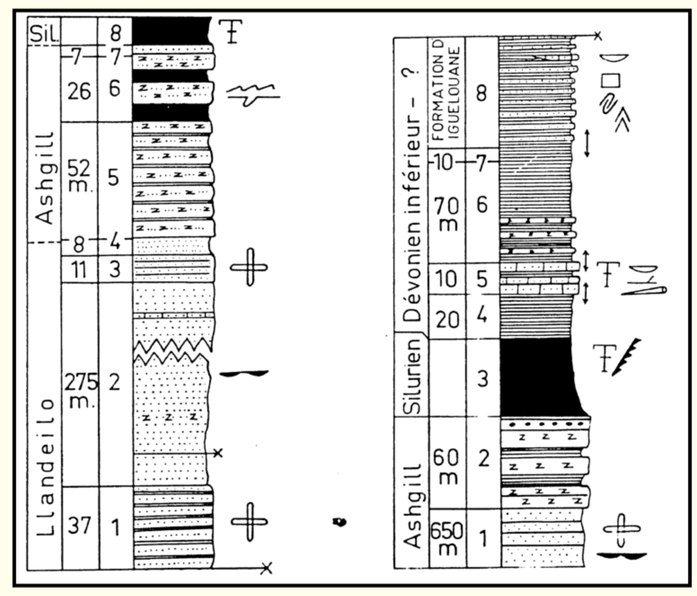
Tmax =pyrolitic yield in °C
HI = S2*100/TOC
OI = S3*100/TOC

Above) Geochemical data from the Missour basin and Middle Atlas mountains. These data exhibit excellent source rock potential in the Cretaceous, Jurassic and Paleozoic. The Maastrichtian source intervals come from a mine previously operated by ONAREP in the Middle Atlas mountains (below).

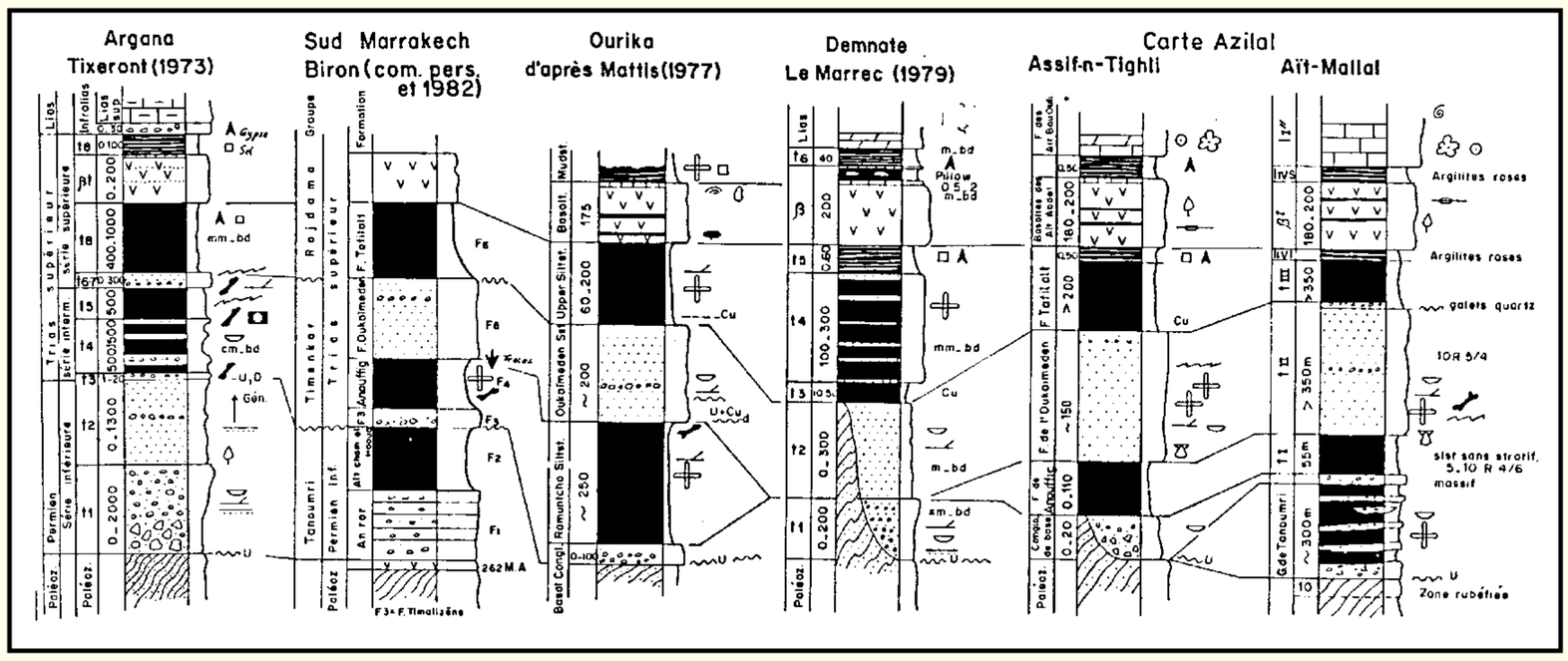




Above) The "schists bitumineux" are Maastrichtian oil shales which were at one time mined by ONAREP in the Middle Atlas mountains. These rich source rocks are found north of the High Atlas and to the south along the margins of the Anti-Atlas. These source intervals are immature in many areas outside of the Atlas mountains, and are absent due to erosion over much of the mountain belt. However, these source rocks are preserved in the footwalls of thrust faults along the margins of the Atlas. These source rocks would have entered the "oil window" during tectonic inversion and thrusting in the Oligocene, providing a source for structures along the Atlas margins.



Above) The Paleozoic section above is from measured outcrops in the High Atlas and illustrates similarities to Paleozoic source and reservoir rocks in Algeria. Silurian source rocks are found throughout Morocco, and illustrate a variety of maturation histories. The Silurian source rocks in the High Atlas are in many cases over-mature due to burial during rifting in the Mesozoic. However, Paleozoic source rocks along the rift margins (Tadla basin, Ouarzazate Basin, Missour basin) are often still in the oil/gas window. These source rocks also entered the oil/gas window during the tectonic inversion of the Atlas rift system.



Above) The above measured sections show the regional variations within the Triassic continental strata. The Triassic attains a thickness of over 4000 meters in the Argana basin of the western High Atlas. Evaporites, volcanics and thick intervals of sandstones commonly are found in the Triassic. The evaporites of the Triassic provide detachments for faulting, and create excellent seals. In the High Plateau of eastern Morocco, the Triassic contains thick evaporite intervals of over 2000 meters. These thick evaporite intervals are also found north of the Atlas in the autochthonous strata beneath the pre-Rif. Opportunities for structural traps are present in "sub-salt" Triassic intervals sourced by the Paleozoic, with reservoirs in the Triassic sandstones, sealed by the overlying Triassic evaporites.