as the result of movements under the influence of gravity, and their distribution is related to growth stages of the delta. Rollover anticlines on the downthrown sides of growth faults form the main targets for oil exploration, the hydrocarbons being found in sandstone reservoirs of the Agbada Formation.

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Mud into Shale: When and How?

Coring of surficial sediments on the sea floor to date has not revealed the presence of indurated, clayey sediments that are worthy of the name mudstone or shale, even though some clay as old as 50 million years has been recovered. In contrast, very young, argillaceous rocks on continental platforms are in many places indurated and cemented. Shale, in the sense of a fissile argillaceous rock, is uncommon in the younger part of the geological record though it is common in older rocks. Therefore, one can conclude that the induration to mudstone and the development of fissility of shale have two different time scales and thus result from two different processes.

The initial process of induration is clearly linked to simple mechanical compaction under load where water can be expelled, as studies of marine sediments have shown. During this stage there is little gross mineralogical or chemical change in the sediment. Later stages include chemical additions that fill pore space and increase bulk density. Chemical additions are restricted to sediments that do not remain buried permanently under deep water; the additions result from ground-water movement through the mud, a movement that is initiated by the bed being raised above sea-level and thus making possible a hydraulic head in the outcrop area. Much of the chemical precipitation in this stage is simply redistribution of carbonate, but small amounts of silica generally are added too.

Fissility, as was noted long ago, is correlated directly with the growth of phyllosilicate minerals in the *ab* plane, parallel with the bedding. It appears that the 10 A.U. micas and the chlorites are the principal causes of fissility. Accompanying this growth is a general increase in cementation that reduces porosity to low levels. However fissility does not always accompany cementation.

Fissility, then, is the result of preferential growth of the 10 A.U. micas and the chlorites under load that is induced by the geochemical environment. That environment may be characterized as one whose K^+/Na^+, Mg^{++}/Na^+, and alkali/H^+ ratios are relatively high compared with sea water, and whose dissolved silica concentration is close to that in equilibrium with quartz. The environment that has these characteristics is that of concentrated subsurface brines typical of most ancient sedimentary basins. The correspondence of the time scales of the production of fissility in shales and the formation of brines is important support for this hypothesis.

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History of Oil Development in Libya

Concessions were first granted in Libya during late 1955. At that time 14 companies obtained concessions totaling 130 million acres. By November 19, 1959, concession areas had increased to 265 million acres, but they decreased to 174 million acres by September 1, 1965. On July 29, 1965, 98 individual blocks totaling 147,589,617 acres were made available for bidding. As of September 1, 1965, no additional acreage had been granted.

Exploration activity has been concentrated in two basins. Of primary interest is the Sirte basin in east-central Libya.

Since drilling activities commenced in 1956, 1,572 wells have been completed in Libya, of which 44 per cent were wildcats. In the Sirte basin 12 per cent of the wildcat wells have been successful, and in the Ghadames basin of western Libya 18 per cent have been successful. No oil has been found in the Murzuck or Cufra basins.

More than 11 million feet of hole has been drilled, 4.84 million feet of which has been wildcat drilling. Eighty-five oil fields, 59 in the Sirte basin and 26 in the Ghadames basin, have been discovered by means of wildcat drilling. It is estimated that more than 9 billion barrels of oil in place have been found. Individual pool reserves range from a few thousand barrels to more than one billion barrels of recoverable oil. The largest reserves are in Eocene and Cretaceous rocks of the Sirte basin.

At the end of 1961, one company was producing at the rate of 40 thousand barrels per day. Today five companies are producing more than 1.25 million barrels per day.

Industry has spent over 1.3 billion dollars in the search for oil, increasing from 33 million dollars in 1957 to more than 270 million dollars in 1964.

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Low-Angle Regional Unconformities

Brief periods of erosion without concurrent structural deformation have produced low-angle regional unconformities. These unconformities may provide the environment for stratigraphic traps where hydrocarbons accumulate within the truncated beds. However, the slight amount of erosional stripping (a few feet per mile) and the absence of significant changes in the lithology make the detection of these low-angle regional unconformities difficult. The chances of recognizing and delineating them seem to depend, at least in part, on the selection of a datum.

Low-angle regional unconformities are common in the Western Canada basin. Only three were selected as examples, because they occur in a sequence generally considered to be one continuous depositional unit: (1) beneath the Mississippian Debolt, (2) beneath the Devonian Calmar, and (3) beneath the Devonian Ireton Formations.

Slight variations in local rates of subsidence effect continuous changes in the direction of the depositional dip. These changes from formation to formation generally are minor. When sedimentation resumes after an hiatus, its new depositional dip represents the cumulative shift in regional tilt gradually introduced during the absence of deposition. The new dip direction in many cases relocated individual members of a sedimentary cycle, more especially the occurrence of sand lenses in a clastic province or of reef build-ups in a carbonate-shale sequence.

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Geology of Arctic Islands

The Arctic Islands present opportunities for study of the most completely undeveloped potential oil basin anywhere in the Western Hemisphere. Strata are