FARNHAM GEOLOGICAL SOCIETY

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Field Excursion to the Northern Cotswolds

A coach carrying fifty-three members and friends left Castle Street, Farnham at 7.30am on Saturday 25th June to examine two Jurassic exposures in Oxfordshire.

The first stop of the day was made at Wood Eaton Quarry (sp.535,122). This quarry is located within an inlier of Great Oolite strata which has been pushed up through the Oxford clay to form a dome-like structure. The dip of the beds decreased markedly towards the centre of the quarry where the beds are virtually horizontal. This pericline allows a considerable thickness of strata to be seen in a shallow quarry. The section seen is:

		cm
1.	Rubbly, Khaki micritic limestone, slightly sandy bedding indistinct. Contains abundant fauna of Liostrea sp.	69
2.	Olive-green/grey limey clay with finely comminuted remains of Liostrea sp.	11
3.	Buff, rubbly marl, appears to show two cycles of fining-up. Liostrea sp. and possible Lopha, abundant Epithyris oxonica.	38
4.	Rusty brown marl with silty and clayey layers, coarsening upwards. Distinct shell layer of broken oysters and echinoid remains.	24
5.	Calcareous marl, green/grey weathering to a very light grey, friable. Vertical rootlets picked out as clay, fauna of small bivalves.	65
6.	Sandy limestone, brown/Khaki, clayey towards the base. Fragmented shell debris enhances apparent current-bedding, probable high energy environment.	52
7.	Dark grey clay, silty in places with rootlets and small logs.	seen 50

Beds 5 to 7 are lithologically and faunally similar to the Hampen Marly Beds. The rootlets in Bed 5 are preserved as clayey pipes; the mode of preservation is probably due to the solution of the calcareous component of the bed by organic acids produced by the decomposition of the rootlets. It has been suggested that these beds represent the discharge of a fairly large river into a brackish lagoon.

Beds 1 to 4 are assigned to the White Limestone, a little over half of the sequence being seen. The molluscan fauna, largely of forms tolerant of reduced salinities suggests the environment having been similar to the present day Persian Gulf - a complex of lagoons with restricted circulation with the open sea.

After lunch the party visited Blockley Station Quarry (sp.182,369) where the Upper clays of the Lower Lias are quarried. There is little lithologic variation of sediment within the quarry. Seen was a thick section of blue/grey bioturbated clays with cement-stone concretions. Some of the concretions were found to contain thin platey crystals of sphalerite.

A very varied abundant fauna was yielded and most members of the party returned to Farnham with some very good specimens of the zone fossil (Tragophylloceras ibex) and other ammonites, bivalves and gastropods.

It is intended in this, and all future newsletters, to provide space for members to ask questions on problems they have found when reading articles or even to put forward questions they would like to have asked former lecturers. The committee will undertake to contact the necessary people to find an answer, which will be published along with the original question, in the next newsletter. Any questions should be submitted to the secretary, Dave Taylor.

Question:-

What is the hydrocarbon potential of the North Sea U.K. sector?

Answer:-

The question of the ultimate hydrocarbon reserves in the North Sea U.K. sector cannot be answered with certainty because it is impossible to predict what the results of future exploration will be or to suggest when and with what results, the basin will be completely explored.

I think it is pertinent to give a brief account of the history of oil exploration in the North Sea at this point. Oil was first discovered in the British sector by Amoco in 1969 (eventually became the Montrose field) and caused no excitement outside of the oil industry. The breakthrough came with BP's discovery of the Forties field in November 1970. A spate of oil discoveries in the British sector followed BP's success, the greatest being Shell/Esso's Brent field which at maximum production will produce 500,000 barrels of oil per day (BOPD) - a barrel being 40 gallons. Exploration activity reached a peak level in 1975, with an average of 28 rigs working through the year, 115 exploration and appraisal wells being drilled, with 66 oil wells discovered, although only about one third of these were described as being significant. During 1976 exploration remained at a reasonably high pitch with 25 significant discoveries being announced. Because of the remarkable number of discoveries through 1975 and 1976 North Sea proven reserves have increased by 27% to 10.3 x 10^9 barrels.

Appraisals of oil reserves and production are as abundant as petroleum geologists, and tend to vary with time and context. Current estimates of reserves, as reproduced below, are based upon recent articles in oil industry journals.

Oil reserves:- 24,000 x 10^6 barrels.

Gas reserves:- 51,000 x 10^9 cubic feet.

However present technology does not allow us to extract all of the reserves. Estimates of recoverable reserves are as follows:-

Recoverable reserves of oil :- 16,874 x 10^6 barrels.

Recoverable reserves of natural gas:- 44,400 x 10^9 cubic feet.

Current production of oil in the U.K. sector of the North Sea is 829,000 BOPD. With two more fields expected to begin production this year, U.K. production should exceed the 1,000,000 BOPD mark. This represents more than 50% of current U.K. domestic consumption. Self-sufficiency for the U.K., when five new fields reach full production, is now virtually assured by 1980.

Question:-

What is the significance and origin of Neptunean dykes?

Answer:-

A neptunean dyke is a sedimentary structure consisting of a more or less vertical sheet of sediment, usually sandstone or breccia, which penetrates cracks or fissures within an earlier rock type. They are commonly developed on ancient wave-cut platforms where the contemporary marine sediments infilled cracks within the older rock of the coastal platform. Examples of such features are well seen in the Mendips (Middle Jurassic in Carboniferous Limestone), in the Welsh Borders (Caradocian in Uriconian Pre-Cambrian) and in the North Downs (Tertiary in Chalk). Neptunean dykes are useful to field geologists as they are sometimes the only evidence that deposits of a certain age were ever laid down in a particular area.

Question:-

The Upper Greensand, or 'malmstone', was used extensively for building stone in Surrey. Where were the major stone quarries in the area?

Answer:-

Much of the malmstone used in building, both in Surrey and the London Basin, was mined rather than quarried in extensive workings in the parishes of Merstham and Chaldon, close to Croydon in East Surrey (Sowan 1975). These mines are all drift workings in which tunnels are driven down the dip of the particular bed of stone being worked, widening out into side galleries, or into large areas with massive pillars left to support the roof. The areas exploited were those where there was a low dip to the Upper Greensand of between 5° and 7° as it eased the problems of manhandling the stone to the surface.

In the Farnham and East Hampshire area however the malmstone seems to have definitely been quarried in bell-pits and similar excavations. The location of many of these is now largely forgotten although it is probable that some of the Farnham stone was derived from pits close to the West Surrey College of Art and Design (835,469) and near Runwick House (822,458). Similar small stone workings can be noted in East Hampshire all along the north-south striking Upper Greensand outcrop from Binsted to Selborne and it is this building stone that provides much of the character of these Hampshire villages, (Sowan, P.W., 1975. "Stone mining in East Surrey" Surrey History, Vol.1, No.3).

Question:-

In certain areas of the Atlantic, Indian and Pacific oceans there are high concentrations of manganese nodules. What is their mode of formation?

Answer:-

Most of the world's manganese is exploited from deposits of three types: (i) sedimentary deposits interbedded with volcanic rocks; (ii) chemical precipitates in shallow current-scoured water; (iii) manganese-rich horizons within banded iron formations of Pre-Cambrian age. There is however a fourth situation in which concentrations of manganese occur, which at present is not economical to exploit. These deposits occur as rounded botryoidal nodules of manganese dioxide (pyrolusite) up to a metre in diameter, covering certain areas of the ocean floors.

The nodules are commonly found in association with brown clay deposits (formerly known as 'red clay'). Manganese nodules consist of heterogenous mixtures of a variety of biogenic, detrital and authigenic particles in finely laminated structures (Margolis & Glasby, 1973). The surface of the nodules contain communities of benthic foraminifera which construct tests from available sedimentary particles, held together by a cementing agent secreted by the organism (Dugolinsky et. al, 1977). It is thought that the organism may either gather or secrete manganese oxide particles in the construction of their tests. Dissolution and diagenetic changes of these tests after death may also act as a nucleating surface for the manganese precipitation. The initial growth of the nodule is usually about some small fragment of hard substrate which the foraminifera can attach to, eg. volcanic glass, bones or shark's teeth. The scavenging activities of the benthic foraminifera may help prevent the burial of the nodules by sediment deposition and could explain the anomaly between nodule growth rates (1mm per 10^3 yrs) and sediment accumulation rates (2mm per 10^3 yrs). The manganese is precipitated biogenically from sea water which has been enriched with metal elements during the interaction of seawater with basaltic rock at high temperatures at spreading centres (Thonis & Burns, 1975). In some areas the density of nodules is so great as to constitute a deposit of possible future economic importance.

References:-

Dugolinsky, B.K., S.V. Margolis & W.C. Dudley, 1977. 'Biogenic influence on growth of manganese nodules'. J. Sed. Pet., Vol. 47, p. 428-445.
Margolis, S.V. & G.P. Glasby, 1973. 'Microlaminations in Marine manganese nodules as revealed by scanning electron microscopy' Geol. Soc. Amer. Bull., Vol. 84 p. 3601-3610.
Thonis, T. & R.G. Burns, 1975. 'Manganese ore deposits and plate tectonics'. Nature Vol. 253, p. 614-616.

THE RESERVOIR PRINCIPLE OF MASS MOVEMENT

I am certain that most members of the Society who have been to the Lyme Regis area of Dorset within the past few years have been concerned at the instability of the cliffs. This article is an attempt to explain the mechanisms which govern these instabilities.

The reservoir principle of mass movement, so termed because it describes the effect of groundwater draining from an overlying permeable stratum onto an impermeable plastic stratum, is the overall mechanism by which a landslip complex degenerates more rapidly from a 'solid' to a 'liquid' state than would be the case if the groundwater flow were not present. The principle is chiefly influenced by the geological structure of the area, and the lithological characteristics of the beds.

The acceptance of rainwater into the reservoir (permeable layer) is rapid but its discharge may continue at a decreasing rate until the reservoir is recharged. In the sequence described the majority of the groundwater is discharged along a spring line at the top of the impermeable layer. The result of this process is that the surface zone of the lower stratum becomes softer due to the acceptance of water while deforming under the stresses caused by gravity and the superimcumbent sediments. In the event of rotational slips occuring on the slope, the debris, being disturbed by the movement, permits easier access of the water. The final movement of debris may be more or less viscous in nature.

The effect of the available water is to allow the removal of material from the slope as a landslip or mudflow, so steepening it, which in turn generates further slips to continue the slope erosion.

Generally slides do not occur over a broad front; there is, however, one exception. If the geological conditions are such that the surface of sliding is within a horizontal layer of coarse sand that separates two layers of clay, the width of the slide, measured parallel to the crest of the slope, is likely to be greater than the length of the slide.

The occurrence of geological conditions favouring the application of the principle is widespread: e.g. Scarborough, Yorkshire; Barton-on-Sea, Hampshire; Black Ven, Dorset.

Example:- Black Ven, Dorset

The cliffs at Black Ven, in Lyme Bay, Dorset are within the Jurassic/Cretaceous succession (Fig.1). An unconformity between the base of the Gault Clay and the top of the Lias is an important factor governing the local application of the principle. In this area the Gault is a sandy silt with only a very small percentage of clay. The overlying Upper Greensand and Chert beds are even more permeable. The Lias, which is a marine basin deposit, is an impermeable clay containing thin jointed limestone bands. The Cretaceous materials, which are nearshore sediments, have a sufficiently low plasticity to enable them to flow upon the addition of only a little water.

The geological structure of the area (Fig.2) also plays an important part in the distribution, type and rate of land movement. The overall dip of the beds, both Jurassic and Cretaceous, is generally to the south-east. The presence of a syncline within the cliff complex serves to localise the discharge of groundwater from the cliffs. A similar channelling process occurs in troughs within the plane of the unconformity.

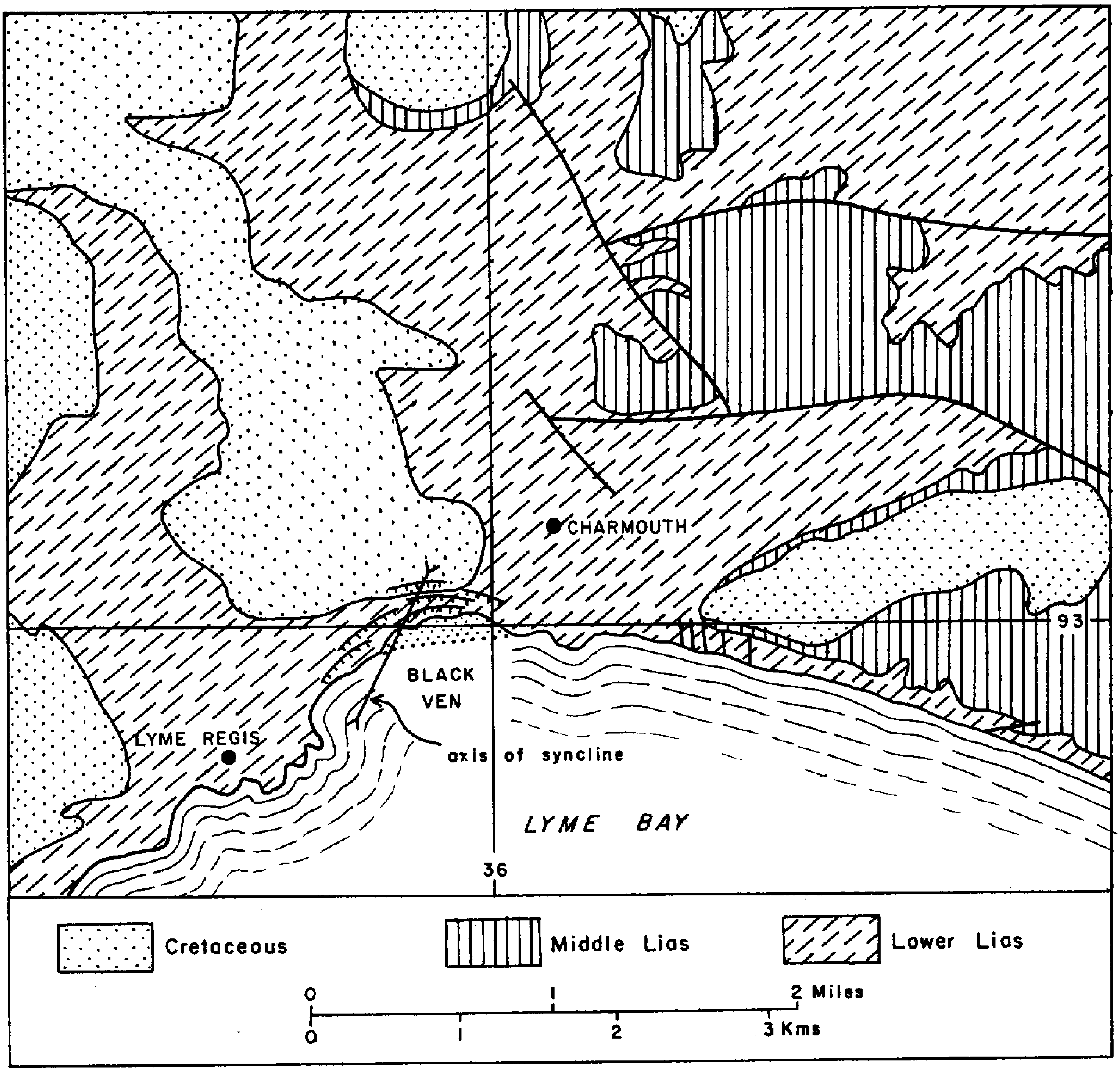


Fig. 1

Geological map of the area showing the relationship between the stratigraphy and the landslip situations.

The majority of the present wasting originates in the upper regions of the cliff section, within the Cretaceous. The height of the steep cliff is more than adequate to permit the generation of stresses in excess of the resistance offered by the low-cohesion Cretaceous material. The consequent collapse by rotational slipping results in the accumulation of a cohesionless material at the uppermost ledge on the cliff. This material is then supplied with copious water from the Cretaceous strata and converts to an arenaceous flow material which rapidly flows to lower ledges where even more water is available and the flow eventually descends to the sea. As a result the upper cliff is deprived of its 'toe' and the stress is again able to reach the level necessary to regenerate the cycle of instability.

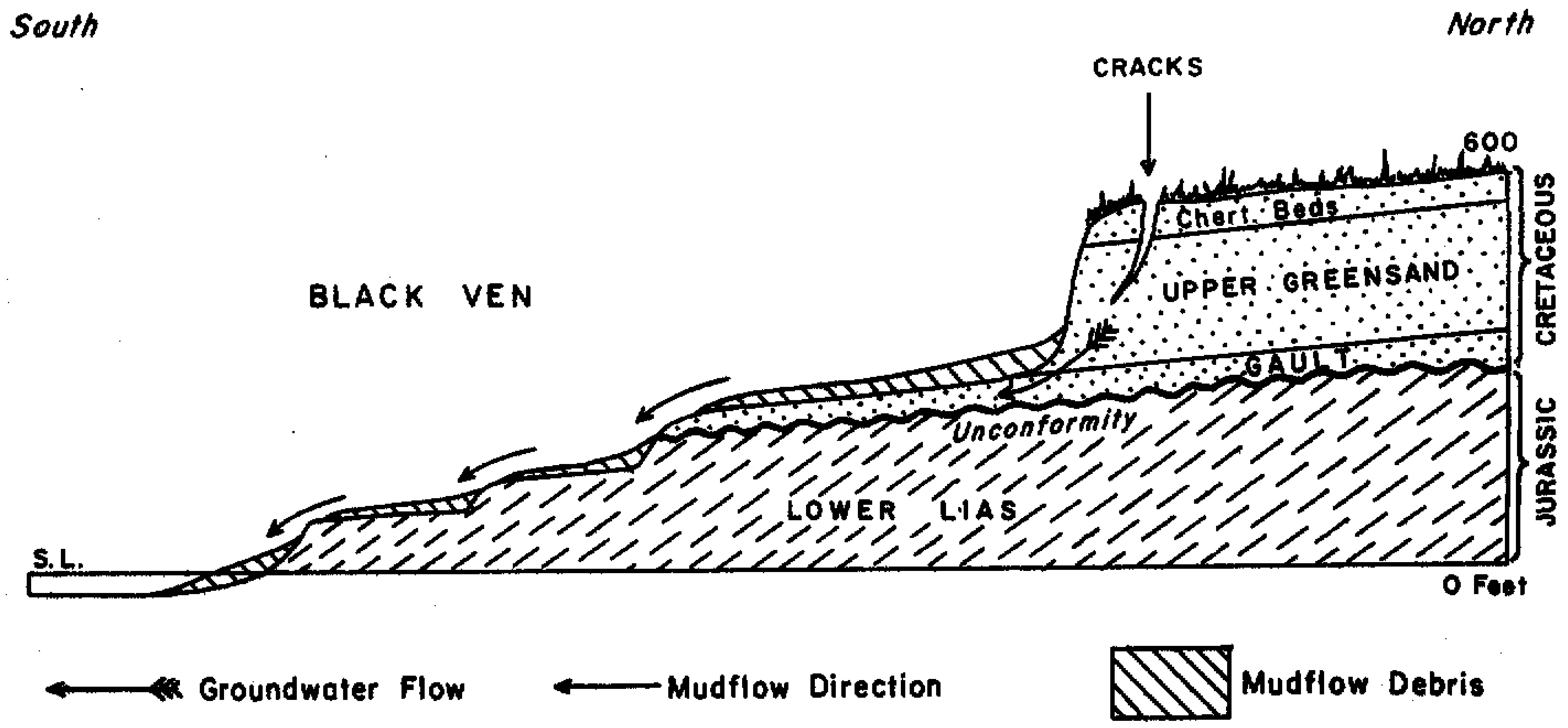


Fig. 2

Schematic cross-section through the Black Ven cliff complex

As the land above Black Ven is open, and there is no immediate threat to any buildings, there has been little effort made to prevent any further degeneration of the cliff complex. Some degree of stability might be achieved by constructing a retaining wall at the edge of the Lias ledge, to prevent further removal of the 'toe', in conjuction with some measure of drainage away from the reservoir.

This article is based on work undertaken by the Institute of Geological Sciences:- Denness, B. 1972. "The reservoir principle of mass movement". Rep. No. 72/7. Inst.Geol. Sci.

Dave Taylor

THE SOUTHERN NORTH SEA:- A NATURAL GAS PROVINCE

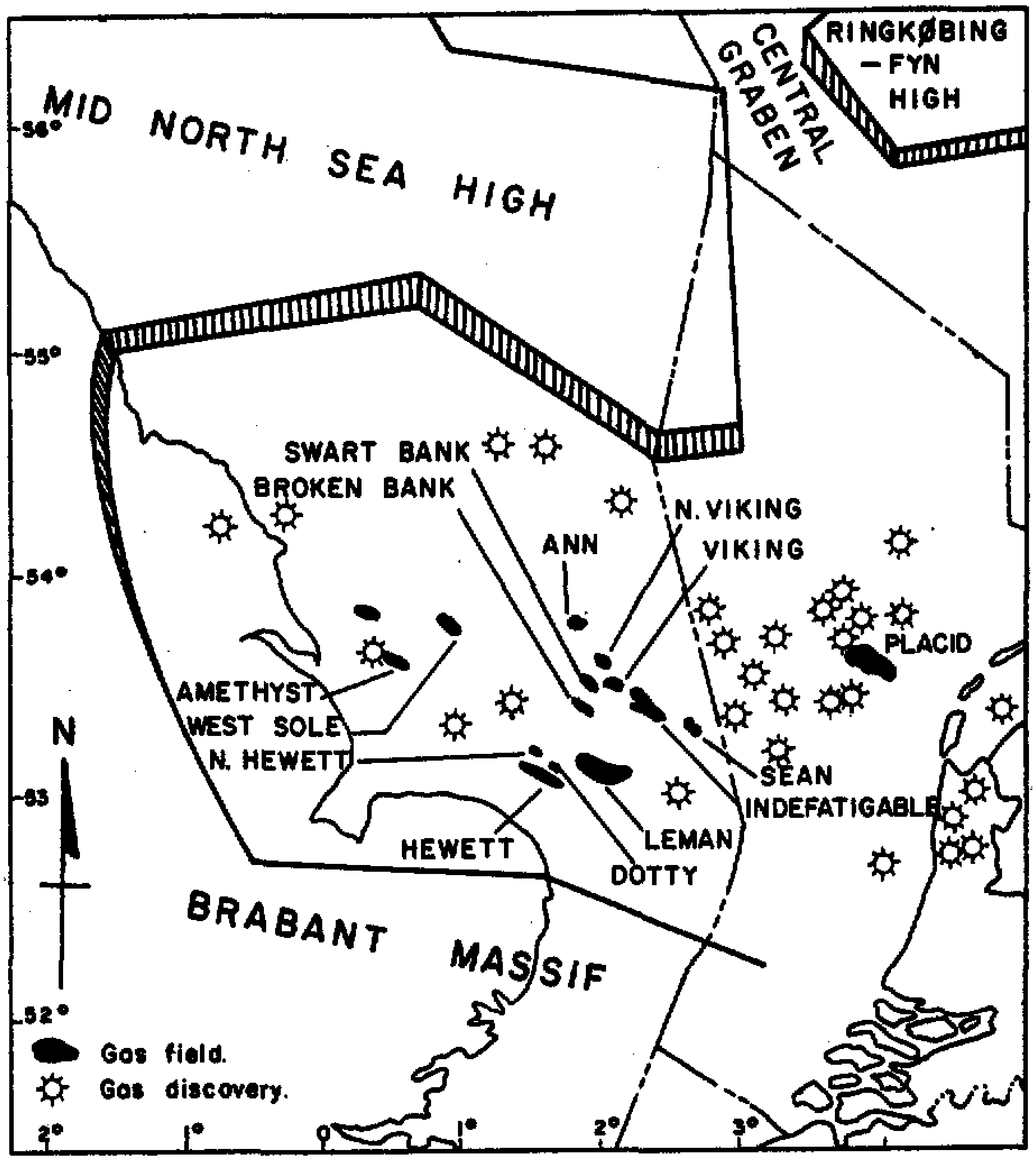
It has become conventional for exploration geologists to divide the North Sea into two major regions: the Southern North Sea and the Northern North Sea. This subdivision is based on geological and physiographical grounds. The Southern North Sea (Fig. 1) is primarily a gas prospective area with a geological sequence comprising a thick section of Permo-Triassic red-bed sediments, frequently overlain by Cretaceous and only thin Tertiary sediments. Towards the end of the Jurassic there were periods of earth movements (Late Kimmerian episode) resulting in considerable faulting and it is in these tilted fault blocks and horsts that the majority of the Southern North Sea gas reserves have been found.

Erosion has been widespread in and about the field areas but fortunately, since the important Rotliegendes reservoir rocks and the Carboniferous source rocks are at the base of the sedimentary sequence they have not been breached and the gas generative and trapping mechanisms have survived undisturbed.

There is little doubt that the gas found in the Rotliegendes reservoirs of the Southern North Sea area has its source in the coal and carbonaceous material in the underlying Carboniferous. The geological conditions under which devolatilization of the coals has occured is, therefore, an important factor in understanding the petroleum geology of the area.

Depth of burial by itself has not subjected coals to sufficiently high temperatures to have caused devolatilization. A slight reduction of volatile content can be attributed to bacterial reduction, but is restricted to low rank coals. Progressive devolatilization at high temperatures results in an increase in the rank of coals. The devolatilization of high rank coals has been caused by heat from plutonic igneous intrusions and by frictional heat generated during strong tectonic folding and thrusting. These igneous intrusions, which are probably of Upper Cretaceous or Tertiary age, have caused devolatilization of the Carboniferous coals, and the gas has migrated at a relatively late stage into the Permo-Triassic reservoirs in structural traps of pre-Cretaceous age.

Fig. 1



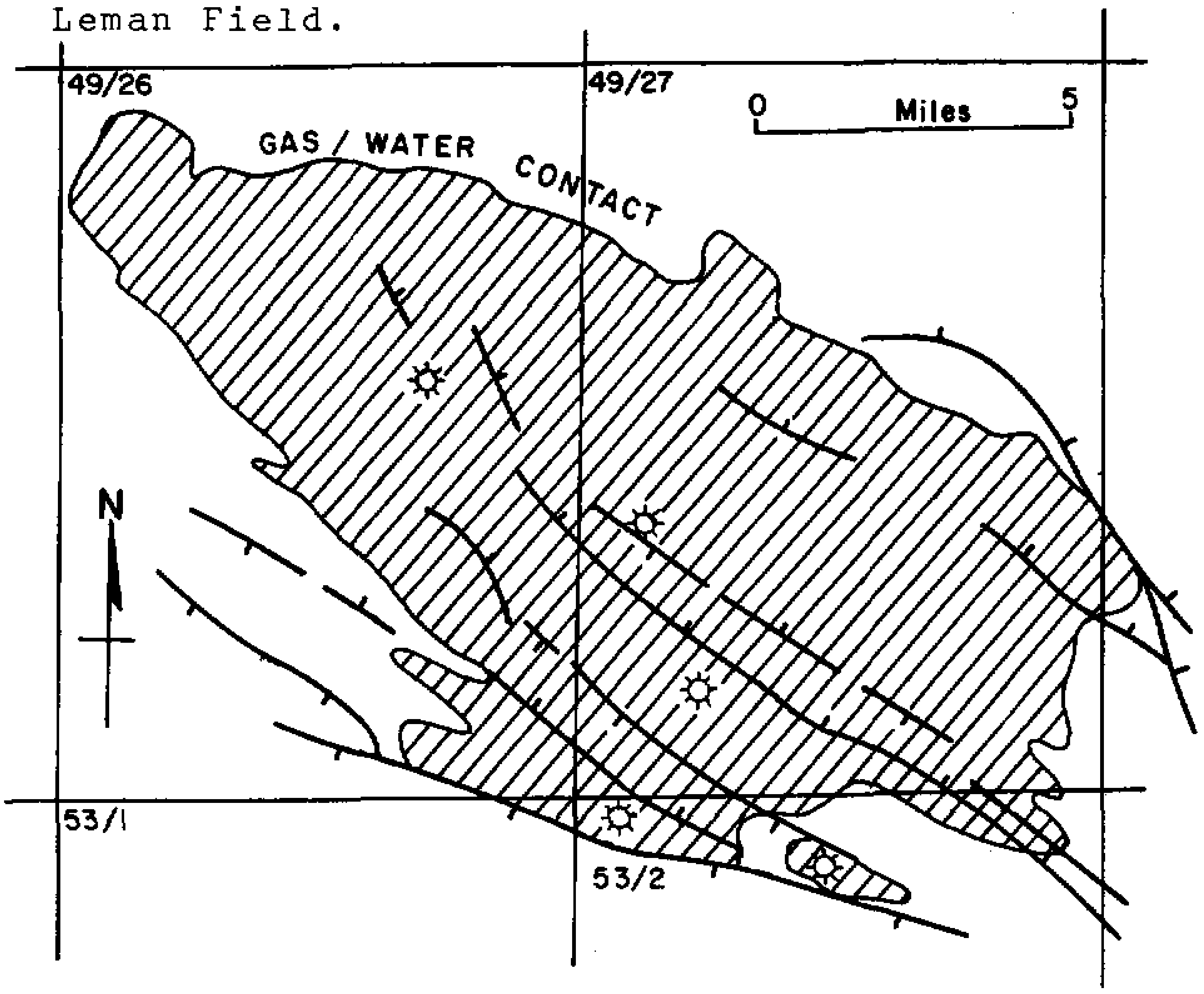
Major structural features of the Southern North Sea, with gas discovery and gas field locations.

Example:- LEMAN FIELD

The Leman Field, discovered by Shell/Esso in April 1966, is the largest offshore gas field in the Southern North Sea and is approximately 18 miles long by 8 miles wide (Fig 2a). The field is a broad gentle anticline with a crest which trends NW-SE, parallel to the dominant Hercynian structural grain, which is broken by several minor faults (Fig 2b). The reservoir rock is 770 feet of Rotliegendes sandstone with estimated recoverable reserves of 10.5 trillion cubic feet.

Fig. 2a

Sketch map showing location and extent of the Leman Field.



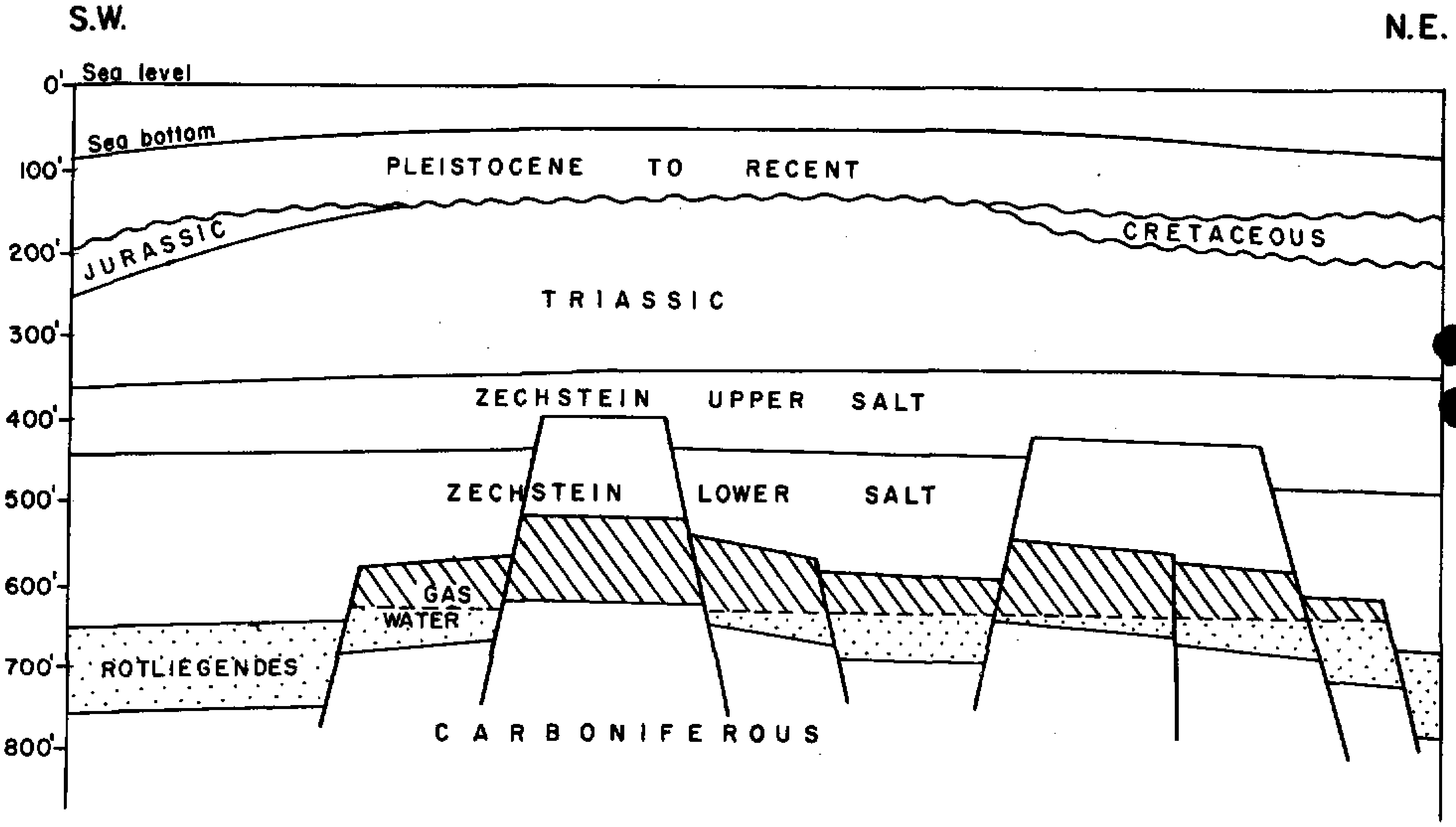


Fig. 2b Diagrammatic cross-section through the Leman Field.

The Rotliegendes consists of three units: a lower unit of wadi deposits with aeolian sands; a middle unit of aeolian dune-bedded sandstones some 450-650 feet thick; and an upper unit of water laid sands. The overlying Zechstein is predominantly a sequence of evaporites and forms an effective seal to the Leman gas accumulation.

D. Taylor