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by

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INTRODUCTION

The Devonian and Lower Carboniferous sediments of the Lennard Shelf (the northern structural subdivision of the Canning Basin) are believed to form one of the most prospective sequences for petroleum in Western Australia. The Lower Carboniferous rocks in Meda no.1 produced a little oil, and the well developed Devonian reef complexes of the area resemble those that have yielded prolific oilfields in other parts of the world.

The Geological Survey of Western Australia is at present conducting a detailed investigation of these rocks. The Devonian reef complexes are well exposed, and a great deal of information can be obtained on them through field studies. However exposures of the uppermost Devonian and Lower Carboniferous units are very poor, and relatively little information regarding their lithology and stratigraphic relationships can be obtained at the surface. It is of considerable importance to the search for oil on the Lennard Shelf that the lithofacies variations of these rocks, and their relationship to the Devonian reef complexes, should be known in as much detail as possible. It seems that the only way in which this information can be obtained is through drilling.

DEVONIAN REEF COMPLEXES

The Devonian reef complexes on the Lennard Shelf range from Middle to Upper Devonian in age. Three basic facies are represented, and are referred to as the barrier reef, fore-reef, and platform facies. No sediments of the basin facies have yet been recognized with certainty.

In each reef complex the platform facies generally consists of biostromal beds built up of stromatoporoids and algae which grew close to sea level on a broad, flat pla form. A barrier reef facies is generally developed along

the seaward margin of the platform, though it is absent in parts of some of the reef complexes. The reef is represented by a massive limestone, built up of algae, stromatoporoids, sponges, brachiopods, and other organisms, and varies from a few feet to a mile or more in width of outcrop. The barrier reef is fronted by extensive fore-reef facies, made up of talus deposits which were derived for the most part by erosion of the growing reef. The fore-reef deposits are mainly calcarenites and calcirudites, including some spectacular megabreccias. Masses of algal limestone in the fore-reef deposits which were previously regarded as bioherms (Smith, Playford,and Williams,1957; Playford and Johnstone, 1959) are now recognized as large blocks of reef which have broken away and rolled down the fore-reef slope. In some areas the fore-reef deposits also include substantial amounts of terrigenous detritus.

The reef complexes can be expected to have good porosity and permeability in the subsurface , and thus act as suitable reservoir rocks. In the Meda wells and the 67-mile bore, excellent porosity and permeability occurred in dolomites interpreted as forming part of Devonian reef complexes. However no satisfactory cap rocks were present overlying the reef complexes in those wells.

An unknown factor with regard to the prospects of the reef complexes of the Lennard Shelf is the character of the basin sediments or any other likely source rocks. The origin of the oil found in reef complexes elsewhere in the world is in many cases problematical, but it appears that the source is not to be found in the reefs themselves, but in the associated facies or in younger sediments overlapping the reef complexes. Any area of the Lennard Shelf where shale is closely associated with the reefs is likely to be more prospective than those areas where shale is lacking.

Such shales may have acted as oil source rocks, and if they extend over the reef complexes would provide the necessary cap rocks. Stratigraphic drilling could do much to assist in locating areas where these favourable rocks are present.

FAIRFIELD AND LAUREL BEDS

The Fairfield Beds are an interbedded sequence of limestone and terrigenous clastic sediments, including shale, siltstone, and sandstone. The unit has been dated as late Famennian (latest Devonian) in age (Teichert, 1943). Smith, Playford, and Williams (1957) suggested that it is a post-reef-complex deposit, though they presented no clear evidence to support this. Subsequent work by the Geological Survey has shown that the Fairfield Formation as mapped in some areas by Guppy et al. (1958) forms part of the fore-reef facies, and other exposures may be best considered as basin facies. However it is nevertheless possible, if not probable, that "true" Fairfield post-dates the reef complexes, and this hypothesis should be further tested.

The upper part of the Fairfield Beds of Guppy et al. was separated out by Thomas (1957) as the Laurel Beds, the basis for this division being that the upper beds contained Lower Carboniferous (Tournaisian) fossils, distinct from the Upper Devonian (Famennian) assemblage of the lower beds. Thomas also suggested that the contact between the two units is an unconformity, though this was not based on field observations. Jones (in Veevers and Wells, 1961) has pointed out that there is really no evidence of any hiatus between the units.

Examination of the Fairfield and Laurel Beds in the field by geologists of the Geological Survey has so far

failed to find any satisfactory means for separating them on a lithological basis. If subsequent work confirms this opinion, and no satisfactory evidence is obtained to support the postulated unconformity, it would seem advisable to revert to the original usage of the name Fairfield to include the Lower Carboniferous rocks.

The recovery of a few gallons of oil from a slightly porous sandstone in the Laurel Beds in Meda no. 1 well has resulted in greatly increased interest in the oil prospects of the Fairfield-Laurel sequence. Unfortunately the facies of these units in the Meda area is not promising, as the sandstones have only low porosity. This situation may improve elsewhere on the Shelf, and facies studies should play a big part in prospecting the Fairfield and Laurel Beds. At present the only significant control is from the Meda, Sisters, and Laurel Downs wells, and stratigraphic drilling of this interval in other areas for facies analysis would be well worth while.

RECOMMENDED DRILLING

Stratigraphic drilling of the Fairfield and Laurel Beds in the area around 12-mile bore on Brooking Springs Station would provide important information regarding the facies developed in these units adjacent to a well known Devonian reef complex, and should at the same time indicate whether the Fairfield Beds were indeed deposited after reef growth ceased.

Details of the geology of the 12-mile bore area, together with the recommended well locations, are shown on the accompanying map. This map is traced from photo 5150, Lennard River Run 15. The bore is located on the Lennard River four-mile Sheet, about 30 miles from Fitzroy Crossing.

The poor exposures of Laurel Beds around 12-mile bore

were designated by Thomas (1957) as one of the two type sections of the unit. He did not quote a thickness for this section, but Williams and McKellar (1959) state that it is about 700 feet. The outcrop of Laurel Beds is limited on the north- east by a fault which is thought to be normal, dipping to the south-west at a high angle. The throw of this fault is not known, though it is probably not large. On the other side of the fault there are no exposures before reaching the Devonian reef complex of the Oscar Range, except for a few small patches of shale and fine-grained calcareous sandstone in a creek bed, which are believed to belong to the Fairfield Beds.

Three facies of the Oscar Range reef complex are exposed in the area - the fore-reef, barrier reef, and biostromal (platform) facies. The reef complex rests on steeply folded Precambrian metamorphic rocks.

A prominent line on the air photos which extends all along the front of the Oscar Range a short distance in front of the limestone exposures was interpreted by Smith, Playford, and Williams (1957) as representing the outer edge of the fore-reef deposits. This is believed to be the most likely explanation, though it could alternatively be due to a fault.

Well no. 1 is proposed primarily to obtain information on the relationship between the sediments in front of the reef complex and the reef complex itself. The proposed location is about 200 yards in front of the line which may represent the outer edge of the fore-reef deposits. If this interpretation of the line is correct the well should pass abruptly from the soft sediments fronting the reef complex into the hard calcarenites and calcirudites of the fore-reef, at a depth of about 350 feet (assuming a fore-reef slope of some 30°), and this would confirm that the Fairfield Beds were deposited after reef growth had ceased.

Wells 2 and 3 are recommended to obtain additional lithological information on a substantial thickness of the sediments in front of the reef complex. Each should be drilled to a depth of about 1,000 feet, and together they should cover much of the section present in front of the reef complex. No. 3 could be terminated if it enters a section which can be correlated with confidence with that encountered in no.2.

An alternative proposal would be to omit drilling at site no. 2, and to take the well at site no. 3 down to 2,000 feet or more, but this would be controlled by the capacity of the drill used. An adequate coring programme would be essential to obtain maximum value out of such important stratigraphic wells.

Another area where significant information could be obtained on the Devonian and Lower Carboniferous sediments fronting the reef complexes is in the "Brooking Embayment" (the area between Brooking and Geikie Gorges). The shallow water bores in this area, none of which were successful, record black shale beneath the black-soil plain. A sample of such shale from the "Mad Russian's well" in this embayment three miles north of Brooking Springs Homestead contained a Famennian microfloral suite (Edgell,1962).

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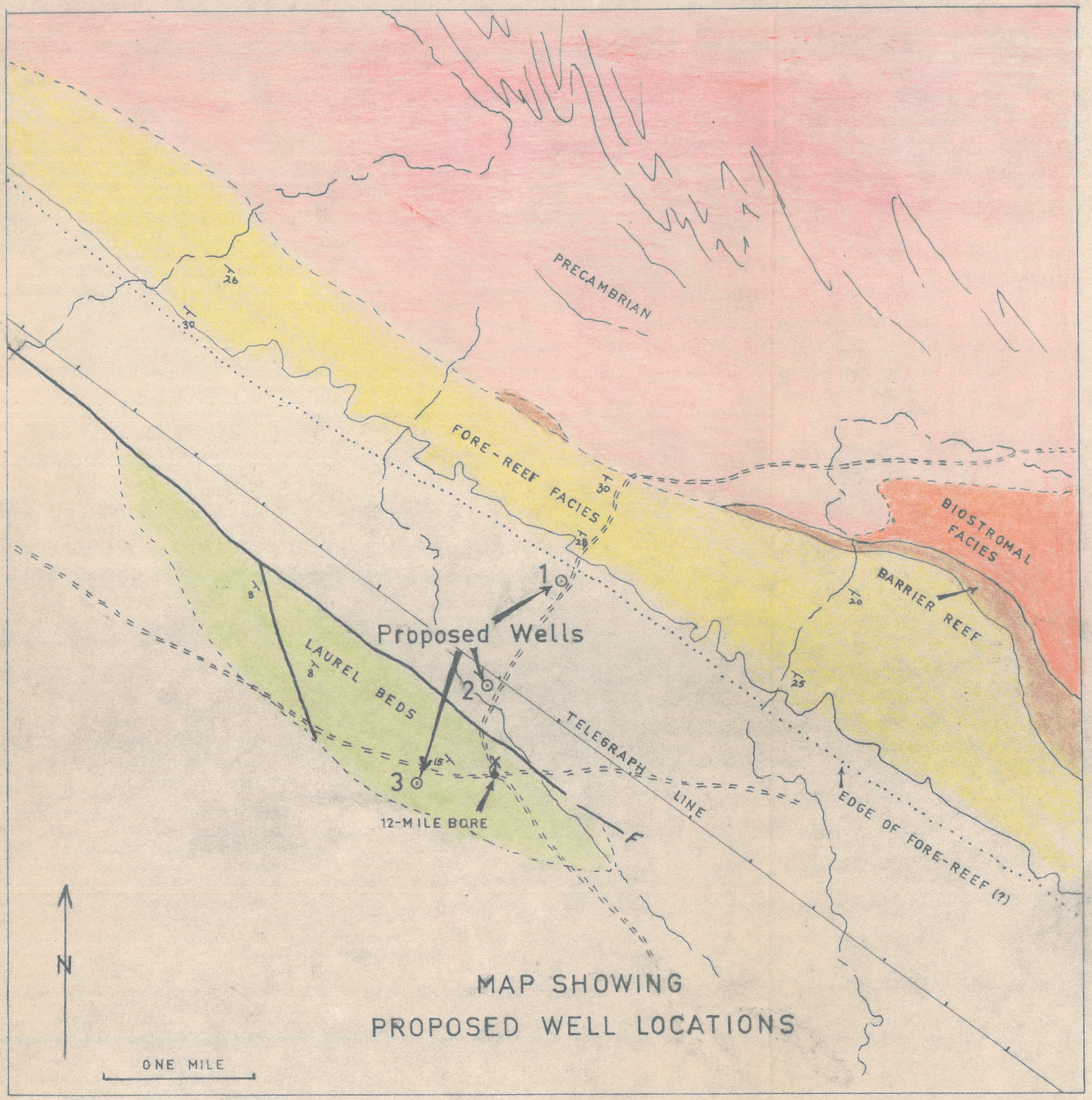

MAP SHOWING
PROPOSED WELL LOCATIONS