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RECORDS:

CORRELATION OF PERMIAN-LOWER TRIASSIC SEDIMENTS, SPRINGSURE-PURBROOK AREA, QUEENSLAND.

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by

E.J. Malone.

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Records 1964/87

CONTENTS

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SUMMARY

The Permian-Lower Triassic sediments exposed in the Springsure Anticline and in Reid's Dome are correlated on the basis of mapping during 1963 and subsequent petrographic studies. This correlation is extended to the sections penetrated in A.F.O. Inderi No. 1, A.F.O. Rolleston No. 1, A.F.O. Purbrook No. 1, and Planet Warrinilla North No. 1 wells.

INTRODUCTION

A combined Bureau of Mineral Resources and Geological Survey of Queensland field party mapped the Springsure 1:250,000 Sheet area during 1963. This mapping resulted in some revision of the Permian-Lower Triassic stratigraphy of the area and the recognition of one newly named unit, the Peawaddy Formation. The mapping and section measuring also suggested an alternative interpretation of the interval between the Cattle Creek Formation and the Ingelara Formation in Reid's Dome. This interval was mapped as Aldebaran Sandstone, as it had been previously, (Hill, 1957) but the possibility that it contained equivalents of the Staircase Sandstone and Sirius Formation as well as the Aldebaran Sandstone is discussed in the report on the season's mapping (Mollan, Exon and Kirkegaard, 1964) Petrographic data now available (Bastian, 1964) supports the alternative correlation which is followed in this paper. The correlation of outcrop sections in the Springsure Anticline and in Reid's Dome presented in this record is based mainly on the 1963 Springsure Party mapping. The report on this mapping (Mollan et al, 1964) includes a correlation of the section encountered in many oil wells, including A.F.O. Inderi No. 1, A.F.O. Purbrook No. 1, and Planet Warrinilla No. 1, with the surface stratigraphy. The purpose of this record is to show in more detail that the revised stratigraphy can be recognised in oil wells in the area, albeit tentatively in some cases. It takes into account some new information and includes correlation with the Rolleston No. 1 well. Composite well logs from the Well Completion Reports of A.F.O. Inderi No. 1, A.F.O. Purbrook No. 1 and Planet Warrinilla North No. 1 were used in compiling the correlation chart. These show the formations recognised by the company geologists. A.F.O. Rolleston No. 1 is represented by an electric log reduced to 100 feet to 1 inch scale.

The four wells were subsidized by the Commonwealth Government under the Petroleum Search Subsidy Act. Under the terms of the Act, the Well Completion Reports of the first three wells are available for examination. The Rolleston Completion Report will be available on 14th August 1964; it was not available at the time of writing this record.

Correlation of outcrop sections

The revised Permian-Lower Triassic stratigraphy of the eastern part of the Springsure Sheet area is summarised in Table 1. It is effectively a revision of the stratigraphy published by Phillips (in Hill and Denmead, 1960, pp. 185-193) which was the most recently published important contribution to the stratigraphy of the area. Examination of the many fossils collected during 1963, as well as previously collected material (Dickins, 1964) indicates the general time equivalence of the Cattle Creek Formation exposed in Reid's Dome, and the Stanleigh Formation exposed in the Springsure Anticline. The lithologies are also similar and Stanleigh Formation is probably a synonym for Cattle Creek Formation. It also indicates that the Sirius Formation of the Springsure Anticline is possibly younger than the Cattle Creek Formation, though this is tentative. However, the evidence certainly does not prove that the Sirius Formation is equivalent to the top part of the Cattle Creek Formation as suggested by Phillips (in Hill and Denmead, 1960, p.191).

In outcrop in the Springsure Anticline, the Orion Formation appears to be conformably and possibly transitionally below the Stanleigh Formation. In A.O.E. Reid's Dome No. 1 Well, the Undivided Freshwater Sediments are conformably and possibly transitionally below the Cattle Creek Formation. Since the Cattle Creek and Stanleigh Formations are equivalent, the Orion Formation is in a similar stratigraphic position to that of the Undivided Freshwater Sediments and is correlated with the upper part of the Undivided Freshwater Sediments at least. The two units contain a Glossopteris flora and are generally similar in lithology.

Correlation of the intervals between the Stanleigh Formation and Catherine Sandstone of the Springsure Anticline, and the Cattle Creek Formation and Catherine Sandstone of Reid's Dome, as shown in Plate 1, is partly based on petrographic data described in detail elsewhere (Bastian, 1964). These data and descriptions of cuttings from the same interval in Warrinilla North No. 1 (Ammin, 1964) are summarised in Table 2. In considering these data, it must be realised that the three sand units, the Staircase, Aldebaran and Catherine Sandstones, are generally similar. All three were deposited in much the same area and were derived from much the same provenance. The lithological differences between them are probably the result of variations in depositional environment, methods of transport and climate. In addition the three units show considerable lateral variation in lithology. They are easily recognised in the Springsure Anticline where the Sirius and Ingelara Formations, dominantly shaly units, separate the Staircase Sandstone from the Aldebaran Sandstone and the Aldebaran

TABLE 1. Permian - Lower Triassic Stratigraphy of the eastern part of the Springsure 1:250,000 Sheet area

	Unit		Palynological Zones	Macropalaeontological Faunas
Lower Triassic	Rewan Formation		R	
Upper Permian to Lower Triassic	Bandanna Formation	Upper Part	P4 (R in top part)	
		Lower Part	P3d	
?Lower Permian to Upper Permian	Peawaddy Formation (Mantuan Productus Beds at top)		P3b	Fauna IV
Lower Permian	Catherine Sandstone Ingelara Formation			Fauna III
	Aldebaran Sandstone		P3a	
	Sirius Formation Staircase Sandstone Cattle Creek Formation (?=Stanleigh Formation)		P2	Fauna II (possibly Fauna I at base)
	Orion Formation (=Undivided Freshwater Sediments, in part at least)		P1	

Palynology based on Evans (1963, a and b), and Hodgson (1963). Palynological zones defined in Evans, 1962. Macropalaeontological determinations by Dr. J. F. Dear, Geological Survey of Queensland, and J. M. Dickins, Bureau of Mineral Resources. Faunas II, III, and IV are defined in Dickins, Malone and Jensen (1964).

TABLE 2.

COMPARISON OF LITHOLOGICAL DATA

Unit	Springsure Anticline		Reid's Dome		Warrinilla North No. 1	
	General Description	Average composition of sandstone	General Description	Average Composition of sandstone	General Description	Average Composition of sandstone
Catherine Sandstone	Mainly quartz sandstone; contains more silt and shale than in Reid's Dome. 400' thick.	Quartz, 60%; feldspar, 5%-10%; shale and low grade metamorphic fragments, 10%; minor mica and chert; matrix 15%.	Mainly quartz sandstone with minor conglomerate. 380' thick, lensing to 0' southwards.	Quartz, 60%-70% K feldspar 5%-10%; plagioclase rare; muscovite, <5%; sericitised grains, 15%, matrix 15-20%. Tourmaline and zircon are common accessories	Fine to medium grained quartz sandstone. 125' thick.	Quartz, 75%; feldspar, 15%, K feldspar plagioclase; chert and kaolinitic matrix, 15%.
Ingelara Formation	Mainly siltstone and shale; some sandy interbeds and calcareous fossiliferous zones. 650' thick.		Mainly siltstone and shale; with many sandy interbeds in basal 200 feet. Some calcareous, fossiliferous zones. 320' thick.		Mainly siltstone and shale; somewhat pebbly near base. 155' thick.	
Aldebaran Sandstone	Quartz sandstone, conglomeratic in part, some siltstone. Pebbles include quartz sandstone, quartz, conglomerate, some volcanics. 1600' thick, thins southwards to 1000' in Aldebaran Creek.	Quartz 40-80%, less abundant in lower part. Feldspar, absent, except near base. 'Chert' 20%; minor muscovite; kaolinitic matrix, 10-15%.	Fine to coarse quartz sandstone, conglomeratic in places. Angular conglomerate at base containing pebbles of siltstone, carbonaceous shale, fine sandstone. 670'.	artz, 70%; ldspar abent; chert, %; sedimenary rock fragents, mainly hale 10%; inor muscote; kaolinitic atrix 10-15%.	Quartz sandstone, conglomeratic in part; siltstone and shale interbeds; conglomerate abundant near base. Conglomerate pebbles include quartz, quartzite, sandstone, siltstone, shale, some volcanics. 865' thick.	Quartz, 70-75%; K feldspar, 5-10%; chert and kaolinitic matrix, 10-20%.
Sirius Formation	Siltstone, shale, some sandy interbeds and calcareous fossiliferous zones. 250' thick.		Fine-medium sandstone with siltstone interbeds and carbonaceous laminae. 135' thick.		Siltstone, some sandstone. 70' thick.	
Staircase Sandstone	Mainly medium grained quartz sandstone, some conglomerate. Conglomeratic pebbles include quartz porphyry, vitric tuff, and quartz sandstone. 740', thickening southward.	Quartz, 40-65%; 'chert' 30%; K feldspar, 3-5%; rock fragments common; muscovite minor or absent; kaolinitic matrix 5-10%.	Mainly fine to coarse quartz sandstone with granule pebble and cobble beds in places; some black carbonaceous laminae, and siltstone interbeds. 1060' thick.	Quartz, 70% feldspar, 5% chert 5-10%; sedimentary rock fragments 5%-10%; kaolinitic matrix 5-10%.	Mainly quartz sandstone, fine to very coarse, conglomeratic in part, with many shale and siltstone interbeds. 705' thick.	Quartz, 60%; feldspar, 10-15% chert and kaolinitic matrix and cement, 15-25%.

Sandstone from the Catherine Sandstone, respectively. The Ingelara Formation is present in Reid's Dome, and can be recognised in the subsurface in Warrinilla North No. 1 and Rolleston No. 1, overlain by the Catherine Sandstone. The Sirius Formation, on the other hand, in the Reid's Dome Section is either absent, poorly represented within the dominantly sandy section above the Cattle Creek Formation or is equivalent to the top part of the Cattle Creek Formation.

If the latter, then the Staircase Sandstone must have lensed out between the Springsure Anticline and the northern end of Reid's Dome because it is not represented within the Cattle Creek Formation. This does not seem likely because the thicknesses measured (Mollan et al, 1964) at the southern end of the Springsure Anticline suggest the Staircase Sandstone is thickening southwards. Thus, instead of lensing out southwards, the Staircase Sandstone is probably represented by the 1060 feet of section above the Cattle Creek Formation in Reid's Dome. This interval varies more in grainsize than does the Staircase Sandstone of the Springsure Anticline and contains more quartz and less chert but otherwise is of similar lithology. The 135 feet of section above that regarded as Staircase Sandstone is equated with the Sirius Formation. Within this interval siltstone and sandstone crop out; several beds which are not exposed are possibly fine grained sediments. Immediately below this interval is a fine grained, white silty sandstone containing abundant worm tracks and tubes. A similar lithology with abundant worm markings is immediately below the Sirius Formation in the Springsure Anticline. The 670 feet of section below the Ingelara Formation and above the possible Sirius Formation in Reid's Dome is regarded as Aldebaran Sandstone. This thickness is compatible with the southward thinning of the Aldebaran Sandstone revealed in outcrop in the Springsure Anticline (Mollan et al, 1964). The basal 70 feet of this interval consists mainly of conglomerate containing angular and rounded fragments of dark, carbonaceous siltstone and shale similar to lithologies in the Sirius Formation. The conglomerate at the base of the Aldebaran Sandstone in Reid's Dome may mark a disconformity and was possibly produced by erosion of Sirius Formation. The Aldebaran Sandstone in Reid's Dome contains considerably more sedimentary rock fragments, mainly shale, than it does in outcrop in the Springsure Anticline. In both areas, the lack of feldspar and the significantly greater amount of matrix distinguishes the Aldebaran Sandstone from the Staircase Sandstone.

A similar three-fold subdivision can be recognised in the interval between the Ingelara and Cattle Creek Formations in Warrinilla North No. 1. The section regarded as Staircase Sandstone is finer grained and contains a higher percentage of feldspar than in outcrop. The 70 feet regarded as

Sirius Formation is a dominantly silt/shale unit. The Aldebaran Sandstone equivalent above it has a basal conglomeratic development; it differs from outcrop in containing considerable feldspar but still much less than is contained in the Staircase Sandstone below.

The Catherine Sandstone can be traced in outcrop from the Springsure Anticline to Reid's Dome and fairly reliably recognised in Warrinilla North No. 1. It is included in Table 2 mainly to indicate the range of lateral variation in these sand bodies. In the main, the shale and low grade metamorphic clasts in the Catherine Sandstone of the Springsure Anticline and the sericitised grains of its outcrop in Reid's Dome are absent in Warrinilla North No. 1; they are replaced by an increase in percentage of quartz and feldspar. The Aldebaran Sandstone also shows some lateral variation from no feldspar in Reid's Dome to 5%-10% in Warrinilla North No. 1. This variation is the same as the main criterion distinguishing the Aldebaran Sandstone from the Staircase Sandstone in Reid's Dome. However, the lateral variation in feldspar content of the Aldebaran Sandstone takes place over a considerable distance; the change in the Reid's Dome section from a consistent 5%-10% of feldspar in the Staircase Sandstone to the equally consistent absence of feldspar in the Aldebaran Sandstone takes place over a stratigraphic interval of only 135 feet. Thus, despite the lateral variation within the sandstone units, the lithological differences between them in each section appear to be significant and support the correlation proposed.

The name Catherine Sandstone is restricted to the dominantly quartz sandstone unit as originally defined by Reid (1930). The upper siltstone, shale and lithic sandstone of the "Catherine Sandstone" of Hill (1957) is included in a newly named unit, the Peawaddy Formation (Mollan, et al, 1964) which contains lenses of lithic sandstone particularly near the top. The lithic sandstone is generally quite distinct from the Catherine Sandstone (Bastian, 1964). The Mantuan Productus Beds, (actually discrete coquinitic lenses) occurs at the top of the Peawaddy Formation in places, associated with calcareous lithic sandstone or calcareous siltstone. The Bandanna Formation on the whole is poorly exposed and only a partial section has been measured in it. The upper and lower parts of the Bandanna Formation, as recognised in the wells, can be recognised in outcrop though they have not been mapped.

Correlation of outcrop and well sections

The outcrop sections are correlated with the four wells, A.F.O. Inderi No. 1, A.F.O. Rolleston No. 1, A.F.O. Purbrook No. 1 and Planet Warrinilla North No. 1. Correlation is mainly be means of gross lithological features. The Mantuan Productus Beds mark one of the few horizons which can be traced in both outcrop and wells. Its recognition in Warrinilla North is confirmed by the fauna contained in core 12, (2956'-2991') cut in this unit, and the same horizon can be recognised in the other wells. Examination of cuttings from Warrinilla North (Armin, 1964) shows that the Staircase, Aldebaran and Catherine Sandstones, as recognised in this Record, show some lateral variation but are generally similar to the same units in outcrop. Their lithologies and their positions relative to one another help to identify them. Palaeontological and palynological data were useful in correlation, generally of fairly broad units, and in some cases they defined formation boundaries fairly closely. Correlation between wells, by means of the electric and composite logs, is generally reliable, though recognition of individual formations is tentative in some wells.

The Orion Formation is recognised on lithology and stratigraphic position in Inderi, Rolleston and Warrinilla North but is absent from Purbrook. It is distinguished on the electric logs from the overlying Cattle Creek Formation by an increase in overall resistivity and more and sharper resistivity peaks. No information from macropalaeontology or palynology is available in this part of the sequence in this area.

The Cattle Creek Formation, or its equivalent the Stanleigh Formation, is recognised in all four wells. The boundaries coincide with those picked by company geologists. The identification is supported by palynological data in Inderi (Hodgson, 1963) and Warrinilla North (Evans, 1963a) and to some extent in Purbrook (Evans, 1963b) and by macropalaeontology in Inderi (Dear, 1963).

Recognition of the Staircase Sandstone in Warrinilla North is supported by petrographic and palynologic data. The 70 feet thick silty unit between the Staircase Sandstone and the basal conglomerate of the Aldebaran Sandstone in Warrinilla North is, considered to be the equivalent of the Sirius Formation. Its stratigraphic position and lithology are similar to those of the Sirius Formation of Reid's Dome. Identification of the Staircase Sandstone and Sirius Formation in the other three wells is tentative. The two units are probably present in Rolleston and Inderi and possibly in Purbrook. In these wells the sandy sequence immediately above the Cattle Creek Formation is equated with the Staircase Sandstone, and the overlying silty sequence is equated with the Sirius Formation. The boundaries of these units are uncertain. In Rolleston, the top of the Staircase Sandstone could be at 4215 feet and the top of the Sirius Formation at 3990 feet. This problem may be resolved by palynological studies

as the top of the Sirius Formation should coincide with the P2/P3a spore boundary.

The Aldebaran Sandstone, Ingelara Formation and Catherine Sandstone are recognised in all four wells. Recognition of the Ingelara Formation in Warrinilla North is supported by the palynologic data and recognition of the Catherine Sandstone is supported by petrographic data. Electric log correlation of the Catherine Sandstone and Ingelara Formation from Warrinilla North to Rolleston is good and to Purbrook fairly good. The Catherine Sandstone, as recognised herein, is the zone which produced considerable gas in Rolleston No. 1 and Inderi No. 1 and a minor gas show in Warrinilla North No. 1. In Purbrook, the top 4 feet of the Catherine Sandstone is porous but it was not tested as the water saturation, as indicated by the electric logs, was considered to be too high.

Recognition of the Ingelara Formation in the Inderi well is very tentative, as the entire section from the top of the Catherine Sandstone to the base of the Aldebaran Sandstone is dominantly sandy. The presence of P3b spores at 1898 feet in Inderi suggests the presence of the Catherine Sandstone. There are no grounds for assuming the absence of the Catherine Sandstone from the Inderi well, and no part of the section above 1870 feet is lithologically similar to the Catherine Sandstone. Hence, the section from 1870 feet to 2065 feet is equated with the Catherine Sandstone. The silty and coaly section from 2062 feet to 2110 feet is tentatively equated with the Ingelara Formation. In outcrop, the Ingelara Formation has in places a 200 feet thick sandy transition to the underlying Aldebaran Sandstone. Possibly, the lateral equivalents of the Ingelara Formation in the Inderi well are dominantly sandy.

The Peawaddy Formation is recognised in all four wells. The boundary is regarded by the company geologists as the base of the Ingelara Formation in Inderi and Purbrook and as being within the Ingelara Formation in Warrinilla North. The top of the Peawaddy Formation is marked by calcareous siltstone or calcareous lithic sandstone. The Mantuan Productus bed is associated with this horizon in Warrinilla North (core 12, 2956'-2991').

The Lower part of the Bandanna Formation is a dominantly shaly unit with some fine grained tuff. It generally has a low resistivity and produces a fairly featureless electric log. It generally contains P3d spores. Recognition of the 'Lower Bandanna' is regarded as reliable in Rolleston, Warrinilla North and Purbrook.

The upper part of the Bandanna Formation consists of interbedded lithic sandstone and siltstone with coal seams about the middle of the unit. Spore zone P4 is generally associated with this unit, at least as high as

the youngest coal; Triassic spores are usually present in the unit above this level. The presence of probably P3d spores associated with coal seams, in Inderi, is anomalous. Recognition of the Lower Bandanna in this well is very tentative though; if present as is suggested by the spores, its base must be near the boundary chosen. The location of its upper limit is less certain. Possibly, the lithology and thickness of the 'Lower Bandanna' correlate in Inderi is very different from its lithology and thickness in Rolleston and farther south. It is possibly similar to the coal measures lithology of the equivalent stratigraphic interval in the north-west of the Duaringa 1:250,000 Sheet area. (Malone et al, 1963).

The 'Lower Bandanna' requires further study. The unit was not mapped during the 1963 field season. However, detailed mapping could probably delineate the unit though the generally poor outcrop would make recognition uncertain. The larger exposures could be identified by their lithology; small, isolated exposures would be difficult to identify. The base of the 'Lower Bandanna' is immediately above the Mantuan Productus Beds, which is a very widespread though not continuous unit in the Springsure area. The base of the overlying 'Upper Bandanna' is marked by a very widespread horizon containing abundant fossil wood. Thus the 'Lower Bandanna' is a mappable unit of distinctive lithology.

The 'Lower Bandanna' is possibly continuous with the Flat Top Formation of the Banana-Cracow area. It can be fairly reliably recognised in the Marathon Glenhaughton No. 1 well, 34 miles south-east of Planet Warrinilla North No. 1. A possible correlate of the 'Lower Bandanna' can be recognised in U.K.A. Cockatoo Creek No. 1 well on the eastern side of the Mimosa Syncline. The interval in Cockatoo Creek is a probable correlate of the Flat Top Formation. It is in approximately the same stratigraphic position relative to the Kianga Coal Measures as is the 'Lower Bandanna' relative to the 'Upper Bandanna' coal measures and possesses electric log characteristics similar to those of the 'Lower Bandanna'. The 65 miles separating Cockatoo Creek from Glenhaughton is too great for positive correlation. However, the 'Upper Bandanna' coal measures of the Springsure area and Glenhaughton can be correlated with the Kianga Coal Measures on the results of seismic surveys. This supports the correlation of the 'Lower Bandanna' and the Flat Top Formation. In addition, the fauna contained in the transition from the Flat Top Formation to the underlying Barfield Formation is equated with that contained in the Mantuan Productus Beds (Dickins, 1964).

Conclusions

This paper presents a revised stratigraphy of the Permian - Lower Triassic rocks of the Springsure Anticline and Reid's Dome and a possible correlation of the outcrop stratigraphy with the section in the four nearest, recent wells. The main gas sand in Rolleston and the less productive gas sand in Inderi are correlated with the Catherine Sandstone. Study of the lithology, crossbedding directions and heavy mineral content of the Catherine Sandstone in outcrop might help to predict permeability trends in the Catherine Sandstone in the subsurface. The recognition of such trends could be of considerable use in exploration for commercial oil or gas accumulations in this unit. This correlation indicates that the stratigraphic units recognised in outcrop can be recognised in the subsurface also. It is hoped that it will help in producing a generally accepted stratigraphical nomenclature of the Permian and Lower Triassic rocks of the Bowen Basin, equally applicable to surface mapping and subsurface correlation.

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Plate 1

Correlation of outcrop sections in the Springsure Anticline and Reid's Dome and some adjacent wells

Springsure Anticline
Outcrop section
B.M.R/GS.Q
Springsure Party 1963

Sections on Staircase Range and Orion and Aldebaran Creeks

Reid's Dome
Outcrop Section

B.M.R/GS.Q
Springsure Party 1963

A.F.O.
Rolleston No. 1

COMPOSITE WELL LOG
COMPANY ASSOCIATED FRENEY OIL FIELDS N.L.
WELL NUMBER A.F.O. INDERI No. 1
STATE QUEENSLAND 4-MILE SHEET SPRINGSURE BASIN BOWEN
LITHOLOGIC REFERENCE

COMPOSITE WELL LOG
COMPANY ASSOCIATED FRENEY OIL FIELDS N.L.
WELL NUMBER A.F.O. PURBROOK No. 1
STATE QUEENSLAND 4-MILE SHEET BARALABA BASIN BOWEN
LITHOLOGIC REFERENCE

COMPOSITE WELL LOG
COMPANY : PLANET EXPLORATION COMPANY PTY. LTD.
WELL NUMBER : WARRINILLA NORTH No 1
4-MILE SHEET TAROOM

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