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DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

RECORDS:

1964/195



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PHOSPHATE DRILLING, AMADEUS BASIN.

by

J. Barrie

PART 1
of 2

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<u>CONTENTS</u>	<u>Page</u>
SUMMARY	1
INTRODUCTION	1
Definitions	2
REVIEW OF OPERATIONS	2
1963 Survey	2
Surveying	3
Assaying/sampling	3
Diamond drilling	3
Ploughing	4
REVIEW OF GEOLOGY	6
Rock units	6
History	6
Structure	7
The Larapinta Group	8
Pacoota Sandstone	8
Horn Valley Siltstone	8
Stairway Sandstone	8
Stokes Formation	9
PHOSPHATE OCCURRENCE IN THE STAIRWAY SANDSTONE	9
DRILL HOLE DATA	10
AP1	10
Phosphate	10
Pyrite	10
Oil	10
AP2	11
Phosphate	11
Pyrite	11
AP3	11
Phosphate	11
Pyrite	11

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	<u>Page</u>
AP4	12
Phosphate	12
Pyrite	12
SECONDARY DEPOSITS	12
GENESIS	13
Field data	13
Geochemical cycle	14
Comparison with known phosphate deposits	16
Source of phosphate in the Amadeus Basin	17
Association of pyrite with phosphate	20
GRAVITY DATA	20
CONCLUSIONS	21
RECOMMENDATION	21
ACKNOWLEDGEMENTS	21
REFERENCES	22

Fig. 1 Location of Amadeus Basin with reference to Australian
 1:250,000 and 1:253,440 map series.

Fig. 2 Diamond drilling summary

Fig. 3 Trenching using a modified plough

Fig. 4 Tentative correlation of rock units

Fig. 5 Geological log of drill hole - AP1

Fig. 6 Geological log of drill hole - AP2

Fig. 7 Geological log of drill hole - AP3

Fig. 8 Geological log of drill hole - AP4

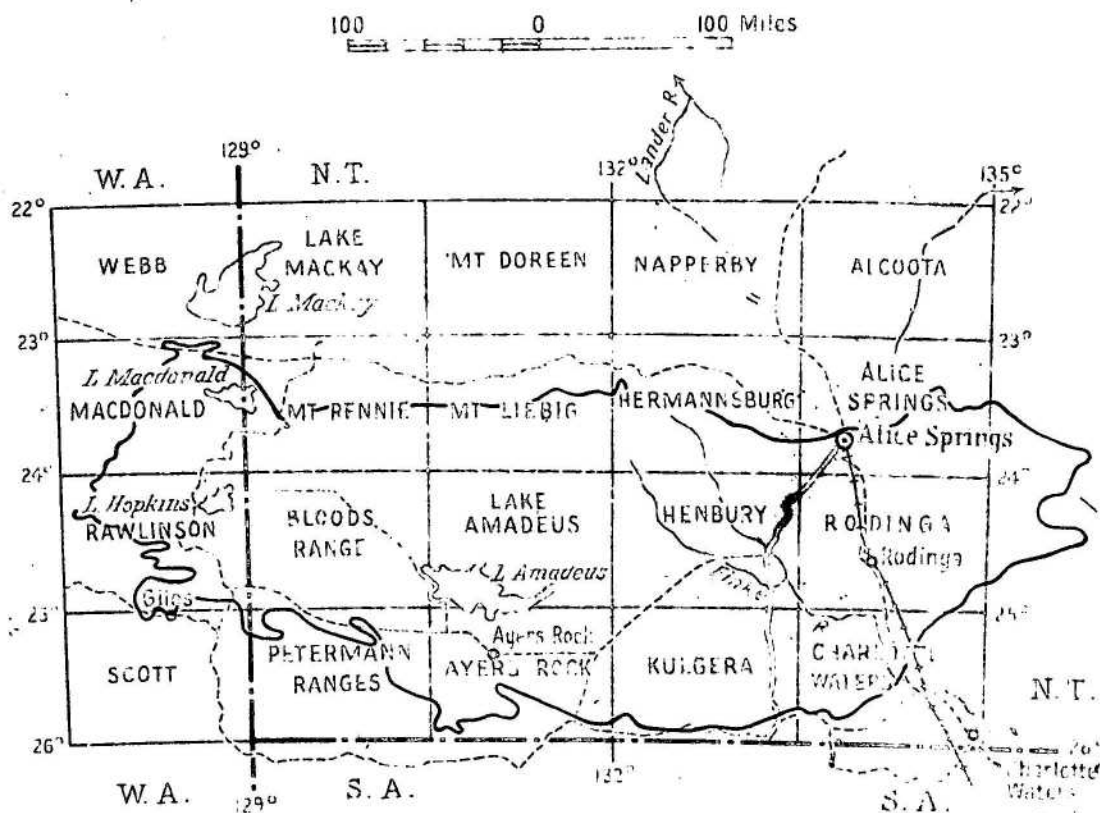
Plate I Distribution of rock units in the Amadeus Basin, N.T.

Plate II Isopach map of Stairway Sandstone

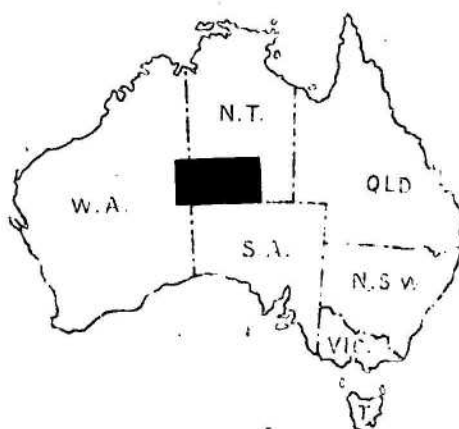
- Appendices
- I - Geological logs of drill holes
 - II - Stratigraphic Sections
 - III - Electric Logs AP2, 3, 4.

Fig 1

LOCATION OF AMADEUS BASIN WITH REFERENCE TO AUSTRALIAN 1:250,000 AND 1:253,440 MAP SERIES



LOCALITY MAP



Bureau of Mineral Resources, Geology and Geophysics, March, 1963
GD 155
To accompany Record 1964/195

G52/4/13

PHOSPHATE DRILLING, AMADEUS BASIN

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SUMMARY

Geologists of the Bureau of Mineral Resources (B.M.R.) commenced mapping the Amadeus Basin, N.T. in 1960. They observed and sampled numerous outcrops of pelletal phosphorite which occur in rock units of the Ordovician Larapinta Group, principally the Stairway Sandstone.

During the period 22nd July to 28th October, 1963, a programme of core drilling to evaluate the phosphorite was completed in the Amadeus Basin. The objective was to test the Stairway Sandstone for distribution thickness and grade of the phosphorite beds. Analysis of core samples has indicated a range of P_2O_5 content from less than 1 percent to 12 percent, in contrast to surface samples which range from less than 1 percent to 22 percent.

No deposits of economic significance were penetrated in the four drill holes completed. The most promising interval of phosphorite was encountered in the Inindia Bore area where an 11 foot section averaged 3.0 percent P_2O_5 .

The most abundant developments of phosphorite occur in the sandy units of a silt facies of the Stairway Sandstone and their distribution is controlled by topographic 'highs' on the Ordovician sea floor.

The potential for the presence of extensive mineable deposits of phosphorite in the Ordovician sediments of the Amadeus Basin appears to be low.

INTRODUCTION

The Amadeus Basin is located south-west of Alice Springs, in the southern part of the Northern Territory of Australia (Fig. 1). The Basin trends westerly and is approximately 500 miles long by 150 miles wide. It is bounded on the north by the Arunta Complex and in the south by the igneous and metamorphic complexes of the Musgrave, Mann, and Petermann Ranges. The Basin is filled almost entirely with Upper Proterozoic and Palaeozoic sediments with a maximum thickness of over 30,000

feet along the northern margin. The rocks of the Basin are essentially shelf deposits and have been subjected to moderate folding and faulting.

The presence of phosphorite in the Amadeus Basin was first mentioned briefly by Wells, Forman, and Ranford (1962) who found isolated outcrops of thin phosphate-rich beds in the Ordovician Stairway Sandstone of the Mount Liebig Sheet area in the north-western part of the Basin. More detailed examination of these phosphorites was carried out during 1962 (Wells, Ranford, and Cook (1963)) and during 1963 (Ranford and Cook, 1964; Wells, Stewart, and Skwarko, 1964). The phosphorite are confined to the Ordovician Larapinta Group, particularly the Stairway Sandstone.

This report deals principally with a diamond drilling programme to investigate the phosphorite occurrences in the Stairway Sandstone.

Definitions :

1. Phosphate is a salt of phosphoric acid : most, if not all, naturally occurring phosphates are derivatives of ortho phosphoric acid. Phosphate assays are generally expressed in terms of phosphorus pentoxide P_2O_5 . The maximum theoretical P_2O_5 content of any rock is 42 percent.
2. Phosphatic rocks are those which contain more than normal amounts of phosphate minerals. (generally $> 1\% P_2O_5$).
3. Phosphate rock is any rock composed mainly of phosphate minerals. (generally $> 20\% P_2O_5$).
4. Phosphorite is a sedimentary phosphatic rock.

REVIEW OF OPERATIONS

The 1963 phosphate survey of the Amadeus Basin principally involved a diamond drilling programme to test the Ordovician Stairway Sandstone in which phosphate had been detected in outcrop by B.M.R. field parties. A continuous core drilling programme provides for :

1. the examination of the unexposed parts of the lithologic section in any one locality.
2. The comparison of the grade of phosphorite in the unweathered zone with that in outcrop.
3. a comprehensive study to be made of the environment of deposition of the sediments.

During the period 22nd July to 28th October four holes (DDH/AP1-AP4) were drilled by Associated Diamond Drillers Pty. Ltd. for a total footage of 2573 feet and a total cost of £17,830.

3



4

Four surface sections, located at the eastern end of the Johnny Creek Anticline, near Carmichael Crag, on the southern flank of the George Gill Range, and in the Inindia Bore area, were examined and samples in detail (Appendix 2). Many other localities were examined briefly.

Concurrently with the drilling programme the regional mapping parties continued their examination of phosphorite in outcrop.

SURVEYING

Sections were measured using a tape and Abney level. Data was recorded directly onto prepared sheets and, with the use of a graphical conversion chart, converted to true thickness.

ASSAYING AND SAMPLING

Samples from drill holes or surface sections were assayed by a semi-quantitative method in a field laboratory at Rum Jungle and check analysis by a quantitative method were made in the B.M.R. laboratory at Canberra.

The quantitative figure for values less than 2 percent P_2O_5 was found to be as much as four times that of the semi-quantitative figure. This error decreased progressively for higher concentrations of P_2O_5 to approximately ± 1 percent for a 20 percent assay.

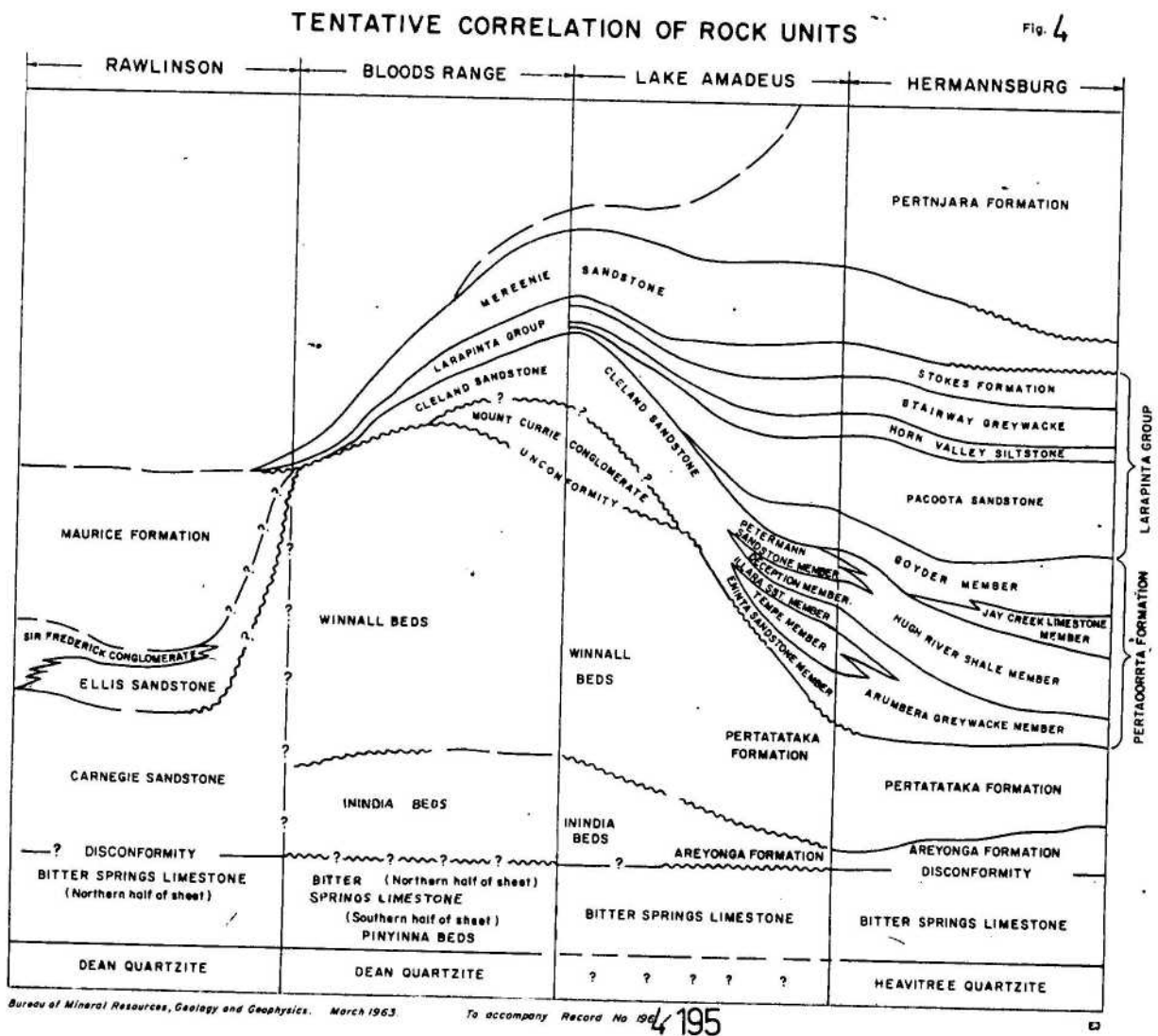
Core samples were split longitudinally with a broad chisel, one half going for assay and the other remaining as a record of the lithology. Later some samples were split with a diamond saw. Samples from surface sections were collected by the channel method.

DIAMOND DRILLING

The diamond drilling contract is summarised in Fig. 2. All four holes were logged geologically, and the last three were also logged electrically with a (B.M.R.) "Widco 1,000 foot Logmaster", by T. Quinlan and J. Barrie. All core was tested for P_2O_5 using a field reagent composed of a mixture of dilute nitric acid and ammonium molybdate. In the beginning all core found to be phosphatic was split, crushed and assayed for phosphate. Later, only relatively rich pelletal material was sampled.

All core was transported to Canberra for storage at the B.M.R. Core and Cuttings Laboratory, Fyshwick, where it is available for examination. Logs of the diamond drill holes are presented in Appendix 1.

Nx casing remains in the top of each hole. AP1, AP2, and AP3 have screwed metal caps, and AP4 a wooden plug. AP1 was plugged at 650 feet and cemented with a quarter barrel of Fondu and one bag of Portland cements.



PLOUGHING

Outcrop is poor in areas where the Stairway Sandstone dips at a low angle. However, in many places the bedrock is less than 1 foot below the surface. To provide a cheap, portable, and easy to use item of equipment to expose bedrock in these areas, a 'plough' was designed and fabricated. Briefly, a one horse plough frame with a fabricated 'snow plough' type shear or blade was towed behind a Land Rover (Fig. 3). After initial experiment and modification trenches to a depth of 9 inches

could be dug in soil and rock debris with relative ease. This enabled as much as 50 percent of the unexpected section to be exposed.

However, at the onset of the diamond drilling, sampling surface sections was curtailed, and the usefulness of the equipment was not fully exploited.

It is suggested that such equipment, adapted to fit directly onto a Land Rover with provision for hydraulic manipulation, would serve a useful purpose in any investigation where it is desirable to determine the nature of the near surface bedrock.

Fig. 3 : Trenching using a modified plough.



REVIEW OF GEOLOGY

The rock units, their distribution and relationship, are summarized in Plate 1 and Fig. 4.

Figure 4, with minor modifications (Forman, and Ranford pers. comm.), and the information contained in the following section have been adapted from Wells et al. 1963 and Forman, 1964.

HISTORY (Wells, et al. 1963)

The oldest known sediments of the Amadeus Basin are of Upper Proterozoic age and lie unconformably on Precambrian igneous and metamorphic basement. The basal Heavitree Quartzite and the overlying Bitter Springs Limestone are considered to be shallow marine sediments and were probably deposits on an epicontinental shelf. The deposition of the Bitter Springs Limestone was followed by minor uplift and erosion in some areas. In the northern part of the basin the overlying Areyonga Formation (siltstone, sandstone, and tillite) contains fragments of the older sediments and basement rocks, and has been interpreted as a water-laid deposit formed in a glacial environment. On the southern half of the basin the equivalent Inindia Beds (chert, chert breccia and dolomite) were deposited apparently conformably on the Bitter Springs Limestone. These sediments were followed unconformably by the Winnall beds (sandstone and siltstone) in the south, and conformably by the Pertatataka Formation (dominantly siltstone) in the north.

Sedimentation probably continued late into the Upper Proterozoic, after which the sediments in the southern half of the basin were strongly folded and uplifted. During the Cambrian the uplifted areas were eroded resulting in the deposition of a suite of sediments ranging from deltaic in the south to marine in the north.

Deposition of the basal sandstone of the marine Larapinta Group during the Upper Cambrian marked the beginning of a period of cyclic marine deposition of sandstone, siltstone and limestone which continued into the Upper Ordovician. These Larapinta Group sediments are largely if not wholly shallow water, marine, stable shelf deposits. The Ordovician seas supported a prolific fauna and the distribution of the sediments indicated that each successive unit transgressed the previous one and that the seas were probably most widespread in the Upper Ordovician.

The succeeding Mereenie Sandstone (?Ordovician-Devonian) has a gradational contact with the Larapinta Group and appears to have been deposited in a combination of deltaic, aeolian and littoral environments.

The Pertnjara Formation was deposited in a continental environment of Upper Devonian age as a result of a series of orogenic movements near the northern margin of the basin. Orogenic movements continued after the deposition of the Pertnjara Formation and caused folding and faulting which affected the sediments throughout the basin.

The folded and uplifted Amadeus Basin sediments then underwent a long period of weathering and erosion forming the strike ridge and valley topography featured in the present land surface.

Remnants of sediments deposited during the Permian glaciation are known from the western (Ligertwood Beds) and south-eastern (Crown Point Formation) parts of the basin and some valley fill deposits of possible Mesozoic age were deposited in the north-east part of the basin. A climatic change during the Tertiary resulted in the deposition of conglomerate immediately adjacent to the ranges, and the formation of a lake system with lacustrine sediments. An arid phase, probably during the Quaternary, formed extensive sand dunes, which have subsequently been fixed by recent vegetation.

STRUCTURE (Forman, 1964)

The Upper Proterozoic rocks along the margins of the Amadeus Basin, particularly in the south-west and north-east, were folded during two orogenies.

The older folding (Petermann Ranges Folding) occurred in the south-west after the Upper Proterozoic sediments had been deposited, and caused the recumbent and isoclinal folding of sediments beneath the Bitter Springs Limestone and Pinyinna Beds. The sediments overlying the Bitter Springs Limestone probably slid northwards on a decollement surface.

The younger folding (Amadeus Basin Folding) took place along the northern margin of the basin, probably late in the Devonian. The Arunta Complex and the Heavitree Quartzite were folded into isoclinal and recumbent folds beneath the Bitter Springs Limestone, and the sediments overlying the Bitter Springs Limestone slid southwards on a decollement surface in the limestone and were only moderately folded.

It is suggested (Forman, 1964) that the Upper Proterozoic sediments represent stable shelf sedimentation and pre-orogenic sedimentation, and the Lower Palaeozoic sediments include orogenic and post-orogenic sediments related to the Petermann Ranges folding. Overlying these are stable sediments of the Ordovician Larapinta Group.

The Middle Palaeozoic sediments comprise a pre-orogenic sandstone, the Mereenie Sandstone, and post-orogenic conglomerate sandstone and siltstone of the Pertnjara Formation related to the Amadeus Basin Folding.

Upper Palaeozoic, Mesozoic, and Cainozoic sediments are typically flat-lying and unconformably overlie the older sediments of the Basin.

Diapiric structures with cores of gypsum and salt are known from the Amadeus Basin (Prichard and Quinlan, 1961, Wells et al, 1963). Gypsum and probably evaporites may be present in the cores of many of the anticlines resulting from decollement folding.

The Larapinta Group

The age of the Larapinta Group ranges from late Cambrian to early Upper Ordovician. The Group is composed of four formations. The oldest, the Pacoota Sandstone, comprises a sequence of silicified sandstones conformably overlying the Cambrian Pertaoorrta Formation and succeeded conformably by the Horn Valley Siltstone. Cross-bedding, ripple marks, and sun cracks are common. A distinctive 'pipe-rock' bed occurs near the base of the formation and the top of the formation is typically glauconitic. Fossiliferous bands are rare but trilobites of Upper Cambrian and Lower Ordovician age have been collected from a section in Ellery Creek (Prichard and Quinlan, 1961). The thickest known section (3,000') is along the Finke River in the MacDonnell Ranges, but thins progressively to the west, south, and east. The Pacoota Sandstone contains negligible amounts of phosphate. Two samples of sandstone with phosphate pellets are regarded by Ranford and Cook (1964) as exceptional lithologies in the Pacoota Sandstone.

Horn Valley Siltstone is a siltstone containing thin limestone and fine grained sandstone beds which conformably overlie the Pacoota Sandstone and is succeeded conformably by the Stairway Sandstone. The thickest known section is about 1400' in the Western MacDonnell Ranges. The pattern of isopachs of the Horn Valley Siltstone is similar to that shown for the Stairway Sandstone (Plate II). The formation is richly fossiliferous. The fauna, which includes gastropods, brachiopods, trilobites, nautiloids, pelecypods and graptolites, indicates a late Lower Ordovician or an early Middle Ordovician age. Thin phosphatic beds have been found in silty fine-grained sandstone near the top of the section.

The term Stairway Sandstone (Wells et al. 1962) was originally named Stairway Greywacke (Prichard and Quinlan, 1962). The dominant lithology is fine and medium grained quartz sandstone but a friable and easily eroded siltstone sandy siltstone and sandy limestone facies (hereafter called the 'silt facies') is present in the Idirriki Range and is common in the thinner sections. Some thin basal conglomerate has been found along the southern margin of the Basin. The formation is richly fossiliferous and bedding planes are characterised by abundant miscellaneous

tracks and trails. The age of the formation has been given as Middle Ordovician. The thickest known section (1840') occurs in the west Idirriki Range (Plate II). Details of the occurrence of phosphate in the Stairway Sandstone are given in the next section.

The Stokes Formation, which conformably overlies the Stairway Sandstone, is the youngest formation of the Larapinta Group. The Formation is composed of siltstone with numerous fossiliferous thin beds of calcarenite typically located near the base of the section. The maximum known thickness of 2,000 feet occurs in the type section at Stokes Pass. Thin pellet bands, found at the base of the section may 'represent a continuation of Stairway Sandstone conditions into the Stokes Formation' (Ranford and Cook, 1964).

PHOSPHATE OCCURRENCE IN THE STAIRWAY SANDSTONE

Since the first recognition of the occurrence of phosphate in the Stairway Sandstone in 1961 many observations of phosphate in outcrop and as surface rubble have been made throughout the Amadeus Basin by B.M.R. field geologists. Over 100 samples have been assayed for P_2O_5 . Reports on these observations and assay results are recorded in Wells, Forman and Ranford, 1961; Wells, et al. 1962, 1963, 1964, Forman, 1963; Ranford and Cook, 1964 and Forman and Hancock, 1964.

In addition to this work many sections were visited and examined during the 1963 drilling programme.

Positive field reagent tests have been obtained from pelletal (also includes granular and nodular) sandstone, siltstone, and limestone, from limestone, calcareous sandstone and siltstone, and from some non-calcareous sandstone and siltstone. Numerous assays of surface samples of these lithologies show that the highest results are obtained from those lithologies containing pelletal material. Other material typically contains a 'trace' but some gives a few percent P_2O_5 . This characteristic is clearly demonstrated in the continuous sequence of assays in DDH/AP1 (Appendix 1). Thus it must be concluded that only pelletal material is of any consequence for concentrations of P_2O_5 .

Pellet beds (pellets dominant constituent), pellet bands (pellets scattered in sand/silt/lime bed) and pellet horizons (pellets random along bedding plane) have been observed through all parts of the Stairway Sandstone section, but the most abundant developments are in sandy bands within the silt facies.

The best exposures of pelletal material observed on the ground are in the vicinity of AP1, in the Johnny Creek area. However the thinner sections of the Stairway Sandstone, and especially the silt facies, are poorly exposed.

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GEOLOGICAL LOG OF DRILL HOLE

Fig 5

PROJECT AMADEUS BASIN PHOSPHATEHOLE NO. AP1 ANGLE 90° BEARING ELEVATION 2200' (APPROX.)LOCATION JOHNNY CK FOUR MILE LAKE AMADEUS LATITUDE 24° 17' S LONGITUDE 131° 41' E (APPROX.)TOTAL DEPTH 918' DEPTH TO WATER TABLE 100'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	ROCK UNIT	MINERAL CONTENT
	NX								20'	Reds & browns		Sand, gravel and clay	STOKES Fm.	All core registered +ve P ₂ O ₅ with field reagent. Assay from intervals 0-257', 469'-504', 669'-729' and 706'-918' ranged up to 11.3% but mostly were <1%.
	BX	AV. 50%			20°				70'	Brown cream grey	Silt to vfg minor f & mg	Calcareous siltstone, sandy siltstone and sandstone and thin beds limestone.		
		AV. 88%			18°				104'	White grey	Vf-fg	Calcareous sandstone, sandy siltstone and siltstone and thin bands pellets, nodules and minor lime.		
		90 to 100%			25°				162'	White minor grey	Fg	Sandstone and occasional thin bands sandy siltstone and siltstone; rare pellets.		
									201'	Grey	Vf-fg	Sandstone and siltstone, slumps, burrows and trails common; occasional thin pellet bands.		
					20°				268'				STAIRWAY SANDSTONE	
					18°				362'	Grey to dark grey		Siltstone and shale calcareous in part and thin beds sandy siltstone and silty sandstone; many thin pellet bands, rare limestone; disseminated pyrite.		
					20°				486'					
					20°				543'	White minor grey	F, m, and c g	Sandstone, more or less silicified, with many thin pellet bands in upper part; thin siltstone and sandy siltstone bands occur throughout.		
					20°				584'					
					20°				614'				HORN VALLEY SILTSTONE	Oil-bearing sandstone occurs between 652'5" - 656'10", 659'3" - 661'0", and 674'0" - 675'4". Residual hydrocarbons are present in fractures to the bottom of the hole.
					16°				682'					
					18°				754'	Dark grey to black with minor grey		Shale and siltstone with thin beds limestone and silty sandstone: thin oolitic pyrite beds at top, disseminated vfg pyrite throughout; several light fractures, mostly filled with calcite and minor residual hydrocarbons.		
					20°				881'					
					20°				907'	Grey	Vf-mg	Silty sandstone and glauconite, minor pyrite, hydrocarbons and limestone.		
					20°				918'	White	F-cg	Sandstone and glauconite, hydrocarbons.		T.D.
													PACOOTA SANDSTONE	

DRILL Mindrill A3000DRILLER O.K. FredericksonCOMMENCED 22-7-63COMPLETED 17-8-63

REMARKS

Drilling fluid - water - consumption less than 400 gallons per 10 hour shift.

LOGGED J.B.SAMPLED W.G.ASSAYED Rum Jungle/CanberraSHEET OF

Drawn by R.G.W.

DRILL HOLE DATAAP1. (AP = Amadeus Phosphate)

The site chosen for AP1 was at the eastern end of the Johnny Creek Anticline adjacent to the section where the highest grade and greatest number of phosphorite beds had been found. Since pellet bands had been observed also near the base of the Stokes Formation the hole was designed to intersect the lowest 100 feet of Stokes Formation before reaching the Stairway Sandstone, and to carry through to the top 50 feet of Horn Valley Siltstone. However, the Horn Valley Siltstone was found to give a strong field reagent test and drilling continued through to the top of the Pacoota Sandstone.

Fig. 5 is a summarised log of the hole.

Phosphate

In order to obtain a suite of data for correlating phosphate content with lithology, the core was sampled continuously from 0' to 256'10" and thereafter only at selected intervals. Assays ranged from not detected to 11.3 percent P_2O_5 . Sample intervals ranged from 1" to 10'. Pellet beds ranged from 1" to 5" and with rare exceptions, only samples of pellet material contained more than 1 percent P_2O_5 . In terms of thickness and average grade the most interesting interval was 93'1" to 101'5½" (8'4½") which averaged 1.9 percent P_2O_5 . The 1'4" interval from 83'7" to 84'11" averaged 4.8 percent P_2O_5 .

Semi-quantitative assays of samples from the top of the Horn Valley Siltstone gave less than 1 percent P_2O_5 . These results are contrary to expectation based on the strong reaction to field test and the presence of scattered grains and pellets.

Pyrite

Fine-grained disseminated pyrite was common in the top 30 feet of the Horn Valley Siltstone. A 2½" bed between 711'8" and 711'10½" was composed almost entirely of pyrite. This zone is equivalent to the oolitic ironstone (limonite/hematite) beds observed during geologic mapping of the Amadeus Basin.

Oil

Sandstone containing free oil was intersected between 652'5" and 656'10", 659'3" and 661', and 674' and 675'4". Residual hydrocarbons were present also in fractures throughout the remainder of the hole. These intervals and other parts of the core fluoresced under ultra violet light.

The occurrence of oil in DDH/AP1 is described in Record 1965/78 .

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GEOLOGICAL LOG OF DRILL HOLE

Fig 6

PROJECT AMADEUS BASIN PHOSPHATE

HOLE NO. AP2 ANGLE 90° BEARING ELEVATION 1850' (approx.)
LOCATION LEVI RANGE FOUR MILE HENBURY LATITUDE 132° 15' E LONGITUDE 24° 33' S (approx.)
TOTAL DEPTH 544' 6" DEPTH TO WATER TABLE 325'

WEATHERING	CASING	CORE SIZE	LIFT	CORE RECOVERY	DP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	ROCK UNIT	MINERAL CONTENT
	NX								11'	Red		Sand and sandstone rubble	STAIRWAY SANDSTONE	All core tested + ve P ₂ O ₅ with field reagent but pelletal developments are poor.
	BX	10 to 100%	6"						66'	White cream brown purple	F-mg	Sandstone with minor silty sandstone and thin siltstone/shale bands. Occasional "veins" of gypsum along bedding planes.		
			7"						110'	Grey	Vf-fg	Siltstone and shale with minor sandy siltstone and sandstone: some intervals calcareous, slumps, burrows and trails common: scattered grains and pellets and a few pellet bands.		
			5"						187'					
		90 to 100%	7"						231'	White	F-mg	Sandstone with thin silty partings: few burrows, slumps and sparse pellets.		
			8"											
			5"							Grey	Vf-fg	Shale and siltstone with minor sandstone, scattered grains and pellets, few pellet bands: slumps, burrows and trails common, some intervals calcareous.	HORN VALLEY SILTSTONE	
			5"											
			6"						333'					
			7"											
			5"							White	F, m and cg	Sandstone with minor thin siltstone and shale bands, rare pellets; abundant oolitic pyrite from 490' to 511'.		
		50 to 100%	6"						527'	Grey	Fg	Siltstone and shale with sandstone and limestone, slumps, burrows and trails.		
	T. D.								544' 6"					

DRILL Mindrill A 3000
DRILLER O.K. Frederickson
COMMENCED 6-9-63
COMPLETED 18-9-63

REMARKS

Core not recovered from 511' to 519' 3" -
suspect due to open, near-vertical fracture.
Major water loss 511' to T.D.LOGGED J.B.
SAMPLED W.G.
ASSAYED Rum Jungle
SHEET OF

AP2

AP2 was collared in the top of the Stairway Sandstone and drilled through to the top of the Horn Valley Siltstone. Fig. 6 is a summarised log of the hole.

All the core gave positive tests for P_2O_5 with field reagent but pellet occurrences, though numerous, were poorly developed. Several samples selected on the relative frequency of pellets were obtained from the interval 69'5" to 91', but semiquantitative assays gave less than 1 percent P_2O_5 .

Disseminated oolitic pyrite was abundant from 490' to 511' and a 1 foot bed of oolitic pyrite occurred at 505' to 506'. The oolites contained from 10 to 20 thin concretions of pyrite and ranged up to 1 mm. diameter. Many parts of the core gave superficial fluorescence under ultraviolet light, but was clearly due to contamination from drill rod grease. One small patch of fluorescence near the centre of a freshly broken face of core was probably due to the presence of natural hydrocarbons.

Lost circulation and no core recovery from 511' to 519' was probably due to an open near-vertical fracture.

AP3

AP3 was collared in the top of the Stairway Sandstone and drilled through to the top of the Horn Valley Siltstone. Fig. 7 is a summarised log of the hole.

All core gave positive tests for P_2O_5 with field reagent but although occurrences of pellets were numerous pellet bands were thin and poorly developed. In view of the results obtained from AP1 and AP2 no samples were taken for assay. Oolitic pyrite was common from 712' to 732' and oolites ranged up to 1/10" diameter. This zone of pyrite rises upwards in the stratigraphic column from west to east (AP1 and AP3) and is thinnest in the east. This trend in thickness agrees with surface observations of the oolitic ironstone band ranging from 4 feet thick in the central western Amadeus Basin to a few inches in the Levi Range. If this zone is continuous across the basin then it may serve as a useful marker for sedimentological and palaeogeographic studies. Probably the genesis of the pyrite is related to biochemical products from the diagenesis of the Horn Valley Siltstone.

The colour of the Stairway Sandstone from 500 to 650' ranges from dark pink to white with minor green and grey. This apparent oxidation of the sediment may be due to non-reduction of the sediment during lithification, a hiatus in the Stairway during which the sediment was weathered, or the sediment may be terrestrial. Also it may have some relationship to the erosion of the Stairway Sandstone in the Waterhouse Range area, 60 miles north-east of AP3, (Ranford and Cook, 1964) e.g. it may be a marker for the time of erosion in the Waterhouse Range area.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

Fig 7

PROJECT AMADEUS BASIN PHOSPHATEHOLE NO. AP3 ANGLE 90°BEARING 1600' (approx.)LOCATION JAMES RANGE FOUR MILE HENBURYLATITUDE 132° 58' E LONGITUDE 24° 20' S (approx.)TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	ROCK UNIT	MINERAL CONTENT
									15'	fg		Sand and sandstone rubble		
					16°					White Cream Brown Pink	f-mg	Sandstone, silty sandstone and sandy siltstone with slumps, burrows, trails and few bands of sparse pellets and grains of phosphate.		All core tested + v.o. P ₂ O ₅ with field reagent but few thin pellet bands.
					18°				95'	Lt Grey & Grey		Siltstone, shale, sandy siltstone and minor sandstone with slumps, burrows, trails and rare thin pellet bands.		
					14°				165'	Lt Grey	vf-fg	Sandstone with silty sandstone and siltstone, few burrows, slumps and rare pellets.		
					16°				223'	White	fg	Sandstone with minor thin siltstone bands at base.		
					13°				287'	White Lt Grey Grey & Dk Grey	f-mg	Siltstone, sandy siltstone, silty sandstone and sandstone, slumps, burrows and trails common, few thin pellet bands.		
					15°				447'	White Lt Grey	vf-fg	Sandstone with minor siltstone, rare pellets.		STAIRWAY SANDSTONE
					13°				498'	White Lt Grey Pink & Dk Pink	fg	Sandstone with very minor silt.		
					15°				628'	Dk Pink Pink White Green Grey	vf-vcg	Sandstone, silty sandstone and minor siltstone, rare pellets.		
					17°				680'	White Lt Grey	f-vcg	Sandstone with minor siltstone.		
					15°				759'	Grey	fg	Calcareous siltstone, sandstone.		HORN VALLEY SILTSTONE
					16°				771' 10"					

DRILL Mindrill A3000

REMARKS

LOGGED J.B.DRILLER O.K. Frederickson

SAMPLED

COMMENCED 30-9-63

Drilling fluid-water ex Finke River consumption less than 400 gallons per 10 hour shift.

ASSAYED

COMPLETED 15-10-63

AP4

AP4 was collared sufficiently high in the Stokes Formation section to allow for intersection of the Stairway Sandstone in the unweathered zone. The hole bottomed in Upper Proterozoic Winnall Beds. The base of the Stairway Sandstone is weathered and the unconformable contact with the Winnall Beds is marked by a 1" conglomerate bed and an abrupt colour change from white to purple and brown. It was considered at first that the soft silty sandstone from 291' to 298' and the white sandstone from 298' to 326' may be equivalent to the Horn Valley Siltstone and Pacoota Sandstone respectively. However, the soft silty sandstone contains the same conodont assemblage as the sediments above it; no conodonts were found in the white sandstone. (P. Jones, pers. comm.). This data, while not conclusive, is consistent with the interpretation that these beds are part of the Stairway Sandstone.

Pellets occurred throughout the Stairway Sandstone with the exception of the weathered siltstone and sandstone at the base. Accumulations of pellets were well developed between 246' and 260'. The 11 foot interval from 248'4" to 259'4" averaged 3.0 percent P_2O_5 and of this the first 7'6" averaged 3.3 percent P_2O_5 . A 4" sample of pelletal sandstone from 274'7" to 274'11" assayed 12.0 percent P_2O_5 and represents the highest assay obtained from unweathered phosphorite. This contrasts with the many surface samples from the Amadeus Basin which range up to 22 percent P_2O_5 .

The basal part of the Stairway Sandstone intersected in AP4 crops out near a ridge of Winnall Beds approximately 2,000 feet north-east of the drill site. Samples (from this area) of sandstone with phosphatic pellets (Wells et al., 1963 Nos. LA 228 and 229) assayed 15.6 and 10.4 percent P_2O_5 and samples of 'coarse sandstone' (Wells, et al, 1964 Nos. 701B and D) assayed 16 and 17.8 percent P_2O_5 . A single pellet (701C) assayed 27 percent P_2O_5 .

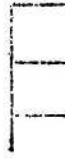
This apparent surface enrichment was investigated by trenching to expose the near surface bedrock (see S4 Appendix). The depth of the trench varied from 6 inches to 3 feet. Assays of the channel samples obtained do not vary significantly in value to those obtained in the drill hole. Thus it is concluded, 1. that the 'enrichment' of surface samples is due to removal of non-phosphatic material by weathering and 2. that such enrichment is confined to the surface and does not persist through the upper part of the weathered zone.

Secondary deposits

Throughout the Amadeus Basin vast amounts of siliceous, calcareous, ferruginous and phosphatic material has been removed by the mechanical and chemical processes of weathering and erosion. Secondary deposits of silica, lime and iron are present in many parts of the basin, but none

of phosphate have been found. This may be expected since information from known secondary deposits indicates that an alkalino environment is required to concentrate phosphate, that such phosphate rock is difficult to recognise without chemical assay, and that the phosphate is a lesser fraction of the chemical weathering products than silica, iron, or lime.

During the field programme some brief examinations were made of outcrops in the Tertiary (?) weathering profile in the Henbury Sheet area. The following is a diagrammatic comparison of the chemical profile of secondary deposits at Rum Jungle, South Australia (Jack 19 , Johns 19), and Dead Bullock Plain (Amadeus Basin) :-

<u>Rum Jungle</u>		<u>South Australia</u>		<u>Dead Bullock Plain</u>	
	SiO ₂		Travertine or Kunkar in part		SiO ₂
	P, Fe, Mn, U		P, Fe, Mn		Fe
	CaCO ₃		CaCO ₃		CaCO ₃
Lower Proterozoic		Cambrian		Upper Proterozoic	

In any search for secondary deposits in the Amadeus Basin probably an ideal combination to look for would be Stairway Sandstone (as source) in contact or close proximity to limestone (to provide an alkaline environment) within the Tertiary weathering profile (to induce concentration).

GENESIS

The genesis of phosphate will be considered from three basic attitudes, field data, geochemical cycle, and comparison with known deposits. Since the Amadeus Basin phosphate is undoubtedly of sedimentary origin all argument presented will have regard to this special case and also to the form of the phosphate viz. as pellets, grains and nodules.

In this section it will be shown that :

1. The distribution of phosphate in the Amadeus Basin was probably controlled by topographic highs on the Ordovician sea floor:
2. The source of the phosphate may have been local:
3. The process of accumulation and restriction of phosphate to the Stairway Sandstone has yet to be fully explained. A discussion on the source and the development of phosphorite is presented as a basis for argument.

Field Data

The principal field evidence pertinent to any hypotheses on the genesis of phosphate in the Amadeus Basin is :-

1. The oxidising marine environment. It is generally agreed that the Stairway Sandstone is a product of a stable shelf environment, with shallow oxygenated waters and probably variable currents and directions of sedimentation.
2. The association of phosphatic pellets with lithology. Typically the pellets are associated with sandy units of the silt facies of the Stairway Sandstone. This association is apparent from the log sheets (Appendix 1) and is being supported in detail by a sedimentology study (Crook and Cook, in prep.).
3. The association of pellets with pyrite. Pyrite is a common constituent of the Stairway Sandstone and is commonly associated with phosphatic pellets. In thin section pyrite is present in the matrix between pellets and in some cases is also present in the matrix of the pellets. This association does not refute the concept of an oxidising marine environment and is discussed at the end of the section.
4. The presence of the most promising concentration of phosphate in AP4, near the southern margin of the basin. This may be typical of the margins of the basin or it may be peculiar to the local conditions at and about AP4. The site of AP4 is adjacent to a ridge of Upper Proterozoic rock mapped as Winnall Beds. The Stairway Sandstone laps onto the side of this ridge. Eastwards of AP4 Stairway Sandstone abuts against similar ridges of older rocks.
5. The apparent absence of lower units of the Stairway Sandstone in the southern parts of the basin. The four drill holes may be broadly correlated in terms of an upper and lower sandstone separated by a silty lithology. It has not been demonstrated that these rock units also correlate in time. The correlation may be a product of a transgressing sea and consequently would emphasise the importance of the environment and type of sedimentation.
6. The pellets are detrital.

The field data alone does not define any principal factor controlling the distribution of phosphorite in the Amadeus Basin. The data suggests three possibilities viz. marginal distribution (shoreline?), control by topographic highs on the Ordovician sea floor, and restriction to the thinnest section of the Stairway Sandstone (less sediment=less dilution of phosphate deposited).

Consideration of the geochemistry of phosphate and comparison of the Amadeus phosphorite with that of the 'Phosphoria' and the 'Sea off Southern California' suggests that the Ordovician sea floor topography was a major control of the distribution of phosphate in the Amadeus Basin. The Geochemical Cycle and factors affecting the accumulation and distribution of phosphate.

It is assumed that the ultimate source of phosphate in sea water is from the weathering of phosphate minerals on land. Since phosphate minerals are a very small percentage of the total mineral content of the earth's crust, the content of phosphate in the solid state (e.g. as detrital

apatite) will remain proportionately small throughout that part of the cycle from weathering to sedimentary rock. Consequently preformed phosphate is not significant in the formation of phosphorite.

Phosphate in solution however, is available for accumulation and concentration and the ultimate formation of phosphorite.

Presumably the relevant part of the cycle is :

1. phosphate in solution
2. solution to suspension
3. Suspension to sediment (deposition).
4. Formation of the pellet form (which may begin during 3).
5. Accumulation and concentration of pellets to form phosphorite.

Concurrent sedimentation and/or chemical precipitation other than phosphate, at stages 3 and 4, would dilute the product (5) and defeat the formation of phosphorite. These factors therefore, must be considered when delineating those areas on a sea floor where, ultimately, phosphate may accumulate to form phosphorite.

Co-precipitation of other chemical products such as lime and silica is not significant since the same conditions, or change or conditions, e.g. of Eh and pH, that precipitate phosphate will act as natural selectors and essentially only one product will dominate at any given time or place.

The rate of terrigenous sedimentation is greatly reduced in still or stagnant waters, areas of strong current or turbulence, in back-reef areas, in seas which have a poor supply of sediment (e.g. where the adjacent land has reached base level of erosion) and on the tops of high ridges and hills on the sea floor.

In the Amadeus Basin the Ordovician sea during Stairway time was shallow and its waters were 'mobile'. Small local stagnant basins may have existed but no evidence for this has been found. Locally, strong currents prohibit the deposition of phosphate. High submarine ridges and hills of 'basement' rocks existed (Wells, pers. comm.), and also it is possible that some of the fold structures of the Amadeus Basin Folding were growing during the Ordovician and had formed ridges on the sea floor. Since abundant sediment was available, either from adjacent land with appreciable relief and/or from the reworking of older sediments, attention is focussed to 'highs' on the sea floor as the principal factor controlling the distribution of phosphate in the Amadeus Basin.

Comparison with known phosphate deposits that have been extensively investigated and documented.

1. Phosphoria Formation (McKelvey et al, 1953) McKelvey states :

"The phosphoria formation accumulated in a large shelving embayment bordered by lands of low relief that contributed little detritus to the sea. Cold, phosphate-rich waters upwelled into this basin from the ocean reservoir to the south or south-west. Phosphorite was deposited from these ascending waters, probably in depths of 1,000 to 200 metres, as their pH increased along with increase in temperature and decrease in partial pressure of CO_2 . Carbonates were precipitated from these waters when they reached more shallow depths, at a somewhat higher pH. The phosphate rich waters nurtured a luxuriant growth of phytoplankton, as well as higher forms of plant and animal life, some remains^{of} which were concentrated with fine-grained materials in deeper waters away from the shore. Part of the phosphate and probably some of the fine-grained silica in the formation were concentrated by these organisms. Finally these conditions persisted over much of Permian time".

In addition, McKelvey postulates a reducing environment and draws attention to the typical association of phosphorite with limestone and chert.

In the Amadeus Basin the marine environment is regarded as oxidising and the association of limestone and chert facies is absent.

The lack of correlation of diagnostic features between the Amadeus and Phosphoria deposits precludes the Amadeus phosphorite as 'Phosphoria' type.

2. In the 'Sea off Southern California' phosphorite has formed on high areas in an oxidising shelf environment by the influx of cold, phosphate-rich ocean water (Emery, 1960). The concentration of phosphate on high hills, ridges, and some parts of the shelf slopes appears to be directly related to the very low rate of deposition of detrital material in these localities.

The Stairway Sandstone has a similar marine environment, and during Ordovician time highs were present as remnant Proterozoic sediments. The ridge of Winnall Beds adjacent to AP4 probably was such a high. Phosphate forming on this high may have spilled down flank to where it is intersected in AP4 or it may have formed only on the high with subsequent redistribution down the flank of the 'high' at the onset of stronger surface currents associated with later sedimentation.

Thus the Amadeus phosphorite has affinities with the Californian type and a potential exists for deposits of phosphorite on or adjacent to Ordovician bathymetric highs in several localities within the present outcrop area of the Amadeus Basin.

Source of phosphate in the Amadeus Basin.

A fashionable and convenient source of phosphate is from upwelling of cold phosphate-rich waters from the deep ocean. This is considered to be the source for the Phosphoria and Californian deposits, and those off the coast of South America.

The nearest Lower Palaeozoic ocean to the Amadeus Basin probably was far distant. The adjoining seas to the Amadeus were those of the Canning Basin to the west, the Georgina Basin to the north-east, and the Artesian Basin area to the south-east.

From a review of the small amount of geological evidence available and interpretations based on this evidence, together with gravity and magnetic data, it seems probable that the Amadeus Basin was connected to its neighbours by low sills. However, no evidence is available to demonstrate whether or not appreciable channels existed for the passage of deep ocean water into the Amadeus Basin. Furthermore the known Ordovician sediments in the neighbouring basins are typically shallow water. Any phosphate-rich ocean water moving towards the Amadeus Basin would be vulnerable to changes of its physical and chemical properties and would be expected to deposit its load of phosphate long before reaching its destination.

Therefore, the alternative of a local source for the Amadeus phosphate must be considered.

Any explanation of a local source must account for the restriction of phosphorite to the Stairway Sandstone and it is apparent that something more than the broad factors controlling the sedimentation of the different lithologies of the Larapinta Group is responsible.

A local source for phosphate may be obtained by 1. a sudden abnormal increase in the supply of phosphate from land. 2. the development of a set of circumstances causing the Ordovician sea to accumulate phosphate in solution in its early history followed by precipitation during Stairway sedimentation or 3. the development of a special set of circumstances that precipitated and accumulated phosphate during Stairway time, from the phosphate 'normally' present in the sea.

1. In the absence of pertinent evidence it is particularly awkward to manipulate climatic conditions, relief of the land, and/or the chemical content of the denuding land surface to provide a sudden abnormal supply of phosphate from the provenance areas. However, the prolific marine fauna of the Horn Valley Siltstone may be an indicator of such an event. A prolific marine fauna requires a substantial supply of nutrient rich water of which phosphate is a principal constituent. Thus the contrast of abundance of fauna between the Pacoota Sandstone and the Horn Valley Siltstone may be the result of an additional supply of nutrient rich water, the phosphate content of which would be occupied with the biological environment until the advent of the Stairway Sandstone. With the less favourable living conditions of the Stairway environment a surplus of phosphate may have been available for the formation of phosphorite. However, the relative abundance of fauna in each of the Larapinta Group units may be solely the product of environment. (i.e. favourable habitat).

2. Sediments, both modern and ancient contain some phosphate other than detrital or pre-existing phosphate minerals, which shows that phosphate in solution may precipitate in any sea and probably in most parts of the sea. The 'richness' or otherwise of the sea water would affect the issue only so far as the relative concentration of phosphate deposited is concerned.

Thus the factors of evaporation in ~~semi-closed~~ parts of the Basin where waters were relatively still, pressure changes where water moves up and over bathymetric rises, coupled with special conditions of low rate of sedimentation, local minor concentrations of phosphate in solution brought about by organic activity, silt or other absorption processes, may be invoked to explain the thinness and low grade of the Amadeus Basin phosphorite. Of course, if such events happened then it must be concluded that without an enriched sea water to begin with any phosphorite resulting from these processes would be thin bedded and low grade, and that such occurrences would be common in other sedimentary basins.

3. Assuming that the provenance providing sediment and phosphate to the Ordovician sea was essentially the same throughout the deposition of the Larapinta Group and that a mechanism is required for accumulating phosphate in the sea as a basis for subsequent precipitation and accumulation, it is considered that the Horn Valley Siltstone, underlying the Stairway Sandstone, played a fundamental role in the restriction of phosphorite to the Stairway Sandstone.

Jitts (1959) has shown that silts are capable of absorbing relatively large quantities of phosphate (experimentally up to 3 mg. phosphate P for 1g silt), and that, in the natural state they seldom approach saturation with phosphate. Areas of silt sedimentation on a sea floor would localise the existing phosphate in the sea and would constitute a continuous trap for phosphate being supplied from weathering and denudation of land masses. The Horn Valley Siltstone is richly fossiliferous indicating an abundant supply of nutrients including phosphorus.

Jitts has also shown that organic matter suppresses the absorption of phosphate so that while silt (during deposition) may bring phosphate down to the sea floor, it may be returned to the sea by the action of organic matter. The marine fauna would secrete a significant fraction of available phosphate in its skeletons and also a significant amount would be represented as coprolite. Thus, while silt particles may localise the distribution of phosphate in the Horn Valley sea and bring phosphate to the sea floor, a complex and continuous interchange of phosphate would take place, in that part of the biosphere located at the sediment-water interface and the upper part of the unlithified sediment.

With reference to the occurrence of phosphate in the succeeding Stairway Sandstone, the product of the factors mentioned above could be :

(i) The Horn Valley sea could become enriched with phosphate ripe for precipitation during the changed physico-chemical conditions of Stairway time.

(ii) Areas of the Horn Valley sea floor above the location of silt deposition (with its associated fauna and organic matter) could accumulate phosphate (by precipitation from sea water) as pellets and constitute a supply for subsequent redistribution during Stairway time.

(iii) Phosphate held by the Horn Valley sediments could be available to the Stairway Sandstone if the reworking of these sediments was a source for Stairway sediments.

Thus, during the deposition of the Stairway Sandstone :

(i) Phosphorite in the basal sand of the Stairway may have derived from redistributed Horn Valley pellets.

(ii) Later Stairway silt facies may represent a time marker for further pellet formation on highs in the Stairway sea.

(iii) Sandy units of the silt facies of the Stairway Sandstone represent periods of stronger currents with redistribution of pellets from the highs in (ii) and/or further redistribution of Horn Valley pellets.

'Highs' have been emphasised principally as areas of minor concurrent sedimentation. However the same effect may be obtained by 'winnowing'. For example :-

During deposition of the Stairway Sandstone the silt fractions may have acted as a continuous trap for phosphate at the expense of the phosphate-enriched sea water. This would produce a sediment containing a few times the normal content of phosphate.

During diagenesis physico-chemical, and possibly biological activity formed foci of concentration of phosphate (e.g. concretions) and as diagenesis progressed these developed into pellets, (i.e. a large grain of concentrated phosphate). Thus a column of sediment containing widely scattered pellets of phosphate would be obtained. If this sediment were to be winnowed, the fines would be removed leaving the pellets and any other coarse or heavy fractions as a residual sediment. Any number of variations of association of pellets with grain size and type of sediment could be obtained in this manner, depending mostly on the composition of the sediment winnowed and the sediment that followed. A thin phosphate band therefore, may represent the passage of a considerable period of time.

It is unlikely that any one of the many possible mechanisms suggested is the sole explanation of the occurrence of phosphate, rather several or even all of these could be represented amongst the hundreds of phosphorite bands in the Stairway Sandstone.

In conclusion it is relevant to note a consistent feature of studies of modern sediments namely that where phosphate occurs as pellets it is associated with areas of little sedimentation and relatively coarse detritus, and where phosphate occurs in a non-pelletal form it is associated with silt.

Association of pyrite with phosphate

The association of pyrite with phosphate does not appear to present a critical problem. Pyrite is generally considered to be indicative of a reducing environment whereas the Stairway Sandstone is regarded as the product of an oxidising environment.

Although the sea water may be well aerated and oxidising the micro-environment in the interstitial waters of the unlithified sediment on the sea floor may be either reducing or oxidising. Emery states that "Values of Eh in the water column are invariably positive with values between +200 and +300 mv. The surface of the sediment is also positive but Eh becomes zero at average depths of about 2 metres whereafter it is negative. Typically the zero mark coincides with the arrival of hydrogen sulphide".

The presence of pyrite within some of the phosphatic pellets implies that the pellets formed in a reducing environment viz. the zone of unlithified sediment. However, pyrite may have filled voids after formation of the phosphate pellet.

Gravity Data

A reconnaissance gravity survey of the Amadeus Basin and the South Canning Basin was carried out by the Bureau of Mineral Resources during 1962 (Lonsdale and Flavelle, 1963).

The site of AP4, in which the best intersection of phosphate was obtained, is adjacent to a gravity 'high' on the 'Angas Downs Gravity Ridge'.

Provided that there has been no pronounced structural deformation of the Amadeus Basin in the area of the gravity ridge since the deposition of the Stairway Sandstone, it is possible that a correlation may exist between phosphate distribution and the gravity ridge.

It follows, from the basic assumption stated, that the gravity ridge was present either as a basement feature before Proterozoic sedimentation, or was a result of the Petermann Ranges folding (Forman, 1964). In either case it can be argued, from a study of the isopachs and relationships of rock units, that the gravity ridge was probably reflected as a topographic ridge on the Ordovician sea floor.

Since geological data indicates that phosphate distribution in the Stairway Sandstone may be controlled by topographic highs on the Ordovician sea floor, the gravity data may indicate an area favourable for phosphate accumulations.

CONCLUSIONS

1. Phosphate occurs as pellets in the Ordovician Larapinta Group in the Amadeus Basin. With minor exceptions the phosphate is restricted to the Stairway Sandstone. The best developments of pellets occur in the sandy units of the silt facies of the Stairway Sandstone.
2. Distribution of the phosphate was probably controlled by high areas on the Ordovician sea floor.
3. The source of the phosphate is unknown. No evidence is available to explain the source in terms of ocean phosphate-rich waters upwelling over the shelf of deposition of the Larapinta Group. Alternatively, in considering a local source for the phosphate, it is thought that the Horn Valley Siltstone may have played an important role in the accumulation of phosphate in sea water and the restriction of phosphorite to the Stairway Sandstone.
4. No economic deposits of phosphorite were intersected in the four drill holes and the potential for the existence of such deposits is low.

RECOMMENDATIONS

Any further work in the Ordovician units of the Amadeus Basin should be directed towards an investigation of the likely increase in grade on or immediately adjacent to high areas on the Ordovician sea floor. Potential 'high' areas may be delineated (i) by selecting combinations of Stairway Sandstone unconformably overlying Precambrian sediments particularly those resistant to erosion (ii) on structures thought to be rising during the Ordovician and (iii) over the Angus Downs Gravity Ridge.

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MAPS TO ACCOMPANY RECORD 1964/195
PHOSPHATE DRILLING, AMADEUS BASIN

503351

CROXLEY
DOCUMENT WALLET

A John Dickinson
PRODUCT



PART 2
OF 2

PLATE I

DISTRIBUTION OF ROCK UNITS.
IN THE AMADEUS BASIN, N.T.

REFERENCE

- Q QUATERNARY
T TERTIARY
M MESOZOIC
P PERMIAN Undifferentiated
Crown Point Formation
Ligertwood Bed
Pzu Pertinara Formation
Idracowra Formation
Horseshoe Bend Shale
Langra Formation
Polly Conglomerate
Pzm Meresnie Sandstone
C-OI Laramia Group
Stokes Formation
Stairway Sandstone
Lam Valley Siltstone
Pacoca Sandstone
C Pertinara Formation
Cieland Sandstone
C Mount Currie Conglomerate
Ayers Rock Arkose
Arumbera Greywacke
Carnegie Formation
Euc Winnall Beds
Eup Peritataka Formation
Eua Areyonga Formation
Lindia Beds
Eub Bitter Springs Limestone
Plylimo Beds
Euh Heavytree Quartzite
Dean Quartzite
p6 Igneous and metamorphic rocks
Undifferentiated

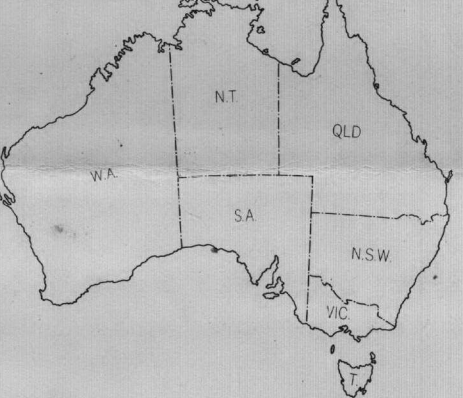
- Geological boundary
Road
Railway
Stream

AP2 Diamond Drill Hole

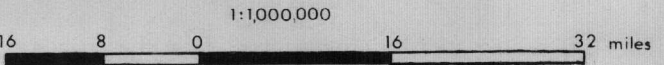
MOUNT RENNIE	MOUNT LIEBIG	HERMANNSTADT	ALICE SPRINGS
BLOODS RANGE	LAKE AMADEUS	HENSBURY	RODINGA
PETERMANN RANGES	AYERS ROCKS	KULGERA	FINKE

1:250,000 Reference

LOCALITY MAP



Scale



Compiled by J. Barrie from field mapping by
C.E. Prichard, T. Quinlan,
A.T. Wells, D. Forman, L.C. Renford, A.W. Stewart,
P.J. Cook, S. Skwarko and P. Hancock with photo
geology of the northeast corner by J.J. Scanwick (I.F.P.)

ISOPACHS

PLATE II

DISTRIBUTION OF ROCK UNITS.
IN THE AMADEUS BASIN, N.T.

REFERENCE

- | | |
|------|--|
| Q | QUATERNARY |
| T | TERTIARY |
| M | MESOZOIC |
| P | PERMIAN Undifferentiated
Crown Point Formation |
| Pzu | Ligertwood Bed |
| Pzp | Pertarjara Formation
Araucario Formation
Horseshoe Bend Shale
Langat Formation
Polly Conglomerate |
| Pzm | Merenje Sandstone |
| E-Ol | Lampira Group
Stokes Formation
Starway Sandstone
Horn Valley Siltstone
Pucosa Sandstone
Pertakorra Formation
Cieland Sandstone |
| E | Mount Currie Conglomerate
Ayers Rock Arkose
Arumberd Greywacke
Carnegie Formation |
| Euc | Winnall Beds |
| Eup | Pertatataka Formation |
| Eua | Areyonga Formation
Lindia Beds |
| Eub | Bitter Springs Limestone
Pinnyon Beds |
| Euh | Heavyweight Quartzite
Loran Quartzite |
| pE | Igneous and metamorphic rocks
Undifferentiated |

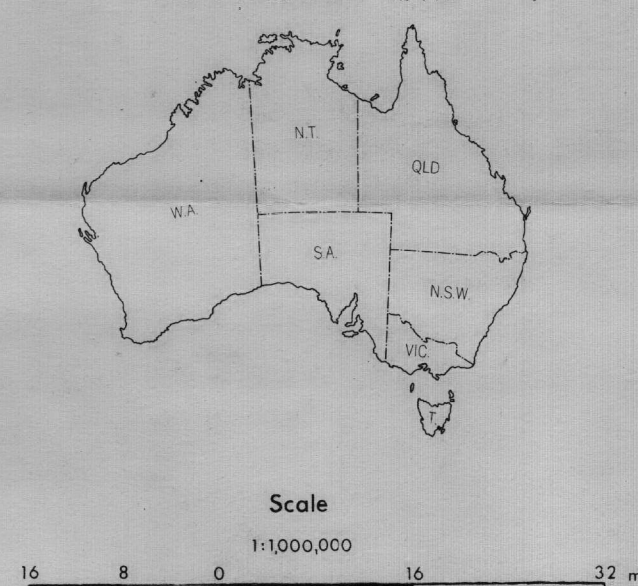
 Geological boundary
 Road
 Railway
 Stream

©AP2 *Diamond Drill Hole*

MOUNT RENNIE	MOUNT LIEBIG	HERMANNSBURG	ALICE SPRING
BLOODS RANGE	LAKE AMADEUS	HENBURY	RODINGA
PETERMANN RANGES	AYERS ROCKS	KULGERA	FINKE

1: 250,000	Reference
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LOCALITY MAP



Compiled by J. Barrie from field mapping by
C.E. Prichard, T. Quinlan
A.T. Wells, D. Forman, L.C. Ranford, A.W. Stewart,
R.J. Cook, S. Skwarko and P. Hancock with photo
geology of the northeast corner by J.J. Scanwick (IFP)

GEOLOGICAL LOG OF DRILL HOLE

503952

PROJECT Amadeus Basin PhosphateHOLE NO. AP1 ANGLE 90° BEARING ELEVATION 2200' (approx.)LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx.)TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
			100												
			100												
			20												
			5' 2' 1"												
			5'												
			5'												
			14'												
			20												
			5												
			21' 20"												
			21' 20"												
			23' 6"												
			23' 6"												
			24'												
			24'												
			28'												
			28' 23' 6"												
			34'												
			34' 10"												
			39' 10"												
			45' 5"												
			49' 3"												
			49' 3"												
			57' 5"												
			61' 3"												
			61' 3"												
			64' 6"												
			69' 10"												
			73' 9"												
			73' 9"												
			76' 6"												
			77' 7"												
			81' 7"												
			84' 11"												
			87' 11"												
			88' 5"												
			92' 3"												
			94'												
			97' 3"												
			98' 11"												
			99' 10"												

DRILL Minevill A 3000DRILLER OK. FredericksonCOMMENCED 22-7-63COMPLETED 17-8-63

REMARKS

Stokes Formation to 69' 10"

Stairway Sandstone 69' 10"

to

NT = No trace

97' 3" <1 <1 LOGGED J.B.

97' 4" 7 4.7 LOGGED V.G.

98' 11" <2 1.1 SAMPLED V.G.

99' <1 1.4 ASSAYED Rimm Tungsten / Carbon

99' 10 1/2" <2 1.2 ASSAYED Rimm Tungsten / Carbon

100' 1 1/2" 8 11.0 SHEET 1 OF 10

GEOLOGICAL LOG OF DRILL HOLE

DRILL	Mindrill A 3000	REMARKS	LOGGED	J. B.
DRILLER	O.K. Fredericksen	Stairway Sandstone	SAMPLED	W. G.
COMMENCED	22-7-63		ASSAYED	R. J. / Campbell
COMPLETED	12-8-63		SHEET	2 OF 10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP1 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx.)
TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
200		8x	100		20°				201'				201'		
					24°				202'4"	grey	silt	Siltstone, sandstone & shale, calcareous at base. Few thin pellet bands & some scattered grains. Some slumps and cavities ex fossils.	202'4"		
			97						203'5"				203'5"		
					15°				205'4"	lt+dk	vf-fg		205'4"		
					20°				207'10"	grey			208'6"	<2	1.6
210									209'6"				208'10"	<1	2.0
									211'7"				209'6"	<1	
									213'6"				210'9"	<1	
			99						214'7"				211'7"	<1	
									216'5"				213'6"	<1	
									217'11"				214'7"	<2	<1
					15°				218'1"			Shale & minor sandstone & thin sandy partings, few thin lime-rich bands and occasional thin bomb grains & pellets P ₂ O ₅	216'5"	<1	
									221'1"				217'11"	<1	
									223'5"	dk grey			221'1"	<1	
									224'6"				223'5"	<1	
			97		17°				226'2"				224'6"	<2	2.2
									227'8"	grey			225'3"	<2	2.0
									228'2"				225'9"	<1	
					19°				230'6"	very			226'2"	<2	1.9
									232'8"	minor			227'8"	<1	
									234'5"	lt grey	silt		228'2"	<1	
			97		18°				238'	creamy	fg		230'1"	<1	
									240'				232'5"	<1	
					20°				241'6"				234'5"	<1	
									242'10"				235'1/2"	2	5.3
									244'7"				238'	<1	
			96		18°				247'6"				240'	<1	
									249'9"				241'6"	<1	
									251'6"				241'11"	<1	
									252'7"				242'5"	<1	
									254'6"				242'10"	<1	
			99		19°				256'10"			Calcareous sandstone & silty sandstone & siltstone. Minor scattered grains & pellets P ₂ O ₅	244'7"	<1	
									259'2"				245'5"	<2	1.5
					21°				260'11/2"				245'9"	<1	
									263'6"				247'6"	<1	
									264'5"				249'9"	<1	
			96		19°				267'7"				250'1"	2	
									268'3"	lt grey	silt		251'6"	<1	
					20°				270'				251'7"	<1	
									271'2"				252'7"	<1	
									272'	grey	vf-fg		254'6"	<1	
			99		20°				273'8"			Sandstone, silty sandstone & silt, slumps common. Minor thin pellet bands & scattered grains P ₂ O ₅ . Few cavities ex fossils.	255'2"	<1	
									275'1"				256'10"	<1	
									277'4"				258'10"	<1	
									278'9"				259'2"	<1	
					23°				280'4"				260'11/2"	<1	
									282'7"	lt	silt		263'6"		
			99		16°				284'5"	grey	vf-fg		264'5"		
									285'8"				267'7"		
									286'6"				268'3"		
									288'5"	grey			270'		
			100		19°				289'6"			Shale siltstone & sandstone	271'2"		
									290'10"				272'		
									291'7"				273'8"		
									293'9"				275'1"		
									296'6"				277'4"		
			100		18°				298'5"				278'9"		
					15°				299'11"	grey	vf-fg		280'4"		
200													282'7"		
													284'5"		
													285'8"		
													286'6"		
													288'5"		
													289'6"		
													290'10"		
													291'7"		
													293'9"		
													296'6"		
													298'5"		
													299'11"		

DRILL Mindrill A3000 REMARKS Stairway Sandstone LOGGED J. B.
DRILLER OK. Fredericksen SAMPLED W. G.
COMMENCED 22-7-63 ASSAYED R. J. Cambella
COMPLETED 12-8-63 SHEET 3 OF 10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP1 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx)
TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SO	O
300			Bx	98		15°			301'8"	lt grey	vf-fg		siltstone & sandstone				
			306'3"			18°			302'4"	white	fg		silicified sandstone				
			316'	100					302'10"				interbedded sandstone, siltstone & shale; slumps, burrows & trails common.				
310									306'4"	lt grey	silt						
				100						grey	vf-fg						
			316'	100		21°			316'10"								
			325'10"	99					319'4"								
									320'1"	lt grey	vf-fg		sandstone & siltstone & shale & few thin pellet bands				
			335'8"	98		18°			322'3"	minor							
									322'10"	dk grey							
			335'8"	98		19°			324'3"								
				100					326'8"								
			345'6"	99		20°			326'10"								
									330'5 1/2"								
			355'4"	98		19°			331'9"	lt grey	vf-fg		interbedded sandstone, siltstone & shale; slumps, burrows & trails common; several thin bands pellets & minor calcareous intervals.				
									333'3"	grey							
			365'2"	98		18°			335'8"	dk grey							
									336'9"	black							
			375'	100					340'1"								
			384'9"	100		21°			342'7"								
									343'10"								
			394'	100		20°			344'3"								
									347'3"								
									349'								
									350' 1/2"								
									351'2"								
									352'3"								
									353'5"								
									354'7"								
									355'6"								
									356'4"	lt grey	vf-fg		sandstone, sandy siltstone & siltstone & burrows slumps & minor lime & pellets				
									357'11"	grey							
									361'4"								
									362'1"								
									363'2"								
									364'2"								
									365'1"								
									366'8"								
									367'8"								
									368'6"	grey	silt		Shale; siltstone, sandy siltstone & silty sandstone				
									370'	to			Few slumps, burrows, & thin pellet bands & occasional scattered pellets				
									370'10"	black	fg						
									371'5"								
									373'4"								
									375'2"								
									377'3"								
									378'6"								
									379'5"								
									381'9"								
									383'6"								
									384'11"								
									386'5"								
									387'10"	black	vf-fg		Siltstone & sandstone & minor thin pellet bands				
									389'3"	dk grey	f-mg						
									391'								
									392'7"	lt grey	fg						
									394'6"								
									395'11"		vf-fg						
									397'6"		vf-fg						
									398'7"								

DRILL Mindrill A3000 REMARKS Stairway Sandstone LOGGED J. B.
DRILLER O.K. Fredericksen SAMPLED _____
COMMENCED 22-7-63 ASSAYED _____
COMPLETED 12-8-63 SHEET 4 OF 10

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
 HOLE NO. AP 1 ANGLE 90° BEARING _____ ELEVATION _____
 LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx)
 TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
													SQ	Q	
		403'1"	100					402'2"	dk grey			Siltstone & sandstone, slumps, burrows, zones of pellets development & few thin bands pellets. Some scattered grains P ₂ O ₅ & sandy fractions			
		403'1"	100					400'5"	grey						
		403'1"	100					405'7"	grey						
		403'1"	100					408'2"	lt grey						
		403'1"	100					408'9"	lt grey						
		403'1"	100					413'11"	vf-fg						
		403'1"	100					415'3"	rare mg						
		403'1"	100					423'	dk grey			Siltstone & sandstone severely slumped upper half, sandier towards base; burrows.			
		403'1"	100					427'7"	lt grey						
		403'1"	100					431'5"	dk grey			Mostly shale & siltstone & sandstone interbeds, slumps, few burrows & pellet bands			
		403'1"	100					434'8"	lt grey						
		403'1"	100					435'	lt grey						
		403'1"	100					437'2"							
		403'1"	100					437'4"							
		403'1"	100					440'5"	dk grey			Interbeds sandstone & siltstone, slumps common, few burrows, rare scattered pellets & lime but rich pellet band 442'8"-443'2"			
		403'1"	100					442'8"	white						
		403'1"	100					443'2"	black						
		403'1"	100					445'6"	white to						
		403'1"	100					449'1"	dk grey						
		403'1"	100					450'5"							
		403'1"	100					451'6"							
		403'1"	100					454'10"				Silty sandstone & sandy siltstone & minor siltstone & sandstone, & very minor lime. Several thin pellet bands & intervals more or less rich & scattered grains, pellets, & nodules			
		403'1"	100					455'7"							
		403'1"	100					457'1"							
		403'1"	100					458'1"							
		403'1"	100					459'7"	lt grey						
		403'1"	100					460'6"	to						
		403'1"	100					462'	dk grey						
		403'1"	100					463'10"	mostly						
		403'1"	100					464'8"	grey						
		403'1"	100					465'11"							
		403'1"	100					469'				Some disseminated and - patchy pyrite			
		403'1"	100					472'2"							
		403'1"	100					474'8"							
		403'1"	100					475'3"							
		403'1"	100					480'							
		403'1"	100					482'							
		403'1"	100					486'6"							
		403'1"	100					487'4"	lt grey			Friable sandstone & nodules & pellets			
		403'1"	100					490'3"				Fairly clean sandstone & minor thin silt partings & bands of sandy silt & silty sand & few burrows & slumps. Few patches pyrite & minor pellet developments			
		403'1"	100					494'1"							
		403'1"	100					495'10"							
		403'1"	100					498'7"							
		403'1"	100					498'7"							
		403'1"	100					500'3"							

DRILL Mindrill A3000DRILLER O.K. FredericksenCOMMENCED 22-7-63COMPLETED 17-8-63

REMARKS

Basal sandstone facies commences at 486'6"

LOGGED

J.B.

SAMPLED

W.G.

ASSAYED R.J. CanberraSHEET 5 OF 10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP 2 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx)
TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% POSS
500									500' 3"	lt grey	m-veg	Sandstone & interbeds	500' 3"		
									504'	dk grey	vf-fg	silty sand, sandy silt & siltstone. Few burrows & minor slumps & scattered pellets & nodules at top	504'	41	
									508' 5"	dk grey	f-cg				
									509' 3"	wh. grey	vf-f				
									510' 1"	white to dk grey	vf-fg				
									513' 9"	white	vf-cg				
									515' 3"	grey	vf-fg				
									516' 4"	white	vf-f				
									518' 5"	white	vf-f				
									520' 7"	white to grey	m-cg				
									522' 10"	white	vf-f				
									524'	grey	m-cg				
									525'	grey	m-cg				
									526' 3"	grey	m-cg				
									527' 1"	dk grey	cg				
									528' 10"	wh. grey	m-cg				
									530' 1"	lt grey	vf-f				
									531' 10"	white	vf-fg				
									532' 9"	white	vf-cg				
									534' 3"	white	vf-cg				
									536' 6"	lt grey	m-cg				
									537' 8"	white	vf-fg				
									539' 1"	white	vf-fg				
									540' 11"	white	vf-fg				
									541' 6"	white	vf-fg				
									543' 4"	white	fg				
									552' 3"	white	fg				
									554' 4"	white	c-veg				
									556'	white	vf-mg				
									558'	grey	vf-mg				
									558' 4"	white & minor grey	fg				
									572' 6"	white	vf-cg				
									573' 4"	white	m-veg				
									576' 7"	dk grey	silt				
									576' 9"	white	m-cg				
									584' 2"	white	vf-mg				
									585' 9"	white to lt grey	vf-mg				
									587' 7"	white	vf-fg				
									588' 6"	white	vf-fg				
									589' 9"	white	vf-fg				
									592' 3"	white	vf-fg				
									593' 6"	white	vf-fg				
									594' 11"	white	vf-fg				
									596' 4"	grey	vf-fg				
									598' 2"	grey	vf-fg				
600															

DRILL Mindrill A 3000 REMARKS Most intervals slightly calcareous LOGGED J.B.
DRILLER O.K. Fredericksen Sandstone generally porous SAMPLED W.G.
COMMENCED 22-7-63 Stairway Sandstone ASSAYED R.I. Canberra
COMPLETED 17-8-63 SHEET 6 OF 10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP.1 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Johany Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx)
TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
600		BX			20°				603'1"	grey	vf-mg	Sandstone, silty sandstone & siltstone & rare pellets minor slumps			
			100						604'8"	white	vf-mg				
									606'8"	grey	f-mg				
									608'2"	grey	vf-fg				
									609'2"	grey	fg				
									611'9"	white	vf-mg				
			99						614'						
										white	mg	Sandstone more or less silicified, clean, occasional short open fractures or cavities (leached patches of silt or cf fossils?)			
									623'3"	white	fg				
			100						625'8"	white to light grey	fg	Sandstone & numerous thin silt partings & minor siltstone at top becoming cleaner to base			
									627'6"	grey	vf-cg				
									628'9"	white	fg				
									631'	white	mg				
									633'	grey	cg				
			100						634'2"						
										white to	mg	Sandstone & minor silt particles scattered throughout & occasional thin patches and partings of silt. More or less silicified & low porosity			
										lt grey					
			100												
									652'5"	Brown & white		Thin shale band 1-5 mm thick followed by sandstone & silt particles & saturated more or less & free oil			
									653'10"	All brown	mg				
									656'6"	white	cg	Fractured sand & oil in fracture top 4"			
									657'6"	white to light grey					
									659'3"	white & brown					
									660'4"						
			100						661'		mg	Sandstone & silt particles, more or less silicified, oil & oil stains in and around open fractures & cavities. Scattered flecks & grains organic matter			
									665'11"	white					
									667'7"						
									669'7"	lt grey	mg	Sandstone & scattered flecks and grains organic matter or phosphate, scattered silt particles & some patches & partings of silt, more or less silicified, oil saturated 674' to 675'4"	669'7"		
			100						672'9"	white			672'9"	41	0.36
									674'	greyish brown					
									675'4"		fg				
			100							white					
									682'1"	black	silt	Siltstone	682'1"		0.26
									683'9"	grey	vf-fg	Thin bedded & laminated sandy silt & silty sand, all more or less calcareous & scattered grains phosphate or organic matter	682'9"		0.76
									685'3"				683'9"		0.30
			92						687'7"				684'1"		0.26
									690'5"	dk grey	vf-fg	Shale & siltstone & minor sand. Pyrite disseminated throughout.	685'3"		0.30
									691'				687'7"		
									694'1"	grey	silt	Sandy silt & silty sand, disseminated pyrite rich in part, calcareous, scattered grains P ₂ O ₅ or organic matter.	690'5"		0.22
									695'6"	to					
									696'9"	dk grey	vf-fg				
									698'2"						
			97						699'9"						
700															

DRILL Mindrill A3000
DRILLER O.K. Fredericksen
COMMENCED 22-7-63
COMPLETED 17-8-63

REMARKS
Stairway Sandstone to 682'1"
Horn Valley Siltstone 682'1" -

LOGGED J.B.
SAMPLED W.B.
ASSAYED R.J.
SHEET 7 OF 10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. A.P. 1 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx)
TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
													SQ		g
700	BX	709'2"	100	18°	6			700'9"				Siltstone, shale, calcareous sandstone, sandy & silty limestone & few grains of pellets P ₂ O ₅ . All gives strong +ve P ₂ O ₅ with field reagent. Abundant disseminated pyrite - rich band at 711'8" - 711'10 1/2"	706'9"	<1	0.50
					6			702'8"	lt grey				707'1"	<1	0.35
					6			704'3"	grey				707'11"	<1	0.35
					6			705'2"					708'2"	<1	
					6			706'9"					709'7"	<1	
					6			708'2"					711'8"	<1	
710					6			709'7"	dk grey	vf-fg			711'10 1/2"	<1	
					6			711'8"					712'4"	<1	
					6			713'8"					713'8"	<1	
					6			715'1"					714'1"	<1	
					6			716'1"					715'1"	<1	
					6			718'4"					716'11"	<1	
720					6			720'9"					717'8"	<1	
					6			725'6"	dk grey				718'4"	<1	
					6			726'10"	grey	vf-fs			719'9"	<1	
					6			728'10"	lt grey				720'9"	<1	
					6			729'10"	grey				725'6"	<1	
					6			731'9"	dk grey				726'10"	<1	
					6			732'5"	lt grey				728'10"	<1	
					6			733'10"	grey				729'10"	<1	
					6			737'8"	grey to dk grey						
740					6			739'8"							
					6			740'10"							
					6			743'8"	grey						
					6			744'9"	to						
					6			746'2"	dk grey						
					6			748'3"	lt grey						
750					6			750'1"							
					6			751'6"							
					6			753'2"							
					6			754'4"							
					6			758'8"	dk grey						
					6			759'6"							
					6			761'2"							
					6			761'11"	grey to dk grey						
					6			763'4"							
					6			765'7"							
					6			766'9"							
					6			768'							
770					6			770'5"							
					6			771'8"							
					6			773'6"							
					6			775'							
					6			777'8"							
					6			780'11"	grey to black						
					6			782'10"							
					6			785'							
					6			785'8"							
					6			788'6"							
790					6			790'2"							
					6			791'10"							
					6			793'							
					6			795'							
					6			797'6"							
800					6			798'1"							

DRILL Mindri'll A3000 REMARKS Horn Valley Siltstone LOGGED J. B.
DRILLER O.K. Fredericksen SAMPLED W. B.
COMMENCED 22-7-62 ASSAYED R. J.
COMPLETED 17-8-63 SHEET 8 OF 10

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP1 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx.)
TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
		Bx	803'	100	16°			800' 5" to 802' 6"	dk grey to black			Calcareous siltstone & thin beds limestone & silty limestone. Core very broken 806' 6" Fluorescence in fractures at 800' 4", 802' 2", 806' 2", 813' 3", 813' 8".			
			812' 9"	100	18°			808' 1" to 810' 3"							
			822' 6"	100	18°			811' 8" to 812' 3"							
			832' 3"	100	20°			814' 4" to 816' 1"							
			844' 10"	100	20°			817' 6" to 820' 2"	Black to dk grey			Calcareous siltstone more or less rich in lime. Fluorescence in fractures at 821', 821' 7", 828' 2", 831'.			
			851' 3"	100	17°			843' 4" to 844' 6"	lt grey			Limestone = thin silt bands.			
			860'	100	18°			844' 6" to 845' 4"	black to dk grey			Siltstone more or less rich in lime. Fluorescence in fractures at 845' 4", 853' 10" & 854' 3".			
			869' 9"	100	18°			858' 4" to 859' 2"	grey to black			Limestone & silt bands & rough calcite			
			879' 8"	100	21°			869' to 871' 2"	black			Siltstone more or less rich in lime. Fluorescence in fractures at 862', 863' 8", 864' 6", 868' 6".			
			889' 8"	100	20°			871' 2" to 881'	grey to black						
				100	18°			881' to 888' 4"	grey dk green at base	vf-fg		Silty & sandy richly fossiliferous limestone & numerous thin shaly partings. Grains and aggregates of glauconite at base. Fluorescence at 885' 1", 887' 2", 887' 10", 889' 10".			
				100	20°			888' 4" to 890' 6"	lt grey grey/green & red/grey			Calcareous silt & sand & scattered grains P ₂ O ₅ or organic matter. 2" swelling shale 890' 6" (Bentonitic?) sandstone			
				100				894' 6" to 894' 9"	grey	fg		Calcareous silt & sand			
				100					grey	vf-fg					

DRILL Mindrill A3000
DRILLER O.K. Fredericksen
COMMENCED 22-7-63
COMPLETED 17-8-63

REMARKS Horn Valley Siltstone

LOGGED J.B.
SAMPLED _____
ASSAYED _____
SHEET 9 OF 10

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
 HOLE NO. AP 1 ANGLE 90° BEARING _____ ELEVATION _____
 LOCATION Johnny Creek FOUR MILE Lake Amadeus LATITUDE 24° 17' S LONGITUDE 131° 41' E (Approx)
 TOTAL DEPTH 918 feet DEPTH TO WATER TABLE 100 feet

	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SO	O
900			Bx			21°				902'4"	grey	vf-fg	Siltstone, sandy silt, & sandstone				
				100						903'6"	grey	vf-mg	Glaucousitic sandstone				
			908'9"							905'5"	grey	vf-fg	Sandy silt & sandstone				
										906'10"	white						
910			918'	100							white & lt grey	f, m, g, eg	Sandstone c glauconite and black scale on sand grains, thin silty partings, occasional short open fractures or cavities some with residual oil (tar) Phosphatic & slightly calcareous All gave strong fluorescence & UV				
920										918'							
930																	
940																	
950																	
960																	
970																	
980																	
990																	
1000																	

DRILL Mingrill A3000
 DRILLER O. K. Frederickson
 COMMENCED 22-7-63
 COMPLETED 17-8-63

REMARKS
Horn Valley Siltstone to 906'10"
Paraceta Sandstone 906'10" to bottom.

LOGGED J. B.
 SAMPLED _____
 ASSAYED _____
 SHEET 10 OF 10

GEOLOGICAL LOG OF DRILL HOLE

503952

PROJECT *Amadeus Basin Phosphate*HOLE NO. *AP 2* ANGLE *90°* BEARING *1850' (approx)*LOCATION *Levi Range* FOUR MILE *Henbury* LATITUDE *132° 15' E* LONGITUDE *24° 33' S (approx)*TOTAL DEPTH *544' 6"* DEPTH TO WATER TABLE *327'*

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
			20							Red		Sand, gravel, & sandstone rubble			
			10							Red to white	fg	Sandstone rubble & coarse, clean, well sorted, round quartz grains. Missing core possibly clay-shale bands			
			25							white					
			92							creamy brown, purple, red, red-brown	fg & mg	Sandstone & minor silty sandstone & thin silt bands & partings. Occasional cavities ex fossils. Some intervals silicified.			
			79												
			48												
			91												
			99												
			72		6°					cream yellow-brown		Shale & minor sandy partings			
			63							brown		Sandstone at top becoming silty sandstone & scattered pellets & grains P ₂ O ₅ . Several veins of gypsum along bedding planes & cavities ex fossils.			
			95							creamy brown	f-mg				
			66							brown to greyish brown					
			100												
			95		8°					brownish grey	vt-fg	Sandy siltstone			
			65' 9"												
			99		6°							Micaceous siltstone & shale & thin bands silty sandstone & sandstone, some calcareous. Scattered grains P ₂ O ₅ throughout & some intervals rich in grains & pellets. Slumps common.	69' 5"		
			50							grey	vt-fg		71' 8"	<1	
			93										73' 1"	<2	
													75'	<1	
													79'	<1	
													80' 3"	<1	
													82' 3"	<1	
													84' 3"	<1	
													86' 8"	<1	
													88' 8"	<1	
													91'	<1	
			99		8°					lt grey	vt-fg	Calcareous sand, silt, & limestone			
			92' 10"												
			94' 11"							grey	vt-fg	Siltstone & shale & minor sandstone & some calcareous intervals, grains, pellets P ₂ O ₅			
			95' 5"												
			96' 3"												
			97' 3"												
			99' 8"												

DRILL *Mindrill A3000*
 DRILLER *O.K. Fredericksen*
 COMMENCED *6-9-63*
 COMPLETED *18-9-63*

REMARKS
Collared in top of Stairway Sandstone

LOGGED *J.B.*
 SAMPLED *W.G.*
 ASSAYED *R.J.*
 SHEET *1* OF *6*

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP2 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Levi Range FOUR MILE Henbury LATITUDE _____ LONGITUDE _____
TOTAL DEPTH 544' 6" DEPTH TO WATER TABLE 327'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
															SQ	Q
									100' 8"			Siltstone & shale & minor sandstone, some calcareous intervals, occasional grains, pellets, & nodules; slumps common.				
									101' 6"							
									104' 7"	grey	vf-fg					
									110' 4"	white		Calcareous sandstone & thin silt partings & 3" limestone at base				
									113' 1"	grey		Shale & minor sandstone				
									114' 10"	white & grey	vf-fg & mg	6" silicified sandstone followed by sandstone & numerous thin silty partings, severe slumping, burrows, core & broken. More silt 119' 6" - 128' 10"				
									119' 6"	lt grey						
										grey	vf-fg					
									128' 10"	white		Partly silicified sandstone & minor silt, cavities & fossils at top - siltier to base				
									133' 5"	lt grey	vf-fg					
										white to lt grey	vf-fg some mg	Sandstone & minor siltstone slumps, burrows, rare scattered grains P ₂ O ₅ . Some sand slightly calcareous, some patches silicified, siltier towards base.				
									144' 2"							
									146' 8"	lt grey	vf-fg					
									150' 9"			Sandstone, siltstone & shale & few developments pellets, nodules & grains P ₂ O ₅ . Some disseminated & patches of pyrite				
									152' 6"	lt grey	vf-fg					
									153' 11"	to						
									154' 4"	grey						
									157' 5"	grey						
									158'							
									161' 1"	grey	vf-fg	Shale & siltstone & sandstone, pellets, grains P ₂ O ₅ , slumps burrows				
									163' 8"	white	fg	Silicified sandstone & minor silt partings, few pellets at top.				
									167'	white to lt grey	vf-f -mg	Sandstone & thin silt bands & partings, poor pellet development, some large cavities, burrows slumps, patchy silicification.				
									173' 9"	grey-dk grey	vf-fg	Silty sandstone sandy siltstone & grains & pellets P ₂ O ₅				
									176' 3"	white	vf-fg	Sandstone & siltstone burrows & slumps				
									179' 11"	lt grey		Sandy silt & shale & pellets				
									181'	dk grey	vf-mg	Sandstone & siltstone partly calc.				
									183' 7"	dk grey		Sandy siltstone, shale, & minor sandstone, & grains & pellets				
									187' 1"							
										grey	vf-fg	Sandstone & siltstone & minor shale, burrows, slumps, rare pellets P ₂ O ₅				
									198' 1"	dk grey	vf-fg	Sand, silt, pellets, grains P ₂ O ₅				
									199'							

DRILL Mindrill A 3000 REMARKS Stairway Sandstone LOGGED J. B.
DRILLER O. K. Fredericksen SAMPLED _____
COMMENCED 6-9-63 ASSAYED _____
COMPLETED 18-9-63 SHEET 2 OF 6

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: Amadeus Basin PhosphateHOLE NO. AP2 ANGLE 90° BEARING ELEVATIONLOCATION Levi Range FOUR MILE Henbury LATITUDE LONGITUDETOTAL DEPTH 544' 6" DEPTH TO WATER TABLE 327'

	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SQ	Q
200													Sandstone & silt partings, burrows & slumps				
		BX	203'2"	98						204'3"	white lt grey	fg	Clean sandstone & few thin silt partings 1/2" pyrite in 70" fracture at top.				
210			212'9"	99							white						
			222'5"	98						213'2"			Sandstone & few thin beds siltstone & silt partings, burrows, slumps, poor development of P ₂ O ₅ grains & pellets in places				
220			225'6"	98							lt grey	vf-fg					
			233'9"	100						231'2"	lt grey		Silty sandstone, sandstone & siltstone & few thin pellet bands & scattered grains P ₂ O ₅				
230			243'9"	96	7°					236'10"	grey		Siltstone & shale & minor sandstone. Slumps & scattered grains P ₂ O ₅ & few pellet bands.				
			253'7"	96	8°					242'6"	dk grey		Siltstone & shale & scattered grains, pellets, & nodules, few bands.				
240			257'5"	94	5°					248'4"	grey		Shale, sandstone & siltstone				
			267'3"	100	5°					251'4"	dk grey		Shale & siltstone & minor sandstone, pellets & grains P ₂ O ₅				
250			274'9"	97	5°					254'9"	grey		Sandstone, siltstone, & shale				
			284'4"	99						257'5"	lt grey		Sandstone minor silt, few pellets				
260			287'6"	100						258'9"	dk grey		Mostly shale & sandstone & siltstone, slumps, scattered grains. P ₂ O ₅				
			293'11"	97						263'7"	lt grey						
270			296'8"							267'	white & grey		Sandstone, shale & siltstone partly siliceous, partly calcareous				
			297'3"							271'3"	grey dk grey lt grey		Shale & siltstone & sandy siltstone, silty sandstone, & sandstone. Pellets at top & 274'6", rare elsewhere, slumps common, few burrows				
280										282'6"							
										283'1"							
290										284'10"			Shale & minor sandy siltstone & sandstone				
										288'11"	dk grey						
300										293'6"	grey		Shale, siltstone, & sandstone partly calcareous.				
										296'8"	dk grey						

DRILL Mindrill A3000
 DRILLER O.K. Fredericksen
 COMMENCED 6-9-63
 COMPLETED 18-9-63

REMARKS

Stairway SandstoneLOGGED J.B.

SAMPLED

ASSAYED

SHEET 3 OF 6

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP 2 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Levi Range FOUR MILE Henbury LATITUDE _____ LONGITUDE _____
TOTAL DEPTH 544'6" DEPTH TO WATER TABLE 32.7 feet

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
															SQ	Q
	Bx	303"	97		5°				303'10"	grey & dk grey	vf-fg	Shale, siltstone & sandstone				
		312'9"	100						305'10"	dk grey						
		321'8"	100		6°				307'9"	grey & white		shale, siltstone & sandstone more or less calcareous & fossiliferous & few pellet bands and scattered grains P ₂ O ₅				
		331'8"	100						308'8"	grey						
		341'8"	96						310'4"	grey						
		351'6"	98						313'10"	lt grey	vf-fg					
		362'6"	100		7°				316'9"	grey						
		372'	97						318'9"	grey						
		381'11"	99						319'6"	grey dk grey						
		391'6"	98						327'1"	grey						
									327'9"	grey						
									329'10"	white	fg	Sandstone, well sorted, clean silicified				
									331'8"	white						
									332'10"	white						
									341'5"	white & lt grey		friable, cavities ex fossils				
									347'1"	pink		becoming silty				
									352'9"	white pinkish & lt grey	vf-fg	Sandstone & minor silt laminae becoming more silty to base				
									356'	white						
									372'6"	pinkish & lt grey	vf-fg					
									373'10"	white & lt grey	vf-fg	Sandstone & minor silt laminae.				
									381'9"	white	fg	Sandstone, fairly clean & minor silt partings				
									383'	white						
									389'5"	white to lt grey	vf-fg	Sandstone & silt laminae & sparse pellets & grains 393'-394'				
									393'	white & lt grey	vf-fg	Sandstone & siltstone, slumps & burrows				
									394'	white & lt grey	vf-fg					

DRILL Mindrill A3000 REMARKS Stairway Sandstone LOGGED J.B.
DRILLER OK Fredericksen SAMPLED _____
COMMENCED 6-9-63 ASSAYED _____
COMPLETED 18-9-63 SHEET 4 OF 6

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
 HOLE NO. AP2 ANGLE 90° BEARING ELEVATION
 LOCATION Levi Range FOUR MILE Henbury. LATITUDE LONGITUDE
 TOTAL DEPTH 544' 6" DEPTH TO WATER TABLE 327'

	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SQ	Q
400																	
		Bx	401' 3"	98							white to lt grey	vf-fg	Sandstone & numerous silt laminae & bands. slumps & burrows common				
410			401' 11"	100													
			420' 9"	98													
420			420' 9"							419' 10"		fg & m-cg	Mostly fg slightly silty Sandstone & few beds mg & cg sandstone				
			430' 5"	99						426' 4"		m-cg	Sandstone & scattered grains & pellets P ₂ O ₅				
30			440' 5"	98						430' 3"		fg	Sandstone, partly silicified silt laminae towards base				
			444' 9"	100	5°					436'		vf-fg	Sandstone & silt stone				
440			445' 3"							441' 9"		vf, f, mg	Mostly soft silty sandstone & beds of coarser grained sandstone & minor thin bands & partings of silt				
			454' 4"	100						447'	white	c-veg	Coarse fractions typically have scattered grains & pellets P ₂ O ₅				
450			464' 3"	99						448' 6"		vf, f, m, & cg	silty sandstone & thin silt bands & partings.				
			474'	98						455' 6"		vf-f	Sandstone				
			483'	76						462' 10"		cg	& silt partings				
470			492' 10"	99						468'		f-cg	Sandstone				
										471'		cg	& silt bands & partings				
480										474' 8"		vf-cg	Silt & burrows & slumps				
										480' 1"		cg	Sandstone				
										480' 10"	lt grey	vf-fg	Sand/silt, burrows, slumps				
										484' 1"	grey	silt	Silt stone				
490										486' 3"			Core loss probably here.				
										487' 9"			Sandstone & abundant disseminated pyrite				
										489' 9"	lt grey (greenish)	m					
										498' 3"	lt grey	m-cg	Sandstone & minor pyrite				
500																	

DRILL Mindrill A300
 DRILLER O.K. Fredrickson
 COMMENCED 6-9-63
 COMPLETED 18-9-63

REMARKS

Stairway Sandstone

LOGGED J.B.

SAMPLED

ASSAYED

SHEET 5 OF 6

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
 HOLE NO. AP 2 ANGLE 90° BEARING ELEVATION
 LOCATION Levi Range FOUR MILE Henbury LATITUDE LONGITUDE
 TOTAL DEPTH 544' 6" DEPTH TO WATER TABLE 327'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
500		502'	99						503'5"	lt grey to greenish grey	m-cg	Sandstone & minor pyrite			
510		519'3"	50						511'			Pyritic sandstone & minor patches & partings of silt. Rich oolitic pyrite 505'-506'			
520		528'9"	91	6°					519'3"	lt grey	vf-cg	Lost core (cavity) probably here. Strongly suspect open near vertical fracture.			
530		534'3"	86						523'3"	grey	vf-fg	Sandstone & increasing silt, scattered grains P ₂ O ₅			
540		544'6"	89						525'3"	grey white	vf-fg	Silt/sand, slumps burrows.			
									527'	white	mg	Sandstone			
										lt grey	vf-mg	Calcareous sandstone & siltstone & minor limestone, fossiliferous slumps, burrows			
									534'						
									536'3"	grey	vf-fg	Calcareous silty sandstone			
										grey	vf-mg	Calcareous sandstone & siltstone & minor limestone slumps, burrows common.			
									544'6"						
550															
560															
570															
580															
590															
600															

DRILL Mindrill A3000
 DRILLER O.K. Frederickson
 COMMENCED 6-9-63
 COMPLETED 18-9-63

REMARKS
Stairway Sandstone to 527'
Horn Valley Siltstone to T.D. 544'6"

LOGGED JB
 SAMPLED
 ASSAYED
 SHEET 6 OF 6

GEOLOGICAL LOG OF DRILL HOLE 503952

PROJECT *Amadeus Basin Phosphate*HOLE NO. *AP 3* ANGLE *90°* BEARING *1600' (approx.)*
LOCATION *James Range* FOUR MILE *Henbury* LATITUDE *132° 58' E* LONGITUDE *24° 20' S (approx.)*
TOTAL DEPTH *771' 10"* DEPTH TO WATER TABLE *155'*

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
		10	10' 7' 49" 36"					3' 6"	grey red	sand to 2"		Sand & sandstone rubble			
		50						6' 6"	white			Clean white sandstone rubble			
		60						10'	white	fg		Sandstone			
		70						10'	white	fg		Little core - all broken.			
		10						17'	pink	silt		Sandstone at top Siltstone at base			
		77						33'	mostly dark pink & green & white	silt v/s to mg		Sandstone, sandy siltstone, & siltstone; laminated, thin & convolute bedded; slumps, burrows common rare (sparse) bands of pellets and/or grains P ₂			
		89			16°			36' 7"	white pink grey						
		94						42' 9"	creamy brown						
		100						44' 2"	white	mg		Sandstone well sorted			
		98			17°			46' 3"	cream			Silty sandstone poorly sorted			
								47' 9"	brown & white & grey (sepa tones)			As for 17' - 42' 9"			
					16°			54' 11"				Sandstone & minor siltstone			
					18°			57'							
								60' 7"				As for 17' - 42' 9" but more sand.			
		98						62'							
								70' 5"				Sandstone, sandy silt, & siltstone & 12 thin bands (veins as bedding) of gypsum: scattered pellets			
								71'				Sandstone/siltstone & convolute bedding.			
								75' 2"							
								75' 7"							
					14°			83' 6"	dk grey	vt-fg		Silty sandstone & grains P ₂ O ₅			
								84' 11"				Shale & sandstone			
								87' 8"	grey			Silty sandstone & grains P ₂ O ₅			
								87' 9"	dk grey			Siltstone/sandstone & convolute bedding & minor shale			
					15°			95'	white			Shale & thin sand bands			
								97'	dk grey			Silty sandstone convolute bed			
								98' 6"				Shale & minor sandstone			

DRILL *Mindrill A3000*DRILLER *O.K. Fredericksen*COMMENCED *30-9-63*COMPLETED *15-10-63*

REMARKS

*Hole cased at top of Stairway
Sandstone*LOGGED *J.B.*

SAMPLED

ASSAYED

SHEET *1* OF *5*

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin PhosphateHOLE NO. AP3ANGLE 90°

BEARING ELEVATION

LOCATION James Range FOUR MILE Henbury

LATITUDE LONGITUDE

TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P2O5
	BX				16°				101'5"			Shale & minor sand			
			98		18°				103'	dk grey		Silty sand & convolute bedding			
		108'6"							105'			Shale			
					22°				107'5"			Silty sand & convolute bedding			
									110'3"			Shale & sandstone, slumps			
			100		16°				112'1"			burrows			
		118'							113'3"			Silty sand & convolute bedding			
									114'5"	dk grey		Shale & minor sandstone			
					17°				118'			Silty sand & scattered pellets			
		127'10"							123'8"			Shale & minor thin sandy			
			99									partings			
		137'6"										Mostly shale & siltstone &			
												sandstone, slumps, few			
		147'3"			16°				135'	dk grey		burrows			
			100									Silty sandstone & convolute			
												bedding; minor sandstone			
		157'										& shale			
			100									Shale & siltstone & sandstone			
		166'10"							140'11"			few slumps & burrows			
			98						143'6"			Mostly sandstone & minor			
									145'11"			shale, slumps, burrows			
		176'6"			(8°)							Shale & minor sand, slumps, burrows			
			100		15°							Interbeds sandstone & shale,			
		186'2"							159'1"			more or less equal proportions,			
			97		16°				160'2"	white		slumps, burrows common,			
									161'10"	white		rare thin pellet bands and			
		196'							163'3"	white + grey		scattered grains.			
			100						164'6"	lt grey		Shale & scattered pellets			
									167'5"	white		Sandstone			
			98						171'8"	white		Shale → sand → sand & pellets			
										lt grey		Silty sandstone & convolute bed			
		196'							176'6"	white		Sandstone & minor thin			
			100						180'7"	grey		shale partings, slumps, burrows			
									182'9"	white		slightly silty sandstone			
			98		14°				186'2"			Silty sandstone & convolute			
					15°							bedding			
					21°				195'2"			Sandstone & thin silt partings			
			100		15°							increasing to base			
												Sandstone & thin silt partings			
												Sandstone & occasional			
												thin partings and patches			
												of silt.			
												Sandstone & siltstone			

DRILL Mindrill A3000

REMARKS

LOGGED J.B.DRILLER O.K. FredericksenStairway Sandstone

SAMPLED

COMMENCED 30-9-63

ASSAYED

COMPLETED 15-10-63SHEET 2 OF 8

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP 3 ANGLE 90° BEARING ELEVATION
LOCATION James Range FOUR MILE Henbury LATITUDE LONGITUDE
TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅					
																SO	Q				
200			205' 8"	100							white & grey		Sandstone & siltstone, burrows, slumps & few bands sparse pellets								
210	Bx	↓	215' 4"	94					208' 4"	white	fg		Sandstone & few laminae pellets								
									211' 4"	grey & dk grey			Sandstone, silty sandstone & shale & scattered green pellets								
									215'	lt grey			Sandstone & siltstone, slumps, burrows, convolute bedding.								
220			225'	94					219' 7"	white	vf-fg		Slightly silty sandstone & fossil markings?								
									223' 2"				Sandstone								
30			235'	98							fg										
240			239' 8"	100						238' 1"	white	silt to fg	Sandstone soft & friable in part & fine white silt.								
										243' 10"			Sandstone & clayey matrix								
250	Ax	↓	249' 3"	0	252' 10"						white	fg									
																		255' 1"	100		
																		264' 4"	100		
60	Bx	↓	264' 4"	100																	
270			274'	100								fg	Sandstone & minor patches, partings, & thin beds silt								
																		274' 7"			
																		280' 3"			
280			284'	95								f-mg	Shale/silt & sand, slumps, burrows								
																		282'			Sandstone & minor thin bands shale/siltstone
290			293' 9"	98									Siltstone shale and sandstone & burrows & slumps								
																		287' 2"			
290				97																	

DRILL Mindrill A3000 REMARKS Stairway Sandstone LOGGED JB
DRILLER O.K. Fredericksen SAMPLED
COMMENCED 30-9-63 ASSAYED
COMPLETED 15-10-63 SHEET 3 OF 8

GEOLOGICAL LOG OF DRILL HOLE

PROJECT.....Amadufus Basin Phosphate

HOLE NO. AP 3 ANGLE 90° BEARING ELEVATION

LOCATION James Range FOUR MILE Henbury LATITUDE..... LONGITUDE.....

TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

DEPTH	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SO	Q
300			303'9"	97						304'			Siltstone shale & sandstone slumps & burrows				
310		Bx	313'6"	100		13°				311'7"	grey & white	vf-fg	Sandy siltstone, convolute bedding & few thin bands sandstone				
			318'3"	100						313'7"	grey	fg	Sandy siltstone & sandstone				
			322'8"							315'6"	grey & white		Sandy siltstone				
320			328'	100		12°				318'	dk grey		Shale & sandstone bands				
			336'	99		15°				321'7"	grey & white	vf-fg	Shale, siltstone, & sandstone & rare scattered pellets & pellet bands				
			346'	96		20°				322'8"	grey & white						
			354'6"	99		16°				323'2"	white	mg	Sandstone & rare pellets				
340			364'3"	99		10°				325'	white		Interbeds of sandstone, shale, & siltstone & slumps, burrows, & many thin sparse pellet bands; scattered grains & pellets throughout.				
			374'	99		15°				328'4"	white to black	vf-mg					
			383'9"	100		10°				329'6"	black		Shale. core broken				
370			393'3"	99		15°				358'3"	white to black	vf-mg	Interbeds sandstone, shale, & siltstone & several thin sparse pellet bands slumps, burrows, & some convolute bedding				
			397'2"	100		13°				359'8"	white						
			398'1"	99		20°				367'	black						
380			399'9"	99		15°				374'10"	grey	vf-fg	Sandstone & shale & siltstone slumps, burrows, some scattered grains & pellets to base				
			400'	99						376'11"	grey		Sandy siltstone, minor shale & sandstone & grains P ₂ O ₅				
										383'9"	dk grey		Sandstone & siltstone & pellets				
										385'10"	grey		Sandy siltstone				
										386'11"	dk grey						

DRILL *Mindrill A3000*

DRILLER O.K. Fredericksen

COMMENCED... 30-9-63

COMPLETED 15-10-63

REMARKS

REMARKS	
Starway	Small stone

LOGGED J. B.

SAMPLED

ASSAYED.

SHEET 4 OF 8

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin phosphate
HOLE NO. AP 3 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION James Range FOUR MILE Henbury LATITUDE _____ LONGITUDE _____
TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

DEPTH	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SO	Q
400													Sandy siltstone				
		Bx	403'	99		10°				403'7"	dk grey	silt to	Sandy siltstone & slumps & burrows becoming sandier to sandstone at base				
			412'6"	100		12°				410'8"	lt grey	fg					
410										413'10"	dk grey	vf-fg	Sandy siltstone				
			422'3"	98		12°				416'6"	lt grey	vf-fg	Sand & silt, burrows & slumps				
						17°				418'10"	grey	vf-fg	Sandy silt becoming sandier				
420						15°				421'2"	grey	vf-fg	Sandy siltstone & patches of silty sandstone				
			432'	98						423'1"	grey	vf-fg	Sandy siltstone → 3" sand at base				
			441'6"	100		15°				425'7"	lt grey	silt to	Sandstone & siltstone & minor shale & few scattered pellets and grains 1'6"				
30										430'11"	grey	fg	Slumps & burrows common				
			441'6"	100		15°				437'	dk grey	.					
440											grey	silt to fg	Sandstone & siltstone slumps & burrows				
			451'	98		18°				447'1"	white	fg	Sandstone				
450										449'6"							
			460'9"	98		18°					lt grey	silt to fg	Sandstone, silty sandstone & minor siltstone & slumps, burrows. Rare scattered pellets towards base & becoming siltier				
60						25°				463'5"	white	fg	Sandstone				
			470'6"	98		(8°)				464'	white	fg	Sandstone becoming siltier				
470						18°					white to lt grey	silt to fg					
			480'	99						475'	white	silt to fg	Sandstone becoming siltier				
480										480'	white	fg	Sandstone becoming siltier				
			489'1"	98		13°				482'10"	lt grey	.					
490											white to v. sil	fg	Sandstone becoming siltier & rare pellets				
			498'10"	100		16°				491'8"	grey		Slight pinkish tinge 496'				
500										497'8"			Sandstone				

DRILL *Mindrill A3000*
DRILLER *O. K. Fredericksen*
COMMENCED *30-9-63*
COMPLETED *15-10-63*

REMARKS	
Stairway	Sand stone

LOGGED J.B.
SAMPLED
ASSAYED.....
SHEET 5 OF 8

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate

HOLE NO. AP 3 ANGLE 90° BEARING ELEVATION

LOCATION James Range FOUR MILE Henbury LATITUDE LONGITUDE

TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
															SO	O
	BX	508' 6"	100		15°				508'	greys & whites Rare Pinks						
510		518' 3"	98							Pink grey & white fg		Sandstone apparently fairly clean & well-sorted but with a abundant markings possibly due to silt. Minor thin siltstone bands & stamp's & burrows				
520		527' 9"	100													
530		537' 3"	100													
540		547'	99						537'	dark pink & lilac pink & minor grey fg						
550		555' 8"	100													
560		564' 9"	100													
570		574' 2"	100		15°				568'	grey & white & minor pink fg						
580		581' 7"	99													
590		591'	100													
600		600' 7"	100													

DRILL Mindrill A3000
DRILLER O.K. Fredericksen REMARKS Stairway Sandstone
COMMENCED 30-9-63
COMPLETED 15-10-63

LOGGED J.B.
SAMPLED
ASSAYED
SHEET 6 OF 8

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadass Exam. Phosphate
HOLE NO. AP 3 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION James Range FOUR MILE Henbury LATITUDE _____ LONGITUDE _____
TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

	WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
																SO	Q
600			600'1"	100									Sandstone & silt (?) markings minor siltstone & shale				
		Bx	610'3"	99	14°					pink & grey & white	fg						
610			610'3"						Log 11" 611'3"	pink & pink & green & grey	cg vf- cg		Sandstone & silt (?) nodules Sandstone & minor siltstone				
			620'	98					6'4'10"	dk pink pink green grey	vf cg		laminated sandstone & minor silt bands to partings (?) of silt.				
620			620'						625'7"	dk pink pink green grey	fg late cg		Sandstone (silty?) & pipes ("pipe rock"?)				
			624'4"	98	15°				625'2"	dk pink pink grey	cg-vfg		Sandstone & v minor siltstone				
30			634'6"	98					625'	dk pink & pink & minor green grey	silt to vfg		Sandstone, silty sandstone & sandy siltstone & slumps, pipes (?) & few burrows				
640			648'10"	100	17°				634'2"	white & green grey	fg		Sandstone & silty intervals & thin siltstone partings				
650			658'5"	100					659'	green grey	f-cg		Sandstone & minor siltstone scattered pellets in coarse fractions				
			667'10"	100					664'		vf-fg		Micaceous siltstone & minor sandstone, pellets & grains P.O.				
670			677'5"	100					667'9"		cg		Sandstone & minor siltstone				
			677'5"		17°				670'2"	white minor green grey	c-vfg		Sandstone				
			677'5"						675'6"	green grey & white	silt to cg		Siltstone, sandy siltstone & sandstone & slumps, burrows				
680			680'3"	100					680'3"	white to lt green grey	c-vfg		Sandstone & silt (?) markings & few thin silt partings				
690			687'1"	97													
700			697'	97													

DRILL Mindrill A3000
DRILLER O. K. Fredericksen
COMMENCED 30-9-63
COMPLETED 15-10-63

REMARKS

LOGGED JK
SAMPLED
ASSAYED
SHEET 7 OF 8

GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
 HOLE NO. AP3 ANGLE 90° BEARING _____ ELEVATION _____
 LOCATION James Range FOUR MILE Henbury LATITUDE _____ LONGITUDE _____
 TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	SO
	Bx	705'	97							white to lt green grey	c-veg	Sandstone & silt (?) markings & few thin siltstone partings			
		714' 9"	98					711' 3"		white	f-eg	Sandstone & silt, shimp, burrows			
		724' 6"	99					712' 10"		lt grey	c-veg	Sandstone & silt markings, few thin silt partings, disseminated oolitic pyrite, oolites to 1/10" at 719'			
		733' 3"	100					732'			mg				
		742' 9"	100		15°					white	m, f, eg	Sandstone & v minor thin silt partings			
		752' 6"	98		16°					lt grey					
		762'	100		18°			759'		white	fg	Calcareous sandstone & siltstone, shimp, burrows, & rare fossiliferous limestone bands.			
		771' 10"	100					771' 10"		lt grey	rare mg				

DRILL Mindrill A 3900DRILLER O. K. FredericksenCOMMENCED 30-9-63COMPLETED 15-10-63

REMARKS

Stairway Sandstone to 759'
 Horn Valley Siltstone 759' to T.D.

LOGGED I. B.

SAMPLED _____

ASSAYED _____

SHEET 8 OF 8

GEOLOGICAL LOG OF DRILL HOLE

503952

TOTAL DEPTH 338' 8" DEPTH TO WATER TABLE 203'

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N I K

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

PROJECT Amadeus Basin Phosphate
HOLE NO. AP4 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION India Bore FOUR MILE Lake Amadeus LATITUDE _____ LONGITUDE _____
TOTAL DEPTH 338' 8" DEPTH TO WATER TABLE 203'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅	
															SQ	Q
		100' 6"	99						100' 6"	dk maroon		Calcareous shale & siltstone ± lime-rich bands & occasional fossiliferous limestone				
		100' 3"			7°				102'	greys & greens						
		120'	100		7°				105' 9"	dk maroon						
		124' 1"							106' 9"	dk grey						
		132'	99		5°				108' 10"	dk maroon						
		141' 9"			4°				111' 9"	dk grey						
		148'	100		5°				112' 5"	maroon						
		157' 9"							113' 10"	maroon						
		166' 5"	80						114' 1"	dk green & grey						
		174'	93						115' 7"	grey						
		184'							117'	maroon ± minor greens & greys						
		193' 9"	85		5°				132' 6"	dk grey						
									134' 8"	maroon ± minor thin greens & greys						
									147'	cream						
									148'	maroon						
									151'	cream		fossiliferous limestone				
									153' 7"	creamy brown	cg	silty calcareous sandstone				
									156'	lt pink brown		Sandstone				
									166' 3"	pink lt brown	fg	pelletal sandstone				
									166' 9"	lt brown		Sandstone ± patches of silt				
									171' 5"	lt brown		Sandstone ± patches & thin bands silt, scattered pellets & nodules P ₂ O ₅				
									175' 10"	dk grey		Shale & siltstone ± scattered grains & few pellets P ₂ O ₅				
									179' 10"	lt brown ± pink & yellow tints	fg	Sandstone ± thin shale bands & patches of silt, few scattered pellets at 190'.				
									192' 10"	dk grey	vt-fg	Shale & siltstone ± minor thin sandy bands & scattered grains				
									195' 6"	grey	vt-fg	Silty sandstone ± scattered grains & pellets				
									198'	lt grey	vt-fg	Calcareous silty sandstone siltstone				

DRILL *Mindrill A3000*
DRILLER *O.K. Fredericksen*
COMMENCED *19-10-63*
COMPLETED *25-10-63*

REMARKS
Stokes Formation to 153'7"
Transition 153'7" - 156'
Stairway Sandstone 156' -

LOGGED J.B.
SAMPLED
ASSAYED
SHEET 2 OF 4

GEOLOGICAL LOG OF DRILL HOLE

TOTAL DEPTH 338' 8" DEPTH TO WATER TABLE 203

246' 9 1/2"	2.4
247' 3"	
248' 4"	2.2
249' 2 1/2"	2.4
249' 7 1/2"	5.0
250' 1"	2.0
251'	6.6
251' 6"	5.0
252' 1"	6.0
252' 3"	6.9
252' 7"	2.2
253' 6"	5.0
253' 11"	2.2
254' 2"	1.8
255'	1.8
255' 5"	0.6
255' 8"	7.4
255' 10"	0.4
257'	1.0
257' 9"	3.2
258' 11"	11.4
259' 1 1/2"	2.2
259' 4 1/2"	
274' 7"	12.0
274' 11"	

LOGGED J.B.
SAMPLED W.G.
ASSAYED Canberra
SHEET 3 OF 4.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
GEOLOGICAL LOG OF DRILL HOLE

PROJECT Amadeus Basin Phosphate
HOLE NO. AP 4 ANGLE 90° BEARING _____ ELEVATION _____
LOCATION Luindia Bore FOUR MILE Lake Amadeus LATITUDE _____ LONGITUDE _____
TOTAL DEPTH 338' 8" DEPTH TO WATER TABLE 203'

WEATHERING	CASING	CORE SIZE	LIFTS	CORE RECOVERY	DIP	FOSSILS	BEDDING	GRAPHIC LOG	FOOTAGE	COLOUR	TEXTURE	LITHOLOGY	SAMPLE INTERVAL	SAMPLE NUMBER	% P ₂ O ₅
		Bx ↓													
300		308'9"	100						white	fg to 1/4"		Sandstone with thin bands coarser fractions			
310		318'4"	100						white	fg to 1/10"		Hard fine grained sandstone & fewer thin bands of coarser fractions			
320		323'6"	99												
330		330'6"	100									1" Conglomerate band at base			
340		338'8"	97						purple brown maroon yellow brown & white	f-cg		Sandstone & few thin shale bands			
350															
360															
370															
380															
390															
400															

Tentative stratigraphy:-
Starway Sandstone to 325'8" unconformably overlaying Upper Proterozoic Winnall Beds
The interval 291'6" to 298' may represent Horn Valley Siltstone & 298' to 325'3" Pacoola Sandstone - ?

DRILL Mindrill A 3000 REMARKS _____ LOGGED J. B.
DRILLER O. K. Frederickson SAMPLED _____
COMMENCED 19-10-63 ASSAYED _____
COMPLETED 25-10-63 SHEET 4 OF 4

503952

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

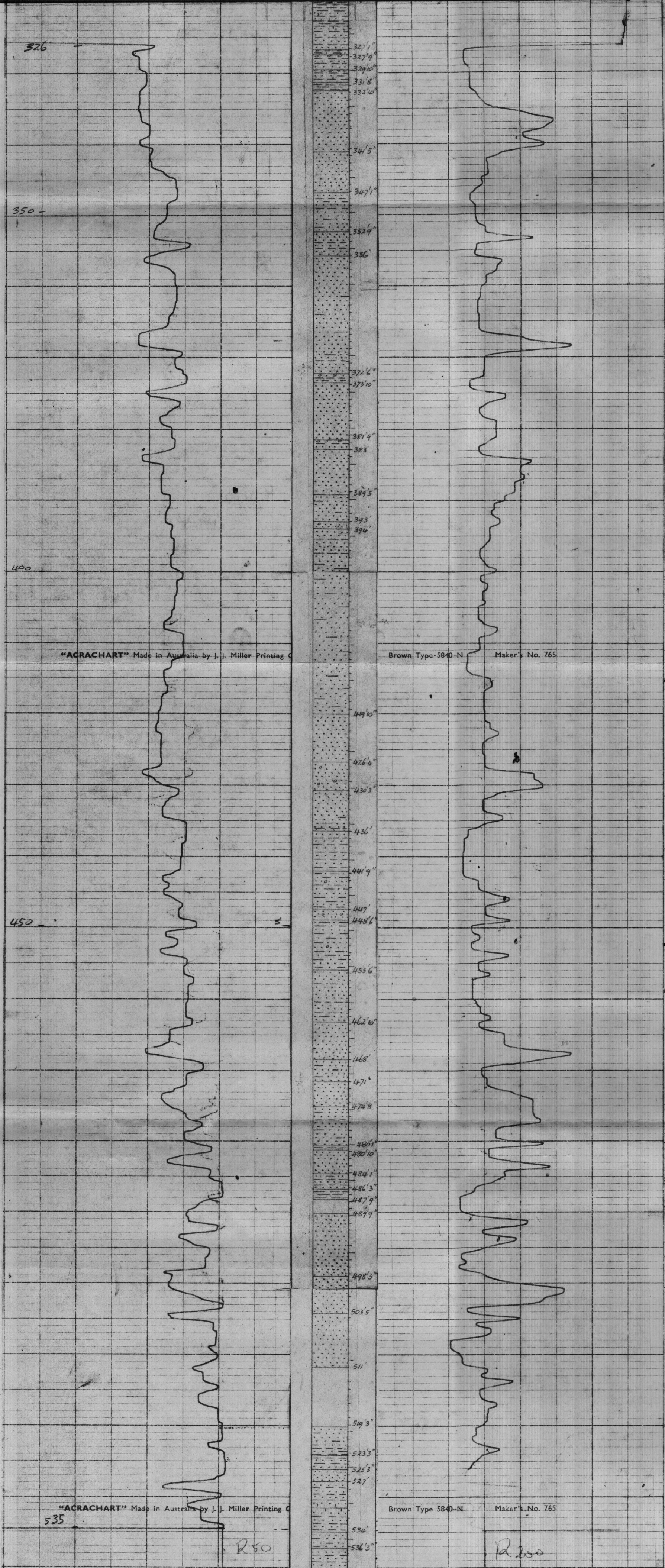
LOG OF DRILL HOLE

PROJECT AMADEUS BASIN PHOSPHATE DATE 18/9/63
HOLE No. A.P. 2 ANGLE 90° BEARING — ELEVATION 1850 (approx)
LOCATION LEVI RANGE 1:250,000 HENBURY LATITUDE 24° 33' S LONGITUDE 132° 15' E (approx)
TOTAL DEPTH 544' 6" DEPTH TO WATER TABLE 325'
FIRST READING 325' LAST READING 535' DATUM Ground Level FOOTAGE LOGGED 210'
REMARKS

SELF POTENTIAL
Sensitivity + 1 50 mV —

Core Log
Drill depth Low

RESISTIVITY
Sensitivity 200 ohms
(no zero obtained) high



LOG OF DRILL HOLE

PROJECT AMADEUS BASIN PHOSPHATE

DATE 15/10/63

HOLE No. AP.3 ANGLE 90° BEARING ELEVATION 1600' (approx)

LOCATION JAMES RANGE 1250,000 HENBURY LATITUDE 24° 20' S LONGITUDE 132° 58' (approx)

TOTAL DEPTH 771' 10" DEPTH TO WATER TABLE 155'

FIRST READING 155' LAST READING 775' DATUM Ground Level FOOTAGE LOGGED 620'

REMARKS

SELF POTENTIAL
Sensitivity + 1 20 mV -RESISTIVITY
Sensitivity 100 ohms
no zero obtainedCore
Depth

Low

high

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Melbourne

Brown Type 5840-N

Maker's No. 765

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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

LOG OF DRILL HOLE

PROJECT AMADEUS BASIN PHOSPHATE DATE 26/10/83

HOLE No. AP 4 ANGLE 90° ELEVATION 1700' (approx)

LOCATION ININDIA BORE AREA 1:250,000 LAKE AMADEUS LATITUDE 24° 56' S LONGITUDE 131° 55' E (GR250X)

TOTAL DEPTH 358' 8" DEPT INTO WATER TABLE 203'

FIRST READING 203' LAST READING 302' DATUM Ground Level FOOTAGE LOGGED 99'

REMARKS Self potential does not repeat same signature

SELF POTENTIAL

Sensitivity + | 50 mV | -

RESISTIVITY

Sensitivity 50 ohms

Core Drill
Log depth Low

(no zero obtained)

high

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