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A PETROLOGICAL STUDY OF THE SEDIMENTS FROM OORAMINNA NO.1 WELL, AMADEUS BASIN. NORTHERN TERRITORY.

by

G. Schmerber
Institut Français du Petrole

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CONTENTS

The opinions and views expressed in this Record are those of the Author, and are not necessarily those of the Bureau of Mineral Resources.

SUMMARY

This report is the result of the examination of cores and cuttings obtained from Ooraminna No.1 well.

New information concerning the texture, the mineral constituents and cementing media have been revealed.

All subdivisions, previously defined from surface mapping and exploratory drilling, can be justified. In this well from bottom to top they are --

1835 feet of Bitter Springs Formation has been recognized and divided into two members, a lower halitic part and a mainly dolomitic upper part with three dolerite interbeds.

535 feet sediments characterized by the appearance of poorly sorted, very fine grained to conglomeratic sandstone which can be correlated with the Areyonga Formation.

2200 feet of very monotonous, pyritic and chloritic shale grading to siltstone followed by a haematitic, sandy carbonate sequence characteristic of the Pertatataka Formation.

1530 feet of ferruginous, medium to poorly sorted, fine to coarse grained, locally conglomeratic, quartz and feldspathic sandstone with haematite coatings and some glauconite horizons at the top; these are correlated with the Arumbera Sandstone.

Particular attention has been directed to diagenetic conditions in relation to strong recrystallization and lithification. The relationship between tectonism and lithification is discussed.

With the exception of the Arumbera Sandstone, which represents sedimentation in a deltaic environment, the sediments are considered marine with very little detrital material due to lack of relief in the surrounding land areas.

INTRODUCTION

The Ooraminna No. 1 well was drilled in the Amadeus Basin (Northern Territory) as a stratigraphic and structural test of Proterozoic beds of the Ooraminna anticline. The well is situated 42 miles southeast of Alice Springs and its coordinates are 24° 0' 6" S., 134° 9' 50" E.

The aim of this study was to examine in detail the lithology from the Proterozoic to the Cambrian.

All cores and cuttings samples held in the B.M.R. collection were examined.

The work carried out on the sediments includes a binocular microscopic examination of all the available material and a thin section analysis of all cores and selected cuttings. A calcimetry log was prepared for the carbonate sequence. Staining tests for dolomite and calcite were carried out on selected thin sections. (see Appendix 1). A brief study of heavy minerals was undertaken on sandstone from the cores.

DESCRIPTION OF LITHOLOGICAL UNITS

The sediments in the Ooraminna No. 1 well have been divided into lithological units based on their composition and texture. It was considered that this would simplify correlation work in the future. All the boundaries of the units were delimited by observed lithological changes shown in the samples and by changes in the electric log pattern.

The detailed core descriptions are given in appendix 2. The lithologies are also shown on the composite well long, plate 1 (sheet 1 and 2).

Bitter Springs Formation

In this report the Bitter Springs Formation has been subdivided into two members, a lower halitic unit, the Gillen Member and a upper clayey calcitic unit, the Loves Creek Member.

Gillen Member (T.D. (6100) to 5920 feet)

Lithology: In this well the member is represented by soft, rusty red, ferruginous, calcitic claystone with very coarse anhydrite crystals growing in patches or lenses, mixed with transparent halite. Typical of this interval is a plastic texture with strong lineations which indicate that the salt is not bedded, but has flowed into place.

Loves Creek Member (5920 to 4265 feet)

Three lithological subdivisions have been recognized in this well: dolomite from 5920 to 5280 feet, three dolerite streaks interbedded with claystone and carbonate from 5280 to 4390 feet, and a succession with a change in lithology characterized by an increase in quartz content from 4390 to 4265 feet. All boundaries are well established by electric logs, especially by gamma-ray.

Lithologies:

Interval 5920 to 5280 feet

This unit consists predominantly of white to light grey strongly dolomitized limestone, cryptocrystalline to microcrystalline, recrystallized, with abundant chalcedony, chert and occasionally pyrite. Very coarse crystalline anhydrite and rare gypsum occur in patches or veins. Towards the bottom (5920 to 5800 feet) a thin sandy and oolitic band is present with 10 to 30% silt - sized angular quartz, muscovite and phlogopite? in fine laminations.

Interval 5280 to 4390 feet

The sediments of this interval are alternating claystone and dolomitized limestone with three interbedded dolerite streaks.

a) Dolerite:

Dolerite appears in three bands from 5010 to 5000, 4738 to 4710 and 4690 to 4578 feet.

It is highly altered and contains plagioclase, augite, chlorite, magnetite and iron oxide, rare quartz and devitrified glass together with apatite and sphene. The texture is ophitic.

a) Dolerite: (Cont'd)

The plagioclase is strongly sericitized albite; augite-generally zoned on crystal margins in ferro-augite which contains haematite - is very often replaced by green chlorite. Chlorite, which is predominant in this rock, is interstitial and also infills cavities. The small amount of quartz, devitrified glass and pyrite is interstitial.

The very strong alteration of these rocks is probably due to late stage igneous activity. It cannot be ascertained from thin-section studies if the dolerite is intrusive or extrusive, but the absence of contact metamorphism in the sediments suggests extrusive rock types.

However the total absence of mineralisation such as anhydrite could be explained by the compact nature of those rocks which reduces porosity and permeability.

b) Limestone and claystone:

The lithology and the mineral constituents of these rocks are not very different from those below. All limestone streaks are dolomitized, recrystallized, cryptocrystalline to microcrystalline with chalcedony, chert and anhydrite in veins and cavities; at 4700 feet a 10 feet thick sandy dolomitized limestone, with 5% detrital quartz without chert, is present.

The interbedded claystone is rusty red, very ferruginous, clayey with cryptocrystalline calcite and scattered euhedral dolomite crystals, about 0.05 mm. across, with minor (2 - 10%) detrital silt-sized quartz, microcline, lithics and 1 - 2% muscovite and phlogopite? Anhydrite is often very abundant as white and pink, coarse crystalline patches in vugs and nodules. Chert grains are rare.

Interval 4390 - 4265 feet

This unit represents a progressive change in the lithology; the limestone bands, which are partly dolomitized and recrystallized, contain 20 - 50% detrital quartz, feldspar, lithics and micas, but do not show secondary silicification and anhydrite as below.

Boundary between Bitter Springs Formation and Areyonga Formation:- The top of the Bitter Springs Formation is placed at the base of the first occurrence of sandstone. Nevertheless this boundary is difficult to pick on account of the progressive change in the lithology and lack of variations in the electric log characteristics.

Lithification: In this dolomitic limestone and claystone sequence the changes that have taken place have been primarily due to lithification by compaction as shown by numerous stylolites although important diagenetic changes including recrystallization, dolomitization, silicification and development of anhydrite have occurred.

The dolomitization takes place throughout the sediments but it is very important in carbonate rocks where recrystallization has taken place. About 5 - 10% dolomite is present in silt sized bodies in claystone, disseminated in a calcite mosaic. In the dolomitic limestone the size is microcrystalline to microgrenue*. The difference in dolomitization between the claystone and limestone is because the originally coarser limestone was probably more porous, facilitating the contact with the Mg - bearing brine.

The silicification (chalcedony - chert) is mainly in carbonates and rarely in claystone; it is limited to the sequence between the bottom and 4390 feet. The bodies of chert vary in size between 0.4 and 1 - 2 mm, replacing calcite and dolomite. It seems that it is associated with anhydrite.

The anhydrite and rare very coarse grained gypsum between the bottom and 4390 feet is always in patches, fractures and filling fissures and diaclases;

Environment: The Bitter Springs Formation was deposited in the reverse order to that in a normal sequence. The sequence changes from evaporites with halite to limestone deposited in shallow water, into which fine detritus came only very rarely or not at all.

The microscopic observations and the presence of oolitic bands suggest a deposit of primary limestone which was subsequently converted either to dolomitized limestone or dolomite.

Equivalent of Areyonga Formation.

This unit is differentiated from the underlying Bitter Springs Formation by a marked change in lithology with the first appearance of sandstone and siltstone. The top of the formation is characterized by a carbonate section clearly defined on the electrical logs.

These sediments can be divided into two intervals: sandstone and siltstone with interbedded dolomitized limestone between 4265' and 3785 feet and dolomitized limestone between 3785' and 3730 feet.

Lithology:

Interval 4265 to 3785 feet

Sandstone and siltstone form the dominant lithology of this interval. Between 4265 and 4172 feet the sandstone is red-brown, ferruginous with intergranular haematite and between 4114 and 4092 feet it is white and calcareous. Both types are poorly sorted, very fine grained to conglomeratic, angular to rounded with 60-70% quartz; orthoclase - microcline and strongly altered acid plagioclase, are present in minor amount. Minor lithics consist mainly of chalcedony - chert, hornfels and carbonate rock pebbles. Pyrite occurs as finely disseminated grains. Rounded tourmaline is an accessory mineral.

The cementing medium, which constitutes about 20%, comprises chlorite coating detrital grains, silica overgrowth, cryptocrystalline calcite and scattered euhedral dolomite crystals.

A finely laminated, siltstone about 200 feet thick, occurs in the higher part of the interval. It contains quartz in variable amounts, biotite and ?phlogopite. Pyrite and organic matter is always present in fine laminations. The cementing medium and clay matrix range between 20 and 30 per cent. The cement comprises chlorite and carbonate minerals, especially dolomite crystals.

The carbonate minerals occur in four bands, and are strongly dolomitized, recrystallized, microcrystalline with 10 to 60% detrital quartz, feldspar and muscovite. Pyrite either with crystal faces or in grains is always present. Detrital or diagenetic quartz grains often have silica overgrowth. Chalcedony-chert occurs throughout. At 4240 to 4235 feet a very thin band of oolites is present.

Interval 3785 to 3730 feet

This sequence is a dolomitized limestone, cryptocrystalline to microgrenue, recrystallized with about 5% detrital fine to coarse grained, angular to rounded quartz, and muscovite.

* : microgrenue : grain - size between 64 and 250u.

Probable authigenic pyrite occurs in clusters or as finely disseminated crystals and ranges from 1 to 20%.

Contacts:

Lower Contact: The presence of a quartzitic - conglomeratic sandstone could mark a minor disconformity between the Bitter Springs and Areyonga Formations.

Upper Contact: The upper boundary of this formation is clearly indicated by lithology and electric logs. Nevertheless no detailed correlation with type section as defined in Wells et al.(1965) seems possible.

From petrographic studies it is questionable whether or not this formation can be correlated with a typical section of the Areyonga Formation.

Lithification: The main changes which affected the composition of these sediments was cementation in sandstone and siltstone and compaction and recrystallization of the carbonate minerals accompanied by dolomitization.

In the sandstones between 4114 and 4092 feet, chlorite coating the grains is thought to have been depositional; between 4265 and 4172 feet hematite cement/matrix is present. Other features include quartz overgrowths in sandstones, and chalcedony - chert in dolomitized limestone below 4100 feet. Dolomitic replacement of limestone is present in all carbonate rock samples and generally only minor cryptocrystalline calcite is present between the coarse dolomite crystals.

In the siltstone between 4075 and 3800 feet intergranular chlorite cement, associated with pyrite and organic matter, makes up 10 to 20 percent.

Environment: The sequence is characterized by rapid variations in the conditions of sedimentation.

In the lower part the accumulation of both arenaceous and calcitic sediments is thought to have taken place in a predominantly paralic environment with interfingering of marine sediments in the form of oolitic bands.

In the middle part the siltstone, which contains abundant pyrite and ?organic matter, represents stagnant conditions resulting from poor circulation.

At the top of the unit another change takes place where again carbonates rocks, probably limestone, were deposited in shallow marine conditions.

Pertatataka Formation

In the Ooraminna No.1 well this formation can be divided into three intervals. Monotonous shale and siltstone between 3730 to 1950 feet, shale, siltstone and sandstone with interbedded dolomitized limestone between 1950 to 1720 feet and dolomitized limestone between 1720 to 1530 feet; the last two units can be correlated with the Julie Member defined in Wells et al. (1965).

Lithology:

Interval 3730 to 1950 feet

Green to dark green shale grading into siltstone, with monotonous quartz content varying from 20 to 80 percent. Mica which occurs throughout this sequence is predominantly muscovite with rare amounts of biotite, which commonly shows banding. About 15 to 20% pyrite and amorphous matter is present in fine laminations.

The important banding medium in this section is clay, probably sericite with a chlorite cement. Towards the top, calcite is present in fine cryptocrystalline laminations with some euhedral dolomite crystals. At the bottom, between 3730 and 3580 feet there is a red-brownish ferruginous and micaceous siltstone band.

<u>Interval 1950 to 1720 feet</u>

This thin sequence consists of interbedded carbonate rocks and sandstones or siltstones which generally grade into each other.

All the sandstone interbeds are poorly sorted, fine grained to conglomeratic, subangular to rounded and can be divided into a lower part between 1950 and 1762 feet with detrital quartz varying from 30 to 70%, microcline and a dominant amount of muscovite; the cement is cryptocrystalline calcite with microcrystalline dolomite crystals. The sandstone grades into sandy dolomitized limestone.

Between 1750 - 1720 feet, the upper part is a thin ferruginous sandstone band which has a similar petrography to the overlying Arumbera sandstones: it has a large amount of biotite strongly altered to chlorite and a cementing medium characterized by haematite coatings, silica overgrowths and euhedral dolomite crystals.

This sandstone is interbedded with green to dark green siltstone with a cement medium of chlorite, cryptocrystalline calcite and dolomitized sandy limestone.

<u>Interval 1720 to 1530 feet</u>

This sequence is a recrystallized, microcrystalline dolomitized limestone, with thin oolitic bands. It is always very sandy with scattered detrital quartz with a grain size between 0.1 to 2 mm, rounded to angular, rare orthoclase, microcline and 5 to 40% lithic fragments; muscovite and strongly altered biotite are present. Pyrite and rounded tourmaline occur as accessory minerals; haematite is present in very minor amounts throughout.

<u>Contacts:</u> These defined intervals are well marked on electric and gamma ray logs. The latter has a very constant deflection ranging from 7-10 units between 3730 and 1950 feet and emphasises the homogeneity of sedimentation throughout this interval.

The upper boundary between the Pertatataka and Arumbera Formation corresponds to a sharp change of sedimentation; it is distinct and easily recognizable on electric logs, especially on the microlog.

<u>Lithification:</u> The major changes which took place in this sequence were in the form of compaction in the siltstone and recrystallization and dolomitization in the carbonate. Silica overgrowths occur in the sandstone between 1750 to 1720 feet, where the matrix is haematitic.

<u>Environment:</u> Conditions of sedimentation during the Pertatataka Formation time were markedly different from those of the other formations. The thick siltstone and shale could be considered as relatively deep-water sedimentation, sheltered and little oxygenated changing to a oolitic calcareous sedimentation interfingered with deltaic arenitic sediments.

Arumbera Sandstone

The predominant lithologies of this sequence are sandstones and siltstones with interbedded thin carbonate bands; in Ooraminna No.1 well three intervals have been recognized.

Lithology:

Interval 1530 to 420 feet

This section is characterized by the presence of poorly consolidated sandstone with siltstone interbeds.

Sandstone: The sandstone is generally brownish-red, also grey to white, poorly sorted, fine to coarse grained rarely conglomeratic especially in the basal part around 1520 feet, compact and dense above 950 feet, friable and unconsolidated in cuttings below this depth. White calcareous sandstone interbeds occur below 1140 feet. The detrital grains in the ferruginous and white sandstones are identical, with the exception of altered biotite which is rare in the white sandstone. The cementing media is very different. The white sandstone has some silica overgrowths and only cryptocrystalline calcite with dolomite crystals, while the ferruginous, brownish-red sandstone contains about 15 to 20% haematite matrix, silica overgrowth and rare dolomite.

Pyrite is always present associated with haematite. Accessory minerals are tourmaline, zircon and a considerable amount of opaque minerals. The green, finely laminated, micaceous siltstone with a chloritic cement is interbedded with brownish-red, very micaceous (muscovite), ferruginous siltstone which has thin interbeds of very sandy and haematitic carbonate rock.

Interval 420 and 130 feet

This sequence is characterized by an increase in clay minerals and a decrease in detrital grain size from sand to silt.

Brownish-red sandstone and siltstone: Dark brownish red, silty to medium grained with a fine average grain size. The sediment shows a higher degree of angularity for the finer grained components than for the coarser grained. The most important constituent of both is quartz and feldspar; some of the feldspar is altered. Lithic fragments are rare and range between 1 and 5 percent. Biotite altered to chlorite, and muscovite are common throughout the interval. Accessory minerals are rounded tourmaline, zircon, rutile and opaque minerals which form an important constituent.

The bànding medium is haematite, intergranular in siltstone, and coating the detrital grains in the sandstone. Silica overgrowths and dolomite are also present.

Greenish-grey siltstone: These siltstones are differentiated from the red brownish siltstone only by its cement medium which is rich in clay, chlorite and dolomite crystals. Pyrite in fine laminations is always an important constituent.

Interval 130 feet to the surface.

This interval is characterized by sandstone grading into dolomitized and sandy limestone with about 20 to 50% detrital grains and rare pelletal bands.

Sandstone: Red, ochre to white, pinkish, ferruginous, poorly sorted, fine to coarse grained, subrounded to rounded. The sandstone has a high content of quartz, about 70%, orthoclase, microcline and a small amount (5-10%) of sericitized acid plagioclase; lithic fragments occur in minor amounts and consist mainly of metaquartzite and fine, silicified sandstone. Muscovite, and predominating biotite is strongly altered to chlorite and presents a fan like form at the margins. The cleavage planes of the biotite are generally filled with iron-oxide. Green to green-brown glauconite is present, in places with iron oxide concentrations along microscopic fractures and in most cases is coated by haematite.

Accessory minerals include rounded tourmaline, zircon and locally about 2% rounded apatite; pyrite is present as finely disseminated crystals in the matrix.

The cementing medium consists of haematite coatings, silica overgrowths on detrital grains and intergranular dolomite mostly with euhedral form.

Contacts: The lower boundary of the Arumbera Sandstone is well established both on the electric log and by the sharp change in lithology. The presence of a conglomeratic sandstone at the base and within the formation suggests the presence of local unconformities.

Heavy Minerals: One of the most interesting characteristics of the Arumbera Sandstone is the sparsity of heavy minerals as observed in thin sections and after dissolution in acid. Three core samples were selected and the heavy minerals from 100g of sediment were separated.

The result is summarized below :

Formation	Core Depth	Rutile	Tourmaline	Zircon	Opaque minerals	diagenetic minerals
Arumbera Sandstone	270,4 ft.	3%	30%	14%	40%	4% baryte
	609,4 ft.		21%	6%	73%	
	1359,4 ft.		12%	10%	78%	
Bitter Springs Formation	4433 ft.		1%			69% anhydrite.

The study of these samples shows some facts which are important to emphasize. The small amount of heavy minerals compared with light minerals seem to be an important characteristic of this unit: the ratio of heavy minerals to light minerals is about 1/5000 to 1/10.000. The mineral suite composed of rounded tourmaline and zircon, and some diagenetic minerals, the presence of very stable minerals like microcline, orthoclase, and some strongly altered acid plagioclases, and the great amount of quartz emphasize the intensity of abrasion on the material composing this unit. The Arumbera Formation is composed of a fine mature sediment.

Lithification: In this predominantly sandstone formation, the diagenetic processes have been very strong. One can observe a series of events which all tend towards a mineralisation of the rocks and therefore to a diminution of the porosity. The sandstones are well cemented owing to the presence of haematite considered to be sedimentary, and intense silicification and dolomitization.

Silicification:

Following the deposit of haematite, silicification has taken place, resulting in overgrowths on the detrital grains where it can be as high as 20% of the total rock. It is exceptional in the carbonate and non existent in the siltstone.

The secondary silicification takes place only where the primary porosity is sufficient.

Dolomitization:

Dolomitization followed silicification in the form of scattered euhedral dolomite crystals, the size of which depends on the grain size of the rocks : coarse to medium in sandstone, silty to fine grained in siltstone.

<u>Porosity</u>: The study of the microlog shows some positive separation in the sandstone between 942 and 1590 feet where one can expect a very good porosity (about 18% according to Exoil). This sequence corresponds to the unconsolidated and friable sandstone.

<u>Environment</u>: The observation of phenomena such as haematite cement, strongly altered biotite and the development of considerable sericitisation on the feldspar, suggests an oxydizing environment.

However these oxyidizing conditions do not occur throughout the complete sequence: they alternate with a more reducing environment particularly in the greenish siltstone which have sedimentary pyrite in fine beds.

Elsewhere the presence of glauconite in the upper part of the sequence is incompatible with an oxidizing environment; in fact it is known that it develops only in a reducing environment in association with pyrite.

These theoretical considerations, together with microscopic observations, oblige one to consider the glauconite as detrital deposited in another area and later incorporated with the oxidized sediments.

Finally the study of heavy minerals leads to further conclusions. The fact that only rounded tourmaline, zircon and in some places rounded apatite are present leads one to think that the source area, where there was strong weathering, was far from this point so that only the most stable residues appear in the sediments.

The Arumbera Sandstone has been deposited in a mainly deltaic environment.

<u>Influence of tectonics on the sedimentary sequences.</u>

The sedimentary sequences have been strongly affected by the regional tectonics. In the carbonate rock sequences as well as in the sandstones the effects of tectonic activity such as traces of shearing, recrystallization of calcite, microjoints and fractures, especially developed in the Bitter Springs Formation, have been observed.

In the siltstone and shale sequence a remarkable and general deformation is characteristic.

The anhydritic post-diagenetic mineralization developing in fissures and nests in the Bitter Springs Formation could be interpreted as a tectonic influence.

CONCLUSIONS

The study has shown that the subdivisions of the Proterozoic and Cambrian sediments in lithological intervals is possible and that the formations recognized at the surface of the basin are also valid in Ooraminna No.1 well; nevertheless the identification of the Areyonga Formation is uncertain.

Particular attention has been paid to the relationship between diagenetic actions and tectonic deformations.

A study of clay-minerals would be necessary to get more details in some sequences.

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APPENDIX NO. I.

SELECTIVE COLORATION OF DOLOMITE AND CALCITE

We can distinguish calcite from dolomite by a process of selective coloration; the complete description is given below. Nevertheless this application is only valid on thin sections and by microscopic observations.

Put the mounted thin section, into a normal solution of silver nitrate, kept at a temperature of 65°C (149°F), for 3 minutes.

Wash rapidly in water to remove the excess silver-nitrate.

Then put the thin section into a 10% solution of potassium-chromate for half a minute.

Rinse again and leave to dry.

A red precipitate of silver nitrate will form on the calcite and the dolomite will remain colourless. The film so obtained is very stable and adherent and resists rubbing.

Disadvantages:

coloration of the clay by adsorption, which can however be distinguished from calcite by the microscope.

with age, the colour tends to become more marked, the colour changes to brown.

Efficiency of this process is about 30 to 50 thin sections in one hour.

This method has been used in the following report.

APPENDIX NO. II.

CORE DESCRIPTION OF WELL OORAMINNA NO. 1

Bitter Springs Formation

C21 : 6085' - 4".

Halite with red claystone. Crystalline salt is extremely coarse (2.5-5 cm.) transparent to reddish brown. Soft clay, rusty red to yellowish-brown with salt veins and gypsum - anhydrite patches are always present. Strong tectonic deformation.

C20 : 5881' - 4"

Grey, light brown dolomitized limestone with white patches or lenses, very dense. Bedding is thin to indistinct, mostly wavy, stressed by micas, fractures are filled with white anhydrite and gypsum. Very fine grained, cryptocrystalline to microcrystalline thin-bedded bands in which occur dolomite, anhydrite and gypsum, micas (phlogopite?) on the bedding planes, quartz in angular to subangular crystals alternate with some bands in which the texture is microgrenue and the mineral content is anhydrite, gypsum, altered biotite and scattered quartz grains.

A minor amount of fine cryptocrystalline calcite occurs in both sequences.

C19 : 5545' - 46' 4"

This core is a grey, very hard, brittle, dense and massive dolomitized limestone; fine fractures and patches filled with white anhydrite. Some stylolites are present.

The mineral content is about 90% microcrystalline dolomite with patches of grained anhydrite and some amorphous debris.

C18 : 5227' - 5223' 4"

This sample is a rusty red, ferruginous, hard, claystone. The core is severely crushed and fractured and all horizontal to vertical fractures are filled with white to pink anhydrite. Bedding is vaguely defined.

The claystone is rich in iron oxide, clay minerals and calcite. Large euhedral dolomite crystal growth form about 10 to 40%, 2% muscovite, some quartz and microcrystalline anhydrite are present.

C17 : 4939' 4"

This is a light brown, dense, dolomitized limestone with crystalline zones and irregular patches of light brown chert, scattered throughout. Numerous stylolites and veins are present. The mineral content is about 60% microcrystalline calcite and 20% dolomite and anhydrite which is coarse grained in patches.

C16 : 4645' 4"

This dark grey very dense and compact dolerite, is strongly altered. Its texture is ophitic with a medium to fine grain-size. Minerals are :

strongly sericitized plagioclase (albite); augite marginally zoned in ferro-augite or magneto-augite and in places completely replaced by green chlorite and iron-oxide; the accessory mineral content is magnetite, chlorite, clinochlore in flakes and cavity fillings, and a small amount of quartz and devitrified glass.

C15 : 4433'

This reddish-brick, ferruginous and argillaceous siltstone has irregular patches of white anhydrite.

The main mass of this core is composed of cryptocrystalline clay-carbonate matrix, rich in iron-oxide with 5% angular to rounded quartz, some chert-fragments, metaquartzite, devitrified glass and carbonate, 1% microcline, muscovite and phlogopite, and a minor amount of pyrite. Euhedral dolomite crystals with haematite overgrowths occur throughout.

Areyonga Formation

C14 : 4168'

This core is a very dark grey, massive, tough and brittle, strongly fractured, argillite.

The main mineral component is fine clay, (illite?), which extinguishes parallel to a common direction. Pyrite, occurs as scattered minute crystals in laminations.

C13 : 3921'

Dark grey, hard and brittle, argillaceous finely laminated siltstone. The mineral content is silt-sized angular; quartz, about 5% mica perhaps phlogopite on the bedding planes and some altered biotite, 5% pyrite is disseminated throughout the thin section. Some dolomite crystal growth is present in the clayey and calcitic cement.

C12 : 3729'- 2"

This medium to dark grey, dense, very hard dolomitized limestone is strongly fractured. The fractures are filled with large recrystallized white calcite grains. The mineral content is about 70%, microcrystalline to micrograngue dolomite, and 20% cryptocrystalline calcite replaced by dolomite, and minor amount of silt-sized quartz and pyrite.

This sample could be considered as a tectonically brecciated dolomitic limestone.

Pertatataka Formation

C11 : 3443' - 4"
3439' - 4"
3437' - 4"

C10 : 3029' - 4"
3010' - 4"

C9 : 2704' - 4"
2702' - 4"
2700' - 4"

Dark grey-green, slightly micaceous, hard and brittle in places distinctly varved shale grades into siltstone. The cement is always clay (illite?) with a variable amount of angular silt-sized quartz, some pyrite in irregular clusters or single crystals along bedding planes, muscovite and subrounded to rounded zircon and rare tourmaline.

C8 : 2359' - 4"
2357' - 4"

C7 : 2058' - 4"
2054' - 4"

These cores are similar to cores 11, 10 and 9 but in addition contain thin cryptocrystalline calcite beds with some euhedral dolomite rhombs.

C6 : 1568' - 4"

This sample is a white to light grey, dense, very hard dolomitic limestone with small vugs and stylolites throughout.

The carbonate is composed of microgrenue to microcrystalline dolomite, recrystallized, with phantoms of oolites and fine crystalline pyrite and cryptocrystalline interstitial calcite.

Arumbera Sandstone

C5 : 1357' - 4"
1359' - 4"
1361' - 4"
1363' - 4"

This core is a rusty-red, ferruginous, friable, fine to medium grained feldspathic sandstone with scattered patches of lithic fragments with a diameter of 5mm. The detrital grains are 50% quartz, 20% sericitized orthoclase and microcline, some lithic fragments and are moderately sorted with an average size about 0.1 mm. Green to brown biotite, strongly altered in chlorite, and some muscovite accentuate the bedding. Accessory minerals are rounded tourmaline and zircon and 8% pyrite.

The cementing medium is composed of haematite coating with interstitial dolomite rhombs.

C4 : 849' - 4"

Green, grey, poor friable and fine grained feldspathic sandstone. Current bedding and some truncated cross-bedding are present. Mineral content is 55% quartz, 15% orthoclase and microcline, 3% lithic fragments of chert and hornfels. These detrital grains are angular to rounded, with a bimodal sorting (diameter about 0.70 and 0.30 mm). 15% micas, muscovite and strongly altered biotite on bedding planes.

Accessory minerals are pyrite, rounded tourmaline, apatite and zircon. The cementing medium contains chlorite and secondary dolomite.

C4 : 847' - 4"

This brownish-red, ferruginous, very fine grained feldspathic sandstone, is current bedded and contains 55% quartz, 10% orthoclase and microcline and some lithic fragments. All detrital grains have haematite coatings and silica overgrowths. Muscovite and 5% altered biotite are present. Subeuhedral dolomite crystals occur in the cementing medium.

C3 : 713' - 4"

Brownish-red, ferruginous, poorly micaceous, clayey, siltstone with wavy laminations of fine grained, dense and hard sandstone. The ratios of detrital grains, quartz, microcline and lithic fragments with haematite coatings and the ratio of clay to haematite varies from about 7/1 to 1/1 in different bands. Bedding is also accentuated by micas, muscovite and altered biotite. The dolomite percentage is also very variable.

C2 : 609' - 4"
607' - 4"
605' - 4"

This brownish-red to pale pink sandstone is fine to very coarse grained, with some fine cross bedding. Tectonic fractures are filled with white calcite. The mineral content is quartz, microcline and altered orthoclase and amorphous matter; strongly altered biotite occurs in minor amount with muscovite. Tourmaline, apatite and pyrite are present.

The ratio of clastics and cementing medium as coatings, silica overgrowths and dolomite varies from 5/1 to 2/1.

C1 : 270' - 4"

This is a brownish-red, ferruginous, hard and compact, fine grained micaceous sandstone which contains 70% quartz, 23% feldspar mainly microcline and some orthoclase and plagioclase and 5% lithics, microquartzite, 2% muscovite and altered biotite flakes are present with some pyrite-crystals.

The cementing medium is dolomite and intergranular calcite.

APPENDIX NO. III.

SHORT PETROLOGICAL DESCRIPTION OF SURFACE SAMPLES IN THE AMADEUS BASIN

Bitter Springs Formation

Gillen Member:

AS 27 : Cryptocrystalline to microcrystalline carbonate rock, probably rich in dolomite, thin wavy beds, with a minor percentage of euthedral quartz and orthoclase crystals. Rare scattered pyrite occurs throughout.

Strongly recrystallized with some microgrenue auhydrite crystals. Numerous fractures.

AS 121 : Microcrystalline laminated carbonate rock (Dolomite ?) with fine stylolites filled with amorphous matter.

Strongly recrystallized with some anhydrite.

Presence of recrystallized structures, perhaps stromatolites.

Loves Creek Member:

AS 41 A : Dolomitized microcrystalline, laminated ? limestone, with a minor amount of anhydrite and pyrite.

Strongly recrystallized.

AS 133 : Carbonate rock, laminated, dolomitized, recrystallized with silt-sized quartz, rarely coarse grained and micas (muscovite and biotite) parallel to the bedding.

The percentage of detrital grains is between 1 and 15%.

Presence of amorphous content. Tectonic microdeformation.

AS 100 E : Red claystone ? with 10% detrital grains of silt-sized quartz, and muscovite.

AS 153 : Red carbonate rock, strongly dolomitized, rich in haematite (about 30%) with 5% detrital grains of silt-sized, quartz chert, rare feldspar, muscovite and biotite.

The dolomite is always euhedral and contains pyrite and anhydrite.

Interstitial clay?

Recrystallized carbonate crystals.

Areyonga Formation:

AS 18 : Sandstone, coarse grained to conglomeratic, angular to sub-rounded with 90% detrital grains of quartz sericitized feldspar and numerous and varied lithic fragments, (igneous and metamorphic rocks); biotite and muscovite are present in minor amounts. Pyrite occurs throughout in fine crystals. Accessory minerals of tourmaline and zircon are rounded.

Cementing medium is composed of pellicular haematite, silica overgrowths, kaolinite? and rare anhydrite.

AS 38 : This sample is a well sorted, sandstone, with an average grain size between 0,10 and 0,20 mm, subangular to subrounded, very rich in quartz, rare feldspars and lithic fragments which are generally chert. Muscovite is always present, also pyrite, chlorite zircon and apatite.

Cementing medium as silica overgrowths and cryptocrystalline calcite with euhedral dolomite crystals. Haematite and kaolinite occur in small amounts.

AS 19 : Same composition and texture as AS 38 but without silica overgrowths.

AS 42 : In this coarse grained, well sorted, subrounded to rounded sandstone, the detrital content is variable : quartz with euhedral silica overgrowths, coarse microcline and orthoclase lithic fragments especially meta and microquartzite. There are about 30% of phosphatic nodules, similar in size to the quartz grains, rounded, but also in the form of interstitial matter. Glauconite grains are mostly altered to chlorite. The cement is calcitic and dolomitic? with chlorite and some anhydrite crystals.

AS 17 A : Conglomerate with diversified lithic fragments of chert, carbonate rock, micro - and macroquartzite and glauconite. Pyrite-haematite. Cement is carbonate - chlorite and baryte.

Pertatataka Formation

Julie Member

AS 101A : This rock contains 95% microcrystalline recrystallized, carbonate minerals, 3% silt-sized quartz, often euhedral, and chalcedonic-chert and minor amount of muscovite.

AS 2 : This sample is a sandy carbonate rock, probably rich in calcite but always strongly recrystallized. Its detritical content is about 15% quartz with silica overgrowths, subrounded to rounded, diameter between 0.5 mm to 0.8 mm, microcline, orthoclase and chalcedony - chert. Accessory mineral is tourmaline.

AS 208 : This strongly recrystallized sandy limestone, is rich in oolites and pellets. Its detrital content is about 25% consisting of rounded, quartz, max. diameter 1 mm, with secondary silica overgrowths, rare altered microcline and orthoclase and some chert.

AS 25 : Sandstone, poorly sorted, fine to coarse grained, subangular to subrounded with 85% quartz and also interstitial chalcedony. Minor amount of muscovite. Accessories are tourmaline and apatite. The cementing medium is a cryptocrystalline calcite with amorphous matter and some kaolinite ?.

Arumbera Sandstone

AS 101 E : (1)

This fine grained sandstone is well sorted with an average size about 0.12 - 0.15 mm, angular to subangular, contains 70% quartz with haematite - coatings, a minor amount of microcline altered plagioclase, lithic fragments of chert, muscovite and strongly altered biotite.

Cementing medium is secondary intergranular silica with haematite.

AS 22 : Well sorted, fine grained and laminated sandstone, with subangular to subrounded detrital grains of quartz, rare microcline and altered plagioclase, lithic fragments of chert which are coated by pellicular haematite and by silica overgrowths, muscovite and biotite strongly altered to chlorite emphasise the bedding.

Accessory minerals are tourmaline zircon, pyrite and amorphous matter. Cement is haematite and silica.

AS 200 A : Sandstone, well sorted and fine grained, subangular to subrounded with 50% quartz, rare microcline and orthoclase, also rare chert, 20% glauconite and iron oxide nodules or concretions. All detrital grains are coated by haematite and in many places by secondary silica overgrowths. The cementing medium is carbonate and rarely amorphous matter.

Lat. 24° 00' 06" S
Long. 134° 09' 50" E
Elevation: G.L. 1613' A.S.L.
K.B. 1624' A.S.L.

EXOIL N.L.
AMADEUS BASIN
Northern Territory

OORAMINNA NO.I.

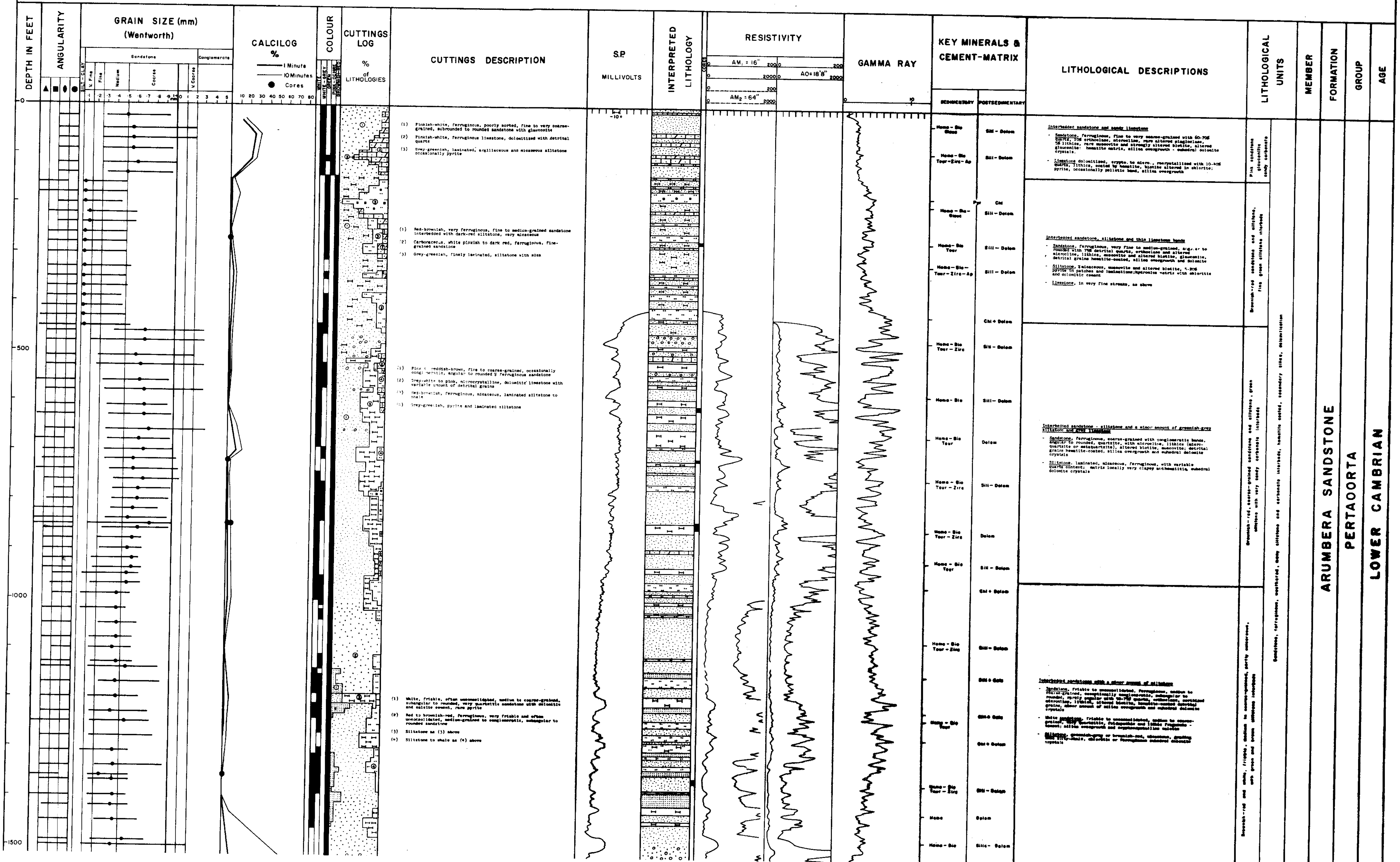
SCALE: I inch : 200 feet

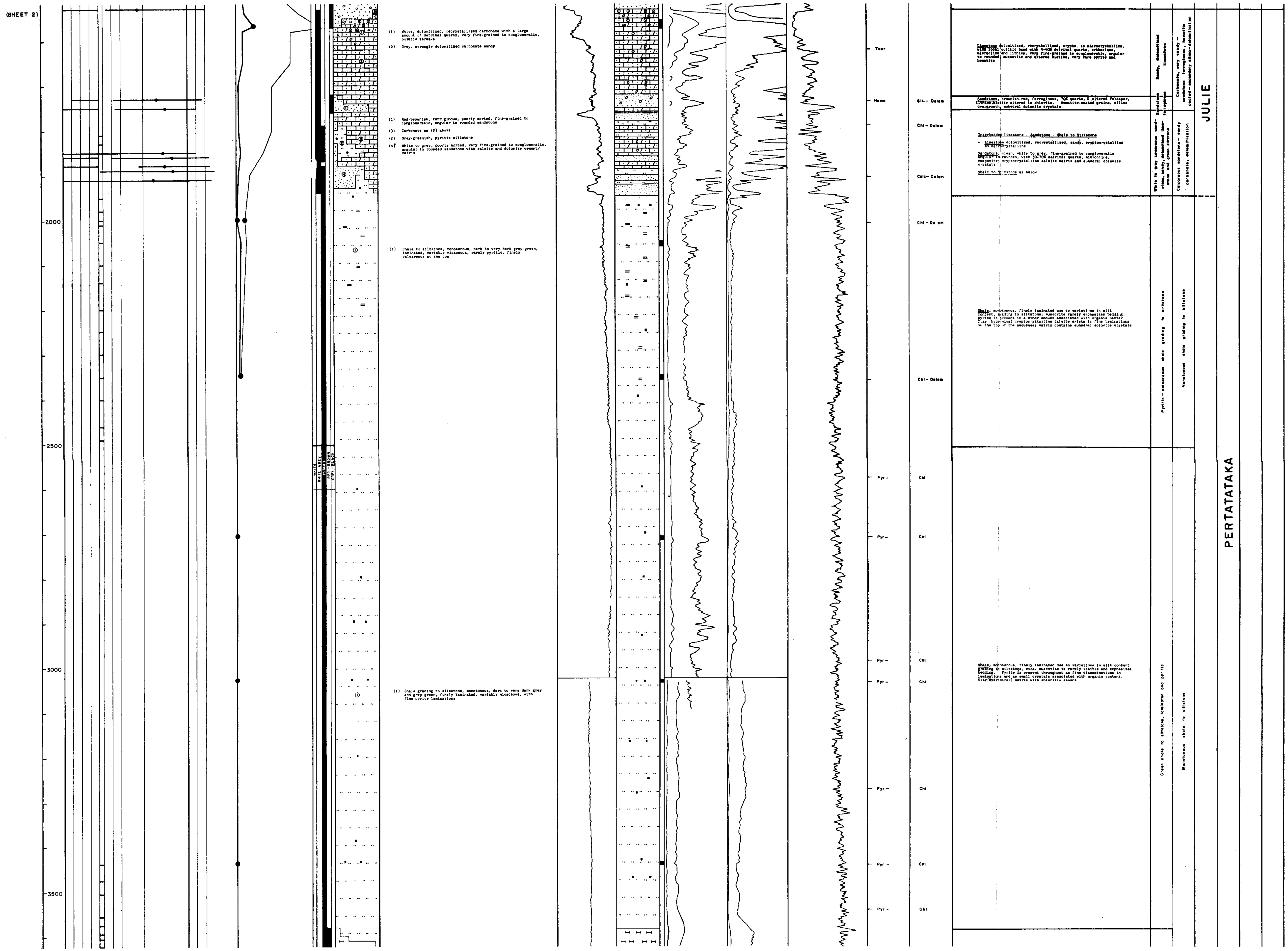
REFERENCE

- Conglomerate
- White sandstone
- Red-brown sandstone
- Green shale to siltstone
- Red-brown siltstone
- Grey to black siltstone
- Calcareous claystone
- Dolomitised limestone
- Sandy dolomitised limestone
- Cherty dolomitised limestone
- Salt
- Dolerite
- Oolites

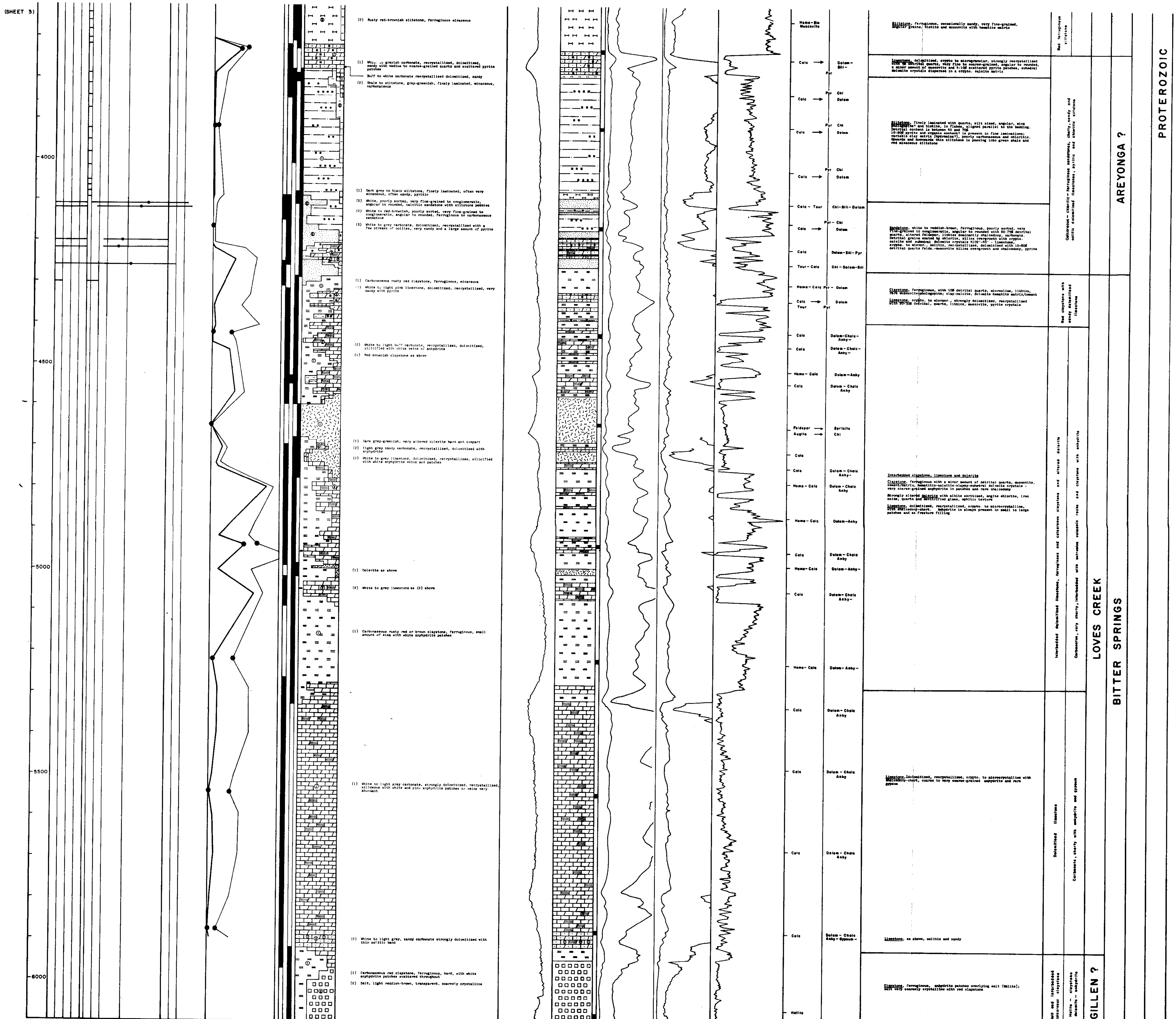
MINERAL ABBREVIATIONS

Anhy : Anhydrite	Dolom : Dolomite
Ap : Apatite	Hema : Hematite
Bio : Biotite	Pyr : Pyrite
Calc : Calcite	Sili : Silica
Chalc : Chalcedony	Tour : Tourmaline
Chl : Chlorite	Zirc : Zircon





(SHEET 2)
2000
2500
3000
3500
(1) White, dolomitized, recrystallised carbonate with a large amount of detrital quartz, very fine-grained to conglomeratic, oolitic streaks
(2) Grey, strongly dolomitised carbonate sandy
(1) Red-brownish, ferruginous, poorly sorted, fine-grained to conglomeratic, angular to rounded sandstone
(3) Carbonate as (2) above
(2) Grey-greenish, pyritic siltstone
(4) White to grey, poorly sorted, very fine-grained to conglomeratic, angular to rounded sandstone with calcite and dolomite cement/matrix
(1) Shale to siltstone, monotonous, dark to very dark grey-green, laminated, variably micaceous, rarely pyritic, finely calcareous at the top
(1) Shale grading to siltstone, monotonous, dark to very dark grey and grey-green, finely laminated, variably micaceous, with fine pyrite laminations
Tour
Hema
Sili - Dolom
Chl - Dolom
Calc - Dolom
Chl - Dolom
Chl - Dolom
Pyr - Chl
Pyr - Chl
Pyr - Chl
Pyr - Chl
Pyr - Chl
Pyr - Chl
Pyr - Chl
Limestone dolomitised, recrystallised, crypto. to microcrystalline, with local oolitic band with 5-40% detrital quartz, orthoclase, microcline and lithics, very fine-grained to conglomeratic, angular to rounded, muscovite and altered biotite, very rare pyrite and hematite
Sandstone, brownish-red, ferruginous, 70% quartz, ∓ altered feldspar, lithics, biotite altered in chlorite. Hematite-coated grains, silica overgrowth, euhedral dolomite crystals.
Interbedded Limestone - Sandstone - Shale to Siltstone
- Limestone dolomitised, recrystallised, sandy, cryptocrystalline to microcrystalline
Sandstone, clean, white to grey, fine-grained to conglomeratic angular to rounded, with 30-70% detrital quartz, microcline, muscovite; cryptocrystalline calcite matrix and euhedral dolomite crystals
Shale to Siltstone as below
Shale, monotonous, finely laminated due to variations in silt content, grading to siltstone; muscovite rarely emphasizes bedding; pyrite is present in a minor amount associated with organic matter Clay (hydromica) cryptocrystalline calcite exists in fine laminations on the top of the sequence; matrix contains euhedral dolomite crystals
Shale, monotonous, finely laminated due to variations in silt content grading to siltstone, mica, muscovite is rarely visible and emphasizes bedding. Pyrite is present throughout as fine disseminations in laminations and as small crystals associated with organic content. Clay(Hydromica?) matrix with chloritic cement
Monotonous shale grading to siltstone
Monotonous shale to siltstone
JULIE
PERTATATAKA



Sheet at scale 1 inch to 100 feet available on request.

T.D. 6097'

To accompany Record 1966/82

Geologist : G. SCHMERBER I.F.P.

G53/A2/5