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DEPARTMENT OF MINES
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GEOLOGICAL SURVEY
PETROLEUM SECTION

DETAILED OBSERVATIONS ON OUTCROP MATERIAL FROM THE OODNADATTA AREA

Field Observations & General Comments
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Petrography & Petrographic Summary
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by

G. R. Heath
and
D. Smale

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

OUTCROP MATERIAL FROM THE OODNADATTA AREA

PART 1 by G. R. HEATH

ABSTRACT

Detailed field studies of outcropping material from the Oodnadatta and Wintinna 4-mile areas, supplemented by analyses and petrological descriptions of selected samples, has revealed a rock assemblage of considerable complexity.

The results obtained have led to a better understanding of the geological history of the area, and of the genesis of some of the more complex rock types. The characteristics of certain silcretes suggest that they may be of economic value as sources of high purity silica, special abrasives and filtering media.

INTRODUCTION

During the latter half of 1962, the writer, in company with I. B. Freytag, and on two occasions, H. Wopfner, was engaged in mapping the Oodnadatta 4-mile military sheet area (latitude 27°-28°S, longitude 135°-136°30'E) as part of the Petroleum Section's exploration programme.

Since this was the first detailed mapping to be carried out by the Department, along the western margin of the Great Artesian Basin, a number of new problems arose, particularly in connection with the Tertiary history of the area.

Most of these problems were solved by the detailed examination of exposed scarp sections and the petrological examination of selected surface material. This report covers the latter line of investigation.

The majority of samples were collected from the Oodnadatta 4-mile area. However, material from surrounding areas, particularly from Imbitcha clay deposit on Wintinna 4-mile sheet (described in Departmental Report 55/129) was also included.

I would like to acknowledge the considerable assistance I have received from I. B. Freytag and Dr. H. Wopfner, both of whom have provided stimulating discussions on the geology of the Great Artesian Basin. Without their help, many of the problems associated with the geology of this area would not have been so clearly defined, and the solution of these problems would have been correspondingly more difficult.

The petrological work was largely carried out by D. Smale of A.M.D.L. His summary forms part of this report, and most of his descriptions are incorporated in Appendix 1. The high calibre of his work, particularly the portion dealing with the silcretes, is gratefully acknowledged. This petrography should serve as an invaluable reference for future projects in duricrusted areas.

Some of the early petrology was carried out by W. R. McCarthy, also of the Petrology Section, A.M.D.L. All analyses quoted throughout the report were carried out at the Parkside laboratories of A.M.D.L. under the direction of T. R. Frost. The analysts responsible are acknowledged before each result.

SAMPLING AND CLASSIFICATION

Because of the paucity of reliable petrological data on the outcropping sediments of the Great Artesian Basin, samples were collected from outcrops of pre-Permian to Recent age.

Fresh material was collected where possible (except of course, when considering alteration products), and the petrological samples were chosen, on the basis of macro examination, as typifying a particular rock type.

The details of each occurrence, together with a general description of the actual specimens collected were recorded and subsequently combined with the thin section descriptions. These composite reports from the appendices to this report.

Samples for analysis were generally restricted to material of possible economic value, such as silcrete, clays, limonite, gypsum and unusually high grade laterites. Each sample was made up of fragments collected across an outcrop or up a scarp section.

The analytical and petrological results are included together in Appendices 1A - 1R since, in many cases, they refer to the same outcrop.

The results have been separated into eighteen groups (Appendices 1A to 1R) to facilitate comparison of like specimens and provide a more usable reference. Appendices 1A to 1G cover the pre-Cainozoic material, which is grouped into rock units arranged in chronological order (pre-Permian "Basement" to Cretaceous ?Winton equivalents).

The Cainozoic material has been treated rather differently, because of the uncertain age of many of the specimens and the complications introduced by several phases of alteration to a single specimen.

The post-Cretaceous sandstones and pebble conglomerates have been grouped together according to gross lithology. These sediments are almost invariably silicified.

The finer silicified clastics from the Mt. Harvey area have been grouped together because of their unusual lithologies and uncertain affinities.

The laterites and duricrust samples were most difficult to classify. Under the system adopted, samples in which either ferruginization or silicification was the sole or extremely dominant alteration process, have been grouped as "laterite plus laterite profile" or "duricrust plus duricrust profile." Samples affected significantly by both processes form a separate group (Appendix 1M).

The remaining Cainozoic samples have been grouped into lithologies (limestones, "young" potches); geomorphic units ("gypsite" limonites and gypsums); and in the case of the Mt. Alice suite, localities.

Appendix 1R covers the eleven specimens which fall outside the groupings described.

Within each group, the descriptions have been arranged in order of increasing "RH" numbers. The "RH" numbers of the specimens in each group are given in the following section.

SUMMARY OF RESULTS

This section is an attempt to integrate and summarize the basic date given in the appendices. Unfortunately, lack of time to fully consider the descriptions has led to a rather superficial treatment in some cases.

D. Smale has prepared a summary of the thin section descriptions (following section), but as he was unaware of the field relations of some of the specimens at that time, the two summaries may differ slightly in some respects.

"Basement" (pre-Permian)

RH: 1, 2, 4, 10, 20. (Appendix 1A)

These descriptions are rather unrelated, and require little comment.

The porphyry erratics rest on (and were presumably derived from) Cretaceous shales, within a few tens of feet (stratigraphically) of the Jurassic - Cretaceous sandstone.

The origin of these boulders, as well as their similarity to the Gawler Range porphyries has yet to be explained. This problem extends far beyond the Oodnadatta 4-mile sheet.

Permian Sediments

RH: 14, 15, 16-164, 54, 163. (Appendix 1B)

All these specimens come from the Permian outcrops along the west side of the Mt. Dutton range.

The dolomites, with their oolitic textures and evidence of abundant replacement, are at marked variance with the ?overlying ?fluvioglacials. They may however be lagoonal deposits formed before the onset of glaciation.

The quartz sand in the boulder clays is generally well rounded, a feature which is common in such deposits in South Australia. This may indicate a rather mature source area.

In view of the extremely rapid (almost violent) way in which the Permian argillites disintegrate in water (particularly RH163), the absence of active clay minerals is rather surprising. The kaolin and illite may be post-depositional alteration products rather than original matrix material.

A photomicrograph of a thin section from RH14 (one of the dolomites) appears at the end of this report.

Sandstones equivalent to Mt. Anna Sequence

RH: 3, 5, 11, 12, 13, 19, 27, 29, 30, 51, 167. (Appendix 1C).

These samples are mainly from the calcareous "fontainebleu" sandstones equivalent to portions of members B and C of the Mt. Anna sequence. The remaining units are generally too friable to be samples effectively.

Once again, the development of oolites is rather unexpected in view of the transgressive nature of the sandstone. It seems

that clastic sedimentation was rather intermittent at several stages and conditions favouring chemical sedimentation prevailed for short periods. The ferruginization which has affected a number of these samples is probably a Pleistocene event, associated with the development of the "gypsite" surface.

The presence of colloform (lisegang) type banding in the limonite is very characteristic of this type of alteration.

The principal features of these sandstones appear to be:

(a) The grain size of the framework is generally in the 0.125-0.25 mm. range (i.e. fine sand). Sands coarser than medium grained are rare.

(b) Quartz is the dominant clastic constituent. It is almost invariably subangular. This suggests deposition with minimal littoral reworking.

(c) Impure calcite seems to have been the only original cementing medium (shown by open packing of the framework). This calcite has remobilised and recrystallized during diagenesis (shown by etching of quartz grains and development of fontainebleu texture).

(d) The clean sandstones are remarkably free of matrix and cement. Only those in which slight recrystallization of the framework quartz has occurred are coherent enough to be collected as hand specimens. However, even the cleanest samples are generally not well sorted.

(e) Certain beds in the sandstone sequence show secondary silicification (RH19) or ferruginization (RH12, 167) but why these beds have been preferentially affected is unknown. The parent sandstone seems to have been calcareous in all cases and oolitic in most. However, apparently similar sandstones elsewhere in the sequence are unaffected. Possibly only the permeable calcareous sandstones were affected.

A photomicrograph of a thin section from RH51 (base of Mt. Anna Sandstone member B, north of Mt. Dutton) appears at the end of this report.

Cretaceous sediments equivalent to ?Roma Formation

RH: 9, 137. (Appendix 1D).

RH137 is typical of the fairly clean concretionary limestones which occur in the lower part of the marine Cretaceous section. RH9 is rather atypical. It may represent a deposit formed in a barred or isolated basin, which became supersaturated and began precipitating calcite. The intraformational texture could result from diagenetic dehydration, or subaerial drying.

Cretaceous quartz-montmorillonite sandstone near ?Roma - ?Tambo Formation equivalents boundary.

RH: 138, 139, 142, 145. (Appendix 1E).

The outstanding feature of these samples (which are probably equivalent to the "glauconite" sandstone in Santos Oodnadatta No. 1 Well) is the presence of iron-rich montmorillonite. The author feels that this probably developed in the same way as normal glauconite. It may, in fact, have formed by the recent weathering of glauconite.

The principal features of these samples are:

(a) Grain size generally lies in the very fine to fine sand range.

(b) The principal framework constituents are quartz, iron rich montmorillonite and goethite. The goethite in some cases may have formed by replacement of calcareous grains or faecal pellets.

(c) The presence of a glauconite type mineral suggests very slow clastic sedimentation. However, the angular shape of most quartz grains shows that littoral reworking was minimal.

(d) The fact that in several cases, calcite is intimately mixed with argillaceous material suggests local supersaturation of the overlying water. The more porous specimens probably indicate periods of subsaturation, although the possibility of post-depositional calcite removal must also be admitted.

Two photomicrographs of thin sections of RH139 (a typical sandstone sample) appear at the end of this report.

Cretaceous sediments equivalent to ?Tambo Formation.

RH: 6, 7, 21, 22, 61, 62, 104, 113, 131, 146-147A.
(Appendix 1F)

With the exception of RH7 and 111, the Cretaceous upper marine (?Tambo) limestones are rather dirtier than the lower marine (?Roma) ones. The other principal differences are the presence of plant fragments in the "Tambo" (not seen in "Roma" limestones) and the occurrence of iron-rich montmorillonite as one of the principal clastic constituents of "Tambo" limestones (accessory or absent in "Roma" samples).

The main features of the suite are:

(a) The grain size of the clastic constituents of the limestones rarely exceeds 0.2 mm. and in most cases lies in the coarse silt to very fine sand range. The coarser clastics may have been trapped closer to the source area.

(b) Clastic grains are mainly subangular, suggesting little abrasive transport or littoral reworking.

(c) The presence of iron-rich montmorillonite may indicate a rather slow rate of sedimentation.

(d) The calcite which, together with some argillaceous material, forms the cement and matrix in most specimens, appears to be of chemical origin. It has been less active during diagenesis than that in the Mt. Anna Sandstone or "Roma" limestones.

The only shale sample studied (RH196) was virtually pure kaolin, suggesting rather severe leaching conditions in the source area and depositional environment.

Photomicrographs of thin sections from RH22 and RH131 (typical calcareous sandstones) appear at the end of this report.

Cretaceous non-marine sediments, ?Winton Formation equivalents.

RH: 95, 96, 98, 99, 100, 101, 102, 105, 106, 107-108A, 111
124, 125. (Appendix 1G)

The most distinctive feature of the "Winton" limestones is their trachytic fragment content. The discovery of this material has provided what may be an extremely valuable correlation tool, as well as raising questions as to the geological history of the area and locality of the ?Cenomanian volcanic activity.

The trachyte grains occur in all but the most basal "Winton" limestones, and appear to be the only distinctive feature by which the marine and non-marine sediments can be differentiated.

The main features of the samples are:

(a) Matrix plus cement is more abundant than framework grains in all samples. Grains rarely exceed 40 per cent of the volume of the rock.

(b) The calcite is usually impure and rather similar to that in "Tambo" limestones. Fibrous crystallization is fairly common.

(c) Grains are usually angular to subangular (suggesting deposition with a minimum of abrasion) and lie in the medium silt to fine sand range. Grains larger than 0.5 mm. diameter are virtually unknown.

(d) The main framework constituents are usually quartz, trachyte and iron-rich montmorillonite, with lesser chert, chlorite, etc.

Only one shale sample (RH107) was studied. This consists of virtually pure montmorillonite, and contrasts markedly with the "Tambo" sample (RH146).

A photomicrograph of a thin section from RH106 (basal "Winton" sandy limestone) appears at the end of this report.

?Pliocene blanket sandstone: Basal silicified pebble conglomerates

RH: 46, 92, 94, 116, 119, 127, 132. (Appendix 1H)

This group of samples comes from the base of the widespread terrestrial ?fluviatile sandstone which caps much of the high plateau country east of Oodnadatta. This sediment varies little over an area of some 2000 square miles, and in fact is highly reminiscent of the basal Tertiary "agate grit" of the northern Flinders Ranges. However, this sandstone is post-lower duricrust, and is thought to be of Pliocene age.

In general, the basal member is a silicified sandy pebble conglomerate or silicified pebbly sandstone.

The pebbles are usually quartz or quartzite with lesser silcrete. However, in RH94, silcrete is dominant. They are usually rounded, and generally lie in the 2-15 mm. size range. The presence of solution cavities in many pebbles suggests that

the pH of the solutions which carried the siliceous cement was exceptionally high (probably over 9).

The matrix is usually the most important constituent of the rock, from a volumetric point of view. It consists of ill sorted subangular quartz sand grains in the silt to medium sand size range.

The cement, which has frequently converted the rock to a tough impervious quartzite, was probably emplaced some time after deposition (probably uppermost Pliocene). The cement is usually leucoxenitic opal, but micro- and cryptocrystalline quartz occur in a large minority of samples, and clay is a rare constituent.

A photomicrograph of a thin section from RH116 (a typical "agate grit" type pebble conglomerate) appears at the end of this report.

?Pliocene silicified blanket Sandstone (occasionally ferruginized)

RH: 42, 45, 47, 64, 82, 84, 85, 86, 93, 109, 112, 115, 134, 154. (Appendix 1I)

Most of the remarks in the preceding section are also applicable to these samples.

The uniformity of these sandstones is remarkable. They virtually all consist of ill sorted, subangular to subrounded quartz medium silt to medium sand (usually coarse silt to fine sand). The matrix or cement is usually opal, although microcrystalline quartz, goethite and kaolin are also common. Finely crystalline leucoxene is often an important constituent. Silicification tends to be rather patchy, so that exposed samples (eg. RH64) often contain an anastomosing network of cavities, where the poorly cemented portions have been removed.

Photomicrographs of thin sections of three typical Upper Tertiary sandstones (RH42, 64 and 84) appear at the end of this report.

Mt. Harvey Area. Bleached and silicified ?Pliocene sediments.

RH: 58, 59, 60, 89, 90, 91 (Appendix 1J)

This group of samples probably belongs in the "Duricrust plus Duricrust Profile" class. However, the suite has been presented separately because I. B. Freytag has mapped the Mt.

Harvey area in detail and, as a discrete group, these descriptions will be easily read in conjunction with or transferred to his report.

The specimens range from finely divided opal with 60-70% porosity to more normal silcretes.

The clastic portion is fairly constant in all specimens, consisting of subangular to subrounded quartz, ranging from 0.01 to 0.4 mm. in diameter (medium silt to medium sand).

The cement is opal (usually rich in leucoxene) in almost all samples. However, RH90 contains microcrystalline quartz (probably after opal).

The economic possibilities of the very fine porous opal should be more fully investigated. Such material may have application as a filtering agent or special abrasive.

?Miocene-Pliocene duricrust and duricrust profile material.

RH: 43, 44, 48, 49, 50A, 88, 129, 140, 150, 152. (Appendix 1K)

The duricrust outcrops from which these samples were collected were usually superimposed on Cretaceous shales ("Roma" to "Winton" equivalents). However, the presence of fairly coarse quartz sand in many samples suggests that some contemporaneously derived alluvium may have been incorporated in the silcrete capping.

The principal features of the duricrusts are:-

(a) The nature of the siliceous matrix or cement seems to be largely independant of the age of the duricrust, although in a general way, the younger duricrust silcretes seem to contain more opal than those of the older duricrust.

(b) Opal is the principal cement in clean white silcretes. The samples containing a significant amount of clay or goethite matrix tend to be cemented by micro- or cryptocrystalline quartz. The matrix minerals may accelerate the recrystallization of opal.

(c) Kaolin is almost invariably the only clay mineral present, suggesting severe leaching conditions. However, RH48 contains some illite as well.

Although there is a marked difference in macro- appearance and field characteristics between the "vertical lineation" silcrete

cap and "bleached zone" of the duricrust profile, there seems to be little difference between them under the microscope. Rather intense silicification extends well down into the "bleached zone", and the boundary between non-silicified (kaolinitic) and silicified "bleached zone" is very ill defined.

(d) The novaculite sample (RH150) is a petrological oddity in this suite. It seems to have formed by the total silicification of a kaolin lens of the type found at Imbitcha.

Upper Tertiary laterite and laterite profile material.

RH: 38, 40, 63, 65, 67, 68, 69, 75, 78, 81, 110A, 117, 118, 122A, 114A-126, 155-156A, 157-158A. (Appendix 1L)

The analytical results which form part of this appendix will be discussed in detail in a report to be prepared.

The principal features of the laterite samples are:

(a) The pallid zone material is mineralogically simple, consisting of virtually pure quartz plus kaolin. In the case of the Imbitcha samples, (RH155 to 158A) the kaolin is partly relict from the parent shale and has also formed by alteration of montmorillonite, and, to a lesser extent, illite.

(b) The mottled zone material is more complex, and frequently contains opal, cryptocrystalline quartz, sericite and illite, as well as dominant kaolin. Goethite is present in all dark mottles, and is invariably the youngest mineral in the rock.

(c) The laterite capping (or ferruginous zone) is characterised by the presence of abundant clastic material. This is usually angular and, in most cases, is probably eluvial or of very local origin.

The clastic fragments are usually quartz, silcrete, claystone or ferruginous sandstone. The matrix is invariably goethite, varying from dark brown to orange-red in colour. It is usually structureless and very fine grained (of the order of 1 micron), but a few samples contain goethite ooliths (usually with clastic nuclei).

The field and petrological data suggest the following sequence of events in the formation of a typical Oodnadatta laterite.

1. Silicification (?older duricrust).
2. Kaolinization (deep leaching), leading to the formation of the pallid zone.
3. Deep emplacement of limonite.
4. Bleaching (iron removal) during development of mottled zone.
5. Mechanical disintegration and minor transport of near surface material (possibly partly contemporaneous with 3 and 4).
6. Goethite impregnation of the surface material to give the ferruginous zone (possibly by iron released during 4).

Photomicrographs of thin sections from typical laterite cappings, which contain much clastic material, appear at the end of this report (RH40 and RH78).

Samples showing evidence of both lateritization and duricrust silicification.

RH: 41, 71, 72, 73, 74, 83, 87, 128, 130, 141, 149, 159, 160. (Appendix 1M)

Despite the extreme variation in macro appearance between samples from this suite, the petrological work shows that the processes which led to their formation are remarkably uncomplicated.

With the exception of RH130 and RH149 (which will be considered in more detail) all textural features can be explained by the following sequence of events.

1. Silicification. This has usually affected sandstones or sandy shales. In several cases (eg. RH128) the silicification can be divided into two phases, with a period of mechanical disintegration in between.

2. Ferruginization. The emplacement of goethite has usually accompanied mechanical disintegration of the silcrete. In RH159, however, the limonite may have been introduced by the chemical replacement of silica.

3. Silicification. Most samples have been well indurated by a final period of silicification.

This sequence of events, based on textural features, agrees well with the field interpretation of older duricrust formation; lateritization; younger duricrust formation.

The samples RH130 and RH149 differ fundamentally from the

rest of the suite, in that they show an initial phase of ferruginization.

In RH130, the older goethite is markedly oolitic, as well as differing texturally from the matrical goethite. It probably formed before the onset of duricrust - laterite conditions, by the replacement of calcite by limonite.

RH149 is more difficult to explain. The comparison of the older goethite with RH47 (a ferruginized "intraduricrustal" sandstone) could indicate that the younger ferruginization is post younger duricrust (possibly associated with the Pleistocene "gypsite" formation).

Cainozoic chemical limestones of Upper Tertiary to Recent age.

RH: 8, 17, 18, 28, 33, 35, 36, 37, 52, 53-56A, 57, 79, 80, 168. (Appendix 1N).

Most of these samples are from limestones of probable Pleistocene age. They seem to have formed in lagoons or as terrace travertine or tufa deposits around artesian springs (which were very active during the Pleistocene - probably in sympathy with uplift of the eastern cordillera during the Kosciuskan Orogeny). They are typically very fine grained (1-5 microns) except where recrystallized, and usually contain a significant amount of ill sorted clastic material.

Samples RH35 to 37 come from a ?post-"gypsite" carbonate sequence east of Mt. Alice (see columnar section S3473). They are probably lagoonal deposits which were intermittently dried out during deposition (forming intraformational conglomerates). They have subsequently been dolomitized and silicified to some extent.

Samples RH79 and RH80 have been classified as kunkars on the basis of field characteristics. However, the presence of calcite ooliths suggests a subaqueous rather than aeolian origin.

Gypsum and limonite occurrences associated with Pleistocene "gypsite" surface.

RH: 31-32A, 70, 76-77A, 120A, 121, 123A, 135A-136. (Appendiz 1o)

These samples form a rather diverse collection. However they are all thought to be roughly contemporaneous.

The limonite, which often underlies the "gypsite" cap, appears to form by the alteration of older limestones (usually Cretaceous). The textures of RH70 and RH136 show that ferruginization preceded gypsum crystallization.

RH121 is of interest as one of the few clearly clastic "gypsite" deposits. Sandstones of this type have been observed in other parts of the Great Artesian Basin (H. Wopfner, pers.comm.).

Mt. Alice Conglomerate and associated silicified sandstones.

RH: 24, 25, 26. (Appendix 1P)

This rather enigmatic association is thought to be of Pleistocene age. The high degree of rounding of pebbles (and to a lesser extent sand grains) in the deposit, as well as the suggested presence of original calcareous cement (D. Smale, pers. comm.) indicate an unusual, and as yet undetermined, depositional environment.

I. B. Freytag will map this area in detail at a later date, so it would probably be unwise to comment durther until this has been done.

Potches formed by Pleistocene-Recent silicification of Cainozoic limestones.

RH: 34, 39, 66. (Appendix 1Q).

These samples of "potch" represent silicified portions of some of the limestones described in Appendix 1N. The silicification is quite recent, and is in no way related to either of the duricrusts.

RH34 is rather complex, and appears to have formed from a rather "dirty" limestone.

The other samples (RH39 and 66) are remarkably similar, despite the fact that they come from outcrops more than fifty miles apart. Both consist largely of fine chalcedonic quartz. They probably formed from clean, fine grained chemical limestones.

Unclassified Samples.

RH: 23, 55A, 97, 103, 133, 143, 144, 148, 151, 153, 165-166A (Appendix 1R)

These samples were largely collected for mineral identification or as unusual specimens. Their age relations (where known) are contained in the descriptions.

CONCLUSIONS & DISCUSSION

Since the "RESULTS" section includes much that would normally be considered as conclusions, little remains to be said. Perhaps the most significant points to emerge from this project are:

1. The discovery of trachytic grains in "Winton" sediments. The significance of this discovery, both from the point of view of subsurface correlation and as an indicator of ?Neocomian volcanic activity, need hardly be emphasized.

2. The discovery that "Tambo" shales are kaolin-rich, whereas "Winton" shales are montmorillonite-rich. Although this result is based on far too few samples to be really reliable, it opens up a potential field of investigation which could be most fruitful, both from the point of view of fundamental research and as a possible correlation tool.

As in all geological problems, much work remains to be done. The final map and explanatory notes for the Oodnadatta 4-mile sheet, (the preparation and compilation of which will fall to the lot of I. B. Freytag) as well as the interim reports on areas of special interest (Mt. Toondina, Mt. Harvey, etc.) will complement the work reported on here. In a broader sense, the reconnaissance mapping of the fifteen or so 4-mile sheets covering the western Great Artesian Basin has much to commend it. The photogeological maps prepared by B. G. Forbes and the French Petroleum Company of Australia would greatly facilitate such a mapping programme. This work, if combined with a planned programme of sampling for petrological purposes, could lead to an understanding of this large and fascinating geological province, as well as solving many of the puzzling problems encountered in the area (the extent and nature of the Permian and other marginal basin sediments; the "Cretaceous glaciation"; the broader aspects of the laterite and duricrust occurrences; and the gypsite-kunkar relationship to name but a few). Perhaps only then could such problems as the petroleum prospects of the central Great Artesian Basin and the younger geological history of much of the State be tackled with any great hope of success.

Finally, the work in progress at present has shown most conclusively that a programme of shallow drilling around the western margins of the Basin is essential, if the potential of this area is to be fully developed, both from the economic and academic points of view. The lack of knowledge of the pre-aquifer sediments of this region is one of the glaring deficiencies in the existing knowledge of fundamental South Australian geology.

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GRH:EMD
23.7.63.

PART 2 BY D. SMALE

PETROGRAPHY OF ROCKS FROM OODNADATTA AND WINTINNA

GENERAL SUMMARY OF THE ROCKS DESCRIBED IN THIS REPORT.

Although most of these rocks have been formed at or near the surface, no attempt has here been made to classify them as laterite, duricrust, silcrete, kunkar, or any other of the available terms, as this can be done only on the basis of field occurrence. However, rocks from South Africa described as silcretes by Lamplugh (1907), Frankel & Kent (1937) and Frankel (1952) bear a strong resemblance to many of the rocks from the area around Oodnadatta. This was noted by Williamson (1957), who applied the term "silcrete" to rocks of this type from Australia. All four terms silcrete, duricrust, laterite and kunkar, would be applicable to these rocks according to their petrography, provided their field occurrence was in accord.

A large number of the quartz grains in nearly all these specimens contain minute acicular inclusions, minute tabular crystals, and rows of minute grains of rutile, tourmaline and goethite.

A. FERRUGINOUS ROCKS

1. Massive goethite, RH71, RH76, RH151

These consist of little else but goethite; a few small quartz or plagioclase grains may be present, not generally more than 0.1 mm across, and forming not more than 1-2 per cent of the rock. RH76 and RH151 have undergone silicification.

2. Ferruginous sandstones

a. Sandstones with goethite cement. RH47, RH65, RH86, RH107

The framework fraction consists mainly of quartz grains, and the matrix is of material similar to that in the massive goethites. The grain size of the goethite is usually very small, of the order of 0.001 mm, or else too fine for optical resolution.

In the ferruginous part of RH85, the goethite is admixed with a considerable quantity of quartz.

Some montmorillonitic sandstones, instead of being cemented by calcite, are cemented by goethite partially filling the voids (e.g. RH138, RH142).

b. Sandstones with goethite coatings on grains. RH41

In these the quartz grains are usually coated in such a way as to make the resulting grain well-rounded, or even an oolith with the original grain as the nucleus. The cement is usually siliceous, and contains colloidal goethite of a much paler colour than that coating the grains; it appears very homogeneous under the microscope, and generally has spherulitic extinction between crossed nicols.

3. Ferruginous conglomerates and breccias

Breccias

The only true breccias (i.e. with angular fragments) in these rocks are RH70 and RH136. In these the fragments consist of goethite and the matrix is gypsum. The fragments appear to have moved so little, relative to one another, that brecciation may have been caused, or at least greatly assisted, by the crystallisation of the gypsum.

Conglomerates

a. With siliceous clay fragments. RH38, RH40, RH68, RH81.

RH38 and RH40 are both probably intraformational; in RH38 the goethite matrix does little more than fill the cracks in the claystone. The pebbles are more or less iron-stained, and consist chiefly of kaolin and silica. A few quartz grains are present.

b. With siliceous fragments. RH73, RH83, RH117, RH118, RH128, Rh130, RH141, RH159.

These frequently appear to have undergone more than one period of silicification and ferruginisation (e.g. RH130). The fragments may be quartz grains, quartz sandstone, or some fine-grained siliceous clay rock. The quartz sandstones usually have an opaline matrix containing much leucoxene.

The matrix most commonly contains angular to subrounded grains of quartz and fragments of siliceous rock 0.1-0.2 mm

across surrounded by a vague or definite coating of goethite. These may be cemented by further goethite (as in RH81), surrounded by opal (as in RH117 and RH141), set in cherty quartz (as in RH83), or a combination (as in RH130). Often the interstitial voids have been filled with chalcedonic quartz, generally indicative of silicification as the final process affecting the rock.

c. With ferruginous fragments. RH67, RH75, RH78.

The ferruginous fragments may consist of massive goethite, sandy goethite, or goethite-cemented sandstone; the goethite is always dark reddish-brown and almost opaque. A distinctive feature of most of these fragments is the way in which the opaque goethite has retreated from the original boundary of the fragment and left brighter-coloured, more translucent goethite. Probably the dark goethite from this brighter area has been partially leached, and become disseminated through the rest of the rock. Quartz grains straddle the boundary between the light and dark goethite within the fragment, but do not straddle the original boundary of the fragment (see fig. 5). There is thus no evidence that these are of the same type as the "syngenetic nodules" described by Frankel and Kent (1937) and Williamson (1957).

A number of ferruginous rocks appear to have undergone as the final stage in their formation a process of ferruginisation which has left a coating of pale colloidal goethite on the walls of voids. These rocks are RH45, RH68, RH73, RH75, RH81, RH82, RH130, RH149.

Some rocks have been cemented by goethite which appears to be an amorphous mass of very minute grains. These rocks are RH47, RH65, RH72, RH85, RH86, RH107. In RH85 and RH86 the goethite is the same deep wine-red, but it is of a different brownish colour in each of the other specimens.

In some rocks the goethite occurs in aggregates of minute grains, each aggregate being about 0.01 mm across. These rocks are RH87 and RH160. RH159 contains fewer, larger, more irregularly-shaped aggregates.

B. SILICEOUS ROCKS

Most of these rocks, being very rich in silica and formed at or near the surface, could be called "silcretes."

Some consist almost entirely of sand grains of quartz (orthoquartzites) e.g. RH26, RH30, RH51. RH45 and RH82 consist of sand grains of quartz with a small amount of goethite cement. RH42 and RH116 consist of sand grains, granules and pebbles of quartz cemented by kaolin.

Others consist almost entirely of quartz, but may be chalcedonic chert (RH34, RH39, RH66) or novaculite (RH150).

Porcellanites (RH43, RH48), containing quartz, clay and opal, are fairly distinctive on account of their porosity and matt surface. RH44, RH49, and RH129 are similar in composition, but are coarser-grained and less porous.

One rock consists almost entirely of opal (RH58); others contain quantities of quartz in an opaline matrix, usually containing much leucoxene (though not always - see RH154). Many fit into this latter category, and they usually show a considerable similarity in their form and composition. Pebbles in ferruginous conglomerates often consist of this material. Specimens of this type of rock are as follows (asterisks mark those rocks in which it occurs as pebbles):- RH25*, RH29, RH46, RH59, RH60, RH64, RH74, RH83*, RH87*, RH89, RH90, RH91, RH93, RH94, RH112, RH115, RH119, RH127, RH128*, RH134, RH141*, RH152*, RH154, RH159*, RH160.

A few of these rocks contain insufficient sand grains (less than 25 per cent) to warrant their being called sandstones (e.g. RH89 and RH91). In these instances, in the absence of any other suitable name, the term "silcrete" has been applied. Some rocks with a cement consisting of quartz in a fine-grained mosaic may have originally had an opaline matrix which has since crystallised into quartz (e.g. RH25*). In most of these the quartz grains are subangular to subrounded and vary considerably in size, but on the average they are between 0.05 and 1.0 mm across. The matrix is characteristically fairly dark between crossed nicols, and may be homogeneous or contain small colloform struc-

tures; these are seldom more than two or three millimetres across, and are formed by different concentrations of leucoxene within the matrix. Rutile, zircon and tourmaline in recognisable grains are persistent accessory minerals.

Siliceous ooliths occur in RH34, RH83, and in pebbles in RH116 (see fig. 6).

A fairly common constituent of many of these rocks is a light brown, rather homogeneous material with a refractive index lower than that of quartz but considerably above that of opal; between crossed nicols it has a blotchy or mottled criss-cross appearance and very low birefringence. X-ray analysis of one specimen (RH34) showed this material to contain in considerable quantity, illite, quartz, and either cristobalite or more quartz. Other specimens containing pebbles of similar material are RH38, RH40, RH68, RH72, RH81, RH149.

Somewhat similar material occurs in pebbles in RH72, but it has lower birefringence (nearly isotropic) and a vague spherulitic appearance and slight translucence between crossed nicols. It has a refractive index similar to the material described above, and probably likewise consists of clay and silica.

C. CARBONATE ROCKS

These include pure limestones, sandy limestones, calcareous sandstones and dolomites.

Most of the pure limestones are fine-grained (RH28, RH33, RH53, RH79, RH113, RH123), but there are also slightly coarser ones (RH35, RH99, RH137). However, none are of greater average grain size than about 0.125 mm. All show coarser grains if recrystallisation has taken place in parts of the rock which were once cavities. Only RH35 shows no signs of recrystallisation.

Many of the calcareous sandstones contain iron-rich montmorillonite, green in fresh rocks such as RH62, RH105, Rh139, and RH145, and yellow in rocks with a more oxidised

appearance, such as RH104, RH106, and RH131. Only three of the rocks containing iron-rich montmorillonite are not calcareous; these are RH121, RH138 and RH142, and are cemented by goethite instead of calcite. The calcareous matrix of several sandstones contains some clay material. Quartz and plagioclase (andesine) usually predominate among the grains; ferromagnesians and volcanic fragments with trachytic texture are commonly present (RH3, RH95, RH96, RH98 and RH111). The rocks with much igneous material appear to contain little or no iron-rich montmorillonite and vice versa. It is likely that the source rock of the volcanic material may outcrop at the present time, though it could be some distance away.

A few calcareous sandstones contain probable plant remains; these are RH22, RH100, RH104 and RH131.

There is a common texture in the matrix of many of the calcareous sandstones, which has here been described as "brush-like." This refers to calcite occurring in subradiating, finely fibrous masses rather resembling a feather duster. It is probably formed as a result of incomplete recrystallisation from a fine calcareous dust or ooze, and may be typical of a kunkar. This texture is present in RH62, RH98, RH105, RH139 and RH145.

Dolomitic rocks are rare by comparison with calcareous rocks; the only ones present are RH36, RH37, RH54, and RH153. In RH54 pebbles of dolomite occur in which there is a considerable quantity (5-10 per cent) of authigenic feldspar in distinctive elongated crystals an average of 0.1 mm long and 0.01 mm wide. They are frequently twinned parallel to the elongation, and are probably albite. It has been suggested (Pettijohn, 1957, pp 666) that a marine environment is necessary for the formation of authigenic feldspar, and in this connexion it is worthy of note that in RH54 the authigenic crystals appear to have formed fairly early in the history of the rock. However, the need for a marine environment appears rather speculative.

D. GYPSEOUS ROCKS. RH70, RH103, RH121, RH136, RH144.

Gypsum is the cementing material in RH70, RH121, RH136, and is vein filling material in RH144. In RH103 fine-grained gypsum forms virtually the whole rock, which may be described as gypsite. RH70 and RH136 are breccias containing fragments of goethite; RH121 is a sandstone.

Several minerals occur fairly persistently in these rocks, and it is advisable to comment on their form and recognition.

1. Leucoxene

This is very common in almost all the siliceous rocks; it occurs most commonly in opal and cryptocrystalline silica. It gives a white colour to the rock in reflected light, and in transmitted light causes the rock to appear a dirty brown. Its concentration frequently varies considerably within a small area in a single specimen, and this commonly produces small colloform structures. It occurs in minute grains of the order of 0.001 mm across, and is of very high refractive index. The grains may consist of rutile, anatase or sphene.

2. Iron-rich montmorillonite.

Both in hand specimen and in thin section this has an appearance very similar to that of glauconite, and it is virtually indistinguishable from glauconite by optical methods. In thin section it varies in colour between yellow, light green and dark green, and is generally non-pleochroic; it has a very finely crystalline texture apparent between crossed nicols. The refractive index varies between 1.55 and 1.57 and tends to be slightly higher in the yellow variety than in the green. It almost always occurs in subrounded or rounded grains or nodules so similar to those of glauconite that it is advisable to consider the possibility that the mode of origin may be comparable with that of glauconite. However, no casts have been found, nor any regular structure save a suggestion of concentric structure in one grain in RH142.

X-ray analysis on this material from RH138 has indicated fairly conclusively that this is a di-octohedral smectite.

According to the results of a spectrographic analysis on the same sample there is not sufficient iron present for it to be nontronite, and the ratio of aluminium to silica does not appear to be sufficiently high for beidellite.

3. Opal, hyalite, lussatite, quartz, chalcedony, chert, flint, cryptocrystalline silica.

The terminology used by Frondel ("Dana's 'The System of Mineralogy' volume III, Silica Minerals", 1962) is followed here.

The terms used may be summarised briefly as follows:-

Opal is characterised by a very low refractive index. Leucoxene is a very persistent associate. Perfectly clear opal is called hyalite, and generally occurs lining cavities, as in RH64 (see fig. 4). Lussatite is fibrous, slightly anisotropic opal, and occurs in RH36, RH46, RH76, RH128 and RH141.

Chalcedony is quartz with a fibrous texture. Generally the fibres have negative elongation, but in the specimens of chert, which is a mosaic of fine chalcedonic quartz, the elongation of the fibres is positive. Flint is similar to chert, but is generally of finer grain and occurs in nodular masses.

Cryptocrystalline silica is indeterminate, as it is probably too fine grained to allow optical determination to be made. Its presence is usually deduced from the hardness of the hand specimen in the absence of a more definite form of silica.

Note.

Specific names for carbonates and clays (viz. calcite, dolomite, kaolin, montmorillonite, illite) have been given as a result of X-ray analysis.

D. SMALE,
PETROLOGIST.
A.M.D.L.

DS:EMD
23.7.63.

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APPENDIX 1A

PRE-PERMIAN SAMPLES

?PROTEROZOIC QUARTZITE RH 1

Identification: RH 1; 1.2; P1336/62; TS 11223

Locality: Curdimurka 4-mile, Bopeechee 1-mile, Run 2, Photo 0091. Sulphur Springs area, north of main road just west of prominent fault.

Lat. 29° 36.6'S, Long. 137° 26.3'E (from mosaic).

Collected: July, 19, 1962 by G.R. Heath.

Field Observations: The rock is a banded quartzite, highly indurated, probably pyritic. Consists of fine to medium, fairly well rounded quartz sand grains in siliceous cement. Bedding (or banding) 0.1 - 0.5 inches thick. Occurs as low flaggy outcrops unconformably below thin sandstones of probable Creta-Jurassic age (Mt. Anna equivalents).

Petrological Report: (D. Smale):

This is an orthoquartzite at least 98% of the rock consisting of irregular interlocking grains of quartz between 0.05 mm and 1.0 mm across. Green biotite and muscovite occur in small flakes and needles 0.02 mm to 0.2 mm long. Some green tourmaline is present, some of it similar in shape to the biotite. A little orthoclase, and rather less plagioclase, is also present.

The distinct banding which shows in the hand specimen, together with the lack of euhedral crystals of mafic minerals and general absence of plagioclase, indicates that this rock is of sedimentary origin, though for the grains to interlock as they do recrystallization must have taken place.

PORPHYRY ERRATIC

RH 2

IDENTIFICATION: RH 2; 1.7; P1337/62; TS 11224

LOCALITY: Warrina 4-mile, Nilpinna 1-mile Run 1, Photo 3608. Adjacent to main Marree-Oodnadatta road, just south of Peake Creek. Lat. 28°03'S. Long. 135°48'E.

COLLECTED: July 21, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a dull reddish porphyry containing 0.1-0.2 inch quartz, felspar and ? epidote crystals. From a 2 ft. diameter erratic showing possible facetting lying on Cretaceous (Roma) shales.

PETROLOGICAL REPORT: (D. Smale)

This is a potassic rhyolite. It consists of large phenocrysts (up to about 7 mm across) in a groundmass consisting mainly of crystals of quartz about 0.05 mm across. Magmatic reddening has affected the groundmass and pervaded much of the phenocryst material.

Sanidine (some showing excellent cleavage) and quartz are the chief phenocryst-forming minerals. Some plagioclase phenocrysts are present, but these have been largely sericitised; it appears likely that they were oligoclase. In some crystals the sericitisation is virtually complete; in hand specimen these crystals appear serpentinous. At least one crystal of what may have been a ferromagnesian has been altered to chlorite. The quartz phenocrysts are finely fractured, but strain extinction is very minor. Most of the phenocrysts have been severely corroded by the groundmass, and in many the small crystals of the groundmass appear to have penetrated the outer parts of the phenocrysts forming a rim which may be 0.5 mm thick in which the phenocryst poikilitically encloses the quartz crystals.

The groundmass contains little else but small crystals of quartz. However, secondary carbonate, biotite and tourmaline occur, the tourmaline poikilitically enclosing crystals of the groundmass. A characteristic of the groundmass near the phenocrysts, and in particular the sanidine phenocrysts is the way in which the quartz crystals of the groundmass become much smaller close to the phenocrysts; they grade from about 0.01 mm across at the edge of the phenocryst to about 0.05 mm in the normal groundmass.

This rock shows a strong resemblance to some of the Gawler Range porphyries.

PORPHYRY ERRATIC RH4

Identification: RH4; 2.3; P1339/62; TS 11225

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 6, Photo 8988, Loc. (1) 5.2 miles at 250° from Algebuckina R.S. Lat. 27°54.8'S, Long. 135°44.3'E.

Collected: July 24, 1962, by G. R. Heath.

Field Observations: This rock is a reddish porphyry containing quartz, orthoclase and ?epidote crystals up to 0.25 inches diameter, with rare mica flakes. From a 4' diameter erratic showing possible facetting, lying on Cretaceous (Roma) shales.

Petrological Report: (D. Smale):

This is a potassic rhyolite almost identical with RH2 (TS11224). However, there are a few minor points worth noting.

1. The phenocrysts are a little larger than in TS11224.

2. The green minerals (biotite, tourmaline and chlorite) occur in rather larger patches than in TS11224, and it appears that they may have been derived from previously existing ferromagnesian phenocrysts.

3. The phenocrysts show a slightly more pronounced tendency to have euhedral outlines than do those in TS11224, though the groundmass has still severely corroded them in places.

4. The presence of an unusually large crystal of zircon about 0.6 mm long and 0.15 mm wide, associated with an opaque mineral.

METAQUARTZITE ERRATIC RH 10

IDENTIFICATION: RH 10; 2.12; P1345/62; TS 11232

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 5, Photo 9041.
Lat. 27° 55.5'S, Long. 135° 35.5'E.

COLLECTED: July 31, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a dark grey metaquartzite (hornfelsic texture), consisting of very fine quartz sand and rare mica. Generally homogeneous in appearance, but with moderately abundant 0.2 to 0.5 inch quartz veins. Occurs as a "pseudo-outcrop" in Cretaceous (lower Roma) shales (probably a fragmented erratic).

PETROLOGICAL REPORT: (D. Smale):

This is a medium-grained quartz sandstone or protoquartzite, consisting mainly of subangular grains of quartz, which form about 90% of the rock. The average grain size is just under 0.1 mm, but it varies from 0.03 mm to 0.6 mm. Epidote makes up about 3% of the rock. Plagioclase (andesine) occurs rather less than half as commonly as epidote. There is a little muscovite present, which with the epidote shows marked alignment. A quartz vein about 5 mm wide cuts at right angles across the direction of this alignment. Within the vein there is a considerable amount (possibly 15% of the vein material) of clinozoisite tending to epidote in columnar crystals ranging up to nearly 1 mm long. Zircon and chlorite are also present, and some fine secondary tourmaline occurs around some grains in particular near a small fragment of chert. Some of the quartz shows strain extinction.

APPENDIX 1B

PERMIAN MATERIAL

FROM

MT. DUTTON AREA.

? WILLOURAN GWKE. ERRATIC RH 20

IDENTIFICATION: RH 20; 3.15; P1355/62; TS11242

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4. Photo 9094. Centre of a small group of limestone mesas, south-west of main mass of limestone south of Mt. Dutton, just north of The Neales. Lat. 27° 51. 7'S, Long. 135°37.5'E.

COLLECTED: August 4, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a dark grey sandstone or sandy mica schist (mica flakes about 1 mm diameter), of rather homogeneous appearance. It occurs as a small area of angular fragments, which are probably the remnants of a large erratic formerly in the Roma shales or Mt. Anna Sandstone. The somewhat metamorphosed appearance suggests a Proterozoic Age.

PETROLOGICAL REPORT: (D. Smale):

This is a feldspathic greywacke, but as rock fragments and feldspar grains are present in similar quantities, it is also very close to a lithic greywacke. The grains are very poorly sorted, generally angular, and range in size from about 0.2 mm to 1 mm or more across. About 15 - 20% of the rock consists of quartz grains; there is also a great deal of other material, namely quartzite fragments (some laminated), plagioclase (at least some of which is andesine), orthoclase, muscovite, biotite (some altering to chlorite), tourmaline, Fe-Mg chlorite, epidote, carbonate (generally present as part of the matrix), zircon, sericite rock, garnet (altering to chlorite), and apatite. The detrital matrix constitutes about 20% of the rock.

PERMIAN OOLITIC SANDY DOL. RH 14

IDENTIFICATION: RH 14; 3.7; P1349/62; TS 11236

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092, Loc. (4). From western slopes of Mt. Dutton Range. Lat. 27°48.5'S, Long. 135°40.7'E.

COLLECTED: August 3, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a buff very sandy dolomite or dolomitic sandstone (no reaction with dilute HCl) containing coarse well rounded quartz grains. It is quite homogeneous and very massive and tight. Weathered surfaces show a typical buff, rough sandy texture. Although not seen in outcrop, it is associated with boulder fields of probable Permian age west of Mt. Dutton and south-west of Mt. Anna. It is thought to be of lower (? post glacial) Permian age.

PETROLOGICAL REPORT (D. Smale):

This is an oolitic arenaceous dolomite, but it differs little from the calcareous sandstones described previously. About 70% of the rock is carbonate, and half that is in the form of ooliths. The sand fraction is mainly quartz. The grains are subangular and fairly variable in size, but average about 0.25mm across; many have been affected by solution. The ooliths are similar in size to the sand grains but are composed of carbonate. There are present, besides quartz, grains of plagioclase and microcline.

PHOTOMICROGRAPH TAKEN

? PROT., PERM. OR JUR. SS. RH 15

IDENTIFICATION: RH 15; 3.8; P1350/62; TS 11237

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092. Just off south-west corner of Mt. Dutton Proterozoic inlier. Lat. 27° 49.7'S, Long 135°40.1'E.

COLLECTED: August 3, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a grey, fairly porous sandstone, consisting of very fine, fairly well sorted quartz. From a low outcrop immediately adjacent to the known Proterozoic of the Mt. Dutton Range. Age unknown (?Proterozoic, Permian or Creta-Jurassic).

PETROLOGICAL REPORT: D. Smale:

This is an orthoquartzite, but it has been poorly cemented and is very porous. The grain size is on the average 0.1 - 0.15 mm. The grains are subangular, and more than 90% quartz. Also present are grains of microcline, zircon, ilmenite, orthoclase, plagioclase, tourmaline and chlorite. Some of the quartz grains contain a few small inclusions of rutile or tourmaline.

RH 16
RH 164

?PERMIAN BOULDER CLAY

Identification: RH16; 3.10; P1351/62; TS11238; RH164; P157/63.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092. From dark area 0.3 miles west of south-west corner of Mt. Dutton inlier. Lat. 27°49.5'S, Long. 135°39.5'E.

Collected: August 3, 1962, by G. R. Heath.

Field Observations: The rock is a greenish grey very poorly sorted mudstone, containing abundant subrounded quartz sand grains and pebbles (mainly quartzite) up to several inches diameter (some showing possible facetting and striae). Bedding is irregular and often obscure, and the various grain sizes are not differentiated to any noticeable extent. This specimen is typical of the ?Permian ?fluvioglacials which unconformably underlie the Mt. Anna Sandstone west of Mt. Dutton.

Petrological Reports: (D. Smale):

(1) This is a poorly sorted argillaceous sandstone. The grain size of the framework is 0.01 mm to 0.7 mm; that of the matrix is about 0.001 mm. Most of the larter grains are subrounded or rounded, though the smaller ones (less than 0.1 mm across) are rather more angular. The framework fraction and the matrix each account for about half the rock. Most of the grains are quartz, but there are also present grains of zircon, chert, microcline, orthoclase, plagioclase, mudstone, muscovite and garnet.

(2) This sample was not sufficiently coherent to allow a thin section to be made. The chief clay minerals present are illite and a rather smaller proportion of kaolin.

PERMIAN DOLOMITE RH54

Identification: RH54; P982/62; TS 11410; TS 11410A

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092. General area of Loc. (4). From western flank of Mt. Dutton Range, 0.3 miles west of Mt. Dutton (near RH14). Lat. 27°48.5'S, Long. 135°40.7'E.

Collected: September 16, 1962 by G.R. Heath.

Field Observations: The rock is a grey and light brown mottled sandy dolomite, containing abundant 1 mm well rounded quartz grains. Weathers to typical yellow-brown rough sandy surface. Occurs abundantly in the Permian boulder field on the west side of Mt. Dutton. Similar rocks have been observed in a boulder field west of Mt. Anna.

Petrological Report: (D. Smale): Two thin sections

This is a coarse dolomite sandstone consisting of subrounded to well-rounded fragments 0.25-3 mm across. Little matrix is present, as most of the grains interlock. The grains consist, in decreasing order of abundance, of:-

1) fine-grained dolomite, with a grain size of 0.001 mm.
2) rather coarser dolimite, with a grain size of 0.02 mm.
3) fine-grained dolomite containing numerous randomly oriented acicular crystals of authigenic plagioclase (? albite) an average of 0.1 x 0.01 mm. This often occurs in the same grains as the dolomitic sandstones (see below), in places where the sand grains are sparse.
4) dolomitic sandstones, about 40 percent consisting of subrounded opaques or angular to subangular quartz grains in approximately equal quantities, about 0.1 mm across, in a matrix of fine-grained dolomite.
5) dolomitic sandstone, as above, but with grains only of quartz.

It is frequently difficult to distinguish between fragments and matrix; while some material in large clear crystals is fairly definitely cement, other fine-grained and rather dirty dolomite appears to enclose dolomite grains, and to be interstitial between other grains. The authigenic feldspar appears to have formed at some fairly early stage of this rock's history, as in some pebbles most of the feldspar crystals have been replaced by carbonate, and in others the crystals are broken off at the edge of the pebble.

Microcline, zircon and tourmaline are present as accessory minerals.

TS11410A

This tends to be a little coarser than the previous slide; there is more matrix, and the quartz grains tend to be larger. The fragments are rounded or well-rounded, except for those less than about 0.5 mm across, which are usually rounded or subrounded; all have been finely pitted by solution and the pittings filled with dolomite. They are set in a matrix of dolomite with grain size of about 0.03 mm, which increases to 0.2 or 0.3 mm where cavities have been filled. Most of the fragments are surrounded by dolomite crystals which have grown radially outwards. Many features in the rock indicate that a considerable amount of replacement of quartz by dolomite has taken

place, and that even apparent "pebbles" may in fact be homogeneous secondary oolitic structures, as quartz grains exist which cross the boundaries of such "pebbles". There does not appear to be any authigenic feldspar present in this specimen.

A few grains of allogenic plagioclase and microcline are present. Zircon and tourmaline are accessory minerals.

PERMIAN BLUE SHALE RH163

Identification: RH163; P156/63.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092. 2-3 miles south-south-west of Mt. Dutton trig. Lat. 27°50'S, Long. 135°39.6'E.

Collected: August 3, 1962, by G. R. Heath.

Field Observations: The sample consists of light, slightly bluish-grey, poorly fissile, homogeneous shale. The shale contains much irregularly distributed quartz sand. Joints and partings frequently contain crystalline gypsum. This sample comes from about 18 inches below the Permian - Jurassic unconformity. The shale becomes weathered looking and red in colour for the 12 inches below the quartz pebble conglomerate, which marks the base of the Mt. Anna Sandstone.

Petrological Report: (D. Smale):

This consists of approximately equal proportions of kaolin and illite.

APPENDIX 1C

SANDSTONES

FROM

MT. ANNA SEQUENCE

EQUIVALENTS

(JURASSIC - CRETACEOUS)

MT. ANNA CALC. SS.

IDENTIFICATION: RH3; 2.2; P1338/62; TS11225

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 6, Photo 8886, Loc. (3). 2½ miles at 239° from Algebuckina R.S.

Lat. 27°55.5'S. Long. 135°46.5'E. From Algebuckina section 1, 56'-57.5' horizon.

COLLECTED: July 24, 1962 by G.R. Heath.

FIELD OBSERVATIONS: This rock is a light grey to buff sandstone, very calcareous, fine grained, poorly sorted, rather angular. Very thinly bedded to laminated, thinly flaggy, with ? rain drop impressions, animal trails and mica flakes on bedding planes. Prominent small scale festoon cross bedding (up to 9" wide by 2" deep). Contains very rare quartzite pebbles up to 1" diameter.

PETROLOGICAL REPORT: (D. Smale):

This is a calcareous sandstone with grain size varying from 0.02 mm to 1 mm. The framework fraction forms only 40-50% of the rock, and consists mainly of fairly angular quartz grains. Generally the coarser grains occur in narrow bands about 2 mm wide. The matrix is rather clayey calcite, generally optically continuous over patches about 10 mm across.

Apart from quartz there are present grains of tourmaline, muscovite, plagioclase, zircon, chert, biotite, chlorite and rutile though these together would not constitute more than 2% of the rock. One fragment of an igneous rock contains euhedral crystals which indicate plagioclase but these are now filled by calcite. Examination of the heavy mineral showed the presence of barite, garnet, monazite, magnetite and other opaques, epidote, and zircon both sharply euhedral and well rounded. As well as occurring in rather squat crystals, some of the zircon is in unusually elongated crystals.

CALC. MT. ANNA SS.

Identification: RH 5; 2.4; P1340/62; TS 11227.

Locality: Warrina 4-mile, Nilpinna 1-mile, Ruh 1, Photo 3606. In north bank of Peake Creek, one mile east of the railway (Marree-Alice Springs).
Lat. 28°2.2'S, Long. 135° 49'E.

Collected: July 21, 1962 by G.R. Heath.

Field Observations: The rock is a greyish sandstone, very calcareous, micaceous, ? slightly carbonaceous. Sand grains dominantly fine, sub-rounded, moderately well sorted quartz. Some suggestion of Fontainebleu texture From lowest exposure in 45' cliff of Mt. Anna Sandstone in Peake Creek. Overlain by fine micaceous sands. Numerous porphyry erratics in the area (none seen in situ).

Petrological Report: (D. Smale):

This is a calcareous sandstone similar to RH 3 (TS 11225), but less well bedded and cleaved in hand specimen. The grain size is between 0.02 mm and 0.6 mm, usually about 0.2 mm. The grains are subangular, and are mainly quartz; other minerals present in the framework fraction are zircon (often rather rounded), muscovite, biotite, tourmaline, (blue or green and some in subradiating groups), rutile, plagioclase, chlorite and chromite. Some of the quartz has been strained; some appears very corroded, and must have been affected by the solution which deposited the calcite matrix.

The rock contains 50-60% clayey calcite matrix though the calcite is rather less clayey than that of TS11225; it occurs in poikilitic patches about 1 cm across. Part of the matrix may at one time have consisted of grains of calcite, but if so they have now become incorporated in optical continuity with the matrix.

OOLITIC MT. ANNA SS. RH 11

IDENTIFICATION: RH 11; 3.1; P1346/62; 11233.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 7, Photo 8944. From small railway cutting near south boundary of Algebuckina sheet, 3½ miles west of Mt. Kingston.
Lat. 27°59.5'5, Long 135°49'E.

COLLECTED: August 2, 1962 by G.R. Heath:

FIELD OBSERVATIONS: The rock is a yellow brown oolitic calcareous sandstone, consisting of 0.5 - 1 mm calcareous ooliths and fine to medium quartz sand grains and rare pebbles in a siliceous, slightly ferruginous cement matrix. The rock is highly indurated. This rock probably belongs to the middle member of the Mt. Anna Sandstone. It is typical of the boldly outcropping oolite sandstones around the basement inliers.

PETROLOGICAL REPORT: (D. Smale):

This is an oolitic calcareous sandstone. The grain size is about 0.3 mm, but some of the grains present are about 0.5 mm across. They are subangular to subrounded, and most are quartz, though microcline and plagioclase are also present; tourmaline and muscovite are present in very small amounts. The matrix consists of calcite and some goethite, both fine grained, but occurring in irregular patches about 0.5 mm across; it accounts for 30-40% of the rock. The ooliths are slightly larger in size than the rest of the grains, and consist mainly of calcite, sometimes with quartz nuclei, and sometimes with narrow isotropic bands around them. Their structure is concentric. They account for about 10% of the rock.

? CAINOZOIC FERRUG. SS. RH 12

IDENTIFICATION: RH 12; 3.2; P1347/62; TS11234.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 7, Photo 8944. From cuesta east of Marree-Oodnadatta railway, 3.3 miles east of Mt. Kingston.
Lat. 27°59.5'S, Long. 135°49.3'E.

COLLECTED: August 2, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a dark brown limonitic sandstone, consisting of fine to medium angular to rounded quartz sand in a ferruginous matrix. Shows prominent irregular lisegang (or colloform) banding. Typical of the Pleistocene to Recent cappings (syn-or post-gypsite) on many of the Mt. Anna Sandstone exposures in the area.

PETROLOGICAL REPORT: (D, Smale);

This is a sandstone consisting largely of subangular quartz grains in a goethite cement. The grain size is about 0.15 mm. Apart from quartz there are among the grains plagioclase (oligoclase), microcline, blue tourmaline orthoclase and muscovite but these do not constitute more than 1% of the rock. In the matrix there is some carbonate associated with the goethite, and there are a few goethite ooliths. The rock in hand specimen shows colloform banding, which on microscopic examination proves to be produced by successive gradations of coarse to finely divided goethite.

CALC. MT. ANNA SS. RH 13

IDENTIFICATION: RH 13; 3.3; P1348/62; TS 11235

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 7, Photo 8944. West of main road, 4.5 miles south of Algebuckina R.S.
Lat: 27° 58.3'S, Long 135°48.5'E.

COLLECTED: August 2, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a pale brown very calcareous sandstone. Clastic fraction is fine grained, sub-rounded, fairly well sorted quartz sand. Generally crops out poorly with flaggy appearance. Adjacent (down dip) to "boulder field", which lies on Mt. Anna Sandstone outcrop south and west of Algebuckina.

PETROLOGICAL REPORT: (D. Smale):

This is a sandstone consisting of subrounded quartz grains an average of about 0.15 mm across in a calcite matrix. The calcite occurs in optically continuous patches about 5-10 mm across and poikilitically encloses the sand grains in the same way as in RH3 and RH5. Some of the quartz grains have approximately subhedral outlines and could be authigenic. However, if this is so, the grains have been affected by solution subsequent to authigenesis, as they have corroded outlines and edges replaced irregularly by calcite. Orthoclase and microline occur among the grains, but do not together account for more than 2-3% of the rock. In very minor quantities there are present zircon, garnet, epidote, sphene, rutile, apatite, (rather worn), tourmaline, chlorite and opaques.

? DURICRUSTED MT. ANNA SS. RH 19

IDENTIFICATION: RH 19; 3.13; P1354/62; TS 11241

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092, Loc. (2). Small butte on eastern edge of Mt. Anna Sandstone cuesta, 1.2 miles west of Mt. Dutton.
Lat. 27°48.5'S, Long. 135°39.9'E.

COLLECTED: August 3, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is light grey silcrete containing abundant rounded very poorly sorted quartz sand and pebbles. This material caps the higher plateaux of Mt. Anna Sandstone (lower to middle member) west and north of Mt. Dutton. It is topographically higher (and ?older) than the main ferruginous surface in the area.

PETROLOGICAL REPORT: (D. Smale):

This is an orthoquartzite consisting of about 40% of subrounded quartz grains 0.07 mm to 2 or 3 mm across in a fine quartz mosaic of grain size 0.02 - 0.03 mm. Grains of zircon, tourmaline rutile, and opaques are present to a small extent, and in size are between that of the sand grains and the matrix.

MT. ANNA SS. - MT. ALICE RH27

Identification: RH27; P957/62; TS 11385.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6345. From north flanks of plateau at Mt. Alice, 1 mile north of the trig station. Lat. 27°11'S, Long. 135°5.9'E (from mosaic).

Collected: September 6, 1962, by G. R. Heath.

Field Observations: The rock is a white, fairly friable sandstone, consisting of fine grained, fairly well sorted angular quartz. This rock type forms the lowest (stratigraphic) outcrops in the Mt. Alice area, and is possibly an equivalent of the middle beds of the Mt. Anna Sandstone.

Petrological Report: (D. Smale):

This is an orthoquartzite, fairly well sorted, consisting of subangular and subrounded quartz grains 0.05 to 0.15 mm across, with very little matrix; the interstices between the grains are usually empty, and account for 10-20 per cent of the volume of the rock. Such matrix as there is consists of a fine quartz mosaic with a grain size of less than 0.01 mm. There are a few quartz grains distinctly larger than the others, 0.5 to 0.8 mm across; these constitute less than 10 per cent of the rock. Present in accessory quantities are tourmaline, biotite, muscovite, rutile, opaques and zircon.

?MT. ANNA OR GYPSITE SS. RH29

Identification: RH29; P959/62; TS 11387

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6345. Some loc. as RH28 (1 mile north of Mt. Alice trig). Lat. 27°11.3'S, Long. 135°5.8'E (from mosaic).

Collected: September 6, 1962, by G. R. Heath.

Field Observations: The rock is a yellow-brown sandstone composed of fine to medium, fairly well sorted, angular quartz, lightly cemented by silica, very porous. This material is associated with the gypsite north of Mt. Alice. It may be a contemporaneous deposit (since it appears to overlie and interfinger with some gypsite) or it may belong to the Mt. Anna Sandstone equivalents in the area.

Petrological Report: (D. Smale):

This is a rather poorly sorted quartz sandstone consisting of angular to subrounded grains of quartz varying in size from 0.01 to 1.5 mm across, though 50-60 per cent are between 0.06 and 0.5 mm across, in a matrix of opal containing much leucoxene, which forms a few colloform structures.

Rutile and opaques are accessory minerals.

MT.ANNA SS. - MT.ALICE RH30

Identification: RH30; P960/62; TS 11388.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6345. 0.3 miles south-south-east of Mt. Alice trig. Lat. 27°12.5'S, Long. 135°5.8'E (from mosaic).

Collected: September 6, 1962, by G.R. Heath.

Field Observation: The rock is a pale yellow sandstone consisting of fine to medium grained, fairly well sorted quartz. Very porous. This material is typical of the Mt. Anna Sandstone equivalents outcropping around Mt. Alice. Field character is similar to RH27.

Petrological Report: (D. Smale):

This is a fairly well-sorted sandstone consisting of subangular to subrounded sand grains of quartz and feldspar 0.05-0.5 mm, but generally about 0.15 mm, across.

Quartz forms 80-90 per cent of the grains. Albitic plagioclase, microcline and orthoclase form most of the remainder. Combined albite and pericline twinning is fairly common in the plagioclase.

There is virtually no matrix; the rock is held together as a result of slight recrystallisation between the grains, and the presence of about 1 per cent of chalcedonic quartz. Voids form about 30 per cent of the rock.

Rutile, tourmaline, muscovite and opaques are accessory minerals.

This rock resembles RH27 and RH51.

MT. ANNA SS. - MT. DUTTON RH51

Identification: RH51; P979/62; TS 11407

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 2, Photo 8825, Loc. (1). Small mesa 1.1 miles north of Mt. Dutton. Lat. 27°47.4'S, Long. 135°41.3'E.

Collected: September 16, 1962 by G.R. Heath

Field Observations: The rock is a friable buff sandstone, consisting of well sorted, sub-angular to sub-rounded, fine to medium quartz. Contains a few laminal rich in dark grains (?heavy minerals). From a small cliff north of the Proterozoic block at Mt. Dutton (west of the major fault). This sandstone is underlain by kaolinitic gritty sandstone. Thus it is probably equivalent to the lower beds of the middle member of the Mt. Anna Sandstone.

Petrological Report: (D. Smale):

This is an orthoquartzite consisting of subangular to subrounded grains of quartz generally between 0.05 and 0.3 mm across. There is virtually no matrix except for a little fine detrital quartz, which would fill less than 3 per cent of the voids. A small amount of recrystallisation has taken place along some of the boundaries of juxtaposed grains, and it is the recrystallised quartz that cements the rock. A few grains of fine-grained quartzite occur, of the same size as the ordinary quartz grains. Zircon, sericite, and plagioclase are present as accessories.

Photomicrograph taken.

FERRUG. MT. ANNA. SS. RH 167

IDENTIFICATION: R.H. 167; 3.4; P1217/62; TS 10691.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 2, Photo 8825, Loc. (1)
Lat. 27° 47,6'S, Long 135°40.5'E.

COLLECTED: August 3, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a dark brown sandstone, generally homogeneous, but sometimes showing irregular ?Liesegang banding. Dominantly clastic quartz in a limonite matrix, but includes abundant, white, 0.5 mm spherical, calcareous clayey grains, some of which are concentrically banded. Typical of the ferruginous material capping the Mt. Anna Sandstone, north and west of Mt. Dutton.

PETROLOGICAL REPORT: (W.R. McCarthy):

This is a poorly sorted sandstone which is cemented primarily by goethite (?) with some carbonate. Clastic grains are sub-angular to rounded quartz with rare grains of feldspar. Quartz grains range in diameter from 1.0 mm to less than 0.0625mm; grains have an average diameter of 0.45 mm. Clastic mica is present in small quantities. Tourmaline was the only accessory mineral observed.

Quartz is noteable in that it commonly has cryptocrystalline, needle-like inclusions which are abundant in the quartz of the high grade metamorphic rocks of north-western South Australia.

Depositional environment of the sediment is not determinable with any precision from the single specimen, but weathering has probably produced the cementing goethite in an arid or temperate climate. According to A.V. Carozzi (Metamorphic Sedimentary Petrology, 1960, p. 46), similar sandstones had an original carbonate primary cement which was replaced by goethite during a later diaganetic period.

APPENDIX 1D

CRETACEOUS SEDIMENTS OF PROBABLE APTIAN AGE.

(?ROMA FORMATION EQUIVALENTS)

? ROMA INTRAFORM. LS. RH 9

IDENTIFICATION: R.H. 9; 2.11; P 1344/62; TS 11231.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 5, Photo 9043. Just south of The Neales, 7½ miles west of Algebuckina R.S. Lat. 27° 55.3'S. Long 135° 41.5'E.

COLLECTED: July, 31. 1962 by G.R. Heath

FIELD OBSERVATIONS: The rock is a slightly brownish light grey limestone, with a massive very finely crystalline (lithographic) texture. Bedding (shown by dendrite development) is very irregular, and the rock contains numerous limestone pebbles (intraformational) up to 1 inch diameter. This limestone crops out as low rounded masses in a broad featureless area mapped as Roma. However, the "chemical" appearance of the rock is more reminiscent of Cainozoic limestones in the area.

PETROLOGICAL REPORT: (D. Smale):

This is a fine grained limestone actually consisting of subrounded fine-grained limestone fragments about 5 mm or more across, cemented by a fine-grained calcareous matrix. The similarity in the composition and texture of the fragments and the matrix suggests that they were both formed by the same process, and that the fragmentation and recementation occurred during the original process of rock formation, which appears to be chemical.

?ROMA LIMESTONE RH137

Identification: RH137; P1055/62; TS11483.

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 3, Photo 9112, Loc. TR5. 22.0 miles west-north-west of Mt. Toondina. Palaeo. loc. Toondina (9) Lat. 27°50.2'S, Long. 135°1.5'E (from mosaic).

Collected: October 31, 1962, by G. R. Heath.

Field Observations: The rock is a light grey, massive, compact, homogeneous limestone, containing some quartz silt. This is typical of the concretionary limestones of the middle and lower Roma equivalents (?Aptian).

Petrological Report: (D. Smale):

This is a fairly pure limestone with a constant grain size of a little less than 0.02 mm. There are a few quartz grains present, comparable in size with the calcite grains.

Ferruginous material accounts for about 1 per cent of the rock, but has stained about 10 per cent. Some has grown dendritically.

Rutile, opaques, yellow iron-rich montmorillonite and chlorite are accessory minerals.

APPENDIX 1E

CRETACEOUS

QUARTZ - MONTMORILLONITE

SANDSTONE

(CLOSE TO ?ROMA - ?TAMBO

FORMATION EQUIVALENTS

BOUNDARY).

?ROMA-TAMBO SANDSTONE RH138

Identification: RH138; P1056/62; TS11484.

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 3, Photo 9110, Loc. TR8. 19.9 miles west-north-west of Mt. Toondina. Lat. 27°48.5'S, Long. 135°4.8'E (from mosaic).

Collected: October 31, 1962 by G. R. Heath.

Field Observations: The rock is a dirty yellow-brown, homogeneous non-calcareous, ?glauconitic sandstone, consisting of very fine to fine quartz and ?glauconite sand. Fairly porous. This sample is from the sandstone mappable across most of Toondina 1-mile sheet. Its stratigraphic position is not positively established, but seems to be near the Roma-Tambo equivalents boundary (if anything, slightly above this boundary).

Petrological Report: (D. Smale):

This is a sandstone, about 30 per cent consisting of grains of iron-rich montmorillonite. Though similar to some calcareous sandstones, there is no carbonate present in this specimen. The rock is fairly well-sorted, and the grain size varies from 0.05 - 0.2 mm. The grains are subangular to subrounded.

Iron-rich montmorillenite predominates. Quartz and plagioclase (andesine) together form about 20 per cent of the rock, and muscovite is present in minor quantity.

The grains are close-fitting, but often not well cemented, so that the rock is fairly porous. Goethite is the only pore-filling material; it is of the same type as that in other calcareous sandstones, and forms about 30 per cent of the rock.

RH 139

?ROMA-TAMBO CALC. "GLAUC." SANDSTONE

Identification: RH139; P1057/62; TS11485

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 3, Photo 9108, Loc. TR9. 19.0 miles west-north-west of Mt. Toondina. Lat. 27°48'S, Long. 135°6.0'E. (from mosaic).

Collected: October 31, 1962, by G.R. Heath

Field Observations: The rock is a greyish olive green massive, slightly calcareous, fairly well consolidated sandstone, consisting of very fine grained quartz and glauconite (or iron-rich montmorillonite) sand. This sample is from the same sandstone near the Roma-Tambo boundary as RH138.

Petrological Report: (D. Smale):

This is a calcareous sandstone consisting of angular or subangular sand grains 0.03-0.10 mm across in carbonate matrix. The sand fraction constitutes 50-60 per cent of the rock, and consists of approximately equal quantities of quartz, glauconite and opaques (sometimes semi-translucent and brown), with plagioclase (andesine-labradorite), muscovite, biotite and zircon forming the remaining 10-15 per cent. The carbonate matrix frequently forms semi-radiating, coalescing, fibrous masses up to 1 mm across, usually diverging from granular carbonate aggregates with a grain size of about 0.01 mm.

Photomicrograph taken.

RH142

"GLAUCONITE" SANDSTONE

Identification: RH142; P1060/62; TS11488

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 2, Photo 8812, Loc. TR14. 15.5 miles north-west of Mt. Toondina. Lat. 27°48.5'S, Long. 135°10.0'E. (from mosaic)

Collected: November 1, 1962, by G.R. Heath

Field Observations: The rock is a dark, rather greenish-brown, non-calcareous, sandstone, consisting of fine grained, fairly well sorted, rounded quartz and "glauconite" sand (see below re "glauconite"). This sandstone (also represented by RH138, 139, 145) is a good marker near the Roma-Tambo boundary for the Toondina area.

Petrological Report: (D. Smale):

This is a sandstone very similar to RH138, about 30 per cent consisting of iron-rich montmorillonite. The grains are subangular to subrounded, and fairly well sorted. Apart from iron-rich montmorillonite, quartz and plagioclase (andesine) are the predominant minerals of the framework. Goethite is the cementing material, but it does not fill all the voids, so that the rock is fairly porous. Carbonate is absent, as in RH138.

Chlorite, muscovite and zircon are accessory minerals.

RH 145

CALC. "GLAUC." SANDSTONE

Identification: RH 145, P1063/62; TS 11491.

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 2, Photo 8812, Loc. TR20. 16.2 miles north-west of Mt. Toondina, on Gidgea Creek.

Lat. 27° 48.4'S, Long. 135° 9.1' E. (from mosaic).

Collected: November 2, 1962, by G.R. Heath.

Field Observations: The rock is an olive green, rather indistinctly bedded sandstone, consisting of fairly well sorted, subangular, fine quartz and "glauconite" (iron-rich montmorillonite) sand in a clayey calcareous matrix. This sample of the ? Roma-Tambo marker sandstone (as RH 138, 139, 142) is from an area of good outcrop, which includes flaggy material as well as beds showing worm burrows.

Petrological Report: (D. Smale):

This is a calcareous sandstone, about 40 - 50 per cent of which consists of fairly well-sorted angular to subrounded sand grains about 0.1 mm across in a calcite matrix showing "brush-like" structure.

The grains consist of approximately equal quantities of quartz, iron rich montmorillonite and goethite similar to that in other calcareous rocks, with minor quantities of plagioclase (andesine-labradorite) and chlorite.

Zircon is an accessory mineral.

The goethite, as well as occurring in rather amorphous masses often slightly larger than the normal sand grains, occurs in small cigar-shaped pellets about 0.07 mm long and 0.02 mm wide.

APPENDIX 1F

CRETACEOUS SEDIMENTS OF PROBABLE ALBIAN AGE.

(?TAMBO FORMATION EQUIVALENTS).

TAMBO SANDY LIMESTONE RH 6

IDENTIFICATION: RH 6; 2.7; P1341/62; TS 11228

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9084. 3 miles north of The Neales, 1½ miles west of Watson Creek.
Lat. 27°49.5'S, Long. 135°58.5'E.

COLLECTED: July 26, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a somewhat brownish grey limestone, containing abundant fine to very fine quartz sand and minor mica. Typical of the Tambo (? lower to middle) limestones which crop out fairly prominently in the north and north-east portions of Algebuckina 1-mile sheet.

PETROLOGICAL REPORT: (D. Smale):

This is a calcareous sandstone consisting of grains an average of about 0.1 mm across in a clayey calcite matrix. Unlike that of RH3 (TS11225) and RH 5 (TS 11227) the matrix in this specimen is amorphous and is not in optically continuous patches. Quartz and a yellow chlorite are the most prevalent minerals in the framework fraction. Present in slightly smaller quantity than either of them is plagioclase (andesine), and in minor quantities muscovite and zircon.

TAMBO CARB. SANDY LS. RH7

Identification: RH7; 2.8; P1342/62; TS 11229.

Locality: Oodnadatta 4-mile, Kurillina 1-mile, Run 6, Photo 8977, Kurillina fossil loc. no. 2. From east bank of The Neales 9 miles west-north-west of Woodduck Bore. Lat. 27°58'S, Long. 136°5'E (from mosaic).

Collected: July 26, 1962, by G. R. Heath.

Field Observations: The rock is a grey limestone containing fine quartz sand, carbonaceous fragments and rare mica. Fairly homogeneous appearance. Associated in outcrop with friable ?glauconitic quartz sandstone. This sample appears identical with many upper Tambo and lower Winton limestones of the area, but may be lower Tambo in this case.

Petrological Report: (D. Smale):

This is a very fine-grained limestone (the average grain size being about 0.003 mm), consisting of about 98% calcite. There are occasional subangular quartz grains about 0.05 mm across or smaller, and a few grains of goethite and opaques about 0.01 mm across. Some of the opaques are surrounded by wide translucent rims. Yellow chlorite occurs in grains a little larger than the quartz, and about as commonly. Biotite is present to a very minor extent. There are a few small cellular fragments; in a few the original cell material remains, but in most the only indication is given by the structure of the calcite, which then occurs in single circular grains or in regular groups of them, each grain being about 0.003 mm diameter. Some of this cellular material appears likely to be plant material; the rest is indeterminate

TAMBO SANDY LS. RH 21

Identification: RH21; 4.3; P1356/62; TS 11243

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9084. Algebuckina fossil loc. no. 26. 14.7 miles east of Mt. Dutton R.S. Lat. 27°49.2'S, Long. 135°57.7'E.

Collected: August 7, 1962, by G.R. Heath.

Field Observations: The rock is a grey very sandy limestone containing minor mica and carbonaceous plant fragments. Animal trails on some bedding planes. Outcrops show prominent cross bedding. This sample is fairly typical of the limestones occurring in the ?middle-upper Tambo sequence east of the basement high (Peake-Denison Range - Oodnadatta Anticline).

Petrological Report: (D. Smale):

This is a very fine-grained limestone, consisting of about 75% calcite and clay matrix, and 25% fairly well-sorted sub-angular or subrounded grains 0.03 mm to 0.07 mm across. Most of the grains are quartz: many of the remainder are too small to enable accurate determination to be made, but angular feldspar grains and biotite flakes are present. Fragments which might have been ferromagnesian grains are now opaque outlines partially filled with clear (but very fine) calcite. Some of the calcite matrix has fine radial structure. Some of the quartz grains have been affected by solution and calcite has filled the resulting pittings. The few narrow veins and cavities present have been filled or lined with clear calcite.

A few remains which could have been plant material, and the form of the matrix and the clay it contains, may indicate a non-marine origin for the rock.

TAMBO SANDY LS. RH22

Identification: RH22; 4.4; P1357/62; TS 11244.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9084. Same general area as RH6 & RH21. Lat. 27°49'S, Long. 135°58'E.

Collected: August 7, 1962 by G. R. Heath.

Field Observations: The rock is a grey limestone containing abundant fine to medium, fairly angular quartz sand and lesser mica and carbonaceous fragments. Forms subdued, sandy outcrops which often persist laterally for some chains. Typical of the middle to upper Tambo limestones (rarely more than 3 or 4 feet thick), east of the basement high (Peake-Denison Range).

Petrological Report: (D. Smale):

This is a calcareous sandstone containing 30-40% of sand grains from 0.01 to 0.1 mm across in a matrix of clayey calcite. Most of the grains are quartz, but plagioclase (labradorite-andesine), muscovite and chlorite (cf RH8) are also present. There is also a small piece of woody material in the slide, consisting of juxtaposed rows of cells about 0.01 mm across.

Photomicrograph taken.

TAMBO "SALT & PEPPER" SS. RH 61

IDENTIFICATION: RH 61; P987/62; TS 11415.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5959. 11 miles north-north-east of Mt. Dutton R.S. in the east bank of Ockenden Creek.

Lat. 27° 41.5'S, Long. 135° 46.3'E. (from mosaic).

COLLECTED: September 12, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a somewhat greenish-brown sandstone to coarse siltstone, consisting of very fine quartz and ?glauconite. It is poorly consolidated and fairly homogeneous, with regular thin laminations. This material is from the Cretaceous shales (possibly middle Tambo) east of the Peake-Denison basement high, and has been described as "salt and pepper" sandstone.

PETROLOGICAL REPORT: (D. Smale):

This is poorly cemented, but fairly well-sorted sandstone. The grains are subangular to subrounded and 0.01 - 0.15 mm across, but mostly between 0.03 and 0.08 mm across. Quartz, goethite and iron-rich montmorillonite predominate; plagioclase and muscovite are minor constituents; biotite, apatite, zircon, amphibole and opaques are accessory minerals.

TAMBO SANDY LS. RH 62

IDENTIFICATION: RH 62: P988/62; TS 11416.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5959, 11 miles north-north-east of Mt. Dutton R.S. in the east bank of Ockenden Creek. (same loc. as RH 61).

Lat. 27° 41.5'S, Long. 135°16.3' (from mosaic).

COLLECTED: September 12, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a somewhat greenish grey silty to sandy limestone, consisting of abundant very fine quartz and ?glauconite in a fairly tight calcareous matrix. This specimen comes from the same outcrop as RH 61, but the limestone forms a thin bed above the "salt and pepper" sands. The limestone shows very marked "pinch and swell" characteristics, with individual beds lensing out over a few feet. Within the outcrop, the limestone ranges from 6 inches to 2 feet in thickness. The age of the material is Cretaceous (?middle Tambo).

PETROLOGICAL REPORT: (D. Smale):

This is an impure limestone. About 69 - 70 per cent consists of subangular to subrounded grains 0.03 - 0.15 mm across in an argillaceous calcite matrix. Much of the matrix is in the form of very ill-defined crystals, similar in size to the grains of the framework and some of it has "brush-like" texture (see Summary). The grains are mainly quartz, with a considerable amount of iron-rich montmorillonite, minor reddish amorphous opaques and chlorite. Plagioclase and muscovite are accessory minerals.

RH 104

? TAMBO CALCAREOUS SILTSTONE

Identification: RH 104; P1029/62; TS 11457

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 3, Photo 1827, Loc. WR 15. 4.2 miles east-north-east of Duckhole Bore (north of Woodmurra Creek).

Lat. 27° 37.4' S, Long. 136°8.7°E (from mosaic).

Collected: October 8, 1962 by G.R. Heath.

Field Observations: The rock is a yellow-brown massive fine sandy limestone or very calcareous fine sandstone or siltstone. Contains rare slightly carbonaceous beds and calcite veins. Weathers to cone in cone structure. Although non-fossiliferous, this outcrop is assumed to belong to the Upper Tambo (Cretaceous, Albian) equivalents.

Petrological Report: (D. Smale):

This is a calcareous siltstone with an average grain size of about 0.03 mm. The grains are angular to subangular and form about 40 per cent of the rock; most are quartz, but many are plagioclase. Grains of yellow iron-rich montmorillonite are present, but are fairly rare.

The calcite is rather brown and fine-grained, but there are a few small, irregular veins of clear, more coarsely crystalline calcite which stand out from the normal yellowish rock.

There is a rather curious feature present in a part of the slide about 1.0 x 0.8 mm : rows of indistinct circles 0.06 mm in diameter. This is probably a cast of a plant fragment. A little opaque material at one side of the circles also suggests this.

?TAMBO LIMESTONE RH113

Identification: RH113; P1036/62; TS11464.

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 5, Photo 0421, Loc. UR2. 23.3 miles south-east of Macumba H.S. Lat. 27°29.7'S, Long. 135°55.4'E (from mosaic).

Collected: October 15, 1962, by G. R. Heath.

Field Observations: The rock is a grey, fairly massive, slightly carbonaceous, homogeneous limestone. It forms a bed, about 2 feet thick, in Cretaceous (?Tambo, Albian) shales. The bed shows marked pinch and swell character. Fossiliferous (Inoceramus, Maccoyella, etc.).

Petrological Report: (D. Smale):

This is a fine-grained limestone with a fairly constant grain size of about 0.005 mm. The only impurity present is a very small amount of amorphous opaque material generally occurring in grains about 0.02 mm across.

Numerous small aligned lenses of finer calcite occur (grain size 0.002 mm), about 0.25 mm long and 0.05 mm thick. They form about 10 per cent of the rock.

A few small calcite spherulites occur, 0.03 - 0.07 mm in diameter, with radial structure.

The mineral deposited on the edge of the hand specimen is also calcite. It is about 1 mm thick, and is probably the lining of a joint.

?TAMBO CALCAREOUS LIMESTONE RH131

Identification: RH131; P1050/62; TS11478.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER4. 13.2 miles north of Duckhole Bore. Lat. 27°26.5'S, Long. 136°4.6'E (from mosaic).

Collected: October 19, 1962, by G. R. Heath.

Field Observations: The rock is a dark greenish grey, compact, homogeneous, somewhat carbonaceous, very calcareous sandstone. Texture varies from massive to slightly flaggy. The presence of a small shell fragment suggests that this is a marine Cretaceous sandstone, and its geographical position and lithology suggest a position well up in the Tambo (Albian) equivalents.

Petrological Report: (D. Smale):

This is a fine calcareous sandstone, about 40 per cent consisting of angular to subrounded grains 0.01 - 0.2 mm across in a fine-grained, rather dirty calcite matrix. The grains consist predominantly of quartz, with yellow iron-rich montmorillonite and plagioclase (andesine) making up most of the remainder. Opaques, muscovite and chlorite are also present. Some plant fragments occur, generally rather larger than the grains, and up to about 0.5 mm long; some of these show somewhat distorted cellular structure, each cell being ellipsoidal with a major axis about 0.125 mm long.

Calcite, coarser and clearer than that of the matrix, appears to be replacing former grains.

Zircon is an accessory mineral.

Photomicrograph taken.

RH 146
RH 147 A

? TAMBO SHALE

Identification: RH 146; P1064/62; RH147A; A535/62.

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Toondina Run 1, Photo 9117, Loc. OR4 - 27.2 miles west-south-west of Oodnadatta.

Lat. 27°42.2' S, Long. 135° 2.5' E. (from mosaic).

Collected: November 2, 1962, by G.R. Heath.

Field Observations: The sample is grey, rather massive, slightly saline, homogeneous, typical marine Cretaceous (Tambo equivalent) clay shale. Non fissile, but shows marked conchoidal fracture. Distinct "soapy" feel.

Petrological Report: (D. Smale):

This is fairly pure kaolin with impurities causing it to be grey.

Analysis: (H. Sears:)

Aluminium oxide	Al_2O_3	18.6%
Ferric oxide	Fe_2O_3	5.20
Ferrous oxide	FeO	0.41
Titanium oxide	TiO_2	0.85
Manganese oxide	MnO	0.01
Calcium oxide	CaO	0.27
Magnesium oxide	MgO	2.45
Sodium oxide	Na_2O	1.56
Potassium oxide	K_2O	2.40
Silica	SiO_2	54.0
Carbonate	CO_2	0.05
Sulphate	SO_3	0.70
Chloride	Cl	0.65
Phosphorus pentoxide	P_2O_5	0.12
Carbon	C	0.22
Water at 100°C	H_2O-	6.20
Water over 100°C	H_2O+	6.30
Total		99.99%
Less oxygen equivalent to chlorine		0.14
Total		99.9%

Analysis - X-Ray Fluorescence: (R.G. Stafford):

Barium oxide	BaO	0.035%
Strontium oxide	SrO	0.001%

APPENDIX 1G

CRETACEOUS NON-MARINE SEDIMENTS (?NEOCOMIAN, ?WINTON FORMATION EQUIVALENTS).

RH95

?WINTON CALC. SANDSTONE

Identification: RH95; P1020/62; TS 11448

Locality: Oodnadatta 4-mile. Woodmurra 1-mile Run 3, Photo 1833, Loc. WR1. Adjacent to seismic road, 20.6 miles east of Duckhole bore. Lat. 27°35.5' S, Long. 136°24.6'E (from mosaic).

Collected: October 4, 1962, by G.R. Heath.

Field Observations: The rock is a somewhat greenish-grey, micaceous, carbonaceous, very calcareous, fine grained, fairly sorted, subrounded quartz sandstone. This sandstone forms a number of crudely bedded low outcrops along the south bank of Woodmurra Creek. Lack of fossils suggests that it is a Winton Formation equivalent (?Cenomanian).

Petrological Report: (D. Smale)

This is a calcareous sandstone, about 40 - 50 per cent consisting of subangular to subrounded sand grains 0.05-0.25 mm across; the matrix consists of fairly finely crystallized calcite with grain size varying between 0.01 and 0.8 mm.

About 50 per cent of the grains are quartz, 20 per cent chert or fine quartzite, and 15 per cent plagioclase (andesine-labradorite). Pyroxene, chlorite, clay, volcanic fragments, biotite, hornblende, and opaques make up the remainder.

?WINTON CALCAREOUS SANDSTONE

Identification: RH96; P1021/62; TS11449

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1847, Loc. WR4. 15.7 miles east-south-east of Duckhole bore. Lat. 27°41.2'S, Long. 136°19.7'E. (from mosaic).

Collected: October 6, 1962, by G.R. Heath.

Field Observations: The rock is a dark grey, massive very calcareous fine sandstone, consisting mainly of quartz with lesser mica. This material crops out fairly well, although outcrops rarely show bedding. It is thought to belong to the lower Winton Formation equivalents (i.e. Cretaceous, ?Cenomanian).

Petrological Report: (D. Smale):

This is a calcareous sandstone similar to RH111 containing much volcanic material. Angular to subangular fragments 0.03-0.12 mm across constitute about 40 per cent of the rock. Quartz, hornblende, opaques, calcic plagioclase, and volcanic (trachytic) fragments constitute about 50 per cent of the sand grains. A few fragments of cryptocrystalline quartz have an opaline appearance comparable with that of the silcrete in RH89 and RH91. A few of the plagioclase crystals have been severely affected by solution.

The matrix consists of very fine-grained, rather dirty calcite.

Zircon, iron-rich montmorillonite and rutile are accessory minerals.

RH98

?WINTON CALCAREOUS SANDSTONE

Identification: RH98; P1023/62; TS11451

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1847, Loc. WR4. 15.6 miles east-south-east of Duckhole bore. Lat 27°41.3'S., Long. 136°19.6'E. (from mosaic).

Collected: October 6th, 1962, by G.R. Heath.

Field Observations: The rock is a dirty greenish grey very calcareous sandstone, consisting of very fine quartz and lesser mica grains in a dirty calcite matrix. Forms fairly prominent outcrops (adjacent to RH96) showing finely etched irregular bedding. Probably Winton equivalents (Cretaceous ?Cenomanian).

Petrological Report: (D. Smale):

This is a calcareous sandstone consisting of angular to subrounded grains 0.03-0.2 mm across in a calcite matrix.

The sand grains consist mainly of quartz, yellow iron-rich montmorillonite, quartzite and plagioclase (andesine-labradorite), the latter being present in slightly smaller quantity than the other minerals. There are also present a few fragments of volcanic rock with trachytic texture.

The calcite matrix occasionally occurs with "brush-like" texture, and sometimes is of fine granular texture with a grain size of less than 0.01 mm.

RH 99

? WINTON LIMESTONE

Identification: RH 99; P1024/62; TS 11452.

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1847, Loc. WR 4, 15.6 miles east-south-east of Duckhole bore.

Lat. 27° 41.3' S, Long. 136°19.6' E (from mosaic).

Collected: October 6, 1962, by G.R. Heath.

Field Observation: The rock is a light grey fairly massive limestone, containing abundant very thin black laminae, some of which intersect. This limestone crops out close to the calcareous sandstones RH 96 & RH 98. It is probably a Winton Formation equivalent (i e. Cretaceous ? Cenomanian).

Petrological Report: (D. Smale):

This is a limestone consisting of a mosaic of calcite with a grain size of about 0.05 mm. There are a few (less than 1 per cent) grains of quartz about the same size as the calcite grains and occasional grains of yellow iron-rich montmorillonite.

A distinctive feature of this rock is the banding present in the hand specimen. The bands consist of an opaque brown mineral (probably goethite) about 0.04 mm wide, which has irregularly stained the surrounding calcite for about half that distance on each side. Small calcite crystals occur within the band.

Rutile is an accessory mineral.

RH 100

? WINTON LIMESTONE

Identification: RH 100; P1025/62; TS 11453

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1849, Loc. WR 6 9.7 miles south-east of Duckhole bore.

Lat. 27°41.9' S, Long. 136°12.7' E (from mosaic).

Collected: October 6, 1962, by G.R. Heath.

Field Observations: The rock is a grey to brown fairly massive limestone, apparently fine sandy in part. Very slightly carbonaceous. Outcrops tend to be massive rather than flaggy, but fine current bedding is visible on weathered surfaces. This material is non fossiliferous and is assumed to be equivalent to Winton Formation (Cretaceous ?Cenomanian).

Petrological Report: (D. Smale):

This is a fine-grained silty limestone. The silt particles occur in irregular patches in the rock of the order of 2- 3 mm across; these patches contain about 25 per cent of well-sorted angular to subangular silt grains 0.02 - 0.05 mm across. The grains consist chiefly of quartz, with muscovite, iron-rich montmorillonite, plagioclase and brown opaques. A few small, stalk-like plant fragments are present.

The remaining parts of the rock contain a few sparsely scattered silt particles, but 99 per cent consists of fine- grained calcite with a grain size of 0.001 mm.

The silty and non-silty parts each form about half the rock.

In spite of the lack of any regular disposition of the silty parts in the thin section, the hand specimen appears definitely bedded. This combination is probably the result of current bedding and the formation of an "intraformational conglomerate" on a small scale.

? WINTON CALCAREOUS SILTSTONE

Identification: RH 101; P1026/62; TS 11454

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1849, Loc. WR7, 8.3 miles south-east of Duckhole bore.

Lat. 27°41.4' S, Long. 136° 12.0' E (from mosaic).

Collected: October 6, 1962, by G.R. Heath.

Field Observations: The rock is a light greenish brown, fairly massive, very calcareous coarse siltstone. Grains are mainly fairly well sorted quartz with lesser mica. Fresh material appears quite homogeneous, but somewhat weathered fragments are flaggy and have a "salt and pepper" appearance. The absence of fossils again suggests a post-Albian age (Cretaceous ?Cenomanian), i.e. Winton equivalents.

Petrological Report: (D. Smale):

This is a calcareous coarse siltstone. The grains, on the average, are about 0.05 mm across, angular to sub-angular, and constitute about 40 per cent of the rock. About 70 per cent of these are quartz, 10 per cent plagioclase (andesine-labradorite), 5 per cent trachytic fragments, and 5 per cent iron-rich montmorillonite. Goethite, chlorite hornblende and muscovite are present in minor quantities; rutile, zircon and opaques are accessory minerals.

The matrix is a mosaic of calcite, with a grain size of about 0.05 - 0.1 mm. It appears to have fewer impurities in it than the calcite in many of the other calcareous rocks.

RH 102

? WINTON CALCAREOUS SILTSTONE

Identification: RH 102; P1027/62; TS 11455

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1849, Loc. WR8 7.8 miles east of Duckhole bore (south of Woodmurra Creek).

Lat. 27° 39.7' S, Long. 136°12.2' E (from mosaic).

Collected: October 6, 1962, by G.R. Heath.

Field Observations: The rock is a brown to yellow-brown, massive, very calcareous very fine sandstone or coarse siltstone. Carbonaceous material is moderately abundant in some beds. Shows fairly well defined irregular fine bedding. This material forms low rounded outcrops and is assumed to be Cretaceous ? Cenomanian (i.e. Winton equivalents).

Petrological Report: (D. Smale):

This is a goethite calcareous siltstone, about 30 per cent consisting of angular to subangular silt grains generally 0.01 - 0.05 mm across. The concentration of the silt grains varies in different bands in the rock, each band being of the order of 1 or 2 mm wide. Some bands have only occasional silt grains in them; in others silt grains form about 50 per cent.

The grains consist predominantly of quartz, yellow iron-rich montmorillonite, and plagioclase. Muscovite, biotite, opaques and clay occur in minor quantities.

One fragment of plant material is present in this thin section, consisting of irregular juxtaposed rows of cells about 0.01 mm in diameter. A little secondary brown opaque material is present.

The matrix consists of brown iron-stained calcite with a grain size of about 0.001 mm.

Most of the apparent bedding in the hand specimen is caused by variations in the goethite staining, though in parts there also appear to be graded bedding and cross-bedding.

RH 105

? BASAL WINTON SANDY LIMESTONE

Identification: RH 105; P1030/62; TS 11458

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 2, Photo 1812, Loc, WR 19. 6.6 miles north-east of Duckhole bore.

Lat. 27° 33.5' S, Long. 136°8.2'E (from mosaic).

Collected: October 8, 1962 by G.R. Heath.

Field Observations: The rock is a dirty yellow-grey "rotten" looking very sandy limestone. Forms fairly bold, widespread outcrops which appear rather ilaggy. Weathers to "salt and pepper" sandstone. This material is nor fossiliferous ard is correlated with the basal Winton Formation equivalents (Cretaceous, ?Cenomanian) of the area.

Petrological Report: (D. Smale):

This is a sandy limestone with about 15 per cent of fine sand or silt grains in a calcite mosaic with a grain size fairly similar to that of the sand or silt grains, but with parts showing "brush-like" extinction.

The grains are angular to subrounded, and on the average are between 0.015 and 0.5 mm across. Most are quartz, but iron rich montmorillonite, plagioclase, zircon, hornblende, muscovite, biotite and opaques are also present.

RH 106

? BASAL WINTON SANDY LIMESTONE

Identification: RH 106; P1031/62; TS 11459

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 1, Photo 1787, Loc. WR 24. 8.4 miles north-north-east of Duckhole Bore.

Lat. 27° 31.7' S, Long. 136° 8.4' E. (from mosaic).

Collected: October 8, 1062, by G.R. Heath.

Field Observations: The rock is a brown and grey-green laminated silty limestone and slightly micaceous and carbonaceous fine sandy limestone. Laminae are markedly interdigitated and show some slumping. This limestone occurs near the marine-non-marine boundary of the Artesian Basin Cretaceous section. Lack of fossils may indicate a lower ? Cenomanian age (i.e. Winton Formation equivalents).

Petrological Report: (D. Smale):

This is an impure limestone consisting of fragments of quartz, 0.02 - 0.25 mm across, in a clayey carbonate matrix which forms 60-70 per cent of the rock. About 5 per cent of the rock consists of grains of yellow chloritic material (cf. RH 6: TS 11228 and RH7: TS 11 229). The specimen shows bedding, the redder, darker layers of which are more fine-grained than the lighter layers, and contain "limonite" in small grains about 0.01 - 0.02 mm across.

Photomicrograph Taken.

RH 107
RH 108A

FERRUGINIZED ?WINTON LIMESTONE

Identification: RH107; P1032/62; TS11460; RH108A; A527/62.

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 1, Photo 1789, Loc. WR26. 9.1 miles north-east of Duckhole Bore. Lat. 27°32.2'S, Long. 136°10.4'E (from mosaic).

Collected: October 8, 1962, by G. R. Heath.

Field Observations: The rock is massive, slightly reddish, very dark brown, fairly homogeneous silty limonite. It has formed by the complete ferruginization of a concretionary, silty limestone of ?Winton age. The replacement probably dates from gypsite (?Lower Pleistocene) time. The sample for analysis is a composite from several outcrops.

Petrological Report: (D. Smale)

This is a ferruginous siltstone with fine and coarse siltstone intertonguing. The fine siltstone layers are generally about 3 mm wide, and the coarser ones 1 - 2 mm, but the latter are very irregular in size and generally occur in lenses.

In the coarse siltstones the grains are generally subangular quartz 0.01 - 0.07 mm across. They form about 40 per cent of the rock. Sericite, plagioclase and chlorite together account for about 30 per cent of the grains.

In the fine siltstone the grains are generally angular to subangular quartz 0.002 - 0.02 mm across. This part of the rock is rather porous, voids being more common than grains, the latter forming only 10 - 15 per cent of the rock.

In both the fine and the coarse siltstone the matrix is goethite. In the fine siltstone it occurs in concentrated masses of grains about 0.005 mm across, but in the coarse siltstone it appears more homogeneous.

The rock contains no carbonate, in spite of its similarity to some of the calcareous rocks; goethite could have replaced carbonate once present.

Analysis: (J. Powell & R. B. Oliver):

Aluminium oxide	Al_2O_3	3.75%
Iron - acid soluble	Fe_2O_3	47.4
- acid insoluble	Fe	0.03
- total oxide	Fe_2O_3	67.7
Titanium oxide	TiO_2	0.139
Calcium oxide	CaO	0.62
Silica	SiO_2	11.48
Carbon dioxide	CO_2	0.26
Phosphorus pentoxide	P_2O_5	0.133
Sulphate	SO_3	0.072
Water - total	H_2O	7.86
Total		92.01%

?WINTON CALCAREOUS SANDSTONE RH111

Identification: RH111; P1034/62; TS11462.

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 2, Photo 1803. Slightly south-west of western end of Manarrinna water hole. Lat. 27°33.7'S, Long. 136°28'E (from mosaic).

Collected: October 13, 1962, by G. R. Heath.

Field Observations: The rock is a grey, very massive, very calcareous sandstone, consisting mainly of fine grained, fairly well rounded quartz. Somewhat carbonaceous. Forms fairly bold, fairly massive outcrops. Probable non-marine sediment (Winton equivalent) of Cretaceous, ?Cenomanian age.

Petrological Report: (D. Smale):

This is a calcareous sandstone. About 35 per cent consists of angular to subrounded sand grains 0.05 - 0.35 mm across; among the grains quartz constitutes about 35 per cent, plagioclase (andesine) 25 per cent, volcanic fragments 15 per cent, ferromagnesians 10 per cent. and chlorite 1 per cent. Some of the plagioclase is zoned. The volcanic fragments consist largely of poorly defined plagioclase microlites and fairly equant opaques forming a trachytic texture; most of the microlites are about 0.03 mm long, but they may be up to 0.1 mm long. Hornblende predominates among the ferromagnesian grains, and is either brown or green.

The matrix is very fine-grained rather dirty calcite.

RH 124

? WINTON CLAY SHALE

Identification: RH 124; P1043/62

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 4, Photo 0398, Loc. UR 17. 19.1 miles south-east of Macumba H.S.

Lat. 27°25.2' S., Long. 135°54.6' E (from mosaic).

Collected: October 16, 1962, by G.R. Heath.

Field Observations: The rock is light grey fairly massive shale, with moderately abundant mica and plant fragments on bedding planes. Moderately gypseous. Weathered portions show well developed fissility.

Petrological Report: (D. Smale)

This is almost entirely montmorillonite, with a few small grains of quartz and opaques less than 0.01 mm across. It is quite distinct in colour and mode of occurrence from the iron-rich montmorillonite of other specimens.

RH 125

WINTON-T MBO CALCAREOUS SANDSTONE

Identification: RH 125; P1044/62; TS 11472

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 5, Photo 0421, Loc, UR 18. 22.6 miles south-east of Macumba H.S.

Lat. 27° 28' S, Long. 135° 56.3' E (from mosaic).

Collected: October 16, 1962, by G.R. Heath.

Field Observations: The rock is a dark brownish grey, very finely crystalline, massive sandy limestone or calcareous sandstone. Both the hand specimen and outcrop show very prominent cross bedding. The specimen comes from an area of poor outcrop, but is thought to lie near the boundary of the Winton and Tambo Formation equivalents (i.e. Albian ? Cenomanian)

Petrological Report: (D, Smale):

This is a calcareous sandstone with much iron rich montmorillonite. Angular to subrounded grains constitute about 40 per cent of the rock the great majority are between 0.03 and 0.06 mm across.

Yellow iron-rich montmorillonite and quartz together account for about two thirds of the grains. Opaques, muscovite, plagioclase, goethite, hornblende, trachytic volcanic fragments, rutile and zircon make up the remainder.

The matrix is rather dirty, fine-grained calcite.

APPENDIX 1H

? PLIOCENE BLANKET SANDSTONE: BASAL SILICIFIED PEBBLE CONGLOMERATE.

TERTIARY PEBBLE CGLN. RH 46.

IDENTIFICATION: RH 46; P975/62; TS 11403.

LOCALITY: Oodnadatta 4-mile, Yardinna 1-mile, Run 2, Photo 6410. Small mesa just east of the railway line, 14 miles north of Oodnadatta (same loc. as RH 45).

Lat. 27° 20.4'S, Long. 135° 26.2'E (from mosaic).

COLLECTED: September 8, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is an off-white pebble conglomerate, consisting of 0.3 inch well rounded quartzite pebbles in a matrix of silicified sandy angular quartz grit. This rock is similar, in appearance to the "post older duricrust" conglomerates of upper Tertiary age on the western part of the sheet. It is probably of Pliocene age.

PETROLOGICAL REPORT:

This is a very poorly-sorted quartz conglomerate consisting of rounded fragments of sand, granule and pebble size 1-12 mm across, in a matrix of subangular or subrounded quartz grains 0.01-1.0 mm across, cemented by opal containing a large amount of leucoxene.

There are very few small cavities, lined with lussatite and filled with chalcedony.

Pyroxene, zircon, rutile and sphene are accessory minerals.

PEBBLE CGLN. ("AGATE GRIT")

Identification: RH 92; PLL17/62; TS 11445

Locality: Oodnadatta 4-mile, Kurillina 1-mile, Run 4, Photo 9073, Loc. KR7. Southern edge of younger duricrust plateau.

Lat. 27° 49.5', Long. 136° 23.3' E (from mosaic).

Collected: October 5, 1962, by G.R. Heath.

Field Observations: The rock is an off-white highly indurated, very sandy pebble conglomerate, consisting of quartz (mainly) and lesser tourmaline quartz and silcrete pebbles up to 10 mm diameter in a matrix of angular poorly sorted silicified quartz sand. This material is typical of the basal beds of the Tertiary (? Pliocene) clastic sequence occurring over much of the eastern half of the 4-mile sheet. It has generally (as in this case) been silicified during the younger duricrust formation.

Petrological Report: (D. Smale):

This is a siliceous conglomerate similar to RH 90, with quartz pebbles and granules set in a very fine quartz mosaic which constitutes over half the rock. The quartz grains, especially the larger ones, are penetrated as far as 0.5 mm by solution cavities filled with matrical quartz,

Small areas of colloform banding about 0.3 mm across occur in some places in the matrix, but these are due to bands of opaque grains similar in size to the rest of the matrix, and probably not to leucoxene.

Zircon and rutile are accessory minerals.

RH 94

SILCRETE CONGLOMERATE

Identification: RH 94; P1019/62; TS 11447

Locality: Oodnadatta 4-mile, Kurillina 1-mile, Run 4, Photo 9073, Lcc. KR 7. South edge of prominent younger duricrust plateau, 15.7 miles north-east of Woodduck H.S. ruins (as RH 92).

Lat. 27° 49.5' S, Long. 136° 23.3'E (from mosaic).

Collected: October 5, 1962 by G.R. Heath.

Field Observations: The rock is a highly indurated pebble conglomerate, consisting of rounded silcrete pebbles up to 10 mm diameter, in a silicified sandy matrix. This rock is similar to RH 94, but contains silcrete rather than quartz pebbles. This material is from the basal beds of the Tertiary (? Pliocene) sandstone sequence. Silicification dates from the younger duricrust.

Petrological Report (D. Smale):

This is a siliceous conglomerate consisting of rounded to subrounded sand grains, granules and pebbles ranging up to 30 mm across in a matrix of slightly leucoxenic opal and microcrystalline quartz.

Most of the pebbles consist of silcrete containing about 10 per cent of rounded to subrounded sand grains of quartz in a matrix of finely crystalline quartz and leucoxenic opal; others are large rounded quartz grains.

The matrix consists of slightly leucoxenic opal and microcrystalline quartz, and contains 30-40 per cent of well rounded grains 0.05 - 0.5 mm across, a few surrounded by cryptocrystalline silica and leucoxene forming ooliths. This oolitic material is the same as that of the matrix of the pebbles, and some of the ooliths could in fact be quartz grains from the pebbles still surrounded by the old matrix.

Rutile is an accessory mineral.

"AGATE GRIT" PEBBLE CONGLOMERATE RH116

Identification: RH116; P1038/62; TS11466.

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 4, Photo 0400. Loc. UR6. 15.6 miles south-east of Macumba H.S. Lat. 27°24.8'S, Long. 135°50.4'E (from mosaic).

Collected: October 15, 1962, by G. R. Heath.

Field Observations: The rock is a light grey, strongly indurated pebble conglomerate, consisting of rounded to well rounded grey and white quartz and silcrete fragments up to 15 mm diameter in a matrix of silcrete cemented fine grained angular quartz sand. This sediment forms the basal beds of the widespread Tertiary (?Pliocene) sandstone of the area. Silicification probably dates from the formation of the younger duricrust.

Petrological Report: (D. Smale):

This is a poorly sorted pebbly sandstone. The fragments vary in size from 0.01 - 13.0 mm across, but those over 2 mm across (i.e. coarser than sand) form less than 15 per cent of the rock. The matrix consists of curved fibrous aggregates of clay, similar to that in RH42.

The pebbles consist of almost equal quantities of:-

1) Quartz grains

2) Oolitic quartzite (see fig. 6). The ooliths consist of an inner zone about 0.2 mm across with a grain size of about 0.003 mm, and an outer zone about 0.1 mm thick with a grain size of about 0.015 mm. All the ooliths are in contact; the interstices are filled with a quartz mosaic with a grain size of about 0.03 mm

3) Fine-grained chert, with a grain size of 0.002 - 0.015 mm.

4) Chalcedonic chert with a grain size of 0.01 - 0.5 mm, consisting of fibrous masses having positive elongation.

5) Vein quartz forming a mosaic, each element of the mosaic elongated in the same direction, and with very irregular crenulate boundaries.

The sand grains and granules are almost all quartz grains, but zircon, rutile (red-brown and yellow-brown and including an excellent basal section 0.16 x 0.13 mm) and opaques are also present.

RH 119

SANDY PEBBLY CONGLOMERATE

Identification: RH 119, P1041/62; TS 11469

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0363, LOC. UR 11. 21.7 miles south-east of Macumba H.S. Lat. 27° 8.6'S, Long. 135° 58.7' E (from mosaic.)

Collected: October 16, 1962, by G.R. Heath.

Field Observations: The rock is a very pale yellow-brown, well indurated, very sandy siliceous pebble conglomerate, consisting of rounded quartz pebbles up to 10 mm diameter in a matrix of silcrete cemented subangular to sub-rounded medium quartz sand grains. This sample (like RH 116) is from the basal beds of the Tertiary (? Pliocene), blanket sandstone of the area east of Oodnadatta.

Petrological Report: (D. Smale):

This is a pebbly sandstone very similar to RH 116, but the matrix appears to consist mainly of cryptocrystalline quartz with leucoxene forming small colloform structures similar to those in opaline matrices of other rocks.

The fragments consist of large quartz grains or very coarse quartz mosaics with a grain size of between 0.3 - 3 mm, and chert with a grain size of 0.005 - 0.05 mm. Many of the quartz grains have been affected by solution.

Zircon and tourmaline are accessory minerals.

TERTIARY PEBBLY SANDSTONE RH127

Identification: RH127; P1046/62; TS11474.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 5, Photo 0426, Loc. 1. 11.6 miles north of Duckhole bore. Lat. 27°27.1'S, Long. 136°4.4'E (from mosaic).

Collected: October 9, 1962, by G. R. Heath.

Field Observations: The rock is a very pale yellow-brown pebbly sandstone or sandy pebble conglomerate, consisting of rounded to well rounded quartz and lesser silcrete pebbles up to 10 mm diameter in a matrix of subrounded, poorly sorted medium to coarse quartz sand, which has been cemented by silcrete. This material is from the basal beds of the widespread Tertiary (?Pliocene) sandstone east of Oodnadatta. Silicification probably took place during the formation of the younger duricrust.

Petrological Report: (D. Smale):

This is a poorly sorted pebbly sandstone containing subangular to subrounded fragments varying in size from 0.005 to 14 mm across, but less than 10 per cent are larger than sand size. They are cemented by microcrystalline quartz.

The fragments are almost exclusively quartz, but a few consist of chert, with a grain size of 0.002 - 0.015 mm and some are of coarser quartzite. The larger fragments are subrounded and the smaller ones are subrounded or subangular. Many of the quartz grains have been affected by solution.

Zircon and rutile are accessory minerals.

"AGATE GRIT" PEBBLE CONGLOMERATE RH132

Identification: RH132; P1051/62; TS11479.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER5. 14.6 miles north of Duckhole bore. Lat. 27°25.3'S, Long. 136°4.7'E (from mosaic)

Collected: October 19, 1962, by G. R. Heath.

Field Observations: The rock is a light grey, very well indurated pebble conglomerate, consisting of abundant rounded 3-10 mm quartz pebbles in a slightly sandy milky silcrete matrix. This material comes from the base of a fairly thick (20 feet) Tertiary (?Pliocene) duricrusted sandstone, which caps the high plateau south of The Macumba.

Petrological Report: (D. Smale):

This is a quartz conglomerate consisting of subangular to subrounded fragments of quartz and coarse quartzite, some showing considerable strain, in a matrix of siliceous kaolin. The diameter of the fragments is generally about 4 - 5 mm but may be more than 10 mm. The matrix has been broken and cemented with opal. The kaolin has in places been almost entirely removed, leaving only a few small subrounded fragments in the opal.

APPENDIX 1I

? PLIOCENE BLANKET

SANDSTONE

SILICIFIED AND OCCASIONALLY

FERRUGINIZED.

RH 42

POST DURICRUST SS.

IDENTIFICATION: RH 42; P971/62; TS 11399.

LOCALITY: Oodnadatta 4-mile. Alberga 1-mile, Run 1, Photo 6261. Same general area as RH 38 and RH 40 (ie south of Mt.Sarah)

Lat. 27° 1.3' S, Long. 135° 20.8'E (from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a pale grey sandstone, consisting of very fine grained quartz in a clayey and possibly slightly siliceous matrix. This sandstone covers a small area well below the duricrust plateaux to the north and south. It may be the remnant of an alluvial (possibly stream channel) deposit formed during the dissection of the duricrust peneplain. Its age could be Pliocene to Recent, but there is some evidence that it is pre-younger duricrust (ie probably Pliocene).

PETROLOGICAL REPORT: (D. Smale):

This is an argillaceous sandstone 50-55 per cent consisting of subangular to subrounded quartz grains 0.05 to 0.4 mm across, in a matrix of fairly pure kaolin, which occurs in the form of curved aggregates of fibres (See fig 3). Some of the aggregates actually form spherulites.

Small rounded grains of rutile (0.05 mm across), zircon, pyroxene, opaques, chlorite and tourmaline are present, but together constitute less than 1 per cent of the rock.

PHOTOMICROGRAPH TAKEN.

LIM. TERTIARY SS.

IDENTIFICATION: RH 45; P974/62; TS 11402.

LOCALITY: Oodnadatta 4-mile, Yardinna 1-mile, Run 2, Photo 6410. Small mesa just east of the railway line 14 miles north of Oodnadatta.

Lat. 27° 20.4'S, Long. 135° 26.2'E. (from mosaic).

COLLECTED: September 8, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a brick red sandstone, consisting of fine to medium grained, poorly sorted, angular quartz in a matrix of very fine grained bright red-brown iron oxides. This sandstone caps a small mesa which is topographically higher than the nearby ? younger duricrust. Its age is probably Pliocene or younger.

PETROLOGICAL REPORT: (D. Smale):

This is a porous ferruginous sandstone, consisting of subangular to subrounded quartz grains an average of 0.1-0.15 mm across, but varying between 0.04 and 1.0 mm across, cemented by homogeneous, orange-brown goethite. The grains constitute 65-75 per cent of the rock and the goethite about 10 per cent. There is a little matrix pf fine-grained quartz, but 10-15 per cent of the rock consists of voids comparable in size with the quartz grains.

Zircon and rutile are accessory minerals.

This rock is similar to RH30 and RH51, but these lack the goethite cement of RH45. RH26 is also similar, except that it is cemented by authigenic overgrowths of quartz. All the specimens mentioned contain fairly well-sorted quartz grains in comparable quantities.

SILIC. TERTIARY SS. RH47

Identification: RH47; P976/62; TS 11404

Locality: Oodnadatta 4-mile. Yardinna 1-mile, Run 2, Photo 6410. Small mesa just east of the railway line 14 miles north of Oodnadatta (same loc. as RH45 and RH46). Lat. 27°20.4'S. Long. 135°26.2'E (from mosaic)

Collected: September 8, 1962 by G.R. Heath

Field Observations: The rock is a yellow brown cherty sandstone consisting of very poorly sorted, open packed, subangular quartz in a limonitic silicious matrix (after argillite?). This material again caps Cretaceous shales, but has been more affected by duricrust formation than RH45 or RH46. Depending on the age of the duricrust concerned, the sandstone is probably pre-Miocene or Pliocene in age.

Petrological Report: (D. Smale):

This is a ferruginous sandstone consisting of poorly sorted subangular to subrounded quartz grains 0.01-0.1 mm across in a matrix of pale goethite. Many of the quartz grains, particularly the larger ones, show solution cavities. The quartz grains constitute 20-30 per cent of the rock.

On account of its hardness the rock appears to have undergone silicification, but the matrix is so dense that it is difficult to tell in what form the silica is present. However, the rock is virtually non-porous; most of the gaps in the goethite matrix disclose quartz, so presumably most of the silica in the rock is present in this form.

Zircon is an accessory mineral

SILIC. TERT. SS. - FAULTED HILL. RH 64.

IDENTIFICATION: RH 64; P990/62; TS 11418.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 3, Photo 5974. Loc. (1). East side of "Faulted Hill", near eastern headwaters of Watson Creek, 14.5 miles north-north-east of Mt. Dutton R.S. (same loc. as RH 63).

Lat. 27° 36.5'S, Long. 135° 48.2'E (from mosaic)

COLLECTED: September 13, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is an off-white sandstone consisting of fine to medium, fairly well sorted, angular quartz in a siliceous cement or matrix. It contains an anastomosing network of 0.2 to 0.5 inch cavities, giving the rock a "vesicular" or "knotted" appearance. This sample comes from the 198' level of the "Faulted Hill" section and is typical of the Tertiary (? Mio-Pliocene) sandstones which cap many of the plateaux in the south-east quadrant of the Oodnadatta sheet. Silicification, probably related to the younger duricrust, has made these sandstones very resistant to erosion.

PETROLOGICAL REPORT: (D. Smale).

This is a medium grained opaline quartz sandstone consisting of angular to subrounded fragments of quartz 0.03 - 0.45 mm across in a matrix of opal containing much leucoxene and finely divided goethite. Zircon is an accessory mineral. Clear opal (hyalite) occurs in some cavities in small deposits up to 1 mm thick. The cavities in this rock are distinctive in shape and size, producing something similar to a complex system of worm-burrows 2-10 mm across.

LIM. TERTIARY SS. RH 82

Identification: RH 82; P1007/62; TS 11435.

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5955. From prominent conical hill south of main laterite-duricrust scarp 6.2 miles north-north west of Mt. Dutton R.S.

Lat. 27°44' S, Long. 135°40.1'E (from mosaic).

Collected: September 18, 1962, by G.R. Heath.

Field Observations: The rock is a light brick red dirty sandstone, consisting of subrounded quartz and silcrete coarse sand grains in a limonitic clay matrix. This material is a Tertiary sandstone deposited adjacent to an area of laterite and duricrust. It appears to be post laterite and older duricrust in age, but underlies the younger duricrust. It is probably Pliocene.

Petrological Report: (D. Smale):

This is a poorly cemented, slightly ferruginous quartzite; similar to RH 45. The grains are poorly sorted, subangular to subrounded, and vary in size from 0.01 - 0.8 mm across; those of less than sand size form the matrix. There is a small amount of goethite present which acts as a cement (cf RH 26), generally in areas where the silt grains are scarce. This goethite coats the grains with a layer an average of about 0.005 mm thick. Between 10 and 15 per cent of the rock still consists of voids.

Occasional quartzite fragments are present, of similar size to the larger quartz grains. A few of the quartz grains contain particles of iron oxide in distinctively large quantities.

Zircon, rutile and opaques are accessory minerals.

RH 84

SILIC. TERTIARY SS.

Identification: RH 84; P1009/62; TS 11437

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5955. From low scarp east of main road to Oodnadatta. 9.0 miles north-north-west of Mt. Dutton R.S.

Lat. 27° 41.2'S, Long. 135° 40' E (from mosaic).

Collected: September 19, 1962 by G.R. Heath.

Field Observations: The rock is a sandstone, white, somewhat silicified, consisting of angular, moderately sorted, quartz coarse siltstone to very fine sandstone. Plant stem impressions are quite common. This is probably a fine grained variant of the widespread intra-duricrustal sandstone of the area. Silicification and bleaching possibly due to the younger duricrust. Age ? Pliocene.

Petrological Report: (D. Smale):

This is a poorly sorted orthoquartzite with grain size ranging from that of the matrix to 0.25 mm. The grains are subangular to subrounded. There are present a few small zircons and opaques about 0.03 mm across, and accessory amounts of each of chlorite, rutile and hornblende,

RH 85

PARTLY FERRUG. SILIC. TERTIARY SS.

Identification: RH 85; P1010/62; TS 11438.

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5955. From low scarp east of the main road to Oodnadatta, 9.0 miles north-north-west of Mt. Dutton R.S. Same loc. as RH 84.

Lat. 27° 41.2'S, Long. 135° 40'E. (from mosaic).

Collected: September 19, 1962 by G.R. Heath.

Field Observations: The rock is a pale and dark brown siliceous and partly ferruginous sandstone, similar to RH 84 (along strike). It is mainly very fine grained quartz, in a siliceous and ? limonitic matrix. The boundary between the iron rich and poor sections is fairly sharp. If it has developed by iron subtraction rather than addition, this sample may represent the upper bleached and silicified zone of the younger duricrust profile. Age ? Pliocene.

Petrological Report: (D. Smale):

This is partly a pale brown sandstone and partly a dark brown sandstone, the only difference between the two types being the presence of more goethite in the darker sandstone.

The rock consists of subangular to subrounded grains of quartz 0.03 - 0.3 mm across in a matrix of fine quartz grains with dark wine-red goethite in the dark part, and with only a few rather dirty patches of brownish goethite in the lighter part. From the fact that there are small cavities with yellowish edges in the matrix of the light sandstone, it seems likely that the rock was originally all dark, and that the goethite was leached from part of it. The boundary between the light and dark sandstone is very irregular, but occurs within a band about 10 mm thick.

Zircon, sphene and rutile are accessory minerals.

RH 86

FERRUG. TERTIARY SS.

Identification: RH 86; P1011/62; TS 11439

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5955. From the low scarp east of main road to Oodnadatta, 9.0 miles north-north-west of Mt. Dutton R.S. Same loc. as RH 84, RH 85.

Lat. 27° 41.2' S. Long. 135° 40'.

Collected: September 19, 1962 by G.R. Heath.

Field Observations: The rock is a dark brown highly ferruginized fine sandstone, consisting of quartz grains (as RH 84 and 85) in a limonite matrix. The parent sandstone may have been calcareous. This is probably an alluvial (or ? eluvial) sandstone of ?Pliocene age (intra-duricrustal).

Petrological Report: (D. Smale):

This is a ferruginous sandstone consisting of subangular to subrounded grains of quartz 0.01 - 0.25 mm across in a cement of almost opaque homogeneous wine-red goethite. The grains constitute about 50 per cent of the rock; they are not in contact,

Zircon is a common accessory mineral.

RH 93

DURICRUSTED TERTIARY SANDSTONE

Identification: RH 93; P1018/62; TS 11446

Locality: Oodnadatta 4-mile, Kurillina 1-mile, Run 1, Photo 9157, Loc. KR8. From dissected younger duricrust plateau, 16.4 miles north-north-east of Woodduck H.S. ruins.

Lat. 27° 46.6' S, Long. 136° 19' E (from mosaic).

Collected: October 5, 1962, by G.R Heath.

Field Observations: The rock is a very pale brown silicified quartz sandstone. Grains are medium size, subangular and very poorly sorted. The surface of the sandstone is stained bright yellow by ? limonitic silica. This material is Tertiary (? Pliocene) sandstone which has been silicified during the younger duricrust formation. The surface deposit may date from this period or may be a comparatively recent addition. Such superficial deposits are common on the Tertiary sandstones of this area.

Petrological Report: (D, Smale):

This is a quartz sandstone consisting of angular to subrounded grains of quartz mostly between 0.01 - 0.25 mm across. The rock is fairly porous; 5-10 per cent is voids. Interstitial leucoxene is abundant

There is little matrix present: what there is, is fine quartz and very fine goethite (about 0.001 mm across), The rock is cemented by recrystallised quartz between the grains.

SILIC ?TERTIARY SANDSTONE RH109

Identification: RH109; P1033/62: TS11461

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 3, Photo 1823, Loc. WR30. 3.9 miles west-north-west of Duckhole Bore. Lat. 27°37'S, Long. 136°1.2'E (from mosaic)

Collected: October 9, 1962, by G. R. Heath.

Field Observations: The rock is off-white to pink, partly silicified sandstone, consisting of very poorly sorted, sub-angular, medium sized quartz and lesser quartzite fragments. This sandstone is thought to be intra-duricrustal in age (i.e. ?Pliocene) and has been silicified, probably during the formation of the younger duricrust. It is underlain by a very pebbly sandstone ("agate grit").

Petrological Report: (D. Smale).

This is a quartz sandstone consisting of angular to subangular quartz grains 0.025 - 1.25 mm across. A few grains 3 - 6 mm across are present.

There are two parts to this rock. One part has very little matrix, is yellowish-pink, and very porous. What matrix there is, consists of fine quartz grains and sericite flakes. Among those fragments over 3 mm across there are some consisting of sandstone with subangular to subrounded quartz grains about 0.25 mm across in a matrix of leucoxenic opal.

The other part of the rock is hard, and very pale yellowish-grey; it is well cemented by a layer of opal about 0.015 mm thick around each grain. The interstices are generally empty, but a few are filled with more opal, and still fewer with chalcedony.

Over the boundary between these two parts there is no variation in the shape, size or concentration of the grains; however, the opaline coating on the grains disintegrates into minute fragments one or two microns across, and disappears. This indicates that the rock was originally all cemented by opaline coatings on the grains.

Some of the larger quartz grains show strain.

Zircon, rutile and pyroxene are accessory minerals.

SILIC. ?TERTIARY SANDSTONE RH112

Identification: RH112; P1035/62; TS11463.

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Woodmurra Run 1, Photo 1788, Loc. UR1. From south east portion of the peak of Mt. Arthur. Lat. 27°28.9'S, Long. 135°58.7'E (from mosaic).

Collected: October 9, 1962, by G. R. Heath.

Field Observations: The rock is a brown, well indurated sandstone, containing an anastromosing network of small (5 mm) cavities, giving it a "contorted" appearance. The clastic material is fairly well rounded, fine to medium quartz sand. Exposed surfaces of the outcrop are often covered by a white smooth ? siliceous coating. This material forms part of a small Tertiary (?Pliocene) outlier capping Mt. Arthur. This sandstone was silicified during the formation of the younger duricrust.

Petrological Report: (D. Smale):

This is a poorly sorted quartz sandstone consisting of subangular to subrounded quartz grains 0.01 - 1.0 mm across, but mostly about 0.25 mm across, in an opaline matrix.

The larger grains generally occur in round areas, 2 - 10 mm across, which appear to have been separate pebbles at one stage in the history of the rock. The area between these "pebbles" has been partly filled with material containing grains similar to those in the "pebbles," but generally a little smaller and slightly less common. Numerous large cavities remain between the "pebbles," and much of theinterstitial material is poorly cemented or porous.

The cement is opal, and contains numerous small quartz grains in the "pebbles," but in some places it is almost clear. The darker colour of the interstitial material may be due to the presence of minute goethite grains.

This rock contains numerous large cavities resembling small worm burrows, and is comparable with RH64, though in the latter the cavities are a little larger and the "burrow system" more complex.

SILICIFIED TERTIARY SANDSTONE RH115

Identification: RH115; P1037/62; TS11465

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 4, Photo 0400, Loc. UR6. 15.6 miles south-east of Macumba H.S. Lat. 27°24.8'S, Long. 135°50.4'E (from mosaic).

Collected: October 15, 1962, by G. R. Heath.

Field Observations: The rock is a light yellow-brown somewhat silicified sandstone, composed of very poorly sorted, fine to medium, subangular to subrounded quartz sand. This material overlies the "agate grit" pebble conglomerate of RH116. The sandstone is probably Tertiary ?Pliocene in age. Silicification dates from the formation of the upper duricrust (?Upper Pliocene).

Petrological Report: (D. Smale):

This is an orthoquartzite consisting of angular to subrounded fragments of quartz 0.005 - 4.- mm across; most are between 0.05 - 0.5 mm across. There is little matrix; what there is consists of fine quartz grains, leudoxene and opal. The rock is porous.

SILIC. TERTIARY SANDSTONE RH134

Identification: RH134; P1053/62; TS11481

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER6. 16.5 miles north of Duckhole Bore. Lat. 27°23.9'S, Long. 136°2.0'E (from mosaic)

Collected: October 19, 1962, by G. R. Heath.

Field Observations: The rock is a light yellow-brown, very well indurated sandstone, consisting of fine to medium grained, subrounded to rounded, poorly sorted quartz sand grains in a silcrete cement or matrix. This is Tertiary (?Pliocene) sandstone which has been silicified during the formation of the younger (?Upper Pliocene) limestone.

Petrological Report: (D. Smale):

This is a poorly sorted quartz sandstone consisting of subangular to subrounded quartz grains mostly between 0.08 and 0.5 mm across in an opaline matrix.

Grains over 0.06 mm diameter (i.e. of sand size) constitute 50 - 60 per cent of the rock; they have been strongly affected by solution.

The matrix consists of opal, leucoxene (often coarser than usual) and fine quartz grains. The leucoxene is concentrated in some parts of the rock to such an extent that these parts have the appearance of separate grains comparable in size with the other grains, though with very indistinct boundaries. There is very little pore space.

SILICIFIED YOUNG SANDSTONE

Identification: RH 154; P1070/62; TS 11498.

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 2, Photo 6090, Loc. OR 27. 2.7 miles south-south-west of Oodnadatta on west bank of The Neales.

Lat. 27°34.4S, Long. 135°26.3' E. from mosaic.

Collected: November 9, 1962, by G.R. Heath.

Field Observations: The rock is a white fairly strongly silicified sandstone, consisting of very clean, subangular, very fine quartz sand. This material forms a small cliff in the west bank of the Neales. Geomorphically it is closely related to the "gypsite" level in this area, being well below the laterite-duricrust plateau remnants to the west. It may be equivalent to the ?Pliocene blanket sandstone further east, or it may be a Pleistocene valley deposit.

Petrological Report: (D. Smale):

This is an orthoquartzite consisting mainly of angular to subrounded grains grading from silt size to 0.5 mm across, but about 50 per cent are between 0.07 and 0.15 mm across. The rock is fairly porous; 10-20 per cent of its volume is pore space.

The matrix consists of the finer quartz grains. The rock is cemented by almost leucoxene-free opal, which constitutes about 5 per cent of the rock.

Opaques, zircon and tourmaline are accessory minerals.

APPENDIX 1J

MT. HARVEY
SILCRETES AND SILICIFIED MUDSTONES.
(?PLIOCENE)

RH 58

TERTIARY SILIC. MUDST.

IDENTIFICATION: RH 58; P984/62; TS 11412.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9090. South west side of Mt. Harvey structure, 0.7 miles south-south-east of the trig.

Lat. 27° 49.9'S, Long. 135° 45.8'E.

COLLECTED: September 14, 1962 by G.R. Heath.

FIELD OBSERVATIONS: This is an off-white silicified silty claystone, showing very irregular lamination. It is very light and porous, with an extremely uniform texture. This is typical of the silty sediments in the Mt. Harvey structure, which rest unconformably on the older duricrust and are capped by the younger duricrust. This latter has produced the bleaching and silicification evident in the specimen. The age of the sample is probably Pliocene, but may range into the Miocene.

PETROLOGICAL REPORT: (D. Smale):

This is a very porous rock, able to absorb nearly 75 per cent of its own weight of water. It consists almost entirely of opal, with about 3 per cent of grains of subangular to subrounded quartz from 0.01 to 0.3 mm across. Leucoxene is abundant in a few parts of the rock, following what may have been very irregular fractures in the original rock.

ANALYSIS: (By. C.S.I.R.O. for bulk sample-DM556/47)

Silica	SiO_2	94%
Alumina	Al_2O_3	1.6
Iron oxide	Fe_2O_3	2.1
	Total.	97.7%

TERT. SIL. SS. - MT. HARVEY

IDENTIFICATION: RH 59; P985/62; TS 11413.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9090. From south-west edge of the Mt. Harvey structure, 0.7 miles south-south-west of the trig. (same loc. as RH58)

Lat. 27° 49.9'S,
Long. 135° 45.8'E.

COLLECTED: September 14, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is an off-white siliceous clayey siltstone or fine sandstone consisting of poorly sorted, fairly angular quartz grains in a tight matrix. Rare "vughs" up to 2 mm diameter occur irregularly throughout the rock. This is another typical example of the "intra-duricrustal" sediments at Mt. Harvey, the colour and silicification being due to the upper duricrust. Age probably Mio-Pliocene.

PETROLOGICAL REPORT: (D. Smale);

This is an orthoquartzite 60-70 percent of the rock consisting of poorly sorted sub-angular to subrounded quartz grains 0.01 - 0.15 mm across, in a matrix of opal, with abundant leucoxene forming small irregular colloform structures 0.5 mm across in a few parts of the rock.

Tourmaline, opaques, rutile and zircon are accessory minerals.

ANALYSIS: See RH58. The analysis quoted probably represents an average for RH 58, 59 and 60.

TERT. CALC. SIL. SLTST. - MT. HARVEY RH 60

IDENTIFICATION: RH 60; P986/62; TS 11414.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9090. From south-west edge of the Mt. Harvey structure, 0.7 miles south-south-west of the trig (same loc. as RH 58 and RH59).

Lat. 27° 49.9'S, Long. 135°45.8'E.

COLLECTED: September 14, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is an off-white siltstone, containing a little sand and much silt in a siliceous clayey matrix. Similar to RH59, but much more "vuggy" and very slightly calcareous. This sample of the Mt. Harvey "intra-duricrustal" sediment is less altered than RH 58 or RH 59, but was still strongly bleached and silicified during the formation of the younger duricrust. Age probably Mio-Pliocene.

PETROLOGICAL REPORT: (D. Smale):

This is similar to RH59, but contains fewer quartz grains and even more leucoxene in the opal matrix. Some clay minerals may also be present in the matrix. A few widely scattered minute fragments of zircon, opaques and tourmaline are present.

ANALYSIS: See RH 58 and RH 59.

RH 89

YOUNGER DURICRUST SANDY SILCRETE

Identification: RH 89; P1014/62; TS 11442.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile Run 4, Photo 9090. From deformed area on south-west flank of the Mt. Harvey structure, 0.5 miles south-south-east of Mt. Harvey.

Lat. 27° 49.8' S, Long. 135° 45.8'E.

Collected: October 20, 1962, by G.R. Heath.

Field Observations: The rock is grey, somewhat sandy, highly indurated silcrete, from the thin duricrust capping on the intra-duricrustal sequence at Mt. Harvey. Age possibly Upper Pliocene.

Petrological Report: (D. Smale)

This is a sandy silcrete consisting of about 10 - 15 per cent of allogenic quartz grains, sub-angular to subrounded, varying in size from 0.02 to 0.2 mm across, in a matrix of leucoxenic opal. Some colloform structures a little over 1 mm across are present within the opal. In some parts of the rock there is a much greater concentration of sand grains, forming up to 50 per cent of the rock, as though these parts had once been sandstone pebbles. The opaline matrix extends through both the normal rock and the apparent sandstone pebbles unaffected. Occasional cavities are present with rounded outlines, lined with opal (? lussatite) about 0.01 mm thick, and filled with chalcedony.

Much of the leucoxenic opal has a finely granular or mottled appearance, as of a rain-pitted surface, each mottle being about 0.015 mm across. In a few places the leucoxene is absent, and the opal appears clear, light brown, cracked and isotropic. The mottled appearance is absent in such places. Zircon is an accessory mineral.

RH 90

YOUNGER DURICRUST SILCRETE

Identification: RH 90; P1015/62; TS 11443.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9090. From deformed area on south-west flank of Mt. Harvey structure, 0.5 miles south-south-east of Mt. Harvey.

Lat. 27° 49.8' S, Long. 135° 45.8' E.

Collected: October 20, 1962, by G.R. Heath.

Field Observations: The rock is pale grey, fairly well indurated silcrete. Somewhat vuggy. Shows fine vertical lineation. From the most prominent "younger" duricrust capping on the intra-duricrustal silty sequence at Mt. Harvey. Age possibly Upper Pliocene.

Petrological Report: (D Smale):

This is a sandy siltstone consisting almost entirely of quartz, though there may be some other form of silica present in the matrix. The grains are subangular to sub-rounded, and vary in size from less than 0.01 to 0.4 mm across: less than 15 per cent are over 0.06 mm across (i.e. of sand size). The cement appears to be a very fine quartz mosaic with a grain size of about 0.003 mm. Leucoxene is abundant, and the cement might well have been opaline at a late stage in the history of the rock.

Tourmaline and zircon are accessory minerals.

FINE SANDY SILCRETE

Identification: RH 91; P1016/62; TS 11444.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9090. From east central portion of Mt. Harvey structure (near axis), 1.6 miles south-east of Mt. Harvey,

Lat. 27° 50' S, Long. 135° 47' E.

Collected: October 20, 1962 by G.R. Heath.

Field Observations: The rock is a grey, somewhat silicified silty mudstone, containing minor quartz sand and rare well rounded and polished silcrete pebbles up to 1 in diameter. Appears to be below or possibly equivalent to a well developed silcrete, tentatively correlated with the steeply dipping (older) duricrust at Mt. Harvey. I.B. Freytag (pers. comm.) suggests that this may be equivalent to the younger (i.e. ? Upper Pliocene) duricrust to north and east.

Petrological Report: (D. Smale):

This is a silcrete virtually identical with RH 89, consisting of subangular to subrounded quartz grains 0.08 - 0.4 mm across in a mottled leucoxenic opaline matrix. Occasional rounded sandstone fragments are present 0.3 - 5 mm across, containing subangular to rounded quartz grains in a cryptocrystalline matrix.

The opaline matrix of the rock penetrates 0.3 mm in some of the sandstone fragments, but not at all in others. Occasional small areas of brownish clear leucoxene-free opal are present; these could be allegenic grains.

Zircon is an accessory mineral.

APPENDIX 1K

DURICRUST
AND
DURICRUST PROFILE
MATERIAL.

?MIOCENE - PLIOCENE

DURICRUST BLEACHED ZONE

IDENTIFICATION: RH 43; P972/62; TS 11400.

LOCALITY: Oodnadatta 4-mile, Yardinna 1-mile, Run 2, Photo 6411. Small mesa 0.7 miles west of the railway, 14.5 miles north of Oodnadatta.
Lat. 27° 20.1' S, Long. 135° 25.4'E. (from mosaic).

COLLECTED: September 8, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is white mottled silty and fine sandy siliceous clay. From a well exposed duricrust profile, about 20 feet below the massive silcrete capping. The whole profile is similar, except for slight limonite staining at the base and pale mauve and brown staining along joints in the upper part of the profile.

PETROLOGICAL REPORT (D. Smale):

This is a porcellanite, very porous and with a matt surface in the hand specimen typical of such rocks, containing in an opaline matrix about 10 per cent of silt-sized angular to subangular grains, most of which are quartz, with some sericite, rutile, zircon and goethite and a small amount of clay. A few narrow bands of fine sand occur, marking bedding.

The matrix consists of kaolin and very fine grains of quartz in an opaline cement.

DURICRUST UPPERMOST BLEACHED ZONE. RH 44

IDENTIFICATION: RH 44; P973/62; TS 11401.

LOCALITY: Oodnadatta 4-mile, Yardinna 1-mile, Run 2, Photo 6411. Small mesa 0.7 miles west of the railway, 14.5 miles north of Oodnadatta, (same loc as RH 43). Lat. 27° 20.1'S, Long. 135° 25.4'E (from mosaic).

COLLECTED: September 8, 1962 by G.R. Heath.

FIELD OBSERVATIONS: This is an off-white, uniform textured, finely mottled rock consisting of alternating 0.05-0.1 inch patches of siliceous clay and fine angular silty quartz sand. From the same well exposed duricrust profile as RH 43. This sample comes from the uppermost portion of the "bleached" zone, just below the massive silcrete capping.

PETROLOGICAL REPORT:

This is a siliceous sandstone similar in mineralogical composition to RH 43. It has an average grain size of 0.5-0.6 mm, though some grains are more than 1 mm across. The framework fraction constitutes 70-80 per cent of the rock, and opal or opaline clay the matrix. Grains of kaolin of sand size form over half the framework, and it is the capacity of these grains for moulding around other grains which allows the high framework-matrix ratio. Many of the clay grains contain worm-like aggregates of kaolin about 0.015 mm thick and of indefinite length. The remainder of the grains consist of angular to subangular quartz grains in a quantity approximately equal to that of the clay.

The matrix consists largely of opal, but does not differ greatly from the clay in many of the grains; probably the opal, or else cryptocrystalline silica, pervades most of the rock, a fact suggested also by the hardness of the hand specimen.

DURICRUST BLEACHED ZONE RH48

Identification: RH48; P977/72; TS 11405

Locality: Oodnadatta 4-mile. Yardinna 1-mile, Run 2, Photo 6411. From north flank of central peak of the "Three Sisters". Lat. 27°20.2'S, Long. 135°23.2'E (from mosaic)

Collected: September 8, 1962 by G.R. Heath.

Field Observations: The rock is an off-white silicified clayey siltstone. This specimen comes from the middle part of a duricrust profile (about 25 feet below the massive silcrete cap) and is typical upper "bleached zone" material. The original rock was probably a silty shale of the Cretaceous Tambo Formation.

Petrological Report: (D. Smale):

This is a porcellanite similar to RH43, but not quite as porous. It consists of subangular grains of quartz, kaolin and sericite 0.01 mm to 0.06 mm across in matrix of opal and opaline kaolin with accessory illite. Some of the kaolin grains are of worm-like, curved, fibrous aggregates similar to those in RH44.

The rock is peppered with minute goethite grains about 0.01 mm across, which form approximately 1 per cent of the rock.

Zircon and rutile are accessory minerals.

DURICRUST LOWER BLEACHED ZONE RH49

Identification: RH49; P978/62; TS 11406

Locality: Oodnadatta 4-mile, Yardinna 1-mile, Run 2, Photo 6411. From north flank of the central peak of the "Three Sisters" (same loc. as RH48). Lat. 27°20.2'S, Long. 135°23.2'E. (from mosaic).

Collected: September 8, 1962 by G.R. Heath.

Field Observations: The rock is a pale pink silty shale. It is bleached and probably kaolinitic. This sample comes from the lower part of a duricrust profile "bleached zone" about 40 feet below the silcrete cap (15 feet below RH48). The original rock, like RH48, was probably a Cretaceous (Tambo) silty shale.

Petrological Report: (D. Smale):

This is a porous fine sandstone consisting of grains of quartz and clay in a matrix of clay, similar to the porcellanites RH43 and RH48. The quartz grains are angular and subangular and an average of 0.07 mm across; the clay fragments are subangular and subrounded and 0.1-0.5 mm across, sometimes occurring in thin flaky crystals and sometimes in worm-like aggregates of fibres similar to those in RH48. The sand grains form about 30 per cent of the rock. Boundaries between some of the clay grains and the clay matrix are indistinct.

Goethite, opaques, zircon, rutile and tourmaline are accessory minerals.

GYPSUM - BASE DURICRUST PROFILE RH50A

Identification: RH50A; A530/62

Locality: Oodnadatta 4-mile, Yardinna 1-mile, Run 2, Photo 6411. Base of central peak of "Three Sisters" north-east flank (same loc. as RH48 and RH49). Lat. 27°20.2'S, Long. 135°23.2'E (from mosaic).

Collected: September 8, 1962 by G.R. Heath

Field Observations: The material is white coarsely crystalline gypsum (selenite). The crystals are columnar or fibrous and about 2 inches long. The sample comes from a thin horizontal layer about 3 inches thick near the base of the duricrust "bleached zone" at the "Three Sisters". The fibrous texture is perpendicular to the upper and lower surfaces. This type of occurrence is fairly common at the base of the Duricrust profile. The host rock is bleached Cretaceous (Tambo) shale, in this case.

Analysis: (J.A. Powell & B. Wood):

Calcium oxide	CaO	32.4%
Barium oxide	BaO	0.007
Strontium oxide	SrO	0.02
Magnesium oxide	MgO	nil
Iron oxide	Fe_2O_3	0.007
Alumina	Al_2O_3	0.003
Silica	SiO_2	0.21
Sulphate	SO_3	46.1
Water	H_2O-	0.12
Water (combined)	H_2O+	20.75
Total		99.62%

RH 88

SANDY SILCRETE

Identification: RH 88; P1013/62; TS 11441

Locality: Codnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5953, Loc. 1. From breakaway remnants west of Hanns Creek, north of railway, 11.5 miles north-west of Mt. Dutton R.S.

Lat. 27°40.5' S, Long. 135° 36.2'E (from mosaic).

Collected: September 20, 1962, by G.R. Heath.

Field Observations: The rock is a light yellow-brown very sandy silcrete. It is part of the duricrust capping on Cretaceous shales. This material is massive and tough, and appears to grade down to less and less silicified bleached shales. This duricrust may be either the younger or older one, as its relation to the laterite in this area is obscure.

Petrological Report: (D. Smale):

This is an orthoquartzite, consisting of subangular to subrounded quartz grains grading in size from 0.15 mm across down to the size of the grains of the matrix. Only about 25 per cent of the grains are more than 0.06 mm across (i.e. of sand size). Abundant leucoxene is present.

Rutile and zircon are accessory minerals.

SILIC. BLEACHED CRET. SANDSTONE RH129

Identification: RH129; P1048/62; TS11476.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER3. From edge of laterite-duricrust plateau, 14.8 miles north of Duckhole Bore. Lat. 27'25.1'S, Long. 136°4.0'E (from mosaic).

Collected: October 17, 1962, by G. R. Heath.

Field Observations: The rock is a very pale grey, faintly mottled, fairly massive and homogeneous, somewhat bleached and silicified siltstone or fine sandstone. This material is from the upper bleached zone of a duricrust profile, and has formed from Cretaceous, Winton equivalent sediments (?Cenomanian).

Petrological Report: (D. Smale):

This is a fine quartz sandstone similar to RH44, consisting of angular to subrounded grains chiefly of quartz and chert 0.12 - 0.3 mm across, in a matrix of very finely crystalline or cryptocrystalline quartz probably with some clay. The sand fraction forms about 40 per cent of the rock, but the distinction between the matrix and some of the fine chert pebbles is often difficult to make.

The chert grains vary in grain size from almost cryptocrystalline to about 0.05 mm or more. Many of the finer ones could probably be called novaculite. A few clay fragments are present.

Tourmaline and rutile are accessory minerals.

RH 140

DURICRUST CONGLOMERATE

Identification: RH140; P1058/62; TS11486

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 3, Photo 9108, Loc. TR11. 16.6 miles west-north-west of Mt. Toondina. Lat. 27°48.6'S, Long. 135°8.5'E. (from mosaic).

Collected: October 31, 1962, by G.R. Heath.

Field Observations: The rock is a red, yellow and grey pebble conglomerate (or ?pseuo-conglomerate), consisting of somewhat rounded light grey quartzitic silcrete pebbles up to 15 mm. diameter in a matrix of red and yellow rather sandy silcrete. This material could result from the incorporation of older duricrust pebbles in the younger duricrust, or it could be a penecontemporaneous deposit (the pebbles and matrix both belonging to the same duricrust).

Petrological Report: (D. Smale):

This is a conglomerate consisting of rounded to well-rounded pebbles in a matrix of fine-grained goethite and leucoxenic opal. The diameter of the pebbles is generally 3-15 mm, but it may be as little as 0.25 mm. They consist of fine-grained orthoquartzite, composed of angular to rounded grains of quartz 0.005-0.125 mm across. Only about 10 per cent of the orthoquartzite consists of grains more than 0.06 mm across.

The matrix forms about 40 per cent of the rock and varies from place to place. In some places it consists of quartz grains of various sizes similar to the material in the fragments; in others it consists of opal containing very fine-grained goethite. It may vary a little between these, but the boundary between the opaline matrix and the other is generally sharp. In a few places the matrix consists of exceedingly fine-grained quartz with very fine-grained goethite; this usually grades into the quartz-grain matrix.

Zircon, opaques and rutile are accessory minerals.

RH 150

NOVACULITE

Identification: RH 150; P1066/62; TS 11494

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 3, Photo 6073, Loc. OR8 20.0 miles west-south-west of Oodnadatta. From south scarp of dissected laterite-duricrust profile west of The Neales.

Lat. 27° 37.5' S, Long. 135°8.1' E (from mosaic).

Collected: November 3, 1962 by G.R. Heath

Field Observations: The rock is a very pale creamy yellow silcrete, possibly a silicified kaolin lens of the type present at Imbitcha. Very homogeneous appearance. Shows well developed conchoidal fracture. The original material was probably a lens of very clean Cretaceous (? Tambo) shale, which was bleached and silicified during the formation of one of the duricrusts.

Petrological Report: (D. Smale):

This is a fine-grained chert, to which the name novaculite is probably applicable. It has an average grain size (as far as can be determined optically) of 0.001-0.003 mm, no grains are more than 0.015 mm across. As far as can be seen they are angular, and often square.

Small fragments of this type of rock have been seen in other rocks of this suite, e.g. RH 129.

RH 152

SILCRETE CONGLOMERATE

Identification: RH 152; P1068/62; TS 11496

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 3, Photo 6082, Loc. OR 18. 7.0 miles south-west of Oodnadatta.

Lat. 27° 37.4' S, Long. 135° 23.3'E (from mosaic).

Collected: November 9, 1962 by G.R. Heath.

Field Observations: The rock is a reddish and yellow-brown "conglomerate" consisting of grey sandy silcrete "pebbles" up to 25 mm diameter, in a grey and yellowish sandy silcrete matrix. The similarity in texture between framework and matrix suggests that the "pebbles" are siliceous concretions developed during the early stages of duricrust formation, while the matrix was deposited somewhat later.

Petrological Report: (D. Smale):

This is a silcrete conglomerate consisting of purplish-pink and light brown-grey silty sandstone in a matrix of almost identical material differing only in that it contains a lot of very fine-grained goethite and is coloured light brown.

The fragments are subangular to rounded, and from 3 to 20 mm across. However, one part of the hand specimen consists of a very large fragment about 70 mm long. The matrix extends along narrowing cracks in some of the larger fragments.

Both fragments and matrix are composed of a sandstone of which 30 per cent consists of rounded or subrounded quartz grains between 0.06 and 0.5 mm across. Subangular to subrounded grains of silt and clay size for, the sandstone matrix, and are almost entirely quartz, though the finer part is goethite in the browner parts of the rock.

Opaques and zircon are accessory.

APPENDIX 1L

LATERITE

AND

LATERITE PROFILE

MATERIAL

(?PLIOCENE)

L.T. SH. - ? LOWER MOTTLED ZONE.

IDENTIFICATION: RH 38; P967/62; TS 11395.

LOCALITY: Oodnadatta 4-mile, Alberga 1-mile, Run 1, Photo 6261.
Lat. 27° 3.2' S, Long. 135° 21.7'E (from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a brownish-red shale. It is limonitic and possibly somewhat silicified. Fairly homogeneous appearance. This specimen comes from the topographic low between the duricrust plateaux of the Mt. Sarah and the "Three Sisters" area. It appears to be a remnant of a partly stripped laterite profile (probably the transition beds at the base of the mottled zone), which has formed on exposed Tambo (Cretaceous) shales.

PETROLOGICAL REPORT: (D. Smale):

This is an iron-stained siliceous claystone consisting of cryptocrystalline silica and kaolin with accessory illite, very similar to the green opaque material in RH 34 and to the fragments in RH40. Dark, fairly massive goethite occupies fractures in the rock and is disseminated through it in the form of minute grains about 0.002 mm across. The degree of staining is proportional to the concentration of the goethite grains.

PISOLITIC LATERITE RH 40

IDENTIFICATION: RH 40; P969/62; TS 11397.

LOCALITY: Oodnadatta 4-mile, Alberga 1-mile, Run 1, Photo 6261. South of the Mt. Sarah duricrust plateau, between the railway line and Mt. Sarah road.
Lat. 27° 2.2' S, Long. 135° 19.4'E.(from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a dark red-brown pebbly laterite, consisting of dark brown, angular, fairly spherical limonite and limonitic pebbles in a brick red clayey and very fine sandy limonite matrix. This material is fairly typical of the clastic "valley" laterites which formed in the partly dissected duricrust peneplain during the late Tertiary.

PETROLOGICAL REPORT: (D. Smale):

This is a ferruginous conglomerate. The fragments are granules and pebbles of claystone, often iron-stained, and are from 1 mm to 10 mm across. The uniformity of the material forming the fragments indicates that the source of the claystone was close by, and the fact that the grains are subangular or angular indicates that they have not travelled far. The ferruginous cement (goethite) appears to have initially coated the fragments, and then to have grown to the extent of cementing them and filling the relatively large interstices remaining. The fragments form 20-30 per cent of the rock. Within the matrix are small quartz grains, angular to subrounded, 0.01 to 0.2 mm across. Although these occur generally in the matrix they also occur within some of the fragments. It seems likely that these quartz grains may have been derived originally from the rock which provided the claystone fragments, so that while the grains are still represented within the fragments, they are more concentrated in the matrix as a result of erosion of the clay material. This again points to derivation, deposition and lithification within a single limited locality.

PHOTOMICROGRAPH TAKEN.

LAT. CRET. SH. - BASAL MOTTLED ZONE. RH 63.

IDENTIFICATION: RH 63; P989/62; TS 11417.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 3, Photo 5974. Loc. (1). From east side of "Faulted Hill", near eastern headwaters of Watson Creek. 14.5 miles north-north-east of Mt. Dutton R.S.

Lat. 27° 36.5'S, Long. 135° 48.2'E. (from mosaic).

COLLECTED: September 13, 1962 by G. R. Heath.

FIELD OBSERVATIONS: The rock is a purplish silty shale, consisting of minor sand and abundant quartz silt in a clayey matrix. Slightly micaceous. Thinly and irregularly laminated due to grain size variations. This is a Cretaceous (? upper Tambo) shale, which was bleached and lightly stained during the ? Pliocene period of lateritisation. Its position within the laterite profile is probably the lower transitional portion of the mottled zone (from 162' level of "Faulted Hill" Section).

PETROLOGICAL REPORT; (D. Smale):

This is a bedded sandy quartz siltstone. About 5-10 per cent consists of grains over 0.03 mm across, and this coarser material occurs in relatively narrow bands 0.3 - 1.25 mm wide. The sequence may be graded, but only very vaguely.

The bulk of the rock is of fine silt grain size, 0.003 - 0.03 mm. Quartz predominates; sericite and goethite are common; clay is present, both finely divided and in large platy crystals. The cementing material is probably also clay.

LAT. TERT. SS. - FAULTED HILL

IDENTIFICATION: RH 65; P991/62; TS 11419.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 3, Photo 5974, Loc. (1). From northern flank of "Faulted Hill", 14.5 miles north-north-east of Mt. Dutton (about 100 yards west of RH 63 and RH 64).

Lat. 27° 36.4'S, Long. 135° 48.1'E. (from mosaic).

COLLECTED: September 13, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a brick red sandstone consisting of poorly sorted fairly well rounded quartz in a dirty clayey ferruginous matrix. It was probably deposited almost simultaneously with RH 64, but has been affected by lateritisation (? Pliocene) and not apparently by the younger duricrust formation. It comes from about the 185' level in the 'Faulted Hill' section. Age probably Mio-Pliocene. Its position within the laterite profile is probably middle ferruginous (or laterite) zone.

PETROLOGICAL REPORT: (D. Smale):

This is a ferruginous sandstone consisting of subangular grains of quartz 0.02 - 0.75 mm across in a goethitic matrix. Apart from quartz there are also grains of tourmaline, zircon, epidote, opaques and rutile, but these together form less than 1 per cent of the rock.

The matrix consists almost entirely of goethite in very fine grains one or two microns across.

DARK MOTTLE - LAT. PROFILE

IDENTIFICATION: RH 67; P993/62; TS 11421; HWA4; A468/62.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 2, Photo 5995, Sec. (2). From the northern wall of "Watson Canyon", at the eastern headwaters of Watson Creek, 15.8 miles north-north-east of Mt. Dutton R.S.

Lat. 27° 35.4' S, Long. 135° 48.6'E (from mosaic).

COLLECTED: September 13-15, 1962 by G.R. Heath and H. Wopfner.

FIELD OBSERVATIONS: The material is dark brick red limonite, with a rather granular texture. It was probably formed by ferruginization of a Cretaceous (? Tambo) shale. The sample comes from one of the dark patches in the upper mottled zone of a very well exposed laterite profile (about the 75' level in Watson Canyon sec. (2)). This laterite probably dates from the Pliocene (it post-dates the older duricrust and underlies the younger).

PETROLOGICAL REPORT: (D. Smale):

This is a ferruginous conglomerate comparable with RH 84. Most of the fragments are subrounded, and consist of a mixture of clay and silica, probably opal, varying from about 0.5 mm to 7 mm across; the larger ones have joints across them filled with ferruginous cement. A few fragments consist of quartz sandstones cemented by massive, dark, almost opaque goethite.

Quartz grains occur both in the matrix and in the fragments, but they are a little more common and generally a little larger in the matrix. They are subangular and vary from 0.01 - 0.5 mm across.

ANALYSIS: (K.G. Heinrich):

Silica	SiO_2	51.8%
Iron oxide	Fe_2O_3	22.8
Alumina	Al_2O_3	14.3
Titanium oxide	TiO_2	0.82
Manganese oxide	MnO	0.009
	Total	89.73%

LATERITE - WATSON CANYON

IDENTIFICATION: RH 68; P994/62; TS 11422; HWA 3; A467/62.

LOCALITY: Oodnadatta ½-mile, Toodla 1-mile, Run 2, Photo 5995, Sec. (2). From the top of the northern wall of "Watson Canyon", at the eastern headwaters of Watson Creek, 15.8 miles north-north-east of Mt. Dutton R.S. (same loc. as RH 67).

Lat. 27° 35.4'S, Long. 135° 48.6'E (from mosaic).

COLLECTED: September 13-15, 1962 by G.R. Heath & H. Wopfner.

FIELD OBSERVATIONS: The rock is a brick red granular gravel conglomerate, consisting of quartz sand and angular silcrete fragments in a limonitic matrix. This material forms the capping over much of the extensive plateau south west of Oodnadatta. The sample comes from about the 90' level of Watson Canyon (sec. 2). It appears rather clastic, but is the uppermost preserved unit of a well exposed laterite profile. This layer overlies the prominent mottled zone typified by RH 67 and RH 69. The laterite probably dates from the Pliocene (post lower duricrust).

PETROLOGICAL REPORT: (D. Smale):

This is a ferruginous conglomerate, similar to RH 67. It consists of angular to subangular fragments 0.25 - 4.0 mm across, and subrounded or sometimes angular quartz grains 0.1 - 0.8 mm across in a ferruginous matrix. The fragments form about 30 per cent of the rock and consist generally of siliceous kaolin containing quartz grains of approximately the same general size and shape as those occurring in the matrix. Other fragments are present which contain a few quartz grains smaller than those elsewhere, in a dark, almost opaque goethite matrix. Some of the claystone fragments have been stained by very bright red-brown goethite.

The matrix consists mainly of pale orange-brown colloidal goethite, and contains grains an average of about 0.06 mm across which have been coated with goethite. Generally these grains are quartz, but they may be goethite or zircon. Occasional goethite grains have a siliceous layer between them and the surrounding matrix and some cavities have a siliceous lining; this indicates that there may have been a minor period of silicification before the ferruginisation which cemented the rock. Ferruginisation definitely was the last process to affect the rock, as all the voids have a thin clear brown colloidal goethite layer lining them.

ANALYSIS: (K.G. Heinrich);

Silica	SiO_2	70.4%
Iron oxide	Fe_2O_3	4.22
Alumina	Al_2O_3	13.9
Titanium oxide	TiO_2	0.94
Manganese oxide	MnO	0.010
	Total	89.47

LIGHT MOTTLE - LAT. PROFILE RH 69

IDENTIFICATION: RH 69; P995/62; TS11423; HWA5; A469/62.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 2, Photo 5995, Sec. (2). From the north wall of "Watson Canyon", at the eastern headwaters of Watson Creek, 15.8 miles north-north-east of Mt. Dutton R.S. (same loc. as RH67)

Lat. 27° 35.4'S, Long. 135°48. 6' E (from mosaic).

COLLECTED: September 13-15, 1962 by G.R. Heath and H. Wopfner.

FIELD OBSERVATIONS: The rock is a white granular claystone, rather kaolinitic and possibly siliceous. This sample comes from one of the light patches in the upper mottled zone of a very well exposed laterite profile, and was taken a few inches from RH 67. (i.e. from about the 75' level of Watson Canyon Sec. (2)). The parent rock was probably a silty Cretaceous (?Tambo) shale. Lateritisation apparently took place during the Pliocene.

PETROLOGICAL REPORT: (D. Smale):

Much of the material in this rock is siliceous claystone similar to that in the pebbles in such rocks as RH 38 and RH40. In a few small patches kaolin occurs in curved fibrous masses as in RH42 and RH116, sometimes forming small colloform structures, possibly with some leucoxene.

About 15 per cent of the rock consists of subangular to subrounded quartz crystals not more than 0.1 mm across, and usually much less; they are more concentrated in some parts of the rock than in others. The boundaries between the quartz-rich and the quartz-poor parts of the rock are gradational over a distance of $\frac{1}{2}$ - 1 mm or more. These variations appear to be due to bedding.

Muscovite, zircon and opaques are accessory minerals, and occur in very small grains about 0.01 mm across.

There are rare porous aggregates present, less than 1 mm across, surrounded by brownish haloes and composed of opaque material and yellowish-brown grains. The opaque material is bluish-black and in the form of a very fine powder between the other grains and cavities. These areas probably represent the former location of some mineral which has been leached out. They occur along faint fractures in the rock and could be phosphatic.

ANALYSIS: (K.G. Heinrich)

Silica	SiO_2	66.9%
Iron oxide	Fe_2O_3	1.45
Alumina	Al_2O_3	19.8
Titanium oxide	TiO_2	1.30
Manganese oxide	MnO^2	0.004
	Total	89. 45%

? VALLEY LATERITE RH 75

Identification: RH75; P1001/62; TS 11429

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5951. From southern flank of prominent plateau north of The Neales, about 2 miles west of the railway line (near RH71-74). Lat. 27°41.9'S, Long. 135°32.7'E. (from mosaic)

Collected: September 14, 1962, by G.R. Heath.

Field Observations: The rock is a deep brick red pebble conglomerate consisting of rounded limonitic and ?siliceous sandstone pebbles up to 1 inch diameter in a ferruginous matrix. This material appears to be ?valley laterite formed in an erosional depression in the older duricrust peneplane. It includes transported limonitic material and hence may be partly "intraformational" in character. This sample comes from the same cliff section as RH71-74, at about the level of RH73 (i.e. 30 feet below plateau top) but does not appear to have been affected by the younger duricrust.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate, consisting of rounded to subrounded fragments of granule and pebble size, 1-12 mm across, in a matrix of pale goethite containing small subangular to subrounded grains of quartz 0.01-0.25 mm across. Many of these quartz grains have been coated with dark goethite, in some instances forming small ooliths.

The fragments are of ferruginous sandstone consisting of angular or subangular quartz grains about 0.125 mm across in an opaque goethite matrix.

?CLASTIC LATERITE

Identification: RH 78; P1003/62; TS 11431.

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 2, Photo 5995, Sec. (2). From the top of the northern wall of "Watson Canyon" at the headwaters of Watson Creek, 15.8 miles north-north-east of Mt. Dutton R.S. (Same loc. as RH67-69). Lat. 27° 35.4'S, Long. 135°48.6'E (from mosaic).

Collected: September 15, 1962 by G.R. Heath.

Field Observations: The rock is a yellow to red-brown gritty conglomerate, consisting of 2 mm to rarely 20 mm off-white silcrete fragments in a brick-red, somewhat sandy ferruginous matrix. This material is the "laterite" which caps the well developed laterite profile in the area. It is definitely reworked to some extent, although the silcrete may still be more or less vertically above its original position. Age is ? Pliocene, suggested by its relatively close morphological affinity to the Pleistocene "gypsite" surface.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of rounded or subrounded fairly well-sorted fragments of dark sandy goethite and opaline sandstone 1 - 5 mm across in a matrix of goethite and quartz grains.

Most of the fragments are ferruginous and consist of dark goethite with a few quartz grains, or quartz sandstone with a dark goethite matrix. A few consist of virtually pure goethite: others consist of opaline sandstone, and a few of porous goethitic silica and clay.

The matrix consists of quartz grains, subangular to subrounded and about 0.05 - 0.4 mm across, cemented by amorphous goethite and possibly cryptocrystalline silica. Ferruginisation was the last process to affect the rock as cavities are lined with varying amounts of light orange-brown colloidal goethite.

The boundaries of the ferruginous pebbles can be seen more clearly between crossed nicols. At the edge of the pebble the goethite is translucent and amorphous, and the darker goethite is shown, at its gradation into the light goethite, to consist of minute pellets 0.003 - 0.01 mm in diameter, almost circular and very regular in size. The translucent boundaries of the pebbles vary in thickness up to 0.1 mm, and the dark goethite from this area has probably been leached and become disseminated through the rest of the rock. Quartz grains cross the inner boundary between the light and dark goethite, but the outer boundary has apparently formed around projecting quartz grains (see fig. 5). These are thus detrital pebbles, and they are not considered to be the "syngenetic nodules" described by Williamson (1957) and Frankel (1952).

RH 81

? CLASTIC LATERITE

Identification: RH 81; P1006/62; TS 11434

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 2, Photo 5995. From upper portion of scarp at the eastern headwaters of Watson Creek, about 1 mile north-west of the south- east corner of the duricrust-laterite plateau. 17.4 miles north-north-east of Mt. Dutton R.S.

Lat. 27° 34.5'S, Long, 135° 51'E (from mosaic).

Collected: September 17, 1962, by G.R. Heath.

Field Observations: The rock is a brick red gritty conglomerate, similar to RH 68. It consists of ? silcrete and mottled zone material in a limonitic matrix. This material caps the laterite section below RH 80. It is the slightly physically disturbed ("clastic") capping of a well developed laterite profile. Age probable Mio-Pliocene or Pliocene.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of subangular to subrounded fragments 0.05 - 10 mm across in an oolitic, pale goethite matrix.

About 75 per cent of the fragments are sandstone consisting of grains of quartz and claystone in an opaque goethite cement. The remaining fragments consist of claystone (some ironstained) containing fairly numerous subrounded medium-sized sand grains of quartz.

The matrix contains numerous quartz grains and small fragments of the claystone of the pebbles, most of which are surrounded by layers of goethite in some instances forming ooliths. Most of the interstitial material is pale goethite, which also lines the remaining interstitial cavities. Ferruginisation was thus the last process to affect the rock.

"CLASTIC" LATERITE CAPPING RH110A

Identification: RH110A; A529/62.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 5, Photo 0426, Loc. ER2. 12.1 miles north of Duckhole Bore. Lat. 27°27.5'S, Long. 136°5.6'E (from mosaic).

Collected: October 9, 1962, by G. R. Heath.

Field Observations: The rock is a pinkish red, rather clayey, silcrete rich grit. This is the "ferruginous" horizon (Whitehouse) of a laterite profile.

Analysis: (J. Powell):

Acid soluble iron	Fe_2O_3	2.37%
Total iron	Fe_2O_3	2.42
Aluminium oxide	Al_2O_3	18.6
Titanium oxide	TiO_2	0.78
Silica	SiO_2	66.7
Moisture at 105°C	H_2O	1.10
Moisture above 105°C	H_2O+	7.18
Total		99.15%

RH 117

SILCRETE-RICH "LATERITE"

Identification: RH117; P1039/62: TS11467

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0359, Loc. UR7. 12.9 miles south-east of Macumba H.S. Lat. 27°22.7'S, Long. 135°50'E (from mosaic).

Collected: October 15, 1962, G. R. Heath.

Field Observations: The rock is a bright brick red silcrete grit, consisting of abundant somewhat rounded silcrete and lesser quartz pebbles up to 10 mm diameter in a sandy limonite matrix. The matrix has been partly silicified in part of the specimen, giving a red jasper. This material is typical of the "ferruginous" layer of the well developed laterite profiles of the area. Age -? Mio-Pliocene.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of separated subangular to subrounded fragments 0.5 to 12 mm across, i.e. of sand, granule and pebble size, in a red goethitic matrix. The fragments are of yellowish sandstone containing 50 per cent of subangular to subrounded quartz grains 0.05 to 1.5 mm across in a fine siliceous matrix. Similar quartz grains occur in the matrix of the rock itself, implying, as was the case with RH40, that the quartz grains were cleaned and concentrated by the process of erosion of the original sandstone. The sandstone fragments and quartz grains were coated with goethite which became sufficiently thick to form a cement, and the interstices have remained empty. A little sphene and hornblende are present. A small cavity in one quartz grain has been filled with a fine quartz mosaic showing a tendency towards radial structure.

SILCRETE LATERITE RH118

Identification: RH118; P1040/62; TS11468

Locality: Codnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0363, Loc. UR9. 18.7 miles south-east of Macumba H.S. Lat. 27°21.6'S, Long. 135°56.6'E (from mosaic).

Collected: October 16, 1962, by G. R. Heath.

Field Observations: The rock is a brick red partly silicified ferruginized silcrete grit, consisting of fairly well rounded silcrete fragments up to 10 mm diameter in a matrix of silcrete (minor) and sandy limonite. The petrological report (below) suggests that the "cherty" texture is due to relict silicification, which survived ferruginization, rather than to later (post laterite) silicification. This material is from the "ferruginous" (or laterite) portion of a laterite profile (apparently superimposed on duricrusted Cretaceous shales). Laterite age probably Upper Tertiary.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of subrounded to rounded silcrete fragments an average of about 3 mm across, but up to 10 mm or more, in a matrix of more porous goethitic material.

The silcrete fragments consist of opaline silica with abundant leucoxene containing about 3 - 5 per cent of sericite flakes and small angular quartz grains not more than 0.02 mm across.

The matrix consists of material similar to that of the fragments, but containing about 50 per cent or more of pale orange brown goethite and about 5 per cent of voids. A few of the voids in the more silicified parts of the rock are filled with a fine-grained quartz mosaic, or else lined with chalcedonic quartz about 0.01 mm thick. Most of the voids, even those already lined with silica, are lined or filled with pale colloidal goethite, signifying that ferruginisation followed silicification.

Some of the cavities within the silcrete fragments are lined with chalcedony and filled with a fine quartz mosaic. Crack-like cavities filled with fine chalcedonic quartz extend across the boundaries between the fragments and the matrix. While this could suggest a final period of silicification rather than ferruginisation, it is far more likely that ferruginisation was the final process, and that it was unable to affect the non-porous, already silicified parts of the rock. If silicification had been the final process, it would be almost impossible to explain the absence of a final layer of silica lining the cavities in the matrix. The few cavities where the ferruginous lining is absent do not affect this conclusion.

RH 122A

PALLID ZONE CLAY

Identification: RH 122A; A534/62

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0363, Loc. UR 14. 21.1 miles south-east of Macumba H.S.

Lat. 27° 23.7' S, Long. 135° 58.0' E (from mosaic).

Collected: October 16, 1962 by G.R. Heath.

Field Observations: The material is white slightly gypseous and saline clay, from the upper pallid zone of a laterite profile. The clay has found during the ? Mio-Pliocene lateritisation of a Cretaceous (? Winton, ? Cenomanian) shale sequence.

Analysis: (H. Sears):

Aluminium oxide	Al_2O_3	17.5%
Ferric oxide	Fe_2O_3	1.10
Ferrous oxide	FeO	0.07
Titanium oxide	TiO	0.90
Manganese oxide	MnO	0.01 -
Calcium oxide	CaO	2.05
Magnesium oxide	MgO	1.06
Sodium oxide	Na_2O	2.60
Potassium oxide	K_2O	1.08
Silica	SiO_2	57.6
Carbonate	CO_2	0.06
Sulphur trioxide	SO_3	3.20
Chloride	Cl	2.70
Phosphorus pentoxide	P_2O_5	0.05
Carbon	C	0.10
Water at 100°C	H_2O-	3.80
Water over 100° C	H_2O+	6.70
Total		100.57%
Less oxygen equivalent to chlorine		0.60
Total		100.0%

Analysis - X-Ray Fluorescence: (R.G. Stafford):

Barium oxide	BaO	0.035%
Strontium oxide	SrO	0.015%

RH 114A
RH 126

KAOLINIZED ? TAMBO SHALE

Identification: RH 126; P1045/62; RH 114A; A533/62.

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 5, Photo 0419, Loc. UR 3. "Bluff Canyon" in east side of Toodla laterite-duricrust plateau. 19.7 miles south-east of Macumba H.S.

Lat. 27° 28.9' S, Long. 135°50.8' E (from mosaic)

Collected: October 15, 1962, by G.R. Heath.

Field Observations: The material is white, slightly silty clay, from the upper part of a laterite profile pallid zone, developed in Tambo (Albian) marine shales.

Petrological Report (D. Smale):

This is rather silty kaolinite, containing about 15 per cent of quartz grains of silt size, and a few small opaque grains.

Analysis: (H. Sears):

Aluminium oxide	Al_2O_3	19.7%
Ferric oxide	Fe_2O_3	0.97
Ferrous oxide	FeO	0.01 -
Titanium oxide	TiO_2	0.82
Manganese oxide	MnO	0.01-
Calcium oxide	CaO	0.46
Magnesium oxide	MgO	0.69
Sodium oxide	Na_2O	2.70
Potassium oxide	K_2O	0.87
Silica	SiO_2	60.4
Carbonate	CO_2	0.05
Sulphur trioxide	SO_3	0.19
Chloride	Cl	2.95
Phosphorus pentoxide	P_2O_5	0.06
Carbon	C	0.01-
Water at 100°C	H_2O-	3.00
Water over 100°C	H_2O+	7.90
Total		100.76 %
Less oxygen equivalent to chlorine		0.65
Total		100.1%

Analysis - X-Ray Fluorescence: (R.C. Stafford):

Barium oxide	BaO	0.055%
Strontium oxide	SrO	0.020%

RH 155

RH 156A

CRETACEOUS CLAY SHALE

Identification: RH155; P1071/62; RH156A; A536/62

Locality: Wintinna 4-mile, Beviss 1-mile, Run 4, Photo 5923, Loc. R1. From river flat adjacent to Imbitcha clay deposit. See also Departmental Report 55/129, G.S. 2496 .

Lat. 27° 44.7' S, Long. 134°39.5' E (from mosaic).

Collected: October 11, 1962, by G.R. Heath.

Field Observations: The rock is typical, light grey, somewhat fissile, fairly homogeneous Cretaceous marine clay shale. This material is from the lowest outcrop in the Imbitcha area, and appears to be relatively unaltered by the processes of lateritisation and duricrust formation which produced the high grade white kaolin lenses higher up.

Petrological Report: (D. Smale):

This consists almost entirely of clay minerals, with a very little fine quartz, less than 0.05 mm. across. Kaolin and montmorillonite are dominant; illite is accessory.

Analysis: (H. Sears):

Aluminium oxide	Al_2O_3	19.1%
Ferric oxide	Fe_2O_3	2.65
Ferrous oxide	FeO	0.16
Titanium oxide	TiO_2	0.88
Manganese oxide	MnO	0.01-
Calcium oxide	CaO	0.38
Magnesium oxide	MgO	1.44
Sodium oxide	Na_2O	0.62
Potassium oxide	K2O	2.00
Silica	SiO_2	59.9
Carbonate	CO_2	0.02
Sulphate	SO_3	0.18
Chloride	Cl	0.48
Phosphorus pentoxide	P_2O_5	0.10
Carbon	C	0.35
Water at 100°C	H_2O-	4.75
Water over 100°C	H_2O+	7.15
Total		100.16%
Less oxygen equivalent to chlorine		0.11
Total		100.1%

Analysis - X-Ray Fluorescence: (R.G. Stafford):

Barium oxide	BaO	0.035%
Strontium oxide	SrO	0.001%

RH 157

RH 158A

IMBITCHA KAOLIN

Identification: RH157; P1072/62; RH158A; A537/62.

Locality: Wintinna 4-mile, Beviss 1-mile, Run 4, Photo 5923, Bulk sample loc. 1 from Imbitcha clay deposit. Near entrance track into "canyon" from Oodnadatta.

Lat. 27°44.6'S, Long. 134° 40.2'E (from mosaic).

Collected: October 11, 1962, by G.R. Heath.

Field Observations: The sample is of brilliant white, massive, homogeneous clay, showing marked conchoidal fracture. It comes from a lens of high quality kaolin in the workings at Imbitcha. These lenses have developed in the lower and upper mottled zone of a laterite profile, from Cretaceous marine clay shales.

Petrological Report: (D. Smale):

This is pure white kaolinite, less than 1 per cent consisting of quartz grains not more than 0.02 mm across

Analysis: (H. Sears):

Aluminium oxide	Al_2O_3	34.6%
Ferric oxide	Fe_2O_3	0.98
Ferrous oxide	FeO	0.01-
Titanium oxide	TiO_2	0.01
Manganese oxide	MnO	0.01-
Calcium oxide	CaO	0.42
Magnesium oxide	MgO	0.48
Sodium oxide	Na_2O	0.52
Potassium oxide	K_2O	4.30
Silica	SiO_2	25.8
Carbonate	CO_2	0.03
Sulphate	SO_2	16.9
Chloride	Cl	0.28
Phosphorus pentoxide	P_2O_5	0.42
Carbon	C	0.01-
Water at 100°C	H_2O-	1.84
Water over 100°C	H_2O+	13.7
Total		100.28%
Less oxygen equivalent to chlorine		0.06
Total		100.2%

Analysis - X-Ray Fluorescence: (R.G. Stafford):

Barium oxide	BaO	0.21%
Strontium oxide	SrO	0.010%

Note: The geology of the Imbitcha deposit is described in detail in reports by Parkin (Mining Review 86, pp 102-105, 1948) and Heath (Rept. Bk. 55/129, 1962, unpub) The properties of the clay are described by Gaskin and Samson in Geol. Surv. S. Aust. Bull. 28, pp.40-42 (1951).

APPENDIX 1M

MATERIAL

WHICH HAS BEEN BOTH

DURICRUSTED & LATERITIZED.

SILIC. ? LAT. RH 41

IDENTIFICATION: RH 41; P970/62; TS 11398.

LOCALITY: Oodnadatta 4-mile, Alberga 1-mile, Run 2, Photo 6274. From northern flank of "Three Sisters" dissected duricrust plateau, between the Mt. Sarah road and the railway line.

Lat. 27° 3.6'S, Long. 135° 19.8'E (from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is concretionary, brick red and off-white silcrete, consisting of ferruginous fragments and ? concretions in a highly siliceous ferruginous matrix. This material forms patches along the northern edge of the duricrust plateau in the south-east corner of Alberga 1-mile. These areas are possibly remnants of "valley" laterites of ? Pliocene age which were silicified during the ? Upper Pliocene duricrust formation.

PETROLOGICAL REPORT: (D. Smale):

This is an oolitic ferruginous sandstone consisting of goethite ooliths and goethite-coated grains, mostly from 0.1-1.5 mm but up to 7 mm across, in a strongly iron-stained siliceous matrix. The ooliths have a general maximum diameter of slightly less than 1 mm.

Between 30 and 40 per cent of the grains are very ferruginous; the remainder consist of brownish sandy opaline material containing 5-10 per cent of angular to subangular quartz grains varying from 0.01 - 0.13 mm across. These opaline grains generally appear to have shrunk, possibly as a result of dehydration; the shrinkage cracks within the grain and the space between the grain and the matrix are filled with chalcedonic quartz which may attain a thickness of about 0.3 mm, depending on the size of the grain which has shrunk.

The matrix consists mainly of spongy masses of goethite with opaline fragments and quartz grains in a siliceous cement. Between the grains of the matrix are chalcedony- filled cavities varying from 0.02-0.3 mm across.

One grain in this section, about 0.5 mm across, consists of a mass of plagioclase laths about 0.05 mm wide and 0.15 mm long, which are probably oligoclase. There does not appear to be any plagioclase present anywhere else in the section.

"TIGER" LIMONITE RH71

Identification: RH71; P997/62; TS 11425

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5951. From southern flank of prominent plateau north of The Neales, 2 miles west of railway line. Lat. 27°41.9'S, Long. 135°32.7'E. (from mosaic).

Collected: September 14, 1962, by G.R. Heath

Field Observations: The rock is yellow-brown limonite with brown patches (giving a "tiger spot" mottled appearance). It is very fine grained and homogeneous, showing well developed conchoidal fracturing. Fairly dense. From the central portion of an erosion scarp section (about 100 feet below plateau cap) which consists of altered Cretaceous (?Tambo) shales. These have been silicified and ferruginized in a very complex manner (?due to duricrust-laterite-duricrust formation).

Petrological Report: (D, Smale):

This consists of amorphous semi-opaque goethite, with less than 0.5 per cent of quartz, plagioclase and chlorite grains not generally more than 0.05 mm across, It is similar to RH 76.

LATERITIZED DURICRUST RH72

Identification: RH72; P998/62; TS 11426

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5951. From southern flank of prominent plateau north of The Neales, about 2 miles west of railway line (near RH71). Lat. 27°41.9'S, Long. 135°32.7'E. (from mosaic).

Collected: September 14, 1962, by G.R. Heath.

Field Observations: The rock is a brown and yellow-brown conglomerate or breccia, consisting of angular silcrete fragments, up to 0.5 inches diameter, in a limonitic matrix. This material comes from a cliff section which is capped by a complicated association of duricrust and laterite. The specimen is from an outcrop about 70 feet below the plateau top (i.e. higher than RH71) and appears to be duricrust (?bleached zone) which has been mechanically disintegrated and then lateritised.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate, about 60 per cent consisting of angular to subangular granules and pebbles 1-15 mm across, in a goethite matrix which contains about 40 per cent of subangular to subrounded quartz grains 0.02-0.25 mm across.

The granules and pebbles consist of yellowish-brown opal and clay, probably kaolin, and contain a few widely scattered quartz grains similar to those in the matrix. A few fragments occur consisting of quartz grains in a matrix of leucoxene and opal, similar to such sandstones as RH29 and RH59.

SILICIFIED LAT. DURICRUST RH73

Identification: RH73; P999/62; TS 11427

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5951. From southern flank of prominent plateau north of The Neales, about 2 miles west of railway line (near RH71 and 72). Lat. 27°41.9'S, Long. 135°32.7'E. (from mosaic)

Collected: September 14, 1962, by G.R. Heath.

Field Observations: The rock is a brick red conglomerate or breccia, consisting of silcrete fragments up to 0.4 inches diameter in a limonite matrix which has been silicified to some extent. This sample comes from the same cliff section as RH71 and 72, but was part of an outcrop within 30 feet of the plateau top. The material appears to be fragmented older duricrust which was consolidated by lateritization and subsequently silicified during the younger duricrust formation.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of goethite-coated fragments of very fine-grained chert 0.2 to 10 mm across containing a few quartz grains generally not more than 0.1 mm across, though there are some as much as 0.3 mm across, with solution cavities. A few of the chert fragments have irregular solution cavities filled with a fine quartz mosaic (grain size 0.005 mm). The goethite coating around the fragments is about 0.05 mm thick, and the interstices between them are usually filled with quartz similar to that filling the cavities within the chert fragments, but may be empty. Thus ferruginisation took place before silicification.

YOUNGER DURICRUST RH 74

Identification: RH74; P1000/62; TS 11428

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5951. From southern flank of prominent plateau north of The Neales, about 2 miles west of railway line (near RH71-73). Lat. 27°41.9'S, Long. 135°32.7'E. (from mosaic).

Collected: September 14, 1962, by G.R. Heath.

Field Observations: The rock is off-white silcrete containing scattered 0.1 inch yellow and brown limonite fragments. This sample comes from the duricrust-laterite complex which caps the plateau mentioned in RH 71-73 descriptions. The specimen is portion of the massive silcrete capping of the younger duricrust which contains reworked ?laterite and ?older duricrust fragments.

Petrological Report: (D. Smale):

This is a coarse sandstone consisting of subrounded rock grains 0.2-2.5 mm across, and subrounded quartz grains 0.01-0.4 mm across, in an opaline matrix. Cavities, which were apparently common in the rock at one time, have been lined with either quartz or lussatite, and filled with either lussatite or chalcedony respectively.

The fragments, in decreasing order of abundance, consist of:-

1) Opal with a network of minute cracks less than 0.01 mm across which are anisotropic, and presumably filled with quartz. It contains many small quartz grains less than 0.03 mm across.

2) Goethite

3) Sandstone consisting of subangular to subrounded quartz grains 0.3 mm across or less in a clayey opaline matrix.

4) Opal with much leucoxene, and grains of opaline sandstone.

RH 83

SILICIFIED LATERITE

Identification: RH 83; P1008/62; TS 11436

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5957. From top of a prominent "peninsula" extending south from main laterite-duricrust plateau, 6.7 miles north of Mt. Dutton R.S.

Lat. 27°42.8' S, Long. 135° 42.9E (from mosaic)

Collected: September 18, 1962 by G.R. Heath.

Field Observations: The rock is a red and white silcrete or jasper, consisting of rounded 1-5 mm silcrete pebbles in a siliceous limonitic matrix. It appears to have formed by the silicification (?younger duricrust) of a "clastic" (or eluvial) laterite which contained silcrete fragments (? older duricrust). Its age is probably Upper Pliocene.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate 45 - 50 per cent consisting of rounded or subrounded fragments mainly between 0.5 - 5.0 mm across, but up to nearly 10 mm across, in a matrix of goethite and quartz. There are a number of fragments, less than 0.5 mm across, which form part of the matrix.

About 20 per cent of the fragments appear to have contracted and broken, leaving a gap between the inner material and the outer part which is still in contact with the matrix. This gap is generally filled with a quartz mosaic, with a minor suggestion of crystal growth perpendicular to the walls.

The material in the fragments is mainly quartz, partly in grains about 0.02 mm across (finer than those in the fragments in other specimens) cemented by very fine-grained quartz with abundant leucoxene. A few of the larger fragments have cracks within them lined with hyalite, often as much as 0.5 mm thick, but more usually about 0.1 mm.

The matrix consists of subangular to subrounded quartz grains 0.02 - 0.2 mm across thickly coated with goethite and set in a cement of fine-grained chalcedonic quartz with a grain size of 0.005 - 0.01 mm. This cement forms only a coating on the larger grains and leaves cavities lined with chalcedony. Silicification was thus the last process to affect the rock.

SILCRETE CONGLOMERATE

Identification: RH 87; P1012/62; TS 11440

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5955. Plateau east of Hanns Creek, 7.9 miles north-north west of Mt. Dutton R.S. From extensively disturbed area.

Lat. 27°42.9' S, Long. 137° 38.8'E (from mosaic).

Collected: September 18, 1962 by G.R. Heath.

Field Observations: The rock is a purplish pebble conglomerate, consisting of subangular to rounded silcrete pebbles, up to 10 mm diameter in a ferruginous (& ? siliceous) matrix. It is rather reminiscent of the Mt. Alice conglomerate, although the pebbles seem less rounded and sorted. This material crops out in an area of severely faulted and disturbed ? older duricrust, The matrix may date from laterite time (? Mio-Pliocene) or may be younger.

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of rounded or subrounded pebbles, granules and sand grains up to 7 mm across in a ferruginous matrix. The fragments consist of quartzite or quartz sandstone with poorly sorted subangular to subrounded grains varying from silt size up to 0.4 mm across. Grains over 0.06 mm across would not account for more than 10 per cent of the fragments. Throughout many of the fragments are minute aggregates about 0.007 mm across of goethite grains. A few of the fragments contain abundant leucoxene. A few grains of jasper are present.

The matrix contains grains of quartz 0.01 - 0.6 mm across cemented by fairly dense goethite or possibly haematite, much being in the form of aggregates similar to those in the fragments but slightly larger.

In a few places in the hand specimen the matrix has an irridescent sheen which suggests that part may consist of specularitic haematite.

SILIC. FERRUG. SILCRETE RH128

Identification: RH128; P1047/62; TS11475.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER3. From edge of laterite-duricrust plateau, 14.8 miles north of Duckhole Bore. Lat. 27°25.1'S, Long. 136°4.0'E (from mosaic).

Collected: October 17, 1962, by G. R. Heath.

Field Observations: The rock is an off-white fragmented silcrete containing angular sandy silcrete fragments and veins and clots of brick-red limonitic silcrete in a siliceous matrix. This material is possibly Cretaceous (?Winton) shale which was silicified by the older (?Miocene) duricrust, fractured and partly ferruginized by lateritization (?Mio-Pliocene) and refractured and silicified during the formation of the younger (?Upper Miocene) duricrust. The plateau area in the south-west corner of Edarteenya is capped by a complex assemblage of residual deposits of this type (eg. RH129, RH130).

Petrological Report: (D. Smale):

This is silcrete, with associated ferruginous material cementing fragments of silcrete as in the conglomerate RH141.

The silcrete consists of siliceous siltstone which has been broken into subangular to rounded fragments 0.1 - 15 mm across and recemented. It contains about 2 per cent of fragments of quartz between 0.03 mm and 0.15 mm across in a matrix of quartz grains an average of 0.015 mm across cemented by leucoxenic opal. Where the siliceous siltstone has been broken and recemented to form the silcrete, the fragments are cemented with a fairly uniform coating of lussatite 0.010 - 0.015 mm thick, and the interstices are completely filled with chalcedony, which as a result forms about 10 per cent of the silcrete.

Where the siliceous siltstone has been broken and associated with the ferruginous material, the fragments have a goethite coating which might on its own have cemented the rock; but a uniform coating of lussatite 0.025 mm thick has been deposited on all free surfaces and chalcedony has completely filled the interstices. Most of the rock is thus firmly cemented, but not all the ferruginous material has been silicified; some remains soft and earthy.

There appear to be no fragments of broken and recemented siltstone in the ferruginous material. This is fairly certainly because the silcrete has been broken along its previous fractures. The possibility that the original rock was broken only once, and that parts were cemented by siliceous material and others by ferruginous material, cannot be excluded; but it is almost impossible to imagine how this could come about.

Silicification was apparently the last process to affect the rock, though from the hand specimen it appears that this has affected only parts of the rock.

FERRUG. SILIC. PISOLITE RH130

Identification: RH130; P1049/62; TS11477

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER3. From edge of laterite-duricrust plateau, 14.8 miles north of Duckhole Bore. Lat. 27°25.1'S, Long. 136°4.0'E (from mosaic)

Collected: October 17, 1962, by G. R. Heath.

Field Observations: The rock is a dirty brown fairly porous pisolite conglomerate, consisting of concretions 1 mm to 10 mm diameter in a slightly ferruginous fine grained quartz sand matrix. The concretions are sub-spherical and consist of alternating bands of silcrete and limonite. This material, like RH128 is a result of the complex interaction of duricrust and laterite processes on Cretaceous (probably) sediment.

Petrological Report (D. Smale):

This is a ferruginous pisolite. The pisoliths are about 2-10 mm across, and consist of granules and pebbles coated with a cryptocrystalline siliceous layer varying in thickness from 0.1 mm to more than 2 mm. The granules and pebbles are of one of two types of rock; (1) Quartzite, consisting of quartz grains 0.05-0.5 mm across in a very fine quartz matrix, or larger quartz grains 2-3 mm across, rounded or subrounded; (2) Oolitic sandstones consisting of goethite-lined quartz grains and goethite ooliths, 0.1-0.2 mm across, with or without nuclei of quartz grains, cemented by goethitic or fine siliceous coatings. The quartz grains appear to have been rounded or subrounded, but have been affected by solution. Pisoliths containing this type of rock are generally a little larger than those containing quartz or quartzite, and account for about 20-30 per cent of the total number of pisoliths.

The matrix between the pisoliths consists mainly of goethite-lined quartz grains and goethite ooliths with or without nuclei of quartz grains, generally a little larger than the ooliths and grains in the pisoliths cemented by very fine siliceous material coated with goethite.

The geological history of this rock may be divided into a minimum of five distinct phases. Initially it consisted of goethite ooliths and goethite-coated quartz grains, and was thus formed by ferruginisation (1). Some of the pebbles of this early "duricrust" show by the thin siliceous coatings on the grains and ooliths that a period of silicification (2) followed. Some show by even thinner ferruginous coatings on the siliceous coatings that a period of ferruginisation then took place, but this ferruginisation affected a rock already cemented by silicification, and could have occurred as part of the later period of ferruginisation referred to below.

After silicification the rock was broken up into fragments of granule and pebble size and mixed with the quartzite fragments, (3) and was then affected by further silicification (4) which formed the pisoliths and cemented the rock in its present form. A final period of ferruginisation (5) followed, lining the interstices and cementing in them a few apparently fresh goethite ooliths. In a few places in the rock small interstices are filled with fine silica, but it is doubtful if this actually represents a period of silicification.

This summary represents a minimum number of processes effecting the rock in its present form; other periods of silicification and ferruginisation could have occurred, but if so they could not be detected without much more thorough investigation.

RH141

SILCRETE CONGLOMERATE

Identification: RH141; P1059/62; TS11487

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 3, Photo 9108, Loc. TR11. 16.6 miles west-north-west of Mt. Toondina (same area as RH140). Lat. 27°48.6'S, Long. 135°8.5'E.(from mosaic).

Collected: October 31, 1962, by G.R. Heath

Field Observations: The rock is a light brick red, silcrete conglomerate, consisting of angular and corroded white silcrete fragments, generally less than 10 mm diameter, in a matrix of red, somewhat silty silcrete. This material may be Cretaceous shale affected by successive periods of silicification (older duricrust), ferruginization (laterite) and silicification (younger duricrust).

Petrological Report: (D. Smale):

This is a siliceous conglomerate consisting of subrounded to rounded fragments usually with a diameter of 5 mm, but it may be up to 25 mm, in a matrix of quartz and opal.

The fragments consist mainly of opaline material and about 10 per cent of angular to subangular quartz grains 0.05 mm across. Small cavities (about 0.1 mm across) have been lined with clear opal about 0.01 mm thick, and filled with chalcedony.

The matrix consists of fine sand grains of quartz and the opaline material in approximately equal quantities. These grains have been coated with goethite about 0.01 mm thick and cemented by a further coating of opal or lussatite of about the same thickness. In the interstitial cavities chalcedony has been deposited, as part of the last process to affect the rock.

This is similar to the ferruginous part in RH128.

RH 149

?LATERITE CONGLOMERATE

Identification: RH 149; P1065/62; TS 11493

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 3, Photo 6073, Loc. OR 8. From south edge of laterite-duricrust dissected plateau, west of The Neales, 20.0 miles west-south-west of Oodnadatta.

Lat. 27° 37.2'S, Long. 135°6.9'E (from mosaic).

Collected: November 2, 1962, by G.R. Heath.

Field Observations: The rock is a brick-red and yellow-brown pebble conglomerate, consisting of rounded sandy limonite pebbles, generally less than 10 mm diameter in a limonitic silcrete matrix. This material may be Cretaceous (? Tambo) marine limestone which has been ferruginized, silicified (? older duricrust) and ferruginized again (? laterite).

Petrological Report: (D. Smale):

This is a ferruginous conglomerate consisting of rounded to subrounded fragments of pebble, granule and size size with a diameter usually of about 2 - 5 mm, but of up to 15 mm, in an opaline matrix.

The fragments consist of light brown semi-opaque goethite (c.f. RH 47) with about 5-10 per cent of angular to subangular quartz grains 0.07 - 0.015 mm across.

A rather unusual feature of this rock is that the framework is intact, so that the matrix would not account for more than about 30 per cent of the rock; in most of the rocks of this suite the framework is disrupted. The cement is of leucoxene-free opal, but it only partly fills the voids. Those remaining unfilled are lined with goethite; hence the final process affecting the rock must have been ferruginisation.

? SILIC. MOTTLED ZONE

Identificatio n: RH 159; P1073/62; TS 11501.

Locality: Wintinna 4-mile, Arckaringa 1-mile, Beviss Run 4, Photo 5923, Loc. R2, From edge of laterite-duricrust capped scarp along north-east bank of Arckaringa Creek, bearing 80° from Imbitcha Bore.

Lat. 27°45.5'S, Long. 134°40.2'E (from mosaic).

Collected: October 11, 1962, by G.R. Heath.

Field Observations: The rock is a red and white terrazo type silcrete, consisting of silcrete fragments up to 10 mm diameter in a reddish limonitic silcrete matrix. This material is probably Cretaceous shale which was bleached and silicified during the formation of the older duricrust, fragmented and surrounded by limonite as a result of lateritisation, and resilicified by the younger duricrust.

Petrological Report (D. Smale):

This is a ferruginous conglomerate consisting of unsorted angular to subrounded silcrete fragments varying in size from 0.03 mm across to more than 8 mm, in a matrix of goethite and quartz. Most fragments are between 1 and 5 mm across.

The rock gives the impression that the ferruginous material (the matrix of the conglomerate) has intruded along joints and fractures in the silcrete, breaking off some fragments but not separating others from the host rock.

About 30 per cent of the silcrete pebbles consists of angular to subrounded quartz grains 0.01-0.5 mm across in a matrix of cryptocrystalline silica containing very abundant leucoxene. Some fragments of an older silcrete occur within the newer silcrete and are generally of a rather darker colour in transmitted light due to the presence of even more leucoxene.

About 40 per cent of the matrix consists of aggregates of powdery goethite 0.015-0.25 mm across, cemented by very fine chalcedonic quartz with a grain size of 0.001-0.01 mm. A fine line surrounds each goethite aggregate about 0.02 mm away from it, but between crossed nicols it can be seen that the quartz grains bear no relation to the line.

Probably it was once the boundary between a coating of opal and cavity-filling chalcedony, which have since both been converted to quartz.

? SILIC. MOTTLED ZONE

Identification: RH 160; P1074/62; TS 11502.

Locality: Wintinna 4-mile, Arckaringa 1-mile Beviss Run 4, Photo 5923, Loc. R2. From edge of laterite-duricrust capped scarp along the north-east bank of Arckaringa Creek, bearing 80° from Imbitcha bore. Same outcrop as RH 159.

Lat. 27°45.5' S, Long. 134°40.2' E (from mosaic).

Collected: October 11, 1962, by G.R. Heath.

Field Observations: The rock is white and reddish-brown limonitic silcrete. The white portion appears to be fine silcrete fragments in a silcrete matrix., while brown portion appears to have a limonite matrix (? siliceous). This material appears to be formed by the silicification (during the younger duricrust formation) of a laterite mottled zone in situ. The laterite may have included older duricrust fragments.

Petrological Report: (D. Smale):

The white part of this rock is silcrete, 10 per cent of which consists of grains of subangular to subrounded quartz 0.01-0.6 mm across. Subrounded fragments of what appears to be a previous silcrete are on the average about 0.4 mm across but vary considerably in size. They differ little from the newer silcrete, except that some have a slightly coarser matrix, and others have more fine-grained goethite.

The matrix of the white part of the rock consists almost entirely of exceedingly fine-grained quartz and abundant leucoxene. Rutile is an accessory mineral, and occurs in grains comparable in size with the quartz grains.

The brown part of the rock is virtually the same as the white part, except for the presence of a considerable quantity of goethite. This is present in the form of small ovoid aggregates about 0.01 mm across. These aggregates in places are so concentrated that they form apparently massive goethite.

At the boundary between the white and the brown rock the goethite in the brown rock becomes more and more concentrate and then stops very abruptly producing a boundary which is sharp even under high magnification.

In spite of a certain superficial resemblance of this rock to RH 85, the two actually bear little resemblance. It is difficult to tell if goethite has been leached from that part of the rock which is now white, but it seems unlikely.

APPENDIX 1N

CHEMICAL LIMESTONES AND THEIR ALTERATION PRODUCTS.

UPPER TERIARY TO PLEISTOCENE.

RH 8

OLD MOUND SPRING LS.

Identification: RH8; 2.10; P1343/62; TS 11230.

Locality: Warrina 4-mile, Neales 1-mile, Run 4, Photo 1639. From small "terrace" at base of Primrose Hill, south-west of the summit, Neales fossil loc. no. 5.

Lat. 28° 10.7'S, Long. 136° 23.3'E (from mosaic).

Collected: July 27, 1962 by G.R. Heath.

Field Observations: The rock is a light mottled grey limestone, fairly massive pure calcite with numerous vughs and irregular cavities (some containing secondary calcite). The rock shows no obvious bedding or layering. Small (0.1 inch) gastropods are fairly abundant. This limestone appears to be an old mound spring deposit, probably of late Tertiary or Pleistocene age.

Petrological Report: (D. Smale):

This is an arenaceous botryoidal limestone. The calcite is very fine-grained, but some, lining and filling cavities, has recrystallized and is coarser and clearer than the other. Angular quartz grains, 0.03-0.15 mm across, make up about 2% of the rock. There are present a few grains of yellow chlorite similar in size to the quartz grains, of the same type as in TS 11228 and TS11229. In parts of the slide the botryoidal structure gives a misleading impression of shell material.

MT. DUTTON YOUNG LS.

RH 17

IDENTIFICATION: RH 17; 3.12a; P1352/62; TS 11239.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092. From small butte in Mt. Anna Sandstone syncline 3.7 miles south-south-west of Mt. Dutton. Lat. 27°51.5'S, Long. 135°39.4'E.

COLLECTED: August 3, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a very light brown limestone containing abundant poorly sorted, fairly well rounded quartz sand and pebbles. Drusy, showing crude layering (due to variations in sand content). Generally tight. Typical of the arenaceous limestone forming the extensive plateau south of Mt. Dutton. Probably Plio-Pleostocene in age.

PETROLOGICAL REPORT: (D. Smale):

This is an arenaceous limestone consisting of about 7% of quartz grains of variable size (0.01 mm - 1.0 mm) in a calcite matrix. Lenticular cavities are present, approximately aligned, in which crystals of clear calcite have grown forming a lining between 0.5 and 1.0 mm thick. Apart from quartz grains there are a few grains of zircon and plagioclase. Most of the matrix is very fine-grained and clayey, but subsequent recrystallization has given rise to patches of crystals of clearer calcite.

A small pebble occurs in the specimen: it is a sandstone consisting of angular quartz grains in a goethite matrix, and is about 5 mm across.

MT. DUTTON PEBBLY LS.

RH 18

IDENTIFICATION: RH 18; 312 b; P1353/62; TS 11240.

LOCALITY: Oodnadatta ½-mile, Algebuckina 1-mile, Run 4, Photo 9092. Small butte in Mt. Anna Sandstone syncline 3.7 miles south-south-west of Mt. Dutton.
Lat. 27°51.5'S, Long. 135°39.4'E.

COLLECTED: August 3, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a light brown limestone containing abundant 0.1-0.5 inch pebbles of Mt. Anna Sandstone and Willouran slates etc. Pebbles generally rounded, and enclosed in a calcite envelope. No obvious layering. From limestone plateau south of Mt. Dutton. Similar to RH 17, but containing much coarser clastics. Probably Plio-Pleistocene.

PETROLOGICAL REPORT: (D. Smale):

This is an arenaceous limestone similar to R17, but containing many granules and pebbles. About 80% of the rock is calcite; the remainder consists of quartz and goethitic sandstone. The quartz occurs in subangular sand grains and granules, which vary in size from 0.05 mm to 3 mm. The goethitic sandstone is generally in fragments rather larger than the quartz. Many fragments of limestone are present, of sand, granule, and pebble size. The calcite which forms most of the rock, but particularly the matrix, is clayey and extremely fine grained, except where it has recrystallized in and around cavities.

PLEIST. LS. - MT.ALICE RH28

Identification: RH28; P958/62; TS 11386.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6345. From northern edge of plateau at Mt.Alice, 1 mile north of trig (near RH27). Lat. 27°11.3'S, Long. 135°5.8'E (from mosaic).

Collected: September 6, 1962, by G. R. Heath.

Field Observations: The rock is an off-white to very light fawn limestone. It is slightly sandy in part, massive, mainly lithographic, with very low porosity. This is typical of the limestone capping the plateau west and north of Mt. Alice. It overlies the "gypsite" layer and hence is probably Pleistocene in age. It appears to be a lagoonal type deposit probably formed from springs derived from the Mt. Anna Sandstone which is exposed in the area.

Petrological Report: (D. Smale):

This is a fine-grained limestone with a grain size of about 0.002 mm, increasing to about 0.07 mm in places where recrystallisation has taken place. In such places the calcite is considerably clearer than in other parts of the rock.

Subrounded quartz grains about 0.1 mm across are present, but these constitute less than 1 per cent of the rock. Microcline and chlorite are accessory minerals.

The rock gives the impression of having been broken and recemented, though the original calcite and the cementing calcite are in the same form, so that the boundaries between fragments and cement are indistinct.

PLEIST. LS. RH33

Identification: RH33; P962/63; TS 11390.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6345. About 2 miles south-south-west of trig at Mt. Alice. Lat. 27°14.5'S, Long. 135°5'E (from mosaic).

Collected: September 6, 1962 by G.R. Heath.

Field Observations: The rock is a pale cream limestone, showing a few reddish patches. It is generally very clean and homogeneous although somewhat vuggy in part. Outcrops show classic karren weathering surfaces. Typical of the lagoonal limestone outcrops south of Mt. Alice. Appears to be post "gypsite" and is certainly pre-dune sands. Probably Pleistocene in age.

Petrological Report: (D. Smale):

This is a pure limestone with a grain size of about 0.005 mm, similar to RH28. However, the rock has apparently had fairly numerous cavities and irregularities where the calcite has recrystallised. Ghost-like fragments are present, usually 1 or 2 mm in diameter, but often less. The recrystallised patches tend to have slightly larger crystals than those of RH28, the grain size here being about 0.15 mm.

Identification: RH35; P964/62; TS 11392.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6343. From lower part of prominent scarp 4 miles east of Mt. Alice. Lat. 27°12.1'S, Long. 135°10'E (from mosaic).

Collected: September 7, 1962 by G.R. Heath.

Field Observations: The rock is a very pale yellow-green marl or calcisiltite. It forms a homogeneous bed about 11 feet thick over concretionary limonite at the base of the carbonate sequence east of Mt. Alice. The upper part of the cliff section above this material becomes progressively dolomitised (see RH36, RH37). The age of the sequence is unknown, but it is post Cretaceous and may be post "gypsite".

Petrological Report: (D. Smale):

This is a fairly pure limestone consisting of lath-like crystals of calcite generally 0.1-0.2 mm long and 0.03-0.1 mm wide. Some of these appear granular in the slide, but almost all of them are six-sided basal sections of the lath-like crystals.

There is an indication of a preferred orientation of the crystals in one direction normal to the plane of the thin section, and possibly another two, not at right angles to each other, in the plane of the section.

A little interstitial chlorite is present, and a few quartz grains slightly larger than the other grains; these constitute less than 1 per cent of the rock.

CAINOZOIC VUGGY DOL.

IDENTIFICATION: RH 36; P965/62; TS 11393

LOCALITY: Oodnadatta 4-mile, Alberga 1-mile Run 4, Photo 6343. From upper part of prominent scarp 4 miles east of Mt. Alice. Same loc. as RH 35.

Lat. 27°12.1'S, Long. 135°10'E (from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a light buff dolomite ? intraformational conglomerate. The "pebbles" are somewhat rounded dolomite, lighter in colour than the host and generally less than 0.5 inches diameter. The rock is rather vuggy, and some of the cavities are partly filled with calcite. The bulk of the rock is very fine grained and tight. This material comes from the same section as RH 35, forming a layer about 4 feet thick near the top of the section (20-24 feet above limonite horizon). It is the alteration product of a lagoon limestone of probable post "gypsite" age.

PETROLOGICAL REPORT: (D. Smale):

This is an exceedingly fine-grained dolomite with a grain size of less than 0.001 mm. About 2 per cent of the rock consists of partially or completely filled cavities lined initially with opal (? lussatite) 0.05-0.06 mm thick, and containing spherulitic chalcedony, each spherulite being about 0.25 mm in diameter. The larger cavities contain aggregates of fibres of chalcedony about 0.3 mm long. Cavities more than 0.3 mm across are generally only partly filled.

The dolomite contains some rounded or well rounded light-coloured pebbles varying in size from 1-17 mm across. They consist of material similar to that forming the rest of the rock, but containing many recrystallised ooliths 0.08-0.4 mm across.

Small subrounded quartz grains about 0.04 mm across are present, and also a little dendritic goethite, but these impurities form less than 0.5 per cent of the rock.

CAINOZOIC DOL. INTRAFORM. CGLN.

IDENTIFICATION: RH 37; P966/62; TS 11394.

LOCALITY: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6343. From top of prominent scarp 4 miles east of Mt. Alice. Same loc. as RH 35 and 36.
Lat. 27° 12.1'S, Long. 135° 10'E (from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a greenish-cream dolomite intraformational conglomerate. The "pebbles" are darker green, somewhat rounded dolomite, up to 0.5 inches diameter. The material is very fine grained and tight, although showing a few very fine vughs and cracks. The secondary crystals in the vughs do not react with dilute HCl (unlike those of RH 36). This dolomite caps the section mentioned in RH 35 and RH 36). It is about 24 feet above the basal concretionary limonite. May be post "gypsite" age.

PETROLOGICAL REPORT: (D. Smale):

This is a very fine-grained dolomite with a grain size of about 0.003 mm. Cracks and cavities, generally not exceeding 1-2 mm across, are filled with coarse mosaics of large clear dolomite crystals 0.2-0.6 mm across.

Subrounded to rounded granules and pebbles which appear darker than the surrounding rock in the hand specimen consist of similar dolomite containing 10-15 per cent of small dolomite rhombohedra about 0.003 mm across.

Quartz grains, subrounded and about 0.05 mm across, form less than 1 per cent of the rock.

PLIO-PLEIST. LS. RH52

Identification: RH52; P980/62; TS 11408

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9094. 5 miles south west of Mt. Dutton. Lat. 27°51.2'S, Long. 135°37.2'E.

Collected: September 16, 1962 by G.R. Heath.

Field Observations: The rock is an off-white lagoonal or mound spring type limestone containing abundant poorly sorted quartz sand and fine gravel. It is typical of the limestones west and south-west of the Mt. Anna Sandstone cuesta, west of Mt. Dutton. These limestones rest on Cretaceous (Roma) shales and the uniform elevation of the outcrops suggests that they are remnants of a dissected plateau which may date from "gypsite" time (?Plio-Pleistocene).

Petrological Report: (D. Smale):

This is a coarse sandy limestone, 80-85 per cent of the rock consisting of a mosaic of granular calcite with a grain size of 0.1-0.4 mm, and 10 per cent of subrounded quartz grains 0.15-0.7 mm across. Most of the quartz grains are not firmly cemented in the calcite, but occupy spaces slightly larger than themselves. Grains of goethite or goethitic sandstone are present; the sandstone consists of about 40 per cent of subangular to subrounded sand grains 0.03-0.3 mm across in a goethite matrix. The grains are mostly quartz, but minor quantities of chlorite and plagioclase are also present.

PLIO-PLEIST. LS. - MT. DUTTON

RH53
RH56A

Identification: RH53; P981/62; TS 11409; RH56A; A539/62.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9094. 4.7 miles south-south-west of Mt. Dutton. Lat. 27°51.6'S, Long. 135°37.9'E.

Collected: September 16, 1962 by G.R. Heath.

Field Observations: The rock is a light brown "chemical" looking limestone. It is very slightly sandy and somewhat vuggy. This limestone comes from the western edge of the prominent plateau south of Mt. Dutton. It is adjacent to an active spring, and probably represents an old lagoonal or mound spring type deposit. The plateau shows topographical affinities with nearby "gypsite" occurrences, and is probably of Plio-Pleistocene or lower Pleistocene age.

Petrological Report: (D. Smale):

This is a limestone containing 1-2 per cent of subangular to subrounded sand grains of quartz, 0.07-0.4 mm across. These appear to have been affected by solution, and the cavities have been filled with calcite. The grain size of the rock-forming calcite varies from 0.005-0.05 mm. Recrystallisation has resulted in the filling of most cracks and cavities with coarser calcite crystals, but a few cavities remain not completely filled.

A little yellow iron-rich montmorillonite is present in rounded grains about 0.07 mm across, and there is one fairly large grain of yellow tourmaline 0.2 mm across.

Analysis: (J.A. Powell & B. Wood):

Calcium oxide	CaO	45.2%
Barium oxide	BaO	0.025
Strontium oxide	SrO	0.03
Magnesium oxide	MgO	0.68
Sodium oxide	Na_2O	0.22
Potassium oxide	K_2O	0.011
Iron oxide	Fe_2O_3	0.94
Chloride	Cl	0.115
Bromide	Br	Nil
Silica	SiO_2	12.4
Sulphate	SO_3	0.25
Carbon dioxide	CO_2	36.3
Water	H_2O-	0.24
Water (combined)	H_2O+	0.83
Total		97.24%

Identification: RH57; P983/62; TS 11411

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 2, Photo 8825. Small plateau north of railway, 2.2 miles north-north-west of Mt. Dutton. Lat. 27°46.8'S, Long. 135°40'E.

Collected: September 20, 1962 by G.R. Heath.

Field Observations: The rock is a very pale brown limestone, very finely crystalline, with abundant vughs. It contains scattered coarse to very coarse rounded quartz grains. The specimen comes from a small plateau to the north of the Mt. Anna Sandstone cuesta west of Mt. Dutton. The outcrop overlies Cretaceous (Roma) shales and rests on the "gypsite" deposits of the area (ferruginised Cretaceous limestones etc.). It is partly covered by a large fixed sief dune and its age is therefore probably Pleistocene. It is a lagoonal or spring type deposit (c.f. RH 17, 18, 52,53 etc.)

Petrological Report: (D. Smale):

This is a very fine-grained limestone, somewhat botryoidal in hand specimen, with a grain size of about 0.002 mm. Former cavities and joints in the rock have been lined or filled with larger calcite crystals. A few subrounded quartz grains are present, 0.06-0.2 mm across, surrounded by a rim of fairly coarsely granular calcite, as though recrystallisation of the calcite had taken place only in the immediate vicinity of the quartz grains. This rim varies in thickness up to about 0.06 mm. Zircon is an accessory mineral.

SANDY ? KUNKAR

Identification: RH 79; P1004/62; TS 11432.

Locality: Oodnadatta 4-mile, Toodla 1-mile Run 2, Photo 5995, Sec. (2). From top of north wall of "Watson Canyon" at the headwaters of Watson Creek, 15.8 miles north-north-east of Mt. Dutton R.S. (Same loc. as RH 67-69 and RH 78).
Lat. 27° 35.4'S, Long. 135° 48.6'E (from mosaic).

Collected: September 15, 1962, by G.R. Heath.

Field Observations: The rock is a pink and white very sandy limestone, consisting of coarse quartz sand grains in a finely crystalline fairly massive calcite matrix. Variations in clastic content produce crude irregular bedding. This material caps the laterite in the area, and ranges up to 4 feet in thickness. It may be a kunkar-equivalent of ? Pleistocene age.

Petrological Report: (D. Smale)

This is a sandy limestone, containing about 10 per cent of sand grains in a matrix of porous calcite with a grain size of about 0.005 mm. The carbonate has a somewhat botryoidal structure, though this is not apparent in the hand specimen. The sand grains are angular to subrounded and vary in size from 0.05 - 1.25 mm across. Most are quartz or goethitic sandstone. About 30 per cent of the grains have formed the nuclei of goethite ooliths, or have received goethite coatings, though goethite is not present elsewhere in the rock. A few siliceous clay fragments are present,

SANDY ? KUNKAR

Identification: RH 80; P1005/62; TS 11433.

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 2, Photo 5995. From edge of plateau at the eastern headwaters of Watson Creek, about 1 mile north-west of the south-east corner of the prominent laterite-duricrust scarp. 17.4 miles north-north-east of Mt. Dutton R.S. Lat 27° 34.5'S, Long. 135° 51'E (from mosaic).

Collected: September 17, 1962, by G.R. Heath.

Field Observations: The rock is a pink to light brick very sandy limestone, consisting of quartz and silcrete coarse sand and gritty pebbles in a matrix of finely crystalline limonite calcite. 3 mm vughs in the original rock have been filled with white calcite. This material, like RH 79, caps a laterite profile, and in this case appears to grade laterally and vertically into "gypsite". It may be ?Pleistocene kunkar.

Petrological Report: (D. Smale):

This is an impure limestone containing fragments of sand, granule and pebble size from 0.5 mm to 10 mm across consisting of quartz sandstone cemented by goethite, limestone with a few quartz grains up to 0.2 mm across, limestone, with a grain size of about 0.02 mm, and chert. The matrix is fine clayey calcite, containing 5-10 per cent of goethite ooliths about 0.25 mm in diameter usually with relatively large quartz grains as nuclei, and many carbonate ooliths the same size and smaller which form 40-50 per cent of the matrix. The quartz grains in the ooliths were rounded or subrounded; those in the fragments are rather more angular. All have been rendered more angular by solution.

As the goethite ooliths are set in a matrix of calcite, ferruginisation must have taken place before calcification, but this does not exclude the possibility of there having been one or more earlier phases of calcification.

YOUNG LIMESTONE RH 168

IDENTIFICATION: RH 168; 3.14; P1218/62; TS 10692.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile Run 2, Photo 8825. 0.75 miles north-west of Wondillina bore. Lat 27° 47.5'S. Long. 135°38.5'E.

COLLECTED: August 4, 1962 by G.R. Heath

FIELD OBSERVATIONS: The rock is a buff coloured limestone, very massive and finely crystalline, with 5-10% vughs, many partly filled with secondary crystalline calcite. The rock shows crude sub-horizontal layering. This is typical of the ? spring limestone west and south of Mt. Dutton. Age probably Plio-Pleistocene to Recent. The limestone collected caps a small mesa (15 feet high) surrounded by dune sands.

PETROLOGICAL REPORT: (W.R. McCarthy):

The rock is a cryptocrystalline to fine-grained limestone. Numerous grains of angular, fine to medium-grained quartz are scattered through the carbonate and comprise 10-15 percent of it. Secondary carbonate has partially to completely filled vugs and these fillings are coarser grained than the matrix.

Similar carbonates have been described by the writer from Lake Eyre bores. It seems probable that the sediment is a lacustrine deposit.

APPENDIX 1o

PLEISTOCENE GYPSITE AND ASSOCIATED LIMONITE DEPOSITS

LIMONITE - MT. ALICE

RH31
RH32A

Identification: RH31; P961/62; TS 11389; RH32A; A525/62.

Locality: Oodnadatta 4-mile. Alberga 1-mile, Run 4, Photo 6345. Small mesa 0.5 miles north-east of Mt. Alice trig. Lat. 27°11.9'S, Long. 135°6.2'E (from mosaic).

Collected: September 6, 1962 by G.R. Heath.

Field Observations: The rock is dark brown concretionary limonite. It is massive, dense and metallic, and consists of closely packed concretionary bodies up to 0.3 inches diameter. Some fragments show what appear to be solution channels and pipes. This limonite caps much of the gypsite in the area, as well as forming large bodies (up to 3 feet across) in the gypsum layer. It appears to be at least partly formed by limestone alteration.

Petrological Report: (D. Smale):

This is an oolitic goethite-quartz rock. The ooliths are goethitic and have marked concentric structure: they vary in size from 0.5 mm to just under 10 mm across. Some of the concentric layers of the ooliths consist of narrow bands of fine grained quartz 0.05 mm or less thick. These may have formed as a result of shrinking of the goethite and the subsequent silicification which formed the rock. About 1-2 per cent of the rock consists of rounded or subrounded quartz grains about 0.05 mm across, coated with a layer of goethite. Some of these grains have authigenic overgrowths of quartz and only a very thin goethite layer between the allogenic and the authigenic quartz.

About 75 per cent of the goethite occurs in irregular masses varying in size from that of the ooliths down to about 0.05 mm across; it is red-brown, and generally isotropic. The remainder of the rock consists of a quartz mosaic with a grain size of about 0.02 mm.

Analysis: (J. Powell and R. B. Oliver):

Aluminium oxide	Al_2O_3	3.62%
Iron - acid soluble	Fe	50.7
- acid insoluble	Fe	0.015
- total oxide	Fe_2O_3	72.4
Titanium oxide	TiO_2	0.072
Calcium oxide	CaO	0.66
Silica	SiO_2	7.95
Carbon dioxide	CO_2	0.07
Phosphorus pentoxide	P_2O_5	0.375
Sulphate	SO_3	1.20
Water - total	H_2O	11.16
Total		97.51%

"GYPSITE" - LIMONITE-GYPSUM RH70

Identification: RH70; P996/62; TS 11424

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 3, Photo 5974, Loc. (1). From base of eastern flank of "Faulted Hill", near the headwaters of Watson Creek, 14.5 miles north-north-east of Mt. Dutton R.S. Lat. 27°36.6'S, Long. 135°48.2'E. (from mosaic)

Collected: September 13, 1962, by G.R. Heath

Field Observations: The rock consists of very dark brown limonite intergrown with 0.5 inch gypsum plates. This type of intergrowth is not uncommon near the base of the Pleistocene "gypsite" in the area. It shows the close relationship between ferruginization and gypsite crystallization. The specimen comes from a "gypsite" layer lapping on to "Faulted Hill" (a cretaceous "monadnock" capped by younger duricrust).

Petrological Report: (D. Smale):

This is a gypseous goethite breccia similar to RH136, consisting of angular fragments 1-20 mm across of massive dark brown goethite in a gypsum cement. The fragments are not widely separated, and appear as though they may have been forced apart by the crystallisation of the gypsum. They are very variable in size, and the larger ones contain a small proportion (about 2 per cent) of lenticular cavities along some of which fracture has taken place to allow the passage of the gypsum.

LIMONITE - ?GYPSITE

RH76
77A

Identification: RH76; P1002/62; TS 11430; RH77A; A526/62

Locality: Oodnadatta 4-mile, Toodla 1-mile, Run 4, Photo 5951. From southern flank of prominent plateau north of The Neales, about 2 miles west of the railway line (near RH71-75). Lat. 27°41.9'S, Long. 135°32.7'E. (from mosaic).

Collected: September 14, 1962, by G.R. Heath.

Field Observations: The rock is brown and yellow-brown mottled ?siliceous limonite, rather similar in appearance to RH71. It is very hard, fine grained and homogeneous. It produces the dark coloured patch on the aerial photo, and occurs well down the cliff section of RH71-75. This material appears to follow a specific horizon within the altered Cretaceous shales, but as the zones of the laterite profile, the "gypsite" surface and shales have very similar attitudes, this may be coincidental. By analogy with other occurrences, this limonite is attributed to processes associated with the "gypsite" formation (lower Pleistocene) which have affected a particular horizon within the Cretaceous (?Tambo). This horizon was probably originally calcareous.

Petrological Report: (D. Smale):

This is massive goethite. Quartz forms not more than about 2 per cent of the rock, and occurs generally as mosaics in patches about 0.2 mm across, and sometimes as single grains. The goethite is semi-opaque and reddish-brown.

The presence of quartz in this form, together with the hardness of the hand specimen, implies that the rock has undergone silicification as a late stage in its history.

Analysis: (J. Powell & R.B. Oliver):

Aluminium oxide	Al_2O_3	0.51%
Iron - acid soluble	$Fe^{2}O_3$	41.1
- acid insoluble	Fe	0.075
- total oxide	Fe_2O_3	58.8
Titanium oxide	TiO_2	0.005
Calcium oxide	CaO	0.32
Silica	SiO_2	30.87
Carbon dioxide	CO_2	0.08
Phosphorus pentoxide	P_2O_5	0.202
Sulphate	SO_3	0.16
Water - total	H_2O	7.94
Total		98.89%

RH 120A

BUTTERFLY GYPSITE

Identification: RH 120A; A531/62.

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0363, Loc. UR 11. 21.7 miles south-east of Macumba H.S.

Lat. 27° 8.6' S, Long. 135° 58.7' E (from mosaic).

Collected: October 16, 1962, by G.R. Heath.

Field Observations: The material is pinkish fairly finely crystalline gypsum, generally in the form of butterfly twins. It comes from the gypsite capping which laps on to the laterite capped plateau north of UR11 at a low angle. Age tentatively Lower Pleistocene.

Analysis: (J.A. Powell and B. Wood)

Calcium oxide	CaO	24.5%
Barium oxide	BaO	0.02
Strontium oxide	SrO	0.08
Magnesium oxide	MgO	0.08
Iron oxide	Fe_2O_3	0.98
Aluminium oxide	Al_2O_3	3.29
Silica	SiO_2	13.6
Sulphate	SO_3	35.4
Water at 44°C	H_2O-	0.59
Water above 44°C	H_2O+	20.18
Total		98.72

RH 121

GYPSUM SANDSTONE

Identification: RH 121; P1042/62; TS 11470

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0363, Loc. UR 13. 22.1 miles south-east of Macumba H.S.

Lat. 27° 24.3' S, Long. 135° 58.8' E (from mosaic).

Collected: October 16, 1962 by G.R. Heath.

Field Observations: The rock is a pale fawn "silky" looking sandstone, consisting of very fine quartz sand grains cemented by crystalline gypsum. The gypsum has crystallized as large units, giving a "fontainebleu" texture to the rock. This material is the lowest constituent of a "gypsite" plateau capping, about 10 feet thick. Age probably Lower Pleistocene.

Petrological Report: (D. Smale):

This is a fine sandstone consisting of well sorted subrounded to rounded fine sand grains in a gypsum matrix nearly optically continuous. The grains form about 30 per cent of the rock, and are on the average about 0.06 mm across. Dark green iron-rich montmorillonite constitutes more than half the grains; quartz, goethite and plagioclase form the remainder.

Tourmaline is an accessory mineral.

RH 123A

FERRUGINIZED CRETACEOUS LIMESTONE

Identification: RH 123A; A528/62.

Locality: Oodnadatta 4-mile, Ucutanna 1-mile, Run 3, Photo 0361, Loc. UR 16.18.6 miles south east of Macumba, H.S.

Lat. 27°24.3' S, Long. 135° 54.7' (from mosaic)

Collected: October 16, 1962, by G.R. Heath.

Field Observations: The rock is dark brown, slightly siliceous very fine grained limonite, from a group of completely ferruginized concretionary limestone outcrops, in the dissected area of Cretaceous shales between the laterite plateaux of Ucutanna and Edarteenya 1-mile sheets. Alteration of the ? basal Winton limestones probably occurred when the "gypsite" surface layer developed (? Lower Pleistocene).

Analysis: (J. Powell and R.B. Oliver):

Aluminium oxide	Al_2O_3	3.70%
Iron - acid soluble	Fe	50.3
- acid insoluble	Fe	0.03
- total oxide	Fe_2O_3	71.9
Titanium oxide	TiO_2	0.129
Calcium oxide	CaO	0.58
Silica	SiO_2	10.77
Carbon dioxide	CO_2	0.11
Phosphorus pentoxide	P_2O_5	0.162
Sulphate	SO_3	0.11
Water - total	H_2O	7.54
Total		95.03%

GYPSUM-LIMONITE MASS

RH135A
RH136

Identification: RH136; P1054/62; TS11482; RH135A; A540/62

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER6. 16.5 miles north of Duckhole Bore. Lat. 27°23.9'S, Long. 136°2.0'E (from mosaic).

Collected: October 19, 1962, by G. R. Heath.

Field Observations: The rock is 50% dark brown, 2-10 mm, prisms of limonite intergrown with 50% platy gypsum. Texture is almost heiroglyphic. The limonite has quite a reddish streak, and may be haematitic. This material comes from the base of a "gypsite" and "gypsite" affected sequence, and may be a ferruginized limestone impregnated with gypsum.

Petrological Report: (D. Smale):

This is a breccia consisting of angular fragments of goethite up to 7 mm across, but generally about 3 - 4 mm across, poikilitically enclosed in gypsum. Fragments less than about 1 mm across are present, but are rare; they are probably the result of brecciation during the cementation of the rock. Little or no transportation of the fragments can have taken place, as many are still alongside those fragments from which they broke. In view of this the relatively uniform size of the fragments is rather surprising; it implies that brecciation took place as a result of something such as dehydration producing homogeneous strain in the rock.

Anhydrite occurs whithin the gypsum in such a way that the anhydrite is nowhere in contact with the goethite.

Analysis: (J. Powell & R.B. Oliver):

Aluminium oxide	Al_2O_3	3.08%
Iron - acid soluble	Fe	35.5
Iron - acid insoluble	Fe	0.03
Iron - total oxide	Fe_2O_3	50.7
Titanium oxide	TiO_2	0.121
Calcium oxide	CaO	8.05
Magnesium oxide	MgO	0.36
Silica	SiO_2	8.20
Carbonate	CO_2	0.10
Sulphate	SO_3	12.20
Water-total	H_2O	13.72
Total		95.53%

APPENDIX 1P

MT. ALICE CONGLOMERATE AND ASSOCIATED SILICIFIED SANDSTONE.

SILIC. SS. - MT. ALICE. RH 24

IDENTIFICATION: RH 24; P954/62; TS 11382

LOCALITY: Oodnadatta 4- mile, Alberga 1-mile, Run 4, Photo 6345. A few yards north-east of trig at Mt. Alice.

Lat. 27° 12.1'S. Long. 135°5.8'E (from mosaic).

COLLECTED: September, 6, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is a reddish sandstone containing irregular clots and lenses of altered shale. It consists of rounded coarse quartz sand grains in a siliceous matrix. Very well indurated. This sandstone is topographically lower than the Mt. Alice conglomerate, but its relationship to the conglomerate is obscure. It may belong to the Mt. Anna Sandstone equivalents in the area, or it may be equivalent to the Mt. Alice Conglomerate (ie post "gypsite" age, probably Pleistocene).

PETROLOGICAL REPORT: (D. Smale):

This is a flinty sandstone consisting of nodular masses and anastomosing veins of reddish flint an siliceous sandstone. A few pebbles or nodules of dark ferric-red jasper occur, distinct from the flint.

The siliceous sandstone consists of rounded to well- rounded grains of quartz from 0.05 to 0.5 mm across, cemented by authigenic overgrowths of quartz, or by flint. In those grains with authigenic overgrowths the boundary of the original grain is marked by a thin layer of iron oxide grains, of 0.001 mm diameter or less, of the same type as those colouring the flint.

The flint contains about 25 per cent of small angular to subrounded quartz grains an average of about 0.02 mm across, and occasional sericite flakes. The iron oxide is probably goethite.

Chlorite, angular tourmaline and rounded zircon grains are accessory minerals.

MT. ALICE CONGLOMERATE RH25

Identification: RH25; P955/62; TS11383.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6345. From trig location at Mt. Alice. Lat. 27°12.1'S, Long. 135°5.8'E (from mosaic).

Collected: September 6, 1962, by G. R. Heath.

Field Observations: The rock is a dark brown pebble conglomerate, consisting of 0.1 to 0.3 inch, well rounded, light yellow and red-brown silcrete and lesser quartz pebbles in a somewhat sandy, dark brown, vuggy siliceous limonitic matrix. This specimen is typical of the Mt. Alice Conglomerate, which is restricted to a few small outcrops in the vicinity of the Mt.Alice trig station. I. B. Freytag (pers. comm.) states that the conglomerate overlies and grades down to the silicified chemical limestone and conglomeratic limestone forming the prominent plateau west and north-west of Mt. Alice. This in turn overlies the "gypsite" layer of presumed Pleistocene age.

Petrological Report: (D. Smale):

This is a siliceous conglomerate consisting of well-rounded to rounded granules and pebbles 2-20 mm across in a matrix of rounded to subrounded quartz grains 0.05-0.6 mm across. The precise nature of the cement is obscured by the large concentration of goethite grains it contains, 0.001-0.003 mm across, but gaps between these grains disclose the presence of quartz. In places where the goethite is absent or nearly so, the quartz grains are cemented by authigenic overgrowths, a layer of goethite marking the boundary of the original grain in each case, as in RH24. (See fig. 2).

The granules and pebbles consist generally of :-

(1) Massive coarse vein quartz, strongly rutilated, consisting of a quartz mosaic with very irregular crenulate boundaries between the grains.

(2) Rock with subangular to subrounded quartz grains 0.3-2.0 mm across in a matrix of poorly sorted quartz grains 0.03-0.2 mm across

(3) Rock containing quartz grains similar to those in (2) above, but forming less than 15 per cent of the rock, in cryptocrystalline silica containing much leucoxene or fine-grained goethite forming small colloform structures, sometimes in the form of whole concentric whorls (see fig. 1).

(4) Fine-grained chert with a few larger grains of quartz.

(5) Chalcedony, with typical botryoidal impurities.

As a result of thorough silicification this rock is almost non-porous.

Rutile, tourmaline and zircon are accessory minerals.

Photomicrograph taken.

SILIC. SS. - MT. ALICE RH26

Identification: RH26; P956/62; TS 11384

Locality: Oodnadatta 4-mile, Alberga 1-mile Run 4, Photo 6345, Adjacent to Mt. Alice trig. Lat. 27°12.1'S, Long. 135°5.8'E (from mosaic).

Collected: September 6, 1963, by G. R. Heath.

Field Observations: The rock is a honey brown sandstone, containing rounded, fairly well sorted, fine to medium quartz sand grains in a siliceous cement or matrix. It underlies and appears to grade into the Mt. Alice Conglomerate. It is probably of Pleistocene age.

Petrological Report: (D. Smale):

This is an orthoquartzite consisting entirely of sub-rounded and rounded quartz grains, 0.08-0.8 mm across cemented by authigenic overgrowths of quartz, as in RH24 and RH25, which completely fill the interstices and form a mosaic. The original grains are outlined by thin coatings of goethite, which gives the hand specimen its colour.

In a few places interstitial carbonate has been deposited, but this would form less than 1 per cent of the rock.

Tourmaline, rutile and zircon are accessory minerals.

APPENDIX 1Q

YOUNG (PLEISTOCENE - RECENT)

SILICIFIED LIMESTONES (POTCH).

SILICIFIED PLEIST. LS. RH34.

Identification: RH34; P963/62; TS 11391.

Locality: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6343. 3.7 miles east of Mt. Alice. Small scarp just east of Todmorden - Mt. Sarah boundary fence. Lat. 27°11.6'S, Long. 135°9.4'E (from mosaic).

Collected: September 7, 1962 by G.R. Heath.

Field Observations: The rock consists of fairly colourless translucent "potch" surrounded by light green chert. The material is very compact, but rather brittle. It forms part of the capping on the plateau east of Mt. Alice. It appears superficially like silicified Cretaceous shale, but is probably a replacement after Pleistocene lagoonal limestone.

Petrological Report: (D. Smale):

This is a recrystallised oolitic chert. It consists in general of a fine quartz mosaic with an average grain size between 0.005 and 0.01 mm; the clear or translucent part of the rock contains the ooliths, and the more opaque greenish part consists of siliceous clay and a few quartz grains, with chalcedony-filled cavities lined with clear opal up to 0.2 mm thick.

Only a few of the ooliths are visible in ordinary light; these are generally 0.3-0.4 mm in diameter and consist of mosaics of quartz grains larger than those elsewhere in the rock, about 0.05 mm across. Some of those ooliths contain carbonate, sometimes almost to the exclusion of quartz, and often a mineral of low birefringence with a refractive index higher than that of quartz; it is probably a clay.

Most of the ooliths are 0.2-0.3 mm in diameter, and are visible only between crossed nicols. They consist of a very fine-grained interior surrounded by a chalcedonic rim about 0.015 mm thick.

Recrystallisation, probably as a result of a late phase of the original formation of the rock, has obscured much of its structure.

The small whitish patches visible in the clear material in the hand specimen are due to concentrations of leucoxene.

X-ray analysis of the opaque greenish material showed the presence of illite and quartz; cristobalite could be present, but it is difficult to distinguish from the quartz. The material is too fine-grained for optical identification.

POTCH (SILIC. LS.) RH 39

IDENTIFICATION: RH 39; P968/62; TS 11396.

LOCALITY: Oodnadatta 4-mile, Alberga 1-mile, Run 4, Photo 6343. From base of lower scarp 3.5 miles east-north-east of Mt. Alice.

Lat. 27° 11.3'S, Long. 135°9.2'E (from mosaic).

COLLECTED: September 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is off-white translucent, somewhat mottled potch. Generally massive and compact, but somewhat vuggy in part. This is typical of the material formed by ? Recent silicification of mound spring and lagoonal type limestones in the Oodnadatta area. This silicification may be equivalent to the Australt Downs silicifi tion east of Lake Eyre (H. Wopfner, pers. comm.).

PETROLOGICAL REPORT: (D. Smale):

This is chalcedonic chert consisting of a fine-grained mosaic, varying in grain size from place to place in the rock from 0.05-0.005 mm. The grains have weakly spherulitic or finely fibrous structure, unusual in that the optical elongation of the fibres is positive and the axis of the fibres is (0001). Chalcedony fibres more usually have negative elongation.

slow evaporite

In ordinary light small colloform structures can be seen, marked by leucoxene; they are generally sharply curved and are about 0.05 mm across. Colloform structures with a particularly small radius of curvature may form complete circles.

POTCH - FAULTED HILL

IDENTIFICATION: RH 66; P992/62; TS 11420.

LOCALITY: Oodnadatta 4-mile, Toodla 1-mile, Run 3, Photo 5974, Loc. (1). From northern flank of "Faulted Hill", near eastern headwaters of Watson Creek, 14.5 miles north-north-east of Mt. Dutton R.S. (same loc. as RH 65)

Lat. 27° 36.4' S, Long. 135° 48.1'E. (from mosaic).

COLLECTED: September 13, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The rock is white "potch". It is translucent fairly homogeneous and rather vuggy. This material occurs as irregular patches associated with Tertiary sandstone which has been affected by younger duricrust formation (eg RH 64). Its origin is obscure - it may be a vein type deposit associated with the younger duricrust or later (Austral Downs) silicification; or it may be a limestone replacement (c.f. Mt. Alice area eg RH 34). Its age is probably Pliocene to Recent.

PETROLOGICAL REPORT: (D. Smale)

This consists largely of chalcedonic quartz. It is a fine, or very fine, mosaic of quartz with a grain size varying from 0.002 - 0.05 mm; the grains show a tendency towards spherulitic extinction and positive elongation, as in RH39.

The small opaque patches visible in the hand specimen 1 or 2 mm across consist of opal. Zircon is an accessory mineral.

APPENDIX 1R

UNCLASSIFIED SAMPLES

ROMA FOSSIL WOOD

Identification: RH23; 4.8; P1358/62; TS11245; F4/63

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 6, Photo 8990. Algebuckina fossil loc. No. 37. 8.2 miles southwest of Algebuckina R.S. Lat. 27°58'S., Long. 135°40.8'E.

Collected: August 9, 1962, by G.R. Heath

Field Observations: The material is calcareous and ?siliceous dark grey fossil wood. H. Wopfner (pers. comm.) suggests that it may be a conifer. The outcrop is in an area adjacent to richly fossiliferous Roma limestones, and consists almost entirely of fossil wood fragments.

Petrological Report: (D. Smale):

This is fossil wood, calcified, consisting of juxtaposed rows of cells each between 0.03 and 0.05 mm across. It consists entirely of the carbonaceous material of the cell walls and the calcite filling. The calcite is considerably in excess of the carbonaceous material.

Palaeontological Report: (W.K. Harris):

The specimen consists of an entire portion of stem.

Preservation is poor and much of the tissue is replaced and distorted by calcite.

In radial and transverse longitudinal section structures are indistinct and indeterminable.

In transverse section the wood shows clear annual rings. The wood consists entirely of tracheidal elements which are generally distorted.

The wood can only be referred to the genus Mesembroixylon.

RECENT SPRING EVAPORITE RH55A

Identification: RH55A; A538/62.

Locality: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9092. Big Cadna-owie Spring, 3.4 miles south of Mt. Dutton. Lat. 27°51.4'S, Long. 135°40.3'E.

Collected: September 16, 1962 by G.R. Heath.

Field Observations: The material is white finely crystalline evaporite deposited along the sides of the channel leading away from one of the springs at Mt. Dutton. The water originates in the Mt. Anna Sandstone (Blythesdale equivalent).

Analysis: (J.A. Powell & B. Wood):

Calcium oxide	CaO	0.45%
Barium oxide	BaO	0.006
Strontium oxide	SrO	0.02
Magnesium oxide	MgO	2.25
Sodium oxide	Na_2O	42.8
Potassium oxide	K_2O	0.45
Iron oxide	Fe_2O_3	0.145
Chloride	Cl	42.8
Bromide	Br	0.08
Silica	SiO_2	2.12
Sulphate	SO_3	12.3 (?1.23)
Carbon dioxide	CO_2	0.06
Water	H_2O-	0.24
Water (combined)	H_2O+	5.75
Total		109.47% (?98.4%)

VEIN CELESTITE

Identification: RH97; P1C22/62.

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 4, Photo 1847. Loc. WR4. 15.7 miles east-south-east of Duckhole bore. Lat. 27°41.2'S, Long. 136°19.7'E. (from mosaic).

Collected: October 6, 1962, by G.R. Heath.

Field Observations: The sample consists of white translucent crystals (?hexagonal) with chisel end terminations. This material occurs as veins, up to 1 inch wide, in calcareous ?Winton sandstones.

Petrological Report: (D. Smale):

This is celestite, distinguished from barite by its slightly lower refractive index. It occurs in masses of crystals general 7-15 mm long and 1-3 mm wide, subradiating in form.

RH 103

? KOPI GYPSUM

Identification: RH 103; P1028/62; TS 11456.

Locality: Oodnadatta 4-mile, Woodmurra 1-mile, Run 3, Photo 1827, Loc. WR12 6.6 miles east of Duckhole Bore (on north side of Woodmurra Creek).

Lat. 27° 37.8' S, Long. 136° 11.2' E (from mosaic.)

Collected: October 8, 1962, by G.R. Heath.

Field Observations: The material is off-white fairly massive, very finely crystalline gypsum. Some suggestion of vertical orientation of crystals. Weathered surface shows karren type weathering. This material is typical of the hard crust which forms on deposits of floury (?aeolian) kopi in the Oodnadatta area.

Petrological Report: (D. Smale).

This is a gypsum rock, probably "gypsite" (Pettijohn 1957, page 485). It is fine-grained (0,004 mm grain size), but on the sites of former probable cavities the gypsum occurs in fibrous aggregates, each fibre being about 0.07 mm long.

A few subangular quartz grains are present 0.03 - 0.25 mm across; these constitute less than 1 per cent of the rock.

SILICIFIED WOOD RH133

Identification: RH133; P1052/62; TS11480.

Locality: Oodnadatta 4-mile, Edarteenya 1-mile, Run 4, Photo 0394, Loc. ER5. 14.6 miles north of Duckhole Bore. Lat. 27°25.3'S, Long. 136°4.7'E (from mosaic).

Collected: October 19, 1962, by G. R. Heath.

Field Observations: The specimen is brown highly silicified fossil wood. It is portion of an annular fragment which was probably 1-2 feet in diameter. The rows of cells are still plainly visible, but the silica has crystallized to a coarse sandy or quartzitic texture. This fragment could be from the Winton equivalents (Cretaceous, ?Cenomanian) or the Tertiary (?Pliocene) blanket sandstone, both of which have been silicified as a result of Tertiary duricrust formation.

Petrological Report: (D. Smale):

This is silicified wood. The annular rings are readily apparent in the hand specimen; on microscopic examination they prove to consist of a series of bands of coarse (0.1 - 0.15 mm) and fine (0.01 mm) quartz generally independent of the cell structure. The cells are elongated in a direction at right angles to the rings, and are in juxtaposed rows parallel to the elongation. They have an average diameter of about 0.05 mm. Where the quartz is fine-grained the cells are clearly visible, but where the quartz is coarse their outlines and shape are very indefinite.

In some parts of the specimen the coarse rings are rather porous, and contain almost equal quantities of light reddish-brown goethite and quartz. The goethite forms a very fine-grained coating on the free surfaces of the quartz grains in the porous parts of the rock; its concentration frequently increases towards the outside of the tree, and then abruptly stops.

RH143

"CONE IN CONE" CALCITE

Identification: RH143; P1061/62; TS11489

Locality: Oodnadatta 4-mile, Toondina 1-mile, Run 2, Photo 8812, Loc. TR18. 16.7 miles north-west of Mt. Toondina.
Lat. 27°45.8'S, Long. 135°11.4'E (from mosaic).

Collected: November 1, 1962, by G.R. Heath.

Field Observations: The material is light grey rather clayey looking "cone-in-cone" material from the outer weathered zone of a Cretaceous (Tambo) concretionary limestone. This surface texture is very common on somewhat weathered Cretaceous "clean" limestones, throughout the Oodnadatta area.

Petrological Report: (D. Smale):

This is calcite consisting of bands a little less than 0.1 mm thick of fine fibres aligned along the bands. The bands are superimposed in two directions which appear in the slide to be a little more than 20° apart; the true divergence is not likely to be much more than 30°.

RH 144

GYPSUM-PYROLUSITE

Identification: RH 144; P1062/62.

Locality: Oodnadatta 4-mile, Toondina 1-mile Run 2, Photo 8812, Loc. TR 18.16.7 miles north-west of Mt. Toondina.

Lat. 27° 45.8'S, Long. 135°11.4'E (from mosaic).

Collected: November 1, 1962, by G.R. Heath.

Field Observations: The sample is crystalline gypsum associated with dull black ? manganiferous material. This association occurs fairly frequently in weathered Cretaceous concretionary limestones, often as thin veins associated with "cone-in-cone" calcite.

Petrological Report: (D. Smale):

This is mainly fibrous gypsum, apparently from a cavity-filling. The black material on the sides of the specimen is in fine powdery form, and gave positive tests for manganese. A positive test for barium was not obtained, and the complete solution of the material in HC l without any siliceous residue indicated an absence of silica; the powder is therefore unlikely to be psilomelane or braunite. It is almost certainly pyrolusite.

RH 148

VEIN GYPSUM

Identification: RH 148A; A532/62

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 3, Photo 6071, Loc. OR 5. From scarp at south edge of gypsite plateau south of The Neales, 24.9 miles west-south-west of Oodnadatta.

Lat. 27° 36.9'S, Long. 135° 2.9'E. (from mosaic).

Collected: November 2, 1962, by G.R. Heath.

Field Observations: The material is coarsely crystalline tabular gypsum, from veins and layers in bleached and kaolinised Cretaceous (Tambo) shales of a partly stripped laterite and/or duricrust profile. Individual veins range up to a foot in thickness, and slabs of gypsum exposed by erosion measure up to 3x4x1 feet. The gypsum may date from the original period of bleaching (upper Tertiary), but is more likely to have been deposited during "gypsite" formation (? Lower Pleistocene).

Analysis: (J.A. Powell and B. Wood):

Calcium oxide	CaO	32.4%
Barium oxide	BaO	0.004
Strontium oxide	SrO	0.04
Magnesium oxide	MgO	Nil
Iron oxide	Fe_2O_3	0.023
Aluminium oxide	Al_2O_3	0.008
Silica	SiO_2	0.018
Sulphate	SO_3	46.1
Water at 44°C	H_2O-	0.10
Water above 44°C	H_2O+	20.84
Total.		99.70%

RH 151

MASSIVE SILICEOUS LIMONITE

Identification: RH 151; P1067/62; TS 11495

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 1, Photo 6150, Loc. OR 13, 2.3 miles west of Oodnadatta.

Lat. 27° 32.6'S, Long. 135° 25.1'E (from mosaic).

Collected: November 9, 1962 by G.R. Heath.

Field Observations: The rock is brown cherty limonite with a 1-5 mm surface layer of green ("malachite") chert. It forms a series of low "outcrops" adjacent to The Neales. The material is often cut by fairly coarsely crystalline quartz veins. Quartz also occurs in vughs in the rock. This limonite may be a limestone replacement product, or it may be related to the Upper Tertiary laterite formation.

Petrological Report: (D. Smale):

This consists largely of light brown goethite and has a distinctive dark green rim about 5mm thick around the outside of most of the specimen. The whole rock is "set" against a background of exceedingly fine microcrystalline quartz with a probable grain size of less than one micron.

The strong green coloration of the outside rim is due to ferrous iron, and is probably the result of recent reduction. On oxidation the rim becomes the same colour as the rest of the rock.

CELLULAR DOLOMITE

Identification: RH 153, P1069/62; TS 11497

Locality: Oodnadatta 4-mile, Oodnadatta 1-mile, Run 1, Photo 6149, Loc. OR 26.4.3 miles west of Oodnadatta in centre of photo-geological anomaly. See also plan 63-608.

Lat. 27°31.3' S, Long. 135° 23.2' E, (from mosaic).

Collected: November 9, 1962, by G.R. Heath.

Field Observations: The rock is a grey cellular looking dolomite, with numerous vughs filled with comb structures. The rock as a whole is fairly porous. This material crops out fairly close to normal concretionary Cretaceous limestone, showing surface "cone-in-cone" structure, and may be a Tertiary or Recent alteration product of these limestones.

Petrological Report: (D. Smale):

This is a dolomite rock consisting of a granular mosaic of dolomite with a grain size of about 0.05 mm. Brownish semi-opaque goethitic impurities form about 5 per cent of the rock. Patches of the rock about 1-5 mm across are very porous, containing only widely-spaced sheet-like dolomite flakes crossing them, in which the dolomite is of the same granular nature as that in the more solid parts of the rock. The patches are probably pseudomorphs after something which has been leached out.

CELESTITE

RH 165
RH 166A

IDENTIFICATION: RH 165; 4.5; P1216/62; RH166A; 4.5A; A420/62.

LOCALITY: Oodnadatta 4-mile, Algebuckina 1-mile, Run 4, Photo 9084, Loc. (S), Lat. 27° 49.6'S, Long. 135° 57.8'E.

COLLECTED: August 7, 1962 by G.R. Heath.

FIELD OBSERVATIONS: The outcropping celestite covers a few square yards. It occurs as a sub-horizontal layer 1½ to 2 inches thick. The crystals are oriented vertically and appear rather fibrous. This texture is strongly reminiscent of the gypsum which forms partings in the area. The celestite is off-white in colour and occurs in weathered Cretaceous (? Tambo) shales of the Great Artesian Basin.

PETROLOGICAL REPORT (W.R. McCarthy):

The mineral submitted for identification was examined in standard refractive index oils. The optical properties determined by this method (i.e., indices of refraction, optical sign, and crystal system) all are diagnostic of celestite.

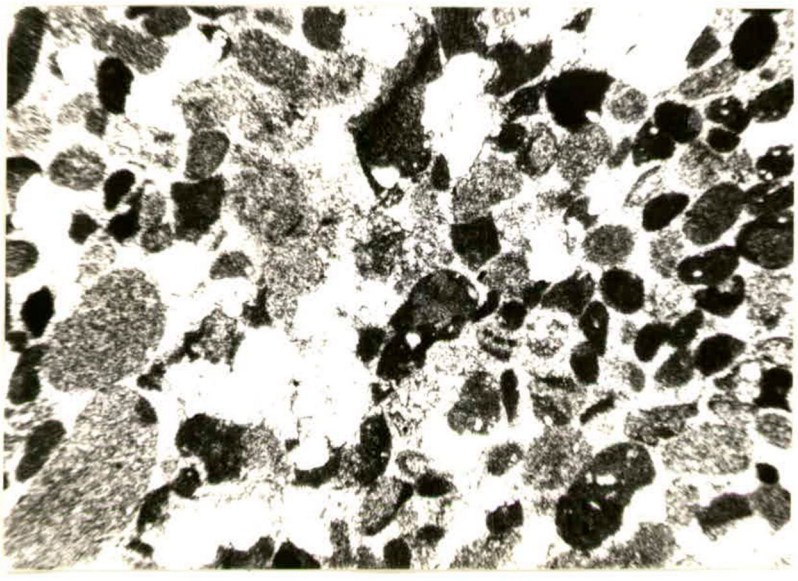
Neither stratigraphic position nor genesis of the mineral are determinable by examination of the sample.

However, celestite has been reported to occur in beds of gypsum, rock salt, etc. The sample examined shows no evidence of being pseudomorphic after an earlier mineral.

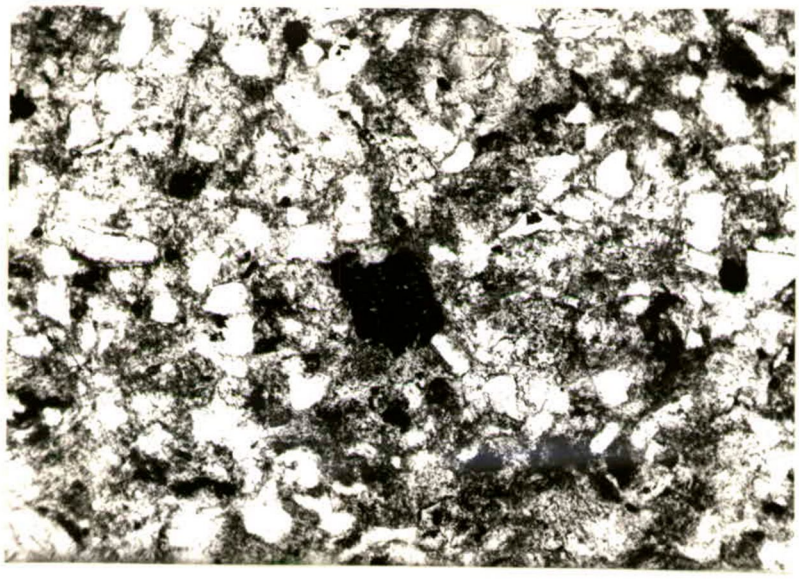
Analysis (R.G. Stafford):

Barium Sulphate	$BaSO_4$	6.0%
Strontium Sulphate	$SrSO_4$	93.4%

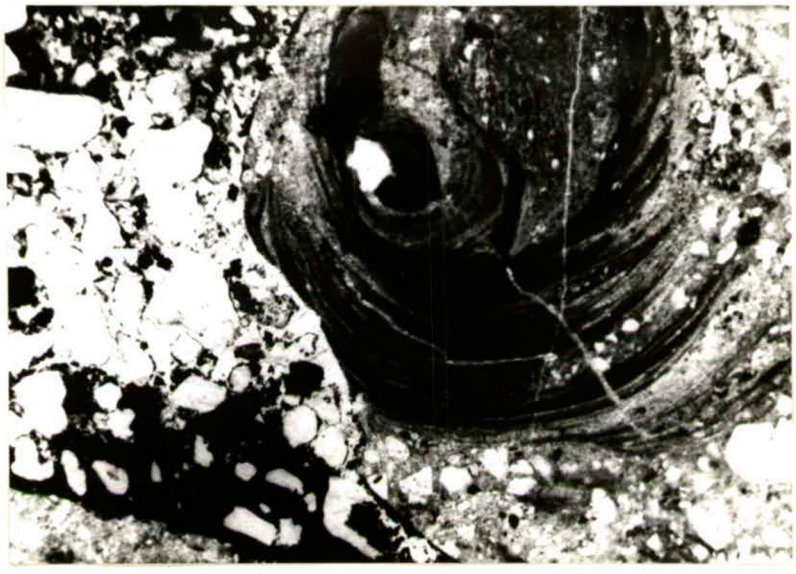
PHOTOMICROGRAPHS 1.



RH14: P1349/62: TS11236. Dolomite ooliths & quartz grains (clear) in a carbonate matrix. Permian x 40.

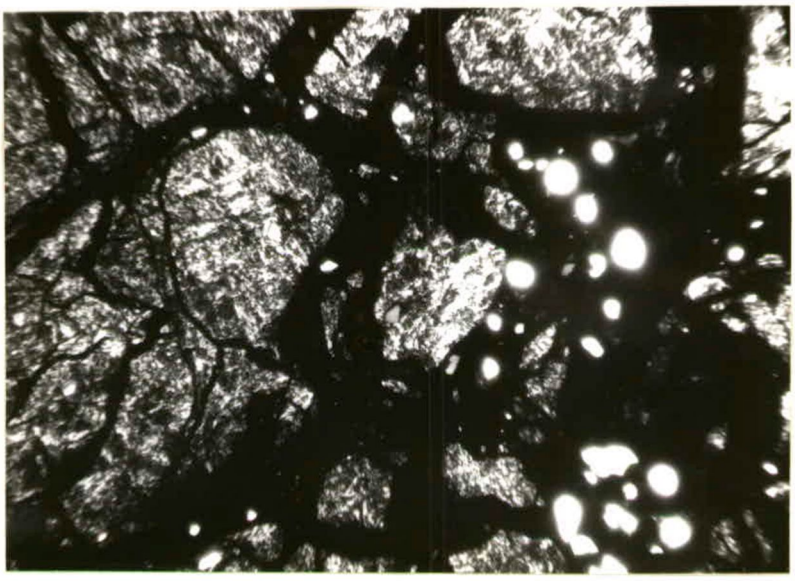


RH22: P1356/62: TS11244. Sand grains (chiefly quartz) in a clayey calcareous matrix. Plant fragment near centre of field. ?Tambo sandy limestone. x 110.

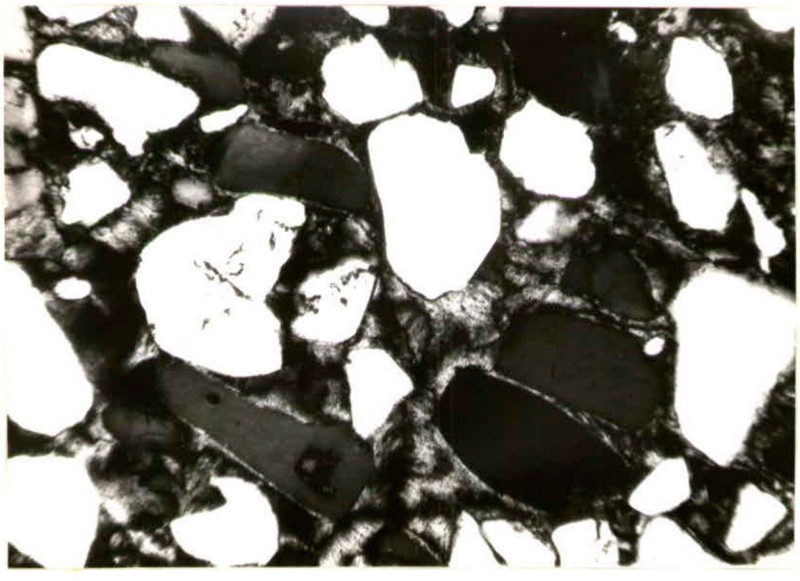


RH25: P955/62: TS11383. Colloform structure formed by leucoxene in opal (in Mt. Alice conglomerate). x 35.

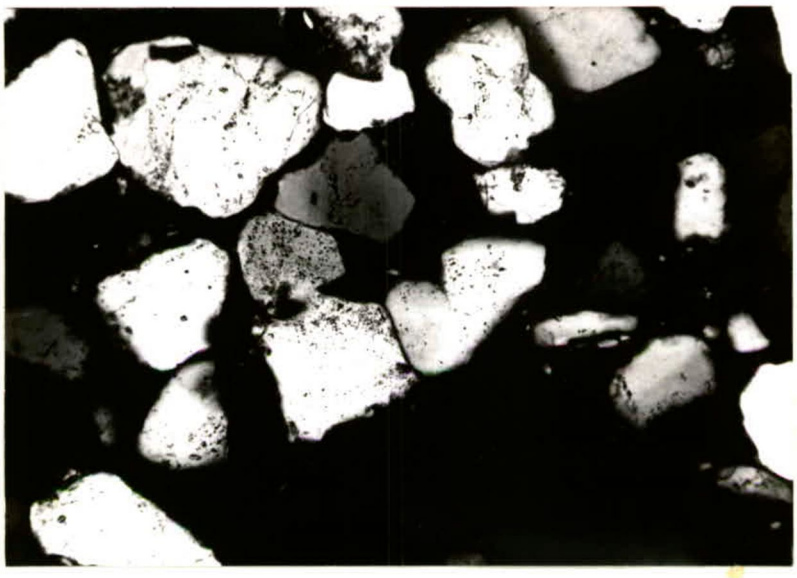
RH25: P955/62: TS11383. Quartzite cemented by optically continuous authigenic overgrowths. Crossed nicols. x 100.



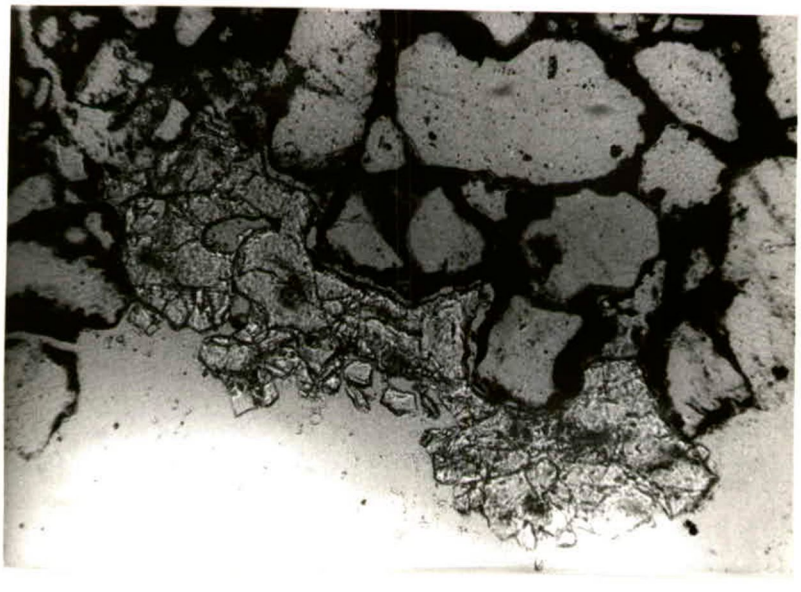
RH40: P969/62: TS11397. Ferruginous conglomerate. Large greyish fragments are claystone; small white grains are quartz. Crossed nicols. x 35.



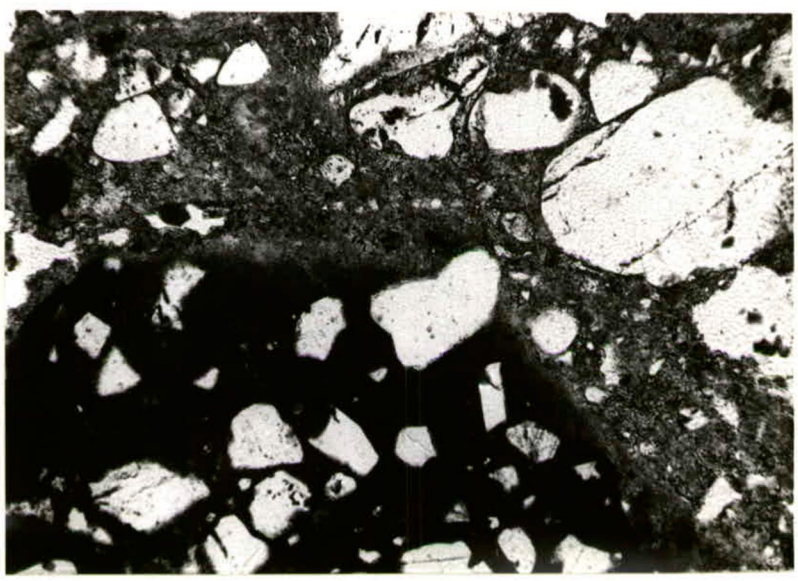
RH42: P971/62: TS11399. Kaolin-cemented Tertiary sandstone. Crossed nicols. x 100.



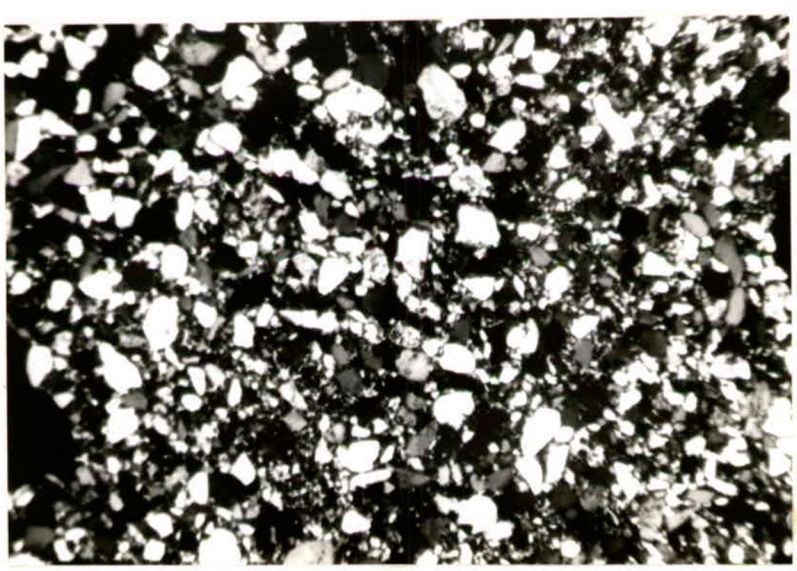
RH51: P979/62: TS11407. Jurassic-Cretaceous orthoquartzite, consisting of quartz grains poorly cemented by recrystallised quartz. Crossed nicols. x 107.



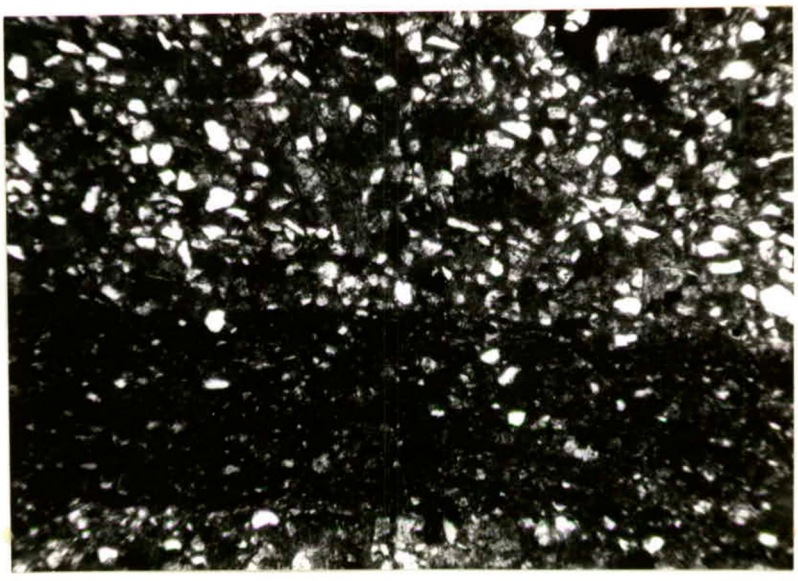
RH64: P990/62: TS11418. Hyalite around edge of a cavity in silicified Tertiary sandstone. x 100.



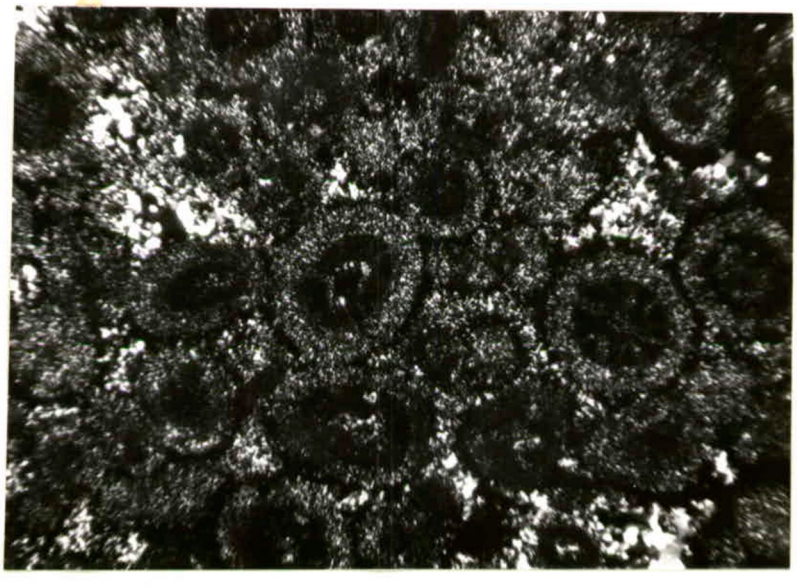
RH78: P1003/62: TS11431. Quartz grain straddling apparent pebble boundary in "clastic" laterite. x 100.



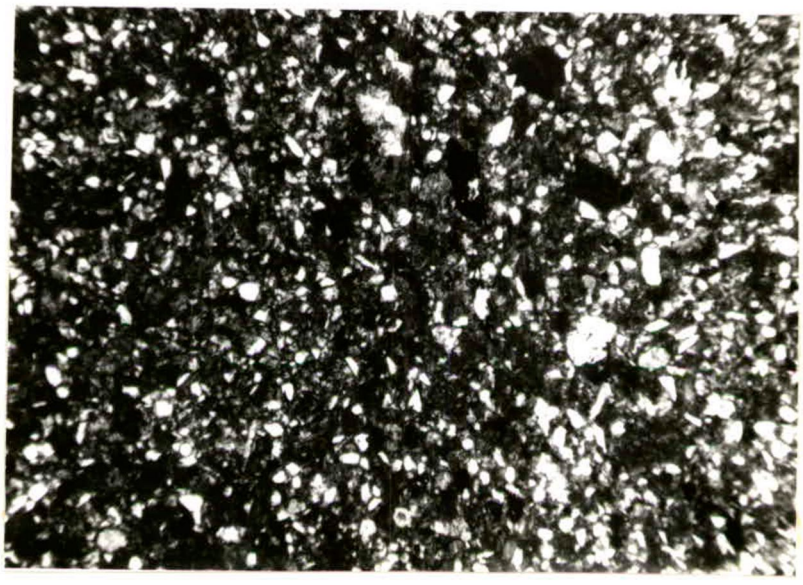
RH84: P1009/62: TS11437. Silicified Tertiary sandstone ("ortho-quartzite"). Nearly all grains are quartz. Crossed nicols. x 38.



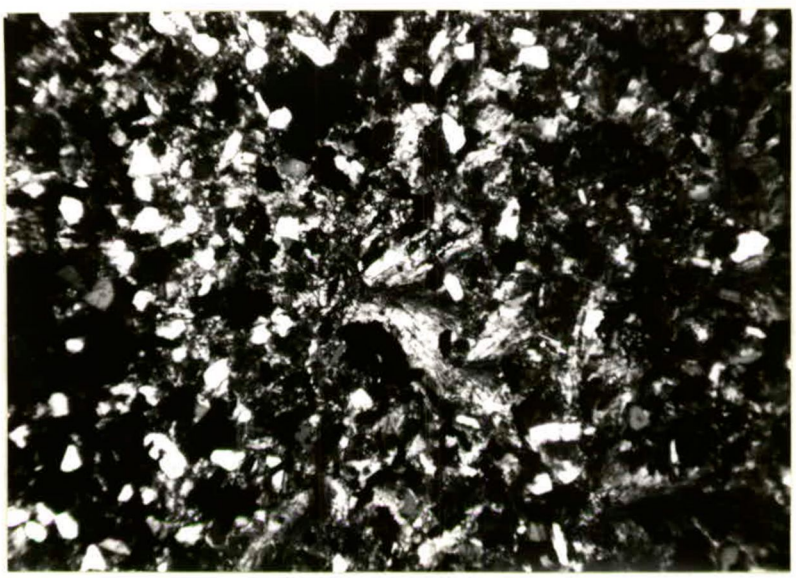
RH106: P1031/62: TS11459. ?Basal Winton sandy limestone. A narrower, finer, more limonitic bed shows as a darker band. Grains visible are mostly quartz. x 38.



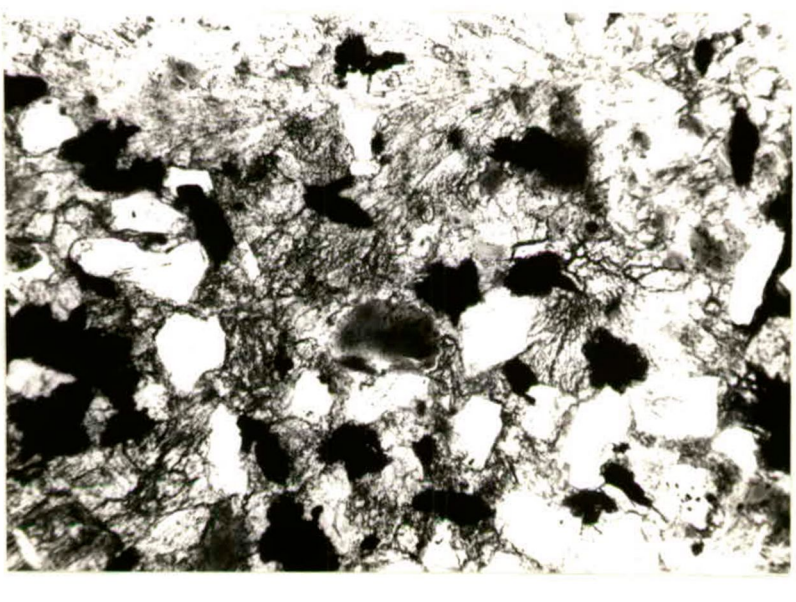
RH116: P1038/62: TS11466. Tertiary basal quartz pebble conglomerate. Showing siliceous ooliths. Crossed nicols. x 35.



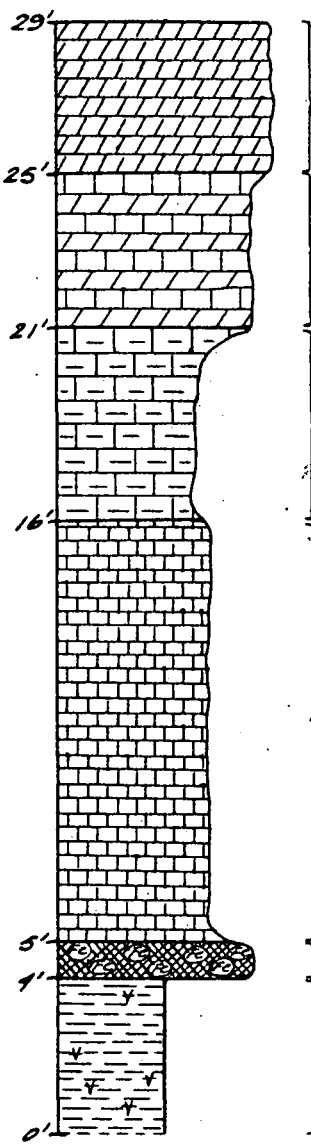
RH131: P1050/62: TS11478. ?Tambo equivalent calcareous fine sandstone. x 38.



RH139: P1057/62: TS11485. Cretaceous calcareous sandstone. Grains are quartz, opaques and ?iron-rich montmorillonite. Matrix is carbonate, some showing subradiating form. From sandstone near ?Roma-Tambo boundary. Crossed nicols. x 38.



RH139: P1057/62: TS11485. Cretaceous calcareous quartz - montmorillonite sandstone as above. Large grey grains are iron-rich montmorillonite. x 100.



Dolomite, off-white, somewhat siliceous, with intraformational pebbles up to ½" diam. Very fine grained & tight.

Dolomite, greenish cream, with intraformational pebbles upto 0.5" diam. Very fine grained tight with rare vughs.

Limestone ? cloyey, green, very fine grained, becomes more indurated near top. Grades into overlying unit.

Chalky limestone, very pale yellow-green, homogeneous, very fine grained.

Limonite, concretionary, fine grained.

Cloy, greenish, powdery, gypseus with scattered gypsum crystals.

To accompany report by R. Heath

S.A. DEPARTMENT OF MINES

Approved	Passed	Drn.	OODNADATTA 4m. ALBERGA 1m.	D.M. .	Scale 1" = 5'
		Tcd. B.G.	LAT. 27° 12·1' S, LONG 135°10' E	Req.	S.3473 Bad
		Ckd.	LIMESTONE SCARP EAST OF MT. ALICE		
Director		Exd.			Date 8-7-63