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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

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SEDIMENTARY PETROLOGY OF SOME UNITS FROM THE SANDOVER RIVER SHEET AREA, N.T.

by

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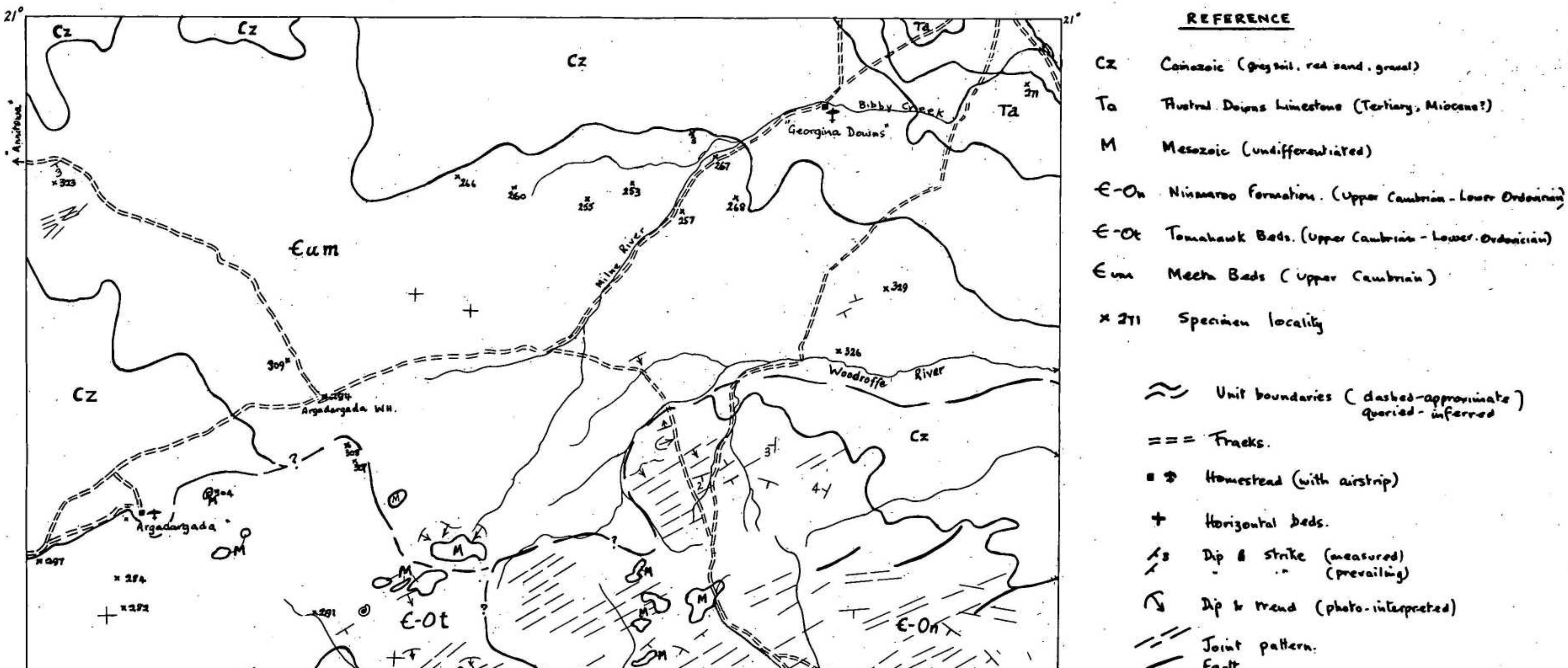
SUMMARY

The Sandover River Sheet area was mapped by the Bureau of Mineral Resources in 1963, during which time a number of rock samples were collected for petrological study. The results of the study are presented here, and supplement the record of the geology done in 1963.

Several different rock units crop out in the area and range from Upper Cambrian to Tertiary in age. They are predominantly dolomites with minor sandstone and siltstone; very few fossils were found.

The different dolomite lithologies in the Lower Palaeozoic vary from microcrystalline dolomite and medium crystalline dolomite, to oolitic, pelletal and intraclastic dolarenites and dolorudites with varying amounts of microcrystalline dolomite matrix and cement. The dolomitisation is thought to have been penecontemporaneous. The quartz sandstones and siltstones are generally fine to medium grained. The Mesozoic(?) sandstones are coarser and conglomeratic: all have siliceous and ferruginous cements. Tertiary limestones comprise algal? and algal stromatolitic varieties.

The interbedded dolomites and sandstones in the Lower Palaeozoic denote variable shallow water shelf conditions which may have existed laterally as well as vertically. The Mesozoic? sandstones may be fluvial in origin, while the Tertiary? limestones possibly formed in shore-line lagoons.



GENERAL GEOLOGY AND SPECIMEN LOCALITIES IN THE SANDOVER RIVER SHEET AREA. N.T.

INTRODUCTION

The Sandover River 1:250,000 Sheet area is situated in the Georgina Basin, near the eastern border of the Northern Territory, between latitudes 21° S and 22° S and longitudes 136°30' E and 138°0' E. In 1963, a field party, led by K.G. Smith, from the Bureau of Mineral Resources mapped the Sheet area and found units ranging from Upper Cambrian to Tertiary in age; these are named the Meeta Beds, Tomahawk Beds, Ninmaroo Formation, Mesozoic? (undifferentiated), and the Austral Downs Limestone. Samples of the different lithologies within the units were collected, thin-sectioned and examined, and the following petrology is supplementary to the geology described in 1964 (Nichols, 1964).

The specimens are numbered with the initials of the 1:250,000 Sheet area (e.g., SR) and a number which has no stratigraphic significance, but is marked on the air photographs and the 1:250,000 map.

The lithologies are described and named in terms proposed by Folk (1959) which give the dominant grain/crystal, the type of matrix (micrite/spar) and the grade size; these are abbreviated to biosparudite, oomicrite or micrite etc. Dolomitic is inserted in the appropriate cases, (to 100%) and an alternative, unabbreviated name is bracketed along side. Certain diagenetic fabrics or textures are described after Bathurst (1959).

MEETA BEDS

The Meeta Beds consist of a number of interbedded rock units, the most frequent unit being microcrystalline dolomite (dolomitic micrite, Folk, 1964). The following descriptions refer to the interbeds or units found in three parts of the area, and are as near as possible in ascending order.

Scarr Hill and N. part

Locality: SR 3, 12m. @ 252° from Georgina Downs Station.

Photomicrograph: Fig. 1.

Lithology: Dolomitic intrapelmicrite

(Fossiliferous, intraclastic, pelletal dolarenite).

Hand specimen: light brown, pelletal, intraclastic, algal stromatolitic layers in parts; rare gastropods, ½-1" in diameter.

Thin section: Grains, 60%, mixed pellets and intraclasts, ½-1 mm, with large platy clasts 3-4 mms. long (1mm thick), composed of cryptocrystalline dolomite, flocculent, microcrystalline to medium crystalline; some are composed of pellets and possibly flocculent algal remains; angular - subrounded, poorly sorted. Thin laminae of cryptocrystalline dolomite, slightly flocculent-algal stromatolites; gastropods not sectioned. Matrix, 40%, mixed microcrystalline dolomite and medium crystalline cement, poorly winnowed.

Origin: The sediment accumulated in very shallow, warm water as a pelletal clastic sand. It was affected by strong periodic currents which deposited the large rudite grains and was possibly intertidal for periods, permitting the growth of algal stromatolites (Logan, Rezak & Ginsburg, 1964). Some reworking and mixing of the matrix and grains may have occurred by scavenging; the gastropods were probably alien to the site as very few were found. The dolomitisation may have occurred before deposition, i.e. in the source area for the clasts, as replacement textures are absent in the present mosaic, but some of the cement may represent precipitation of dolomite in pore spaces, or pseudomorphing of calcite cement. (Murray, 1964).

Locality: SR 253b, 19 m. @ 248° from Georgina Downs Station.

Photomicrograph: Fig. 2.

Lithology: Dolomitic quartz sandstone.

Hand specimen: light brown, grey, fine-medium grained, average sorting, hard.

Thin section: Grains, 80%, quartz 60%, dolomite clasts 40%; quartz grains vary in size from 100-150 microns (longest axis), are subangular to subrounded in shape, rarely spherical, and show average sorting. They are strain shadowed, clear, compound and cryptocrystalline (chert?). In some cases grain-on-grain texture occurs and grain boundaries are sutured, due to pressure solution.

Rare grains of microcline feldspar, zircon and blue-green tourmaline occur, forming less than 1% of the rock.

Clasts of microcrystalline dolomite vary from pelletal to oval in shape, and from 0.1 - 1.5 mms. in size; they show no internal structure. Matrix, 20%, the matrix varies from cryptocrystalline to microcrystalline dolomite which may have partly replaced some quartz grains. Poorly winnowed.

Origin: The sediment probably accumulated in shallow warm water, near land, where currents of variable strength deposited quartz sand, dolomite clasts and possibly mud. The several types of quartz indicate different source areas eroded by one stream or several streams; the dolomite clasts were eroded from the sea floor (intraclasts) or from nearby land (beach rock?). Little sorting or winnowing seems to have occurred during accumulation and the carbonate mud may have been transported or precipitated. The origin of the dolomite is unknown, but the clasts may have been dolomitised before transport and deposition, and the mud altered soon after, as the finely crystalline texture does not show replacement features.

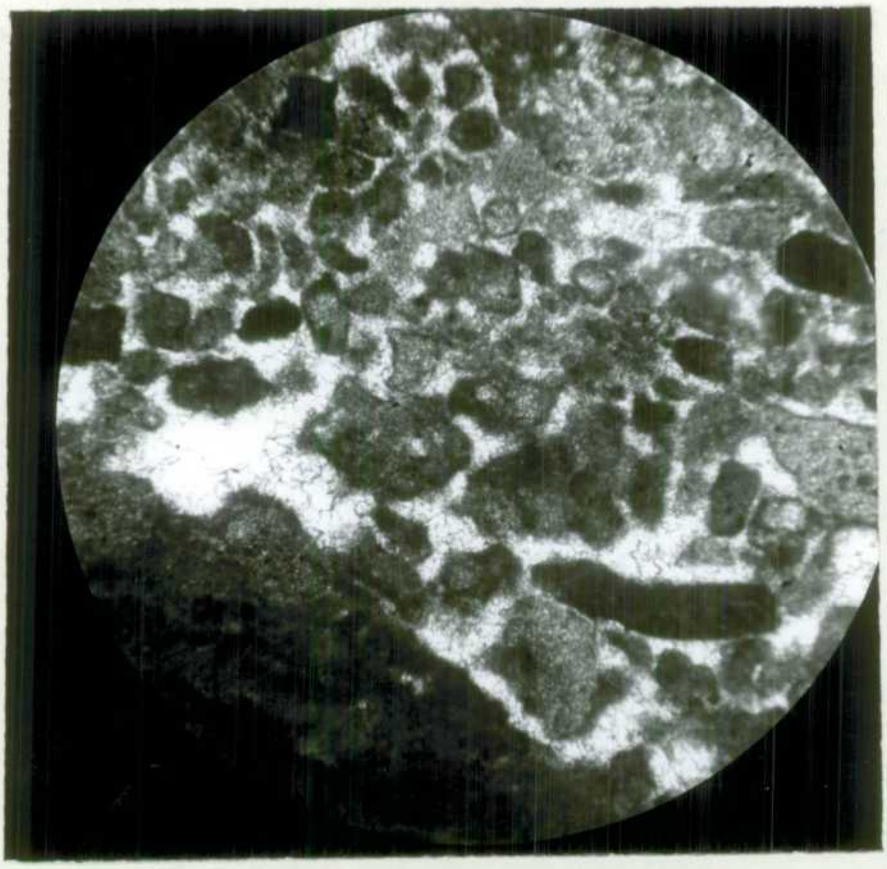


Fig. 1. Meeta Beds, showing stromatolitic algal fragment (bottom), and intraclasts in a mixture of microcrystalline dolomite, and dolomite cement. X30, (SR 3), File No. g/8272.

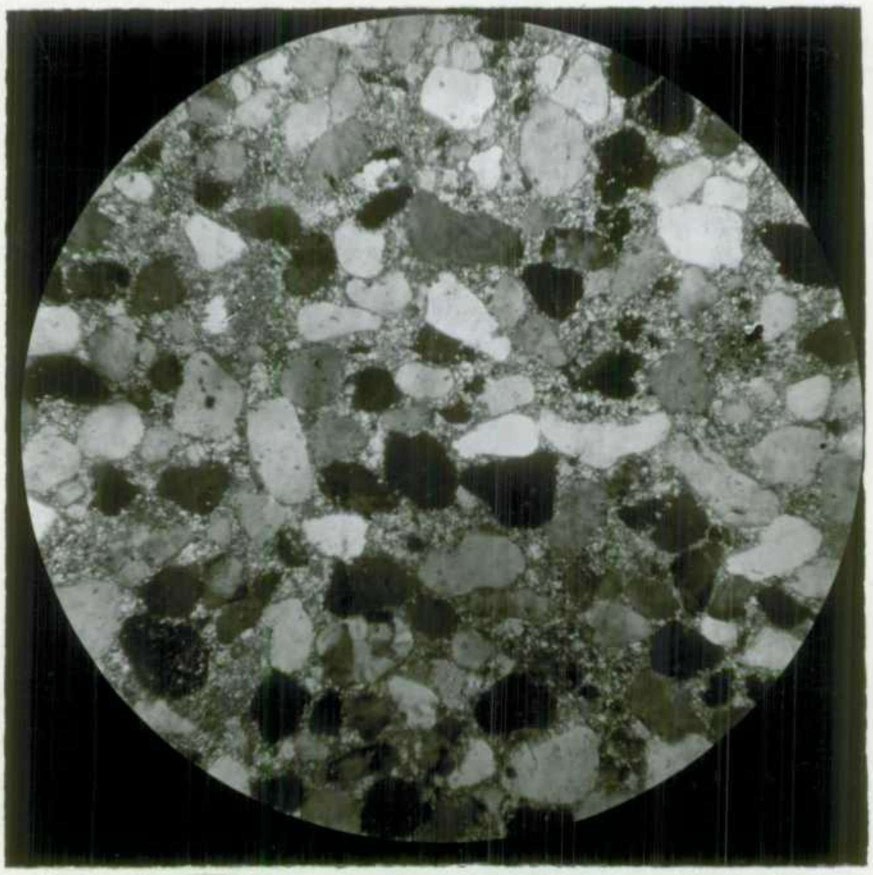


Fig. 2. Meeta Beds, showing dolomitic quartz sandstone, medium grained, sub-rounded, well sorted, in a microcrystalline dolomite matrix. X30, (SR 253(b)), File No. g/8267. (x-nicols).

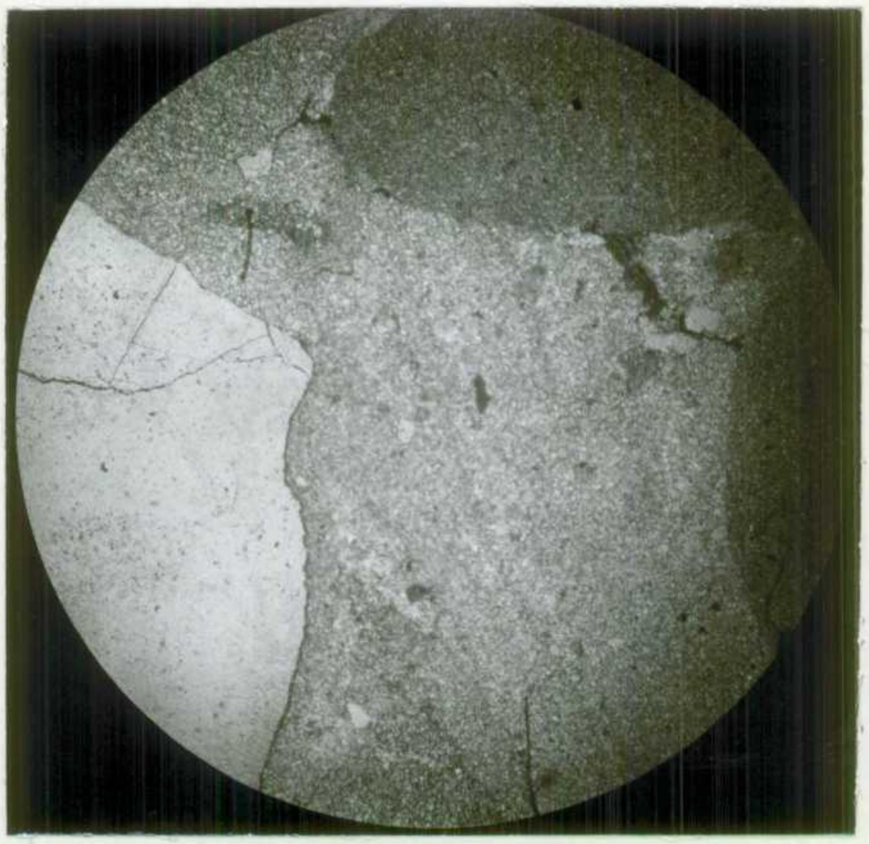


Fig. 3. Meeta Beds, showing dolomitic intramicrudite with large clasts of microcrystalline dolomite (right) and angular chert grain (left) in matrix of microcrystalline dolomite. X15 (SR 253(c)). File No. g/8264.

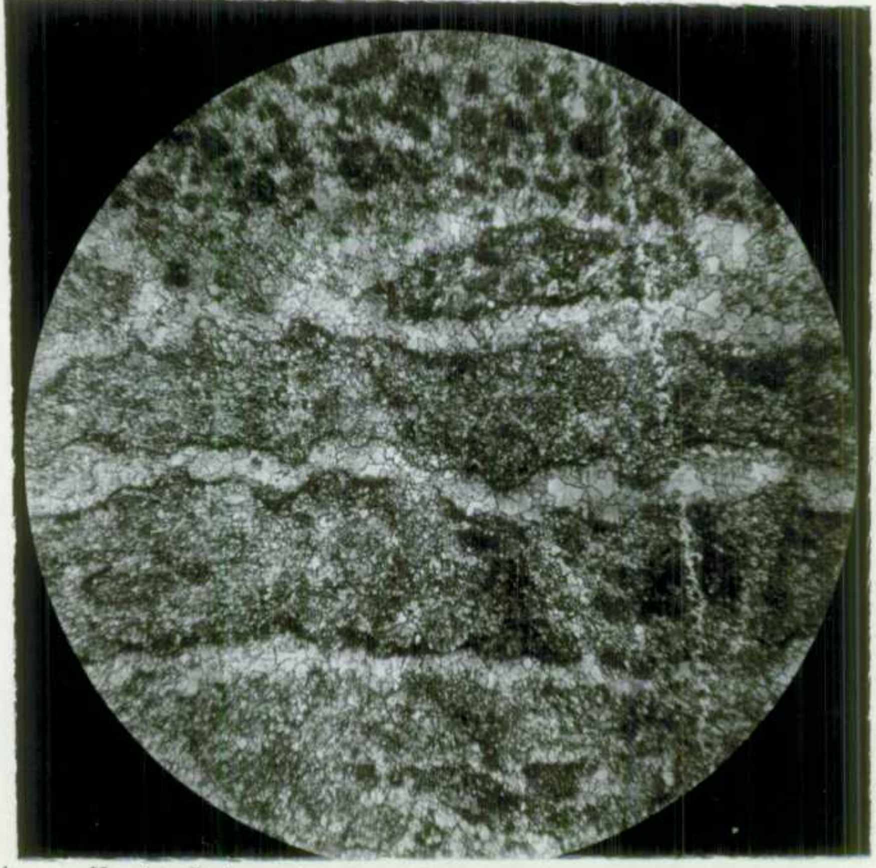


Fig. 4. Meeta Beds, showing large intraclasts of partly recrystallised microcrystalline dolomite developed by the apparent "forcing apart" of beds. X15, (SR 255), File No. g/8271.

Fig. 5. Meeta Beds, showing dolomitic intra sparudite, with clasts of micro-crystalline dolomite in dolomite cement (left) and partly recrystallised micro-crystalline dolomite. X30, (SR 266), File No. g/8259.

Locality: SR 253c, 19 m. @ 248° from Georgina Downs
SR 255, 22 m. @ 247° from Georgina Downs
SR 266, 34 m. @ 258° from Georgina Downs

Photomicrographs: Figs. 3, 4, 5.

Lithology: Dolomitic intramicrudite, and intrasparudite.
(Intraclastic dolorudite)

Hand specimen: SR 253c is a light brown-grey, intraclastic dolorudite with large weathered clasts of dolomite and pebbles of chert. SR 255 and 266 are light brown-grey, intraclastic dolorudites with long "raft-like" grains and pellets.

Thin section: SR 253c; grains, 85%, large, generally rounded elongate grains of cryptocrystalline dolomite and microcrystalline dolomite, some angular, varying in size from 1-5 mms., poorly sorted. Medium to coarse size grains of cryptocrystalline silica (chert?) also occur, varying in size from 1-5 mms. Grain-on-grain texture predominates and the elongate grains are not orientated. Matrix, 15%, comprises microcrystalline dolomite, partly recrystallised; unwinnowed. SR 255 and 266; grains; percentage varies from 70% (SR255) to 50% (SR266) and consists of long intraclasts and pellets. The intraclasts are generally 5mms. long, (and up to 20 mms. in SR266) ½ mm. thick, and composed of pellet dolarenite, microcrystalline dolomite, partly mottled. They vary from angular to rounded, and some have irregular shapes and indistinct boundaries. The pellets of microcrystalline dolomite vary from 150-1000 microns in size, and are irregular in shape with indistinct boundaries, some are mottled and recrystallised internally; poorly sorted, partly orientated pellets and clasts. Matrix; varies from 30% (SR255) to 50% (SR266) and consists of microcrystalline dolomite, partly recrystallised, and unwinnowed, and dolomite cement.

Origin: The three lithologies are generally coarse grained with variable concentrations of grains and matrix, and accumulated under slightly different conditions. The grains are different in shape and composition denoting different source areas, while the different concentrations indicate variable energy conditions or possibly scavenging. SR 253c derived material both from partly siliceous rocks and partly indurated sediments, and either accumulated nearer land or from different currents than the other sediments. SR255 and 266, on the other hand, appear to have formed after strong currents had broken up several different adjacent deposits, and transported them, together with pellets, or into a pelletal sand environment. The presence of carbonate mud may be due to the lack of prolonged current activity, or to the later reworking of mud layers into the rudite layers. The scattered nature of the grains in SR266 implies weaker current action and possibly intermittent deposition from suspension, rather than rapid deposition, possibly during traction or local turbulence.

Dolomitisation probably occurred before erosion and deposition, and possibly penecontemporaneously as the original grain boundaries are unaltered.

Locality: SR 257, 16 m. @ 235° from Georgina Downs Station.

Photomicrograph: Fig. 6.

Lithology: Dolomitic algal micrite.

Hand specimen: light brown, orange-brown with few algal pellets; some appear broken or squashed.

Thin section: Matrix, 90%, consists of microcrystalline to medium crystalline dolomite, with some cryptocrystalline areas, generally not mottled. Grains, 10%, comprise medium to coarse arenite, algal clasts and pellets of microcrystalline dolomite, flocculent. Some mottled patches of microcrystalline to medium crystalline dolomite exists between walls or rims of cryptocrystalline dolomite.

Origin: The prevalence of carbonate mud and algal textures suggests the lithology formed in shallow warm water, with little or no current activity, possibly in a mud flat environment. The minor algal remains may have been derived by scavenging or current action. Dolomitisation was probably penecontemporaneous.

Locality: SR 267, 12 m. @ 244° from Georgina Downs.

Photomicrograph: Fig. 7.

Lithology: Dolomitic micrite.

(microcrystalline dolomite; dololutite?; primary dolomite)

Hand specimen: light brown, mottled, microcrystalline, with medium crystalline veins in polygonal to subcircular pattern.

Thin section: Grains: nil.

Matrix: 100%, microcrystalline dolomite, approximately 50 microns in size with some cryptocrystalline areas. Well defined veins of medium crystalline dolomite occur; mosaic is inequigranular, recrystallised?

Origin: The origin of the carbonate mud is unknown. Direct precipitation of dolomite mud seems rare at present and it is difficult to find evidence for it from hand specimen or thin section. The fine grained and generally uniform nature of the above rock does not suggest late stage dolomitisation which often produces an anhedral mosaic, and there are no syntaxial overgrowths. The texture is similar to that of finely crystalline dolomites being formed at present in the Persian Gulf by penecontemporaneous alteration of calcite and aragonite mud (Illing, 1964), before induration. Some carbonate mud may be transported and deposited after being formed either by precipitation or biological action (Cloud, 1962); again dolomitisation could occur just before or after this process.

The coarser crystalline dolomite in the veins may be a result of dolomitisation and recrystallisation of calcite formed in mud cracks, or in later tension cracks, or in solution channels in a more indurated rock.

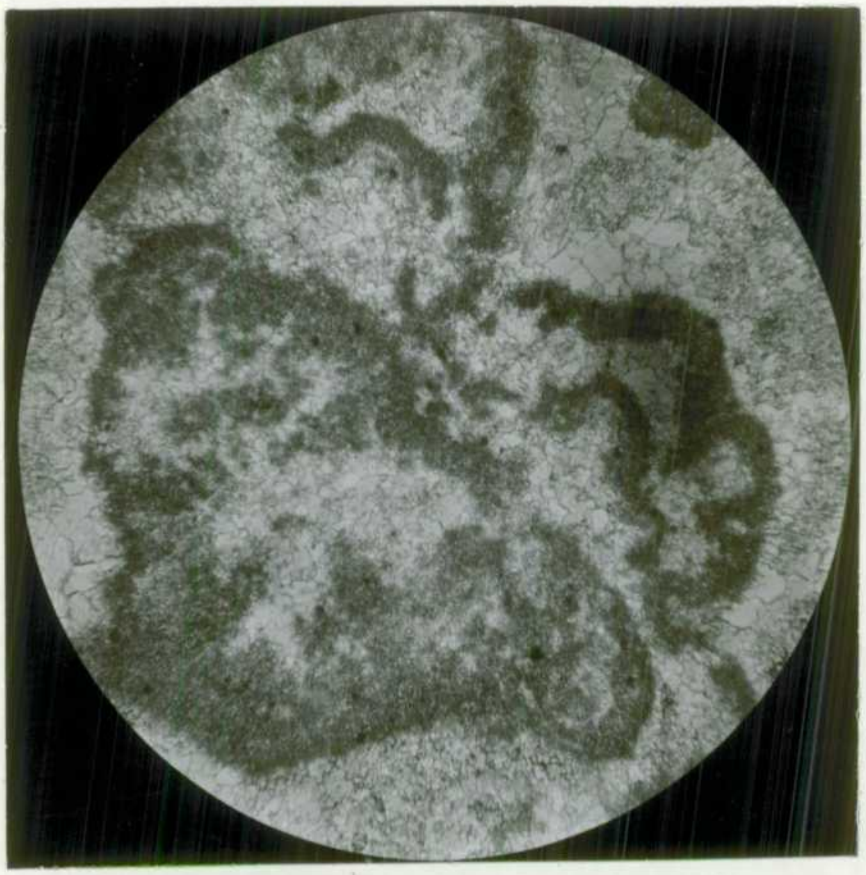


Fig. 6. Meeta Beds, showing algal dolomite, with flocculent algal grains of microcrystalline dolomite in matrix of microcrystalline to medium crystalline dolomite. X45, (SR 257), File No. g/8266.

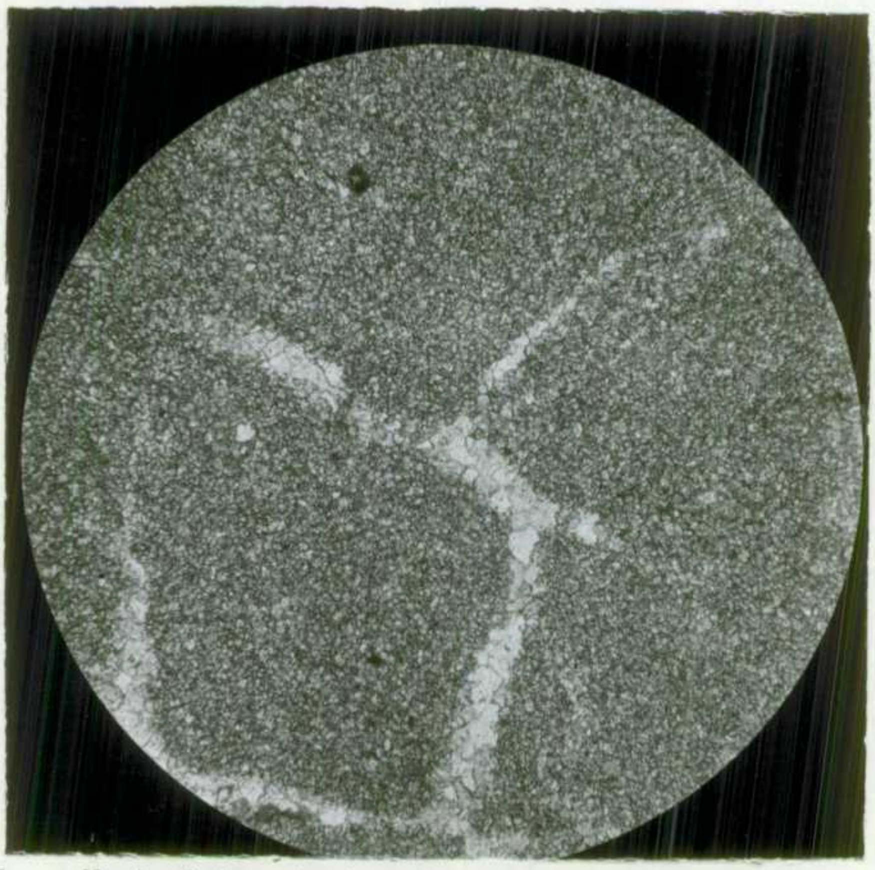


Fig. 7. Meeta Beds, showing microcrystalline dolomite (dololutite? or primary dolomite?), and veining. X30, (SR 267), File No. g/8265.

Locality: SR 268, 11½ m. @ 233° from Georgina Downs.

Photomicrograph: Fig. 8.

Lithology: Quartzose dolomitic pelmicrite.
(quartzose pelletal dolarenite)

Hand specimen: light brown-grey, quartzose pelletal dolarenite, partly cross-bedded, brown wuartz laminae on the weathered surface.

Thin section: Grains, 80%; Pellets, 75%, cryptocrystalline dolomite, 300-500 microns in diameter, some with medium crystalline core and thin rims of cryptocrystalline dolomite; some with mixed textures of above (recrystallised?). Quartz, 20%, is angular to subrounded, fine grained (approx. 250 microns), shows average sorting; is strain shadowed and rarely microcrystalline. Some replacement by dolomite gives crenulated boundaries. Rare microcline and plagioclase feldspar occurs. Ooliths and oolitic intraclasts, 5%, fine grained, approx. 250 microns, some 500-1000 microns, average sorting; some eroded ooliths and intraclasts of ooliths in medium crystalline dolomite cement. Matrix, 20%, microcrystalline to medium crystalline dolomite, appears unwinnowed.

Origin: The deposit formed as a pelletal sand in a medium to high energy environment, where periodic currents eroded and transported adjacent, partly indurated oolitic beds, and deposited quartz sand. The final depositional site may have been of low energy, as the sediment appears unwinnowed. The dolomitisation possibly occurred before final deposition, as replacement textures occur in some pellets, the original textures having been partly obliterated, but the edges are still intact. The nature of the original matrix is unknown.

Locality: SR 260a; SR 260b. 30 m. @ 255° from Georgina Downs.

Photomicrograph: Fig. 9.

Lithology: Quartz sandstones.

Hand specimen: brown, medium grained, ripple marked, with clay pellets, thin beds, approx. 1' thick.

Thin section: Grains, 85%; quartz 99%, medium grained (¼-1 mm.) subrounded to rounded (angularity due to overgrowths), average sorting; grain-on-grain texture, sutured grain boundaries and triple point contacts due to pressure-solution. Grains comprise unstrained quartz with inclusions, strain shadowed quartz, and cryptocrystalline silica (chert?). Some tourmaline and possibly zircon occurs, together with rare feldspar (< 1%). SR 260b is similar but has a more uniform grain size, more chert fragments and tourmaline. Some thin pellets of white clay up to 4 mms. in diameter are scattered among the quartz grains. Matrix, 15%, is a siliceous cement, formed mainly by overgrowths from quartz grains. The sandstones are average to well sorted and seem to have been winnowed.

Origin: The sands probably accumulated in shallow water after a period of climatic change or slight uplift which caused more rapid erosion of adjacent land. Ripple marks are small, with four, 1"-high ripples occurring within 1 foot on the bedding surface, indicating more agitated or shallow water than during the deposition of the carbonates. In some cases the boundary with the underlying dolomite is a scour surface implying rapid deposition or spate(?) conditions of currents.

Eastern part of the area (Woodroffe River)

Several more types of dolomite were found in this part of the area, and although their relationship with those in the north is uncertain, they are included to show the variety of carbonate rocks present, vertically, and possibly laterally.

Locality: SR329 a & b, 19 m. @ 163° from Georgina Downs.

Photomicrographs: Fig. 10, 11.

Lithology: Dolomitic pelsparite and quartzose variety.
(Pelletal dolarenite and quartzose, var.)

Hand specimen: light brown-grey, pelletal dolarenite, with scattered quartz sand in 329b; thin bedded.

Thin section: Grains, 75%, comprise pellets, intraclasts and ooliths. The pellets and intraclasts are rounded and oval, and sometimes squashed, composed of cryptocrystalline dolomite, mixed microcrystalline and medium crystalline mosaic, and medium crystalline mosaic, surrounded by rims of cryptocrystalline dolomite. Ooliths occur with concentric layering, and are ½-1 mm. in diameter, partly eroded and truncated, and partly composed of dolomite crystals. SR 329 contains about 5% quartz sand, angular to sub rounded, ¼-1 mm. in size, scattered. Matrix, 25%, cement composed of medium crystalline dolomite, drusy growth around grains, apparent granular cement elsewhere; well sorted, unwinnowed.

Origin: The sediment accumulated in shallow, warm water where strong current action continuously sorted and abraded ooliths, and winnowed the carbonate mud. Some of the clasts may have been derived from adjacent areas by erosion, and some may have formed in the present area. The quartz fraction is small, but denotes a slight change in conditions. The origin of the dolomite cement is unknown; possibly original calcite textures have been pseudomorphed, or dolomite was precipitated in the pore spaces, though the latter seems to be a rare occurrence at present. The ooliths or pellets were probably compacted and broken before recrystallisation and dolomitisation.

Locality: SR 326 a, b, & c. 23 m. @ 175° from Georgina Downs.

Photomicrograph: Figs. 12, 13, 14.

Lithology: Microcrystalline dolomite and medium crystalline dolomite.
(cf. SR 267) (dolomitic micrite, dololutite?)

Hand specimen: light brown-grey microcrystalline dolomite and medium crystalline dolomite, thinly bedded.

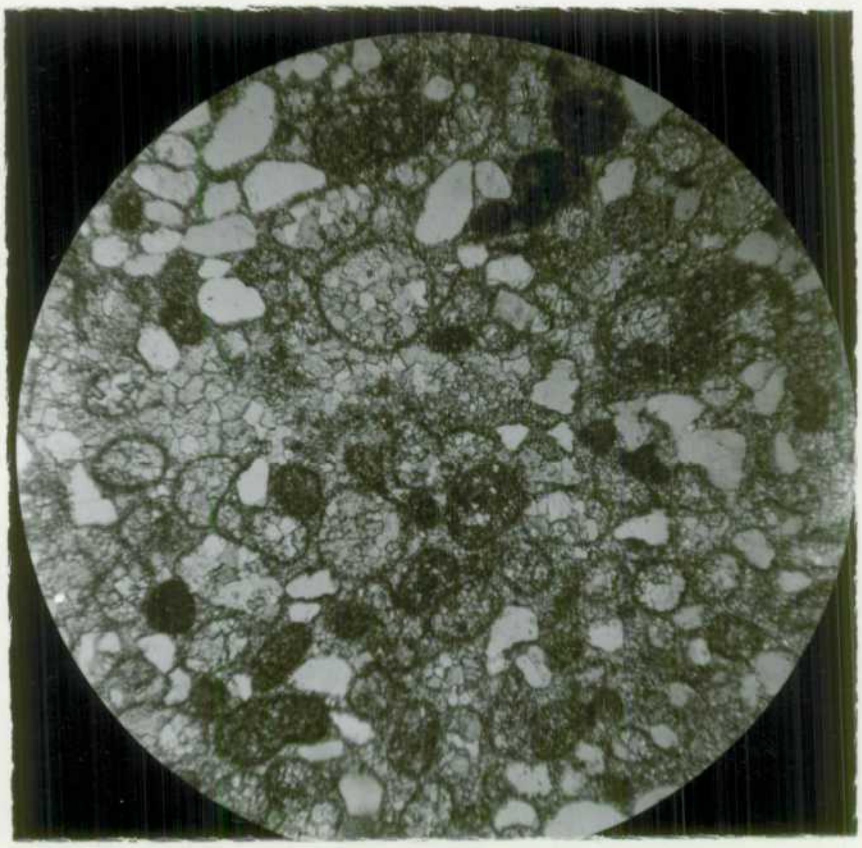


Fig. 8. Meeta Beds, showing quartzose dolomitic pelmicrite, with subangular-subrounded quartz and partly to wholly recrystallised pellets and intraclasts, in a partly recrystallised and dolomitised? matrix. X45, (SR 268), File No. g/8260.

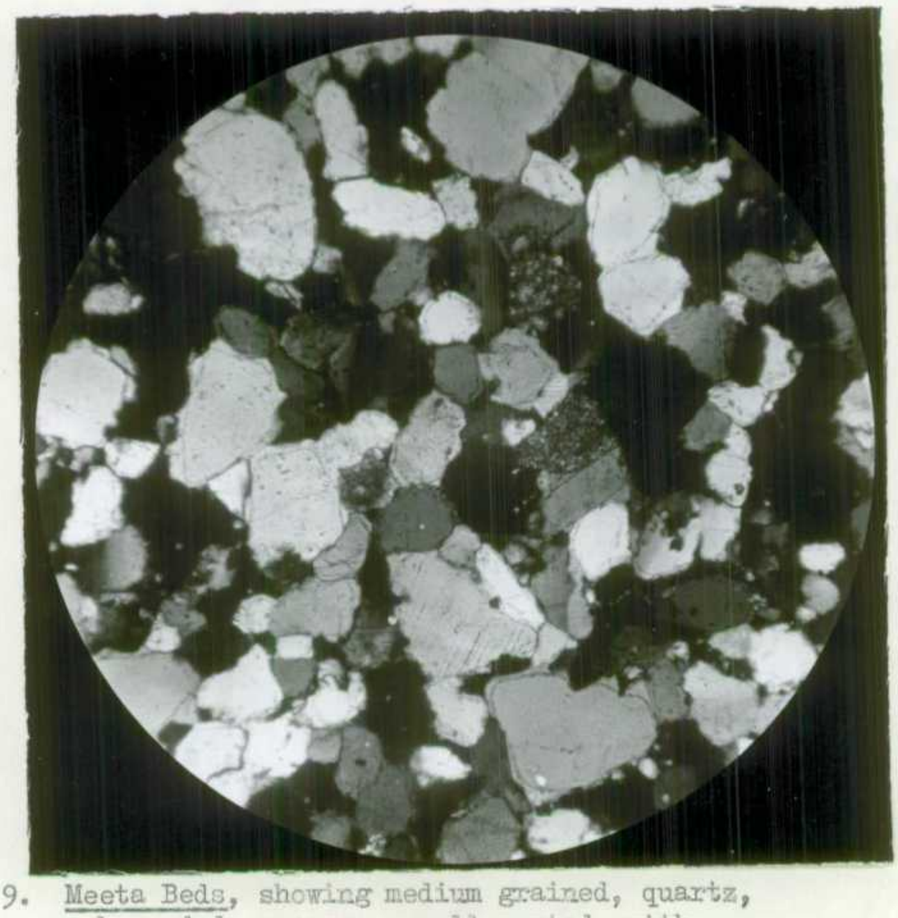


Fig. 9. Meeta Beds, showing medium grained, quartz, subrounded, average - well sorted, with siliceous overgrowths forming silica cement. X45, (SR 260(a)), File No. g/8270.

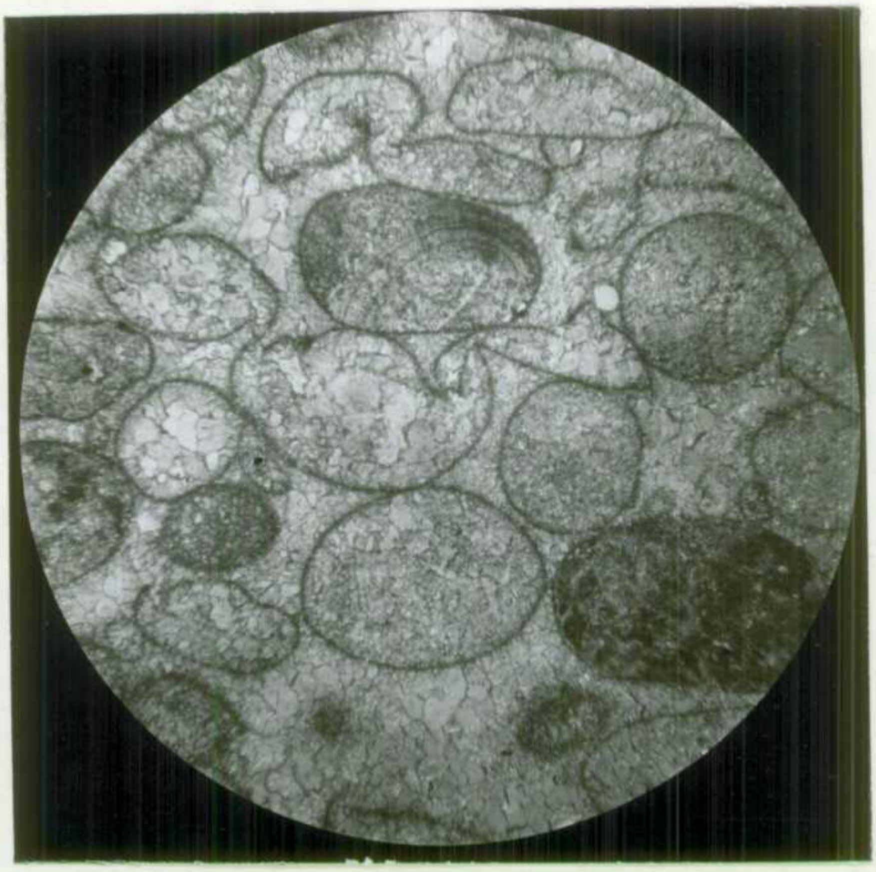


Fig. 10. Meeta Beds, showing dolomitic pelsparite with pellets and intraclasts, well rounded and sorted; compacted grains occur in centre and upper centre, recrystallised, and possibly leached and infilled. X45, (SR 329(a)), File No. g/8268.

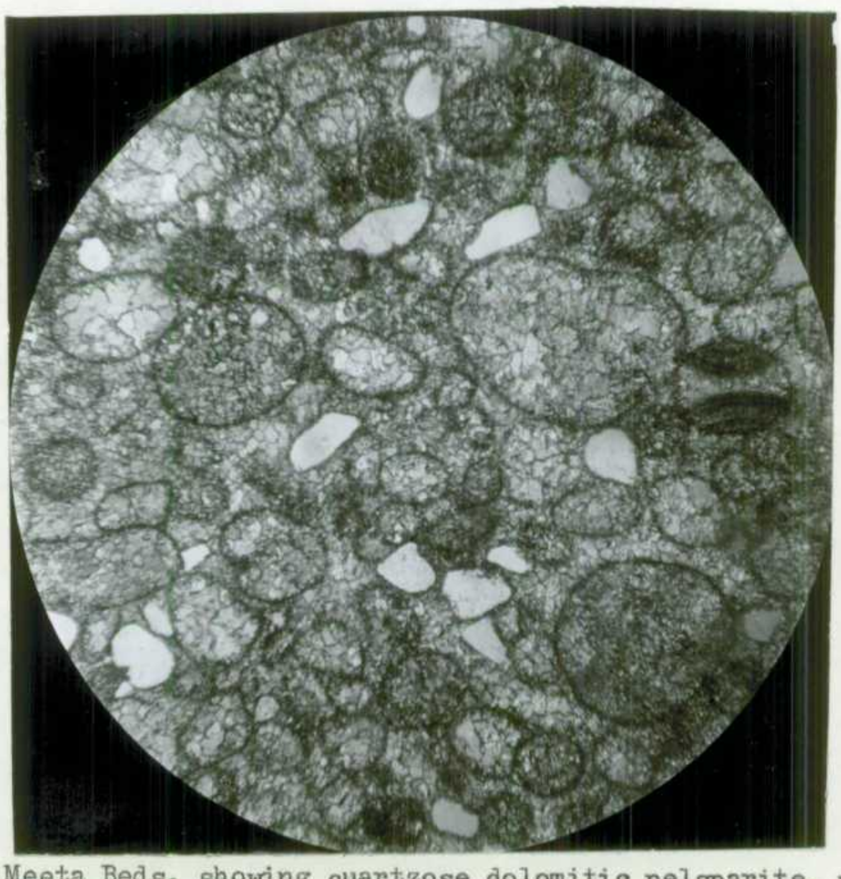


Fig. 11. Meeta Beds, showing quartzose dolomitic pelsparite, with subrounded quartz and recrystallised pellets (?intraclasts) from micrite to medium crystalline fabric. Note abraded sparite (right). X25, (SR329 b), File No. g/8257.

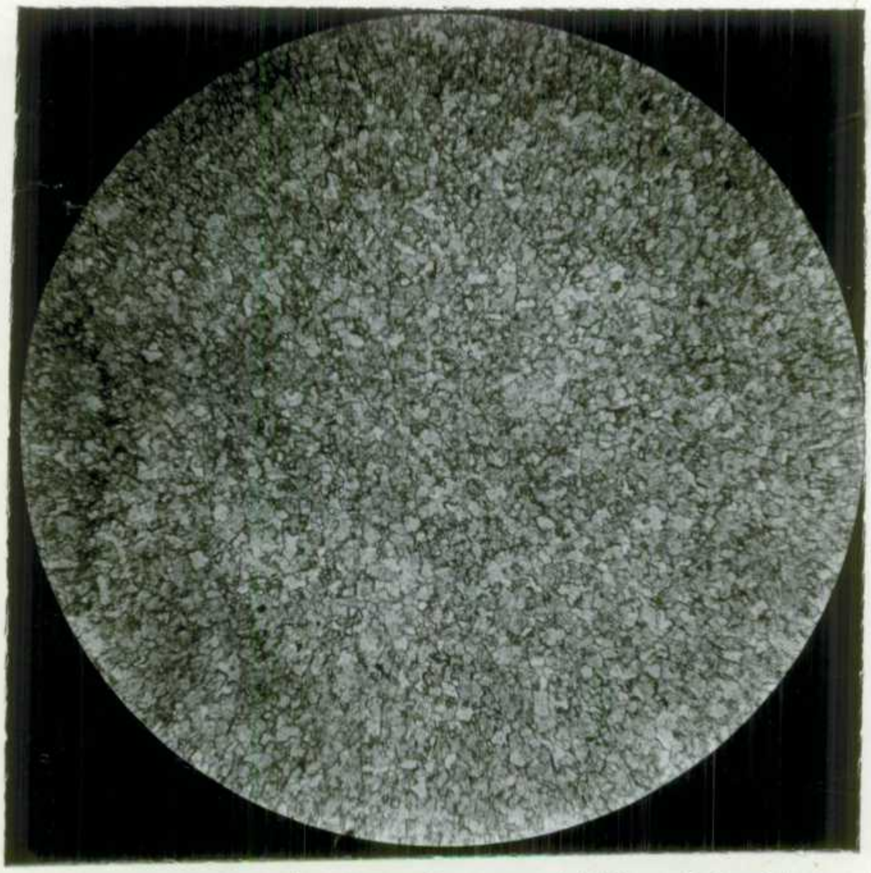


Fig. 12. Meeta Beds, showing microcrystalline dolomite. X45, (SR 326(a), File No. g/8258.

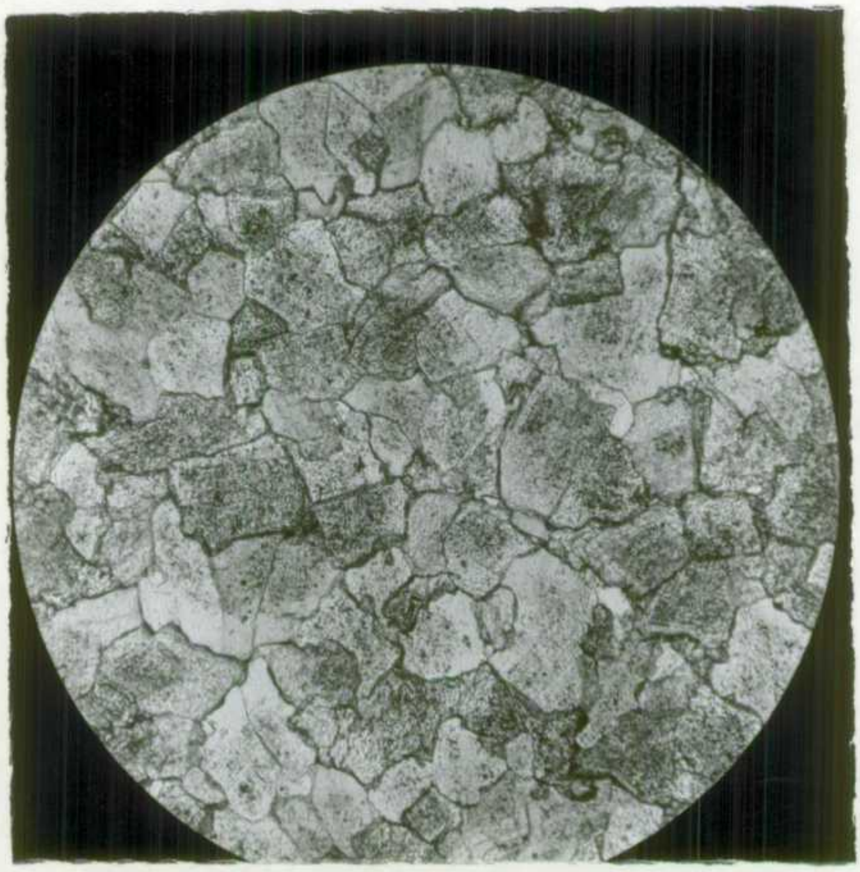


Fig. 13. Meeta Beds, showing medium crystalline dolomite with inclusions of iron oxide and relatively clear outer parts of crystals due to later growth. X45, (SR 326(b)), File No. g/8197.

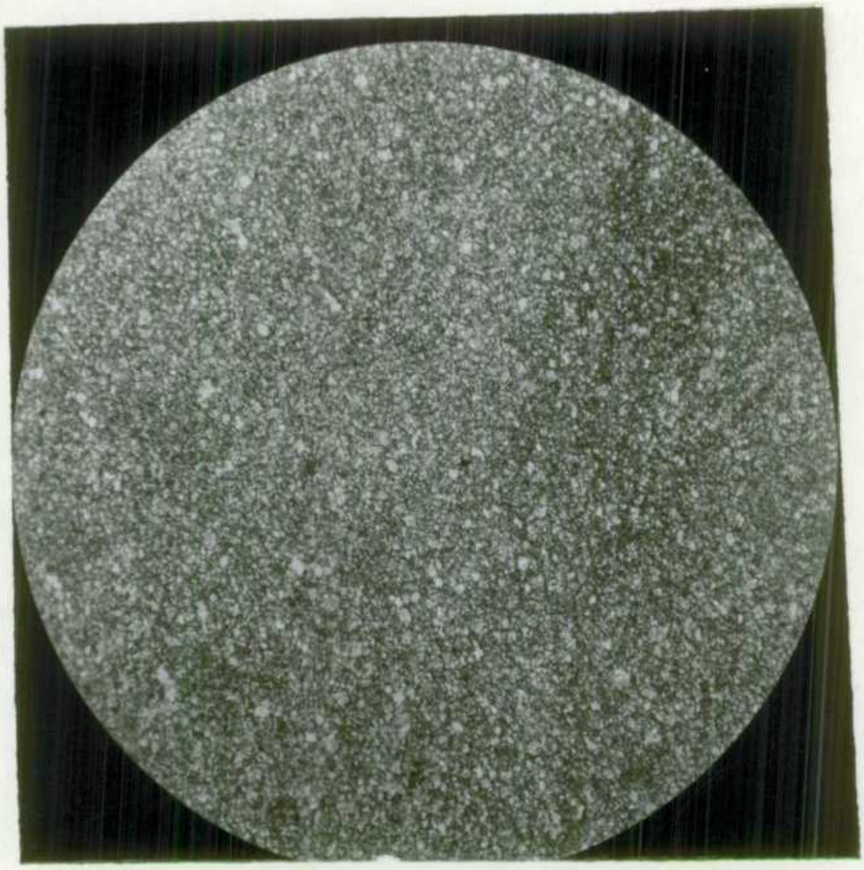


Fig. 14. Meeta Beds, showing microcrystalline dolomite, dololutite? X45, (SR 326(c), File No. g/8196.

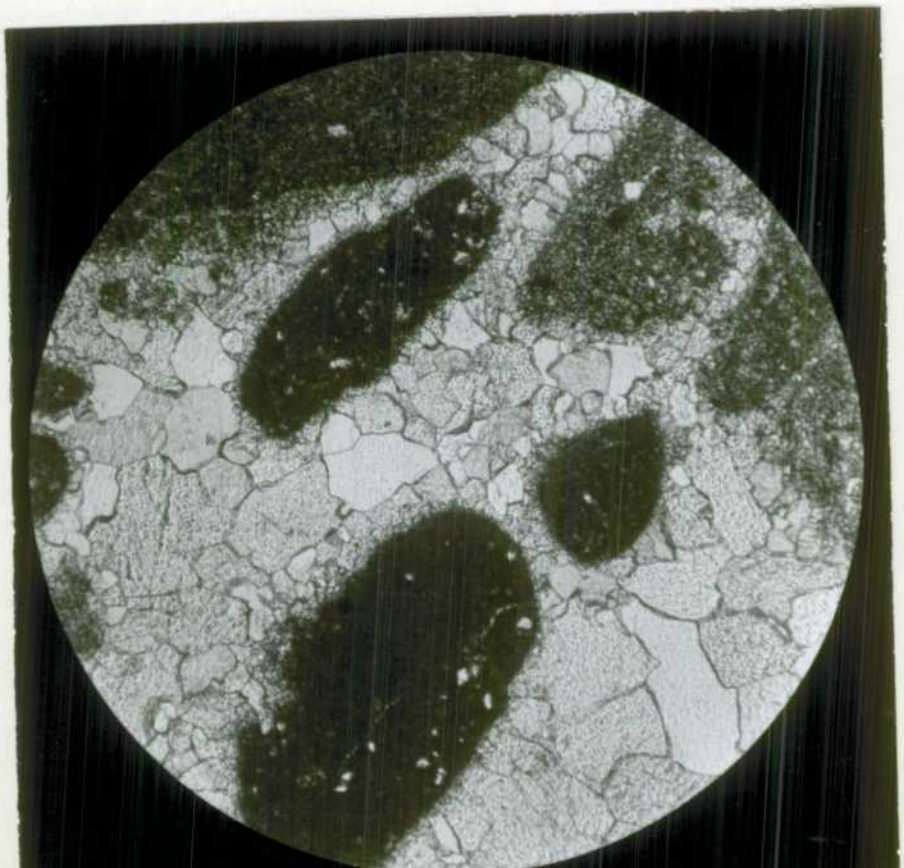


Fig. 15. Meeta Beds, showing dolomitic intrasparudite with clasts of cryptocrystalline dolomite and some quartz silt in dolomite cement (drusy dolomite around grains). X30, (SR 323(b)), File No. g/8195.

Thin section: Grains: nil.

Matrix: 100%, consists of a mosaic of microcrystalline dolomite, with crystals ranging from 20-60 microns in SR326 a & c; no relict structures occur in the samples, but patches of slightly coarser dolomite, and scattered tourmaline grains of silt and fine sand size, sub rounded, occur in SR326 a. Sample 326 b comprises a mosaic of anhedral and rhombic crystals of medium crystalline dolomite; some crystals are clear but the majority have concentrations of iron oxides occupying all, or just the central part of the crystal, and along the junctions. The clear, outer part of the crystal denotes later growth.

Origin: The microcrystalline dolomite may have accumulated as a primary precipitate, but evidence for this is rare, both in the present and the past. The textures are very fine grained and relatively uniform, and suggest penecontemporaneous dolomitisation probably of an unconsolidated or partly indurated aragonite or calcite mud. It is also possible that the carbonate mud (aragonite, calcite or dolomite) was transported, possibly during storms; certain terrigenous grains were possibly derived in a similar way. The coarser dolomite appears to be a product of later stage dolomitisation as the crystals do not seem to relate to an original texture, i.e., there are no ghost structures or textures.

West and north-west part of the area

In this part of the area another set of samples were collected from the Meeta Beds, at various places along the track from Argadargada Waterhole, north-west to Annitowa Station. Again, these strata and samples cannot be related directly to those from around Scarr Hill and the Woodroffe River to the east, and a precise knowledge of lateral or vertical change is therefore lacking.

Locality: SR323 b. 33 m. @ 348° from Argadargada Station.

Photomicrograph: Fig. 15

Lithology: Dolomitic intrasparudite.
(intraclastic dolorudite)

Hand specimen: light brown, intraclastic, pelletal dolorudite, thinly bedded.

Thin section: Grains, 60%; consisting of large intraclaclasts from 3-7 mms. long and approximately 3 mms. thick. They are composed of
a) microcrystalline dolomite.
b) silty (quartzose), microcrystalline dolomite.
c) dolomitic-pelmicrite (pelletal dolarenite).
d) algal? flocculent microcrystalline dolomite.

Irregular shapes vary from angular to sub rounded, cylindrical (or cigar shaped), platy, to spherical. Pellets vary in size from ¼-½ mm. and are composed of microcrystalline dolomite (possibly end sections); also occur in concentrations of 70% packing, ranging from 50-100 microns (faecal?). Matrix, 40%, drusy dolomite, and medium crystalline granular (cement?) dolomite. Well winnowed lithology showing average sorting.

Origin: The sediment accumulated in shallow warm water, possibly highly saline, subject to strong current action capable of eroding and transporting the largest clasts and preventing the settling of the mud fraction. The clasts may have come from adjacent partly indurated sediments, but may also have been derived from beach rock. The variety of clasts implies currents from variable sources, or erosion of thin interbeds of different types. The dolomitisation may have occurred before final deposition, and the presence of drusy dolomite may indicate primary precipitation, or early diagenesis of high magnesium calcite drusy cement, with preservation of the texture.

Locality: SR 309 a. $20\frac{1}{2}$ m. @ 042° from Argadargada Station.

Photomicrograph: Fig. 16.

Lithology: Algal stromatolitic dolomite.

Hand specimen: light brown, layered, columnar, microcrystalline dolomite, thin beds, 6" - 1' thick, columnar sections approximately 6" in diameter.

Thin section: Grains, nil

Algae: consists of alternating layers or laminae of microcrystalline and slightly coarser crystalline dolomite. The texture is indistinct and is probably palimpsest, having been largely altered.

Origin: In situ growth of algal stromatolites occurs today in the intertidal zone and shallow warm waters of Shark Bay, Western Australia (Logan, Rezak & Ginsburg, 1964). The specimens described are assumed to have grown under similar conditions, and they represent a shallow, near-shore algal flat; dolomitisation probably occurred at an early stage in diagenesis, thus preserving some of the stroma; a similar process is affecting stromatolites in the Persian Gulf at present (Illing, 1964). Current or wave action was negligible as clastic grains are not present. Dolarenite crops out below the stromatolite, and the algae started to grow on that deposit. The top of the algal bed is planar, supporting the idea of uniform growth in undisturbed conditions.

Locality: SR 294 a, 20 m. @ 058° from Argadargada Station.

Photomicrograph: Fig. 17.

Lithology: Dolomitic, silty chert.

Hand specimen: light brown, fine grained, hard, slightly ferruginous.

Thin section: Grains, 10%, scattered quartz silt grains, and microcrystalline dolomite crystals, with small spots of iron oxide. Matrix, 90%, cryptocrystalline silica.

Origin: The silica is probably secondary, and has obliterated all original textures, leaving only relict quartz silt, dolomite and iron oxides. However, the iron oxide may also be a late stage diagenetic feature which occurred along with silicification during the lateritisation of this region. The original rock may have been a silty (quartzose) microcrystalline dolomite.

Locality: SR 294 b, 20 m. @ 058° from Argadargada Station.

Photomicrograph: Fig. 18.

Lithology: Siliceous quartz sandstone.

Hand specimen: fine grained, red-brown, siliceous, quartz sandstone, hard, tight.

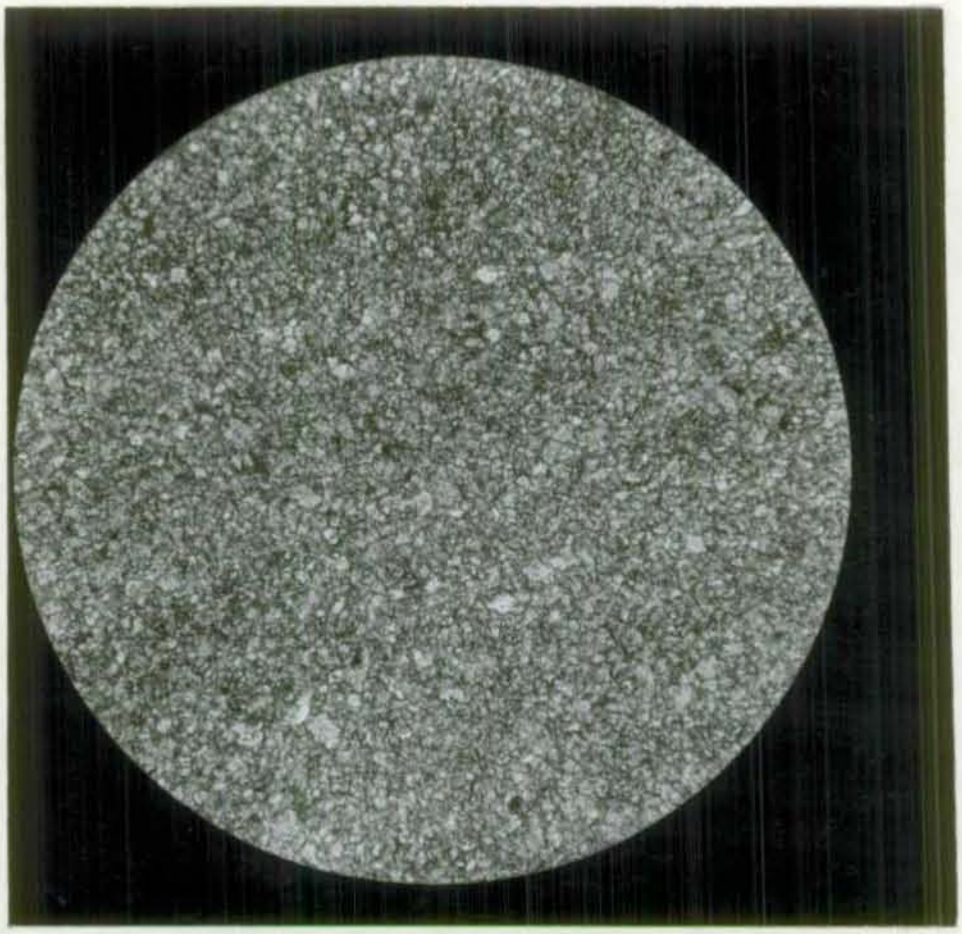


Fig. 16. Meeta Beds, showing relict textures in algal stromatolite (microcrystalline dolomite in vague layers with intervening layers of finer crystalline dolomite). X45, (SR 309(a)), File No. g/8194.

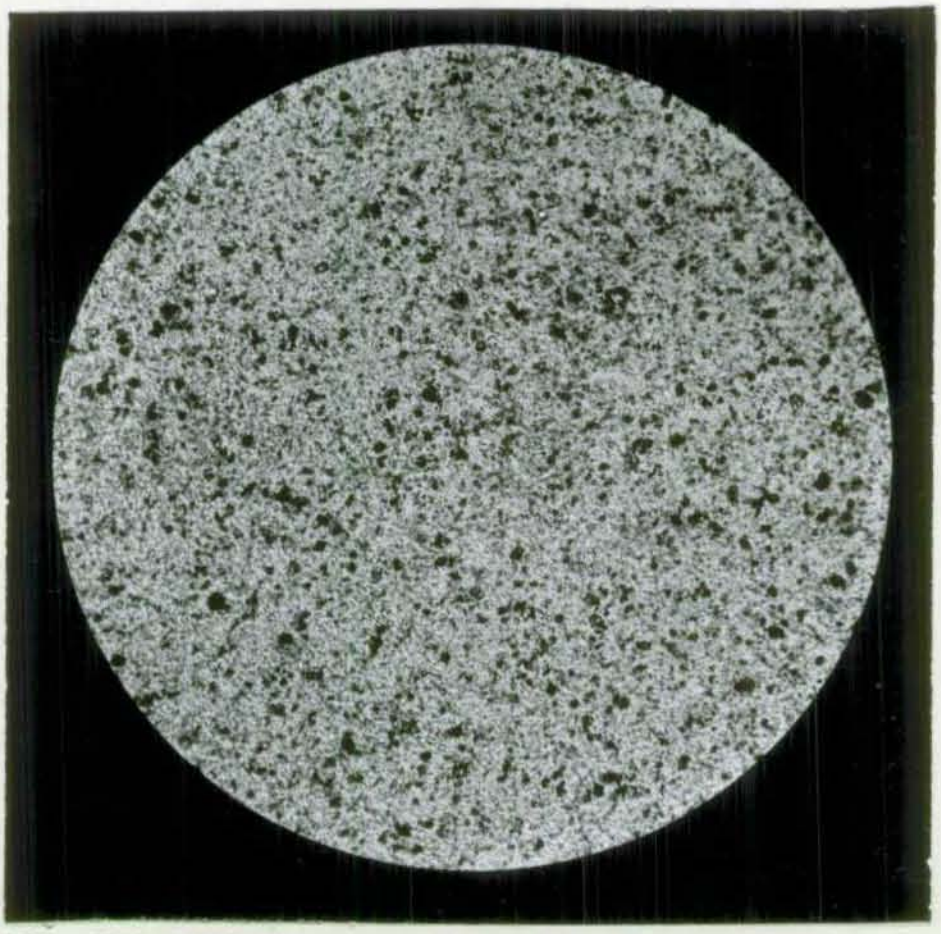


Fig. 17. Meeta Beds, showing dolomitic ferruginous chert, with iron oxide and microcrystalline dolomite in cryptocrystalline siliceous matrix. X45, (SR294a), File No. g/8193.

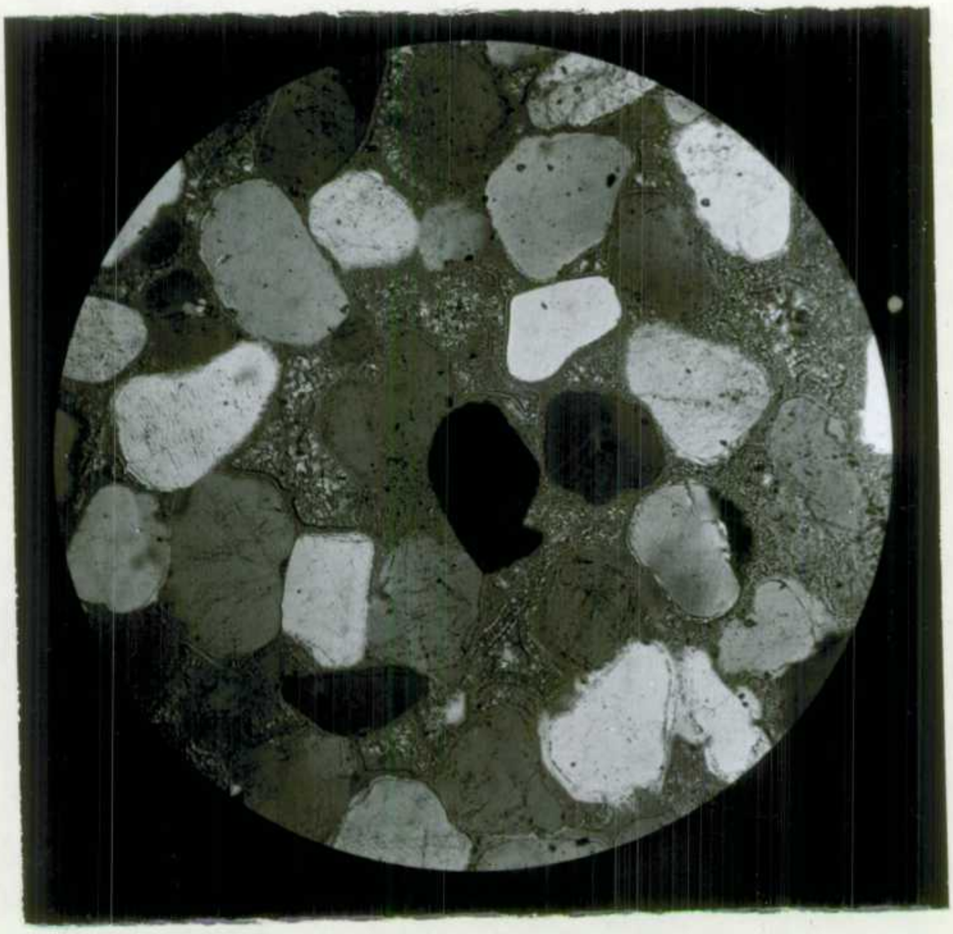


Fig. 18. Meeta Beds showing well sorted siliceous quartz sandstone with fibrous chalcedony veins and drusy siliceous cement. X45 (SR 294 b), File No. g/8192. (x-nicols).

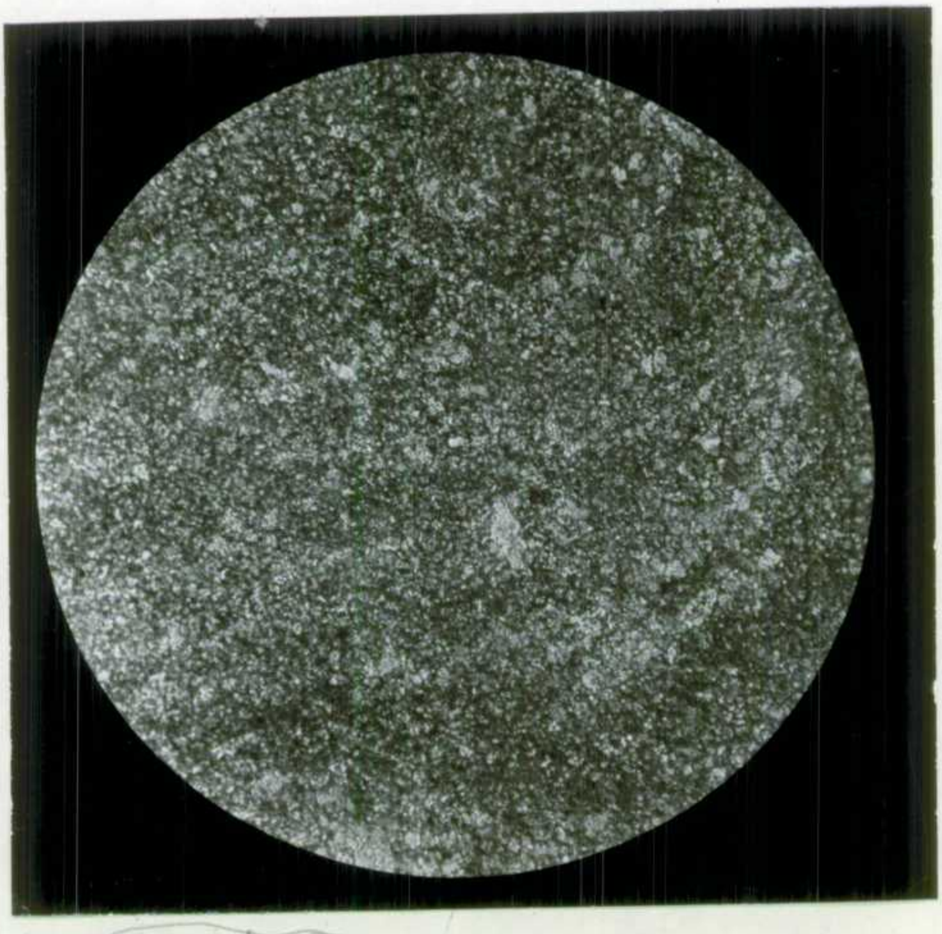


Fig. 19. Tomahawk Beds showing vague algal stromatolite layers with cryptocrystalline dolomite laminae alternating with coarser crystalline dolomite. X45 (SR 307), File No. g/8191.

Thin section: Grains, 80%, quartz, rounded-sub rounded, average size, 600 microns, well sorted, composed of cryptocrystalline to microcrystalline silica, and strain shadowed grains. Some grain-on-grain texture and some sutured contacts; many grains have thin rims (20 microns) of fibrous chalcedony. Overgrowths are rare. Some microcline and plagioclase feldspar grains are present. Cement, 20%, siliceous, microcrystalline, drusy and granular; some partial development of kidney structure (spherulitic chalcedony) next to fibrous rim of the grains.

Origin: The sediment represents an abrupt change from shallow water conditions of carbonate sedimentation to conditions dominated by deposition of terrigenous material. The sediment change was probably due to changes in climate or stability, and increased erosion, on land. The deposit is well sorted and winnowed, indicating persistent current action. Cementation probably occurred before deep burial, as there are no load casts, and few solution or triple point contacts and suturing.

TOMAHAWK BEDS

Rock units forming these beds crop out in the south-western part of the area and comprise dolomites, sandstones and siltstones.

Locality: SR 307, 21½ m. @ 071° from Argadargada Station.

Photomicrograph: Fig. 19.

Lithology: Algal stromatolitic dolomite.

Hand specimen: light brown, layered, columnar, algal stromatolites, Not in situ; columns 1" in diameter.

Thin section: Grains, nil.

Algae: comprise alternating laminae of cryptocrystalline and slightly coarser dolomite, approximately 20 microns thick. Orientation is unknown.

Origin: They are presumed to have grown in warm, shallow sunlit waters, possibly in intertidal areas; their relationship to adjacent rocks is unknown. (cf. sample SR 309 a, p. 9)

Locality: SR 297, 10½ m. @ 247° from Argadargada Station.
SR 291 a & b. 19 m. @ 120° from Argadargada Station.

Photomicrographs: Figs. 20, 21, 22.

Lithology: Dolomitic pelsparite and quartzose dolomitic pelsparite? (pelletal dolarenite and quartzose pelletal dolarenite)

Hand specimen: light brown, pelletal dolarenite, medium grained with algal stromatolites and scattered quartz sand and silt. (SR 291 b.).

Thin section: Grains, 70%, pellets, ooliths?, palimpsest grains, average diameter - 1 mm. (SR 297) and $\frac{1}{4}$ mm. (SR 291 a), well sorted, composed of dolomite rhombs, 50-70 microns in size, but some have a finer crystalline core, or finer crystalline rims (SR 291 a). Concentrations of iron oxide (limonite?) form the approximate boundary of the grain. In some with the finer crystalline cores, single crystals of coarser dolomite are scattered in the core. In sample SR 291 b, sub angular quartz silt and fine sand (60-100 microns) is scattered and forms layers. Some feldspar, clay minerals and green tourmaline also occur, plus ferruginous pellets (average 60 microns in size). Matrix, 30%, medium crystalline anhedral calcite (SR 297) and minor dolomite, 100-150 microns in size, with a relatively uniform texture, generally free from iron oxides, but some occurs as specks in the crystals. In sample SR 291 b, the matrix is anhedral crystalline dolomite, with an average size of 100 microns.

Origin: The sediment possibly accumulated as a calcareous pelletal or oolitic sand in warm shallow water. The relatively good sorting in all the specimens indicates persistent current action, but the variation in pellet size may indicate variable current strength (or the different anal sizes of scavengers if pellets are faecal). The presence of quartz sand and silt indicates slight changes in climate or stability of the land. Little else can be determined about the possible environment as dolomitisation has effectively obliterated much of the original texture. The relatively uniform nature of the texture indicates that dolomitisation probably occurred while the sediment was partly indurated, thus allowing more thorough saturation by magnesium solutions.

Locality: SR 308, 21 m. @ 069° from Argadargada Station.

Photomicrograph: Fig. 23.

Lithology: Oolitic chert.

Hand specimen: brown, grey siliceous, oolitic arenite; as chert rubble.

Thin section: Grains, 80%, consisting of ooliths (90%) and pellets (10%). Ooliths are siliceous, 300-400 microns in size and consist of cores of microcrystalline silica, and oolitic rims of cryptocrystalline silica-laminae, alternating with layers of fibrous silica (chalcedony?). Siliceous pellets of cryptocrystalline silica, 300-400 microns in diameter are also present. Matrix, 20%, comprises microcrystalline to medium crystalline silica, with possible drusy crystals around some grains.

Origin: Ooliths are forming at present on the Bahama Banks under shallow water conditions and persistent current action (Newell, Purdy, Imbrie, 1960). They are composed of aragonite and eventually become cemented by calcite. Leaching and infilling occurs in some ooliths (Friedman, 1964) the infilling consisting of drusy calcite. In the sample described, the original texture is completely silicified and replaced; the age of the silicification is unknown. The drusy silica may be a primary precipitate, or have pseudomorphed an original calcite mosaic.

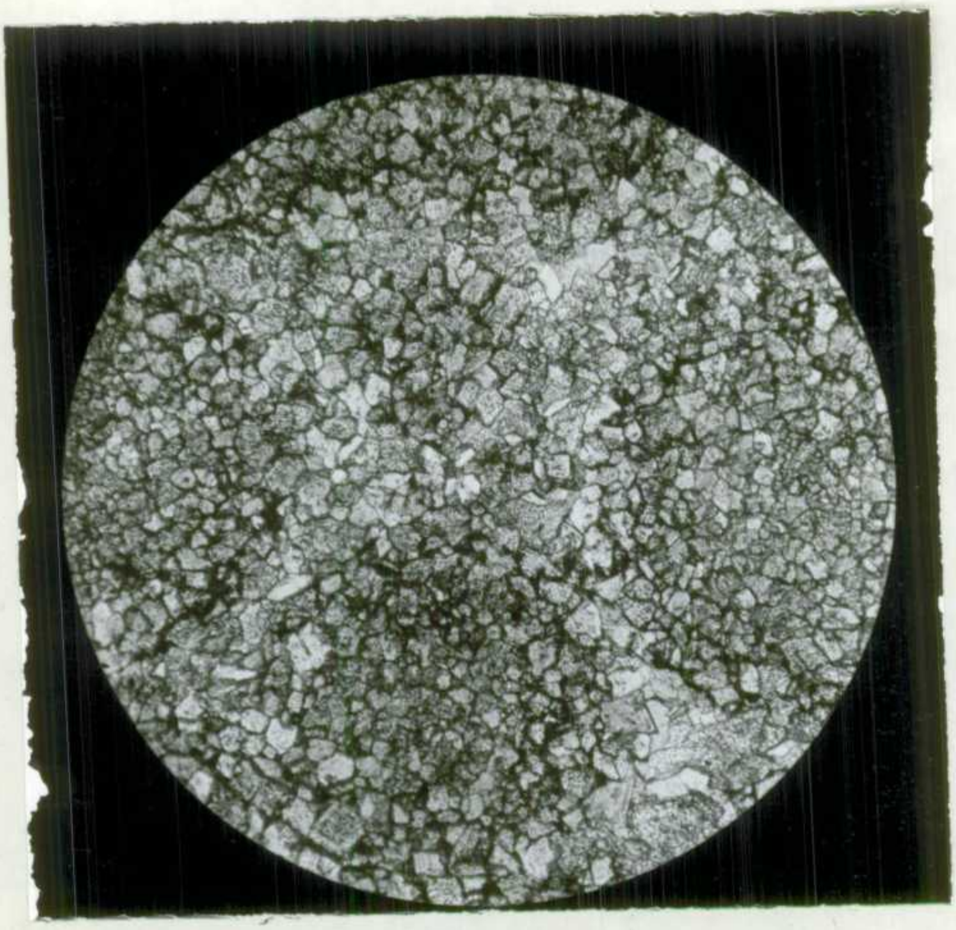


Fig. 20. Tomahawk Beds showing dolomitic pelsparite with nearly completely altered pellets, dark circular areas of dolomite rhombs with inclusions and veins of iron oxide. Matrix is of relatively clear calcite (spar) and dolomite. X45 (SR 297), File No. g/8190.

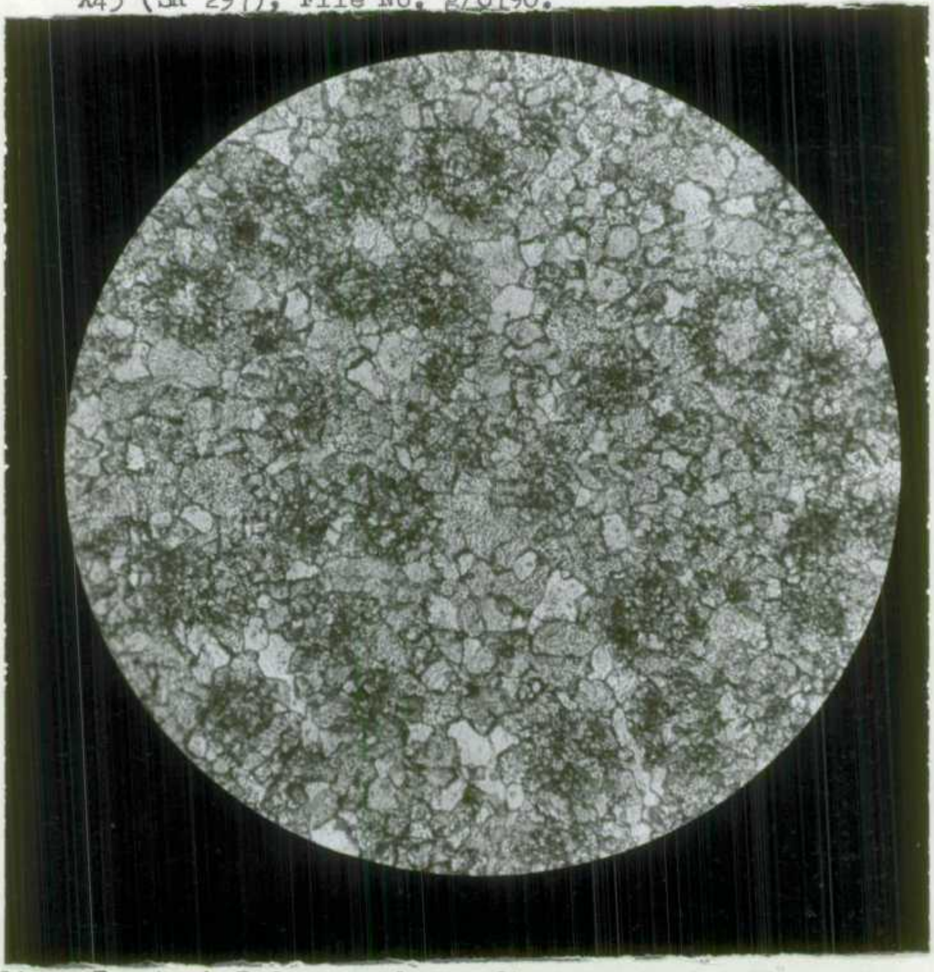


Fig. 21. Tomahawk Beds, as above; finer grained, well sorted, possibly oolitic, with coarser sparry crystalline dolomite matrix. X45 (SR 291 a), File No. g/8188.

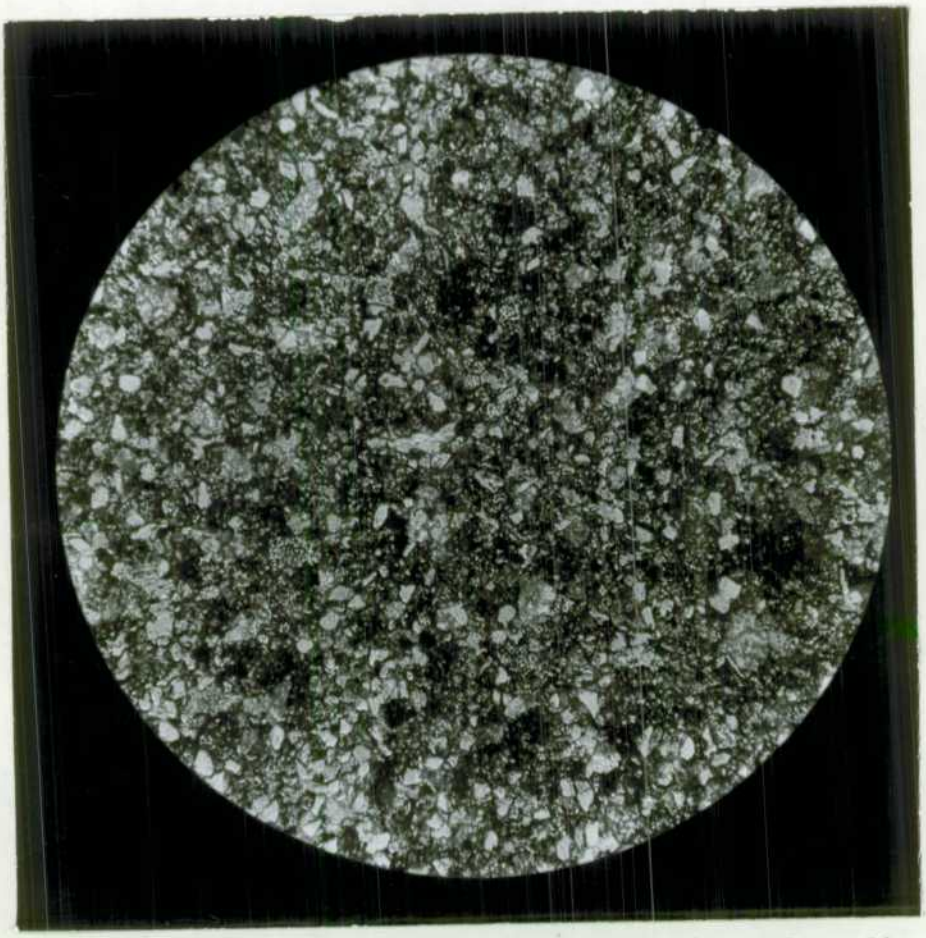


Fig. 22. Tomahawk Beds showing quartzose dolomitic pelsparite with vague pellets of cryptocrystalline dolomite, quartz silt and sand, and microcrystalline to medium crystalline dolomite matrix. X45 (SR 291 b), File No. g/8187.

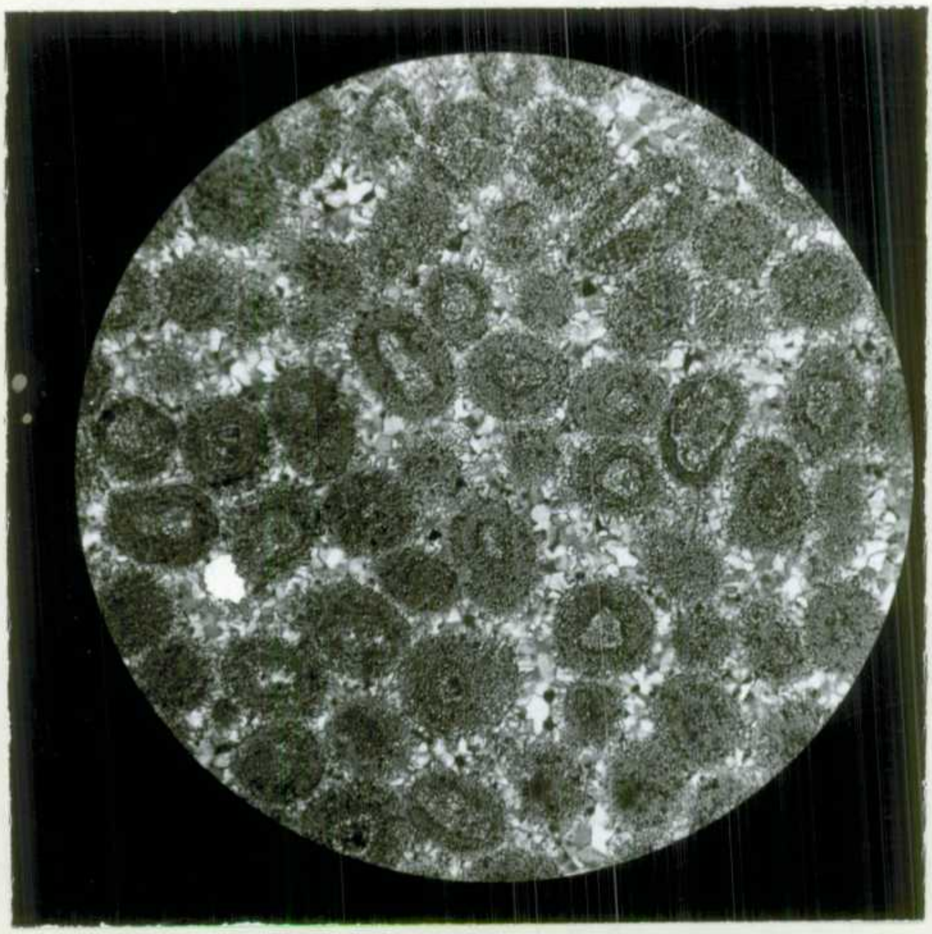


Fig. 23. Tomahawk Beds, showing oolitic chert, with ooliths of crypto-microcrystalline silica, in drusy siliceous cement. X45 (SR 308), File No. g/8189. (x-nicols).

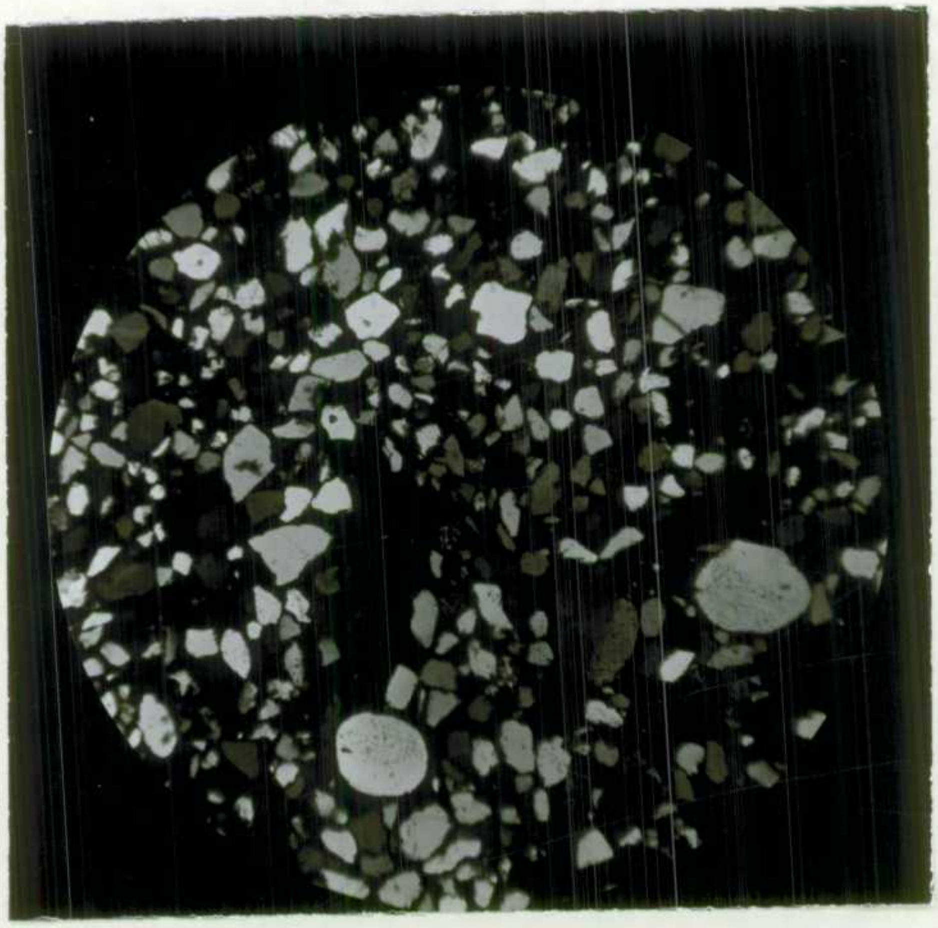


Fig. 24. Tomahawk Beds, showing siliceous quartz sandstone, with angular fine grains and coarser well rounded ones, average sorting. X30 (SR 282), File No. g/8261. (x-nicols).

Locality: SR 282, 10 m. @ 204° from Argadargada Station.

Photomicrograph: Fig. 24.

Lithology: Siliceous quartz sandstone.

Hand specimen: brown, fine to medium grained, hard, thin bedded.

Thin section: Grains, 90%, angular to subangular, poor to average sorting, comprises clear and strain shadowed quartz grains and compound crystalline quartz grains; bimodal size exists, with the majority 100-150 microns (longest axis); the largest are 400-500 microns (approx. 5% of total). Tourmaline, blue, green and brown, also occurs, together with zircon and some iron oxide. There is some point contacting of grains, but few sutures and pressure-solution contacts. Matrix, 10%, consists of cryptocrystalline silica, opaque in ordinary light (chalcedonic? in parts), some clay minerals and iron oxide (limonite?).

Locality: SR 284 a & b., 8 m. @ 217° from Argadargada Station.

Photomicrographs: Fig. 25.

Lithology: Siliceous quartz siltstone and fine grained sandstone.

Hand specimen: brown-grey, fine grained siltstone, banded, showing micro-slumping and faulting; quartz sandstone, brown, fine grained, mottled, thinly bedded, hard.

Thin section: Grains, 80%, fine grained quartz, angular-subangular, 50-75 microns in size; occurs in layers with 80% concentration, alternating with layers of 10% concentration; some slumped layers, some grain-on-grain texture, some pressure solution contacts (sutured boundaries); some tourmalines and zircons, subangular and of silt size. Matrix, 20%, variable distribution, cryptocrystalline in some parts, microcrystalline in others, silica occurs in bands or layers, often forming 90% of the layer with scattered silt and some clay minerals and iron oxide. Some slumping; well sorted in the layers.

Origin: These sediments represent a change from shallow water, pelletal and oolitic sand deposition to dominantly shallow water deposition of fine grained terrigenous material. The fine grade size implies accumulation far from the shore line and source area, and that persistent currents sorted and transported the sediment. The unit is thicker than siltstones and sandstones elsewhere in the Sheet area, and this may denote uplift of the land rather than climatic or current direction changes. The micro-slumping and faulting also indicates slightly unstable conditions.

South-eastern part of the area

Dolomites also crop out in the south-eastern part of the area and were mapped as the Ninmaroo Formation. They comprise similar lithologies to those found in the Meeta Beds, for example, microcrystalline dolomite, algal stromatolitic dolomite intraformational dolomite breccia and rare oolitic dolarenites with and without quartz. Rare vari-coloured siltstones and sandstones also occur (Milligan, B.M.R. pers. comm.).

MESOZOIC? (UNDIFFERENTIATED)

Rocks, possibly of Mesozoic age, crop out in the southern-central part of the area, and consist of coarse quartz sandstones and conglomeratic sandstones; one sample is described.

Locality: SR 304, 6½ m. @ 075° from Argadargada Station.

Photomicrograph: Fig. 26.

Lithology: Siliceous, ferruginous, rudaceous, quartz sandstone.

Hand specimen: brown, coarse grained, quartz sandstone, ferruginous, siliceous with rudite grains and large pebbles, partly cross-bedded.

Thin section: Grains, 90%, quartz of bimodal size; a) large grains (30-40%), average size 2 mms., subangular to subrounded; some up to 1 cm. long. Consist of large strain shadowed and clear quartz, and lithic fragments of quartzite?, many fractured. b) small grains, 60-70%, subangular, ¼-½ mm. in size forming the ground mass; grain-on-grain texture, pressure-solution contacts (sutured boundaries), and triple points, result in angular appearance. Poorly sorted, and unwinnowed. Matrix, 10%, cryptocrystalline silica, with iron oxide (limonite?).

Origin: The sediment may have accumulated in a fluvial or littoral marine environment, where strong current action transported large grains and pebbles and deposited them without sorting. Some of the large pebbles of sandstone are well rounded, and discoidal in shape. The silicification and ferruginisation may have occurred during lateritisation.

TERTIARY? (AUSTRAL DOWNS LIMESTONE)

Limestones comparable to the Austral Downs Limestone (Noakes, 1951), crop out in the north-eastern part of the area, and two lithologies were found.

Locality: SR 271 a. 20 m. @ 084° from Georgina Downs Station.

Photomicrograph: Fig. 27.

Lithology: Algal? limestone (dismicrite, autobrecciated, calcilutite).

Hand specimen: white, light grey, light brown, autobrecciated? calcilutite.

Thin section: the brecciated parts consist of fragments of cryptocrystalline calcite, flocculent and irregular in shape. Many fragments are joined by thin and irregular shaped "wall-like" structures of cryptocrystalline calcite, partly surrounding areas of microcrystalline to medium crystalline drusy and granular calcite, giving a quasi cellular appearance in parts. They are not layered and do not form a continuous structure.

Origin: The specimen may represent a disintegrated or flocculent algal mass, which was subject to solution and infilling by calcite cement, or a variety of collapsed stromatactis structure (Bathurst, 1959). In either case the environment was one of shallow, warm water, sunlit, and supporting algal growth. The brecciated appearance does not seem to have resulted from turbulence in the environment, but from collapse, i.e. autobrecciation.

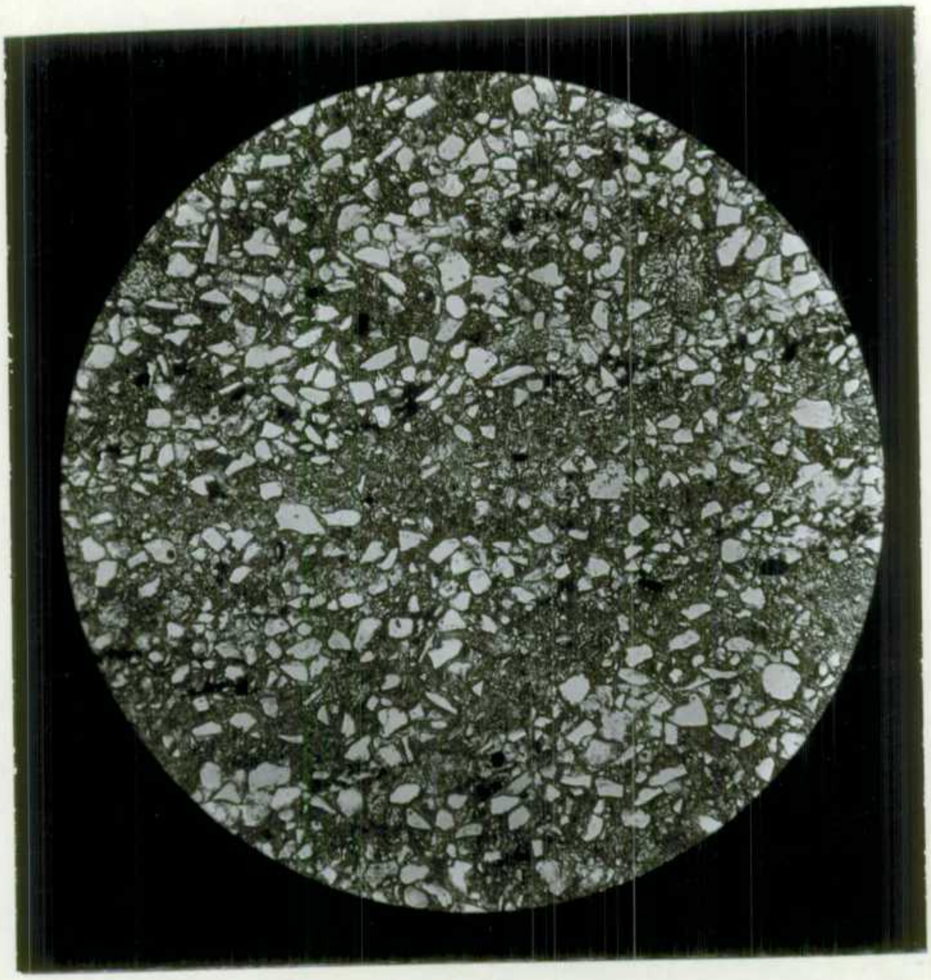


Fig. 25. Tomahawk Beds, showing fine grained siliceous quartz sandstone with silty layers and iron oxide, and siliceous matrix. X50, (SR 284 a), File No. g/8186. (ord. light).

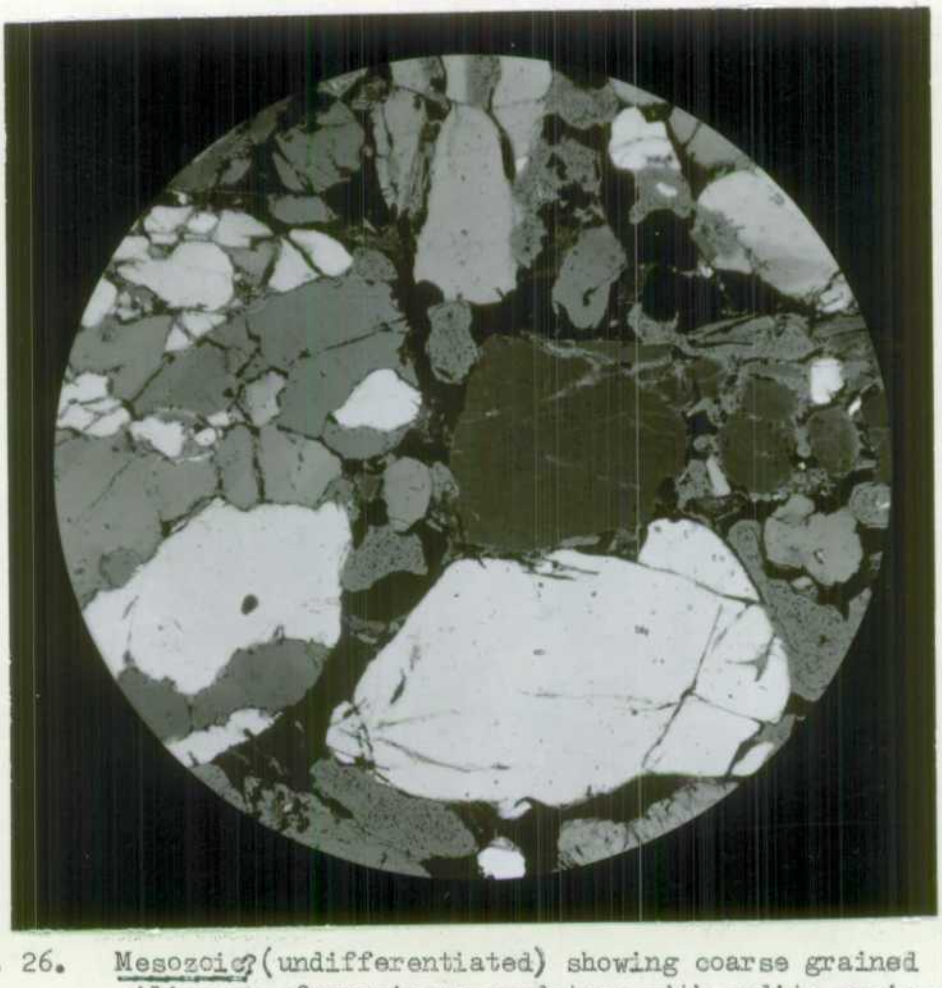


Fig. 26. Mesozoic? (undifferentiated) showing coarse grained siliceous, ferruginous sandstone with rudite grains of fractured quartz and ?quartzite. X45 (SR 304), File No. g/8185. (x-nicols).

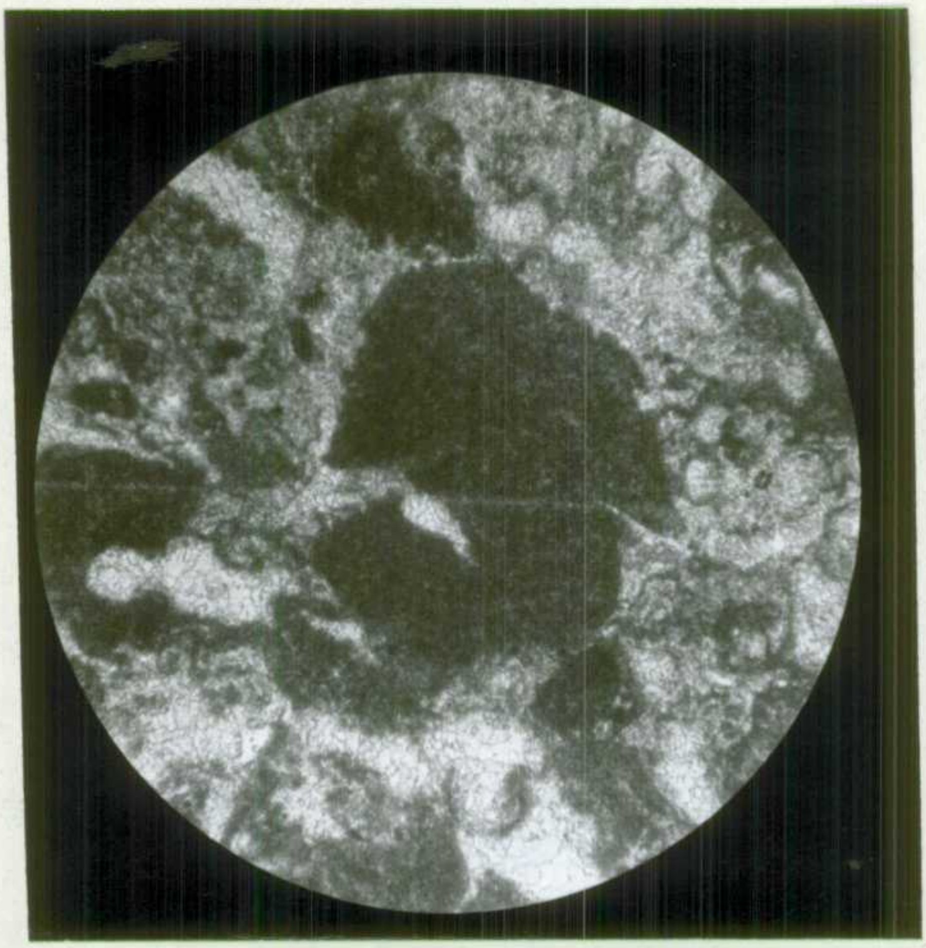


Fig. 27. Tertiary, Austral Downs Limestone, showing flocculated algal? fragments (autobrecciated) and possible cellular structures (medium cryptocrystalline drusy calcite partly surrounded by walls? of cryptocrystalline calcite.) X45, (SR 271a), File No. g/8182.

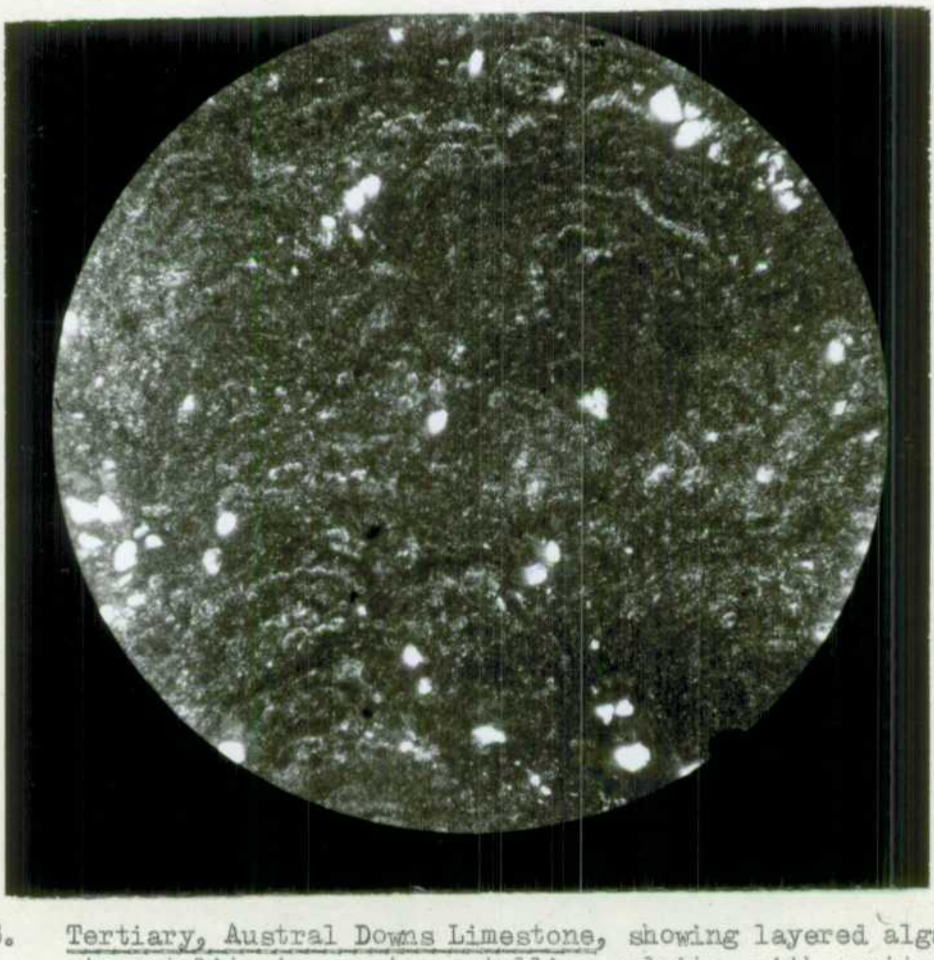


Fig. 28. Tertiary, Austral Downs Limestone, showing layered algal stromatolite in cryptocrystalline calcite, with scattered quartz sand. X45, (SR 271b), File No. g/8183.

Locality: SR 271 b. 20 m. at 084^{o} from Georgina Downs.

Photomicrograph: Fig. 28.

Lithology: Quartzose algal stromatolite.

Hand specimen: white, red, laminated, hard, tight.

Thin section: layers or laminae of cryptocrystalline calcite, undulating and alternating with layers of slightly coarse microcrystalline calcite; vague columnar structures, convex upwards (1 mm. apart); iron oxide occurs along some layers. 5-10% quartz, sub-angular, 40-100 microns in size, is scattered and concentrated in areas between vague columns.

Origin: This structure is similar to the laterally linked forms described by Logan, Rezak & Ginsburg (1964), which occur at present in the intertidal zone at Shark Bay, Western Australia. It is assumed that similar forms grew in shore-line lagoons and on intertidal flats during the Tertiary. Similar algal forms occur in the Brunette Limestone in the Brunette Downs Sheet area (Nichols, 1963). (The ages of these limestones were determined by Noakes, (1951) and Lloyd (1963).

CONCLUSIONS

During Upper Cambrian times the Sandover River Sheet area was covered by shallow warm waters, and a variety of carbonate and land-derived sediments accumulated in a shelf environment. This environment changed from time to time and periods of carbonate mud accumulation gave way to periods of oolitic and pelletal sand formation (possibly as banks), and more turbulent periods of intraclastic and microconglomeratic deposition. A certain amount of mixing of the carbonate mud and the clastic grains may have occurred through scavenging action. At certain other times, due either to slight instability or climatic and current changes, quartz sand was deposited in shallow water and subject to wave action; it also partly scoured the underlying carbonate beds, and was derived from islands or nearby larger land areas. Similar variations in conditions and sediments may have also existed laterally as well as vertically, but this is not easily visible. At certain rare intervals, algal stromatolites developed, and may have flourished in intertidal areas. Conditions continued to vary in this way and similar alternations from carbonate mud to oolitic and pelletal sands etc. occurred in Ninmaroo Formation and Tomahawk Beds time. A greater amount of terrigenous material accumulated during deposition of the Tomahawk Beds, and possibly the adjacent land was more unstable at this time.

Dolomitisation is thought to have occurred penecontemporaneously in most cases, as the textures are preserved. Similar sediments are being dolomitised in the Persian Gulf at present where the upper 1.5 feet are up to 3000 years old (Illing, 1964). The question of primary dolomite and its existence is difficult to answer as there is no conclusive evidence of it occurring at present. The presence of drusy dolomite in the samples described, may indicate primary precipitation or the pseudomorphing of calcite textures.

During Mesozoic? times, very strong fluvial or possibly marine currents transported and deposited large pebbles of quartz and sandstone with quartz sand in the southern part of the area.

In the Tertiary? however, a carbonate environment developed where lime mud was precipitated in shallow lakes or shore-line lagoons, inhabited by some algae.

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