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THE GEOLOGY OF THE AREA
EAST OF POINT PASS
SOUTH AUSTRALIA.
With emphasis on the Sturtian
Glacials

BY KEVIN R. HAMDORF, B.Sc.

1972.

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This thesis is submitted as partial fulfilment of the course requirements of the Honours Degree of Bachelor of Science in Geology at the University of Adelaide, 1972.

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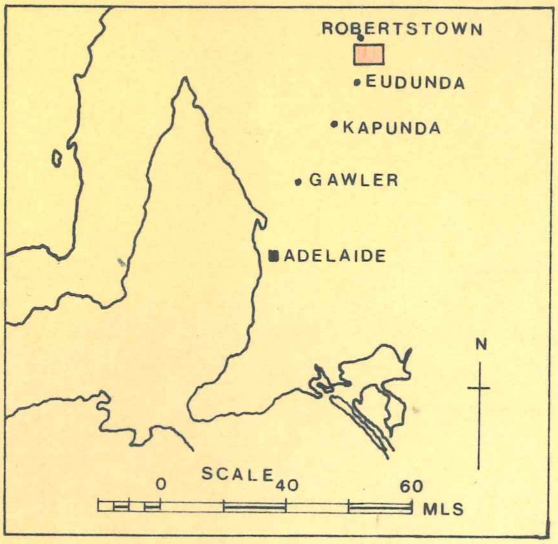


LOCALITY MAP POINT PASS AREA S.A.

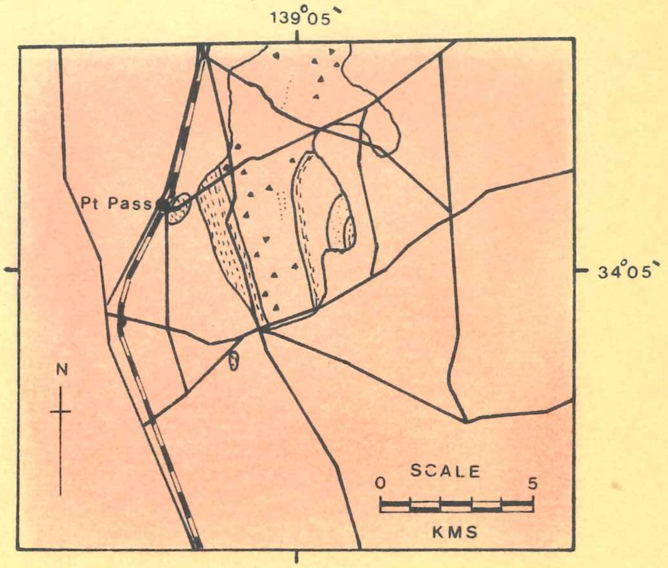


FIG 1

ABSTRACT.

The elevated range east of Point Pass is defined by a sequence of 3,650 metres of Late Pre-Cambrian glacial and post-glacial sediments.

The glacial sequence is composed of 1,850 metres of pebbly tillite and bedded arenaceous interglacials, which unconformably overlie the laminated Saddleworth Siltstones. The 1,800 metres of sediment conformably overlying the glacial sequence are generally composed of calcereous and non-calcereous argillites and feldsarenites which have been deposited under a shallow sea in the slowly subsiding Adelaide Geosynclinal Basin.

Major block-faulting has resulted in the truncation and subsequent disappearance of the upper beds of the Tarcowie Siltstone, which represents the youngest Pre-Cambrian sediments exposed in the area.

INTRODUCTION

The area under scrutiny lies some two kilometres east of the township of Point Pass, which is situated on the main road joining Robertstown to Eudunda. (see Fig. 1)

Of the 42 square kilometres (9.1 km x 4.6 km) covered, approximately 65% came under close observation, while the remaining 35% was denied visible examination because of a blanket coverage of Recent sediments.

The topography of the area is varied. The western sector comprises of gently undulating, cultivated hills, which rise eastward before abruptly terminating at a boldly outcropping, vegetated quartzarenite ridge, which rises some 50 metres above the surrounding plain. The ridge strikes slightly west of north for almost the entire length of the area. To the south this same ridge is suddenly truncated. The southern extension disappears abruptly, then re-emerges as a displaced and subdued outcrop some 2.25 kilometres to the S.W. Eastward of the quartzarenite ridge the topography bears witness to extensive differential erosion, where the softer more susceptible lithologies form broad but shallow valleys between the more hardy and massively indurated quartzarenite and siltstone subparallel ridges. Eastward of this a further elevated ridge composed of resistant subfeldsarenites defines the relief, however, its eastward extension is abruptly terminated by a sinuous line striking approximately NW - SE. Once again a subdued relief of gently rolling rises and depressions occupies the extreme eastern sector of the mapped area.

The drainage system is dominated by a series of consequent streams and shows a very juvenile stage of development at their fault marked origins in the western quartzarenite ridge. Their south-easterly drainage trends are delineated by deeply eroded channels, which frequently dissect the underlying bedrock as well as the thick, pebbly alluvium deposits. This feature tends to suggest some form of recent earth uplift. Broader and more mature subsequent streams that flow approximately N - S, reveal a lesser degree of downward erosion in the central part of the area. Numerous subsequent streams of lesser significance within the western quartz-arenite ridge, (particularly at its southern termination) show deeply eroded concave gradients, (often in excess of 30 degrees) for their entire although limited lengths.

Fieldwork encompassed approximately seven weeks during May and June with an additional week in August. Access to the area was made available by numerous conveniently spaced secondary roads and tracks. (see Fig. 10)

Base mapping was performed on lucid, black and white aerial photographic enlargements (178.5m to the cm.)

The area had been mapped previously by W.B. Robinson of the S.A. Department of Mines as a section of the Eudunda 4-mile geological sheet (1966).

A.J. Drummond and L.J. Morris have studied nearby areas to the S.E. and S.W. respectively.

Laboratory time was occupied by the preparation of the following:-

a) approximately 60 thin sections.
b) a single rock staining experiment.
c) photographic work involving numerous handspecimens and thin sections.

STRATIGRAPHY

The intention of conducting a stratigraphic study of the Sturtian tillite and associated strata was to compile sedimentary information to form a basis for a hypothesis on the environment of deposition of these rocks in the area east of Point Pass.

A preliminary perusal of the area was conducted over the first few days to determine suitable traverses for the taking of a representative stratigraphic section. Initial photographic interpretation had revealed at least three potential stream beds for this purpose. Field examination dispelled these hopes when it was discovered that the industrious primary producers of the area had found the same creek beds provided, convenient dumping grounds for unwanted stones. In addition often large stretches of the creeks had not as yet eroded through to bed rock. As a consequence of these misfortunes I was forced to take a composite stratigraphic section over several outcropping ridges and cultivated fields. (Fig. 9) Float-scree sectioning of ploughed fields must of course suffer the inherent errors involved with such a method. Consequently where such a method of sectioning has been employed and where an element of uncertainty has occurred the stratigraphic column has been appropriately question-marked. (Fig. 9) Despite this short-coming, confidence in the veracity of the overall sequence is maintained. As a corollary to the above, bias has been shown towards a more detailed study of the better exposed outcrops; the Gilbert Range Quartzite, the Appila Tillite, Tindelpina Shale, and to a lesser degree the Eudunda Arkose.

Unfortunately, with the exception of a few areas of a limited extent, the entire Saddleworth Formation and Hansborough Tillite exposures have undergone intensive cultivation. Considerable effort was exerted in an attempt to piece together sufficient stratigraphic information to yield the general trend shown by these sequences.

I have retained the stratigraphic subdivisions imposed on the area by the South Australian Mines Department, because they best delineate the boundaries of significant change in the history of environmental deposition.

THE SADDLEWORTH FORMATION.

The basal section of this formation is obscured by Recent sediments, the maximum thickness exposed being approximately 680m. Sufficient outcrop revealed the formation to consist of a monotonous sequence of very well indurated, laminated black and brown siltstones. There were no mànifest changes in grain size or sorting in those exposures examined, all of which responded negatively to acid testing. The only visible variable was in the nature of the bedding. Thicknesses varied from extremely fine (.02 mm.), well defined laminae to more broadly spaced (.5 - 1.5 cm.), less well defined discontinuous laminae. (T.S. 379/A1, 379/A1a; Hand-specimen 379/A1 and 379/H1). The latter handspecimen shows lenticular sedimentation units (flaser bedding) with cross stratification formed as a result of the migration of small ripples. Also present in the same specimen are incipient micro-flame structures developing on the lee-slope of the ripple. This feature has apparently been produced by the drag effect of a sediment-laden current overriding the underlying finer unconsolidated sediments.

A broad appraisal of the current direction can be taken from a composite consideration of the above sedimentary structures. It is apparent that the upper sequence of the Saddleworth Formation in this area was deposited by currents flowing from a general western direction.

MEASURED STRATIGRAPHIC SECTIONS

EAST OF POINT PASS S.A.

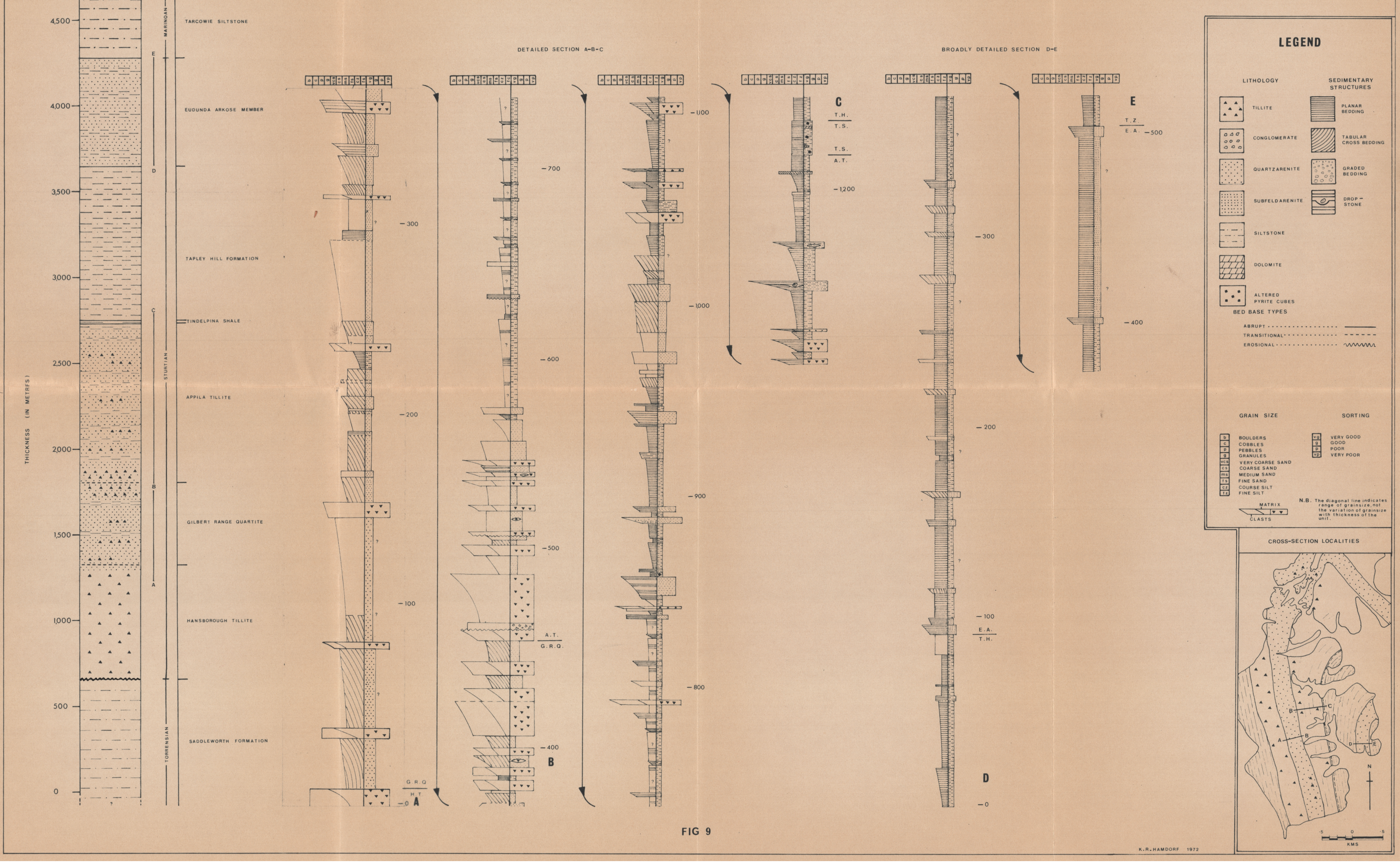


FIG 9

HANSBOROUGH TILLITE

The Hansborough Tillite demonstrates an approximate constant thickness of 680m along its strike length in the area of consideration.

There are no visible exposures of the contact between the tillite and the underlying Saddleworth Formation, but f rom a critical examination of the available sedimentary evidence the contact does appear to be unconformable. Two pieces of evidence help substantiate this conclusion. Firstly, at one of the few outcrops still intact adjacent to the contact, several chunks of pebbly conglomerate were observed in the scree. Although no actual outcrop of the conglomerate was observed, the status of the chunks imply them to be of local derivation. (Handspecimen 379/H2). Secondly, the abundance of angular siltstone rock fragments within the lower sequence of tillite, and their close lithological resemblence to the underlying Saddleworth siltstone possibly reflects the formation as being their source of origin. A combination of the above two observed sedimentary features suggests the existence of an erosional hiatus of short duration between the Saddleworth Formation and the overlying Hansborough Tillite.

Shown in the same outcrop are several lenticular shaped, medium grained, white quartzarenite interbeds with lateral extents of 8 to 10 m and approximate widths of 1 to 2 m. Two of the three examined showed small scale cross stratification, one of which was festoon cross bedded. The lenses are surrounded by a homogeneous, unstructured mass of tillite. Preferential orientations shown by the clasts in these tillites can be attributed to mechanical effects related to cleavage development. (Handspecimen 379/A2).

Approximately 150m. above the base of the Hansborough tillite was found a single lenticular shaped varve deposit. Petrological examination confirms its varved nature. (T.S. 379/A3). The deposit, although poorly exposed, has a lateral extent of at least 10m. and a thickness of approximately 1m. This interbed is again bound above and below by pebbly tillite. A recent drainage excavation traverses some 150m. of the lower tillite sequence, beginning about 100m. above the basal contact. Close scrutiny of this valued exposure failed to disclose any hint of an intersection with the above mentioned varve deposit, confirming its limited lateral extent in one direction at least. Lacking also were intersections with quartzarenite interbeds. This may imply that such interbeds are restricted to the very basal section of the sequence. The entire exposure along the trench was composed of noncalcereous, unstructured pebbly tillite. A noted feature ubiquitous in the lower sequence but lacking in the middle and upper sequences of tillite, are ill defined ferrous stain horizons. This phenomena, although of an obvious weathering origin, possibly reflects an early influx of iron rich sediment at the onset of glaciation.

The remaining scanty tillitic outcrops all reveal the same pebbly tillite typical of those found in the lower sequence. (Plate A-A). Scree in the cultivated fields between the sparsely separated outcrops confirms this picture.

A finely laminated, fine grained, noncalcereous, black siltstone outcrops 10m. below the first cross stratified quartzarenite ridge which mark the beginning of the Gilbert Range Quartzite at one locality. The exact nature of the contact between the tillite and siltstone was not clearly evident, although it appeared to be sudden. The contact between the siltstone and the overlying quartzarenite was visible and showed an abrupt relationship.

CLASTS.

As part of the investigation of the Hansborough Tillite a statistical survey was conducted to determine the abundance of the various clast types with respect to each other, and to their stratigraphic position within the sequence. Measurements of clast size and shape were also taken and statistically scrutinized.

The procedure adopted and its limitations are discussed in detail in Appendix I. The limitations of the method described must be stressed. The results do resolve certain trends in clast abundances but do nothing more, and are applicable only to the narrow vertical section of the tillite investigated. Trends shown by size and roundness are very distinct and an attempt to interpret them has been made.

The survey has been restricted so as to only include clasts with sizes greater than small pebble size. The reasons for this decision are given in Appendix I.

The various types of clast were grouped into five broad lithological divisions;

(a) White metaquartzarenites.
(b) Black metaquartzarenites.
(c) Gneisses.
(d) Porphyries.
(e) Dolomites.

When this study was initiated the objective intended was only to resolve the abundance or paucity of the broad clast types (suggested above) with respect to their stratigraphic locality. This original goal has met with some success. At no time was it intended for the results to act as a possible guide to provenance. The wide variety of gneissic rocks alone can soon be realised if one examines the accompanying petrological descriptions listed in Appendix III. Such a spectrum of rocks comes from an equally wide range of localities.

The results of the survey are plotted on Fig. 2(a).

Discussion.

(i) Abundance. The generalized trend of abundance for each of the five clast groups with respect to stratigraphic locality is graphically illustrated. Variable trends are noted in each case. Both metaquartzarenite varieties indicate their abundance maxima to lie within the basal section. The gneissic group demonstrate an almost constant abundance throughout the sequence, but occur in slightly greater numbers in the lower sequence. Porphyry clasts show their abundance maxima in mid sequence while the dolomites reveal theirs to occur in the upper section.

The abundance of clast types with respect to each other is tabulated as percentages in part (iv) of Fig. 2(a). The metaquartzarenites account for approximately 50% of the total number of clasts examined, while dolomites comprise only 5%.

(ii) Size. The results derived from the measurement of the largest diameter shown by the clasts are tabulated in Fig. 2(a). The range of sizes for each clast group are recorded in addition to the range shown by the clasts as a single total. (Part (ii)). Almost 50% of all clasts studied fell within the range of very large pebble size. A distinct absence of clasts larger than small cobble size was noted. This feature may reflect processes of crushing occurring during ice transport. Although this process probably took place, it does not appear to account for the bulk of small clasts examined. This becomes obvious in the following discussion. (A single well rounded, medium size boulder was located near the basal section of the tillite. Its occurrence is discussed briefly in Appendix I.)

(iii) Roundness. The relevant figures illustrating the variability of roundness shown by the clasts are listed in Fig. 2(a). As can be observed in part (iii) approximately 95% of all clasts were either subrounded or rounded. It is hard to believe that weathering processes post-dating the deposition of the clasts have been responsible for their exhibited roundness. Exposures of clasts still bound by matrix material show similar rounding to the 'free' clasts. (Plate A-B). Rounding either occurred during transportation in the ice or within the preglacial environment. The

PLATE A.

A. Pebble size clasts contained in a silty-sand matrix. Lower Hansborough Tillite.

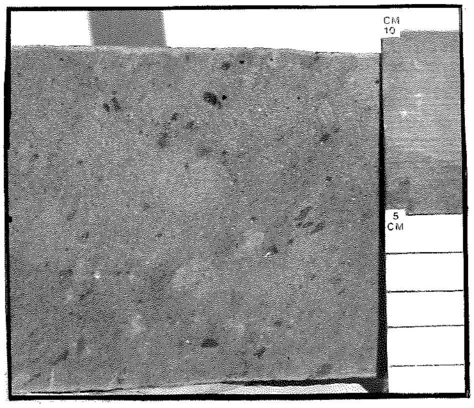
B. Metaquartzarenite clast embedded in a sandy-silt matrix. Middle Hansborough Tillite.

C. Well sorted, cross stratified quartzarenite overlying a pebbly tillite. Gilbert Range Quartzite.

D. Well rounded, black metaquartzarenite pebble contained in a sandy silt matrix. Upper Gilbert Range Quartzite.

E. Sharp contact between a well bedded quartzarenite and an underlying, unstructured pebbly tillite. Lower Gilbert Range Quartzite.

PLATE A



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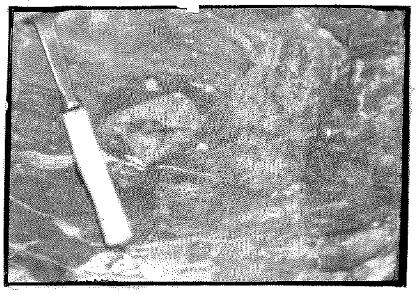

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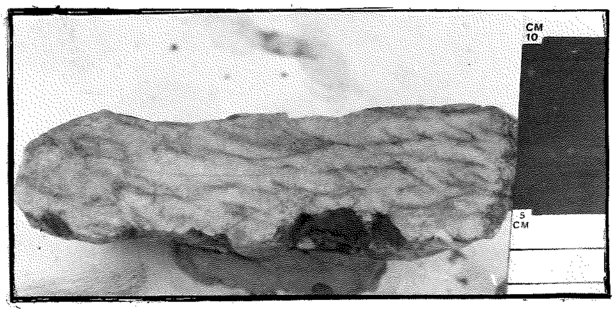


C

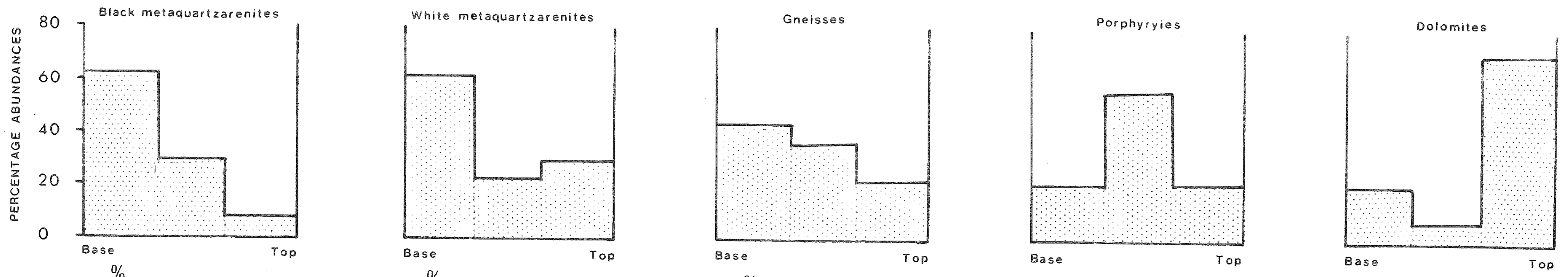
D

E

STATISTICAL ANALYSIS OF GLACIAL ERRATICS

FIG 2(a) THE HANSBOROUGH TILLITE

(i)



(iv) TOTAL ERRATICS (547)

Black metaquartzarenite	24 %
White metaquartzarenite	32 %
Gneisses	22 %
Porphyryies	17 %
Dolomites	5 %

(ii) SIZE

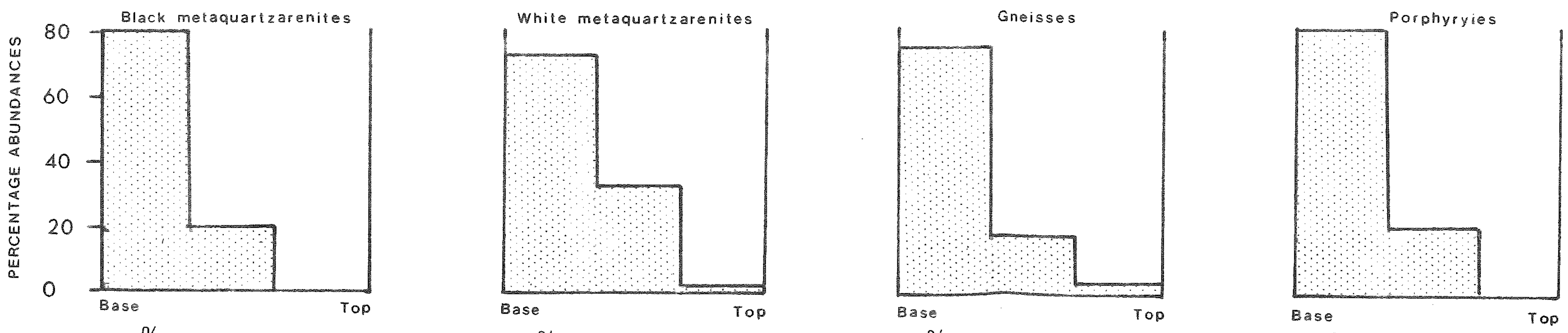
	Black metaquartzarenites %	White metaquartzarenites %	Gneisses %	Porphyryies %	Dolomites %	Total %
SC	17	33	31	44	0	31
VLP	36	38	69	56	45	45
LP	17	11	0	0	55	9
MP	30	18	0	0	0	15

(iii) ROUNDNESS

	Black metaquartzarenites %	White metaquartzarenites %	Gneisses %	Porphyryies %	Dolomites %	Total %
R	78	50	38	0	100	62
SR	20	45	54	57	0	34
SA	2	5	8	34	0	4
A	0	0	0	9	0	0

FIG 2(b) THE APPILA TILLITE

(i)



(iv) TOTAL ERRATICS (239)

Black metaquartzarenite	27 %
White metaquartzarenite	23 %
Gneisses	34 %
Porphyryies	26 %

(ii) SIZE

	Black metaquartzarenites %	White metaquartzarenites %	Gneisses %	Porphyryies %	Total %
SC	26	40	41	41	38
VLP	24	53	34	59	45
LP	33	7	25	0	14
MP	17	0	0	0	3

(iii) ROUNDNESS

	Black metaquartzarenites %	White metaquartzarenites %	Gneisses %	Porphyryies %	Total %
R	58	58	25	27	41
SR	33	36	58	60	48
SA	9	6	9	13	10
A	0	0	8	0	1

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rounding exhibited by most of the clasts can hardly be attributed to the erosive action of ice. Rare faceting has produced some smoothly bound wedge-shaped clasts. (Handspecimen 379/H3). The abrasive action of sediment-laden melt water may also account for some of the clasts. However the total lack of angular exotic clasts must be interpreted as the result of preglacial rounding processes.

Conclusion.

A combined consideration of the clasts relatively small size and well rounded surfaces coupled with their overwhelming abundance, supports an argument which suggests that the clast morphology had been determined dominantly by a preglacial environment. A transgressive or regressive beach environment could account for the features discussed above.

As stated in Appendix I the exclusive consideration of clasts greater than small pebble size resulted in the elimination of siltstone clasts from the survey. The fragile nature of siltstone fragments prevented them from attaining sizes within the range nominated. However, such fragments are very abundant in the size range below small pebble size. Voids within the matrix often occupy the position originally taken by the since eroded siltstone fragment. Large quantities of metaquartzarenites and lesser amounts of clasts of the varieties already discussed (dolomite is an exception) also occur within this smaller size fraction. Such clasts exhibit a considerable degree of angularity and possibly reflect the action of percussion forces at and within the basal layer of the glacier.

Clast populations in this size fraction are dominated by the siltstone fragments especially in the basal section. Metaquartzarenite abundances showed little variation throughout the sequence.

The matrix is composed of a poorly sorted array of fine grain silt and coarser grained sand particles. The finer fraction dominates. (Handspecimen 379/A2; Plate A-A).

The results of petrological studies of clasts and a suggestion as to their possible provenance will be discussed later.

THE GILBERT RANGE QUARTZITE.

Despite the fact that this formation is the best exposed of all those studied , stratigraphic sectioning of its more erodable interbeds had to be performed by examination of the appropriate float material. What is presented as a representative section of this formation is graphically illustrated in Fig. (9). More revealing exposures of a few of the softer interbeds are found in the northern section of the eastern fold limb, but these have not been incorporated into the stratigraphic section of Fig. (9). Some of the sedimentary structure revealed in these northern exposures will be discussed under this sectional heading.

The approximate thickness of the Gilbert Range Quartzite in the area is 480m. The sequence is typified by thin continuous, cross stratified white quartzarenite beds, interbedded with softer pebbly tillites and laminated siltstones. This sequence of beds is repeated throughout the formation and possibly reflects seasonal fluctuations.

The quartzarenite interbeds exhibit variable thicknesses ranging from 1 metre to as much as 40 metres and show lateral extents which vary from lenticular shaped bodies 10 metres long to continuous beds traversing the entire length of the area. The most common variety are 5 to 10 metres thick and show continuous outcrop over many kilometres.

The lower contact of the Gilbert Range Quartzite with the underlying Hansborough Tillite is very sharp in local detail but shows an apparent intertonguing relationship on a scale incorporating the area under study.

No bedded tillites were found. They generally showed very limited thicknesses never exceeding 10 metres and were traceable over lateral distances of at least 500 metres in many cases. It is quite possible that such interbeds traverse the entire length of the area but lack of outcrop prevented confirmation of this. Time limitations prevented the pacing of all such interbeds although many more could have been appended to the accompanying geological map. (Fig. 10).

Direct exposures of contact zones between quartzarenite and tillite interbeds are very rare and at the few locations that they were observed indicated sharp conformable contacts. Plate A-E demonstrates the contact between a well sorted, cross stratified quartzarenite and an underlying pebbly tillite. Elsewhere the rapid transformation from finely bedded quartzarenites to unstructured tillites occurred over a few centimetres, along almost planar contacts.

The same range of exotic pebble and cobble size clast found in the underlying Hansborough Tillite were also located in the interbedded tillites of the Gilbert Range Quartzite. (Plate A-D and Plate B-A). The dominant occurring clast size is small pebble, and only on rare occasions were clast larger than medium pebble size found. With the exception of the very small fraction most of the clasts demonstrated a high degree of roundness. The matrix material was generally composed of moderately sorted sandy-silt, and possibly reflects subaqueous current transportation.

Laminated siltstone interbeds are not abundant in the sequence and those that do occur appear to be of limited thickness and lateral extent. They occur most frequently in the basal section of the Gilbert Range Quartzite.

Pertinent sedimentary structures occurring within the interbeds of the Gilbert Range Quartzite shall now be discussed in some detail.

The most persistent sedimentary structure observed in the quartzarenite interbeds were the regular small scale cross stratification sets. The lower boundaries of these were generally discordant and implied minor erosional contacts between adjacent sets of cross strata. (Conybeare and Crook, 1968). Palaeocurrent measurements were obtained from the lower and upper quartzarenite beds of the Gilbert Range Quartzite and indicated a broad N - NW approach of the depositing medium. (Fig. 3a). The small scale and lack of variability in the nature of the cross stratification suggests a stable low velocity aqueous current acting in

CURRENT DIRECTIONS

(CROSS-BEDDING)

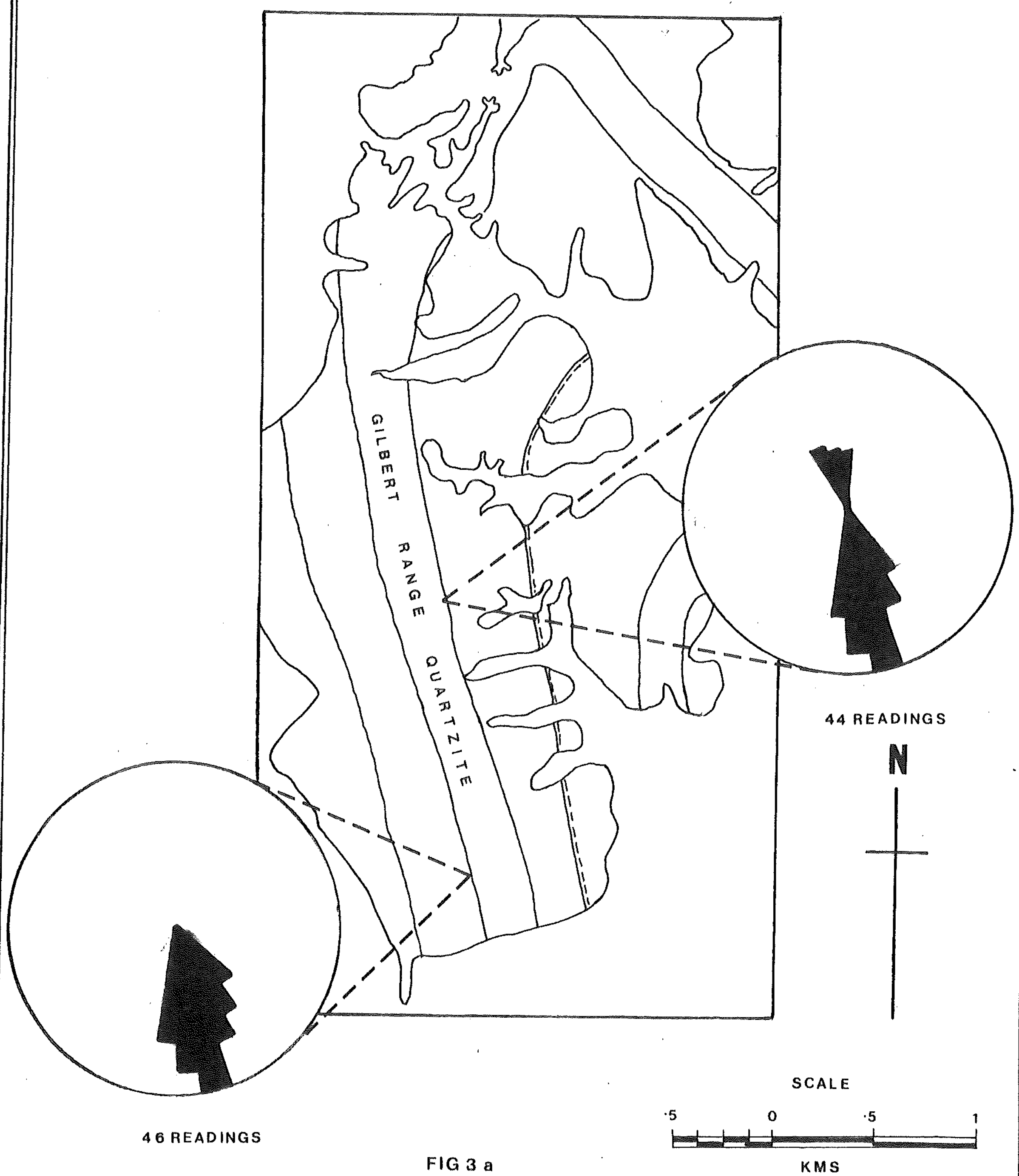

FIG 3 a

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PLATE B.

A. Well rounded metaquartzarenite (left) and granitic gneiss clasts. Middle Gilbert Range Quartzite.

B. Quartzarenite indicating small scale herring-bone cross stratification. Upper Gilbert Range Quartzite.

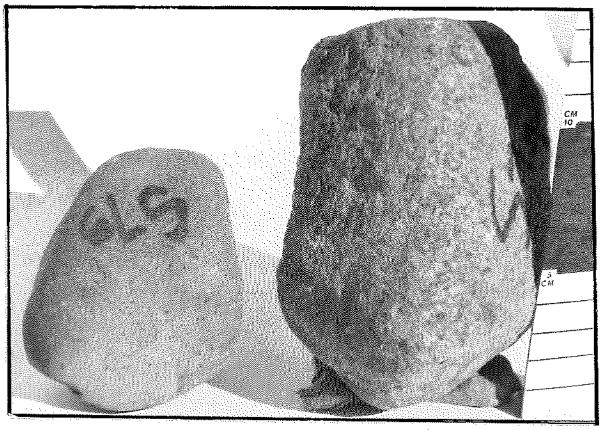
C. Wavey-bedding development in a fine grained siltstone. Middle Gilbert Range Quartzite.

D. Sandstone dyke structures within a load cast. Middle Gilbert Range Quartzite.

E. Plane view of incipient load cast development in a bedded fine grained quartzarenite. Middle Gilbert Range Quartzite.

F. Sectional view of the above.

PLATE B



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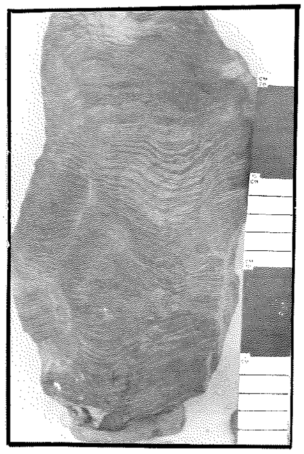

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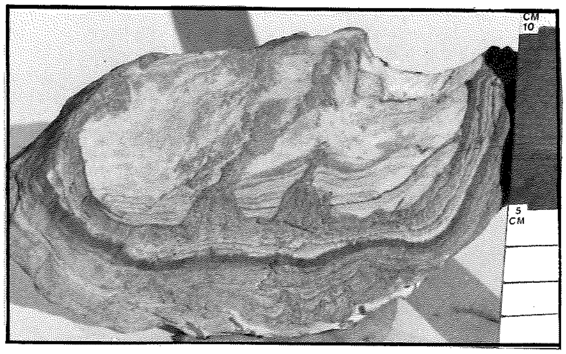

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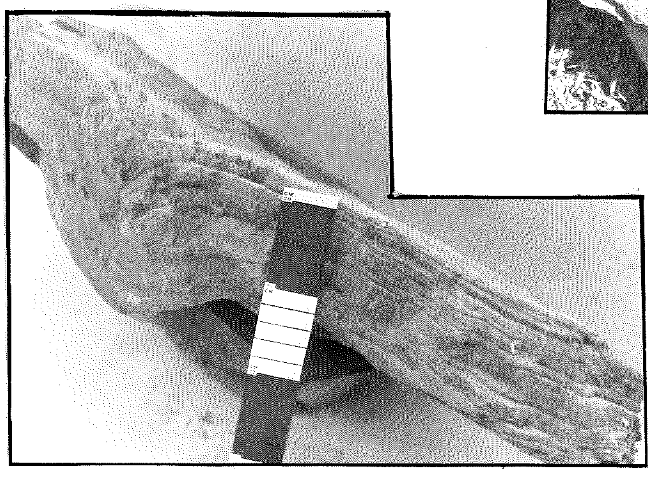


F

the environment of deposition. Variability did occur in the upper quartzarenite beds in the form of herring-bone cross stratification. (Plate B-B). This cross stratification is diagnostic of tidal action. Intimate association of clasts and cross stratification was also noted on occasion in the upper quartzarenite beds and possibly indicates the presence of float ice, which released its sediment load, upon melting, onto the underlying sands. (glacial outwash?)

Only on one occasion were ripple marks within the quartzarenite beds observed. Unfortunately the sample upon which they occurred was not intact but occurred upon a tabular slab found amongst scree in the middle Gilbert Range Quartzite sequence. The crests and troughs of the symmetrical ripples were parallel and continuous with wavelengths of 2 cms and an amplitude of .5 cms. The formation of such ripples has been attributed to the oscillatory movements of wave action. Conybeare and Crook (1968) infer that such ripples are indicative of depths considerably less than 30 metres.

Rare examples of small scale sandstone dyke structures can be found amongst scree in the upper-middle sequence of the Gilbert Range Quartzite in the north of the area. (Plate B-D). This plate records an interesting sequence of events.

Initially a thin, very fine grained layer of sand was deposited followed by a thicker and coarser layer. The greater density of the second layer initiated load cast movements, the development of which was aided by the deposition of a third layer of fine grained silt into the subsiding depression. Possibly a local earthquake shock then caused the still unconsolidated courser sand to inject along a high angle fissure produced as a consequence of the shock. The driving force causing the injection is assumed to be the pressure of the overlying sediment. Subsequent compaction has resulted in a slight flattening of the sandstone dyke. As the dykes have been injected along fractures without extensive upward dragging of the intersected, laminated sediments, it could be assumed that these sediments were relatively rigid at the time of injection. Consequently the hypothesis that an earthquake shock initiated their formation appears to be feasible. If this is the case, then such earthquake action may reflect possible earth movements at or near the time of deposition.

A thin pebbly conglomerate band showing an erosional contact with an underlying tillite and a gradational contact with an overlying cross bedded quartzarenite, was found in the northern sector of the area. The conglomerate had a lateral extent of approximately 25 metres and a thickness of .5 metres. This conglomerate possibly reflects an aqueous reworking of the underlying tillite; metaquartz-arenite pebbles were found in both beds. An influx of finer sediments under more subdued currents then buried the conglomerate deposit.

One of the few outcropping laminated siltstone interbeds within the Gilbert Range Quartzite revealed the poor development of slump bedding structures. The slumps were all assymetrical and had variable wavelengths of 10 to 20 centimetres and amplitudes ranging from 5 to 10 centimetres. The bed was calcereous. Similar wavey laminations were observed in siltstone scree found in the middle of the sequence. (Plate B-C).

One other type of sedimentary structure was observed in the Gilbert Range Quartzite, and was found to occur directly beneath a pebbly tillite interbed. The pressure exerted by the overlying tillite is believed to be responsible for the formation of incipient load casts, in the underlying originally planar fine sand layers. (Plates B-E and B-F). Examination of the specimen suggested a penecontemporaneous date of formation as the sediments of the load casts must have been relatively viscous for them to have deformed into such a complex three dimensional series of discontinuous troughs and crests.

THE APPILA TILLITE.

This formation has a stratigraphic thickness of approximately 950 metres and is the thickest of all the formations studied in the area. A representative stratigraphic section of this sequence of rocks is illustrated in Fig. (9). The general trend demonstrated by the strata indicate the very rapid cessation of glacial activity towards its top.

The last thick cross stratified quartzarenite bed outcropping on the eastern side of the western ridge has been chosen to represent the upper boundary of the Gilbert Range Quartzite. This bed is sharply overlain by a pebbly tillite and represents the base of the Appila Tillite. Conglomerate occurrences have been detected in this unit which tend to reflect the presence of local erosional surfaces in the vicinity of the contact. The conglomerate occurs as scree (one outcrop visible) and the great bulk of it is composed of cemented masses of angular pebbles incorporating all sizes, with very little matrix finer than the coarse sand fraction. Such samples provide evidence of the action of powerful water currents which have winnowed out the finer sand and silt fractions. An aqueous reworking of underlying tillite is envisaged as the source of the conglomerate. Both tillite and conglomerate contain an abundance of metaquartzarenite clasts.

The minor outcropping conglomerate found about 10 metres above the one already described shows a gradational contact with an underlying coarse grained, moderately well sorted sand stone. (Plate C-A). On this occasion the more abundant matrix material had been derived from the underlying sandstone which, at the time of conglomerate formation, was unconsolidated. There was no evidence to suggest that either conglomerate occurrence had extensive lateral spreads. Thus even though there do appear to be minor erosional surfaces near the contact between the Gilbert Range Quartzite and the Appila Tillite they do not appear to be of a regional importance, as the contact between the two is sharp and planar for the entire length of the area.

The first 100 metres of the Appila Tillite contains numerous occurrence of tillite deposits, which show a

PLATE C.

A. A pebbly conglomerated forming an erosional contact with a well sorted medium grained quartzarenite. Lower Appila Tillite.

B. Linguoid Ripples development in a finely laminated siltstone. Lower Appila Tillite.

C. Regularly outcropping, finely laminated siltstone interbeds showing lateral continuity. Middle Appila Tillite.

D. Weathered Tindelpina Shale showing an abundance of limonitic pyrite pseudomorphs.

E. Cleavage development (Parallel to staff) in finely laminated siltstones. Lower Tapley Hill Formation.

F. Liesegang development in feldsarenite rock. Middle Eudunda Arkose.

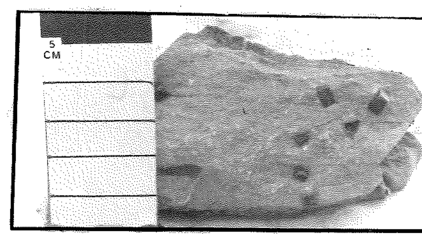
G. Massive while quartz pod development in the vicinity of the major NW - SE striking fault. Lower Gilbert Range Quartzite.

PLATE C

A

B

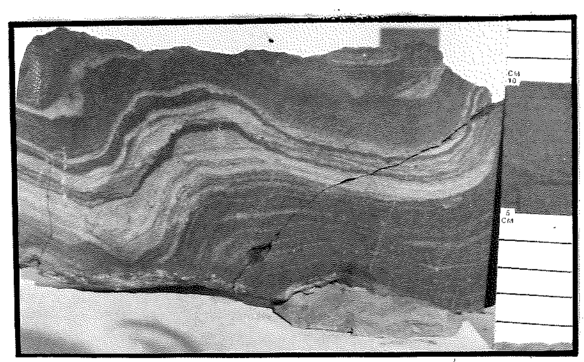
C



D

E

F



G

decrease in thickness as one moves up the sequence. This feature represents a tapering off of the major glacial activity which the preceeding two formations (The Hansborough Tillite and the Gilbert Range Quartzite) represent.

Approximately 170 metres above the basal contact two well rounded large pebble size dropstones were found to be indenting an underlying finely laminated black siltstone. It is envisaged that the two dropstones were deposited as a result of the melting of sediment-laden float ice. At the same locality symmetrical small scale ripple marks (traverse section visible only) occurred within a minor interbed of medium grained, well sorted quartzarenite. At another locality to the north and occupying a slightly lower stratigraphic position, a second occurrence of ripple structures was noted. (Plate C-B). This set of linguoid ripples indicated an assymetrical development within a very finely laminated siltstone. Wavelengths varied between 10 and 12 centimetres while the amplitude ranged between 3 and 4 centimetres. Ripples with this morphology demonstrate the action of bottom currents (Kolpack, 1965). It would appear from a consideration of the three features just discussed that the surface of deposition was subaqueous at this level of the Appila Tillite sequence.

No further tillitic material was encountered until approximately midway up the sequence where pebbly tillite occurred as scree. The interval between this occurrence and the lower tillites was composed of a monotonous cyclic sequence of often very regularly spaced grey and black laminated siltstones. (Plate C-C). Separating these beds were less well indurated, laminated and unlaminated siltstones and less frequently, fine grained quartzarenites. Other than the laminations the fine grained rocks appear to be totally devoid of any other visible sedimentary structure. The sequence is interpreted as having been deposited under a shallow subsiding body of water, which demonstrates alternating periods of calm and mild turbulence, the latter condition accounting for the unlaminated beds. The alternating conditions are probably representative of seasonal fluctuations. The rare occurrences of thin tillitic interbeds of limited lateral extent within this cyclic sequence are interpreted as ice rafted material which has been released from melting icebergs.

Approximately 400 metres above the basal contact pyrite pseudomorphs are found within a finely laminated siltstone and possibly reflect euxinic conditions of deposition at this level. Thirty metres above this point an example of small scale graded bedding was found. (T.S. 379/A14 and accompanying handspecimen 379/A14). As can be noted from the handspecimen the graded material overlies very fine silt and the contact between the two has probably been slightly scoured. The graded bedding shows constantly poor sorting throughout with fine material intimately mixed with coarse. The graded bedding sequence is overlain conformably by further bands also indicating some graded characteristics. The evidence suggests a turbidite origin. The subsequent alternating layers of coarse and fine sediment probably imply seasonal fluctuations related to ice melting.variations.

A series of coarse and medium grained quartzarenite beds exhibiting small scale cross stratification occur approximately 500 metres above the basal contact. Strong bottom currents may have been responsible for their development. Above this, coarsely banded tillitic interbeds occur within laminated and unlaminated siltstones, the last of which occurs approximately 75 metres from the top of the Appila Tillite boundary. The clasts contained within these tillitic bands, rarely range in size beyond very small pebble size and often demonstrate rounded edges. An origin similar to that of the mid-sequence tillitic beds is envisaged. The presence of a small cobble size, white metaquartzarenite dropstone within a very fine grained siltstone, in addition to a small exotic boulder of granitic gneiss are interpreted as representing the last distinct evidence of glacial activity within the Appila Tillite formation.

The remaining 70 metres of the formation consist of finely laminated and unlaminated siltstones, a small coarse sand filled lens was noted in one of these.

Approximately 10 metres from the upper boundary cross bedding was noted in a thin medium to fine sand size quartz-arenite bed. The contact of the Appila tillite with the overlying Tindelpina Shale, although not outcropping, appeared sharp.

Clasts.

An analogous statistical survey to that conducted on the clasts of the Hansborough Tillite was also performed on the Appila Tillite clasts. The results of this survey are recorded in Fig. 2(b).

Discussion.

(i) Abundance. Clasts of gneissic rock are present in greater numbers than the other three categories of clasts listed. The latter indicate approximately equal concentrations in the tillite. The occurrence of dolomite clasts was noted but they were not incorporated into the survey data because of their rarity. Three dolomite clasts were found in the basal section and one in the middle section.

The frequency histograms showing individual clast abundances reflect the pronounced glacial activity occurring in the lower part of the formation and the rapid tapering off of this activity towards the upper boundary.

(ii) Size. A similar trend as noted with the Hansborough Tillite clasts was also recorded with the clasts of the Appila Tillite. Approximately 85% of all clasts considered were bigger than very large pebble size. An analogous explanation as that given to the same phenomena found in the Hansborough Tillite is also attributed to the clast sizes found in the Appila Tillite.

(iii) Roundness. Parallel trends and explanation for th e observed clast roundness in the Hansborough Tillite can be found in the clasts of the Appila Tillite.

THE TINDELPINA SHALE.

The Tindelpina Shale shows poor outcrop along its strike, but its very distinct appearance in both the fresh and weathered samples enabled its geological boundaries to be paced with confidence. The average thickness shown by the formation is 25 metres.

The fresh rock consists of a bluish-black, finely laminated, fine grained siltstone showing well developed cleavage planes. The laminations often show both continuous and discontinuous concentrations of pyrite along their boundaries. The presence of this pyrite possibly reflects an anerobic environment of deposition. D. McKirdy (1972) has recently detected trace amounts of organic carbon within the Tindelpina Shale. The fresh sample weathers to an equally characteristic grey-green and brown and shows an abundance of pyrite pseudomorphs composed of limonite. (Plate C-D). This feature enables easy distinction between the other-wise very similar Tapley Hill siltstone to be made.

Thin discontinuous interbeds of dolomite also occurred in the middle and upper parts of the shale. Poor out-crop prevented an exact determination of their lateral extents, but they do appear to form thin lenticular shaped bodies with lengths of at least 6 metres. The upper and lower contacts of the dolomite lenses within the surrounding shale are very sharp. The dolomites are very fine grained and despite the endurance of a mild metamorphic phase they have retained their original sedimentary laminations. (Slide 379/A18; Plate E-C). The sharp contacts of the dolomite within the carbonate-poor shales (negative response to acid testing) suggests that they were formed by direct precipitation or by penecontemporaneous dolomitization. If the dolomites had formed subsequent to deposition of the silts as a result of dolomitization one would normally expect irregular shaped enclosing boundaries cutting the bedding planes which was not observed. It therefore appears that the post-glacial environment of deposition was suited to the formation of dolomites.

THE TAPLEY HILL FORMATION.

The Tapley Hill Formation is composed of approximately 850 metres of poorly outcropping finely laminated and unlaminated siltstones.

The lower sequence is dominated by extremely fine laminated dark grey and green calcereous siltstones which show strong cleavage development (Plate C-E). Although the upper contact with the Tindelpina Shale was not outcropping there appeared to be a rapid transformation of one formation to the other over a few metres. The very regular banding shown by the siltstones have the appearance of varve structures. However, petrological examination revealed the banding to be the result of rapid pigment changes and possibly reflect regular seasonal fluctuations in the environment of deposition (T.S. 379/A20).

The lower sequence gradually merges into darker and distinctly more massive beds which are often unlaminated. Such beds outcrop across the hillsides enabling many of them to be paced.(Fig. 10).

Thin dark beds of dolomite in addition to laminated and unlaminated siltstones occurred in the upper part of the sequence. The massive unlaminated siltstones are more prevalent near the upper boundary and generally indicated poor cleavage development.

THE EUDUNDA ARKOSE.

The Eudunda Arkose formation is composed of approximately 430 metres of boldly outcropping beds of feldsarenites and siltstones with dolomite beds and lenses frequently occurring in the basal section. A representative stratigraphic section of the formation is shown in figure 9, and the cyclic nature of the beds shown possibly reflects seasonal fluctuations in the environment of deposition.

The presence of the apparently primary dolomites coupled with the extensive development of cross stratification and fine laminations suggests an aqueous environment of deposition for this formation. The feldspar content of the feldsarenites most probably indicates a retardation of the weathering processes in the source region. The rigorously cold climate prevailing at this time, inhibited the chemical decomposition of the feldspar grains and enhanced their preservation.

THE TARCOWIE SILTSTONE.

The upper boundary of the Tarcowie Siltstone is shielded f rom view by a cover of Recent alluvium, the lower boundary however forms a sharp contact with the underlying Eudunda Arkose. Approximately 400 metres of the sequence is exposed in discontinuous flaggy outcrops which show extensive weathering amongst the often finely laminated grey siltstones. Cross stratification was noted on several occasions and was generally delineated by heavy mineral concentrations, consequently an aqueous environment of deposition is suggested.

PROVENANCE OF THE STURTIAN GLACIAL ERRATICS.

Handspecimen and petrological examination of clasts larger than small pebble size fortify arguments which suggest a North-Westerly provenance for the Sturtian tillitic deposits. With the independent collaboration gratefully acknowledged of both Chas Coin and Nick Lemon* some feasible correlations of Sturtian erratic material with presently outcropping North and North-Eastern Eyre Peninsular rocks was made by collating the textures and compositions of the pertinent rock types (Fig. 4a).

Appendix III lists brief petrological descriptions of erratics derived from the Sturtian glacial sequence. The erratics most redolent of a North Eastern Eyre Peninsular origin are the porphyryies, gneisses and the mineral bearing rooks diagnostic of iron-rich formations. (T.S. 379/B1; 379/B4; 379/B5; 379/B6; 379/B8; 379/B11; 379/B18).

The presence of erratic material not typical of rocks found on North-Eastern Eyre Peninsular are noted. This could possibly insinuate; (a) Derivation of material from other geologically separate areas.

* Both Chas Coin and Nick Lemon have worked with Eyre Peninsular Rocks in recent years and both possess a working knowledge of them.

BASEMENT OUTCROPS

EYRE PENINSULAR

You can't use a map of this type! You have forgotten that Palaeozoic & younger rocks have been deposited since the Precambrian.

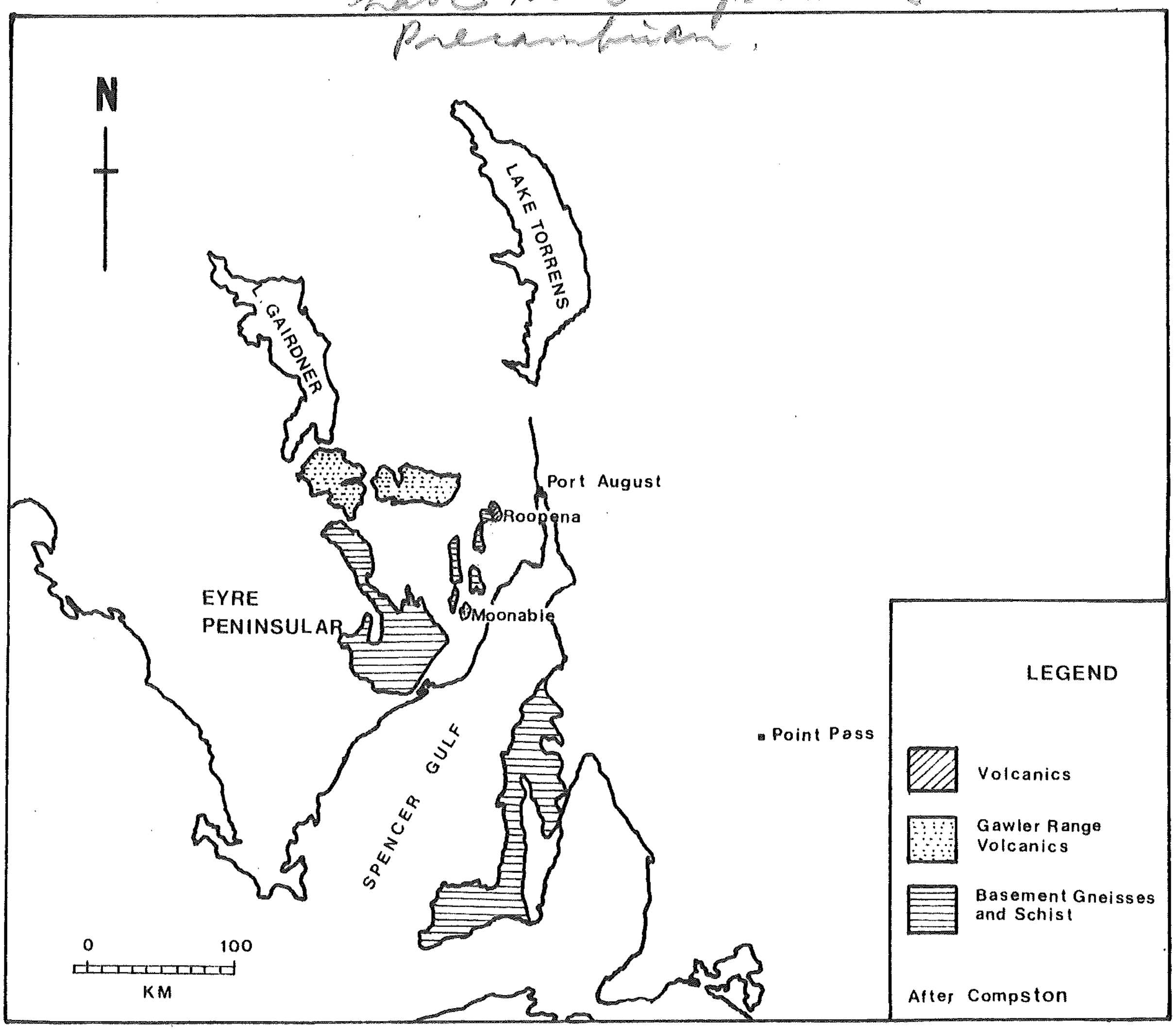


FIG 4a

(b) The presence of yet undiscovered rock types on Eyre Peninsular.

(c) The complete removal of those sources of rock from the Eyre Peninsular region by the processes of erosion.

Should not be after Fig. 4a

ENVIRONMENTAL HISTORY OF DEPOSITION.

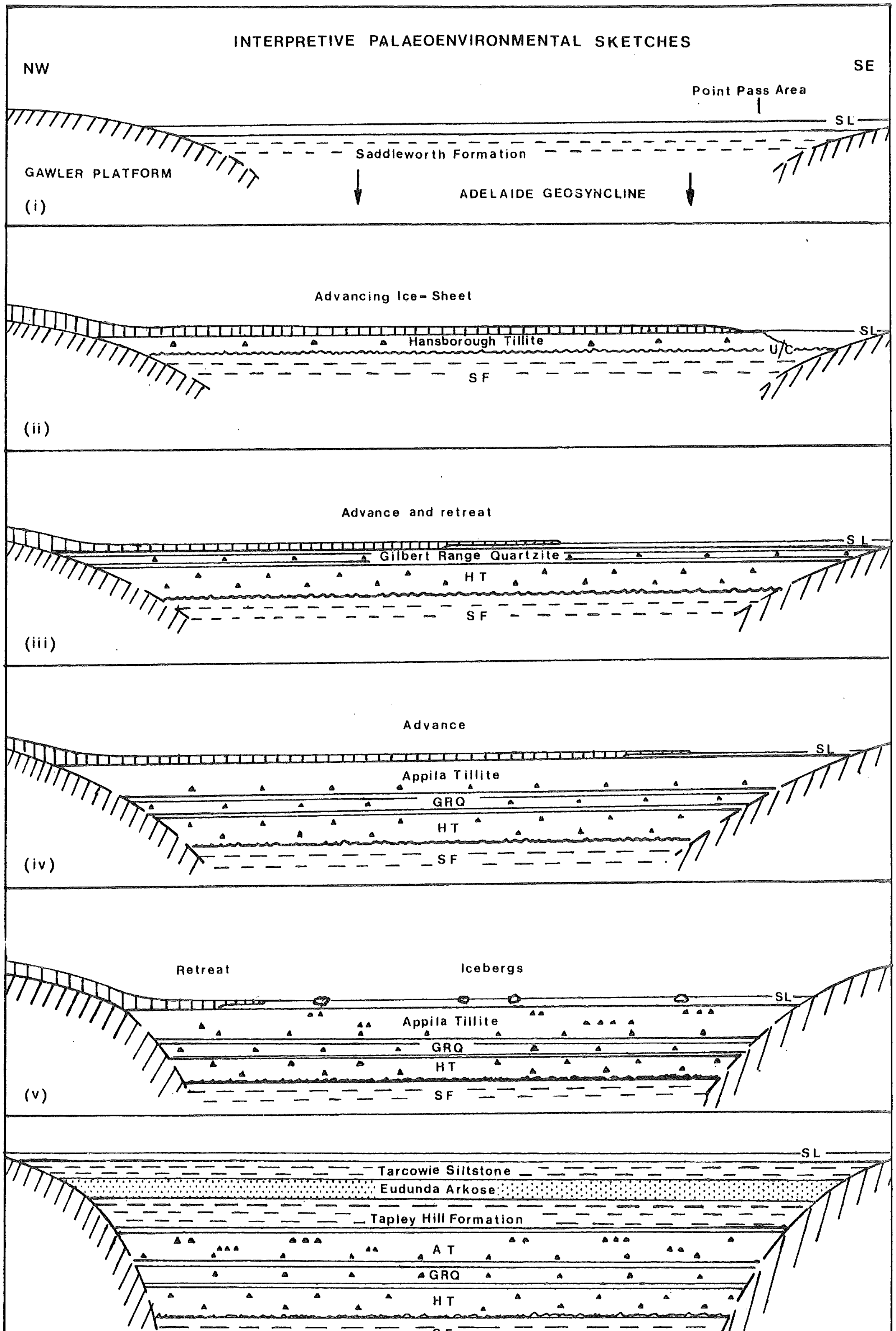
On the basis of the foregoing discussion the following mechanism of glacial deposition is postulated.

Figure 3(b) represents a possible diagramatic succession of events which could account for the stratigraphic sequence of rocks observed in the area east of Point Pass. The sections illustrated follow a NW - SE traverse from the Gawler Platform area to the Murray Plains.

Part (i) represents the deposition of the regular, finely laminated, Saddleworth siltstones beneath a shallow tranquil sea in the slowly subsiding Adelaide Geosynclinal Basin. Subsequent turbulent conditions in the shallow sea were initiated by the onset of cooler conditions and resulted in the development of a minor erosional surface.

Part (ii) demonstrates a dry-based terrestrial ice sheet blanketing the western exposures of the basement rocks of the Adelaide Geosyncline in the Gawler Platform area. The sediment-choked grounded extension of this ice sheet is envisaged as fanning out from this point towards the south, south-east and east to override the underlying Saddleworth Formation. The development of closely associated discontinuous basal conglomerates and cross stratified quartzarenites heralds the advance of the ice sheet and are assumed to represent seasonal outwash deposits from it. The rarity of faceted clasts demonstrates the absence of ubiquitous grinding activity at the base of the advancing ice sheet and adds credence to the possibility of the preservation of these outwash deposits beneath the overriding ice.

As the line of basal melt rises in the ice sheet deposition of the previously entombed sediments occurs, such that the original random fabric they exhibited in the ice medium is retained in the resultant thick unstructured


INTERPRETIVE PALAEOENVIRONMENTAL SKETCHES
NW
SE
Point Pass Area
SL
Saddleworth Formation
GAWLER PLATFORM
ADELAIDE GEOSYNCLINE
(i)
Advancing Ice-Sheet
SL
Hansborough Tillite
U/C
SF
(ii)
Advance and retreat
SL
Gilbert Range Quartzite
HT
SF
(iii)
Advance
SL
Appila Tillite
GRQ
HT
SF
(iv)
Retreat
Icebergs
SL
Appila Tillite
GRQ
HT
SF
(v)
SL
Tarcowie Siltstone
Eudunda Arkose
Tapley Hill Formation
AT
GRQ
HT
SF
(vi)
K.R.H. 1972
FIG 3(b)

beds of tillite.

Part (iii). With the advance of a period of climatic warming the ice sheet began to retreat, releasing its melt-waters as strong currents flowing approximately towards the south-east. These currents had sufficient strength to produce the well-sorted, cross stratified quartzarenite beds representing the lower boundary of the Gilbert Range Quartzite. Alternating climatic conditions then prevailed for a period of time with the resultant development of oscillating glacial and interglacial rocks. Their fluvio-glacial nature reflected the repeated advance and withdrawal of the ice under shallow water conditions. At the time of deposition of the Gilbert Range Quartzite sequence of sediments it is postulated that the ice sheet was of the wet-base, grounded shelf variety. This model adequately accounts for the observed sharp, conformable lower contacts of the structureless tillites and the underlying well bedded quartzarenites and siltstones. (Carey and Ahmad, 1960).

Part (iv). A final major resurgence of glacial activity is marked by 30 metres of pebbly tillite at the base of the Appila Tillite formation. Minor advances and retreats of the ice followed and represent the rapid tapering off of this last major period of glaciation. The nature of associated cross stratified quartzarenites and conglomerate lenses indicate that the expiration of the glacial activity occurred in a shallow tidal environment.

Rapid inundation resulting from the melting of the retreating ice sheet prov idedthe return of normal marine sedimentation. Finely laminated calcereous and non-calcereous siltstones were deposited as very regular beds indicating great lateral continuity. Rare occurrences of dropstones and thin, discontinuous lenses of tillitic material throughout the remainder of the Appila Tillite represent the remnants of ice-berg sedimentation. (Part V)

Part (vi). With the continued subsidence of the previously accumulated sediments of the Adelaide Geosyncline the shallow water deposits of the Tindelpina Shale, the Tapley Hill siltstones, the Eudunda Arkose and the Tarcowie Siltstone followed in turn. The feldsarenite beds of the Eudunda Arkose possibly indicates the continued (or a resurgence of) cold climatic conditions in the source area.

STRUCTURE

A. FOLDING.

The sharp, asymmetrical syncline delineating the surface out-crop of the area has resulted from the action of hypogene earth forces. These diastrophic forces deformed the original planar sedimentary sequence comprising of the Umberatana and other stratigraphic Groups during Palaeozoic time.

The western limb of the syncline shows the development of a large scale drag fold. Small scale disharmonic drag folds indicating dextral vergence relationships also occur in a number of the more massive incompetent beds of the Tapley Hill Formation. Approximately three quarters of the western limb has been obscured by Recent alluvium as the direct result of downward block faulting of the eastern area.

After examination of the accompanying contoured equal area stereoplots of poles to bedding (Fig. 5) and bedding-cleavage intersections, (Fig. 6) the following conclusions have been drawn.

(i) The poles to bedding plot has failed to define a sufficiently distinct distribution from which an accurate axial plunge angle and direction can be measured. The plot does demonstrate several features.

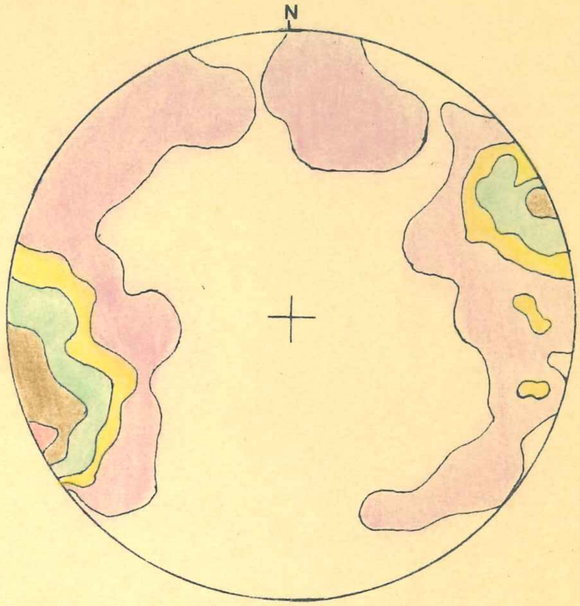
(a) The plot indicates a large population of very steeply dipping bedding planes showing angles in the vicinity of 85 degrees. Rarely do the bedding planes show dips below 60 degrees. The general trend demonstrated is for shallower bedding dips nearer the axial plane while at the outer limb, the bedding dips are considerably steeper.

(b) Bias is revealed in the plot as a consequence of the plight of the eastern limb. The overwhelming majority of bedding-dip readings were taken on outcropping strata of the western limb. Nevertheless a

FIG 5 POLES TO BEDDING

132 READINGS

- 2 %
- 5 % PER 1% AREA
- 10 %
- 15 %
- 20 %
- 50 %



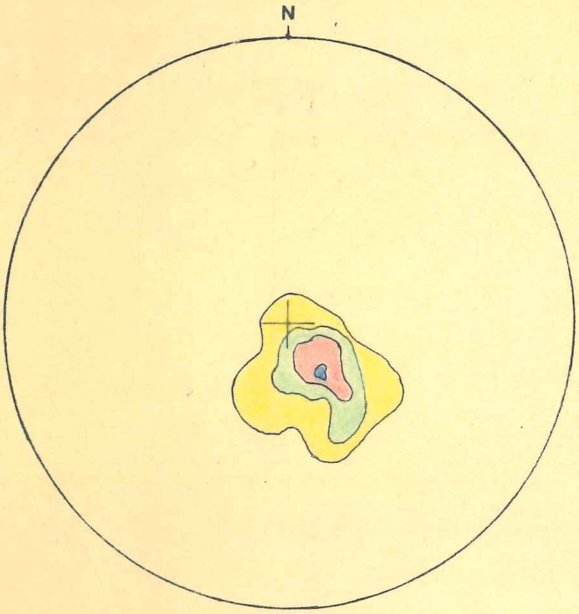


FIG 6 BEDDING-CLEAVAGE INTERSECTIONS

14 READINGS

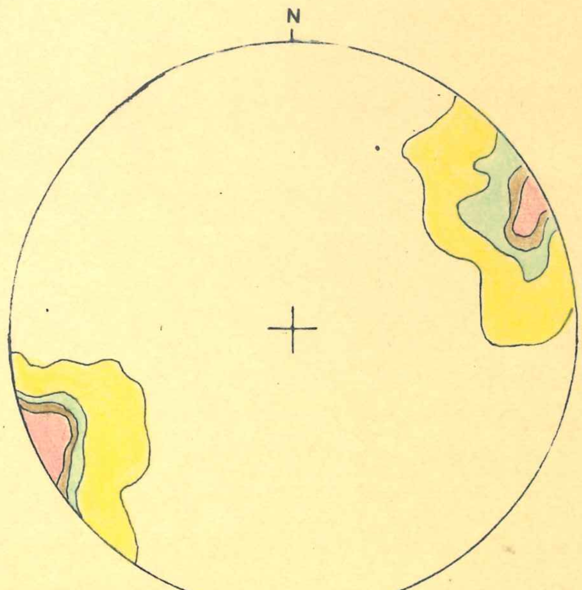


FIG 7 POLES TO CLEAVAGE

31 READINGS

K.R.H. 1972

strong concentration is shown on the eastern side of the plot. This reveals the ubiquitous nature of the overturned beds in the western limb. Because most of the strata is so steeply dipping, it requires only the action of minor local force variations to topple the beds past the vertical to form overturned bedding.

(ii) Bedding-cleavage intersections. This plot clarifies the unanswered questions above. Measurement on this plot yields an axial plunge angle of 72 degrees striking towards 150 degrees. This plunge angle represents only the mean. In fact the angle of plunge is variable, showing decreasing angles along a concave axial hinge line towards the S.E. A subtle indication of this trend is shown on the plot as a slight elongation of the contours towards the S.E. Consultation with A.J. Drummond on this point has revealed that the mean axial plunge angle has decreased to 35 degrees in the area to the south east of the region under consideration.

It is interesting to note the dramatic variations in stratigraphic thicknesses of the various folded units. The obviously more incompetent Appila Tillite and Tapley Hill Formation have responded to the compressive forces operating by plastic flow, as demonstrated by the extreme variation in their thicknesses. The more rigid and competent quartzarenites and subfeldsarenites of the Gilbert Range Quartzite and Eudunda Arkose respectively, have maintained an almost uniform consistency with respect to stratigraphic thickness, by reacting more stiffly to the folding forces. The north-western section of the Gilbert Range Quartzite stands as a glaring exception. One must remember that the Gilbert Range Quartzite, as a formation, is a composite sequence of alternating well indurated quartzarenites, softer siltstones and tillites. Thus, despite the fact that the formation as a whole shows considerable variation in stratigraphic thickness at this point, it is to be noted (Fig. 10) that the quartzarenite interbeds themselves have maintained an almost constant thickness, despite considerable contortion. The interbeds of siltstone and tillite adjacent to these quartzarenites again demonstrate extreme variations in thickness, as do their counter parts in the Appila Tillite.

Despite the rather severe deforming forces operating in the vicinity of the drag fold, the quartzarenite interbeds have yielded to the bending with little resultant faulting. In fact, what little faulting that is present, may not all be contemporaneous with the folding deformation but, post-date it. This phenomena tends to imply that during the phase of folding even the quartzarenite interbeds must have possessed some plasticity. Those faults present that are not attributed to the folding deformation are probably related to the anachronistic block faulting phase.

B. CLEAVAGE.

A strong axial plane cleavage system has developed throughout the area and is particularly noticable in the finer grained sediments as a slaty cleavage. The cleavage is less well developed in the more massive quartzarenite and subfeldsarenite units.

This secondary feature can be attributed to the combined effects of the major folding deformation and the mild metamorphism which have occurred in the area. Because of the geometrical affinity between the cleavage and the axial plane of the fold it is thought that the deforming horizontal compressions responsible for the initial formation of the syncline, were also responsible for the initiation of the mild metamorphic event. This is evident in many of the thin sections, where extensive alteration of the original clay matrix minerals of the argillaceous sediments, exhibits as well developed interstitial biotite, which in turn defines the cleavage.

The mechanical effects often associated with the formation of the cleavage are demonstrated in some of the thin sections.

(i) Microshearing along an individual cleavage plane is shown in thin section 379/A18.

(ii) Elongation of the elemental parts of a tillitic rock in the direction of the cleavage dip, combined with shortening perpendicular to the cleavage dip is revealed in thin section 379/A2 and handspecimen 379/A2.

The accompanying contoured equal area plot of poles to cleavage (Fig. 7) graphically indicates the strong development of a single, steeply dipping cleavage system paralleling the axial plane of the syncline. This plot also provides conclusive proof that the area has endured only one phase of deformation of sufficient magnitude to develop such an intense cleavage as is shown. Neither was there any petrological evidence forthcoming in this area to support suggestions of an incipient second deformation.

C. FAULTING.

(i) Major Faults.

There are two major faults traversing the area under study.

The first of these to be discussed trends NW - SE and has indirectly resulted in the concealing of the eastern limb of the syncline. It is believed to be a normal fault with a steeply inclined fault plane showing a decrease in throw along its length. Termination of the fault occurs in the north western sector of the area. Thus the mechanism proposed to account for the down throw of the eastern block is a hinged normal fault. (see Fig. 8).

Several pieces of evidence support the fault's existence. The most convincing of these is the abrupt truncation of the massive outcropping Eudunda Arkose, and softer associated strata along a deeply dissected

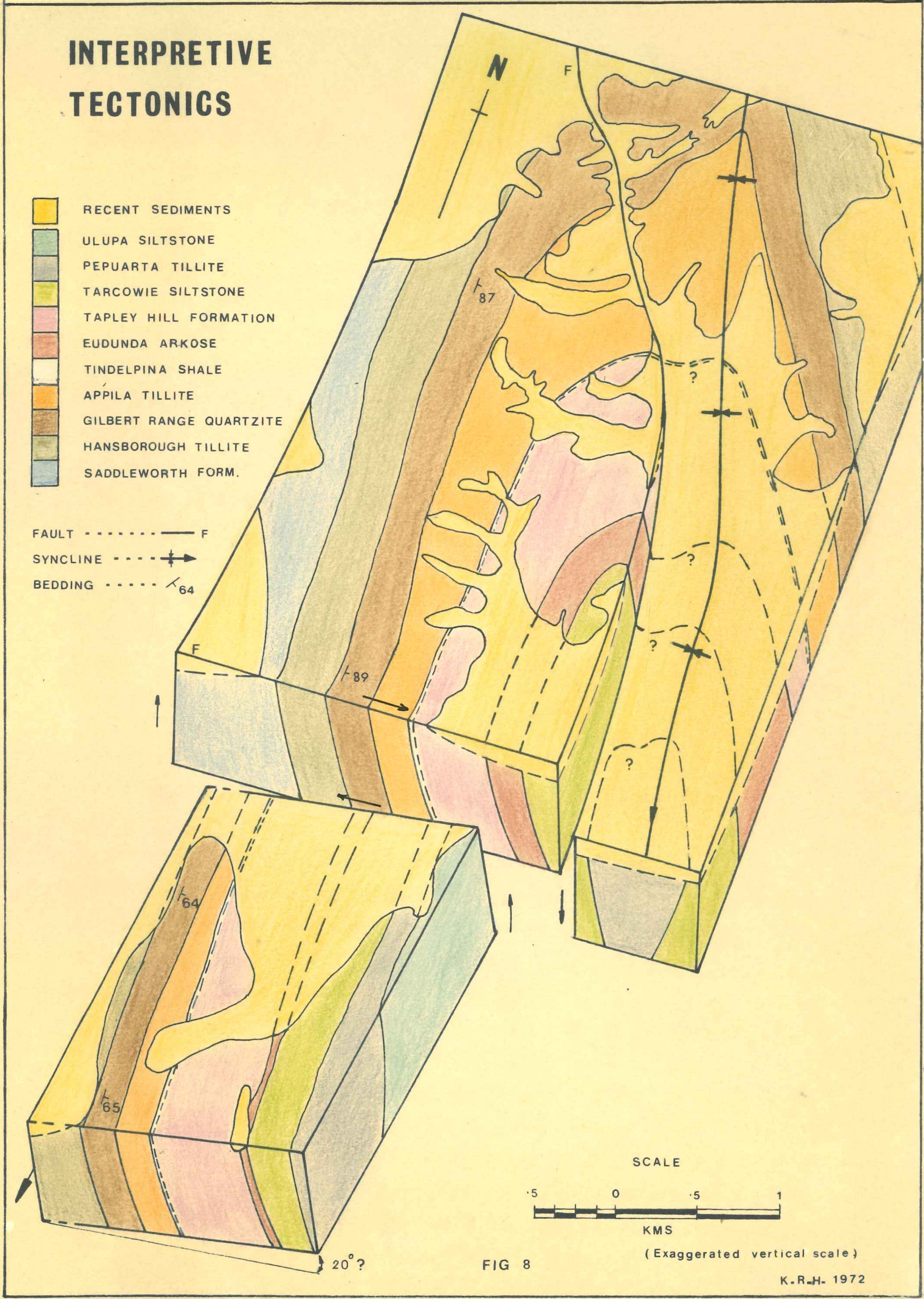

INTERPRETIVE TECTONICS
N
F
RECENT SEDIMENTS
ULUPA SILTSTONE
PEPUARTA TILLITE
TARCOWIE SILTSTONE
TAPLEY HILL FORMATION
EUDUNDA ARKOSE
TINDELPINA SHALE
APPILA TILLITE
GILBERT RANGE QUARTZITE
HANSBOROUGH TILLITE
SADDLEWORTH FORM.
FAULT F
SYNCLINE
BEDDING 64
87
89
64
65
?
20°?
SCALE
·5 0 ·5 1
KMS
(Exaggerated vertical scale)
K.R.H. 1972

FIG 8

scarp trending NW - SE. Eastward of the scarp lies a gently undulating alluvial plain. The intrinsic association of massive white quartz pods along the scarp also suggests the presence of a major structural break. The gently dipping south-easterly gradient, controlling the drainage pattern of the eastern block, supplies additional support for the existence of the fault.

The proposed hinge hypothesis accounts for the lack of lateral displacement shown by the outcropping quartz-arenite beds of the Gilbert Range Quartzite if this area in fact represents the terminal zone of the fault. Apparent lateral displacement would be predicted further along the scarp as is demonstrated in the accompanying block diagram. The exact nature of the fault cannot be fully determined on account of the alluvial cover.

It is speculated that the fault was induced to trace the proposed path shown because it delineates the locus of inflexion points of the drag fold in the eastern limb of the syncline. This linear zone represents an area of relative weakness and could be expected to yield preferentially to faulting when suitable conditions prevail.

It is further suggested that this fault might actually represent the northern termination point of the Palmer Fault Zone. Extension of the fault can be recognised beyond the southern limit of the area to the S.E. under the study of A.J. Drummond (pers. comm.).

The second major fault proposed is marked by the extemporary termination of the western quartzarenite ridge, and strikes approximately N 70 degrees E. Consequently if the fault is extrapolated along this trend to intersect the major NW - SE striking fault, it would do so at a very steeply inclined angle, possibly 80 degrees to 90 degrees. Hence, its origin of formation does not appear to be contemporaneous with this latter fault, although this NW - SE trending fault may have had some indirect influence upon its formation.

Evidence suggesting the existence of the fault, other than that already presented above, is the considerable lateral displacement of 1,100 metres between the bold northern outcropping quartzarenite ridge and its rather subdued continuance to the S.W.

A noted contrast between the northern and southern quartzarenite ridges was the shallower bedding dips demonstrated by the latter. Some 20 degree difference was shown. This feature may have some significance when considering a mechanism by which the fault formed. A possible sequence of events which has led to the present situation may have been initiated by the formation of a major strike-slip fault which produced the relative horizontal displacement shown by the quartzarenite ridge and associated strata. This rather severe movement may have rejuvenated movement along the older NW - SE fault in the form of an upward rotation (approx. 20 degrees) of the eastern side of the southern block. (see Fig. 8). Erosion post-dating this event has since reduced the uplifted eastern side of softer strata to a level approaching that of the surrounding plain. The proposed rotation would not only account for the reduced bedding dips noted in the southern extension of the quartzarenite ridge, but would also explain some of its horizontal displacement.

Both strike-slip faulting and rotation probably occurred contemporaneously.

(ii) Minor Faults and Joints.

Several conclusions can be drawn from a consideration of the minor faults marked on the accompanying geological map. (Fig. 10).

Firstly, the most obvious common feature demonstrated by the majority of faults is their prevalence along the strike lengths of the quartzarenite and subfeldsarenite ridges. The incompetent shale and siltstone ridges show a paucity in fault numbers. The existence of further, yet undiscovered faults in the incompetent beds is not denied; erosion and weathering processes have no doubt obscured many of these.

Secondly, based upon the strike of the fault trends there appears to be three structural divisions of minor faults.

(a) Those that strike approximately N 80 degrees E and which almost exclusively fracture the rigid quartzarenite beds of the Gilbert Range Quartzite. It is postulated that these are of the high angle reverse-fault and strike-slip fault variety which have formed contemporaneously with, or soon after, the folding phase. A genetic connection is proposed because they show a strong geometrical relationship with the syncline. Some of the high angled reverse-faults may in fact represent the progressive evolution of major joints by vertical displacement of blocks along their planes. The latent vertical displacements were possibly induced by a redistribution of stresses created by the post-folding block-faulting phase.

(b) Those faults which strike approximately N 35 degrees W. It is proposed that this set of minor faults had a similar mechanism of formation as those discussed in (a), and that their directional differences merely reflect their position in the syncline.

(c) The third group of minor faults also strike approximately N 35 degrees W. In this case the surface trace of the fault plane is often marked by a vein of white quartz. They appear to be strike-slip faults related to disturbances created by the major NW - SE trending fault. For this reason it is thought that they postdate the other two sets of minor faults.

METAMORPHISM.

The presence of well developed cleavage in many of the stratigraphic units, particularly the fine grained siltstones suggests that the area has suffered a phase of metamorphism. Handspecimen examination of all rock types present imply that there has been very little mineralogical alteration due to this metamorphic event. Micaceous development along the cleavage planes being the only hint of any mineralogical change within the rocks. Petrological examination reveals extensive development of interstitial biotite paralleling the cleavage planes. This is particularly prevalent in the argillaceous sediments. (T.S. 379/A13; 379/A26). The rocks thus show a greenschist (biotite grade) mineral assemblage.

The compressive forces related to the folding phase can be held responsible for inducing the metamorphic event, because of the apparent genetic relationship between the cleavage and the syncline.

Rubidium/Strontium dating of illitic shales from the Saddleworth Formation from nearby Riverton, give the metamorphic event a Palaeozoic age of 465 million years. (Compston, Crawford and Bofinger, 1966).

CONCLUSIONS.

The following conclusions have been deduced from a critical assessment of geological findings in the area east of Point Pass.

(1) The geological boundaries imposed on the area by The Mines Department of South Australia, adequately delineate the significant transformations in the environment which deposited the rocks found. Robinson (1966)

(2) Two major advances of a wet-based and dry-based grounded ice-sheet occurred, and were separated by alternating minor glacial and interglacial conditions. Significant glacial activity tapered off rapidly with the conclusion of the second major period of glaciation. A subsequent rise in sea level coupled with continued subsidence of the Adelaide Geosynclinal Basin, enabled the resumption of normal marine sedimentation.

(3) Clast studies strongly suggest a north-western provenence which included north-eastern Eyre Peninsular.

(4) The morphology of a major proportion of clasts larger than small pebble size appear to indicate significant preglacial influences upon them.

(5) Two major faults have been outlined which do not appear on the Eudunda 4-mile sheet (Robinson, 1966). It is proposed that the major NW-SE striking fault represents the termination zone of the Palmer Fault Zone.

(6) One major folding deformation has affected the area. Petrological and structural examinations have failed to locate any evidence suggesting the presence of an incipient second deformation.

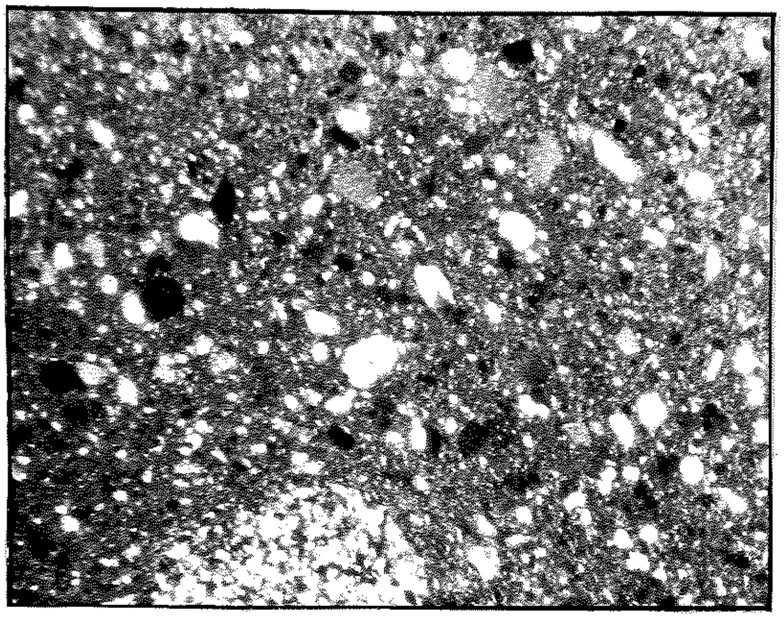
PLATE D.

A. Pebbly clasts showing tectonicly induced elongations within a silty-sand matrix. Lower Gilbert Range Quartzite. (T.S. 379/11).

B. Micro-graded bedding development in varve sediments. Lower Hansborough Tillite. (T.S. 379/A3).

C. Broad lamination development due to grain size variations. Upper Saddleworth siltstone. (T.S. 379/A1).

PLATE D

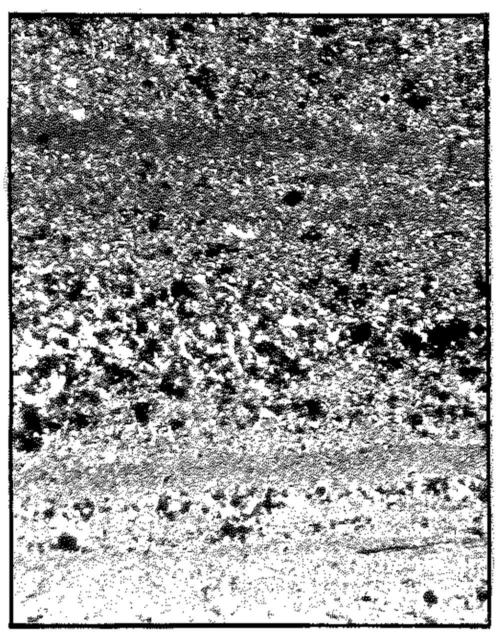


A

X 35

C

B



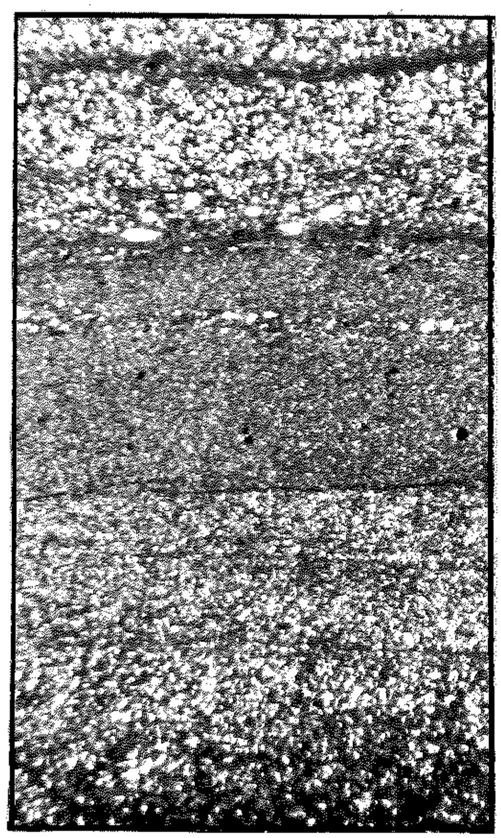


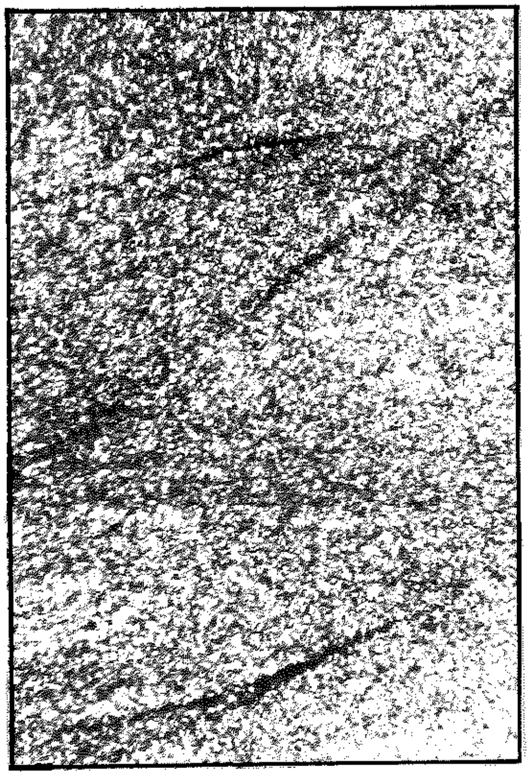
PLATE E.

A. Cross-stratification defined by heavy mineral concentrations in a fine grained siltstone. Middle Tarcowie Siltstone. (T.S. 379/A26).

B. A banded Stilpnomelane schist erratic. Lower Hansborough Tillite. (T.S. 379/B5).

C. Calcite filled cleav age plane in a fine grained, laminated dolomite. Tindelpina Shale. (T.S. 379/A18).

PLATE E

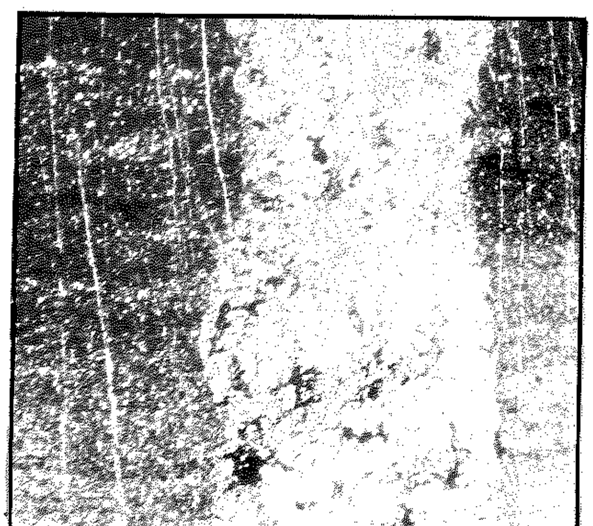


A

X 35

B

C



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McKirdy (1974) see p 18

Robinson (1966)

APPENDIX I

METHOD OF STATISTICAL ANALYSIS OF TILLITIC CLASTS.

Due to the restrictive outcrop of both the Hansborough and Appila Tillites it was decided to conduct the statistical survey along traverses located in cultivated fields. The direction of the traverses ran perpendicular to the strike of the tillite formation. At about the time the survey was conducted the fields had undergone deep furrowing which had succeeded in exposing previously obscured clasts.

The fields were densely littered with rock fragments which included numerous clasts unbound by matrix material, which was the type of clast under consideration. A lower size limit was placed upon the clasts to be counted in order to retain some viability in the statistical nature of the study. The lower limit chosen was small pebble size (Folk, 1968) for this size delineates the smallest readily noticed clasts from those smaller less readily recognised clasts. Consequently no consideration for clasts smaller than this size was taken. One distinct disadvantage involved with this decision was the exclusion of siltstone clasts from the survey. Due to the fragile nature of 'free' siltstone clasts no observations of them in the size fraction considered were made.

A total of four adjacent parallel traverses were made in the two tillite formations, each of which covered a lateral width of approximately 2 metres. As traverses were paced identification of all visible clasts in the size range nominated were made. Their roundness and size was also recorded on prepared data sheets.

LIMITATIONS OF THE METHOD.

In addition to the limitation discussed above several others are pointed out below.

(a) The exact stratigraphic locality of each clast could not be recorded with certainty. The clasts occur as scree in fields which have been cultivated. Some man-influenced transportation of them must have occurred as a consequence of this ploughing. To help alleviate this problem the formation under consideration was subdivided into three broad equal zones into which their constituent clasts were recorded.

(b) Extensive 'stone-picking' has been carried out by the primary producers. As a consequence the analysis would have been expected to show bias towards the smaller remaining clast sizes. A close check of stone heaps in the vicinity revealed them to be deficient in clasts unbounded by matrix material. This suggests that very large clasts are almost nonexistent in the tillite formations. The major constituents of the heaps were large chunks of moderately well consolidated pebbly tillite. A single granitic gneiss boulder (60 x 40 x 40cm.) was noted in a pile of rock close to the basal section of the Hansborough Tillite.

(c) The angularity demonstrated by some of the clasts had obviously been produced by percussion effects related to ploughing. Due consideration of this was taken into account when assessing the original roundness or angularity of the rock.

APPENDIX II

379/A1 Strat. Locality. Upper Saddleworth Siltstone.

A very fine grained, moderately indurated, broadly laminated, grey and brown non-calcereous siltstone.

Micro: One centimetre thick laminations due to grain size differences. Grain sizes range downwards from .05 mm. Larger quartz grains contained in a very fine clay matrix. Extensive interstitial biotite formation. Smaller amounts of detrital muscovite generally showing preferential orientation parallel to bedding planes.

Minerals: 30% Quartz grains.
77% Mica (biotite and muscovite) and clays.
3% Opaques

Slide 379/Ala. Strat. Local. Upper Saddleworth Siltstone.

Macro: A very fine grained, well indurated, very finely and broadly laminated grey and reddish, cleaved siltstone. Non-calcereous.

Micro: A heterogeneous fabric showing both fine and broad laminations, attributable to the separation of heavy minerals into thin continuous bands and to a lesser extend to varying grain size. Sample appears to show poorly developed micro graded bedding. The heavy minerals and quartz grains appear to be held in a clay matrix of detrital muscovite which shows a statistically preferred orientation parallel to the bedding planes. Interstitial biotite is widely developed as a result of the alteration of clay matrix material. Iron oxide opaques upon alteration give the rock its reddish-brown colour.

Minerals: 30% Quartz.
65% Micaceous clay - muscovite, biotite.
5% Opaques.

Name: Siltstone.

Slide 379/A2. Strat. Locality. Lower Hansborough Tillite.

A poorly sorted, moderately indurated tillite. Shows a wide range of clast sizes dominated by quartz and siltstone rock fragments. A reddish-brown, sandy-silt matrix. Clasts show an elongation paralleling cleavage planes.

Micro: A heterogeneous mass of gravel size clasts and sandy-silt matrix.
75% Clasts. Dominated by quartz grains generally well rounded to sub-rounded. Rarer amounts of Polycrystalline quartz grains. Clast size ranges from as large as 2mm. down to coarse sand size. Numerous sub-rounded to sub-angular siltstone fragments (possibly Saddleworth siltstone). Most clasts show an elongation paralleling the cleavage planes. (related to Palaeozoic metamorphism).
25% Matrix. Composed of fine silt to medium sand size quartz and clay minerals, including detrital mica grains. Extensive interstitial formation.

Comments: Possible correlation of siltstone fragments with Saddleworth siltstone implies an erosional surface

between the latter and overlying Hansborough Tillite.
Clast elongation implies mechanical effects of cleavage formation.
Interstitial biotite, evidence of a low grade metamorphic event.

Slide 379/A3. Strat. locality. Lower Hansborough Tillite.

A very fine to course grain siltsize, finely laminated, poorly indurated, buff white to light brown siltstone. Shows brown iron oxide staining along cleavage fracture.

Micro: A heterogeneous fabric showing regularly spaced laminations defined as the result of grain size differences, indicating micro-graded bedding. The coarser laminations consist of coarse siltsize, well rounded, highly spherical quartz grains with lesser amounts of clay matrix. Detrital muscovites indicate a preferred orientation to the bedding planes. The finer laminations are composed of clay materials which is micaceous in nature. Possibly sericite and chlorite alteration developing. Iron stains paralleling cleavage and bedding planes.

Minerals: 45% quartz - some showing undulose extinction.
50% Clay - muscovite, sericite and chlorite. Some biotite.
5% Iron oxide opaques.

Comment: Show stratigraphic significance. Occurs in the lower Hansborough tillite sequence and implies conditions suited to varve formation.

Slide 379/A4. Strat. locality. Upper Gilbert Range Quartzite.

A fine grained, reddish-white, herring-bone, cross-bedded quartzarenite.

Micro: Shows a high degree of homogeneity, with heavy mineral (iron oxides) concentrations delineating the herring-bone cross bedding. Iron oxides show alteration to limonite. Well developed siliceous cement. Quartz grains showing serriated boundaries.
Grainsize: .1 - .05 mm. and smaller. Grains show a moderate sphericity and were probably well rounded to subrounded. Well sorted.

Minerals: 94% Quartz grains, some polycrystalline.
4% Feldspar, Microcline, plagioclase and rare orthoclase.
1% Detrital Muscovite - showing alteration.
1% Hematite - showing alteration to limonite.

Name: subfeldsarenite.

Comment: Herring bone, cross-bedding is diagnostic of shallow water conditions involving changing current directions. Well rounded and sorted grains imply a well worked environment. Presence of minor amounts of feldspar implies a moderate distance of transport.

Slide 379/A5. Strat. locality. An erratic from the Middle Gilbert Range Quartzite.

A very fine grained, well indurated, dark grey to black. irregularly banded quartzarenite. The banding is delineated by heavy mineral concentrations.

Micro: A moderately homogeneous rock showing a equidimensional texture of welded quartz grains showing quartz overgrowths. Chlorite is also developing as an interstitial filling in addition to rarer amounts of biotite. The quartz grains are well rounded in general and show a high degree of sphericity although some show weak elongations. Opaques are concentrated along bedding planes and demonstrate the banding.

Minerals: 90% quartz.
8% Micas; chlorite and rarer amounts of biotite.
2% Opaques.

Slide 37 9/A6. Strat. locality. Middle of Gilbert Range Quartzite.
Macro: A very fine to coarse grained, well indurated, cross-bedded, brown and grey siltstone.

Micro: Moderately homogeneous in terms of grain size, but shows lens-like micro cross-bedding due to the separation of extreme fines, particularly clay minerals and opaque heavy minerals. The dominant mineral type is quartz followed by an abundance of clay minerals, notably detrital muscovite. There has been considerable alteration of the clay fraction to biotite.

Minerals: 45% Quartz.
45% Clay minerals, notably muscovite - showing alteration to sericite.
10% Biotite.

Name: Siltstone.

Slide 379/A7. Strat. locality. Middle of Gilbert Range Quartzite.
Macro: A fine grained, white, well sorted cross-bedded quartzarenite. Sample features a quartz tension gash striking perpendicularly to the trend of the bedding.

Micro: The original quartz grains show a high degree of homogeneity and are well rounded, sorted and possess a high degree of sphericity. The grains are tightly bound by a siliceous cement. Many of the quartz grains are polycrystalline. The quartz tension gash crystals are up to 5 mm. in diameter. Adjacent quartz boundaries show development of 120 deg. triple points. The tension gash filling appears to form by the merging of finer detrital quartz grains.

Slide 379/A8. Strat. locality. Middle of Gilbert Range Quartzite.
Macro: An erratic. A grey-white with reddish alteration spots, very fine grained, very well indurated regularly banded metaquartzarenite.

Micro: Shows high degree of homogeneity. Banding has been produced by the concentration of heavy minerals, probably hematite or magnetite. (Shows red staining, which probably accounts for the red spottiness seen in the handspecimen). The high degree of packing of the grains is indicated by the limited dispersion of the red staining about opaques. Grain-size, less than .05 mm. The heavy minerals are slightly smaller. The grains are well sorted and rounded and show quartz overgrowths.

Minerals: 92% Quartz. 4% Interstitial mica, muscovite and biotite. 4% Opaques. Hematite or magnetite.

Name: Metaquartzarenite.

Slide 379/A9. Strat.Local. Lower Gilbert Range Quartzite.

Macro: A very fine grained, well indurated, cross-bedded, brown and black quartzarenite.

Micro: Shows a high degree of homogeneity, the cross-bedding being delineated by heavy mineral concentrations, probably hematite which shows alteration to limonite. High induracy the result of development of siliceous cement. Grainsize ranges from .1 to .2 mm. for larger quartz grains. Plagioclase similarly for microcline grains. Rare hematite crystals approx. .2 mm. Grains well rounded to subrounded and show high sphericity and are well sorted.

Minerals: 90% Quartz - some polycrystalline. 2% Feldspars Dominated by plagioclase and microcline, lesser amounts of orthoclase. 1% Hematite showing limonitic alteration. 5% Interstitial limonite - alteration product of clays. 3% Cement siliceous.

Name: subfeldsarenite.

Slide 379/A10. Strat. Local. Lower Gilbert Range Quartzite.

Macro: A very fine sandsize well sorted, very well indurated black quartzarenite showing quartz filled tension gashes.

Micro: Excluding the quartz tension gashes the rock shows a high degree of homogeneity. Quartz overgrowths form a tightly bonding cement. Original grains are well rounded to subrounded, well sorted and a high degree of sphericity. Grainsize, .3 to less than .05mm. The quartz tension gashes are composed of large irregular crystals with serriated boundaries. Poor development of 120 deg. boundary contacts are also present. Most of the quartz crystals contain fluid inclusion trails often set at 120 deg. to each other.

Minerals: 90% Quartz - grains and crystals - some polycrystalline. 5% Siliceous cement which contain opaques. 5% Sericite (interstitial). Rare zircon.

Name: quartzarenite with quartz tension gashes.

Comment: The black opaques contained in the interstitial cement give the rock its black colour.

Slide 379/A11. Strat. Local. Lower Gilbert Range Quartzite.

Macro: A tillitic rock with abundant very coarse sand, and small pebble size black quartzarenite and siltstone fragment clasts. Matrix is composed of a gritty fine sand and silt. Clasts are angular to subrounded in shape.

Micro: Heterogeneous fabric showing tight packing of clasts by matrix minerals. Wide range of grainsizes (see above). Quartz and polycrystalline quartzarenite grains dominate the clast population. Shapes range from well rounded and spherical grains to angular and subangular elongated grains. Implies a multimodal source. Quartz show straight to profound undulose extinction. Some contain fluid inclusions. The matrix is dominated by clay and silt fractions. Detrital muscovites shows random orientations. Lesser amounts of quartz and opaques are also present. Muscovite and biotite dominate.

Minerals: 80% Quartz grains and fragments. 15% Micas - muscovite, biotite, chlorite. 3% Opaques - iron oxides.

Name: Pebbly tillite.

Slide 379/A12. Strat. Local. Lower Appila Tillite.

Micro: A tillitic rock containing a single small pebble size, white-grey, fine grained clast. The matrix consists of a gritty-course silt size, brown well packed mass with abundant very coarse sand size and smaller quartz and siltstone clasts.

Micro: A heterogeneous fabric. The quartzarenite clast is composed of a fine grained mixture of well rounded to subrounded quartz, polycrystalline quartz and feldspar grains. The quartz often shows quartz overgrowths. Some also show fluid inclusions. Red iron oxide staining is visible also. The matrix is composed dominantly of very fine grained quartz grains and clay material

Name: Pebbly tillite.

Slide 379/A13. Strat.Local. Middle of Appila Tillite.

Macro: A coarse grained, grey, slightly calcereous, well indurated siltstone. Shows a coarser grained layer (fine sand size to medium sand size) - possibly a graded bedding feature.

Micro: Moderately homogeneous, well packed grains bound by a carbonate cement. Grain size is variable. The quartz grains are generally   in diameter and are subrounded to subangular, although they still show a moderate degree of sphericity. The coarse layer is dominated by quartz grains, generally less than .02 mm. in diameter, embedded in a clay matrix which in places shows extensive alteration to biotite, which is preferentially aligned parallel to the cleavage planes.

Minerals: 50% Quartz grains. Rarer polycrystalline grains. 20% Clay matrix - includes carbonates and detrital micas. 30% Biotite (interstitial alteration product).

Name: Siltstone.

Slide 379/A14. Strat. Local. Middle Appila Tillite.

Macro: A very poorly sorted, gravel to very fine silt size rock showing roughly defined bedding and graded bedding.

Micro: A heterogeneous mixture of angular and rounded detrital grains of quartz, feldspar and siltstone rock fragments, bound in a gritty-silt matrix of clay an d very fine grained quartz. Micaceous grains are also present.

Minerals: 55% Quartz (rare polycrystalline grains). 25% Siltstone rock fragments. 20% Clay and fine detrital muscovite matrix. Rare opaques.

Comment: Origin?

Slide 379/A15. Strat. Local. Lower Appila Tillite.

Macro: A very fine to coarse siltsize, very well indurated finely laminated, black siltstone.

Micro: Overall, a moderately homogeneous rock where the laminations are the result of differences in grainsize. Micro graded bedding is also shown. Grainsize is always less than .02 mm. The darker laminae are composed of very fine material which is not recognisable but is probably composed of very fine grained quartz and clay minerals. The larger laminae are composed of subrounded to subangular quartz grains embedded in matrix of very fine clay material, possibly muscovite. Alteration of some of this material to biotite has occurred. Numerous cubic shaped opaques are present, possibly replaced pyrite crystals. Rare amounts of detrital muscovite is also present.

Minerals: 60% Quartz grains. 35% Clay material - notably muscovite, chlorite and interstitial biotite. 5% Opaques - possibly iron sulphides - show limonitic staining.

Name: Laminate Siltstone.

Comment: The regular laminations defined by varying grainsize, in addition to the presence of micro graded bedding tends to suggest that the rock is actually a varved siltstone.

Slide 379/A16. Strat. Local. Lower Appila Tillite.

Macro. A conglomerate showing an erosional contact above a coarse grained moderately sorted, red stained sandstone. Conglomerate pebbles consist of angular to subangular quartzarenite and elongated siltstone rock fragments. The Matrix is composed of the sandy grains lying below the conglomerate. Strong iron oxide staining gives the rock its red colour.

Micro: A heterogeneous mixture of angular to subrounded and rounded detrital grains of feldspar, quartz, iron oxide opaques and siltstone grains and rock fragments. The matrix is made up of medium to fine grained, well rounded to s ubrounded quartz grains and micaceous clay material. Detrital muscovite flakes and rare zircon grains are also present. Fine grained iron oxide opaques showing limonitic alteration is ubiquitous. The quartz grains show serriated boundaries, implying some pressure solution activity. Siliceous cement development binds the constituents of the rock.

Minerals: 70% Quartz - polycrystalline quartz also present. 10% Feldspars - dominated by plagioclase; some orthoclase. 5% Opaques. Iron oxides showing limonitic alteration. 12% Clay material. 1% detrital muscovite. rare zircon.

Name: Pebbly conglomerate.
Comment: Appears to represent the reworking of tillitic material.

Slide 379/A17. Strat. Local. Lower Appila Tillite.

Macro: A tillite with pebble and very coarse sand size clasts within a gritty-fine sand size matrix. The clasts are subrounded to subangular with low sphericity. One quartz-arenite clast shows regular banding.
Micro: A very heterogeneous rock consisting of very angular to subrounded and rounded clasts, mainly composed of quartz and rarer polycrystalline grains. The quartz-arenites show inclusions. Numerous feldspar and opaque grains show alteration the latter to limonite. The matrix is composed of fine to very fine sand size quartz and rarer amounts of feldspar grains. Clay matrix shows alteration to biotite, in addition to limonitic staining. Rare zircon grains are also present.

Minerals: 75% Quartz - rare polycrystalline grains. 10% Feldspar - dominated by plagioclase. 10% Interstitial clay, often showing alteration to biotite. 5% Opaques - iron oxides. Rare zircon.
Name: Pebbly tillite.

Slide 379/A18. Strat. Local. Upper Tindelpina Shale.

Macro: A very fine grained, well indurated, well sorted black dolomite. Shows very fine laminations with calcite filled cleavage planes cutting them at a low angle. Mechanical slippage has occurred along a major calcite filled cleavage planes with a displacement of the laminations of approx. .5 mm. A calcite filled ptygmatic f old is also present. Shows characteristic weathering pattern of carbonate.
Micro: Excluding the carbonate filled cleavage planes the rock shows a moderate degree of homogeneity. Laminations appear to be the result of heavy mineral concentrations, as well as the separation of finer grain size clay and quartz grains from slightly coarser fractions. The rock is well packed and indurated. Grainsize generally less than .02mm. Recrystallized carbonate being the larger; quartz grains are slightly smaller.
Minerals: 15% Quartz. 80% Calcereous clay minerals and micas. 5% Opaques. Iron oxides showing alteration to interstitial limonite sub-paralleling the carbonate filled cleavage traces.
Name: Laminated dolomite.
Comment: This slide demonstrates micro shearing along an individual cleavage plane in the form of a displacement of fine laminations. The presence of a calcite filled ptygmatic fold implies shortening within the rock (Ramsey 1967). This structure post-dates the development of the cleavage but pre-dates the micro shearing.

Slide 379/A19. Strat. Local. Middle Tindelpina Shale.

Macro: An extremely fine grained, well indurated, broadly laminated, weathered grey and red-blue shale. The sample shows several well developed pseudopyrite cubes composed of limonite replacement material. The sample shows well developed cleavage planes at a low angle to the bedding planes.

Micro: Generally quite homogeneous in terms of grain size. The broad laminations are the result of pigment differences not grain size. (Bands approx. .25 mm. in thickness). Heavy minerals present in the darker bands are probably iron sulphides. There are numerous larger quartz grains (.02mm.) and rare fla`es of detrital muscovite. These are contained in a very fine grained clay material. The rock is probably carbonaceous.

Minerals: 20% Quartz. 30% heavy minerals - iron sulphides? 50% Clay. Rare detrital muscovite.

Name: Pyritic siltstone. (shale).

Comment: Pigmentation differences producing laminations possibly reflect seasonal variations in the environment of deposition.

Slide 379/A20. Strat.Local. Middle Tapley Hill Formation.

Macro: A very fine grained, well indurated, finely laminated, grey-green, non-calcereous siltstone.

Micro: High degree of homogeneity. The lamination development is attributed to pigment differences, possibly reflecting seasonal variation in the chemical environment. Lack of sharp grainsize variation dispels a possible varve environment of deposition. Preferential orientation of detrital muscovite parallel to bedding is also notable. Shows excellent sorting.

Minerals: 20% Quartz. 75% Clay material - muscovite, sericite and biotite. 5% opaques.

Name: Siltstone.

Slide 379/A21. Strat. Local. Upper Eudunda Arkose.

Macro: A fine grained, well sorted, unstructured red-white feldsarenite.

Micro: High degree of homogeneity. Grain size ranges up to .2mm. for the quartz grains, the feldspars are slightly smaller. The quartz grains show subrounding while the feldspars are slightly sub-angular. Shows good sorting.

Minerals: 75 % Quartz, rare polycrystalline grains, some chert fragments. 25% feldspars, 80% of which is plagioclase, 15% microcline and the remainder orthoclase rare amounts of hematite showing limonitic alteration.

Name: Feldsarenite.

Slide 379/A22. Strat. Local. Upper Eudunda Arkose.

Macro: A fine to medium grained, poorly sorted, moderately indurated, red-brown, roughly banded subfeldsarenite.

Micro: A homogeneous assortment of quartz, feldspar, muscovite, biotite and opaque grains. The quartz grains are angular to subangular and show a wide range of grain sizes ranging downwards from .05 mm. The moderate amounts of feldspar is dominated by plagioclase. Rare amounts of detrital muscovite. There has been extensive formation of interstitial biotite. Iron oxide opaques show red limonitic staining.

Minerals: 75% qu artz. 20% Clay minerals - muscovite and biotite. 2% Feldspars - plagioclase. 3% Opaques-iron oxides.

Name: Subfeldsarenite.

Slide 379/A23. Strat. Local. Middle Eudunda Arkose.

Macro: Medium to coarse grained, structureless moderately well sorted subfeldsarenite.

Micro: Moderately homogeneity. The rock is composed of subangular to subrounded quartz and feldspar grains contained within a fine matrix. Grain sizes range from .05mm. downwards to very fine silt size.

Minerals: 90% Quartz. 5% Feldspars - dominated by plagioclase - minor amounts of orthoclase. 4% Micaceous material, possibly biotite and sericite. 1% Opaques.

Name: Subfeldsarenite.

Slide 37 9/A24. Strat. Local. Middle Eudunda Arkose.

Macro: Coarse to fine grained, well indurated, grey-brown siltstone.

Micro: High degree of homogeneity - appears structureless. Quartz dominates the mineral assemblage and show angular to subangular rounding - often elongated grains tend to show preferential orientations. The remaining materal is dominated by interstitial biotite - an alteration product of fine clay material. Numerous flakes of detrital muscovite also preferential orientations. Rarer iron oxide opaques showing limonitic alteration.

Minerals: 40% Quartz grains. 55% Micas - biotite and detrital muscovite. 5% Iron oxide opaques

Name: Siltstone.

Slide 379/A25. Strat. Local. Middle Eudunda Arkose.

Macro: A very fine grained, well indurated, finely laminated black siltstone.

Micro: Moderately homogeneous and well indurated as a consequence of the fine muscovite and clay matrix bonding numerous subrounded but elongated quartz and opaque grains. The abundant interstitial mica flakes; muscovite, sericite and biotite show preferential orientation parelleling the elongation of the quartz grains. This defines cleavage. The heavy mineral content defines the laminations.

Minerals: 40% Quartz, 55% Micaceous clay. Muscovite, sericite, biotite. 5% Hematite or magnetite - shows limonitic alteration.

Name: Siltstone.

Slide 379/A26. Strat. Local. Middle Tarcowie Siltstone.

Macro: Very fine grained, dark grey to brown siltstone. Features small scale cross bedding. Non-calcereous.

Micro: Shows a high degree of homogeneity, heavy minerals (iron oxides) are concentrated in thin bands. The quartz grains were originally held in a clay matrix, which has since been converted to biotite - defines cleavage planes.

Minerals: 40% Quartz. 30% Biotite. 5% Hematite and limonite. 20% Clay minerals. 1% Detrital mica.

Comment: Cross bedding implies an aqueous environment of deposition with moderately slow currents in operation.

Slide 379/A27. Strat. Local. Lower Tarcowie Siltstone.

Macro: Very fine grained, well sorted, grey siltstone. Highly calcereous, but no apparent sedimentary structures.

Micro: High degree of homogeneity, well packed. Shows extensive carbonate cement development - the result of alteration of the clay fraction. Grainsize generally less than .05mm., but variable, detrital flakes smaller. Quartz grains are subrounded to subangular. Well sorted in terms of grain size.

Minerals: 50% Quartz. 45% Carbonate cement. 1-2% Detrital muscovite. Rare plagioclase grains.

Name: Siltstone.

Slide 379/A28. Strat. Local. Lower Tarcowie Siltstone.

Macro: A very fine grained, well indurated, finely laminated crossbedded, dark grey siltstone. Heavy mineral concentrations in this noncalcereous siltstone emphasize the cross bedding.

Micro: An essentially homogeneous, very fine grained rock showing fine continuous laminae of heavy mineral concentrations. The opaques show irregular edges. The dominant minerals are clay minerals, including very fine mica and quartz grains. Detrital muscovites are present. Rare grains of zircon are also visible in addition to rutile. Alteration of clay minerals to biotite has taken place.

Minerals: 50% Quartz. 30% Micas. (muscovite and biotite). 15% Heavy minerals. Rare zircon and rutile.

Name: Siltstone.

APPENDIX III

ERRATICS

Slide 37 9/Bl. Strat. Local. Hansborough Tillite.

Macro: Feldspar porphyry, black and weathered. 60% phenocryst. Feldspar, angular and altered. 40% Groundmass-fine, unidentifiable.

Micro: Quartz - feldspar porphyry. Phenocryst: Quart z 50% - shows magmatic attack, others rounded. 50% feldspar - lath-like, show excessive alteration to sericite - show relic plagioclase twinning. Rare microcline phenocrysts. Groundmass: Quartz shows a devitrified texture.

Comment: Shows very similar texture and composition as some Gawler Range porphyrys.

Slide 379/B2. Strat. Local. Hansborough Tillite.

Micro: A quartz - feldspar pegmatite. Large welded quartz crystals. Feldspar undergoing alteration.

Comment: No obvious correlation with Eyre Peninsular rocks.

Slide 379/B3. Strat. Local. Hansborough Tillite.

Micro: A quartz f eldspar muscovite pegmatite. 5% Biotite. 25% Muscovite, 5% Chlorite, 40% Quartz, 20% Feldspar.

Comment: Origin?

Slide 379/B4. Strat. Local. Hansborough Tillite.

Micro: Quartz - plagioclase porphyry. 80% Myrmekite (intergrown plagioclase and versicular quartz). 10% Plagioclase - all feldspar altered to some extent to sericite. 10% Quartz.

Comment: Shows a possible textural correlation with the Moonabie porphyry found outcropping south of Whyalla. Similar porphyry have been found in the Corruna Conglomerate. (N. Lemon, pers.comm.) The Moonabie porphyry shows a very similar myrmekite development.

Slide 379/B5. Strat. Local. Hansborough Tillite.

Macro: A finely banded, extremely fine grained black rock with extensive development of white needles.

Micro: Needles are opaque - possibly leucoxene alteration product of Stilpnomelane. Very fine grained green ground mass, possibly chlorite.

Name: Stilpnomelane schist.

Comment: A microscopic comparison was made with a stilpnomelane schist associated with banded iron formations in the Hamersley Ranges. A very similar texture was noted. Hence such a rock may have been derived from the Middle Back Ranges on Eyre Peninsular, where banded iron formations are a common occurrence. (M. McBriar pers. comm.).

Slide 379/B6. Strat. Local. Hansborough Tillite.

Micro: Granitic Gneiss. 60% Plagioclase - has been vacuolized and sericitized. 5% Green and brown biotite. 30% Quartz. 5% Chlorite, minor Muscovite. Shows a hornfelsic texture; quartz shows undulose extinction and serriated contacts - subgrained.

Comment: A number of localities on northern Eyre Peninsular show similar rock types.

Slide 379/B7. Strat. Local. Hansborough Tillite.

Macro: A quartz - feldspar porphyry.

Micro: Phenocrysts	40%.	quartz 40%, plagioclase 40% - shows alteration to sericite. small amounts of microcline, 10% orthoclase.
Groundmass	60%.	quartz, feldspar, 5% opaques.

Comment: Origin?

Slide 379/B8. Strat. Local. Hansborough Tillite.

Macro: Very fine grained, well indurated metaquartzarenite.

Micro: Shows an excellent polygonal equilibrium texture.- completely recrystallized - shows unstrained crystals. Siderite is present. Odd grains of calcite and sericite.

Comment: The presence of siderite may imply an origin from quartzarenite - iron formation - found thoughout eastern Eyre Peninsular.

Slide 379/B9. Strat. Local. Gilbert Range Quartzite.

Macro: A quartzo-feldspathic porphyry.

Micro: Phenocrysts	60%.	plagioclase, microcline, quartz, K-feldspar - orthoclase.
Ground Mass	40%.	plagioclase - abundant, sericite - abundant, chlorite, quartz, opaques - rare.

Comment: Origin?

Slide 379/B10. Strat.Local. Gilbert Range Quartzite.

Macro: A quartz-feldspar-muscovite granite gneiss.

Micro: 10% Muscovite - large whole grains, 40% Plagioclase - altered, 40% Quartz, minor Opaques, minor Chlorite, Matrix of very fine grained muscovite, 10% Biotite - green. Some crystals are lobate, others are sutured. An occasional poorly developed triple point.

Comment: Origin?

Slide 379/B11. Strat. Local. Appila Tillite.

Macro: An iron rich rock showing gossan development.

Micro: As above, shows quartz filled tension gashes.

Comment: Possible correlation with Middle Back Range iron formations.

Slide 379/B12. Strat. Local. Appila Tillite.

Macro: Quartzo - feldspathic - chlorite gneiss.

Micro: Plagioclase 50%. Large areas altered to sericite. Quartz 30%. Blobs of quartz showing undulose extinction and lobate contacts.
Hematite 5%. Large euhedral opaques undergoing alteration to limonite. Chlorite 10%. Sericite 5%.

Comment: Origin?

Slide 379/B13. Strat. Local. Appila Tillite.

Macro: Quartz - feldspathic - muscovite gneiss.

Micro: 5% Biotite. Large green grains and associated opaques - 1%. 20% Orthoclase. Shows alteration to sericite. 40% Quartz. Highly strained showing grid extinction. 30% Plagioclase. Altering to sericite - 5%. minor Microcline. 5% Muscovite.

Comment: Origin?

Slide 379/B14. Strat. Local. Appila Tillite.

Macro: Quartz - feldspathic - muscovite gneiss.

Micro: 50% Quartz. Several polycrystalline grains showing undulose extinction. 45% Plagioclase - altered to sericite. 5% Muscovite.

Comment: Origin?

Slide 379/B15. Strat. Local. Appila Tillite.

Macro: Quartz - feldspathic - chlorite gneiss - Dark grey-green.

Micro: Sericite 20%. Quartz 40%, Lobate contacts. Plagioclase 25%, Alteration to sericite. K-Feldspar 10%. Chlorite 5%. Gives rock its green colour. Associated opaques. Appears in long wavey thin bands.

Comment: Origin?

Slide 379/B17. Strat. Local. Appila Tillite.

Micro: Altered dolerite.

Comment: Origin?

Slide 379/B18. Strat. Local. Appila Tillite.

Macro: Granitic Gneiss.

Micro: Quartz-feldspathic-muscovite gneiss.
50% Plagioclase. 30% Quartz. 10% muscovite. 5% Sericite. 5% Orthoclase.
A completely homogeneous rock, feldspars partially altered to sericite.

Comment: A similar gneissic rock occurs in the Middle Back Ranges in close association with the iron ore deposits.

Slide 379/B19. Strat. Local. Appila Tillite.

Macro: A coarse grained metaquartzarenite.

Micro: 100% quartz grains cemented by a siliceous cement.

Some rounded sedimentary grains indicate the development of quartz overgrowths.

Comment: Origin?

Slide 379/B20. Strat. Local. Appila Tillite.

Micro: Altered acid volcanic - similar to 379/B7.

Comment: Origin?

Slide 379/B21. Strat. Local. Appila Tillite.

Macro: Granitic gneiss.

Micro: 60% Quartz. 20% Plagioclase - altering to sericite. 5% Orthoclase. 10% Biotite - green. 5% Muscovite. rare opaques.
A slight banding shown by the concentration of quartz and a partial lineation of quartz grains, but most grains are equant.

Comment: Origin?

Slide 379/B22. Strat. Local. Appila Tillite.

Macro: A fine grain granitic gneiss - weathered.

Micro: Similar to 379/B18.
40% Quartz. 10% Chlorite - whole grains.
5% Muscovite. 40% Feldspar - plagioclase, orthoclase - altered to sericite.
5% Opaques.

Comment: Origin?

GEOLOGICAL MAP

EAST OF POINT PASS

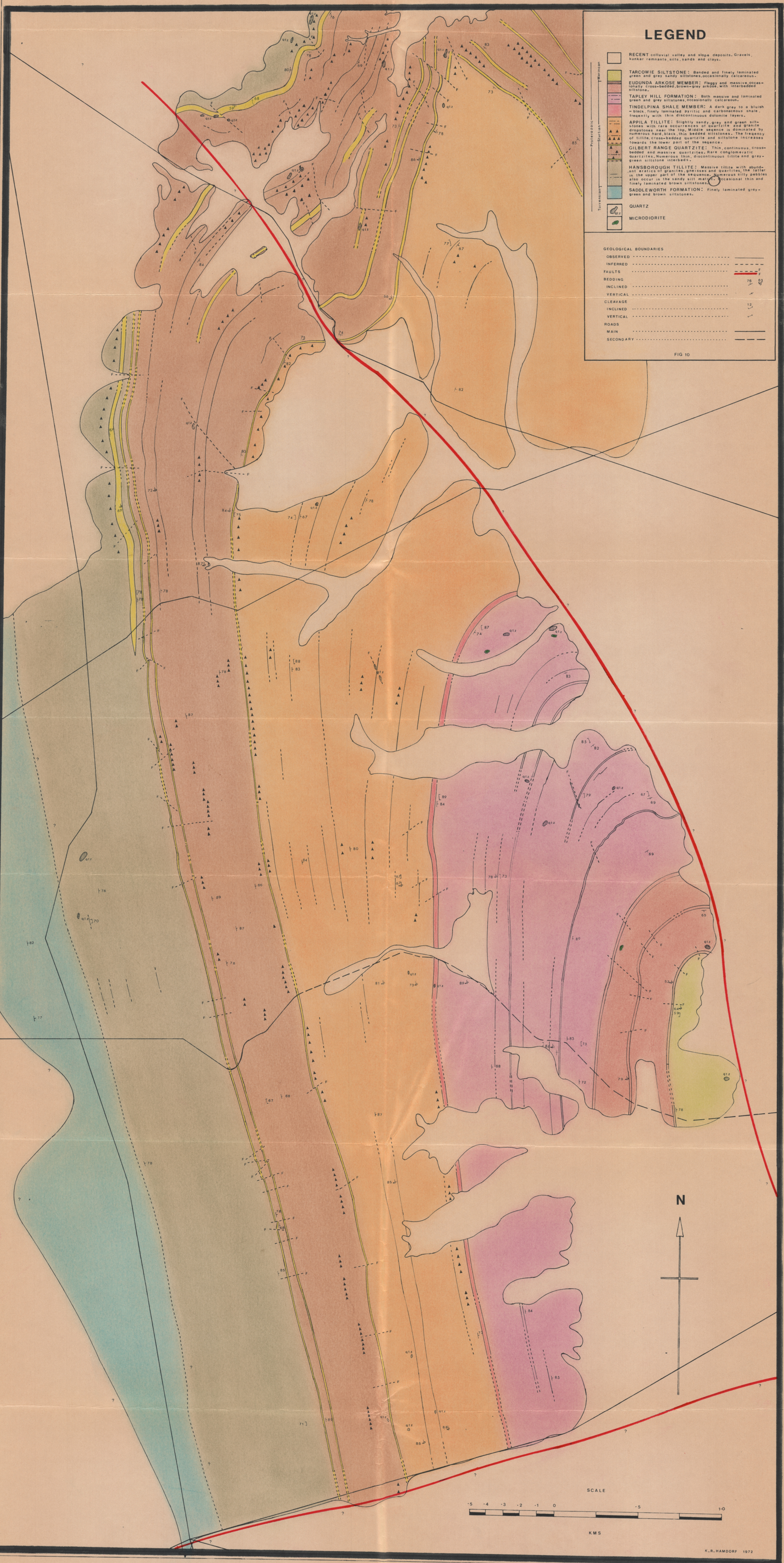

FIG 10