THE UNIVERSITY OF ADELAIDE

DEPARTMENT OF GEOLOGY

HONOURS THESIS

"GEOLOGY OF THE MT. OSMOND AREA, SOUTH AUSTRALIA"

by
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ABSTRACT

The area of uniform stratigraphic sequence studied is essentially part of the west limb of a regional anticlinorium. Both the mesoscopic and the macroscopic folds have the same concentric style. Two different explanations are suggested for the apparently odd occurrence of a 30-foot arkosic quartzite band near the top of the northern foothills.

* * * *

CONTENTS

INTRODUCTION

The locality map shows the area of investigation occupying approximately two square miles. This area is situated two miles to the south-east of Adelaide.

The purpose of this mapping project is to increase the understanding of the geology in this area by detailed studies. The consequence of such an investigation is a clearer picture of the stratigraphy and structure of the area. There is general agreement between the previous work (Sprigg 1946, Brooks 1959) and the result of the present investigation over the stratigraphy of the area. Using the method of geometrical analysis of folds, the simple structural geometry of the area has been demonstrated. The detailed studies have pointed out some questionable conclusions in the previous mapping and interpretation of the area on a smaller scale of four inches to the mile (Sprigg, 1946).

During the mapping in the field all the geological data were plotted directly on to an enlarged aerial photograph of a scale eight inches to the mile. At the outcrops of the siltstones where the bedding and cleavage attitudes could not be measured directly, their attitudes were indirectly obtained from the stereographic plots of the measurements of their respective traces on the joint surfaces.

TOPOGRAPHY

The area mapped forming part of the Adelaide Hills is essentially a young and heavily dissected landscape. Prominent landscape features are the steep hillslopes and the deep gullies. The hilly nature of the area and in particular the precipitous hillslopes are well shown by the closely spaced contour lines (refer to the geological map). Block faulting of the Tertiary-Recent time (Sprigg, 1946) is responsible for the characteristic radiating drainage pattern in this hilly area. Mt. Osmond (1200 ft.) is the highest hill in this area.

Most of the steep hillslopes are extensively covered by soil resulting in the general lack of outcrop. There are several old quarries but only one slate quarry to the south-west is still operating in the area.

STRATIGRAPHY

In the Mt. Osmond area, the recognisable rock sequence in stratigraphic order consists of slates and phyllites, dolomites with interbedded shaly bands, siltstones, arkosic quartzite and shaly siltstones. According to Sprigg (1946), the lower three rock units were included in the Torrensian Series and the upper two in the Sturtian Series. The bottom of the arkosic quartzite was arbitrarily chosen as the base of the Sturtian Series. These two Series together with the uppermost Marinoan Series embracing the thick continuous rock sequence of presumed Proterozoic age of South Australia were collectively known as the Adelaide System. Daily (1963) proposed the replacement of the time-stratigraphic terms "System" and "Series" as previously applied to these Precambrian rocks by the more acceptable rock-stratigraphic terms "Supergroup" and "Group" respectively. His arguments presented for this proposed change are based on the lack of fossils for correlative purposes in these Precambrian rocks. Consequently, the terms Torrensian and Sturtian Series as formerly applied to the non-fossiliferous Precambrian rocks in the area mapped are replaced by the Torrens and the Sturt Groups respectively, these two Groups being incorporated into the Adelaide Supergroup.

TORRENS GROUP:

The upper portion of this Group consists of a conformable sequence of slates and phyllites with minor quartzite bands, the Beaumont dolomites with shaly interbeds and the Glen Osmond Siltstones. These rocks differ only in their calcareous contents, their general appearances being quite comparable through having a notable amount of silty material. They suggest a basin of quiet sedimentation. The presence of the substantial quantity of calcareous material in the Beaumont dolomites could be due to chemical precipitation during deposition or subsequent alteration effect.

1. SLATES AND PHYLLITES:

This succession of slates and phyllites shows faint laminations throughout. Several quartz rich bands are present in this predominantly argillaceous sequence. These mildly metamorphosed rocks grade stratigraphically up into the Beaumont dolomites.

2. BEAUMONT DOLOMITES:

These hard, dark bluish-grey, faintly laminated and calcareous rocks consist of interbedded silty bands. The laminae are essentially made up of silt-sized quartz, feldspar and interstitial chloritic mineroids. In the interbedded silty bands the lamination is more pronounced due to the alternation of light and dark thin layers.

This silty calcareous rock has been identified as a dolomite containing notable amounts of quartz, feldspar and accessory chlorite on the basis of X-ray analyses of two specimens Y118a and Y118b.

3. GLEN OSMOND SILTSTONES:

The boundary between the underlying Beaumont dolomites and this sequence of siltstones and shales is gradational.

In this area the whole siltstone sequence exhibits laminations and distinct slaty cleavages. These two outstanding features are readily distinguished by the following three criteria:

i. the bedding is folded (observed in the field) and varies in the direction and magnitude of the dip.

ii. the cleavages which are laterally discontinuous assume a consistent east dipping attitude relative to the folded bedding.

iii. the sedimentary structures like current bedding and slumping of the laminae are absent in the cleavages.

The common but independently unreliable criterion of compositional differences in beddings is applied with caution as these features have been observed developed in the cleavages in various parts of the area.

Throughout this entire siltstone sequence the development of fissility is distinctly observed in both the bedding and the cleavage planes. The rocks become more fissile towards the top of the sequence as expressed by the change from the fresh, massive grey siltstones near the base to the fissile shale at the top. This observed increase in fissility appears to be related to the greater amount of siliceous material in the rocks.

Facing throughout the siltstone sequence is determined by the attitude of the cross-lamination and the relationship of the slaty cleavages to the bedding. There are notable occurrences of interbedded quartzo-feldspathic lenses which are variable in thicknesses in the upper part of the sequence. The largest lens, 3-foot thick, occurs ten feet below the sharp boundary between these siltstones and the overlying arkosic quartzite in an old quarry to the south-west of the right angled bend of the Mt. Barker Road.

STURT GROUP:

The Glen Osmond arkosic quartzite because of its distinctive lithology remains the basal rock unit of this Group which was formerly known as the Sturtian Series. The succeeding rock unit sharply overlying this quartzite is the Belair Siltstone. Together, these two formations form the lower portion of the Sturt Group.

The deposition of the characteristic arkosic quartzite suggests a period of rapid sedimentation during which the clastic feldspars had escaped severe chemical weathering. Possibly, there could be a cold climatic change (Sprigg, 1946) but diagnostic evidence is lacking in this area.

1. GLEN OSMOND ARKOSIC QUARTZITE:

This massive quartzite outcrops prominently in the southern foothills of the area mapped. This 130-foot thick medium-grained quartzite varies inhomogeneously in lateral extent from a cross-bedded pink subarkose in the west to a hard, faintly laminated quartzite in the east. In general, the fresh pink feldspar contents though varying from 5 to 20% is sufficiently high to indicate the arkosic nature of the quartzite. Highly weathered, yellow-stained quartzite is observed to contain a substantial quantity of white altered feldspar. Multi-coloured, concentric Liesegang rings are found in a highly weathered outcrop of friable quartzite which tends to split into thin slabs. (Specimen Y122). These striking Liesegang bands are produced by the rhythmic diffusion of iron enriched solution. The presence of these Liesegang structures in the upper limit of the Glen Osmond Siltstones seriously confuses the identification of the true bedding.

2. BELAIR SILTSTONE:

In the Adelaide 1-mile geological map, the Belair Group consisting of slates and quartzites was mapped by Sprigg, Whittle and Campana (1951). This name "Belair" is applied by the writer for the siltstone unit sharply overlying the Glen Osmond quartzite. On the geological map, this Belair Siltstone occupies the south-western portion. The upper part of this Belair Siltstone lies beyond the south-western limit of the geological map.

This grey shaly siltstone, heavily laminated and cleaved, resembles the Glen Osmond Siltstone in appearance except that the fissility of the bedding is more pronounced. Interbedded quartzo-feldspathic lenses are common.

STRUCTURE

The area is bounded between the major Eden fault to the west and the Beaumont fault to the east (just off the geological map). Throughout the area the structure is simple with the bedding being broadly folded and plunging 8^{o} in the direction 173^{o}.

Macroscopic Geometry:

Owing to the general lack of outcrop, macroscopic folds have not been observed in the Glen Osmond siltstone sequence. On the other hand, the competent arkosic quartzite features four closely spaced macroscopic* folds at its eastern end. In accordance with the south plunging attitude of the folding, the anticlines close to the south while the adjacent synclines ~~are~~ close to the north. The well exposed macroscopic folds of the brittle quartzite display the characteristic rounded style and the consistency of limb thickness of the concentric fold (refer to the geological section AB). The overturning of the western limb of the more prominent anticline produces an axial plane dipping approximately 40^{o} east (illustrated in

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*Macroscopic means larger than a single outcrop. Mesoscopic refers to the scale of a hand specimen or an outcrop (Weiss and Turner, 1963).

the geological profile AB). Thus the folds become inclined gently to the west with the short west limbs dipping steeper than the long east limbs.

Mesoscopic Geometry:

Bedding, cleavages, lineations or bedding-cleavage intersections and small scale folds are treated as mesoscopic features. The small scale folds are conspicuously developed in the siltstones with alternating hard siliceous and soft argillaceous layers. These distinctively folded coarse laminae are observed to reflect the concentric style of the mesoscopic folds by having similar short west and long east limbs (Plate I, cf. Talbot, 1964). In most instances, the mesoscopic folds are intimately associated with the slaty cleavages. Mesoscopic shearing of the small scale folds commonly occurs parallel to the east-dipping cleavages giving rise to small scale faulting (Plate I). The slaty cleavages are oriented parallel to the axial planes of the mesoscopic and macroscopic concentric folds.

Crenulation cleavages observed elsewhere in the schistose rocks of the Mt. Lofty Ranges (Talbot 1964, Offler 1963) are absent in the siltstones of the area. Fracture cleavages occur in the arkosic quartzite (specimen Y104).

Interpretation of Geometrical Analysis:

Stereoplots have been separately prepared for the two readily recognisable penetrative structural elements, the bedding and the cleavages respectively. For the purpose of comparison, the lineations are directly plotted on to the stereoplot of the bedding poles. The following discussion of the stereographic interpretation refers to the two stereo-plots in the structural map.

The stereodiagram for the poles of the slaty cleavages shows a concentration of points culminating in a maximum which suggests that the area investigated is structurally homogeneous with respect to the cleavages. The structural analysis of the Torrens Group in the Houghton area gives a comparable stereo-plot (Talbot 1963, p.44). The axial plane which is parallel to the slaty cleavages strikes 5^{o} and dips 30^{o} east. The consistency of the east-dipping and approximately north-south striking cleavages throughout the entire region for the siltstones (Ayres, 1959) suggests that the area of homogeneity could be extended further eastwards. It appears from the consistent attitude of the cleavages that the area mapped is part of the west limb of a regional anticline to the east near Mt. Lofty. This regional anticline is believed to be overturned to the west (Madigan 1925, 1927) and plunging gently south (Ayres 1959, Haslam 1959).

The stereoplot for the poles of the bedding shows a monoclinic symmetry in a plane normal to the statistical fold axis, β. The distribution of the points along a great circle near the centre of the stereodiagram indicates that the beds are folded about the fold axis β which plunges 8^o in the direction 173^o. The maximum of the plotted lineations corresponds to another fold axis that plunges 10^o in the direction 171^o. On comparison, both values for the same fold axis of the concentric folds agree remarkably well.

From the favourable correlation of the field observation with the results of the geometrical analyses of the mesoscopic features, it is suggested that the gently south plunging macroscopic folds of the area are the major subsidiary folds developed on the west limb of the regional anticlinorium to the east.

Faulting:

The Beaumont fault (Barnes and Kleeman, 1934) lying off the eastern limit of the geological map has, according to Sprigg (1946), complicated the exact stratigraphic relationship of the slaty phyllite sequence and the Beaumont dolomites to the east. To the south-west, the Glen Osmond quartzite terminates abruptly at an escarpment, this being explained by the Eden fault rejuvenated in the Tertiary-Recent (Sprigg, 1946).

No conclusive evidence has been observed to support the existence of the Glen Osmond fault which Sprigg (1946) postulated striking north-south from Mt. Osmond. Brooks (1959) questioned the existence of this fault.

Sixty yards to the west of the exposed folded quartzite, a localized fault striking approximately east-west dips steeply north. This normal fault displaces the sharp upper boundary between the quartzite and the Belair siltstone by 20 feet.

DISCUSSION

A seemingly odd 30-foot band of pink feldspathic quartzite poorly outcrops to the south of the Glen Osmond golf house. The trend of the outcrop appears to indicate a dip to the east, the lateral extent of this quartzite being obscured by the soil cover. The doubtful Glen Osmond fault postulated by Sprigg (1946) is assumed to have truncated this quartzite band. Although it is tempting to place a fault here, the writer believes that the faulting is unnecessary and that there are other possible explanations for the seemingly isolated quartzite band. Admittedly, the exact relationship between this quartzite band and the relatively thicker Glen Osmond quartzite is not known but there appears to be two possible solutions, namely:

i. the two quartzites belong to the same stratigraphic unit.

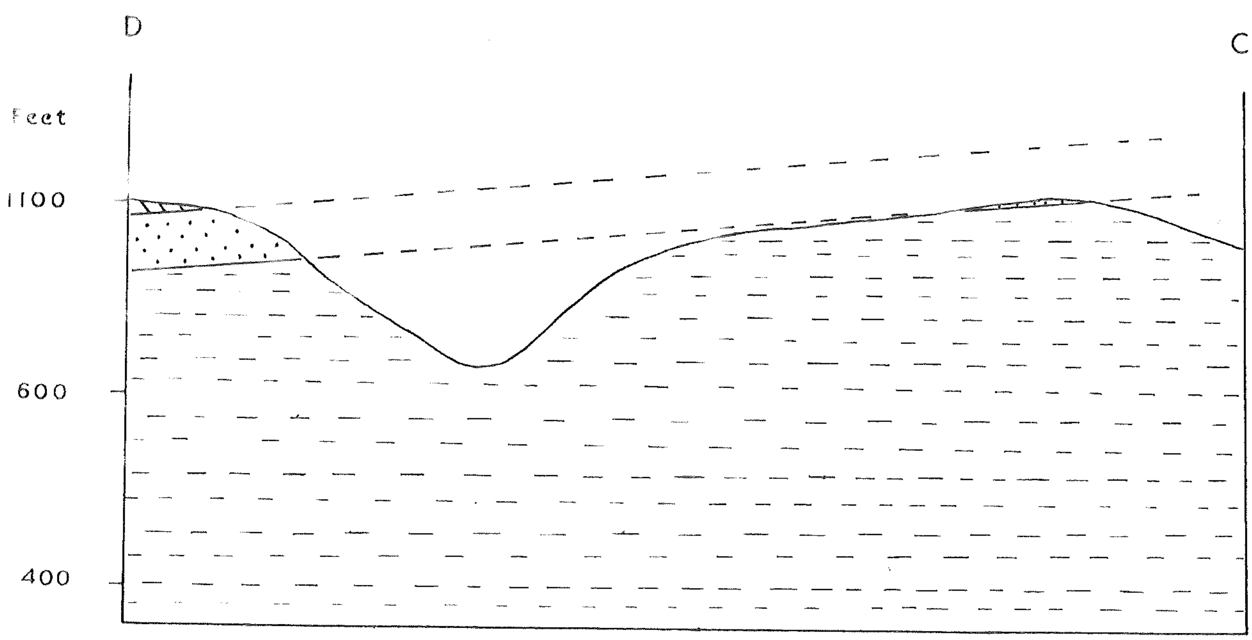
ii. the isolated quartzite band is an interbedded lens in the siltstone sequence.

The first explanation that the two quartzites form the same unit is based on the following evidences:

1. Similarity in lithology:

From fresh hand specimens, both quartzites show 15-20%

FIGURE 1



PROFILE DC

QUARTZITE

SHALE

SILTSTONE

Graphical extrapolation of quartzite for 5° south plunging syncline (Refer to the Geological Map).

of pink sub-angular feldspar. Evidently, the fresh, medium-sized feldspar grains have suffered little chemical weathering. This piece of evidence by itself is not conclusive as marked lithological similarity does not necessarily imply that the two quartzites are of the same stratigraphic unit. This similarity in lithology can be produced by the recurrence of similar conditions of erosion in feldspar-rich source areas, fast transportation and rapid deposition.

ii. Gentle south plunge of the folds:

The south plunging folds vary from 8^{o} in the south to 5^{o} in the north. A single extrapolation of the Glen Osmond quartzite along a 5^{o} south plunging syncline across the northern foothills gives rise to a thin outcrop which corresponds in position to the isolated quartzite band shown in fig. 1. This oversimplified graphical construction is susceptible to criticism because of the implicit assumption that there is no dominant structure between the two quartzites. The absence of the Glen Osmond quartzite in the lower part of the northern foothills is explained by the gentle south plunge of the folded quartzite.

iii. Topography of the area:

The slope for the line MN (shown in the geological map) which joins the southern limit M of the "isolated" quartzite to the point N at the lower contact of the Glen Osmond quartzite is calculated to be 13° south-west. With this value as the dip of the quartzite across the Mt. Barker road, the two quartzites could be shown to be one rock unit. This dip requirement of 13° south-west is fulfilled by the range of bedding dips of 10° to 20° south-west.

The evidences in support of the alternative explanation of the quartzite band being an interbedded quartzite lens in the siltstone sequence are:

i. the occurrence of interbedded quartzo-feldspathic lenses of variable thicknesses is common in the Glen Osmond siltstones. The largest lens, 3-foot thick, at the top of the siltstone sequence has been cited earlier. Thus, it is possible that the quartzite band is another thick lens in the siltstones.

ii. the drastic reduction of the 130-foot thick Glen Osmond to the 30-foot thick quartzite band is possible but highly improbable over a distance of 550 yards. On this basis the interbedded explanation for the quartzite band sounds more feasible.

From the comparison of the evidences for these two explanations, the first one appears to be more favourable. Nevertheless more detailed investigation in the field needs to be done to establish an accurate stratigraphic relationship of these two quartzites. Perhaps, the problem may never be solved because of the lack of outcrop. In the geological map, the two arkosic quartzites are interpreted as belonging to the same stratigraphic unit.

ACKNOWLEDGEMENTS

This half-year mapping project was suggested by Dr. A. Kleeman as part of my course for an Honours Degree in geology. Sincere thanks are due to Dr. B. Daily and Dr. J. Talbot for their invaluable assistance and sound advice on mapping in the field. Deep appreciation is expressed for the helpful advice from K.J. Mills and R. Offler. In particular, I am indebted to K.J. Mills for fruitful discussion of various geological problems. I am very grateful to Miss M. Swan for helpful suggestions in map drafting, to Mr. J. Biddle for kindly carrying out the X-ray analysis of the Beaumont dolomites, to Miss S. Summer for the excellent typing of the thesis and to Miss D. Henzell for her admirable photographic assistance.

APPENDIX I

Description of Hand specimens:

Y105. A float specimen showing the interlaying of silty material and coarse rounded quartz and fresh feldspar.

STURT GROUP:

1. Belair Siltstone

Y30. Grey, cleaved and laminated siltstone.

2. Glen Osmond Arkosic Quartzite

Y59. Fresh massive subarkose with 20% medium-grained pink feldspar forming irregular bands of variable width 2-10 mm.

Y104. Slabby, pale yellow quartzite with scattered pink feldspar and pronounced fracture cleavages.

Y122. Thin slab of heavily weathered, friable subarkosic quartzite with multi-coloured, concentric liesegang rings.

Y157. Medium-grained subarkose with 15% pale pink feldspar.

TORRENS GROUP:

3. Glen Osmond Siltstones

Y41. Grey blocky siltstone with a smear of brassy yellow pyrite on a weathered joint surface.

Y45. Grey massive siltstone with a dark coarse lamina clearly faulted by a small scale shear plane not parallel to the cleavages.

Y50. Pale brown, mildly weathered shale with even lamination.

Y60. Grey cross-laminated siltstone.

Y128. Pale brown shale with strongly rippled surface parallel to bedding being accentuated by the less distinct slaty cleavages. Fine lineations probably due to bedding intersections with the fracture surface.

4. Beaumont Dolomites

Y118a. Pale, bluish-grey and hard dolomite.

Y118b. Silty, pale grey dolomite with faint lamination.

5. Slates and Phyllites

No specimen.

Plate I

Mesoscopic concentric folds in the siltstone with the shear zone parallel to the cleavages. Ball-point pen shows the east-dipping direction of the cleavages.

Plate II

Wedge shaped cross-bedding. Extent of outcrop of siltstone 10 feet.

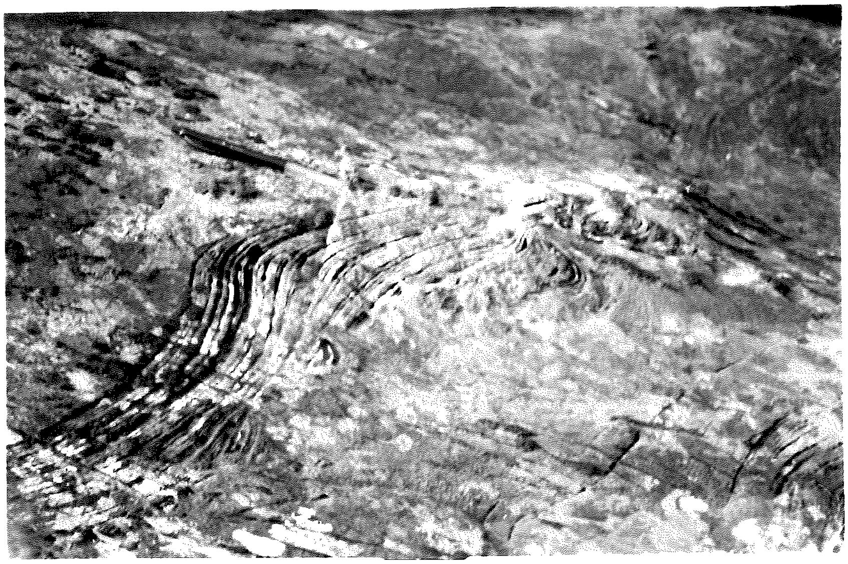


Plate III

Mesoscopic slump bedding in siltstone. Ball-point pen in the direction of poorly developed cleavages.

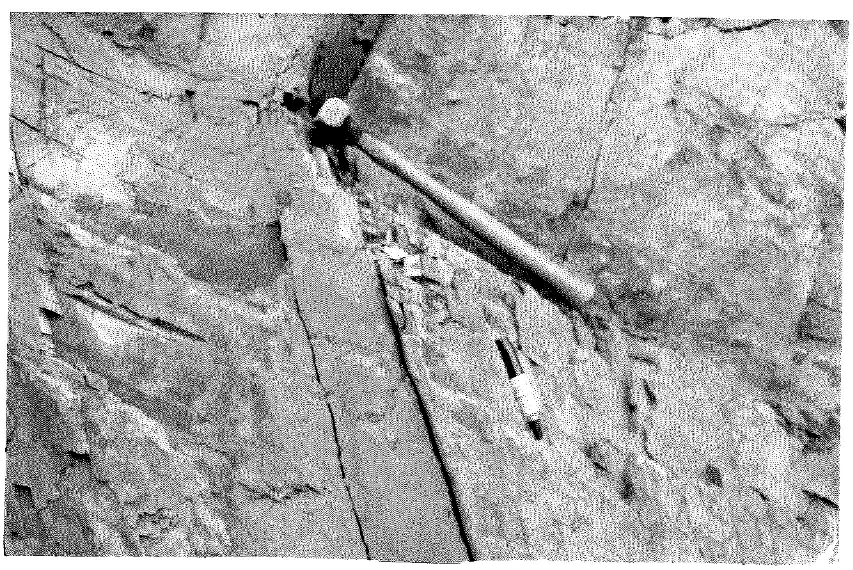


Plate IV

Sharp lower contact between quartzite above and siltstone below. Indicated by the handle of the hammer. The felt pen is in the direction of steeply east dipping cleavages.

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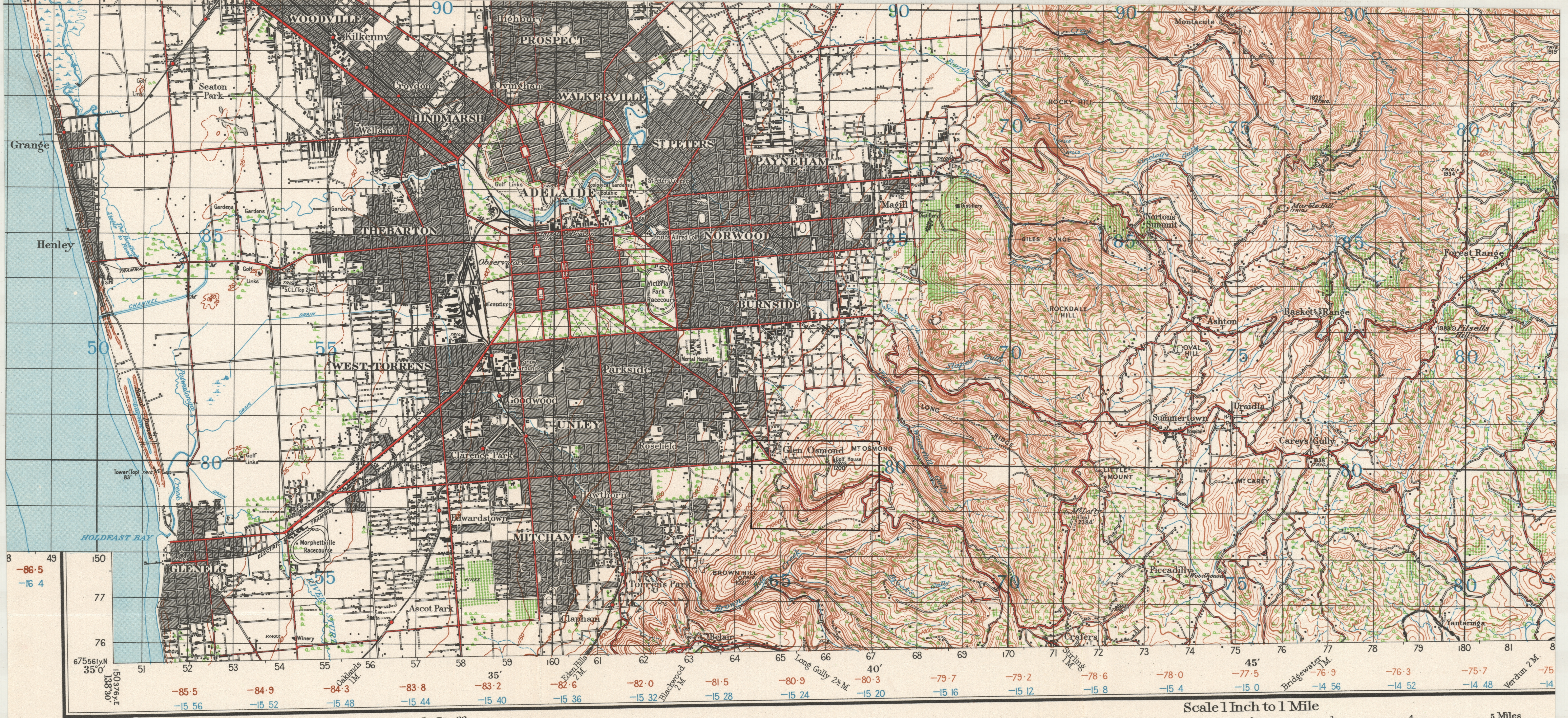


Prepared by Australian Section Imperial General Staff

AHQ/A4-6/0059 N

The framework of this Map depends entirely upon the First and Second Order Triangulation as carried out by the Australian Survey Corps.
Transverse Mercator Projection. Elevations in feet; Mean Sea Level, Port Adelaide. Surveyed in 1937 by the Australian Survey Corps with aid of Air Photos by the Royal Australian Air Force.

Origin of Longitude; Sydney Observatory, 151°12′17″85

Bridge (wood except where shown as masonry or iron) — M or I
Culvert
Water Hole
Swamp or Marsh
Creek
Watercourse (non-perennial)
Water Channel
Railway (double line) — STATIONS
Railway (single line)
Light railway

Embankment
Cutting
Post Office — P
Post & Telegraph Office (in villages) — T
Roads — *First Class*, *Second*, *Third*, *Fourth* — *Fenced* / *Unfenced*
Roads impassable to M.T. in bad weather
Stone Wall

Scale 1 Inch to 1 Mile

Mile 1 ¾ ½ ¼ 0 1 2 3 4 5 Miles
Yards 1000 500 0 1 2 3 4 5 6 7 8000 Yards

Contour interval 50 Feet

Kilom. 5 4 3 2 1 0 5 Kilom.
Metres 1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 Metres

1 Mile = 1·60 Kilom., 1 Kilom. = 0·62 Miles

INDEX TO ADJOINING SHEETS

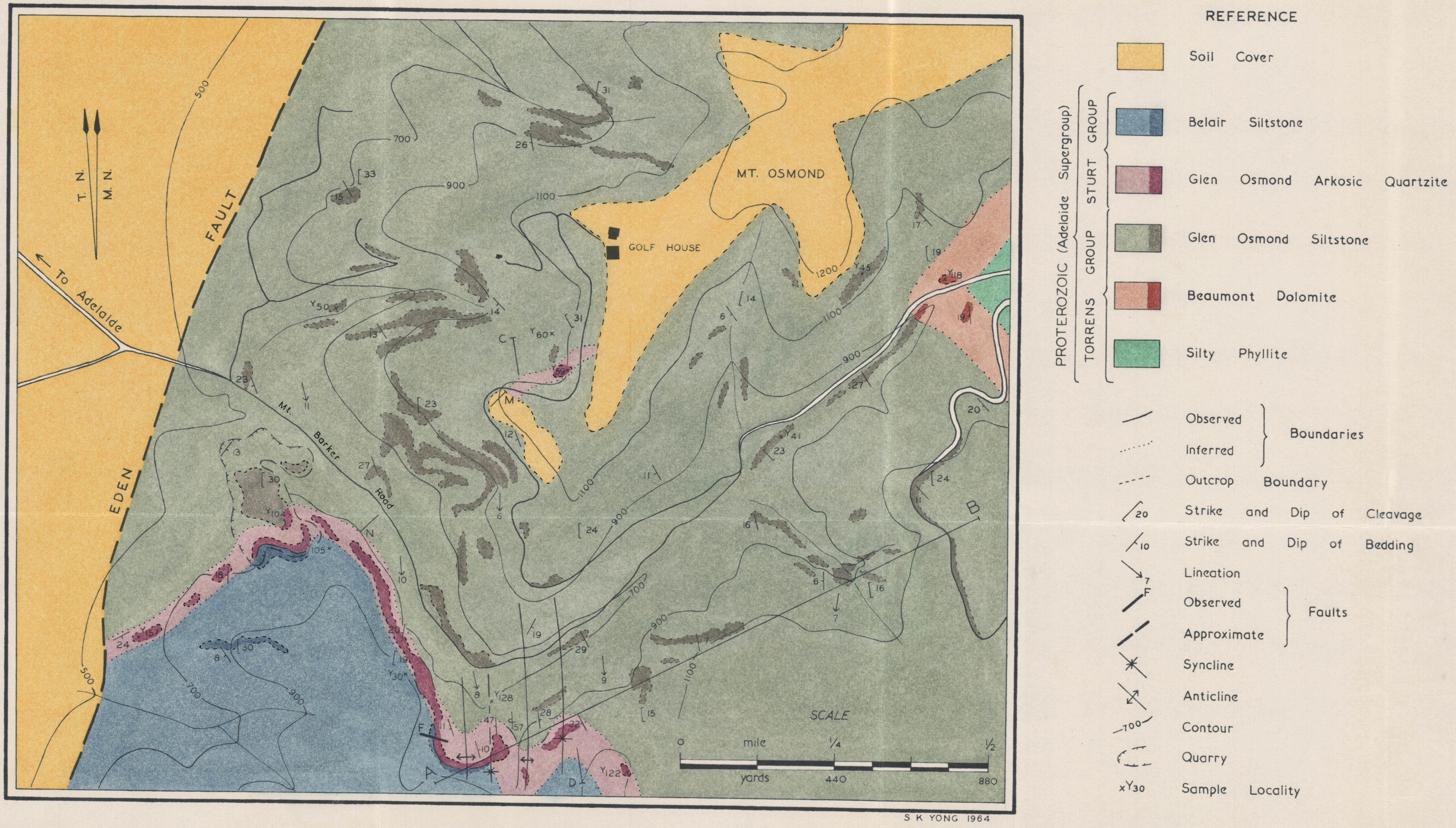
VINCENT	GAWLER	CAMBRAI
	ADELAIDE	MANNUM
	ECHUNGA	MOBILONG

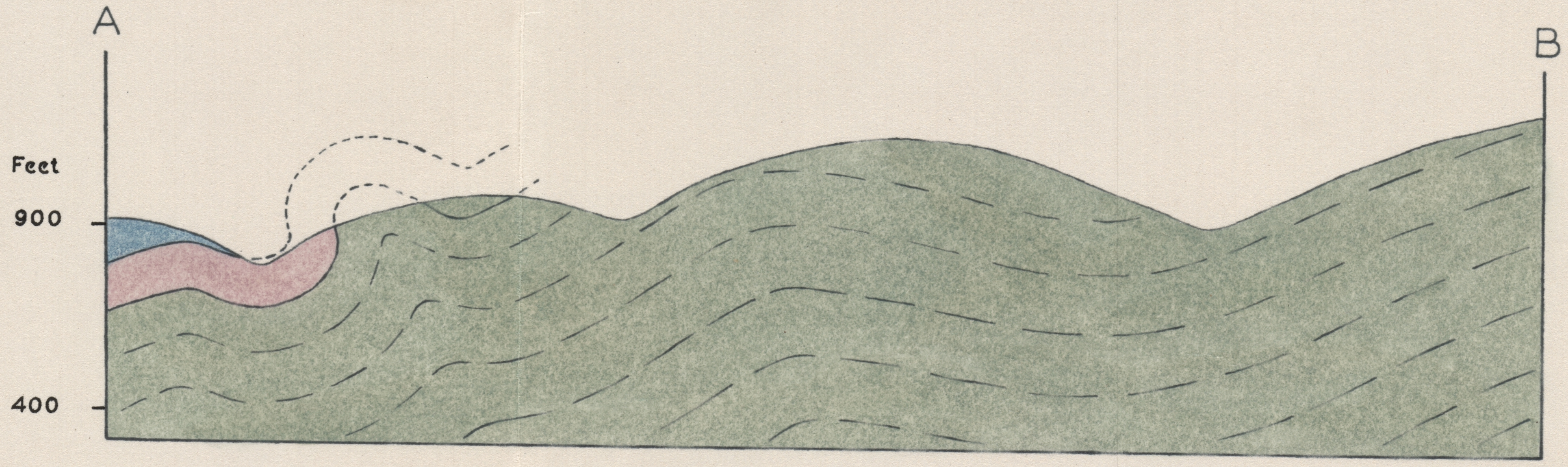
LOCALITY MAP
MT. OSMOND AREA

NOTE. *The brown (convergence) and blue (time correction) figures within the borders of this map are for Artillery purposes. Convergence based on Longitude 141° E*

S.K. YONG
1964

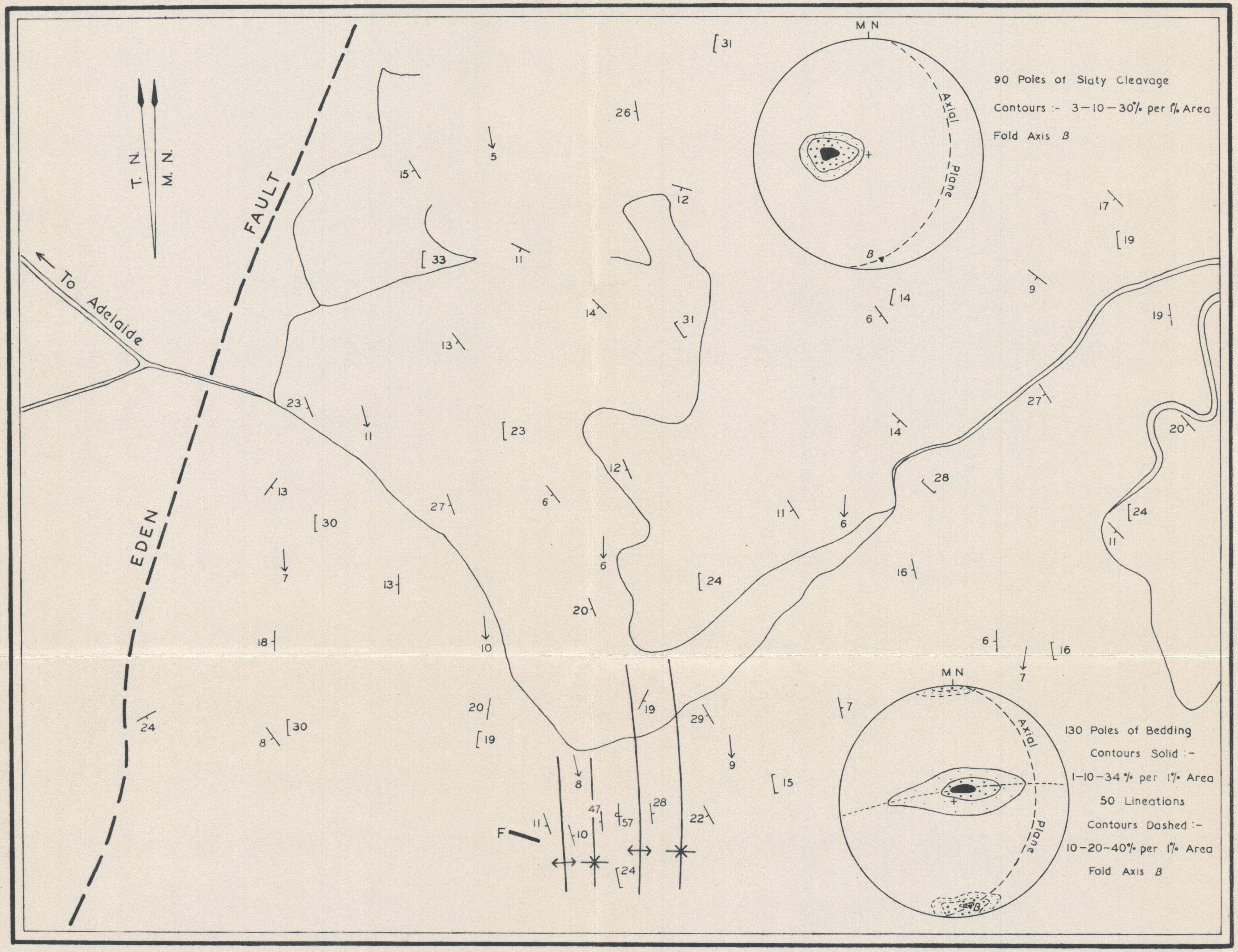
GEOLOGY OF THE MT. OSMOND AREA





GEOLOGICAL SECTION

STRUCTURAL MAP OF THE MT. OSMOND AREA



REFERENCE

Strike and Dip of Bedding

Strike and Dip of Cleavage

Accurate Fault

Approximate Fault

Lineation

Syncline

Anticline

SCALE

0 Mile 1/4 1/2

Yards 440 880

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