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THE UNIVERSITY OF ADELAIDE  
DEPARTMENT OF ECONOMIC GEOLOGY

HONOURS THESIS

"THE GEOLOGY OF THE TALISKER MINE AREA"

by, R. J. George, B.Sc.,  
Department of Economic Geology,  
November, 1963.

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ABSTRACT

Extensive stratigraphic thinning of the Inman Hill Formation in the Talisker mine area has produced a weakness in an otherwise very resistant formation. This weakness has resulted in a local assymetry of structure, which has had a strong influence on the localisation of the lead-arsenic ore bearing solutions.

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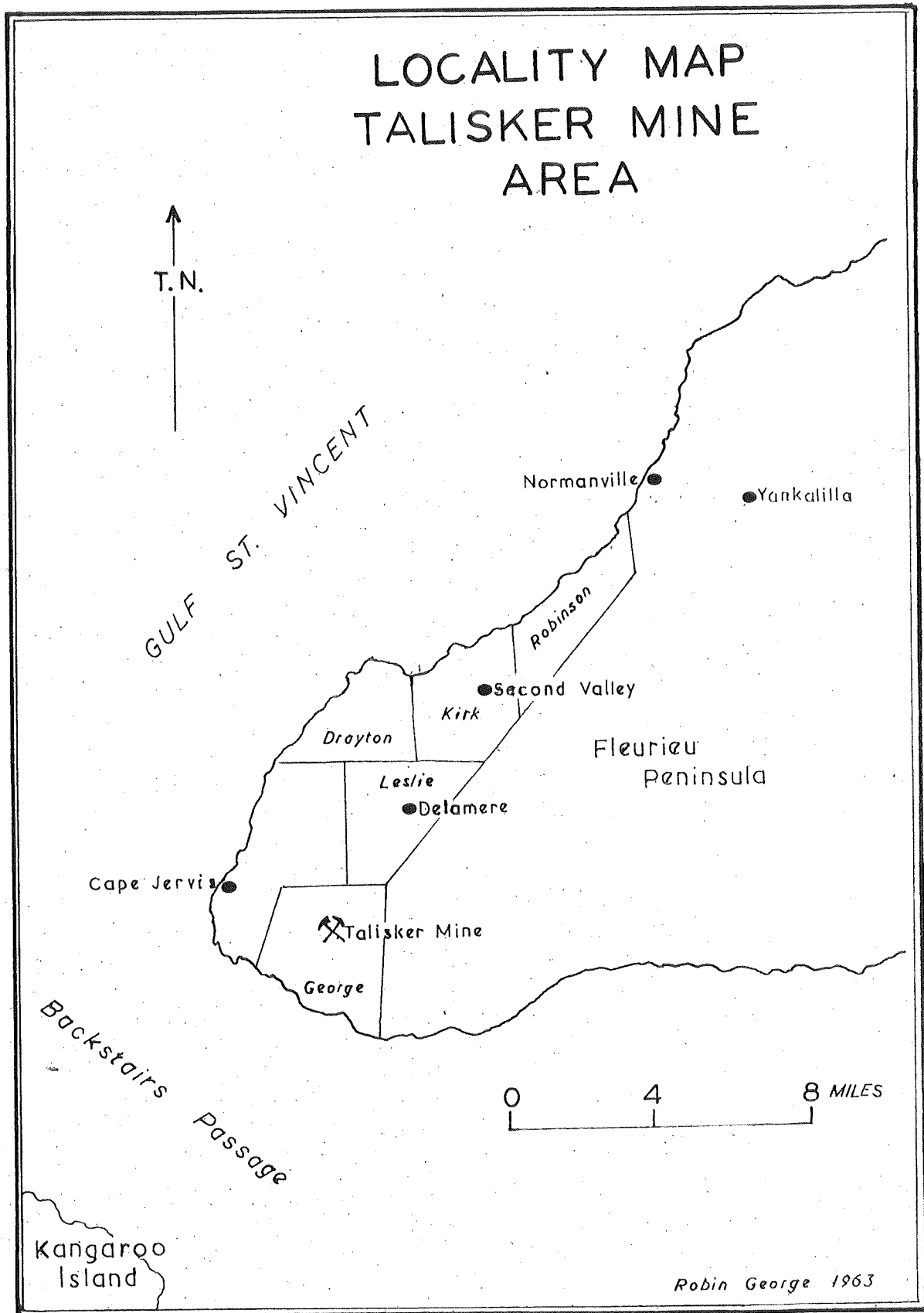
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FIGURE 1



Robin George 1963

## INTRODUCTION:

In the year 1962 four areas were assigned as mapping projects to honours students of the Geology Departments of the University of Adelaide. The aim was towards a greater understanding of the geology of the Fleurieu Peninsula. The author carried out the following project during 1963 as an extension to the work of the previous year.

The locality map (figure 1) shows the area studied. It lies sixty miles south of Adelaide and covers about ten square miles. The areas mapped during 1962 are also shown on the locality map (figure 1). The main road to Cape Jervis and the Range Road to Victor Harbour form the northern boundary of the area, with Fishery and Blowhole Creeks, as well as the South Coast, approximately the other boundaries.

In general the area consists of tight recumbently folded slates, phyllites and coarser clastics, in which the tight folding has been accompanied by thrust faulting. Previous work by Wilson<sup>1</sup>, Campana<sup>1</sup>, and Thomson<sup>2</sup> has not provided a satisfactory explanation for the distribution of rock types in terms of structure and stratigraphy.

These problems were approached by mapping in more detail than the previous workers. All of the geological information obtained in the field was plotted on transparent overlays covering aerial photographs. This was then transferred to a base map having a scale of eight inches to the mile, but only the most important details were retained when the final maps, with a scale of four inches to the mile, were compiled. The results of the mapping suggest a new interpretation of the geology of this part of the Fleurieu Peninsula.

## PHYSIOGRAPHY:

A laterite plateau which corresponds to a pre-Tertiary peneplain, caps the northern extremity of the area. The plateau is over one thousand feet above sea level, and acts as a water divide for the main drainage system which flows into the sea along the south coast. This main drainage system is represented by such creeks as Campbell Creek, Fishery Creek, and Blowhole Creek which run parallel to the strike

of the country rock, and have produced a series of steep V-shaped valleys and rounded spurs in that direction. Where the creeks run into the sea there are local sandy beaches, these being the only breaks in an otherwise rugged coastline characterised by steep, rocky cliffs. Where accessible, these cliffs are ideal for study as they run at right angles to the strike of the country rock.

#### STRATIGRAPHY AND LITHOLOGY:

Besides a phosphatic phyllite which can be correlated with the Heatherdale Shale, and a flaggy limestone which appears to be the top member of the Fork Tree Limestone, the rest of the rocks in the area are phyllites, slates, greywackes, arkoses and other sandstones.\* Thomson<sup>2</sup> has provisionally equated many of these sediments with the Delamere Marble which lies to the north. To explain the absence of a thick Cambrian carbonate sequence on the South Coast he claims that the greywackes and other sediments are merely facies changes from the limestone. This interpretation seems highly improbable.

Because of the tight recumbent folding which has taken place, it was essential to determine which beds were overturned. When this was combined with the structural interpretation, it showed that all of the remaining sediments were actually younger than the Heatherdale Shale, and not older, as had been previously suggested.

The youngest fossiliferous Cambrian beds of the Mount Lofty Ranges are found in the Heatherdale Shale. Above this phosphatic horizon there is a monotonous series of coarse and fine grained clastic sediments which are known by definition as the Kanmantoo Group. It is on this basis that the author has correlated nearly all of the rocks in the Talisker mine area,\* with the Kanmantoo Group.

During the following discussion, reference should be made to the accompanying cross section (figure 2).

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\* 1. The term sandstone is used in this report as a general term incorporating all clastic sediments having sand size grains.

\* 2. Throughout the report, this term is used to represent that area shown on the accompanying maps, and is not confined to the mine itself.

### FORK TREE LIMESTONE

A limestone was recognised on the South Coast by Madigan<sup>3</sup> in 1925: he correlated it with the Delamere Marble to the north. (Recently Daily B.<sup>4</sup> and Leslie W.C.<sup>5</sup> have subdivided the Delamere Marble into the Fork Tree Limestone, the Sellicks Hill Limestone and the Wangkonda Formation). Later workers<sup>1,2</sup> have not recognised the limestone on the South Coast as a stratigraphic unit. At first sight the limestone appears to be a lens set in the Heatherdale Shale. However on closer examination it can be seen that it is actually in the core of a very tightly folded recumbent anticline, and in the cliff face along the coast a faint trace of this anticline can be seen in the limestone. The fold trace is almost obliterated by later axial plane cleavage. The outcrop is very flaggy and covered by kunkar.

A petrological description of a sample taken from this formation can be found in Appendix 1. (RG 70)

The lithology and stratigraphic position identify this unit as the Upper member of the Fork Tree Limestone.

### HEATHERDALE SHALE

The key to the geology of the Talisker mine area lies in the correct interpretation of the Heatherdale Shale unit. On the Jarvis one mile sheet Campana<sup>6</sup> and Wilson<sup>6</sup> have shown it in a recumbent anticline over an area of at least ten times that actually observed in the field. Thomson<sup>2</sup> recognised its limited extent during later mapping, and has shown it as a simple, unfolded, east dipping bed which passes below the laterite cover and joins up with the Heatherdale Shale in the area mapped by Leslie.

In actual fact the Heatherdale Shale is in the same tight recumbent anticline as the Fork Tree Limestone, and lies stratigraphically above that unit. Because of the north plunge of the fold there is a well defined closure to the north.

This unit has a very distinctive lithology, and because of this it can be confidently correlated with the Heatherdale Shale in

the area mapped by Leslie<sup>5</sup> (1962). As in other localities, where this unit occurs it does not form a prominent rock outcrop pattern, but rather weathers to an earthy friable state which crumbles to form a rich black soil. Below the soil cover and in the cliff faces the rock itself appears as a dark carbonaceous phyllite or slate which exhibits a distinct slaty cleavage. It is characterised by numerous black phosphatic and carbonaceous nodules which are arranged in parallel rows along the bedding planes; these are very distinctive, and in places are one to two inches long. The Mines Department of South Australia<sup>7</sup> have analysed a sample of this formation from section 120; Hundred of Waitpinga, a locality which coincides with this anticline on the South Coast. The results show that a bulk sample has 2.2% P<sub>2</sub>O<sub>5</sub>.

A petrological description of a typical sample from this formation may be found in Appendix 1. (RG 108)

#### KANMANTOO GROUP

In a thick monotonous series of sediments like the Kanmantoo only very small variations exist: any subdivisions and correlation on a pure petrological basis is unsound. Because of this a stratigraphical and structural approach has been used. With the absence of fossils any correlation of formations is unsound, however this has been attempted, and whether the conclusions made are justified remains to be seen.

The conclusions and correlations which have been made are considered necessary to show how inconclusive earlier work in the area has been. The aim is to provide a starting point for new approaches into understanding the Kanmantoo stratigraphy of the south western Mount Lofty Ranges.

#### Carrickalinga Head Formation

During 1962 Daily<sup>4</sup> and Leslie<sup>5</sup> recognised that the Heatherdale Shale of the Delamere area passed conformably into a series of inter-bedded shales, siltstones and meta greywackes which they correlated with the Carrickalinga Head Formation.

Both limbs of the Heatherdale Shale in the tightly folded recumbent anticline on the south coast pass conformably into grey

phyllites which are interbedded with more massive horizons of greywacke composition. This formation shows graded bedding and occasional shallow water horizons, especially near the top where it grades into a cross-bedded shallow water arkose sequence.

The formation mapped in the most westerly portion of the area is very similar, but may be more phyllitic; it also passes upwards into a shallow water, ripple marked sequence before grading into a cross-bedded arkose formation. Both of these greywacke-phyllite formations are being correlated with the Carrickalinga Head Formation in this report. This means that the phyllitic schists which Drayton<sup>8</sup> has tentatively called "Kamantoo" actually belong to the Carrickalinga Head Formation.

The sandstone grain size rocks in this formation have a fairly consistent greywacke composition (figure 3) and the phyllites are generally fine grained quartz mica rocks. A greywacke and a phyllite typifying this formation are described in Appendix 1. (RG 43 & 71)

#### Inman Hill Formation

As mentioned previously the Carrickalinga Head Formation becomes richer in feldspar near the top and grades into a shallow water cross-bedded sequence. This formation is dominantly arkosic, but it also contains phyllite and quartzite interbeds, with occasional greywacke, subgreywacke and feldspathic subgreywacke horizons. However it is the predominance of cross bedded arkoses which is characteristic; the arkose beds tend to part along the fine phyllite interbeds and produce flaggy outcrop. The cross bedding is regular and is very useful in obtaining facings. The subgreywackes and other darker sediments which tend to occur near the top and bottom of this formation also show sedimentary features, but these are harder to interpret. The banding and bedding present are very irregular, and may indicate either more vigorous bottom conditions, or extensive slumping.

This formation occurs in three different positions in the area (see cross-section figure 2).

1. On the east limb of the main recumbent anticline
2. On the west limb of the same anticline
3. To the west of the Talisker fault.

At localities (1) and (3) the formations are the same. Although (2) is a similar shallow water sequence, and is lithologically the same as (1) and (3), it is much thinner. Intense shearing has taken place on this limb, but such shearing would not be sufficient to account for the reduction in thickness observed. The main control appears to be sedimentary. Similar sedimentary thinning has been recorded in this same formation in other parts of the Mount Lofty Ranges<sup>9</sup>.

Thomson<sup>2</sup> has correlated the two thicker sections with the Inman Hill Formation, but he has failed to recognise the much thinner band.

A plot of the quartz, feldspar, mica components on a ternary diagram (figure 3), and the description of a type example in Appendix 1 shows a change in lithology from the Carrickalinga Head Formation. (RG 54)

#### Review of Kanmantoo Sedimentation in the eastern and south-eastern Mount Lofty Ranges.

To help explain the correlations which are being made it appears necessary to enter into a brief discussion of the Kanmantoo sedimentation in the Mount Lofty Ranges.

##### Eastern Ranges

Stratigraphic columns compiled by Horwitz<sup>10</sup>, Thomson<sup>10</sup>, and Webb<sup>10</sup>, (figure 4a) show that there is a consistent change throughout the eastern Ranges from a phosphatic slate horizon to greywacke. This passes into a cross-bedded arkose sequence which is overlain by the Nairne Pyrite Formation. Kleeman<sup>11</sup> and Skinner<sup>11</sup> agree in part with these findings when they say that "Over most of the area mapped the beds immediately below the Nairne Pyritic Formation are massive cross-bedded micaceous quartzites and arkoses". Offler<sup>9</sup> recognises a similar sequence in the Strathalbyn area.

##### South-Eastern Ranges.

Thomson<sup>12</sup> has followed an equivalent of the Nairne Pyrite Formation down to the south-eastern Mount Lofty Ranges. Figure 4b is a geological cross section which shows the formation just

before it is terminated by the South Coast, it represents the most southern extension of known Pyrite Formation outcrop. At this locality the underlying cross-bedded arkose is called the Inman Hill Formation, and above the Nairne Pyrite Equivalent there is a massive greywacke called the greywacke of Brown Hill. Forbes<sup>13</sup> (figure 4c) has not recognised the Nairne Pyrite equivalent between the Inman Hill Formation and the Brown Hill beds. Below the Inman Hill Formation he has classified the rocks as subgreywackes: these are most probably equivalent to the greywackes to the north.

Thus in summary, in the eastern and south-eastern Mount Lofty Ranges a phosphatic slate horizon grades into greywackes which are most probably equivalent to Forbes<sup>13</sup> Strangway Hill beds. These pass into cross-bedded arkoses which in many places have been called the Inman Hill Formation. Above this there is the Nairne Pyrite Formation, which is overlain by the massive greywackes of Brown Hill. On the Barker four mile<sup>14</sup>, the Nairne Pyrite Formation and the Brown Hill beds have been included in the Brukunga Formation. This is the best way of representing these two units.

The sedimentary history outlined above agrees with the Talisker mine area. The phosphatic slate appears to be equivalent to the Heatherdale Shale and the Carrickalinga Head Formation may correspond to the overlying greywackes. If this is correct the Strangway Hill beds and the Carrickalinga Head Formation are the same. The cross-bedded arkoses have been established as the Inman Hill Formation by Thomson<sup>2</sup>, and therefore anything younger than this in the Talisker mine area can be equated with the Brukunga Formation.

### Brukunga Formation

The Brukunga Formation has only very tentatively been divided into the Nairne Pyrite Formation and the Brown Hill greywacke beds.

#### Nairne Pyrite Equivalent

On the west side of the Talisker fault the thick Inman Hill Formation grades into a series of sandstones which no longer show cross bedding and shallow water features. The sandstones are

subordinate to the slates, phyllites, and silky phyllites which are interbedded with them. Small specks of limonite which have been derived from pyrite can be seen on the cleavage surfaces of many of the fine grained rock types. There are also a few horizons of slates and phyllites which contain thin, iron rich, sandstone beds.

To the east of the fault, and on the west limb of the tightly folded recumbent anticline the thin portion of the Inman Hill Formation passes into dark calcareous slates and phyllites which are partly limonitic. Calcite is found both dispersed throughout the argillaceous rocks and as thin marble bands. There are also a few sandstone interbeds, and two of these are quite prominent. Higher in the sequence the phyllites and slates are non calcareous, and contain very fine limonite rich sandstone interbeds. The sandstone interbeds in this iron rich formation become thicker towards the top and grade into a sequence which is similar to that observed on the west side of the fault. This part of the formation makes up the core of a synclinal fold system.

On the east limb of the same anticline there is a series of calcareous phyllites above the Inman Hill Formation. Although these were only briefly examined they appear to be the same as those on the other anticlinal limb.

Therefore from west to east the formation becomes more calcareous and contains less sandstone. The compositions of some of these sandstones are shown in figure 3. Facies changes along the strike are also noticeable, this is evidenced by the lenticular nature of many of the beds. Three typical samples may be found in Appendix 1. (RG 26, 162 & 65)

#### Reasons for Calling this the Nairne Pyrite Equivalent:

1. The stratigraphic position is the same as that of the Nairne Pyrite Formation in the Eastern and South-Eastern Mount Lofty Ranges.
2. The lithology has similarities to the Macclesfield-Strathalbyn region, where the Nairne Formation consists of greywacke,

phyllite and pyritic schists. Calc-silicate horizons, and pebble beds (Offler<sup>9</sup>) are also present. The calcsilicates may be the metamorphic equivalent of the calcareous phyllites in the Talisker mine area, and although no pebble beds have been mentioned in the preceding description, one has been recognised just to the north of the Talisker mine workings.

Whittle<sup>15</sup> has made a petrological study of this Formation throughout the Eastern and South-Eastern Ranges. There are no major differences in his rock descriptions to those of the Talisker mine area, but the proportion and distribution of these rock types may be considerably different.

3. A few horizons, in which there are traces of syngenetic iron ore, are similar to the eastern Ranges. The presence of cubic box-works in some outcrops and the occurrence of jarosite in a few thin sections seem to indicate the alteration of pyrite. Two polished sections examined show only traces of pyrite, and this appears to be sedimentary. The rest of the iron is in the form of epigenetic haematite and limonite spread along bedding planes. These iron minerals may be derived from pyrite. This scanty evidence suggests the possibility that the limonite and haematite have been produced by the weathering of pyrites. The consistency of iron along definite beds supports the view that the iron may have been originally sedimentary. A common association of iron with the coarser sediments (sandstones), and the absence of carbonaceous material, are two additional features which indicate a similar mode of formation as the Nairne Pyrite<sup>14</sup>.

Therefore the stratigraphic correlation of certain sediments in the Talisker mine area with the Nairne Pyrite Formation cannot be opposed on lithological and petrological grounds.

#### Greywacke of Brown Hill

On the west side of the Talisker fault the iron rich phyllites and coarser clastics grade conformably into a monotonous series of dark massive greywackes which contain minor phyllite interbeds.

Although this unit is too young to be found in the synclinal core it does occur above the calcareous slates and phyllites in the far east of the area. The formation has not been studied in this locality.

Three thin sections of this formation were examined with the finding that all have a consistent greywacke composition (figure 3). A petrological description of a typical sample may be found in Appendix 1. (RG 99)

#### Reasons for calling the Greywacke of Brown Hill:

The greywacke represents a distinct lithological change from the underlying Nairne Pyrite beds.

In the south eastern Ranges the Nairne Pyrite Formation is overlain by the Brown Hill greywacke (figure 4b). East of Grey Spur, Forbes<sup>13</sup> does not recognise any Nairne Pyrite equivalent, for he shows the Inman Hill Formation passing conformably into the Brown Hill beds.

This is the only basis for equating the massive greywackes of the Talisker mine area with the greywackes of Brown Hill, therefore the correlation should not be regarded as any more than a suggestion.

#### LATERITE.

In the north of the Talisker mine area the rocks are iron stained for a short distance before being covered by a red-yellow clay. The clay is a soil horizon in the lateritic crust or capping which obscures the underlying rocks. This prevents any direct link with the sediments in the area mapped by Leslie<sup>5</sup>.

The lateritic plateau is very flat, and it contains quartz and iron residuals which are often solidified into a silty rock. This horizon represents the remains of a Pre Tertiary peneplain in which there was extensive leaching and little movement over a long period of time. Later rejuvenation produced a series of swift flowing streams which removed much of the residual cover and exposed some of the underlying rocks.

PETROLOGY AND METAMORPHISM:

## PETROLOGY

Throughout the Kanmantoo Group the variation in rock types is small. Most of the rocks consist of quartz, mica and feldspar, and when these three components are plotted on a ternary diagram they provide a basis for the subdivision into quartzites, arkoses, greywackes and various other sandstones. In figure 3 two different ternary diagrams have been used to classify these sandstones, and by comparison of these diagrams it can be seen that in many cases one rock can have more than one name. This adds to the confusion which already exists in the Kanmantoo petrology.

Plots of sandstones from the different formations are shown in figure 3. The pelitic rocks in the area are all finer grained phyllites and slates, and therefore they have not been included in figure 3.

Minerals in the sand grain size sediments have certain features which are common to many of the rocks.

Quartz.

Besides a certain amount of secondary quartz most of the quartz is original detrital material.

The grains are nearly always less than .3mm, and it is only in a few samples that isolated grains reach .6mm. Besides the sandstone size fragments, there are variable amounts of quartz silt and interstitial quartz. In some cases the rocks have so much of this quartz silt that they would be better classified as siltstones. The quartz in the arkoses has a uniform sand grain size, in contrast to that in the greywackes which is illsorted and irregular.

There does not appear to have been very much alteration of quartz, however this is hard to determine. There is the possibility that quartz may be taking place in the metamorphism. The boundaries of the sandstone size grains are often fused, and tend towards a granoblastic texture. Where the boundaries have not been fused, of

trapped interstitial material define their outline, the grains are sub-angular.

Although the boundaries of the sandstone size grains are fused, the body of the grains are not as strongly affected. This is shown by the common occurrence of conchoidal fractures which appear to be original detrital features. The fracturing is often made more obvious by the presence of fine grained iron-clay material in cracks. In many cases the conchoidal fractures are approximately at right angles. This evidence of crystallographic control is interesting because quartz has no cleavage. The regular pattern suggests that it may be some kind of crystallisation effect associated with a high grade metamorphic or igneous source. All of the quartz is clean and relatively free from inclusions.

In contrast to the larger grains, some of the finer granules of interstitial quartz have been reshaped into small globules and intimately mixed with feldspar. Considerable fusion among the grains themselves has also taken place. The reason for this lies in the fact that the finer grains take up the forces which are exerted on the rock, and are more susceptible to the physical and chemical reactions which take place.

#### Feldspar.

Practically all of the feldspar is either sodium or potassium rich.

Plagioclase has an albite composition.

The almost complete absence of epidote indicates that the composition is not much different to that of the original detrital plagioclase. If the plagioclase were originally more calcic, then more epidote would be expected to form during metamorphism.

Where twinning is absent the plagioclase and potassium feldspars are hard to distinguish. In addition to this the feldspars are often so fused and sericitised that the original grain shape cannot be determined. Both the plagioclase and orthoclase can be seen riddled with fine grained sericite: whether this sericite has been produced by metamorphism or by hydrothermal activity is debatable. Many of the surface examples show a clay association which appears to be the result of weathering.

The abundance of feldspar in most of the formations suggests that the sediments have been derived from orogenic regions rather than mid-continental.

#### Micas.

Sericite has been produced by the break down of feldspar. Whether this break down is the result of hydrothermal action or metamorphic readjustment is not known.

Besides the fine grained sericite which is randomly arranged in the feldspar there are thin streaks of sericitic material streamed through many rocks. This sericite or fine grained muscovite may be the product of metamorphism of clay minerals: this is confirmed by the almost complete absence of any sedimentary clay.

With the absence of chlorite, and the presence of plentiful brown biotite there is a strong suggestion that all of the chlorite has been metamorphosed to biotite. In fact all of the biotite present appears to be metamorphic, for almost without exception the biotite is brown rather than green and is unstressed, uncontorted and in optical continuity. The biotite is often associated with iron opaques and occurs as crystal lathes which have either diffused into aggregates or remain as individuals. The aggregates are in the form of dense clusters, streaks and bands, and in many cases this has produced foliations and lineations which are measurable in the field.

In the arkosic rocks there is a general deficiency of mica, and the mica that is present has a somewhat higher proportion of muscovite than the greywackes. This reflects the presence of a more chloritic matrix in the greywackes.

#### Rock Fragments.

The nature and amount of the rock fragments is often hard to pick. It appears that in the coarser grained rocks the fragments are generally quartzitic. Thin slithers of slate often occur at the base of sandstone beds: they are derived from underlying slates, and are merely an expression of more vigorous bottom conditions.

Accessory Minerals.

Apatite, tourmaline, zircon, opaques, and detrital garnet are common accessories. Their nature indicates either an igneous or high grade metamorphic provenance.

## METAMORPHISM

At Carrickalinga Head, the Carrickalinga Head Formation consists of highly angular quartz and feldspar in a base of clay-sericite-chlorite rock flour. The presence of epidote with this assemblage indicates that the metamorphism has reached the quartz-albite-muscovite-chlorite sub facies of the greenschist facies. Plagioclases containing calcium have broken down to albite and epidote.

Further to the south in the Delamere-Rapid Bay area there is an abundance of green minerals such as green biotite and chlorite. This indicates that the biotite isograd has been reached and marks the incoming of the biotite zone of regional metamorphism. The chemical reaction involved is most probably:



The rocks of the Talisker Mine area are characterised by the absence of green minerals. The green biotite which is found to the north is no longer present, for it has all been converted to brown biotite. There is also a pronounced absence of green chlorite and clays. This conversion of green biotite to brown biotite, and the removal of chlorite indicates an increase in the grade of regional metamorphism to the quartz-albite-epidote-biotite sub facies of the greenschist facies.

All of the plagioclase is albitic, and as mentioned previously this is mainly due to an acidic provenance which has only been slightly modified by metamorphism. The presence of epidote in some of the slides shows that under the conditions of metamorphism which prevailed the plagioclase could not accommodate very much calcium. Quartz and potassium feldspar may also be involved in these metamorphic reactions.

There is an upgrading of metamorphism in some of the greywacke sequences. The migration of the mineral solutions into bands parallel

to the foliation, and the chemical reactions which have taken place, were facilitated by the more porous nature of the beds. In these bands porphyroblastic garnets and hornblendes have grown among the quartz, feldspar and micaceous material. The plagioclase feldspar is an andesine, and there is a complete absence of epidote. This mineral assemblage is characteristic of the staurolite-almandine sub facies of the almandine-amphibolite facies. This means that quartz-albite-epidote-almandine sub facies of the greenschist facies has only a small field of stability in the Talisker mine area, and that the metamorphic conditions correspond to the region A - B in figure 5<sup>16</sup>. Figure 5 shows that the pressures causing regional metamorphism have not been as pronounced as those in the Scottish Highlands: and on this basis it appears that temperature has played a bigger part than pressure in increasing the metamorphic grade.

#### CONCLUSIONS

Sediments derived from a granitic terrain have been transported moderate distances into neighbouring geosynclinal areas. There has been rapid accumulation of Flysche type sediments in the deep mobile basins. The presence of a cross-bedded arkose sequence suggests at least one period of relative stability.

Subsequent metamorphism, which is characterised by a regional north south gradient in the Western Mount Lofty Ranges, has produced mineral assemblages in the Talisker mine area which border on the amphibolite zone of regional metamorphism.

STRUCTURE:

STRUCTURAL ANALYSIS

The structural analysis of an area requires a geometrical examination of all structural elements, and such an examination should be made on all scales. It is from this analysis that inferences of movements and stress can be made.

From a structural analysis of the Talisker mine area it appears that there are two areas of structural homogeneity, the approximate division between the two is shown by the line X-X on the structural map.

Macro Scale.

To help understand the following discussion reference should be made to figures 2 and 6.

The Carrickalinga Head and Inman Hill Formations to the west of the Talisker fault are in a simple syncline. The west limb of the syncline has a dip of  $35^{\circ}$  to the east; the east limb is somewhat steeper and dips to the west. From the orientation of bedding, and the general lithology, it appears that there is a closure to the north and a shallow south plunge.

Further to the east the west dipping limb of the syncline steepens until it passes through the vertical and finally dips to the east. These east dipping beds, which belong to the Brukunga Formation, have been truncated by the Talisker fault. Therefore in general to the west of the fault there is a broad syncline which plunges at a shallow angle to the south. The syncline breaks into a tight anticline of unknown plunge before being affected by the fault.

The sediments on the east side of the fault, and most probably those belonging to the tight anticline on the west side, have been thrust up as a series of sharp recumbent folds over the synclinal block. Both limbs of these recumbent folds dip at about the same angle, and much of the bedding in the more massive horizons has been obscured by the development of axial plane cleavage. This

makes the identification of major folds difficult, however by tracing a few indistinct marker horizons some folds have been outlined. Where these marker horizons are absent the extent of folding may be greater than has been shown on the generalised geological cross section (figure 2). In these recumbent folds the anticlines close to the north and the synclines close to the south. The closures are relatively sharp, and the axial plane dips and strikes at about the same angle as the bedding. It therefore appears from field observations that the recumbent folds plunge at moderate angles to the north east.

### Meso Scale.

The elements measured in this part of the analysis were drag folds, bedding - cleavage intersections, bedding, foliation, and mineral lineations. The term lineation, on the accompanying structural map and stereo plots, applies to the plunges of drag folds, cleavage - bedding intersections, and mineral lineations.

Drag-Folds. Throughout the area, and in particular along the cliff faces of the south coast, there is meso scale drag folding. To the east of a line approximately in the same position as X - X the drag folds are very tight and all of the limbs dip steeply to the east. The style of this drag folding is the same as the recumbent folding on the macro scale. To the west of X - X the drag folds are usually in the form of synclines which break into tighter anticlines, therefore they duplicate the macro scale folding in the region west of the Talisker fault.

Mineral Lineations. In the more micaceous rocks recrystallised mica flakes are generally streamed in one direction. Iron minerals have also been stretched out in the same direction, and often this process has produced fine grooves or shadows on cleavage planes.

Cleavage-Bedding Intersections. These lineations are more variable in their values than the other two.

Besides their use in determining lineations, bedding-cleavage relationships are useful in obtaining facings.

Bedding and Foliation. Bedding is obvious in many parts of the area, especially where there are striking changes in the texture and composition. However, in the fine grained slates and phyllites, and in many of the more massive rock types, bedding is not always obvious. This is because the micas have recrystallised and segregated into bands and foliation planes parallel to the axial plane of the folding.

Because of the very tight recumbent folding which has taken place in the east of the area, foliation and bedding are either parallel or almost parallel. This can be seen in many of the rock slides, where feldspar and quartz compositional bedding is present, and the micas have recrystallised and segregated into bands parallel or sub parallel to this bedding. Whenever micas recrystallise at any great angle to the bedding, they are not in great enough concentration to produce a foliation.

In the stereoplots no distinction has been made between bedding and foliation.

Results of Meso Scale Stereoplots. A plot of all the penetrative meso scale structural elements mentioned above shows that the overall symmetry of the area is triclinic. This overall triclinic symmetry can be divided into two areas which have monoclinic symmetry on a meso scale. The line X-X is an approximate boundary between the two areas.

West of X - X:

To the west of this line bedding in the Inman Hill Formation is the most dominant planar element. The plots of the poles to the bedding are spread about the girdle of a great circle, implying that the beds are folded about a fold axis perpendicular to the plane of the great circle. This gives a  $10^{\circ}$  plunge in a direction of  $202^{\circ}$  for the fold axis. The plot of the lineations shows a plunge of  $15^{\circ}$  at  $198^{\circ}$ . Both values compare favourably.

East of X - X:

All of the beds in this part of the area have approximately the same strike and dip. The foliation is also parallel to the bedding, and it is because of this that the bedding-foliation stereoplot shows a concentration of poles. This concentration of poles indicates that the axial plane dips at about  $68^{\circ}$ E and strikes at  $42^{\circ}$ . The plot of all the lineations in this part of the area indicates a plunge of  $32^{\circ}$ N at  $48^{\circ}$ .

#### Micro Scale.

Quartz does not appear to have been strongly deformed, a few slides show a general preferred dimensional orientation of the quartz grains. In hand specimen there is no evidence which indicates that quartz may be lineated. This, combined with the fact that there are no pure quartzites, suggests that little additional information would be gained from carrying out petrofabric analyses on quartz optic axes. There is also no point in carrying out microscopic petrofabric work on micas, as their preferred orientation is often obvious in hand specimen.

Conclusions of Macro Meso and Micro Scale Observations.

1. A line which corresponds to X-X on the structural map divides a tricline area into two areas of monoclinic symmetry.
2. The two areas divided by X-X have different styles of folding, in each of these areas the style of the drag folding is similar to the macrofolding.
3. Values obtained for the fold axes on a meso scale agree favourably with the macro scale estimates.
4. Points 1, 2 and 3 indicate that the Talisker mine area can be divided into two areas of monoclinic symmetry which are structurally homogeneous on all scales.

The line X-X dividing these two areas is parallel to the main Talisker fault. To the west of X-X plunge is  $10^{\circ} - 15^{\circ}$  at  $200^{\circ}$ , and to the east the plunge is  $32^{\circ}$  at  $48^{\circ}$ . This indicates that there has been a certain amount of rotation parallel to the fault and X-X. There is a slight chance that the line X-X and the Talisker fault are coincident. If this is the case then simple rotation about the break would explain the reversal of plunges. Although the number of lineations measured in the region between the fault and X-X are few, there are enough to indicate that the reversal in plunge is not sharp, and that the line about which rotation has taken place is not coincident with the fault.

FAULTING

In the preceding stratigraphic and structural considerations the overall picture has been greatly simplified. In actual fact everything has been complicated by two fault systems.

The first generation of faulting occurs as slip planes which are associated with the very tight squeezing which has taken place during the folding. On the map a few of these are shown, however they have been very hard to pick in the field as they have been affected by later movement along the axial plane of the folding. The directions of this slip plane fault development are shown on the geological interpretation map as cross faults. These faults cannot be traced. They can only be

discerned by the general discontinuity of a number of beds, and therefore the directions shown on the map are approximate. Much of the movement in the cross faults appears to have a large vertical component, therefore it may be better to call them dip faults.

Certain of the cross faults are cut off by other cross faults, suggesting that the development may have been a continuous process associated with the tightening recumbent fold system. The most important of the cross faults is the Talisker fault which strikes at about  $20^{\circ}$  and appears to join up with a major fault mapped during 1962 by Leslie<sup>5</sup> and Drayton<sup>8</sup>. The fault dips steeply to the east, and the east block has been thrust up over that in the west. In addition there has been lateral displacement, with the west block being pushed to the north.

This faulting, combined with lack of outcrop in the area to the north of the Talisker mine has made the stratigraphic correlation of the sediments particularly difficult. From the mapping carried out there is the possibility that this area could belong to any of the three Kanmantoo Formations mentioned in this report. On lithological grounds there are similarities to certain of the Inman Hill beds, however the presence of greywackes indicates that either the Carrickalinga Head or Brukunga Formations may be represented. In the accompanying geological interpretation map the beds have been shown as the Inman Hill Formation, but this is only a very tentative correlation.

As mentioned previously, the initial cross (or dip) faults have been diffused by later axial plane faulting. Although this has only been shown by a few separate displacements on the interpretation map, it is better to consider this faulting as a large number of movements along foliation planes which have developed during the major compressive phase.

RELATION TO NEIGHBOURING AREAS

The areas mapped by Drayton<sup>8</sup>, Kirk, Leslie<sup>5</sup> and Robinson<sup>17</sup> are shown on the locality map (Fig. 1). Their work suggests that "the region from Little Gorge almost to Cape Jervis of Cambrian-Precambrian sediments is structurally homogeneous" (Drayton<sup>8</sup>). The whole region is characterised by a low angle of dip and a consistent plunge of 25° in a direction of 150°.

This is in contrast to the Talisker mine area where two areas of structural homogeneity have been recognised. The plunges in the two areas are approximately 15° in a direction of 200° and 30° in a direction of 50°. This indicates that the movements which have taken place in the Talisker mine area are different to those which have operated in the areas mapped by Drayton et al<sup>5, 8, 17</sup>.

The differences in movement may be explained by either rotation about fault planes or by variations in the nature of the folding.

The only fault about which there has been any great movement, is the Talisker fault, and although this is obscured for about a mile by the laterite cover it is directly in line with a major fault recorded by Drayton<sup>8</sup> and Leslie<sup>5</sup>. In all probability these two faults meet under the laterite. Drayton's<sup>8</sup> structural analysis of the Rapid Bay area shows that the plunges and lineations are the same on either side of the fault. This suggests that there has been very little rotation of the beds on one side relative to those on the other.

In the Talisker mine area the relationship is not as clear cut. This is because the line which separates the two areas of structural homogeneity is close to and approximately parallel to the fault. However from the previous structural considerations it appears that the line X-X and the Talisker fault are not coincident. Although this is inconclusive reasoning it seems to indicate that the changes in the direction of plunge and lineation have been produced by folding rather than by rotation about fault planes.

To explain the controls for the assymetrical folding it is necessary to consider the sediments of the Fleurieu Peninsula prior

to the folding. The sediments were initially flat horizontal sheets in which the formations underwent normal thickness variations. However one notable exception occurred in that portion of the sedimentary basin which now corresponds to the central part of the Talisker mine area. Here the Inman Hill Formation was reduced to 100 feet thickness in places. This is an extraordinary amount when it is compared with values of about 1,500 feet for the same formation in the rest of the basin. There is evidence which indicates that the Carrickalinga Head Formation has also undergone a certain amount of thinning.

When the basin was subjected to later tectonic deformation the rocks tended to fold and break in places of weakness. The thickness, and other physical properties of the Inman Hill Formation normally made this unit very resistant to structural deformation, however the extensive thinning mentioned previously provided the necessary weakness to create an area of more intense compression and thrusting. The assymetrical movements which took place are now reflected by the reversal of plunge and the steep recumbent folding to the east of X-X. The dip and plunge of the sediments to the west of X-X does not differ considerably to those recorded by Drayton, et al. The difference which exists may only represent a modification of the regional plunge by the thrusting, pinching and compression to the east of X-X.

Figure (6a) shows the style of folding which has been imposed on the sedimentary layers. It consists of a steeply dipping recumbent fold system which plunges to the north-east. This is set in a more shallow series of beds which plunge to the south-east. Similar fold patterns were obtained by squeezing flat slabs of putty and plasticine. The breaking up shown in figure (6a) is only diagrammatic, and no importance should be placed on the orientation of the fractures. It has only been included in the diagram because it corresponds to the crumpling obtained when the flat slabs of putty and plasticine were folded.

The three block diagrams (figs. 6a, b, c) roughly encompass that part of the Fleurieu Peninsula south of Stockyard Creek. By comparing figures 6a & b with the generalised block diagram in figure 6c a possible evolution of the outcrop pattern can be seen. Movement along the major

fault plane, and the present day level of erosion are represented in figure 6b. By slicing plasticine models of figure 6b along the approximate erosional surface it is possible to reproduce outcrop patterns similar to that shown in figure 6c.

Before the sediments pass under the laterite in the north of the Talisker mine area there is considerable displacement of the different rock types. After being concealed by the laterite cover for about a mile the next rock exposure is in the area mapped by Leslie<sup>5</sup> (1962). Although Leslie<sup>5</sup> does not show the complications which exist, it is apparent from a brief look at the area, and from personal communication with Leslie, that much faulting and distortion of the Formations has taken place for a distance of about one mile north of the laterite. There is therefore the possibility that the crumpling of the putty and plasticine models corresponds to the area of deformation outlined above, and that this is associated with the change from the shallow, east dipping, south plunging sequence of Stockyard Creek, to the tight, north plunging, recumbent folding of the Talisker mine area.

An aeromagnetic map, which includes most of the region mapped by honours students during 1962 and 1963, is shown in figure (7). Three magnetic highs are obvious, and when allowance is made for the regional gradient they have approximately the same magnitude. The northern and central anomalies correspond to the same magnetite rich stratigraphic horizon in the Marino Group. If this is a simple left hand displacement then the direction of the displacement is at about 25°. The cause of the southern anomaly is obscured, but there is every possibility from the mapping of Leslie<sup>5</sup> and the Mines Department<sup>6</sup> that this corresponds to the same magnetite horizon in the Marino Group. The displacement of this anomaly is in a similar direction to the displacement of the other two anomalies. The inference, therefore is that there has been at least two approximately parallel displacements of the Marino Group. However this simplified picture is complicated by the fact that the magnetite is not consistent along the strike of the Marino beds (Kirk: personal communication).

Although the aeromagnetic map shows that the Marino Group passes under the laterite, none has been found in the Talisker mine area. The continuation of the Talisker fault or some type of dip faulting may account for this termination.

It is obvious from all of the above discussion that the area from Stockyard Creek to just north of the Talisker mine should be remapped in detail.

ECONOMIC GEOLOGY

The main economic interest lies in the Talisker lead-arsenic mine. A comprehensive study of the geology and mineralogy of the mine may be found in Mining Review No. 110 (18, 19, 20, 21). Included in this Review is a list of references which covers previous work published on the mine. Rather than duplicate the work already carried out it was decided to approach the problems of mineralisation on a larger scale.

## LODE CONTROLS

It has been shown in this report that the greywackes which contain the main Talisker lode are Kanmantoo Group sediments, and not facies changes from the limestones in the north. Regardless of the stratigraphic position of the host rocks, the fact remains that sixteen of the nineteen shafts scattered throughout the whole Talisker mine area are located in brittle sandstone beds which border the contact with more phyllitic, finer grained sediments of the Brukunga Formation. These preliminary observations indicate that the sulphide mineralisation may be related to the breaking up which occurs when competent and incompetent rocks are folded together.

The extent of mineralisation increases from the South Coast towards the north, and reaches a maximum in the vicinity of the main Talisker lode. The amount of shearing and dip faulting increases in the same direction. Plasticine and putty models also show a tendency to crumple in the same relative position. This breaking up and maximum mineralisation is associated with an area in which there is a change from shallow east dipping beds to steep recumbent folds which plunge back in the other direction. Apparently this deformation has provided the necessary channelways for the ascending hydrothermal solutions.

There is a prominent fault which cuts across the north of the synclinal core of the Brukunga Formation. Scattered along the line of this north-south fault are a number of small shafts. The lode material in these shafts has not come directly up the fault plane, but has been

emplaced in nearby fissures. Although this fault does not continue through to the Talisker mine, it is in line with, and strikes in the same direction as, the main lode. The main lode may therefore be associated with the partings which have produced the fault and related mineralisation.

A similar situation occurs in an arsenopyrite prospect described by Nixon<sup>22</sup>. The lode strikes in a similar direction to, and is in the vicinity of, another prominent cross fault. Along the line of the fault there are a few isolated workings.

Samples of material taken from the mines scattered throughout the area show brecciation. This, combined with the lack of idiomorphic form in the arsenopyrite and pyrite suggests that breaking up and movement took place at the same time as mineralisation. Therefore the movements along the cross faults must have been accompanied by a certain amount of shearing and brecciation in the neighbouring lode bearing fractures and tension gashes. It is possible that the absence of cross faulting and the greater amount of material in the Talisker lode has enabled more complete and uninterrupted crystallisation to take place.

There is a difference of opinion between La Ganza and Nixon. La Ganza<sup>21</sup> considers the main lode to be "a series of closely spaced shears or fractures into which the mineralising solutions were injected", while Nixon<sup>20</sup> claims "the veins intruded tension fractures, not closely spaced shears". Although Nixon's proposal for tension fractures is nearest to the truth, it should be realised that these fractures are related to the same breaks which produce the cross faulting. The absence of movement along these breaks in the Talisker lode is an exception to the other areas of sulphide mineralisation. In most workings the breaks have been tight and movement has taken place. In comparison the fractures of the Talisker lode have been subjected to more tension and less slip.

Along the south coast, quartz veins, which are the same age as the ore bearing solutions, have been intruded into joints and tension gashes. Many of these veins have been displaced by the later axial plane fault movements. This process has produced the en echelon pattern

of the main Talisker lode. Nixon<sup>18</sup> confirms this when he says that "slides shown on the underground plans have displaced the lodes and movement on them must have been post ore. The slides are probably shear planes which have developed at the time of folding and along which movement has continued after the emplacement of the lodes".

## MINERALOGY

### Primary Sulphides

La Ganza has noted that galena and arsenopyrite are the most abundant sulphides in the main Talisker lode. Among the other minerals present there are pieces of primary pyrite and accessory chalcopyrite. The writer agrees with these observations.

Galena is only present in the main lode and in a few nearby diggings (G63-123). It is absent along both the eastern and western flanks of the Inman Hill - Brukungu contact. Away from the main lode galena dies out and in places pyrite becomes more abundant (G63 - 64). Pyrite diminishes towards the south on both the western and eastern flanks, until finally the lodes consist of almost pure arsenopyrite (G63 - 119, 120). No sulphide mineralisation has been recognised on the south coast, and this suggests that arsenopyrite also eventually dies out. Typical pyritic (G63-64) and non-pyritic (G63-120) lode material are described in Appendix 1.

### Alteration of Primary Sulphides

The samples studied under reflected light are from surface dumps. Because of this, the primary sulphides are often affected by weathering. Galena is usually altered to anglesite, while arsenopyrite commonly forms a fine, granular, pale green alteration product which has been identified as scorodite<sup>23</sup>. In all probability the traces of covellite present have been derived from primary chalcopyrite.

### Paragenesis

In the few samples studied replacement textures between the sulphides are rare. This is in contrast to the country rock which has been absorbed, altered, and replaced, by the hydrothermal solutions. The difference

in chemistry between arsenopyrite and the other sulphides may partially account for the absence of replacement textures. However the obvious inference is that all of the sulphides were intruded at about the same time. The few replacement features that are present indicate that the arsenopyrite and pyrite were formed a little before the galena.

The paragenetic relationships between quartz and the sulphides is not obvious. Three generations of quartz have been recognised. The first is detrital material belonging to the country rock. The second is a subhedral variety which most probably crystallised before the sulphides. Another generation, which is younger than the sulphides, may be secondary quartz.

#### DISCUSSION

The lodes are hydrothermal in origin, however the source of the hydrothermal solutions is unknown. A granitic source is often postulated for similar hydrothermal deposits. A relationship to the formation of granite <sup>is suggested</sup> by the following points.

- (1) "There are many outcrops of granite in the Encounter Bay area . . . . The granite at Cape Willoughby, Kangaroo Island, is considered by Tilley to part of the same batholith" (Bowes)<sup>24</sup>. This opinion has been supported by later workers. From maps which show Kangaroo Island, Encounter Bay and Cape Jervis, it can be seen that the batholith could affect the Talisker mine area.
- (2) This granite batholith was emplaced during the orogenic movements which folded the Kanmantoo, Cambrian, and Precambrian sediments in the Mount Lofty Ranges. The Talisker lodes were produced at the same time.
- (3) There is an increase in regional metamorphism from Carrickalinga Head to the Talisker mine area. This upgrading in metamorphism is due to an increase in temperature rather than pressure (see metamorphism). It is therefore possible that the granite batholith of Kangaroo Island and Encounter Bay is associated with the production of a regional metamorphic gradient.

The only conclusion which can be reached is that the lodes were produced at the same time as the batholith. Whether the hydrothermal solutions were derived directly from granite, or whether they were produced by other processes during the orogeny is not known.

Hydrothermal solutions have filled fractures and fissures of low pressure. The veins formed are generally barren, and where sulphides are present the mineralogical and textural features are simple. Evidence indicates that there has only been one period of injection of lode material. This is in contrast to many sulphide deposits where there is commonly a resurgence of ore solutions. Both pyrite and galena are limited in their distribution. Replacement of the country rock is evident, but fissure filling is also quite common. Where movement has not caused interference, the sulphides are medium to coarse grained.

Most of the above points suggest that the lodes are simple mesothermal veins in which the sulphide mineralisation is not very extensive. Drilling has proved that the main Talisker lode continues at depth, and in discussing this Nixon<sup>20</sup> concludes, "At the present time it is improbable that the lodes intersected at depth could be mined profitably". It therefore appears that any work carried out on the Talisker mine would be an uneconomic proposition. Considerable changes in the present day lead, arsenic market would be necessary before the mine could be reopened profitably, and such changes are unlikely in the foreseeable future.

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APPENDIX I

DESCRIPTIONS OF THIN SECTIONS.

Fork Tree Limestone.

(RG 70)

MACRO: Grey-blue marble which is weakly banded

MICRO: Calcite: 100%

The average grain size is .1mm, in places this may be as large as .5mm. The calcite has been remobilised to a certain extent, this is evidenced by the presence of secondary calcite veins.

Accessories: Carbonaceous material.

The rock is a limestone.

Heatherdale Shale

(RG 108)

MACRO: Dark grey phyllite which has a lighter grey weathered surface, and black nodules.

MICRO: Phosphate Nodules: 20%

The outline between these and the host rock is sharp; the nodules appear to be elongated in the same direction as the mineral lineations. The nodules which are black and opaque are probably very carbonaceous.

Quartz: 40%

Shows dimensional orientation, and a very fine grain size.

Mica: 40%

Mainly fine grained muscovite; there is some brown biotite present. All of the micas are recrystallised and strongly lineated.

The rock is phyllite containing phosphate nodules.

KANMANTOO GROUP -

Carrickalinga Head Formation.

(RG 43)

MACRO: Dark coloured, massive, low grade metamorphic rock which appears to have been a sandstone.

MICRO: The rock is generally a fine grained sand-silt, and is irregularly sorted.

quartz: 60%.

The grains are clean and relatively free of gas bubbles. Some of the grains show conchoidal fracture, but many have been fused, and as a result the fracturing has been obscured.

There is 15% (.1mm - .2mm)  
30% (.1mm - .025mm)

The finer grains are often completely fused with feldspar, this may be the start of myrmeketic growth.

Feldspar: 25%

The grains are about .1mm - .2mm. There appears to be two types of plagioclase, one variety is relatively clean and shows twinning while the other is quite extensively sericitised. The plagioclase has an albitic composition.

The potassium feldspar is hard to distinguish from the plagioclase; some of it is showing myrmeketic growth with quartz.

Mica: 30%

Brown biotite makes up 20% of the rock, this is a metamorphic product which has recrystallised and segregated into streams which have a general optical continuity.

Fine grained muscovite and sericite make up about 10% and are also directionally recrystallised.

Accessory: Garnet (detrital), apatite, zircon.  
The rock is a greywacke.

(RG 71)

MACRO: Grey, fine grained rock, with a cleavage produced by micas.

MICRO: Fine grained rock.

Quartz: 75%

Very clean, fine grained quartz, which are uniformly packed and all about the same size. The grain contacts are fused.

Biotite: 25%

Brown pleochroism with a very strong lineation and pronounced optical continuity, the length of these fine grained mica streaks is usually four times the breadth. In places the biotites have segregated into bands.

The rock is a grey phyllite.

#### Inman Hill Formation.

(RG 54)

MACRO: Massive, light coloured, recrystallised sandstone.

MICRO: No visual lineation, the average grain size is .2mm.

Quartz: 55%

The grains are relatively clean and show a prominent conchoidal fracture. The grain size is fairly constant - .2mm, there are a few smaller interstitial grains.

Feldspar: 40%

Plagioclase grains show twinning which indicates an albitic composition. The grain size of the feldspar is also .2mm. There is also some potassium feldspar. The feldspars are generally dirty, this is only clay which has been produced by weathering.

Muscovite: 5%

Is present as a few coarse lathes which are all interstitial and have no preferred orientation.

The rock is an arkose.

BRUKUNGA FORMATION -

Nairne Pyrite Equivalent?

(RG 26)

MACRO: Laminated sandstone and phyllite bands of contrasting thickness. There is one prominent iron rich sandstone band.

MICRO: A banded rock.

Iron rich bands. 2 present in more uniform rock.

One band contains 60% of .4 mm - .5 mm grains of clean, somewhat fractured quartz, and 40% of iron oxides. This iron rich band produces much of the iron staining in the rest of the rock. The other iron rich band is a ferruginous shale which contains mica, quartz and iron oxide. This lies directly on the coarse iron rich band.

Remainder of rock: This more uniform rock.

Matrix: 55%

Ferruginous clays which vary in amount, fine grained muscovite and sericite micas (15%) granular (siltstone) quartz (40%).

Quartz: 35%

Angular larger grains .4mm are set in the matrix, in different bands the quartz grain size varies, and the sorting of these grain sizes vary. The quartz is fairly clean and is fractured in some places.

Feldspar: 10%

These grains are irregular and are scattered with the larger quartz grains, the boundaries are not well defined. The plagioclase is albite.

Accessories: Two notable accessories are jarosite (break down of sulphides?), and epidote (break down of more basic plagioclase?).

Banded ferruginous rock of overall greywacke composition.

(RG 162)

MACRO: Massive, iron-stained, recrystallised siltstone.

MICRO: Quartz: 65%

This is clean, and shows good and extensive conchoidal fracture. There are two grain sizes, 25% and 1-2mm and 40% are siltstone sized quartz which are scattered throughout.

Feldspar: 20%

Sericitised plagioclase and orthoclase which are present in about equal amounts. The plagioclase is albitic.

Biotite: 15%

This is the brown variety which is often present as clumps, and shows rough optical continuity.

Accessories: Detrital tourmaline, garnet, zircon.

By Folk's classification, this is a feldspathic subgreywacke.

(RG 65)

MACRO: Dark coloured, fine-grained, calcareous rock, with a very pronounced slaty cleavage.

MICRO: Quartz: 55%  
Shale size grains.

Biotite: 20%

Brown variety which shows optical continuity and is streamed, mainly as individuals in one direction.

Calcite: 25%

The grain size is generally greater than the other minerals. The calcite is either present as clumps or individuals.

GREYWACKE OR BROWN HILL EQUIVALENT?

(RG 99)

MACRO: Massive, recrystallised brown-grey sandstone.

MICRO: Quartz: 60%

The grains are about .5mm, most of them are clean and show prominent conchoidal fractures. This fracturing is quite dense and is made more pronounced by the presence of fine grained, iron stained, clay material in the cracks. Some of the quartz present is filled with fine grained inclusions, and is nowhere as clean as the fractured varieties. The grains are often very irregular, with the boundaries being fused to such an extent that they are not visible under ordinary light.

Mica: 25%

Brown biotite micas dominate (20%). They appear to be metamorphic in origin as they occur in lathes, which are only very weakly oriented. However these lathes have segregated into aggregates which are grouped in one general direction.

Diffusion of these mica forming solutions is also evidenced by the way in which the micas have grown around the larger detrital quartz and feldspar grains. The biotite lathes are of the order of .1mm.

Less noticeable, but yet still quite common (5%) are colourless fine grained muscovite, sericite flakes which are streamed out in a general direction.

Feldspar: 15%

Both plagioclase and some orthoclase having an irregular size and shape. The plagioclase is albitic.

The rock is a greywacke.

DESCRIPTION OF POLISHED SECTIONS

(RG 64)

MACRO: Ore and gangue material through fractures in brecciated country rock.

MICRO: Arsenopyrite: 50% of the sulphides.  
None of the grains show the usual idiomorphic form of arsenopyrite.

Pyrite: 50% of the sulphides.

These also occur as irregular grains scattered through the section. In no place at all are pyrite and arsenopyrite in contact, this may suggest simultaneous formation.

Quartz:

There is detrital quartz of country rock, subhedral quartz of lode which is older than sulphides, and secondary quartz younger than sulphides.

Accessory: Decomposition products of sulphides around the outside of the broken grains, traces of covellite and pyrrhotite.

(RG 120)

MACRO: Massive lode material in almost completely replaced country rock.

MICRO: The sulphide is essentially monominerallic, and is arsenopyrite. The arsenopyrite is anhedral and contains absorbed country rock. There is a generation of quartz running through the sulphide fractures.

APPENDIX II

EXPLANATORY NOTES FOR MAPS.

LITHOLOGICAL MAP

- (1) This is intended to show the rock types present, and therefore is a fact map. All of the numbers represent samples collected in the field. Those that are not available in the University collection are in the possession of the author. Thin sections have been made of these samples, and these have been filed under the index number of 63G.
- (2) The terms used for the various rock types on the map may not be perfectly correct, and may need modification by microscopic observations. However the terms are good enough for field classification.
- (3) The actinolite segregations shown on the map have now been recognised as hornblende and not actinolite.

STRUCTURAL MAP

- (1) The form trends are present to show the general style of folding.
- (2) Many of the dips, strikes and lineations measured in the field have been included. The stereoplots of all of these measurements, and a line X-X dividing the area into portions of homogeneity are also shown.

GEOLOGICAL INTERPRETATION MAP

- (1) This is a generalised map in which an attempt has been made to simplify and make more obvious the geology of the Talisker mine area.
- (2) The interpretation of the area around the Talisker mine itself is subject to alteration. The sediments have been shown as the Inman Hill Formation but in all probability the Carrickalinga Head Formation is also present. All of this is in an area where exposure is poor and faulting is prominent.
- (3) The whole faulting system is generalised and approximate, however because of the difficulty in discerning faults in the field, this cannot be avoided.
- (4) Rock sample numbers correspond to samples accompanying this thesis can be divided into two groups:
  - (a) Rock samples typical of each formation, descriptions of these may be found in Appendix I.
  - (b) Samples of lode material; polished sections of these have been studied.

- (5) To the north of the laterite, part of the area mapped by Leslie W.C. has been included. In all probability this will have to be remapped.
  - (6) The presence of the Nairne Pyrite Equivalent and the Greywacke of Brown Hill are only tentatively suggested. Most probably the best way to represent the two formations would be to collectively call them members of the Brukunga Formation.
-

## EXPLANATION OF FIGURES

- Fig. 1            Locality map showing the area mapped
- Fig. 2            Generalised geological cross-section of  
the Talisker mine area.
- Fig. 3            Quartz, feldspar, mica ternary diagrams of  
sandstones in the Talisker mine area.
- Fig. 4            (a) Correlation of Kanmantoo sediments in the  
                  eastern Mount Lofty Ranges.  
                  (b) & (c) Correlation of Kanmantoo sediments in  
                  the south-eastern Mount Lofty Ranges.
- Fig. 5            Diagram showing stability of metamorphic facies  
under different conditions of T and P (Shido)<sup>16</sup>
- Fig. 6            (a) Diagrammatic representation of the type of  
                  folding which has been superimposed on original  
                  flat sedimentary layers.  
                  (b) Similar diagram to (a) but the movement along  
                  the fault plane, and the present day erosional  
                  level are shown.  
                  (c) Generalised block diagram of that part of the  
                  Fleurieu peninsula below Stockyard Creek.
- Fig. 7            Aeromagnetic map of part of the Fleurieu Peninsula.
-

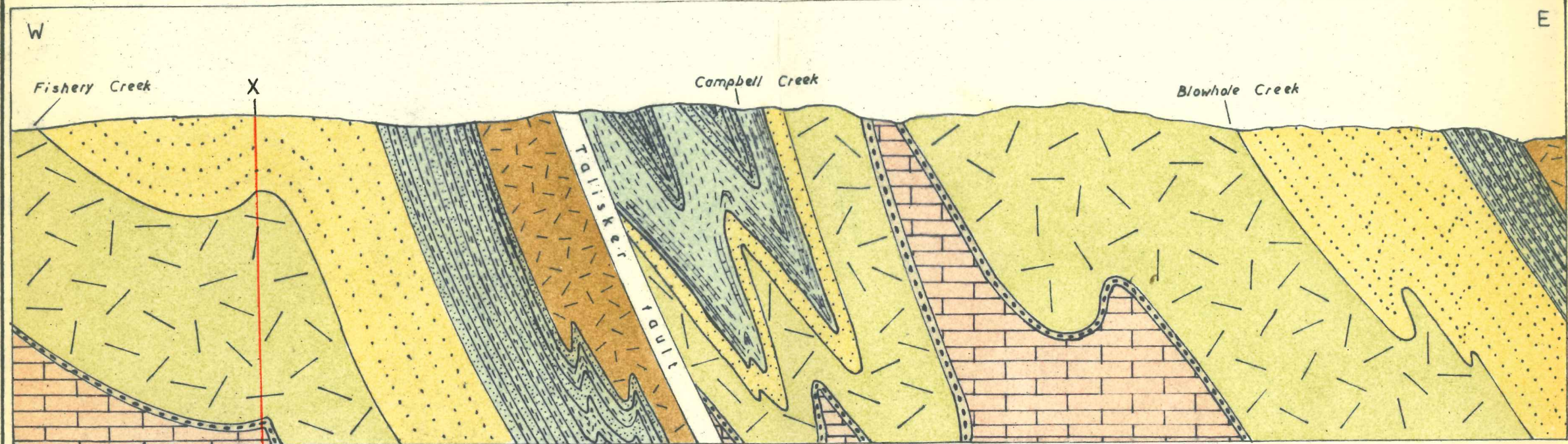
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18. Nixon, L.G.B. 1960 Talisker Lead-Arsenic Mine. Min. Rev. Adelaide, 110 pp. 22-28.
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Min. Rev. Adelaide 110 pp 49-56.
22. Nixon, L.G.B. 1960 Arsenopyrite Prospect-Sec. 108, Hundred of Waitpinga. Min. Rev. Adelaide, 110 pp 57-60.

# GENERALIZED GEOLOGICAL CROSS-SECTION OF THE TALISKER MINE AREA



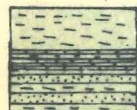
GREYWACKE OF BROWN HILL



INMAN HILL FORMATION

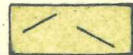


HEATHERDALE SHALE

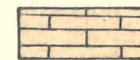


1 NAIRNE PYRITE EQUIVALENT

- 1 phyllites & slates
- 2 calcareous phyllites
- 3 sandstones



CARRICKALINGA HEAD FORMATION

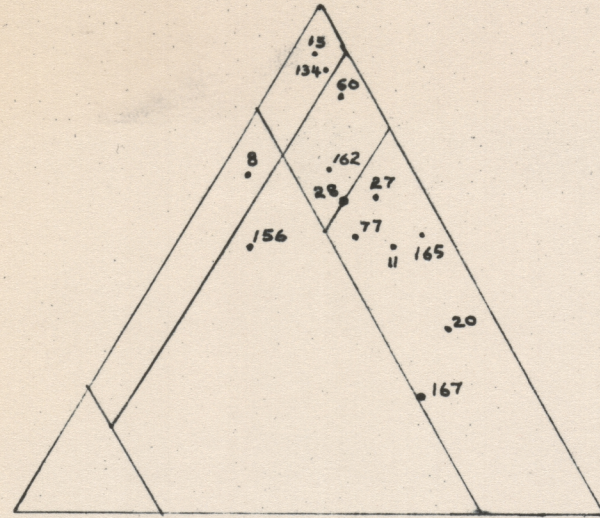


FORK TREE LIMESTONE & OLDER

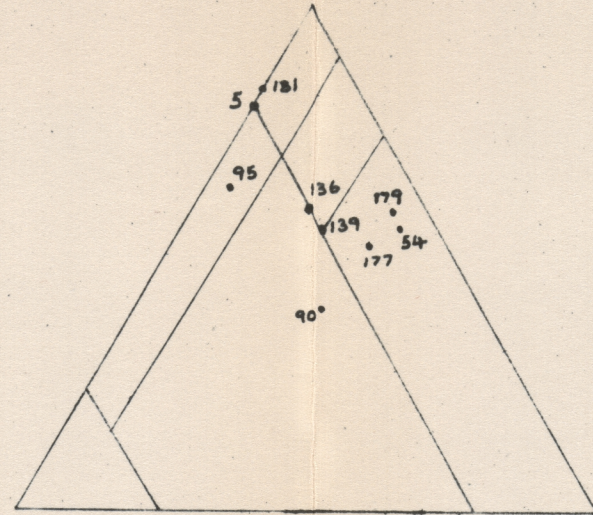
Robin George 1963

FIGURE 2

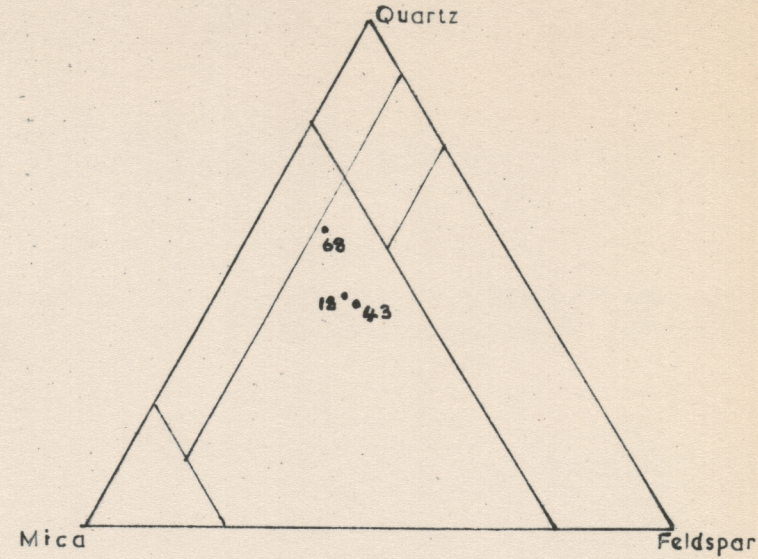
NAIRNE PYRITE EQUIVALENT



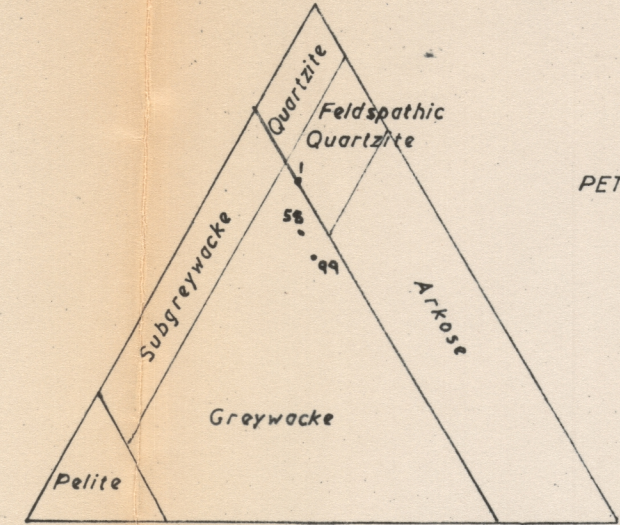
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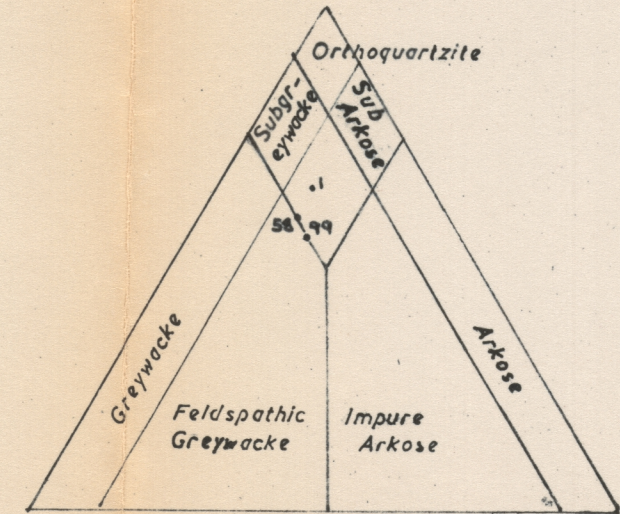
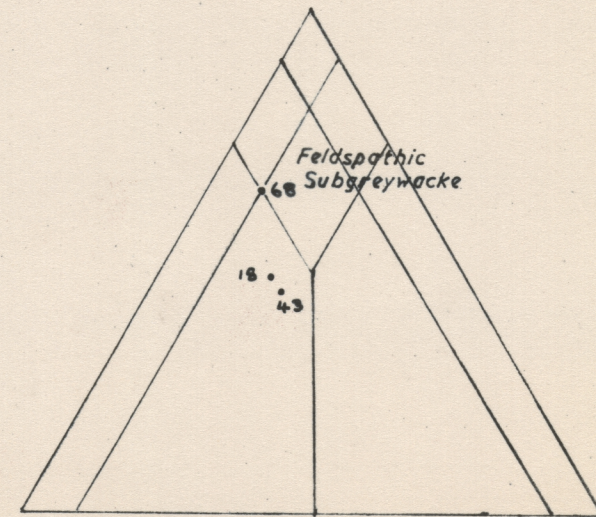
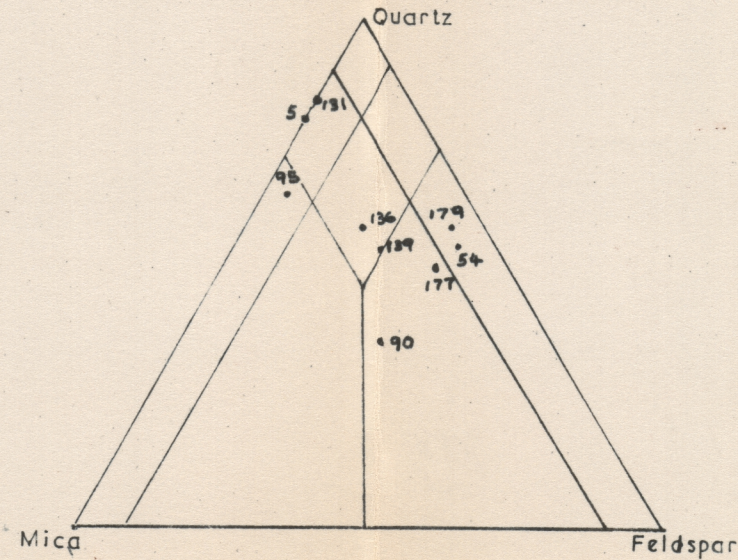
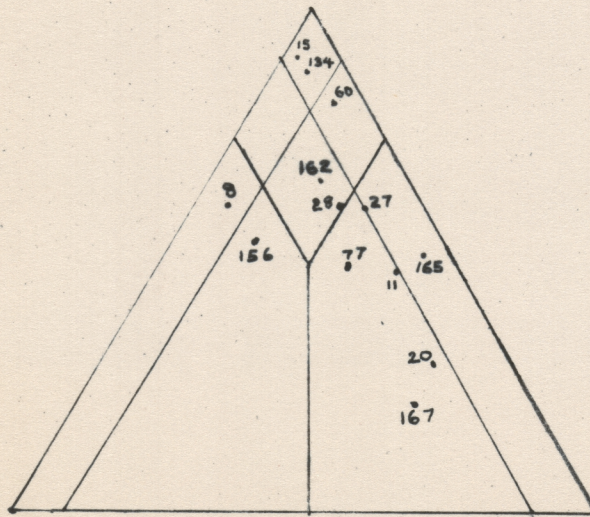
CARRICKALINGA HEAD FORMATION



GREYWACKE OF BROWN HILL



PETTIJOHN 1949



FOLK 1954

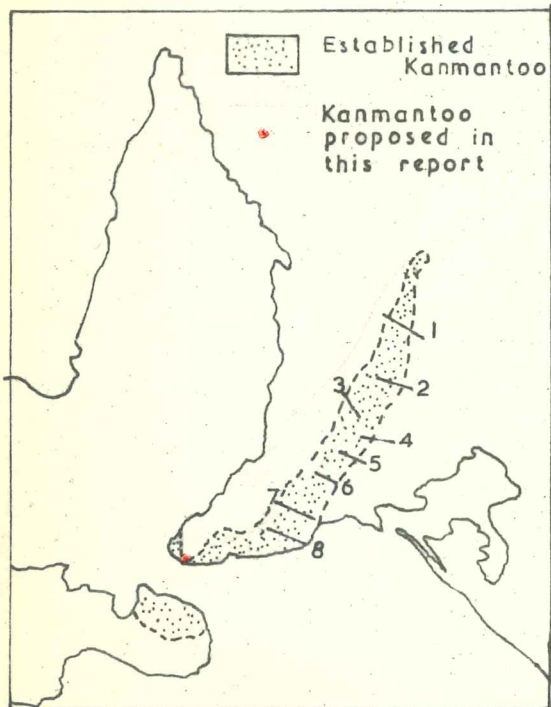
Robin George 1963

FIGURE 3

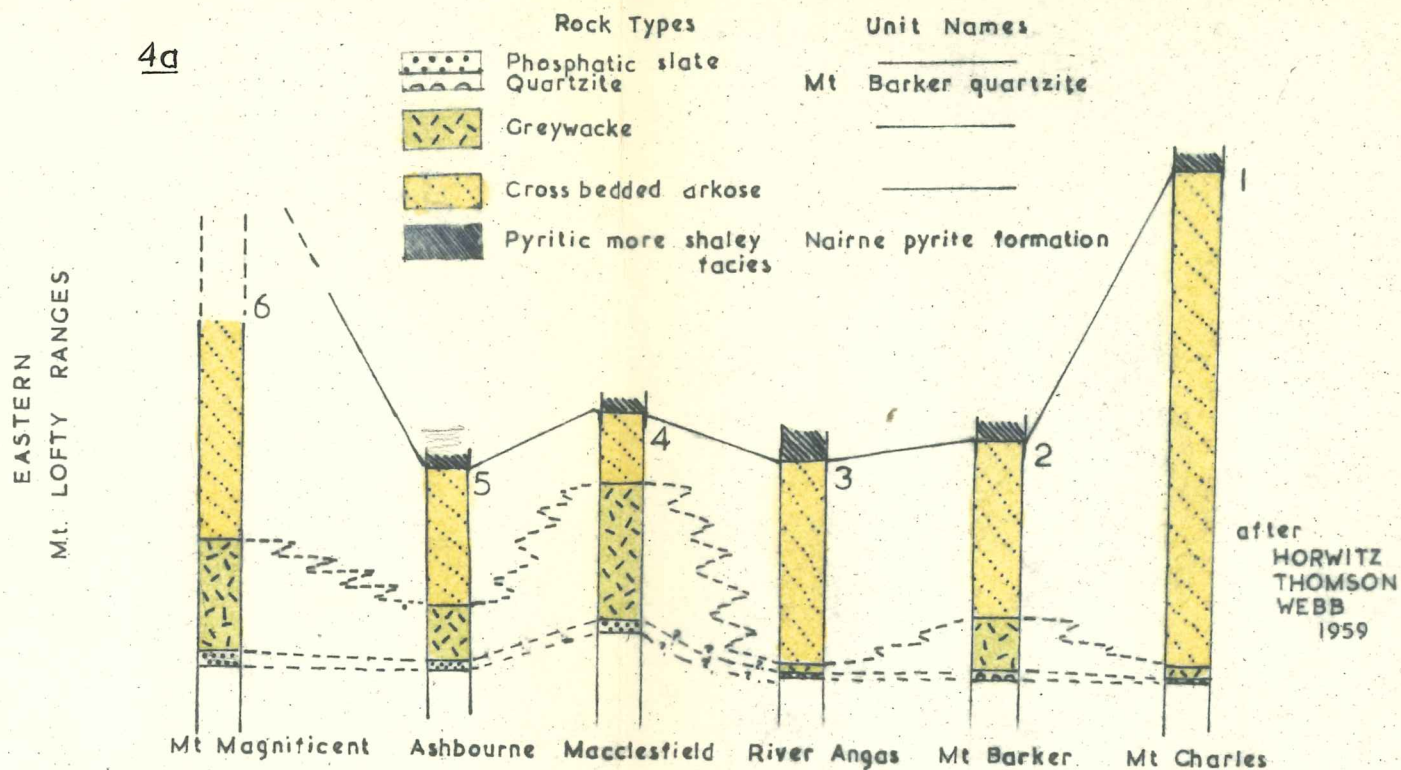
FIGURE 4

STRATIGRAPHIC  
CORRELATIONS  
OF THE  
KANMANTOO ROCKS  
IN THE  
Mt. LOFTY RANGES

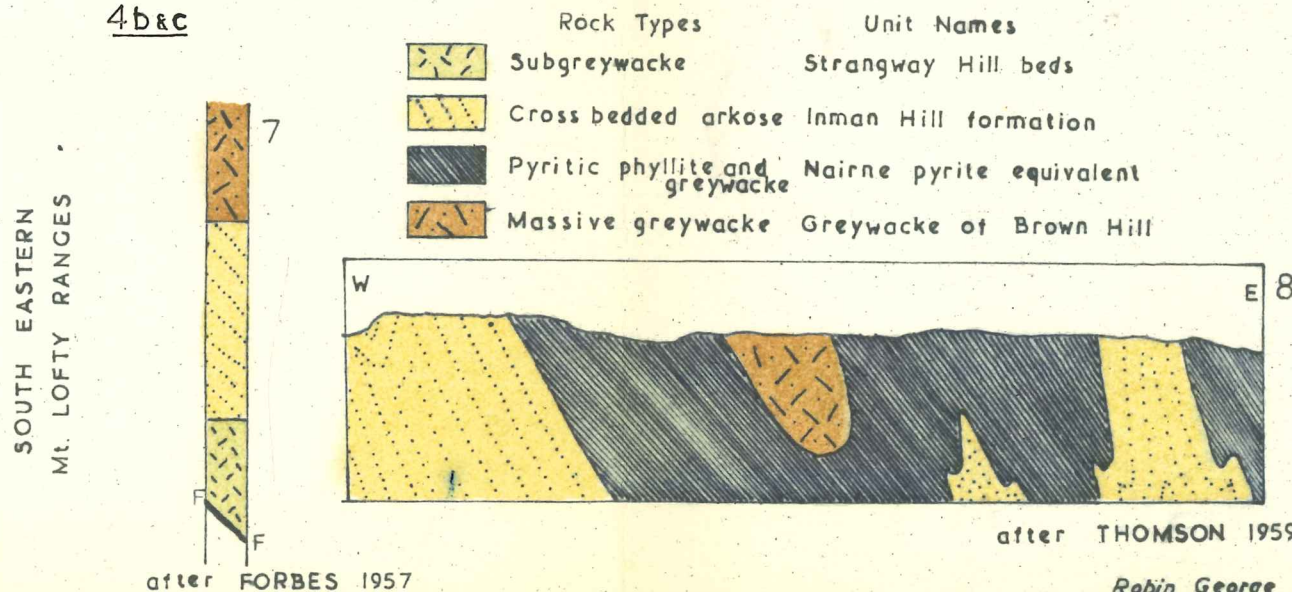
LOCATION OF SEQUENCES



4a



4b&c



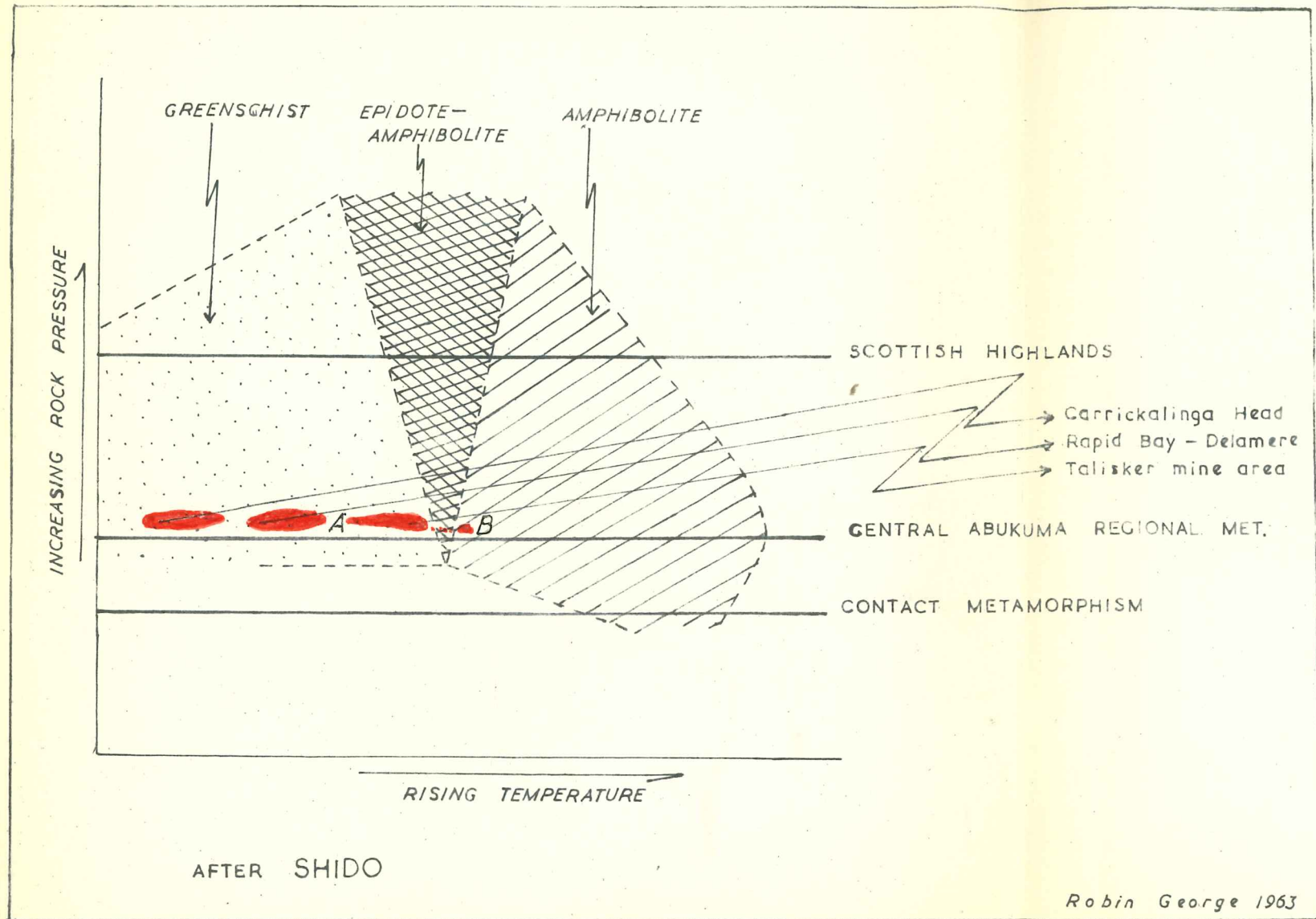


FIGURE 5

FIGURE 6a

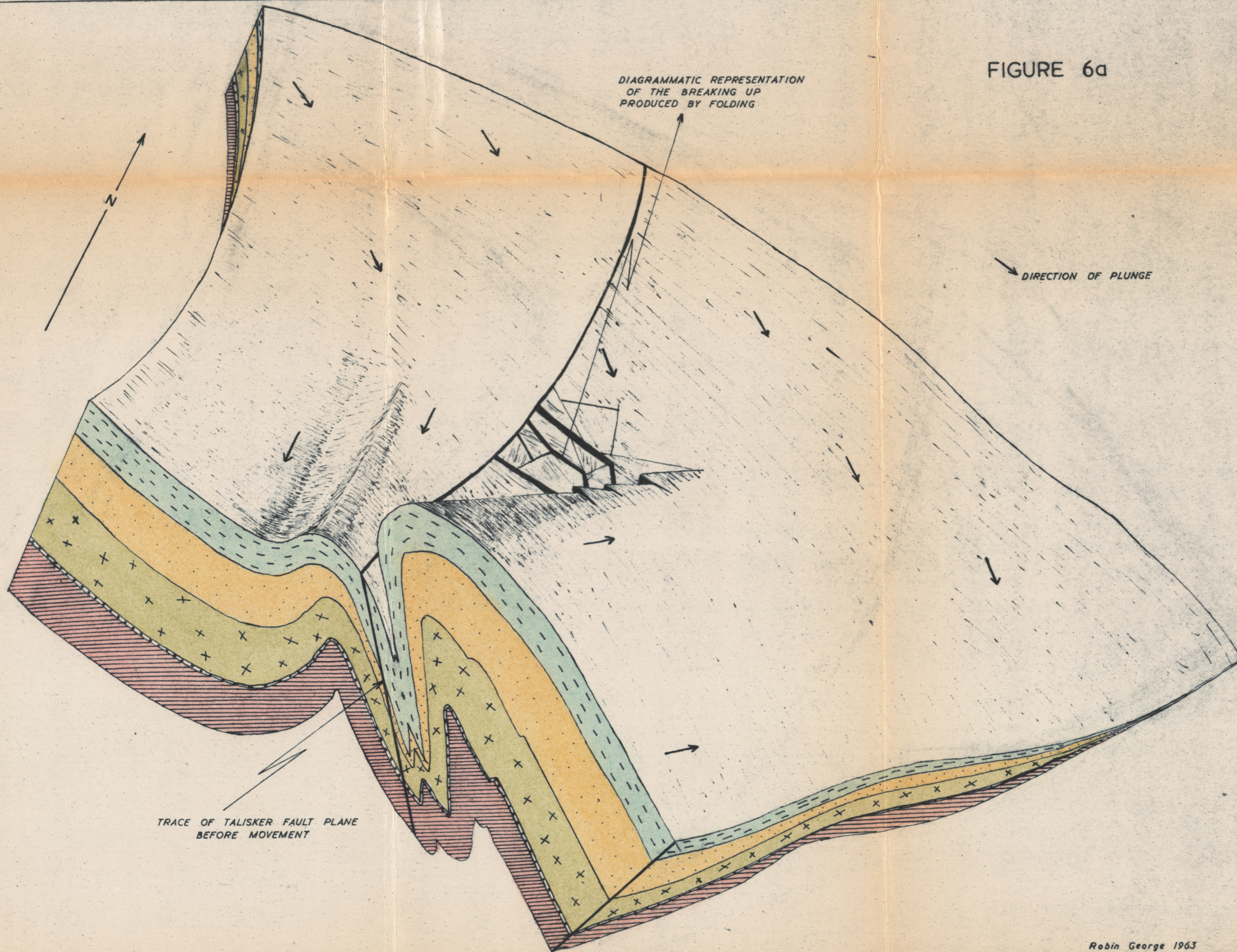
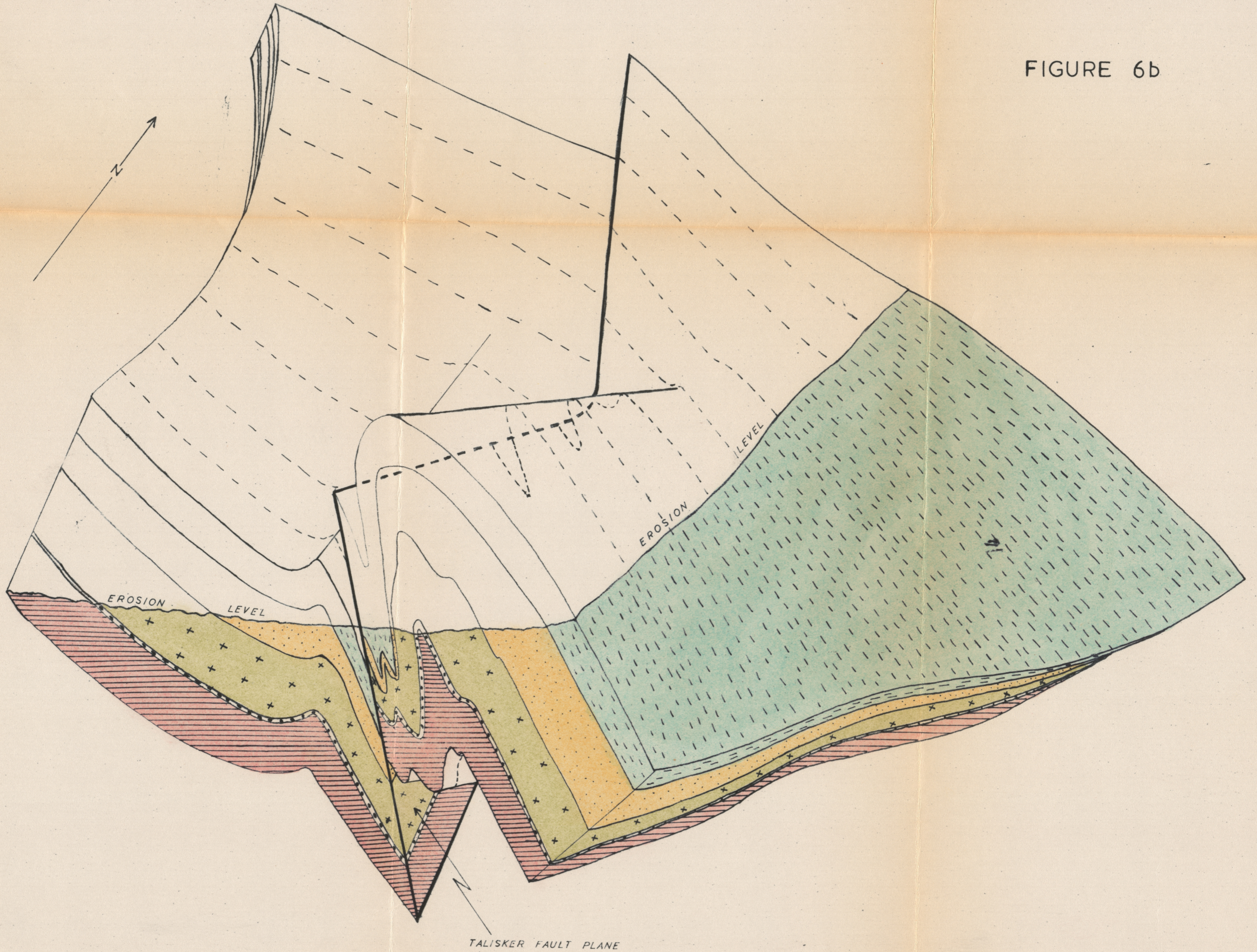
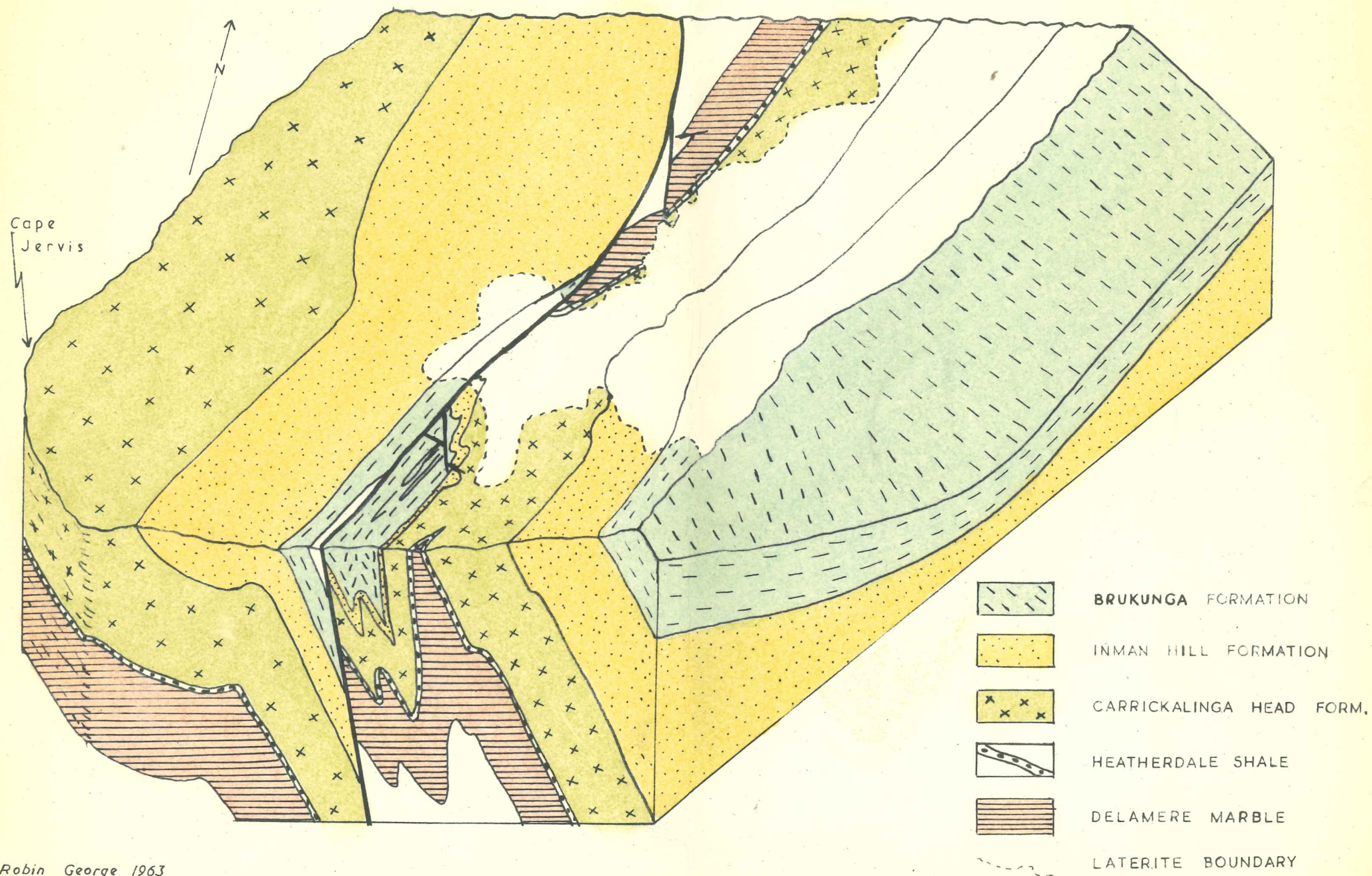


FIGURE 6b

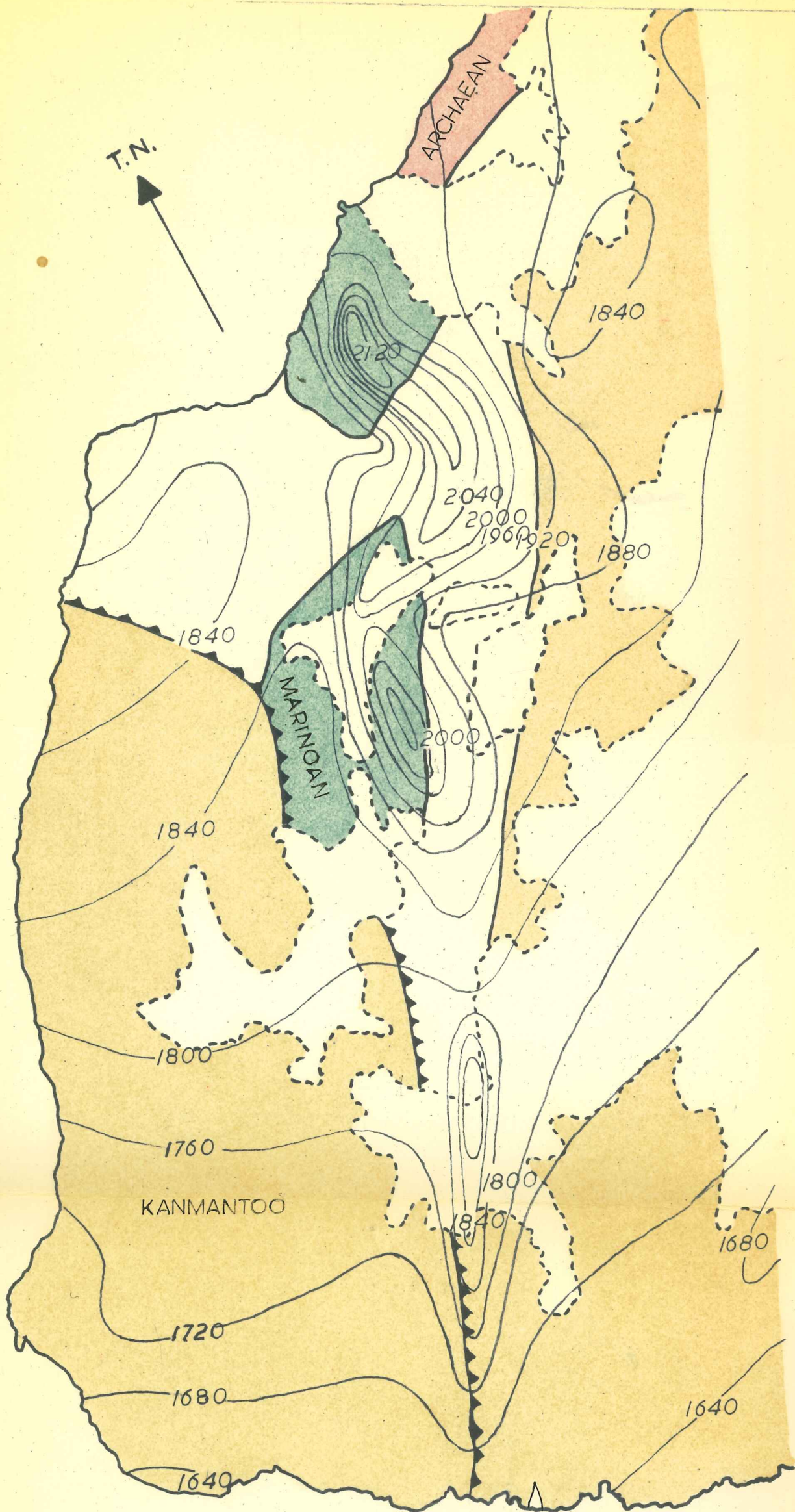


GENERALIZED BLOCK DIAGRAM OF PART OF THE FLEURIEU PENINSULA  
SOUTH OF STOCKYARD CREEK



Robin George 1963

FIGURE 6C



**AEROMAGNETIC MAP OF TOTAL INTENSITY**  
*Values in gammas*

Figure 7



# LITHOLOGICAL MAP OF THE TALISKER MINE AREA

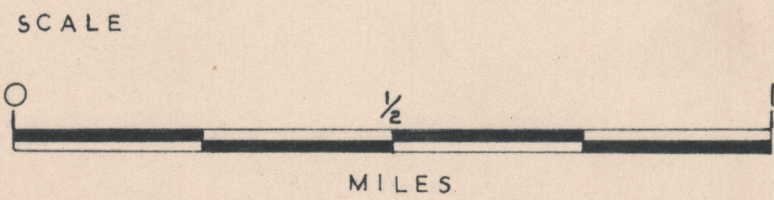
TO CAPE JERVIS

TO ADELAIDE

TO VICTOR HARBOR



-  Flaggy Limestone
-  Black Carbonaceous Slates and Phyllites with Phosphate Nodules
-  Greywacke  
Grey Phyllites  
Actinolite Segregations  
Hornblende
-  Banded and Bedded Sub Greywacke and Feldspathic Sub Greywacke
-  Dark Calcareous Slates and Phyllites
-  Non Calcareous Slates and Phyllites, often Ferruginous and interbedded with thin Sandstones  
Thicker Beds of Sandstone
-  Arkose
-  Massive Greywacke
-  Laterite
-  Approximate Rock Boundaries
-  58 Sample Number



# STRUCTURAL MAP OF THE TALISKER MINE AREA

T.N.  
↑

TO CAPE JERVIS

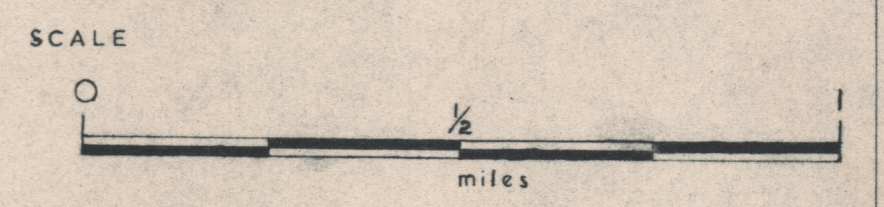
TO ADELAIDE

TO VICTOR HARBOR



West of X-X  
Foliation-Bedding  
2-5-10-15-20 %  
Lineations  
5-10-20-40 %

- 70 Strike and Dip of Foliation
- 60 Strike and Dip of Bedding
- 35 Lineations
- Generalized Traces of Form Surfaces
- Laterite Boundary



Whole Area  
Foliation-Bedding  
1-5-10-15-20-25 %  
Lineations  
25-5-10-15 %

East of X-X  
Foliation Bedding  
1-5-10-15-25-35 %  
Lineations  
4-10-15-20-30 %

