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PROGRESS REPORT OF GEOLOGY

PLUMBAGO 1:63,360 MAP AREA

by

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GEOLOGIST
REGIONAL MAPPING SECTION

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PROGRESS REPORT OF GEOLOGY PLUMBAGO 1:63,360 MAP AREA

ABSTRACT

The Plumbago 1:63,360 sheet has been mapped on a scale of one inch represents 60 chains as part of a programme for the production of the Olary 1:250,000 sheet. It is an area where Adelaide System rocks are faulted against, or transgressive onto the block faulted crystalline basement of the Willyama Block. The oldest Adelaidean rocks present belong to the Burra Group and are preserved in tongues around the Weekeroo inlier. Elsewhere, close to the inlier the Yudnamutana Sub-Group is exposed while further away, the sequence passes up into the Farina Sub-Group. The youngest Precambrian unit present on the sheet is the Tarcowie Siltstone.

A number of units have been recognised in the Willyama Complex. To the southeast, some of these units outline fold structures. However, the Willyama complex which outcrops near Plumbago H.S. is almost entirely granitoid and major structures cannot be seen of the original rock types, only the remnants of "resisters" remain.

The structures of the Adelaide system on the eastern half of Plumbago are controlled in part by the underlying basement blocks. Folding on the western half is concordant with that of the Lofty-Olary Arc elsewhere on the OLARY 4-mile sheet.

INTRODUCTION

PLUMBAGO has been mapped as part of a programme for the production of the OLARY 1:250,000 sheet. The boundaries of Plumbago are latitudes 32°00' and 32°15' south, longitudes 139°30' and 140°00' east.

No townships are present on the sheet, however, Yunta (population 180) and Mannahill (population 100) are 25 miles and 12 miles respectively south of the southern map border. Both towns are on road/rail links between Broken Hill and Peterborough.

Three pastoral properties, Mt. Victor, Plumbago and Weekeroo occupy the major portion of the map area. The stations of Morialpa, Koonamore and Glenorcy adjoin on the southwestern and northern sides. These stations are concerned almost exclusively with sheep grazing, as the continental climate, with large diurnal variations of temperature and scattered infrequent rainfall renders the area suitable for little else.

Prospecting and mining activity in the region has been intermittent. From ca. 1885 to 1910 alluvial and reef deposits on the Teetulpa and Nillinghoo Goldfields were worked (Brown, 1908 and 1887). At the turn of the century the Ethiudna Mine yielded copper and cobalt. Recent activity, exclusively within Willyama Complex rocks, includes work by Electrolytic Zinc Co. of A/Asia Ltd. in the Crocker Well - Mt. Victoria area, and Petrocarb Ltd. at the Ethiudna Mine. Minor beryl, feldspar and sillimanite shows near Weekeroo Hill are also worked intermittently.

The region mapped represents an area where Torrensian Sturtian sediments of the Adelaide Geosyncline, forming part of the Mount Lofty - Olary Arc (Campana, 1955 (a)) lap against the westernmost outcrops of Willyama Complex rocks.

PREVIOUS INVESTIGATIONS

The first published work on the area is that of Brown (1887, 1908). This was concerned largely with the geological setting and production of the Teetulpa and Nillinghoo Goldfields. Subsequently Mawson and others published material on basement geology and 'tillites' to the east, mainly on Outalpa. References to these may be found in Campana and King (1958).

The discovery of uranium ore deposits in the Olary Province in the 1950's resulted in publication of a large number of papers. These include, on the tillitic sequences, Campana (1955 (a) and (b)), and on the uranium mineralization, Campana (1954), King (1954(a)), (1954 (b), Smith (1955), Sprigg and Seedsman (1951) and Whittle (1954, (a) and (b). The major work of this period was Campana and King (1958), which gave the first comprehensive picture of the regional geology and recognised the major units of the Burra Group and overlying glacigene sequences, as well as certain subdivisions of the Willyama Complex.

Talbot, in 1967, published a study of a small area north of Mannahill, which was basically a summary of an unpublished Ph.D. thesis completed in 1962. He recognised six main units within the crystalline basement and several major structural features. The latter comprised an antiformal structure the layering of which is transposed bedding (S_1). In the more schistose units, axial foliation (S_2) has been developed by the folding which resulted in the antiform. He also noted the presence of two major periods of pre-Adelaidean metamorphism, the first of lower amphibolite grade, and the second, a retrogressive phase to biotite grade. This is somewhat similar to the pattern noted at Broken Hill (Vernon, 1969).

Further work has been done on the Weekeroo area by members of the Geology Department, University of Adelaide. This includes some unpublished theses (such as that of Talbot (1962) and a paper by Jones, Talbot and McBriar (1962) on structures within the amphibolite bodies.

Prospecting work by Electrolytic Zinc Ind. Ltd. on S.M.L. 118 (Crockers Well-Mt. Victoria are) has resulted in a number of consultant and company reports which detail mineralization, geology, petrology and geophysics of the major prospects within the S.M.L. Main reports of interest to the Plumbago sheet are: Liverton (1967), Johnson (1968 (a) and (b).

The present investigation took place during the second half of 1970, and is now (January 1971) being extended eastwards across Outalpa. Geology and topographical information was plotted on 1":60 chain black and white aerial photographs and transferred to 1":60 chain transparency base maps. Colour photographs (SVY1211) on a scale of 1:83,000 were also available and proved useful, particularly regarding Quaternary units: however, the difference in scales detracted from their usefulness to some extent.

PHYSIOGRAPHY

Plumbago covers a northeastern portion of the Mount Lofty-Olary Arc the physiographic expression of which, on the Olary four mile sheet, is a wide range of hills composed largely of Adelaidean rocks, separating the Frome Embayment and Murray Basin.

The map area may be subdivided as follows:- (See Figure 3).

1. A central basin or lowland of Quaternary - Recent cover, quartz gravels and alluvium, with rare hard rock outcrops.

Also included are two low mesas, beside the major watercourse, and rising about 40-50 feet above plains level. They are capped with fine calcreted gravels and buckshot, possibly older than the Telford Gravel.

2. Surrounding unit 1, to the south and southwest erosion of the relatively soft beds of the Farina Sub-Group result in a gently undulating topography. Outcrop is usually poor and the hills are covered, except on the crests, with a thin veneer of alluvium.

3. Bolder relief is provided by the Yudnamutana Sub-Group, Burra Group and Willyama Complex rocks. The massive quartzite beds common to these units result in prominent strike ridges hundreds of feet above plains level. Willyama Complex rocks typically result in a characteristic wooded, rugged terrain.

The relief varies from a general plains level of 900 to 1100 feet above sea level to the peaks of Mt. Victor (1522 feet) and Weekeroo Hill (1865 feet).

Drainage of the area is primarily into the Frome Embayment. Over the major portion of the sheet it is therefore to the north, while the area around PlumbagoH.S. is drained to the northeast. The pattern of drainage is generally irregularly dendritic; however, on outcrop of Tapley Hill Formation a trellis pattern is developed, with subparallel second and third order streams. Major water courses (fifth and sixth order) are commonly wide and braided.

STRATIGRAPHY

WILLYAMA COMPLEX

Five of the following Willyama Complex units are those as defined by Talbot (1967). The application and future use of these and the other units is discussed at the conclusion of this section.

Anatexites

A unit termed 'Anatexites' has been informally used for the large body of often porphyritic and occasionally foliated, granitoid rocks in the Plumbago H.S. area. Most of these granitoid rocks contain sedimentary calc-silicate and marble beds (and intrusive amphibolites) and it is apparent that the granitoid rocks, when bearing relatively undisturbed metasedimentary beds, have not been intrusive. As these rocks closely fit the description of anatexites given by Mehnert (1968, p. 353) this convenient term is used for the present.

It is likely that the intrusive granites in the area are merely mobilized representatives of the anatexite-large (up to 7m across) xenoliths of calc-silicate rocks have been noted, e.g. at Tombstone Hill. For this reason, and also because of the similarity in the granite/anatexite lithologies, the boundaries of the intrusive granites are difficult to map.

The alaskites and adamellites of Crockers Well are more easily delineated. A full description of them may be found in Campana and King (1958, p. 25).

Leucogneiss

This unit forms the centre of the antiform southwest of Weekeroo Woolshed (See Fig. 5) and consists primarily of leucocratic gneisses with minor schists. Layering is assumed to be singly transposed bedding and is designated S_1 (bedding is designated S_0) The upper boundary (with the overlying migmatitic schists) is particularly sharp. Below this, in turn, are well developed migmatites (photo 7), then granofelses and gneisses which form the core. The gneissic layering outlines the antiform which is

inferred to be a second generation (F_2) fold structure, layering being developed during the first folding, F_1.

Migmatitic Schist

The lithology of the migmatitic Schists is invariably a schistose rock, injected by pegmatites (up to 10 cm wide and 1 to 2 metres long) which are now seen as schlieren (photos 5 and 6).

The unit overlies the leucogneiss and outcrops around the core of the antiform.

Foliation of the schist trends approximately 055°, but the pegmatites are isoclinally folded indicating that an S_2 axial plane foliation is developed in the more schistose lithologies, whereas the pegmatites, which effectively represent relict fold hinges, have survived the second folding without being transposed.

Granitoid Gneiss

The term granitoid gneiss is used here to indicate a medium to fine grained, leucocratic, equigranular rock of metamorphic origin and granitoid appearance. Layering is poorly developed or absent.

This gneiss is found in a strip of country to the north of and in contact with, the Migmatitic Schis Unit.

To the east of Weekeroo Woolshed, Talbot mapped a large area as 'granitoid gneiss', though he expressed some reservations about this (Talbot 1967, p. 48) (see Fig. 5). This region in fact

consists of a heterogeneous assortment of rock types from the granitoid gneisses described above to migmatites and magnetite schists. Some mapping by the present writer east of Weekeroo Woolshed has shown that this "granitoid gneiss" may be subdivided into a number of the units discussed in this section. Mapping of this eastern portion of the Weekeroo Block is at present (Jan.,1971) incomplete.

Layered Gneisses and Schists

This unit consists predominantly of layered quartz-rich schists, gneisses and migmatites, with large pegmatites parallel to the meso-and microlayering. Alternating with these are layers of aplitic, leucocratic granitoid gneiss.

Within the gneissose rocks, layering has been maintained parallel to the S_1 structure surface, however, in the more schistose portions, an S_2 crenulation is developed (see Photo4).

Typical mineralogy is as follows quartz, plagiocalse, K feldspar, acessory sphere, zircon and apatite.

Mica Schist

The base of this unit is gradational over 50 m., but has proven relatively easy to distinguish from the underlying unit Layered Gneisses and Schists) due to its lower content of gneisses and pegmatites. Lithologically it consists of a fairly homogeneous silvery to bronze coloured, even grained mica schist. Pegmatites (quartz-feldspar) are common and range in size from a few metres to hundreds of metres in length.

The unit outcrops to the north and west of Weekeroo Woolshed

and has a well defined foliation trending 040° to 065°, which dips steeply southeast.

Talbot describes the mineralogy as quartz, muscovite, minor feldspar, biotite and/or chlorite, garnet and tourmaline with relict andalusite.

In the northeastern corner of the sheet a golden coloured coarsely crenulated mica schist occurs as a number of bodies some 50-300 m across, interlayered with a coarse leucocratic (pegmatitic or quartzofelspathic) rock, up to 100 m. across. Though included in the Mica Schit unit, these schists are not likely to be equivalent to those at Weekeroo. They are possibly melanocratic differntiates developed by the high grade metamorphism of the Plumbago Block (?restites; Mehnert, 1968, p. 356, 298).

Bedded Mica Schist

This unit is present on the northern side of the Weekeroo Block. It is a red-brown weathering sandy granofelsgrading with increasing mica content to a sandy micshist . Occasionally clean quartzite beds are present, commonly with large (10-20cm) cross-bed foresets. Also, within the more granofelsic layers sedimentary structures have been observed. They consist of crossbedding, small scale scours and what appear to be truncated slump folds (approx. 8 cms. to 14 cms across) (Photos 1,2 and 8).

The unit is intruded by large pegmatites which, with the macrolayering of the granofels, results in a distinctive structure visible on aerial photos.

The upper boundary of the unit is invariably the "Grand Unconformity" of Mawson (Campana and King, 1958, p. 31) with the low grade metasediments of the Adelaide System. The lower boundary is easily recognisable on aerial photographs but is poorly defined on the ground.

Worthy of note is the fact that amphibolite (metadolerite, Campana and King, 1958, p. 27, Talbot, 1967) dykes have been observed by the writer in all units above the Leucogneiss, expect for the Bedded Mica Schist.

Possible Unconformity

Between the Mica Schist and Bedded Mica Schist Units, Talbot suggests the presence of an unconformity. Similar ideas have been entertained with respect to some low grade schists (with sedimentary structures) and low grade metamorphics in the Broken Hill area (Bijerkerno andWonominta Beds: Rose, 1968).

Some points in favour of Talbot's suggestion are as follows:-

1. Marked change of character across the boundary of the two above-mentioned units, visible on aerial photographs.
2. Absence of amphibolite dykes in the bedded unit, as discussed above. Further more, one dyke appears to cut off abruptly fairly close to the contact.
3. Presence of sedimentary structures in the bedded unit, and retention of bedding in general, butabsence of the same elsewhere. Furthermore, the Bedded Mica Schist, "Kalabity Series", Bijerkerno and Wonominta Beds are all of a markedly lower metamorphic grade than the remaining Willyama Complex.

4. Variation in character of the pegmatites. In the bedded unit pegmatites are almost invariably large (tens of metres thick) sill-like bodies, persistent along strike for hundreds of metres. In the underlying Mica Schist unit, however, there is a greater variety of sizes, from small schlieren-like bodies to large sills, though the country rock is fairly homogeneous. This would possibly suggest that pegmatites in the bedded unit are generally intrusive and that the grade was never high enough to develop pegmatites in situ. In contrast, the presence of small lenses of pegmatitic mobilizates in the Mica Schist may indicate that the grade was somewhat higher.

Samples from both units were submitted to Amdel (p701/70 and p702/70) for petrological examination to establish, if possible, any differences in metamorphic histories. No definitive results were obtained (see Appendix I), however both samples may be suitable for Rb-Sr dating.

THE WILLYAMA COMPLEX: DISCUSSION OF STRUCTURE AND METAMORPHISM

The mapping of Willyama Complex rocks on Plumbago has enabled a revision of the units of Campana and King (1958) to be commenced and has resulted in a more comprehensive subdivision of the complex. The work of Talbot (1967) in the Weekeroo area had shown that a fairly detailed subdivision may be made in localized areas, and in the mapping of Plumbago his units were used in the original area with the hope of subsequently applying them elsewhere. The extension of the work to Outalpa (to be described in a later report) has resulted in considerable modification of some of Talbot's Weekeroo units and the elimination of

others e.g. Migmatite Schist, which appear to be local variants and are not common overall. Talbot's subdivision has, however, provided a sound basis for the present development of units suitable for use over wide areas of crystalline basement. His distinction of two schist units on the basis of presence or absence of sedimentary structures is considered to be important.

Outcrop of Willyama Complex on Plumbago may be divided into two main areas which are informally named the Weekeroo and Plumbago Blocks. Both may be further subdivided into a number of "sub-blocks" (see Fig. 5) on the basis of shearing and possible rotation within the blocks.

The lithological distinction between the two major blocks is quite marked. To the south the Weekeroo Block consists of alternating schists, gneisses, migmatites and granite-gneisses. It is subdivided into three portions (East, Central and West). The western sides of these sub-blocks are in sheared contact with Adelaidean sediments while the eastern sides are in sedimentary contact. This tectonic pattern is also found on Outalpa (to the east of Plumbago).

Differences in axial plane trends and certain fold structures in the bordering Adelaidean sediments may indicate that these sub-blocks have been rotated relative to one another. In contrast to the shears bordering and within the Plumbago Block, those at Weekeroo are rarely straight, and this may be a reflection of the movements of sub-blocks. Preservation of Burra and lower Umberatana Groups in synclinal tongues (the eastern limbs of which are partially sheared out, as described above) extending onto the basement, indicates that in post-Torrensian and post-Sturtian times the

basement, as well as being sheared, also was folded to some degree. The facility with which an apparently stable crystalline block was folded is largely due to the relative incompetence caused by the interlayering of schists and granitoid rocks.

By contrast the Plumbago Block is almost entirely granitoid, consisting of porphyritic anatexites, intrusive granites and late stage intrusive granitoid rocks such as alaskites and adamellites.

Lineaments (assumed to be dislocations) are straighter and far more regular than those on the Weekeroo Block. This reflects the greater competence due to the homogeneous granitoid nature of the block and may indicate that the Plumbago Block was not affected by the post-Torrensian and post-Sturtian folding movements. Some generalized lineaments of the block are shown in Fig. 5. For a more detailed picture of the lineament pattern the reader is referred to Johnson (1968 (a)., Fig. 1 and 2). Johnson shows three major sets, which are oriented respectively northwest, northeast and west-northwest.

The subdivisions of the Plumbago Block are quite distinctive (Fig. 5). The Crocker and Mt. Victoria Sub-blocks have large amounts of granitoid intrusives and are uraniferous. On the other hand the Ethuidna Sub-block is cupriferous and contains very few such intrusives. As there is no gradation in zoning between these two areas, relative movement by shearing is suggested. The Ethiudna area represents country rock which has been metamorphosed almost to the point of anatexis, resulting in porphyritic granitic-looking rocks which are not intrusive and for the present are termed

anatexites (Mehnert, 1968, p. 353).

Sedimentary calc-silicates and marbles are present in the Ethiudna Sub-block (the Ethiudna Calc-Silicate Group of Campana and King (1958, p. 6), but are absent to the northwest. The preservation of these "resisters" (Mehnert 1968, p. 278, 298) shows that the anatexites have not been mobilized to any great extent.

The absence of the Ethiudna Calc-Silicates at Weekeroo prompted Talbot (1967, p.55) to reject it as a valid stratigraphic unit.

However, on the extreme east of the Weekeroo block some calc silicate-bearing hornfelsic beds were noted by the present wirter, and these may be related to the Ethiudna Group.

Generally over the OLARY 4-mile sheet the Ethuidna-type calc-silicates occur in low grade schists and commonly in the vicinity is found an iron formation (e.g.) Putts Well and Meningie Well areas on Outalpa and also south of Plumbago H.S. on the Ethiudna Sub-block). It would seem then that Ethiudna, and for example the Meningie and Putts Wells areas are approximately equivalent stratigraphically. The great difference in country rock lithologies (anatexites versus schists) may be due to a number of variablefactors - the primary one would be of course a much greater metamorphic grade. However, facies changes of original sediments, variations of water content, depth of burial and degree of premetamorphic folding are all factors which should be considered as these all affect the apparent degree of metamorphism.

In summary, then, it appears that the Willyama Complex of Plumbago has been broken up by a northwest-north east faulting pattern which has initiated block movements, bringing different portions of the sequence, originally at different depths, into juxtaposition.

ADELAIDE SYSTEM

BURRA GROUP

Sediments of the Burra Group have been recognised in three areas on Plumbago: within five tongues which extend onto the Weekeroo Block, on the north side of Mt. Victor, and four miles E.S.E. of Plumbago H.S.

In the Mt. Victor-Kirkeeks area a sequence of ripplemarked crossbedded clean quartzites, overlain by dolomitic shales and dolomites is exposed in the core of an anticline. On the limbs it is overlain by Appila Tillite, and at Mt. Victor itself there is an exceptional exposure of the Torrensian-Sturtian unconformity (see frontispiece, Fig. and Photo 11).

Around Weekeroo the Burra Group is in both sedimentary and faulted contact with the basement. Near the base is a dolomite-magnesite sequence which sometimes has a fragmental structure and is considered to be equivalent to the Skillogalee Dolomite (Mirams and Forbes, 1964; Wilson, 1952). This is the most easily recognised Burra Group unit. Underlying conglomerates, minor shales and sandstone may be correlated with the Rhynie Sandstone.

Above the Skillogalee equivalent is a sequence of shales and phyllites, a possible equivalent of the Woolshed Flat Shale or the Myrtle Springs Formation, followed by a clean crossbedded quartzite. A similar quartzite occurs at the other two regions of Burra outcrop, and these are considered to be equivalent. Folding of the beds in the N.E. Weekeroo tongue has caused considerable thickening of portions of the sequence, which, in turn, results in difficulties in interpreting the sequence in terms of units defined elsewehre. It would seem at present, however, more prudent to consider the Burra Group in this area separately from the sequences to the west and southwest, which are well within the geosyncline. This is partly because it is doubtful if one can expect a formation to maintain its unity over the length and breadth of a geosyncline, as well as out onto the marginal area, which is strongly influenced by an underlying basement block.

As a result a correlation erected under these conditions may be quite artifical and the defining of new units, if need be, for these marginal areas would be preferable.

UMBERATANA GROUP

Appila Tillite

The Appila Tillite (Segnit, 1939; Mirams, 1964, p.17) is the lowermost unit of the Umberatana Group and as such its base marks the Burra-Umberatana unconformity. The formation typically consists of a bouldery, pebbly or gritty indurated siltstone, the matrix of which is a light grey or greenish-grey in colour. The character of the tillites is however highly variable, as shall be discussed below.

The presence of a relatively stable block of crystalline rocks has had a marked modifying influence on the formation and it would seem likely that the crystalline areas formed major positive areas during glaciation.

A few examples will serve to illustrate the lithology and variability of the unit.

Mt. Victor: The Mt. Victor Range is formed by a ridge of Wilyerpa Formation quartzite capping a sequence of Burra Group, and lower Yudnamutana units. The sequence is very well exposed, in particular the sub-Willyerpa and sub-Appila unconformities.

The Appila Tillite overlies Burra Group (Photo 11) with apparent disconformity. The basal portion of the Tillite appears truly tillitic, with clasts ranging from grit-size (generally monomineralic) to boulder size. Fragments above

a few millimetres in diameter are of greenish phyllites, a variety of quartzites and laminated buff-weathering dolomites - all typical Burra Group lithologies from that vicinity.

Cross-bedding in the tillite matrix is common, indicating the presence of fluvial action and that some reworking of the bouldery detritus has probably taken place.

Higher up in the unit erratics are more sparsely scattered and somewhat better sorted. Near the top of the unit, the tillite becomes slightly ferruginous and contains interbedded quartzites with occasional cross-beds. The latter may be interpreted as representing coastal or fluvioglacial phases adjacent to the glaciated region.

Plumbago: One mile south of Plumbago H.S. the Appila Tillite outcrops with a thickness of 200m. in contact with crystalline basement. It is represented by a fairly homogeneous bouldery unit with clasts of granitic and migmatite material, layered calcsilicates and (?)Burra Group siltstone, ranging from less than 1mm. to 1.5m. across. The presence of minor silty lenses indicate some fluvioglacial action and allow the determination of a dip.

North of Weekeroo: In the northwest of the four major tongues of Adelaidean sediment in the Weekeroo area, the tillite consists of rounded erratics of crystalline basement and typical Burra Group lithologies, in an unstratified matrix. Eastward along strike it slowly grades to a flaggy grey indurated siltstone with a highly variable erratic content, due north of the Weekeroo Woolshed. Further east, beside the Whey Whey Creek, it again appears as a true boulder tillite. Interbedded hematitic

siltstones are here overturned, dipping 80° towards the basement block.

The terming of the unit a "tillite" is somewhat misleading to those unfamiliar with the Umberatana Group, since by definition it means a lithified till. However, the unit varies in facies from morainic deposits near basement areas to basinal non-glacial silts with rare (?ice rafted) erratics. Furthermore, the distincition of turbidites from tillites poses considerable problems. For this reason it is suggested that the Appila Tillite be renamed the Appila Formation.

Benda Siltstone

Benda Siltstone (Forbes, 1970) has been recognised in the sequences at Mt. Victor, south of Plumbago H.S. and on the northern side of the Weekeroo Block. In all cases the unit shows considerable erosional thinning, and is unconformable with the overlying Wilyerpa Formation.

The unit is typically developed as an indurated, sometimes calcareous, flaggy dark siltstone with grit bands and scattered erratics principally of Willyama rocks. Quartzites are more poorly developed than in under-or overlying formations.

In the vicinity of Mt. Victor the Benda Siltstone varies from about 50 meteres thick at the eastern end to nil at the western end, where Wilyerpa Formation rests directly on Appila Tillite (see frontispiece). In this area haematitic siltstones (? equivalent to Braemar Iron Formation) are also present. Usually they are of low iron content, though at one locality the siltstone had been brecciated and contained some 30% of coarsely micaceous haematite (flakes about 1-1.5cm. across).

Sequences south of Plumbago and north of Weekeroo are essentially similar. They consist largely of hard, medium grey-brown weathering indurated siltstones, occasional quartzites, rare erratics and grit bands.

Haematitic siltstones considered to be equivalent to the Braemar Iron Formation (Mirams, 1962, p. 7 and Appendix 1 and 2) occur in the lower part of the Benda. They are generally quite thin (never more than 10m. thick) but markedly persistent. (On Outalpa, a 15cm. thick bed of iron-rich siltstone persisted for some miles.)

Wilyerpa Formation

Wilyerpa Formation (Mawson, 1949; Dalgarno and Johnson, 1964 p.19) rocks lie unconformably upon older units ranging from Benda Siltstone to Burra Group and possibly crystalline basement as well. It outcrops over an extensive area south of Plumbago H.S. and also west of Mt. Victor Woolshed.

North of the Weekeroo Block it consists essentially of a pebbly dolomitic phase followed by indurated siltstones with a low but variable erratic content underlying a thick quartzite sequence which forms the core of a wide, open synclinal keel.

Elsewhere the sequence is quite dissimilar, such as south of Mt. Victor or west of Hughes prospect. These sequences consist of massive quartzite bands alternating with siltstones and overlain by a boulder bed. Four miles north-northwest of Hughes' Prospect, the latter, as pebble and boulder tillite attains a thickness of at least 300 metres, yet four miles downstrike it grades into a considerably thinner erratic-bearing siltstone.

Tapley Hill Formation

Siltstones of the Tapley Hill Formation (Coats, 1964; Mawson and Sprigg, 1950) cover an extensive area over the south-central and southwestern portions of Plumbago. They form broad open folds and generally outcrop is quite poor, except west of Mt. Victor H.S. The typical lithology is a blue-grey laminated siltstone which is tough, indurated and has a siliceous appearance. Thin bedding and lamination is visibla almost invariably both on fresh and weathered surfaces and ranged from 1mm. to 5cm. thick within a single outcrop. Flame structures and fine scale crossbedding are common where layers of sandier material are present. In areas of poor outcrop the siltstones are shaly and comparatively soft with laminations visible on fresh surfaces.

Limestones are present west of Mt. Victor H.S. though pure limestones are rare - in general they either contain 30-35% quartz granules, or else numerous lenticules, possibly compacted galls of calcareous material with a different clay content (and hence solubility) to the matrix. The Tindelpina Shale Member (Coats, 1964) has been recognised overlying the Wilyerpa Formation in several areas, but it cannot be traced over the full length of the Wilyerpa-Tapley Hill boundary on the northern and northwestern side of the Weekeroo Block.

Tarcowie Siltstone

Only the lower portion of the Tarcowie Siltstone is present on the sheet. It occurs as the core of a synclinal keel six miles south of Mt. Victor, forming a low range of hills surrounded by the less resistant laminated siltstones of the Tapley Hill Formation.

It is typically indurated, medium grained sandstone which exhibits spheroidal weathering and contains rare silty or dolomitic beds. Dips are generally less than 15° and none greater than 20° were recorded. Near the base of the sandstones are dolomites. Occasionally these may be sandy or have a brecciola structure. This agrees well with observation of the lower Tarcowie Siltstone made by Cramsie (1968, pp9-10) on Winnininnie.

The Tarcowie-Tapley Hill boundary is difficult to map particularly on the western side as it is obscured by the Qca (calcrete) and Qrs (sand) which veneers a large proportion of the surrounding Tapley Hill Formation.

QUARTERNARY

Within the Quaternary cover, five mapping units have been recognised. In order of decreasing age, these are: Qca, calcrete (? of Bakara Soil); Qrt, plains and slope alluvium; Qpp, Pooraka Formation; Qrs, loose sands; and Qra, river alluvium.

Qca: this is a thick bed of calcrete which occurs over a wide area as far east as Gum Lake and as far south as Winnininnie Dam. Its absence in the eastern and southeastern basement areas is marked, and may possibly be due to the lack of carbonate in the sandy soils.

In some places the edge of calcrete outcrop is represented by a scarp of very low relief. Elsewhere it may be at the same level as the surrounding Qrt or Qrs, but a change of vegetation and colour renders it distinctive both on the ground and on aerial photographs (both black-and-white and colour).

The calcrete is present in two forms:

1. As a loose nodular surface rubble, and
2. As a solid pink material which shows a complex brecciated and recemented structure on a fresh surface.

Included in this unit are two minor outcrops of high level gravels, cemented by calcrete.

Qrt: This has been mapped essentially as defined by Cramsie (1968, p. 17): "alluvium and colluvium of slopes and plains above present creek level."

It consists of reddish sandy silts with pebbly layers with a typical surficial cover of white, angular reef-quartz gravel.

One or two feet below the furface, a Loveday soil profile has commonly been observed, but is not seen in the red silty sands of the north-eastern granitic areas (the reason for this is presumably, as with calcrete, the low carbonate content of the soil). On the assumption that Loveday mottling reflects the presence of Pooraka Formation, it would seem that Pooraka underlies most areas mapped as Qrt.

Qrs. This unit consists of yellow - red sands occurring on the south side of Mt. Victor Range and adjacent to this around the Nillinghoo Goldfield.

Qra: This is limited to the alluvium of the wide, often braided watercourses and lake beds.

In the present work colour photos have proven particularly useful in the delineation of these units as they reflect clearly the change of soil colour and vegetation colour and density. In fact, it has been found that where bedrock subcrops at shallow depth, particularly onslopes, the colour photos emphasize surfical cover at the expense of "hard rock" outcrop.

ECONOMIC GEOLOGY

Deposits of economic interest in the area have been those of gold, copper and cobalt, and more recently uranium and some rare earths.

The discovery of the first major goldfield in the area, that of Waukaringa, stimulated widespread prospecting activity which resulted in development of Teetulpa and Nillinghoo goldfields, in 1886 and the early 1890's respectively.

The Teetulpa field lies on the southern margin of the map area and extends onto Winninninnie (Cramsie, 1968). The major portion of gold was won from alluvial workings, but a considerable number of shafts were sunk on higher ground. Country rock in the area is east-west striking calcareous siltstones and slates of the Tapley Hill Formation. Details of this and other fields is to be found in Brown (1908).

Some years later gold was discovered northwest of Mt. Victor at the so-called Kirkeeks Treasure mine and from this, the Nillinghoo field developed. Here, the quartz-ironstone reefs occur in quartzite and hard siliceous shales that are "striking east and west, and tilted up into an anticlinal arch" (Brown, 1908, p. 256). The country rock is considered to be Burra Group. Occasionally work at Kirkeeks is revived, but without encouraging results.

Elsewhere, past activity has been concentrated on copper prospects. The major occurrence is at the Ethiudna (New Year) mine. Four main shafts were worked from 1889 to 1908, with chrysocolla as the major ore mineral, and accessory copper, cobalt, tungsten and nickel minerals. There are other minor prospects such as Hughes' and Mitchell's. The former is located at the boundary of a large amphibolite body. The ore is

principally azurite with some malachite.

Crocker Well and Ethiudna are the foci for present activity. Since 1968 Petrocarb Expl. N.L. have been engaged in exploratory work at Ethiudna, and a small smelter has been recently (Oct. 1970) installed.

The Crocker Well deposit was discovered during a radiometric survey in 1951. Subsequent work is described by Campana and King (1958). The principal radioactive minerals are davidite and absite.

In 1966 E.Z. Ind. Ltd. obtained a Special Mining Lease over the area and have been conducting exploratory work there since.

Non-metallic deposits are few. King (in Campana and King, 1958 p.114) notes two fluorite occurrences a short distance southeast of Plumbago H.S., one of which was worked from 1932 to 1936 to produce nearly 600 tons of fluorite.

In the crystalline basement west of the old Plumbage road, sillimanite, feldspar and beryl are quarried occasionally.

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REGIONAL MAPPING SECTION

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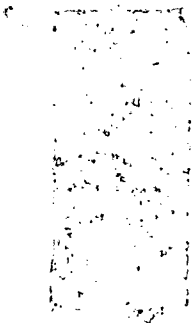
The hospitality and assistance of Mr. D. Parish of Mt. Victor Station, Messrs. B. Baker and D. Crawford of Plumbago H.S., and Mr. D. Boucher of Petrocarb N.L. is gratefully acknowledged.



PHOTOGRAPHS

Photos 1 - 9 Willyama Complex rocks

Photos 10 - 13 Yudnamutana Sub-Group rocks

(See locality map for phtograph and thin section locations).

Photo 1: Bedded Mica Schist Unit, Weekeroo.
Fold structures (?sedimentary) in sandy quartzite. No.21204

Photo 2: Bedded Mica Schist Unit, Weekeroo.
Foresetting in quartzite. No. 21203

Photo 3: Layered Gneiss Unit, Weekeroo.
Folding of interlayered gneissic and schistose bands No.21212

Photo 4: As above, closeup of formation in Photo 3.
Note preservation of S_1 layering in the gneiss, and development of axial plane crenulation (S_2) in the schistose layers.
No.21213

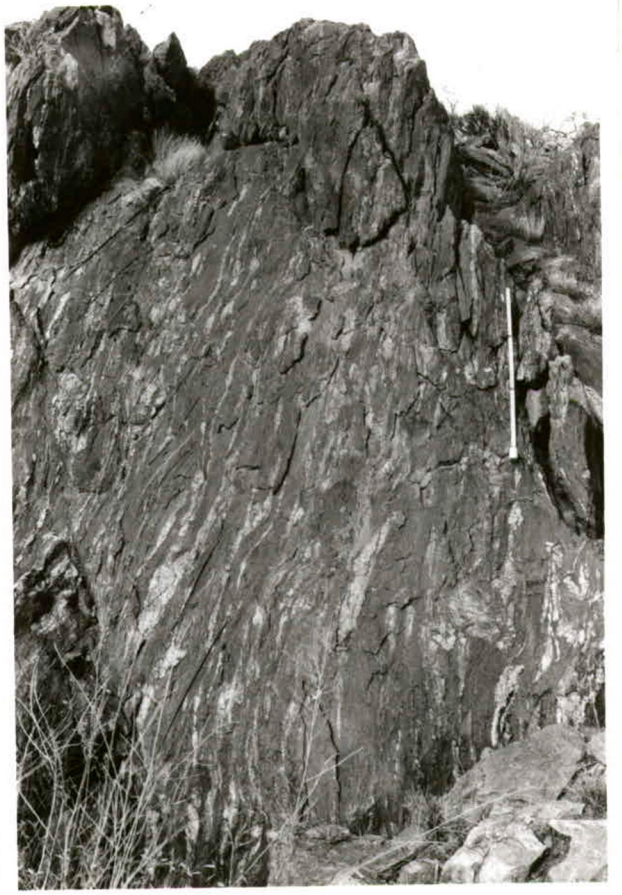


Photo 5: Typical lithology in the Migmatitic Schist Unit, Weekeroo. No. 21223.

Photo 6: Closeup of formation in Photo 5. Note isoclinal folding of pegmatite schlieren. No. 21224.

Photo 7: Typical migmatite from Leucogneiss Unit, Migmatite Subunit, Weekeroo. No. 21221

Photo 8: Bedded Mica Schist Unit, Weekeroo. Scouring and crossbedding in micaceous sandstone. No.21219

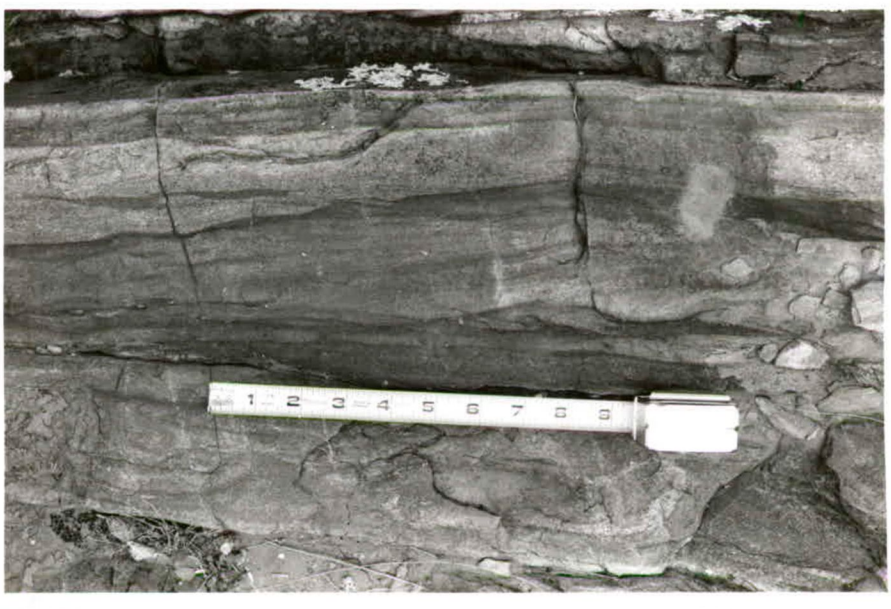


Photo 9: Layered epidote-garnet quartzite from Mindamereeka Hill, Plumbago. NO. 21222.

Photo 10: Basal conglomeratic horizon (?tillitic), equivalent to Appilla Tilltie. Note large angular boulder of layered gneiss. (from Slide No. k/7, 8956.)

Photo 11: Contact between Burra Group dolomite and Appila Tillite at Mt. Victor. No. 21205.

Photo 12: Large boulders of crenulated mica schist and quartzite in boulder tillite (Appila Tillite). The nearest known source is some 10km. away.

(from Slide No. K/7, 8946).

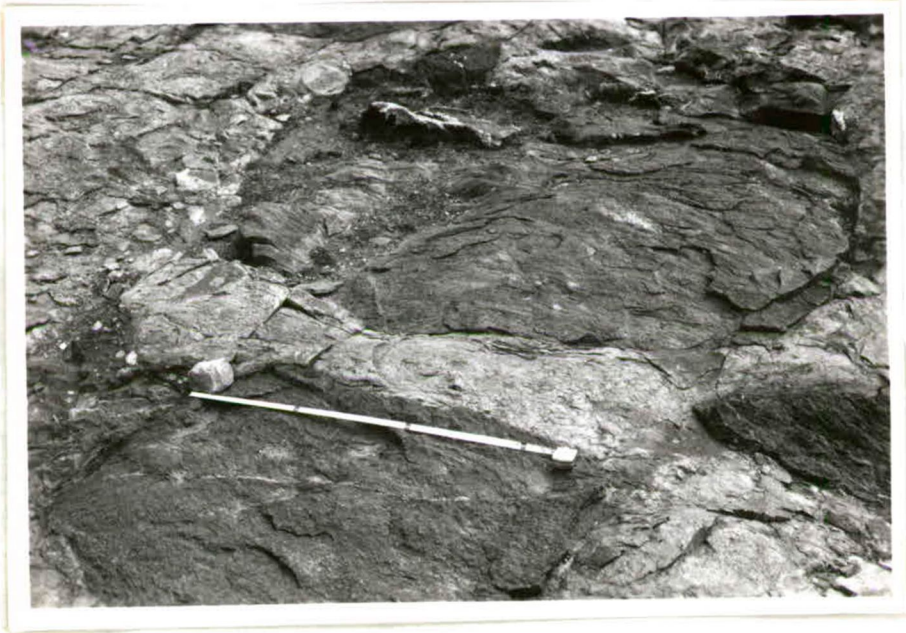


Photo 13: Tillite with a dolomitic matrix, (pebbles are exclusively from the Willyama Complex.) Although the formation appears to rest directly on Willyama Complex granite-gneiss, it is believed to be part of the Wilyerpa Formation. (from Slide No. K/7, 8951).

APPENDIX I

Summary of Amdel petrological reports on specimens from the Plumbago 1-mile sheet.

Report 481-71

Investigation and report by P.J. Simpson and B. Collins.

p. 357/70

Location: Adjacent to the Crocker Main Shear.

Rock Name: Sheared leuco-granodiorite.

p.358/70

Location: Adjacent to the Crocker Main Shear.

Rock Name: Sheared (?) tonalite.

A banded medium grained rock consisting of plagioclase, biotite muscovite, quartz opaques and leucoxene. Plagioclase comprises 70-75% while quartz is only 2-3%. The rock appears to be dacitic with a dynamic metamorphic overprint.

p.359/70

Location: Within the Crocker Main Shear.

Rock Name: Amphibolite (metadolerite).

This rock consists of hornblende and Albite-twinned plagioclase of andesine composition. It is considered to be a sheared, regionally metamorphosed basic intrusive.

p.362/70

Location: Within the Crocker Main Shear.

Rock Name: Quartz-muscovite-biotite schist (phyllite).

A foliated rock, which consists of parallel orientated micas enclosing 'eyes' of quartz.

p.360/70

Location: 1 mile west of Marsh's Well, Mt. Victor Station.

Rock Name: Sheared ?adamellite.

The rock is poorly foliated and shear planes are common; a gneissic texture is present. Crystals are often broken, and subsequently "healed". Extinctions are often highly undulose. The stresses which caused the granulation fractures and shear zones were post dated by a phase of recrystallization.

(This rock in fact was a conglomerate consisting entirely of granitoid material, and very similar to the "Boolcoomata Conglomerate").

p.361/70

Location: 2.6 miles west of Highes Prospect.

Rock Name: Partly recrystallized silty-quartz tillite.

The matrix has heen recrystallized by regional or thermal metamorphism and now consists of quartz biotite carbonates and white mica. The framework consists of quartz and quartzite and quartz-mica schist.

p.363/70

Location: 2.9 miles west of Ethindna main shaft.

Rock Name: Banded calc-silicate rock.

This rock has a compositional layering and consists largely of

quartz (xenoblastic), horneblende, epidotized plagioclase, epidote, garnet and sphene. The assemblage may be found from regional metamorphism of calcareous pelites.

p.365/70

Location: 2.5 miles from Hughes Prospect.

Rock Name: Folded phyllite. Though the structural history is uncertain, it seems at least two phases of deformation. The rock is finely crenulated micaceous siltstone from the Yudnamutana Sub-Group. A crenulation or strain-slip cleavage is developed at places.

Report 2430/71

Investigation and report by Dr. B.G. Stevenson

p.698/70

Location: 5 miles east of Plumbago H.S.

Rock Name: Muscovite schist or phyllite.

The constituents are quartz muscovite, plagioclase (andesine) and garnet (1%). The latter has undergone some reaction indicating some retrogression has taken place. The specimen was taken from the 'anatexite' unit on Plumbago. In hand specimen, it is leucocratic, and only the light coloured muscovite crystals are oriented. Presence of the latter gives the rock a greisen appearance.

701/70

Location: Plumbago, Run 4; photo 31, locality 2.

Rock Name: Muscovite schist.

The rock has a granoblastic texture and schistosity is due to orientation of micas. Magnetite subhedra are common. A second foliation has been developed, deforming and obscuring an earlier foliation.

702/70

Location: Plumbago, Run 4, photo 31, locality 3.

Rock Name: Muscovite schist.

This is a quartz-orthoclase-mica rock with apatite and opaques as accessories. Compositional banding (mainly due to presence or absence of feldspar) is present and considered to be originally sedimentary. The metamorphic grade appears to be the same as p.701/70, and both were derived from the regional metamorphism of aluminous, probably clay-rich sediments.

p.703/70

Location: 2.5 miles southwest of Weekeroo Woolshed.

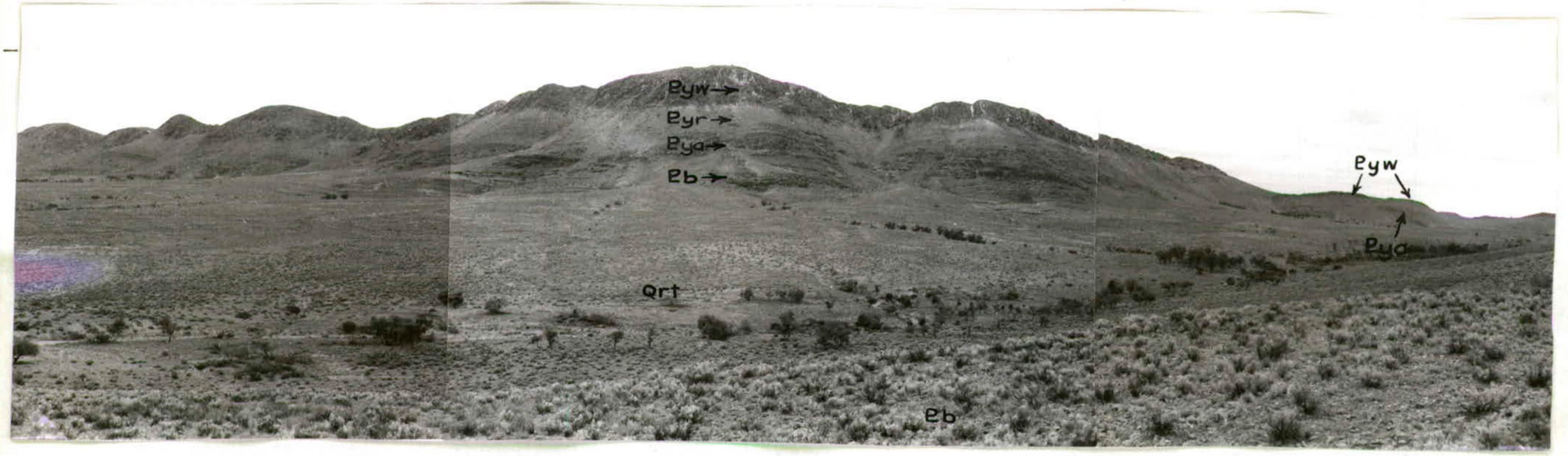
Rock Name: Quartz-felspathic schist.

A massive felsic rock consisting mainly of quartz (80%). Phyllosilicates (mica and chlorite, 3-4%) are the only ferromagnesians present.

The assemblages found in specimens p.701/70 to p.703/70 are found in rocks of the upper greenschist and amphibolite facies but due to their composition the metamorphic grade cannot be more precisely defined.

The presence of chlorite in p.703/70 is the only evidence of retrogression and it seems that if retrogression has taken place at all, it has not proceeded very far.

Rocks p.701/70 and p.702/70 are probably suitable for Rb/Sr dating although they contain rather small proportions of biotite which may be difficult to separate from muscovite. Specimen p.703/70 is unsuitable due to secondary alteration of biotite to chlorite.



Plains alluvium & slope deposits	Qrt
Wilyerpa Formation	Pyw
Benda Siltstone	Pyr
Appila Tillite	Pya
Burra Group	Pb

Frontispiece: Panoramic view of Mt. Victor Range
Photo 21209-21211

139°30'
14°00'
32°00'
32°15'

Nillinghoo Gold-Field
Kirkeeks Treasure Mine
Au
Photos 21209-11
Photo 21205
MT VICTOR
Mt Victor Woolshed (OS)
Mount Dam
Cons Bore
Tin Hut Bore
Winninnie Dam
Teelulpa Goldfield
MT Victor HS
Gums Lake
Crocker West Mine
U.Th.
Crocker East Mines
East Crocker Shear
Crockers Well Camp
Crocker Shear
T.S.25236
T.S.25239
T.S.25234
T.S.25235
ETHIUDNA HILL
Ethiudna Mine
Cu Co Ni.
T.S.25240
Photo 21222
MINDAMEREEKA HILL
T.S.26029
Plumbago HS
K/7 8946
K/7 8951
Photos 21216-9
T.S.26033
T.S.26032
Photos 21203-4
Mitchells Prospect
T.S.25242
Cu
Hughes Prospect
Sil
Au
Fsp
Be
Photo 21223-4
Photo 21220-1
T.S.26034
Weekeroo Woolshed
T.S.25238

Qra
Py
Pb
Pf
pεW

REFERENCE

U. PROTEROZOIC — ADELAIDIAN — TORRENSIAN — STURTIAN — YUDNAMUTANA SUB GROUP — FARINA SUB GROUP

CAINOZOIC — QUATERNARY — RECENT — Qra

Pf, Py — UMBERATANA GROUP

Pb — BURRA GROUP

L. PROTEROZOIC

pεW — WILLAMA COMPLEX

Thin Section ....T.S.26033.

SCALE

MILES 2 1 0 2 4 6 8 10 MILES

To accompany report by G.Pitt.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PLUMBAGO 1 MILE SHEET

SIMPLIFIED GEOLOGY & LOCALITY MAP

		Drn. G.P.	SCALE : 1 INCH REP 2 MILES
		Tcd. D.J.C	71-229. FL
		Ckd.	
Director of Mines		Exd.	DATE : 18-March-71

REFERENCE

CAINOZOIC

QUATERNARY — RECENT

Qra	Low level alluvium
Qrs	Sand
Qrt	Slope and plains alluvium

PLEISTOCENE

Qca	Calcrete

Unconformity

UPPER PROTEROZOIC

ADELAIDEAN — STURTIAN–MARINOAN — UMBERATANA GROUP

Pfr	Tarcowie Siltstone
Pft	Tapley Hill Formation
Pfd	Tindelpina Shale Member
Pyw	Wilyerpa Formation
	Unconformity
Pyr	Benda Siltstone
Pya	Appila Tillite

TORRENSIAN — BURRA GROUP

	Unconformity
Pb	Undifferentiated Burra Group
Pbk	Skillogallee Dolomite equivalent
Pbr	Rhynie Sandstone equivalent (conglomerate)

"Grand Unconformity"

LOWER PROTEROZOIC

CARPENTARIAN — WILLYAMA COMPLEX

pEWb	Bedded Mica Schist
	? Unconformity
	Amphibolite
pEWs	Mica Schist
pEWe	"Ethuldna" type calc-silicates
	Layered Gneiss and Schist
	Granitoid Gneiss
	Migmatitic Schist
	Leucogneiss
	"Anatexites", Porphyritic granitoid diatexites and some anatectic granites
	Crockers Well adamellites

Minor tillitic developments

Tillites

Granite conglomerate ("Old Boolcoomata" type)

Braemar Iron Formation — Fe

Amphibolite (metadolerite) dykes — A

Faults — F

Unconformity

Uncontormity (approximate)

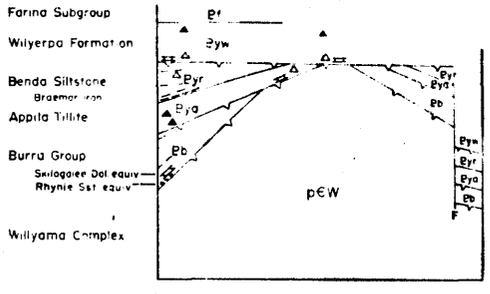
Trend lines

SCALE

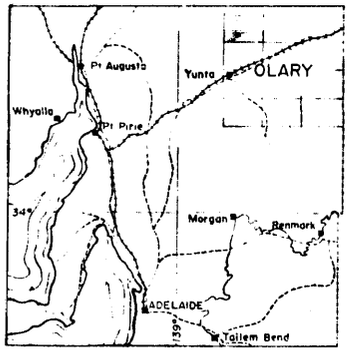
MILES 2 1 0 1 2 4 6 8 MILES

KILOMETRES 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 KILOMETRES

ROCK RELATION DIAGRAM



LOCALITY MAP



To accompany report by G. Pitt.

Area previously mapped by B Campana – 1956

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PLUMBAGO 1 Mile Sheet

GEOLOGY

		Drn. W.F.J.	SCALE: AS SHOWN
		Tcd. W.F.J.	71-237
		Ckd.	FI
Director of Mines		Exd.	DATE MARCH 19 1971

RECORDS FILE COPY

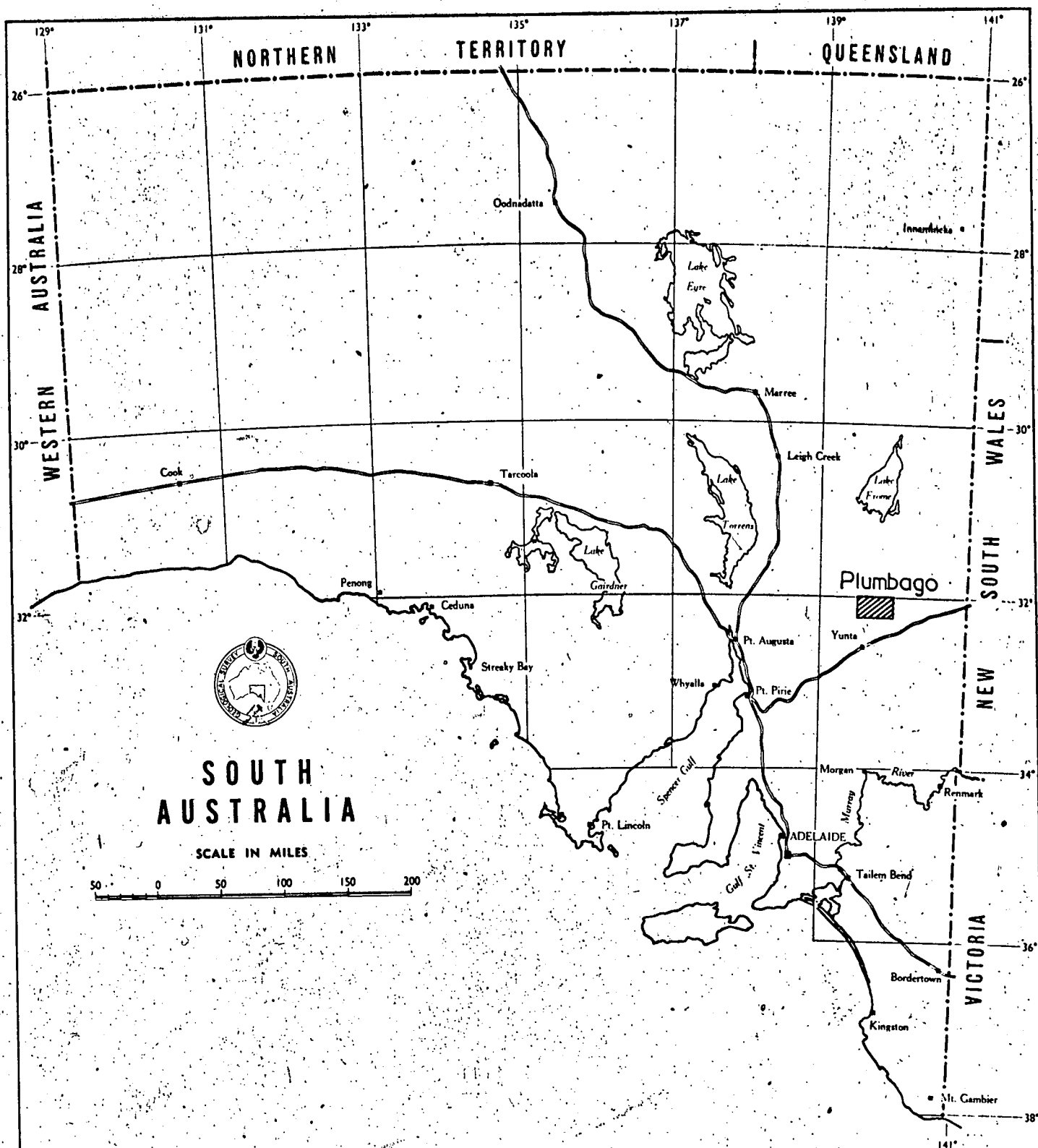


FIG. 1

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: as shown
Compiled: G. PITT.	PLUMBAGO AREA LOCALITY MAP	Date: 11. JAN. 71.
Drn: D.J.M Ckd: L.V.W.		Drg. No. S 9134 FL

P.F. Nº S5850 994·2

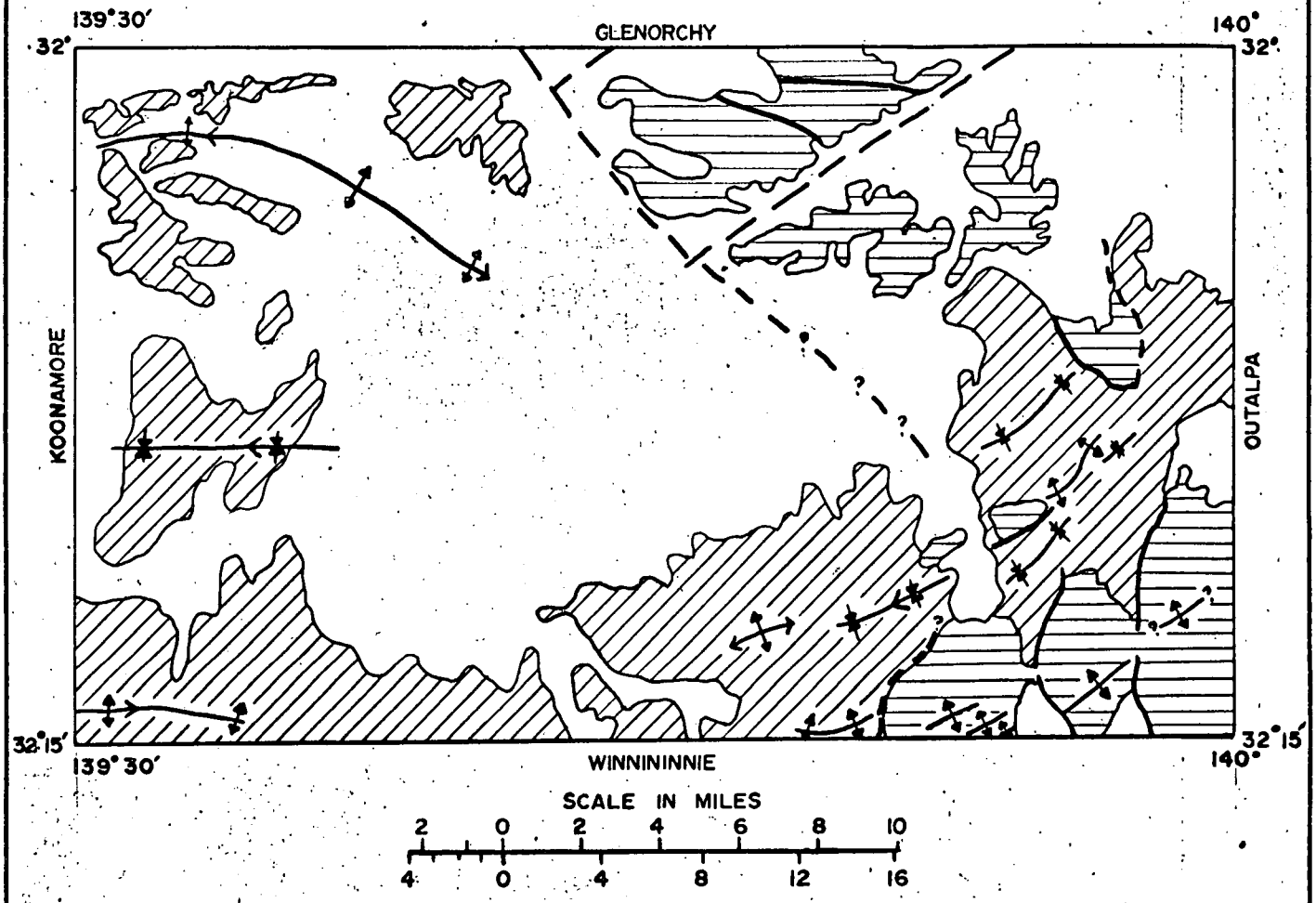
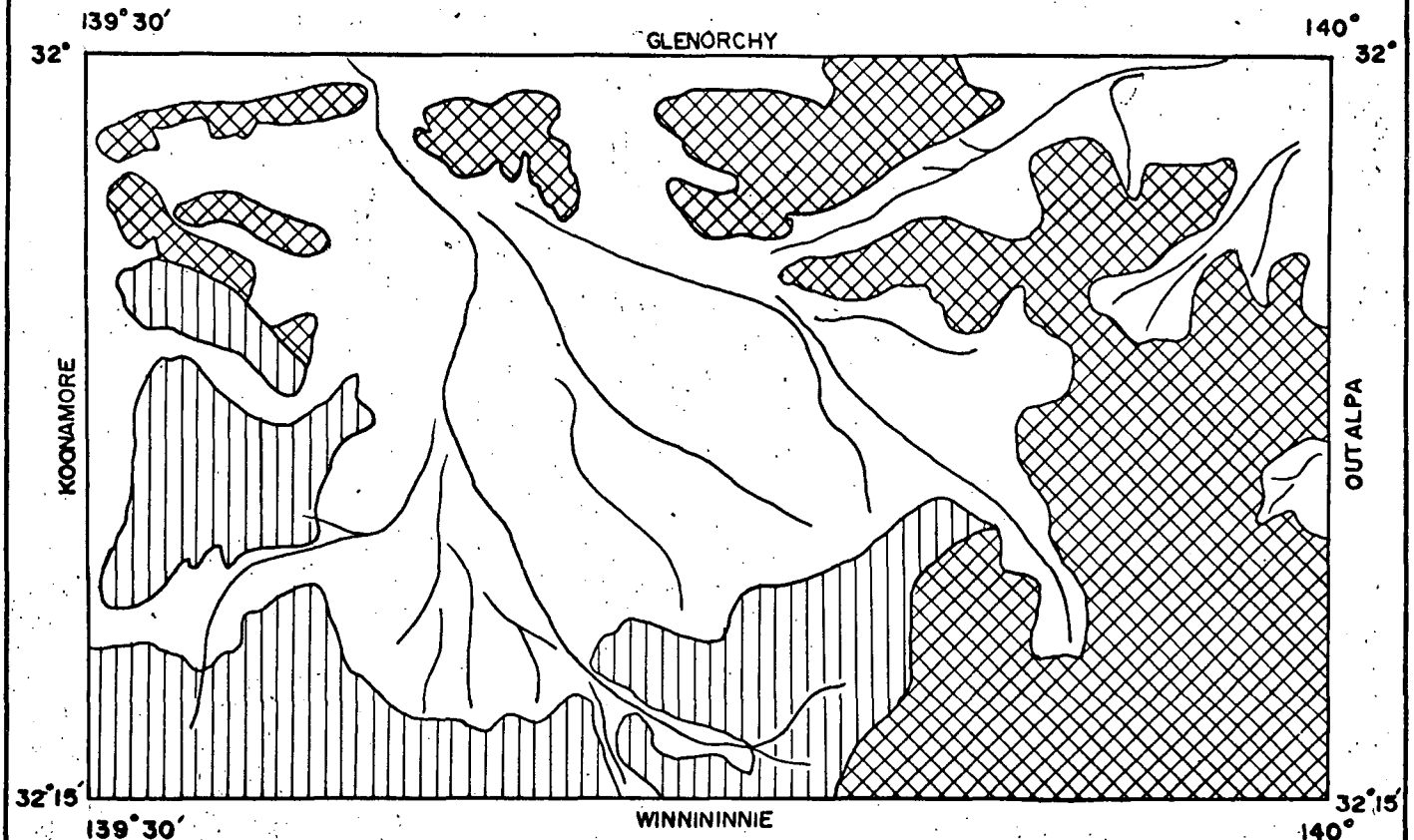


FIG. 2

REGIONAL MAPPING SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: As shown.
Compiled: G. PITT.	PLUMBAGO 1:63360 SHEET AREA	Date: 8 April 1971
Drn. J.M.B. | Ckd. L.V.W.	TECTONIC SKETCH	Drg. No. S 9249

FR

1M—2.70 A1810



SCALE IN MILES

2 0 2 4 6 8 10

4 0 4 8 12 16

SCALE IN KILOMETRES

Physiographic Unit 1.

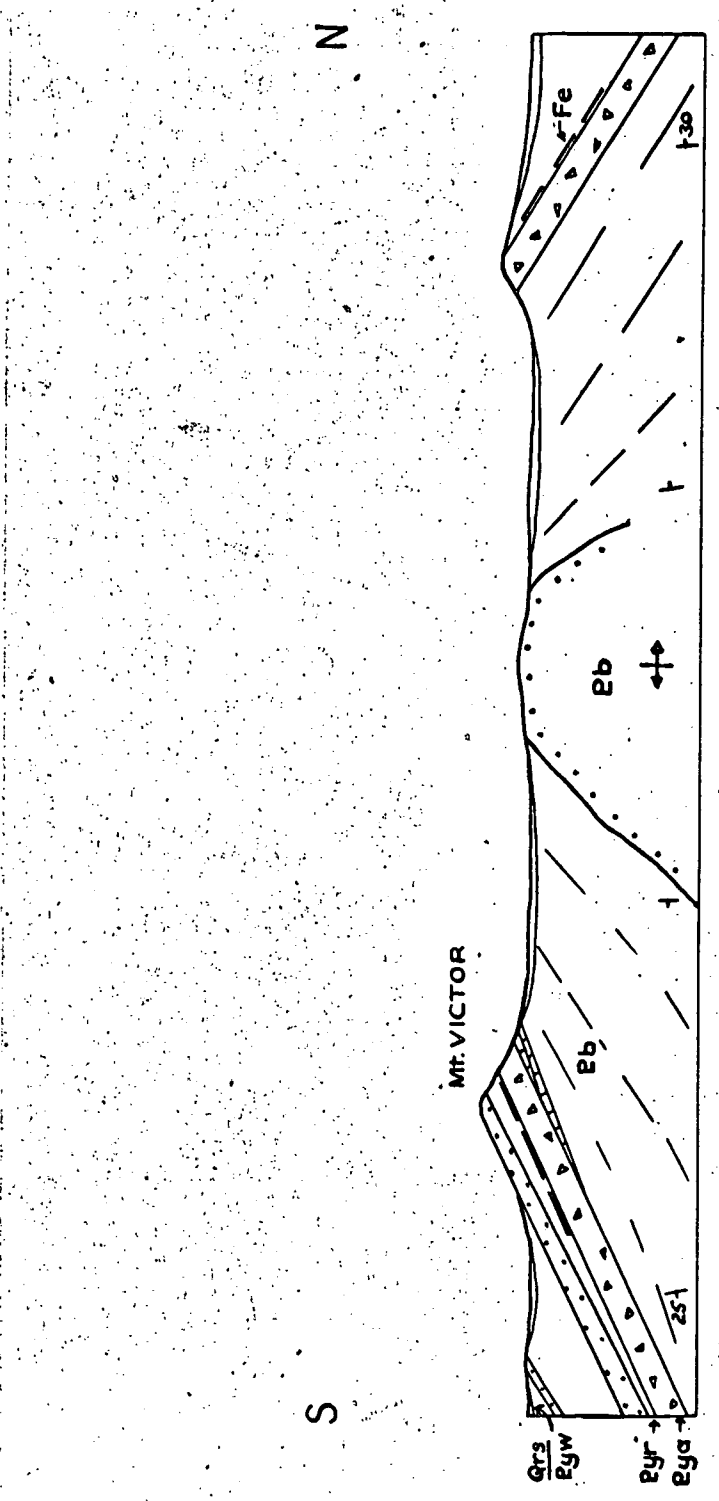
Physiographic Unit 2.

Physiographic Unit 3.

FIG. 3

REGIONAL MAPPING SECTION	**DEPARTMENT OF MINES – SOUTH AUSTRALIA**	Scale: *As shown.*
Compiled: *G.PITT.*	PLUMBAGO 1:63360 SHEET AREA	Date: *8 April 1971*
Drn. *J.M.B.* Ckd. *L.V.W.*	PHYSIOGRAPHY	Drg. No. S 9250 F2

1M—2,70 A1810



SEQUENCE:

- Pyw — Wilyerpa Formation
- Pyr — Benda Siltstone with Braemar Iron Formation. (Fe).
- Pya — Appila Tillite.
- Eb — Burra Group [Possibly Craddock Quartzite and Mintaro Shale equivalents.]

FIG. 4

REGIONAL MAPPING SECTION	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: *Not to Scale.*
Compiled: *G.PITT.*	PLUMBAGO 1:63360 SHEET AREA	Date: *8 April 1971*
Drn. *JM.B.* Ckd. L.V.W.	DIAGRAMMATIC SECTION ACROSS MT. VICTOR	Drg. No. S 9251 F.L

1M—2.70 A1810

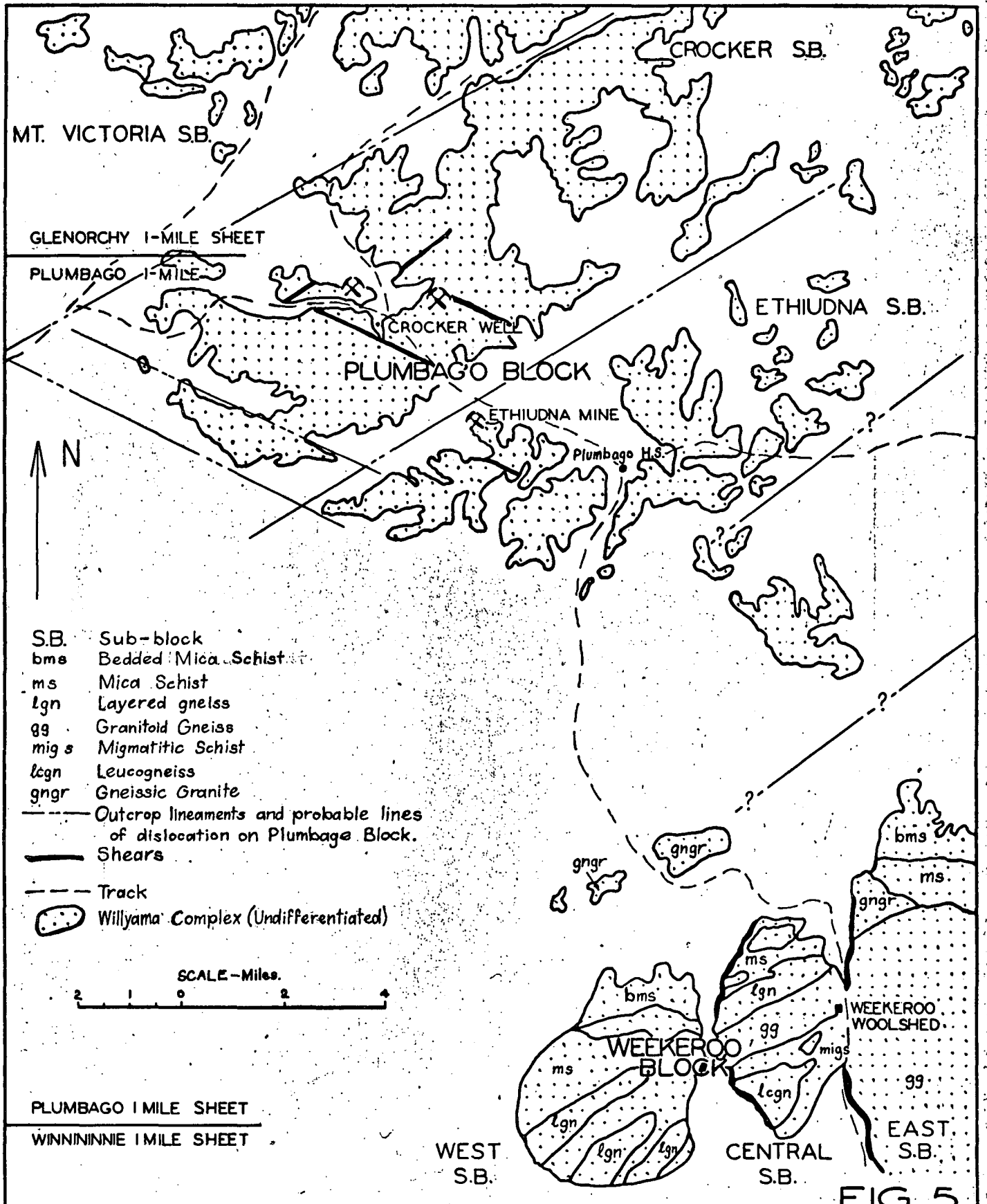


FIG. 5

REGIONAL MAPPING SECTION	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1:170,000
Compiled: G. Pitt.	WILLYAMA COMPLEX—PLUMBAGO AREA. OUTCROP BOUNDARIES FROM OLARY PROVINCE (SPECIAL SERIES) MAP	Date: 13th. Jan. 1971.
Drn. D.J.M. Ckd. L.V.W.		Drg. No. S9137 Fl

1M—2.70 A1810