THE STRUCTURE AND METAMORPHISM OF THE PEWSEY VALE AREA NORTH-EAST OF WILLIAMSTOWN, S. A.

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SUMMARY.

The structure and petrology of Upper Precambrian and Cambrian rocks have been studied in detail, in an area 28 miles north-east of Adelaide, South Australia. The rocks occur within a broad zone of high grade metamorphism on the eastern side of the Mt. Lofty Ranges.

The Upper Precambrian succession consists predominantly of pelitic and semi-pelitic schists, quartzites, calc-silicate rocks and calc-schists, and the Cambrian sequence of quartzo-feldspathic schists, migmatites, granite gneiss, calc-silicate rocks and minor pelitic schists and quartzites.

The rocks have reached the sillimanite grade of metamorphism and the metamorphism is of the low pressure-intermediate type.

Dolerites, pegmatites, minor granodiorites and granites intrude the meta-sediments.

Mineralogical and structural relationships of the granite gneiss, indicate that it has been formed by recrystallization of the quartzo-feldspathic schists. Small scale metamorphic differentiation, appears to have accompanied the recrystallization. The migmatites are believed to have been formed by metamorphic differentiation rather than by anatexis.

Three phases of deformation are recognised in the Upper Precambrian rocks and two in the Cambrian. The second deformation recorded in the Upper Precambrian rocks does not appear in the Cambrian rocks. Each deformation has been accompanied by the formation of foliation. In the Proterozoic rocks deformed by the second and third phases of folding, the foliation is a crenulation cleavage. The deformations in both the Upper Proterozoic and Cambrian sequences are considered to be related. Petrofabric studies of quartz, scapolite and biotite are related to the respective macroscopic structures. An analysis of the chronology of crystallization and deformation of these rocks indicates that crystallization continued during and after each phase of deformation.

Faulting commenced either prior to or during metamorphism. Intense metasomatic activity followed a later phase of faulting resulting in the widespread development of albitites and in some cases talc ore bodies. The albitites formed in the fault zone were subsequently brecciated by further movement and later healed by the introduction of more metasomatic fluid.

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Dr.A.W. Kleeman read part of the initial draft and Dr.B. Daily read the Introduction and Stratigraphy sections. The author is particularly indebted to Dr.J.L. Talbot for his reading and critical examination of the whole manuscript.

Mr.J. Lorenzin prepared the thin sections and Miss A.M.C. Swan assisted with the layout of some maps. Mrs.R.Shortland typed the draft copies and the final manuscript, and Miss S. Summer the text figure descriptions. The author also wishes to express his gratitude to his wife for the preparation of the photographic figures and for the help and encouragement she gave during the writing of the thesis.

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This thesis contains no material which has been accepted for the award of any other degree or diploma in any University and that, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Robin Offler

All specimens referred to in this thesis are catalogued in the museum of the Geology Department of the University of Adelaide. Specimens with the prefix A200- have been collected by the author; those with the prefix A126- , or GAC- and A9- are specimens lent to the author by Dr.A.W. Kleeman (University of Adelaide) and Dr.G.A. Chinner (University of Cambridge). The catalogued information includes the name of the rock, the catalogue number and the approximate location. The location of each specimen is given as a national grid reference as shown on the Gawler 1 inch to 1 mile Military Sheet (Fig.2) and reproduced on Plate 1.

INTRODUCTION.

The area investigated and discussed in this thesis covers 35 square miles of pastoral country in the Pewsey Vale area, approximately 28 miles north-east of Adelaide (Figs.1 and 2). It contains folded and metamorphosed Upper Precambrian and Cambrian rocks in faulted contact. Intruding them are small bodies of dolerite, granite and pegmatite (Plate 1). Extensive metasomatism has altered some of the metamorphic and igneous rocks to albitites.

This region forms part of the Mt.Lofty Ranges, an arcuate belt made up of "Archean", Precambrian and Cambrian rocks (Figs.1 and 3). Unconsolidated Permian and Tertiary sediments also occur within the ranges (Fig.3). The relationship between the older rocks is shown in Table 1.

"Archean".

The "Archean" rocks occur as isolated inliers overlain unconformably by rocks of the Adelaide Supergroup (Fig.1). They consist of high grade meta-sediments, metasomatic and igneous rocks, which have undergone retrograde metamorphism before the deposition of the Adelaide Supergroup (Talbot,1963).

The terms "Houghtonian Complex" (Howchin,1926), "Barossa Series" (Woolnough,1908;Hossfeld,1935) and "Houghton Complex" (Talbot,op.cit.), have been used to describe the

FIG.1.

General relationships between the Lower Precambrian, Upper Precambrian and Cambrian. The area studied is outlined.

LOCALITY MAP

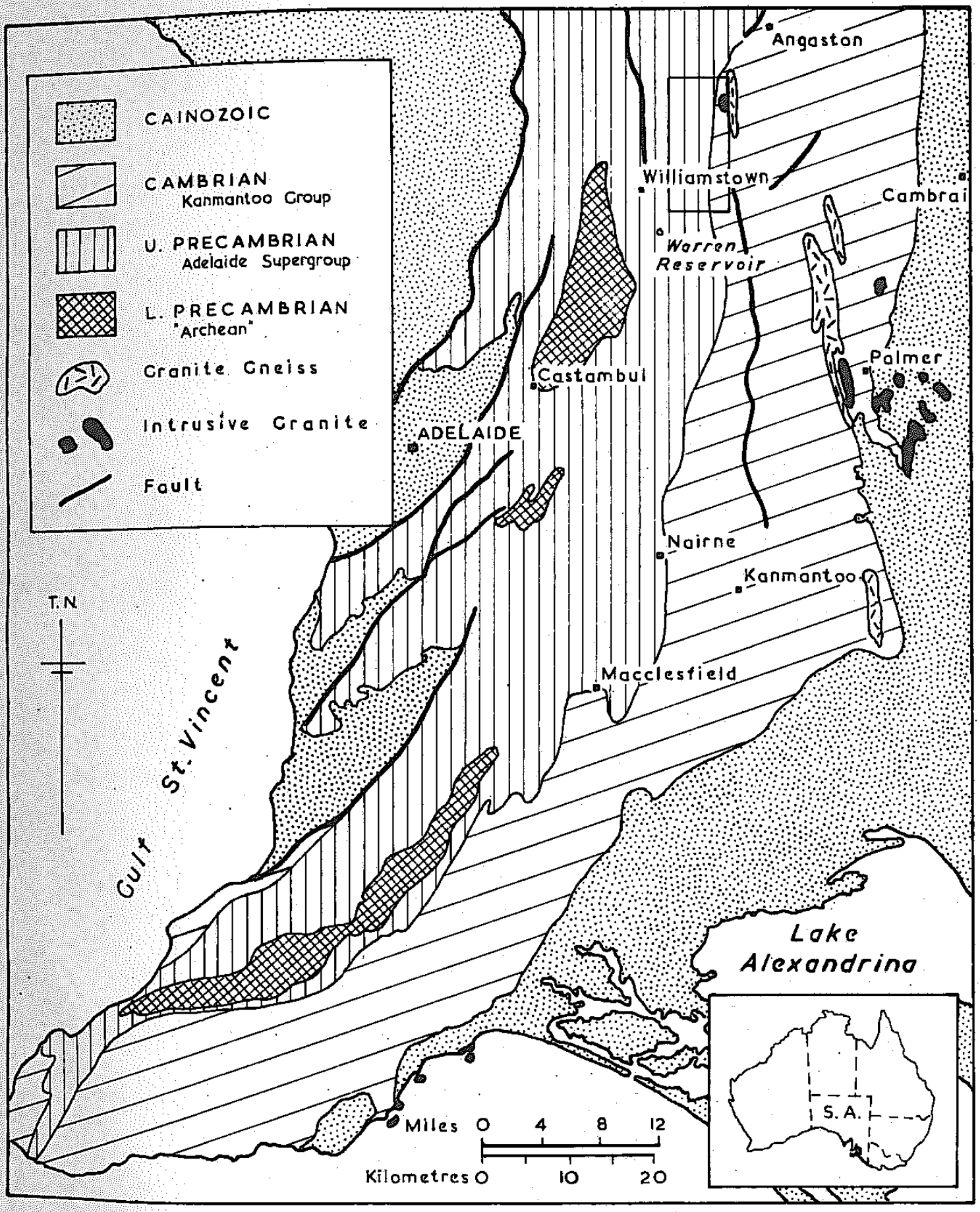


FIG. 1

FIG.2.

Part of the Gawler Military Sheet. Scale 1 inch = 1 mile. The area studied is outlined.

NORTH
PARA
Rowlands Flat
Orlando Winery
Altona
Lyndoch
Reynella Winery
(TRIG) 997'
Karawirra
Tweedies
Trial Hill
MT KITCHENER 1965' (TRIG)
Pewsey Vale
▲ 2064'
Pewsey Vale Peak
Corryton Park
Williamstown
Victoria Ck
Wirra Wirra
Springfield
Tower
Mine
Pines
QUARRY
SAND PIT
VINES
ORCHARDS
RIFLE RANGE
FORD
Springton 6 M
35'
40'
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
90
95

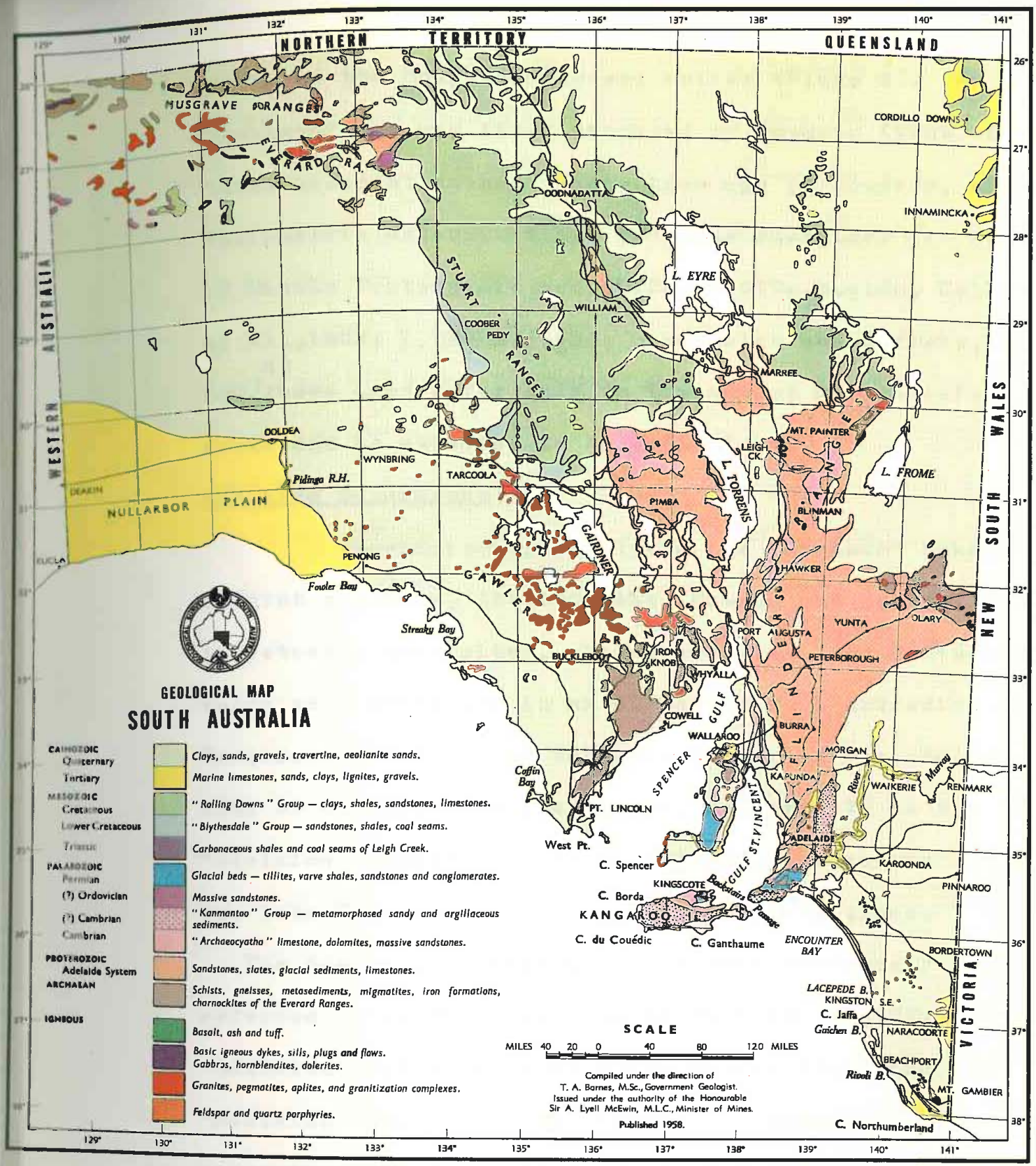
TABLE 1.

Age	Eastern Mt.Lofty Ranges.	Western Mt.Lofty Ranges
Cambrian	Kanmantoo Group Lower Cambrian [1]	Kanmantoo Group[2] Lower Cambrian
Contact	Conformable, unconformable or faulted.	Conformable or unconformable.
Proterozoic	Adelaide Supergroup.	Adelaide Supergroup.
Contact	Violent unconformity.	
"Archean"		

1. Age documented by fossils only in the Delamere region, in the Southern Mt.Lofty Ranges.
2. Only 450 feet exposed compared with 30,000 feet in the Cape Jervis region - see text.

FIG. 3.

Geological map of South Australia.



the Torrensian, Sturtian and Marinoan. Subsequently,

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1. All locality names mentioned subsequently in the text are given in Plate 2.

rocks of the Houghton-Barossa inlier (Plate 2).[1] An "Archean" age was first proposed by Howchin (1906) for these basement rocks. Their true age is however, unknown. Radiometric determinations indicate that they are at least of Middle Proterozoic age (U/Pb, 1,510m.y.±100, Collins et al.,1953; 1,660 m.y.±25, Greenhalgh and Jeffery,1959), but as these ages refer only to the age of metamorphism, the rocks can be expected to be much older.

Adelaide Supergroup.

Unconformably overlying the "Archean" basement is a thick sequence, (28,000 feet, Mawson and Sprigg,1950) of limestones, quartzites, shales and glacigene sediments, which were deposited in an elongated zone extending from Kangaroo Island to the northern border of the state. This site of extensive sedimentation, referred to as the "Adelaide Geosyncline" (Sprigg,1952), was active during the late Precambrian and early Palaeozoic times.

The Adelaide Supergroup rocks have previously been referred to as the "Adelaide Series" (David,1922), the "Adelaide System" (Clarke,1938; Mawson,1948) and the "Adelaide Supergroup" (Daily,1963). Mawson and Sprigg(1950) formally defined the Adelaide System and subdivided the sequence found in the Adelaide region into three series, the Torrensian, Sturtian and Marinoan. Subsequently,

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1. All locality names mentioned subsequently in the text are given in Plate 2.

Sprigg (1952) added a fourth division, the Willouran Series,[1] which is considered to be older than the Torrensian. Daily (op.cit.) proposed that the terms Supergroup and Group replace the time-rock terms System and Series, a proposal which has been adopted in this thesis.

The Adelaide Supergroup rocks pass conformably[2] into fossiliferous Lower Cambrian on the western and lower south-eastern sides of the Mt.Lofty Ranges, and are therefore considered to be Upper Proterozoic in age. Rb/Sr determinations indicate that the base of the Adelaide Supergroup rocks is either Middle or Upper Proterozoic (Compston et al., in press).

Kanmantoo Group.[3]

The Kanmantoo Group sediments occupy an arcuate belt on the eastern side of the Mt.Lofty Ranges from beyond Angaston in the north, to Kangaroo Island in the south, a distance exceeding 200 miles (Sprigg and Campana,1953; Figs.1 and 3). They consist of a thick (more than 30,000 feet,)unfossiliferous and monotonous sequence of greywackes, silty phyllites, siltstones, and micaceous quartzites, with minor orthoquartzites, conglomerates and limestones (Sprigg

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1. Type area about 350 miles north of Adelaide.
2. An unconformity between the Cambrian and Precambrian in the Normanville-Sellick Hill region was originally proposed by Thomson and Horwitz (1961), but in 1962 they apparently rejected this hypothesis (Thomson and Horwitz,1962).
3. Type section occurs between Campbell Creek and Rosetta Head, Victor Harbour, in the Cape Jervis region (Sprigg and Campana,1953).

and Campana, op.cit.) The deposition of these "flysch like" sediments is believed to have been initiated by a Lower Cambrian orogeny (Daily,1956).

In the southern Mt.Lofty Ranges, the Kanmantoo Group conformably overlies fossiliferous Lower Cambrian, but in other areas the stratigraphic and structural relationships are not clear, since outcrops are poor and fossiliferous or distinctive lithological marker horizons are absent. However, despite these difficulties many interpretations have been put forward.

Originally, the Adelaide Supergroup and Kanmantoo Group rocks were considered to be in faulted contact (the Nairne Fault, Sprigg et al.,1951). Subsequently, Campana and Horwitz (1955) suggested that the Kanmantoo Group was transgressive over folded "Adelaide System" sediments, but this was later rejected by Kleeman and Skinner (1959) on the grounds that there was no evidence for an earlier period of folding involving the "Adelaide System". In the same year Horwitz et al.(1959) proposed that both the Lower Cambrian and Kanmantoo Group sediments were transgressive over eroded and folded "Adelaide System" rocks. The author has found that the Kanmantoo Group and Adelaide Supergroup rocks are in faulted contact in the Pewsey Vale region (see Chapter 11).

Because of the widespread metamorphism affecting the Kanmantoo Group, its age was regarded as "Archean" (Woolnough,1908; Hossfeld,1935), or Precambrian (Howchin, 1929). Madigan (1925) was the first to assign a Cambrian age to these rocks. Later, on structural and stratigraphic evidence, Sprigg and Campana (1953) suggested a Cambrian to Ordovician age. It is now generally accepted that the Kanmantoo Group is Cambrian in age, and this has been supported by recent radiometric datings (White et al., in press).

[1]

Early Palaeozoic Orogeny.

The Adelaide Supergroup and Kanmantoo Group sediments were deformed and metamorphosed during an early Palaeozoic orogeny. Deformation "was achieved by jostling and warping of the Archean basement of the geosyncline" (Webb,1958).

The metamorphism (Rb/Sr,approx.465m.y.,Compston et al., in press) produced at its peak, a north-south elongate belt of amphibolite facies rocks, extending from Tanunda to below Strathalbyn, on the eastern side of the Mt.Lofty Ranges (Fig.4). Within this belt there are granite gneisses, migmatites and pelitic schists containing andalusite, kyanite,

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1. In this category Madigan included rocks which are now known to belong to the Adelaide Supergroup.

FIG. 4.

General relationships of the metamorphic zones in the Mt. Lofty Ranges.

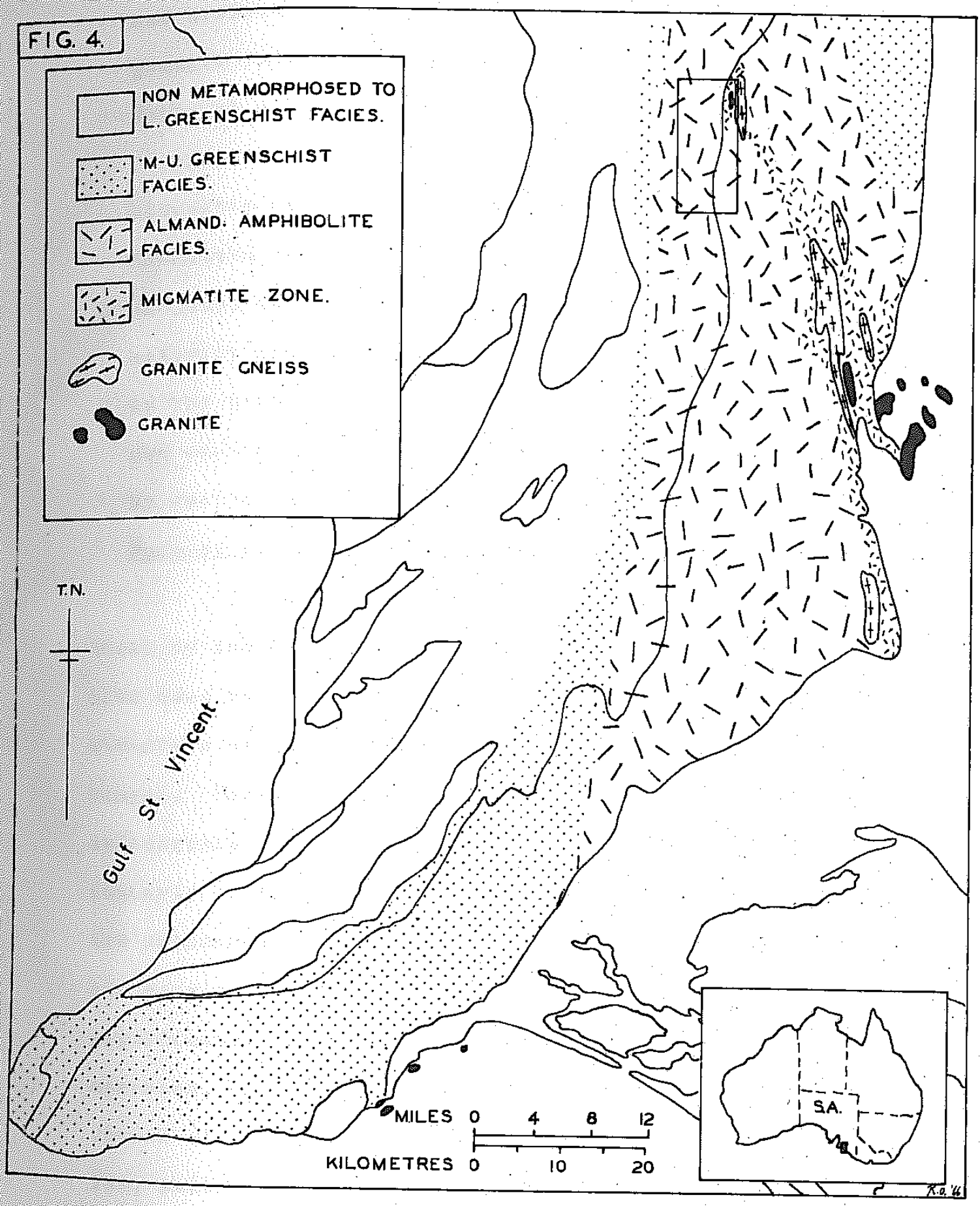
FIG. 4.
NON METAMORPHOSED TO L. GREENSCHIST FACIES.
M-U. GREENSCHIST FACIES.
ALMAND. AMPHIBOLITE FACIES.
MIGMATITE ZONE.
GRANITE GNEISS
GRANITE
T.N.
Gulf St. Vincent.
MILES 0 4 8 12
KILOMETRES 0 10 20
S.A.
K.O. '46

and sillimanite, as well as synkinematic dolerite and granite intrusions (e.g. Palmer Granite, Rb/Sr, 480m.y.±15, White et al., in press).

Igneous activity culminated in the intrusion of post kinematic granites of batholithic dimensions into the Kanmantoo meta-sediments (Victor Harbour Granite, K/A, 457 m.y. Evernden and Richards, 1962). A revival of tectonic activity occurred during the Tertiary Period, particularly in the late Pliocene to Early Pleistocene times. The area now occupied by the Mt.Lofty Ranges was strongly uplifted by doming and faulting, and the landscape rejuvenated.

Purpose of the Present Investigation.

Since the publication of the first 1" to 1 mile sheet by the S.A.Geological Survey in 1951, major advances have been made in the understanding of the stratigraphy and structure of the Precambrian and Cambrian rocks of the Mt.Lofty Ranges. However, more detailed structural, stratigraphic, metamorphic and igneous studies still remain to be done, particularly on the eastern side of the ranges, where deformation and metamorphism are dominant aspects of the geology. Here our knowledge of the position of mineral isograds and their significance, and the relationship of deformation to metamorphism, is extremely limited. In addition, the number of phases of folding recorded in these rocks is known only in a few, small isolated areas. Furthermore, many stratigraphical

problems are as yet unsolved, particularly the relationship between the Kanmantoo Group and the Adelaide Supergroup metasediments.

It is the purpose of the present investigation to try and elucidate some of the problems outlined above by the mapping and study of a small representative area (Fig.1).

Physiography.

The physiographic features in the present area have resulted from Tertiary to Recent uplift of an old eroded (Pre-Tertiary) land surface (Campana,1955; Dalgarno,1961). Remnants of this surface are now found at elevations of 1,500 to 1,600 feet, 500 feet above the floor of the adjacent Barossa Valley. Mt.Kitchener (elevation 1,965 feet), Pewsey Vale Peak (elevation 2,064 feet), are former monadnocks (Specht et al.,1961). Dissection of this plateau has been most active along the fault scarp east of Rowlands Flat (Fig.2,5a). Away from the fault scarp, the topography is mature, outcrops are more scattered, and alluvial flats cover much of the area (Fig.5b). The main watercourse is Jacobs Creek, an antecedent stream, which cut down through the Palaeozoic rocks during the Tertiary uplift.

Previous Investigations.

The earliest geological investigations in this area were entirely petrological (Moulden,1895;Woolnough,1904). Hossfeld (1935) produced the first geological map of the area in his study of the "Geology of part of the North Mt.Lofty

FIG.5A.

General view of the fault scarp topography adjacent to Tweedies Gully, looking north-west from location 940 200. Barossa Valley appears in the background.

FIG.5B.

General view of the more mature topography beyond the fault scarp, looking east from Pewsey Vale Peak.

FIG. 5A.

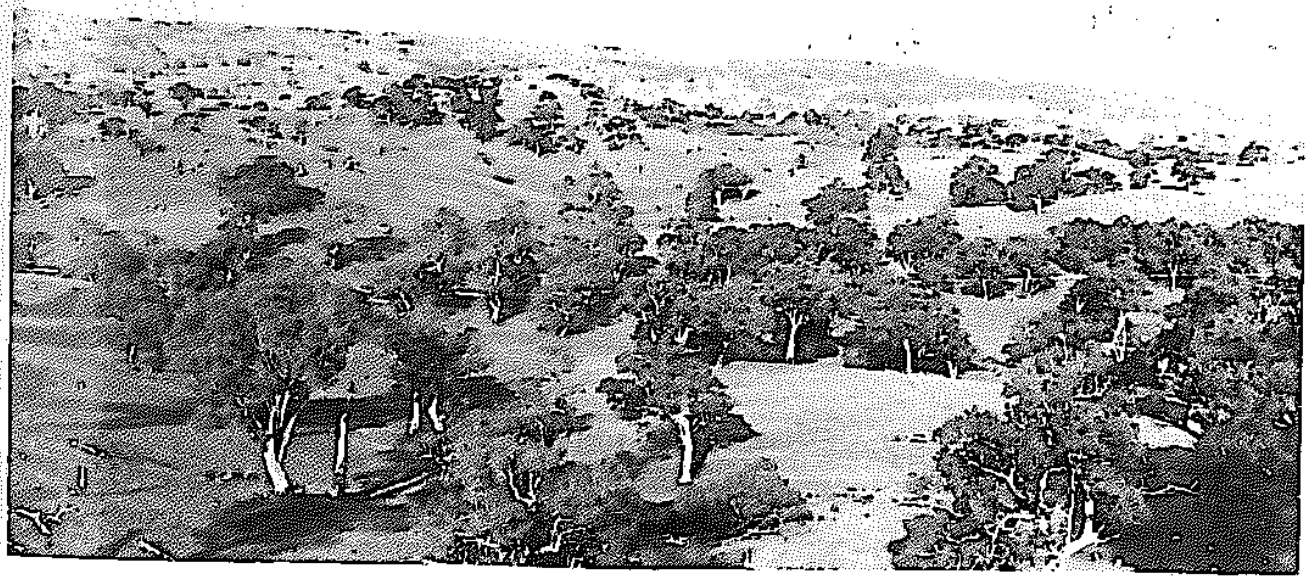

FIG. 5B.

Ranges". Subsequently, Whittle (1951) mapped and assessed the talc deposits on the western side of the area and later, Campana (1953) included this area in his regional mapping of the Gawler Sheet. Chinner (1955) mapped a portion of the area during his investigation of the granite gneisses of the Barossa Ranges.