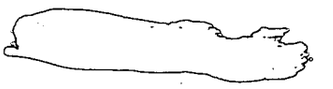
COMMONWEALTH OF AUSTRALIA.



DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/135

GEOLOGY OF THE BELCONNEN AREA AUSTRALIAN CAPITAL TERRITORY.

by

E. G. Wilson

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CONTENTS

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SUMMARY

The Belconnen area, five miles north-west of Canberra City, is divided centrally by a fault which is the northerly extension of the Deakin Fault in Canberra. The Black Mountain Horst lies to the east of the fault; it is made up of folded Pittman Formation (Middle Ordovician) and Acton Shale (Upper Ordovician), which are overlain unconformably by a veneer of Silurian shales. West of the fault, outcropping Middle and Upper Silurian sediments and volcanics are intruded by a granodiorite-porphyry similar to the Painter Porphyry. Another granodiorite, coarse-grained, and porphyritic in texture, intrudes both granodiorite-porphyry and sediments, and cuts across the Deakin Fault; this intrusion post-dates the faulting. In the north, the Deakin Fault lies along the western margin of a wedge of Ordovician rocks which have been pushed eastwards over part of the Black Mountain Horst. As a result, the veneer of Silurian shales on the horst has been drag-folded and partly brecciated, and the shales now form the footwall of a reverse fault which dips gently to the west. The presenoe of Monograptus in the shale of the footwall establishes the enclosing strata as Lower Silurian.

INTRODUCTION

The Belconnen area lies south-west of the Barton Highway, and is five miles north-west of Canberra City. The area described in this report is bounded approximately on the north and west by the Gundaroo Road, Barton Highway, Charnwood Road, and Glebe Road; (see Plate 1) the eastern boundary is a line passing through Belconnen Naval Station to the north-east. Part of the area was acquired by the Commonwealth Scientific and Industrial Research Organization in 1960, to establish a new experimental farm.

The whole area was mapped intermittently during 1959 and 1960, in order to extend the area of known geology beyond the limits of city development in Canberra. Mapping and interpretation of the geology is still incomplete owing to the complexity of the faulting; this report sets out the geology as determined at the time of writing (June, 1961).

Dr. Öpik described the geology of Canberra City in detail in "Geology of the Canberra City District" (1954), and all formation names used in this text have been taken from that publication. In some cases positive identification with the Canberra units is based on lithology and the presence of fossils; in other cases, identification with Canberra units is based on lithological resemblances only.

GENERAL GEOLOGY

The Belconnen area is divided into two parts by a north-north-east fault, which is a continuation of the Deakin Fault from the Canberra area. On the east is the Black Mountain Horst containing the Pittman Formation (Middle Ordovician), and the Acton Shale (Upper Ordovician); overlying these formations unconformably, is a veneer of Lower Silurian sediments including the State Circle Shale, which contains Monograptus exiguus. West of the fault, undifferentiated Middle and Upper Silurian rocks are gently folded and have been intruded by a granodiorite-porphyry which is similar to the Painter Porphyry. A coarse-textured granodiorite intrudes both Silurian sediments and the granodiorite-porphyry, but shows no evidence of stress or displacement along the Deakin Fault which it transgresses; this suggests that the granodiorite was intruded after the faulting.

A small outcrop of gravel in the south-west of the area caps a rise near Ginninderra Creek; it is probably a stream gravel formed during an earlier stage in the history of Ginninderra Creek. Cappings of ironstone are present on a number of rises in the north-east; large boulders of silcrete (silicified quartz conglomerate) are found near the margins of the ironstone; this association of ironstone and silcrete suggests that the two may have a common origin: they may be remnants of a laterite.

STRUCTURE

The structure near the Yass Road is interpreted as a wedge bounded by two faults as shown in the geological section C-D (Plate 1). The wedge is bounded in the west by a normal fault with downthrow to the west (the Deakin Fault), and on the east by a reverse fault. The predominantly Ordovician rocks of which the wedge is composed have been thrust against the footwall block of the reverse fault. Silurian shales in the footwall show flow folding and brecciation; drag folding on a small scale is widespread, and all minor folded structures are overturned to the east.

The reverse faulting probably followed normal faulting as the result of a reversal of movement along the Deakin Fault; however, the movements along both faults probably took place within a single period of deformation.

In the south of the area, a fault striking north-north-west joins the Deakin Fault at an acute angle. Displacement along the fault has not been seen, and determination of the movement on the fault must await the collection and identification of fossils in the area.

DESCRIPTION OF ROCK UNITS

PRE-MIDDLE ORDOVICIAN

Outcropping sediments which underlie Middle Ordovician rocks are about 300 feet thick; their exact age is unknown as fossils have not been found. The lowest beds originally consisted of thin-bedded siltstone and mudstone but have been regionally metamorphosed to a chlorite-sericite schist; they underlie massive quartz greywacke, with interbedded shale, which grades up into quartz sandstone and siltstone. The sandstone beds are less than four feet thick and contain numerous slump structures. These rocks dip to the west and occupy most of the wedge between the two faults (see "Structure"); the dip increases from 10 degrees in the east to 80 degrees in the west; load-casts and truncated slump structures indicate that the beds have not been overturned. On the west the pre-Middle Ordovician rocks are overlain by micaceous sandstones and siltstones of probable Middle Ordovician age, and are faulted against undifferentiated Silurian sediments; on the east the reverse fault has brought them into contact with Lower Silurian shales.

MIDDLE ORDOVICIAN

A sequence of white and pink sandstone, micaceous siltstone, shale, mudstone, and chert east of, and within the fault-bounded wedge, lithologically resembles the Pittman Formation which, in Canberra, contains fossils of Middle Ordovician age. Fossils have not been found by the author in the Belconnen area, but Dr. A.A. Opik reports the presence of thin chert interbeds with radiolaria, and conodonts in shale near 2CA radio transmitter, which lies one mile to the east of the area (personal communication); similar fossils are found in the Pittman Formation in Canberra. The sandstone and siltstone are massive, soft, and deeply weathered; they form most of the Black Mountain Horst and are at least 200 feet thick in this area. Near the reverse fault, the sandstone is shattered and forms asymmetrical folds whose fractured axial planes dip steeply to the west.

UPPER ORDOVICIAN

Acton Shale

Acton Shale crops out in a syncline infolded along the crest of a north-east trending ridge, in the east of the area. Graptolites, identical with those of the Acton Shale in Canberra, have been collected from this locality by Öpik (locality F1, Plate 1). The formation consists of black, partly silicified, carbonaceous shale which has been leached grey in places. The Acton Shale is resistant to weathering, and is generally preserved as infolds along the top of ridges surrounded by more easily weathered Pittman Formation.

A shaft north-east of Belconnen Naval Station (locality F2) was sunk in Acton Shale, and the spoil of red and grey shale contains many biserial graptolites of Upper Ordovician age.

LOWER SILURIAN

Grey shales, some containing Monograptus exiguus, have been found at a number of localities; the Monograptus-bearing shales are considered on lithological and fossil evidence to be a north-western continuation of the State Circle Shale. Mapping in great detail would be required to delineate the State Circle Shale from other mudstone, calcareous mudstone, and tuffaceous shale of probable Lower Silurian age. For this reason, all sediments thought to be of Lower Silurian age are grouped together.

Monograptus-bearing shales crop out in a very disturbed area along Ginninderra Creek, fifty yards east of the Barton Highway; they are also to be found at two places in an old road cutting which is now by-passed by the straightening of the Barton Highway, and at two points south-west of the Barton Highway in the P.M.G. coaxial cable trench (locality F3). The shale contains small asymmetrical drag-folds whose axial planes dip to the west-north-west; the anticlinal crests are about two to four centimetres apart. The deformation was produced by the over-riding from the west of competent feldspathic sandstone over the incompetent shale. At no other point in the area do Monograptus-bearing shales underlie sandstones; they are found beneath mudstones, tuffaceous shales, and shales with no sandy interbeds whatsoever. The fact that sandstone rests on the shale at this point is attributed to thrusting from the west-north-west, with movement taking place along a westward-dipping reverse fault. Dip of the fault increases from 15° in the east, to 70° further west.

Monograptus-bearing shale is also present south of Belconnen Naval Station, just to the east of the stock route (locality F4); it is thought to overlie Middle Ordovician sediments unconformably at this point.

MIDDLE AND UPPER SILURIAN

Undifferentiated Silurian shales lie west of the Deakin Fault in the central part of the area; the shales are well bedded, grey and calcareous, and dip gently to the south-west. The shales have been metamorphosed to a hornfels on the west side of Ginninderra Creek opposite Belconnen Naval Station; this metamorphism was caused by the nearby granite rather than the Painter Porphyry which has had little effect on the surrounding rocks elsewhere. Within the hornfels, a nautiloid and some corals have been found (locality F5).

Near Glebe Homestead, the undifferentiated Silurian rocks include buff-coloured mudstone, fissile shale, crystal tuff, and lavas. Some rocks near the granite margin appear to be recrystallised, and nodules of epidote are present. Gastropods, brachiopods, and trilobites have been found in the mudstone along the creek bed thirty yards south of Glebe Homestead, but have not been collected (locality F6). The fossils suggest a Middle Silurian age for some localities and probably an Upper Silurian age for others.

W. R. Morgan has described in the Appendix thin sections from the Volcanics as deuterically altered dacite. Slide Nos. 4646 and 4648 are of rocks obtained from localities L1 and L2 respectively.

INTRUSIONS

Granodiorite-Porphyry

A massive porphyritic granodiorite, dark green in colour and containing many xenoliths, occupies a large part of the area; it intrudes the undifferentiated Silurian sediments. The rock is well-jointed and deeply weathered. It is cut by a number of quartz dykes that trend north-west; numerous quartz veins, which contain some epidote, are present along joints. There are many xenoliths near the margin; the contact against Silurian mudstone in the creek bed south of Rose Hill Homestead is well defined. There is no metamorphism, but the mudstone is closely jointed and shattered near the irregular contact with the porphyry, which is regarded as an intrusive contact.

The granodiorite-porphyry is similar in composition to the Painter Porphyry of the Canberra area, and may be part of the same intrusion; however, the connection cannot be traced out in the field. The Painter Porphyry is regarded as a sill in the Canberra area (Öpik, 1954). In the Belconnen area, the granodiorite-porphyry has a margin more or less conformable with the surrounding sediments, and could also be regarded as a sill with transgressive phases.

W. R. Morgan has examined the rock in thin section and classified it as a saussuritized and chloritized granodiorite-porphyry. (See Appendix: Slides No. 4644 and 4645 are of rocks obtained from localities L3 and L4).

Granodiorite

A lenticular mass of intrusive granodiorite, elongated to the north-west, crops out in the south-west quadrant. It is massive, shows no foliation, and has evenly-spaced joints that have produced, in places, boulders up to six feet across. It intrudes Ordovician and Silurian sediments, and the granodiorite-porphyry. Intrusion took place after the formation of the Deakin Fault, which the granite crosses without displacement. A large quartz dyke, 20 feet wide, has been prospected by a shaft and a few diggings; no mineralisation is present, but vugs contain euhedral quartz crystals, and casts of calcite crystals. The surrounding sediments show low-grade metamorphism.

The granodiorite is a grey, coarse-grained, holocrystalline rock containing euhedral crystals of biotite and plagioclase. The phenocrysts of plagioclase show multiple twinning, zoning, and alteration in the core of the crystals; they range in length from 10 to 20 mm.. Slides were not available for detailed description.

CAINOZOIC

Ironstone

Ironstone caps a number of rises on the Black Mountain Horst. It is composed of hydrated iron oxide; considerable manganese staining is visible, and minor amounts of manganese dioxide are present. A deep red soil is developed on the deposit by the Barton Highway. The small ironstone capping in the extreme north-east of the map and another ironstone capping (not shown) a mile farther to the east overlie Silurian sediments. As a result of leaching, white clay has been produced beneath the ironstone cappings wherever argillaceous material was present. This clay has been mined by amateur potters in Canberra.

Silicified quartz sand and gravel have been found around the margin of the ironstone on the Barton Highway and the association of silicified material and ironstone at this point and at other points in the area north of Canberra suggests they may have a common origin. If formation of the ironstone and silicification are contemporaneous, they must post-date deposition of the gravel.

Gravel

The gravel deposit in the south-west consists of quartz sand and gravel about ten feet thick, capping a rise south of Ginninderra Creek. It has not been silicified.

The age of the gravel is not known, but proximity to Ginninderra Creek suggests that it is a river gravel belonging to an earlier stage in the history of the creek. The gravel has been used for road metal.

REFERENCES

ÖPIK, A.A., 1954 - Geology of the Canberra City District, in CANBERRA, A NATION'S CAPITAL, ed. by H.L. White. Aust. Ass. Adv. Sci., Handb. for Canberra, 131-148, pl. 33a.

_____, 1958 - The Geology of the Canberra City District, Bur. Miner. Resour. Aust., Bull. 32

APPENDIX

Description of Thin Sections

by

W. R. Morgan

Note: A number prefixed by R is the registered number of the rock which is retained in the Bureau of Mineral Resources Museum. The slide number is the number assigned to the thin section in the Bureau of Mineral Resources slide collection at the Laboratory, Gordon Street, Canberra City.

Locality 1

R7964 Slide number 4646

The hand specimen is seen to have a dark grey, very fine-grained groundmass that encloses phenocrysts of tabular white feldspar, prismatic ferromagnesian minerals, and rounded quartz. The phenocrysts range between 0.5 mm. and 2 mm. in size, and they show some flow orientation. The weathered surface has a thin crust of hydrated iron oxide-enriched material.

In thin section the rock is seen to have a fine-grained idiomorphic-inequigranular groundmass, in which abundant lean laths of plagioclase show strong flow texture. The groundmass encloses and flows around anhedral to euhedral phenocrysts.

The phenocrysts consist of plagioclase, altered ferromagnesian mineral, and quartz. Labradorite (about An_{60}) forms tabular crystals that are, in places, strongly saussuritized. The ferromagnesian mineral appears to have been amphibole, some of which was probably pseudomorphed by biotite. Both are now replaced by green chlorite, epidote, carbonate, and sphene: epidote occurs more commonly in the altered "biotites". Quartz forms anhedral to subhedral, embayed phenocrysts.

The groundmass is composed mainly of lean, lath-like plagioclase crystals that range in size from 0.003mm. breadth and 0.01mm. length to 0.01mm. breadth and 0.06mm. length. The plagioclase has a refractive index higher than that of Canada balsam. Chloritized(?) amphibole forms euhedral prismatic crystals. Some chlorite occurs interstitially to plagioclase. Quartz is present as granular, slightly poikilitic crystals. The whole groundmass is dusted with somewhat sparse granules of hydrated iron oxide.

The rock is cut by several veins, 0.02mm. thick, containing fine, dusty, opaque material. Two or three other veins, of a similar thickness, contain quartz, carbonate, and small amounts of epidote.

Accessory leucoxene, zircon, and apatite may be found in the groundmass. Zircon may sometimes be seen enclosed in chlorite, and cause pleochroic haloes in that mineral.

An estimation of the percentages of minerals present in the rock is: labradorite: 65, ferromagnesian minerals: 20, and quartz: 15. The rock is a deuterically altered granodiorite porphyry, or dacite.

Locality 2

R7966 Slide number 4648

The hand specimen has a grey, fine-grained groundmass enclosing phenocrysts of tabular white feldspar, prismatic ferromagnesian minerals, and rounded quartz. The phenocrysts have an average size of 1mm., although some measure up to 4mm. The groundmass tends to be amygdaloidal. On the weathered surfaces, feldspar and quartz phenocrysts stand out in relief.

In thin section the specimen is seen to be porphyritic, and has a fine-grained amygdaloidal groundmass which shows some flow lineation of the tabular feldspars.

The phenocrysts consist of feldspar, ferromagnesian minerals, and quartz. Albite-oligoclase (An_{10}) forms subhedral to euhedral, commonly corroded, tabular crystals, that are in places, strongly saussuritized. The crystals range in length between 0.25mm. and 3.25mm. Potash feldspar occurs as tabular, somewhat kaolinized, phenocrysts, having a refringence lower than that of Canada balsam, and a large negative optic axial angle. Quartz occurs as rounded, commonly embayed phenocrysts that have pseudo-inclusions in places. Amphibole has been pseudomorphed by a variety of alteration-products: green chlorite, yellowish epidote, brownish nontronite, and leucoxene. Some unaltered, and partly chloritized augite is present as rare clusters of small euhedral phenocrysts.

The groundmass consists of flow-oriented tabular sodic feldspar, green chlorite pseudomorphing prismatic crystals and occurring as interstitial masses, and granular quartz. Accessory black iron ore, leucoxene, apatite, epidote, and zircon are also present.

In the groundmass are several amygdale- and schlieren-like structures, ranging up to 1.25mm. in size. Commonly these have a thin rim of zeolite that encloses fine, scaly, green chlorite. Some, however, differ in being composed of augite and zeolite with, in places, quartz. The augite was found to have a birefringence of 0.026, and on a universal stage, was found to be biaxial positive, with an apparent 2V of 52°, and to have ZAC = 43°. The schlieren are connected by very thin veins containing zeolite and chlorite, and, in places, fine dusty opaque material.

An estimation of the amounts of minerals present is: Plagioclase: 50%, potash feldspar: 5%, ferromagnesian minerals: 25%, quartz: 15%, and others: 5%. The rock is a deuterically altered granodiorite porphyry, or dacite.

Locality 3		Locality 4
R7962	and	R7963
Slide No.4644		Slide No.4645

These two specimens are very similar to one another, and so are described together. The hand specimens are pale grey, porphyritic acid igneous rocks, in which phenocrysts of tabular feldspar, rounded quartz, and apparently prismatic ferromagnesian minerals are enclosed in a fine-grained quartzo-feldspathic groundmass. The weathered surfaces are stained with orange-brown hydrated iron oxide.

In thin section, the specimens are seen to have a hypidiomorphic-granular groundmass, with average grain-sizes ranging between 0.03mm. and 0.1mm. The groundmass encloses numerous hypidiomorphic phenocrysts that range in size between 0.1mm. and 5.0mm.

The groundmass contains stubby, tabular to granular, partly sericitized plagioclase that has a low refractive index, indicating that it is sodic. Quartz is granular to interstitial. Green chlorite occurs as fibrous intergrowths replacing a tabular ferromagnesian mineral, possibly amphibole. Some interstitial chlorite is also present.

With regard to the phenocrysts, labradorite occurs in specimens R7962 (An_{60}), and andesine (An_{40}) in R7963. In both specimens it is commonly saussuritized, and forms sub-hedral to anhedral phenocrysts with embayed margins and pseudo-inclusions.

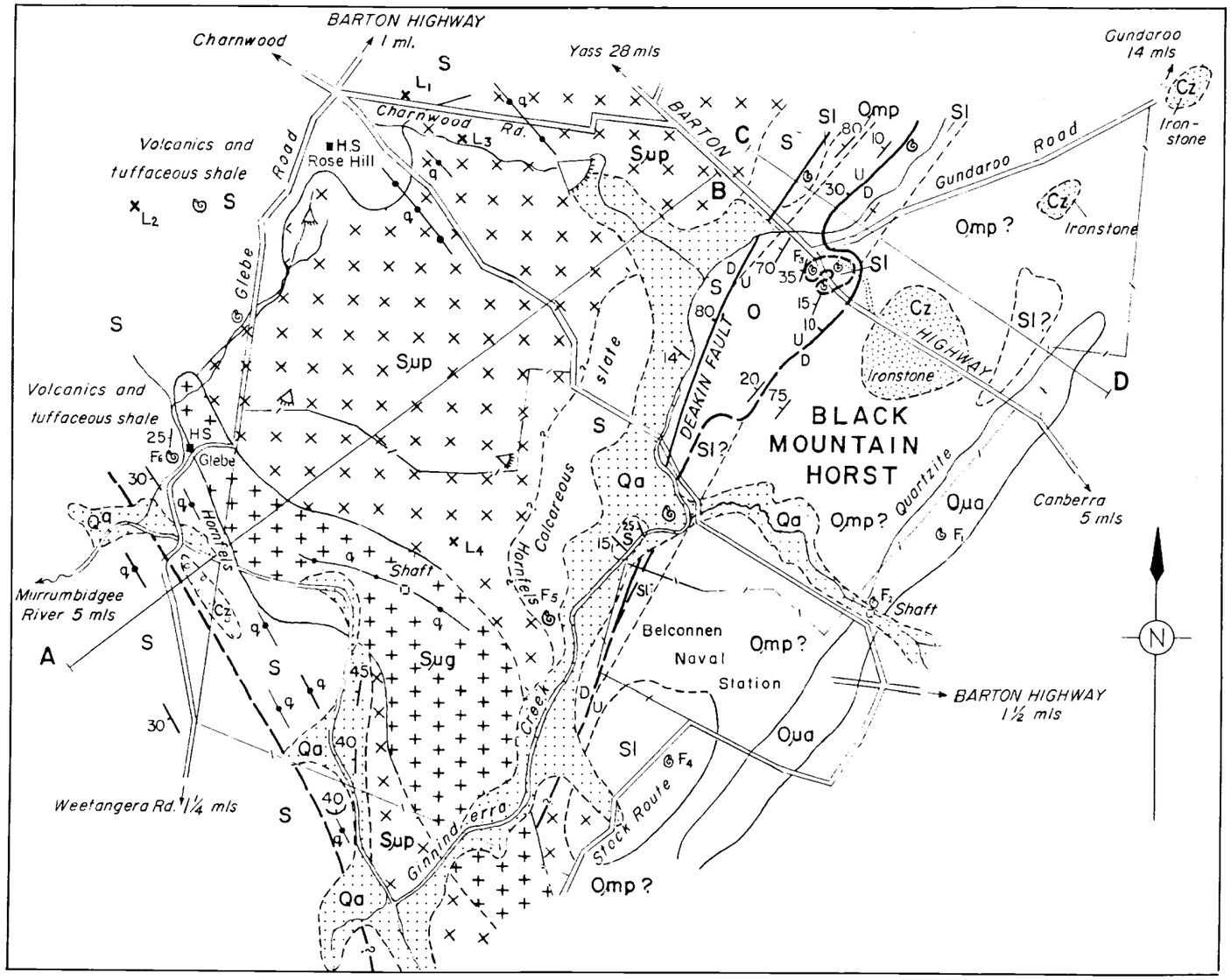
The original phenocryst ferromagnesian mineral appears to have been a prismatic and, in places, acicular amphibole, although some of this was probably pseudomorphed by biotite. Both are now replaced by late stage minerals. Amphibole not pseudomorphed by biotite has been converted to apple-green chlorite which forms masses of sub-radiating flakes having grey polarization colours; granular sphene, carbonate, and epidote are also present, and, in places, some flakes of nontronite are intergrown with chlorite. The biotite pseudomorphs commonly have an ampibole-like outline, but the chlorite (penninite) replacing it has a well marked biotite-like cleavage. Prismatic sphene, epidote, and prehnite are also commonly present, and are all elongated parallel to the "biotite" cleavage. In specimen R7963, sericite is also present.

Accessory apatite forms stubby prismatic crystals commonly associated with the ferromagnesian minerals. Zircon may be found in the groundmass and, with allanite, enclosed in chlorite and causing pleochroic haloes in that mineral. Granules of leucoxene may be found in the groundmass. Some former irregular cavities have been filled with carbonate, and others with chlorite.

An estimation of the percentages of minerals present in these specimens is: plagioclase: 55-60, quartz: 20-25, ferromagnesian pseudomorphs: 20-25. The specimens are somewhat saussuritized and chloritized granodiorite porphyries.

GEOLOGY OF THE BELCONNEN AREA AUSTRALIAN CAPITAL TERRITORY

Geology and compilation by E.G.Wilson 1961.



REFERENCE

CAINOZOIC

Quaternary	Qa	Soil and alluvium
	Cz	Gravel
	Cz	Ironstone

PALAEOZOIC

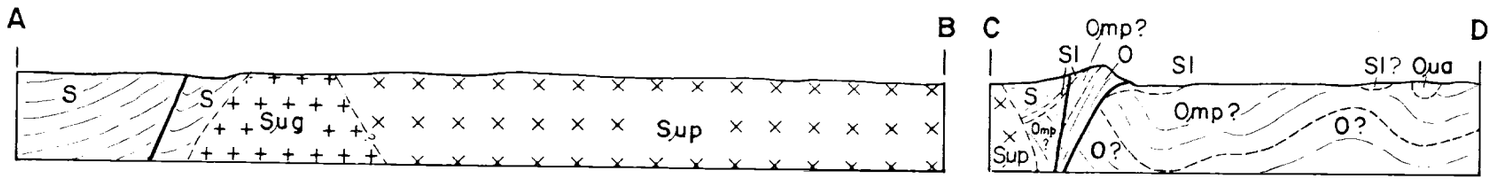
Silurian	Upper	+Sug+	Granodiorite
		×Sup×	Granodiorite - porphyry
		S	Undifferentiated (sediments and volcanics)
	Lower	Sl	Mudstone and shale, includes State Circle Shale with Monograptus exiguus)
Ordovician	Upper	Oua	Acton Shale ? Pittman Formation
	Middle ?	Omp	White and pink sandstone and siltstone
		O	Quartz sandstone, subgreywacke, sericite schist

- Geological boundary
- U 15 / D — Fault showing direction of movement and dip } Where position is approximate - line is broken, where inferred - queried.
- 30 — Strike and dip of strata.
- × — Vertical strata.
- q — Quartz vein
- F2 — Marine fossil locality.
- L1 — Rock specimen locality.
- Railway.
- Road.
- Road (abandoned)
- Boundary of C.S.I.R.O. farm.
- Territory boundary.
- H.S. Homestead.
- Dam.

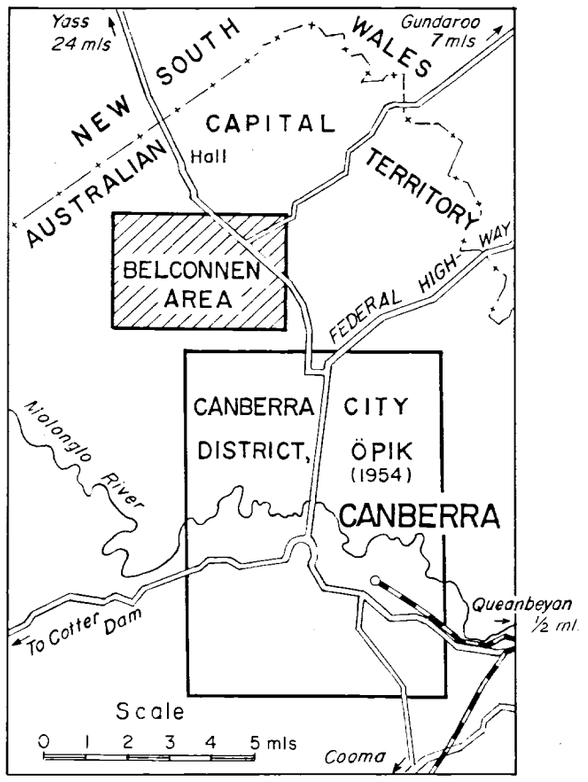
VERTICAL AND HORIZONTAL SCALE

Chains 40 30 20 10 0 — 0 — ½ — 1 Mile

SECTIONS



LOCALITY SKETCH



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EJ