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# BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

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1967/146



GEOLOGICAL INVESTIGATIONS, BELCONNEN SHEETS H4C & H5A, AUSTRALIAN CAPITAL TERRITORY, 1967

by

L. Yendall, L.E. Walraven, H.F. Doutch



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Record 1967/146

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GEOLOGICAL INVESTIGATIONS

BELCONNEN SHEETS H4C & H5A

AUSTRALIAN CAPITAL TERRITORY, 1967

## INTRODUCTION

This report deals with part of the Belconnen area, five miles north-west of Canberra City, three miles south of Barton Highway, bounded by Glebe Road in the west and Weetangera Road in the south. The area includes the proposed regional centre and artificial lake for the new satellite city of Belconnen. The area mapped, approximately three square miles, is covered by map sheets H4C and H5A of the A.C.T. Contour Series, Scale 1 inch = 200 feet, provided by the Lands & Surveys Branch, Department of Interior, A.C.T.

The land is at present occupied by farms and is used for grazing sheep and cattle. In the north, most of sheet H4C is covered by the C.S.I.R.O. Experimental Farm.

Mapping was carried out during July and August, 1967; a total of eighteen geologist-days was spent in field work. Information was plotted directly onto the contour sheets H4C and H5A; outcrops were mapped in detail and all surface evidence of depth of soil was noted.

Identification of lithologies is based on hand specimens; no thin sections were cut and examined. Formation thicknesses cannot be estimated because of lack of outcrop and difficulty of obtaining dip measurements.

Previous geological work in the area was carried out by Wilson (1961,1966), and work on soils by van Dijk (1965). Several unpublished reports on neighbouring sheets in the Belconnen district have been produced by vacation students working at the Bureau of Mineral Resources. Published reports on the geology of the Canberra district include Pittman (1911) and Öpik (1958).

## PHYSIOGRAPHY.

Physiographically the area can be divided into four units:

1. Broad, gently-undulating terrain on Upper Silurian sediments and volcanics west and south-west of the Deakin Fault.

2. The hillier, mainly granite, country contained by the V-bend of Ginninderra Creek.

3. Gentle valley slopes on granite and altered sedimentary rocks along the east (left) side of Ginninderra Creek.

4. Rough hills of Ordovician metasediments in the south-east of the area.

The four units are the result of differential weathering and erosion of hard and soft rocks, some of which have been juxtaposed by fault movements. The courses of Ginninderra Creek and two major north-south tributaries on sheet H5A are controlled by erosion along faults. Differences in weathering are reflected in the relative abundance of outcrop of the various rock types: resistant Ordovician rocks in the south-east of sheet H5A crop out abundantly, but softer Upper Silurian sediments and volcanics are generally seen only in creek beds, or where they have been silicified in fault zones. Soil thicknesses and types mapped by van Dijk (1965) complement outcrop abundance and reflect the same process.

The area is drained by Ginninderra Creek and its tributaries. Ginninderra Creek is gradually incising its valley down through old flood plain deposits to the base level created by Ginninderra Falls. Similarly its tributaries are adjusting to the slowly changing base level of Ginninderra Creek, and in their lower courses display variations of gradient or incision of fan deposits. Ginninderra Creek partly dries up occasionally; its tributaries are all non-perennial. The rate of erosion is slow, apart from some gullying induced by man's activities. Seepages and permanently or intermittently saturated superficial deposits are dealt with later in this report. Many of these occurrences have been taken advantage of for the construction of earth dams.

## GEOLOGY

The geology on maps H4C and H5A is broadly divided by the Deakin Fault. North-east of the Deakin Fault, outcropping Middle Ordovician and Silurian metasediments and volcanic rocks are intruded by granodiorite. South-west of the Deakin Fault, Upper Silurian volcanics and sediments crop out.

In general, the strata of the area have been thoroughly lithified, and slightly metamorphosed. Pelitic Lower Silurian and Ordovician rocks are weakly cleaved; sedimentary rocks of this age are therefore described as metasediments but similar Upper Silurian rocks are considered not to have been altered to the same degree and are classified as sediments. Local silicification, shearing and crumpling affects all strata in the area.

Beds dip moderately steeply and are folded on roughly north-westerly axes. Ordovician strata are crenulated in places.

The geology of areas H4C and H5A may be summarised as follows.

| | | |
|---|---|---|
| Upper Silurian | Granodiorite | (Sg) |
| Upper Silurian | Volcanics & Interbedded Sediments | (Sud) |
| | Yarralumla Formation | (Suy) |
| Lower-Upper Silurian | Volcanic Sequence A | (Sav) |
| Lower Silurian | State Circle Shale? | (Sls?) |
| Upper Ordovician | Acton Shale ? | (Oua) |
| Upper-Middle Ordovician | Pittman Formation | (Omp) |

ORDOVICIAN

Pittman Formation (Omp)

The oldest sediments present were mapped by Wilson (1961, 1966) as Pittman Formation. In O'Connor, A.C.T. the sequence consists of quartzite, metagreywacke, chert and slate. On sheet H5A the formation consists predominantly of silicified siltstone (with grainsize that ranges from fine to medium), silicified sandstone and shale. It was mapped by Wilson (1966) partly as Pittman Formation, and partly as Acton Shale. On structural evidence, this sequence of metasediments has been entirely included in the Pittman Formation. The silicification is probably related to the intrusion of granodiorite into the sediments. Although outcrop is extensive, the beds are closely jointed and no indication of dip or dip direction was found. The rocks are resistant to weathering and soil cover is thin. No fossils were found; according to Öpik (1958), the Pittman Formation is Middle-Upper Ordovician in age.

Acton Shale? (Oua)

On sheet H4C, grey sandstone of the Pittman Formation is conformably overlain by rocks correlated with the Acton Shale(Öpik, 1958). They consist of black carbonaceous, silicified slate, with bands of brown shale and siltstone; the unit crops out in the bed of Ginninderra Creek. It contains Upper Ordovician graptolites, possibly Orthograptus (personal communication by D.L. Strusz). The beds are strongly cleaved and minor folding is visible. The beds form a syncline, the limbs of which dip to the east and west, but this is not shown on the map. According to Wilson (1966), the syncline plunges to the north-east.

The lithology, structure and fauna are similar to those of the Acton Shale of the Canberra City area, but until further mapping is carried out, the unit cannot be definitely assigned to the Acton Shale.

SILURIAN

State Circle Shale? (Sls?)

Overlying the Upper Ordovician beds on sheet H4C are silicified shale and siltstone which rarely show bedding planes. These beds appear to overlie conformably the strata mapped as Acton Shale although in other parts of the Canberra district Silurian rocks lie unconformably on Ordovician strata. Rocks in many of the outcrops are very closely jointed, fractured and sheared, and contain quartz veins and bands of quartzite. The quartz-rich areas form a series of resistant hills, with little soil, that trend north-west, parallel to Ginninderra Creek. The silicification is probably related to intrusion of the granodiorite which crops out in the east of Sheet H4C. As no fossils were found the formation cannot be definitely correlated with the Canberra succession. By comparison with the underlying rocks (Oua), it is probably Lower Silurian and may be State Circle Shale, or its equivalent.

Volcanic Sequence A (Sav)

Overlying the Lower Silurian beds, on sheet H4C, is a succession of volcanics, here called Volcanic Sequence A, that dips to the west and crops out almost continuously along the western half of Ginninderra Creek east of the Deakin Fault. The volcanics extend north into sheets G4B and H4A. In hand specimen, they are very weathered and are green with white feldspar; grainsize ranges from 0.6 to 0.1cm. Petrological examination of thin sections of rocks from G4B and H4A indicate that there is a complex sequence of acid to intermediate dacitic tuffs, lava flows, and high level intrusives. The age of the sequence is not known: it lies within the range Lower to Upper Silurian. The volcanics could be genetically related to the granodiorite which intrudes them and cuts the Ginninderra Fault. Further mapping to the north of sheet G4B is required before this unit can be defined.

Much of the outcropping rock previously mapped as "Painter Porphyry" intruding sediments (Wilson, 1961) north-east of the Deakin Fault, is now believed to be part of Volcanic Sequence A. The interpretation is based on detailed mapping to the north-west of the area (sheet G4B) and the examination of slides.

Upper Silurian Volcanics and Interbedded Sediments (Sud)

Öpik (1958) has divided the Upper Silurian into the Deakin Volcanics and the overlying Yarralumla Formation, together forming the Red Hill Group. On sheet H5A, west of the Deakin Fault, coarse-grained welded tuffs crop out extensively in creek beds and probably correlate with the Deakin Volcanics. They are grey to purple and coarser-grained than those of Volcanic Sequence A which are grey-green. The purple coarse-grained tuffs are not found east of the Ginninderra Fault.

Yarralumla Formation (Suy)

Unfossiliferous shale and siltstone exposed on the boundary between sheets H4C and G4D are probably the same age as the Yarralumla Formation as similar rocks 200 feet to the west, on sheet G4D, contain fossils similar to those in the Yarralumla Formation. They are brown, cleaved and dip south-west; shale predominates over siltstone.

Granodiorite (Sg)

The granodiorite was described by Wilson (1961, 1966). It intrudes the Pittman Formation, rocks correlated with the Acton Shale, the ?Lower Silurian metasediments and Volcanic Sequence A. Shale and siltstone near the contact with the granodiorite have been silicified and fractured. The rock is leucocratic in hand specimen, with large white feldspars and biotite. It occurs only on the north-east side of the Deakin Fault and cuts the Ginninderra Fault in the north-east corner of H5A. The rock mass was probably emplaced in Upper Silurian time,the intrusion belonging to the Painter Phase or the post-Painter Phase of the Bowning Orogeny. (Opik, 1958).

Quartzite and Silicification.

Quartzite has been formed by two processes:
(1) North-west and north-east trending zones of quartz stringers, which have converted the host rock to quartzite, occur in the north-west of sheet H4C and in the north-east of both sheets. The stock-works of quartz stringers are attributed to quartz injection along faults.

(2) Around the margin of the granodiorite, on both sheets, contact silicification has affected the metasediments.

CAINOZOIC

Deposits of sand and gravel occur in the stream beds and patches occur on hills, particularly on sheet H5A. Angular to sub-rounded quartzitic gravel and boulders near "Emu Bank" are about ten feet thick (Wilson, 1966). In areas devoid of outcrop, soil is generally well developed. The greatest depth of soil measured is 15feet in the main creek flowing to the north on sheet H5A. Along creeks the soil depth ranges from 2-15 feet. Superficial deposits are dealt with in more detail under "Engineering Geology".

Structure

The main structural feature is the Deakin Fault Zone which trends north and north-west. The zone has been traced south and north-west of the area mapped and its arcuate trace can be clearly seen on air photographs.

In the Canberra area, the movement along the zone was normal and resulted in downward displacement of the south-west block of at least 4,000 feet (Öpik, 1958). This event was possibly part of the Faulting Phase of the Bowning Orogeny. The fault is covered by Lower Devonian ashstone and by other, probably Lower Devonian, volcanics (Öpik, 1958).

On sheets H4C and H5A, the fault zone cuts Lower and Upper Silurian sediments, metasediments and volcanics. Although movement was estimated by Wilson (1966) to be thousands of feet (based on evidence found near "Emu Bank"), the amount of displacement cannot be accurately determined as it is impossible to determine thicknesses of the metasediments in the area.

A smaller north-eastern fault, which Wilson (1966) shows as an extension of the Deakin Fault, is renamed the Ginninderra Fault in this report; it is cut by granodiorite. Wilson (1966) also shows another north-east trending fault to the east of the Deakin Fault. Within sheet H5A, the only evidence for this fault is a gossan with iron-rich quartz veins, along the western edge of the sheet.

Minor folds can be seen in outcrops of Acton Shale, Lower Silurian metasediments in the bed of Ginninderra Creek, and on the hills flanked by the V-bend of Ginninderra Creek.

A fold axis may occur between outcrops of the Acton Shale, State Circle Shale? (H4C) and the silicified sandstone and shale of the Pittman Formation (H5A). The line of possible axis is obscured by the intrusion and deformation by the granodiorite. In addition the volcanics are massive and show no bedding planes.

The youngest sediments involved in the folding are Upper Silurian; the folding was probably produced by the Folding Phase of the Bowning Orogeny. More detailed work is necessary to determine the nature of folding more accurately.

ENGINEERING GEOLOGY

All bedrock in the area is, where fresh, strong, hard and stable; it would require explosives to break and/would be amply strong to support all normal building and engineering structures. No limestone or other soluble rocks in which solution cavities might have developed, are known to occur. The main spheres of uncertainty are therefore the depths and nature of unconsolidated sediments and of weathering and groundwater conditions.

GROUNDWATER, UNCONSOLIDATED SEDIMENTS AND DRAINAGE

van Dijk (1958) has distinguished between

(a) seepage caused by groundwater
(b) superficial hillslope seepage
(c) seepage of linear aquifers (in valley bed deposits)

His general remarks should be read in conjunction with the locality descriptions given below under similar headings.

(a) Groundwater:

No investigation of groundwater in bedrock has been made, and no reliable estimate of bore yields is possible. It is very likely that groundwater behaviour is the same as elsewhere near Canberra, with an annual rise of the piezometric surface in the latter half of each year helping to maintain flow in Ginninderra Creek during the succeeding hotter months.

An intermittent spring on the top of a spur above the dam west of "Emu Bank" homestead is probably supplied from a bedrock aquifer. At the time of writing (October, 1967) the spring is dry, and the piezometric surface is at its lowest level for many years. In the wettest years groundwater may rise to the surface at a number of localities not discernable during the present survey.

The spring could be controlled by excavating the area intermittently saturated to a depth of two feet, filling the excavation with carefully graded layers of boulders, gravel and sand, and capping with one foot of impermeable material. Overflow could be accommodated by a closed or open drain of the dimensions of, and possibly following, the present natural overflow channel.

(b) Superficial hillslope deposits and drainage:

Superficial deposits of clay, sand and gravel, generally modified into soils, range from 0-5 feet in depth on the hills and valley slopes. These deposits cover the greater part of sheets H4C and H5A. The mapping units of van Dijk (1965) are the best general guide for the moment to soil depths and classifications. A more detailed analysis of soil profiles in the Canberra area is given in van Dijk (1959).

No seepages or permanently saturated localities in the superficial hillside deposits were noted during the survey. Few, if any, drainage problems should arise except in areas of slope wash, scree and alluvials fans (see maps). Such occurrences should be treated with caution; coarse grass cover on fans and scree suggest intermittent saturation during wetter years. Perched aquifers have frequently been found in these landforms elsewhere around Canberra - e.g. at Woden (Wilson, 1963). Cut-off drains near the heads of fans would divert creek water from them; drainage problems in slope wash and scree should not be serious and can best be solved as they arise.

Minor earth slumping occurs sporadically on steep slopes cut into granite by an abandoned meander of Ginninderra Creek on the eastern edge of sheet H4C. Detailed investigation is necessary before methods of stabilisation could be considered.

(c) Valley bed deposits and drainage:

Valley bed fill may be flood-plain alluvium, colluvial slope wash deposits, or a mixture of both. On sheet H5A isopachs (superficial deposit thickness contours) taken from Wilson (1966) have been modified from observations made during the present survey. They should be considered to indicate the most probable depths of unconsolidated material. They have not been drawn on sheet H4C, where thicknesses probably exceed 5 feet only along Ginninderra Creek, and there the flood plain alluvium would probably be thicker than 10 feet in only a few places, if any.

Ginninderra Creek is cutting down into and eroding its earlier alluvial flood plain at a faster rate than it is adding material to the plain during floods, but the rate of erosion is slow. The flood plain deposits range from 1-2 feet thick in constricted parts, to 10 feet in wider parts of the creek valley. Buried soil profiles are visible in the creek banks. Buried clays, particularly heavy black clay soils, indicate that water may perch after heavy rains or floods. The swamp in the lower reaches of the tributary immediately west of "Emu Bank" homestead is formed by water perched on such an old black clay soil; it can be drained by normal methods (if not inundated by the proposed artificial lake).

Construction work on the river alluvium of Ginninderra Creek in the vicinity of alluvial fans should not be planned before the drainage characteristics of the fans have been fully investigated; fans can hold both creek and rain water, and discharge it slowly, and more or less continuously, into the adjoining river alluvium. Another hazard to watch for in the larger areas of river alluvium is buried, permanently saturated, lenses of gravel or sand.

The other major occurrences of valley bed deposits are along the two northerly-flowing tributaries of Ginninderra Creek which join the creek north of "Emu Bank" homestead.

The valley bed of the more westerly of the two is filled with up to 10 feet of mixed colluvium and alluvium, at present undergoing slow erosion. Because of the creek's low gradient there had been patchy development of heavy black clay soils on the surface of the deposits. In places this has now been covered with fill, which may therefore become waterlogged in wet years.

A bog where a small creek enters the dam west of "Emu Bank" homestead will diminish and possibly disappear if the dam is destroyed.

All erosion gullies associated with this tributary could be converted to storm water drains, and gullying would then stop. However some linear aquifers of sand and gravel may still remain, and might present problems if punctured by excavations for large buildings. If it is proposed to lay drains directly on sand and gravel deposits in the present main tributary bed, the extreme variability in permeability of the bed of the tributary should be borne in mind.

The valley bed of the tributary east of "Emu Bank" homestead contains the swamp already described. Upstream from the swamp, above a rock bar at about E18900, N27050, sediments (mainly colluvium), including shrinking clays, is up to 15 feet thick. The engineering properties of the clays should be investigated further before proceeding with major construction work. The trunk erosion gully of this tributary is of recent origin; the roots of a living eucalypt of moderate size cross it ten feet above its floor. Conversion of the gully to a storm-water drain would halt erosion. However, perched aquifers and saturated sand and gravel lenses are quite likely to occur in the floor of the valley and to provide water which would discharge over the rock bar in wet years, together with bedrock groundwater. The alluvial fans on the eastern side of this tributary would contribute water to its aquifers, and should be treated as suggested generally in (b) above.

In the smaller tributary creeks there are a number of boggy areas, mainly caused by valley constrictions and rock bars at the exits of small basins. Most of the constrictions and bars are associated with silicified rocks along the Deakin Fault (see maps). The basins are generally characterised by the development of heavy black clay soils and the growth of coarse grasses, and/or intermittent springs and seeps which have caused gullying upstream from the constriction. van Dijk (1958) discusses this phenomenen, and suggests that the general water table (piezometric surface) rises to the surface in such places. The best remedy is probably a deep central drain in the lower end of the waterlogged area, as van Dijk suggests, cutting through the rock bar if necessary.

## EXCAVATIONS

A general account of the distribution and thickness of alluvium and colluvium is given in the preceding section. Little systematic information is available on depths of weathering of the bedrock. As a generalization, doubtless with many exceptions, bedrock tends to be more deeply weathered in the low-lying areas than the higher parts. Most rock exposures along Ginninderra Creek are weathered/but the general level of weathering in the area would not extend below the level of the creek. The exposed rock along the tributaries, east and west of "Emu Bank" homestead is generally moderately to slightly weathered; that in the upper reaches of the tributaries is weathered to an unknown depth. It is understood that the trunk sewer north of "Emu Bank" homestead to about co-ordinates 34,300 E, 16,750 N was excavated entirely by mechanical means. Most of the material removed was unconsolidated sediments with depths up to 12 feet but towards the northern end, where the greatest depth of excavation was 16 feet, the trench was probably in weathered bedrock. Explosives were used in places for the bottom four feet, north of co-ordinates 34,300 E, 16,750 N to the northern banding of sheet H4C; depth of excavation ranged from 8 to 16 feet.

South from "Emu Bank" homestead, in the sewer trench soil was generally less than 6 feet thick and bedrock, though weathered, had to be broken with explosives. In the south-east of sheet H5A (the northern part of the suburb of Macquarie)excavations for reticulation services have revealed similar bedrock conditions but with generally thinner soil.

The various rock types in the two sheet areas tend to have characteristic patterns of weathering. The shale and siltstone tend to decompose fairly uniformly giving a uniform level within, say, the dimensions of a block. Sandstone beds do not weather as deeply as the shale and siltstone.

Granite has two characteristic patterns of weathering. On elevated ground it tends to weather deeply along joints leaving boulders of fresh, or slightly weathered, rock outcropping on all shallow depths between the joints. Boulders of fresh granite may be underlain by completely weathered material. The weathering profile therefore tends to be extremely irregular and unpredictable. In low-lying poorly-drained, ground weathering proceeds along joints but the intervening blocks of rock tend to be thoroughly weathered giving a tough material which can be excavated by mechanical means.

Sheared and crushed rock tends to weather more deeply than rock, however, because of silicification, weathering is probably no deeper along the Deakin and Ginninderra Fault zones than in adjoining areas.

## FOUNDATIONS

All sites for major buildings and engineering structures should be tested as there may be marked local variations from general conditions. Strong, sound rock should be found at shallow depths in all parts of the two sheet areas. Slightly to moderately weathered rock is expected to provide adequate foundations for all but the largest structures. Depths at which bedrock might be encountered, and the condition of the bedrock, is discussed in the section on Excavations.

MATERIALS

The unconsolidated sediments in the area tend to be clayey; loamy mantles of soil are thin. Shed from the granitic areas is more sandy than elsewhere. There are patches of alluvial sandy loam of unknown thickness, along Ginninderra Creek. The deposits within the storage area of the proposed lake should be tested by augering to ascertain whether there are useable resources of garden loam in the area. Deposits of sand and gravel of economic size are not likely to be found within the lake area, or elsewhere on the two sheets.

On the extreme west of sheet H4C there is a shale-siltstone succession which has been correlated with the Yarralumla Formation in the Canberra area. The latter has, in the past, been a source of brick shale and clay. The exposures on sheet H4C are silty, but possibly in the broad area without outcrop, to the south, on both sheets, suitable shales exist. It is pointed out that there are extensive occurrences of brick shale and clay in, and near, the A.C.T. and presumably, therefore, utilization of any source of heavy clayware material in the Belconnen area is not of over-riding importance.

There is a fair range of earth and rock materials within the area of sheets H4C and H5A suitable for engineering purposes - fill, aggregate, building stone, etc. - but none have been noted of such particular merit as to call especially for its exploitation.

No metallic mineralization has been observed. The gossan along the western edge of sheet H5A is probably related to sulphide mineralization but surface indurations do not warrant any further investigation.

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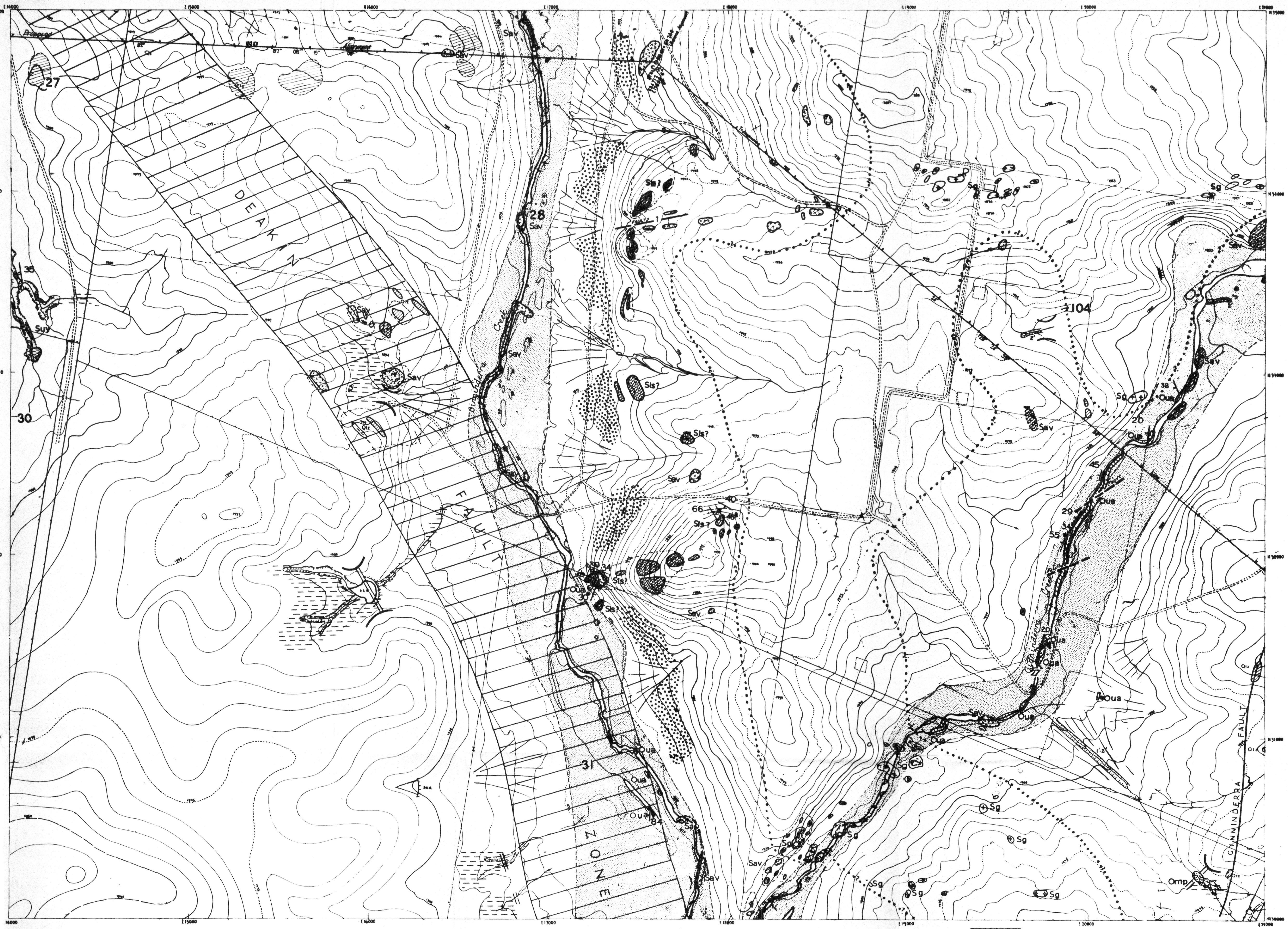
Plate I

# GEOLOGY OF BELCONNEN - SHEET H4C

Geology 1967 by L. Yendall, L.E. Walraven, H.F. Doutch (B.M.R.)




| | | | |
|---|---|---|---|
| | | | Quartzites and silicified rock |
| | | Sg | Granodiorite |
| SILURIAN | Yarralumla Formation | Sud | Acid tuff |
| | | Suy | Siltstone and shale |
| | | Sav | Acid and intermediate extrusives and tuff |
| | State Circle Shale ? | Sls ? | Indurated shale and siltstone |
| ORDOVICIAN | Acton Shale ? | Oua | Hard black shale |
| | Pittman Formation | Omp | Indurated sandstone and siltstone Shale |

- Alluvium
- Colluvium
- Scree
- Slump
- Alluvial fan
- Bog
- Swamp
- Valley constriction
- Rock bar
- Soil and alluvium isopachs
- 2' Gully depths
- 70 Dip of strata
- Geological boundary, approximate
- Geological boundary, inferred, concealed
- Limit of floaters and thin soil cover
- Fault
- Syncline
- Fossil locality

AUSTRALIAN CAPITAL TERRITORY
CONTOUR SERIES

SCALE

KEY TO ADJOINING SHEETS

H4C

Topographical base by Lands & Survey Branch, Dept. of the Interior, Canberra, A.C.T. Geology by the Bureau of Mineral Resources, Geology & Geophysics, 1967.

To accompany Record 1967/146

I55/A16/458

Plate 2

# GEOLOGY OF BELCONNEN - SHEET H5A

(including proposed Town Centre)

Geology 1967 by L. Yendall, L.E. Walraven, H.F. Doutch (B.M.R.)


| | | | |
|---|---|---|---|
| | | Quartzites and silicified rock | |
| SILURIAN | | Sg | Granodiorite |
| | Yarralumla Formation | Sud | Acid tuff |
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- Alluvium
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- Limit of floaters and thin soil cover
- Fault
- Syncline
- Fossil locality
- Fill

AUSTRALIAN CAPITAL TERRITORY
CONTOUR SERIES

DATE OF MAP - JAN 1961

SCALE

FEET 200 0 200 400 600 800 1000 FEET

Topographical base by Lands & Survey Branch, Dept. of the Interior, Canberra, A.C.T. Geology by Bureau of Mineral Resources, Geology & Geophysics, 1967.

H5A

To accompany Record 1967/146
I55/A16/459