COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1957/108

STRUCTURE AND STRATIGRAPHY OF THE COUNTRY BETWEEN QUEANBEYAN AND SUTTON, WITH SPECIAL REFERENCE TO BUILDING STONE

by

D. Moore

STRUCTURE AND STRATIGRAPHY OF THE COUNTRY BETWEEN QUEANBEYAN AND SUTTON, WITH SPECIAL REFERENCE TO BUILDING STONE

by

D. Moore.

RECORDS 1957/108.

INTRODUCTION

Location:- The area mapped lies east and north east of Canberra, covering the eastern part of the district of Gungahlin, A.C.T., and some part of the shire of Yarrowlumla, N.S.W. The border of the Capital Territory runs sinuously across the area from northwest to southeast.

Access:- Roads form a framework to the mapped area; Canberra Avenue south of the Molonglo River, and Fairbairn Avenue north of the river, give access to the southern boundary; the Sutton-Queanbeyan road follows the line of the Queanbeyan Fault along the eastern margin; the western side is served by the Majura road; and the Federal Highway offers easy access to the northern part, which is further served by a network of minor roads.

Method of Working:- The ground was covered mainly on foot by closely spaced traverses, the geology being plotted directly on to air-photos. Very little of the geology could be interpreted from the photographs, probably because of the extensive cover of vegetation. Over the greater part of the area, up to the village of Sutton, the photographs used were recently flown, at a scale of 1:30,000, approximately the scale of the final map. From Sutton northwards older photographs were used, at a scale of approximately 1:14,000, about $2\frac{1}{2}$ times the scale of the final map.

The work occupied the months of July, August and September of 1957, the approximate rate of working being 20 square miles per month.

STRATIGRAPHY

ORDOVICIAN

Muriarra Formation:- The oldest part of the geological sequence exposed in the area is a thick sequence of interbedded shales and greywackes, with minor beds of quartz sandstone in the lowest exposed part, and minor beds of black chert in higher parts of the sequence.

The whole formation is strongly folded, and no complete section has been seen. A measured section taken along the Molonglo River just west of the Queanbeyan Fault showed 325 feet of strata, with one thin slumped greywacke band and with occasional shale bands over ten feet thick; one or two greywacke beds approached 20 feet in thickness, but in general interbeds of no more than one or two feet in thickness are more usual.

In other outcrops the thinly bedded sequence is found to be the normal sequence within the formation. The total thickness of the formation is unknown. Certainly it must be at least one or two thousand feet, possibly much more.

This formation consists, apart from the thin quartz sandstones previously mentioned, of turbidites (Kuenen, 1956) - density current deposits with well-developed grading, and many sole markings. These suggest currents derived from the south and east.

Acton Shale:- Conformably overlying the Muriarra Formation is a sequence of black, siliceous shale, usually with graptolites, although they have not been found in the present investigation. No complete section has been seen, but at least 100 feet are seen in a creek on the north side of Fairbairn Avenue where it crosses the outcrop. The major outcrop belt runs meridionally from the Molonglo River to the vicinity of Dundee Homestead. Two smaller belts occur to the west, and a further belt of black shale, siliceous, but poorly exposed and not known to be fossiliferous, occurs north of the Federal Highway near Sutton.

SILURIAN

Camp Hill Sandstone:- The Camp Hill Sandstone runs in a belt parallel to the Acton Shale, and to the west of it. The only outcrop belt is between the Molonglo River and Dundee Homestead.

The rock is a white, soft, highly quartzose sandstone with partings, up to 1 or 2 inches, of green phyllite. For the most part the beds are fine grained, flaggy or well-bedded, but at the base is a 2-foot bed of very coarse grit with indeterminate fossil fragments. The total thickness is unknown, but south of Dundee an exposed thickness of 220 feet is seen.

? State Circle Shale:- Near the northern end of the outcrop of Camp Hill Sandstone are isolated exposures of buff shales 200 feet thick, and others of black shales with a quartzite band. Lithologically these resemble the State Circle Shale of Canberra (Opik, 1954) but could equally well be some other part of the known Lower Silurian sequence.

? Mt. Pleasant Porphyry:- Two isolated outcrops of highly sheared tuffs and rhyolites occur in close association with the Ainslie Volcanics. One is completely surrounded by the Lower Devonian lavas; the other is bounded by them on the south, and faulted against Gladefield Volcanics on the east; the line of the fault is marked by a quartz reef.

Fairbairn Group

The type locality of the group is around Fairbairn Aerodrome (Opik, 1954). Some correlations with the present area are clear, but there are sundry differences.

Neither top nor base of the group is exposed in the area mapped. The lowest beds seen lie west of the Majura road, and consist of eastward dipping shales with ash stones in the lower part. These are succeeded by buff shales, well exposed on the Majura road, and in Woolshed Creek at the ford. These beds appear to underlie the Molonglo Formation, but the contact is obscured by alluvium, and these lower beds have not so far yielded any fossils.

Molonglo Formation:- East of Woolshed Creek, and stretching in a north-south line from the ruin of "Miss Cameron's Farm" (Mahony & Taylor, 1913) to a point two and a half miles north of the Federal Highway, lie the shales and limestone lenses of the Molonglo Formation. Much of the sequence is richly fossiliferous, the locality of Miss Cameron's Farm being particularly so. At this place three dark blue-gray limestone lenses are present in the fossiliferous shales. Farther north lenses of limestone occur in three places south of the Federal Highway, but are probably on or near the one stratigraphic horizon.

The total thickness of the Molonglo Formation in this area cannot be less than 400 feet. Its base is never seen, and there is no evidence of the Molonglo Sandstone which underlies it in the type locality (Öpik, 1954).

Gladefield Volcanics:- The Gladefield Volcanics are a thick series of acid lavas, tuffs, and ashstones with some interbedded shales cropping out in a meridional belt north of Fairbairn Aerodrome. Despite intensive search, there is no evidence of folding in the sequence, which must attain a thickness of at least 5,000 feet just north of the homestead of Gladefield. The type section is in the creek which flows south of the homestead. This section is incomplete at the base, but shows the lithological variation present in the formation. It has not been measured.

The Volcanics form a conformable sequence with the underlying Molonglo Formation. South of the Federal Highway the volcanic rocks show a conformable passage from the shales beneath, but, to the east of Goorce Trigonometrical Station the shales of the Molonglo Formation and the tuffs of the Gladefield Volcanics are interbedded with great complexity. In almost every outcrop the tuffs are seen to coarsen upwards, and to end abruptly against overlying shales. The graded nature of the tuffs precludes their interpretation as infolds; the succession must be a normal stratigraphical one.

DEVONIAN

Ainslie Volcanic Series:- These occur around and under the Fairbairn Aerodrome. They appear to lap over Sullivan's Line Fault, and rest with profound unconformity on the Gladefield Volcanic Series, Molonglo Formation, ?Mt. Pleasant Porphyry, ? State Circle Shale and Camp Hill Sandstone. They show no deformation except in the one outcrop on the north bank of the Molonglo River, where they are faulted against limestone presumably belonging to the Molonglo Formation.

Two main lithological types are present:- (1) a fragmentary volcanic rock, probably vesicular, and commonly badly weathered, and (2) a porphyritic massive dacite. The dacite is exposed extensively around the Canberra R.A.A.F. station at Fairbairn, and, in a separate area, in the bend of the Molonglo River at Honeysuckle homestead.

The tuffs lie between these two areas of outcrop. In general they are not well exposed.

Superficial Deposits

There may be at least three different ages in the formation of these deposits, although no more than two groups of beds can be seen in superposition. The deposits involved are:-

(1) alluvium of the present erosion cycle

(2) calcareous clays of the Fairbairn Lake

(3) indurated, coarse, angular gravels, often with a lateritic top.

The "recent" alluvium, in places at least 20 feet thick, is seen overlying both the lake clays and the lateritised gravels. Occasionally fragments of laterite are found near the contact. No lateritisation of the lake clays has taken place, and one may thus adduce that either the lake existed at the time of lateritisation, as a permanent body of water, or the lake post-dated the lateritisation, evidence of which has not yet been uncovered by present-day erosion. At the junction of the lake clays and lateritised gravels near "Miss Cameron's Farm" all traces of lateritisation disappear, which favours the contemporaneity of lake and laterite.

Intrusive Igneous Rocks

The major intrusive in the area is the Greenwood Granite, which underlies the large flat area to the west of Greenwood Trig. The granite is a eucrystalline, finegrained biotite granite; its outcrop lies athwart the State boundary. In the Capital Territory it is well exposed, and the contacts are generally vertical. Dykes invade the country rock (Muriarra Formation) along the contact. They are generally not connected to the main body of the intrusive. The dyke swarm runs south-south-east along the watershed between Reedy Creek and Doughboy Creek, and is last seen in the headwaters of the latter. A very small intrusion on the north bank of the Molonglo, some 6 yards square, may be a last vestige of the swarm.

In New South Wales the outcrop is much poorer, but parts of the contact can be traced. Thick alluvium conceals the northern tip, and the small dyke shown separately may equally well be the end of the main stock. Dykes occur in this area of New South Wales, but do not assume the characters of a swarm.

Quartz veins are common in the New South Wales section of the area mapped. They occur also in the A.C.T., but are much rarer. The bulk of the quartz veins run parallel to the dyke swarm, but several cut right across the Greenwood Granite. Pyrite is present in small quantities throughout.

East of the Yass River, in the north-east corner of the map, a second granite body crops out. This, the Bywong Granite (Day, 1952), extends several miles farther north than the limits of the map. It is a linear body about a mile wide, cutting discordantly across the strike of the Muriarra Formation into which it is intruded. Like the Greenwood Granite, which it resembles both structurally and petrologically, several quartz reefs are found in or near it. One reef, running parallel to the Yass River, forms the western boundary of the intrusion. Exposures in a small creek show that the actual reef, though younger than the granite, follows the line of a fault which must predate the intrusion. A second reef forms the boundary at an old gravel pit on the Bungendore Road. A third large reef cuts right across the granite in the vicinity of Ashburton Homestead. The dislocation on which the reef occurs has no apparent effect upon the western boundary of the granite, but shifts the eastern boundary by nearly half a mile. It is interpreted as a hinge-fault downthrowing to the south.

Unlike the Greenwood Granite, the Bywong Granite has only a few small dykes around its margins. One group occurs in the bed of the Yass River immediately west of the granite boundary. A second group, consisting of four dykes, is found south of the Tallagandra Road, near Sutton. The third group includes the Sutton Granite. This is a chevron-shaped intrusive less than half a mile across. It was formerly worked for road-metal near Kelvin Homestead.

STRUCTURE

There are two major structural breaks in the area, the Sullivan's Line Fault, a north-south structure dividing Silurian and Devonian rocks from the Ordovician, and the Queanbeyan Fault, seemingly of little throw, in the Ordovician. Minor structures west of Sullivan's Line run north-south, but between the two faults run at angles of approximately 30°W of N and 30° E of N. Most of the dykes and quartz veins associated with the Greenwood Granite follow the 30°W of N trend, and a few are elongated E of N.

The location of intrusions along the minor fractures suggests that these latter were open, and hence tensional features. They must, of necessity, predate the intrusion of the granite. The restriction of these lineations to the Ordovician sediments is a probable indication that they are a result of the Canberra orogenic phase (Öpik, 1954).

Of the two major faults, the Queanbeyan fault is more persistent in the area mapped. It has still a marked topographic expression, and it throws together beds of very similar lithology, excepting that those on the Kowen side of the fault show intense crushing near the fault-plane. In view of the considerable overturning of the beds on both sides of the fault, it is likely that the Queanbeyan Fault is a reverse fault. Its straight-line outcrop indicates that it must be near vertical, but it is not exposed clearly enough to verify this.

Sullivan's Line Fault is a different type of structure. It separates isoclinally folded Ordovician rocks from Silurian beds with more open folds. The fault plane is rarely exposed, but, from its outcrop pattern, must be vertical or thereabouts. The fault can be traced from beyond the northern boundary of the area mapped to the vicinity of Dundee, a homestead east of Fairbairn R.A.A.F. station. Here the fault swings and is covered by Lower Devonian Ainslie Volcanics. At the point of disappearance, the fault throws Camp Hill Sandstone (basal Silurian in this area) against Molonglo Formation, its throw being rapidly reduced from the point of flexure. To the south, the Camp Hill Sandstone continues as a ridge. The beds are generally vertical, but become slightly overturned at the Molonglo. Minor faulting reappears at the river bank, but post-dates the Ainslie Volcanics, and hence cannot be of the same age as Sullivan's Line, which is covered by the Volcanics.

In the ground between the two major faults a number of interesting features are found. Isoclinal folding is the rule in the Murrarra Formation from the Molonglo River northwards to the incoming of the dykes associated with the Greenwood Granite. More open folding is the rule around the granite and farther north. In the vicinity of Sutton minor faults marked by quartz reefs divide the country into parallel blocks elongated in a north-north-westerly direction.

The Oak Hill block, being the most westerly, is in part bounded by the Sullivan's Line Fault. This block includes the outcrop of probable Acton Shale. Its eastern neighbour, the Kelvin Block, contains the outcrop of the Sutton Granite (Day, 1952). In the Sutton Block outcrop is very poor, but only Muriarra Formation is known, whereas in the most easterly block, the Ashburton Block, granite dykes are again present. This arrangement suggests a pair of graben - the Oak Hill and Sutton Blocks - separated by horsts - the granite-intruded Kelvin and Ashburton Blocks.

Age of the faulting

The oldest faults in the area seem to be the minor, presumably tensional cracks in the Muriarra Formation along which the Greenwood Granite and its associated dykes were intruded. The failure of the granite to cross Sullivan's Line suggests that the intrusion predates the faulting. The sudden change in direction of Sullivan's Line Fault at the Oak Hill node can be explained as a later fault following an already existing line of weakness.

Minor faults all seem to be related to one or other of these two major episodes, excepting the small dislocation which affects the Ainslie Volcanic Series near Honeysuckle Homestead.

The Queanbeyan Fault in part follows the tension faults of the Sutton area. In the area mapped it lies entirely within the Muriarra Formation, assuming that the rocks on both sides of the fault belong to the same formation as lithology would indicate. South of Queanbeyan, however, the fault throws crushed Gladefield Volcanics and the probably Middle Silurian Morley Formation (Phillips, 1956) against the greywackes, and so must be of similar age to the Sullivan's Line Fault.

Recapitulating the various phases of movement, therefore, one sees first the Ordovician rocks pushed into open folds amongst which relieving fractures appeared aligned north-north-west and north-north-east. During the Silurian, granite magma invaded some of these tensional faults, but apparently avoided others. Towards the end of the period major stresses brought into existence the Sullivan's Line Fault and the Queanbeyan Fault, the latter at least a compressional structure in part. At this time the compression crushed the open folds in the Muriarra Formation into isoclinal structures. It is possible that the areas where open folding now persists were protected from further deformation by the granitic intrusions present, although minor readjustment can be seen in the better-exposed dykes, which are shifted in a sinistral sense along east-west joints. The shift is never more than one or two inches on a single joint.

Tertiary movement along the Queanbeyan Fault is suggested by the present fault scarp, and the existence of a broad wind gap opposite the upper part of Reedy Creek.

ECONOMIC GEOLOGY

Building stone

In some of the older buildings of Canberra and Queanbeyan which predate the formation of the Federal Capital, local stone was used. The following rocks have been used:- greywackes of the Muriarra Formation, sandstones of the Black Mountain Sandstone and of the Camp Hill Sandstone, the massive beds of the Gladefield Volcanics, and the dacites of the Ainslie Volcanics. In addition, there are parts of the Greenwood Granite which would also yield stone of workable quality.

In regard to exploitation, the sedimentary rocks offer quite different problems from the igneous, and are best considered separately. The greywacke members of the Muriarra Formation are, in general, quite thin (60 feet is exceptionally thick); they are considerably stressed and jointed, and are often cut by minor quartz veins; furthermore, they are interbedded with approximately equal amounts of siltstone and shale. Any quarry opened in this formation must expect to yield only 50% of building stone even if no close jointing or quartz veining were present. With these added disadvantages, as little as 10% of the stone broken out could prove to be of suitable quality.

The Camp Hill Sandstone is as thin bedded, and somewhat softer than the greywackes of the Muriarra Formation. Although it stands vertically, or slightly overturned against Acton Shale just east of Honeysuckle, it has not been so strongly stressed. Two quarries have been opened in the outcrop. One, now intermittently active, is on the north bank of the Molonglo River, the other, overgrown and long abandoned, occurs east of Fairbairn.

Thin shale and phyllite bands are present in the active quarry. They rarely exceed two inches in thickness, and are commonly mere films. Apart from softness, the rock has a potential yield of about 80% of stone broken out, providing care is taken in blasting.

The igneous rocks all offer good quality, durable building stone. They would, however, necessitate the establishment of a permanent quarry, with men capable of dressing stone adequately. Both the Ainslie dacites and the Greenwood Granite are freestones, the latter especially should yield blocks as large as any required in Canberra. Depth and irregularity of weathering would be the biggest drawback to commercial quarrying. They could be predicted by adequate drilling.

The Gladefield Volcanics could be roughly dressed by unskilled persons, and the prominent lineation would make exploitation easier than either the Greenwood Granite or the Ainslie Volcanics. The Gladefield Volcanics do not seem so susceptible to weathering, and are easily accessible from the Majura road. They would also appear to be more durable than either of the sedimentary rocks mentioned above.

Water supply

Most stations in the area derive their water supply from surface flow by means of shallow dams located in favourable positions. Shallow wells have been dug in alluvium in places - notably around the old villages of Sutton and Majura. Apparently they were successful in obtaining water, but this is not surprising as they are all located close to the permanently flowing Woolshed and McLaughlin's Creeks. A deep well sunk on the flanks of the ridge at Sutton, in the Muriarra Formation, proved dry at a depth of 60 feet (estimate from memory of villagers). A well on the property of Malcolm Vale, near the Fairbairn Aerodrome, sunk in Ainslie Volcanics, was dry at 50 feet, but is being deepened at present.

Bores have been put down in two places - along the Yass River, into the Bywong Granite, and at Kelvin Homestead, into the Muriarra Formation near the margin of the Sutton Granite. Both yield copious supplies of water, but that at Kelvin is only suitable for stock.

REFERENCES

DAY, A.A., 1952 - Report of the geology of the Sutton-Narima-Gundaroo district, N.S.W. Bur. Min. Res. Aust. Rec. 1952/39.

MAHONY, D.J. and TAYLOR, T.G., 1913 - Report on a reconnaissance of the Federal Capital Territory. Govt. Printer Melbourne.

ÖPIK, A.A., 1954 - Geology of Canberra. A.N.Z.A.A.S. handbook.

PHILLIPS, J.R.P., 1955 - Geology of the Queanbeyan District, J.roy.soc.N.S.W. Vol. 89, pp. 116-126.

KUENEN, P.H., 1956 - Sole markings on graded greywackes. Jour. Geol. Vol. 64.

GEOLOGICAL MAP
OF THE
SUTTON-QUEANBEYAN AREA

GEOLOGY BY
D. MOORE

LEGEND

Established boundary
- position accurate
- position approximate

Established Fault
- position accurate
- position approximate

Quartz vein

Dip & strike of beds
- normal
- vertical
- overturned
- orientation unknown

Anticlinal axis, with plunge

Synclinal axis

Well (W) or bore (B)

Qa	Superficial deposits scree, alluvium, lake clays
Dla	DEVONIAN:- Ainslie Volcanics
Smg	SILURIAN:- Gladefield Volcanics
Smr	Molonglo River Formation
Sm	unnamed Middle Silurian :- shales with interbedded tuffs
Smp	Mt. Pleasant Porphyry
Sls	State Circle Shale
Slc	Camp Hill Sandstone
Oua	ORDOVICIAN:- Acton Shale
Omm	Murrarra Formation
Sg	SILURIAN:- Greenwood & Bywong Granites
	intermediate to basic igneous dykes, AGE UNKNOWN

Sutton
Kelvin
Oak Hill
Ashburton
Bywong Granite
Greenwood Granite
McQuoin's Creek
Woolshed Creek
Doughboy Creek
Molonglo River
Roadside Creek
Reedy Creek
Gladefield
Majura
Fairbairn R.A.A.F. Station
Fishwick
Dundee
Malcolm Swamp
Yass
Honeysuckle
QUEANBEYAN
1861
2010

N69-5

1 mile