DEPARTMENT OF
MINERALS AND ENERGY

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD 1975/54

GEOLOGY OF THE WODEN/WESTON CREEK AREA, A.C.T.

by

G.A.M. Henderson

RECORD 1975/54

GEOLOGY OF THE WODEN/WESTON CREEK AREA, A.C.T.

by

G.A.M. Henderson

CONTENTS

SUMMARY

Over the last decade, mapping in the Woden and Weston Creek areas has extended that of A.A. Öpik and earlier workers in the Canberra district. The extended mapping has included both detailed outcrop mapping before urban development, and mapping of many of the trenches dug for services during urban development. Recent mapping outside the Woden/Weston Creek area has been cited to interpret the stratigraphy.

The rocks regarded as the oldest in the area mapped probably form part of the Uriarra Volcanics. Recent study of fossils from sedimentary horizons in the Uriarra Volcanics west of Coppins Crossing indicate that they are Middle rather than Upper Silurian. The inferred Uriarra Volcanics in the area mapped may therefore also be Middle Silurian.

To the northwest, near Mount Stromlo, the volcanics are overlain by an Upper Silurian sequence (believed to correlate with the Deakin Volcanics) which includes the formations described by Öpik. Additional data have generally confirmed the validity of Öpik's Red Hill Group, comprising the Deakin Volcanics and overlying Yarralumla Formation, but lithological similarities between beds in the two formations create problems in detailed mapping; however, a rhyolite and ashstone marker bed in the Deakin Volcanics has been useful in determining structure. Further evidence supports the intrusive relationship between the Mount Painter Porphyry and the Red Hill Group, and Öpik's conclusion that the Mugga Mugga Porphyry is an intrusive body is considered to be valid. Two previously undescribed formations overlie the Red Hill Group; the lower one consists of tuff and sandstone (Sua) and the upper one of dacite (Sub).

In the southwest and west of the area, the inferred Uriarra Volcanics are overlain by a porphyry (Sus) which is probably a sill separate from but similar to the Mount Painter Porphyry. Another porphyry (Sun) which occurs south of Weston Creek may also be a sill. Rhyolite dykes (Suo) intrude the volcanics on the southwestern slopes of Oakey Hill.

The porphyritic rocks (some of which are described as volcanics) are mostly dacites and rhyodacites belonging to a number of formations, some extrusive in origin and some probably intrusive. Differences in the features of these rocks - composition, texture in thin section, colour, and primary structures - can be used to distinguish the rocks of each formation; some of these features may be related to their origin.

Thermal metamorphism of the Yarralumla Formation on Red Hill, which Öpik attributed to the Mugga Mugga Porphyry, is now thought to have been caused by the proximity of a volcanic vent centred on Federal Golf Course, between Red Hill and Hughes. The metamorphism also affects the Mugga Mugga Porphyry and adjacent volcanics. A strong positive magnetic anomaly occurs in the area of the golf course.

The structure of the Woden/Weston Creek area is complex. The dominant features are a general regional dip of strata to the southwest, numerous faults striking northwest, and a major meridional fault passing through the centre of the Woden area. The rocks are also folded in places, particularly close to the major faults. Jointing in the rocks ranges from regular joint systems obviously related to folds and stress patterns, to more complex systems.

The geomorphology and depths of weathering in the area can be related to an erosional history which involves the partial formation of a peneplain between R.L. 550 and 640 m, recession of hill slopes, and the formation of the entrenched Molonglo River valley. Rock is generally deeply weathered on the gentle slopes of the peneplain and less deeply weathered on steep slopes, but the weathering profile is also affected by the underlying lithology and the proximity of faults and shear zones.

INTRODUCTION

This report is based on a synthesis of geological information gathered from the Woden and Weston Creek areas of Canberra up to 1973. The area described (see Fig. 1) covers 95 km^2, about half of which is urban and half grazing land and pine forest.

Much of the first detailed mapping was carried out at Deakin and Yarralumla, in the northeastern part of the area, by Dr A.A. Öpik during the early 1950s (Öpik, 1954, 1958). Öpik named and defined three stratigraphic units in addition to the one named by Pittman (1911), and discussed some aspects of the geology which had received attention in previous reports (Pittman, 1911; Mahony & Taylor, 1913; Woolnough, 1938). During the 1960s the Canberra urban area expanded to the southwest, and detailed mapping of rock outcrops was carried out to obtain geological information of use in urban planning. Much lithological detail was also obtained from mapping of excavations during urban development. Some of the outcrop mapping was described in previous reports in the BMR Record Series (Wilson & Newstead, 1967; Rossiter, 1971); however a great deal of the geological information, gathered mainly by D.E. Gardner, has not previously been reported.

Four maps (Plates 1-4) accompany this report. Plate 1 is an interpretative map of the stratigraphy. Plates 2, 3, and 4, at a larger scale, show individual outcrops and areas of numerous outcrops, and, where possible, boundaries between rock units. Representative geological cross-sections are shown in Plate 5, and Figure 2 shows interpreted rock relations in a semi-diagrammatic form. Formations northeast of the Deakin Fault (shown in Plate 1) are not described in this report. Localities mentioned in the text are shown in Plate 1.

PHYSIOGRAPHY

The land surface ranges from gently undulating to hilly. Drainage is mainly to the north via Yarralumla and Weston Creeks into the Molonglo River and thence northwest into the Murrumbidgee. The southwestern part of the area drains directly into the Murrumbidgee, to the west. Three main topographic units can be identified in the area. They are the hills and ridges with steeper slopes generally above 630 m, the moderately to gently undulating country between 540 and 630 m, and the entrenched Molonglo and Murrumbidgee river valley (southwest corner of Plate 1) below 630 m. Many of the ridges and creeks trend northwest, which is the general strike direction of geological formations. The highest hill is Mount Taylor, 855 m (2 850 feet). Small alluvial flats are present along Yarralumla and Weston Creeks.

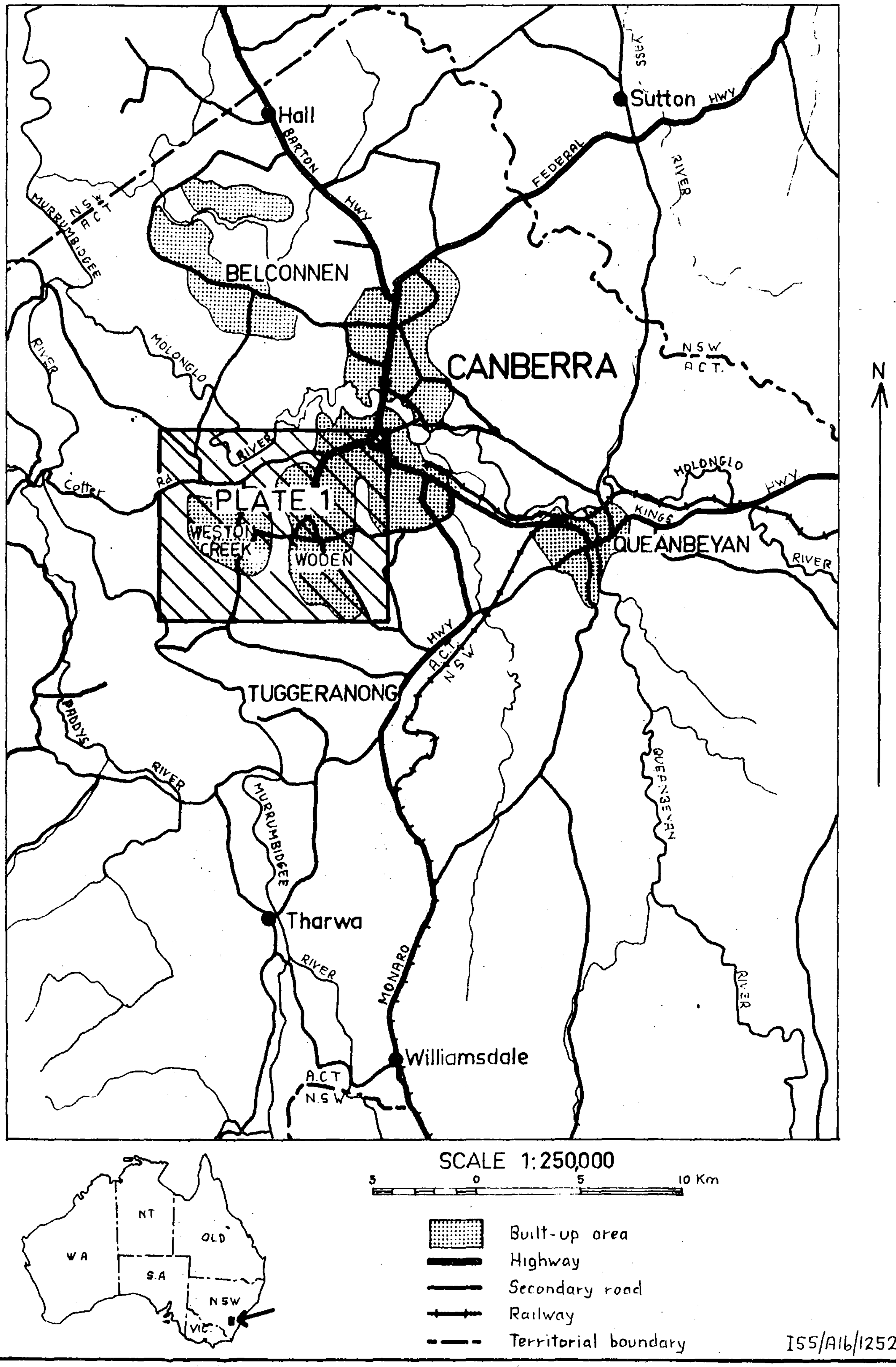
GENERAL REGIONAL GEOLOGY

The Woden/Weston Creek area lies within a structural feature known as the Canberra Graben (Strusz, 1971), which extends from south of Bredbo to north of Yass. Most of the rock formations within the graben range in age from Middle Silurian to Lower Devonian; they consist predominantly of acid volcanic rocks, with some associated sedimentary rocks and porphyries. The graben is considered to have originated in the Silurian and to have affected the pattern of deposition of the rocks within it.

A number of faults define the boundaries of the graben, and numerous faults occur within the graben itself; the faults influence the pattern of folding. The complex structure creates difficulty in attempting to unravel the stratigraphy and structure of small parts of the graben, such as the Woden/Weston Creek area. The difficulties of interpretation are compounded by similarities in the lithologies of many of the volcanic rocks,

Fig. 1

LOCATION MAP



the massive nature of many of these rocks, the scarcity of fossiliferous sedimentary horizons, and difficulties in distinguishing between volcanic flows conformable in the sequence and discordant high-level intrusives. Interpretation is also complicated by the possibility of Devonian volcanics unconformably overlying the Silurian volcanics (Strusz, 1971) and also the possibility of other unconformities within the Silurian volcanics similar to that discovered during recent mapping in the Boambolo area, northwest of Canberra (D.L. Strusz, pers. comm.).

The tectonic history of the Tasman Geosyncline, of which the Canberra Graben is a local development, comprised several orogenic episodes and substantial uplift, erosion, and peneplanation. The final orogenic event, the Kosciusko Uplift, towards the end of the Tertiary, rejuvenated some of the ancient faults and renewed the topographic expression of the graben. Another result of the uplift was the formation of several peneplain surfaces at levels representing base levels of erosion (Craft, 1933); owing to subsequent stages of uplift most of these peneplain surfaces have been dissected to some extent.

The general geological setting of the Canberra Graben in conjunction with reports on previous local geological mapping (Öpik, 1954, 1958) forms the basis on which the geology of the Woden/Weston Creek area has been interpreted.

STRATIGRAPHY

Three stratigraphic units in the area southwest of the Deakin Fault were defined by Öpik (1954, 1958). They were the Deakin Volcanics, the Yarralumla Formation - a sedimentary sequence conformably overlying the volcanics - and the Mount Painter Porphyry, which he interpreted as a sill intruding the two other formations. A fourth formation, the Mugga Mugga Porphyry, had previously been named by Pittman (1911), and Öpik regarded this unit as an intrusive stock. Öpik also introduced another stratigraphic name, the Red Hill Group, for the combined Deakin Volcanics and Yarralumla Formation. All formations were regarded by Öpik as Upper Silurian - the Yarralumla Formation from the fossils it contained, and the other formations by the nature of their relationship to the Yarralumla Formation.

The mapping carried out since 1958 indicates that Öpik's stratigraphic units extend some distance to the southwest of his map area; however, additional formations farther to the southwest, which cannot be correlated with any of Öpik's units, have also been mapped. One of these formations can be correlated, at least provisionally, with the Uriarra Volcanics (Malcolm, 1954), but the others do not appear to match any previously named formations. Permanent or even provisional names for the new formations are being withheld at this stage pending fuller knowledge and understanding of all formations in the Canberra Graben.

The definition of the Deakin Volcanics has been altered from that adopted for the 1:50 000 special Canberra geological map (Strusz & Henderson, 1971) and restored to that of Öpik (1954). During the 1971 mapping in the Woden-Belconnen area, the Deakin Volcanics were regarded as including all the volcanic rocks were considered to be Upper Silurian and were included in the Deakin Volcanics; volcanics both older and younger than the Yarralumla Formation were shown as Deakin Volcanics, as well as volcanics whose stratigraphic position relative to the Yarralumla Formation was uncertain. Table 1 shows the Silurian stratigraphy southwest of the Deakin Fault after Öpik (1954, 1958) and Strusz & Henderson (1971), and sets out the extended scheme adopted in the present report; intrusives are not included. The interpreted relationship of rock units, including intrusives, is shown diagrammatically in Figure 2. Some of the petrological names assigned in this report, such as dacite and rhyodacite, differ from those used in previous BMR Records describing engineering geological investigations in parts of the area. The petrological nomenclature used in this report follows the system of Hatch, Wells, & Wells (1961).

Table 1

Changes in stratigraphic nomenclature in the Woden/Weston Creek area

Age	ÖPIK (1954, 1958)		STRUSZ & HENDERSON (1971)		THIS REPORT	
UPPER SILURIAN			Red Hill Group	Deakin Volcanics (Sud)	Unnamed Volcanics (Sub)	
UPPER SILURIAN			Red Hill Group	Deakin Volcanics (Sud)	Unnamed Volcanics (Sua)	
UPPER SILURIAN	Red Hill Group	Yarralumla Formation (Suy)	Red Hill Group	Yarralumla Formation (Suy)	Red Hill Group	Yarralumla Formation (Suy)
UPPER SILURIAN	Red Hill Group	Deakin Volcanics (Sud)	Red Hill Group	Deakin Volcanics (Sud)	Red Hill Group	Deakin Volcanics (Sud)
					Unconformity?	
MIDDLE SILURIAN			Red Hill Group	Deakin Volcanics (Sud)	Uriarra Volcanics (Smu)	

MIDDLE SILURIAN

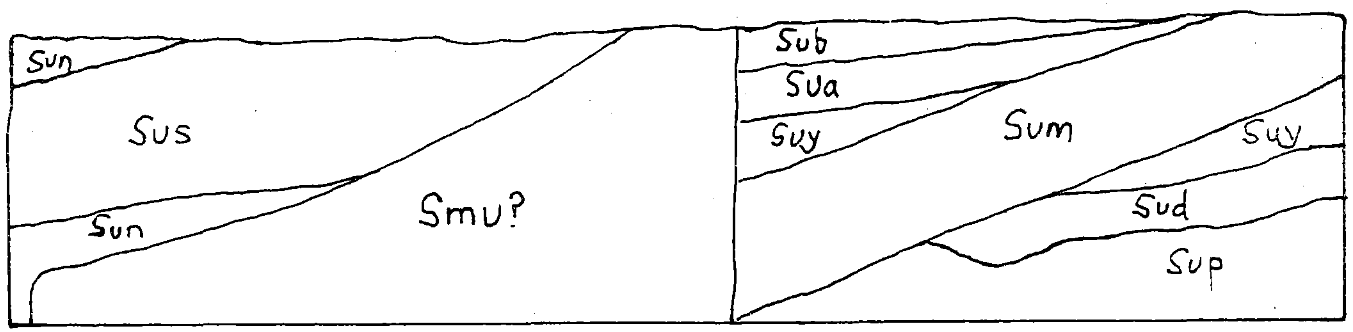
Uriarra Volcanics (Smu)

A belt of volcanic rocks comprising mainly purple porphyritic dacite, extends from south Woden through Weston Creek to the eastern slopes of Mount Stromlo; it was initially thought to be a single formation in the Weston Creek area (Wilson & Newstead, 1967). Mapping along the eastern margin of the belt since 1967 indicated that the dacite was younger than, and probably conformable with, the Upper Silurian Red Hill Group. Further mapping to the west showed some differences in colour and composition between the dacite outcrops immediately southwest of the Red Hill Group rocks and the dacite farther to the south and west, but the differences were regarded as merely lateral and vertical variations which could be expected in a succession of volcanic rocks. However, recent stratigraphic interpretation in the Coppins Crossing area (Henderson, in prep), to the north of the area described in this report, has suggested an alternative interpretation to explain the variations in the purple dacite.

Northwest of the Winslade Fault in the Coppins Crossing area, dacite, some of which is purple, crops out extensively, and resembles the dacitic volcanics in the Weston Creek area. However, this dacite contains lenses of limestone whose fossils indicate a Middle Silurian age (D.L. Strusz, pers. comm.); therefore the dacite must now be regarded as older than the Red Hill Group. Limestone lenses with similar fossils have also been found in the Uriarra Volcanics (Strusz, pers. comm.), and hence it is likely that the dacite northwest of the Winslade Fault is part of the Uriarra Volcanics.

The establishment of a purple dacite older than the Red Hill Group prompted re-examination of the purple dacite in the Weston Creek area. A dacite younger than the Red Hill Group was confirmed by excavations for the Tuggeranong Freeway and another road (Heysen Street) on Oakey Hill.

WODEN/WESTON CREEK
ROCK RELATIONSHIP DIAGRAM



Sun	Unnamed Porphyry
Sus	Unnamed Porphyry
Sum	Mugga Mugga Porphyry
Sup	Mount Painter Porphyry
Sub	Unnamed Volcanics
Sua	Unnamed Volcanics
Suy	Yarralumla Formation
Sud	Deakin Volcanics
Smu?	Uriarra Volcanics

Fig. 2

155/A16/1415

Secondly, it was found that sedimentary and volcanic rocks on the northern slopes of Mount Stromlo (northwest corner of Plate 1) resembled rocks in the Deakin Volcanics and that they appeared to overlie a purple dacite cropping out to the east. Thirdly, strong faulting was observed in the Tuggeranong/Weston Creek sewer tunnel near the intersection of Hindmarsh Drive and Streeton Drive, in the middle of the area of purple dacite. It is inferred from these observations that there are two separate purple dacites in the Weston Creek area, and that they have been brought into proximity, and apparent continuity, by faulting. The older of the two dacites appears to correlate with the Uriarra Volcanics, of Middle Silurian age, and the younger dacite appears to be a formation overlying the Red Hill Group and therefore Upper Silurian or even younger.

The position of the inferred fault shown on the map (Plate 1) between the two dacites is based on the location of the most intense faulting in the Tuggeranong sewer tunnel, and on variations in the composition of the dacite noticed in outcrops and in thin sections. The curved trace of the inferred fault line apparently indicates a thrust fault; however, this conclusion is not supported in the critical tunnel section, where the main faults dip steeply to the north or south; the fault regarded as the main fault dips 75° north.

The purple dacite at Weston Creek southwest of the inferred fault, thought to be part of the Uriarra Volcanics, is composed of phenocrysts of quartz, plagioclase, and altered mafic minerals set in a microcrystalline groundmass which in some thin sections shows a spherulitic texture (e.g., thin section 69360021). Typical outcrops of the dacite occur on the northern slopes of the Mount Taylor ridge between the suburbs of Pearce and Fisher. Beds of tuff in the dacite are exposed on the northeastern slopes of Mount Taylor, and have also been found at Waramanga (thin section 69360023) and on the eastern slopes of Mount Stromlo. In all places the tuff seems to be at or near the top of the dacite.

The total thickness of dacite and tuff is not known as the base of the formation is not exposed. Even a minimum thickness is difficult to estimate because few outcrops show bedding or flow banding. The dips and strikes measured indicate some folding, with a predominant dip of about 25° SW. From this information a minimum thickness of about 400 m is probable.

UPPER SILURIAN

Red Hill Group

The two formations comprising the Red Hill Group, the Deakin Volcanics (Sud) and the Yarralumla Formation (Suy), were described by Öpik (1958). The Deakin Volcanics were referred to as 'a formation of acid volcanic rocks (tuffs, rhyolites) interbedded with tuffaceous sandstone and in places tuffaceous shales with limestone bands, and jasper, in a thickness of 350 feet' (105 m). The Yarralumla Formation, which he regarded as conformably overlying the volcanics, was described as 'calcareous shale and sandstone, with limestone beds, all more or less tuffaceous', and its thickness was estimated at about 500 feet (105 m).

The descriptions of the Deakin Volcanics and the Yarralumla Formation indicate that similar rocks occur in both formations. The Woden/Weston Creek mapping has borne out these similarities. Furthermore it has shown that in some areas complex folding and faulting, together with the similar lithologies, makes it difficult to separate the two formations. Some useful marker beds do exist, the most important being a white rhyolite with ashstone lenses in the middle of the Deakin Volcanics, but the marker beds are not sufficiently widespread to be able to match the successions in all places. Therefore, although an attempt has been made to show Deakin Volcanics and Yarralumla Formation separately on the map (Plate 1), the interpretation is not unquestionably proven. The rhyolite and ashstone marker bed has been shown separately as a subordinate unit of the Deakin Volcanics on the map to help clarify the structural relationship between the Deakin Volcanics and the Yarralumla Formation.

Öpik may have erred in identifying the rocks in one area as Deakin Volcanics by not recognizing the presence of volcanics younger than the Yarralumla Formation. Mapping since 1958 indicates that the tuff in Red Hill Quarry, which Öpik nominated as the type locality of the Deakin Volcanics, probably belongs to a formation of volcanics younger than the Yarralumla Formation. A new site for the type locality of the Deakin Volcanics is needed as the quarry has now been filled in; probably the best exposure of the volcanics is in the cutting at Hindmarsh Drive near its junction with Mugga Way, south of Red Hill; the volcanics are exposed over a distance of about 60 m and consist of white rhyolite and tuff dipping gently to the west.

Öpik's map shows the Red Hill Group as underlying most of the suburbs of Deakin and Yarralumla, the Yarralumla Formation being more extensive than and lying to the west of the Deakin Volcanics. Exposures on Red Hill, where the Yarralumla Formation has been metamorphosed to a hornfels, indicate a general dip to the southwest with beds repeated by reverse faults. Öpik gave they type locality of the Yarralumla Formation as the disused Yarralumla brick pit; another exposure is at the Deakin Oval, the site of another disused brick pit.

Extensive exposure of the Yarralumla Formation was mapped during construction of Yarra Glen, both east and west of the Kent Street overpass (Plate 2). The succession there resembles another sedimentary succession mapped at Hughes during excavation of trenches for services. Correlation of the succession at Hughes with the Yarralumla Formation is supported by fossils and by the presence beneath the sedimentary rocks of white rhyolite, ashstone, and tuff, which are presumably Deakin Volcanics. The white rhyolite is probably the same as that at the proposed new type locality for the Deakin Volcanics.

A third sequence of sediments and tuff - probably the upper part of the Yarralumla Formation - was mapped at west Deakin, between Hughes and the Yarra Glen exposures. The beds in all three places dip mainly to the southwest, which suggests repetition by faulting in the same style as that found on Red Hill. Table 2 shows the succession of rock units at each of the three localities, and the inferred correlation.

The succession mapped at Hughes is the most complete and probably the least likely to contain undetected faults; its total thickness is close to 400 m - considerably greater than the 150 m estimated by Opik. Also the Deakin Volcanics is at least 230 thick at Hughes - somewhat greater than the 105 m of Opik, who gave no indication of how or where he estimated his thicknesses. However, likely thickness variation from place to place are likely, both within individual rock units and in the whole of the succession, owing to the irregularities of deposition in an unstable volcanic environment. Such variations are evident from the thicknesses indicated in Table 2 and at other exposures of the sequence discussed below.

Rocks of the Red Hill Group occur in several places west and southwest of those localities already described. A succession which partly matches that at Hughes was mapped along a belt extending from Phillip northwest through Lyons to the Molonglo River. At the north of Lyons the following sequence was mapped:

top	sandstone and shale	at least 100 m
	laminated micaceous tuff	10 m
	coarse micaceous tuff	10 m
base	rhyolite with ashstone lenses	up to 140 m

Table 2

Correlation of successions of rock units in Red Hill Group at Hughes, west Deakin, and along Yarra Glen west of the Kent Street overpass

	HUGHES		WEST DEAKIN		YARRA GLEN	
	Rock Unit	Thickness (m)	Rock Unit	Thickness (m)	Rock Unit	Thickness (m)
	<u>Mugga Mugga Porphyry</u>		<u>Mugga Mugga Porphyry</u>			
Yarralumla Formation					Tuff or dacite	NK
	Shale, mudstone	25			Shale, mudstone	55+
	Sandstone	35	Sandstone	75	Sandstone, shale, mudstone	45+
	Shale, mudstone, ashstone	40	Shale, mudstone	50		
	Tuff	45	Tuff	50		
	Shale, mudstone	105	Shale, mudstone	45	Shale, mudstone	210
			Banded tuff	40		
			Tuff	20+		
	Sandstone, shale, mudstone	65			Sandstone, shale, mudstone	55
	Purple sandstone	80			Purple sandstone	10
Deakin Volcanics	Tuff (or dacite?)	130				
	Rhyolite with ashstone lenses	100+				

The thickness of the rhyolite and ashstone varies considerably, which is partly due to the lower part having been replaced in some exposures by the Mount Painter Porphyry. The rhyolite with ashstone lenses, and the micaceous tuffs, are regarded as Deakin Volcanics. The sandstone and shale at the top are regarded as Yarralumla Formation; a minimum thickness is given because continuous exposure was lacking in the trench excavations, and a fault may have displaced some of the formation. The sandstone and shale of the Yarralumla Formation is overlain by tuff that has been mapped as Sua.

Northwest of Lyons the rhyolite of the marker bed in the Deakin Volcanics can be traced as far as the Cotter Road, where it terminates. A similar rhyolite regarded as the same marker, crops out north of the Molonglo River, and a northwest-trending fault is inferred to account for the lack of continuity of the rhyolite. Outcrops of tuffaceous sediments including sandstone, massive siltstone, and fissile laminated micaceous siltstone northeast of the inferred fault were initially regarded as part of the Yarralumla Formation; however, some of these rocks appear to underlie the rhyolite north of the Molonglo River, and therefore would be better placed in the Deakin Volcanics. The thickness of the beds beneath the rhyolite is probably at least 100 m, and they appear to be intruded by the Mount Painter Porphyry.

Rocks similar to those in the Red Hill Group were also mapped in the eastern part of Curtin. They include both sedimentary rocks and ashstone, but owing to complex folding and faulting the sequence is not clear. Ashstone that crops out north of the Cotter Road near Government House may underlie some of the sedimentary rocks, and may be a correlate of the rhyolite and ashstone marker bed at Hughes and Lyons.

The inferred Deakin Volcanics north of Mount Stromlo comprise sandstone, laminated tuffaceous siltstone and minor white rhyolite. Identification with the Deakin Volcanics is based only on lithology, mainly on the white rhyolite and its association with laminated siltstone. Malcolm (1954) mapped these rocks as Deakin Volcanics, although his reasons for doing so are not clear. Relationship with the supposed Uriarra Volcanics was not seen but may be unconformable: D.L. Strusz (pers. comm.) has recently mapped an unconformity between two formations close to the base of the Upper Silurian in the Boambolo area, 40 km northwest of Mount Stromlo.

Tuffaceous sandstone along Darwinia Terrace, Rivett, (Plate 4, thin section 66360043) might belong to the Red Hill Group, and may be the sandstone at the base of the Deakin Volcanics mapped to the north of Mount Stromlo. However, no clear contact with the surrounding rhyodacite was seen, and its relation to the rhyodacite and the possible Uriarra Volcanics to the northeast is not known.

The localities where the Red Hill Group has been mapped provide enough data to give a generalized succession for the whole of the Red Hill Group. Six main subunits can be recognized, three in the Deakin Volcanics and three in the Yarralumla Formation; they are shown in Table 3.

Table 3

Main subunits of the Red Hill Group

FORMATION	SUBUNIT	THICKNESS (m)
	Sandstone, shale, mudstone	60-100
Yarralumla Formation	Shale, mudstone, tuff	190-210
	Sandstone, shale, mudstone	145
	Coarse tuff and tuffaceous laminated siltstone	20-130
Deakin Volcanics	Rhyolite with ashstone lenses	140+
	Sandstone, siltstone, laminated siltstone	100+

Thin sections of some of the rocks in the Red Hill Group are listed in Appendix 2, and their localities are shown in Plates 2, 3, and 4; the thin sections comprise a range of the tuffs and sedimentary rocks. Thin sections of the rhyolites, all of which were sampled outside the areas shown in Plates 2, 3, and 4, have been excluded from Appendix 2. The rhyolites are massive and consists of phenocrysts of quartz, orthoclase, and altered mafic minerals set in a cryptocrystalline to microcrystalline groundmass.

Fossils are common in the Yarralumla Formation. They include the brachiopods Atrypella and Howellella, and the trilobites Encrinurus etheridgei and Otarion (Strusz & Henderson, 1971). The fossils indicate a Ludlovian (Late Silurian) age.

Unnamed volcanics (Sua)

A formation of bedded tuff and coarse sandstone overlies the Yarralumla Formation in the belt extending northwest from Lyons, and is referred to in this paper as unnamed volcanics (Sua). A similar formation is present to the east of Yarralumla Creek, where it appears to overlie the Yarralumla Formation; however the repeated faulting in this area hides the true relationship. The tuff and sandstone in the two areas are correlated by their similar lithologies and by the overlying dacite, which is probably the same formation (unnamed volcanics, Sub) in both areas.

The tuff and sandstone are well exposed in a cutting in the Tuggeranong Freeway north of Oakey Hill and also in another cutting in nearby Heysen Street. The tuff includes strongly banded purple and green tuff and also more massive beds. The sandstone is generally coarse, and has well rounded grains, mainly of quartz. One bed of particularly coarse sandstone (thin section 70360023) near the top of the formation extends northwest from Lyons to the Cotter Road, and is a useful marker bed. The total thickness of tuff and sandstone between Lyons and the Molonglo River is about 130 m.

Most exposures of the tuff and sandstone at Garran were mapped during excavation of service trenches, and the formation is thought to extend north to the Red Hill Quarry area, where it may be represented by they volcanics which Öpik regarded as Deakin Volcanics. Thin sections indicate some dacite resembling Mugga Mugga Porphyry southeast of the quarry, but most outcrops appear to be metamorphosed tuff and sandstone. Between Garran and Red Hill Quarry the continuity of the tuff and sandstone is interrupted by an area of little or no outcrop on the Federal Golf Course, and by some areas of Mugga Mugga Porphyry. The area of no outcrop is shown as part of the unnamed volcanics (Sua) in Plate 1, but may include intrusives in the neck of a possible volcanic centre whose age relative to the surrounding rocks is not known. Evidence for the volcanic centre is discussed under 'Metamorphism'. The thickness of tuff and sandstone at Garran has been determined on the western slopes of the Mugga Mugga ridge as about 70 m.

Unnamed Volcanics (Sub)

A formation consisting mainly of green-grey and purple dacite (Sub) conformably overlies the unnamed volcanics (Sua); the contact can be seen in the Tuggeranong Freeway cutting about 1 km south of the Cotter Road and in the Heysen Street cutting. The dacite crops out on Oakey Hill and is extensively exposed in another cutting in the Tuggeranong Freeway to the west of Oakey Hill. The dacite also occurs over an extensive area of southeast Woden and occupies a broad belt to the northwest of Oakey Hill. Tuff dipping 30° east possibly overlies the dacite in the southern part of Weston, west of Namatjira Drive (Plate 4), but tuff has not been found elsewhere.

Most of the dacite is green-grey or only slightly purplish, except for the uppermost part north of the Weston Creek area, where it is purple. The purple colour is due to hematization. Outcrops are generally massive, although the pattern of jointing gives an impression of layering in some places. Banding is evident in the Tuggeranong Freeway cutting west of Oakey Hill. The dacite is folded but dips predominantly to the southwest. The total thickness is not known because the uppermost exposed part lies adjacent to the inferred fault which separates the dacite from the inferred Uriarra Volcanics to the southwest. A minimum thickness of 200 m is likely.

The dacite is composed of phenocrysts of quartz, plagioclase, and altered mafic minerals set in a microcrystalline groundmass (thin section 70360021).

INTRUSIVES

Five formations in the Woden/Weston Creek area are probably intrusive. Öpik regarded one of them, the Mount Painter Porphyry, as Upper Silurian but younger than the Red Hill Group, which show evidence of folding before the porphyry was emplaced. Lithological similarity between the Mount Painter Porphyry and the uppermost unnamed volcanic formation (Sub) suggests that they may be comagmatic and possibly contemporaneous. Evidence for the ages of the other intrusives is lacking, but their general lithological similarity to the Upper Silurian volcanics indicate that they are probably Upper Silurian. One intrusive, a rhyolite which occurs at Weston, is more acid than most of the volcanics and may be significantly younger, perhaps Devonian; its age is discussed below.

Mount Painter Porphyry (Sup)

The Mount Painter Porphyry was regarded by Öpik (1954, 1958) as an intrusive sill beneath the Red Hill Group. The type locality, Mount Painter, is to the north of the Woden/Weston Creek area, but the porphyry extends south and southeast to the suburb of Curtin. It also occurs east of the Mugga Mugga-Red Hill ridge and at a number of localities in the Deakin-Yarralumla area. The porphyry is a dacite and consists of abundant phenocrysts of quartz, plagioclase, and altered mafic minerals set in a cryptocrystalline groundmass. (Thin section 69360027 from north of Curtin is typical.) Öpik reported xenoliths of sedimentary and igneous origin. Xenoliths of dacite of the same composition as the porphyry but with a different texture were seen in some thin sections.

Öpik regarded the Mount Painter Porphyry as intrusive because of contact relations observed in a number of places. However, the resemblance of the rock to the massive extrusive rocks of similar composition has led a number of workers, both before and since the publication of Öpik's Bulletin (1958), to regard the porphyry as an extrusive rather than an intrusive rock. The present investigations have found further field evidence for an intrusive origin as follows:

1. Exposures showing intrusive relationships have been observed in several places, the Tuggeranong Freeway cutting on the northern slopes of Oakey Hill, an outcrop immediately east of the Tuggeranong Freeway about 500 m north of the Molonglo River Bridge, and an outcrop immediately south of the Cotter Road about 100 m east of its junction with Lady Denman Drive.
2. The sinuous boundary of the porphyry with sedimentary rocks in the eastern part of Curtin indicates a discordant relationship.
3. Contact metamorphism of laminated tuffaceous silstone occurs near the northern portal of the Ryan Sewer Tunnel close to outcrops of the porphyry (to the north of the area of this report).

4. The porphyry is found not only beneath the Red Hill Group but also appears to intrude overlying formations, for example Sua at Red Hill Quarry.

Some of these observations may perhaps be discounted; the intrusive dacite observed in outcrops may not be Mount Painter Porphyry but only small intrusions adjacent to the porphyry, or a small intrusion could also possibly account for the metamorphism near the north portal of Ryan Sewer Tunnel. On the other hand a considerable number of thin sections of the porphyry have been examined and the sample localities include some close to places where intrusive relationships have been observed. As all thin sections show the same characteristic texture and composition, a separate intrusive rock is unlikely to have been confused with the porphyry at all the sample localities. Another possibility is that rocks which appear to be intruded by the porphyry have been rafted up in a volcanic flow. Some outcrops of sedimentary rocks surrounded by the porphyry can perhaps be explained in this way, but in many places the intruded rocks are continuous with large areas underlain be bedded rocks which are too extensive to be rafts.

The thin-section evidence for an extrusive origin for the porphyry is the cryptocrystalline, almost glassy, groundmass and the fragmented appearance of the phenocrysts. This texture is also characteristic of a welded tuff, but whether it is also possible in an intrusive rock demands a wider knowledge and understanding of extrusive and intrusive porphyries than can be obtained from the study of a small area such as Woden/Weston Creek. The compositions and textures of the various porphyritic rocks in the area are compared in a later section of this report and some of the observations may be relevant to the question of distinguishing extrusives and intrusives in thin section.

öpik regarded the Mount Painter Porphyry as a sill. Even though a lower contact is not evident, this interpretation seems more than likely to be correct if one discounts the evidence of an extrusive origin. The texture of the rock is incompatible with a deepseated intrusive body.

Some alterations to Öpik's map in areas underlain by the Mount Painter Porphyry in the Deakin and Yarralumla areas have been made as a result of additional exposures. One alteration is near the Kent Street overpass over Yarra Glen, where excavations revealed a dacite underlying but showing discordant relations with the adjacent sedimentary rocks of the Yarralumla Formation. The dacite is isolated from the main body of the Mount Painter Porphyry on the surface but it resembles the porphyry in thin section and is therefore shown as such on the map.

Another departure from Öpik's map concerns the distribution of the porphyry northeast of Red Hill Quarry. Although the porphyry in the quarry showing the intrusive contact with tuff is not now visible because the quarry has been filled with refuse, a thin section of dacite from nearby (thin section 68360060) resembles the Mount Painter Porphyry and appears to confirm its presence in the area. However Öpik's map shows the Mount Painter Porphyry in the quarry as continuous around the northern foot of Red Hill with that in the Forrest and Red Hill areas. Mapping of the catchdrain around the northern foot of Red Hill showed almost continuous exposure of tuff and sedimentary rock, but no sign of any porphyry. Some porphyry might occur in this area but it would have to be less extensive than is shown on Öpik's map. The most likely place where the porphyry could crop out is near the intersection of Hopetoun Circuit and Adelaide Avenue, where Öpik's sinuous boundary between the porphyry and the Yarralumla Formation suggests that he mapped a contact there.

Evidence that the Mount Painter Porphyry underlies some of the Woden Town Centre (Phillip) is indicated by thin section 68360072. However, if the porphyry is present its extent is uncertain because it would intrude volcanic dacite and coarse tuff which would be similar in appearance in hand specimen, and would possibly not have been distinguished in the trench mapping of weathered rock.

Mugga Mugga Porphyry (Sum)

An acid porphyry which crops out on the Mugga Mugga Ridge was named the Mugga Mugga Porphyry by Pittman (1911). Öpik's (1954, 1958) map shows it as occurring only on the Mugga Mugga ridge south of Red Hill; however, the recent mapping shows that the porphyry also crops out on the western spur of Red Hill, north of Red Hill Quarry (Plate 2, thin section 68360064). Thin sections indicate that some of the dacite mapped in the northeast of Hughes is Mugga Mugga Porphyry, and outcrops of the porphyry have been mapped on the ridge between Hughes and Garran. Although it has an apparent thickness of 400 m on the Mugga Mugga ridge, it appears to be completely absent from the area west of Yarralumla Creek.

The Mugga Mugga Porphyry ranges in composition from dacite to rhyodacite, as studied in thin sections from they type locality, Mugga Quarry (e.g. thin section 65360035). The rock is composed of large phenocrysts of quartz, plagioclase, altered mafic minerals, and, in places, pink potash feldspar set in a microcrystalline groundmass. Fresh rock is green-grey, but generally hematization (alteration of the mafic minerals to iron oxide) gives it a dark, slightly purplish colour.

Pittman (1911) regarded the Mugga Mugga Porphyry as an intrusive rock. However, Mahony & Taylor (1913) regarded the rock as extrusive and referred to it as a dacite tuff. Öpik (1954, 1958) supported Pittman's interpretation and described the porphyry as an intrusive stock. An intrusive origin for the rock was again questioned by Oldershaw (1966), who observed what he regarded as flow banding in Mugga Quarry. More recently, Vanden Broek (1971) considered the porphyry as a welded tuff, and cited thin section evidence and flow banding in the Blue Metal Industries Quarry southeast of Mugga Quarry in support of his conclusion.

Öpik mentioned rafts of metamorphosed sediments on the Mugga Mugga ridge in support of an intrusive origin, and discounted Mahony & Taylor's (op. cit.) conclusion by suggesting that they were referring to volcanic rocks adjacent to the Mugga Mugga Porphyry. No evidence could be found, however, that the metamorphosed sediments on the northern end of the Mugga Mugga ridge, close to outcrops of the porphyry, are definitely intruded by the porphyry.

Evidence in support of an extrusive origin for the porphyry is the dip of the flow banding to the southwest which conforms with the general southwest dip of the rocks in the Red Hill Group. At Hughes, however, although the Mugga Mugga Porphyry appears to be almost conformable where it overlies the Yarralumla Formation, a discordant of boundary of the porphyry with sedimentary rocks, considered to be the Yarralumla Formation, was observed by D.E. Gardner (pers.comm.), and raises the possibility that the porphyry is a shallow-dipping intrusion. This conclusion gains some support from the strong possibility that the sedimentary rocks at Garran immediately to the west of the porphyry are Yarralumla Formation. An intrusive origin for the Mugga Mugga Porphyry is therefore preferred in this report.

Unnamed Porphyry (Sus)

An acid porphyry formation which crops out mainly to the south and southwest of Mount Stromlo was first mapped by Malcolm (1954), who regarded it as a dacite porphyry similar to the Mount Painter Porphyry. Malcolm regarded the rock as intrusive because of its contact relations with tuff and sedimentary rocks (Deakin Volcanics) on the northern slopes of Mount Stromlo. He also noted a fluidal texture in some thin sections.

Recent mapping and comparison of thin sections has shown that

Malcolm's dacite prophyry crops out on the ridge southwest of Chapman and on the western slopes of Mount Taylor. The same rock type was also mapped in the Village Creek area by Rossiter (1971), who regarded it as a dacitic tuff.

Thin sections from the Weston Creek, Village Creek, and Mount Stromlo areas show that the rock is composed of phenocrysts of quartz, plagioclase, biotite with complete or partial alteration to chlorite, and orthoclase set in a groundmass which ranges from cryptocrystalline with a eutaxitic* texture to microcrystalline. Owing to the presence of the potash feldspar the rock is probably more correctly termed a rhyodacite rather than a dacite. The eutaxitic texture is presumably what Malcolm described as 'fluidal' texture.

The relation of the rhyodacite to the inferred Uriarra Volcanics (Smu) to the north and east is indicated on the northern slopes of Mount Taylor, where the rhyodacite appears to overlie the volcanics with a gentle dip to the southwest. This interpretation was confirmed in the Tuggeranong Weston Creek sewer tunnel, where the rhyodacite overlies the typical purple dacite of the volcanics (Smu); the contact dips about 10° S.W. The superposition of the rhyodacite on the volcanics indicates that it is a sheet-like body, and the eutaxitic texture in some thin sections apparently confirms that the rock originated as a welded tuff. However, this interpretation does not take into account the intrusive contacts with the Deakin Volcanics which Malcolm observed on the northern slopes of Mount Stromlo, and which have been confirmed by re-examination.

*Eutaxitic structure: Ignimbritic, compact or flow structure; streaky appearance caused by parallelism of welded shards (Joplin, 1964).

The relation of the rhyodacite to the inferred Deakin Volcanics (Sud) along Darwinia Terrace, Rivett, is not known. No contact between the tuffaceous sandstone of the volcanics and the rhyodacite was seen in the temporary exposure in an excavation.

A problem thus arises similar to that which has already been discussed for the Mount Painter Porphyry. By adopting the same approach as that taken with the Mount Painter Porphyry, which was to give greater weight to field evidence than to textures in thin section, a solution to the problem consistent with the field evidence is that the rhyodacite is a sill.

Some further observations about the rhyodacite can be made on the assumption that it is a sill: a comparison of thin-sections from several localities indicates that the formation grades vertically from rock with a cryptocrystalline eutaxitic groundmass and strongly altered mafic minerals at the base to rock with a microcrystalline groundmass and fresh biotite at the highest observed level; corresponding variations occur in the abundance of phenocrysts, which decrease upwards, and in the colour in hand specimen of the fresh rock, which is dark grey at the base and becomes progressively paler above; orthoclase is found in all thin sections but is only visible as small pink grains in some places, generally in the lower part of the formation; and quartz is absent from the rock in some places near the base.

Unnamed porphyry (Sun)

A pale pink to pale grey coarse porphyry which crops out on Mount Neighbour and in other places in the southwest corner of the area shown in Plate 1 was regarded by Rossiter (1971) as intrusive. This interpretation is supported by the texture of the groundmass, in which the crystals are larger than in any of the volcanic rocks. The porphyry consists of large phenocrysts of quartz, plagioclase, orthoclase and altered mafic minerals set in a fine-grained crystalline groundmass of quartz and orthoclase (thin section 70360091). Rossiter named the porphyry a dacite, but the presence of potash feldspar indicates that it is more correctly termed a rhyodacite.

No clear contact of the porphyry with the surrounding rocks is exposed and therefore it is not possible to confirm in the field that the rock is intrusive. If an intrusive origin is accepted, then it is possible that the porphyry comprises several small separate but related stocks. Alternatively the outcrops could represent remnants of a once continuous sill-like body overlying the unnamed porphyry (Sus). The second alternative is indicated by mapping in the Tuggeranong/Weston Creek sewer tunnel, in which coarse porphyry was not even encountered in a section of the tunnel which passed almost directly beneath one of the outcrops.

If the coarse porphyry is a group of small stocks it must intrude the unnamed porphyry (Sus) and consequently be the younger of the two rocks. If, on the other hand, the coarse porphyry is a sill it could have been emplaced either before or after the unnamed porphyry (Sus).

Unnamed rhyolite (Suo)

Pale pink to pale green rhyolite which crops out at Weston was regarded by Wilson & Newstead (1967) as an ashstone. This interpretation has been disproved by subsequent excavations for the Tuggeranong Freeway, Hindmarsh Drive, and the Tuggeranong/Weston Creek sewer tunnel. All excavations revealed the rhyolite as dykes intruding the surrounding dacite. It consists of phenocrysts of quartz, orthoclase, altered mafic minerals, and some plagioclase set in a microcrystalline groundmass; the relative proportions of the minerals and the texture are variable.

The distribution of the rhyolite, particularly in the sewer tunnel, indicates that it has intruded mainly in the zone of faulting which separates the inferred Uriarra Volcanics from the volcanics which overlie the Red Hill Group. The faulting may have taken place well after the deposition of the youngest Upper Silurian dacite, but may have occurred as part of the block-faulting associated with the Late Silurian volcanism.

CAINOZOIC DEPOSITS

All previously described formations are hard-rock formations of Late Silurian or probable Late Silurian age. No younger deposits are known, apart from the Cainozoic alluvium and colluvium in the low-lying areas along Yarralumla and Weston Creeks and their tributaries; their distribution is shown in Plates 2, 3, and 4. The greatest thickness of superficial deposits is about 10 m. The alluvium ranges from sandy clay to clayey sand, with some sandy and gravelly horizons and beds of clay. The colluvium is found mainly at the foot of steep slopes and is generally poorly sorted; in places it has been partly cemented. Beds of greenish-grey clay are present in some places. The clay probably accumulated in local swampy areas which were subsequently buried under later deposits.

The alluvium and colluvium have been studied in some detail from augering on the slopes of Mount Taylor (Wilson, 1963; Vanden Broek & Kellett, 1972) and east of Yamba Drive in the proposed suburb of Isaacs (Henderson, 1974). Van Dijk (1959, 1965) has also studied alluvial and other soils in the Woden area and, in his earlier report, relates the successive alluvial horizons in the Canberra area (including Woden) to changes of climate in the Cainozoic Era.

COMPARATIVE FEATURES OF THE PORPHYRITIC ROCKS

In the preceeding section of this report macroscopic and microscopic features of the porphyritic rocks which serve to distinguish them, have been referred to. Some of the textural differences are evident only in thin section under the microscope. Mineralogical differences not obvious in hand specimen can be clearly seen in thin section. The following notes are a discussion of the similarities and differences between the various porphyritic rocks, and include those observations relevant to determining intrusive and extrusive rocks.

MINERALOGY

The mineralogical content of the porphyritic rocks enables them to be assigned names based on the relative feldspar proportions. The Hatch, Wells, & Wells (1961) system of classification is used. The estimated average mineral composition of each of the porphyritic rock units is given in Table 4 below. The composition of the groundmass is estimated with the help of staining of some slides with sodium cobaltinitrite. The transition from dacite to rhyodacite seems to coincide roughly with the appearance of phenocrysts of orthoclase and is taken as such for the purposes of assigning the rock name. However some marginal rocks classified as dacite may be rhyodacite, and vice versa, or they may grade from one to the other.

Table 4

Average mineral compositions of the porphyritic rocks

FORMATION	ESTIMATED AVERAGE COMPOSITION							Av. Plag. Comp.	ROCK NAME
	PHENOCRYSTS				GROUNDMASS				
	Qtz	Plag.	K-feld.	Mafic	Qtz	K-feld.	Plag.		
Mount Painter Porphyry	25-30	25-30	0	5-10	15-20	15-20	0-5	An49	Dacite
Mugga Mugga Porphyry	20-25	15-20	0-5	5-10	20-25	25-30	0	An53	Rhyodacite
Unnamed volcanics (Sub)	20-25	20-25	0	5-10	15-20	15-20	10-15	An58	Dacite
Unnamed rhyolite (Suo)	20-25	0	15-20	0-5	20-25	25-30	0	-	Rhyolite
Unnamed porphyry (Sus)	25-30	20-25	5-10	5-10	15-20	15-20	0	An58	Rhyodacite
Unnamed porphyry (Sun)	15-20	20-25	0-5	5-10	20-25	25-30	0	An49	Rhyodacite
Uriarra Volcanics?	20-25	20-25	0	5-10	15-20	15-20	10-15	An55	Dacite

The predominant mafic mineral in most of the rocks is biotite, which is generally altered to chlorite and opaques. Epidote may also be present and apatite is found as an accessory mineral in some sections. The apparently very calcic plagioclase in the dacites and rhyodacites may be partly due to the method of determining composition from maximum extinction angles. The plagioclase may be a mixture of more and less calcic crystals ranging from oligoclase to labradorite; zoning of some crystals in some sections indicates that this could be so. The calcic feldspar may, however, be due to temperature and pressure conditions in the original magma favouring the formation of biotite rather than hornblende; biotite contains less calcium than hornblende, and extra calcium would have been taken up by the plagioclase.

The nature and degree of alteration of the biotite varies between the supposed intrusive and volcanic porphyries. In the Mount Painter Porphyry and unnamed porphyry (Sus) the biotite is still present, or is only partly altered to chlorite and opaque minerals in a way that preserves the recognizable biotite cleavage. In the volcanic formations the mafic mineral that may originally have been biotite is commonly completely altered to opaques.

TEXTURE

The textural differences between the porphyritic rocks have been studied for possible indications intrusive or extrusive origin. The most marked textural differences are found between the Mount Painter Porphyry and unnamed porphyry (Sus) on the one hand, and the massive dacites and rhyodacite in the Uriarra Volcanics, Mugga Mugga Porphyry, unnamed volcanics (Sub) on the other hand. The former two porphyries, which from the field relations are considered to be intrusive, display in thin section an abundance of phenocrysts in a groundmass which is commonly only slightly devitrified. The proportion of phenocrysts may be as high as 70 or 80 percent but is commonly about 60 percent. In some sections, particularly in the unnamed porphyry (Sus), eutaxitic texture is evident. In the porphyries in the Canberra area this texture has, until now, been generally regarded as firm evidence of a welded tuff; however, as the field evidence supports an intrusive origin for the Mount Painter Porphyry and unnamed porphyry (Sus), the validity of a fluidal texture as definitive evidence for an extrusive origin now seem dubious. The temperature and pressure conditions which produce this texture in welded tuffs may also be present in the emplacement of high-level intrusive sills. Such a texture might be produced in a magma injected under high pressure; sudden release of pressure and rapid cooling might then preserve the eutaxitic texture.

In the Uriarra Volcanics, Mugga Mugga Porphyry, and the unnamed volcanics (Sub), two of which are regarded as extrusive rocks in the field, the proportion of phenocrysts (about 50 percent) is generally lower than in the porphyries; the groundmass is commonly more devitrified, and, under crossed nicols, the groundmass commonly has a distinctive mottled appearance. No eutaxitic texture is evident, even where the groundmass is only slightly devitrified.

The textural distinctions between the supposed intrusive and extrusive porphyritic rocks are most obvious in the large rock bodies. The smaller bodies, which include the unnamed porphyry (Sun) and the unnamed rhyolite (Suo), show textures that differ from the other rocks. The unnamed porphyry (Sun) contains moderately abundant phenocrysts in a uniform microcrystalline groundmass, but does not show the mottled appearance of the volcanics. The unnamed rhyolite (Suo) is somewhat variable in composition and texture both between different slides and within a particular slide; phenocrysts are generally sparser than in the other porphyritic rocks.

COLOUR

The colours of the porphyritic rocks range from blue-grey and green-grey to purple and pale pink. In the field, some of the extrusive rocks can be distinguished from the probable intrusives by their colour. For instance the extrusive porphyries are commonly purple, whereas the probable intrusives such as the Mount Painter Porphyry are only purple where they have intruded and incorporated a purple volcanic rock. The colour of a porphyry depends on the composition and the grainsize in the groundmass. Blue-green may be due to chlorite and yellow-green to epidote, whereas a reddish colour indicates hematite. A combination of blue-green and red minerals results in a purple rock. Pink rocks derive their colour from pink potash feldspar. Dark rocks generally have less devitrified groundmass than pale rocks; rocks lacking mafic minerals are pale.

The reason for the hematite and the consequent purple colour in some of the extrusive rocks is that they probably cooled in an oxidizing environment; volcanics not purple were probably extruded under water or were covered too rapidly by succeeding flows to enable oxidation to take place. The proportion of intrusive porphyries which penetrated the oxidation zone would have been small, and hence they are rarely purple.

PRIMARY STRUCTURES

The main primary structure which may or may not be present in the porphyritic rocks is flow banding. The banding is rarely obvious, and is best seen in large exposures such as the Mugga and BMI Quarries. Because the banding is generally indistinct its recognition is somewhat subjective, and it can be confused with strong jointing or a stress-induced foliation. Joint systems parallel to both flow banding and foliation are generally present, those parallel to foliation, however, are generally more steeply dipping.

METAMORPHISM

Thermal metamorphism of the sedimentary rocks on Red Hill was noted by Öpik (1954, 1958), who attributed it to the Mugga Mugga Porphyry, which he regarded as an intrusive stock. However, it now seems more probable that a volcanic vent was present in the area of the Federal Golf Course, and that sustained heat from the vent caused the metamorphism of the adjacent sedimentary rocks on Red Hill. Evidence for the volcanic vent includes the semi-circular distribution of the metamorphic rocks and the presence of a strong positive magnetic anomaly centred in the area (Canberra magnetic map I55/B1-38).

Calcareous and pelitic rocks have been hornfelsed, and sandstone has been altered to quartzite. Two thin sections of quartzite show that they were originally sandstones with a calcareous matrix: one (72360013) contains zoistite; the other (68360062) zoisite, grossularite garnet, and biotite. One bed of calc-silicate hornfels is particularly resistant to weathering and commonly forms outcrops with a characteristic pitted appearance. The rock is formed from an irregular mixture of pale and dark material, and it is the dark material which weathers to form the cavities. In the thin sections (72360012 and 72360014) zoisite is evident in the pale patches. A thin section of a pelitic hornfels (72360011) contains quartz, biotite, and irregular patches of altered cordierite.

Metamorphism of the Mugga Mugga Porphyry is evident in outcrop in the Federal Golf Course area, where the pale colour of the rock suggests that the groundmass has been recrystallised. Some thin sections of the dacite from near Red Hill Quarry show recrystallisation in the groundmass. An outcrop of granodiorite on the western side of the golf course may be a recrystallized dacite. Quartzite and fine-grained hornfels are also present in this area.

Metamorphism of adjacent rocks by the Mount Painter Porphyry is evident in some places where sandstone has been altered to quartzite, but the effect of fine-grained sediments is generally slight; an exception is near the northern end of the Ryan Tunnel, where the porphyry intrudes a fine-grained laminat ., micaceous siltstone with injection of silica along lamination planes. Metamorphism by dacite flows immediately overlying sandstone has produced quartzite in some places, for example in the cutting in Heysen Street.

STRUCTURE

FOLDING

Some broad folds are present in the area, and a number of minor folds are evident from changes in dip and from outcrops where folds are exposed. Several folds are exposed in outcrops of the hard calc-silicate hornfels on Red Hill, and an anticline is exposed at Deakin Oval. Many of the folds are close to faults or inferred faults and probably resulted from drag along these faults.

Nearly all folds plunge gently to the southeast, and some are overturned to the northeast with axial planes dipping southwest. Reversals of the direction of plunge may indicate broad secondary folding about an axis striking northeast. Overturned bedding was observed on the northeastern limb of one of the folds on Red Hill. Where no small folds are present bedding generally dips between 20° and 55° SW. Some irregular bedding attitudes occur in the eastern part of Curtin; they are probably related to a combination of the effects of intrusion of the Mount Painter Porphyry and drag along an inferred meridional fault along Yarralumla Creek (Plate 2).

The number of measurements of bedding in the sedimentary rocks has enabled the structure to be worked out fairly accurately; however, in the massive volcanic rocks exposures showing definite bedding are sparse. Faint banding was seen in the unnamed volcanics (Sub) at Mawson and Farrar, and lenses of tuffaceous sandstone and tuff at Pearce show bedding. In some places where massive volcanics are exposed, prominent joint systems dipping southwest may be parallel to the layering, but this cannot be established definitely.

Most of the indications of bedding in the volcanic units are consistent with a dip to the southwest, similar to that in most places in the sedimentary rocks. A possible anticline and syncline trending northwest are indicated at Waramanga (Plate 4). Some of the apparent banding dips to the southwest more steeply than the general bedding attitudes. The strike of this steeply dipping banding is parallel to the strike of minor folds and it may represent a tectonically induced foliation.

FAULTING

A number of faults have been observed, and others are indicated by lithological discontinuities. Most of the recognized faults lie in the sedimentary rocks in the northeastern part of the area. However, faults are probably as common to the southwest in the volcanics, whose massive nature and similar litholigies make recognition difficult; the correlation between faults in Tuggeranong Tunnel and trend lines on aerial photographs indicates their presence. Owing to the numerous faults in some places, only the main faults are shown in Plate 1. The remainder are shown in Plates 2, 3, and 4.

In terms of displacement the major faults are the Deakin Fault, which lies immediately southwest of Capital Hill; a curved meridional fault following Yarralumla Creek and Yarra Glen; and the inferred fault separating the possible Uriarra Volcanics (Smu) from the younger rocks to the north and east. The Deakin Fault forms the northeastern boundary of the Upper Silurian volcanic and intrusive rocks in the Woden/Weston Creek area; it is a normal fault whose displacement has been estimated by Öpik as at least 1200-1500 m. The fault along Yarra Glen is inferred from structural disturbance and lithological discontinuities. The displacement north of Hughes is considered, probably more than 500 m, but it lessens to the south; the downthrow is on the eastern side. The inferred fault at the northeastern boundary of the possible Uriarra Volcanics has already been discussed in the section on the volcanics. Assuming that the fault is present, its displacement must be considerable, possibly more than 1000 m.

Four northwest-trending faults at Hughes and Garran were recognized and identified from silicified rock in excavations and from lithological discontinuities. The fault that passes through the centres of both Hughes and Garran has a displacement of about 500 m at its northwest end. It appears to continue southeast into the volcanics at O'Malley, but its displacement there is not known; downthrow is on the northeast side. On the cross-sections (Plate 5) this fault and adjacent faults are shown as reverse faults to conform with the displacements indicated by the lithological mapping and the probable reverse faults striking in the same direction on Red Hill.

The northwest-trending faults on Red Hill appear to be parallel to the overturned axial planes of folds and probably therefore dip steeply southwest. Those with the downthrown block on the northeastern side are probably reverse faults. A minor fault of similar orientation to these faults is present at Deakin Oval. The fault shown at the eastern foot of Red Hill is inferred from the shearing on the eastern side of the Mugga Mugga Porphyry at Hindmarsh Drive, and the juxtoposition of the porphyry and the white rhyolite of the Deakin Volcanics, and indicates that the Yarralumla Formation has been removed by the fault. A quartz reef shown on Öpik's map near Adelaide Avenue is possibly a northern continuation of the fault.

At Curtin and Lyons a system of faults trending northeast is inferred from displacements of beds of ashstone and other rocks. Small steeply dipping faults striking northeast have been seen in excavations and are regarded as confirmation of the fault system.

JOINTING

No systematic measurements of joint orientations have been made over the whole area. However, observations in selected areas indicate that in some places the joint pattern is regular and in other places very complex. Oldershaw (1966) recorded a regular joint system in Mugga Quarry. One joint set in the quarry is parallel to a faint banding which dips about 25° SW; other sets are roughly perpendicular to the banding and are possibly primary cooling joints. A complex system of joints is developed in the Mugga Mugga Porphyry along Hindmarsh Drive north of Mugga Quarry; here joints dip at widely variable angles to the southeast, south, and southwest. Joints parallel to banding are evident in the unnamed volcanics (Sub) at Mawson and in the unnamed porphyry (Sus) on the northern slopes of Mount Taylor. Joints dipping steeply to the southwest parallel to a slight foliation are also present in the volcanics.

Joint spacing varies with the different rock types. It ranges from more than 3 m in the coarsest rocks, such as those parts of the Mugga Mugga Porphyry and unnamed porphyry (Sus) not affected by shearing to a few centimetres in the fine-grained sedimentary rocks. In the other rocks joint spacing ranges between these extremes depending on grainsize and the presence or absence of shearing.

WEATHERING AND GEOMORPHOLOGY

Outcrops are common on the steep hills and ridges, and along the steep sides of the entrenched Molonglo River valley, but are sparser in the gently undulating areas. The sedimentary rocks at the surface tend to be softer and more weathered than the porphyries and volcanics, and rarely form large natural outcrops. Where the sedimentary rocks have been hardened by metamorphism, such as on Red Hill, outcrops are bold. On steep slopes the thicknesses of weathered rock between the outcrops are generally less than in the gently undulating areas. On the lower slopes of high hills such as Mount Taylor, colluvium derived from the higher slopes has accumulated. Depths of weathering and thicknesses of colluvium have been determined in some areas from investigations for engineering projects (Wilson, 1963; Gardner & Lang, 1966; Vanden Broek & Kellett, 1972; Purcell & Simpson, 1973; Purcell, 1974).

Surface and subsurface information indicates variations in the depth and form of weathering between the various porphyries and volcanics. The more siliceous porphyritic dacites and rhyodacites have weathered to form boulders surrounded and underlain by highly weathered rock. In areas where the rock is less siliceous the weathering profile is more uniform.

The texture of the groundmass of the porphyritic rocks may also affect the form and degree of weathering: dacites with a microcrystalline groundmass may decompose to a highly weathered cohesionless material, whereas some dacites with a cryptocrystalline or glassy groundmass break down to moderately to highly weathered rock containing clay minerals that retain considerable strength, particularly when the rock is dry (E.J. Best, pers. comm.). A feature of intrusive dacites is that, where a contact with sedimentary rocks is exposed, the dacite is generally much more weathered than the sediments; this is attributable to the sediments having been hardened and made more resistant to weathering by slight metamorphism.

Other factors affecting the weathering profile are shearing, close jointing, and the proximity of faults, all of which tend to increase the depth of weathering. In some places, however, close jointing facilitates weathering and produces a uniform weathering profile without boulders.

All of the lithological and structural factors affecting weathering in the Woden/Weston Creek area are reflected in the shapes of the hills and ridges, and in the preferred directions of creeks and watercourses. The tendency of ridges to trend in a northwesterly direction conforms with the general strike of bedding, fold axes, and one of the major fault systems. Watercourses tend to follow deeply weathered zones close to faults; for example Yarralumla Creek appears to follow a major inferred fault for much of its length. In places a combination of factors may affect the shape of a ridge: the curved form of Red Hill is thought to be due to the distribution of the hard bed of calc-silicate hornfels of the metamorphic zone around the inferred volcanic vent.

Some features of the topography have resulted from the successive periods of uplift, followed by erosion and the formation of peneplains or pediplains, which is thought to have occurred during the Tertiary and Quaternary (Van Dijk, 1959). One of these surfaces is found between 550 and 640 m (1800-2100 feet) above sea level. Gradual removal of weathered rock from hillslopes by erosion has resulted in recession of the slopes and formation of a gently undulating surface between the hills, and the transported material has been deposited as colluvium on the lower slopes. The removal of weathered material from the hillslopes has left relatively unweathered outcrops, but weathered rock to considerable depth remains beneath the colluvium of the lower slopes. At a certain stage in the development of the mature land surface at about 500 m above sea level, uplift is postulated to account for headward erosion and entrenchment of the Molonglo River to the west of Canberra. The river has incised its bed through the deeply weathered rock on the partly formed peneplain, and formed a gorge in fresh rock. In the broad tributary valleys of Weston and Yarralumla Creeks, the streams have removed much of the lower valley colluvium, and benches of residual colluvium remain on the flanks of the hills.

BIBLIOGRAPHY

BUREAU OF MINERAL RESOURCES, 1960 - Canberra special, New South Wales, total magnetic intensity map. Bur. Miner. Resour. Aust. Map 155/B1-38.

CRAFT, F.A., 1933 - the surface history of the Monaro, N.S.W. Proc. Linn. Soc. NSW, 58(3-4), 229-44.

DALLWITZ, W.B., 1949 - Rock from Mt. Mugga Quarry, A.C.T. - its suitability as aggregate. Bur. Miner. Resour. Aust. Rec. 1949/50 (unpubl.).

GARDNER, D.E., & LANG, R.A., 1966 - Investigation of soil thickness along route of Woden-Stromlo water main, A.C.T. Bur. Miner. Resour. Aust. Rec. 1966/138 (unpubl.).

GARDNER, D.E., & PRITCHARD, D.W., 1957 - Geological report on the brick pit at Deakin, A.C.T. Bur. Miner. Resour. Aust. Rec. 1957/93 (unpubl.).

HATCH, F.H., WELLS, A.K., & WELLS, M.K., 1961 - PETROLOGY OF THE IGNEOUS ROCKS, 12th ed. London, Murby 1961.

HENDERSON, G.A.M., 1973a - Stratigraphy and structure, Canberra 1:50 000 geological map area. Bur. Miner. Resour. Aust. Rec. 1973/11 (unpubl.).

HENDERSON, G.A.M., 1973b - Geology of the Capital Hill area, Canberra, A.C.T. Bur. Miner. Resour. Aust. Rec. 1973/35 (unpubl.).

HENDERSON, G.A.M., 1974 - Geological investigation for proposed urban development at Isaacs, Woden Valley, A.C.T. Bur. Miner. Resour. Aust. Rec. 1974/158 (unpubl.).

HENDERSON, G.A.M., in prep. - Coppins Crossing 1:10 000 engineering geological series. Bur. Miner. Resour. Aust.

JOPLIN, G.A., 1964 - A PETROGRAPHY OF AUSTRALIAN IGNEOUS ROCKS. Sydney Angus & Robertson

MAHONY, D.J., & TAYLOR, T.G., 1913 - REPORT ON A GEOLOGICAL RECONNAISSANCE OF THE FEDERAL TERRITORY, WITH SPECIAL REFERENCE TO AVAILABLE BUILDING MATERIALS. Melbourne, Govt. Printer.

MALCOLM, D.K., 1954 - The geology of the Cotter River and Uriarra area, Australian Capital Territory. Bur. Miner. Resour. Aust. Rec. 1954/71 (unpubl.).

OLDERSHAW, W., 1966 - Geological investigation of Mugga Quarry, A.C.T., 1965. Bur. Miner. Resour. Aust. Rec. 1966/76 (unpubl.).

ÖPIK, A.A., 1954 - Geology of the Canberra City district. In WHITE, H.L. (Ed.) - CANBERRA, A NATIONS CAPITAL. Handbk 30th ANZAAS Congr. Canberra, 131-48.

ÖPIK, A.A., 1958 - The geology of the Canberra City district. Bur. Miner. Resour. Aust. Bull., 32.

PITTMAN, E.F., 1911 - REPORTS ON THE GEOLOGY OF THE FEDERAL CAPITAL SITE. Melbourne, Govt. Printer.

PURCELL, D.C., 1974 - Tuggeranong-Weston Creek sewer tunnel, A.C.T.: geological investigations, 1971. Bur. Miner. Resour. Aust. Rec. 1974/11 (unpubl.).

PURCELL, D.C., & SIMPSON, G.B., 1973 - Molonglo valley interceptor sewer, Canberra, A.C.T.: geological investigations, 1970-1972. Bur. Miner. Resour. Aust. Rec. 1973/173 (unpubl.).

ROSSITER, A., 1971 - Preliminary notes on the geology of the Village Creek area, A.C.T. Bur. Miner. Resour. Aust. Rec. 1971/11 (unpubl.).

STRUSZ, D.L., 1971 - Canberra, Australian Capital Territory and New South Wales - 1:250 000 Geological Series. Bur. Miner. Resour. Aust. explan. Notes. SI/55-16.

STRUSZ, D.L., & HENDERSON, G.A.M., 1971 - Canberra, A.C.T. - 1:50 000 geological map and explanatory notes. Bur. Miner. Resour. Aust. explan. Notes.

VANDEN BROEK, P.H., 1971 - Geological evaluation of the proposed Mugga saddle refuse disposal area, Woden district, A.C.T. Bur. Miner. Resour. Aust. Rec. 1971/60 (unpubl.).

VANDEN BROEK, P.H., & KELLETT, J.R., 1972 - Geological, seismic, and soils evaluation along the route of the proposed Tuggeranong Freeway, Stage II, A.C.T. Bur. Miner. Resour. Aust. Rec. 1972/73 (unpubl.).

VAN DIJK, D.C., 1959 - Soil features in relation to erosional history in the vicinity of Canberra. CSIRO Soil Publ. 13.

VAN DIJK, D.C., 1965 - Soil studies for urban development in the Yarralumla Creek catchment and the Belconnen area proposed extensions of the Canberra City district. CSIRO Soil Publ. 5/64.

WILSON, C., & NEWSTEAD, P., 1967 - Geology of the Weston Creek area, Australian Capital Territory. Bur. Miner. Resour. Aust. Rec. 1967/102 (unpubl.).

WILSON, E.G., 1963 - Soil and scree deposits at Woden, Australian Capital Territory, and their relationship to underground drainage. Bur. Miner. Resour. Aust. Rec. 1963/107.

WOOLNOUGH, W.G., 1938 - Geology and physiography of the Australian Capital and surrounding areas. Handbk 24th Congr. Aust. Ass. Adv. Sci., Canberra, 1939, 111-18.

APPENDIX 1

DEFINITIONS OF SEMIQUANTITATIVE DESCRIPTIVE TERMS

Bedding

Laminated	- Less than 10 mm thick
Thinly bedded	- 10 mm to 100 mm thick
Thickly bedded	- More than 100 mm thick

Grainsize

Coarse-grained	- 1 mm to 4 mm in diameter
Medium-grained	- $\frac{1}{4}$ mm to 1 mm in diameter
Fine-grained	- Less than $\frac{1}{4}$ mm in diameter

Hardness of Rock

Hard to very hard	- Impossible to scratch with a knife blade
Moderately hard	- Shallow scratches with a knife blade
Soft	- Deep scratches with a knife blade

Joint Spacing

Closely spaced	- Joints spaced less than 15 cm apart
Moderately spaced	- Joints spaced between 15 cm and 90 cm apart
Widely spaced	- Joints spaced more than 90 cm apart

Percussive Strength of Rock

Strong to very strong	- Cannot be broken by repeated blows with a hammer
Moderately strong	- Rock broken by 3 or 4 blows
Weak	- Rock broken by 1 blow

Weathering of Rock

Fresh	- No discolouration or loss in strength
Fresh stained	- Limonitic staining along fractures; rock otherwise fresh and shows no loss of strength
Slightly weathered	- Rock is slightly discoloured, but not noticeably lower in strength than the fresh rock
Moderately weathered	- Rock is discoloured and noticeably weakened; N-size drill core generally cannot be broken by hand across the rock fabric.
Highly weathered	- Rock is discoloured and weakened; N-size drill core can generally be broken by hand accross the rock fabric.
Completely weathered	- Rock is decomposed to a soil, but the original rock fabric is mostly preserved.

APPENDIX 2

LIST OF THIN SECTIONS SHOWN IN PLATES 2, 3, and 4

REG. NO.	FORMATION	ROCK NAME
67360050	Uriarra Volcanics?	Dacite
67360058		Dacite
67360059		Spherulitic dacite
67360091		Dacite
67360093		Dacite
67360116		Dacite
67360117		Spherulitic dacite with rhyolite vein
67360118		Dacite
67360119		Dacite
67360120		Rhyolite (intrusive dyke?)
67360121		Recrystallized tuff
67360122		Dacite
68360032		Dacite
68360033		Dacite
68360034		Dacite
69360021		Spherulitic dacite
69360022		Dacite
69360023		Slumped tuff
69360024		Dacite
64360008	Red Hill Group	Fine-grained tuff
65360001		Fine to medium-grained tuff
65360003		Purple quartz sandstone
65360004		Altered dacitic tuff
66360043		Feldspathic sandstone
67360004		Banded sandstone
67360006		Silty mudstone
67360007		Fine-grained sandstone
67360064		Laminated micaceous tuff
67360067		Tuffaceous siltstone
67360068		Tuffaceous siltstone
67360069		Tuffaceous siltstone
68360036		Shale
68360059		Rhyolitic tuff
68360072		Dacite (possibly intrusive)
68360077		Feldspathic sandstone containing chlorite

REG. NO.	FORMATION	ROCK NAME
68360100	Red Hill Group	Feldspathic sandstone
68360102		Siliceous fine tuff or ashstone
70360022		Siliceous fine tuff or ashstone
72360011		Pelitic hornfels
72360012		Calc-silicate hornfels
72360013		Quartzite
72360014		Calc-silicate hornfels
68360058	Mugga Mugga Porphyry	Dacite
68360064		Dacite
68360071		Dacite
64360005	unnamed volcanics (Sua)	Tuff
64360006		Tuffaceous sandstone
64360007		Tuffaceous sandstone
65360005		Banded tuff
67360065		Medium-grained tuff
67360066		Bedded fine tuff
68360001		Tuff
68360002		Tuff
68360004		Banded tuff
68360061		Dacite
68360062		Quartzite
68360063		Dacite
68360065		Dacite
68360066		Dacite
69360055		Tuffaceous siltstone
69360056		Dacite tuff
70360023		Coarse-grained quartzite
67360002	unnamed volcanics (Sub)	Dacite
67360051		Dacite
67360070		Dacite
67360071		Rhyolite (possibly a dyke)
67360073		Dacite
67360077		Dacite
68360003		Dacite
70360021		Dacite
71360023		Dacite

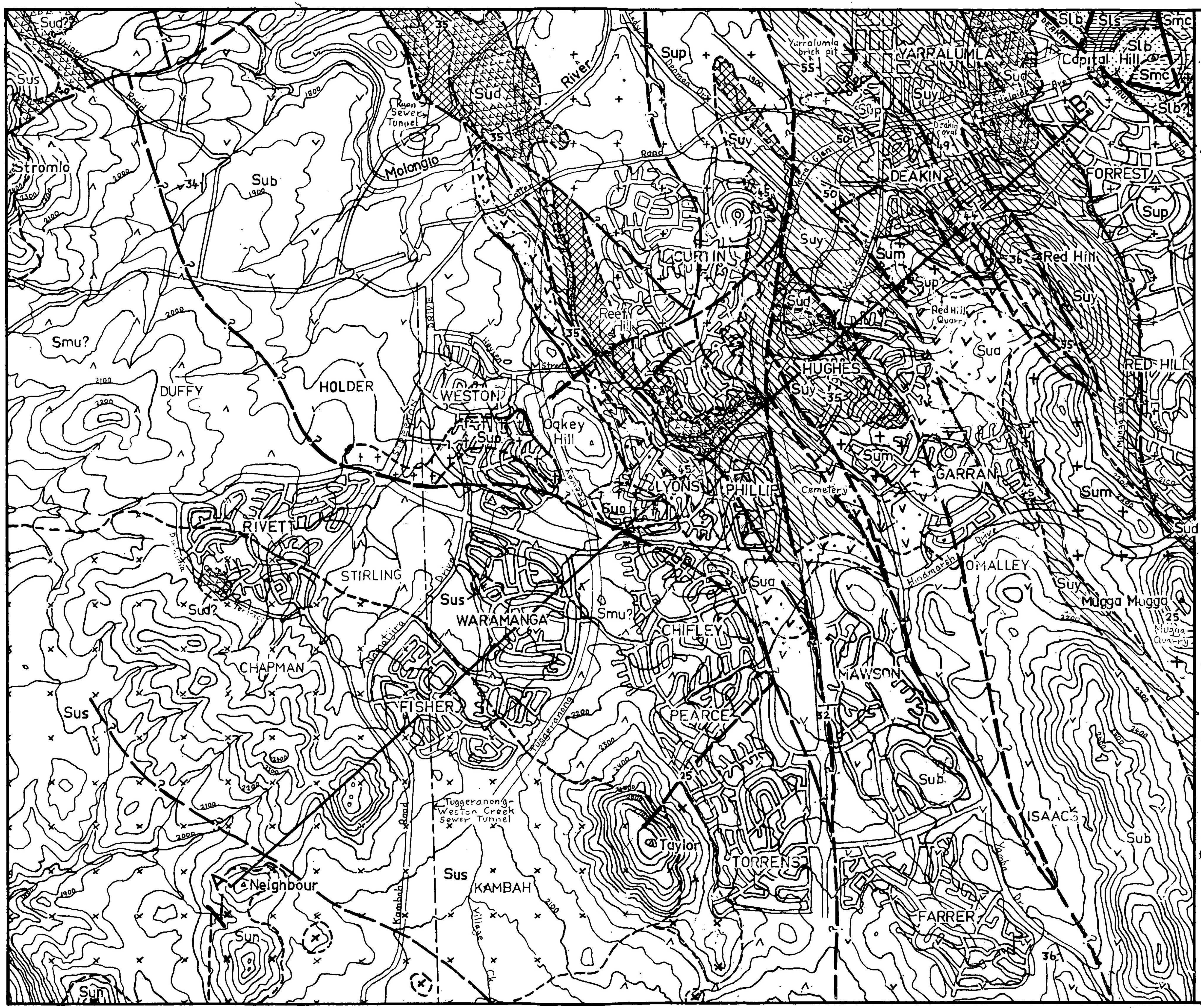
REG. NO.	FORMATION	ROCK NAME
71360025	unnamed volcanics (Sub)	Dacite
71360026		Dacite
71360027		Dacite
72360001		Dacite
72360002		Dacite
72360003		Dacite
72360004		Dacite
72360005		Dacite
72360006		Dacite
72360007		Dacite
72360008		Dacite
72360009		Dacite
67360010	Mount Painter Porphyry	Dacite
68360060		Dacite
68360099		Dacite
69360027		Dacite
67360052	unnamed porphyry (Sus)	Rhyodacite with eutaxitic texture
67360053		Rhyodacite with eutaxitic texture
67360054		Rhyodacite
67360056		Rhyodacite
67360057		Rhyodacite with eutaxitic texture
67360078		Rhyodacite with fresh biotite
67360079		Rhyodacite with fresh biotite
67360094		Rhyodacite with fresh biotite
67360095		Rhyodacite with fresh biotite
67360096		Rhyodacite with fresh biotite
67360097		Rhyodacite
67360098		Rhyodacite
67360099		Rhyodacite with fresh biotite
67360100		Rhyodacite
67360101		Rhyodacite with fresh biotite

REG. NO.	FORMATION	ROCK NAME
67360102	**unnamed porphyry (Sus)**	Rhyodacite
67360103		Rhyodacite with eutaxitic texture
67360104		Rhyodacite with eutaxitic texture
68360026		Rhyodacite
68360027		Rhyodacite
68360028		Rhyodacite
68360031		Rhyodacite
69360025		Rhyodacite
71360028		Trachyandesite
71360034		Rhyodacite with eutaxitic texture
71360035		Rhyodacite with eutaxitic texture
73360079		Trachyandesite
73360080		Rhyodacite
73360081		Rhyodacite
67360062	**unnamed rhyolite (Suo)**	Potash felspar rich rhyolite
67360063		Quartz rich rhyolite
67360123		Quartz rich rhyolite
67360124		Quartz rich rhyolite
67360125		Rhyolite with sparse phenocrysts
68360005		Quartz rich rhyolite

PLATE 1

INTERPRETATIVE GEOLOGICAL MAP OF THE WODEN/WESTON CREEK AREA

(Cainozoic deposits omitted)



0 — 1 — 2 Miles

0 — 1 — 2 Km.

N — Grid North — Magnetic North

REFERENCE

UPPER SILURIAN INTRUSIVES		Unnamed rhyolite	Suo	+ +	Rhyolite
		Unnamed porphyry	Sus	×	Rhyodacite
		Unnamed porphyry	Sun	✕	Rhyodacite
		Mugga Mugga Porphyry	Sum	+	Rhyodacite
		Mount Painter Porphyry	Sup	+	Dacite
UPPER SILURIAN		Unnamed volcanics	Sub	V	Dacite
		Unnamed volcanics	Sua	V·	Tuff, sandstone
	Red Hill Group	Yarralumla Formation	Suy		Mudstone, shale, sandstone, tuff, hornfels
		Deakin Volcanics	Sud		Tuff, sandstone, siltstone, rhyolite; Rhyolite, ashstone marker bed
MIDDLE SILURIAN?		Uriarra Volcanics?	Smu	^	Dacite, tuff
		Canberra Group	Smc		Sandstone, mudstone
LOWER SILURIAN		Black Mountain Sandstone	Slb		Sandstone
		State Circle Shale	Sls		Shale

- Geological boundary, position accurate
- Geological boundary, position approximate
- Geological boundary, position inferred
- Fault, position accurate
- Fault, position approximate
- Fault, position inferred
- 35 Dip and strike of bedding
- Possible unconformity
- Road or street
- 2200 Topographical contour, in feet above M.S.L.
- A—B Cross section (see Plate 5)
- Sewer tunnel lines

AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE 0 — ½ — 1 MI.

Base map/survey NCDC map TP224/67

Geology by D.E. Gardner, A.A. Opik, D.A. Buchhorn, P. Vandenbroek, I. Lotterton, C. Wilson, P. Newstead, R. Thieme, A. Rossiter, G. Henderson

Compiled and checked G.A.M.H. Project geologist

Checked and approved — Senior geologist

Supervising geologist

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.

TITLE INTERPRETATIVE GEOLOGICAL MAP OF THE WODEN-WESTON CREEK AREA

PROJECT GEOLOGY OF THE WODEN WESTON CREEK AREA

To accompany	Drawn by	Drawing No.
Record 1975/54	G.A.M.H.	I55/A16/1253

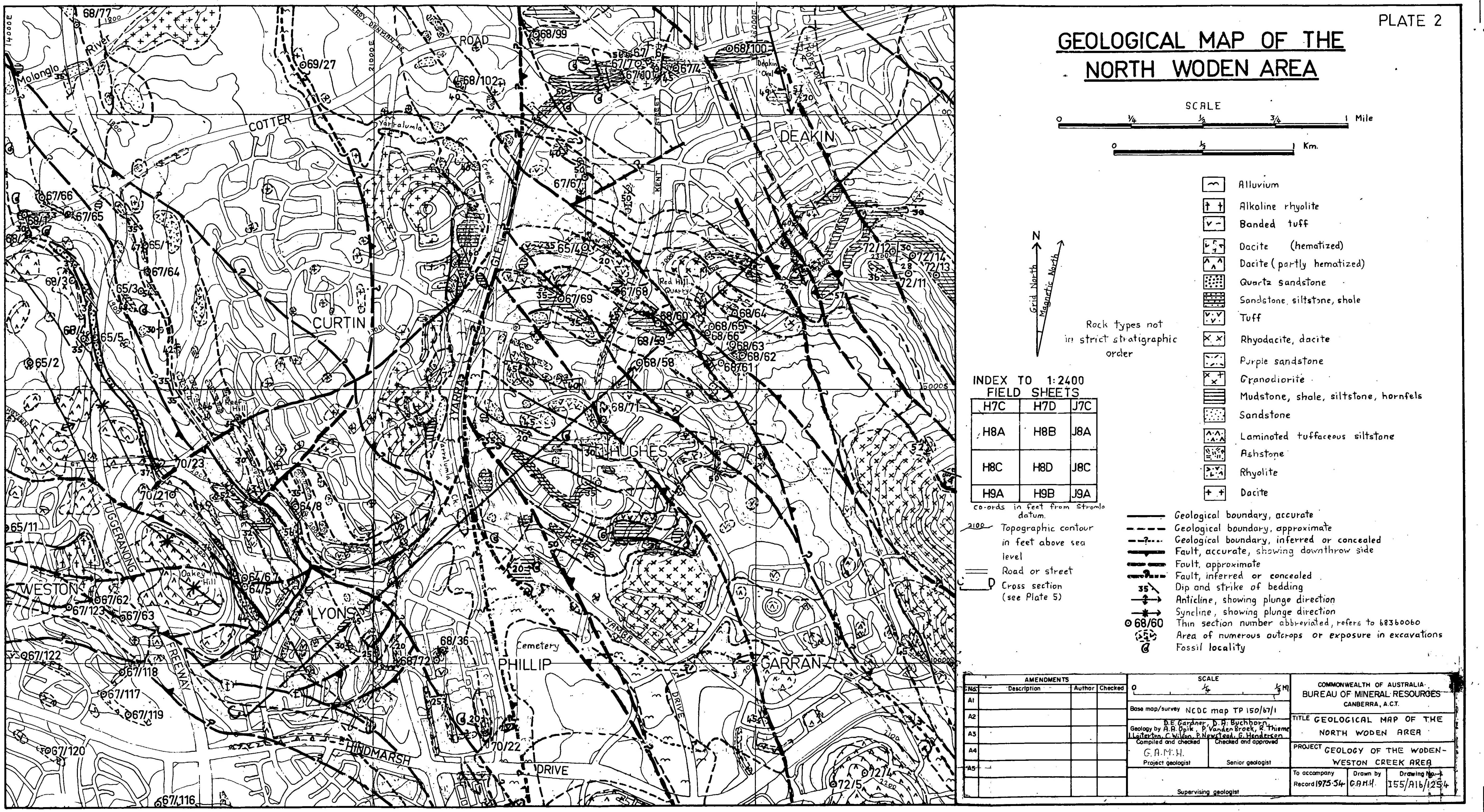


PLATE 2
GEOLOGICAL MAP OF THE NORTH WODEN AREA
SCALE
0 1/4 1/2 3/4 1 Mile
0 1/2 1 Km.
Grid North
Magnetic North
N
Rock types not in strict stratigraphic order
Alluvium
Alkoline rhyolite
Banded tuff
Dacite (hematized)
Dacite (partly hematized)
Quartz sandstone
Sandstone, siltstone, shale
Tuff
Rhyodacite, dacite
Purple sandstone
Granodiorite
Mudstone, shale, siltstone, hornfels
Sandstone
Laminated tuffaceous siltstone
Ashstone
Rhyolite
Dacite
INDEX TO 1:2400 FIELD SHEETS
H7C H7D J7C
H8A H8B J8A
H8C H8D J8C
H9A H9B J9A
Co-ords in feet from Stromlo datum.
Topographic contour in feet above sea level
Road or street
Cross section (see Plate 5)
Geological boundary, accurate
Geological boundary, approximate
Geological boundary, inferred or concealed
Fault, accurate, showing downthrow side
Fault, approximate
Fault, inferred or concealed
Dip and strike of bedding
Anticline, showing plunge direction
Syncline, showing plunge direction
68/60 Thin section number abbreviated, refers to 68360060
Area of numerous outcrops or exposure in excavations
Fossil locality
DEAKIN
CURTIN
HUGHES
WESTON
LYONS
PHILLIP
GARRAN
Cemetery
Red Hill Quarry
Reef Hill
Oakey Hill
Molonglo River
COTTER ROAD
HINDMARSH DRIVE
TUGGERANONG FREEWAY
YARRA GLEN
Yarralumla Creek
AMENDMENTS
No. Description Author Checked
A1 A2 A3 A4 A5
Base map/survey NCDC map TP 150/67/1
Geology by D.E. Gardner, D.A. Buchhorn, A.A. Öpik, P. Vanden Broek, R. Thieme, I. Laiterton, C. Wilson, P. Newstead, G. Henderson
Compiled and checked G.A.M.H. Project geologist
Checked and approved Senior geologist
Supervising geologist
COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.
TITLE GEOLOGICAL MAP OF THE NORTH WODEN AREA
PROJECT GEOLOGY OF THE WODEN-WESTON CREEK AREA
To accompany Record 1975/54
Drawn by G.A.M.H.
Drawing No. I55/A16/1254

PLATE 3

GEOLOGICAL MAP OF THE SOUTH WODEN AREA

SCALE

0 — 1/4 — 1/2 — 3/4 — 1 Mile

0 — 1/2 — 1 Km.

Rock types not in strict stratigraphic order

- Alluvium
- Rhyodacite
- Rhyolite
- Dacite (hematized)
- Dacite (partly hematized)
- Quartz sandstone
- Tuff
- Rhyodacite
- Rhyodacite
- Sandstone

N

Grid North

Magnetic North

- Geological boundary, accurate
- Geological boundary, approximate
- Geological boundary, inferred or concealed
- Fault, accurate, showing downthrow side
- Fault, approximate
- Fault, inferred or concealed
- 31 Dip and strike of bedding, banding or foliation
- Anticline, showing plunge direction } most folds inferred
- Syncline, showing plunge direction } most folds inferred
- ⊙ 69/56 Thin section number abbreviated, refers to 69360056
- Area of numerous outcrops or exposure in excavations
- 2200 Topographic contour in feet above sea level
- Road or street

INDEX TO 1:2400 FIELD SHEETS

H9A	H9B	J9A
H9C	H9D	J9C
H10A	H10B	J10A

Co-ords in feet from Stromlo datum

AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE 0 — 1/4 — 1/2 Ml

Base map/survey NCDC map TP150/67/1

Geology by D.E. Gardner, R. Thieme & G.A.M. Henderson

Compiled and checked G.A.M.H. Project geologist

Checked and approved Senior geologist

Supervising geologist

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.

TITLE GEOLOGICAL MAP OF THE SOUTH WODEN AREA

PROJECT GEOLOGY OF THE WODEN-WESTON CREEK AREA

To accompany Record 1975/54 | Drawn by G.A.M.H. | Drawing No. I55/A16/1255

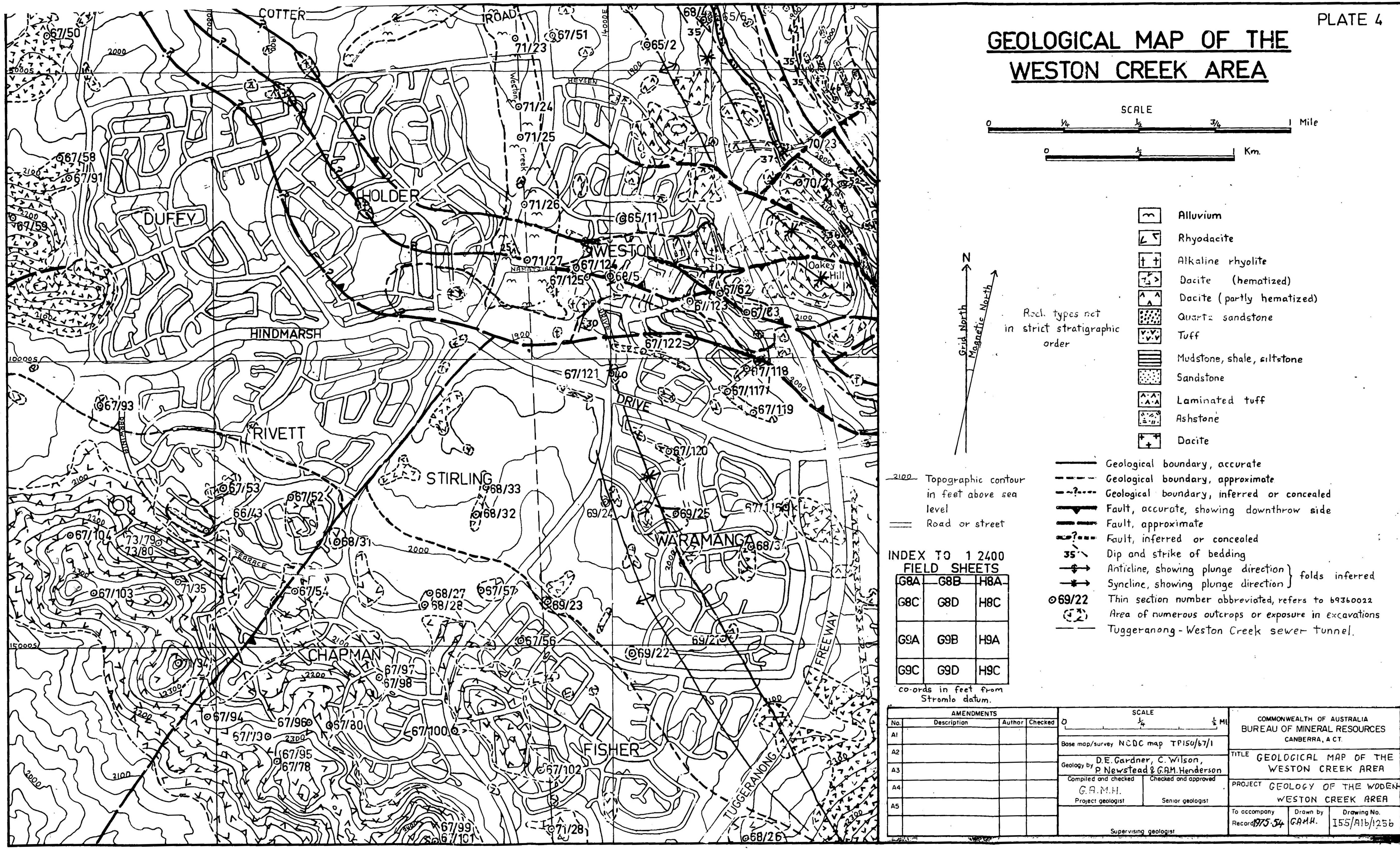


PLATE 4
GEOLOGICAL MAP OF THE WESTON CREEK AREA
SCALE
0 1/4 1/2 3/4 1 Mile
0 1/2 1 Km.
Grid North
Magnetic North
N
Rock types not in strict stratigraphic order
Alluvium
Rhyodacite
Alkaline rhyolite
Dacite (hematized)
Dacite (partly hematized)
Quartz sandstone
Tuff
Mudstone, shale, siltstone
Sandstone
Laminated tuff
Ashstone
Dacite
Geological boundary, accurate
Geological boundary, approximate
Geological boundary, inferred or concealed
Fault, accurate, showing downthrow side
Fault, approximate
Fault, inferred or concealed
Dip and strike of bedding
Anticline, showing plunge direction
Syncline, showing plunge direction
folds inferred
69/22 Thin section number abbreviated, refers to 69360022
Area of numerous outcrops or exposure in excavations
Tuggeranong - Weston Creek sewer tunnel.
2100 Topographic contour in feet above sea level
Road or street
INDEX TO 1 2400 FIELD SHEETS
G8A G8B H8A
G8C G8D H8C
G9A G9B H9A
G9C G9D H9C
co-ords in feet from Stromlo datum.
AMENDMENTS
No. Description Author Checked
A1
A2
A3
A4
A5
SCALE
0 1/4 1/2 MI
Base map/survey NCDC map TP150/67/1
Geology by D.E. Gardner, C. Wilson, P. Newstead & G.A.M. Henderson
Compiled and checked G.A.M.H. Project geologist
Checked and approved Senior geologist
Supervising geologist
COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.
TITLE GEOLOGICAL MAP OF THE WESTON CREEK AREA
PROJECT GEOLOGY OF THE WODEN-WESTON CREEK AREA
To accompany Record 1975/54
Drawn by G.A.M.H.
Drawing No. I55/A16/1256
COTTER ROAD
HOLDER
DUFFY
WESTON
HINDMARSH
RIVETT
STIRLING
WARAMANGA
CHAPMAN
FISHER
DRIVE
TERRACE
TUGGERANONG FREEWAY
Oakey Hill
HEYSEN
Weston Creek

INTERPRETATIVE CROSS-SECTIONS OF THE WODEN/WESTON CREEK AREA

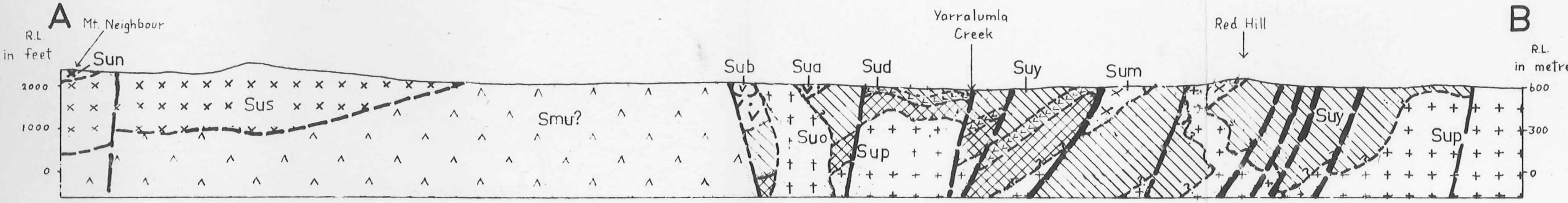
SECTION A-B

For location and reference see Plate 1

SCALE $\frac{V}{H} = 1$

0 ½ 1 1½ 2 Miles

0 1 2 3 Km.



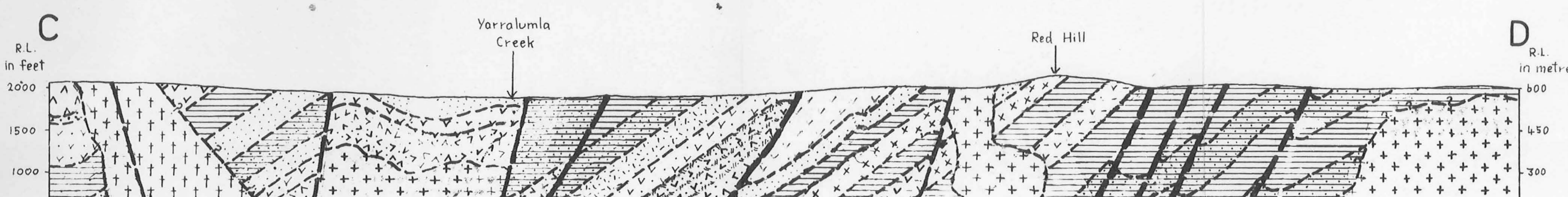
SECTION C-D

For location and reference see Plate 2

SCALE $\frac{V}{H} = 1$

0 ¼ ½ ¾ 1 Miles

0 ½ 1 1½ Km.



Cainozoic deposits omitted

AMENDMENTS			
No.	Description	Author	Checked
A1			
A2			
A3			
A4			
A5			

SCALE: As above

Base map/survey

Geology by: As for Plate 1

Compiled and checked: G.A.M.H. Project geologist

Checked and approved: Senior geologist

Supervising geologist

COMMONWEALTH OF AUSTRALIA
BUREAU OF MINERAL RESOURCES
CANBERRA, A.C.T.

TITLE: INTERPRETATIVE CROSS SECTIONS OF THE WODEN - WESTON CREEK AREA

PROJECT: GEOLOGY OF THE WODEN - WESTON CREEK AREA

To accompany	Drawn by	Drawing No.
Record 1975/54	G.A.M.H.	I55/A16/1257