DEPARTMENT OF
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Record 1973/210

GEOLOGY OF SHEETS J3C, J3D, AND J4B, GUNGAHLIN, A.C.T.

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CONTENTS

SUMMARY

Within the area covered by the 1:2400 A.C.T. Detail Series Sheets J3C, J3D, and J4B, Ordovician sedimentary rocks and Silurian sedimentary and volcanic rocks crop out. The rocks are folded and faulted, and some fault-fillings have been silicified or ferruginized. The Siluro-Ordovician contact is thought to be mainly faulted.

The oldest rocks exposed in the area belong to the Middle to Upper Ordovician Pittman Formation, which contains the Acton Shale Member with Middle to Upper Ordovician graptolites.

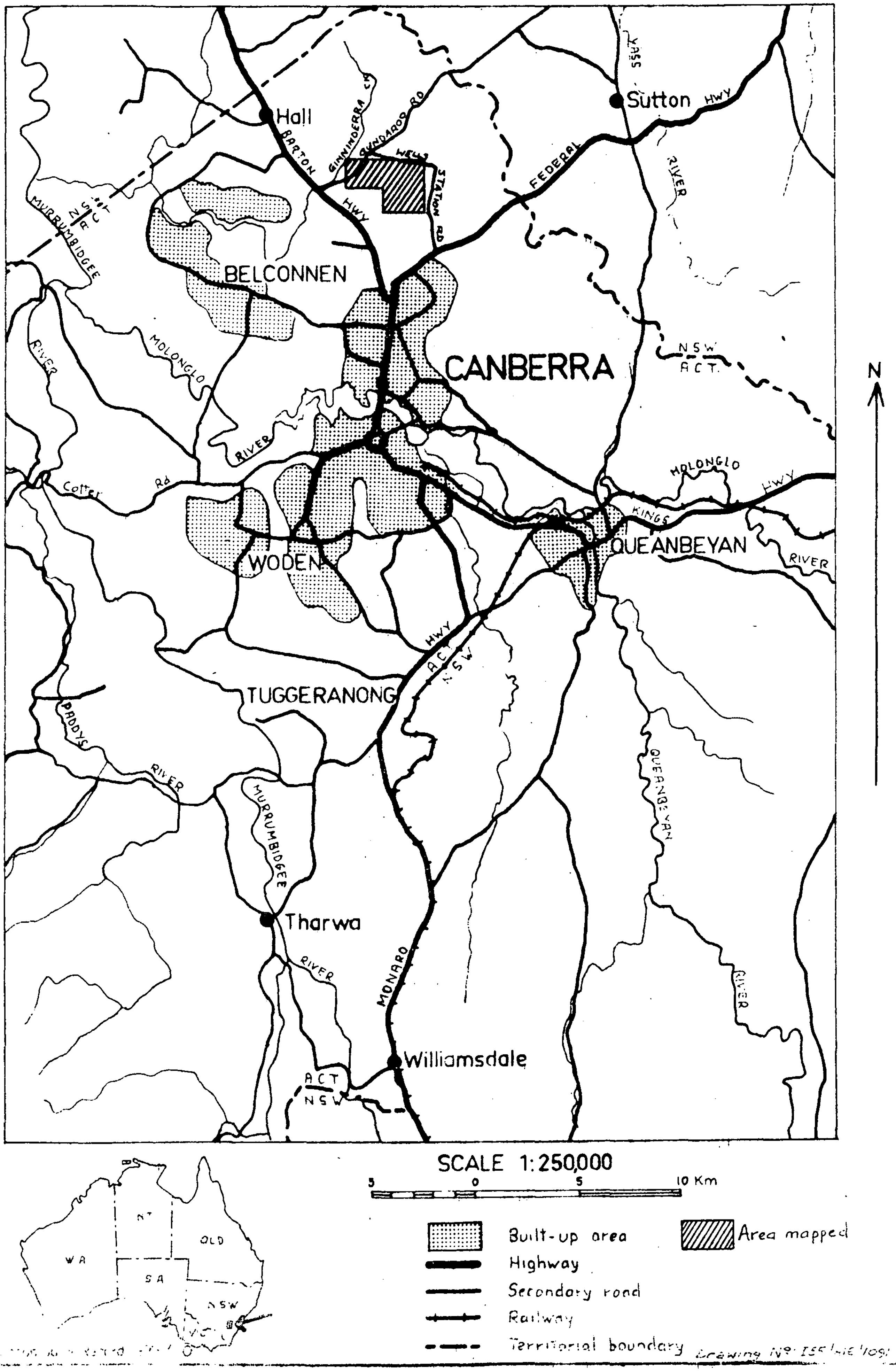
Lower Silurian State Circle Shale and Black Mountain Sandstone crop out in the northwest of the area and are unconformably overlain by a sequence of Middle to Upper Silurian mudstones, shales and volcanics (principally dacitic tuff ('ashstone') and tuff). Silurian fossils were found at localities B17 and B19 in mudstone that is regarded as part of the Riverside Formation.

Upper Silurian? intrusives are also present: three separate outcrops of a metabasalt, are regarded as minor intrusives into Ordovician and Silurian rocks; and an outcrop of dacite (probably intruded as a dyke), was also mapped.

Ironstone gossans are common and are thought to indicate prominent fault lines.

A subvertical slaty cleavage, which is subparallel to the axial trace of folding and trends about northeast, is developed throughout the area.

LOCALITY MAP fig. 1



INTRODUCTION

The aim of this project was to map in detail three 1:2400 A.C.T. Detail Series Sheets J3C, J3D, and J4B as part of the geological survey of the proposed Gungahlin urban development area. All outcrops in the area were plotted on the 1:2400 topographic sheets; the geological map of the area was then compiled at a scale of 1:9600 (Plate 1). The mapping was carried out during mid-December 1972 and January 1973. Grid co-ordinates are in feet and are based on a datum at Mount Stromlo.

The area mapped, 12 km^2 (Fig. 1), lies between the Federal and Barton Highways north of Canberra and about 7 km south of the northern extremity of the NSW/A.C.T. border. The Gundaroo Road and the Wells Station Road are two minor roads which cross the northern part of the area. Access is by sealed, all-weather highways (Barton or Federal Highways) and thence by secondary gravel roads (Gundaroo or Wells Station Roads). Dry-weather tracks provide good vehicular access to most of the area.

The topography is mainly gently undulating with the maximum height of hills about 648 m (2127') above mean sea level. Most streams are ephemeral and many small dams have been built in the area. Ginninderra Creek is the only perennial stream. Much of the land has been cleared for grain crops or for sheep and cattle grazing. Rock outcrops are scattered and discontinuous. Annual precipitation is around 700 mm/year. Vegetation is open woodland.

The area mapped lies within a regional structure known as the Canberra Graben, which is flanked to the west by the Cotter Horst and to the east by the Cullarin Horst (Strusz, 1971).

STRATIGRAPHY, PALAEONTOLOGY AND LITHOLOGY OF THE ROCK UNITS

ORDOVICIAN

Pittman Formation (Omp)

The oldest rocks exposed in the area belong to the Middle to Upper Ordovician Pittman Formation; the main rock type cropping out is a ferruginous fine-grained quartzose sandstone (thin section 73360017); smaller amounts of siltstone and mudstone are also found. The amount of siltstone and mudstone in the formation is probably greater than indicated by the amount of outcrop, and the sandstone is more commonly exposed because of its greater resistance to weathering. The sandstone is light purple-grey where fresh, and weathers to an orange or dark-brown colour. No fossils were found.

Most of the mapping of this unit was based on the presence of floaters, as outcrops are sparse.

The thickness of the Ordovician sequence was estimated to be more than 500 metres, including about 70 m of Acton Shale.

Acton Shale Member (Oua)

The Acton Shale Member is a grey, siliceous fissile shale (thin section 73360016) which weathers to an orange, brown-grey, or purple colour. The shale is seen as floaters and also as isolated outcrops in the southeastern part of Sheet J3C; a few outcrops are also found in the northwestern part of Sheet J4B. The shale is fossiliferous and contains *Dicellograptus* sp. and *Orthograptus* sp. (Middle to Upper Ordovician).

LOWER SILURIAN

State Circle Shale (Sls)*

Shale thought to be State Circle Shale is well exposed in Ginninderra Creek in the northwestern corner of Sheet J3C. A prominent cleavage is developed and trends 010°, dipping 85° to the west. The strike of the beds trends 040°, and dips range from 4° to 26° to the southeast. The folds have a shallow southerly plunge. Where exposed, the shale is generally fresh dark grey-green and exhibits a sheen, which is probably due to the alignment of chlorite and mica parallel to the cleavage. No fossils were found.

Black Mountain Sandstone (Slb)

Sandstone thought to be Black Mountain Sandstone crops out on a rise northwest of the State Circle Shale in the northwestern corner of Sheet J3C. It overlies the State Circle Shale. The sandstone is quartzose and very fine-grained and weathers to an orange-brown or brown-red colour. All outcrops mapped were highly weathered. No fossils were found.

* Middle to Upper Silurian fossils have been found 500 m to the southwest of the Sls exposure in the northwestern corner of Sheet J3C (Crook et al., 1973).

If continuity exists between this exposure and the present mapping, then shale mapped as State Circle Shale (Sls) may belong to the Middle to Upper Silurian Canberra Group.

Reference

CROOK, K.A.W., BEIN, J., HUGHES, R.J. & SCOTT, P.A., 1973 - Ordovician and Silurian history of the southeastern part of the Lachlan Geosyncline. J. Geol. Soc. Aust., vol. 20, pt 2, p. 113-138.

MIDDLE TO UPPER SILURIAN

Canberra Group (Smc)

The Canberra Group in the area is a sequence of interbedded sedimentary and volcanic rocks, which unconformably overlie the Lower Silurian sequence. The sediments are predominantly mudstones, and in some that are regarded as part of the Riverside Formation (a unit within the Canberra Group) fossils were found: at locality B19 (39400E, 37900N), the mudstone contains the trilobite *Encrinurus* sp. (Ordovician to Silurian), the coral, *Heliolites* sp. (Ordovician to Devonian), the brachiopod *Atrypa* sp. (Middle Silurian to Lower Carboniferous), Halysitids (Ordovician to Silurian), Fenestellids, and a tetracoral; locality B17 (41200E, 40100N) contains strophomenoids. The fossils are poorly preserved and are mainly external moulds, so further taxonomic classification is not possible. However, from their ranges the fossils indicate an age of Middle to Upper Silurian and confirm the correlation of the rocks with the Canberra Group.

Most of the volcanics were given the field name of 'ashstones', but on petrographic examination thin sections 73360001, 2, 3, 6, 7, 8, 9, 10, 12, 14 and 73360015 some were found to be dacitic tuffs, (see Appendix 2).

Fifty rocks (including the 20 submitted for thin-sectioning) were slabbed and stained for potash feldspar with a solution of sodium cobaltinitrite (Appendix 3). A blank was used to determine if the staining technique was positive on potash feldspar. No potash feldspar was detected in any of the rocks examined.

The ashstone is highly resistant to weathering and erosion, so it seems likely that the amount of outcrop indicates the proportion of this rock in the sequence, although areas of ashstone could be covered by slopewash. The mudstone generally crops out on steep slopes, in creeks, or is found as dam-wall material. Most of the sequence probably consists of mudstone, with ashstone and tuff as minor interbeds.

A tuff in the southeastern corner of Sheet J4B crops out sparsely over an area of about six hectares. It occupies a ridge which stands out topographically higher than the surrounding softer sediments. A thin section was not prepared, so its affinity with the volcanics, which crop out about 2 km to the northwest, is not known.

A conformable contact(33700E, 43900N) was noted between mudstone and metadacite, (thin section 73360011). The metadacite overlies the mudstone and a gradation can be seen from the mudstone through a tuffaceous mudstone to the metadacite. The dacite was probably extruded as a flow; it is less than 2 to 3 m thick.

Several blocks of unfossiliferous limestone containing small (up to 1 cm wide) siderite veins were found around a fence strainer post in the northeastern corner of Sheet J3D (40400E, 43900N). As this was the only outcrop seen over the entire area, it seems more than likely that the limestone has been transported from elsewhere to support the strainer post. Limestone which is possibly the source of the blocks occurs to the northeast (42500E, 46900N).

The combined thickness of the Canberra Group was estimated to be more than 300 m.

UPPER SILURIAN? (Sp and Sb)

Intrusive dacite and metabasalt are probably Upper Silurian, or possibly younger. One small outcrop of dacite (Sp, intruded as a dyke?) occurs predominantly in the southwestern corner of Sheet J3B.

It is coarse-grained with quartz, plagioclase, and ferromagnesian minerals evident in hand specimen. Unweathered material is light grey-green, and weathers to an orange-yellow colour.

A metamorphosed basalt crops out in both Silurian and Ordovician rocks; hence it is thought to be intrusive. At co-ordinates 32800E, 40200N, the basalt outcrop, which is probably a dyke, dips at 60° to the northeast. The unweathered rock has a dark green groundmass, which contains clear crystals of zoisite? (up to 1 cm long) and vugs with green fibrous crystals (probably actinolite). The rock is more fully described in Appendix 2 (thin sections 73360004 and 73360005).

POST SILURIAN

Ironstone gossans appear to be associated with faults and are regarded as a surface weathering phenomenon. Iron-rich solutions possibly migrated along the fault line and precipitated as an iron complex which has been subsequently oxidized. These outcrops are resistant and tend to form prominent ridges. No evidence exists, as yet, for any primary mineralization at depth. A specimen of jarosite? was submitted for determination of trace metals using a Direct Reading Optical Spectrometer. The results indicated the presence of a considerable amount of iron with trace amounts of magnesium, barium, and potassium. No metals of economic potential were detected.

QUATERNARY

Alluvium (Qa)

Alluvium, 1-3 m thick, occurs as deposits of both emphemeral and perennial streams; it covers only a small part of the area mapped. Clay and sandy alluvium, with lenses of gravel, are exposed in the banks of Ginninderra Creek.

STRUCTURE

Folding

The area appears to be folded into a series of roughly northeast-trending synclines and anticlines. Folding in the Lower Silurian tends to be open, but not as broad as in the Middle to Upper Silurian Canberra Group. In the eastern part of the map area, a shallow easterly regional dip predominates.

Folding in the Ordovician is more intense than in any of the Silurian rocks. Dips of strata are generally steeper in the Ordovician rocks than in the Silurian sequence.

Faulting

Two highly resistant quartz ridges crop out in the map area. These are interpreted as silicified fault zones, although, owing to lack of exposure, no displacement was evident.

In the east of Sheet J4B, a highly resistant ridge of ferruginous fault breccia is exposed. The ridge extends southwest for about 440 m from co-ordinates 40900E, 39100N; then over the next 80 m, ironstone floaters are present on the surface; and the final 150 m is continuous outcrop. The fault dips at 80° to the southeast. Minor flexures in the fault can be seen, e.g. at co-ordinates 39700E, 37800N. Most gossans are associated with faults (see Plate 1). Quartz-filled fractures and joints up to 200 m long occur in the central area of sheet J4B.

The Ordovician sequence is thought to have a faulted boundary with the Middle to Upper Silurian Canberra Group, and a series of fault blocks is postulated to explain the outcrop pattern in the area.

ENGINEERING GEOLOGY

Road Materials

The ashstones break with a conchoidal fracture to form sharp angular fragments, and are generally too fine-grained to be used as gravel for road material. However, weathered 'porphyry' (dacite or tuff) is commonly used as plastic gravel for gravel roads; the amount of this material, however, is very small. The dacitic tuff could possibly be crushed and used as road metal aggregate; this material would not be suitable for use as concrete aggregate, as the rock contains up to 3 percent pyrite.

Brickshale and Clay

Kaolin (40700E, 45200N) has been mined for use as pottery clay. A deposit of brickshale occurs in mudstone of the Canberra Group (33200E, 42000N).

Rock Excavation

Sandstone of the Pittman Formation is fairly strong, even where moderately weathered*; it consists of over 90% quartz particles, and blasting may be necessary to remove it. The Acton Shale Member would require some blasting in excavations.

The State Circle Shale has a prominent cleavage; it may be possible to rip weathered material along the cleavage surfaces, but moderately weathered rock would require blasting. Moderately weathered Black Mountain Sandstone, unless closely jointed, would normally require blasting; completely and highly weathered material should be rippable.

The tuff, within the Canberra Group should be rippable near the surface; fresh rock would require blasting.

Dacitic tuff, basalt, and dacite are generally very hard and resistant to weathering. Moderately weathered to fresh rock would require blasting.

* Terms used to describe weathering are set out in Appendix 1.

The mudstone and shale of the Canberra Group, which are the dominant rock types in the area, are soft, and are highly weathered near the surface. The zone of weathering is thought to extend from 2 to 4 m; the material should be rippable to this depth. Ripping may be necessary on tuffaceous sediments, or where slight metamorphism of sediments has occurred. Bulldozers should be able to excavate weathered iron-rich gossan material. Below the zone of weathering, ripping or blasting may be necessary, depending on the closeness, tightness, and continuity of jointing.

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APPENDIX 1

WEATHERING - DEFINITION OF TERMS

FRESH:	Rock shows no discolouration or loss of strength
SLIGHTLY WEATHERED:	Rock is slightly discoloured but not noticeably weakened; a two-inch-diameter drill core cannot usually be broken by hand across the rock fabric
MODERATELY WEATHERED:	Rock is discoloured and noticeably weakened, but a two-inch drill core cannot usually be broken by hand across the rock fabric; ripping by bulldozer not possible
HIGHLY WEATHERED:	Rock is usually discoloured and weakened to such an extent that a two-inch drill core can readily be broken by hand across the rock fabric. Wet strength generally lower than dry strength; ripping with bulldozer may be possible along joint planes
COMPLETELY WEATHERED:	Rock is discoloured and entirely broken down to an aggregate of particles that has the mechanical property of a soil; the original fabric of the rock is mostly preserved. The properties of the soil depend on the composition of the parent rock; easily ripped by a bulldozer.

APPENDIX 2

BRIEF PETROGRAPHIC DESCRIPTIONS

Petrographic descriptions of some rock specimens from Gungahlin are given below. Sample numbers refer to the Bureau of Mineral Resources collection in Canberra. Numbers in parentheses refer to map co-ordinates.

Pittman Formation (Omp)

73360017 (33000E, 40500N) Very fine-grained sandstone

This rock consists of predominantly angular quartz grains (90%), having a diameter of about 0.07 mm. A few subrounded crystals are present. Iron oxides occur in the interstices between the quartz particles. Zircon and magnetite are present (as accessory inclusions in quartz).

Acton Shale Member (Oua)

73360016 (33400E, 40200N) Siliceous laminated claystone

This rock is mainly (90%) quartz grains, invariably less than 0.004 mm in diameter (clay range of particle size). Some quartz grains (< 1%) are about 0.015 mm in diameter. Epidote and biotite occur in trace amounts. Sericite? constitutes about 5 percent of the rock. Pyrite is present (about 2%) and occurs in thin blebs parallel to the direction of bedding.

In addition, powdered Acton shale was analysed by X-ray diffractometry and revealed mainly quartz with some mica and chlorite.

Canberra Group (Smc)

74460001 (32800E, 45700N) Fine dacitic tuff

The rock is fine-grained (size 0.02 mm diameter) with quartz and minor plagioclase making up the bulk. Isolated crystals of sericite? and epidote are also present. Iron oxides make up about 2 percent of the rock and patches of green chlorite (3%) are also evident. In the weathered portion of this slide, yellow staining of the chlorite is attributed to the weathering of iron minerals.

<u>73360002</u> (33700E, 44800N) Fine dacitic tuff

This is fine to very fine with many grains (up to 80% of the rock) about 0.02 mm in diameter (predominantly quartz). About 10 percent phenocrysts (plagioclase and quartz) are present and range from 0.1 to 0.2 mm in diameter. The plagioclase is partly altered to sericite and has a composition within the oligoclase-andesine range. Plagioclase phenocrysts make up about 4 percent of the rock. Sphene and sericite ($<1\%$) and calcite (up to 5%) are also present.

<u>73360003</u> (37600E, 46000N) Altered tuffaceous dacite

Quartz phenocrysts make up 15-20 percent of this slide. Most of the quartz grains have been fractured and corroded, and strain is indicated by undulose extinction. Plagioclase (15%) is extensively altered to secondary calcite and chlorite. Green chlorite ($<1\%$) exhibits later deformation. Pyrite and minor magnetite (2%) exhibit leaching, and oxidation products have stained surrounding minerals. The groundmass is mostly quartz (25%), sericite (15%), and minor plagioclase and calcite; epidote occurs in minor quantities.

<u>73360006</u> (37600E, 46000N) Ashstone

Quartz is the most common mineral in this specimen and particles, 0.15 mm in diameter, constitute 25 percent of the slide. The largest quartz and plagioclase crystals are 0.7 mm in diameter. Plagioclase (An_{52} - labradorite) constitutes 2-5 percent of the rock. The groundmass (50% of total) is composed of quartz particles about 0.02 mm in diameter. Pyrite (10%) has been altered in part to hematite, and chlorite ($<1\%$) and minor epidote are also present.

<u>73360007</u> (35700E, 46100N) Altered dacitic tuff

Subangular fragments of quartz and minor plagioclase and epidote are set in a finer groundmass of chlorite and quartz. Fragments (up to 1 cm in diameter) of material, possibly foreign to the original rock, have been incorporated as aggregates of epidote (50%), chlorite (1-2%) and quartz (45%). 1-2% of opaques are also present.

Epidote, quartz and chlorite are also present as veins crossing the specimen.

7336008 (33500E, 43900N) Ashfall tuff

Fine and coarser lamellae are present in this slide. Grainsize diameters in the fine lamellae are about 0.05 mm and in the coarser lamellae are 0.2 mm. In the fine lamellae, plagioclase (An_{49} - andesine) constitutes 10-15 percent, quartz (70%), chlorite (5%) and pyrite (5-10%, anhedral crystals as blebs and elongate masses).

The coarser lamellae contain plagioclase (1%), quartz (80%), opaques (10%), chlorite (10%) and accessory apatite. Minor epidote and sphene are also present.

73360010 (34400E, 44700N) Metadacite

This rock has a porphyritic texture - phenocrysts of quartz (82%), extensively altered plagioclase (An_{50} - labradorite, 15%) and chlorite (3%) are set in a finer groundmass of quartz (95%), plagioclase (2%), chlorite (2%), opaques (1%) with minor sphene, apatite, and hematite. Some of the quartz phenocrysts are embayed.

73360012 (33600E, 44100N) Altered very fine, quartzose ashstone

This rock comprises mainly quartz, and sericite (5-10%). The largest quartz crystals are 0.16 mm in diameter - most are less than 0.005 mm in diameter. Original plagioclase? has been wholly altered to sericite.

73360014 (32000E, 40700N) Altered very fine ashstone

Clusters of quartz crystals up to 0.15 mm in diameter, and tremolite and quartz intergrowths (crystals 0.2 mm in diameter) are set in a very fine groundmass of quartz and acicular tremolite crystals up to 0.01 mm in length. Epidote and pyrite occur in minor quantities.

Upper Silurian? Basic Volcanics (Sb):

73360004 (34900E, 44000N) Metabasalt

Epidote (zoisite and clinozoisite?) constitutes up to 60 percent of this rock. Crystals are lathlike and vary in size from 0.05 mm to 0.2 mm. Chlorite, as a green mineral and as a brown aggregate, constitutes 15-20 percent. Other minerals present are opaques (pyrrhotite?, $<1\%$), secondary calcite and actinolite (4%) and minor sphene? and apatite.

73360005 (32800E, 40200N) Metabasalt

Predominantly epidote (60%), with chlorite filling veins (15%), and opaques (pyrite and magnetite?, <1%). A dark brown mineral, possibly a decomposition product, makes up the remainder. Sphene and calcite are present in minor quantities. The ratio of zoisite to epidote is about 1:2 with some crystals up to 0.10 mm in diameter, but most between 0.01 and 0.04 mm in diameter.

APPENDIX 3

STAINING TESTS FOR POTASH FELDSPAR

A representative sample of 50 rocks from the area mapped were slabbed, etched with hydrofluoric acid and stained with cobaltinitrite solution (sodium hexanitritocobalt (III)).

No potash feldspar was detected in any of the rocks examined.

GEOLOGICAL MAP OF GUNGAHLIN - SHEETS J3C, J3D & J4B

PLATE 1