BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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GEOLOGICAL NOTES ON THE EXCAVATIONS FOR THE NEW PARLIAMENT HOUSE, CAPITAL HILL, CANBERRA, A.C.T.

by

G.A.M. Henderson

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CONTENTS

ABSTRACT

Geological mapping of the excavations for the new Parliament House has provided further data on the geology of the Capital Hill area, central Canberra.The angular unconformity between the Middle Silurian Camp Hill Sandstone Member and the Lower Silurian Black Mountain Sandstone has been well exposed, and a detailed lithological sequence in the Black Mountain Sandstone has been obtained. The excavations have confirmed that the State Circle Shale in this area overlies the sandstone formation mapped as Black Mountain Sandstone, not the reverse as elsewhere around Canberra; thus there now appears to be more than one sandstone or shale formation in the local Lower Silurian succession.

The site is transected by a number of faults which form a complex pattern of intersections and offsets. Excavation and foundation conditions have generally proved to be as expected from previous site investigations.

INTRODUCTION

In January 1981 work began at the site of Australia's new and permanent Parliament House on Capital Hill, Canberra. The building design, chosen by a select committee after an open competition, required extensive site preparation involving removal of the top part of the hill. Exposure of a considerable amount of rock was expected in the process. At the request of the Parliament House Construction Authority geological mapping of the site was carried out as excavation proceeded, in order to preserve a record of the geology of the foundations of the building. At the present time (February 1982) most of the major excavation work has been completed. This report and the accompanying map (Plate 1) combine data from the recent mapping with that from previous investigations to produce an as complete as possible representation of the geology of the whole site. The site area, which is that enclosed by the Capital Circle ring road, is about 32 ha. (for location see inset, Plate 1).

PREVIOUS INVESTIGATIONS

GEOLOGICAL INVESTIGATIONS

Geological data in the Capital Hill area was obtained initially from outcrops, and later from site investigations and major road excavations. Opik (1958) mapped three rock formations in the area - Black Mountain Sandstone, State Circle Shale and Camp Hill Sandstone (now Camp Hill Sandstone Member). An important aspect of Opik's work was his recognition of an angular unconformity between the Camp Hill Sandstone Member and the underlying Black Mountain Sandstone.

Understanding of the geology of the area was considerably enhanced by the creation of extensive rock faces in excavations for Capital Circle in 1970 (Henderson, 1973). A major cutting around the northeastern section of the road exposed at the western end sandstone (Black Mountain Sandstone) apparently overlain by shale containing *Monograptus exiguus* (State Circle Shale), and, to the east, siltstone interpreted as overlying the Camp Hill Sandstone Member. A major fault was exposed between the Black Mountain Sandstone and the siltstone.

In 1979 site investigations were carried out by Coffey and Partners Pty Ltd for the Parliament House Construction Authority. These included trenches and pits into rock, and drilling. Geological boundaries were located more accurately, including several faulted boundaries. The results of these investigations, including studies of the foundation and excavation characteristics of the rock units, were issued in a geotechnical report (Coffey and Partners, 1979).

GEOPHYSICAL INVESTIGATIONS

Gardner (1964) carried out a hammer and seismic timer investigation in the Capital Hill area to determine thicknesses of soil and weathered rock, and thereby obtain information on excavating conditions and bearing strength for foundations. This was followed by a seismic refraction traverse across the top of the hill from Adelaide Avenue to Brisbane Avenue to test rock conditions for a proposed road tunnel (Polak and Wainwright, 1965).

As part of more recent site investigations after the site was chosen definitely for the new Parliament House two seismic refraction traverses, one across the northwest and the other across the southeast of the hill, were done (Hill and Ramsay, 1979). The results of these two traverses are reproduced in Plate 2 with geological interpretation from the latest mapping added.

SITE EARTHWORKS

The original form of the site consisted of a central hill with an elevation of RL 611.7 m falling away on its flanks to RL 570-590 m. The hill formed a ridge elongated in a northeast direction. On the western edge of the site a small watercourse flowed north in a valley at about RL 570-575 m.

Preparation of the site for the planned building required the removal of up to about 21 metres thickness of soil and rock from the higher parts of the hill. The excavated material was used to raise the level of the western valley and other marginal parts of the site. A surplus of excavated material was removed from the site.

The general form of the site after excavation and placement of fill is shown in Plate 1. The levels and batters indicated are those shown on plans dated September 1981 modified in a few places to conform with amended excavation design. Some areas, mostly on the eastern side of the site, shown on these plans for excavation have not yet been excavated because of design changes; where this is so the excavation outline is dashed.

Numerous vertical rock faces have been formed in the excavation, and rock is also exposed in some of the sloping batters. Although the entire central area of the site has been excavated below the original surface little rock is clearly exposed in the level areas between the batters owing to pulverisation of rock by earthmoving machinery.

STRATIGRAPHY

EARLY SILURIAN

State Circle Shale (Sls)

Shale mapped as State Circle Shale occurs in several areas on the northern and northwestern sides of the site. This formation elsewhere in the Canberra area is consistently found underlying the other Early Silurian unit, the Black Mountain Sandstone (Henderson, 1980). However, at Capital Hill the State Circle Shale appears to overlie a sandstone formation mapped as Black Mountain Sandstone. The relationship was revealed during excavations associated with the construction of Capital Circle in 1970 (Henderson, 1973). Possible explanations for the apparent stratigraphic reversal are discussed under 'Black Mountain Sandstone' below.

The State Circle Shale where it has been exposed at various times is brown or pale grey, and generally laminated. The laminae represent alternate silty and clayey layers. A few thin sandstone interbeds are present in places immediately above the contact with the Black Mountain Sandstone. In some places the shale shows evidence of slumping. Where this has occurred disoriented blocks of laminated shale are surrounded by shale in which the laminations have been obliterated. The slumping apparently took place when the sediment was in a variably consolidated state, with the more consolidated layers breaking into separate blocks and being carried along in a slurry of unconsolidated sediment.

The characteristic graptolite of the State Circle Shale, *Monograptus exiguus*, has been found at two places near the northern margin of the site as shown in Plate 1. Neither of these places is within the present area of excavation. The only exposure of the shale created during the present site works is on the western side of the site at the foot of a sloping batter.

The minimum thickness of State Circle Shale on the northern margin of the site is about 30 m. A greater thickness could be present on the western side of the site, but the extent of the shale and attitudes of bedding there are insufficiently known to make an estimate.

Black Mountain Sandstone (Slb)

The Black Mountain Sandstone occupies much of the central part of the site and it extends to the margins in places to the north and west. The core of the original hill consisted largely of this formation. The sandstone has now been exposed in many of the vertical and sloping batters where its characteristics are clearly visible. A measured section of the sandstone across the centre of the site (Fig. 1) represents most of the exposed part of the formation and illustrates the variations in lithology. A sketch of an extensive rock face in the sandstone showing typical features is shown in Plate 3.

The formation consists predominantly of medium-grained quartz sandstone which is blue grey where fresh, or buff to pale grey and white where slightly to moderately weathered or leached. Much of the sandstone is thickly bedded, and bedding planes can be distinguished from joints only by their greater persistence and regularity. Interbeds of siltstone occur in some places. Towards the top of the formation, in the northern half of the site, a section of the sandstone contains regular and numerous interbeds of siltstone up to 10 cm thick between somewhat thicker sandstone beds. Similar interbedded sandstone and siltstone is exposed in three separate areas offset along strike as shown in Plate 1 and Figure 6; it is probably the same unit in each area, with the offsets due to displacements along the intervening faults.

The basal part of exposed formation in the southern half of the site contains siltstone only at a few places widely separated by thickly bedded sandstone. The siltstone units contain interbeds of fine sandstone in places, and are up to 2 m thick. A one-metre-thick bed of laminated shale was mapped at the northern end of the excavation (co-ords 410 X, 740 Y). This shale is close to the contact with the State Circle Shale of which it is probably a precursor.

Like the State Circle Shale the Black Mountain Sandstone shows evidence of slumping. This is most obvious where the sandstone contains clasts of siltstone. In some places the clasts are very numerous and form a slump breccia; in other places they are relatively sparse, and the distribution is erratic. The size of the clasts ranges from as small as 1 mm to as large as 1 metre, but mostly they are a few centimetres in diameter, and, where numerous, tend to be of fairly uniform size. The largest clasts were observed close to the centre of the site (co-ords 350X, 515Y), and consist of angular blocks of laminated siltstone as sketched in Plate 3. These clasts must have been in a well consolidated state when they were transported, because there is no appreciable distortion of the laminations.

The proven thickness of Black Mountain Sandstone on Capital Hill is about 130 m, of which all but the topmost part has been well exposed in the excavation. The measured section (Fig. 1) was obtained from the vertical excavation faces near the centre of the site between co-ordinates 415X, 590Y, and 550X, 420Y - STUV as shown in Plate 1. The section starts about 15 m stratigraphically below the contact with the State Circle Shale and ends to the south where the lowermost exposed beds abut the unconformity. An additional unknown thickness of sandstone presumably occurs farther to the south at depth beneath the unconformity.

The measured section (Fig. 1) is drawn on the assumption that the Black Mountain Sandstone is upward facing. Doubt about the facing of the sandstone arises because of its anomalous relationship with the State Circle Shale referred to previously. Complete overturning of the Early Silurian sequence on Capital Hill would neatly solve the problem of the apparent reversal of the shale/sandstone sequence. However the evidence does not favour such a solution. Graded bedding consistently indicates that the Black Mountain Sandstone is an upward facing sequence, and this is supported by an observation of upwardly truncated ripple marks at one place (co-ords 380X, 480Y) during excarvation. Also in another place (co-ords 430X, 590Y)? slump folds or antidunes, up to 30 cm high, in a sandstone bed are draped with siltstone a few centimetres thick and covered with further sandstone; one of the folds is peaked at the top which indicates probable upward facing (see illustration in inset at location of feature on Plate 1). Another possibility, besides overturning, is that the shale has been thrust over the sandstone. This could have occurred with respect to the shale/sandstone contact on the western side of the site where a low-angle fault forms the contact, but is inconsistent with observations around Capital Circle to the north where only some of the contacts are faulted. The conclusion must be, therefore, that the shale does indeed overlie the sandstone at Capital Hill, and that the Black Mountain Sandstone/State Circle Shale relationship in the Canberra area in general is more complex than previously interpreted - viz that there is either more than one shale or more than one sandstone formation in the Lower Silurian succession.

MIDDLE SILURIAN

Camp Hill Sandstone Member of Canberra Formation (Smc_1)

The Canberra Formation underlies the eastern and southern sides of the site. The Camp Hill Sandstone Member of the formation (Smc_1), at the base of the formation, occurs along the southern margin of the Black Mountain Sandstone. The sandstone overlies the Black Mountain Sandstone with marked angular unconformity, which is well exposed at present

(February, 1982) in several vertical rock faces, one of which is sketched in Plate 3. Photos of the unconformity are shown in Figures 4 and 5. The Camp Hill Sandstone Member consists of interbedded sandstone and siltstone in beds ranging from 2 to 25 cm thick with sandstone giving way to siltstone towards the top of the unit. Typical Camp Hill Sandstone Member is shown in Figure 3. The beds are coloured red-brown, yellow-brown, purple and pale grey. In the site area the unit is about 17 m thick. The sandstone in the unit ranges from very coarse quartz sandstone to fine silty sandstone, the coarsest beds being near the base. Some of the coarse sandstone contains rock fragments. For example on the section illustrated in Plate 3 two coarse sandstone beds within one metre of the base contain small pieces of cherty mudstone ranging to 4 mm diameter. Generally the sandstone and siltstone are moderately to highly weathered and soft, but some of the coarse sandstone beds have been hardened by silicification.

Canberra Formation (Smc_2)

The Camp Hill Sandstone Member passes up gradationally into clayey siltstone, with a few fine sandstone beds, (Smc_2) belonging to a higher part of the Canberra Formation. The siltstone has remained exposed for some years in the rock face around the northeast of Capital Circle, and its extent around the eastern side of the site has been proved in test pits and trenches (Coffey and Partners, 1979). The rock is coloured yellow-brown, purple, buff, pinkish or white. The estimated minimum thickness of this unit in the site area is about 80 m in the section immediately overlying the Camp Hill Sandstone Member. A stratigraphically higher part of the unit is downfaulted against the Black Mountain Sandstone in the northeast.

Canberra Formation? (Smc?)

An area on the southern and southwestern side of the site is underlain by mudstone (Smc?) which is tentatively assigned to the Canberra Formation on the basis of lithology and traces of shelly fossils. However from a structural viewpoint the mudstone could be older than the Black Mountain Sandstone, depending on the net movement on the fault (Fault E) which defines its northern limit. The mudstone was exposed in a number of test trenches and pits (Coffey and Partners, 1979), and along Capital Circle (Henderson, 1973), but has not been re-exposed to any appreciable extent in the present site excavations. At the time it was exposed along Capital Circle it was thought to be part of the State Circle Shale. However none of the more extensive exposures in the test trenches and pits showed shale with the characteristic laminations of the State Circle Shale.

The mudstone is generally brown and massive, with no definite indication of bedding. Towards the east a steeply dipping meridional cleavage is evident, and at the eastern extremity tight folding is defined by thin lenses of sandstone. Some of the mudstone in the eastern part is purplish rather than brown, and in places close to Fault E it is leached white.

STRUCTURE

The structural relations between the various formations and fault blocks are shown in Figure 6. Two structural zones are clearly defined. One zone consists of the Black Mountain Sandstone and State Circle Shale where prevailing dip is to the north and northwest, and the other consists of the Camp Hill Sandstone and overlying siltstone (Smc_2) of the Canberra Formation where dips are to the south and southeast. A third zone consisting of the mudstone (Smc?) lacks bedding measurements in much of its outcrop area and the prevailing dip is not clear; however dips measured in the eastern part suggest folds plunging north, parallel to the strike of cleavage.

In the Black Mountain Sandstone and State Circle Shale a few small folds strike east -northeast and plung either east-northeast or west-southwest. In the Camp Hill Sandstone and overlying part of the Canberra Formation variations in the strike of bedding indicate broad folds plunging south.

Numerous faults, of various types and differing amounts of displacement, cross the site. The main faults have been designated with letter symbols, as shown in Figure 2 and Plate 1, to facilitate discussion. The faults generally contain fracture fillings of either quartz or iron oxides along at least some of their length, but in places they are clean cut. One of the faults (Fault A) is illustrated in Figures 7 and 8.

Most of the faults appear to belong to one of two systems, one striking north to north-northwest and the other striking approximately west-northwest. Where faults of each system intersect, offsets are invariably in a clockwise sense. The offsets are probably due mainly to strike-slip movements, combined to a greater or lesser extent with vertical movements. The offsets indicate a sequence of fault movements. For example Fault A, a major normal fault, was displaced by Faults B and C, which in turn were displaced by Fault D. The probable displaced extensions of Faults B and C west of fault D are shown with queries. Displacement of the marker unit (interbedded sandstone and siltstone) in the Black Mountain Sandstone by Fault C indicates that a vertical component of movement along the fault is also involved; this is because the distances between the marker unit and Fault A each side of Fault C are different. From the location of Fault A and the marker unit each side of Fault C it is possible to estimate a horizontal displacement along Fault C of about 70 m, and a downwards displacement of the southern block of about 55 m.

The fault with presumably the largest displacement is Fault E. This fault is shown as a thrust fault in Figure 2, because of drag folding observed immediately to the south of it is a test trench. However if its inferred stratigraphic position is correct the net movement must be downwards on the southern side.

Fault F is a reverse fault that was exposed as a quartz reef at the original unconformity exposure before excavation; the fault dies out to the east and is replaced by a fold which can be seen in the vertical face immediately beyond its eastern end.

Fault G is a low-angle thrust fault, sub-parallel to bedding, along part of the contact of the State Circle Shale and Black Mountain Sandstone. Slickensiding (lineation) on bedding and joint planes in the sandstone and shale indicate the direction of movement in the overriding shale.

One 'fault' on which there is little or no relative movement occurs in the centre of the site and is exposed in two excavation faces. The 'fault' is vertical, about 0.5 m wide and is interpreted as a tensional fracture. It is filled with pale buff to white kaolinitic clay which appears likely to have been derived from the weathered profile, although this cannot be demonstrated because the overlying weathered profile has now been entirely removed by excavation. The lack of vertical movement on the 'fault' can be seen by the match between bedding planes on each side of it. However movement on one of the bedding planes at the eastern of the two exposures has displaced the 'fault' itself about 0.5 m (see Plate 3).

ENGINEERING GEOLOGY

Geotechnical advice for the project is being provided by consultants. Therefore the following notes are brief and confined to general qualitative observations made during the course of geological mapping. Excavation and foundation conditions appear to be generally as predicted from the site investigations (Coffey and Partners, 1979).

EXCAVATIONS

Excavation was effected by first removing as much soil and rock as possible with mechanical earthmoving equipment. Generally only two or three metres of material could be easily excavated in this way from areas underlain by Black Mountain Sandstone. The Camp Hill Sandstone Member and other rock unit were generally easily excavated by mechanical means to the depth required. The remainder of the Black Mountain Sandstone was then excavated by working back progressively from the (site) northern side by pattern drilling and blasting with explosives. Final design vertical rock faces in the sandstone were formed by the pre-split method of laying explosive charges in closely spaced drill holes along the line of the required face. Although the Black Mountain Sandstone is generally hard and strong its stability in vertical rock faces is affected in places by open bedding plane joints striking sub-parallel to the line of the face and dipping at moderate angles towards it. Potentially unstable rock was removed in places from the upper parts of vertical rock faces where these conditions applied. In one place, illustrated on Plate 3, a small wedge failure occurred where two intersecting vertical joints and a bedding plane joint produced a section of unconfined rock. Faults had little effect on the stability and rock faces in most places.

Some of the designed excavation faces were in areas at or near the original surface. These were excavated either vertical or at a slope of 1.5:1 depending on the condition of the weathered rock revealed during excavation. The Camp Hill Sandstone and overlying siltstone of the Canberra Formation, although softer and weaker than the Black Mountain Sandstone, could be formed into vertical rock faces in many places because of the lack of open joints and the binding qualities of the clayey decomposition products of weathering. No vertical rock faces were designed or excavated in State Circle Shale or the Canberra Formation (Smc?). Mechanical excavation was possible where these rock units were excavated.

FOUNDATIONS

A large part of the building is being constructed on Black Mountain Sandstone which appears to be of more than ample strength for foundations. Potentially the worst foundations are in leached clayey siltstone of the Canberra Formation where it is crushed and decomposed adjacent to faults. Where the faults are at the contact with Black Mountain Sandstone there could be differential settlement between footings in the strong sandstone and footings in the adjacent weak decomposed siltstone. The contrasting hard sandstone and soft siltstone are well exposed in vertical section where Fault A crosses the northern end of the excavation (Figs 7 and 8).

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COMPOSITE
SECTION OF BLACK MOUNTAIN SANDSTONE ACROSS CENTRE OF SITE

Fig 1

(For location see Plate 1)

ABBREVIATIONS: lam - laminated
Sst - sandstone
Sltst - siltstone

STRATIGRAPHIC THICKNESS

	LITHOLOGY	GRAIN SIZE	COLOUR	THICKNESS OF BED(S)
S 0	Sandstone	Fine, medium & coarse units	Yellow-brown to white	20-130 cm
	Interbedded sandstone and siltstone (MARKER UNIT (see Fig. 6))	Sst medium	Sst brown to white Sltst white to pale grey	Sst 20-60 cm Sltst up to 10 cm
	Interbedded sandstone and siltstone (MARKER UNIT (see Fig. 6))	Sst medium	Sst white Sltst mostly white, one bed mottled mauve and white	Sst 30-150 cm Sltst up to 40 cm ?
	Sandstone & breccia	Medium to coarse	Buff	200 cm
20 m	Sandstone with minor 1 cm thick micaceous sandstone interbeds	Medium	Buff	Up to 200 cm
	Sandstone & breccia	Medium to coarse	Buff	200 cm
	Sandstone	Medium	Buff to pale grey	Thickly bedded to massive
	Sandstone, small siltstone clasts at some levels	Mostly medium, some coarse	Buff	Generally less than 50 cm
40 m	Sandstone	Medium	Pale buff	Thickly bedded to massive
	Siltstone, minor Sst	Sst medium to fine	Pale grey	10-35 cm
	Sandstone	Medium	Grey	Thickly bedded to massive
	Sandstone & lam Sltst	Sst medium	Grey	10-40 cm
T U 60 m	Sandstone	Medium	Grey	Thickly bedded to massive
	Sst, large Sltst clasts	Medium to coarse	Grey	100 cm
	Sandstone, small siltstone clasts at some levels	Medium to coarse	Grey	Mostly thickly bedded
	Sandstone & lam Sltst	Sst medium to fine	Buff to grey	1-35 cm
80 m	Sst, minor Sltst clasts	Medium	Buff	150 cm
	Siltstone & sandstone	Sst medium to fine	Buff to grey	1-35 cm
	Sandstone	Medium	Buff to grey	Generally less than 50 cm
	Sandstone, some lam	Medium to fine	Grey	3-30 cm
	Laminated siltstone	-	Grey to mauve	40 cm +
	About 5m of sequence removed by fault F			
	Sandstone	Medium	Buff	Thickly bedded
	Faintly lam siltstone	-	Grey	70 cm
	Sandstone	Medium to fine	Buff to grey	45-160 cm
	Sandstone & lam Sltst	Sst medium	Grey	2-15 cm
	Sandstone	Mostly coarse to medium, some fine	Buff, grey, purple	20-200 cm
100 m	Laminated siltstone	-	Pale grey to buff	200 cm
	Sandstone	Medium	Buff to grey	Thickly bedded
	Lam Sltst & Sst	Sst medium to fine	Grey	1-10 cm
V	Sandstone, minor laminated siltstone	Sst medium	Sst buff Sltst pale grey	Sst thickly bedded Sltst up to 15 cm

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To accompany Record 1982/13

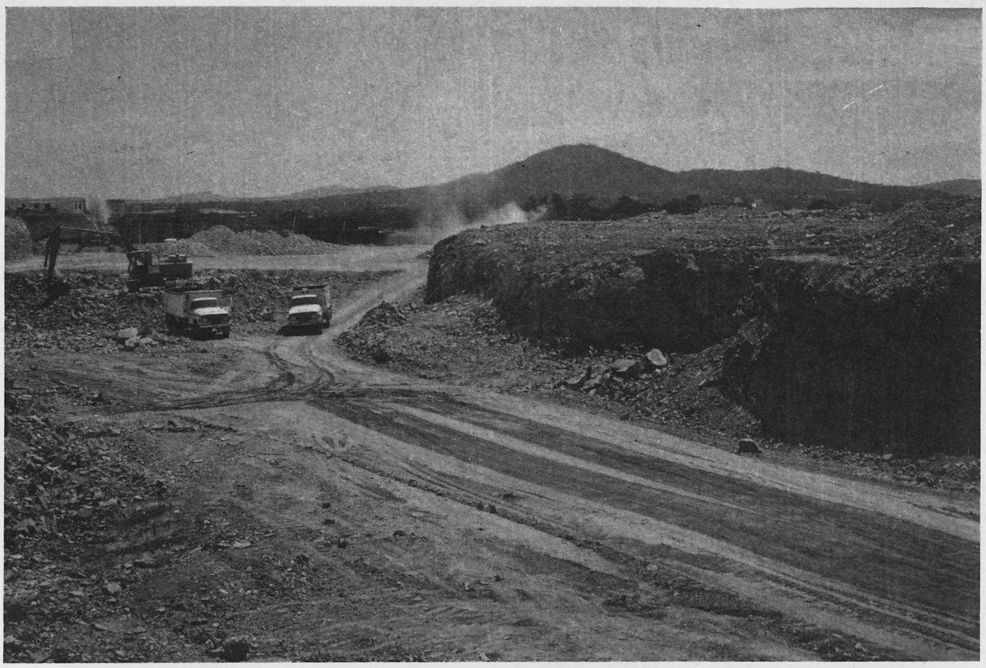

Fig. 2. General view of central part of excavation in advanced state of completion. Looking north, Mount Ainslie on skyline. Exposure of unconformity shown in Fig. 5 is in rock face at right.

(Neg. No. GB2916)

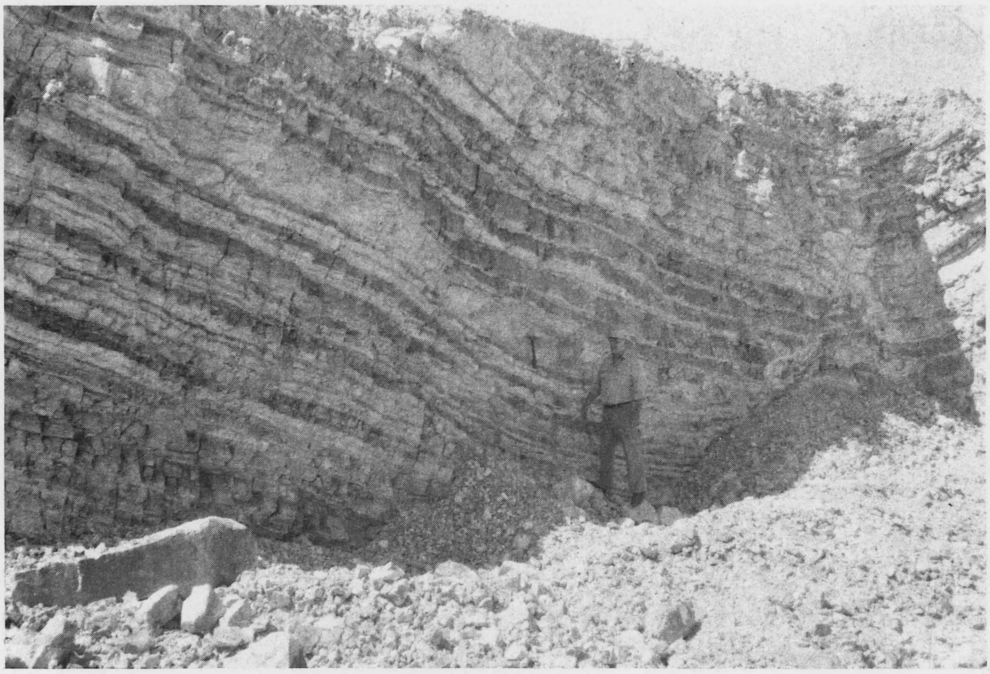

Fig. 3. Well-bedded Camp Hill Sandstone Member showing dark sandy beds contrasting with pale, leached silty beds.

(Neg. No. M2502, frame 16)

Fig. 4. Exposure of unconformity at site co-ords 545X, 425Y (Plate 1). Camp Hill Sandstone Member dips to right and unconformably overlies Black Mountain Sandstone which dips to the left. Rock face is about 5 m high.

(Neg. No. GB2911)

Fig. 5. Exposure of unconformity at site co-ords 540X, 380Y. Camp Hill Sandstone Member dips to left, Black Mountain Sandstone, with siltstone interbed, to right.

(Neg. No. GB2915)

Fig. 6

STRUCTURAL SKETCH MAP OF CAPITAL HILL

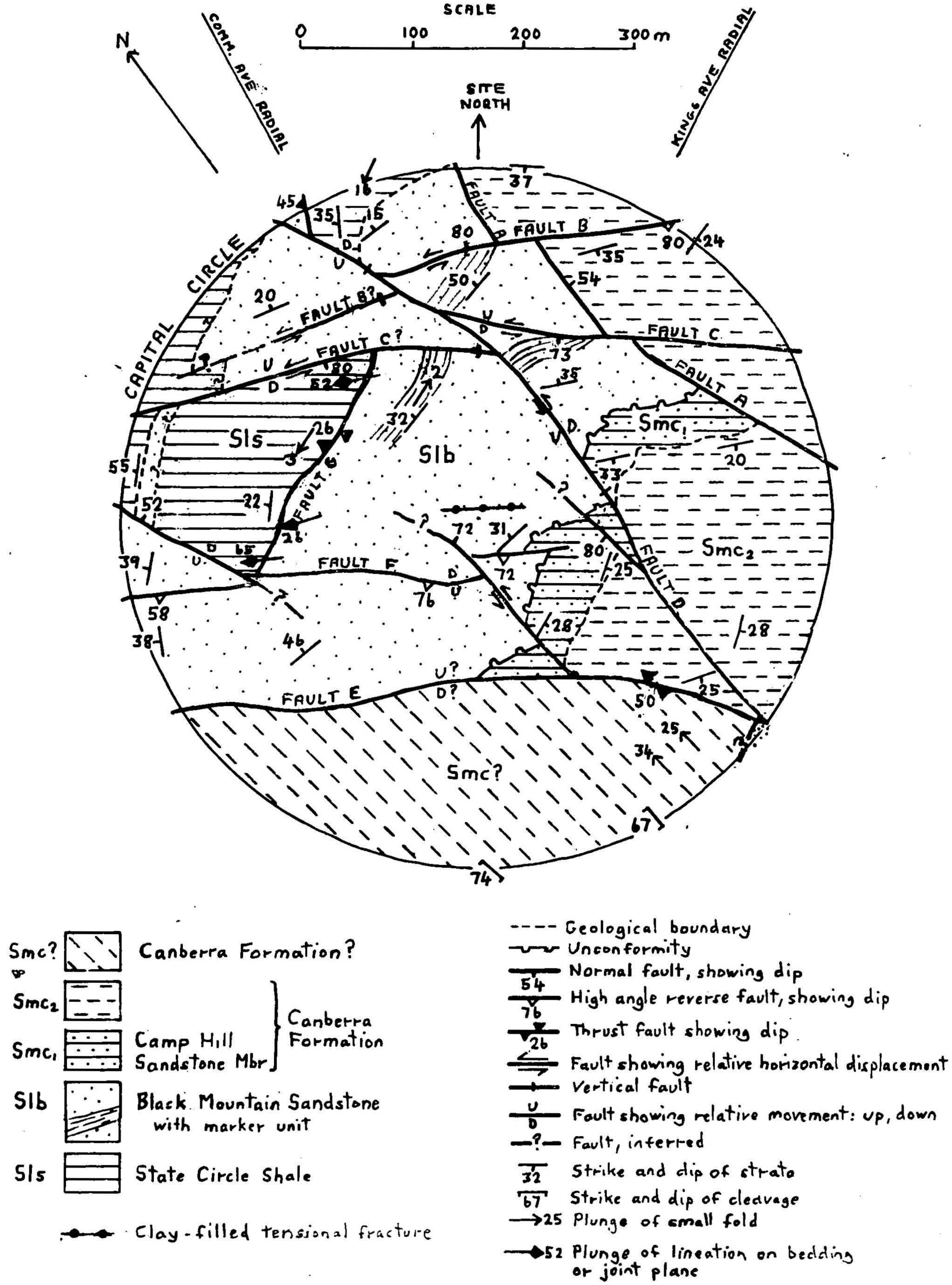

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Fig. 7. View of completed rock face on eastern side of central excavation at northern end. Dark patch on face at left centre is ferruginous fault zone (Fault A) separating white, leached siltstone of Canberra Formation at extreme left from Black Mountain Sandstone.

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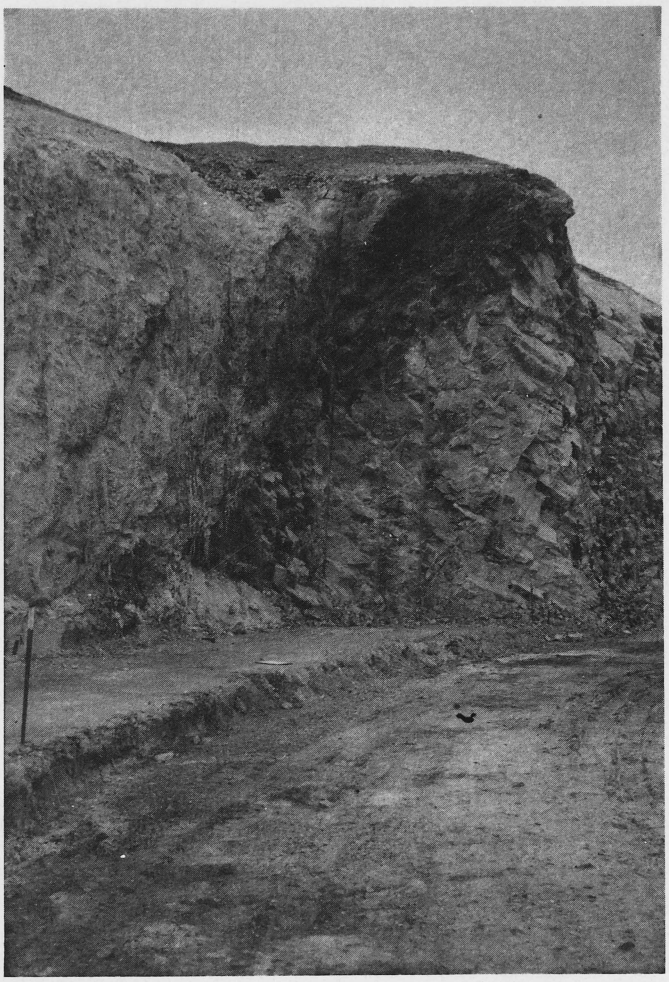
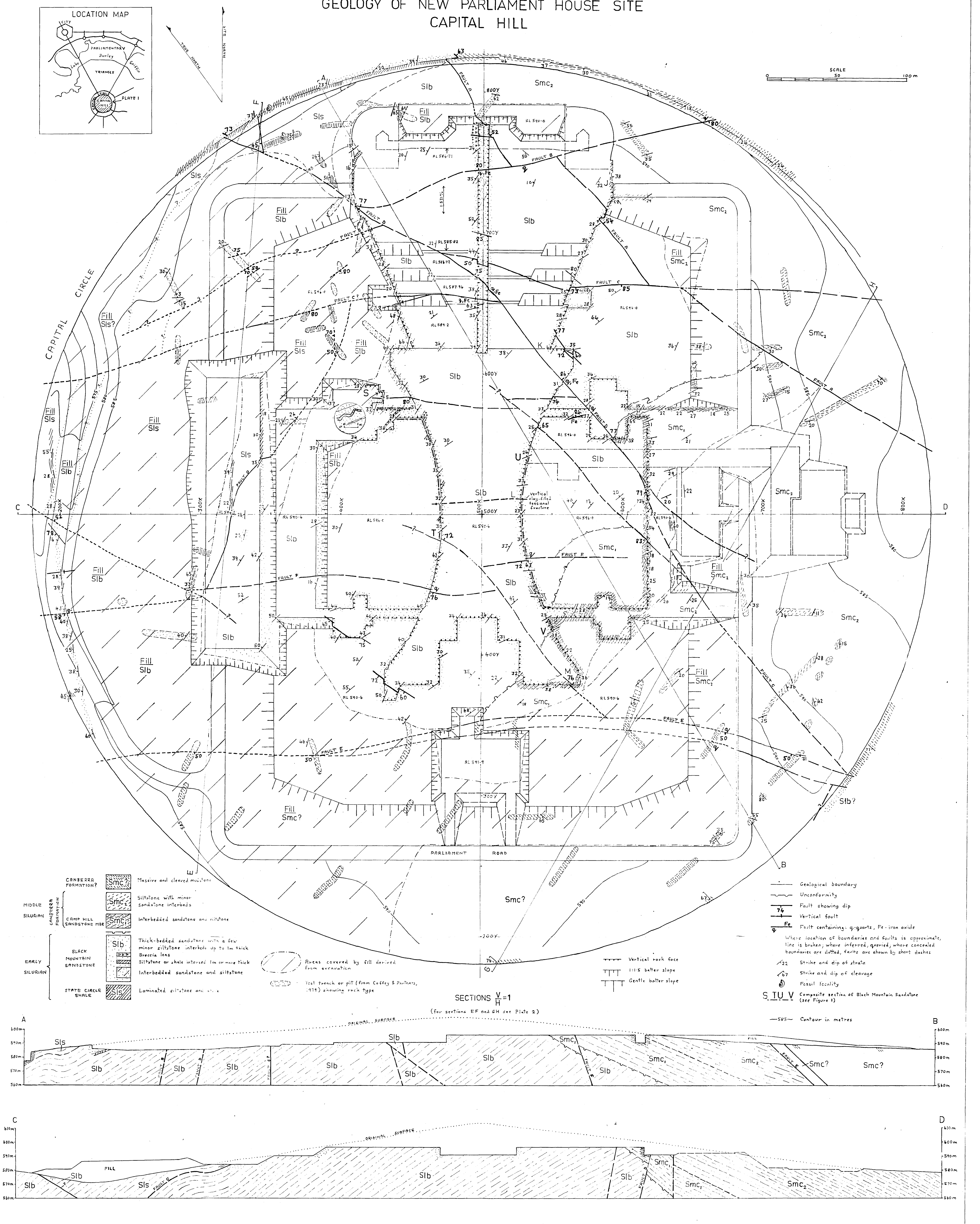


Fig. 8. Closer view of fault zone shown in Fig. 7. Bedding in Black Mountain Sandstone at right dips towards rock face which is about 10 m high.

(Neg. No. GB2917)

GEOLOGY OF NEW PARLIAMENT HOUSE SITE
CAPITAL HILL



Geology by G.A.M. Henderson 1970, 1981 and Coffey and Partners 1979
Bureau of Mineral Resources, Geology and Geophysics, 1982
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16/I55-16/74

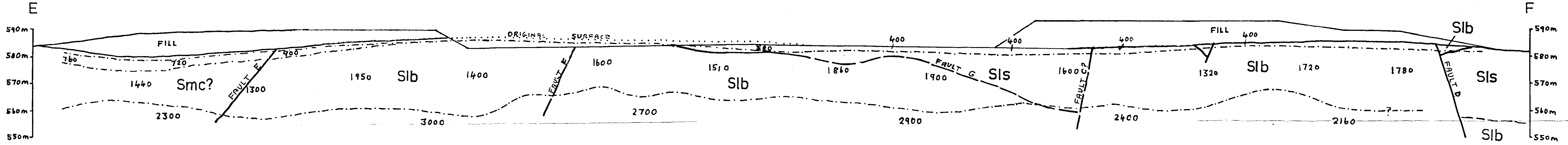
PLATE 2

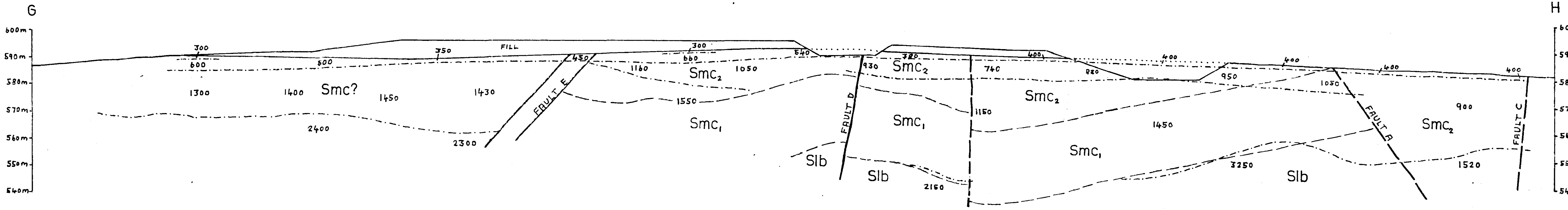
CAPITAL HILL - COMBINED GEOLOGICAL AND SEISMIC CROSS SECTIONS

SCALE

0 50 100m

For locations of sections and reference to rock unit symbols see Plate 1





1400 Seismic velocity of rock layer

-·-·- Boundary of seismic velocity layer

SKETCHES OF ROCK FACES ON EASTERN SIDE OF CENTRAL EXCAVATION