A Preliminary Note on the Lava Succession near Spicer's Peak, South-East Queensland

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Price: Two Shillings
Twenty Cents

University of Queensland Papers
Department of Geology
Volume V Number 12
THE UNIVERSITY OF QUEENSLAND PRESS
St. Lucia
17 August 1965

WHOLLY SET UP AND PRINTED IN AUSTRALIA BY
WATSON FERGUSON AND COMPANY, BRISBANE, QUEENSLAND
1965

A PRELIMINARY NOTE ON THE LAVA SUCCESSION NEAR SPICER'S PEAK, SOUTH-EAST QUEENSLAND

ABSTRACT. The erosion scarp of the Main Range near Spicer's Peak exposes a 3,000-foot-thick sequence of Tertiary lavas and pyroclastics. The flows can in general be divided into seven alternating basaltic and trachytic units, superimposed on a more general variation of basic–intermediate–basic from base to top. There is apparently complete gradation from olivine basalt to trachyte.

INTRODUCTION

In 1916 Richards established a sequence of basalt-trachyte-basalt for the Main Range, which sequence poses an interesting problem of igneous differentiation in the area. This note summarizes the stratigraphy and petrography of a small part of this area, based on part of the author's thesis towards a B.Sc.(Hons.) degree, but with a few modifications from subsequent work. It is hoped it will stimulate interest in the area towards the solving of the many problems associated with it.

The Main Range forms part of a Tertiary alkali-olivine basalt province lying to the south-west of Brisbane. Spicer's Peak occupies a median position on the main Range between Mount Castle on the north and the state border on the south. The area is rugged, with several peaks (including Spicer's Peak) over 4,000 feet high, and a steep erosion scarp dropping from these through 3,000 feet or more in a little over a mile in places.

Jensen (1909) described the Range as mainly of trachyte and believed the scarp to be fault-induced. Wearne & Woolnough (1911) developed the fault hypothesis and advocated a Trias-Jura age for the volcanics. Richards (1916) first established the subordinate nature of the trachytes and developed a general sequence of basalt-trachyte-basalt. He also established a post-Jurassic age for the lavas. Reid (1922), supported by Marks (1933), rejected the fault hypothesis and proposed the now generally accepted erosion theory for the origin of the scarp. From then until recently interest in the area has been dormant. A brief note on the volcanic rocks of the Main Range (Figs. 51 and 52) recently appeared in the "Geology of Queensland".

The nomenclature adopted is that of Macdonald (1949) for the Hawaiian alkaline sequence, as he later modified it (Macdonald, 1957; 1960). Terms applicable to the Main Range include olivine basalt, basalt, hawaiite, mugearite, and trachyte. Olivine basalt consists of labradorite, clinopyroxene, and olivine (at least 5 per cent of the rock). Basalt is similar but with less than 5 per cent of olivine. Hawaiite consists of andesine and clinopyroxene, with or without olivine and alkali feldspar. Mugearite consists of oligoclase and clinopyroxene with or without olivine; alkali feldspar is usually present. Trachyte consists of alkali feldspar and albite-oligoclase, with or without pyroxene or glass; they may be fragmented into tuffs and breccias. In the field "basalts", comprising olivine basalt, basalt, hawaiite, mugearite, and pyroxene trachyte, and "trachytes", comprising trachyte, trachyte tuff, and trachyte breccia, were distinguished. These divisions corresponded to the melanocratic and leucocratic lavas respectively.

STRATIGRAPHIC RELATIONS

A volcanic flow sequence about 3,000 feet thick is exposed in a scarp and on two ridges and a residual hill projecting into the lowlands. The sequence lies between a minimum elevation of less than 1,000 feet on a ridge east of Spicer's Peak and a maximum of 4,004 feet on the peak. Although the volcanics may be conveniently divided into basalts and trachytes, the distinction is not clear-cut, and a complete petrographic gradation seems to occur between true basalt and trachyte.

The stratigraphy of the lavas is based on four unevenly spaced traverses of varying usefulness up the Main Range scarp, one up Spicer's Peak from the north-east, hereinafter called the Spicer's Peak traverse, one north of Double-Top, the Double-Top traverse, and two close together near the headwaters of Seven Mile Creek, discussed together as the Seven Mile Creek traverse. In addition, short traverses were made to the base of the scarp at Coulson's Creek and up the outlying ridges and the residual hill.

In the Seven Mile Creek traverse seven units of alternating basaltic and trachytic rocks have been distinguished and are listed in Table 1, though the upper middle basalts here consist entirely of the melanocratic pyroxene trachyte. A similar sequence can be deciphered on the Spicer's Peak traverse if one projects the lensing trachyte of Governor's Rock south to this traverse to correspond to the upper trachytes. The whole Spicer's Peak traverse is depressed relative to the Seven Mile Creek traverse by varying amounts between 100 feet and 300 feet. The intervening Double-Top traverse is disappointing in that only the contacts of lower basalts—lower trachytes and upper trachytes—upper basalts can be fixed with any certainty, while in between lie masses of trachyte outcrop and trachyte scree. While these two contacts agree with the seven units concept, the existence of two intervening "basalts" is purely interpretive. The results of the various traverses are presented in Table 1 and Figure 1.

In the flow-to-flow relations the picture is not so simple, and there is little lateral correlation in the broad divisions of "basalts" and "trachytes".

Lower basalts

This is easily the best known unit. A reasonably complete section through the lower basalts of the Double-Top traverse gives a sequence from base to top of olivine basalt, with subordinate basalt and mugearite, grading to mugearite with subordinate basalt. In general this relation holds throughout the area, though mugearite is replaced by pyroxene trachyte on the residual hill. The mugearites at Spicer's Peak and Seven Mile Creek are very similar, with nesophitic (Walker, 1957) pyroxenes. The intervening mugearite at Coulson's Creek is coarser and of different character, and the mugearites at Double-Top are different again.

TABLE 1

STRATIGRAPHIC RELATIONS OF THE FLOWS

	Seven Mile Creek Traverse	Residual Hill Traverse	Coulson's Creek Traverse	Double-Top Traverse	Spicer's Peak Traverse
Upper Basalts	2850'– ?			2730'–3300'	2545'–4004' Olivine Basalt (8) Hawaiite (3) Mugearite (2)
Upper Trachytes	2750'–2850' Vesicular Trachyte (1)			? –2730'	2445'–2545'* Sanidine Trachyte (1)
Upper Middle Basalts	2430'–2750' Pyroxene Trachyte (3)			?	2330'–2545'* Basalt (1) Hawaiite (1)
Middle Trachytes	2320'–2430' Trachyte (2)			?	2200'–2330' Trachyte Breccia (1)
Lower Middle Basalt	2170'–2330' Olivine Basalt (1) Basalt (1)			?	1980'–2200' Hawaiite (2)
Lower Trachytes	1870'–2170' Trachyte Breccia (1) Trachyte Tuff (1)	1350'–1600' Trachyte (1)	1340'– ?† Trachyte (1)	1600'– ?	1580'–1980'
Lower Basalts	1185'–1870' Olivine Basalt (2) Mugearite (2)	1150'–1350' Olivine Basalt (1) Pyroxene Trachyte (1)	1155'– ?† Olivine Basalt (1) Hawaiite (1) Mugearite (2)	985'–1600' Olivine Basalt (2) Basalt (2) Mugearite (4)	? –1580' Olivine Basalt (2) Mugearite (1)

*This overlap of heights is due to the lensing nature of the trachyte. On the actual traverse there is no trachyte evident.

†The trachyte dips east at a larger angle than the basalts, implying either an unconformity or an intrusive trachyte. For this reason heights vary so much that only the lowest outcrops are given. The Lower Basalts have been traced up Coulson's Creek to 2000'.

Rock types are named only if identified from thin sections; the number of these in each division is indicated thus: (2)

The situation on the Coulson's Creek traverse is complicated. The overlying trachyte is either a low-angle intrusion or in unconformable contact with the lower basalts. The base elevation of the trachyte varies from 1,340 feet to over 2,000 feet along Coulson's Creek, an average dip of about 15 degrees east. The mugearite may be traced along the bed of the creek and has a dip not exceeding 5° E. Olivine basalt and hawaiite overlie the mugearite upstream. The anomalous features here include:

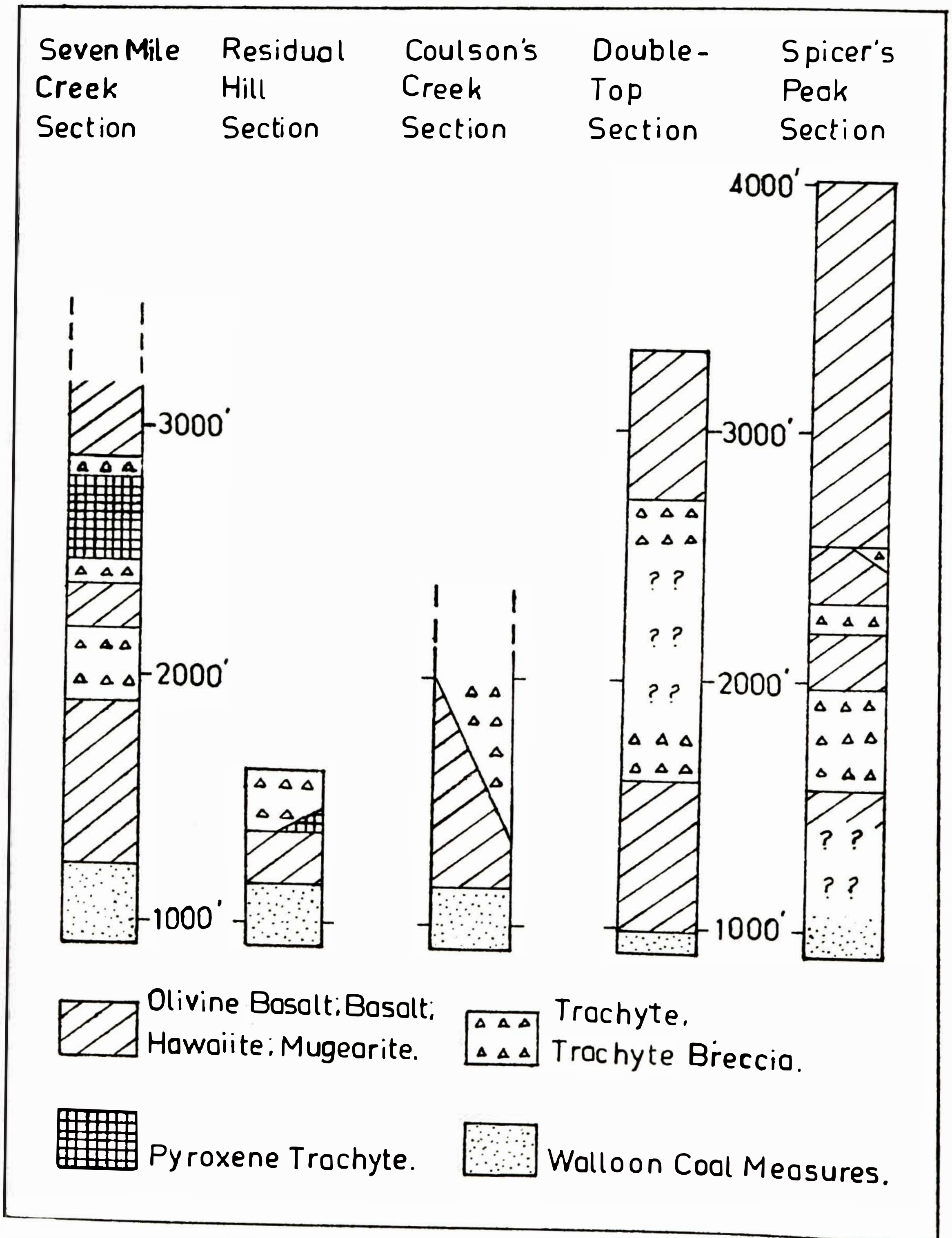

FIG. 1.—Sections through the traverses of Table 1.

the excessive elevation of the top of the lower basalts (over 2,000 feet); the occurrence of a thick layer of basalts above the mugearite layer; and the unusual dip of the trachyte. These suggest the more probable presence of an unconformity, with the trachyte surrounding or draped off a hill of olivine basalt rising above an ancient topographic level in the mugearites. The crosscutting nature of the trachyte is made clear in Figure 2.

Estimates of the thickness of the unit depend on interpretation of basement topography, and of the contact between the lower basalts and lower trachytes. Except near Coulson's Creek, the only estimate of the dip of the upper contact is between Seven Mile Creek and the residual hill, where a 4° dip to the north-east was measured. The four elevation readings of the basement contact do not suggest this is parallel to the upper contact. Thus Figure 2 and the estimates of thickness are based on base levels uncorrected for any slope of the basement. On this basis the lower basalts at the residual hill are about 200 feet thick, at Seven Mile Creek and Double-Top about 600 feet, and at Coulson's Creek thicker still.

Lower trachytes

These trachytes reach a maximum known thickness of 400 feet on Spicer's Peak traverse and are composed mainly of breccia. A thin tuff layer is found near the base of the Seven Mile Creek traverse. True flows are rare but have been found on the north-west flank of the residual hill. The trachyte of Coulson's Creek may be an intrusion but is more probably a flow. The top of the trachyte here is unknown. The unusually large dip of the lower contact has been discussed above.

Lower middle basalts

These basalts, up to 200 feet thick, show a marked difference between the sodic andesine-bearing hawaiites of the Spicer's Peak traverse and the basalts and olivine basalts of Seven Mile Creek. A thin trachyte breccia layer occurs in the Spicer's Peak traverse, and a possible dolerite sill, or more probably a coarse olivine basalt flow, among the Seven Mile Creek lavas.

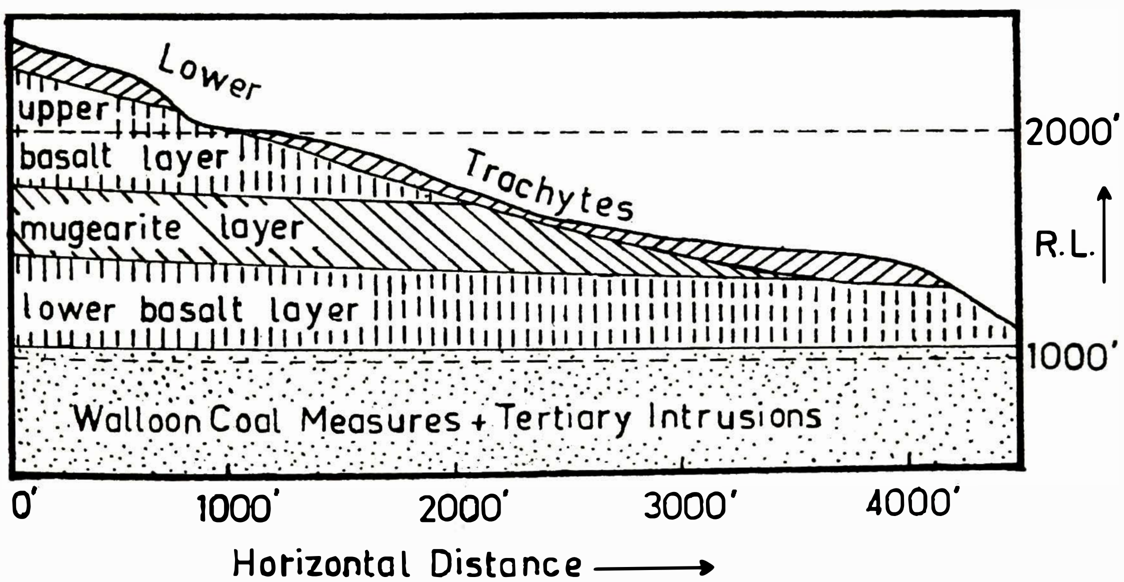

FIG. 2.—Cross-section based on data from the bed of Coulson's Creek and the ridge immediately to the north. R.L.=Reduced Level=elevation above Mean Sea Level.

Middle trachytes

On Spicer's Peak there are 130 feet of typical feldspathic trachyte and trachyte breccia. The Seven Mile Creek traverse consists of 40 feet of trachyte and fluidal trachyte overlain by 70 feet of trachyte breccia, while nearby the whole unit is of trachyte breccia.

Upper middle basalts

These are badly weathered on Spicer's Peak but appear to consist of two thick flows with a basalt overlain by a coarsely porphyritic hawaiite; the latter, if persistent, may form a marker bed in the absence of overlying trachytes. In contrast, the Seven Mile Creek traverse has 300 feet of pyroxene trachyte. This must wedge out rapidly to the north into basalts and hawaiites but is even thicker to the south (Stevens, pers. comm.).

Upper trachytes

These trachytes vary markedly between the two major traverses. On Spicer's Peak they have lensed out completely, but further north a sanidine trachyte occurs at Governor's Rock, with sanidine phenocrysts in a sanidine-glass groundmass. Trachyte breccia is still evident and is the only rock type found at the top of the trachytes on the Double-Top traverse. In the Seven Mile Creek traverse the base is of chalcedony-bearing amygdaloidal trachyte, while the top is of a pink, highly vesicular trachyte bordering on pumice.

Upper basalts

The upper basalts have been studied only from Spicer's Peak, where the 1,500-foot-thick sequence changes broadly from the porphyritic hawaiites and olivine basalts of the base to the cliff-forming olivine basalts at the top, with a capping of mugearite. These flows average about 70 feet thick, with a maximum of 135 feet in one coarsely porphyritic hawaiite about 300 feet above the base of the unit; this may prove to be a useful marker bed as similar rocks have been found in similar positions elsewhere (Stevens, pers. comm.).

PETROGRAPHY

Though the rocks appear to form a complete gradational petrographic sequence, it is convenient to divide them into five major rock types.

Olivine basalt

In hand specimen, olivine basalt is black to very dark green in colour. A porphyritic texture, always present, is usually inconspicuous. Labradorite may occur as phenocrysts or as groundmass laths. It is almost invariably zoned, and twinning may be on the albite, Carlsbad, and pericline laws. Core compositions vary from $An_{60}-An_{50}$. Pyroxene, occasionally ophitic or subophitic, occurs as phenocrysts or in the groundmass. The colour varies from light brown to pink. It appears to be a titaniferous salite-augite in composition, using the Poldervaart & Hess (1951) classification. Olivine, euhedral to anhedral and fresh to completely altered, occurs in excess of five modal per cent. Magnetite and ilmenite are prominent accessories. Apatite is found in many rocks as acicular prisms. Chlorite, calcite, and iddingsite are secondary minerals.

Basalt

This differs from olivine basalt only in that the modal olivine percentage is less than five.

Hawaiite

In hand specimen, hawaiites are lighter in colour than olivine basalts though still dark green or dark grey. Some of these, especially the calcic andesine-bearing varieties, are very coarsely porphyritic in plagioclase, with phenocrysts over 1 centimetre in length. Plagioclase may occur as phenocrysts of composition An_{65}–An_{40}, and as groundmass laths of andesine. Alkali feldspar may occur in association with, or mantling, sodic andesine, but only in small amounts. Greenish-brown pyroxene occurs as phenocrysts or groundmass grains. Olivine is generally present in moderate amounts, but is often represented by pseudomorphs of iddingsite or serpentine. Iron ore and apatite are the most important accessory minerals.

Mugearite

In hand specimen, mugearite is characteristically dark to medium green with a greasy or sparkly lustre, though it may appear basaltic. A trachytic texture is generally present. Oligoclase occurs as tiny groundmass grains, often of uncertain composition, and as rare phenocrysts, either of oligoclase or of sodic andesine. It is typically mantled by alkali feldspar, which may also occur as tiny equant grains of low 2V suggesting sanidine. Pyroxene is found as phenocrysts and, in the groundmass, as greenish-brown grains suggesting a ferroaugite composition. Olivine occurs as rare phenocrysts and in the groundmass. It has a faint yellow tint suggesting a high fayalite content. Iron ore, apatite, and chlorite are commonly present.

Trachyte

Hand specimen variation is marked. The most distinctive type is pyroxene trachyte, a light green rock crossed by numerous iron-stained cracks on weathered surfaces. It is probably transitional from mugearite to the ordinary cream-coloured trachytes. Vesicular and fluxion-banded trachytes tend to be orange, the colour deepening with increasing vesiculation. The creamy trachytes are commonly brecciated and may be tuffaceous. All these phenomena reflect the greater viscosity of trachyte as compared to basalt or even pyroxene trachyte. Texturally, all except the tuff show either a flow banding or a felted texture. Most are porphyritic in feldspar, and pyroxene trachyte also in pyroxene.

Alkali feldspar is the dominant mineral but is generally rare as a phenocryst, except in the sanidine trachyte of Governor's Rock. In this, both phenocrysts and groundmass grains are of sanidine. In the pyroxene trachytes rare sanidine phenocrysts are found in a sanidine groundmass. In other rocks alkali feldspar is too fine-grained for determination. Plagioclase is the dominant phenocryst, and an important groundmass mineral in some rocks. In the pyroxene trachytes, phenocrysts may be of calcic oligoclase, but the groundmass is of the albite-oligoclase typical of all the trachytes. Generally alkali feldspar greatly outweighs plagioclase, but they may be about equal in amount. Pyroxene is restricted to the pyroxene trachyte where it occurs as large green phenocrysts and as pink microphenocrysts and groundmass grains. Iron ore is an important accessory. Some glass is found in the sanidine trachyte and the tuff. Haematite and zeolites are secondary minerals.

CONCLUSIONS

In the Spicer's Peak area the generalized sequence is from basic to intermediate to basic from bottom to top, though mapping has revealed seven alternating basaltic and trachytic units. However the "basalts" sandwiched between the three leucocratic trachyte units are mostly hawaiites, mugearites, and pyroxene trachytes. In addition, the flows show an apparently complete gradational sequence, both petrographically and mineralogically, between olivine basalt and trachyte.

ACKNOWLEDGMENTS

Much of the field expense incurred was defrayed by a University Travel Grant. The author wishes to thank Professor A. F. Wilson and his staff, especially Dr. N. C. Stevens, for interest, advice, and useful discussions; he also wishes to thank those who accompanied him into the field and aided in the presentation of this report.

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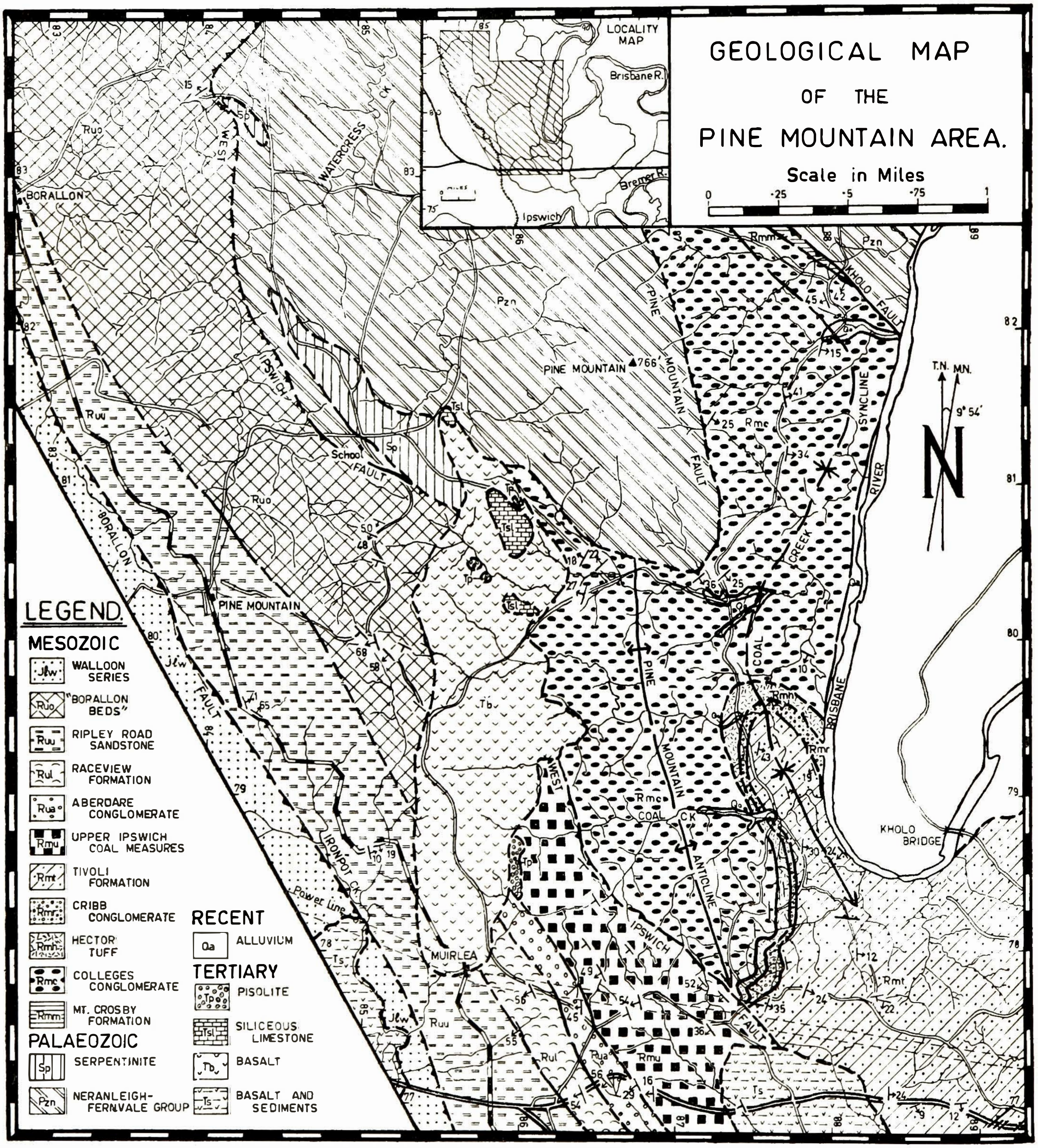
STRATIGRAPHY AND STRUCTURE OF THE PINE MOUNTAIN AREA, NEAR IPSWICH, SOUTH-EAST QUEENSLAND


GEOLOGICAL MAP
OF THE
PINE MOUNTAIN AREA.
Scale in Miles
0 ·25 ·5 ·75 1
LOCALITY MAP
Brisbane R.
Bremer R.
Ipswich
LEGEND.
MESOZOIC
Jlw WALLOON SERIES
Ruo "BORALLON BEDS"
Ruu RIPLEY ROAD SANDSTONE
Rul RACEVIEW FORMATION
Rua ABERDARE CONGLOMERATE
Rmu UPPER IPSWICH COAL MEASURES
Rmt TIVOLI FORMATION
Rmr CRIBB CONGLOMERATE
Rmh HECTOR TUFF
Rmc COLLEGES CONGLOMERATE
Rmm MT. CROSBY FORMATION
PALAEOZOIC
Sp SERPENTINITE
Pzn NERANLEIGH-FERNVALE GROUP
RECENT
Qa ALLUVIUM
TERTIARY
Tp PISOLITE
Tsl SILICEOUS LIMESTONE
Tb BASALT
Ts BASALT AND SEDIMENTS
T.N. M.N.
9° 54'
N
BORALLON
WEST IPSWICH FAULT
WATERCRESS CK
PINE MOUNTAIN 766'
PINE MOUNTAIN FAULT
KHOLO FAULT
SYNCLINE
BRISBANE RIVER
COAL CREEK
School
PINE MOUNTAIN
BORALLON FAULT
IRONPOT CK
Power Line
MUIRLEA
WEST IPSWICH FAULT
PINE MOUNTAIN ANTICLINE
COAL CK
KHOLO BRIDGE