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NOTES ON THE LAMINGTON VOLCANICS OF THE McPHERSON RANGES, QUEENSLAND-NEW SOUTH WALES BORDER

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CONTENTS

SUMMARY

The geology of the Lamington Volcanics is reviewed and some new data are presented.

The previously assumed basalt-rhyolite-basalt subdivision of the mid-Tertiary Lamington Volcanics is not applicable throughout the whole outcrop, the middle rhyolite division being absent in some areas, and showing rapid thickness changes in others.

A recorded five-fold division of the volcanics (basalt-rhyolite-basalt-rhyolite-basalt) in the Mount Lindesay-Mount Glennie area was not confirmed in the field.

The rhyolite sequence in the Hillview area contains the Chinghee Conglomerate, for which a type section is given.

INTRODUCTION

During the regional mapping and compilation of earlier geological work on the post-Palaeozoic sequence of the Warwick 1:250 000 Sheet area by Geologists of the Bureau of Mineral Resources, Geological Survey of Queensland, and Geological Survey of New South Wales, it became apparent that the Lamington Volcanics presented problems that merited fuller discussion than that presented in the record dealing with the regional geology (Exon, Reiser, Casey, & Brunker, 1969).

As much of the earlier work had been done without air-photographs, boundaries were changed in most of the units shown in Figure 1. However, only in the Lamington Volcanics, which had been less intensively studied, were there any basic advances over earlier work.

The main problem is the distribution and continuity of the acidic extrusive rocks which are commonly interlayered with the basalts of the essentially flat-lying Lamington Volcanics. Richards (1916) had recognized a widespread three-fold subdivision into basalt-rhyolite-basalt, and later workers such as McTaggart (1961) and Solomon (1964) confirmed this subdivision and further subdivided the sequence. Because of the ragged forested nature of the country there had been difficulties in establishing the sequence in sufficient areas to be able to correlate confidently between outcrops. As the sequence was essentially similar in most areas, with acid volcanics at much the same level, there was a natural tendency for workers to assume they were in fact continuous, and to extrapolate into unknown areas by assuming that the acid volcanics would roughly follow the topographic contours, as the volcanics are virtually flat-lying.

The present work has helped to show that the acid volcanics, although of similar age, change rapidly along strike and are discontinuous. Thus any three-fold subdivision of the volcanics can only be of local significance. A corollary of this is that, without much more detailed mapping, it is impossible to know whether or not the acid volcanics are synchronous. It would, for example, require meticulous detailed mapping to prove or disprove synchroneity of, say, the basalt flow immediately overlying the acid volcanics in two areas separated by areas containing no such acid volcanics. Until that is done the only possible regional approach is to map the acid volcanics, give them local names, and to call the whole sequence Lamington Volcanics. To give the 'upper' and 'lower' basalts regional names requires unjustified assumptions of synchroneity, and drawing boundaries between the two is at present impossible in some areas.

Another problem was the presence or absence of a five-fold subdivision basalt-rhyolite-basalt-rhyolite-basalt in limited areas. This was suggested by McTaggart (1961), within the area of Figure 1, for Mounts

Lindesay and Glennie, where he showed the Mount Lindesay Rhyolite to be separated from the underlying Chinghee Conglomerate/Hillview Rhyolite unit by a basalt sequence. The present author could not confirm this five-fold subdivision for Mount Glennie. On Mount Lindesay there are (Stephenson in McElroy, 1962) a few thin basalts in the acidic sequence, but it would be unjustifiable to split the sequence, at least on a regional scale.

The following notes give a summary of present knowledge of the Lamington Volcanics based largely on the work of previous authors, and amended by contributions from the regional mapping.

GENERAL GEOLOGY OF THE LOCAL TERTIARY IGNEOUS ROCKS

Mid-Tertiary igneous rocks in the area include, in addition to the Lamington Volcanics (eastern side of Figure 1), the Main Range Volcanics (western side) and numerous acidic intrusions such as the Mount Barney and Mount Alford complexes between.

The Mount Barney Central Complex (Stephenson, 1959, 1960) consists of several intrusions ranging from acid granophyre to tholeiitic dolerite, in the form of bosses, sills, and dykes (Fig. 1). The complex has updomed the Walloon Coal Measures and has exposed underlying Jurassic, Triassic, and Carboniferous sediments.

The Mount Alford Ring Complex (Stevens, 1959, 1960, 1962) consists of a central boss of microdiorite and granophyre, with associated ring-dykes, and dykes and sills of rhyolite and trachyte (Fig. 1). Younger dykes are more basic in composition. The complex has updomed the Jurassic Walloon Coal Measures and Marburg Sandstone. Other ring-dykes are at Minto Crags southeast of Mount Alford, and near Urbenville and Capeen in New South Wales (Fig. 1). Trachyte plugs and related sills are common, especially in the south. The sills were probably intruded into the Jurassic sediments as the lava attempted to reach the surface; the final vertical breakthrough formed the vents which are now represented by plugs.

The Main Range Volcanics (Stevens, 1965), consist of up to 1 000 m of basalt and lenticular trachyte flows which generally dip gently westward. Relationships are complex but a succession basalt-trachyte-basalt is common. The lowest flow is invariably basalt, but the lowest 300 m contains numerous trachyte lenses up to 165 m thick. The upper 600 m is basalt. Each trachyte flow had a local vent; some of the vents are represented by exposed plugs.

In general, potassium-argon dating (Table 1) and field relationships indicate the following sequence of events:

a) Intrusion of trachyte and perhaps of basalt about 25 million years ago.

b) Basalt extrusion (alkaline in the west and subalkaline in the east) about 24 m.y. ago, followed shortly by trachyte extrusion in the west and rhyolite extrusion in the east. The dates from both extrusives and intrusives suggest that although extrusion of the two volcanic suites overlapped, the Main Range Volcanics (west) started and ended somewhat earlier than did the Lamington Volcanics (east). Acidic extrusion stopped long before the last basalts were extruded. The time span from the first intrusion to the last extrusion may have been as much as 5 m.y. (25 m.y. to 20 m.y. ago).

c) Erosion of the volcanics from the central part of the area, exposing the acid intrusions. As the main basalt vents appear to have been along the Main Range in the west and at Mount Warning in the east, it is probable that the intervening sequence was originally thinner and topographically lower. Thus it was selectively eroded as compared to the areas in which volcanics now predominate.

LAMINGTON VOLCANICS

The Queensland outcrop of these volcanics was first discussed in detail by Richards (1916). Bryan & Jones (1945) named them the Lamington Series and suggested that they were Pliocene, and Stephenson, Stevens, & Tweedale (in Hill & Denmead, 1960, p. 355) renamed then the Lamington Volcanics. They are mainly basalt with interbedded rhyolite, rhyolitic pyroclastics, and sediments. The general three-fold vertical subdivision into basalt-rhyolite-basalt was first recognized by Richards (1916). The volcanics were, in large part, extruded from the Mount Warning Volcano west of Murwillumbah and some 30 km east of Cougal; they were discussed at length by McTaggart (1961) and Solomon (1964). The volcanic rocks were deposited on a very irregular land surface to a maximum thickness of about 1 050 m, in the form a shield volcano with lavas extending in all directions for up to 55 km. The volcano's original height was about 1 800 m above sea level (Solomon, 1964). Spine-like supplementary vents of acid material - Egg Rock and Charrabomba Rock - were noted by Tweedale (1950) in the Binna Burra area 25 km east of Tamrookum. McTaggart (1961), whose work was in reconnaissance detail only, gave this generalized sequence for the northern part of Figure 1:

	Maximum thickness (metres)
Hobwee Basalt	600
Binna Burra Rhyolite, Mount Lindesay Rhyolite	250
Beechmont Basalt	270
Chinghee Conglomerate and Hillview Rhyolite	30-60
Albert Basalt	250

His map shows two continuous rhyolites separated by basalt in much of the area, but nowhere have I, or Geological Survey of Queensland geologists working in the Tweed Heads Sheet area to the east, found such a situation, although a three-fold subdivision is common. Even at Mount Glennie, specifically mentioned by McTaggart (1961) as displaying a five-fold subdivision, there is no such subdivision. There are several rhyolite layers, totalling 120 m thick, capping the mountain (Mount Lindesay Rhyolite) but they rest directly on one another, and overlie some 520 m of basalt. The situation is essentially the same at Mount Lindesay, where 30 m of the upper basalt overlies three rhyolitic sequences (the lowest being a tuff) totalling 270 m in thickness, which overlie the lower basalt.

McElroy (1962) found a three-fold division to exist south and east of this area. He used the name 'McPherson Volcanics' for the sequence, but in a footnote (Ibid, p. 53) indicated that Lamington Volcanics had priority. He named the lower 210 m thick basaltic sequence the Lismore Basalt. Overlying it is a sequence of rhyolite, obsidian, porphyritic pitchstone, tuff, and agglomerate, which attains a maximum thickness of 490 m near Nimbin, and which he named the Nimbin Rhyolite. The upper basalt, which he named the Blue Knob Basalt, reaches a maximum thickness of 250 m near Nimbin. On the basis of photo-interpretation, and the then widely held opinion that all the rhyolite sequences were probably continuous, McElroy extended the Nimbin Rhyolite too far to the north and west.

The recent mapping has made it clear that there were rhyolitic extrusions in different areas, probably at different times. The sequences in various areas, and their maximum thicknesses, are shown in Table 2. Perhaps the earliest phase of rhyolitic extrusion was that which led to deposition of the Hillview Rhyolite and the Chinghee Conglomerate between Hillview (3 km NNE of Lamington) and Wiangaree. The Binna Burra and Nimbin Rhyolites, which may or may not be equivalent, are at a higher level but farther east. The Binna Burra Rhyolite pinches out in the McPherson Range

(G. Tweedale, pers. comm.) and the Nimbin Rhyolite in the Tweed Range to the south. The Mount Lindesay Rhyolite exposed at Mounts Lindesay and Glennie thickens northwestward, so its vent is certainly unrelated to those of the eastern rhyolites. Its relationship to these other rhyolites is unknown.

Although the names Albert Basalt, Beechmont Basalt, Hobwee Basalt, Lismore Basalt, and Blue Knob Basalt have local application, where the corresponding rhyolites are present, they have not been traced from one area to another. Accordingly the one symbol is used for all the basalts of the Lamington Volcanics, and the earlier name Lamington Volcanics is preferrable to McTaggart's (1961) Lamington Group.

Hillview Rhyolite and Chinghee Conglomerate. These names were proposed by McTaggart (1961) for sequences in the Hillview area. The Hillview Rhyolite, which is up to 60 m thick, is described as 'a band of agglomerate tuffs and brecciated rhyolite that is well exposed in the valley walls of Christmas and Chinghee Creeks. The band shows marked outcrop in the escarpment known as Hillview Cliffs'.

The Chinghee Conglomerate is named after Chinghee Creek where a maximum of 30 m of the sequence is exposed 10 km south of Hillview. McTaggart states that it persistently overlies the Hillview Rhyolite and describes it as consisting of 'alternating beds of coarse, argillaceous, current-bedded sandstones and polymictic conglomerates with boulders up to two feet diameter. Boulders consist of Palaeozoic sediments, rhyolite and granophyre, the last being similar to that of the Mount Barney central stock (Tweedale, 1950)'. In the type area a basalt is interlayered in the sequence towards the top.

D.J. Casey and R.F. Reiser (GSQ) measured a section in the type area of the Chinghee Conglomerate which, as McTaggart (1961) published no section when defining the unit, is here regarded as the type section. It was measured using an Abney level, and shows a thickness of 30 m of Chinghee Conglomerate and 16 m or more of Hillview Rhyolite (see Appendix). The strongly cross-bedded sandstone of the Chinghee Conglomerate varies from fine to very coarse-grained, is feldspathic and weathers readily; it contains plant fragments. It is regarded as part of a fluviatile sequence deposited during a period of acid volcanism. The Hillview Rhyolite, which is largely agglomerate, must have had its vent in the Hillview - Chinghee area, where the unit is coarsest.

The Hillview Rhyolite and Chinghee Conglomerate are interbedded outside the type area, and have been combined in Figure 1. The sequence is fairly well exposed down the valley of Grady's Creek north of Wiangaree, although it is no longer cliff-forming as it is in the type area. It consists of white feldspathic tuff grading to agglomerate, very fine to coarse-grained white feldspathic sandstone grading to conglomerate, and rhyolite. Proportions of these constituents vary, and as much of the sequence does not crop out, are difficult to judge. The sequence thins steadily southward from about 60 m near Cougal to about 3 m south of Mount Lion. There is a very gentle regional dip in this direction (respective elevations of base of sequence about 330 m and 300 m above sea level) and it dips to the east at 3° near Loadstone.

The unit appears to pinch out westward but, should it be present but unresistant and non cliff-forming in that direction, could only be mapped by ground traverses. Many benches are visible in the volcanics between Mount Glennie and Cougal but reconnaissance traverses during the present mapping showed that all the accessible benches were basalt. Nine metres of very fine clayey sandstone, carbonaceous siltstone and mudstone occur in basalt east of Long Creek at about 530 m above sea level, some 6 km west of Cougal. Assuming an easterly dip these could be Chinghee sediments, but alternatively they could represent a high-level window of Walloon Coal Measures. McTaggart (1961) mentions 6 m of Chinghee Conglomerate at 245 m above sea level at the Pinnacle in the Tweed Range, just east of the area of Figure 1.

Mount Lindesay Rhyolite. This name was introduced by McTaggart (1961) for 'the sequence of tuffs, agglomerates, obsidian and rhyolite that forms the cliffs on Mount Lindesay and nearby Mount Glennie'. J. Stephenson (McElroy, 1962, p. 55) measured a section up Mount Lindesay in which 420 m of basalt is overlain by 60 m of rhyolitic agglomerate and pale tuff. Above this the 180 m-high cliffs consist of 90 m of rhyolite with fluidal perlitic glass at the base, and 90 m of spherulitic rhyolite flow with thin interbedded basalts and acid pyroclastics at the base. The mountain is topped by 30 m of basalt. This acidic sequence and the 120 m thick sequence at Mount Glennie must correspond, but the flows on Mount Glennie are more uniform, being largely white rhyolite with some feldspar phenocrysts, some flow structure, and some biotite.

A dip to the south is visible on Mount Glennie, and the same beds are about 180 m higher on Mount Lindesay to the northwest. As the Mount Lindesay sequence is thicker and more agglomeratic as well as higher, Tweedale & Stephenson (in Hill & Denmead, 1960, p. 356) suggested that Mount Gillies, some 8 km farther north, was the vent for the Mount Lindesay Rhyolite.

The original, and indeed the present, distribution of the Mount Lindesay Rhyolite is uncertain. Richards (1916) in a sketch map of the district, showed the McPherson Range between Mount Lindesay and Running

Creek to be sporadically capped with acid volcanics, a spur of which was shown running northward east of Palen Creek, but his evidence for their presence was not given. A plateau on the border at the head of Back Creek has been photo-interpreted (Fig. 1) as being rhyolite, but this is conjectural. Traverses up all the creeks north of Old Grevillia and along the forestry track south of Terrace Creek to Mount Glennie failed to reveal the tall-tale white cliffs so characteristic of rhyolite flows. The numerous terraces are flanked by cliffs but all are basalt.

However, in all the creeks there are large and abundant cobbles and boulders of acid volcanics which vary from very fine rhyolite to very coarse acid porphyry, and they must have been derived from the headwaters of the creeks. Thus a rhyolite suite of rocks must exist at a high level along the McPherson Ranges.

Basalts: Richards (1916) was the first to make a wide-ranging study of these rocks. Chemical analyses listed by a number of workers, including Richards, show that the Lamington Volcanics are less alkaline than the Main Range Volcanics (Text-fig. 2 in Webb, Stevens, & McDougall, 1967). Webb et al. pointed out that the Lamington Volcanics, while not tholeiitic by generally accepted standards, are closer to that suite than the Main Range Volcanics, at least in the lower silica region of the curve.

McTaggart (1961) and McElroy (1962) described the basalts in some detail and gave thicknesses for the various subdivisions of the volcanics. The thickness of individual flows varies considerably. Table 2 relies heavily on McTaggart (1961) and McElroy (1962) but includes data gathered during the present mapping. As the pre-basalt surface was very irregular, the lower basalts vary greatly in thickness; also there has been very great erosion, so that the upper basalts may have been much thicker than they are now.

The basalts vary from glassy, very fine-grained types to coarsely porphyritic rocks with phenocrysts of olivine or feldspar. The upper basalt sequence in the Tweed Range is remarkable for some rocks with very coarse plagioclase phenocrysts, and Richards (1916) reported porphyritic andesite from the upper sequence further north. Vesicular and amygdaloidal basalts occur sporadically and zeolite infillings are common. The groundmass of some basalts contains nepheline, magnetite, and chlorite (McElroy, 1962). Basaltic agglomerate and tuff have been seen only in the lower part of the sequence and are rare.

Age: Richards (1916) established that the volcanics were of post-Walloon age and suggested that they were Tertiary. Geomorphological (Solomon, 1964) and palaeomagnetic (Robertson, 1966) evidence suggested an Upper Tertiary age for the volcanics.

Webb, Stevens, & McDougall (1967) obtained apparent ages ranging from 22 to 20 million years for four samples from the volcanics, the most reliable age being 21.8 million years. Lack of internal agreement between the stratigraphy and the ages suggested that the discrepancies were probably due to the altered nature of the samples. These dates are all younger than the biotite age of 22.5 to 23 million years from the Mount Warning gabbro; the ages of 22.6 and 22.9 million years from basalts at Fingal and Burleigh Heads (McDougall & Wilkinson, 1967) are probably more representative of the Lamington Volcanics than those listed in Webb et al. An age of 23.6 million years from an olivine tholeiite near Tabulam, published in the same paper, may or may not be from the Lamington Volcanics. The Lamington Volcanics are thus of late Oligocene/early Miocene age.

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The author wishes to thank G. Tweedale, at that time of the Geological Survey of Queensland, for his help in defining the problems existing in the Lamington Volcanics before mapping began, and in the field. Thanks are also due to R. Reiser, who mapped the Lamington Volcanics north of the border.

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APPENDIX

TYPE SECTION IN THE CHINGHEE CONGLOMERATE MEASURED BY D.J. CASEY AND R.F. REISER

Chinghee Conglomerate

50-56 m conglomerate; boulders up to 1 m, subangular, basalt and acid volcanics.

46-50 m basalt, probably infilling a valley in the conglomerate

39-46 m conglomerate; boulders up to 1 m, subangular, basalt and acid volcanics.

34-39 m fine to coarse-grained yellow tuffaceous sandstone; thick to well-bedded; feldspathic; minor lenses of cobble conglomerate.

31-34 m fine-grained feldspathic sandstone with fine interbeds of tuff; some beds of pebble conglomerate 15-30 cm thick.

27-31 m generally coarse conglomerate with fragments up to boulder size, cobbles common; clasts of tuff, rhyolite porphyry and 'chert' of low sphericity, subangular, in a tuffaceous matrix.

16-27 m No outcrop

Hillview Rhyolite

0-16 m agglomerate of large angular boulder to cobble sized clasts of tuff, containing feldspar and quartz crystals.

TABLE 1 POTASSIUM-ARGON DATES

Subdivision	Alkali trachyte intrusives of central area	Acid intrusions of central area	Main Range basalts	Mount Warning Volcano			Tabulam basalts
				gabbro	basalts	basalts	
Age (m.y.)	25-24*	23.5 - 22.5*	24-22*	22.4*	22-20*	22.9, 22.6+	23.6+
Comments	Mount Edwards only one dated within area of Figure	One sample from each of Mounts Alford, French, Barney, Gillies	Consistent decrease up sequence from basal flow. 4 samples in Mount Mitchell area	One sample	Weathered, internally inconsistent; probably too young. 4 samples	More reliable 2 samples	Not known whether part of Main Range or Lamington sequence, or neither

* Webb, Stevens & McDougall, 1967.

\+ McDougall & Wilkinson, 1967.

TABLE 2 MAXIMUM THICKNESS OF PARTS OF THE LAMINGTON VOLCANICS IN VARIOUS AREAS

Mount Lindesay	Mount Gipps	Tweed Range	Binna Burra	Nimbin
upper basalt 30 m	upper basalt 330 m	upper basalt 820 m	upper basalt 600 m	upper basalt 250 m
Lindesay Rhyolite 240 m	Hillview/Chinghee sequence 60 m	Chinghee Conglomerate 6 m	Binna Burra Rhyolite 300 m	Nimbin Rhyolite 490 m
lower basalt 430 m	lower basalt 250 m+	lower basalt 90 m+	lower basalt 490 m	lower basalt 210 m
Approximate elevation of base of rhyolitic sequence				
880 m	330 m	240 m	610 m	240 m

The major sources of information for these thicknesses are:

Mount Lindesay: Stephenson (in McElroy, 1962)

Mount Gipps (north of Wiangaree): McTaggart (1961) and the author

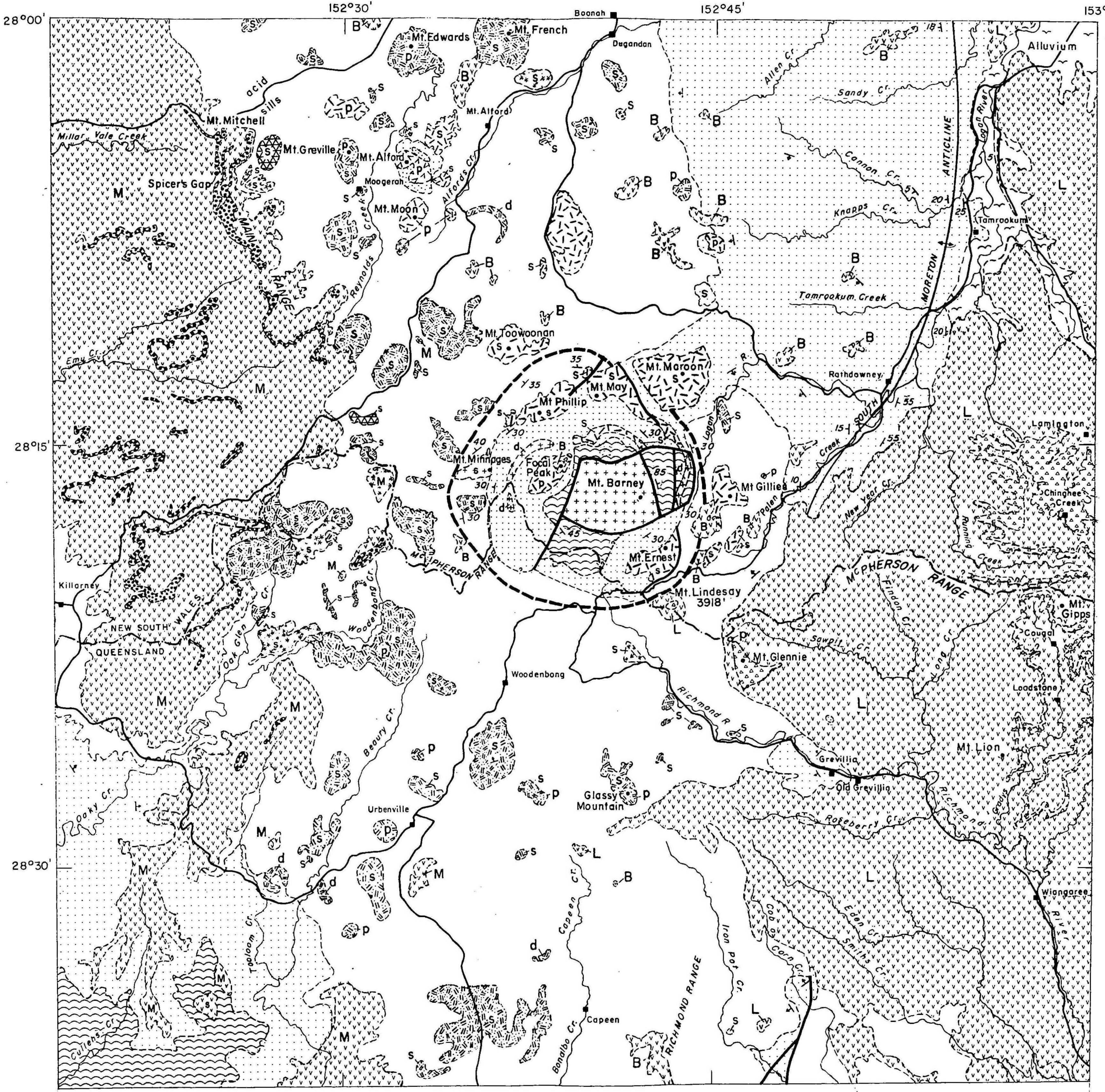
Tweed Range (northern part): McTaggart (1961)

Binna Burra: Tweedale (1950) and McTaggart (1961); upper basalt thickness is at Mount Hobwee, rhyolite thickness near Binna Burra, lower basalt thickness at Mount Bithongabel in Mount Warning caldera wall.

Nimbin: McElroy (1962)

OLIGOCENE TO MIOCENE IGNEOUS ROCKS

IN THE AREA ABOUT THE MAIN AND MC PHERSON RANGES, SOUTH OF BOONAH



0 5 10 15 km
0 5 10 M

- EXTRUSIONS
  - Main Range Volcanics: M — *Alkaline olivine basalt*; *Trachyte*
  - Lamington Volcanics: L — *Sub-alkaline basalt*; *Rhyolite, acid pyroclastics, conglomerate*
  - B — *Basalt (unknown affinities)*
- INTRUSIONS (OLIGOCENE TO MIOCENE)
  - *Rhyolite*
  - *Granophyre*
  - *Trachyte, comendite, alkaline rhyolite*
  - *Microsyenite*
  - *Microdiorite and diorite*
  - *Andesite*
  - *Dolerite, basalt, teschenite*
  - s,d,p — *sill, dyke, plug or stock*
- JURASSIC
  - Post-Bundamba Group — *Sandstone, siltstone, mudstone, coal*
  - Bundamba Group — *Sandstone, siltstone, mudstone, conglomerate*
- CARBONIFEROUS
  - Mount Barney Beds — *Labile sandstone, conglomerate, mudstone*

Fault

Doming within this line

Strike and dip of strata

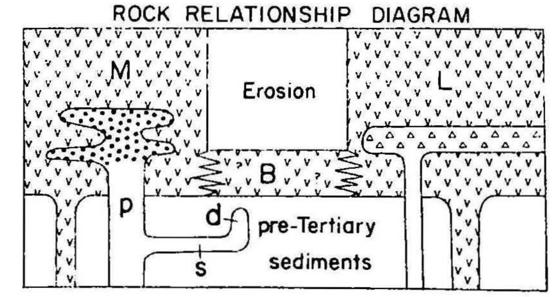
Dip<15°; air-photo interpretation

Main road

Homestead or township

State border

ROCK RELATIONSHIP DIAGRAM



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