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Igneous Rocks of the Kalbar District, South-East Queensland.

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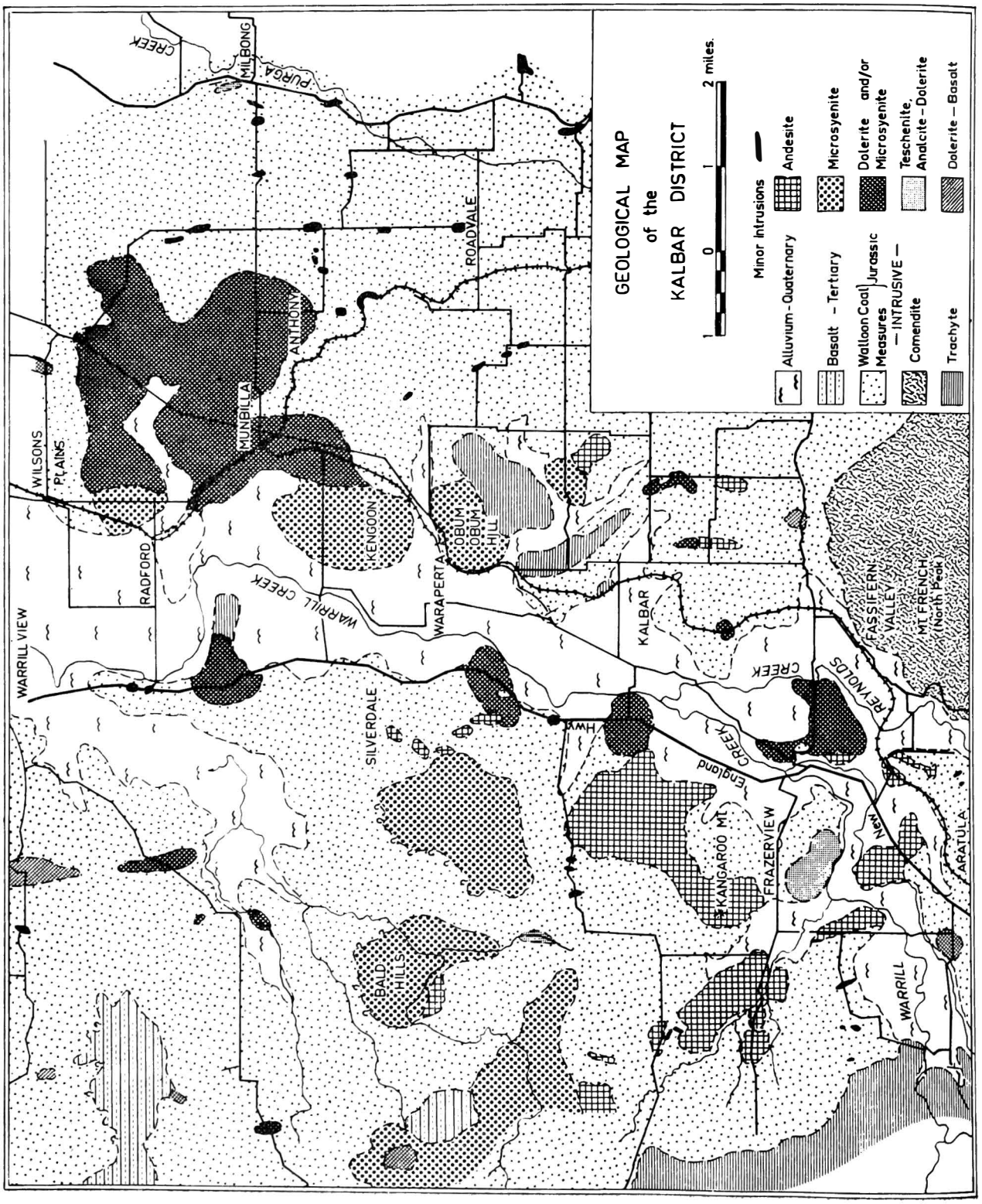
Gently dipping Jurassic Walloon Coal Measures are overlain by Tertiary lavas, mostly olivine-basalts, N.W. of Kalbar. Numerous small intrusions, of dolerite, teschenite, microsyenite, andesite, trachyte and comendite, appear to be older than the flows. Relations between the igneous rocks and their affinities are discussed.

I. INTRODUCTION

Kalbar is situated 40 miles S.W. of Brisbane in gently undulating, open farmland. The soil cover is thick and most of the rocks are highly weathered. Probably for this reason the district has not been geologically mapped in any detail.

The sketch-map (Plate 1) comprises an area of about 130 square miles, on either side of the New England Highway, between Warrill View and Aratula. Relief is generally low, with elevation ranging from 200 feet at Warrill View to 800-900 feet at Kangaroo Mountain, Bald Hills and an unnamed hill to the north. Around the southern margins of the area, the trachytic and rhyolitic masses of Mt. Fraser, Mt. Edwards and Mt. French are all close to 2000 feet.

Jensen (1909) noted the occurrence of trachyte in the Fassifern Scrub (now largely cleared) and basalts and dolerites further north. He found analcite in a dolerite near Milora and syenitic rocks south of Engelsburg (Kalbar). Wearne and Woolnough (1911) described quartz-syenite with anorthoclase from the Munbilla-Engelsburg road. Reid (1922) produced a rough map and suggested that the basic intrusives were in sills or laccoliths and that their extent was greater than previously thought.


GEOLOGICAL MAP
of the
KALBAR DISTRICT
1 0 1 2 miles.
Minor Intrusions
Andesite
Alluvium - Quaternary
Basalt - Tertiary
Microsyenite
Dolerite and/or Microsyenite
Walloon Coal Measures
Jurassic
— INTRUSIVE —
Teschenite, Analcite - Dolerite
Comendite
Trachyte
Dolerite — Basalt
WARRILL VIEW
WILSONS PLAINS
RADFORD
MUNBILLA
ANTHONY
MILBONG
PURGA
CREEK
ROADVALE
KENGOON
COBUM
COBUM HILL
WARAPERTA
WARRILL CREEK
SILVERDALE
BALD HILLS
KALBAR
HWY
CREEK
REYNOLDS
FASSIFERN VALLEY
MT FRENCH (North Peak)
England
KANGAROO MT
FRAZERVIEW
New
ARATULA
WARRILL

II. STRATIFIED AND EXTRUSIVE ROCKS

(1) Jurassic.

The oldest rocks in the district are the Walloon Coal Measures, of Jurassic age, a formation of brown to green mudstones, buff, cream or grey sandstones, with some siltstones, shales and thin coal seams. The mudstones contain abundant plant remains including *Cladophlebis australis, Taeniopteris spatulata* and *Brachyphyllum* sp. Fossil wood, in fragments from sand-size to logs several inches in diameter is frequently present in the sandstones.

Most of the sandstones are lithic and many are calcareous, especially the compact, light grey types. Thin beds of limestone, including some showing cone-in-cone structure, are known. Contact metamorphic effects are usually slight except in isolated instances where sandstones have been locally recrystallised and even vitrified.

Over the greater part of the area the coal measures are almost horizontal; the steepest angles of dip are in the east near Milbong, where westerly dips of 10-15 degrees have been noted. An anticline is possible at Kalbar, but elsewhere, strike and dip readings are so few and so scattered that no generalisations about the regional structure can be made.

(2) Tertiary.

Resting with slight unconformity on the Jurassic rocks in the western part of the area, are lavas of Tertiary age. They are mostly basaltic and form flat-topped ridges, some of which are below the tops of hills of intrusive rocks.

The basalt outliers west and north of Bald Hills have a slightly irregular base at an elevation of about 500 feet, conforming with the north-easterly slope of the lavas from the Little Liverpool Range, to the west. The southern outlier is mainly olivine-basalt, and is capped by a vesicular andesitic basalt. The northern outlier is made up of several flows, like Mt. Walker, a prominent residual beyond the northern limit of the map.

Weathered andesitic and trachytic rocks with volcanic textures are found in the south-west part of the area. The distribution and level of some of these (especially those just south of Silverdale and west of Kangaroo Mountain) is consistent with an origin as flows, but their thickness north of Fraserview and dissimilarity with known flows in adjacent areas support an intrusive origin.

III. INTRUSIVE ROCKS

The area mapped forms the northern half of the region of greatest concentration of Tertiary intrusives in southern Queensland. The smaller intrusions are sills and dykes, and the larger ones sills or stocks. The rock types range from comendite and trachyte to microsyenite, dolerite and teschenite. Most of these rocks are highly weathered, making distinction difficult. Another factor which complicates mapping is the gradation between some of the trachytes and the microsyenite and between microsyenite and dolerite.

(1) Dolerites and Basalts.

Porphyritic dolerites and basalts are closely associated in an intrusion (probably a sill, dipping west) which forms a low north-south ridge west of Warrill View. A quarry exposes a rapid vertical gradation from coarse porphyritic dolerite upwards into a basalt with few plagioclase phenocrysts, which appears to be a chilled margin of the intrusion. The pyroxene of both rocks is titan-augite.

A porphyritic dolerite containing altered olivine has been collected from the weathered dolerite intrusion 2½ miles south of Warrill View. Numerous other intrusions of weathered dolerites and porphyritic basalts are found, especially between Milbong and Kalbar. Some are dykes, such as the grey porphyritic basalt with glassy felspar east of Waraperta, others are concordant, like the two feet thick dolerite sill in a quarry at Milbong and the thicker dolerite sill in a railway cutting near Blantyre. A weathered greenish-grey rock with large felspar phenocrysts forms a sill 15 feet thick in a highway cutting N.W. of Kalbar. It closely resembles the porphyritic andesitic basalts found around the Mt. Alford ring-complex to the south (Stevens, 1959).

Very fresh olivine-dolerite, probably a plug, forms a conical hill west of Bald Hills. It is intrusive into microsyenite and is intersected by dykes of olivine-basalt. At the northern end of Mt. French, an olivine-basalt with analcite in small amygdules, may be intrusive. A similar rock with a platy fracture and a more titaniferous augite is exposed in a quarry west of Aratula. Another minor basic intrusion, of olivine-dolerite with a very uneven grain-size, is situated south of Milbong on the eastern boundary of the area mapped.

(2) Analcite Dolerites and Teschenites.

Small intrusions, dykes and stocks, of teschenitic rocks are found south of Frazerview School, in Waterholes Creek to the north, and on the eastern side of the area at Milbong.

The Frazerview teschenitic dolerite consists mainly of calcic andesine and titan-augite, with skeletal ilmenite, iron oxides and abundant apatite. Radiating aggregates of chalcedony and colloform opal, with quartz grains fill cavities. Analcitization of the felspar is slight in this rock, but a higher proportion of analcite is present in the teschenite from Waterholes Creek, which also contains natrolite, replacing felspar. This rock is similar to the coarse teschenite from the Flinders Intrusion (Cochrane, 1960).

The Milbong teschenitic intrusion is mostly olivine-analcite-dolerite containing purplish-brown titan-augite, often with green borders. Olivine has been altered to iddingsite and the plagioclase has been partly replaced by analcite, chlorite and natrolite. The same deuteric minerals occur interstitially. Analcite is euhedral against natrolite in cavities and its crystals have clear borders and a turbid interior. Natrolite is also present in striking radiating aggregates along joints.

A dolerite possibly related to these rocks has been found in a well 1½ miles east of Wilson's Plains. Ilmenite and titan-augite are again present, together with doubtful analcite, iron-stained and replacing plagioclase. This intrusion does not outcrop and is apparently a sill. South of Aratula, an olivine-analcite-dolerite forms a flat-topped hill which is probably a denuded sill.

Jensen (1909) described analcite-gabbro xenoliths from decomposed dolerite near Milora, but no rock fresh enough to section has been found there during the present survey.

(3) Microsyenites.

Fine, even-grained rocks resembling dolerite in hand-specimen form intrusions of moderate size between Kalbar, Bald Hills and Milora.

East of Warrill Creek, fresh microsyenite is available at only a few localities (e.g. 1½ miles N.E. of Kalbar and in a quarry north-east of Radford); so that determination of the intrusive rocks is difficult and some areas have been mapped as microsyenite and/or dolerite. The weathered rocks show textural differences which may aid in their distinction. The coarser varieties may be teschenites, while porphyritic types may be related to the porphyritic dolerites described above.

Outcrops of microsyenite are better west of Waraperta, where the intrusives form low hills. Bare rock surfaces parallel to the hill slopes are characteristic. The fresh rock is dark-grey and non-porphyritic, and is best termed microsyenite because of the presence of alkali felspar. The ferromagnesian minerals are green pyroxene, amphibole and olivine.

A sample of this rock, probably from Waraperta, has been described by Wearne and Woolnough (1911), who recognised anorthoclase as the dominant felspar, with subordinate oligoclase. Quartz, ilmenite, apatite, dark-brown biotite and greenish-brown augite with borders of dark-green hornblende were also noted.

During the present survey, olivine has been found in many of the thin sections. It is partly replaced by yellow, orange-red and green alteration products, some of which are isotropic (chlorophaeite) and others moderately birefringent iddingsite. The same minerals occur interstitially and as vugh-fillings. Similar anisotropic alteration products have recently been found to consist largely of smectite-chlorite, while the chlorophaeite probably has a chlorite structure (Wilshire, 1958).

Clinopyroxene is grey to greenish with a high extinction angle. Some sections show green borders and parallel inter-growth with a strongly pleochroic amphibole [Z (greenish-brown) > X (pink-brown)]. The felspars have optical properties consistent with anorthoclase and albite-oligoclase, but did not stain after treatment with hydrofluoric acid and sodium cobaltinitrite. A small amount of interstitial orthoclase was found by staining in a specimen from the south end of Bald Hills mass. This rock departs from the usual in having a more calcic plagioclase, and is closer to a normal dolerite.

A narrow sub-horizontal sill of syenite in weathered dolerite is exposed in a road cutting east of Kalbar. It is mineralogically similar to the microsyenite and is related to the "arfvedsonite-bearing syenite-pegmatite" described by Jensen (1909) from this district. A notable amount of aegirine is present in the syenite but the presence of arfvedsonite has not been established.

(4) Andesites.

In the Aratula district there are numerous small areas of weathered, cream to pale-brown rocks with sparse, medium-sized felspar phenocrysts. On microscopic examination, most of these are found to be andesites, as the phenocrysts are usually andesine. The groundmass consists of fine-grained plagioclase, magnetite and alteration products. A vesicular structure is common and indicates the attitude of the dykes and sills.

Non-vesicular, fresher andesites containing augite are found west and north-east of Fraserview and south of Silverdale. At the latter locality the andesites have a micro-crystalline groundmass and analcite occurs in small amygdules. These fresher andesites are dark rocks, weathering pale grey.

(5) Trachytes and Comendite.

Three different kinds of trachyte have been recognised. The first is a fine-grained phase of the microsyenite, which, on the south-eastern side of Obum Obum Hill and in the railway quarry N.W. of Kalbar, has green-brown pleochroic amphibole in place of pyroxene. A colourless isotropic mineral, probably analcite, traverses the felspar and forms small cubic crystals in zeolite.

Another type forms Mt. Fraser, the eastern foothills of which are included in the area mapped. This rock is porphyritic in slightly perthitic K-felspar and has a groundmass of felspars (including oligoclase) and opaque minerals.

The remaining type is similar in hand-specimen to the weathered andesites described above, except that phenocrysts are fewer. The fine-grained felspar is usually albite.

The comendite of Mt. French has been described by Jensen (1909), who regarded it as a flow. The writer prefers to classify it as a sill, assuming that it is coeval with the Mt. Edwards trachyte, which has been dissected by a superimposed stream (Marks, 1933).

IV. RELATIONS BETWEEN THE IGNEOUS ROCKS, THEIR AGE AND AFFINITIES

Evidence from west of Bald Hills suggests that the basaltic lavas (which are extensions of the Little Liverpool Range flows) are younger than the microsyenite. The latter was presumably intruded beneath some cover (e.g. Walloon sediments) which was removed by erosion and valleys several hundred feet deep were formed in microsyenite before the outpouring of the basalt.

The alternative suggestion, that the basaltic flows were originally much thicker and more extensive and have been intruded by the microsyenite, is rejected because no intrusions into the flows have been found, while fresh dolerite and basalt dykes intrude the microsyenite adjacent to the basalt margin.

A similar sequence has been noted in other parts of Eastern Australia (David, 1950) as at Bowral, New South Wales, where an alkaline microsyenite laccolith has been unroofed prior to the outpouring of the older basalt.

The relation of the other intrusives to the flows is unknown. It is possible that the trachyte stocks in the southern part of the area were feeders to the trachyte flows of the Main Range, although it has recently been found that the flows near Cunningham's Gap dip easterly towards the stocks, indicating a more westerly source (unless the dip is due to later warping).

At Limestone Ridges, analcite-dolerite and teschenite similar to those of the Kalbar district have intruded dolomite which overlies basaltic flows (Cochrane, 1960). The dolomite is considered Oligocene, and if this is correct, the teschenitic rocks are post-Oligocene.

Very few contacts between intrusive rocks are exposed in the area studied. In a small weathered dolerite intrusion east of Kalbar there are sills of a more compact dolerite and microsyenite, but the dolerite is too weathered to determine whether analcite is present. It is more likely that the microsyenite preceded the teschenite and the flows of Limestone Ridges, as the present level of the microsyenite at Bald Hills is several hundred feet higher than the base of the basalt at

Limestone Ridges. If so, the microsyenite is pre-Oligocene, either Eocene or Cretaceous. On the other hand, if the microsyenite is later than the teschenite, the Main Range lavas would be post-Oligocene.

The weathered andesites and trachytes (excluding those related to the microsyenite) closely resemble those in ring-dykes, dykes and sills of the Mt. Alford ring-complex (Stevens, 1959), and are likely to have been intruded at the same time. South of Aratula, a trachyte dyke has penetrated olivine-analcite-dolerite.

The district is part of a petrographic province characterised by teschenitic rocks and alkaline microsyenites as well as alkaline trachytes and rhyolites and more normal calcic types. The analcite-bearing intrusives first noted at Milora and Limestone Ridges are now known to be present near Frazerview and south of Aratula, while the microsyenites described in this paper have also been recognised in the Bremer Valley south of Rosevale, and related types have been collected from Kinnane's Cliffs near Wilson's Peak and Woodenbong, New South Wales (the latter by E. R. Phillips).

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