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Revised Interpretation of the Geology of the Smithton District of Tasmania

By

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WITH 2 PLATES AND 1 TEXT FIGURE

ABSTRACT:

The geology of the Smithton district is described in Bulletin No. 41 of the Geological Survey of Tasmania. The abundance of vesicles and amygdules mentioned in the description of the doleritic rocks which form a prominent feature of the area, seemed inconsistent with their interpretation as intrusive dykes and prompted us to check their occurrence in the field. We report that these rocks do in fact contain abundant vesicles and amygdules, and that in places they exhibit pillow structure and are associated with volcanic breccias and volcanic bombs. We have examined the exposures on which an intrusive character was claimed and are satisfied that they are due to extrusive and volcanic phenomena similar to those we have studied in the Cambrian or Late Proterozoic volcanic suite on King Island, 80 miles to the north-west. Native copper which is described as a common constituent, we find to be not native copper but pyrrhotite. " Fine-grained silicified conglomerate interbedded with dense black cherts exposed in the Irishtown gravel pits " (loc. cit. p. 31), we find to be silicified oolite. The two formations of dolomite described in the bulletin we consider to be a single formation repeated by strike faulting.

We agree with the previous authors in their correlation of their " Slate Stage " with the Dundas Group. We also correlate this group with similar rocks outcropping on the east coast of King Island and suggest that the tillite found in close association with these rocks in several parts of the State is part of the Dundas Group and is of Cambrian age. We suggest that a silicified breccia described by the previous authors is possibly the representative of the tillite in the Smithton district.

INTRODUCTION

The geology of the Smithton district of North-west Tasmania has been described in detail by Nye, Finucane, and Blake, in Bulletin No. 41 of the Geological Survey of Tasmania. A prominent feature of the geology of the district as described by the authors is a broad but rather complex dolerite dyke having a general meridional trend which the authors suggest to be of Devonian age and intrusive into the Dundas Slates and Breccias of Cambro-Ordovician (now known to be Middle Cambrian) age. Their descriptions of these rocks made frequent reference to the presence of amygdules.

For example:—

> p. 66.—" The white amygdules consist mainly of aggregates of quartz and calcite which may contain augite or chlorite. The green amygdules consist of a central nucleus of quartz, surrounded by fibres of the same material, with a thin outer layer of chlorite; the fibrous quartz between the nucleus and the outer chlorite layer radiates in fan-shaped fashion from a number of points on the inside of the chlorite layer. In a small outcrop of the dolerite on the northern spur of Tier Hill the white amygdaloidal inclusions are so numerous that the rock has quite a coarse appearance ".

p. 68.—" There are two main types . . . . both are amygdaloidal ".

p. 69.—" The amygdules consist of quartz and chlorite; in some cases the chlorite occupies the centre of the amygdule, and is surrounded by quartz; in others the amygdule is of quartz surrounded by a thin film of chlorite ".

p. 69.—" The amygdules are small vesicular cavities lined with quartz ".

These descriptions of abundant amygdules seemed to us inconsistent with the view expressed by the authors that these rocks were intrusive. In addition one of us (B.S.) has been studying the Cambrian or Late Proterozoic basic lavas of Tasmania generally, and has found them to be widely distributed in the area between Queenstown and King Island, and this suggested that the amygdaloidal basic rocks at Smithton associated with the Cambrian Dundas Group might in fact be another occurrence of these old lavas.

Extrusive Character of So-Called Dolerite

We examined the " dolerite dyke " in the following localities: Tier Hill, Coward's Road, the quarry ¾-mile south of Groom's Road on the Smithton-Trowutta Road, along the eastern shore of Duck Bay, and for a distance of about ¾-mile eastwards from Park Point along the shore. In each of these localities there was strong evidence to support an extrusive rather than an intrusive origin.

Throughout this paper the term " dolerite dyke ", as used by Nye, Finucane and Blake, will be replaced by " basic volcanics ".

The basic volcanic rocks occupy a similar stratigraphical position in the Dundas Group to those which crop out along the south-east coast of King Island and at Zeehan. For the most part they overlie well bedded chocolate coloured shales, but as on King Island, volcanic activity commenced before deposition of the shales was completed.

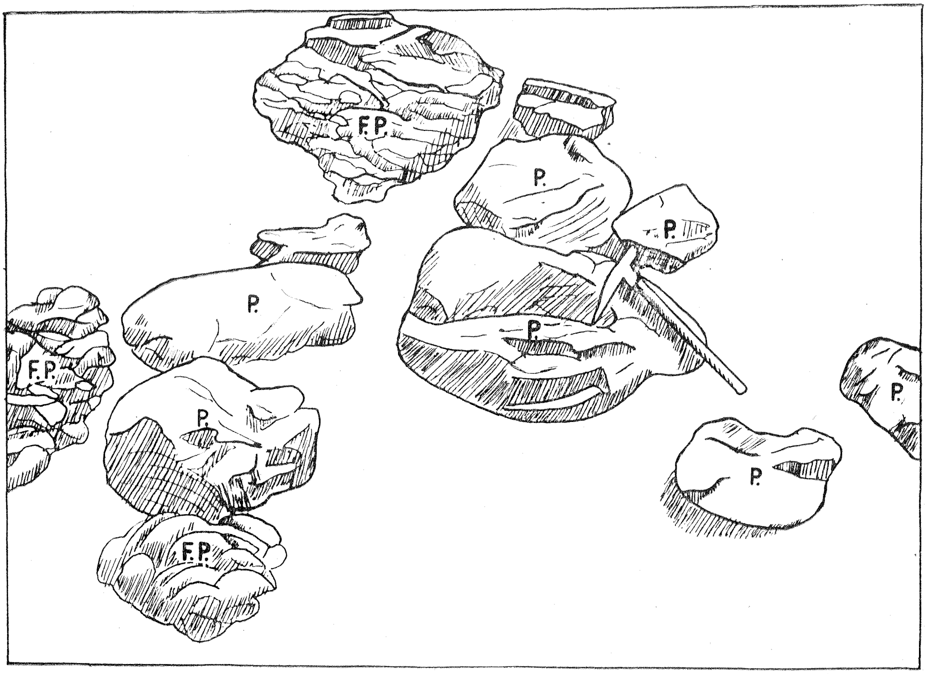
About 30 to 35 chains east of Park Point occurs a bed of volcanic breccia, fragments of which range from about ¼-inch to 1-inch in diameter with a few up to 3 inches. The fragments are generally angular and are composed of very fine grained greenish-grey volcanic rock, cemented together by dark chocolate-coloured shaley material. (see Plate I, Fig. I). It seems that showers of volcanic material fell on to the unconsolidated mud which probably oozed up between the fragments of lava. The description on pp. 70-71 (*loc. cit.*) of a thin section of the altered basic augite porphyrite which was assumed to occur in dykes and tongues on the eastern margin of the dolerite dyke could be applied to thin sections of the fragments of rock in the breccia, examined by us. It seems to be no more than a quickly cooled phase of the main rock type. The similarity between the main dolerite rock type and the basic augite porphyrite is also borne out by the chemical analyses given in the bulletin.

Closely associated with the breccia are volcanic bombs which fell on unconsolidated mud. These bombs are not nearly so numerous as the fragments of the breccia. They vary from about 2 inches to 12 inches in diameter, the most common size being about 4 inches. The exceptional number of vesicles which in places gives the rock an appearance of pumice, indicates quick cooling, and on examination of a thin section the state of incipient crystallization of the rock also confirms the condition of cooling. Needles of plagioclase appear to be embedded in a groundmass of devitrifying glass. Numerous microscopical vesicles filled with quartz and chlorite are also present. An illustration of a bomb appears on Plate I, Fig. 2. Some of the bombs have re-entrant and irregular shapes on cross sections exposed by weathering, but it appears that the bomb when it fell into the mud was still hot enough to be plastic under its own weight, with the result that bulging deformation or viscous protrusion occurred leading to concave and (in section) re-entrant profiles.

The association of the breccias and volcanic bombs with the slates was given an entirely different interpretation by Nye, Finucane and Blake on pp. 72-73; " the slate appeared to be undergoing digestion by the dolerite, the process resembling magmatic stoping on a minute scale ".

Overlying the fragmental rocks is a dense massive fine grained, greyish-green lava in the same relative stratigraphical position as the massive lavas of King Island. Petrographically the rock resembles those on King Island and their correlates elsewhere in Tasmania. Microscopic descriptions appear in the bulletin on pp. 65-66. One slide of a porphyritic rock appears to contain phenocrysts of olivine which have been completely pseudomorphed by chalcedony and bright green nickel bearing chlorite. None of the original mineral remains but the crystal outlines and the fact that the pyroxene in the slide is fresh indicate olivine. On p. 69 the presence of biotite is mentioned. " Chlorite and biotite occur as interstitial grains; the latter is not common ". In all the sections of rocks examined not a trace of biotite has been found but hydrogrossular, a brown coloured mineral in ordinary light, has been noted and when present is usually associated with chlorite as interstitial grains and in vesicles or replacing tiny crystals of olivine. It is possible that this mineral, a member of the hydrogarnet series, has been mistaken for biotite. The occurrence of hydrogarnet in the King Island lavas has been described recently by one of us (Scott, 1951). Whenever possible the plagioclase was studied carefully. It was on all occasions found to be albite and to show the characteristic clear appearance under high power. In some sections it showed alteration to chlorite and very rarely to epidote. In parts this massive lava is quite amygdaloidal or vesicular, this phenomenon being most noticeable in the rocks outcropping on Tier Hill and in the quarry along the Smithton-Trowutta Road. The vesicles may be oval or irregularly shaped and vary from microscopical dimensions to about ⅜-inch in diameter. The infillings are generally quartz, albite, calcite, chlorite and epidote. We can account for the augite recorded from the vesicles by the previous authors (p. 66) only by assuming that some of the epidote was indentified as augite.

The next rock type in the suite appears to be the pillow lava which is found along the eastern shore of Duck Bay. The pillows (see Plate I, Fig. 3, & Text-Fig. 1) range from 1 foot to 6 feet in diameter, and were immediately recognized because of their similarity to those on King Island, notwithstanding the fact that the Smithton pillows are more broken up by mechanical weathering. Between the pillows is to be found banded tuff, the misinterpretation of which may have contributed to the theory of an intrusive origin. Microscopically the rock type closely agrees with the description of the mugearites given on pp. 68-70 and it seems possible that the so-called tongues and dykes of mugearites have



TEXT-FIG. 1.—Diagrammatic sketch of pillows of lava depicted in Plate II, Fig. 3. P. = pillow. F.P. = pillow fractured by weathering.

been confused with the pillow lavas. The pillow lava consists of laths of plagioclase approximately 0·5 mm long with interstitial chlorite, magnetic and possibly ilmenite, and tiny needles of apatite. The plagioclase shows quite good albite twinning, has an extinction angle of 17° and a refractive index less than Canada balsam indicating albite with the composition $Ab_{95}An_5$. The chlorite is greenish-brown in colour and has probably been derived from the pyroxene, no fresh grains of which still remain. From the mineralogical and chemical composition this rock type would better fit the name of spilite, although the CaO and MgO contents are rather lower and the Al_2O_3 content rather higher than usual for spilites.

Several chemical analyses have been given in the bulletin and on the basis of these and the microscopical descriptions the rocks were divided into fine grained and porphyritic varieties of dolerite, mugearites, and augite porphyrites. However, with the experience of one of us (B.S.) in studying similar ancient volcanics elsewhere in Tasmania it seems that such a classification is unnecessary. Generally speaking there is not a great deal of variation in the rocks either mineralogically or chemically. The slight variation chemically may be accounted for by the slight difference mineralogically and by various stages of hydrothermal alteration, the vagrant constituents usually being Al_2O_3, CaO, MgO, and Na_2O.

To summarise, the evidence on which we base our belief that the igneous rocks are extrusive rather than intrusive is:

(i) Great abundance of vesicles and amygdules.
(ii) Presence of pillows, volcanic bombs, and breccia.

(iii) General homogeneous fine grain-size inconsistent with the great volume and thickness of basic rock regarded as an intrusion.

(iv) The similarity in broad characters and in details to known basic lavas occurring in the same stratigraphic group, with a distribution which straddles the Smithton occurrences.

That small dykes associated with the volcanic rocks exist is not denied. The rock material in them is essentially the same as the volcanic type. Such cognate dykes are a common feature of the King Island volcanic suite.

Re-Determination of So-Called Native Copper

Scattered rather abundantly through the basic volcanic rocks are specks and flakes of a copper coloured mineral referred to in the bulletin as native copper. A similar looking mineral has been found in much less abundance in the King Island basic volcanic rocks associated with a dark green chlorite (the nickel-bearing variety garnierite). This was thought to be nicolite which megascopically resembles native copper (Scott, 1951). The so-called native copper of the Smithton rocks is also associated with nickel bearing chlorite. However, chemical and magnetic tests by one of our students (R. J. Ford) have now established that the mineral is pyrrhotite, probably containing some nickel. No chemical reaction for copper even in small quantity could be obtained. It is probable that the King Island mineral is actually nickel bearing pyrrhotite also. It is of interest to record that we have observed the same nickel bearing chlorite associated with the basic lavas at Heathcote, Victoria, which are recognised as correlates of the Dundas Group, to which the Smithton lavas are also referred.

Possible Occurrence of Tillite

The previous authors have described a silicified breccia which outcrops as a small rocky headland about 10 chains west of the mouth of Deep Creek. Stratigraphically it is at or near the base of the Dundas Group. In its general appearance it closely resembles some phases of the tillite at King Island and at Zeehan. However pebbles and matrix are completely silicified and there is no possibility of extracting striated pebbles to confirm the glacial origin. Its position with respect to the basic lavas is analogous to the position of the tillite at King Island and at Zeehan. Complete metasomatic replacement is a common phenomenon in the tillite elsewhere. At King Island some outcrops are dolomitised, both the pebbles and the matrix being wholly replaced by dolomite. Elsewhere the replacement is by haematite. We suggest that this Smithton breccia may be tentatively correlated with the tillite though it should be emphasized that a glacial origin cannot be established on the evidence available in the Smithton district alone.

Re-Determination of Silicified Conglomerate as Silicified Oolite

On page 31 of the bulletin the previous authors described a silicified conglomerate in their " Chert Sub-stage " in the following terms: " In the Irishtown road gravel pits, about a mile south of Smoker's Bank road, a fine-grained silicified conglomerate is interbedded with dense black cherts and grey and purplish-grey slates. The rock is composed of rounded, with some angular, quartzose pebbles, set in a siliceous matrix. The pebbles are black or white in colour, and remarkably uniform in size; their diameter is one-eighth to three-sixteenths of an inch. The rock sometimes has the appearance of a silicified grit, but, as the bulk of the pebbles are rounded, it corresponds more to a fine grained conglomerate. Grey and purplish-grey slates are interbedded with the above members ".

We had no difficulty in identifying the locality and found the rocks answering closely to the description of the so-called silicified conglomerate. However we find the rocks to be not a silicified conglomerate but a silicified oolite (See Plate I, Fig. 4). Microscopically the silicified oolite indicates complete replacement of the original carbonate by quartz. Definition of the individual oolites is less distinct than in hand specimen where colour plays an important role. Both the oolites and the material between them consist of finely granular quartz. The quartz grains in the oolites are a little larger and in some cases towards the centre may grade to 0·5 mm. Macroscopically, the rock is sometimes deeply pitted, presumably owing to removal in solution of unsilicified carbonates.

Relation of " Chert Sub-Stage " to Dolomite " Sub-Stage "

The previous authors suggested (p. 30) that their Dolomite Sub-stage is intimately associated with the Chert Sub-stage, and that it underlies or forms the base of the Chert Sub-stage. We go somewhat further and suggest that the " Chert Sub-stage " of the previous authors has no separate existence as an independent formation but is merely the result of widespread silicification of part of the Smithton dolomite and also in places of the lower part of the overlying Dundas Group. Most of the cherts have the texture and characteristic jointing of the dolomite. Shallow solution depressions occur within areas mapped as Chert Sub-stage indicating the removal by solution of residual unsilicified dolomite (e.g., near where Fahey's Lane crosses the Smithton-Irishtown Railway). Complementarily, the previous authors write (p. 28) concerning their " Dolomite Sub-stage " that in many cases the rock is partly or wholly silicified, the complete silicification producing a chert. At Nabageena irregular areas are replaced by chert while the dolomite also appears to be interbedded with cherts, which may also represent complete replacements of dolomite beds. The silicified oolite described above, which is part of the Chert Sub-stage was derived presumably from oolitic dolomite. If the Chert Sub-stage (excluding fringes regarded as belonging to the Dundas Group) and the Dolomite Sub-stage are combined as a single formation, the former being regarded as a silicified form of the latter, the combined outcrop makes a reasonable structural picture. (See Plate I.)

Revised Stratigraphic Sequence in the Smithton District

The stratigraphic sequence as given by the previous authors is as follows:—

		Approx. thickness in ft.
(vi)	Upper Slate and Breccia Stage	
(v)	Dolomite Stage	3000-9000
(iv)	Slate Breccia and Limestone Stage	4000
(iii) b	Chert Sub-Stage	2000

	Approx. thickness in ft.
(iii) a Dolomite Sub-Stage	1000
(ii) Grey-Green Quartzite Stage	3000
(i) White Quartzite Stage	1500

Of these formations we suggest that the White Quartzite Stage is a more silicified variant of the Grey-Green Quartzite Stage. As pointed out above we consider that the Chert Sub-stage (iii) b is a silicified variant of (iii) a, the Dolomite Sub-stage. We also consider that there is a large strike fault separating Stages (iv) and (v) causing a repetition of the sequence so that the Dolomite Stage (v) is a repetition of the lower Dolomite (iii) a and (iii) b, and the Upper Slate and Breccia Stage (vi) is a repetition of the Lower Slate Breccia Stage (iv).

The revised stratigraphic sequence of the Smithton district thus becomes;

			Stages of Nye, *et al.*	Approx. thickness
Cambrian	DUNDAS GROUP	Slates, Breccias basic lavas and tuffs	(iv), (vi).	5000
Lower Cambrian or *Late Pre-Cambrian*	CARBINE GROUP	Smithton Dolomite	(iii) a, (iii) b, (v).	3000
		Bryant Hill Quartzite	(i), (ii).	3000

The previous authors have described two occurrences probably of the same bed of blue limestone which occurs within a few hundred feet of the highest exposure of the Dundas Group in the area. This limestone contains structures determined by Chapman as crinoid osicles, and traces of other organic remains so far unidentifiable. The stratigraphic position of this limestone is uncertain. No limestones have been recorded from the Dundas Group in Tasmania although the correlates of the Dundas Group in South Australia do contain limestone. However the facies of the Dundas Group in the Smithton district as elsewhere in Tasmania is typically eugeosynclinal whereas the facies of the correlates in South Australia are miogeosynclinal. On palaeogeographic grounds therefore, the limestone is somewhat alien in the Dundas Group. However, the overlying Junee Group in Western Tasmania normally contains limestone which often overlaps the basal conglomerates and rests on the Dundas Group. Perhaps the most likely interpretation therefore is that this crinoidal limestone should be correlated with the Junee Group of Ordovician Age. For the present however neither hypothesis can be substantiated or excluded.

Relation of Basic Volcanic Rocks and Tillite of Western Tasmania to Dundas Group

In the Zeehan, Smithton, and King Island areas we have an old series of basic amygdaloidal lavas which have many petrological features in common. The King Island occurrence is approximately 80 miles northwest of Smithton which in turn is 70 miles north of Zeehan. In between, petrologically similar rocks occur at Magnet. The King Island and Zeehan occurrences are underlain by tillites containing striated pebbles. At Smithton the lavas are underlain by a silicified breccia lithologically similar to phases of the King Island Tillite. At King Island the glacial beds and volcanic rocks are partly interbedded. At Zeehan the slates and tuffs immediately and conformably overlying the volcanic rocks contain Middle Cambrian trilobites indentical with those occurring in the type area of the Dundas Group, eight miles to the east. In the type Dundas sequence there is a suite of lavas and tuffs petrologically similar to those at King Island and the other localities. These are interstratified with Middle Cambrian fossils. Also interstratified with fossilferous Middle Cambrian beds in the type Dundas section are conglomerates and breccias which one of us (S.W.C.) and independently Elliston (who worked out the type section) consider to resemble tillites, but no unquestionable striated pebbles have yet been extracted from them. However there are some striated pebbles preserved in the Museum of the Geology Department in the Adelaide University, which were collected by Waller from near Montezeuma Falls, Dundas, and along the north-east Dundas tramline, and forwarded by Waller to Howchin for confirmation of their glacial origin. Although the recorded localities are not precise enough to pinpoint which of the conglomerates yielded the striated pebbles, Elliston's mapping has revealed that all the rocks outcropping in the area where these striated pebbles were collected belong to the Middle Cambrian Dundas Group.

Integrating all the above evidence it is difficult to escape the conclusion that the glacial beds as well as the basic lavas belong to the Dundas Group and are of Cambrian Age.

This raises again questions about the age of the glaciation in the Adelaide Group of South Australia which has latterly been regarded as late Pre-Cambrian. It is of interest to note that near Broken Hill the Torrowangie Group, which contains a basal tillite, has breccias and greywackes strikingly reminiscent of the Dundas Group; also that basic lavas petrologically similar to the Dundas Lavas have recently been reported in the Torrowangie Group which recalls an earlier record of basic lavas by E. J. Kenny. A close search of this sequence for Cambrian dendroids and trilobites seems warranted.

References

NYE, P. B., FINUCANE, K. J., BLAKE, F., 1934.—The Geology of the Smithton District, Bull. 41. *Geol. Surv. Tas.*

SCOTT, BERYL, 1951.—The Petrology of the Volcanic Rocks of South-East King Island, Tasmania. *Pap. & Proc. Roy. Soc. Tas.*, 1951, pp. 113-136.

Locality Index

	Latitude S.	*Longitude E.*
Broken Hill	32° 0′	141° 30′
Coward's Road	40° 51′	145° 8′
Deep Creek	40° 49′	145° 10′
Duck Bay	40° 50′	145° 4′
Dundas	41° 53′	145° 28′
Fahey's Lane	40° 54′	145° 11′
Groom's Road	40° 54′	145° 8′
King Island	39° 35′	143° 50′
Irishtown	40° 54′	145° 9′
Magnet	41° 28′	145° 26′
Montezeuma Falls	41° 50′	145° 27′
Nabageena	40° 59′	145° 8′
Park Point	40° 49′	145° 8′
Queenstown	42° 5′	145° 33′
Smithton	40° 52′	145° 7′
Tier Hill	40° 52′	145° 8′
Torrowangie	31° 28′	141° 29′
Trowutta	41° 0′	145° 4′
Zeehan	41° 53′	145° 20′

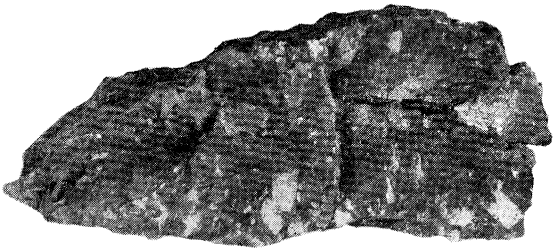


FIG. 1 x 0·4

FIG. 2 x 0·35

FIG. 3

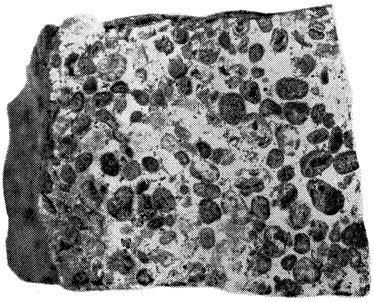


FIG. 4 x 0·75

EXPLANATION OF PLATES

Plate I.

Figure 1: Volcanic breccia, the lava fragments of which are depicted by the lighter colour and the chocolate shale by the darker colour.

Figure 2: Volcanic bomb showing its shape and vesicular nature. Note its sharp boundary with the shale.

Figure 3: Pillows of lava. See text figure 1, for explanation.

Figure 4: Silicified oolite showing the oval shaped oolites which vary in colour. The light coloured material between them is composed of very fine granular quartz.

Plate II.

Geological Map of the Smithton District of Tasmania.