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PYROCLASTICS IN THE UPPER PARMEENER SUPER-GROUP, NEAR BICHENO, EASTERN TASMANIA

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(with two tables, three text figures and one plate)

ABSTRACT

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Extensively altered, poorly welded ash-fall tuffs of rhyolitic to rhyodacitic composition occur both *in situ* within the Upper Parmeener Super-Group and as loose talus, at five localities up to twelve kilometres apart in the vicinity of Bicheno in eastern Tasmania. Three closely spaced tuff layers up to 0.7 m thick have been intersected in a drill hole. These and the four outcrops may represent the same stratigraphic interval. The rocks contain phenocrysts of embayed quartz, kaolinized feldspar and altered vermiculite in a devitrified matrix of quartz and kaolinite, in which may be discerned relict glass shard and bubble structures. In some localities, the vermiculite has been thermally exfoliated, suggesting heating to more than 300°C during the intrusion of nearby Jurassic dolerite. Rhyolite, probably derived from unlocated Triassic flows, occurs as clasts within Triassic conglomerate float and as pebbles within Quaternary river gravels.

INTRODUCTION

Triassic volcanism in Tasmania, contemporaneous with the deposition of the Upper Parmeener Super-Group, has long been suspected. Lewis and Voisey (1938) described beds of tuffaceous rock bearing fragments of altered volcanic rock, within coal-bearing Late Triassic feldspathic sandstones at New Town, near Hobart. Hale, in Spry and Banks (1962), described volcanic fragments as "ubiquitous" in the litharenites of the Tasmanian Triassic, and commented that igneous activity appeared to have been increasing during the period. Spry (*ibid.*) noted that no Triassic lavas had been found, but the only other possible source was limited outcrops, over one hundred kilometres away, of fine-grained Cambrian volcanics which would be unlikely to survive travel in water for that distance.

This paper describes acid pyroclastic rocks occurring as outcrop and in drill core within the Triassic sequence and as loose talus, at five localities near Bicheno, Tasmania (table 1 and fig. 1). Reworked fragments of rhyolite occur in the district as clasts within Triassic conglomerate float and in Quaternary river alluvium. All samples were collected by the senior author in 1979 during an Honours project, except for sample 47851 which was collected by Mr P. Sansom of the Shell Company.

LOCAL GEOLOGY

Adamellite of Late Devonian age crops out near Bicheno, in the eastern part of the area. Drill hole data indicates that the adamellite directly underlies sediments belonging to the Upper Parmeener Super-Group (Forsyth *et al.* 1974), on Buster Ridge, southwest of Bicheno (Bacon 1979). North of Bicheno, in Department of Mines, D.D.H. Bicheno 5 (FP040677) Siluro-Devonian Mathinna Beds form the basement.

Marine limestones belonging to the Lower Parmeener Super-Group (Forsyth *et al.* 1974) disconformably overlie the basement north of Bicheno. The limestone does not crop out, but has been intersected in D.O.M. D.D.H. Bicheno 5 (FP040677) and Bicheno 4 (EP994636). Overlying and interbedded with the limestone are well sorted super-mature quartz arenites.

Overlying the marine sediments is a fluvial sequence belonging to the Upper Parmeener Super-Group (Forsyth *et al.* 1974), consisting of minor quartz arenites (different from those associated with the marine sediments), overlain by quartz-rich litharenites which in turn are overlain by "quartz-poor" litharenites interbedded with shale, mudstone, siltstone, conglomerate, coal and rare tuff.

Jurassic dolerite has intruded the fluvial sequence. Large flat lying areas surrounding the Apsley River are covered with a thick layer of Quaternary alluvium.

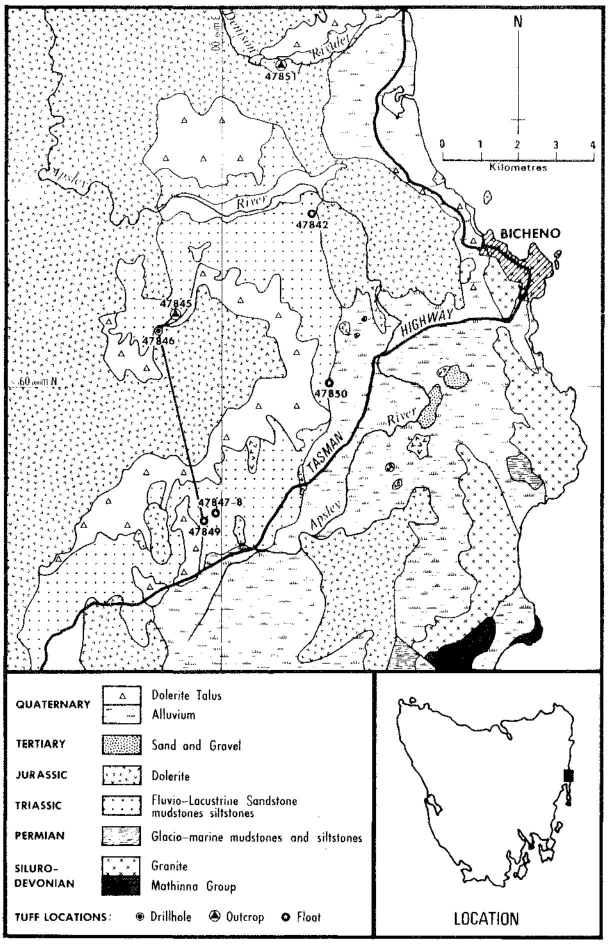

FIG.1.- Locality map.

FLORA AND AGE

Forsyth (1980) described the following palynomorphs from a sample of siltstone from the bed of the Denison Rivulet, less than 50 m stratigraphically below sample 47851: *Alisporites australis* De Jersey 1962; *Anapiculatisporites pristidentatus* Resier and Williams, 1969; *Annulispora folliculosa* (Rogalska) De Jersey 1959; *Apiculatisporis globulus* (Leschick) Playford and Dettman 1964; *Aratrisporites* sp. *cf. A. coryliseminus* Klaus (poor preservation prevents positive identification); *Dictyophyllidites mortoni* (De Jersey) Playford and Dettman 1965; *Neoraistrickia* sp.; *Stereisporites antiquasporites* (Wilson and Webster) Dettman 1963; *Stereisporites* sp. A. De Jersey 1970; *Uvaesporites verrucosus* (De Jersey) Helby *nov.* De Jersey 1971; A very poorly preserved specimen could be *Semiretisporis denmeadi* (De Jersey) De Jersey 1970.

Forsyth (1980) assigned the microflora to the *Craterisporites rotundus* Zone, suggesting correlation with the Ipswich Coal Measures and therefore a probable Carnian age (De Jersey 1971, 1975).

Fragments of *Dicroidium odontopteroides* var. *odontopteroides* occur in one outcrop of pyroclastic rock (47851), indicating an age range of Late Anisian to Norian (Retallack 1977) for the rock.

The age of the pyroclastic rocks is, then, Late Triassic; probably Carnian and possibly Norian.

PETROGRAPHY

Welded tuff

At all five localities the welded tuffs are lithologically similar, with only minor variations in grain size, mineral abundance, degree of alteration and development of lamination. They are hard off-white to buff-coloured rocks consisting of abundant (5-15%), fine grained (<1 mm) phenoclasts of vermiculite, kaolinized feldspar, quartz and accessory haematite, zircon and (?) ilmenite in a cryptocrystalline matrix of devitrified glass (85-95%). The rocks typically display a well developed, wavy to streaky, horizontal lamination defined by variations in the colour, composition and grain size of the matrix and the abundance and, to a lesser extent, the alignment of phenoclasts.

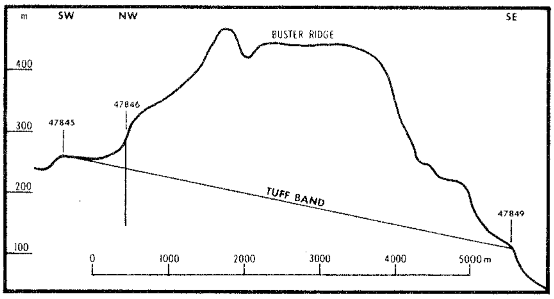

FIG.2.- Section through Buster Ridge showing relationship of tuff occurrences.

The largest phenoclasts (<1 mm, commonly about 0.3 mm) are deep orange-brown vermiculites, probably formed by the alteration of biotite. Pleochroism is absent or very weak, birefringence is probably moderate although anomalous green-blue predominates, and extinction is parallel to the cleavage. The mineral is optically negative and uniaxial or nearly so. The shape of the phenoclasts ranges from euhedral or subhedral pseudohexagonal basal sections, to distorted rectangular laths and ragged anhedra. Many are rounded or embayed, suggesting corrosion within the magma before extrusion. Except in sample 47846, many are distorted, with curved or radiating cleavage and wavy or fanning extinction. Parting along the cleavage is common. In places the texture of the surrounding matrix is disrupted. These features are attributed to thermal exfoliation of the vermiculite, caused by intrusion of Jurassic dolerite, which in the case of 47845 crops out 5 to 10 m stratigraphically above on the hillside. According to Deer *et al.* (1962, p.251) heating to more than about 300°C is required.

The vermiculites themselves are often partly or completely altered to colourless to pale yellow, low birefringence clay minerals. Partial analysis by electron microprobe of altered vermiculites from 47845 showed compositions either close to kaolinite or to a highly aluminous three-layered, dioctahedral phyllosilicate such as pyrophyllite or the smectite, beidellite.

Four stages are envisaged in the alteration of the original biotite:

(a) Alteration of biotite to vermiculite, probably soon after deposition, by hydrothermal action with the volcanic ash at temperatures of less than 250° to 300°C (*cf.* Roy and Romo 1957).
(b) Thermal exfoliation of vermiculite to over 300°C during the intrusion of Jurassic dolerite.
(c) Low temperature leaching of Mg, and addition of Al from the matrix, to form beidellite, probably with montmorillonite forming as an intermediate stage. Both minerals are well known as alteration products of tuff and volcanic ash, particularly under alkaline conditions (*ibid.* pp.240-241).
(d) Further leaching and weathering of beidellite, to form kaolinite (*ibid.* p.241).

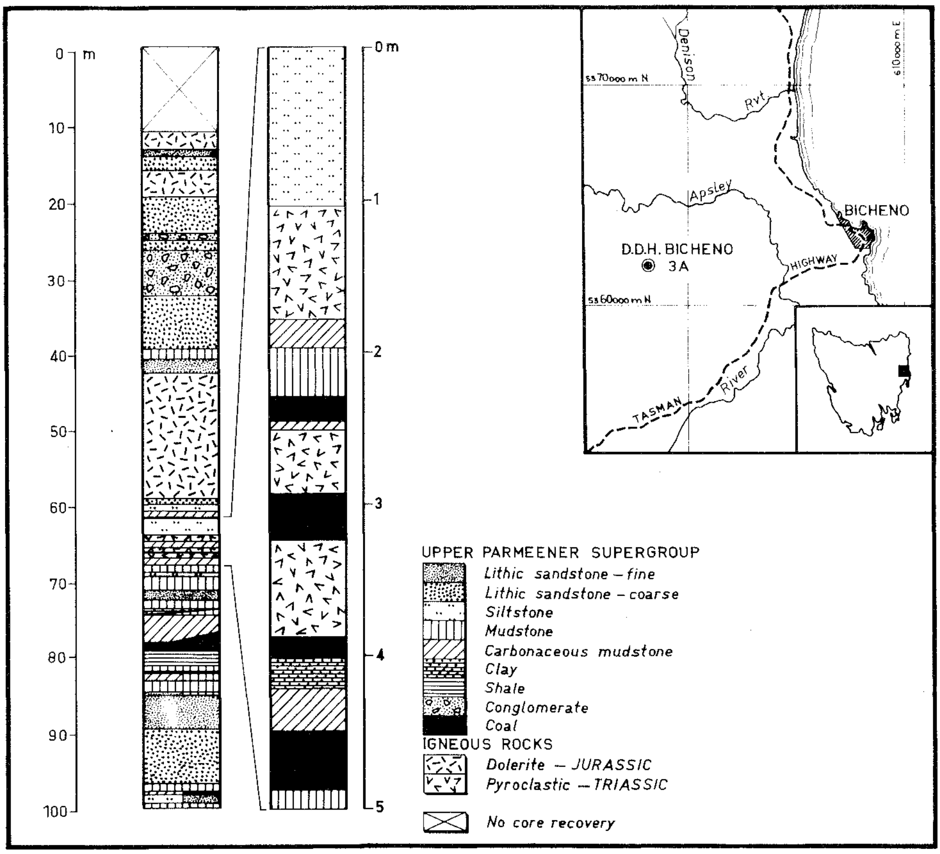

FIG.3.- Graphic log of Department of Mines, Bicheno, Diamond Drill Hole 3A.

The most abundant phenoclasts are altered feldspars occurring as oriented laths (typically 0.2 mm x 0.4 mm), oblong squat euhedra and subhedra, and numerous smaller (0.1 - 0.2 mm) anhedra. Often they are embayed suggesting resorption into the magma. All phenoclasts are completely altered to a very fine (0.002 - 0.010 mm) low birefringence aggregate, probably consisting largely of kaolinite and quartz.

Quartz occurs as scattered, small (0.1 - 0.3 mm), sometimes embayed, equidimensional, angular subhedra and anhedra, sometimes with wavy extinction. Accessories include small quantities of anhedral to subhedral, almost opaque to very deep red haematite grains (0.05 - 0.10 mm) and traces of minute zircons and (?) ilmenite.

The matrix is a colourless to pale grey cryptocrystalline devitrified glass, probably largely consisting of silica and clay minerals (e.g. kaolinite and/or smectite). Within it may be discerned sometimes flattened, crescentic to rarely circular structures a few tenths of a millimetre long, sometimes apparently fused together. These represent broken, deformed shards and unburst bubbles of devitrified volcanic glass. They tend to be oriented parallel to the lamination (plate 1).

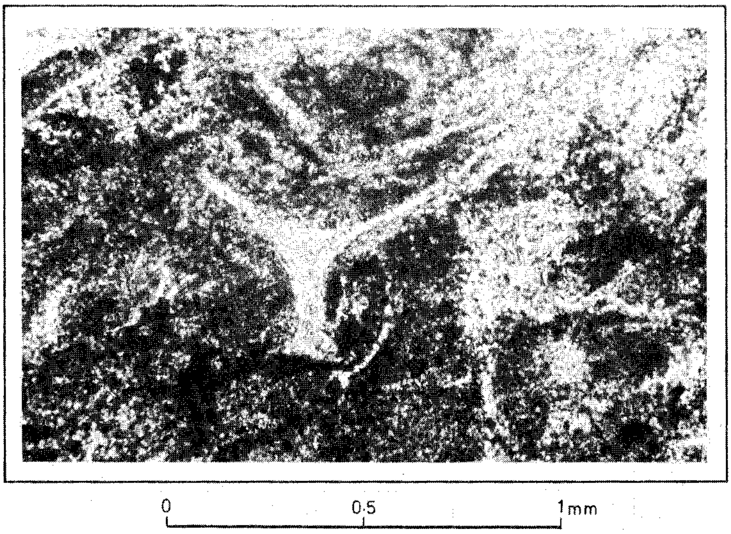

PLATE 1.- A well-developed glass shard in ignimbrite, nicols crossed. University of Tasmania Catalogue No. 47845. Photo: D. Seymour.

The relict, slightly deformed vitroclastic texture suggests that the rock is a poorly welded, ash-fall tuff, formed by aerial deposition of ash following explosive volcanic activity. Weak compaction resulted in some welding of the glass shards while they were still hot, accentuating the depositional lamination.

There is apparently no consistent lateral variation in the grain size of the pyroclastic rocks. Specimens 47846 and 47847 have the fewest (5%) and the smallest (≤0.3 mm) phenoclasts, whilst 47848 and 47849 have the most (15%) and the largest (≤1 mm). However, vertical variation in grain size is rapid and, although not observed on an outcrop scale, can be seen in thin section. The sorting is attributed to aeolian differentiation of ash. Together with the existence of three discrete layers of tuff, at least in D.O.M. Bicheno D.D.H. 3A, the rapid vertical variations in grain size suggest intermittent emission of ash, perhaps from several widely spaced vents.

TABLE 1

LOCALITY OF SPECIMENS

Sample No.*	AMG Reference	Lithology	Other Comments
47845	EP989619	Pyroclastic	Outcrop
47846	EP981618	Pyroclastic	Drill core
47847	EP997567	Pyroclastic	Talus
47848	EP997567	Pyroclastic	Talus
47849	EP995566	Pyroclastic	Talus
47851	FP014686	Pyroclastic	Outcrop
47852	FP025646	Rhyolite	Pebble - in Quaternary river alluvium
47850	FP028601	Conglomerate	Float - with rhyolitic clasts

* University of Tasmania Catalogue

RHYOLITE

Rhyolite pebbles occur within unconsolidated Quaternary river alluvium in the valley of the Apsley River. Specimen 47842, a portion of a water-worn elongate pebble, is a fine-grained, pale yellow-grey to beige-coloured rock. It consists of partly-saussuritized and often embayed euhedral to subhedral laths and squat phenocrysts (2.0 - 0.5 mm) of sanidine (5%) enveloped in a matrix of abundant, very fine-grained (rarely 0.1 mm, ranging to a few thousandths of a mm) quartz grains and straw-yellow crypto-crystalline devitrified glass. The quartz grains are well-rounded and subspherical to ellipsoid with their long axes aligned, to form a very well developed and macroscopically visible flow lamination, which parts to curve and wrap around each sanidine phenocryst. Fibrous ghost structures suggestive of completely altered biotite and a fine (<0.01 mm) sprinkling of inconspicous (?) ilmenite occur throughout the matrix.

Angular blocks of conglomerate (47850) found in paddocks are most probably derived from a conglomerate band in the Triassic fluvial sequence now covered by talus. However, a Triassic age for the conglomerate has not yet been proved. The conglomerate is composed of large (up to 0.1 m in diameter) well-rounded, equant to elongate, lithic clasts in a medium-grained litharenite matrix. The clasts are of black siltstone, white and pink quartzite with rare inclusions of garnet, rhyolite, and two varieties of welded tuff. All the volcanic clasts are strongly weathered.

CHEMICAL ANALYSES

Three analyses of welded tuffs and a partial analysis (by broad area electron micro-probe scans) of rhyolite are given below:

TABLE 2

CHEMICAL ANALYSES OF THE PYROCLASTICS

Sample No.*	47851	47845	47847	47852
Reg. No.**	800285	800286	800287	-
SiO_2	70.60	78.60	77.10	78.33
TiO_2	0.35	0.19	0.67	0.23
Al_2O_3	14.30	12.00	13.00	11.11
Fe_2O_3	0.83	0.91	0.5	1.73†
FeO	1.40	0.29	0.71	
MnO	0.06	<0.01	<0.01	<0.20
MgO	0.45	0.20	0.15	0.20
CaO	1.40	0.08	0.11	0.64
Na_2O	0.40	0.05	0.05	1.68
K_2O	2.50	1.30	3.60	6.36
CO_2	0.70	-	-	n.d.
H_2O^+	4.40	4.00	3.90	n.d.
H_2O^-	1.90	1.80	0.66	n.d.
Total	99.27	99.42	100.00	n.d.

* University of Tasmania Catalogue. n.d. not determined.
† total iron reported as FeO.
** Department of Mines, Launceston.
\- not detected

The welded tuffs are rhyodacitic (47851) to rhyolitic (47845, 47847) in composition. The High H_2O^+ values result from alteration of the feldspars, the glassy matrix and, later, the vermiculites to clay minerals. This process has also led to the depletion of the rocks in Na_2O and CaO, whilst K_2O appears to be better retained, possibly in the more resistant vermiculite.

The amount of H_2O^+ is sufficient to account for almost all of the Al_2O_3 as kaolinite, suggesting that the devitrified matrix (85-95%) of each rock is largely kaolinite and quartz.

Allowing for differences in the method of analysis and in the degree of alteration, especially the better retention of alkalis in the sanidine phenocrysts, the rhyolite appears to be close in composition to the welded tuffs.

CONCLUSION

It is probable on both stratigraphic and petrologic evidence that the five localities at which welded tuffs occur represent the same horizon. Minor lateral or vertical variations in grain size and mineralogy are attributed to aeolian sorting of ash, perhaps emitted intermittently from a number of vents. The lateral limits of the horizon, which may be stratigraphically useful, are unknown.

Reworked rhyolite pebbles in Quaternary alluvium and in conglomerate float in the district are thought to be derived from associated Late Triassic flows which have not yet been found *in situ*.

Recently reported alkali olivine basalts near St Marys (Calver and Castleden 1980) are significantly older (Middle Triassic), and their petrogenetic relation, if any, to these rocks is unknown.

ACKNOWLEDGEMENTS

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