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A Record of Volcanic Activity in Tasmania During Triassic Times

By

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Plate IV

Part I.—Field Occurrence

By

A. N. LEWIS

There has been no previous record of volcanic activity in Tasmania during the period occupied by the deposition of the coal-bearing rocks of Permian-Triassic age. Certain layers of flinty rock interbedded in the New Town coal measures used to be considered to be metamorphic products from contact with the intrusive dolerite. Whilst working on the occurrences of the dolerite in this area, I formed the opinion that these hard layers could not possibly be related to the dolerite intrusions, and they appeared to have been directly deposited in the sequence now visible. I took advantage of the presence in Hobart in March, 1937, of Mr. Alan H. Voisey, of the Sydney University, who has had considerable experience amongst the tuffs of New South Wales, to examine the layers in question. Mr. Voisey confirmed my suspicions of the existence of tuffs in the New Town coal measures, after a few minutes' inspection. He has been good enough to make a detailed petrological examination of specimens I selected as representative types. The result is a contribution to Tasmanian geology of outstanding significance, and workers in this State must be grateful for Mr. Voisey's interest and labours.

Locality of the Occurrence

The rocks which are the subject of this paper, and which will be referred to collectively as the *New Town Tuffs*, were found in the quarry now worked by the Hobart Brick Company, No. 110 Giblin-street, New Town, directly opposite the north-western terminus of Pedder-street. (Lewis and Murray's Map of Hobart, 1 inch = 1m — 052743.) This is near the *Adit* and *Brook's Engine Shaft* marked on Krause's Chart (Krause, 1884), and, as far as I can identify from the vague descriptions now extant, part of the workings of the Enterprise Coal Mining Company.

This quarry-face has now been cut back some 75 yards from the drainage creek which runs just north-west of Giblin-street and about 125 yards from the street. As the quarry is continually extending it is difficult to give a more exact datum. The tuffs are exposed from the floor of the quarry upwards for some 30 feet. The strata dip at about 10 degrees to the south-west, and thus the tuffs hitherto identified disappear beneath the overlying coal measures and sandstones within the short distance occupied by the quarry. No exposures exist further north or north-west where, a short distance away, a mass of dolerite abuts on the sedimentary series.

I have carefully examined the very meagre exposures in road-cuttings through the New Town basin and the better sections along the face of Knocklofty without tracing any further occurrences of tuff, and several specimens of doubtful appearance from these areas, and also from the sandstones between the 1450 and 2500 feet contour round Mt. Wellington, were all pronounced by Mr. Voisey to be of purely sedimentary origin. However, I have located another tuff of distinctive and almost scoriaceous appearance interbedded in the fresh-water shales of Spring Hill. This layer is about 24 inches in thickness, and is to be seen in the large sidling one-quarter of a mile north of Timsbury House. No other occurrence of tuff was discernible in the sections between Melton and the top of Spring Hill.

Geological Horizon of the Tuffs

The rocks in question occur in the New Town coal basin, a typical member of the upper coal measures of Tasmania. The beds of tuff are in intimate association with shales replete with a rich equisetaceous flora. Splendid specimens of *Neocalamites* cf. *carrerei* Zeiller; *Phyllotheca australis* Brongniart; *Schezoneura* sp.; and many unidentified pith casts are to be found within inches above and below the tuffs. *Johnstonia coreacea* Johnston is very common in the section exposed by the quarry, with *Cladophlebis australis* Morris less common, and rich *Thinnfeldia odontopteris* Morris beds in the higher levels some 20 feet above the topmost identified layer of tuff. The rich cycad flora of Lord's Hill, a half-mile further south, is not to be seen at Giblin-street, and appears to be a slightly higher horizon. From this evidence the beds may be located near the top of the Rhaetic (Upper Triassic) (Walkom, 1926). They are not at the top of the coal measures, which may possibly just extend into the Jurassic System, and therefore Upper Triassic appears to be a reasonably safe determination.

The location of these rocks within the Tasmanian coal measures is more difficult, and, until I have completed my work on the Geology of Hobart, I am not quite prepared to say more than that the tuffs appear to be rather low in the coal-bearing series as developed in this area. The Geological Survey, in the *Coal Resources of Tasmania*, appear to have assumed that during the period of deposition Tasmania was one geographical unit, to the extent that each coal-seam was deposited over the whole country at the same time, and that seams in different places can be correlated by palaeontological groupings. Without stressing the point here, my observations lead me rather to the view that many separate coal basins were in existence, and it is impossible to arrive at a correlation, seam or stratum for seam and stratum, from one basin to another; also, that the plant life responsible was governed by environmental factors, so it is dangerous to rely on any particular grouping within the series as a basis of correlation; further, that the rocks which have been termed the *Felspathic Sandstones*, with the included coal measures, were deposited in a relatively brief space of time, during which there was no marked floral change sufficient to give a definite zoning key within the series. Fossil groupings are certainly very useful for correlating or differentiating several seams within one basin, but cannot be used in the same way between different basins.

I cannot accept, therefore, the Geological Survey's correlation of these coal measures as final, and previously published sections appear to me to be open to doubt, owing to the failure to have due regard for the many faults which occur in the area. At present, I am inclined to the view that the Knocklofty sandstones overlie the coal measures, but there is certainly a fault of some magnitude between the two beds. As far as my investigations carry me, I consider that the New Town coal-seams lie high in the felspathic series, and that the tuffs are within 200 feet of the top of the coal measures as developed in this area. This view, however, is not finally proved.

Previous Accounts of the New Town Coal Fields

Considering its accessibility and interest this area has received scant attention from geologists. In 1883 Mr. G. Thureau made a very brief report, which contains no information of present interest. In 1884 Mr. F. M. Krausè advised against drilling for coal. His report contains a map, which is virtually the only published account of the geology of New Town. He also added a detailed section. This, however, is hypothetical, in that it is based on a measurement of surface features. As Krausè failed to recognize the great Knocklofty Fault, with its throw in the neighbourhood of 2000 feet, and which separates the Permian mudstones from the Triassic coal measures, his section is worthless except as to the coal measures themselves. R. M. Johnston virtually copied Krausè's report into his *Geology of Tasmania*, and the Geological Survey did the same in 1922. (The geological map referred to on page 171 of *Coal Resources of Tasmania* does not appear to have been published.) R. M. Johnston did wonderful work in collecting and describing the fossil flora of the locality but contributed little towards a knowledge of its structural geology. (See, e.g., Johnston, 1886.)

Field Occurrences of the New Town Tuffs

The rocks described in this paper have only been identified from the Hobart Brick Company's quarry and within a vertical range of about 30 feet by a horizontal distance of 50 yards. The identification should therefore not be generalized as typical of the series.

Three types easily distinguishable to the naked eye were found, these being described respectively as—

No. 1.—Greenish tuff. A soft greenish-brown rock, speckled with dark-green to black spots. No harder than the surrounding shale and only distinguishable in the field by its colour.

No. 2.—Yellow tuff. A very hard rock, somewhat resembling a quartzite in hand specimens, and clearly distinguishable by its hardness, which necessitates it being hand-picked from the quarried material before crushing for brick-making. Its colour is predominantly a dull buff.

No. 3.—Grey tuff. A bluish-grey rock, usually harder than the surrounding shale, but softer than No. 2. It is frequently impregnated with carbonaceous matter, which is sometimes well preserved as fossils.

All the above types occur in repeating layers. They are exactly interbedded with the fossiliferous shales of the coal measures. The average thickness is six inches, but twenty-four inches is attained in at least one layer. In many cases they merge sometimes at the top, sometimes at the bottom, sometimes on both sides, of the tuffaceous layer into normal freshwater shales. Sometimes the separation from shale to tuff is very clearly marked. The tuffs form one bed with the shales, and the difference is not easy to identify at the distance of a few yards. It is quite clear that both rocks followed each other in a normal sequence of deposition. In at least one layer of grey tuff (No. 3) the volcanic material overwhelmed growing plants.

W. H. Twelvetrees noted a peculiar rock in the coal-bearing strata at South Cape Bay. The present writer has examined these occurrences, and expresses the view that they are probably water-worn blocks of tuff or volcanic bombs of tuffaceous material. (Twelvetrees, 1915.)

Part II.—Petrological Descriptions

By

A. H. VOISEY

An examination of three rocks submitted to me by Dr. A. N. Lewis from the New Town coal field has yielded the following results:—

No. 1.—Grey Crystal Tuff

(Greenish in weathered hand specimens)

The rock is a light greenish-grey colour, marked by numerous black spots each a millimetre or two in diameter. The fracture is irregular, and the surface is easily scratched with a knife. The presence of a large quantity of calcite is demonstrated by the violent effervescence when hydrochloric acid is applied.

When examined under the microscope the rock is seen to consist of angular grains of minerals and fragments of igneous rock, all being set in a matrix of calcium carbonate in the form of calcite. Decomposition has affected all of the minerals with the exception of quartz, and the calcite, which, for the most part at least, is secondary, has replaced many of the original constituents.

The dark spots so noticeable in the hand specimen are irregular masses of chloritic material, with minute particles of iron ore, which impart a dark colour to the fragments. Some of these represent igneous rock which has been ejected from a volcano. Under the high power objective they are seen to be composed of minute felspar laths, set in a chloritic groundmass.

Quartz is the most common mineral, and is in the form of irregular grains, generally about ·25 mm. in diameter. Some of the grains are wedge-shaped, and others have concave sides which suggest a volcanic origin. None of them show any signs of wear through transport by water.

Plagioclase felspar is present in small quantities, but is extensively decomposed, and it is probable that calcite has replaced much of the felspar which was originally present. One grain showing carlsbad and albite twinning occurs, and may be andesene. Apart from the chloritic material which forms part of the included rock fragments, the mineral chlorite is present, and has been derived from what were probably ferro-magnesian minerals originally in the rock. Small quantities of haematite and limonite are to be seen.

By far the most common constituent of the rock is calcite. All the other mineral and rock fragments are set in it, while the outline of certain grains suggests the replacement of other minerals. Such replacement is not an uncommon feature of tuffs, as they are usually porous and particularly liable to alteration by solutions. Some of the calcite is in the form of radiating fibrous aggregates, which give rather striking extinction effects when seen between crossed nicols.

The chemical composition of the fresh rock is in doubt owing to decomposition. It appears to be best described as a crystal tuff with basic affinities.

No. 2.—Grey Crystal Tuff

(Yellowish in weathered hand specimens)

The rock is grey in colour, turning to a buff owing to decomposition. It differs from No. 1 in that the characteristic dark spots are absent. It is calcareous, and effervesces strongly with hydrochloric acid.

Under the microscope angular wedge-shaped and triangular quartz grains, ragged chlorite, plagioclase felspar, and occasional rock fragments were detected. All these are set in a matrix of calcite.

Plagioclase is more abundant than in No. 1, but it is still subordinate to quartz. It is being replaced by calcite, but otherwise does not show a great deal of decomposition. Albite twinning is well displayed, and the high extinction angle of 32 degrees denotes the presence of the basic variety of felspar, labradorite. The grains are generally ·25 mm. in diameter.

Any ferro-magnesian minerals which were in the rock have been decomposed, yielding chlorite. A few fragments of haematite and limonite are present.

The inclusions of igneous rock are of interest. Most of them are lighter in colour than those in No. 1, and are less than half a millimetre in diameter. Under the high power objective some are seen to possess trachytic fabric, and to consist of minute felspar laths with interstitial chloritic material. The felspars are too small to permit accurate identification.

Several small rock fragments showing a mosaic of quartz and felspar between crossed nicols appear to be pieces of metamorphosed sedimentary rock, probably torn off the walls of the vent as the volcanic material burst through.

Calcite, mainly in the form of fibrous aggregates, makes up the remainder of the rock. The presence of labradorite denotes a basic rock, but the basicity is off-set somewhat by the quantity of quartz.

The rock is a decomposed crystal tuff with basic affinities.

No. 3.—Grey Crystal Tuff

This rock is light-grey in colour, and is characterized by the presence of thin bands of black carbonaceous material, which represents plant remains. It effervesces strongly with acid, and closely resembles rocks Nos. 1 and 2.

When examined in thin section it is seen to contain more quartz grains and fewer rock fragments than the other two rocks. Plagioclase is comparable in amount to No. 2, and is either andesene or labradorite. Chlorite and iron oxides are present in the usual quantities.

The carbonaceous material is black, and is closely associated with fibrous masses of calcite. Plant cells, probably the remains of secondary wood of a gymnospern, are seen.

Calcite, as usual, comprises the bulk of the rock. It has a fibrous spherulitic structure in part, and has replaced a large proportion of the other original constituents.

The rock is a crystal tuff of intermediate composition.

General Remarks

The tuffaceous character of the rocks submitted is sufficiently proven by the nature and shape of the various constituents. Especially noteworthy is the presence of small fragments of rock, presumably thrown out by the volcano. The curved faces and wedge-like shape of many quartz grains constitute supporting evidence.

The presence of so much calcite is a notable feature of the rocks, but most, is not all, of it must be regarded as secondary. The original tuffs were probably far more felspathic than the specimens examined, and it is on this assumption, following the identification of some basic felspar, that the writer suggests they have basic tendencies.

It is not possible for the writer to state definitely the nature of the magma from which the tuffs were derived.

Part III.—Significance of the Discovery

By

A. N. Lewis

(With suggestions by A. H. Voisey)

The mere record of tuffs from the Tasmanian coal measures is of itself sufficiently important to warrant notice. In future, attention should be directed to an endeavour to identify further occurrences. A useful correlation may be possible by this means. It will also be interesting to observe whether this igneous material is at all widely distributed throughout Tasmania.

Beyond this, however, we have here a definite record of volcanic activity during a time when none was previously suspected. The Tasmanian coal measures are included in a group of felspathic sandstones. It is difficult to see what rock would yield predominate felspar grains, since this mineral usually weathers out first, and breaks up first under the mechanical effects of transportation. It is possible that our felspathic sandstones are the result of the resorting by water of ash and other volcanic material erupted contemporaneously with the deposition of the coal measures.

No indication is yet forthcoming of the location of the volcano responsible for these tuffs. The absence of signs of wear due to transportation indicates a reasonably close proximity. The whole circumstance indicates the existence of a geography at the time very different from a continuous coal swamp. No igneous plugs or vents of an age absolutely contemporaneous with the formation of the coal measures have yet been identified, but it is possible that occurrences hitherto generally assigned to the later intrusions of dolerite may be associated with this phase of volcanic activity. The possibility of islands of permian mudstone amongst the coal swamps should also be borne in mind. No solution of the new problems thus opened up by the discovery can yet be offered, but they are mentioned as a guide for future observations.

The most important fact for future investigation is the relationship, if any, of these tuffs tc the later dolerite intrusions. As Mr. Voisey has indicated, the specimens examined give us no clue as to the origin of the magma. Tuffs of highly doubtful origin occur in various places in Eastern Australia in rocks from Permian to Jurassic age. However, it has long been my opinion that the dolerite intrusions close the epoch of fresh-water deposition—that is, they should be assigned an age either late Triassic or very early Jurassic, and also that some igneous material must have found its way to the surface, although this has probably all been eroded away long since. I am also of the opinion that there were several phases of dolerite intrusions, giving rocks of slightly different chemical and physical properties. The dolerite was an undifferentiated basic magma of enormous bulk. It is not impossible that such an igneous phase would be preceded by an eruptive volcanic stage yielding a more acid rock, and that these tuffs are therefore the result of the opening phase of intense igneous acvitity, which later gave us our dolerite masses and associated structural deformation. Definite conclusions on these lines of thought must, however, await further field evidence.

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PLATE IV.—EXPLANATIONS OF MICROPHOTOGRAPHS.

FIG. No. 1.—Magnification 33/1. The large black patch is a fragment of volcanic rock, black being chlorite, and the lath-shaped crystals felspar. The white quartz grains are irregular in shape. Most of the grey background is calcite.

FIG. No. 2.—Magnification 33/1. The irregular outlines of white quartz grains are noteworthy. Black areas represent chlorite, and the grey speckled groundmass is calcite.

FIG. No. 3.—Magnification 77/1. Peculiar extinction effects in fibrous aggregates of calcite. Black patches are mainly calcite.

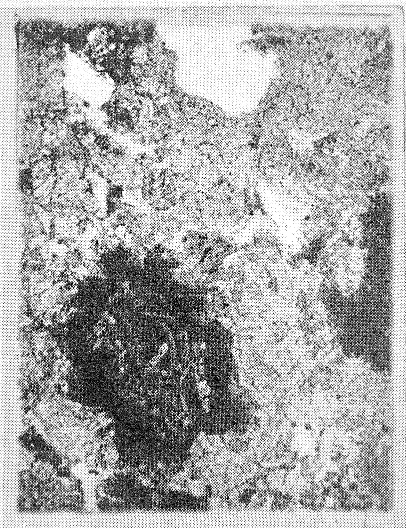

FIG. 1

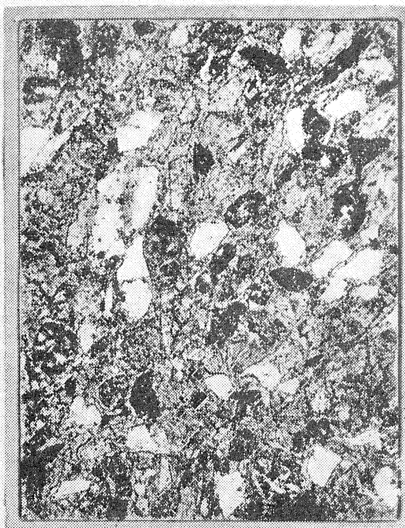

FIG. 2

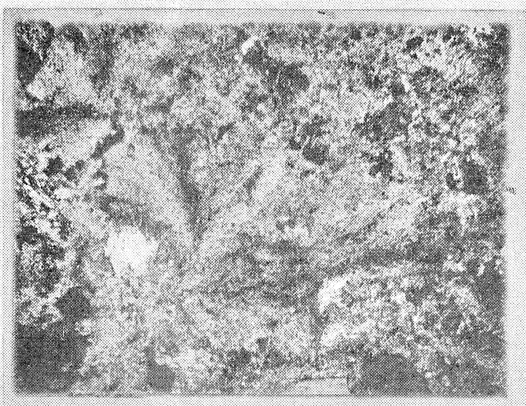

FIG. 3