Part I: Geological Reports

Section 1: Economic and General Geology

TR14_7_15

1. The regional significance of the Don Hill fault zone of Mt Bischoff, Tasmania

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CONTENTS

ABSTRACT

A fault zone exists between the lithologically contrasting Mt Bischoff and Waratah River sequences on Don Hill adjacent to the Mt Bischoff Mine. A comparison of the structural histories of the rock sequences indicates that there is a marked hiatus between them and that the Mt Bischoff sequence is the older. This indicates that the Mt Bischoff sequence may well be earlier than the Penguin Orogeny and in an equivalent position to the Oonah Formation, which would invalidate its inclusion in the Success Creek Phase.

INTRODUCTION

There has been considerable controversy over the relationship of sedimentary sequences considered to be Upper Precambrian and those considered to be Cambrian in age in Tasmania (e.g., Taylor, 1954; Campana *et al.,* 1960; Blissett and Gulline, 1961; Solomon, 1965a). However, limited detailed mapping has been carried out over the contacts, mainly because of poor exposure, with the result that correlations are indefinite and relationships between sequences uncertain (e.g., Loftus-Hills *et al.*, 1967). This paper demonstrates that sequences apparently regionally conformable may include notable structural breaks.

At Don Hill, on the SE slopes of Mt Bischoff, recent sluicing has exposed part of the southern contact between successions ascribed to the Upper Precambrian and Cambrian (e.g., Groves and Solomon, 1964). A detailed plan of the contact (fig. 2) is presented and a comparison has been made of the composition, texture and structural elements of the sedimentary rocks in juxtaposition.

REGIONAL GEOLOGY

Stratigraphy

The quartzite, shale and dolomite sequence of Mt Bischoff (the Mt Bischoff sequence) was originally believed to be of Ordovician age (eg., Nye, 1923; Reid, 1923), but lately has ben considered as Upper Precambrian (Carey, 1953; Knight, 1953; Groves and Solomon, 1964). The Mt Bischoff sequence form a relatively narrow, E-W trending, wedge-shaped inlier that extends from Deep Creek to the Magnet Mine. The sequence is at maximum width at Mt Bischoff where it is at least 2000 ft thick and consists of over 1000 ft of quartzite, siltstone and shale overlain by 0-200 ft of dolomite followed by over 1000 ft of shale, siltstone and minor quartzite. Solomon (1965a) included this sequence, with the Carbine Group at Dundas, the Smithton and Jane Dolomites and the Success Creek Group (Taylor, 1954), in the Success Creek phase which was considered to be a period of deposition transgressing the Upper Precambrian miogeosyncline.

Enclosing this sequence in the Mt Bischoff district are successions of greywacke, sandstone, mudstone, chert, chert breccia and altered lava which have been ascribed to the Cambrian System by all authors. These have been tentatively subdivided by the author into two phases which appear to be gradational and may be stratigraphically equivalent: the greywacke-sandstone and mudstone sequence of the Waratah River, the Waratah River sequence) and the red mudstone and sandstone sequence of the Arthur River (the Arthur River sequence). The lack of fossils in the rocks of these sequences prevents precise correlation with other Cambrian sections in Tasmania. It may be significant that gabbroic intrusions are extremely common in the Waratah district (Groves and Solomon, 1964), particularly in the Arthur River sequence, because Rubenach (pers. comm.) suggests that the frequency of intrusions of gabbroic rocks into the Crimson Creek Formation is much greater than for the Dundas Group in the North Dundas area. However at this stage no direct correlation with other sequences is possible although the lithology (particularly of the Arthur River sequence), lack of fossils and abundance of gabbroic intrusions suggests that they may in part be equivalent to the Crimson Creek Formation of Early Cambrian age.

Reid (1923) and Nye (1923) considered the Mt Bischoff sequence to be an outlier of Ordovician rocks bounded by two convergent faults. Groves and Solomon (1964) and Solomon (1965b) considered that the sequences had a partly faulted contact along the northern boundary and were apparently essentially conformable along the southern boundary although the change in lithology between sequences was abrupt.

Structure

Knight (1953) believed the Mt Bischoff sequence to be folded into a large recumbent syncline. However, Groves and Solomon (1964), using the dolomite as a marker horizon, considered that the Mt Bischoff sequence formed the core of an E-trending, W-plunging anticlinorium with an approximate wavelength and amplitude of five and two miles respectively, flanked by younger rocks.

Superimposed on this structure are smaller, subparallel, gently to steeply plunging, flexural folds with wavelengths of 100 to 1000 ft which are typically associated with sub-longitudinal tensional faults that obliterate limbs of the folds. These folds are intersected by NNW-trending faults which are almost transverse to the fold axes. Smaller flexural folds, with a predominant ENE and a subordinate NNW trend of axes, are superimposed on the longer wavelength folds and are so strongly developed in places that the E-trending folds are obscured. The ENE and NNW trend of axes are reflected in folds in the Arthur and Waratah River sequences but the larger folds with E-trending axes are regionally absent in these sequences.

The E-W structure at Mt Bischoff is a discordant trend in the regional framework of this section of NW Tasmania where the majority of structures trend NW or NNE (Carey, 1953; Solomon, 1962). Groves and Solomon (1964) concluded that the E-W trend may reflect an earlier deformation which has locally affected the dominant trends associated with the Tabberabberan Orogeny.

CONTACT AT MT BISCHOFF

Stratigraphy

The contact at Don Hill is between the sedimentary rocks at the highest stratigraphic level of the Mt Bischoff sequence and those at the lowest stratigraphic level of the Waratah River sequence. There is a marked contrast in the lithology between the two sequences, for the sand-grade rocks of the Mt Bischoff sequence are usually lithic sandstone (subgreywacke and protoquartzite) whereas the rocks of equivalent grain size of the Waratah River sequence are usually greywacke (see Pettijohn, 1957, p. 291).

The Mt Bischoff sequence is locally represented by predominantly grey to black shale and fine siltstone with interbedded pale grey coarse siltstone or fine sandstone which form detached blocks in places. The coarse siltstones are well sorted with a continuous framework and consist of up to 70 per cent clastic quartz grains, minor muscovite, fine quartz siltstone and chert grains and a predominantly quartz and sericite matrix constituting approximately 10-15 per cent of the rock. The clastic grains measure up to 0.2 mm in diameter, with an average grain size of approximately 0.05 mm. Although the quartz grains show undulose extinction in part they exhibit a dimensional orientation subparallel with clastic muscovites which are aligned parallel to bedding, suggesting that the orientation is a depositional feature. The fine siltstone and claystone (largely shale) horizons consist of fine clastic quartz and chert grains with a high proportion of clastic muscovite in a finer matrix of quartz and sericite. The grain size of the fine siltstone beds is generally 0.015 mm and grains of this diameter comprise approximately 10 per cent of the claystone or shale. Lamination appears due to variations in the proportions of clastic muscovite.

The Waratah River sequence adjacent to the contact consists of predominantly graded greywackes which are poorly sorted with a disrupted framework.

They consist of large, subangular to sub-rounded clastic grains up to 0.5 mm in diameter in a finer-grained matrix which constitutes up to 50 per cent of the rock. The clastic grains are largely quartz with muscovite, albite and rock fragments including altered lava, siltstone, claystone and quartzite grains.

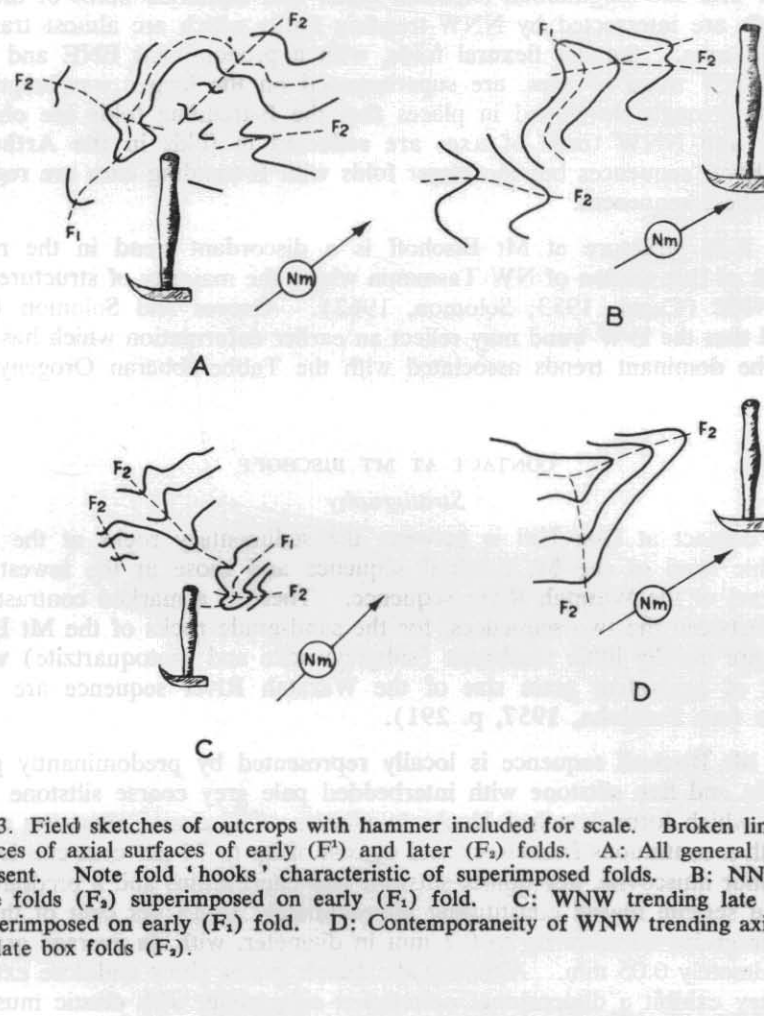


FIGURE 3. Field sketches of outcrops with hammer included for scale. Broken lines indicate traces of axial surfaces of early (F^1) and later (F_2) folds. A: All general fold trends present. Note fold 'hooks' characteristic of superimposed folds. B: NNE trending late folds (F_2) superimposed on early (F_1) fold. C: WNW trending late folds (F_2) superimposed on early (F_1) fold. D: Contemporaneity of WNW trending axial surfaces of late box folds (F_2).

The greywacke sandstone encloses large blocks of laminated mudstone, which are irregular in detail but show an overall subparallelism to bedding. These blocks are apparently confined to within 300 ft of the contact. The mudstones exhibit strong black and pale grey colour banding which appears to be a weathering effect. They are extremely fine-grained rocks consisting largely of quartz and sericite and it is impossible in general to determine whether they are blocks of mudstone of the Mt Bischoff sequence or penecontemporaneous mudstones. At least one large block, approximately 40 ft in length, in the NE corner of the mapped area is of grey shale identical to shales in the Mt Bischoff sequence.

The beds to the east of the immediate contact are largely of finely interlaminated coarse claystone-fine siltstone and interbedded medium-coarse siltstone. The claystone-fine siltstone has a grain size of 0.01-0.025 mm and consists of about 10 per cent quartz grains in a dense clay or micaceous matrix. The medium-coarse siltstone consists of approximately 50 per cent clastic grains which are predominantly quartz, muscovite and albite, averaging 0.04 mm in diameter, in a brown sub-opaque matrix. The siltstone beds are cut by fine-quartz-carbonate veinlets and contain disseminated pyrite in places.

Nature of the Contact

The contact, which occupies a zone a few centimetres wide, is locally subparallel to the strike of both sequences (i.e., NNE to NE) and dips at a variable high angle to the SW. The contact zone contains numerous slickensides. Small fractures parallel to the contact intersect both sequences imparting a shredded appearance, particularly in the greywacke sandstone of the Waratah River sequence. It is evident that the contact has been a surface of movement.

The exact relationship of the bedding in both sequences to the orientation of the contact zone is difficult to determine. In general, the siltstone and shale layers of the Mt Bischoff sequence dip steeply away from the contact while the greywacke sandstone beds dip towards the contact at variable angles.

Comparison of Structural Elements

Mt Bischoff Sequence

The deformation of the Mt Bischoff sequence is depicted in Figure 2 and may be analysed in the critical exposures sketched in Figure 3.

A predominant NE to NNE trend is shown in Figure 2, and is slightly oblique to the dominant regional trend (Groves and Solomon, 1964). Three main trends of folding are demonstrated in Figure 3: early (F_1) folds being refolded by later (F_2) folds which trend obliquely in two directions. Figures 3B and 3C demonstrate the superimposition of (F_2) folds (with axial surfaces trending NE to NNE and NW to WNW respectively) on early (F_1) folds. The contemporaneity of the NW and NE trending axial surfaces of the late box-type folds (F_2) is demonstrated in Figure 3D. ' Hook ' structures characteristic of superimposed folds are present in places due to interference of F_1 and F_2 folds (e.g., fig. 3A).

Other features of the deformation include the occurrence of detached blocks of coarse siltstone or fine sandstone which form distinct trains, subparallel to the bedding in the shale horizons, with elongation of the blocks parallel to the bedding direction. In places these boudins appear to have formed by rotation of joint blocks, probably during folding. Small faults subparallel to bedding are present in places.

Waratah River Sequence

The interbedded greywacke-sandstone and siltstone beds of the Waratah River sequence also exhibit a predominant NE to NNE trend (fig. 2). In this sequence box-type folds or conjugate folds are common. A typical fold is

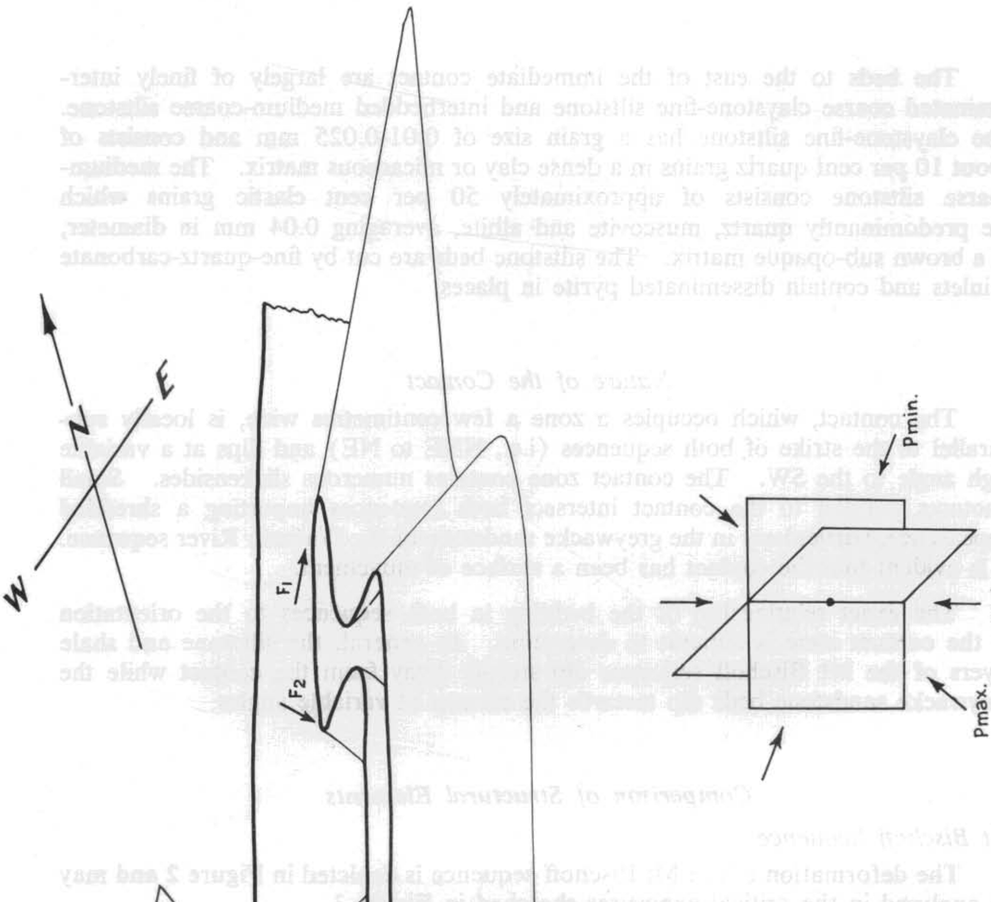
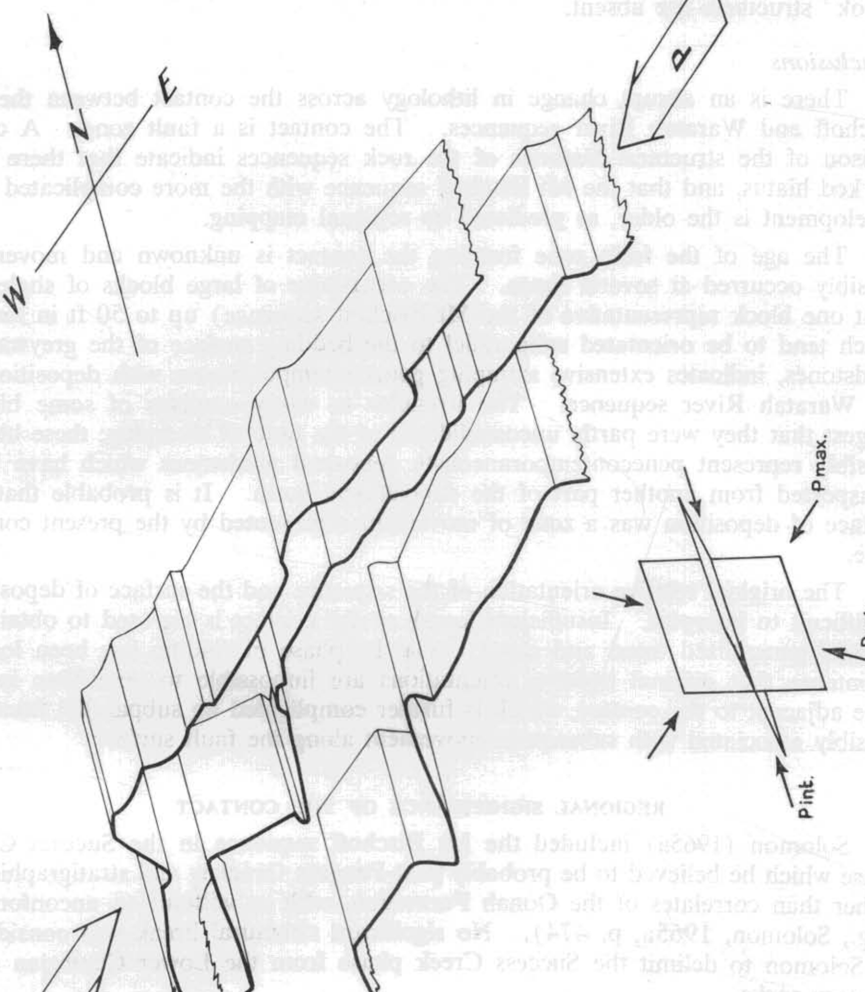


FIGURE 4. Diagrammatic representation of deformation of layer of fault zone of SE slope of Mt Bischoff. Early folds (F_1) disturbed by later folds (F_2) of box type resulting from stress field indicated.

FIGURE 5. Bedding layers from conjugate folds in rocks of fault zone. Contortions of bedding surfaces indicate stress pattern shown. Note P median bedding surfaces.



reproduced in Figure 5 and the local stress field indicated. It is noteworthy that the direction of maximum stress for the production of box-type folds in the Mt Bischoff and Waratah River sequences are at right angles. There is no evidence of F_1 folds, ubiquitous in the Mt Bischoff sequence, refolded axial surfaces and 'hook' structures are absent.

Conclusions

There is an abrupt change in lithology across the contact between the Mt Bischoff and Waratah River sequences. The contact is a fault zone. A comparison of the structural histories of the rock sequences indicate that there is a marked hiatus, and that the Mt Bischoff sequence with the more complicated fold development is the older, as predicted by regional mapping.

The age of the fault zone forming the contact is unknown and movement possibly occurred at several times. The occurrence of large blocks of shale (at least one block representative of the Mt Bischoff sequence) up to 50 ft in length, which tend to be orientated subparallel to the bedding surface of the greywacke-sandstones, indicates extensive slumping penecontemporaneous with deposition of the Waratah River sequence. The irregular to wispy contacts of some blocks suggest that they were partly unconsolidated at the time of slumping; these blocks possibly represent penecontemporaneously deposited mudstones which have been transported from another part of the depositional basin. It is probable that the surface of deposition was a zone of movement represented by the present contact zone.

The original relative orientation of the sequence and the surface of deposition is difficult to interpret. Insufficient length of the contact is exposed to obtain its original generalised trend and slope. The F_2 phase of folding has been locally so intense that original bedding orientations are impossible to determine in the zone adjacent to the contact, which is further complicated by subparallel fractures possibly associated with subsequent movement along the fault surface.

REGIONAL SIGNIFICANCE OF THE CONTACT

Solomon (1965a) included the Mt Bischoff sequence in the Success Creek phase which he believed to be probably post-Penguin Orogeny and stratigraphically higher than correlates of the Oonah Formation, with or without an unconformity (e.g., Solomon, 1965a, p. 474). No significant structural break was considered by Solomon to delimit the Success Creek phase from the Lower Cambrian sedimentary rocks.

The demonstration of deformation in the Mt Bischoff sequence prior to deposition of the Waratah River sequence indicates that the Mt Bischoff sequence does not occupy the position of the Success Creek phase as envisaged by Solomon (1965a) and therefore should not be included within it. The Mt Bischoff sequence may well be pre-Penguin Orogeny and in an equivalent position to the Oonah Formation.

In conclusion it should be pointed out that the position of the Success Creek phase as envisaged by Solomon (see also Loftus-Hills *et al.,* 1967) appears doubtful in other areas. R. D. Gee (pers. comm.) considers the Smithton Dolomite to be pre-Penguin Orogeny and suggests that it should not be correlated with the Success Creek phase (e.g., Solomon, 1965a, p. 466-467) because they were deposited in separate basins on different sides of the Rocky Cape Geanticline. Blissett (1962) considered that the Success Creek Group of Taylor (1954) and the Carbine Group of Elliston (1954) represented the upper part of the Oonah Formation, which comprised generally finer grained rocks with dolomite towards the top (i.e., similar to the Mt Bischoff sequence). Blissett (1962) considered the Crimson Creek Formation to conformably overlie the Oonah Formation, although Campana and King (1963) suggest an unconformity on regional evidence. Solomon (1965a) recorded thin lenticular conglomerates above the contact at Renison Bell, which also indicates instability at the beginning of Cambrian sedimentation.

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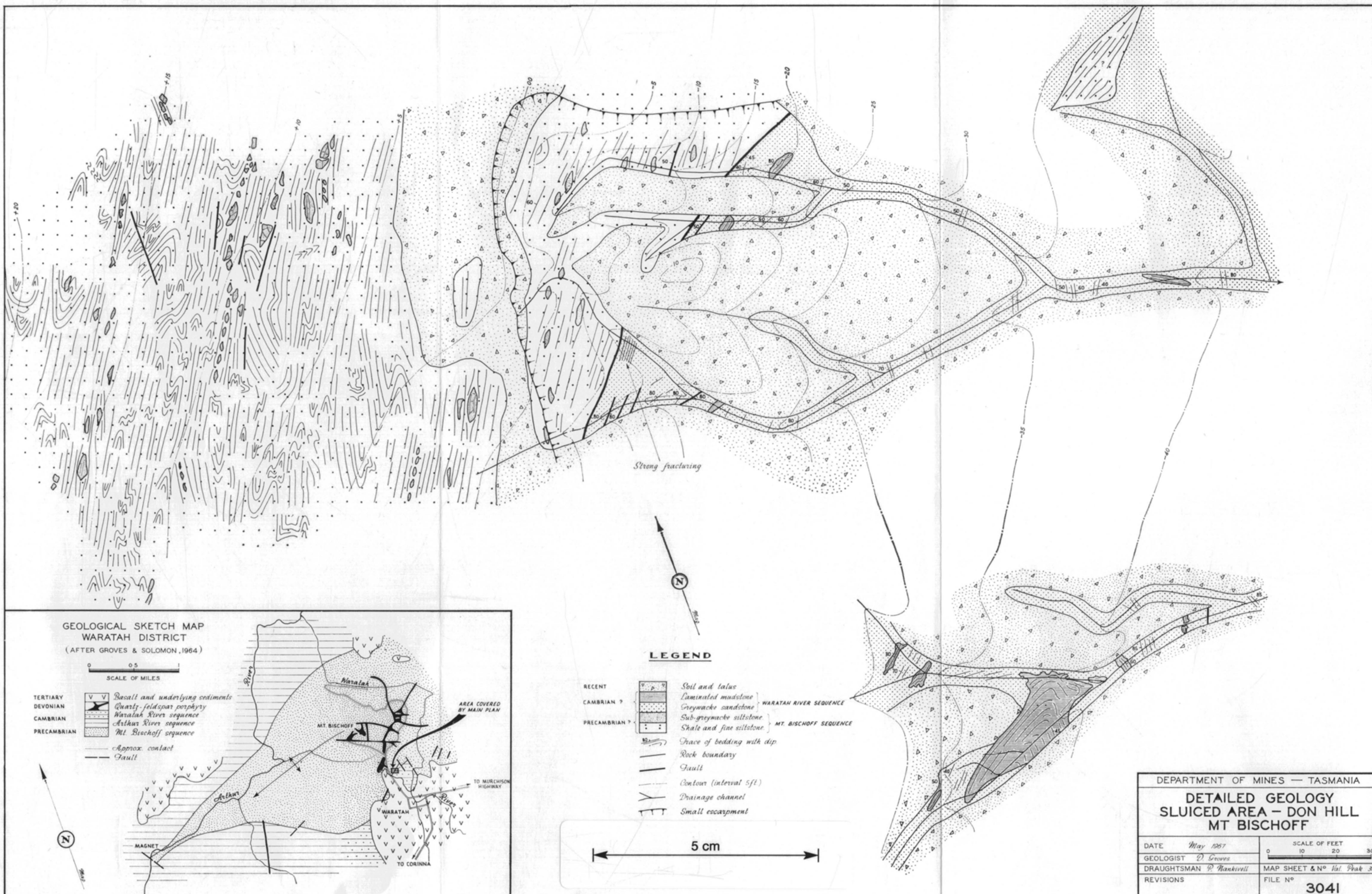

FIGURE 2

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