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Synopsis of the regional geology of the Macquarie Harbour, Point Hibbs, and Montgomery 1:50 000 map sheets

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Abstract

The Sorell Peninsula–Low Rocky Point region of south-western Tasmania contains two areas of Precambrian rock successions; six Eocambrian–Cambrian volcano-sedimentary associations; Tertiary graben-fill sediments; and Recent coastal deposits.

The rock successions in this area are considered to be the remnants of a collision zone between volcano-sedimentary sequences formed within an Island Arc and rock successions belonging to a continental margin. The Island Arc rocks were overthrust onto the continental margin, probably from the east, during the end of the Middle Cambrian. The whole area was reworked by major thrusting during a Mid-Devonian tectonic event.

A rock sequence with a high prospectivity for base metals, the calc-alkaline, andesite-bearing succession (Noddy Creek volcanics), extends south from Asbestos Point in Macquarie Harbour, to the area around the mouth of the Mainwaring River. This sequence is considered to be a southern extension of the Middle Cambrian, pyroxene-plagioclase phyric andesitic rocks of the Lynchford and Que River areas. As such, it is a correlate of one of the more mineralised parts of the Mt Read Volcanics. The Noddy Creek volcanics have had relatively little modern exploration carried out over them and are therefore a prime exploration target.

INTRODUCTION

This paper combines the reports of Findlay *et al.* (1989, 1991), Brown *et al.* (1991) and work in preparation for Explanatory Notes for the Macquarie Harbour (McClenaghan and Findlay, 1989) and Montgomery (Brown, 1988) 1:50 000 geological map sheets, to present a synthesis of geological information obtained during the mapping of the Sorell Peninsula to Low Rocky Point region. It also includes additional important unpublished work from the Point Hibbs 1:50 000 map sheet (Seymour *et al.*, in progress).

More detailed descriptions of the work discussed will be presented in the forthcoming Explanatory Notes for the Macquarie Harbour (McClenaghan and Findlay, in prep.) and Montgomery (Brown, in prep.) geological map sheets, and in a forthcoming progress report for the Point Hibbs 1:50 000 map sheet.

This report also presents additional correlations based on geochemical data, and gives a new regional structural geological interpretation involving thin-skinned tectonics for the Sorell Peninsula–Elliott Bay region. This structural interpretation increases the prospectivity of the study region, and in the context of western Tasmanian regional geology, demands re-interpretation of previous geological mapping.

REGIONAL GEOLOGY

Precambrian Rock Successions

Two areas of Precambrian rocks, separated by rock sequences presumed to be of Cambrian age, occur on the Sorell Peninsula (fig. 1). The northern area consists of metamorphosed, interbedded, orthoquartzite, mudstone/siltstone and minor conglomerate units. Sedimentary structures indicate a shallow water origin for these rocks. In the southern area, the rocks consist of metamorphosed, impure, dolomite-rich beds and metamorphosed quartzwacke and mudstone/siltstone units. The dolomitic units may be of shallow water origin; sedimentary features in the quartzwacke sequence indicate that they were deposited by turbidity currents. The boundary between the two successions is gradational.

Drilling has proved that the northern Precambrian rock units are thrust over the presumed Cambrian rocks found to the southeast; further south several outliers of this thrust sheet overlie the Cambrian rocks. The southern Precambrian sequences are faulted against rocks of Cambrian age both to the southeast and northwest. The rocks of the southern Precambrian belt can be traced as far south as the southern edge of the Point Hibbs peninsula, where a small outcrop of metamorphosed quartzwacke and pelite surrounded by Jurrasic dolerite occurs (fig. 2).

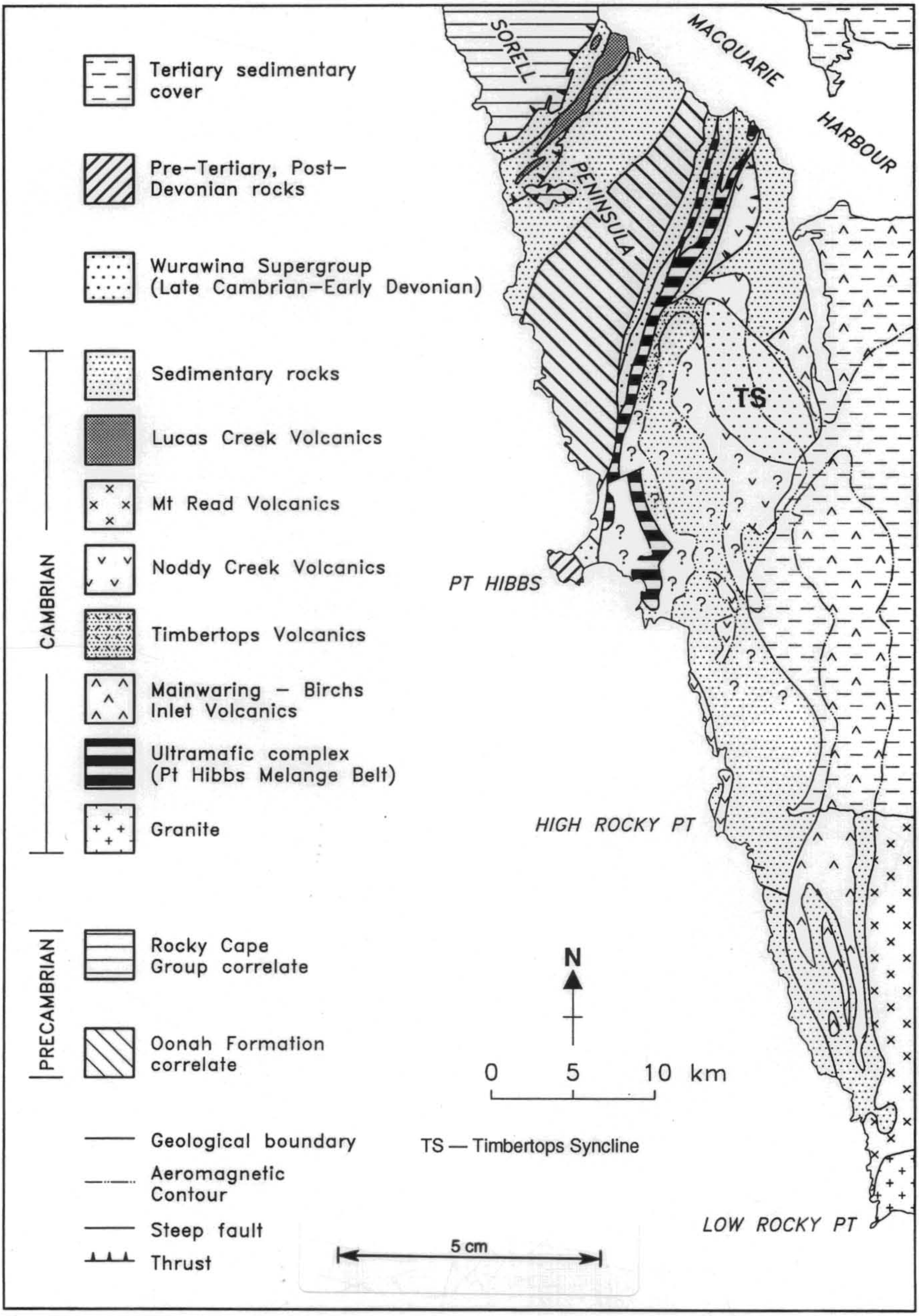

Figure 1. *Schematic geological map of the Sorell Peninsula–Low Rocky Point area (after Findlay et al., 1991).*

Eocambrian–Cambrian Rock Successions

Six volcano-sedimentary associations of probable Eocambrian-Cambrian age are recognised. Fossils are known from only one locality (fig. 1, CN646982). They occur within proximal fan deposits, overlain by beds of probable Ordovician age, and consist of Late Cambrian agnostid trilobites (Jago, 1972). Additional confirmation of the Eocambrian-Cambrian age of these six associations is given by the presence of the fossiliferous Ordovician rocks within the Timbertops Syncline, which unconformably overlie three of the associations (Timbertops volcanics, Noddy Creek volcanics, Birchs Inlet volcanics; fig. 1).

The six volcano-sedimentary associations are distinguished on the basis of their igneous rock component. The associations are:

(1) Alkaline to tholeiitic basalt association with intra-plate and island-arc affinities (Lucas Creek volcanics)

(2) Boninitic association (Timbertops volcanics)

(3) Picritic basalt-Basalt association with intra-plate and island-arc affinities (Birchs Inlet–Mainwaring River volcanics)

(4) Andesite-rhyolite association of probable island-arc origin (Noddy Creek volcanics)

(5) An association of serpentinised ultramafic rocks and gabbro incorporating sheared units derived from the boninite and andesite-rhyolite associations (Point Hibbs Mélange Belt)

(6) Felsic volcanic sequence (correlate of the Tyndall Group of western Tasmania)

ALKALI BASALT–THOLEIITE BASALT ASSOCIATION (Lucas Creek Volcanics)

This sequence of rocks consists of pillow and sheet flows with minor amounts of alkali basalt, associated with mudstone/lithicwacke units. These consist of medium to dark grey mudstone and siltstone with some sandstone beds, interbedded on a 1–10 cm scale. Parallel laminations of siltstone occur in the mudstone units and size-grading occurs in some of the coarser beds. Local occurrences of thin (<1 m) dolomite beds are known. The clastic rocks contain quartz and lithic fragments with lesser plagioclase; some quartz grains clearly have a volcanic origin, whereas others have been derived from a metamorphic source. Some lithic grains are derived principally from a low-grade greenschist facies terrane (quartz, white mica, chlorite assemblages), whereas others have been derived from an acid volcanic source; grains with granophyric texture are also present.

These sedimentary units are faulted against massive and oncolitic dolomitic beds, as well as a variably calcareous mudstone and sandstone association. The relationships between these units are not clear in the field, but we consider that thrust and reverse faulting has been involved. The variably calcareous mudstone-sandstone beds contain current-bedded sandstone horizons up to one metre thick, and rare beds of granule and pebbly conglomerate interbedded with mudstone. Within the conglomerate beds the clasts may be as large as 25 centimetres. The dominant clast type is well-rounded, massive or foliated quartzite.

Petrography

Basaltic rocks from this association contain glomerophyric patches of plagioclase, generally fresh clinopyroxene phenocrysts, and olivine phenocrysts pseudomorphed by chlorite in a matrix of plagioclase, intersertal clinopyroxene and ilmenite. The plagioclase has sericite alteration; minor epidote and chlorite are also present. Highly altered rocks, where the original mineralogy has been entirely replaced by albite, actinolite, chlorite, epidote, sphene and leucoxene also occur.

BONINITIC ASSOCIATION (Timbertops Volcanics)

As mapped at present, these rocks are restricted to the Timbertops region of the Macquarie Harbour Quadrangle. In the Timbertops region they are interbedded with mudstone and siltstone beds and are associated with gabbroic rocks. The outcrops here are such that it is impossible to determine the physical character of the lavas, although in thin sections they include fragmented beds and vesicular units.

The boninitic rocks in the Timbertops region are juxtaposed against the calc-alkaline Noddy Creek volcanics. The outcrop distribution could indicate a low-angle thrust relationship, with the Noddy Creek volcanics forming the upper plate (McClenaghan and Findlay, 1989). The unexposed contact between the two units is crossed by unconformably overlying and folded fossiliferous Ordovician siliciclastic rocks correlated with the Denison Group.

Petrography

In all cases these volcanic rocks are altered. The better preserved units contain talc, and chlorite pseudomorphs of pyroxene phenocrysts set in a matrix of talc, chlorite and spinel. The more altered rocks are highly sheared and consist principally of talc.

Some pyroxene pseudomorphs have parallel lamellae after exsolution of Ca-rich pyroxene in clinoenstatite. Other pseudomorphs may be after orthopyroxene. Where highly sheared, the rocks are formed of felty talc, minor chlorite and primary chrome spinel.

Microprobe analyses of the spinel have Cr* of about 0.9 (McClenaghan and Findlay, in prep.) which confirms a composition characteristic of those in modern boninitic lavas as well as other boninitic rocks in western Tasmania (Brown and Jenner, 1989). Geochemical data from these rocks and the composition of the spinels, together with their petrography, leads us to interpret these rocks as boninitic lavas erupted in an island-arc setting.

PICRITIC BASALT–BASALT ASSOCIATION (Birchs Inlet – Mainwaring River Volcanics)

This sequence occurs as vesicular, pillow and sheet flows of pyroxene-phyric and/or plagioclase-phyric basaltic rocks interlayered with hyaloclastite and basalt breccia.

The association also contains interbedded sedimentary rocks which increase in proportion south from Birchs Inlet to the Mainwaring River area. The sedimentary rocks contain one area of interbedded mudstone and chert, and other areas of volcaniclastic siltstone and lithicwacke with minor, interbedded, mudstone and carbonate units. Also present are laminated siltstone with minor carbonate beds, siliceous pebbly quartzwacke, and lithicwacke with minor siliceous pebble conglomerate.

Sedimentary features within this succession indicate a predominantly east-facing sequence.

The petrography of the clastic rocks indicates a mixed volcanic, low-grade metamorphic source (Brown, in prep.; McClenaghan and Findlay, in prep.).

Petrography

These rocks contain glomerophyric patches of sericitised plagioclase, mainly fresh clinopyroxene phenocrysts, and chlorite pseudomorphs after olivine. The matrix consists of fine plagioclase, subophitic to intersertal augite, ilmenite and chlorite with or without epidote. A few samples show small, sparse, intergranular patches of quartz. Some samples of lavas contain small chrome spinel grains.

ANDESITE–RHYOLITE ASSOCIATION (Noddy Creek Volcanics)

This sequence of volcanic rocks consist of calc-alkaline (Brown, in prep.; McClenaghan and Findlay, in prep.) andesitic, dacitic, and rhyolitic lavas associated with pyroclastic, volcaniclastic and epiclastic rocks. Where the association is dominated by the sedimentary component, the volcanic units occur as pillowed and sheet lavas, breccia flows and porphyritic flows containing volcanic xenoliths. Where the volcanic units dominate the section, they are formed of autobrecciated flows or porphyritic flows with volcanic xenoliths. These rocks are interbedded with thin (2–3 m) vitric tuff or volcaniclastic siltstone with preserved angular glass shards and 10–15 mm thick volcanicwacke beds.

Within the sediment-dominated part of the section the sedimentary rocks form a flyschoid sequence which includes channelised sandstone and pebble-cobble conglomerate, suggesting a proximal submarine fan origin. The thickest sandstones and conglomerates are about 2 m thick, and occur in channels as thick as ten metres. Sedimentary structures include scoured bases, truncated cross-bedding, convolute bedding, flame structures and zones of slump folding.

The granule to pebble conglomerate beds include clasts of locally-derived volcanic rocks as well as angular clasts of locally-derived black mudstone. The main clastic component is derived from a quartz-rich acid volcanic terrane with a minor component of metamorphic rock, exotic volcanic clasts, and quartz fragments showing graphic intergrowths with feldspar. The particular composition of the sedimentary rocks closely reflects the particular volcanic beds with which they are associated, thus indicating local erosion.

In the Montgomery Quadrangle this sequence faces east.

Of considerable importance is the discovery of a clast of boninite lava in a typical pebble to granule conglomerate in the Montgomery Quadrangle (at grid reference CN673655). The clast consists of chlorite and serpentine pseudomorphing a porphyritic lava which contains red chrome-spinel grains. Brown (in prep.) has confirmed that the composition of these grains is typical of that for spinels in boninitic lavas. This indicates prior development of a boninitic volcanic terrane in the area of formation of the Noddy Creek volcanics.

Petrography

The andesite is generally fine grained with phenocrysts of plagioclase and augite. Phenocrystic plagioclases may be randomly orientated, may be flow aligned, or occur as glomerophyric patches. Pyroxenes may be altered to chlorite or epidote-chlorite-actinolite; some other amphiboles may be hornblende. The matrix contains laths of plagioclase, chlorite, fine opaques, and sporadic pyroxene. Pyroclastic textures are evident in some sections.

The rhyolitic rocks contain quartz and feldspar as phenocrysts in fine-grained quartz, feldspar, sericite, chlorite and opaque grains. Plagioclase phenocrysts outnumber those of quartz, may occur as glomerophyric patches, and are commonly sericitised. Quartz phenocrysts are embayed and strained. Possible small pyroxene phenocrysts have been pseudomorphed by chlorite; partly chloritised biotite phenocrysts may occur.

The xenolithic blocks in some of the lavas consist of ophitic to subophitic plagioclase and twinned and zoned single or glomero-porphyritic clusters of clinopyroxene with accessory anhedral Fe-Ti oxide minerals. Plagioclase is sericitised; clinopyroxene crystals are partly altered to chlorite and tremolite-actinolite. The matrix around the blocks is a crystal mush of euhedral to broken clinopyroxene and plagioclase with a matrix of vesicular glass, to anhedral pyroxene and feldspathic microlite in a black glass.

ULTRAMAFIC ROCKS

The ultramafic rocks consist of peridotite which is variably massive to highly sheared, and is invariably serpentinised. The massive units occur as kilometre- to decimetre-scale boudins within highly sheared serpentinite (McClenaghan and Findlay, 1989), and in some of these the original mineralogy is only partly replaced.

The ultramafic rocks are closely associated spatially with gabbroic bodies, and small gabbroic blocks also occur within the sheared serpentinite. Similar ultramafic rocks have been described throughout the Dundas trough, where they form a crudely S-shaped belt (fig. 1). Brown (1986) identified three broad associations of ultramafic rocks and associated lavas; these are a Layered Pyroxenite Dunite Succession, a Layered Pyroxenite Gabbro Succession, and a Layered Dunite Harzburgite Succession. The Pyroxenite Gabbro Succession is associated with low-Ti basalt and the Dunite Harzburgite Succession with high-Mg andesite (boninite) lavas.

In the Macquarie Harbour Quadrangle, the ultramafic rocks occur in close spatial association with sheared talc-rich rocks containing flattened vesicles (McClenaghan and Findlay, in prep.) which may be derived from boninitic lavas. The presence of these rocks, together with boudins of gabbro, lead us to correlate the ultramafic rocks with the Pyroxenite Gabbro and Dunite Harzburgite successions. Similar lithological and structural associations of ultramafic rocks, gabbro and boninitic volcanics also occur in the mélange belt in the recently mapped parts of the Point Hibbs Quadrangle.

Petrography

The foliated, and also most of the massive ultramafic rocks, consist of serpentine mineral with minor amounts of primary dark-brown and black spinel. Serpentine mineral completely pseudomorphs the original pyroxene grains. In the more massive rocks some samples show only partial replacement of the original pyroxenes by serpentine-group minerals. These occurrences indicate that the rocks were dominantly orthopyroxene with less than 5% clinopyroxene, although one sample consists entirely of clinopyroxene. Elsewhere the ultramafic rocks consist entirely of talc, chlorite and probable tremolite.

The gabbroic rocks contain coarse andesine-bytownite and augite-diopside with bronzite or hypersthene, and are generally extensively altered. The plagioclase is cloudy and altered to sericite; alteration of orthopyroxene precedes alteration of clinopyroxene; orthopyroxene alteration products are talc, tremolite with cummingtonite, and chlorite; clinopyroxene alters to actinolite.

Gabbroic rocks in the sheared serpentinite consist of patches of fine sericite after plagioclase and colourless amphibole. One such gabbro consists of fibrous actinolite, chlorite and plagioclase altered to fine sericite and grossular garnet; one sample contains hornblende.

FELSIC VOLCANIC ASSOCIATION (Tyndall Group Correlates)

Along the eastern boundary of the Montgomery Quadrangle, this sequence contains tectonically deformed quartz- and/or plagioclase-phyric, felsic volcanic rocks with associated tuffaceous rocks and interbedded sandstone, siltstone and mudstone. These rocks have a phyllitic character formed by tectonic modification of the original igneous rocks, and the rocks have been altered to such an extent that the original layering has been destroyed and a compositional banding formed.

In the south of the Montgomery Quadrangle the felsic volcanic rocks consist of calc-alkaline, quartz and plagioclase phyric lavas with interbedded felsic tuff and minor sedimentary rocks. These sequences have been correlated with the Mount Read Volcanics (Large, 1981; Large *et al.* (1987).

Petrography

The volcanic rocks contain plagioclase and/or quartz phenocrysts in a groundmass of semi-recrystallised quartzo-feldspathic material containing leucoxene after Fe-Ti mineral. Flattened elongate areas of chlorite and epidote, and euhedral and broken plagioclase crystals, are also present in some samples.

GEOCHEMISTRY

Alkali Basalt–Tholeiite Basalt Association (Lucas Creek Volcanics)

Geochemically, some of the Lucas Creek rocks carry a signature characteristic of an intra-plate volcanic environment whereas others resemble volcanic rocks from island arcs; a minor component of the sequence has an alkali character. A dyke in this sequence has geochemical characteristics similar to those of the low-Ti basalts of western Tasmania (Brown, 1986).

In a number of chemical characteristics some lavas in this suite resemble the Birchs Inlet–Mainwaring volcanics (McClenaghan and Findlay, in prep.). Other volcanic units of the Lucas Creek sequence resemble volcanic rocks intercalated in the Eocambrian sequence of the Smithton region and among the unfossiliferous Eocambrian lithicwacke of the Crimson Creek Formation, which is inferred to underlie the Dundas Group in the Zeehan district (see Burrett and Martin, 1989).

Boninitic Association (Timbertops Volcanics)

Geochemical data for these rocks and the composition of the spinels, together with their petrography, lead us to interpret these rocks as boninitic lavas erupted in an oceanic island-arc setting (McClenaghan and Findlay, in prep.). Microprobe analyses of the spinel have Cr* of about 0.9, which confirms a composition characteristic of those in modern boninitic lavas as well as other boninitic rocks in western Tasmania (Brown and Jenner, 1989).

Picritic basalt–Basalt association (Birchs Inlet–Mainwaring River volcanics)

Two groups of lava occur in both the Montgomery Quadrangle and at Birchs Inlet. The lower lavas, Group 1, are generally picritic basalts with olivine and spinel phenocrysts. The upper lavas, Group 2, are pyroxene/plagioclase tholeiitic basalt. Chemically they represent successive batch melts, with each group showing continuing differentiation.

Group 1 lavas resemble lavas from the Miners Ridge basalt at Queenstown. The Miners Ridge volcanic sequence has been taken (see Burrett and Martin, 1989) as representing the base of the Middle to possibly Late Cambrian andesitic to rhyolitic Mt Read Volcanics, which flanks the eastern part of the Dundas trough sequences.

The Birchs Inlet–Mainwaring volcanics contain units geochemically similar to the island-arc tholeiites of the South Sandwich Islands, as well as others similar to intra-plate basalts (McClenaghan and Findlay, in prep.; Brown, in prep.)

Andesite/rhyolite association (Noddy Creek volcanics)

Samples of this association, from both the Macquarie Harbour and Montgomery Quadrangles, are calc-alkaline and have an island-arc geochemical character. In the southern part of Point Hibbs and northern Montgomery area three groups of pyroxene/plagioclase basaltic-andesite to andesitic rocks, and a later group of hornblende-bearing andesite/dacite dykes, have been recognised. The four groups define a chemically evolving suite of volcanic rocks consistent with the east-facing nature of the sequence.

Two distinct groups of calc-alkaline rocks have been identified in the Macquarie Harbour Quadrangle. The first group consists of pyroxene/plagioclase phyric andesite lavas, while the second group consists of quartz/feldspar phyric rhyolitic lavas. Chemically the Macquarie Harbour rocks closely resemble the calc-alkaline Mount Read volcanic rocks from the Queenstown to Hellyer area (Burrett and Martin, 1989).

Ultramafic Rocks

Samples of ultramafic rocks from the mélange zone in the Macquarie Harbour and Point Hibbs Quadrangles have similar geochemical characteristics to all three groups of layered ultramafic rocks described from western Tasmania (Brown, 1986). Associated with the ultramafic rocks are lavas with similar geochemistry to the low-Ti basalt and boninitic suites from western Tasmania (Brown and Jenner, 1989). Also present are blocks of gabbro, andesite and rhyolite with similar geochemical characteristics to the Noddy Creek volcanics.

Brown and Jenner (1989) argue strongly that the low-Ti and high-Mg lavas of western Tasmania indicate a supra-subduction zone setting, with the various ultramafic rock associations being low-pressure, high-temperature magma chamber cumulates derived from the parental liquid for the lava. We consider that the ultramafic rocks of the study region formed in the same way.

Geochemical comparisons with western Tasmania

When comparison of immobile element chemistry, including Rare Earth Elements, is made between igneous rocks from the Montgomery, Point Hibbs and Macquarie Harbour Quadrangles and rocks from western Tasmania (Brown, 1986; Burrett and Martin, 1989; Corbett, 1979; Jack, 1989) the following correlations can be made:

(1) The boninitic and low-Ti basalt lavas are similar to lavas found in the Heazlewood–Waratah and McIvor Hill–Stonehenge areas of western Tasmania.

(2) The basaltic rocks from the Birchs Inlet–Mainwaring River basalt suite fall into two groups; a lower picritic basalt and an upper tholeiitic basalt. Analyses of the lower picritic basalt are similar to samples of the Miners Ridge Basalt, and analyses of the tholeiitic basalt are similar to samples from the Henty Fault area. These correlations indicate that similar basaltic lavas to the Mainwaring River–Birchs Inlet rocks underly the main body of Mt Read Volcanics in western Tasmania.

(3) The pyroxene/plagioclase-pyhric basaltic andesite and andesitic rocks from the southern part of the Point Hibbs and Montgomery Quadrangles, the Noddy Creek volcanics, have geochemical similarities to analyses from the Que River–Hellyer area, although the Montgomery samples are less evolved.

(4) The late-stage hornblende-phyric andesitic-dacitic dykes from the Montgomery Quadrangle and the rhyolitic rocks from the Macquarie Harbour Quadrangle have similarities to the bulk of the acid to intermediate rocks of the Mount Read volcanics.

These geochemical correlations between the mafic and felsic rocks of the Montgomery, Point Hibbs and Macquarie Harbour Quadrangles and the mineralised volcanic rocks from western Tasmania, indicate that the Noddy Creek volcanics are a prime exploration target.

STRUCTURAL GEOLOGY

Macquarie Harbour Quadrangle

The region north of the Point Hibbs Mélange Belt contains Precambrian and Cambrian rocks showing evidence for as many as six deformation events and widespread faulting, including very low-angle, probably post-Ordovician thrusting. Of these, the correlative F_4 (Precambrian rocks) and F_3 (Cambrian rocks) folds and associated variably-developed axial plane cleavage are the most widespread. These folds trend northeast, and fold axes range in plunge from vertical to horizontal in a uniform axial plane. The fold axial planes follow the trend of the steep faults, interpreted as thrusts, in the Sorell Peninsula. As the regional NE-trending folds show a wide range of plunges in a uniform axial plane, it is plausible that they could have been produced during thrusting.

A flat thrust of Precambrian rocks over Cambrian beds has been confirmed by drilling in the northern part, and by mapping in the central part, of the Sorell Peninsula (fig. 1). The age of this thrusting is uncertain; all units involved contain a weak development of the NW-trending cleavage formed during folding of the Ordovician rocks in the Timbertops Syncline (fig. 1).

The Point Hibbs Mélange Belt has been interpreted (McClenaghan and Findlay, 1989, cross-section C-E) as a thrust complex cut by younger steeply dipping faults; analysis (McClenaghan and Findlay, in prep.) of fault striations emphasises a late transcurrent phase of movement within the belt.

Point Hibbs Quadrangle

Recent geological mapping in the central part of the Point Hibbs Quadrangle (fig. 2) has indicated that the pattern of westward-directed thrust faulting inferred in the coastal sections by Carey and Berry (1988) may be the dominant structural pattern of the hinterland as well (Section A-B-C, fig. 3). The area between the coast and the more-inland of the two ultramafic belts near Point Hibbs represents the southern extension of the Point Hibbs Mélange Belt as defined by Findlay *et al.* (1989) in the Macquarie Harbour Quadrangle. The two distinct, probably fault-bounded belts of ultramafic rocks in the Point Hibbs area are interpreted as due to thrust imbrication of the same unit. The apparent doubling-up of the thicker ultramafic belt just SE of Hibbs Lagoon (fig. 2), and the merging of the two belts to form a single belt which trends NNE towards Macquarie Harbour, may be due to a combination of thrust imbrication and transfer faults.

The stack of relatively thin east-dipping thrust sheets recognised in the Point Hibbs coastal strip by Carey and Berry (1988) is thought to be folded into a strongly westward-verging synform (Section A-B-C, fig. 3). This event may have taken place during continuing westward tectonic transport. On the western flank of this synform the thrust sheet stack is probably floored by Precambrian basement, as suggested by outcropping Precambrian basement surrounded by Jurassic dolerite on the southern coast of the Point Hibbs peninsula (fig. 2).

Given the observed dominant westward-transport thrust regime in the western part of the Point Hibbs area, it is possible that the poorly-known western contact of the 'Noddy Creek volcanics' against a ?Cambrian mostly clastic sedimentary sequence may also be an eastward-dipping thrust (Section A-B-C, fig. 3).

Montgomery Quadrangle

Three fault-bound structural domains are recognised, according to the orientation of what appears to be the regionally-developed second generation structures. These three domains correspond to the three main volcano-sedimentary successions of the area (Brown, 1988). Subsequent deformations produced cleavages and kink band foliations which maintain a uniform orientation throughout all domains.

In Domain 1, second generation structures trend 155°; they are rotated by 15° to the east in Domain 2; and in Domain 3 they are rotated a further 20° to the east.

The rocks adjacent to the domain-bounding faults are intensely sheared, and are in places schistose containing porphyroclasts of the original material. In most cases these have been rotated and recyrstallised, and display asymmetric pressure shadows.

Based on cross-cutting cleavage relationships in generally restricted localities, the following structural history is proposed:

D_1 Production of rootless isoclinal folds with a commonly bedding-parallel cleavage and axial-plane quartz veining. The cleavage is obvious only where bedding is oblique to the D_2 cleavage.

D_2 This regional event produced both decimetre-scale isoclinal folds and 100 m-scale open folds. Generally one limb of the isoclinal folds has been sheared out. Strain partitioning has produced local zones of intense transposition along the folds' axial plane cleavage to produce a compositional banding; in the low strain zones folds are open to tight and contain an axial plane cleavage. The D_2 folds have been seen only in Domain 1, although the D_2 cleavage occurs in all three domains.

D_3 This deformation formed chevron folds and kink bands and a well-developed crenulation cleavage. These structures trend between 020° and 040°, the latter dominating, and are common to all three domains. Locally, intense D_3 strain has produced a transposition layering.

D_4 These structures are also chevron folds and kink bands, and formed along a trend of 050° to 060°.

D_5 This deformation produced an anastomosing system of two synchronous cleavages along trends of 110° and 140°. It is intensely developed locally and again strain partitioning has been prevalent. This cleavage is restricted principally to the felsic volcanic rocks in the western and southeastern part of the quadrangle. The D_5 structures also include kink bands.

Summary of structural geology

Multiple deformation is common throughout the study area, with between three and five deformation events in the prospective Cambrian sequences. In many examples in the Montgomery Quadrangle rootless isoclinal folds and transposition of bedding are common features, and this development of early high-strain zones and repetition of sequence by isoclinal folding must be considered when exploration models are being evaluated. In the Macquarie Harbour / Point Hibbs region there is a possibility that pre-Ordovician thrusting has juxtaposed the ultramafic rocks, the boninitic lavas, and the calc-alkaline Noddy Creek volcanics to form one or more early thrust stacks; these may extend into the Montgomery Quadrangle.

Late, probably Devonian, widespread thrusting is an important feature of the region, and has both reworked the earlier structures and also may have been responsible for possible sheath folding.

The hypothetical section (fig. 4) indicates the possible results of this late event; packets of previously deformed Precambrian, Cambrian, Ordovician and Devonian (e.g. fig. 3) rocks are believed to have been thrust towards the west/northwest, along a hypothetical basement sole thrust. It is envisaged that thrust ramps have formed within this system, although such structures have not been located with any accuracy. Younger transcurrent faulting along the steeply-dipping anisotropy of the Point Hibbs Mélange Belt has contributed to the structural complexity; this faulting is not shown in the summary diagram (fig. 4).

This developing interpretation has vital implications for the mining industry. These are:

1. A newly-confirmed occurrence of rock units correlated with the Mount Read volcanic belt of western Tasmania. These may be found in the

Macquarie Harbour–Point Hibbs area at several levels within the thrust complex, and thus there may be a repetition of the prospective economic mineralised units.

2. The Precambrian units must be regarded as a potentially thin (perhaps no more than 100–200 m thick in places) cover over extensive Cambrian rocks of high economic potential.

3. The presence of thrust structures throughout the Macquarie Harbour–Point Hibbs–Montgomery Quadrangles (an area of approximately 1000 km^2) points strongly to the likelihood that low to moderate angle Devonian thrusting, as proven in this area, will be important in the re-interpretation of other mineralised regions in western Tasmania.

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[28 October 1991]

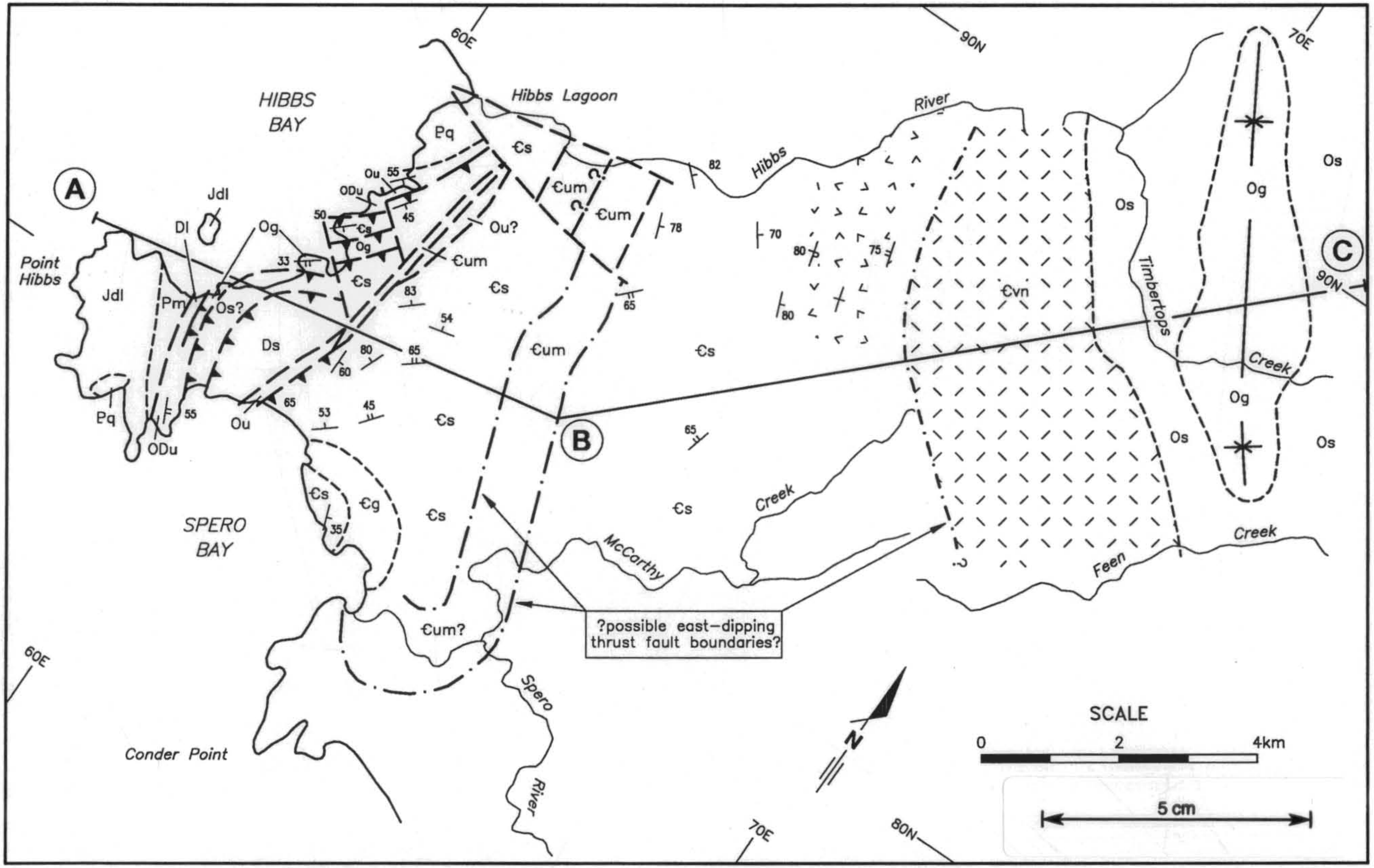

Figure 2. Interpretive Geology: Part of Point Hibbs Quadrangle (Compiled by D. B. Seymour from data of D. B. Seymour and M. P. McClenaghan

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GEOLOGY: POINT HIBBS AREA
LEGEND

PERMIAN	Pm	? Tillite, glaciomarine & marine clastic sedimentary rocks.
DEVONIAN	ODu / Du / Dl	Coralline limestone.
	ODu / Du / Ds	Siliciclastic sedimentary rocks, fossiliferous.
	~~?~~~~?~~~	?Unconformity
LATE CAMBRIAN TO ORDOVICIAN	ODu / Ou / Og	Limestone & dolerite, fossiliferous (GORDON GROUP)
	ODu / Ou / Os	Siliciclastic sedimentary rocks.
	~~	Unconformity
CAMBRIAN	€u / €vn	Andesitic lava & breccia, minor acid volcanics (NODDY CREEK VOLCANICS).
	€u / €s	Laminated siltstone, lithic sandstone & conglomerate, turbiditic in part. Volcaniclastic conglomerate & possible pyroclastic flows derived from acid volcanic source indicated (› ‹ v › ‹ v).
	~~	Unconformity
PRECAMBRIAN	Ꝑq	Metamorphosed turbiditic quartzwacke and mudstone–siltstone.

IGNEOUS ROCKS

JURASSIC	Jdl	Dolerite
CAMBRIAN	€vn	NODDY CREEK VOLCANICS (see above).
	€g	Gabbro
	€um	Ultramafic rocks, sheared serpentinite and minor gabbro with associated boninitic volcanics in places.

Geological boundary, position approx.; inferred from aeromagnetic data, position approx.

Fault, position approx., nature not indicated; thrust fault position approx., teeth on upper plate; fault boundary, trend inferred from aeromagnetic data, position approx.

Bedding, facing known; overturned; facing unknown; vertical

Figure 2

Interpretive geology: Part of Point Hibbs Quadrangle

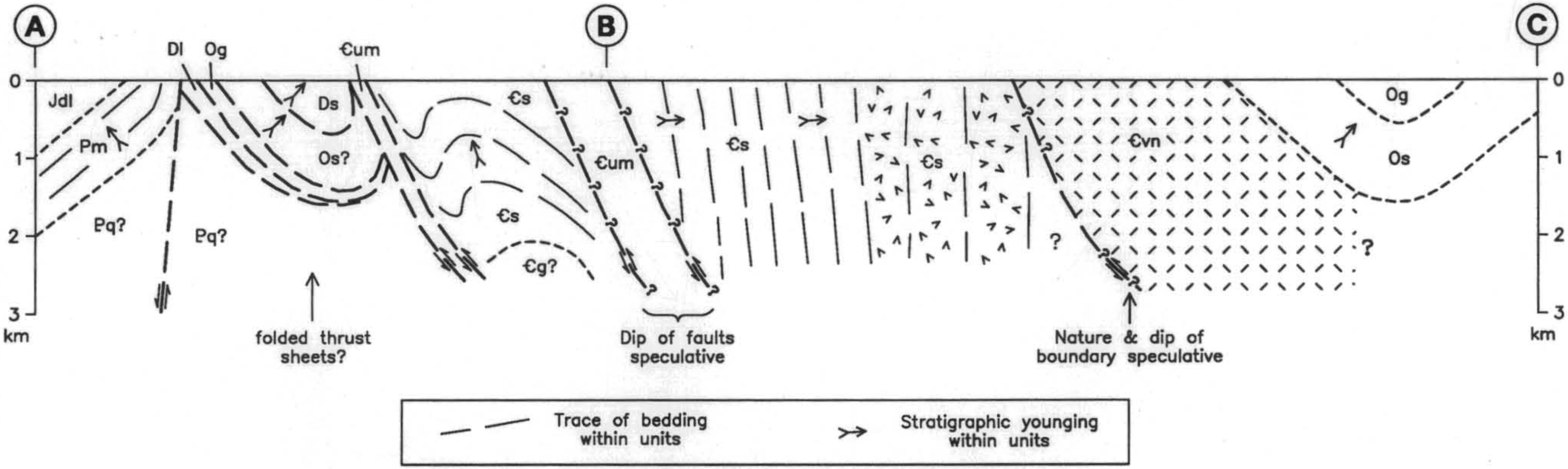

Figure 3. Interpretive section A–B–C, part of Point Hibbs Quadrangle (V/H = 1)

5 cm

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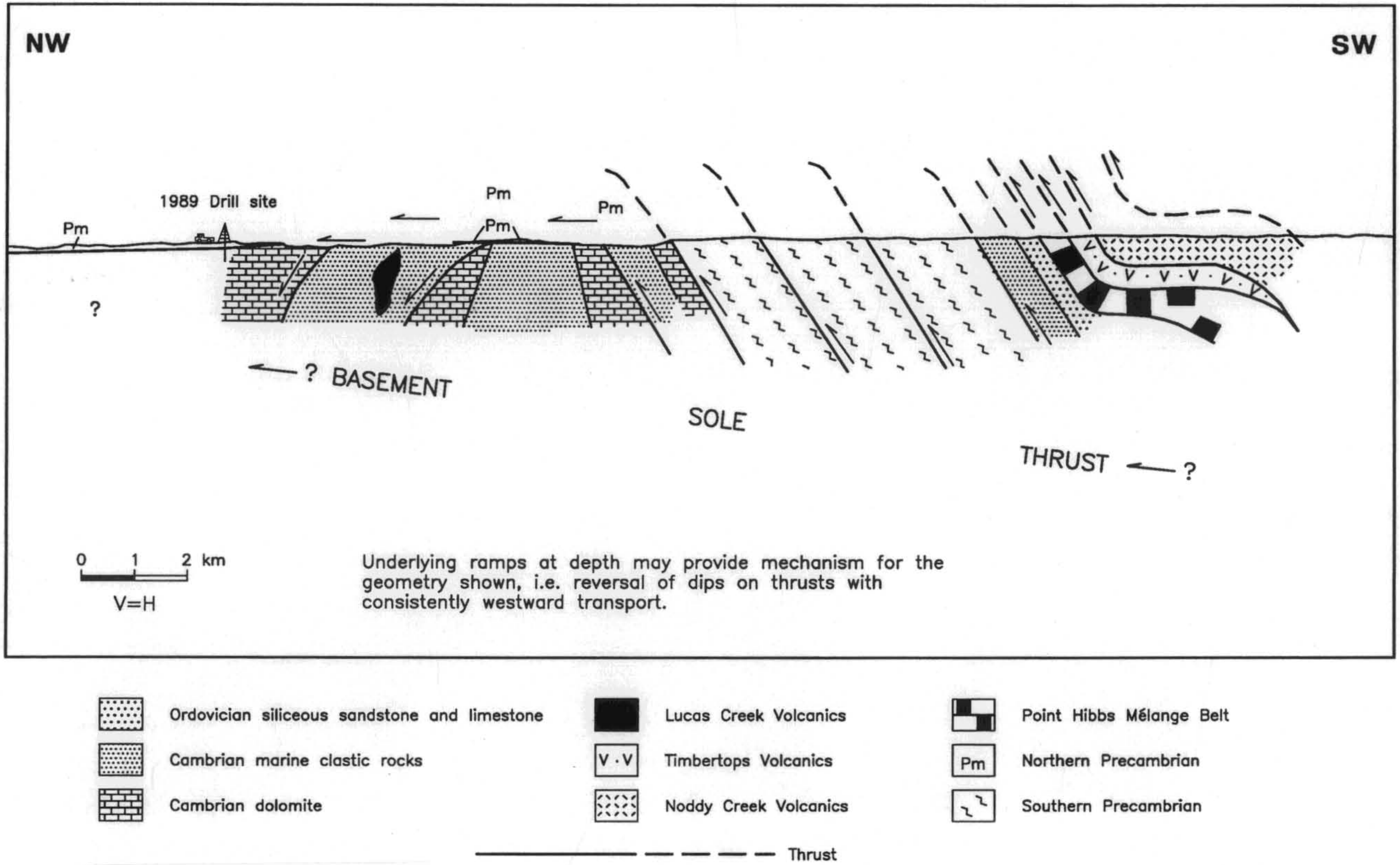
NW
SW
1989 Drill site
Pm
Pm
Pm
Pm
?
? BASEMENT
SOLE
THRUST ?
0 1 2 km
V=H
Underlying ramps at depth may provide mechanism for the geometry shown, i.e. reversal of dips on thrusts with consistently westward transport.
Ordovician siliceous sandstone and limestone
Cambrian marine clastic rocks
Cambrian dolomite
Lucas Creek Volcanics
V · V
Timbertops Volcanics
Noddy Creek Volcanics
Point Hibbs Mélange Belt
Pm
Northern Precambrian
Southern Precambrian
Thrust

5 cm

Figure 4.