EXCURSION GUIDE TO THE SEVENTY MILE RANGE GROUP:

MOUNT WINDSOR VOLCANICS AND TROOPER CREEK FORMATION

To be run as part of the R.A.F. CAS and J.V. WRIGHT Workshop:

MODERN AND ANCIENT VOLCANICS: AN APPROACH TO ANALYSIS OF PROCESSES, PRODUCTS AND SUCCESSIONS

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S.D. Beams

Minerals Department
Esso Australia Limited
Townsville Qld 4810

INTRODUCTION

The volcano-sedimentary terrain of Cambro-Ordovician age NOW REPRESENTED BY the Mount Windsor Subprovince is a worthy subject of an excursion for a Workshop on volcanic rocks and volcanic processes. The volcanics, dominated by acid and intermediate compositions, are well-exposed in parts of the Subprovince, but are only now beginning to be properly documented.

They are of interest for two main reasons. Firstly their age and lithological characteristics invite obvious comparison with acid-intermediate volcanic terrains in the early Palaeozoic elsewhere in the Tasman Fold Belt. A close comparison reveals significant differences. The Mount Read Volcanics in the southern Lachlan Fold Belt are older (Early to Late Cambrian) and in the central and northern Lachlan Fold Belt the next younger acid-intermediate terrain of significance does not appear until the Middle Silurian (the Canberra magmatic province, Cas, 1983). The time-equivalents of the main volcanic suite in the Mount Windsor Subprovince, of Early Ordovician age, in the Lachlan Fold Belt are basalt-andexite suites, exemplified by the Cargo Andesite and Walli Andesite of the Hill End Trough. What then do the volcanics of the Mount Windsor Subprovince tell us about the early tectonics of the northern Tasman Fold Belt?

The second aspect of great interest is the demonstrated economic potential of the Mount Windsor Subprovince. The Thalanga deposit and the Liontown group of volcanogenic Cu/Pb/Zn/Ag deposits together total + 5 million tonnes of high-grade ore, and these have been discovered in only one decade of modern exploration. Strong exploration activity continues in the area.

The excursion and excursion guide would not be possible without the generous co-operation of Esso Australia Limited. Their help is gratefully acknowledged.

W.P. LAING

REGIONAL SETTING OF THE SEVENTY MILE RANGE GROUP

Along the southern margin of the Charters Towers Province the middle Ordovician Lolworth-Ravenswood Batholith intrudes a volcano-sedimentary terrain termed the Mt. Windsor Subprovince (Henderson, 1980). The terrain forms an east-west strip, some 180 km long and up to 30 km wide, stretching from the Leichhardt Range east of the Burdekin River to Pentland in the west. Outcrop is generally poor, being obscured by substantial areas of Tertiary fluviatile sediments, the Campaspe Beds. Rocks of the Subprovince were accorded a general late Cambrian age on the basis of a poor whole rock Rb/Sr isotopic age determination (530-510 m.y.,) obtained for a sample of Mt. Windsor Volcanics and this is is agreement with early Ordovician fossils in the overlying strata.

Strata of the Mt. Windsor Subprovince comprise a conformable sequence over 15 km thick, characterised by felsic and intermediate volcanics and volcaniclastic sediments, and termed the Seventy Mile Range Group (Fig. 1, Henderson, 1982). The sequence generally dips south away from the Lolworth-Ravenswood Batholith. The base of the sequence is everywhere truncated by the batholith, and its top has either likewise been removed by granitoid intrusion, or is covered by Late Palaeozoic strata of the Clermont Province. Henderson (1982) has recently redefined the stratigraphy of the Mt. Windsor Subprovince and recognised the following four formations in the Seventy Mile Range Group. They are listed in stratigraphic order below, with additional lithological information obtained from 10 years extensive field and petrographic examination by Esso Minerals.

Top — Rollston Range Formation: laminated siltstone, siliceous siltstone, and shale, with subordinate volcaniclastic sandstone intercalations. Minor interbedded rhyolite to andesite volcanic units. Over 1500m.

Trooper Creek Formation: interbedded andesite and dacite lava, vitric tuff, and coarse fragmentals, with intercalations of volcaniclastic carbonaceous sandstone and siltstone. 1500-3000m.

Mt. Windsor Volcanics: rhyolitic and rhyodacitic crystal, vitric and lapilli tuffs, with high-level instrusive equivalents interlayered with dacitic to andesitic lavas, and fragmental units. Some barite/chert/bedded sulphide/chlorite/jasper exhalative units. 1600-3500m.

Base — Puddler Creek Formation: quartz-rich micaceous sandstone and siltstone. Over 8000m.

In general the sequence strikes east-west and dips and youngs to the south. It dips steeply away from the Lolworth-Ravenswood Batholith, which typically has subvertical contacts, but dips become more gentle away from the batholith, eventually decreasing to values of 20° - 30°. The Mt. Windsor Volcanics and the Puddler Creek Formation are intruded by an early phase of the Ravenswood Granodiorite (481 m.y., Middle Ordovician).

The Seventy Mile Range Group adjacent to the Ravenswood Granodiorite reveals low-grade slate belt-type deformation, of lower greenschist facies, with simple open folding about a weak subvertical slaty cleavage, trending east-west. Structural complications occur locally, notably the prominent syncline northeast of the Highway Mine on the Clermont Highway.

A metamorphic aureole is developed in rocks of the Subprovince adjacent to the Lolworth-Ravenswood Batholith. Biotite-cordierite-andalusite assemblages are present within this aureole.

Features such as volcanogenic exhalative mineralization, andesite pillow lavas, graded volcaniclastic units, extensive thin dacite lavas, and interbedded epiclastic sediments indicate subaqueous deposition for the bulk of the Seventy Mile Range Group.

Volcanic mineralization is known to occur along the entire length of outcrop of the Mt. Windsor Subprovince, at the following locations (with current Title holders):

Landers Creek	(CEC/Chevron)
Dreghorn	(Esso)
Warrawee	(Noranda)
Highway Gold Mine	(R.C. Hill)
Handcuff	(Esso/EZ/BHP)
Liontown	(Esso/Charters Towers Mines)
Thalanga	(Pennaroya/EZ/BHP)

All of these occurrences are in the exploration stage, except for Thalanga were a predevelopment decline has recently been completed.

LOCAL GEOLOGY OF THE HIGHWAY GRID AND TROOPER CREEK AREAS

The Highway Grid area contains the Highway East and Handcuff Prospects (Fig. 1). The Highway East Prospect occurs 5 km east of the Clermont Highway toward the base of the Mt. Windsor Volcanics, on the eastern limb of the south plunging Highway Synform.

The geology of the Highway East Prospect is shown in Fig. 2. The sequence begins with a complex of felsic high-level intrusives and extrusives (QEP)* which overlie the basement derived quartz rich sandstones and siltstones of the Puddler Creek Formation. These felsic units are characterized by porphyritic rhyodacite lava domes and crystal rich volcanics. Coarse framework supported volcanic breccias (DF) largely consisting of equant pebbles and boulders of porphyritic rhyodacite/rhyolite overlie the felsic volcanics and probably represent debris flows off the flanks of the lava domes. The volcanic breccia is interbedded with fine tuffaceous sandstone and siltstone units and overlain by a fine grained siliceous package of bedded chert, red jasper and fine grained tuff aceous sediments (CH). This unit is in turn overlain by an interbedded sequence of andesite lavas (AND) and fragmentals, medium grained dacite lava flows and fine grained dacitic volcaniclastics (DAC). The dacites and andesites are pyritic and occasionally contain disseminated base metal.

The Handcuff Prospect occurs 2 km east of the Clermont Highway on the western limb and hinge of the Highway Synform, and occupies a higher stratigraphic position within the Mt. Windsor Volcanics than the Highway East area. The footwall sequence at Handcuff (Fig. 3) consists of units of dacite and andesite lavas and fragmentals (FWIV) together with rhyodacite crystal tuff (RDFL). A thin unit of barite-rich chert (SCI) occurs within these footwall sequences which in turn are overlain by the Handcuff Horizon marking a break in the deposition of coarse volcanic units. The Handcuff Horizon (HHCS) is a complex package of fine grained units including exhalative chert, fine grained tuffaceous sediments, vitric units, massive bedded sulphide and chlorite-carbonate exhalite. Explosive volcanism followed with the deposition of coarse dacite rhyodacite fragmentals (DFA) and crystal-rich rhyodacitic tuff (AVRD). Epiclastic volcanic conglomerates and tuffaceous siltstone (SVTS) are interlayered with the later units.

The Trooper Ck Prospect occurs 10 km east of the Clermont Highway south east of the Highway Synform (Fig. 1). It occurs at a slightly higher stratigraphic level than the Handcuff Prospect, at the contact of the Mt. Windsor Volcanics and overlying Trooper Ck Formation. The Liontown deposit ocupies the same stratigraphic position, 25 km to the west.

* For rationale behind abbreviated lithological notation see Keys to Figs. 2, 3 and 4.

The geology of the prospect (Fig. 4) consists of a southward dipping (40-65^{O}) and younging volcanic sequence, having a quartz-eye rhyodacite unit at the base interlayered with coarse rhyodacite breccias, overlain by fine grained dacite lava and vitric tuff units. These rhyodacite units are in turn overlain by a slightly less silicic rhyodacite to dacite coarse flow banded fragmental (fragments 5-20 cm) with some interbedded very fine grained dacite lava and vitric tuff units. Examination of diamond drillcore has shown these latter units to consist of a series of several upward fining coarse breccia units grading up to fine grained ash and vitric units (Fig. 5). This series of units is typical of that observed in documented, so-called subaqueous pyroclastic flows (e.g. Fiske, 1963; Fiske & Matsuda, 1964).

Some jasper units occur at the top of the volcanics. These are overlain by a predominantly fine grained sedimentary sequence of siltstone and fine sandstone, which is bleached at the surface with prominent manganese oxide staining, but consists of black pyritic-pyrrhotitic carbonaceous and calcareous siltstone at depth.

Petrographic work on the pyritic siltstone has indicated a tuffaceous component is present, evidenced by the angular quartz grains and very irregular devitrified glass shards.

The sediments are intruded by coarse dolerite and overlain by a coarse basaltic/andesitic fragmental unit intelayered with thin cross bedded tuffaceous sandstone. The mafics are followed by a thin jasper unit having a continuous strike length of 1 km, and then by fresh dacite lava and ironstained dacite tuff. The sequence has been offset by a large northwest trending left lateral fault at the eastern end of the prospect.

HIGHWAY EAST-OUTCROP NOTES

The excursion turns off the Clermont Highway at the Policeman Ck Bridge and follows a series of exploration tracks to reach Highway East. Outcrop through the area traversed is generally poor, with some good exposures in the deeper creeks of the overlying Tertiary age Campaspe Beds conglomerate and clay rich sandstone.

Stop 1: (100,000 Map Sheet Grid Reference: GR200477 Charters Towers)
Strongly outcropping massive porphyritic rhyolite forms the range of hills at the base of the Mt. Windsor Volcanics and is well exposed in this creek. Quartz and feldspar phenocrysts are conspicuous in hand specimens. In thin section both well formed and broken crystals of quartz, K-feldspar and plagioclase are present (Figs. 6 & 7) in a holocrystalline quartz feldspar groundmass. Flow banding and well developed breccias are present in the creek south of the massive rhyolite. Overall the textures and field relations suggest a coulee breccia marginal to a lava dome.

Stop 2: (GR198477 Charters Towers)
Bedded medium grained tuffaceous sandstone in gully. Highly angular broken crystal of quartz and feldspar in a fine interlocking matrix of quartz and feldspar (Fig. 8). Some brown wispy sheet silicate illite?

Stop 3 & 4: (GR198477 Charters Towers)
Interlayered sequence in creek of very coarse volcanic breccia and thick to thin bedded tuffaceous sandstone. Equant bladey framgents of rhyolite prophyry up to 20 cm occur in the breccia.

A much younger (Tertiary to Recent) talus overlies the bedrock and confuses the surface geology. 10m further down the creek fine laminated cherty sediments are exposed. What do the breccias represent? In a sketch schematically represent the possible relationships between the rhyolite of Stop 1 and the breccias at this stop.

Stop 5: (GR197476 Charters Towers)
Massive andesite lava. Some wellformed phenocrysts of plagioclase in a holocrystalline flow-lineated matrix dominated by plagioclase laths, minor clinopyroxene and abundant secondary epidote (Fig. 9). Some amygdales of quartz and epidote.

Stop 6: (GR191479 Charters Towers)
Columnar jointed dacite lava. Phenocrysts of perfectly formed plagioclase in holocrystalline (non-vitroclastic) matrix of fine plagioclase laths and interstitial quartz (Fig. 6). Minor disseminated pyrite is present. The lateral extent of these flows is a function of the subaqueous environment (Cas, 1978).

Stop 7: (GR188470 Charters Towers)
Coarse andesitic Breccia containing abundant fragments (1-10 cm) of chloritic vesiculated andesite and rhyolite porphyry. 10m to the east is a quartz-feldspar porphyritic rhyodacite dyke. 100m to the west is a fine grained pyritic dacite which appears to be a massive chert but thin sections show crystals of quartz and plagioclase with abundant (5-10%) disseminated and fine veins of pyrite with minor base metals.

TROOPER CREEK-OUTCROP NOTES

The excursion turns off the Clermont Highway 6 km south of the Highway Mine. Outcrop is poor on the track in to Trooper Creek.

Stop 1: (GR268430 Charters Towers)
TA024 drill path (Figs. 5 & 11) traverses the top of the Mt. Windsor Volcanics from overlying black siltstone to a series of graded block and ash subaqueous flows - to be also examined in core if time permits.

Stop 2: (GR270425 Charters Towers)
Medium to coarse grained diorite intrusive; plagioclase laths ophitically intergrown with clinopyroxene (Fig. 12).

Stop 3: (GR273423 Charters Towers)
Creek traverse includes interbedded siltstone with scoriaceous basalt in basaltic/andesitic matrix.

Stop 4: (GR270421 Charters Towers)
Coarse andesite fragmentals interbedded with laminated cross-bedded siltstone lenses. Overlain by jasper and dacite lava (Fig. 13).

EXAMINATION OF CORE

1) TROOPER CK PROSPECT TA024 (Figs. 4, 5 & 11)
(GR268430 Charters Towers).

SUMMARY LOG:

0.18m	Weathered fine grained siltstone.
18-36m	Mixture of fine grained dacitic vitric tuff + ironstained tuff sandstone.
36-40m	Black pyritic siltstone 5-10% pyrite.
40-56m	Fine grained flow banded rhyolitic vitric tuff.
56-147.5m	Sequence of fining uphole block and ash flows. Each flow unit 10-30m thick.

2) HANDCUFF PROSPECT HH007 (Fig. 3).
(GR183489 Charters Towers)

HOLE ID	M	FORM-ATION	M	SUB-FORM-ATION	LITHOLOGY
HH007	0-207.4	HWVS	0-36	SVTS	Tuffaceous siltstone
			36-45.2	SOP	Epiclastic conglomerate
			45.2-48.2	SV	Reworked Tuff
			48.2-138.5	AVRD	Rhyodacitic feldspar porphyry (Fig. 14).
			138.5-149.2	SCI	Chert minor tuffaceous ss.
			149.2-196.9	DFA	Dacite fragmental
			196.9-203.5	ATG	Broken zone-fault
			203.5-207.4	IVA	Andesite fragmental
	207.4-344.7	HHCS	207.4-220.3	SCI	Chert
			220.3-225	CHCB	Chlorite carbonate rock
			225-224.3	SVTS	Tuffaceous siltstone
			224.3-261.7	SCI	Yellow chert "accretionary lapilli"
			261.7-271.1	DL	Dacite lava
			271.1-292.0	SCI	Vitric tuff (Fig.15)
	344.7-489.5	FWIV	344.7-489.5	DBHP	Dacite hydrothermal breccia veined by hm, cpy, py, sp.

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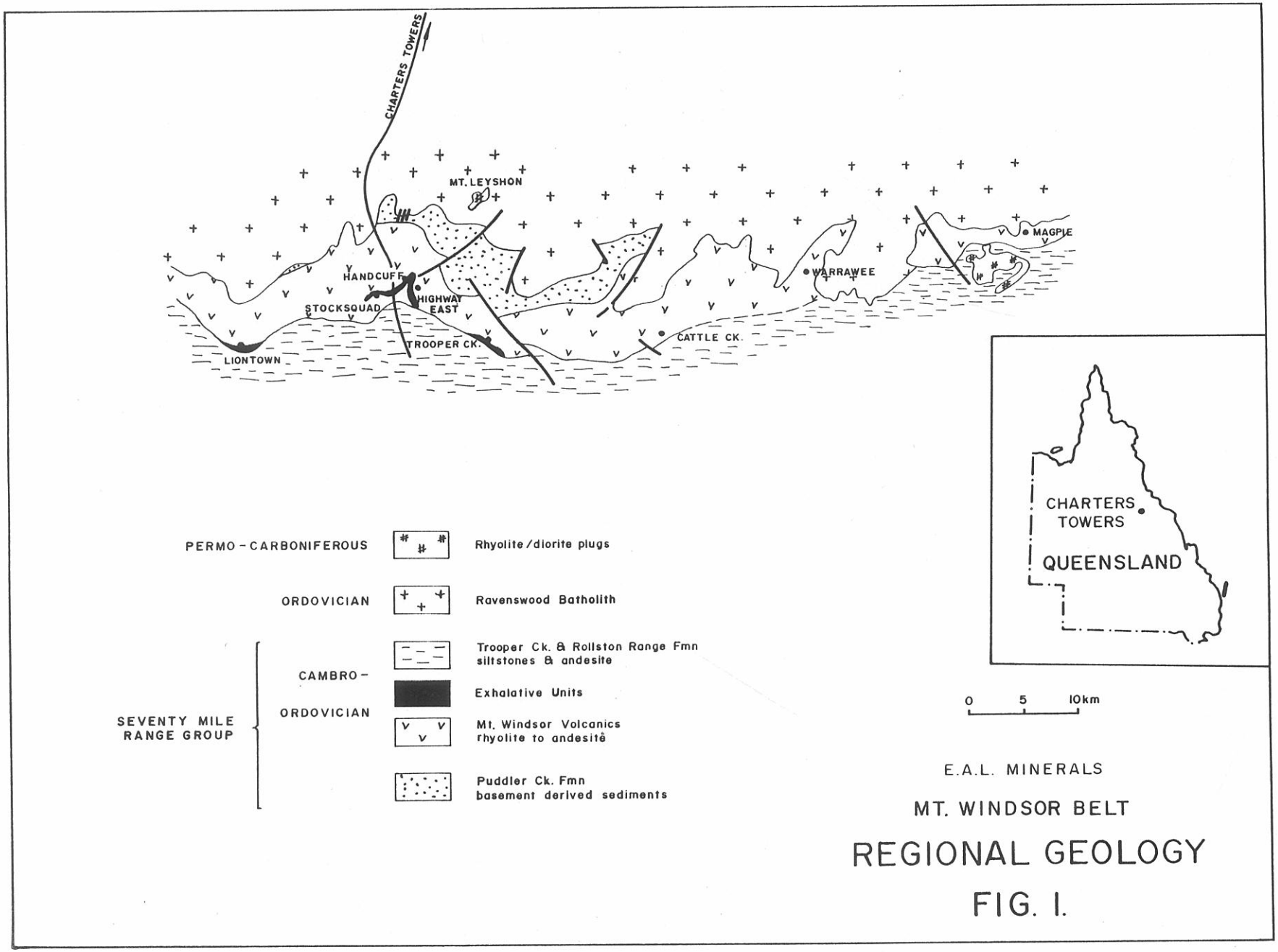
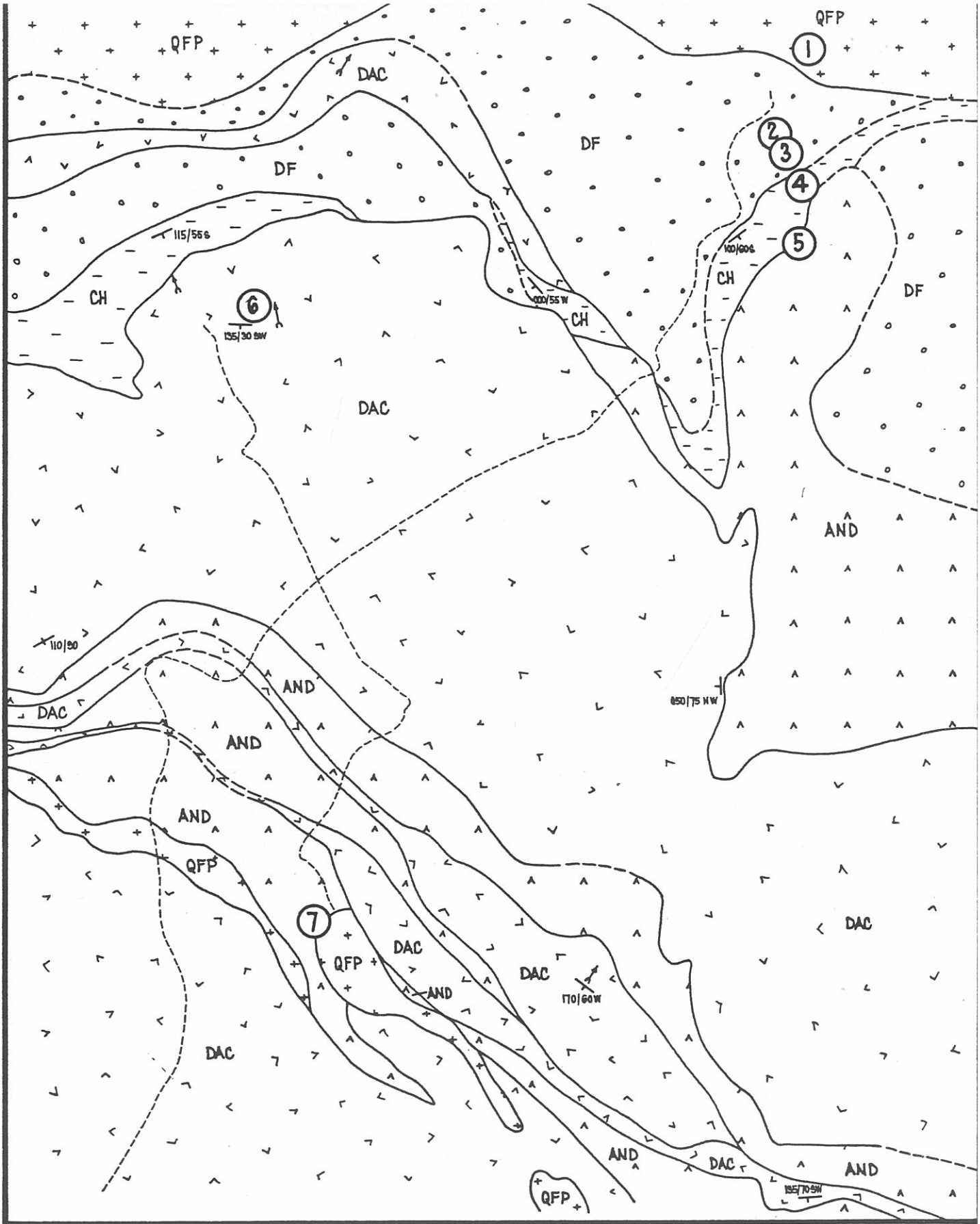

CHARTERS TOWERS
MT. LEYSHON
MAGPIE
WARRAWEE
HANDCUFF
HIGHWAY EAST
STOCKSQUAD
TROOPER CK.
CATTLE CK.
LIONTOWN
PERMO - CARBONIFEROUS
Rhyolite / diorite plugs
ORDOVICIAN
Ravenswood Batholith
SEVENTY MILE RANGE GROUP
CAMBRO - ORDOVICIAN
Trooper Ck. & Rollston Range Fmn siltstones & andesite
Exhalative Units
Mt. Windsor Volcanics rhyolite to andesite
Puddler Ck. Fmn basement derived sediments
CHARTERS TOWERS
QUEENSLAND
0 5 10km
E.A.L. MINERALS
MT. WINDSOR BELT
REGIONAL GEOLOGY
FIG. I.



DAC — Dacite lava, some fine vitric tuff. RJ ~ 1%.

AND — Andesite lava and coarse fragmentals.

CH — Bedded chert, bedded fine grained tuff.

DF — Debris flow conglomerate interbedded tuffaceous sandstone.

QFP — Rhyodacite porphyry high level intrusive.

170/60W — Strike and dip of bedding. Plunge direction of columnar jointing.

(2) — Excursion stop.

GN / MN 50°

FIG. 2.

MINERALS DEPT, ESSO AUSTRALIA LTD

MT WINDSOR A to P 3380 M - PROJ. 348

HIGHWAY EAST

INTERPRETATIVE GEOLOGY

SCALE 1:5000

0 100 200

METRES

Author : G.D. Beame

Drawn: Jan. 1985

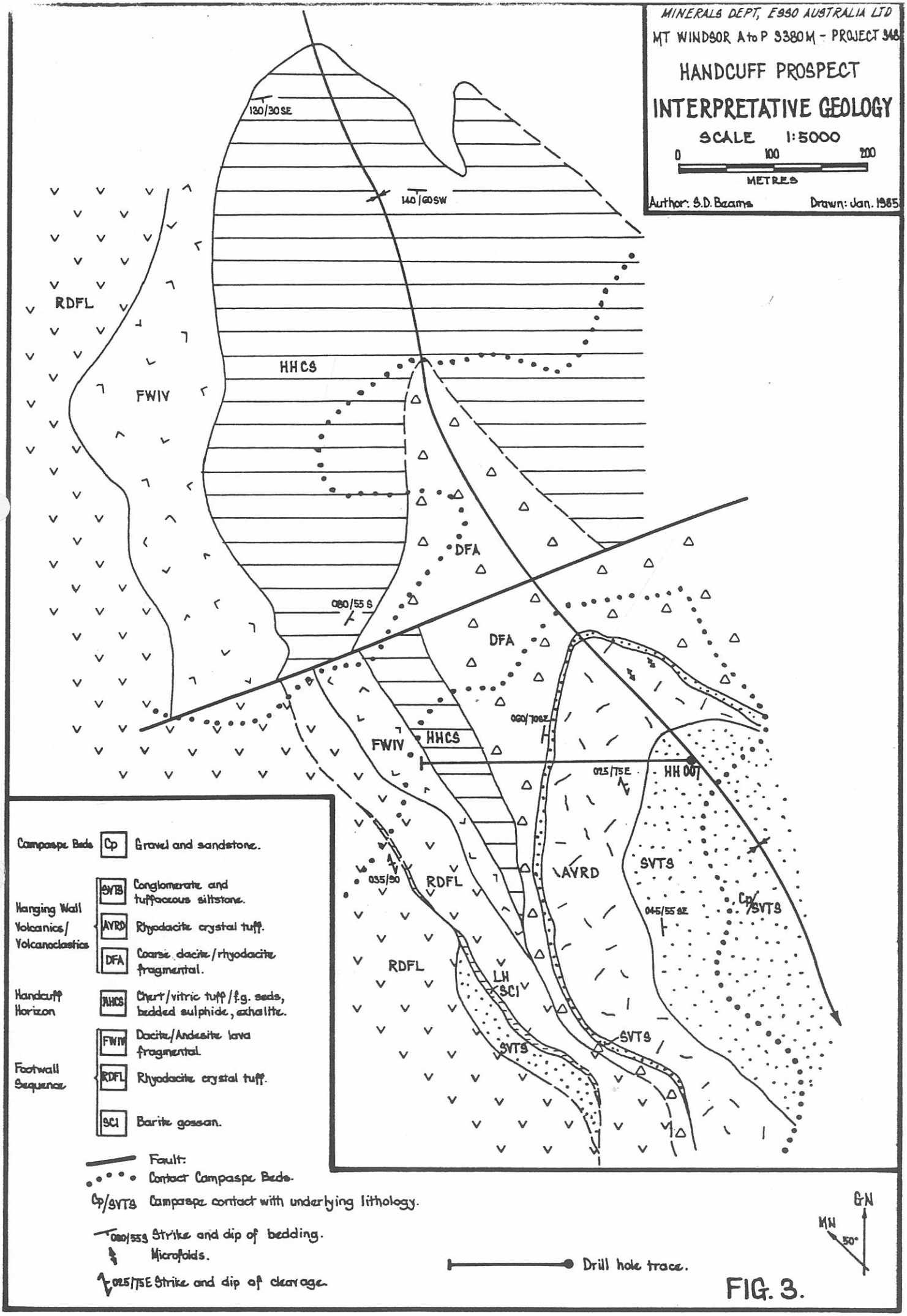
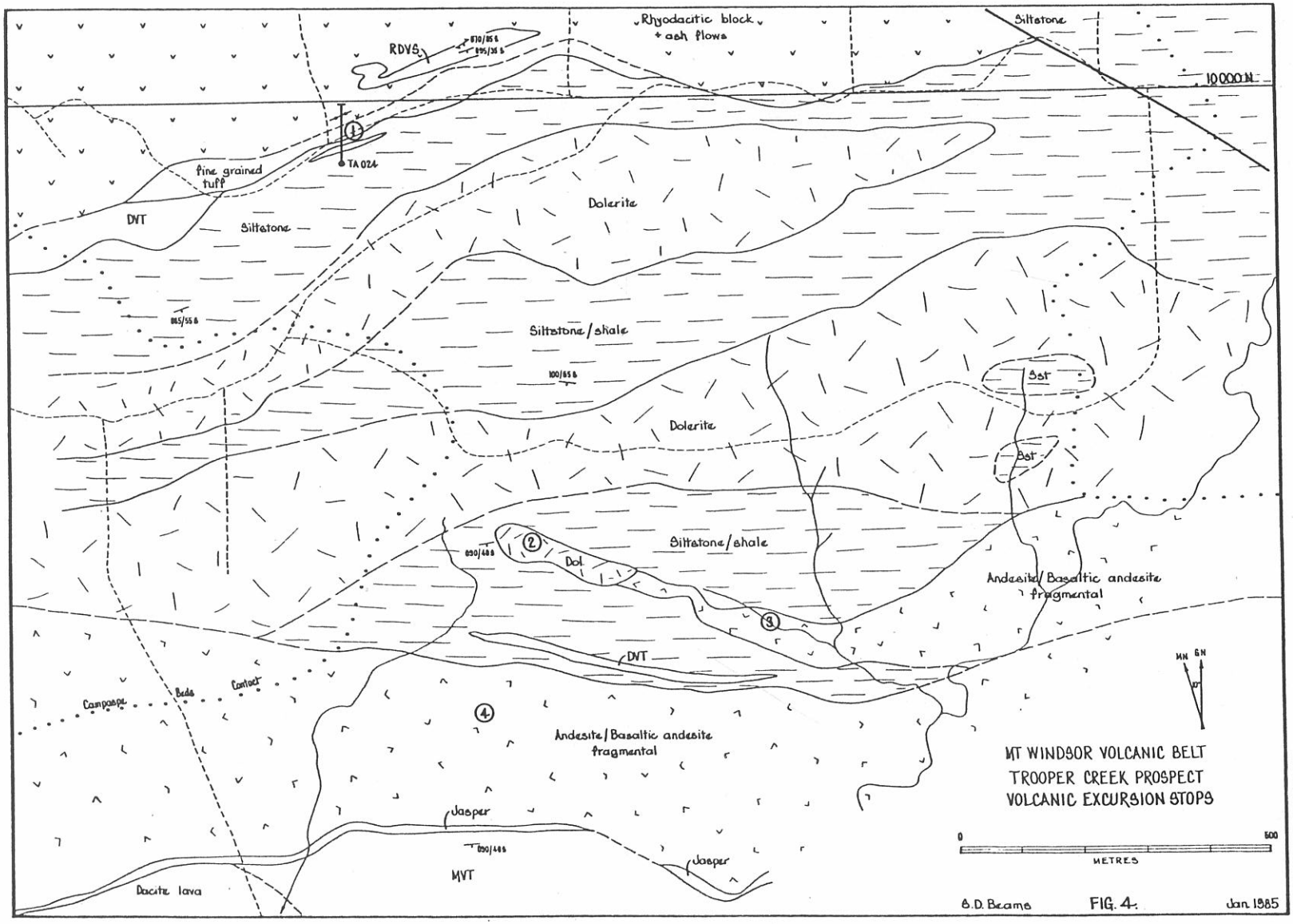

MINERALS DEPT, ESSO AUSTRALIA LTD
MT WINDSOR A to P 9380M - PROJECT 348
HANDCUFF PROSPECT
INTERPRETATIVE GEOLOGY
SCALE 1:5000
0 100 200
METRES
Author: S.D. Beams
Drawn: Jan. 1985
130/30SE
140/60SW
RDFL
FWIV
HHCS
DFA
080/55S
DFA
FWIV
HHCS
060/70SE
025/75E
HH OUT
035/90
RDFL
AVRD
SVTS
045/55SE
Cp/SVTS
RDFL
LH SCI
SVTS
SVTS
Campaspe Beds
Cp
Gravel and sandstone.
Hanging Wall Volcanics/ Volcanoclastics
SVTS
Conglomerate and tuffaceous siltstone.
AVRD
Rhyodacite crystal tuff.
DFA
Coarse dacite/rhyodacite fragmental.
Handcuff Horizon
HHCS
Chert/vitric tuff/f.g. seds, bedded sulphide, exhalite.
Footwall Sequence
FWIV
Dacite/Andesite lava fragmental.
RDFL
Rhyodacite crystal tuff.
SCI
Barite gossan.
Fault:
Contact Campaspe Beds.
Cp/SVTS Campaspe contact with underlying lithology.
080/55S Strike and dip of bedding.
Microfolds.
025/75E Strike and dip of cleavage.
Drill hole trace.
GN
MN 50°

FIG. 3.


RDVS
Rhyodacitic block + ash flows
Siltstone
10000 N
Fine grained tuff
TA 024
DVT
Siltstone
Dolerite
Siltstone/shale
Dolerite
Sst
Sst
Siltstone/shale
Dol
Andesite/Basaltic andesite fragmental
DVT
Campsoil
Beds
Contact
Andesite/Basaltic andesite fragmental
Jasper
Jasper
MVT
Dacite lava
MN
GN
MT WINDSOR VOLCANIC BELT
TROOPER CREEK PROSPECT
VOLCANIC EXCURSION STOPS
0
500
METRES
B.D. Beams
FIG. 4.
Jan. 1985

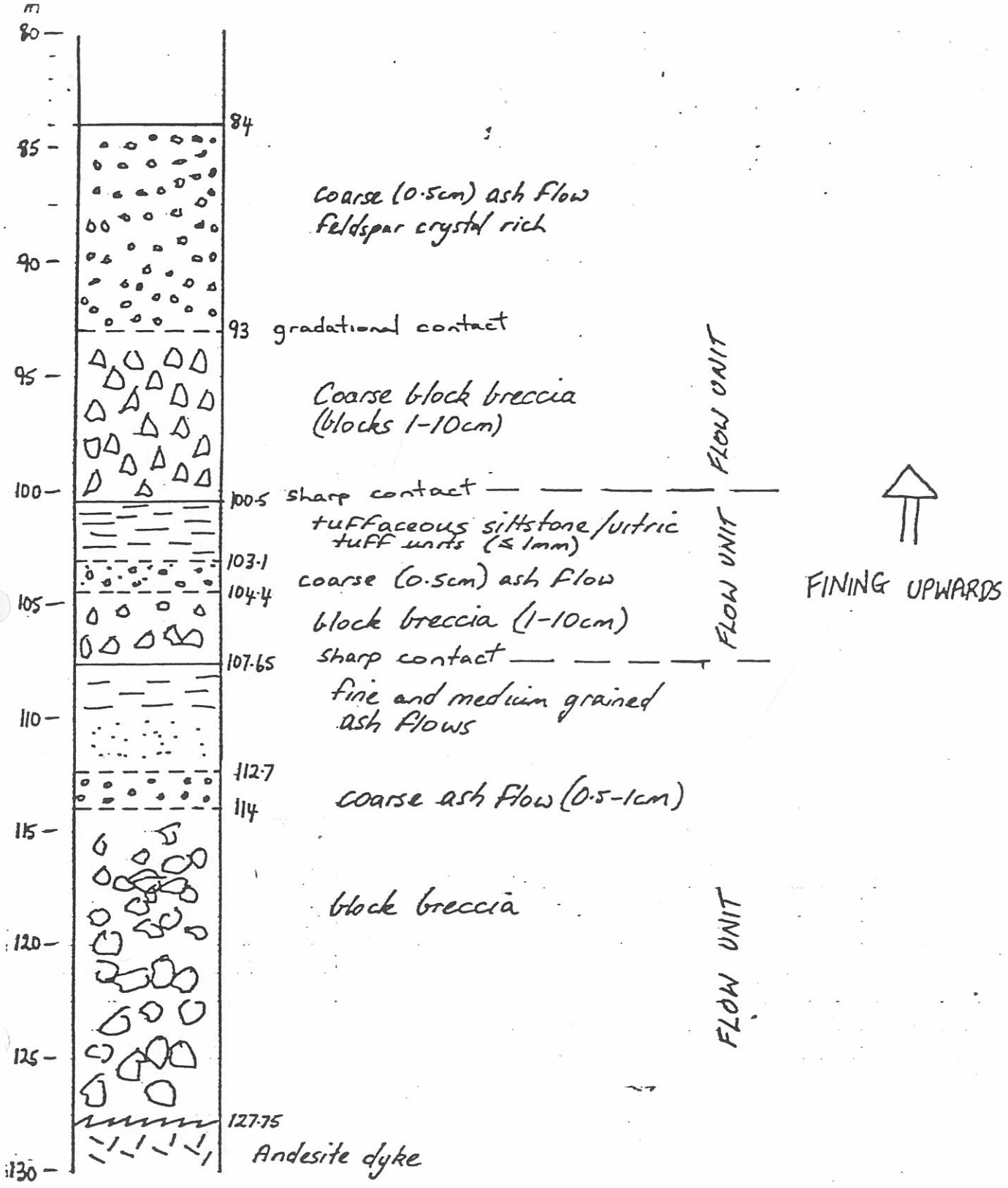


FIGURE 5. PORTION OF DRILLHOLE TA024 SHOWING SEQUENCE OF FINING UPWARDS BLOCK AND ASH FLOWS MT WINDSOR PROJECT TROOPERS CK PROSPECT.
S.D.BEAMS, DEC 1983

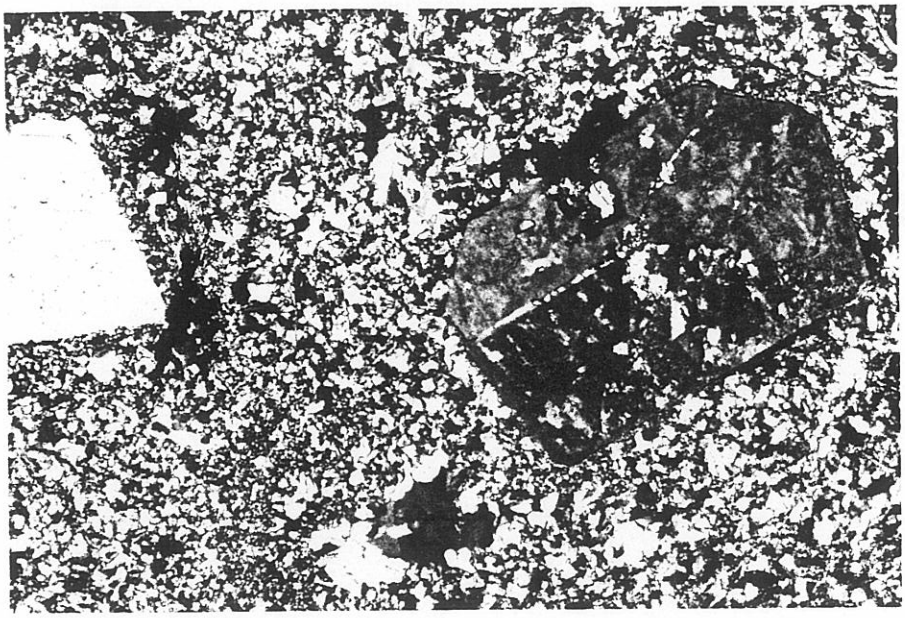


Fig. 6: HIGHWAY EAST, Stop 1. Photomicrograph of porphyrytic rhyodacite. Note large perfectly formed K-feldspar phenocryst with quartz phenocryst in holocrystalline quartz feldspar groundmass.
Xs Nicols 2 mm across.

Fig. 7: HIGHWAY EAST, Stop 1. Photomicrograph of porphyrytic rhyodacite. Well formed and embayed quartz phenocrysts holocrystalline quartz feldspar groundmass.
Xs Nicols 2 mm across.

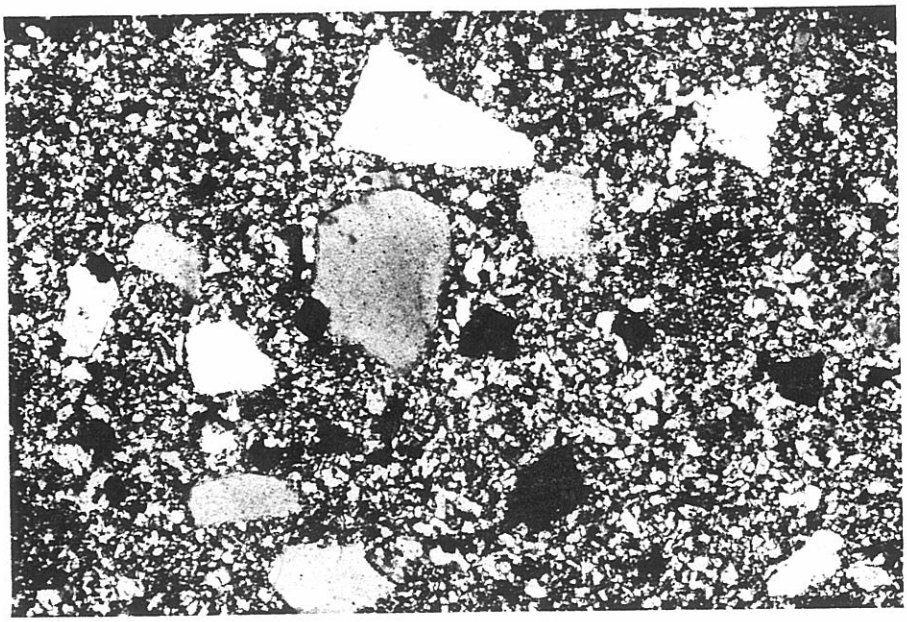


Fig. 8: HIGHWAY EAST, Stop 2. Photomicrograph of bedded tuffaceous sandstone. Angular quartz and feldspar grains in fine grained quartz-feldspar groundmass.
Xs Nicols 2 mm across.

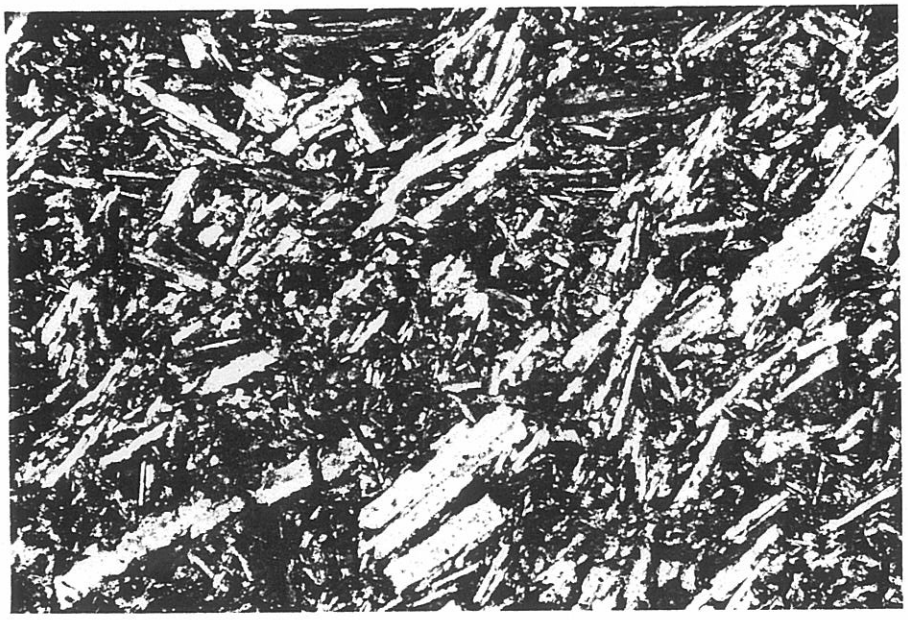


Fig. 9: HIGHWAY EAST, Stop 5. Photomicrograph of andesite lava. Some large well-formed plagioclase crystals in matrix dominated by fine plagioclase laths with interstitial epidote.
Xs Nicols 2 mm across.

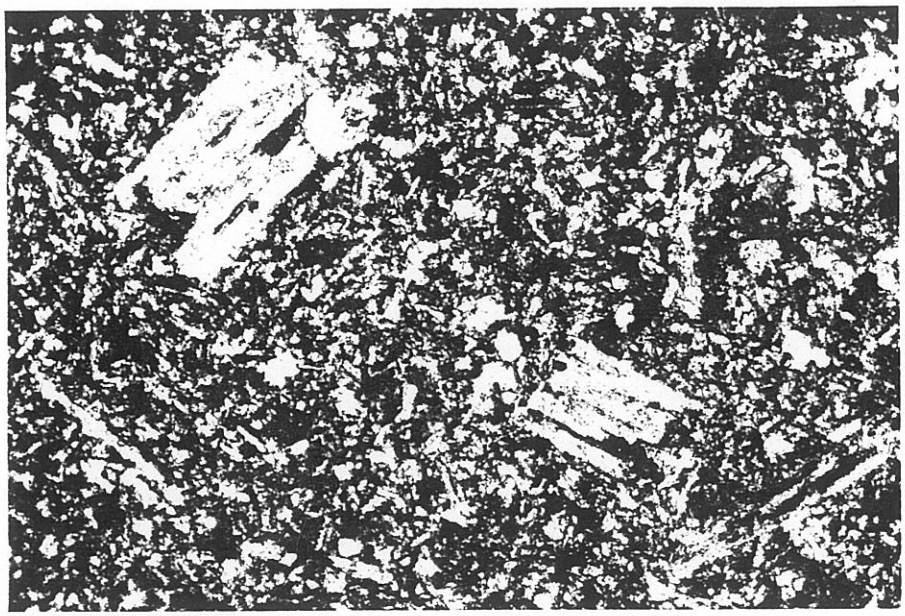
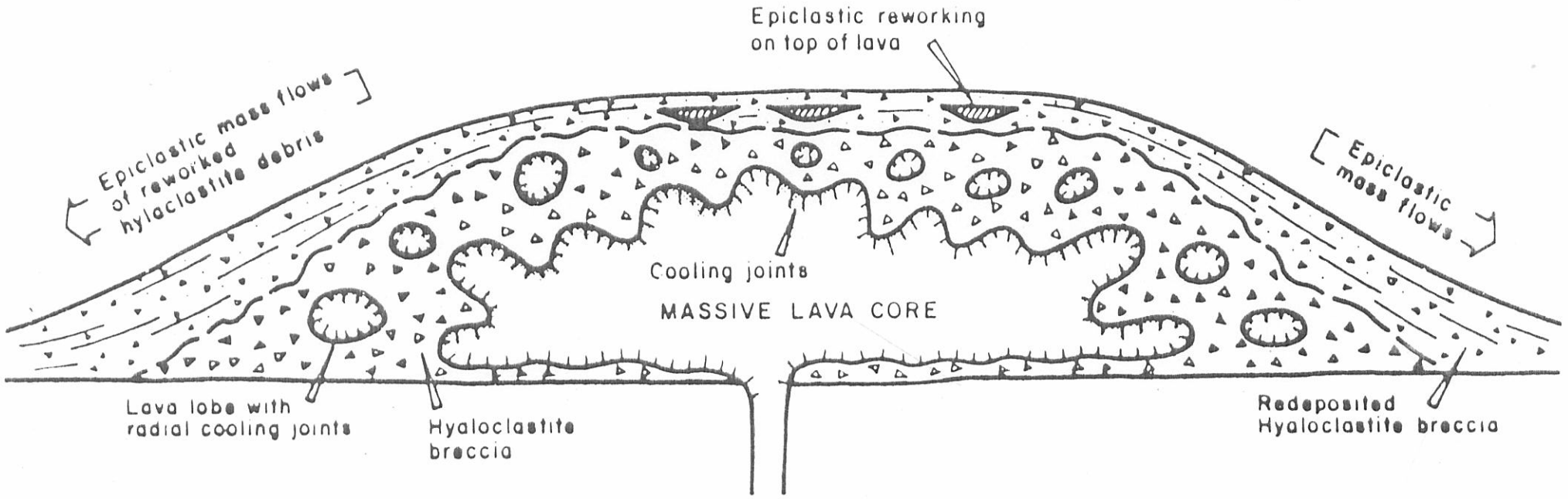


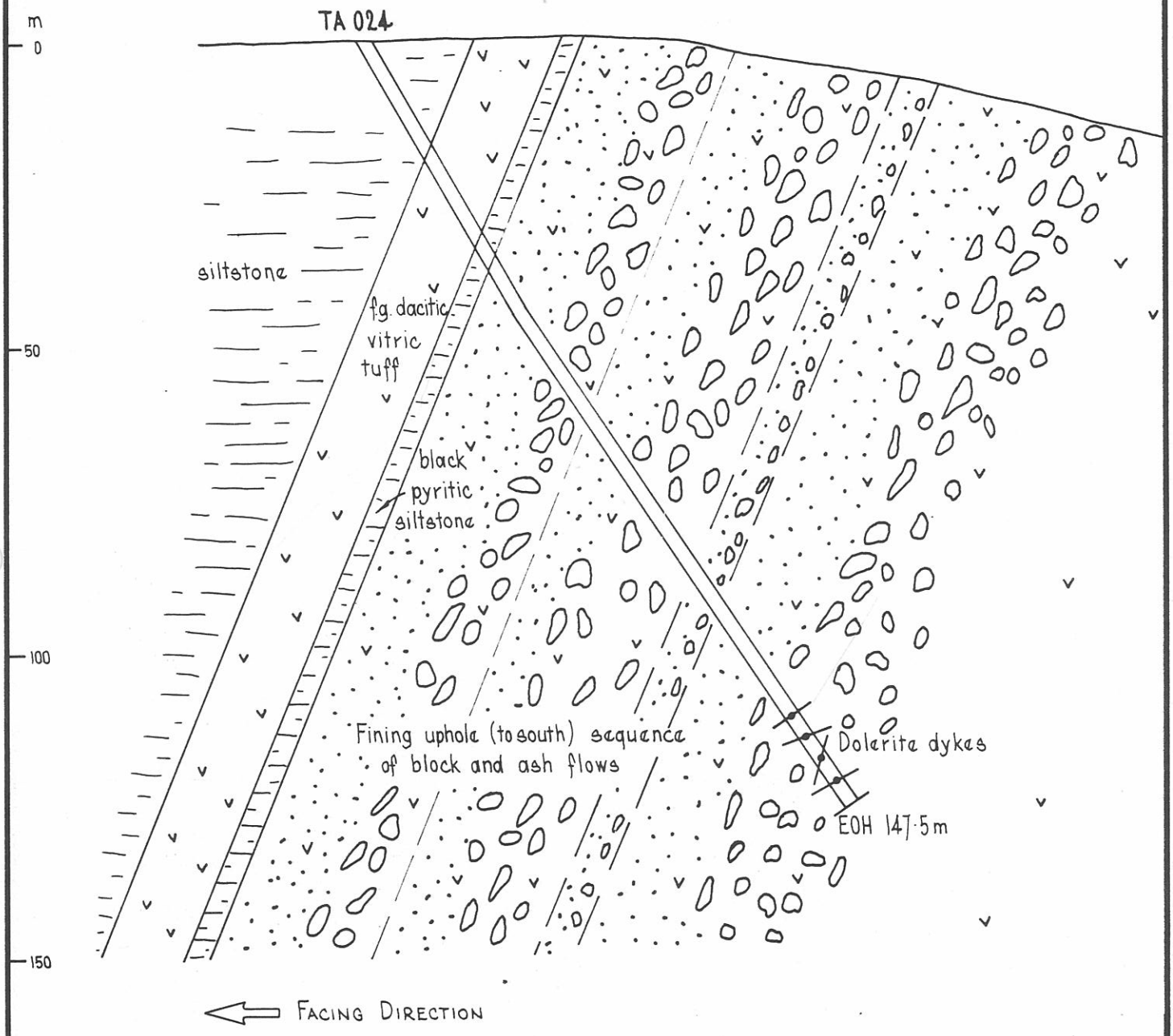
Fig. 10: HIGHWAY EAST, Stop 6. Photomicrograph of dacite lava. Well formed plagioclase phenocrysts in quartz-feldspar groundmass.
Xs Nicols 1 mm across.

SCHEMATIC CROSS-SECTION THROUGH A SUBMARINE SILICIC FLOW OR DOME

Sea Level

Width of lava could be <0·5km - >5km
Height of lava could be 100m - 500m





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MT WINDSOR A to P 3380M - PROJECT 348

TROOPERS CREEK PROSPECT

SECTION 11600E

Precollared Diamond Drill Hole TA024

SCALE 1:1000

0 20 40 60 80 100

METRES

Author : S.D. Beams

FIG. 11.

Drawn : Feb. 1984

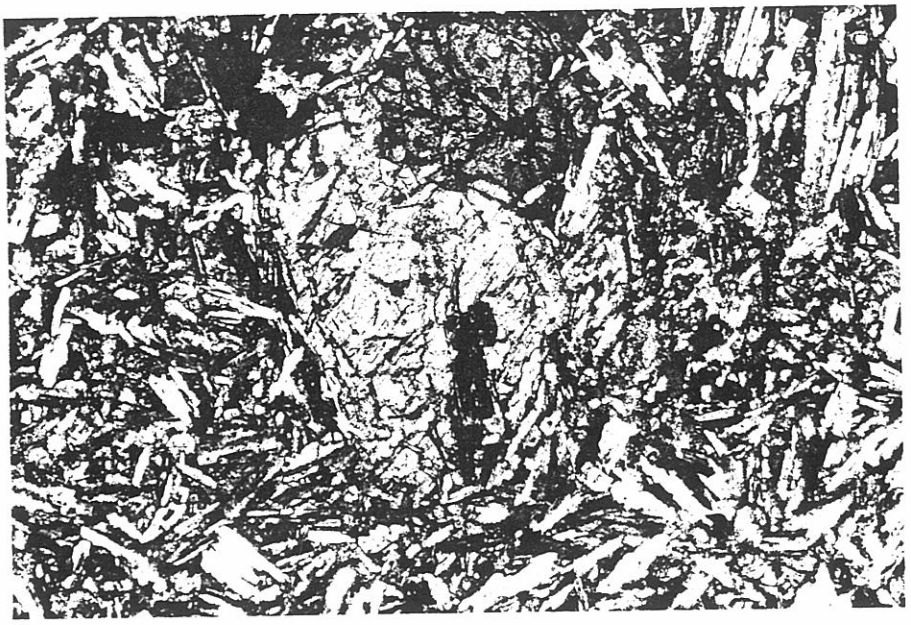

Fig. 12: TROOPER CK, Stop 2. Photomicrograph of medium grained diorite. Large clinopyroxene intergrown with coarse plagioclase laths.
Xs Nicols 2 mm across.

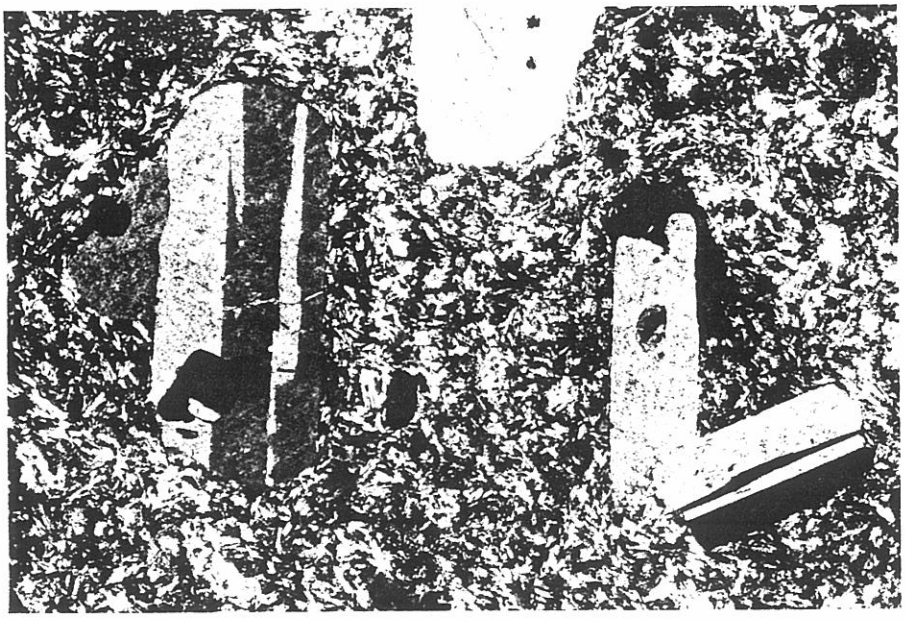

Fig. 13: TROOPER CRK., Near Stop 4. Photomicrograph of dacite lava. Perfectly formed plagioclase crystals in groundmass dominated by fine plagioclase needles and interstitial quartz.
Xs Nicols 2 mm across.

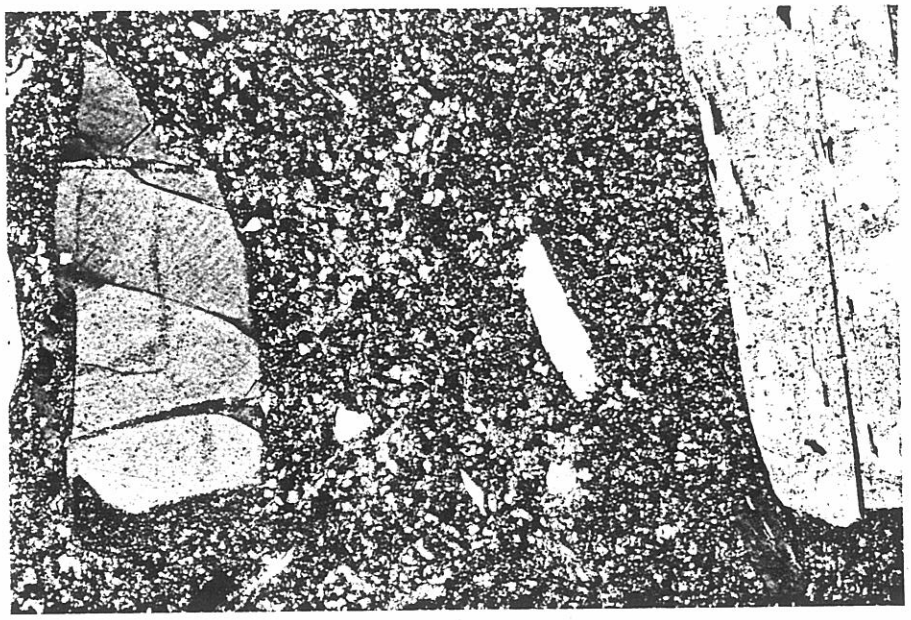

Fig. 14: HANDCUFF, HH021, 106m. Photomicrograph of crystal rich rhyodacite tuff (AVRD). Note angular quartz, plagioclase phenocrysts. Fine angular crystals in quartz feldspar groundmass.
Xs Nicols 2 mm across.

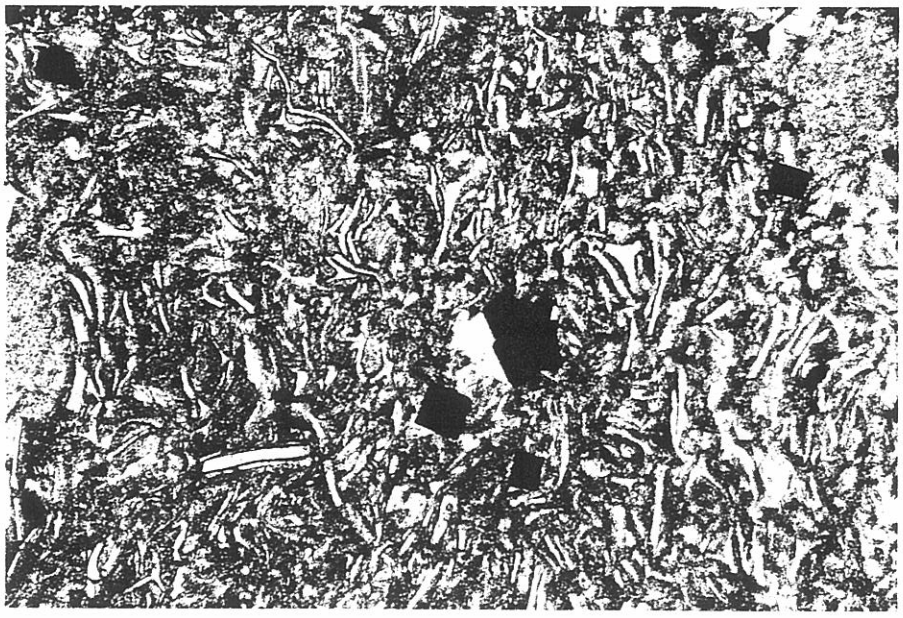

Fig. 15: HANDCUFF, HH007, 282.4m. Photomicrograph of vitric tuff unit in Handcuff Horizon (HHCS). Note beautifully preserved non-welded glass shards. Disseminated pyrite cubes.
PPL. 2 mm across.