DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

A PROGRESS REPORT ON A MEASURED REFERENCE SECTION AT RED CREEK FOR THE KANMANTOO GROUP IN THE KARINYA SYNCLINE.

REPORT BK NO. 91/27

GEOLOGICAL SURVEY

by

C G GATEHOUSE

J B JAGO[1]

and

B J CLOUGH

JANUARY, 1991 DME 673/81

---

[1] University of South Australia. The Levels.

G02323

CONTENTS	PAGE

INTRODUCTION 1

Heatherdale Shale Equivalent 2

Truro Volcanics 3

PETROLOGY 3

GEOCHEMISTRY 4

Carrickalinga Head Formation 7

REFERENCES 10

FIGURE 1 LOCALITY MAP S21957

FIGURE 2 LOCATION OF MEASURED SECTION S21958

FIGURE 3 STANSBURY BASIN STRATIGRAPHY S21959

FIGURE 4 MEASURED SECTION AT RED CREEK S21961a-j

FIGURE 5 PART OF CLASSIFICATION PLOT OF LE BAS ET AL (1986) S21960

FIGURE 6 PART OF CLASSIFICATION PLOT OF WINCHESTER AND FLOYD (1977) S21962

FIGURE 7 CIPW NORMATIVE CLASSIFICATION PLOT FOR SUB-ALKALINE INTRAPLATE LAVAS (JOHNSON, 1989) S21963

FIGURE 8 TECTONIC DISCRIMINATION PLOT OF PEARCE AND CANN (1973). "WITHIN-PLATE" BASALTS PLOT IN FIELD D, MORB (OCEAN FLOOR BASALTS) IN FIELD B, LOW-K THOLEIITES IN FIELDS A AND B, CALC-ALKALINE BASALTS IN FIELDS C AND B S21964

FIGURE 9 MORB NORMALISED SPIDERGRAM FOR AVERAGES OF MURRAY BASIN BASEMENT AND MT LOFTY RANGES ?CAMBRIAN MAFIC SUITES S21965

FIGURE 10 KAROO BASALT NORMALISED SPIDERGRAM FOR AVERAGES OF MURRAY BASIN BASEMENT AND MT LOFTY RANGES ?CAMBRIAN MAFIC SUITES. S21966

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT BK NO. 91/27
DME NO. 673/81
G02323

A PROGRESS REPORT ON A MEASURED REFERENCE SECTION AT RED CREEK FOR THE KANMANTOO GROUP IN THE KARINYA SYNCLINE.

INTRODUCTION

Geological mapping of Cambrian strata on Tepko (Gatehouse, 1988) 1:50 000 sheet area required an understanding of the type sections of units of the Kanmantoo Group on Fleurieu Peninsula (Figs. 1, 2).

Detailed sections were measured at Myponga Creek, Carrickalinga Head, and along the south coast of Fleurieu Peninsula (Fig. 1). These sections were summarised in Gatehouse *et al.* (1990). Mapping on Angaston sheet area has shown that excellent exposures occur at Sedan Hill and Red Creek (Fig. 1).

The Sedan Hill section, on the east limb of the Karinya Syncline, (Cooper and Gatehouse, 1988) is significantly different from a similar stratigraphic interval on Fleurieu Peninsula. Subsequently, a section in Red Creek (Fig. 3) was found to expose an interval from Heatherdale Shale through to, and including the Backstairs Passage Formation.

Because of excellent exposures, the Red Creek section is here proposed as a reference section for the Heatherdale Shale, Truro Volcanics, Carrickalinga Head Formation and Backstairs Passage Formation for the Karinya Syncline area of the Kanmantoo Trough.

To date a total of 934 m has been measured (Fig. 3) which encompasses units referred to the Heatherdale Shale, Truro Volcanics and part of the Carrickalinga Head Formation. The upper sections of the Carrickalinga Head Formation and the Backstairs Passage Formation have yet to be measured although some data are available in McCulloch (1990). The whole sequence exhibits low-grade metamorphism.

Heatherdale Shale equivalent

The base of the section is not exposed and is cut off by the Palmer Fault. The interval between the base of the section (0 m) up to about 290-300 m (Fig. 4) is considered to comprise Heatherdale Shale equivalent with interbedded volcanics being referred to the Truro Volcanics of Forbes *et al.* (1972). The Heatherdale Shale equivalent is overlain gradationally by rocks referred to the Carrickalinga Head Formation.

Lithologically the interval between 220 m and 290 m in the Red Creek section largely is a dark blue-grey, partly pyritic, finely laminated non-micaceous unit comparable to the Heatherdale Shale as exposed in its type section at Sellick Hill (Daily, 1963). This interval also contains some thin cross-bedded sandstone beds. In the basal 220 m of the measured section is a grey, micaceous laminated siltstone with interbedded volcanics which are described in detail later in this paper.

At present the 0-300 m interval is taken to be equivalent to the Heatherdale Shale. However, it could be argued that only the blue-grey non-micaceous unit, as exposed between 220 m and 290-300 m, should be referred to the Heatherdale Shale. This blue-grey unit thins northwards. The micaceous unit may therefore represent a new unit which thickens as the Kanmantoo Trough shallows to the north. Recent mapping by CGG supports this hypothesis.

Truro Volcanics

The volcanics which occur interbedded within the Heatherdale Shale and also within the basal parts of the Carrickalinga Head Formation are referred to the Truro Volcanics of Forbes *et al.* (1972). At Red Creek they comprise lava flows, dykes, tuffs, and crystal tuffs. The presence of pillow lava indicates subaqueous extrusion.

McCulloch (1990) showed that tuffaceous units are interbedded with Heatherdale Shale and that they contain feldspar phenocrysts. Soft recessive thin beds of similar appearance in the basal Carrickalinga Head Formation may also be tuffaceous.

Elsewhere in the Stansbury Basin, green tuff beds in the Parara Limestone may be correlated with the Truro Volcanics of the Karinya Syncline (Alexander, 1990).

PETROLOGY

In hand specimen the volcanics in Red Creek are grey with distinctive large (approx. 0.5 mm diameter) phenocrysts of feldspar (up to approx. 25%) and minor iron staining. The rocks show variable intensities of tectonic foliation.

In thin section it appears that the phenocrysts are predominantly of zoned plagioclase although approximately 10% of the phenocrysts are of an alkali feldspar. The groundmass is predominantly of acicular feldspar laths producing an overall trachytic texture. The tectonic fabric of these rocks varies from slight to intense foliation in which the feldspar phenocrysts have rotated parallel to the foliation. Alteration is pervasive with sericitisation of the feldspars and chlorite/iron-oxide replacement of mafic minerals. Occasional veinlets of quartz and calcite cross-cut this rock. Petrologically the lavas classify as trachytic basalt.

GEOCHEMISTRY

Two samples (6728 RS 1632 and 6729 RS 1515) of massive pillow lava were taken from separate localities near Red Creek and geochemically analysed for a comprehensive suite of elements (Table 1). Several analytical methods were used, including:

IPC (acid digestion) - Major elements
XRF - As, Ba, Bi, Sb, Sn, V, Zr
Atomic Absorption Spectrography - Ag, Cr, Cu, Ni, Pb, Zn
Fire Assay - Au, Pt, Pd
ICP Mass Spectrography - Ce, Dy, Nd, Er, La, Eu, Lu, Yb, Y, Sm, Gd, U, Th, Sr, W, Ta, Mo, Nb, Ga, Co, Cs, Rb.

The two geochemical analyses of the pillow lava reflect their described lithology, as basaltic lavas that have undergone greenschist facies metamorphism. Elevated loss on ignition (LOI) values (average 11.5%) attest to alteration effects resulting in hydration.

Obviously the present chemical composition of the Red Creek lavas is not primary, as the volatile content is significantly higher than in analagous fresh rocks. This is to be expected from the presence of hydrous secondary minerals in these lavas. Similar alteration of mafic lavas in the Victorian greenstone belts (Crawford and Keays, 1978) is considered to have caused hydration, along with slight addition of CO_2 and Na_2O accompanied by leaching of SiO_2, CaO, Al_2O_3 and K_2O. However the degree of chemical change was considered to be minimal, and magmatic trends were clearly visible.

To minimise the effect of hydration related to chemical mobility, plots using elements considered immobile during alteration are used; analyses are recalculated to 100% volatile-free prior to plotting.

The lavas at Red Creek plot on the border between Phono-Tephrite and Tephrite-Basanite close to the Basaltic-Trachyandesite field in the SiO_2 versus Na_2O+K_2O classification plot of Le Bas *et al.* (1986; Fig. 5). In the Nb/Y versus Zr/TiO_2 classification plot (Winchester and Floyd, 1977; Fig. 6) using elements considered immobile during alteration, the lavas classify as Alkali Basalt.

To further define the alkaline basalt a classification scheme devised for the Tertiary alkaline volcanics of eastern Australia, (Johnson, 1989) based on CIPW norms was utilised (Fig. 7). Using this classification scheme the division between sub-alkaline and alkaline mafic lavas is that alkaline lavas have <10% normative hypersthene; on this basis the basalts in Red Creek classify as alkaline and plot within the field of Hawaiites. The presence of considerable levels (average 11.5%) of normative nepheline suggests a trend towards silica undersaturation. However plots using 'immobile elements' (Fig. 6) do not suggest that these rocks have attained silica undersaturation although they plot close to the nephelinite field.

The analyses agree with field evidence suggesting that the lava at Red Creek represents a single, relatively thin submarine flow, in that they plot close together on all classification plots.

The lavas plot outside the tectonic discrimination fields of Pearce and Cann (1973; Fig. 8), although close to the intraplate field. However on a MORB normalised spidergram (Fig. 9) the average of Red Creek analyses shows a distinctive trend of elemental enrichment relative to MORB values of the incompatible elements from Sr through to Ni, which is typical of the more silica undersaturated alkaline mafic lavas of such provinces as the Tertiary eastern Australian volcanic province (Johnson, 1989).

Other alkaline volcanic areas similar to Red Creek include the Yumali/Coonalpyn area, the MBT-1 drillhole into the northwestern termination of the magnetically defined Mt Stavely Belt (Rankin *et al.* in prep.), and the Truro Volcanics as defined in Mt Rufus 1 drillhole (Gatehouse *et al.* in prep; Fig. 9). Of the other volcanics the nearest are the Truro Volcanics that crop out on the west limb of the Karinya Syncline; the lavas at Red Creek represent a more evolved lava type than the Truro Volcanics of their type section, resulting in a line more distant from MORB in Fig. 9. This chemical difference is seen in the petrology where the lavas at Red Creek are distinctively porphyritic with phenocrysts of alkali feldspar.

When normalised to Karoo type basalts (Fig. 10) the basalts at Red Creek and the other Cambrian alkaline volcanics noted above exhibit enrichments relative to Karoo basalt of the elements Sr to Ti, with Red Creek being one of the most chemically evolved suites. This suggests that these lavas are not directly analagous to the dominantly tholeiitic basalt fissure lavas of the Karoo Province, but rather are more closely analagous to the central complexes seen in intraplate alkaline volcanic complexes, (Johnson, 1989).

In summary, it is proposed that the lava at Red Creek represents a single flow of hawaiite composition from a central volcanic complex, closely analagous to that of the Truro Volcanics but not necessarily from the same centre or erupted at exactly the same time. However, both the lava at Red Creek and the Truro Volcanics undoubtedly belong to the same Early Cambrian alkaline'within plate' volcanic province, which may be genetically linked to other Cambrian-mafic alkaline provinces such as the Yumali/Coonalpyn and MBT-1 areas (Rankin *et al.*, in prep.). The closest tectonic analogue for these provinces is that of a rifted continental margin as proposed for the Tertiary intraplate volcanic province of eastern Australia, (Johnson, 1989); metadolerites which post date the volcanics indicate a change with time from intraplate to MORB type composition (Liu and Fleming, 1990) indicating an ensuing period of crustal thinning and major dyke emplacement associated rifting and crustal extension.

Carrickalinga Head Formation

The interval between 300 and 934 m is referred to the Carrickalinga Head Formation which at Sedan Hill, 5.5 km to the south, is divided into several members (Cooper and Gatehouse, 1988). The contact between the Heatherdale Shale Equivalent and the Carrickalinga Head Formation is gradational over several metres.

The basal 40 m comprises finely laminated sandstone with subordinate siltstone. The sandstone shows some low-angle cross-bedding, ripples and small-scale channelling. Above this is 8 metres of laminated calcareous siltstone exhibiting some slumping, cross-bedding, and small-scale channelling.

The interval from about 344 m to about 610 m comprises almost entirely siltstone and shale which are phyllitic in places. About 133 m above the base of the formation (at 433 m) is a 3 m deep, 5 m wide channel containing angular calcareous siltstone clasts up to 150 mm long set in a sandy matrix.

The remaining section measured to date between 610 m and 934 m comprises essentially fine sandstone and siltstone. Numerous trace fossils are found between 800 m and 880 m. This occurrence represents the most fossiliferous interval yet found in the Kanmantoo Group.

TABLE 1 GEOCHEMICAL ANALYSES AND CIPW NORMS

MAJOR ELEMENTS IN PERCENT			CIPW WEIGHT % NORMS		
	6728 RS 1632	6729 RS 1515		6728 RS 1632	6729 RS 1515
SiO_2	42.30	42.30	ab	18.85	19.92
TiO_2	2.42	2.24	or	19.71	13.69
Al_2O_3	15.80	14.40	an	18.47	15.31
Fe_2O_3	8.75	8.05	ne	9.85	13.22
FeO	.	.	di	18.11	25.15
MnO	0.28	0.26	ol	4.67	3.21
MgO	2.64	3.32	mt	2.94	2.72
CaO	8.05	8.85	il	5.32	4.95
Na_2O	3.78	4.50	ap	2.09	1.73
K_2O	2.88	1.99			
P_2O_5	0.78	0.66	Total	100.01	100.01
H_2O+	.	.			
H_2O	.	.			
CO_2	.	.			
LOI	10.80	12.30			
Total	98.48	98.87			

. = not analysed, B = ppb

TRACE ELEMENTS IN PPM

	6728 RS 1632	6729 RS 1515
Ag	<1.00	<1.00
As	64.00	72.00
Au	2.00B	7.00B
Ba	880	610
Bi	4.00	<4.00
Ce	82.00	78.00
Co	30.00	44.00
Cr	110	105
Cs	1.80	1.20
Cu	6.00	5.00
Dy	8.00	7.20
Er	3.90	3.30
Eu	2.80	2.50
Ga	26.00	20.00
Gd	9.00	8.60
La	38.00	36.00
Lu	0.60	0.50
Mo	4.00	3.60
Nb	76.00	66.00
Nd	44.00	42.00
Ni	52.00	54.00
Pb	12.00	12.00
Pd	1.00B	<1.00B
Pt	<5.00B	<5.00B
Rb	82.00	60.00
Sb	<4.00	4.00
Sm	9.60	8.80
Sn	<4.00	10.00
Sr	240	260
Ta	3.00	2.20
Th	4.80	3.60
U	2.60	2.20
V	<5.00	<5.00
W	3.00	3.00
Y	34.00	30.00
Yb	3.70	3.00
Zn	26.00	26.00
Zr	380	320

. = not analysed
B = ppb

REFERENCES

Alexander, E.M., (Compiler), 1990. Stansbury Basin. Petroleum exploration and development in South Australia. *South Australia. Department of Mines and Energy. Report Book,* 90/34.

Coats, R.P. and Thomson, B.P., 1959. Truro map sheet. *South Australia Geological Survey. Geological Atlas,* 1:63 360 *Series.*

Cooper, B.J and Gatehouse, C.G., 1988. Sedan Hill, Carrickalinga Head Formation. *In*: Gatehouse (compiler) 1988. Kanmantoo Field Symposium Ecursion Guide. *South Australia. Department of Mines and Energy. Report Book,* 88/35.

Gatehouse, C.G., 1988. Tepko map sheet. *South Australia. Geological Survey. Geological Atlas* 1:50 000 Series, sheet 6728-III.

Crawford, A.J. and Keays, R.R., 1978, Cambrian greenstone belts in Victoria: marginal sea-crust slices in the Lachlan Fold Belt of southeastern Australia. *Earth and Planetary Science Letters.,* Vol 41:197-208.

Daily, B., 1963. The Fossiliferous Cambrian succession in Fleurieu Peninsula, South Australia. *South Australian Museum Records,* 14:579-601.

Forbes, B.G., Coats, R.P. and Daily, B., 1972. Truro Volcanics. *South Australia. Geological Survey. Quarterly Geological Notes,* 44:1-5.

Gatehouse, C.G., Jago, J.B. and Cooper, B.J., 1990. Sedimentology and stratigraphy of the Carrickalinga Head Formation (low stand fan to high stand systems tract), Kanmantoo Group, South Australia. *In*: Jago, J.B. and Moore, P.J. (Eds) 1990. The evaluation of a Late Precambrian-Early Palaeozoic rift complex: The Adelaide Geosyncline. *Geological Society of Australia. Special Publication,* 16: 351-368.

Gatehouse, C.G., McCulloch, A.J., Clough, B.J. and Sarunic, W., 1991. Mt Rufus 1 Well Completion Report. *South Australia. Department of Mines and Energy. Report Book,*

Gravestock, D.I., in prep. Early and Middle Palaeozoic. Geology of South Australia.

Le Bas, M.J., Le Maitre, R.W., Streckeisen, A. and Zanettin, B., 1986. A chemical classification of volcanic rocks based on the total alkali-silica diagram. *Journal of Petroleoy* 27: 745-750.

Johnson, R.W. (Ed.), 1989. *Intraplate volcanism in eastern Australia and New Zealand.* Cambridge University Press, p. 408.

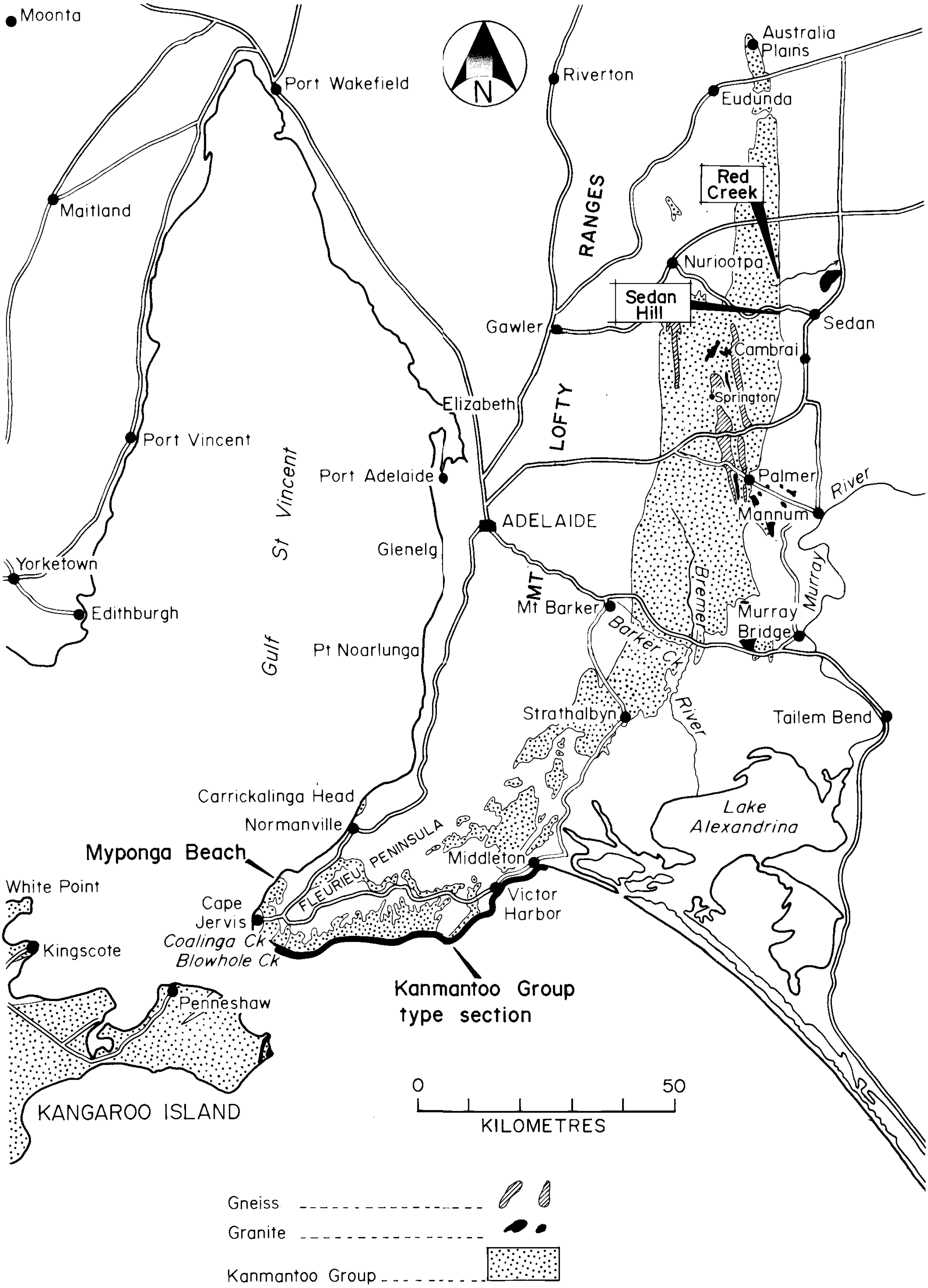
Liu, S.F. and Fleming, P.D., 1990. Mafic dykes and their tectonic setting in the southern Adelaide Foldbelt, South Australia. *In*: Parker, A.J., Rickwood, P.C. and Tucker, D.H. (Editors). Mafic Dykes and Emplacement Mechanisms. Proccedings of the second International Dyke Conference, Adelaide 12-16 September, 1990. A.A. Balkema, Rotterdam, pp. 401-413.

McCulloch, A.J., 1990. The geology of the Towitta area. *South Australia. Institute of Technology. B. app. Sc. thesis* (unpublished).

Pearce, J.A. and Cann, J.R., 1973. Tectonic setting of basic volcanic rocks determined using trace element analyses. *Earth and Planetary Science Letters,* 19:290-300.

Rankin, L.R., Clough, B.J. and Gatehouse, C.G., 1991, Mafic suites in basement beneath the Murray Basin: new data for the Early Palaeozoic history of the Tasman orogenic Province. *South Australia. Department of Mines and Energy. Report Book,*

Winchester, J.A. and Floyd, P.A., 1977. Geochemical discrimination of different magma series and their differentiation products using immobile elements. *Chemical Geology,* 20:325-343.

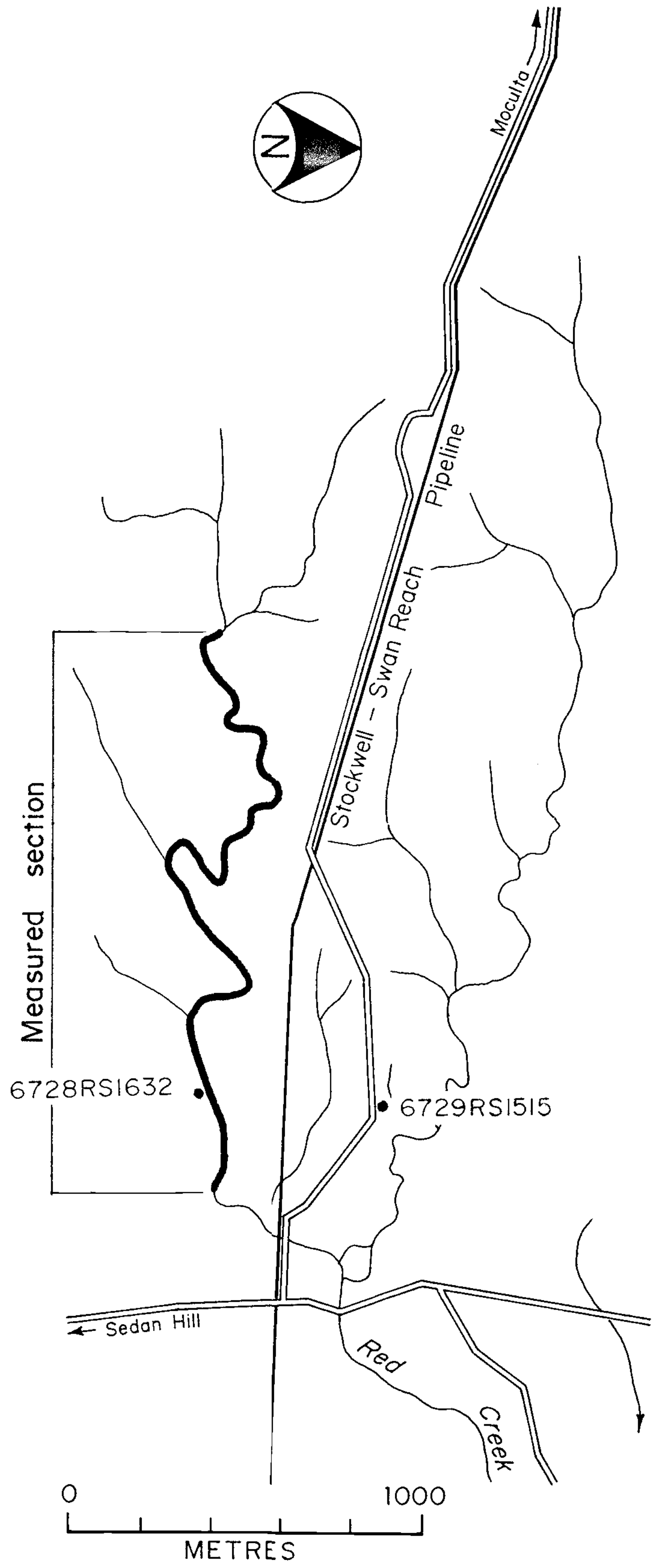


Locality Plan

Figure 1

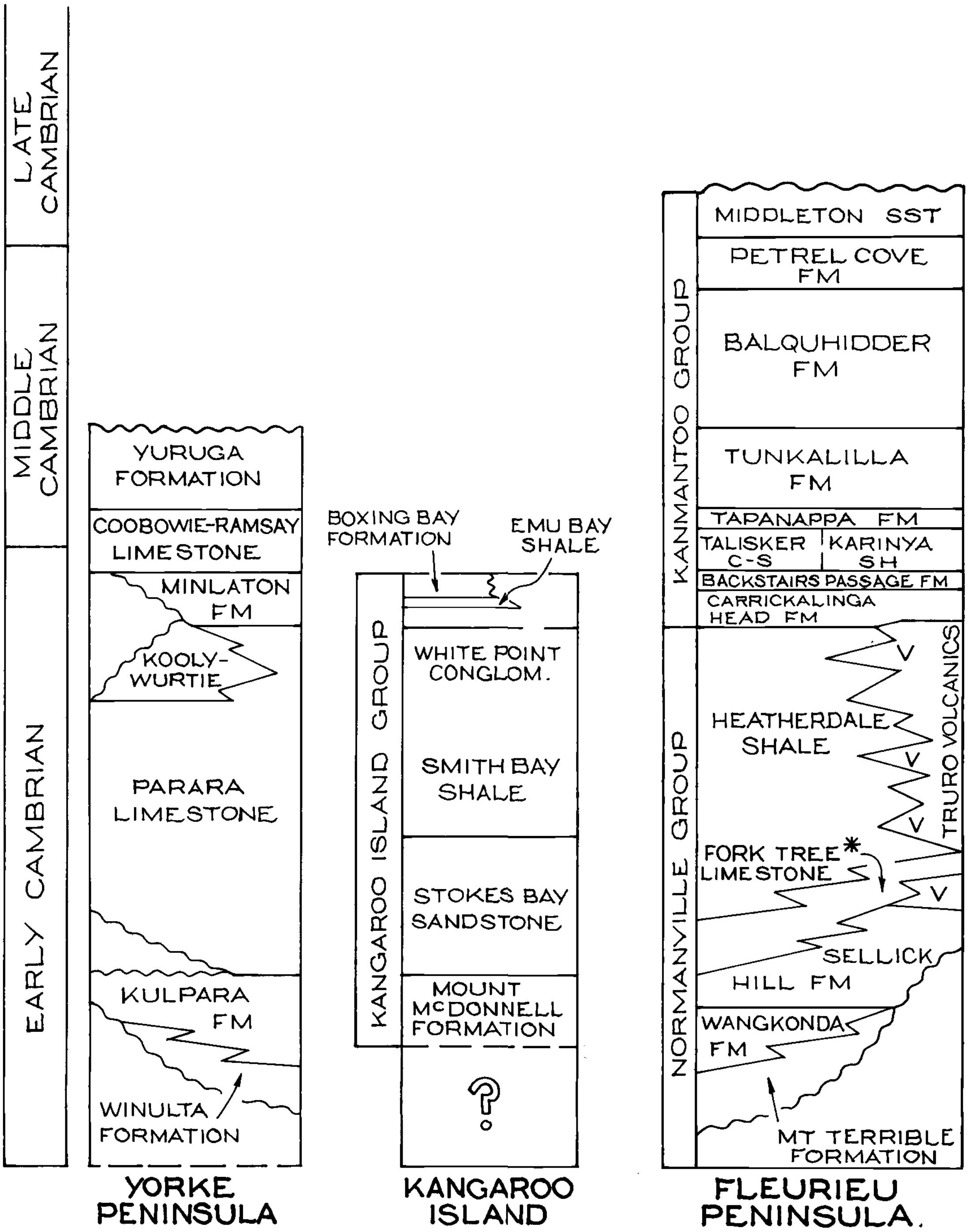
SADME

S21957



Location of the measured section

Figure 2



* Includes Angaston Marble
Modified from Gravestock, in prep.

STANSBURY BASIN STRATIGRAPHY

SADME S21959

FIG. 3

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Location RED CREEK, ANGASTON 6728

Sheet 1 of 10

From 0 m to 100 m

Measured by C.G.G. / J.B.J.

Orientation

Facing W

Strike / dip of beds

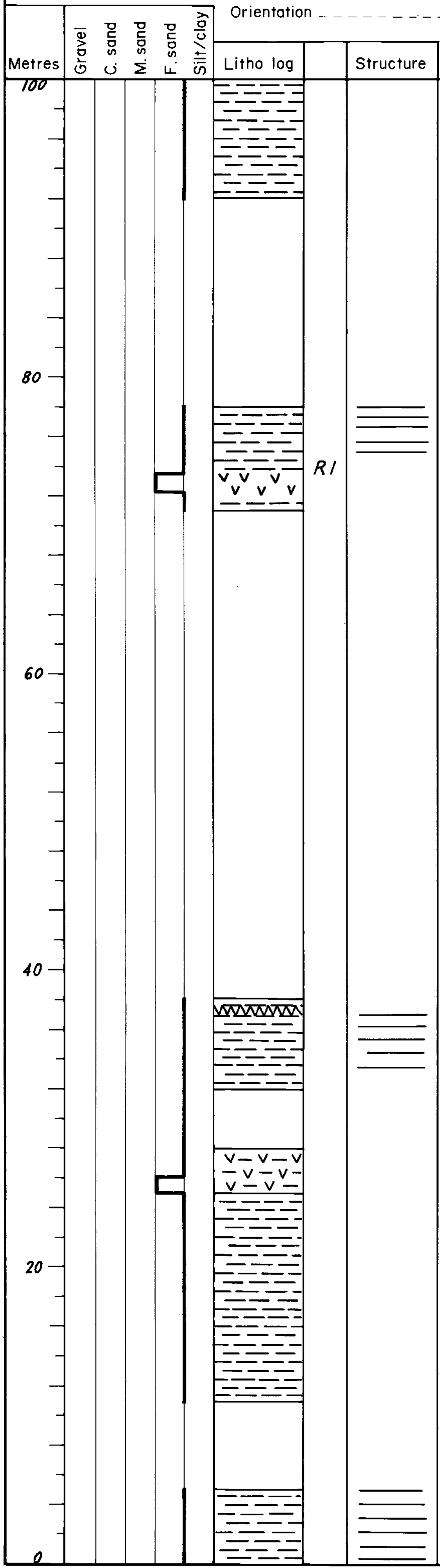
▨ Volcanics

▨ Shale

▨ Siltstone

▨ Sandstone

▨ Limestone



Phyllite (shale): Laminated, grey. Poor outcrop

Outcrop poor. Assumed as phyllite

Phyllite (shale): Laminated, grey.
- 6728 RS 1596
Graded feldspar crystal tuff 50mm thick.

Poorly outcropping, appears to be laminated grey phyllite. Possibly with tuffaceous horizons.

Quartz-filled fault zone

Phyllite (shale): Very finely laminated. Grey (fresh), brown - weathering, tuffaceous ?

Tuff: Greenish, deeply weathered, limonitic, silty in part.

Phyllite: Laminated, micaceous
Dip 60° to 278° T

Poor outcrop. Interpreted as laminated phyllite.

Dip 25° to 278° T (hill creep ?)

Fault Zone

Phyllite: Micaceous, grey where fresh. finely laminated.

Dip 60° to 263° T

Fig. 4a

S21961 a

MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

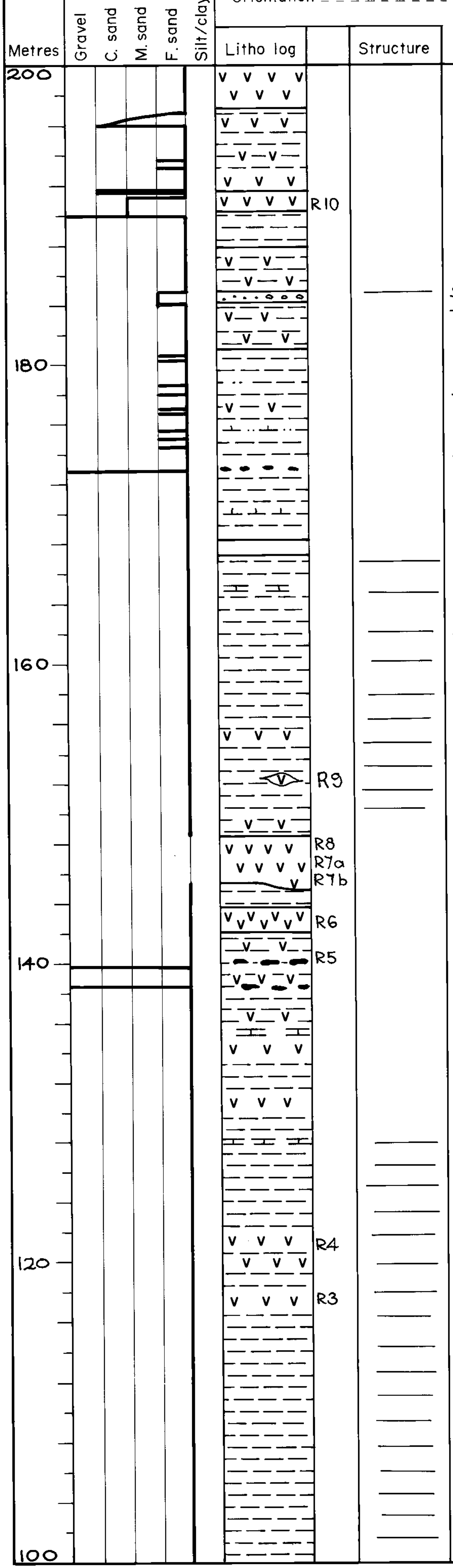
STRATIGRAPHIC LOGGING SHEET

Location RED CREEK

Sheet 2 of 10
From 100 m to 200 m
Measured by CGG/JBJ

Orientation
Facing W
Strike/dip of beds

▤ Shale ⬚ Siltstone ▨ Sandstone ▦ Limestone



Pillow Basalt

Phyllite : Laminated

Sandstone : very fine-grained
Tuff : Tuffaceous phyllite, very micaceous

Tuff and minor Sandstone
Sandstone : very fine-grained, calcareous
Siltstone : Siliceous with intraformational conglomerate
10 mm band

Fault Zone : dip ≏ 80° W

Calcareous
Phyllite (Shale): non micaceous thinly laminated.
Typical Heatherdale Shale.

Tuff : Laminated, blue-grey, phyllitic. 200mm thick.

Volcanics: lenses

Tuffaceous

Volcanics : one or more flows.
R7a : 6728 RS 1602, R7b : 6728 RS 1603,
R8 : 6728 RS 1604. Uneven base
Phyllite, grey, laminated crystal tuff : massive,
with tuff. 6728 RS 1601
Thin bedded.
Agglomerate : pebbles to 30mm. 6728 RS 1600

Tuffaceous Phyllite (Siltstone) : with interbeds
of siltstone.

Tuffaceous Phyllite (Siltstone) : 30% tuff beds.
Calcareous in places.
Bedding to 0·3m thick

Phyllite (Siltstone)

Tuff : with Lapilli ? 6728 RS 1599

Tuff : micaceous, greenish, very soft. 6728 RS 1598

Phyllite (shale): laminated, grey, micaceous.

Fig. 4b

S21961 b

MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Location RED CREEK

Sheet 3 of 10

From 200 m to 300 m

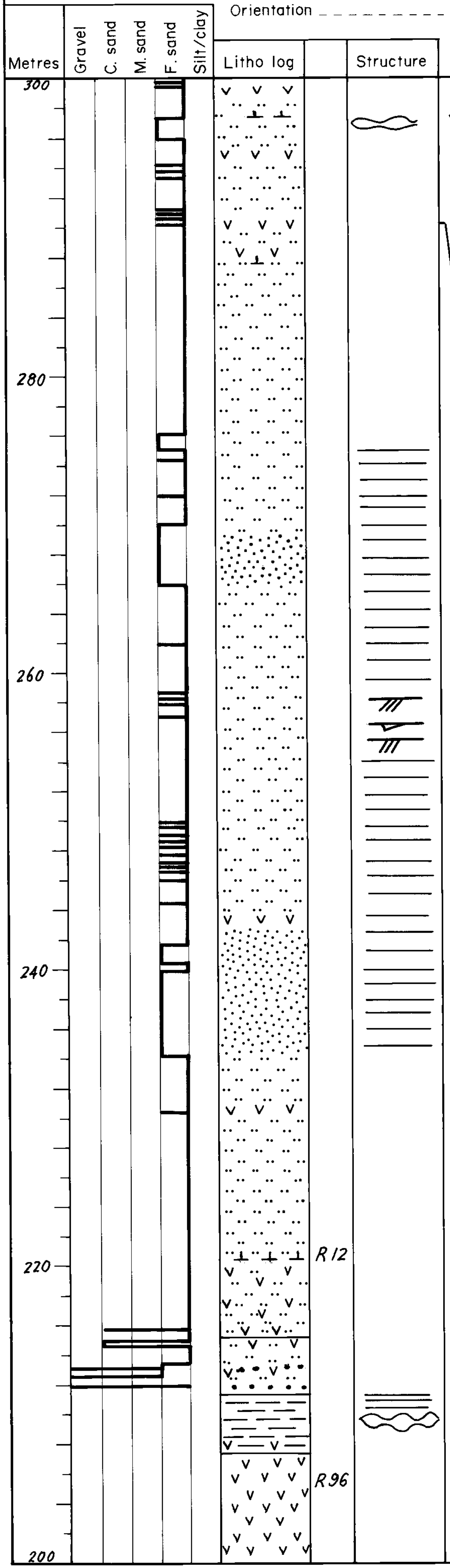
Measured by C.G.G. / J.B.J.

Orientation

Facing W

Strike/dip of beds

▤ Shale ⁘ Siltstone ▒ Sandstone ▦ Limestone



Sandstone: Blue-grey, hard brittle calcareous
Boudinage common.

Phyllite (siltstone)

Sandy laminae
Dip 74°. Thinly laminated, pyritic, tuffaceous.
Calcareous.

CARRICKALINGA HEAD FORMATION ↑

HEATHERDALE SHALE ↓

Siltstone with minor sandstone.

Sandstone: Mottled, micaceous

Quartz veins.

Siltstone: Blue-grey. Sandstone beds to 100mm, commonly 10mm, cross-bedded.
Currents to east.

Sandstone: Micaceous, thin bedded, laminated.

Green-grey where weathered.

Pyritic, dark grey, calcareous, massive

Siltstone

Phyllite (siltstone) with boudinage

6728 RS 1605

Fig. 4c

S21961 c

MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Location RED CREEK

Sheet 4 of 10

From 300 m to 400 m

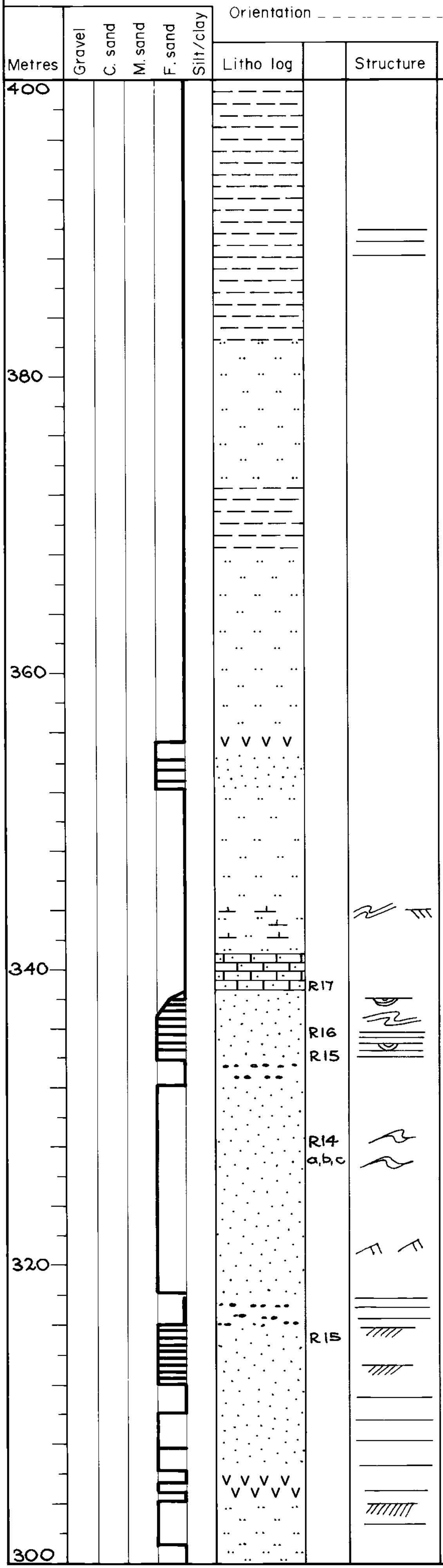
Measured by CGG / JBJ

Orientation

Facing W

Strike / dip of beds

▤ Shale ⣿ Siltstone ▒ Sandstone ▦ Limestone



Grey, laminated, micromicaceous

Siltstone : grey, micromicaceous

Shale : grey, laminated

Tuff : dip 70°

Sandstone : beds 150-200mm with green-grey sandstone and siltstone

Siltstone : pale to dark grey, thinly bedded

Slumping, crossbedding, smallscale channelling.

Siltstone : strongly calcareous, laminated

6728 RS 1609

Sandstone : sharp flat base 6728 RS 1608, calcareous in part.

Sandstone : beds 150mm thick, cross-laminated, ? flaser bedding, currents to east.

Very finely laminated (1mm)

R14c 6728 RS 1607

Ripple marks

Siltstone : medium to light grey, siliceous, very finely laminated.

6728 RS 1606

Sandstone with thin siltstone laminae to 10mm thick, low angle cross-bedding.

Tuff : laminated

Sandstone : massive, laminated, cross-bedded.

Fig. 4d

S21961d

MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Sheet 5 of 10

From 400 m to 500 m

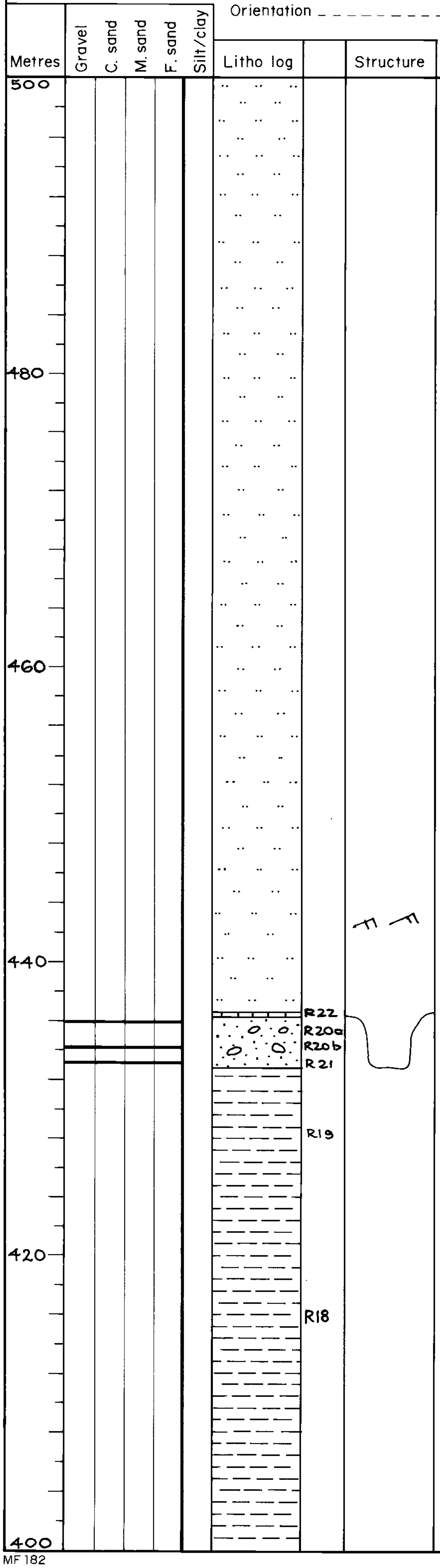
Location RED CREEK

Measured by CGG / JBJ

Orientation

Facing W

Strike / dip of beds



Shale ▤ Siltstone ▨ Sandstone ▦ Limestone ▦

Dip 68° to 278° T

Quartz veins

Thinly laminated

Micromicaceous

Poorly exposed, micromicaceous, laminated

Tuffaceous ?

Cleavage vertical

Siltstone : (phyllitic) with thin rippled brown sandstone.

Dip 75° to 276° T

Channel 433 to 436 m, 3 m deep, 5 m wide, steep sided.
Sandstone with clasts to 100/150 mm. R20a : 6728RS 1613, R20b : 6728RS 1614, R21 : 6728RS 1615 in channel floor.
clasts calcareous, angular

6728RS 1612 : Sandy in part, calcareous, up to 20mm.

Shale (phyllitic) weathers soft, grey (possibly tuff)

6728 RS 1611

Fig. 4e

S21961e

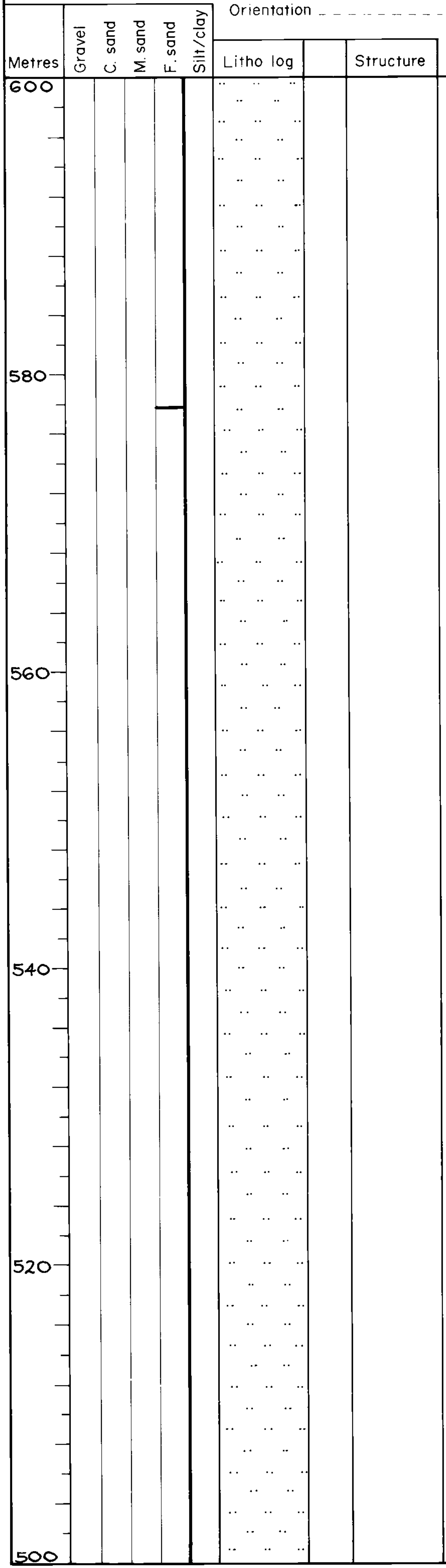
MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Sheet 6 of 10
From 500 m to 600 m
Location RED CREEK
Measured by CGG
Orientation
Facing W
Strike / dip of beds

Shale Siltstone Sandstone Limestone



Trace of calcite

Sandstone : very fine-grained
Phyllite (siltstone, shale) : medium grey, thinly laminated, poorly exposed.

Phyllite (siltstone, mudstone) : poorly exposed

Fig. 4f

S21961f

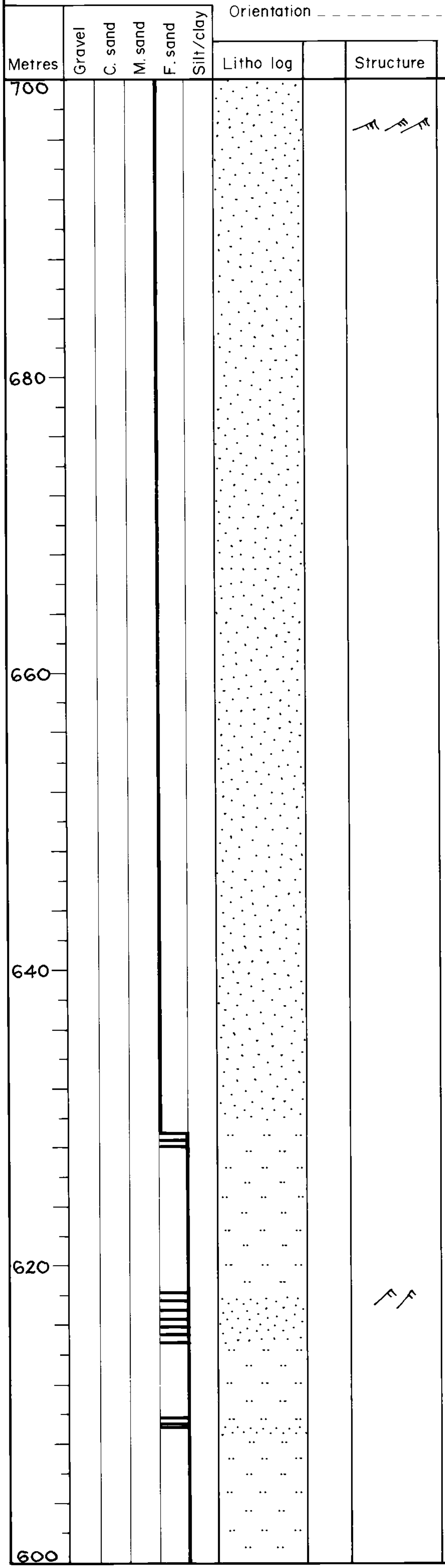
MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Sheet 7 of 10
From 600 m to 700 m
Location RED CREEK
Measured by CGG
Orientation
Facing W
Strike/dip of beds

▤ Shale ⛶ Siltstone ▨ Sandstone ▦ Limestone



Bedding 50-200mm, rippled, with lenticular and flaser bedding

Dip 70° to 264° T regional dip

Poor exposure, lenticular, with shale drapes

Dip 80° to 245° T

Sandstone : metamorphosed, lenticular, with shale drapes, flaser bedding.

Phyllite (siltstone): with sandstone lenses to 5mm thick, slightly calcareous.

Metasandstone : rippled, thin lenses, dip 90°.

Sandstone : thin laminae (1 mm)

Fig. 4g

S21961g

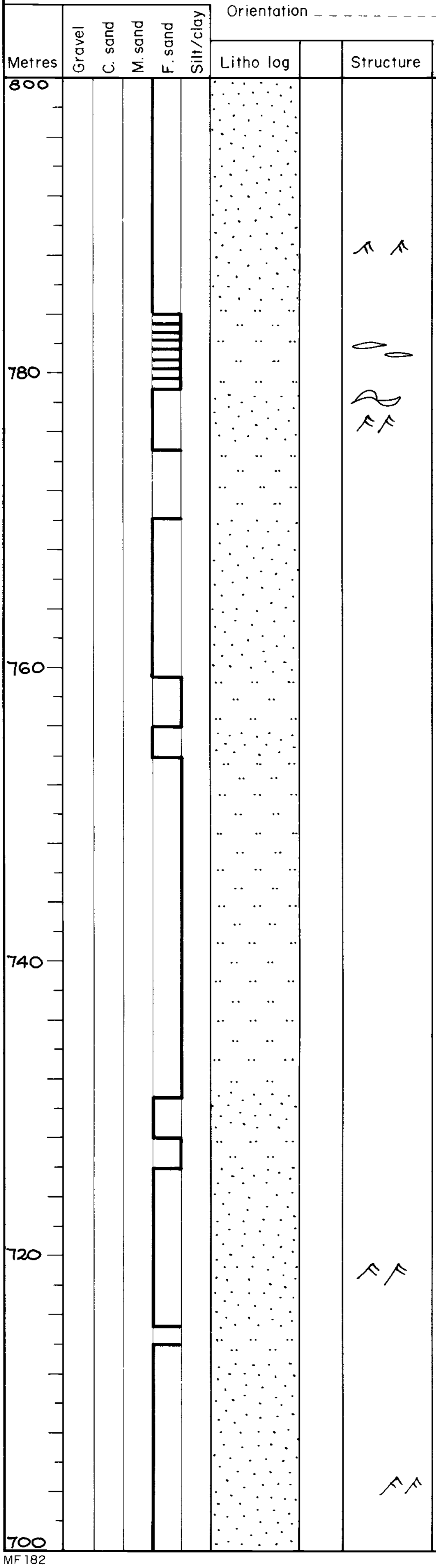
MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Sheet 8 of 10
From 700 m to 800 m
Location RED CREEK
Measured by CGG
Orientation
Facing W
Strike/dip of beds

▤ Shale ⁙ Siltstone ▒ Sandstone ▦ Limestone



Asymmetric ripples, currents from 268° T

Laminae 1-3mm, asymmetric ripples, flaser bedding, with minor sandstone

Dark grey, hard, bedding 100 - 300mm

Dip 71° to 269° T

Pale grey, dark grey, laminated (1-3mm)

Pale grey, laminated, poorly exposed

Micaceous, sandy, pale grey, cleaved

Dip 43° to 254° T

Bedding 0·6m, laminae 5-15mm

Grey, micaceous, laminated

Rippled, laminated, minor folding, crenulation cleavage

Fig. 4h

S21961 h

MF 182

DEPARTMENT OF MINES AND ENERGY – SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Location RED CREEK

Sheet 9 of 10

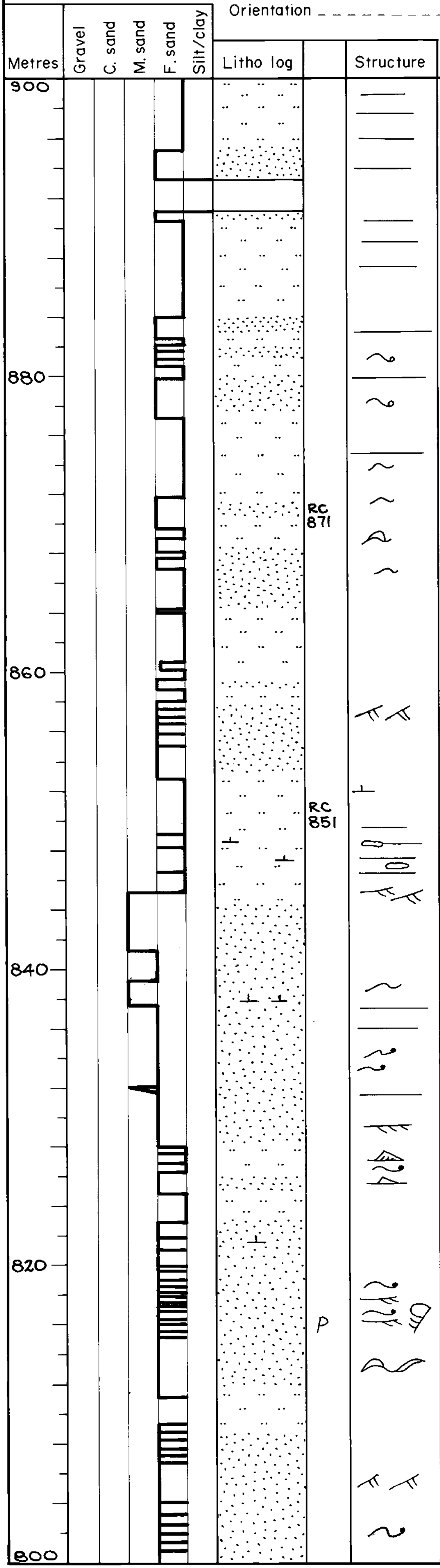
From 800 m to 900 m

Measured by CGG

Orientation ____________ Facing W

Strike/dip of beds ________

▤ Shale ⋯ Siltstone ▒ Sandstone ▦ Limestone



Siltstone : grey

Fault zone

Siltstone : with minor sandstone

Sandstone and Siltstone : lenticular

Ripples

Fault ?

Lenticular bedding

Sandstone : bedding 50mm, non calcareous, rippled with thin siltstone interbeds.
Lenticular bedding

Siltstone : finely laminated, micaceous

Mudstone : with occassional sand lenses (internally cross-bedded).

Flaser bedding, beds 50-150mm.

Sandstone : minor siltstone. Slumping ? Slightly calcareous.

Micromicaceous, thinly laminated, medium to light grey.

Lenticular bedding.

Sandstone : beds 50-100mm, ripples, trace fossils, slightly calcareous.

Bedding 50-100mm, very micaceous contourites.

Tracks, phosphatic brachiopods ? flaser bedding, asymmetric ripples bedding 200-300mm

Flaser bedding

Siltstone : with less than 50% sandstone

Sandstone : rippled, with thin siltstone /shale drapes, lenticular at top.

Fig. 4i

Sandstone : very thinly laminated. Beds up to 150mm, red-brown, undulose top and bottom. Regional dip 80° to 268° T.

S21961i

MF 182

DEPARTMENT OF MINES AND ENERGY — SOUTH AUSTRALIA

STRATIGRAPHIC LOGGING SHEET

Location RED CREEK

Sheet 10 of 10

From 900 m to 1000m

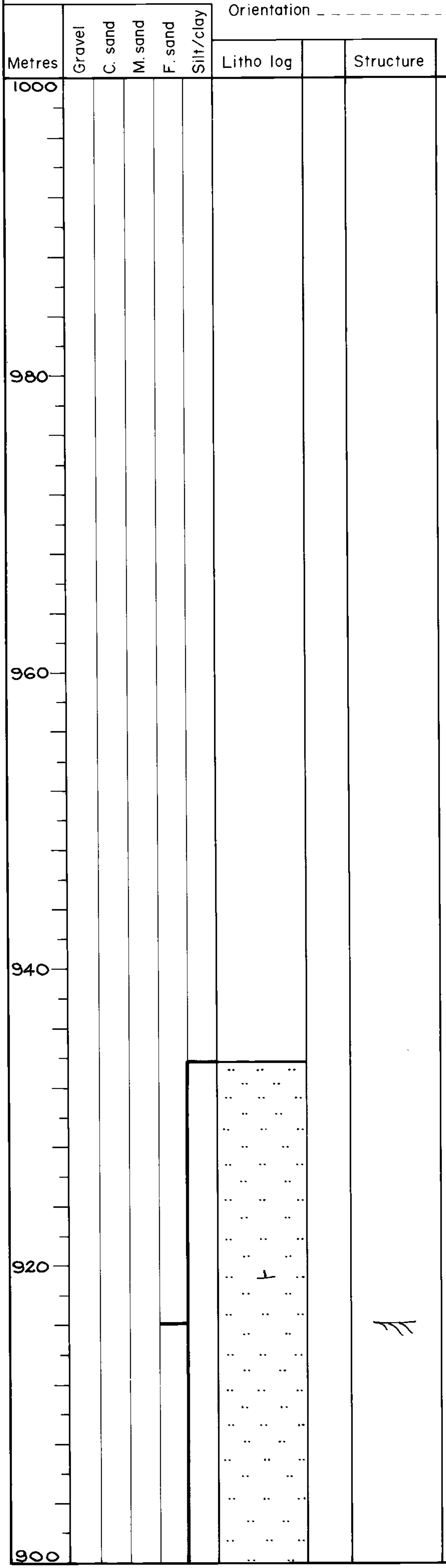
Measured by CGG / JBJ

Orientation

Facing W

Strike/dip of beds

Shale Siltstone Sandstone Limestone



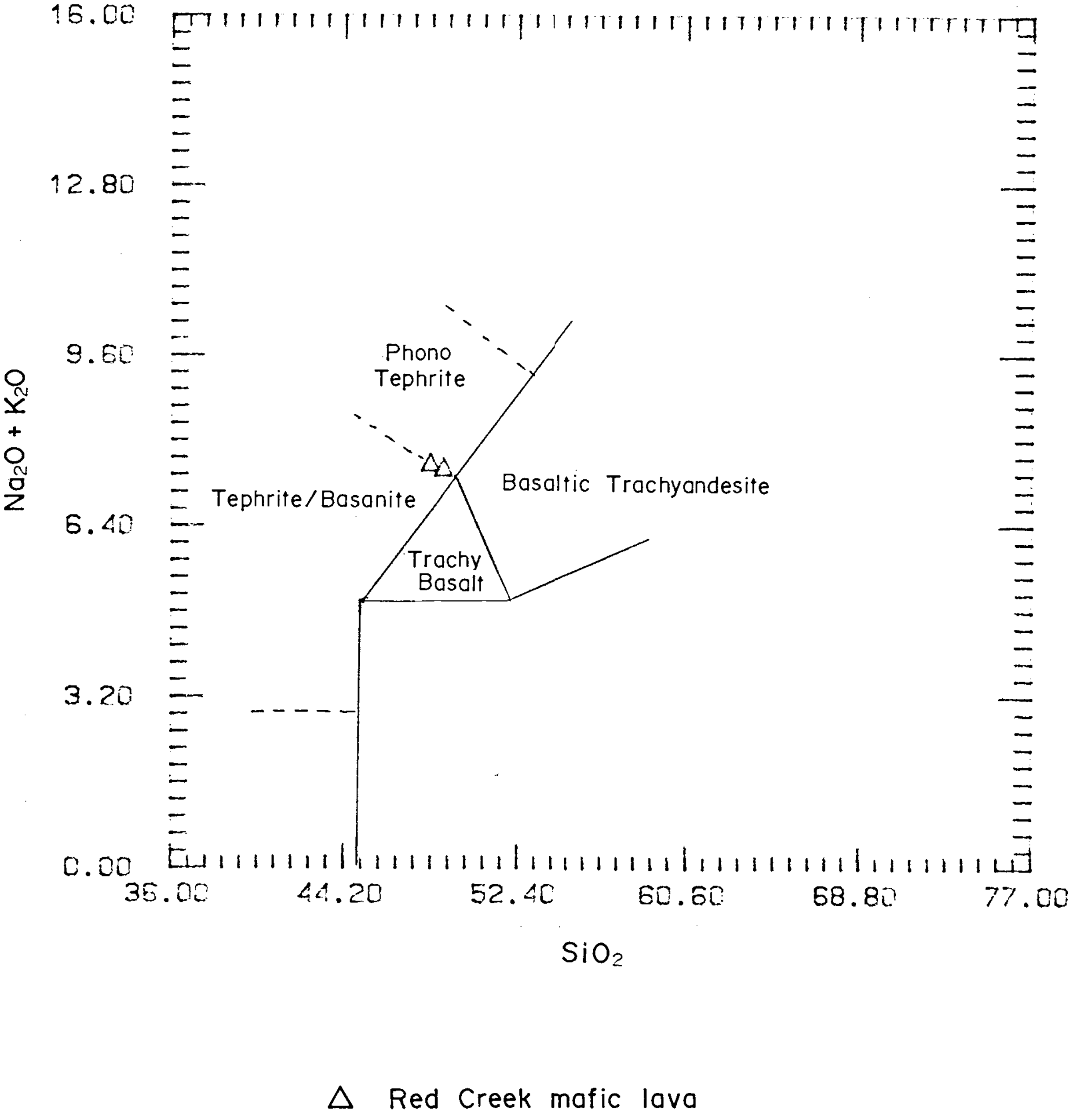
Fault : Low angle Southeast
Lineation 52° Dip 91° 89° to 68° T
STR 150°

Siltstone : with sand lenses up to 30mm with crossbedded lenticular ripples

Dip 75° to 261° T plunge 16° to north

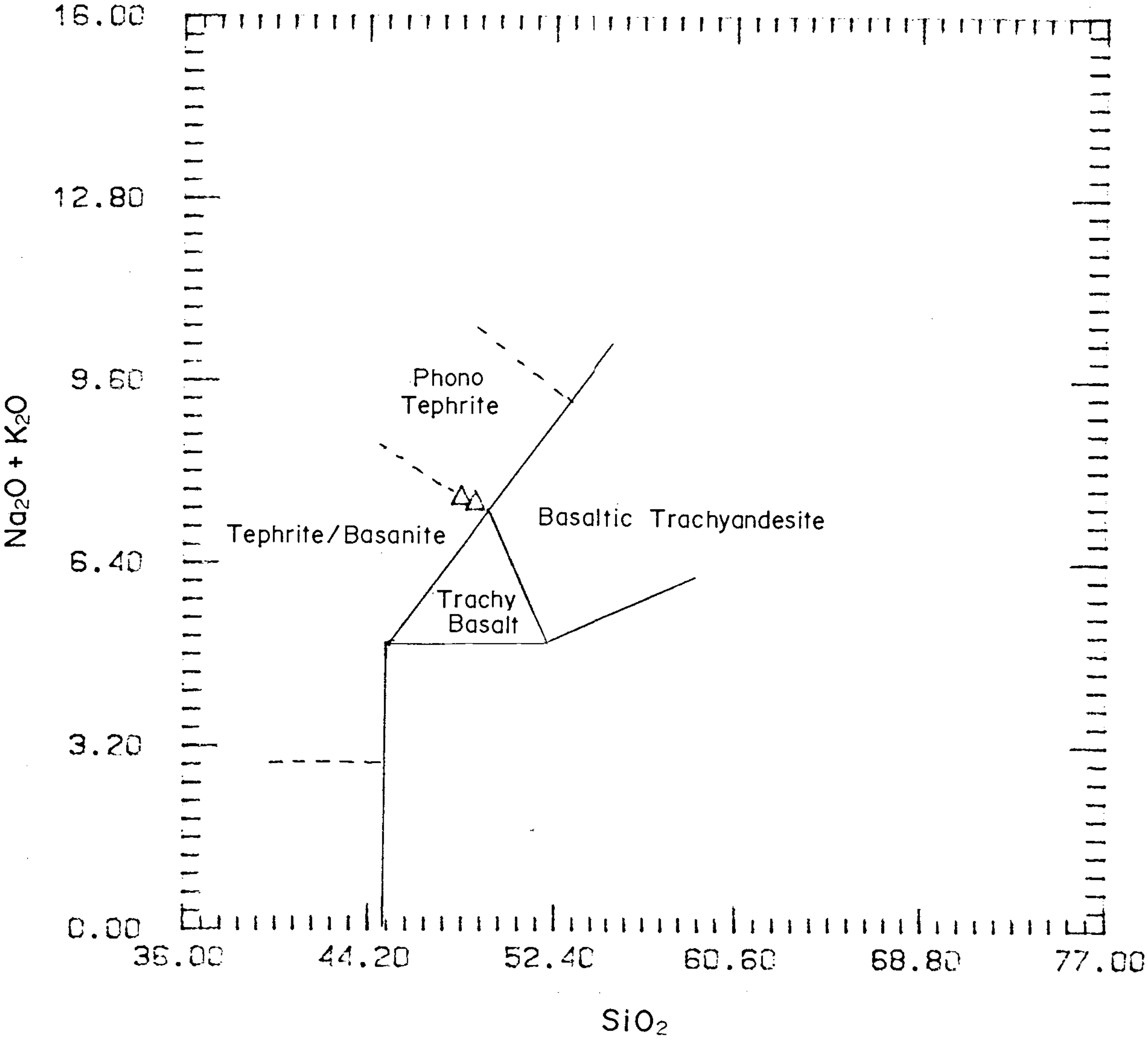
Fig. 4j

S21961j



Part of classification plot of Le Bas et al (1986)

Figure **5**



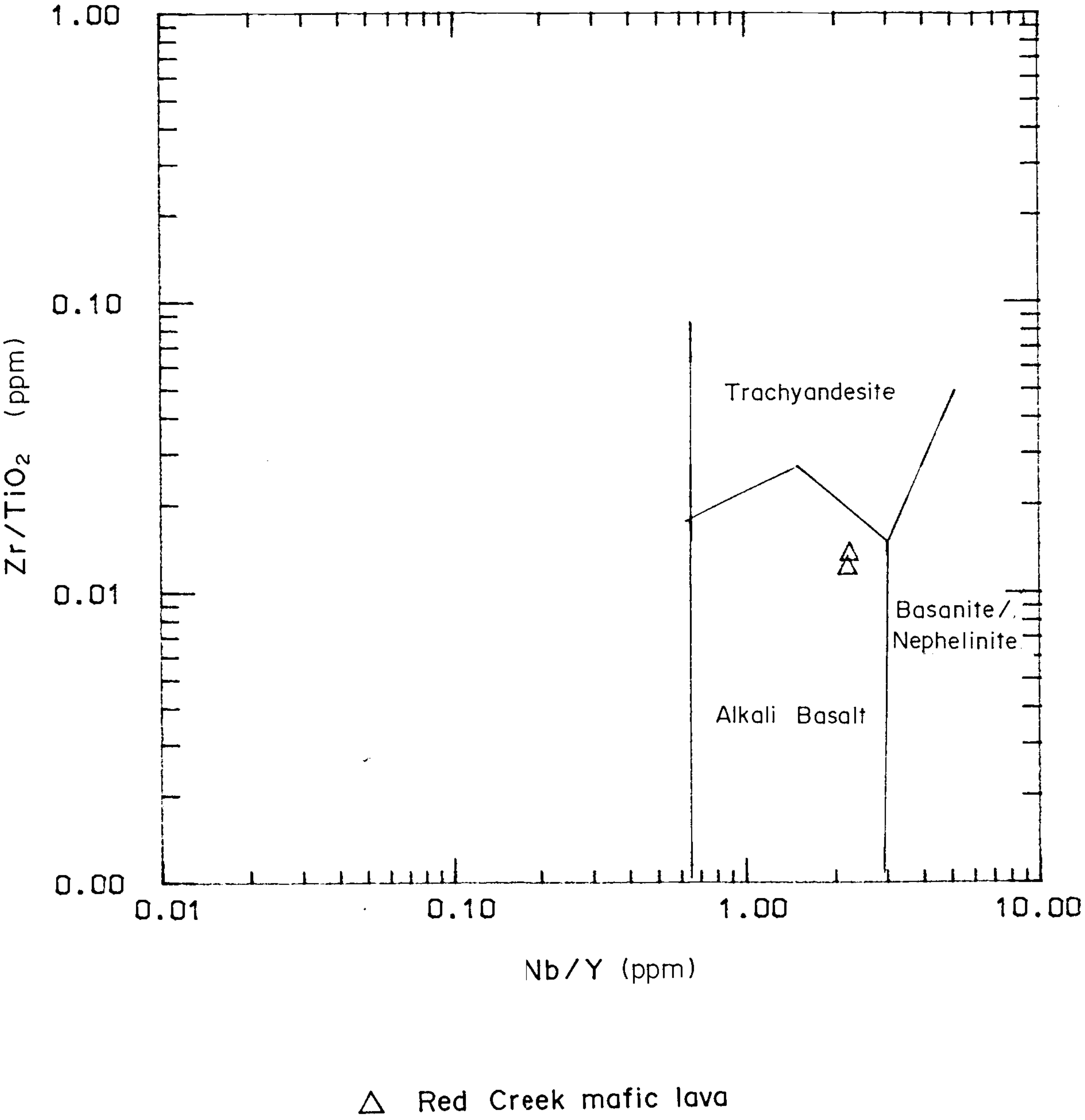
△ Red Creek mafic lava

Part of classification plot of Le Bas et al (1986)

Figure **5**

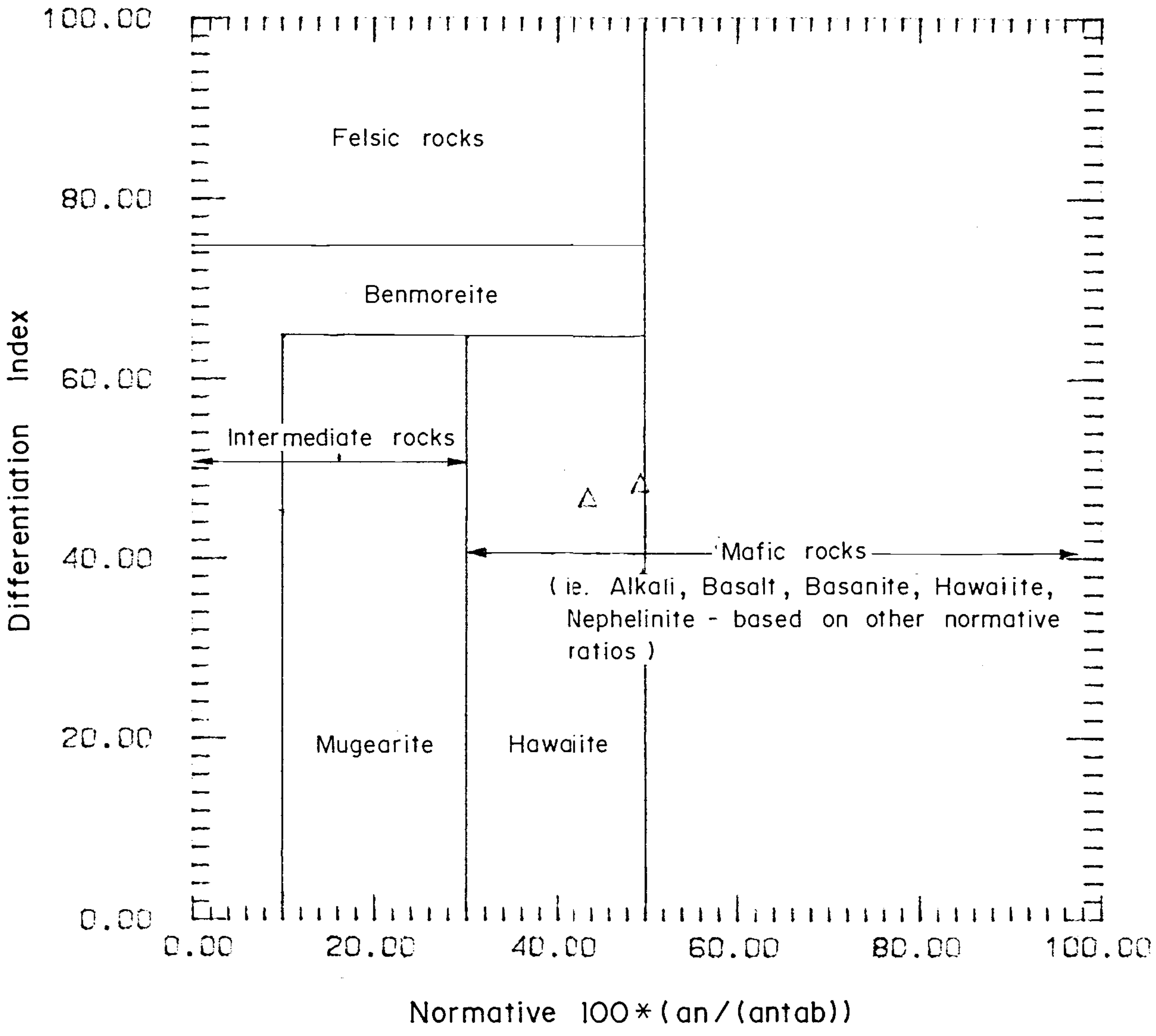
SADME

S21960



Part of classification plot of Winchester and Floyd (1977)

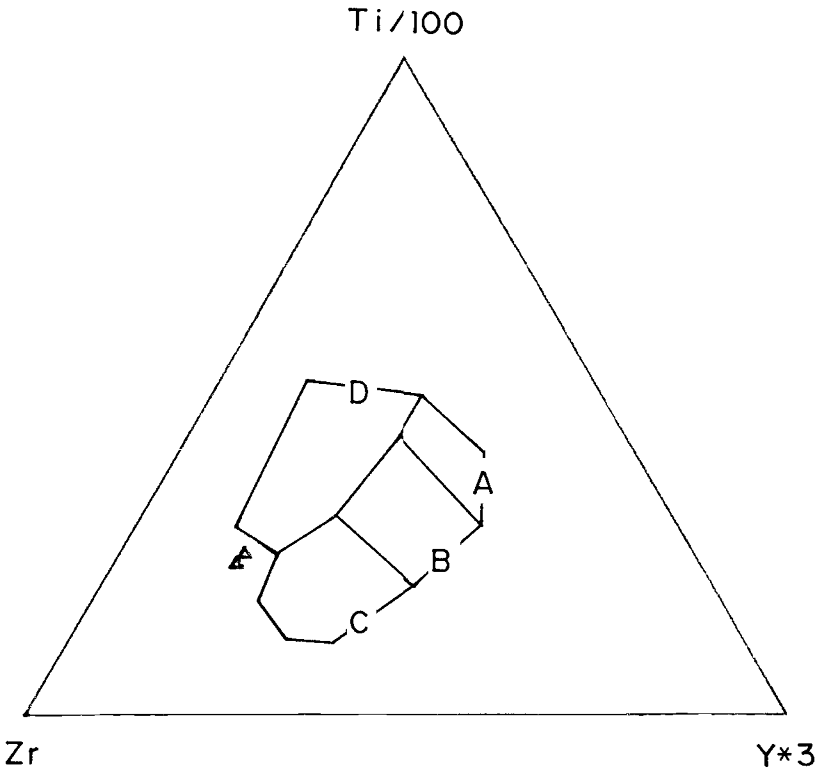
Figure **6**



△ Red Creek mafic lava

CIPW normative classification plot for sub-alkaline intraplate lavas (Johnson, 1989)

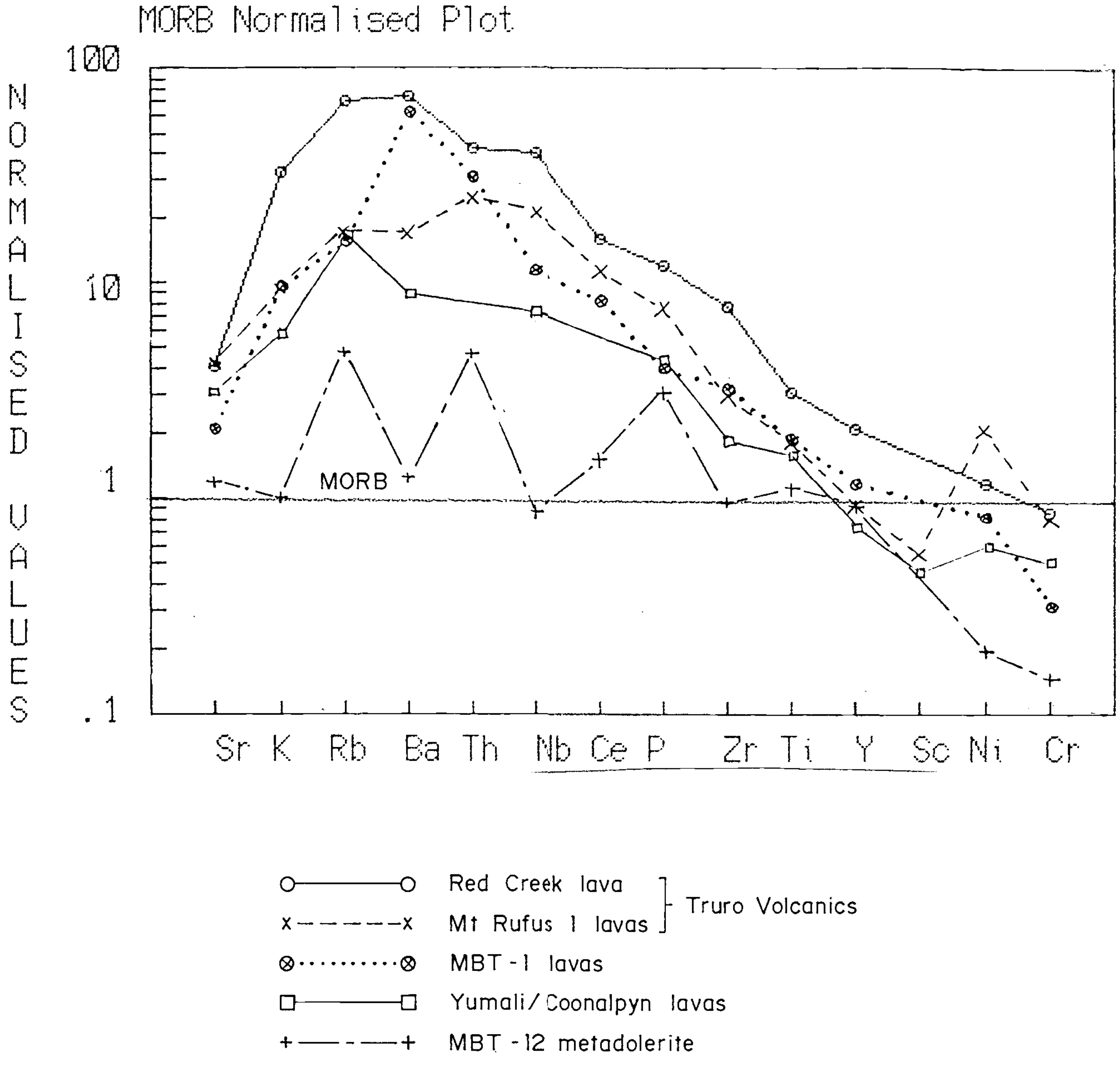
Figure **7**



△ Red Creek mafic lava

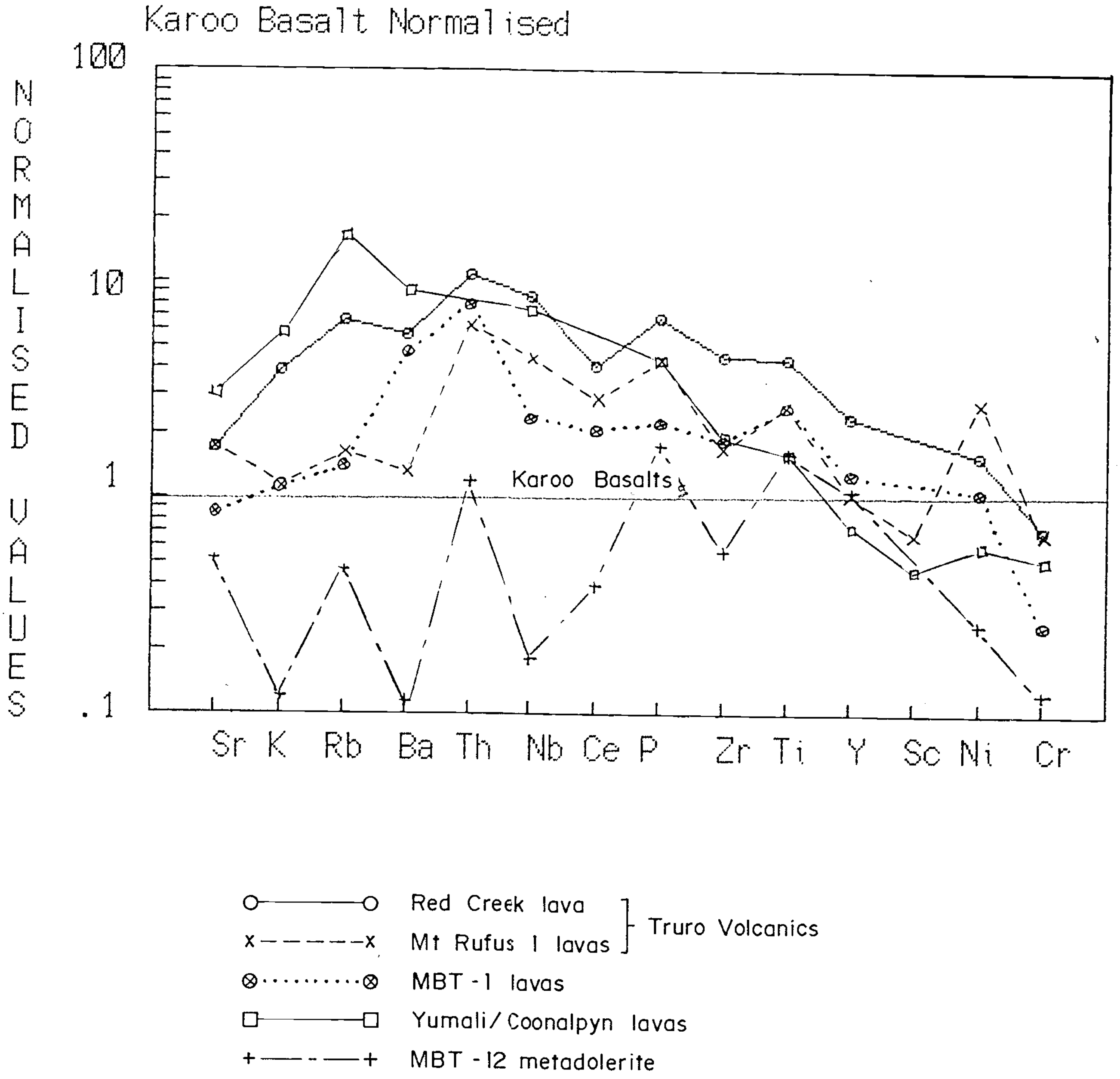
Tectonic discrimination plot of Pearce and Cann (1973). "Within-plate" basalts plot in field D, morb (ocean floor basalts) in field B, low K tholeiites in fields A and B, calc-alkaline basalts in fields C and B.

Figure **8**



MORB normalised spidergram for averages of Murray Basin Basement and Mt Lofty Ranges ? Cambrian mafic suites.

Figure **9**



Karoo Basalt normalised spidergram for averages of Murray Basin Basement and Mt Lofty Ranges ? Cambrian mafic suites

Figure 10