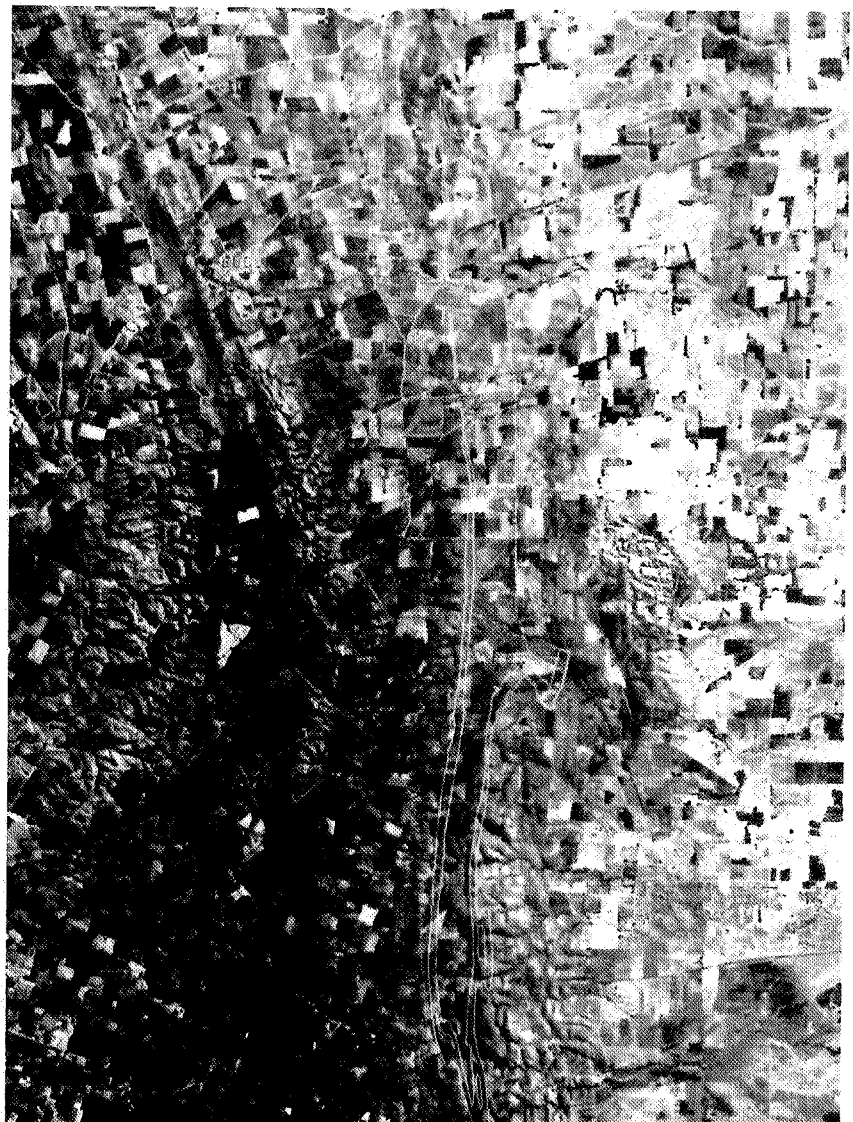
Department of Mines and Energy
South Australia



KARINYA SYNCLINE

SATELLITE AND AIR PHOTO INTERPRETATION

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT BK NO. 91/33

PRELIMINARY INVESTIGATION OF LANDSAT SATELLITE AND AERIAL PHOTOGRAPHY KARINYA SYNCLINE, KANMANTOO TROUGH, SOUTH AUSTRALIA.

GEOLOGICAL SURVEY

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ABSTRACT

Landsat imagery together with aerial photography have been utilised to assist detailed ground investigations to define lineaments and regional geological structures that may be favourable zones for concentration of mineralisation.

Two structural regimes have been identified from Landsat Multi Spectral Scanner imagery covering Adelaide and the Mount Lofty Ranges:-

- a thrust terrain in the Adelaidean metasedimentary sequence
- a major shear zone, termed the 'Kanmantoo Shear Zone', affecting the Cambrian Kanmantoo Trough.

Landsat Thematic Mapper imagery and air photographs were used to map lithology and structural lineaments over the Karinya Syncline the site of Mineral Resources Branch investigations for potential Pb-Zn mineralisation. A number of significant NNW trending structures were identified which may represent shear planes.

Near the intersection of NW and NE trending lineaments a small diffuse circular anomaly, identified from TM imagery, is associated with minor NE trending lineaments and TM colour anomalies. This area is in close proximity to a geochemical anomaly, the Gap Prospect.

Reconnaissance ground traverses in the Truro-Frankton area have identified mylonites and semi-brittle/ductile faults which may provide evidence for the postulated "Kanmantoo Shear Zone". Also identified are small, intrusive volcanic dykes and plugs including a small lamprophyre dyke found in Adelaidean siltstones.

INTRODUCTION

In 1987 a task force was established within SADME to review existing data and to identify favourable geological environments for Pb-Zn mineralisation in South Australia (Horn and Morris 1988).

As a result of the review Mineral Resources Branch, South Australian Department of Mines and Energy (SADME) initiated investigations in the Kanmantoo Trough, identified by Morris (1988) as highly prospective for Pb-Zn-Ag mineralisation. An area east-northeast of Truro, 80km northeast of Adelaide, Figure 1, over the Karinya Syncline was recommended for follow-up exploration.

Mineral Resources Branch investigations include soil geochemistry, geophysical surveys, drilling and (this report) Landsat imagery and aerial photographs.

Landsat Multi Spectral Scanner (MSS) imagery over the Mount Lofty Ranges was utilised to provide a conceptual model for the structural setting of the Kanmantoo Trough with two broad regimes identified:

- a "thrust zone" in the western (Adelaidean) half,
- a "shear zone" in the eastern (Cambrian) half.

Landsat Thematic Mapper (TM) imagery and aerial photographs were used to assist in definition of lithology and regional structural lineaments that may be favourable zones for concentration of significant mineralisation.

Follow up field reconnaissance traverses identified NNW trending mylonites and semi-brittle/ductile faults, which may be cited as evidence for the "Kanmantoo Shear Zone" as defined on MSS imagery.

This report is a preliminary investigation and detailed work is required to define relationships between lineaments and structures identified on Landsat TM images, air photographs and on the ground and to relate these to the broader structure defined as the Kanmantoo Shear Zone.

PHYSIOGRAPHY

The following description of the physiography of the Adelaide MSS scene is based on a CSIRO study (Laut *et al.*, 1977a; 1977b) which used Landsat imagery to document land resources and environmental conditions of South Australia. The study recognised thirty-three environmental regions within eight environmental provinces and describes for each region climate, landform, soil, native vegetation conservation, land use and population.

Three environmental provinces are identified on the Adelaide scene:

- Murray Mallee
- Mount Lofty Block
- Eyre and Yorke Peninsulas

and are further subdivided into environmental regions and environmental associations.

The Kanmantoo Trough falls within the boundary of the Mount Lofty Block Province and a description of the two regions in this province is summarized (Laut *et al.*, 1977b):

- Peninsula Uplands - from Fleurieu Peninsula to Barossa Valley; comprises 20 environmental associations; predominantly undulating to low hilly uplands with steep marginal ranges and hills; various types of open forest and woodland exist as scattered remnants in nature reserves and in isolated inaccessible areas; mean annual rainfall ranges from 300mm along the north-eastern margin to 1100mm in the Mount Lofty Ranges.

- Mid North Wheatlands : from south of Freeling to Wilmington and comprising 19 environmental associations; considerably drier than the Peninsula Uplands with mean annual rainfall ranging from 250mm in the north-east to 700mm in the southwest; characterised by a series of undulating intramontane basins of variable width, separated by low, north-trending strike ridges; few strands of native vegetation with most land cleared for wheat, barley and grazing.

GEOLOGICAL SETTING

The Cambrian KANMANTOO GROUP (Table 1) comprises an 18 000 metre succession of medium to fine-grained, craton-derived clastics, deposited in a deeply subsiding, fault-controlled basin, the KANMANTOO TROUGH. Outcrop extends over the Mount Lofty Ranges, Fleurieu Peninsula and Kangaroo Island, covering an area of approximately 365km x 35km (Gatehouse *et al.*, 1990) (Figure 2). Sedimentation was probably initiated during the Waitpingan Subsidence (Thomson 1969a) - Kangarooian Movement of Daily and Forbes (1969) - terminating at the onset of the Late Cambrian-Early Ordovician Delamerian Orogeny.

Offler and Fleming (1968) and Mills (1973) describe three phases of folding and metamorphism affecting Proterozoic and Cambrian sediments in the Mount Lofty Ranges. Highest metamorphic grade, sillimanite facies, was achieved in the Kanmantoo Group in the vicinity of Springton. Granitoids, basic dykes and plugs are widespread in the highest grade metamorphic zones and are in part related to mineralisation.

Various stratigraphic subdivisions have been proposed for the Kanmantoo Group - Thomson and Horwitz (1962), Thomson (1969a), Daily and Milnes (1972, 1973), Gatehouse (1988), Gatehouse *et al.* (1990). Table 1 is based on the subdivision proposed by Gatehouse (1988) and Gatehouse *et al.* (1990).

Morris (1988) in relating mineralisation to stratigraphy uses the term Brukunga Formation which in context of Table 1 encompasses the Inman Hill and Brown Hill Sub-groups. (Gatehouse, pers. comm.).

TABLE 1

KANMANTOO GROUP - STRATIGRAPHIC SUBDIVISION (after Gatehouse (1988) and Gatehouse et al. (1990))

WATTA BERRI SUB-GROUP	MIDDLETON SANDSTONE	grey, fine-grained, metasandstone, well laminated and cross-bedded, with scour channels, ripped-up clasts and slump structures.
	PETREL COVE FORMATION	siltstones and fine-grained sandstones metamorphosed to schists and metasandstones.
BROWN HILL SUB-GROUP	BALQUHIDDER FORMATION	fine-to coarse-grained metasandstone with some carbonaceous and sulphide rich phyllites with thin pebble conglomerate beds.
	TUNKALILLA FORMATION	dark grey phyllitic and silty unit weathering to yellow and brown caused by sulphide oxidation; bioturbation common, and well preserved worm casts.
INMAN HILL SUB-GROUP	TAPANAPPA FORMATION	uniform dark-brown and grey, fine- to coarse-grained biotitic sandstone; structures include cross-bedding, scour channels, current bedding, worm casts; minor conglomerate present; several sulphide-rich horizons.
	TALISKER CALC-SILTSTONE	banded calc-siltstones, coarse-grained marble and sulphide-rich zones; contains Nairne Pyrite Member and the (considered) equivalent Karinya Shale Member.
	BACKSTAIRS PASSAGE FORMATION	sandstone, silty near base; feldspathic and micaceous and characterised by cross-bedding and slump structures.
CARRICKALINGA HEAD FORMATION	CAMPANA CREEK MEMBER	sandstone.
	BLOWHOLE CREEK SILTSTONE MEMBER	mainly siltstones, but includes Milendella Limestone Member.
	MADIGAN INLET MEMBER	sharp-based sandstone-mudstone couplets.

Karinya Syncline Geology

The Karinya Syncline (Figure 2) is defined on the Truro 1 mile (Coats, 1959) and the Adelaide 1:250 000 sheets (Thomson 1969b) by a blue-black, carbonaceous shale, Karinya Shale Member, extending from Australia Plains in the north, to near Mount Karinya in the south. The eastern limb is folded into an antiform and faulted in the vicinity of Frankton.

Kanmantoo Group lithologies are mapped as basal grey-green meta-siltstone, greywacke with saccharoidal pink marble (Milendella Limestone Member), grey metamorphosed greywacke, arkose and turbidites, with calc-silicates and conglomerate members, Karinya Shale Member and metasiltstones and greywacke.

MINERALIZATION

Base metal mineralisation is widely distributed throughout the Kanmantoo Trough, though generally confined to three prospective horizons (Horn and Morris, 1988; Morris 1988).

1. INMAN HILL SUB-GROUP

a) Tapanappa Formation: Cu, Pb, Zn, Ag, Au; generally stratabound in garnet - andalusite - biotite schist and quartz-biotite schist.

eg. Kanmantoo Mine, Cu ± Au
Bremer Mine, Cu
Aclare Mine, Ag, Pb, Zn ± Au
Wheal Ellen, Pb, Ag, Zn, Cu ± Au
Strathalbyn Mine, Cu, Pb, Ag, Zn ± Au

b) Talisker Calc-Siltstone: Brukunga Mine - Nairne Pyrite Member mined for pyrite; Talisker Mine, Au-Zn in sandstone; Mount Torrens Prospect - Pb-Zn-Ag in dolomitic quartzites.

2. CARRICKALINGA HEAD FORMATION: Cu, Pb, Zn, Ag, Au, mainly in Milendella Limestone member; generally associated with faulting, the limestone acting as a chemical trap.

LANDSAT IMAGE STUDY

Landsat MSS and TM imagery was used to evaluate the geological significance of lineaments in the northern Kanmantoo Trough. Multispectral scanner imagery was used to interpret structural relationships of regional scale lineaments with mapped faults and to provide a conceptual structural framework for the Kanmantoo Trough. An area covering the Karinya Syncline was subset from TM digital data and processed at the South Australian Centre for Remote Sensing (SACRS) to assist in regional mapping of lithological horizons and structural geology.

Multispectral Scanner Imagery

Two standard processed MSS scenes from the Australian Centre for Remote Sensing (ACRES) were used for annotation and interpretation of lineaments.

- SCENE ID: Path 97, Row 84
- SCENE CENTRE 34°38′S, 139°00′E
- BANDS 4, 5, 7, BGR
- SCENE DATES: 14 July 1986, sun angle 20°
  26 January 1988, sun angle 48°
- SCALE: approximately 1:250 000

Lineament Interpretation

A base plan was compiled on drafting film and significant lineaments were annotated. The base was overlain onto the ADELAIDE and BARKER 1:250 000 geological sheets from which Kanmantoo Group boundaries, stratigraphic marker horizons, granitoids, faults, and mineral occurrences were annotated (Figure 3). Significant location discrepancies between the base Landsat plan and the published geological maps were apparent.

Although not a comprehensive lineament map, Figure 3 shows that most major Landsat lineaments coincide with mapped faults. Outlined on Figure 3 is a "Structural Corridor" defined by the style of the fault and lineament pattern within the Kanmantoo Trough compared to those to the west in the Adelaidean metasediments.

Figure 4 synthesises the lineament and fault patterns into a structural model, identifying two contrasting zones, separated by lineament A, the Bremer Fault.

a) to the west an arcuate series of lineaments, concave west, possibly representing thrust faults are cross-cut by WSW and ENE trending lineaments; Archaean - Early Proterozoic basement inliers are associated with the thrusts and are equated to metamorphic core complexes; Au - mineralisation appears to be associated with the major inlier with a zoning outwards along the thrust planes and later faults of Au-Ag, Pb-Ag, Ag-Cu, Pb-Ag-Zn.

b) east of the Bremer Fault is a series of NNW trending, closely spaced lineaments with minor WNW and ENE cross-cutting lineaments; this zone appears to form within a structural corridor bounded to the west by the Bremer Fault, along which are extensive breccia zones, and the eastern edge of the Mount Lofty Ranges (Figure 3); this structural corridor, referred to as the KANMANTOO SHEAR ZONE, falls within the G2 gravity lineament of O'Driscoll (1986); near Australia Plains, the shear zone appears to bend northwest along the northern boundary of the G2 lineament; dextral displacement is postulated along a northwest fault, Lineament B, through the central zone of the Kanmantoo Trough and along which granite intrusion may have been contemporaneous; copper and lead-zinc mineralisation appear to be associated with the NNW trending lineaments, especially where they are cross-cut by the WNW and ENE lineaments.

<u>Thematic Mapper Imagery</u>

Landsat Thematic Mapper (TM) data have been used in this study to assist with lithological and structural discrimination of the Karinya Syncline.

Spectral responses of minerals on satellite images are influenced by the presence of clays, iron oxides and vegetation. Spectral reflectance curves (Figure 5) in the visible (VIS) and near infrared (NIR), 0.4-1.1 µm, are dominated by strong absorption features due to charge transfer effects and electronic transitions in iron oxides and chlorophyll absorption in vegetation. The shortwave infrared (SWIR) region, 1.1 - 2.5 µm, is dominated by high reflectance values with strong absorption features for clays and vegetation due to vibrational processes of anionic groups, particularly hydroxyls.

Although the broad Landsat TM bands do not allow discrimination of mineral species, it is possible to detect mineral groups e.g. clays, carbonates, iron oxides.

A 100 x 87km subscene was extracted from image 97/84, 7 November 1987, acquired through the AMIRA Signal Processing Experiment (P203) and processed by the author and W.S. McCallum, Senior Geologist, Mineral Resources Branch SADME, on the Meridian Image Analysis System at SACRS.

The subscene was geometrically corrected and two areas covering the central and southern half of the Karinya Syncline, identified as KAR-NTH and KAR-STH, were subset for further processing. Plates 1 and 2 are false colour composites using bands 7, 3, 1 in red, green and blue respectively and have been edge enhanced using a 15 x 15 high pass filter. Both areas are 15 x 11km and have a 3km overlap.

Image KAR-NTH (Plate 1) is dominated by intensely cultivated land. Kanmantoo Group quartzites and siltstones form the central ridges and plains whereas Umberatana Group metasediments and tillites form the deeply incised areas on the western and eastern edges of the image.

KAR-STH (Plate 2) is dominated by deeply incised ranges flanked on the west by cultivated lowlands, by dense native vegetation to the south, and heavily cultivated Murray Basin plains to the east.

The Karinya Syncline appears as a depression (KARINYA DEPRESSION) in the central part of the ranges, the Karinya Shale Member outcropping within and adjacent to the margins (Figure 6).

Image Enhancement

The scene was difficult to process due to variable scene characteristics which gave strong, contrasting effects:

- areas of intense cultivation, with cropped, stubble and barren paddocks producing high albedo effects
- deeply incised drainage providing areas of shadow
- dense strands of native vegetation producing low reflectance on the 7, 3, 1 band combination
- high reflectance from crests of hills.

These effects coupled with a poor look-up-table (LUT) definition are evident on the false colour compositions (Plates 1 and 2) particularly on KAR-STH. Procedures used in attempting to enhance lithology and structure included:

- contrast stretching
- high and low pass filtering
- band additions
- ratio images
- false colour composites
- principal components analysis
- directed principal component analysis (Fraser and Green, 1987)
- selected principal component analysis (Chavez and Kwarteng, 1989)
- shade filtering.

Discussion of individual enhancements is not presented in this report although interpretation (Figure 6) incorporates features identified from most processes. A list of images generated in 35 mm slide format are given in Appendix 2.

Lithology

Spectral reflectance curves were derived for four lithologies (Figure 7) from known outcrop localities:-

1. Blowhole Creek Siltstone member - quarry on Sturt Highway.

2. Milendella Limestone Member - outcrop near Accommodation Hill.

3. Karinya Shale - quarry.

4. Truro Volcanics - outcrop adjacent to Eudunda Road, north of Dutton.

With the exception of the Karinya Shale Member, spectral curves of the lithologies show small contrast variance in all TM bands. The high values in band 1 are an effect of atmospheric absorption and scattering.

The Karinya Shale Member, however, shows lower DN values in bands 3, 4, 5 and 7, indicating that false colour composites using these bands should discriminate this unit. Most enhancements show outcrop and sub-crop of Karinya Shale Member only on the western margin of the Karinya Depression which on the 7, 3, 1 images (Plates 1 and 2) are dark saturated blue. Also highlighted on the 7, 3, 1 image, in a reddish-blue - magenta, is the Milendella Limestone Member, with diffuse reddish margins indicating possible iron oxide alteration.

Structural Trends

Structure, dominated by north-south trending lineaments also influences drainage as shown by:-

- coarse, dendritic drainage cross cutting the N-S trend, north of Pine Creek on KAR-NTH,
- medium, trellis pattern in the ranges on KAR-STH.

Other structural controls of drainage are shown by the linearity of Pine Creek and also by the deflection of drainage pattern parallel to Lineament A-A′, Figure 6.

The dominating N-S lineaments possibly represent cleavage and shear planes, e.g. lineament E-E′ interpreted to be a shear plane.

Two other trends, a NW-SE and WSW-ENE, are evident. The NW-SE trend e.g. (the dual) Lineament B-B′ do not appear to effect drainage whereas the WSW-ENE trend, C-C′, D-D′ appears to modify drainage. Of particular interest is the dual lineament C-C′, obvious as a broad diffuse feature on KAR-STH (Plate 2). The lineament runs adjacent to the Wheal Barton Copper Mine, through the Milendella Limestone at Accommodation Hill and apostrophe passes just to the south of Schneider′s gossan.

Within the central part of the Karinya Depression adjacent to lineament (B-B′) and near the intersection with lineament C-C′ is a weakly defined circular feature (an intrusive plug?) showing magenta to purple margins (Figure 6) with an associated minor NE trending lineament showing some colour anomalies. Just to the southeast, adjacent to the Sturt Highway are some bright red zones trending NE across lineament B-B′. These features require further investigation given their in close proximity to the Gap Prospect.

AIR PHOTO INVESTIGATIONS

To complement Landsat TM investigations aerial photographs covering a similar area as KAR-NTH and KAR-STH were also interpreted and an uncontrolled base compiled (Figure 8).

Lithology

Milendella Limestone Member was readily mappable and appeared to be associated with some form of reddish-purple iron-alteration, also interpreted from Landsat TM. This was confirmed in the Accommodation Hill area where copper-lead-zinc bearing gossans and ironstones were found. A suspected sink hole was verified in the field with cavernous solution features, cavities and breccias identified.

Outcrops of Karinya Shale Member show as discontinuous dark greenish-grey, bluish-grey outcrop and subcrop along the western margin of the Karinya Depression and adjacent to a NNW trending lineament. Between Pine Creek and the Sturt Highway an interpreted E-W fault appears to displace the unit.

Other units appear to be interbedded sandstone, shales, siltstones and minor quartzites varying from massive, sandy to very laminated sandy, orange-red, reddish-brown in colour with possible facies changes along strike. The north-south strike ridge on the western margin of the Karinya Depression is probably quartzitic.

Lineaments

Air photographs reinforce the strong NNW lineament trend evident on TM imagery, particularly on the eastern part of the ranges. The NW trends appear but are much weaker, and are probably masked by cultivation. The WSW-ENE trend is more pronounced on aerial photographs particularly in the southern half of the region.

Immediately south of the Sturt Highway pronounced, fine, east-west lineaments overprint the WSW trend and possibly relate to the structure controlling Pine Creek.

Apparent rejuvenation along N-S lineaments is suspected in the northeast corner, east of Frankton, with deeply incised drainage cutting through the Adelaidean metasediments.

Drainage and Geomorphology

The area is subdivided into 5 drainage basins (Figure 8):

I. Predominantly medium- to coarse parallel/dendritic (?relict) drainage, trending NS-NE and subsequently modified by movement along N-S lineaments.

II. Deeply incised fine to medium dendritic drainage, appears to have an ?annular pattern imposed.

III. Comprises two sub-basins (a) Primarily medium dendritic pattern draining eastwards, with pattern modified to trellis drainage in (b) where the drainage incises a peneplained plateau.

IV. Also two related sub-basins with (a) consisting of dendritic drainage flowing eastwards to a south flowing channel, turning eastwards into the (b) zone, which shows a pronounced fine to medium trellis drainage with major channels flowing eastwards, influenced by two strong lineament patterns, N-S and WSW-ENE.

V. Coarse dendritic drainage flowing NW.

A number of geomorphologic features are also mapped, Figure 8:

1. South of the Sturt Highway, the Karinya Depression appears to be related to a strong topographic depression. A second depression, offset eastwards is also seen to the south of the Karinya Depression.

2. Three kilometres north of Pine Creek is an asymmetric monoclinal ridge, steep slope facing north, which may be related to an interpreted E-W fault on the eastern side of the ranges. Drainage appears in places to be deflected eastwards between these features. Strong E-W trending lineaments between Pine Creek and the Sturt Highway may be related to the structure controlling the flow of Pine Creek.

3. A series of stepped depressions in the northern part of the area along which ?relict drainage channels are seen to follow provide further evidence of movement along the N-S lineaments immediately to the east.

FIELD INVESTIGATIONS

Following interpretation of TM imagery, a brief reconnaissance was made in the Accommodation Hill area, in particular to seek evidence for interpreted alteration anomalies around the Milendella Limestone Member. Ironstones and gossaneous rocks, some copper-bearing, were found on the margins, as were breccias (Plate 3) dissolution structures and sink holes within the limestone. Quartz-iron veins and ironstones were found just to the west of the limestone along the margin of an interpreted shear plane, Lineament E-E' (Figure 6.).

Outcrops along Wild Dog Creek, just west of a Pb-Zn occurrence show protomylonitic character, hence providing evidence for the interpreted Kanmantoo Shear Zone.

Further field investigations were undertaken after compilation of the airphoto interpretation. Six reconnaissance traverses along creeks were undertaken (Figure 8) to check for mylonites and shear zones that would provide evidence for the Kanmantoo Shear Zone and were arranged on both the western and eastern margins to cross the contact between the Kanmantoo and Adelaidean Groups.

Twenty-seven samples were collected for petrography (Table 2) and silicate and trace element analysis (Table 3). Petrographic descriptions are given in Appendix 1.

Two traverses on the western boundary did not cross into Kanmantoo Group sediments. However, highly ferruginised and silicified zones on traverse T2, interpreted as faults, were crossed, east of which no outcrop was observed. The Adelaidean metasediments are generally poor to well-bedded sandy shales, shales, siltstones and quartzites which become mylonitic approaching the faults on T2 (Plate 4). Between the mylonite zone and the fault is an outcrop of Truro Volcanics (6729 RS 3268) which appeared to have ?brecciated margins (Plate 5).

Four traverses were made on the eastern side of the area:

- T1: In the northern area within drainage basin II, to check for possible causes of the ?imposed annular drainage pattern, none found. Main rock type, tillite, with most clasts being well rounded (although in some areas showed slight elongation), with interbedded dark green, gritty sandy units. Some darker porphyritic units and ferruginised outcrops may be of volcanic origin (6729 RS 3260, 3261, 3262).

- T4: Along Rocky Creek and tributaries. Adelaidean metasediments comprising well bedded grey and green siltstones and shales (Plate 6), the green siltstones, often gritty progress to tillite eastwards, which is intruded by an albite dyke (6729 RS 3275, 3276). Brittle and ductile deformation features are evident in the form of:

  - stretched clasts in tillite (Plate 7)
  - ferruginised fault zones, to 5 metres wide (Plate 8)
  - pressure solution cleavage (Plate 9)
  - mylonitic fabric.

  Adjacent to some semi-brittle/ductile faults are brecciated zones which may possibly be volcanic plugs (6729 RS 3269). Kanmantoo Group metasediments comprising quartzitic sandstones, siltstones and shales show few sedimentary structures. Rare clasts (Plate 10) show some stretching and mylonitic fabric appears to be developed. The "contact zone" between the Adelaidean and Kanmantoo Groups appears to be a highly ferruginised unit, highly fractured and weathered with densely developed, fine stockwork of iron-rich veins, the base of the Kanmantoo Group being possibly the eastern margin of the outcrop.

Outcrops of the Karinya Shale Member, where encountered, were generally weathered to fine-grained creamish grey, often with a orange-brown weathering skin. In places black shales, considered to be Karinya shale appear to be caught up in shear zones. The author therefore considers that the Karinya shale Member, in the vicinity of Frankton is sheared out along the margins of minor fold axes rather than being a complete antiform as mapped on Truro 1 mile (Coats 1959).

- T5: Pine Creek. Kanmantoo Group sediments showed clear evidence of semi-brittle/ductile deformation, particularly on the eastern half of the traverse, where an open folded sandstone unit is sheared along the eastern limb seen as strong cleavage (Plate 11) which develops eastwards into a mylonitic fabric towards Schneider's Gossan, where the Kanmantoo Group is extensively folded, faulted and injected with lamprophyres and plugs (Plate 12). Schneider's Gossan is interpreted to be the faulted contact between the Adelaidean and Kanmantoo Group and is on strike with the ferruginous outcrop to the north in Rocky Creek, described in T4.

- T6: Southern Area, east of Wyeroo Homestead. Rock units, predominantly siltstones and shales show badinaging along bedding planes (Plate 13). Eastwards, deformational features intensified to very strong cleavage zones (Plate 14) and highly disrupted to mylonitic fabric (Plate 15).

Petrography

Twenty seven samples were collected during the course of field investigations (Figure 8), twenty four of which were examined petrographically (Table 2) and seventeen submitted for chemical analysis (Table 3). Summary petrographic descriptions were provided by Analabs (Appendix 1) whilst Farrand (in press) described the samples in detail.

Petrography confirms the authors field identification of 2 samples suspected of being volcanic in origin:-

- RS 3261 possible dyke in Adelaidean tillite
- RS 3270 possible Truro Volcanics.

RS 3262, non-descript and highly ferruginous in outcrop was also identified as volcanic in origin and may possibly be a small plug.

Unusual rock types (RS 3269, 3286) described in the field as breccias are petrographically described as volcanics. RS 3269 may in fact be a small plug intruded along a fault zone.

A small lamproite (RS 3273) measuring 1.1 m x 0.2 m was found in Adelaidean rocks, the first such in the Truro-Frankton area.

TABLE 2

Samples from Reconnaissance Traverses

6729 RS NO.	SUMMARY FIELD DESCRIPTION	PETROGRAPHIC CLASSIFICATION ANALABS	PETROGRAPHIC CLASSIFICATION FARRAND (in press)
3260	Dark grey massive ?siltstone or ?porphyritic volcanic; weakly magnetic.	Metasediment	Metasandstone.
3261	Dark grey, with pink phenocrysts; porphyritic volcanic or amphibolite.	Plagioclase-rich intrusive.	?Metatrachyte.
3262	Ferruginised outcrop.	Ferruginous volcanic.	Porphyitic microsyenite.
3263	Grey, dark-grey laminated, spotted.	Biotite metasiltstone.	Retrograde ?cordierite hornfels.
3264	Grey, dark grey speckled siltstone, diffuse layering.	Spotted biotite metasiltstone.	Retrograde cordierite hornfels.
3265	Dark blue-grey laminated siltstone.	Phyllite	Laminated phyllite.
3266	Epidotised marble.	Epidote quartz vein.	Epidote and quartz veins.
3267	Dark grey calcareous siltstone.	Marble.	Silty limestone.
3268	Epidotised, grey green Truro Volcanic.	Metabasite/Biotite Amphibole.	Porphyritic metabasalt.
3269	Brittle/brecciated - fault zone.	Altered igneous rock.	Metatrachyte.
3270	Grey, ?Truro volcanic.	Altered, plagioclase-rich igneous rock.	?Metatrachyandesite.
3271	Dark grey-black mafic ?amphibolite.	Plagioclase biotite sandstone.	Metatrachyte.
3272	Quartz veins.		
3273	Lamprophyre	Biotite-quartz-feldspar rock.	Lamproite.
3274	Black, fine grained, mica siltstone with clots; mylonitic foliation.	Metamorphosed igneous rock.	Metatrachyte.
3275	White dyke in tillite.	Albitite.	Albitite.
3276	Contact metamorphosed tillite.	Metatourmaline sandstone.	Greisenised metasandstone.

TABLE 2 (cont.)

6729 RS NO.	SUMMARY FIELD DESCRIPTION	PETROGRAPHIC CLASSIFICATION ANALABS	FARRAND (in press)
3277	Ferruginised fault zone.		
3278	Quartz-Iron vein; ?trace sulphide.		
3279	Weathered/altered brecciated rock.	Plagioclase Porphyry.	Albitite.
3280	Siltstone, phyllonite texture	Phyllite	Dolomitic metasiltstone.
3281	Dark, fine-grained mylonite quartzite	Phyllite/Carbonate Quartz Arenite.	Fine bedded phyllitic metasiltstone.
3282	Very fine grained, black ?Karinya Shale.	Carbonate Phyllite/Marl.	Phyllite.
3283	Dyke, grey, quartz phenocrysts, ?vesicular.	Amygdular Na-plagioclase porphyry.	Porphyritic, amygdaloidal basaltic meta-andesite.
3284	Grey-blue ?lamprophyric.	Muscovite Schist.	Muscovite schist.
3285	Green ?lamprophyric.	Chlorite schist (volcanic igneous rock).	Muscovite-chlorite-quartz-feldspar schist.
3286	Foliated, brecciated rock.	Meta plagioclase porphyry.	Schistose, volcanigenic metasandstone.

TABLE 3: Silicate and Geochemical Analysis

%	6729RS 3262	6729RS 3266	6729RS 3269	6729RS 3269	6729RS 3270	6729RS 3271	6729RS 3272	6729RS 3273	6729RS 3274	6729RS 3275	6729RS 3277	6729RS 3278	6729RS 3279	6729RS 3283	6729RS 3284	6729RS 3285	6729RS 3286
SiO_2	49.70	59.40	43.80	50.00	49.70	49.60	88.20	61.60	47.00	65.70	61.30	70.60	56.00	43.60	51.00	54.00	50.40
Al_2O_3	17.20	12.40	14.30	20.00	15.50	15.60	2.56	12.60	15.30	18.10	8.77	3.00	17.90	15.70	16.70	14.00	16.40
TiO_2	2.08	1.77	2.20	2.68	2.79	2.98	0.20	1.93	2.63	1.07	0.53	0.30	2.35	2.81	2.33	1.64	2.43
Fe_2O_3	9.11	7.55	12.90	10.40	13.60	14.00	5.55	7.89	17.30	2.66	19.40	20.50	8.06	9.67	19.00	16.40	11.60
MgO	2.77	0.05	9.14	2.08	3.42	3.74	0.27	4.82	2.96	0.22	0.64	0.38	1.67	2.09	0.68	2.38	6.88
MnO	0.14	0.16	0.18	0.07	0.33	0.09	0.08	0.02	0.20	0.04	0.03	0.19	0.10	0.14	0.01	0.13	0.14
CaO	3.66	13.90	9.77	2.05	5.20	1.92	0.20	0.64	2.72	0.55	0.19	0.60	0.94	9.73	0.96	1.48	1.09
Na_2O	6.34	0.75	1.59	4.53	3.17	3.98	0.26	3.72	3.73	9.60	0.89	0.23	7.14	5.93	1.04	1.74	3.46
K_2O	2.35	0.42	1.01	3.50	1.73	4.46	1.13	3.43	3.64	0.53	2.47	0.77	2.21	0.15	4.81	1.78	2.46
P_2O_5	0.76	2.05	0.89	0.81	1.17	1.46	0.07	0.12	0.79	0.33	0.32	0.10	0.57	1.14	0.17	1.00	0.65
LO1	5.68	1.50	3.83	3.75	3.09	1.82	1.20	3.21	3.57	0.75	5.12	3.34	2.96	8.87	3.21	5.12	4.08
TOTAL	99.79	99.95	99.61	99.87	99.70	99.65	99.72	99.98	99.84	99.55	99.66	100.01	99.90	99.83	99.91	99.67	99.59
ppm																	
As	2	2	2	5	4	4	3	3	1	5	21	71	6	3	3	10	25
B	15	30	<5	25	12	10	31	<5	12	11	114	58	12	<5	38	107	10
Cu	305	75	1200	50	115	145	75	35	75	15	315	730	65	15	15	135	45
Pb	5	10	5	<5	5	<5	5	5	<5	20	10	<5	<5	<5	<5	<5	<5
Zn	1200	230	2950	125	1000	450	100	80	105	35	210	45	110	100	20	120	150
Ni	5	5	165	30	15	5	10	220	5	10	140	275	20	5	15	35	70
Ag	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mo	10	01	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Cr	10	40	80	5	<5	<5	10	80	<5	5	15	10	10	10	<5	5	50
Co	30	10	65	40	40	35	35	25	40	25	55	205	35	60	20	70	40
Be	2	1	1	2	2	3	2	6	3	2	3	1	3	1	1	1	2
Li	16	1	31	20	33	72	8	71	44	3	16	5	20	44	13	50	70
Nb	49	25	54	35	86	87	<10	<10	35	<10	<10	<10	45	68	10	40	42
Zr	210	36	63	111	104	207	34	77	145	157	81	72	303	238	11	137	207
Ba	1978	530	727	1037	552	851	285	1067	603	169	301	258	542	56	2390	264	1446
V	85	138	226	261	216	201	46	308	318	125	148	51	132	260	49	156	303
Sc	13	17	27	22	18	20	4	22	24	9	13	5	15	18	27	16	24
Sm	8	7	5	10	9	12	<5	12	6	7	<5	<5	11	8	6	6	7
La	118	89	65	76	84	98	20	196	60	80	57	25	105	92	50	39	42
Sr	373	3600	622	375	733	850	47	522	457	252	93	60	273	148	56	54	523
Pd	<0.0005	0.0006	0.0007	0.0016	0.0006	0.0008	0.0013	0.0037	<0.0005	0.0013	0.0048	0.00025	0.0012	0.0005	<0.0005	0.0009	0.001
Pt	<0.0005	0.0006	<0.0005	0.001	0.0005	0.0001	0.0011	0.0021	<0.0005	0.001	0.0054	0.0026	0.0017	0.0011	<0.0005	0.0013	0.0007
Au	0.0016	0.0022	0.0021	0.0018	<0.001	0.003	0.004	0.003	0.0024	<0.001	0.0044	0.0084	0.0018	0.0018	<0.001	0.0023	<0.001
Y	38	28	29	56	51	69	9	42	20	18	25	56	44	18	32	32	41

SYNTHESIS

A) Landsat MSS Imagery

Interpretation of MSS imagery, over the Mount Lofty Ranges has:

- defined two broad structural units, separating, along the Bremer Fault, the Proterozoic metasediments in the west from the dominant Cambrian metasediments to the east. These units appear to be zones of thrust faulting and semi-brittle/ductile shearing respectively;

- intrusion of granite may be contemporaneous with a NNW fault, cutting across the mid-section of the Kanmantoo Trough,

- Cu and Pb-Zn mineralisation is possibly associated with intrusion of the granite and possibly localised by WNW and ENE lineaments cross-cutting the NNW trends.

B) TM Imagery and Air Photographs

- Landsat TM and air photographs effectively define outcropping Karinya Shale and Milendella Limestone Members and an iron-oxide halo associated with the Milendella Limestone Member.

- The Karinya Syncline is defined as a depression on TM imagery with air photographs showing topographic depressions south of the Sturt Highway. East-west trending lineaments are clearly apparent between the Sturt Highway and Pine Creek and are probably related to a major structure controlling Pine Creek.

- A circular feature identified from TM imagery in the centre of the Karinya Depression is associated with a NW trending lineament and colour anomalies. This feature is not identified on air photography.

- Five drainage basins have been defined within the study area the pattern of which appear to be controlled largely by structure (Figure 8).

- Lineaments are strongly developed in a NNW trend with a prominent WSW trend evident south of the Sturt Highway.

- Reconnaissance field investigations near Frankton and along the eastern margin of the Mount Lofty Ranges have shown evidence of NNW trending semi-brittle/ductile faults developed in both the Adelaidean and Cambrian metasediments with possible associated intrusion of volcanic plugs.

CONCLUSIONS AND RECOMMENDATIONS

Satellite imagery in conjunction with air photo investigations have defined strong NNW trending lineaments which impose a strong regional trend and fabric particularly on Kanmantoo Group metasediments. These are considered to represent major shear planes and may form part of a much larger structure termed the "Kanmantoo Shear Zone".

Evaluation of mineral potential of the Kanmantoo Group requires understanding the complexity and geometry of the "Kanmantoo Shear Zone" as there would probably be a strong association between structure and ore deposits.

It is recommended that:

- further work be undertaken on KAR-NTH, KAR-STH, TM imagery to improve contrast of the images and to merge ground geophysics and geochemistry to assist in the evaluation of structure and lithology.
- detailed mapping of the Karinya Depression and Karinya Shale Member be undertaken to:
  - determine the structural geometry and the extent of shearing
  - define contact margin and relationship between the Kanmantoo Group and Adelaidean
  - outline occurrence of volcanic plugs and lamprophyre dykes.
- a re-appraisal of the regional geology and structure of the Kanmantoo Trough be initiated using a combination of TM imagery, digitised geology and geophysics
- a metallogenic study of the Kanmantoo Trough be undertaken to determine the nature of mineralisation, host lithologies associated structures and effects of shearing and faulting.

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E.A. Dubowski

<u>E.A. DUBOWSKI</u>

G02519

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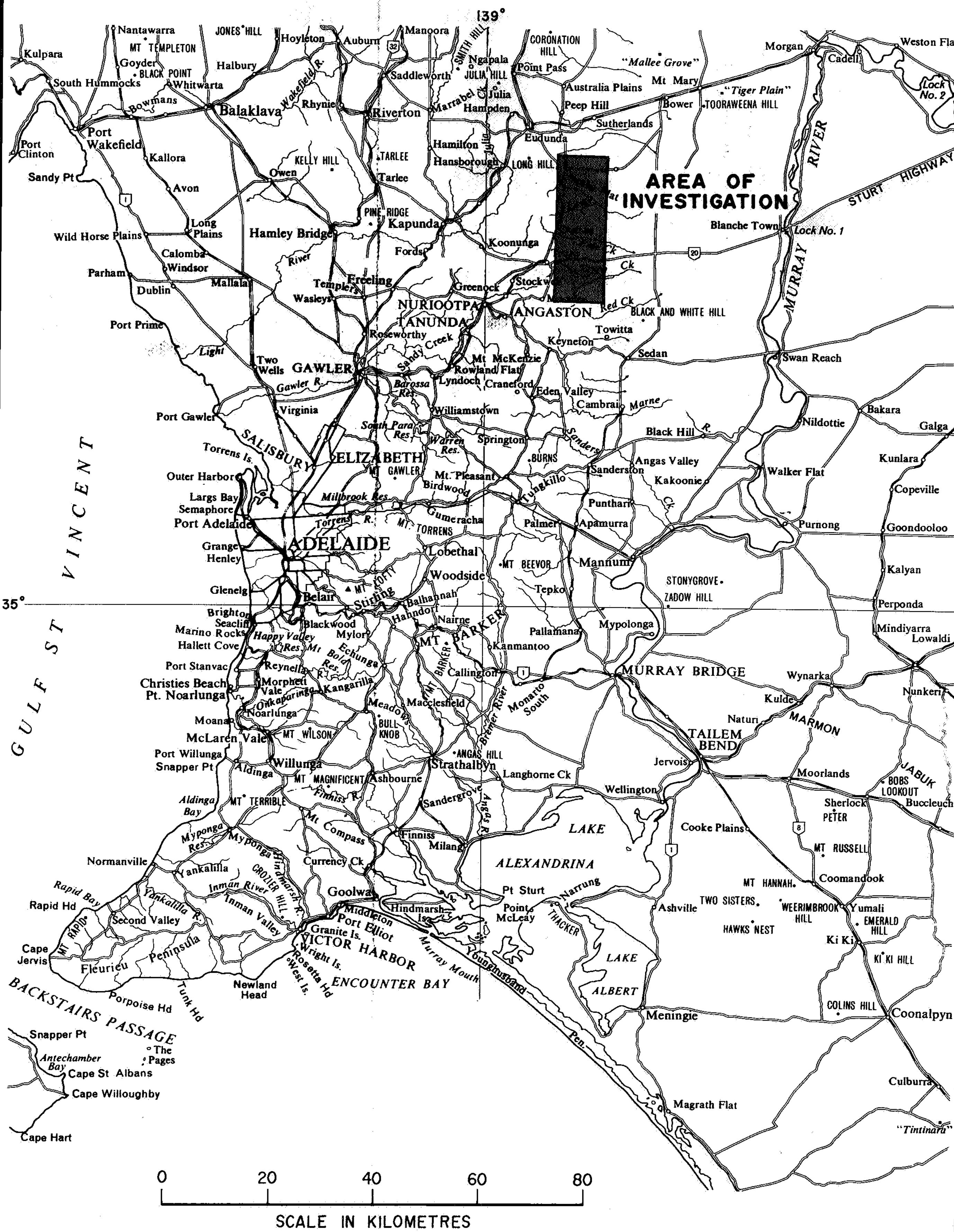
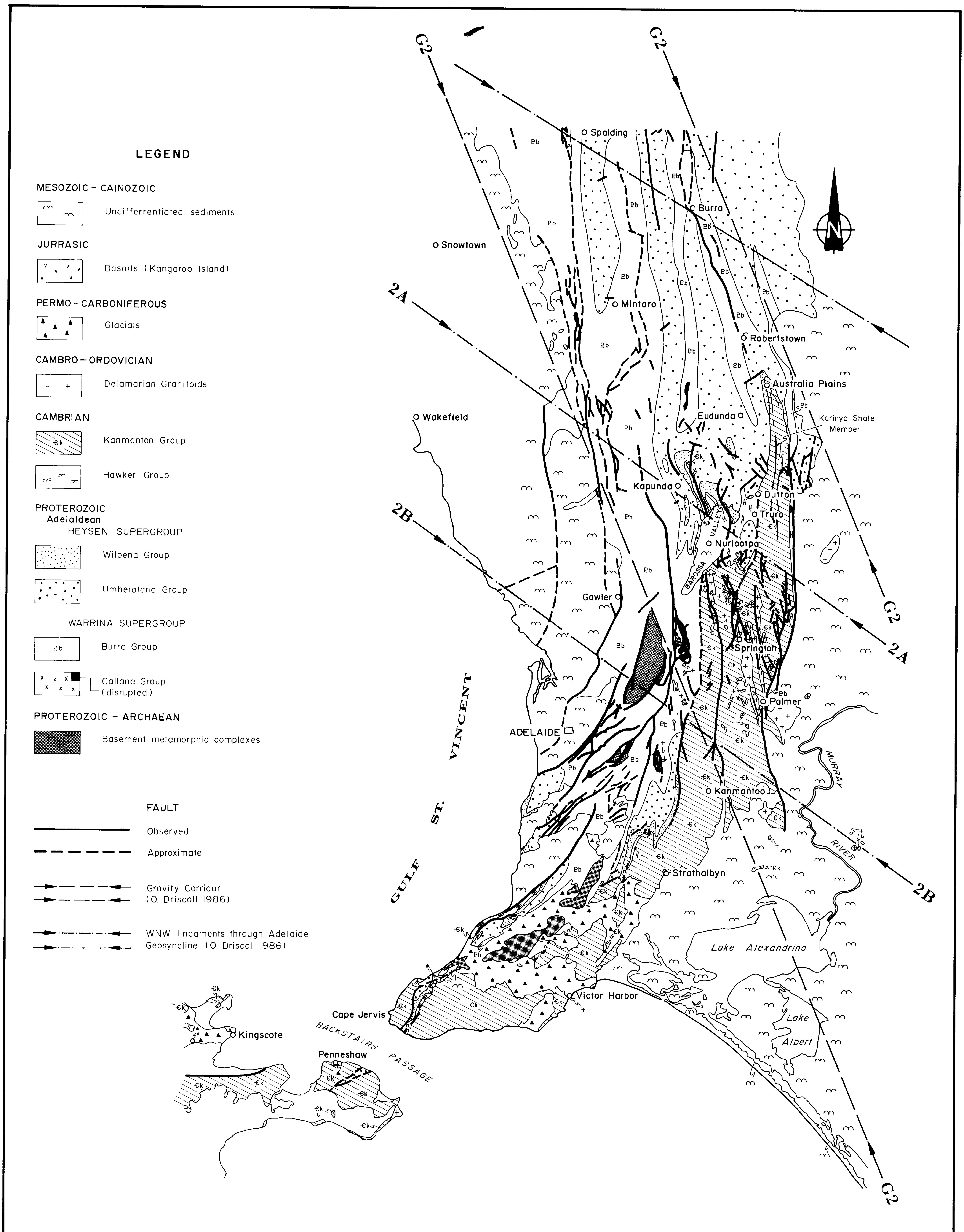


FIG. 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED E. Dubowski	C.D.O. DATE 4-3-91
NORTHERN KANMANTOO TROUGH LANDSAT STUDY	DRAWN E. Calabio	SCALE 1:1 000 000
LOCATION OF LANDSAT AND AIR PHOTOGRAPH INVESTIGATIONS	DATE Feb. 1991	PLAN NUMBER
	CHECKED	S 21995

5170



SCALE IN KILOMETRES

0 10 20 30 40 50

Modified from: Preiss, W. V. 1983: ADELAIDE GEOSYNCLINE AND STUART SHELF
Precambrian and Palaeozoic Geology, Dept. of Mines and Energy, Adelaide

FIG. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NORTHERN KANMANTOO TROUGH
LANDSAT STUDY

REGIONAL GEOLOGY
KANMANTOO GROUP

COMPILED	E. D.
DRAWN	E. C.
DATE	2 / 91
CHECKED	
	WR 4·3·91
SCALE	AS SHOWN
PLAN NUMBER	91-195

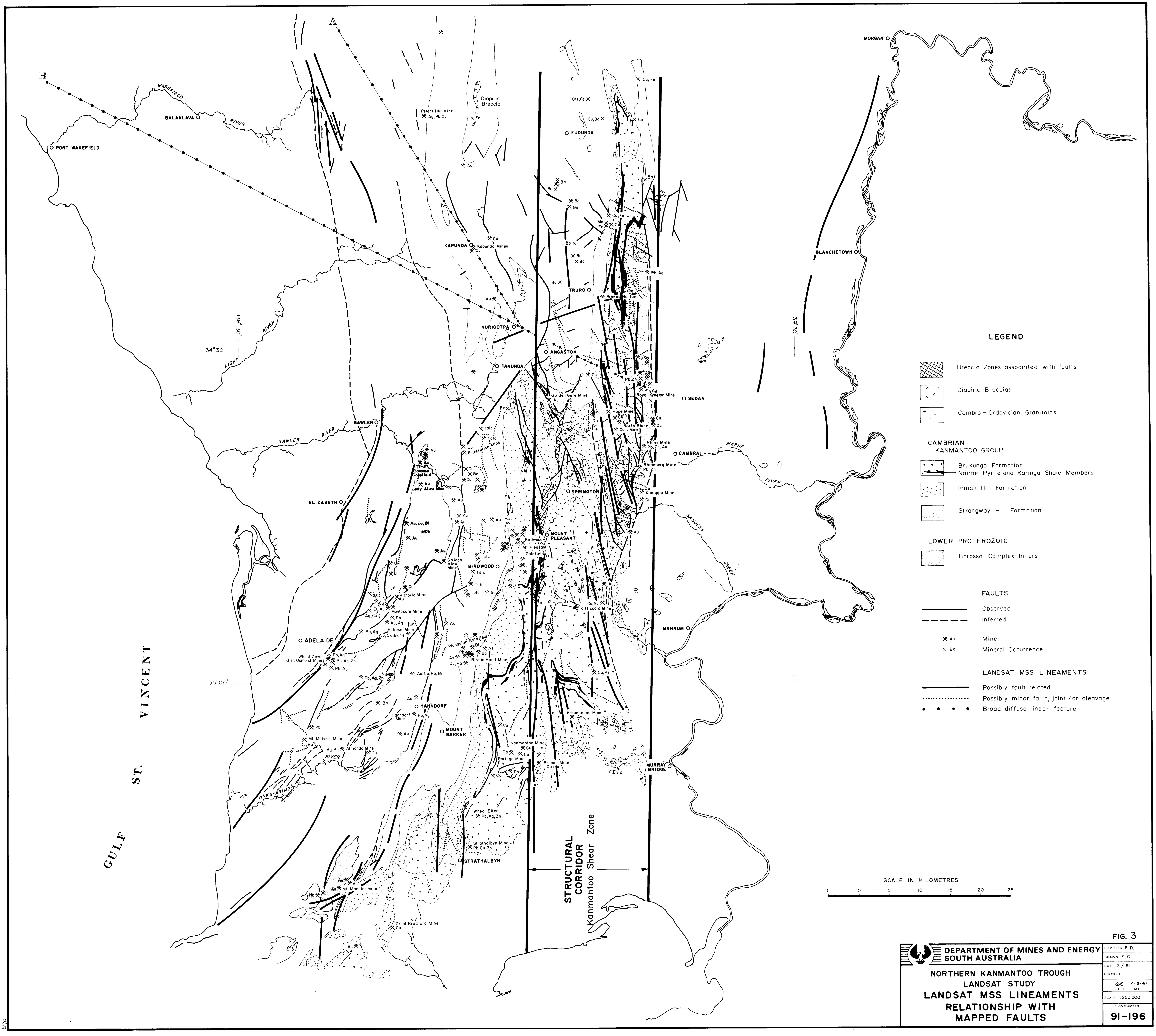


FIG. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHERN KANMANTOO TROUGH
LANDSAT STUDY
LANDSAT MSS LINEAMENTS
RELATIONSHIP WITH
MAPPED FAULTS

COMPILED E.D.
DRAWN E.C.
DATE 2/91
CHECKED
C.D.O. DATE 4.3.91
SCALE 1:250 000
PLAN NUMBER
91-196

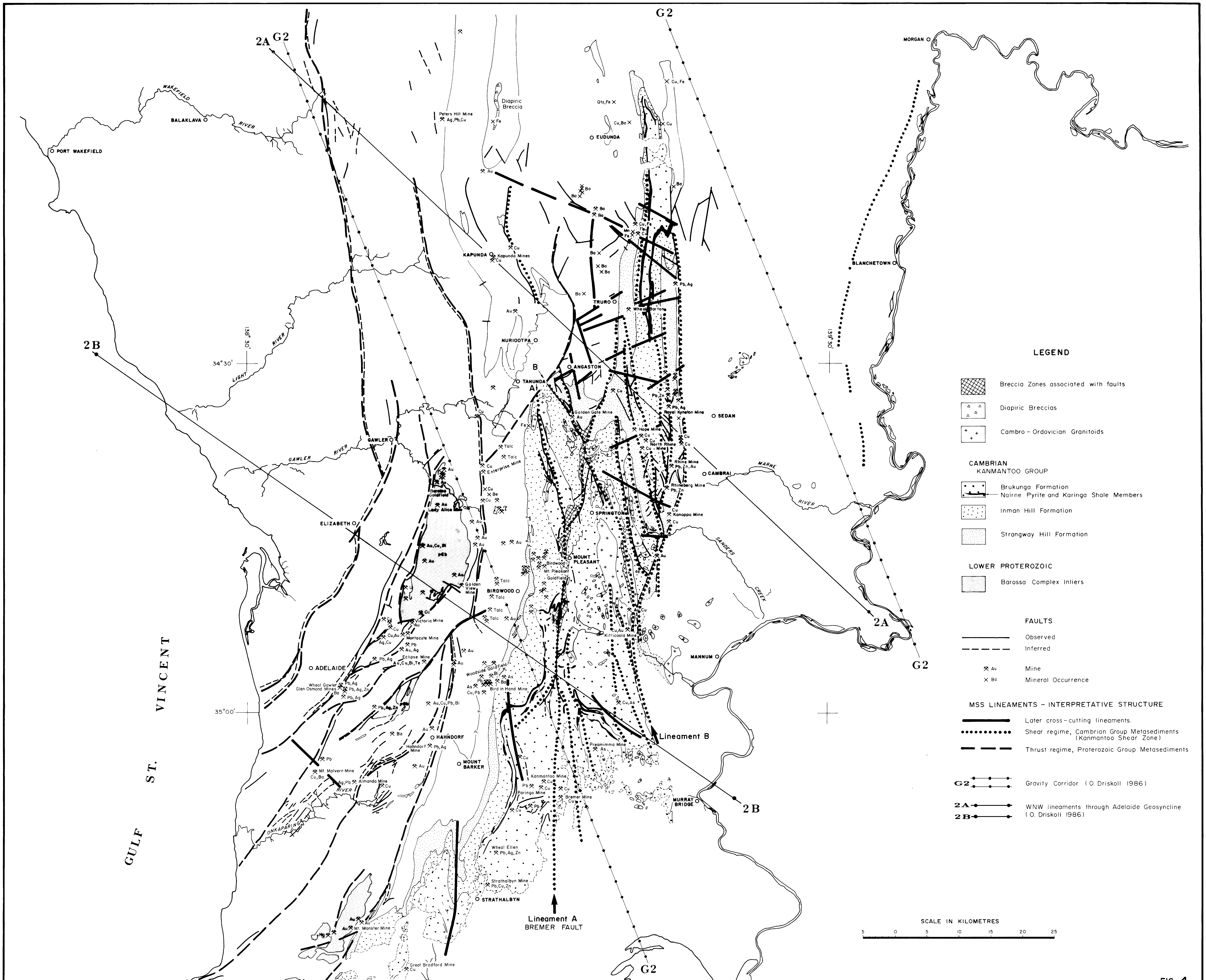


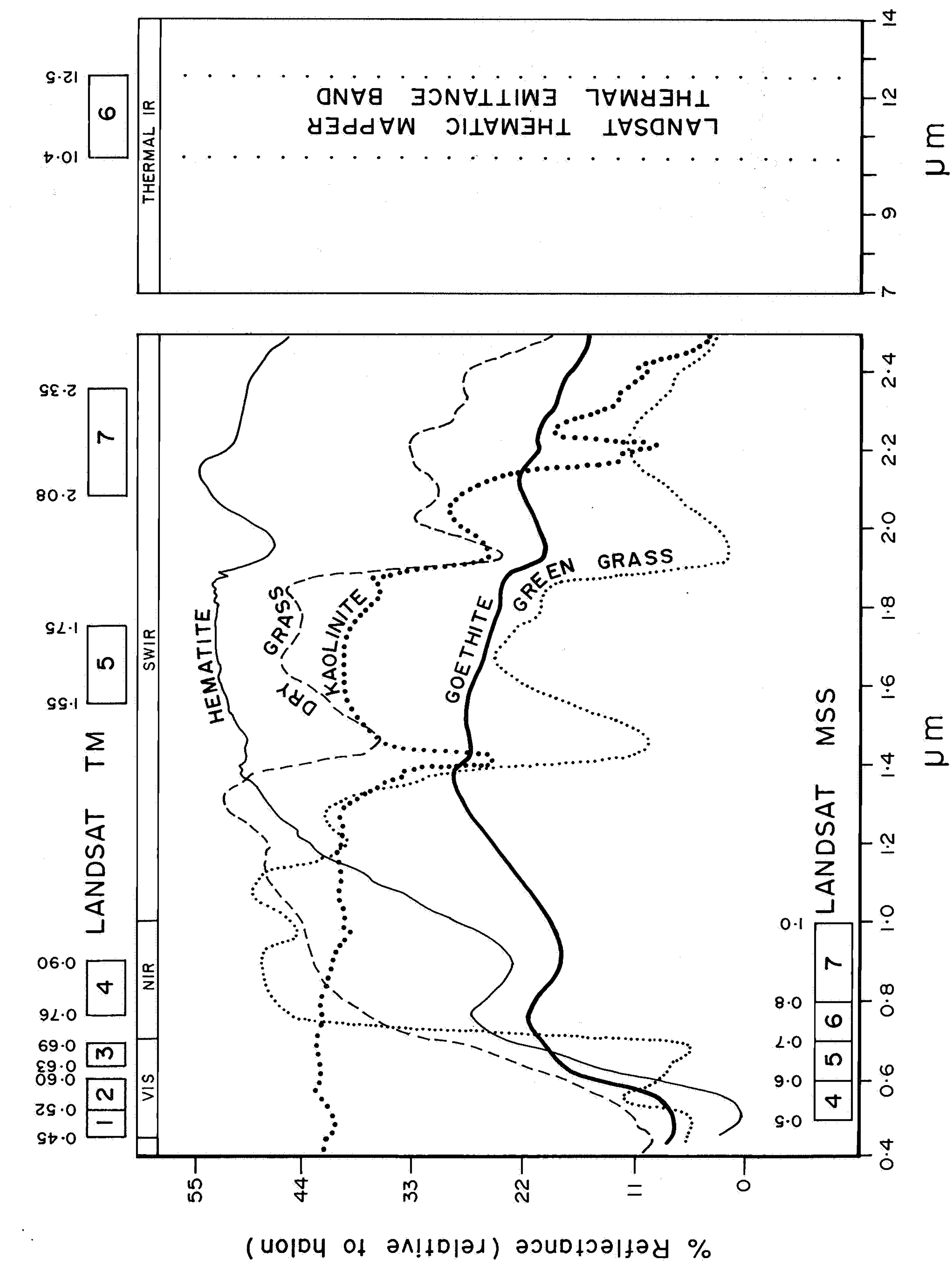
FIG. 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

NORTHERN KANMANTOO TROUGH LANDSAT STUDY

INTERPRETED STRUCTURAL ELEMENTS

Compiled E. D. Drawn E. C. Date 2/91 Scale 1:250 000 Plan Number 91-197

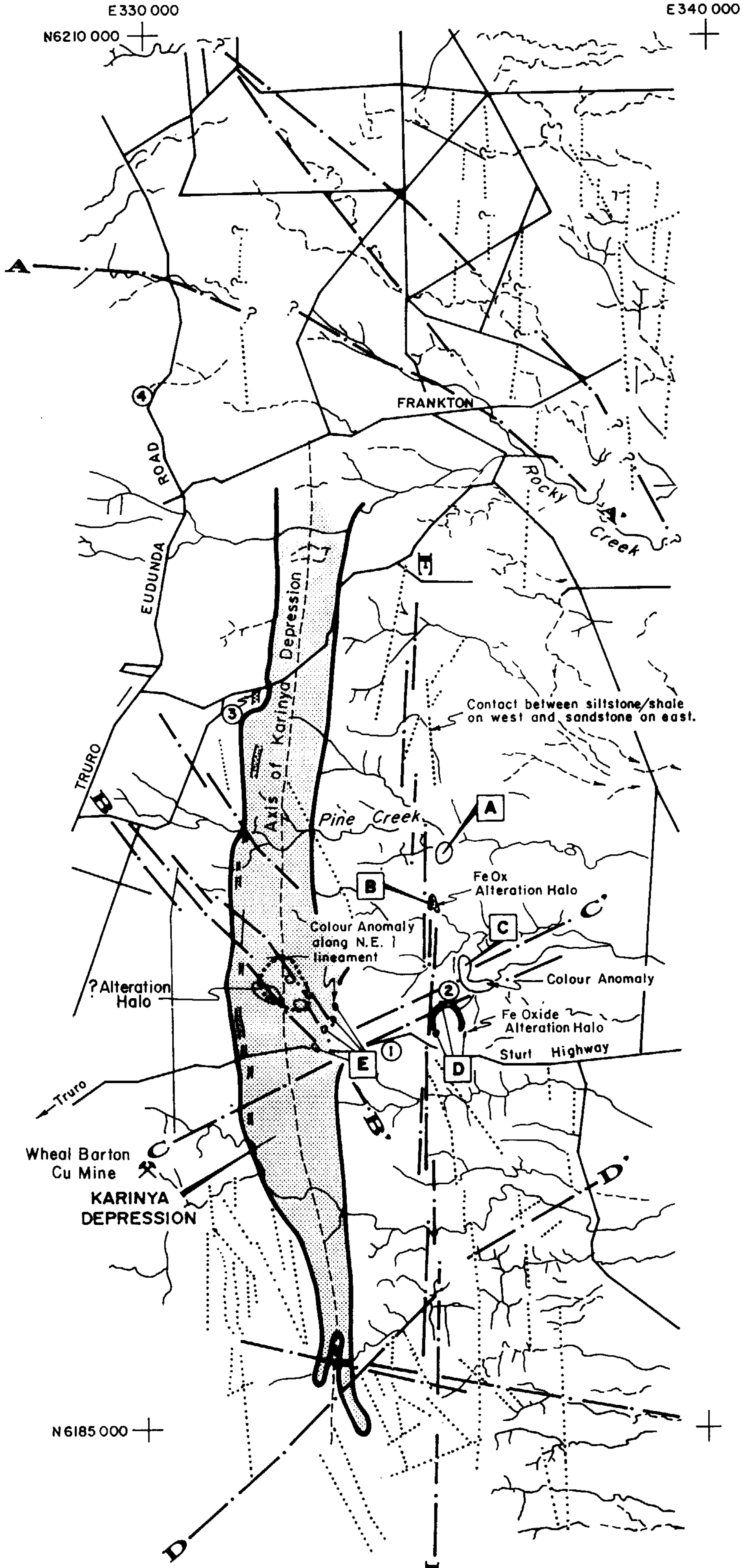


Data and graph by CSIRO Division of Mineral Physics and Mineralogy.

FIG. 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED E. Dubowski	C.D.O. DATE 4·3·91
NORTHERN KANMANTOO TROUGH LANDSAT STUDY	DRAWN E. Calabio	SCALE graph
REFLECTANCE CURVES OF SELECTED COVER TYPES	DATE Feb. 1991	PLAN NUMBER
	CHECKED	**S 21996**

5170



LEGEND

- Karinya Shale Member
- Milendella Limestone Member
- Road or track
- Drainage
- Relict drainage
- D- -D' Major linear feature (mentioned in text)
- Minor linear feature
- ② Location of areas where spectral curves (Figure 7) were derived.
- C Identified colour anomalies (See notes)*

SCALE IN KILOMETRES

0 2 4 6 8 10

NOTES*

A Bright, distinctive, especially on image 5/2, 3/1, 1+2+3. On 7, 3, 1 image, deep yellowish; on 3, 2, 1, Orange brown.

B Mapped outcrop, fold hinge, of Milendella Limestone. Red, reddish-purple adjacent to margin on 7, 3, 1 image. Milendella Limestone dark on Directed PC2 (FeOx-Veg); red on 3, 2, 1 and 5/2, 3/1, 1+2+3 images.

C Cyan and red margin on 7, 3, 1 image; Minor Orange-Yellow feature on 3, 2, 1. Anomaly was first identified from Eudunda subset image (7, 3, 1) as a green colour on a red background.

D Mapped fold hinge of Milendella Limestone. Slight purple colours on margins on 7, 3, 1 image; strong blue with trace magneta on 3, 2, 1.

E Pronounced bright red feature on 7, 3, 1 image; however:
- 7, 5, 2 image shows associated yellow/blue pair;
- 5/2, 3/1, 1+2+3 blue;
- Selected PC1 (5-7), PC1 (1-2-3), 4 shows cyan;
- 3/1 mid grey;
- Directed PCs mid greys with dark area.

FIG. 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED E.D.	C.D.O. 4·3·91 DATE
NORTHERN KANMANTOO TROUGH LANDSAT STUDY	DRAWN E.C.	SCALE As shown
THEMATIC MAPPER IMAGE INTERPRETATION	DATE Feb. 1991	PLAN NUMBER 91-198
	CHECKED	

5170

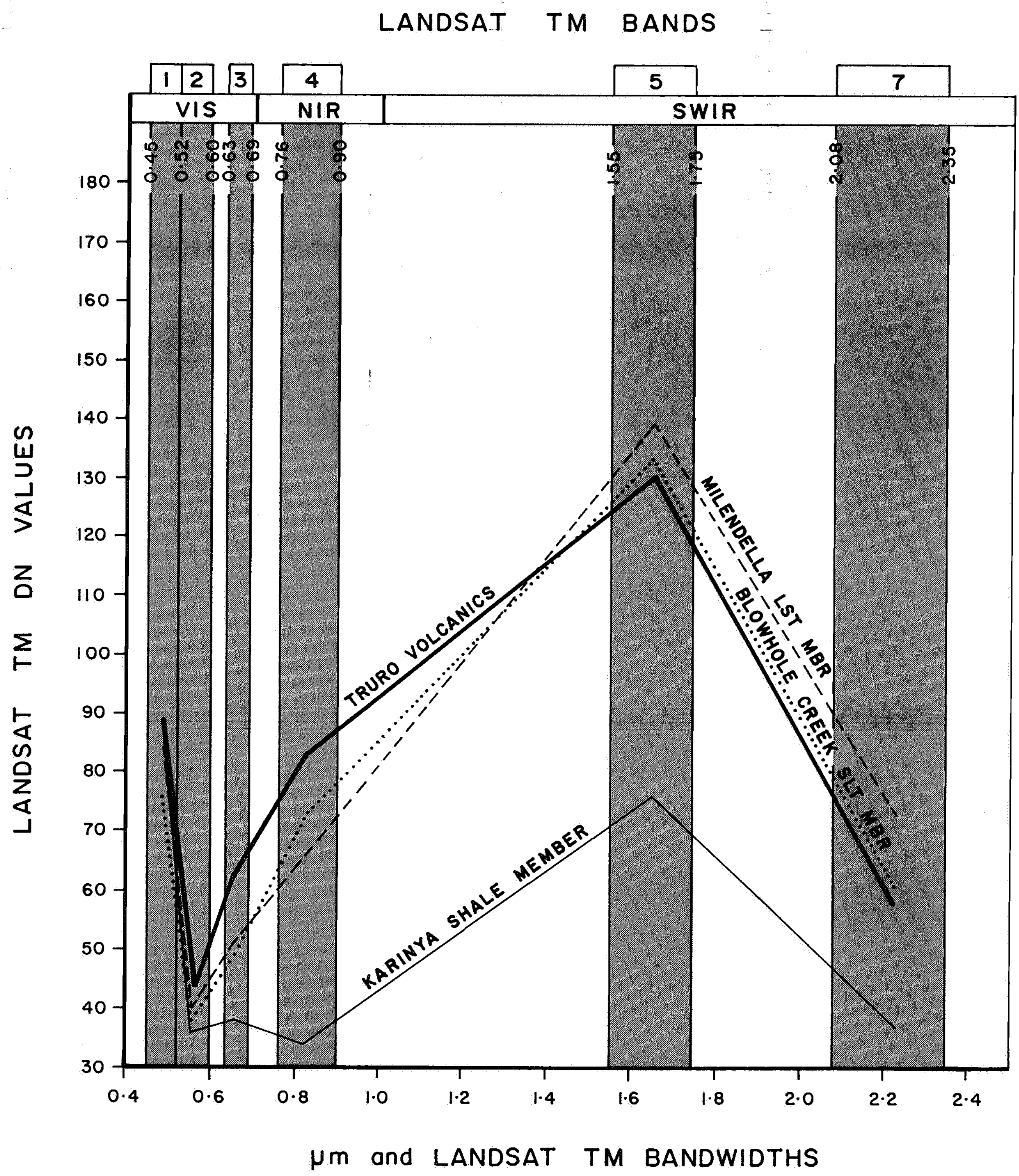


FIG. 7

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED E. Dubowski	C.D.O. DATE 4·3·91
NORTHERN KANMANTOO TROUGH LANDSAT STUDY	DRAWN E. Calabio	SCALE graph
LANDSAT TM SPECTRAL REFLECTANCE CURVES OF SELECTED CAMBRIAN LITHOLOGIES	DATE Feb. 1991	PLAN NUMBER
	CHECKED	S 21997

5170

FIG. 8

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

NORTHERN KANMANTOO TROUGH
LANDSAT STUDY

AIR PHOTOGRAPH INTERPRETATION

(uncontrolled photo mosaic)

COMPILED	E. Dubowski
DRAWN	E.C.
DATE	Feb. 1991
CHECKED	
	GR 4.3.91
SCALE	1:40 000
PLAN NUMBER	91-199

APPENDIX 1

Petrographic Descriptions
(extracted from Analabs report 1000 0 07 1270)

Sample RS 3260

Rock sample "volcanic'

Thin section

CLASTS	major	
Quartz		dominant
Lithics		minor
Feldspar		accessory
Chlorite		accessory
MATRIX	dominant	
Quartz		major
Biotite		major
Carbonate		minor
Muscovite		accessory
Tourmaline		accessory
Opaques		trace

Vein
Alkali feldspar
Carbonate

This is a Metasediment composed partly of sand sized clasts of quartz, lithics and some feldspars, in a matrix that is equivalent to a Biotite Metasiltstone. The quartz clasts are more mono. than polycrystalline, and are commonly subrounded. Some epitaxial overgrowths are visible.The lithic materials include coarser equivalents of the matrix, that may not strictly be extraneous.Others include rather feldspathic types although not obviously igneous.Coarse flakes of chlorite are regarded as grown in situ. The matrix is uniformly textured, with the mica not well oriented. Carbonate is intimately associated with the mica.Feldspar is present as plagioclase.

Sample RS 3261

Rock sample "amphibolite"

Thin section

Plagioclase	dominant
Biotite	major
Carbonate	minor
Chlorite	minor
Muscovite	minor
Opaques	minor
Quartz	accessory

This is an even textured Plagioclase-rich probable intrusive, weakly metamorphosed igneous rock.The Na-rich feldspar forms interlocking stubby laths of around 0.3mm lengths, that are commonly in contact. Partly separating them are areas of carbonate ,to 0.4mm with limonite impregnation.There are also scattered patches of fine roughly oriented biotite as a regional metamorphic imprint. Some recrystallization of the feldspar results in pockets of fine polygonal material.Larger chlorite flakes are a later product.Ores are quite common as quite coarse isometric habit material, rarely with a goethite margin. There is a suggestion of magnetism to the sample.See discussion.

Sample RS 3262

Rock sample "ferruginised volcanic"

Thin section

Plagioclase	
Sericite}	dominant
Carbonate	minor
Biotite	minor
Opaques	minor
Muscovite	minor

This is a classified as an Albitite. It is essentially composed of coarse to medium sized well twinned laths of plagioclase feldspar, that are slightly sericitised. The feldspar occurs as about 1/3 0.5-1mm , and 2/3 a finer generation, resulting in an almost seriate texture.Biotite , carbonate and muscovite are scattered at contacts, without orientation, with the carbonate ferruginous. Ores are abundant, as 0.1mm isometric crystals throughout that are not magnetic.Staining for K feldspar was negative.

Sample RS 3263

Rock specimen "spotty siltstone"

Thin section

MATRIX

Quartz	major
Biotite	major
Muscovite	accessory
Apatite	trace
Opaques	trace

SPOTS

Chlorite	major
Quartz	major
Biotite	accessory
Opaques	accessory

This is classified as a Biotite MetaSiltstone that contains an abundant of non biotitic spots that are composed of felsic material, chlorite and minor fine biotite. The siltstone matrix consists mainly of fine oriented biotite and quartz, the former often dominant. These non biotite areas are interpreted as indicating some thermal affect, of a retrograde nature.

Sample RS 3264

Rock specimen "siltstone"

Thin section

MATRIX

Biotite	major
Quartz	major
Muscovite	accessory

SPOTS

Chlorite	major
Quartz	major
Biotite	accessory

This is a spotted Biotite Metasiltstone , that is more or less identical to the previous samples.Thus it is composed off a matrix essentially silt sized biotite and quartz containing 1mm average semi rounded patches low in the mica.The main difference is in the presence of occasional sandy quartz material, within both matrices.Some of these are well rounded.

Sample RS 3265

Rock specimen "siltstone"

Thin section

Muscovite	major
Quartz	major
"Biotite"	accessory
Rutile	trace
Opaques	trace
Altered Micas.	dominant
Quartz	accessory
Goethite	accessory

This is a fine Metasediment, classified as a Phyllite. This is a uniformly fine muscovite quartz fabric, with a cleavage that is at an angle to the fine bedding?, shown by a faint dusting. The matrix also contains abundant pale "biotite , similar to the mica that occurs as coarse lenses or strips parallel to the faint bedding described above. These are associated with subordinate sand sized quartz material, and some goethite.

Sample RS 3266

Rock specimen " epidotised marble"

Thin section

Quartz	major
Epidote	major
Sphene	accessory
Apatite	accessory
Opaques	trace

This is interpreted as an Epidote Quartz Vein. The major fabric consists of coarse bladed divergent bunches of epidote, that are hosted by allotriomorphic quartz. The quartz may be up to half a mm and there is a marginal area, where it is lacking epidote and is then millimetric. There are areas of fine more polygonal quartz. Sphene of variable habit is spread through both species. Apatite is locally rather common, as rather rounded crystals to 0.1mm in the quartz.

Sample RS 3267

Rock specimen "sltstone"

Thin section

Carbonate	dominant
Quartz	minor
Biotite	accessory
Opaques	trace

This is a fine grained carbonate-dominant rock, a Marble. The fabric is a consistently fine lineated carbonate accompanied by stained biotite , and quartz that are not particularly oriented.

Sample RS 3268

Rock specimen " Truro Volc."

Thin section

Plagioclase	major
Clinoamphibole	major
Biotite	major
Epidote	minor
Sphene	accessory
Opaques	trace

This is a metamorphosed igneous rock whose texture is probably pseudoporphyritic, and the preferred fabric of the groundmass or matrix is influenced by deformation.The macrocrystals are epidote, that may occur as single idioblasts of 0.5mm, or as clusters of the same. There are lines of the crystals following the matrix.The latter consists of an aligned combination of biotite, clinoamphibole,and microlites of plagioclase feldspar.Staining for K feldspar was negative. Classified as a Metabasite or Biotite Amphibolite, perhaps related to the biotite plagioclase rocks in this suite.

Sample RS 3269

Rock specimen "foliated breccia'

Thin section

Plagioclase	major
Biotite	major
Muscovite	minor
Epidote	minor to accessory
Opaques	minor to accessory
Quartz	trace

This is an altered igneous rock, dominated by plagioclase and aggregates of secondary micas.The rock is porphyritic, as well as seriate textured.The largest plagioclases which are of albite composition, reach 2mm, down to 0.15mm.This feldspar is associated with clusters of non oriented pale biotite,epidote and muscovite. There are frequent 2-4mm patches of fine biotite, usually with a few included flakes of muscovite.Other large muscovite dominant areas may be after coarse plagioclase.The biotitic areas are totally irregular in shape more compatible with an amygdale., or part resorbed xenolith.The ores are mainly fine spongy clusters, ?ilmenite, and occasional goethite-rimmed equant material.See discussion.

Sample RS 3270

Rock specimen "Truro volc."

Thin section

Plagioclase	dominant
Epidote	major
Chlorite	minor
Biotite	minor
Opaques	minor
Quartz	minor
Limonite	accessory
Leucoxene	accessory
Apatite	trace

This is an altered , partially schistose plagioclase-rich igneous rock.The feldspar forms disoriented 0.2-0.3mm normally, twinned crystals that are surrounded by a thin biotite and locally chlorite-rich schist fabric. Granular epidote of 0.1-0.2mm is common.The chlorite is concentrated in mm patches with inclusions of epidote.Fine quartz can be scattered through the phyllosilicates.Opaque material is common as linear material almost forming a network. See discussion.

Sample RS 3271

Rock specimen "amphibolite"

Thin section

Plagioclase	major
Biotite	major
Opaques	accessory
Muscovite	accessory

This is a Plagioclase Biotite Schist , that is interpreted as a possible metamorphosed lamprophyre, alternatively it could be a biotitised amphibolite.The schist fabric is due to the orientation of the mica, while the coarser feldspar crystals are quite well aligned.The latter have their faces commonly penetrated by the enveloping mica.There are occasional flakes of muscovite within the biotite areas. Fine ores form trails sub-parallel to the micas , and in them.There are rare casts of non deformed goethite, ex sulphide? See discussion.

Sample RS 3273

Rock specimen "lamprophyre"

Thin section

Biotite	-	major
Quartz		major
Plagioclase		major
K feldspar		accessory
Limonite		accessory

The samples consists of about 50% biotite of a yellow brown polarizing colour as poorly oriented flakes from under 0.2 to a mm in length, set in a quartz feldspar matrix. The larger flakes tend to be narrow and rather curved. The principal fabric of the feldspar part of the matrix is as part spherulites, the rest being quartz. Staining for K feldspar was positive. See discussion.

Sample RS 3274

Rock specimen "mylonitic siltstone"

Thin section

Plagioclase	major
Biotite	major
Limonite Goethite	minor
Opaques	accessory
Chlorite	accessory
Muscovite	accessory
Epidote	accessory
Apatite	accessory

This is a foliated metamorphosed igneous rock, dominated by plagioclase feldspar, and a partly altered biotite. The biotite has a good oriented fabric', wrapped around the feldspar crystals.Some is part or wholly chloritised. Opaques strips are commonly following this fabric.The feldspars are typically about 0.3mm ,slightly spotted with secondary products. Its composition is probably quite calcic, based on the rock assay, and allowing for the epidote. The latter is weakly dispersed hosted by the mica areas. The slide contains very occasional polyhedral goethite rimmed ores,? ex pyrite. There is extensive limonite. Apatite is a fine acicular inclusion in feldspar.See discussion.

Sample RS 3275

Rock specimen "dyke"

Thin section

Plagioclase	dominant
Opaques	minor
Muscovite	accessory
Rutile	accessory

This is classified as an Albitite.It is essentially composed of half mm length bunches of blades of randomly oriented fresh albite, some showing incipient chessboard twin textures.There is a little fine mica, occasional translucent goethitic ore concentrations, and tiny prisms of rutile.

Sample RS 3276

Rock specimen "hornfelsed tillite"

Thin section

Quartz	major
Tourmaline	major
Biotite	minor
Opaques	accessory
Limonite	accessory
Muscovite	accessory

This is classified as a metasediment, a Meta Tourmaline Sandstone, containing occasional lithic fragments. The quartz occurs as a minor proportion of medium sand sized grains both mono. and polycrystalline that are usually subrounded to rounded. The lithic material includes sericitic and biotitic quartzites to 5mm lengths with lens shapes.The major fabric consists of a rather lineated strongly pleochroic tourmaline intimately associated with fine sand to silt sized quartz, often with the tourmaline dominant. There is a little biotite and accessory limonite in the form of staining, plus rare ores.

Sample RS 3279

Rock specimen "brecciated siltstone"

Thin section

Phenocryst
Plagioclase

Groundmass	
Plagioclase	dominant
Muscovite	accessory
Opaques	accessory

The slide features a fine aphanitic Plagioclase Porphyry, containing a band of a coarse grained Plagioclase porphyry.The assay indicates the soda rich nature of the plagioclase.The coarser band is compatible with the albitite, RS 3275, except that the present material has rather more ores.These are in rather linear arrangements following a rough lineation of the feldspar laths. The fine grained part appears to be essentially similar in mineralogy but more rapidly cooled.

Sample RS 3280

Rock specimen "phyllonite"

Thin section

Muscovite	major
Quartz	major
Carbonate	major
Biotite	minor
Plagioclase	minor
Chlorite	accessory
Opaques	accessory
Tourmaline	accessory
Zircon	trace
Rutile	trace

This is classified as a Metasediment that consists of dominant Phyllite interspersed with lenses of Carbonate-rich coarse Silty lithology. The phyllite has a major fine mica showing good orientation, with a sericitic type of muscovite dominant.The biotite often shows partial chloritization.Quartz grains are very fine obscured by the micas. There is some carbonate present. The carbonate in the lenses is a coarser anhedral lineated mass enclosing quartz , micas etc.

Sample RS 3281

Rock specimen " quartzite mylonitic"

Thin section

A

Muscovite	dominant
Quartz	major
Biotite	accessory
Feldspar	accessory
Chlorite	accessory
Opaques	accessory

B

Carbonate	major
Quartz	major
Feldspar	minor
Micas	accessory
Chlorite	accessory
Zircon	trace

This is a Metasediment that is a series of irregularly interbedded Phyllites, and a Carbonate Quartz Arenite.The former is dominated by a well oriented sericitic muscovite plus minor part chloritised biotite, enveloping fine quartz and plagioclase. The arenite has a uniform 0.1mm average quartz and carbonate, plus or minor fresh feldspar, lacking a marked lineation, but with a weak mica schist overprint. There are some transitional areas between the two rock types.

Sample RS 3282

Rock specimen "shale"

Thin section

Muscovite	dominant
Carbonate	major to accessory
Quartz	minor
Chlorite	accessory
Opaques	accessory

This is a Metasediment that is classified as a Carbonate Phyllite, that may have been a Marl. There is also a 2mm lens that is composed of carbonate > quartz with a little oriented phyllosilicate. The phyllite is dominated by a fine well oriented muscovite with a little chlorite ex biotite? The quartz component is siltsize. There is a variable quantity of carbonate that is usually well lineated. Fine equant ores are ubiquitous.

Sample RS 3283

Rock specimen "Truro volc."

Thin section

Phenocrysts	
Plagioclase	
Groundmass	
Plagioclase	dominant
Chlorite	major
Carbonate	minor
Opaques	accessory
Amygdales	
Carbonate	

This is an Amygdular Na Plagioclase Porphyry with a preferred fabric, of the matrix microlites,associated chlorite and some of the linear amygdales, that is considered to be tectonic rather than original flow, although the phenocrysts are perfectly euhedral. These range from 2mm to sub 0.5mm with the coarser examples poorly twinned. The groundmass plagioclase is usually albite twinned and the larger more elongate examples can show considerable curvature.They are set in a chlorite matrix that is allotriomorphic to the feldspars.There is some carbonate of similar disposition. The large amygdales of carbonate are coarsely crystalline, but there are zones at their apices that have a fine lamellar texture supporting partial recrystallization under stress.

Sample RS 3284

Rock specimen "lamprophyric'

Thin section

Muscovite	dominant
Quartz	major
Opaques	minor
Feldspar	accessory
Tourmaline	accessory
Apatite	trace

This is a Muscovite Schist containing numerous lenses that are composed of quartz and secondary iron oxides, (non magnetic).These lenses vary from sub 0.2mm length material to half cm sizes. The dominant mica fabric is almost monomineralic where it lacks these lenses. There is evidence of altered plagioclase crystals to 1mm part sericitised and poorly twinned that form part of one of lens. The latter vary from even grained non lineated quartzites with minor ores, to examples where the ores are dominant as isometric shapes.There is an apatite crystal part enclosed. The origin of this schists is equivocal. It may be a very sheared acid porphyry with the large feldspars as relics of phenocrysts. A lamprophyric origin is not favoured.

Sample RS 3285

Rock specimen "lamprophyric"

Thin section

Chlorite	major
Plagioclase	major
Quartz	minor
Opaques	accessory
Limonite	minor
Clay	accessory
Tourmaline	accessory

This is a heterogeneous part schist sample that retains unequivocal evidence of volcanic activity. The main framework is a Chlorite Schist that encloses abundant plagioclase feldspars of very variable dimensions.The largest reaches 3mm and is part fractured and sericitised.Smaller examples appear rounded. There is a population of small fresh feldspars in the chlorite also , with some quartz.The slide features a number of large irregular boxworks like structures composed of a limonite network with clay.These are partly leached. There are a few perfect isometric goethite casts, probably ex pyrite.The evidence for the volcanic nature is the presence of numerous areas of pumiceous palimpsests now preserved in silica. These are usually complete,not shard -like. It is possible that they are from extrusive acid fragments in a pyroclastic host, as well.

Sample RS 3286

Rock specimen "breccia"

Thin section

Biotite	major
Plagioclase	major
Opaques	minor
Leucoxene	accessory
Quartz	accessory

This is a Biotite Schist containing a major content of plagioclase feldspar crystals.The feldspars range up to 5mm, where they appear corroded and penetrated by the matrix, that retains a preferred fabric. Although the mica forms a good schistocity, the small feldspar laths often are not well aligned.The Na/Ca rock analysis supports an intermediate composition, ie not albite.The biotite is accompanied by fine spongy ?titaniferous ores.Classified as a Meta Plagioclase Porphyry.

APPENDIX 2

Processed Imagery KAR-NTH and KAR-STH

(as 35 mm Slides)

Band(s)	Comment
1	15 x 15 High Pass Filtered
1	3 x 3 Low Pass Filtered
2	15 x 15 High Pass Filtered
2	3 x 3 Low Pass Filtered
3	15 x 15 High Pass Filtered
3	3 x 3 Low Pass Filtered
4	15 x 15 High Pass Filtered
5	15 x 15 High Pass Filtered
7	15 x 15 High Pass Filtered
1 + 2 + 3	Low Pass Filtered Bands
5 + 7	High Pass Filtered Bands
3/1	Low Pass Filtered Bands
4/3	
5/2	
5/3	
5/4	
5/7	
Selected PC1	Principal Component 1 on Bands 1 ,2 3
Selected PC2	Principal Component 2 on Bands 1, 2, 3
Selected PC1	Principal Component 1 on Bands 5, 7
Directed PC1, veg-clay	Principal Component 1 on Ratios 4/3, 5/7
Directed PC2, veg-clay	Principal Component 2 on Ratios 4/3, 5/7
Directed PC1, FeOx-veg	Principal Component 1 on Ratios 3/1, 4/3
Directed PC2, FeOx-veg	Principal Component 2 on Ratios 3/1, 4/3
Shade Filter	on Ratio 5/4
3, 2, 1 RGB	Low Pass Filtered Bands
5, 3, 1 RGB	High Pass Filtered Bands
5, 3, 2 RGB	High Pass Filtered Bands
5, 4, 3 RGB	High Pass Filtered Bands
7, 3, 1 RGB	High Pass Filtered Bands
7, 5, 2 RGB	High Pass Filtered Bands
7, 5, 3 RGB	High Pass Filtered Bands
5+7, 4, 1+2+3 RGB	
PC1(5,7), 4, PC1(1,2,3) RGB	Selected Principal Components
PC2(5,7), 4, PC1(1,2,3) RGB	Selected Principal Components
5/2, 3/1, 1+2+3 RGB	
5/2, 3/1, 5+7 RGB	

PLATE 1: Landsat Thematic Mapper Image KAR-NTH. False colour composite of bands 7, 3, 1 in red, green and blue. Enhanced with a 15 x 15 high pass filter.

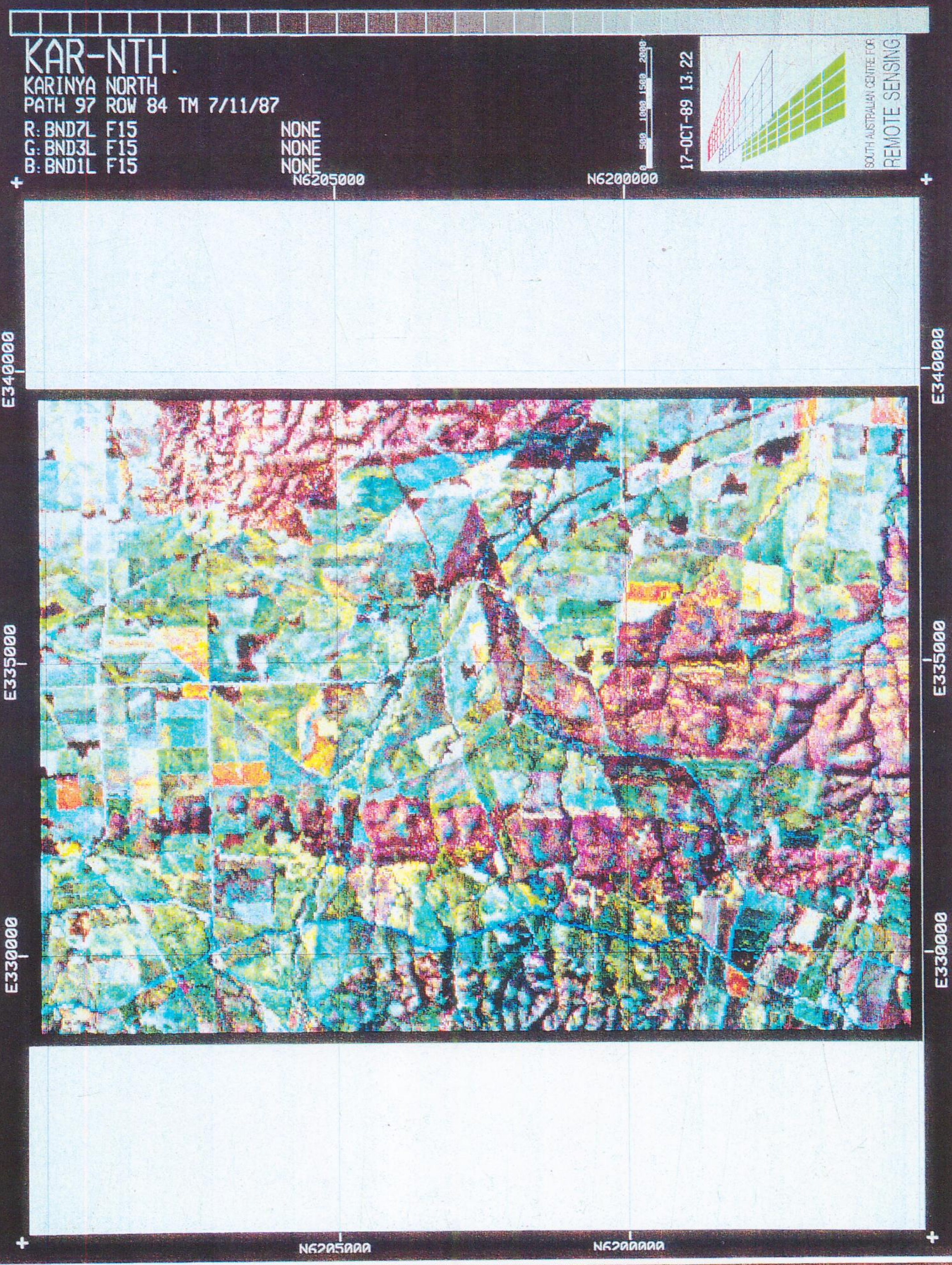

KAR-NTH.
KARINYA NORTH
PATH 97 ROW 84 TM 7/11/87
R: BND7L F15 NONE
G: BND3L F15 NONE
B: BND1L F15 NONE
0 500 1000 1500 2000
17-OCT-89 13:22
SOUTH AUSTRALIAN CENTRE FOR
REMOTE SENSING
N6205000
N6200000
E340000
E335000
E330000

PLATE 2: Landsat Thematic Mapper Image KAR-STH. False colour composite of bands 7, 3, 1 in red, green and blue. Enhanced with a 15 x 15 high pass filter.

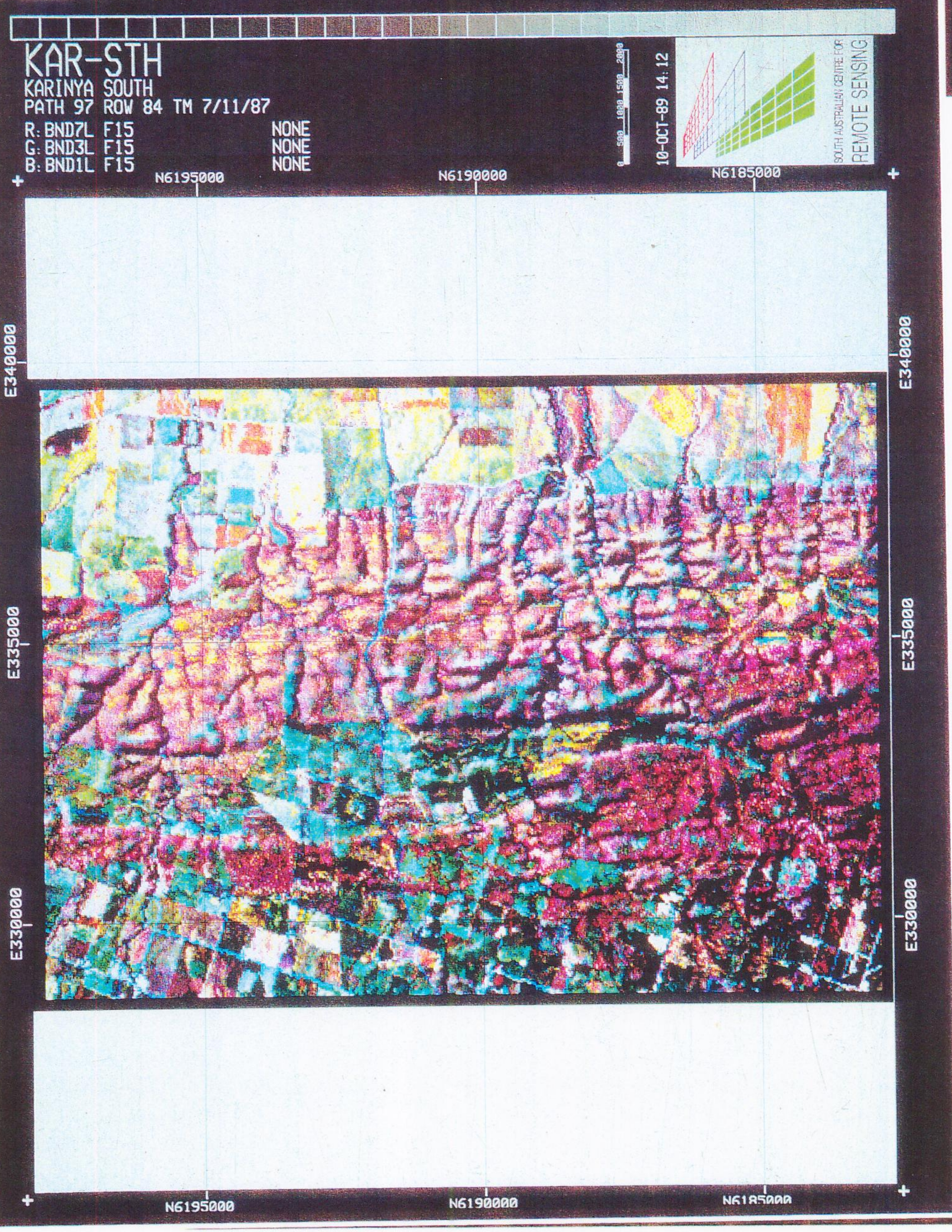

KAR-STH
KARINYA SOUTH
PATH 97 ROW 84 TM 7/11/87
R: BND7L F15 NONE
G: BND3L F15 NONE
B: BND1L F15 NONE
0 500 1000 1500 2000
10-OCT-89 14:12
SOUTH AUSTRALIAN CENTRE FOR
REMOTE SENSING
N6195000
N6190000
N6185000
E340000
E335000
E330000

PLATE 3: Brecciated Milendella Limestone Member, Accommodation Hill. Slide No. 39310.

PLATE 4: Mylonitic fabric developed in Adealidean metasediments; located on Traverse T2. Slide No. 39311.

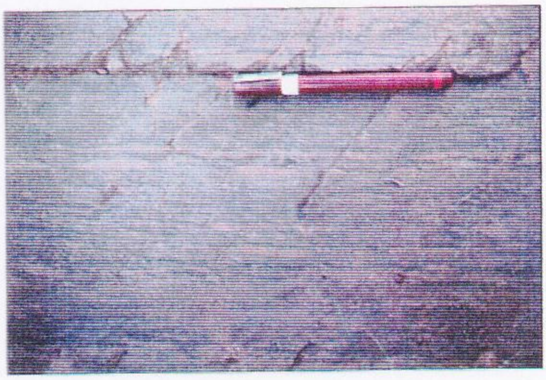
PLATE 5: Outcrop of Truro Volcanics; Traverse T2 shows possible ?brecciated texture. Slide No. 39312.

PLATE 6: Well bedded Adelaidean metasediments in Rocky Creek, Frankton area; shows a pronounced foliation developed across the bedding. Slide NO. 39313.

PLATE 7: Stretched clasts in tillite, Rocky Creek Frankton. Slide No. 39314.

PLATE 8: Ferruginised fault zone approximately 1 metre wide, Rocky Creek, Frankton. Folds are developed on both sides of the fault. Slide No. 39315.

3.



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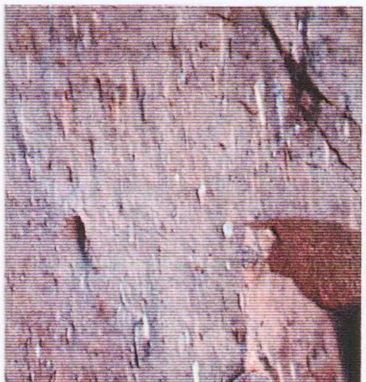
6.



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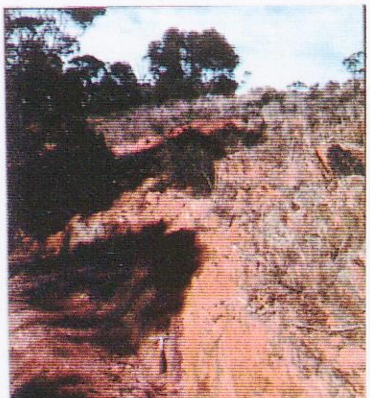


8.

PLATE 9. Pressure solution cleavlage in Adelaidean metasediment, Rocky Creek. Developed adjacent to semi-brittle fault. Slide No. 39316.

PLATE 10: Rare stretched clast in Kanmantoo Group siltstones, near Frankton. Slide No. 39317.

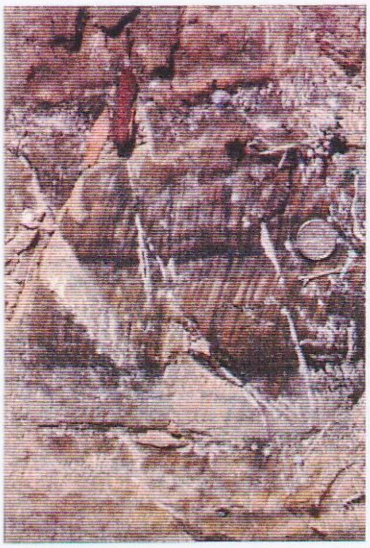
PLATE 11. Open fold in Kanmantoo Group metasediments showing pronounced development of axial plane cleavage, Pine Creek; view south. Slide No. 39318.

PLATE 12: Schneider's Gossan, Pine Creek; view south. Slide No. 39319.

PLATE 13: Boudinage developed along bedding plane in Kanmantoo Group siltstones, east of Wyeroo Homestead, Traverse T6. Slide No. 39320.

PLATE 14: Cleavage Zone developed in Kanmantoo Group metasediments, east of Wyeroo Homestead. Slide No. 39321.

PLATE 15: Disrupted mylonitic fabric. Slide No. 39322.



9.

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11.

12.

13.

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15.