DEPARTMENT OF MINES AND ENERGY

GEOLOGICAL SURVEY

SOUTH AUSTRALIA

REPORT BOOK 95/43

SYNSEDIMENTARY MINERALISATION IN THE KANMANTOO TROUGH

GEOLOGICAL SOCIETY OF AUSTRALIA
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FIELD EXCURSION
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S TOTEFF

Mineral Resources

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INTRODUCTION

The metamorphic rocks to be examined on the field excursion have been assigned to the Tapanappa Formation (Early Cambrian Kanmantoo Group: Daily and Milnes, 1972), a generally monotonous sequence of greywackes with narrow siltstone partings. This formation hosts most significant base metal occurrences known in the Kanmantoo Trough.

The Kanmantoo Group as a whole is dominated by siliclastic sediments which were mostly rapidly deposited in a fault - controlled basin (Kanmantoo Trough) developed in the Early Cambrian on the southeast side of the late Proterozoic Adelaide basin. During the late Cambrian-early Ordovician Delamerian Orogeny, the sediments were deformed and metamorphosed, attaining P-T conditions around the andalusite-sillimanite boundary and probably close to the aluminosilicate triple point (T around 500-600^{o}C, P around 3-4kb) in the areas examined during the field excursion.

During the late seventies and much of the eighties, numerous apparently "epigenetic" mineral deposits and associated alteration zones were recognised as having precursors formed during sedimentation (or diagenesis) of the host rocks. In recent years there has been a reversal of this trend (by no means universal), particularly in relation to certain Cu and Au, but also Pb Zn Ag deposits. The role of transport of ore constituents during deformation and metamorphism and their ore-forming potential has been stressed. Large scale transport by metamorphic mineralising fluids along permeability created by deformation (cleavage fabrics) and formation of mineral deposits by emplacement into structural (dilational) or chemical traps is envisaged.

Mineralisation to be examined on the excursion is considered to be essentially "syngenetic' or "synsedimentary". The Pb Zn deposits have been remobilised and probably upgraded during the Delamerian Orogeny but retain evidence of their earlier genesis. When examining the rocks at the Pb Zn occurrences, particularly Scotts Creek and Aclare, consider the implications of what you observe - does it tend to support syngenesis or epigenesis?

IRON SULPHIDE MINERALISATION (NAIRNE PYRITE)

The Nairne Pyrite, a sulphide-rich member of the Talisker Calc-siltstone (Daily & Milnes, 1972), was mined at Brukunga (approximately 8 kms to the north on strike of STOP 1) for sulphur. About 5.5 million tonnes of ore were extracted. At Brukunga the unit is over 100 m thick, containing up to 12% pyrite and 6% pyrrhotite. Minerals in the calc-silicates are quartz, actinolite-tremolite, phlogopite, muscovite, carbonate and scapolite. In the siliciclastic sediments, minerals are quartz, plagioclase, muscovite, phlogopite, and minor garnet and microcline (Skinner, 1958; George, 1969). Apart from the iron sulphides,

there are trace to minor amounts of galena, chalcopyrite, arsenopyrite and sphalerite.

The iron sulphides are conformable and considered to have been deposited as part of an original variably carbonaceous siltstone and shale, with minor marl. Occasional units of poorly to moderately well sorted sands are present.

Sulphur isotope studies support a synsedimentary (biogenic) origin (Seccombe et.al, 1985).

Stop 1

Road cutting, north side Southeastern Freeway. Here the Nairne Pyrite is approximately 70 m thick, and the sulphides are largely oxidised. Acid solutions released during oxidation have altered the metamorphic mineral assemblage. There are locally numerous concordant and discordant veins of yellow jarosite ($K\ Fe_3\ (SO_4)_2(OH)_6$ and white alunite $KAl_3\ (SO_4)_2(OH)_6$.

The lower contact of the Nairne Pyrite here is fairly sharp, but there are minor pyritic zones below, for example a 3-4 m thick weakly pyritic schist unit occurs about 20 m below the contact. The upper contact is gradational over 1 m, passing into greywakes of the younger Tapanappa Formation, which in the exposure contains minor pyritic intervals (<30 cm). Elsewhere the Tapanappa Formation is normally of similar lithology; massive, rarely laminated greywacke units of up to a few metres in thickness with interbedded units of more pelitic quartz-micaschists. Occasional pyritic/pyrrhotitic schists reflect starved sediment supply and local stagnation.

Pb Zn Ag MINERALISATION

As a result of a sulphur isotope study of some areas in the Kanmantoo district, Seccombe et. al, (1985) suggested a dual sulphur source may explain the observed clustering of $\delta^{34}S$ around zero per mil. This concept involved mixing of biogenic and Cambrian seawater sulphur. They observed that mineralisation at the Aclare and Wheal Ellen Mines was concordant with bedding, suggesting these may represent syngenetic basin floor deposits.

Stop 2 - Scotts Creek Ag Pb Mine (FormerlyWheal Margaret)

No reliable production figures are available for this mine which finished production around 1887. The deepest (northern) shaft is approximately 40 m, being sunk to water level. Three north-south striking lodes are referred to; they seem to dip steeply east. It was commented by the Inspector of Mines (1890) that there were similarities with the Aclare Mine, although it appears the ore may have plunged to the north at Wheal Margaret. Reference is made to the ore occurring in "shoots and small veins". Dressed ore grades of 50-60% Pb, 52-80 oz/t Ag were recorded.

On the mine dumps, observe disseminated sphalerite and galena distributed along layering in a garnet-quartz rock host. Enclosing rocks are quartz-micaschists, with minor andalusite, rare garnet.

It is assumed that the ore shoots that were mined were of higher grade than the disseminated mineralisation discarded on the dumps, which grades around 3-7% Pb, 0.5-2% Zn, 200-600 g/t Ag and 0.5 g/t Au. Apart from the main sulphides galena and sphalerite, there is lesser chalcopyrite, pyrite, pyrrhotite, minor tetrahedrite, and minor gangue minerals are cummingtonite, actinolite, biotite, muscovite and microcline.

Note the laminated quartz-spessartine-feldspar rock (interpreted as manganiferous exhalite) adjacent to the northern shaft. Immediately on strike to the north there are thin garnet-rich bands in the quartz-micaschists, interpreted as lateral exhalative equivalents in the ore

position. To the west are narrow zones with numerous quartz-garnet-feldspar exhalite hands (mostly <1 cm), which are traceable along strike for up to 75 m

About 200 metres to the south another shaft has been sunk adjacent to a ?partly boudinaged quartz-spessartine lens ("coticule" rock). On strike of this lens are rare bands of interpreted exhalite.

Stop3 Aclare Ag Mine

This mine was worked intermittently from 1859 to 1891. Incomplete production figures are available. In the oxidised zone, from surface to around 10 m (and locally 20 m) depth, ore graded approximately 50% Pb, 45-90 oz/t Ag, then to approximately 40 m (?Partly oxidised and unoxidised): 40% Zn, minor Pb, 60-302 oz/t Ag. A bulk sample of sulphide ore at the 40 m level returned a grade of 6% Pb, 35% Zn, 32 oz/t Ag and sulphide ore near the base of the known orebody assayed 10% Pb, 25% Zn, 30 oz/t Ag. Total production was estimated by Chilman (1982) as 14,000 tonnes at 7% Pb, 12% Zn, 680 g/t Ag, 2 g/t Au.

Five shafts were sunk. Rosewarnes adit, on the north east side of the orebody, enters the hill, encountering the layered chert (with disseminated sphalerite, galena) at approximately 140 m into the hill, following this horizon for another 140 m or so to the lower part of the orebody. Here a southerly dipping shoot of ore was intersected (see longitudinal section). Other adits were excavated into the base of the hill to the south by Mt Barker Creek in an endeavour to find more ore, but without success.

On the mine dumps observe disseminated sphalerite and galena distributed along layers in metachert. Note occasional fine needle-like steel grey crystals of antimony-lead sulphide (meneghinite Cu Pb_{13} Sb_4, S_{24}). Grades of the disseminated ore are around 3-6% Pb, 2-11% Zn, 300-800 g/t Ag, 0.5-2 g/t Au. Gangue mineralogy is quartz with very minor muscovite, biotite, trace K-feldspar, garnet, apatite.

A longitudinal section (after Armstrong, 1938) shows that the high grade orebody (possibly a composite of several lenses (Brown, 1908)) plunges to the south at about 30^o. Width varied from approximately 1 m to 4.5 m. Apart from sphalerite, galena, meneghinite there is minor boulangerite (Pb_5 Sb_4 S_{11}), arsenopyrite, pyrite, pyrrhotite, tetrahedrite and chalcopyrite in the orebody.

Observe layers of quartz-feldspar (-garnet) with minor biotite, muscovite, interpreted to be metamorphosed exhalative horizons. These are anomalous in Pb, Zn and Sb. They appear approximately 80 m north of the orebody (at surface they are less than 30 cms thick) and rapidly thicken towards it. In the vicinity of the north shaft, observe extreme thickening (primary and also due to folding), where the chert interval is over 6 m wide.

Rare, thin (1 cm) "exhalite" bands of similar composition can be seen up to 100 m south of the southern shaft. They occur within a fairly monotonous sequence of greywackes and lesser quartz-micaschists.

Stop 4- Angas Prospect

Inspect core from DDH-AN5 at the farm of Ian and Sue Jettner. The orebody is covered by flat-lying Tertiary marine sandy limestone, up to 15 m thick. The limestone and calcrete scree-covered unconformity lies just to the northeast of the core display area.

At this prospect, high grade Pb Zn Ag mineralisation occurs within an envelope of garnet $\pm$ gahnite, staurolite-bearing quartz-biotite-muscovite-schists with trace disseminated pyrrhotite and sphalerite, and rare galena. The envelope has a strike extent of around 1200 m, with the orebody occurring near its centre. Width of this anomalous envelope

averages around 70 m.

Gahnite, garnet and to some extent staurolite, are most abundant near the ore. Other silicates in the anomalous envelope are andalusite, sillimanite, and local concentrations of chlorite. Quartz, gahnite, garnet, chlorite, biotite, muscovite are the main gangue minerals in the massive sulphides, intimately intergrown with sphalerite, galena, pyrite and pyrrhotite. Part of the mineralisation is extremely coarse grained with only trace gangue component, and probably represents local remobilisation.

Narrow sericite shears with pyrrhotite, usually lesser pyrite and trace base metal sulphides transect the prospect. These are virtually parallel to the prominent high grade schistosity.

Preliminary estimates of the orebody resource vary from 1 to 1.5 Mt @ 15-18% Zn + Pb.

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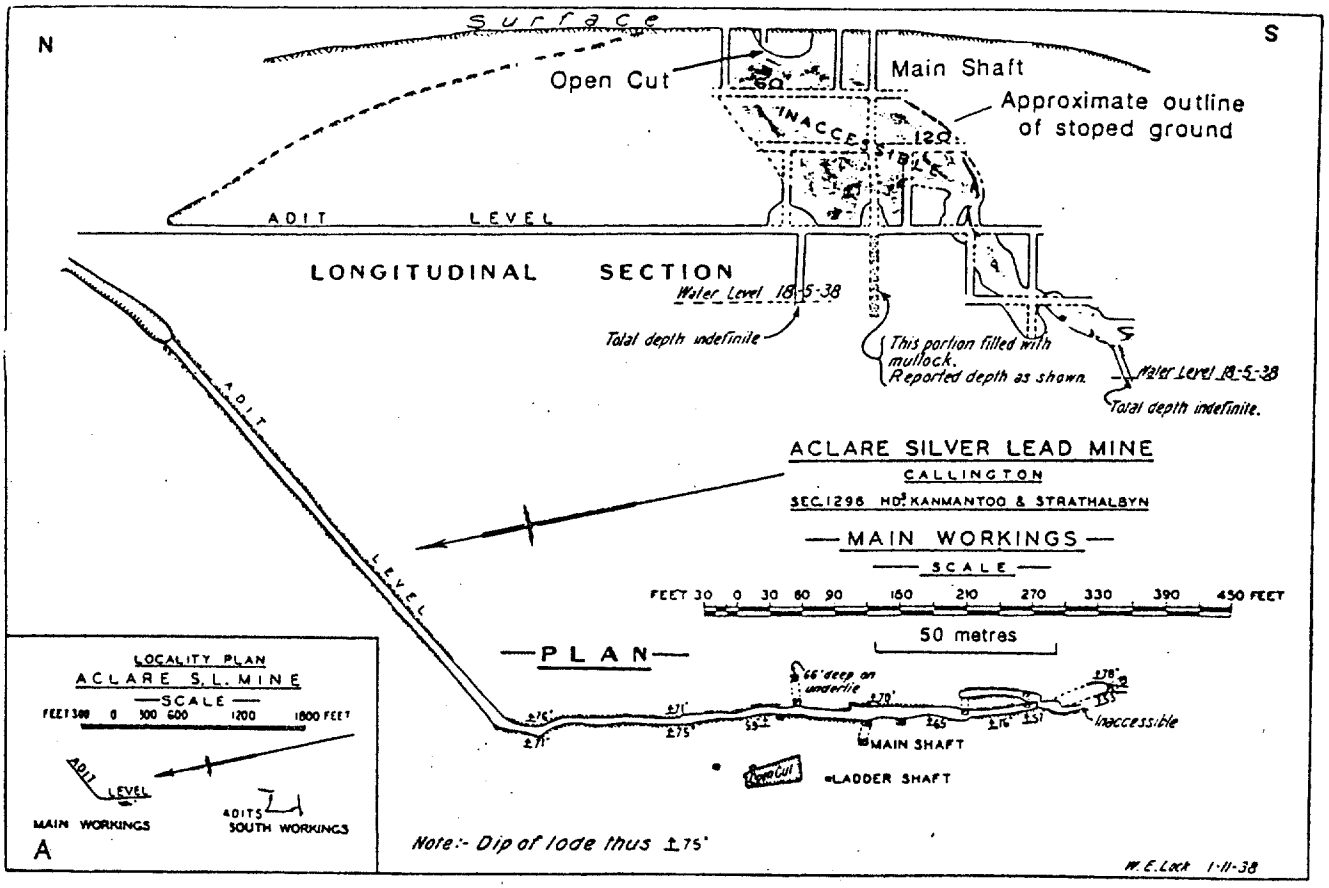
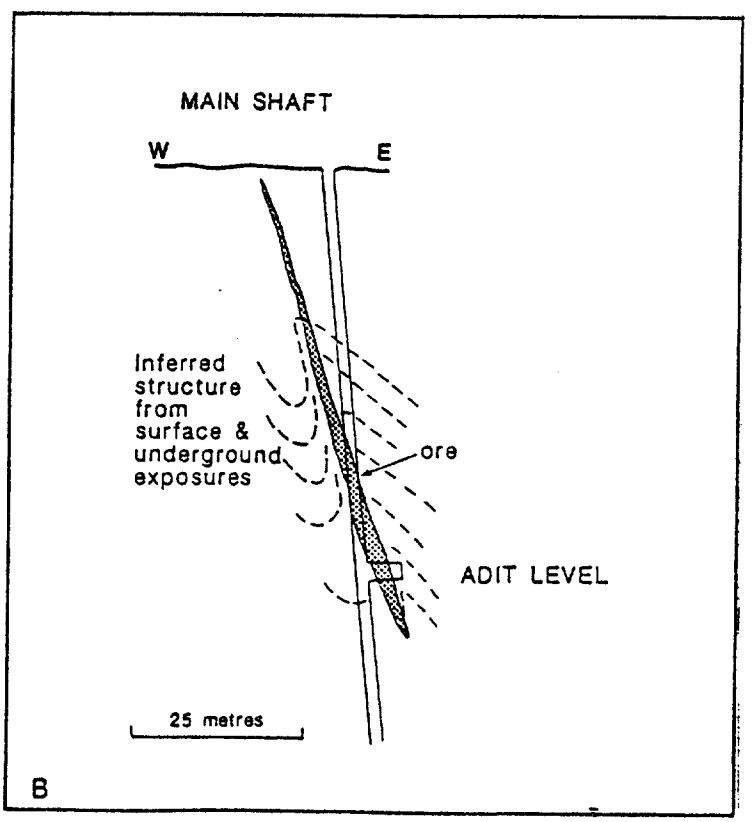


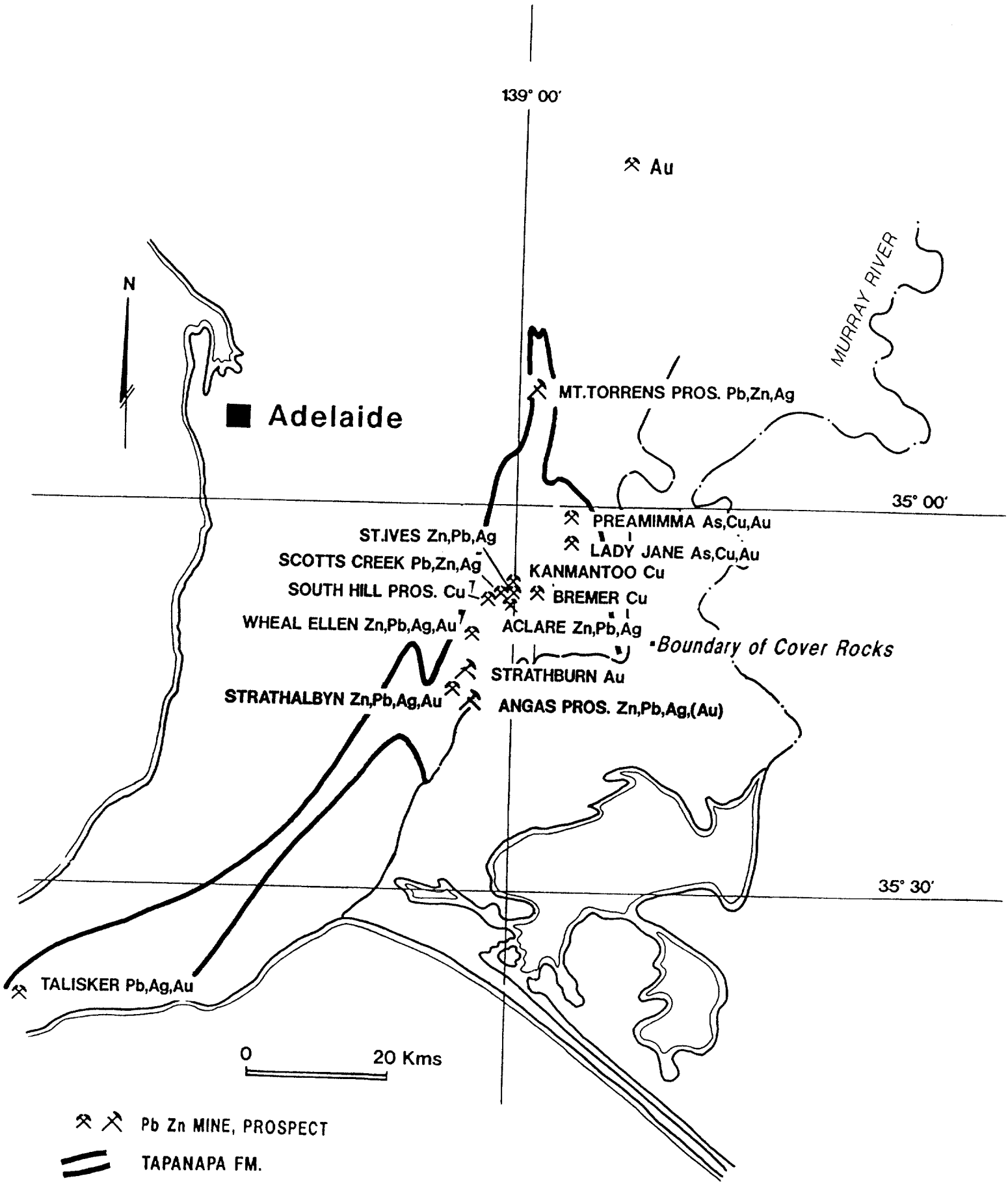
A: Longitudinal section through workings
From Armstrong, 1938



Aclare Mine

B: Diagrammatic transverse section through main shaft
From Askins, 1968

100157.st



Major Mineral Occurrences in the Kanmantoo Group

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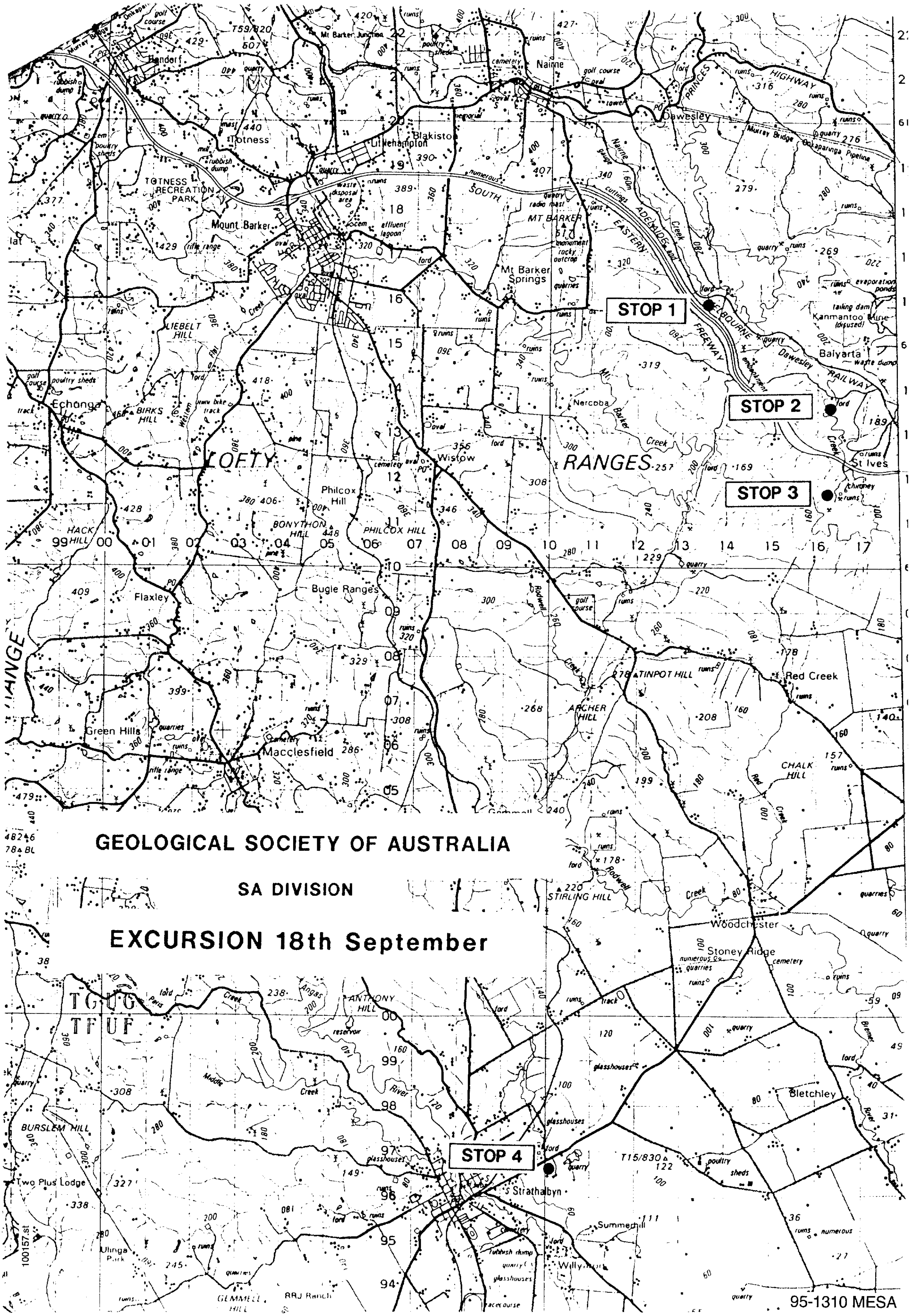
95-1311 MESA


STOP 1
STOP 2
STOP 3
STOP 4
Mount Barker
Nairne
Dawesley
Hahndorf
Totness
Littlehampton
Blakiston
TOTNESS RECREATION PARK
MT BARKER
Mt Barker Springs
SOUTH EASTERN FREEWAY
PRINCES HIGHWAY
Kanmantoo Mine (disused)
Balyarta
St Ives
Nercoba
LOFTY RANGES
Wistow
Philcox Hill
PHILCOX HILL
BONYTHON HILL
Echunga
BIRKS HILL
LIEBELT HILL
HACK HILL
Flaxley
Bugle Ranges
Green Hills
Macclesfield
TINPOT HILL
Red Creek
ARCHER HILL
CHALK HILL
STIRLING HILL
Woodchester
Stoney Ridge
ANTHONY HILL
Bletchley
Strathalbyn
Summerhill
BURSLEM HILL
Two Plus Lodge
Angas
Middle Creek
River
95-1310 MESA

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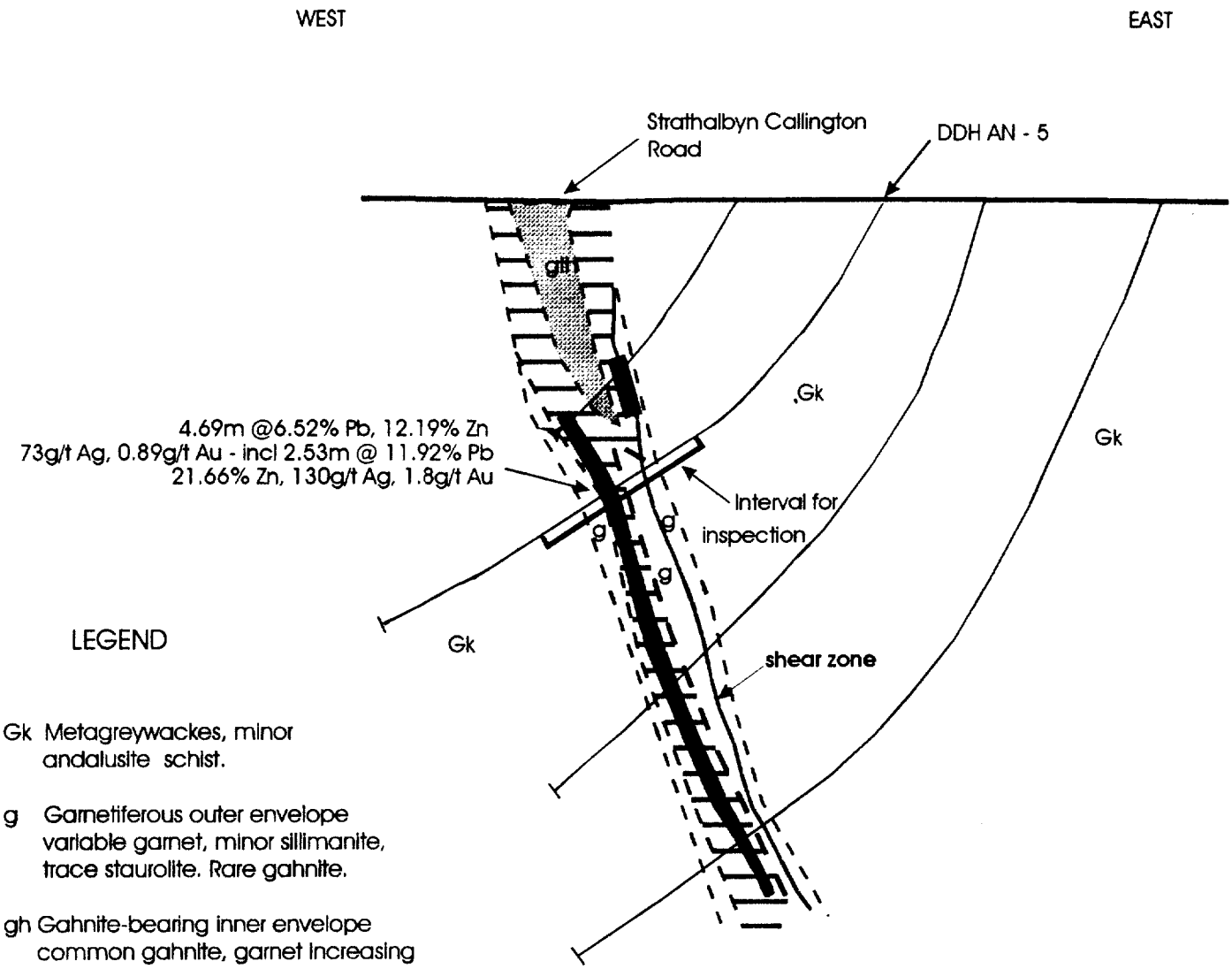
ANGAS PROSPECT

CROSS SECTION 97000 N



LEGEND

Gk Metagreywackes, minor andalusite schist.

g Garnetiferous outer envelope variable garnet, minor sillimanite, trace staurolite. Rare gahnite.

gh Gahnite-bearing inner envelope common gahnite, garnet increasing sulphides **(mainly pyrrhotite, sphalerite) towards ore**

gth Massive garnet rock, minor variable biotite, gahnite , staurolite

Massive sulphide rock sphalerite , galena, pyrrohotite, pyrite.

SCALE

0 100m

100157.st

95-1313 MESA