INDUSTRIAL AND MINING INVESTIGATIONS PTY LIMITED

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REPORT ON FIELD INVESTIGATIONS WITHIN EL 4/61

WEST COAST TASMANIA

SUMMER FIELD SEASON 1982-83

By

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(PART II - continued)

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INTRODUCTION

Field work in the area finished on 27-5-83, with core logging, etc., continuing into June.

Part I of the report covers geochemical work in the northern section of EL 4/61, comprising more detailed work over anomalies discovered in the previous field season plus some reconnaissance soils lines over other geological/magnetic targets, and stream sediment sampling in the western part of the section.

Part II covers geological reconnaissance and mapping in the Main Creek magnesite area, with preliminary results of the drilling work.

PART I

(a) NORTHERN AREA SOILS GEOCHEMICAL SURVEY

1) INTRODUCTION

The main work in the area was (a) the sampling of a 100 m spaced series of lines in the central anomaly (Little Donaldson River area as defined in the previous season), and (b) a smaller grid was also established over the Southern anomaly (near McAuliffe Creek). Other projects were: (c) In the North of the area, where each of the lines 16.4 E, 16.7 E and 16.4 W, 16.7 W, were extended eastward, in response to the new Mines Department aeromagnetic survey information, which showed that the target anomalies had been severely mislocated on the older survey. (d) A small grid in the area of the isolated extreme lead value found in the previous season. (e) Scout lines over magnetic features lying west of the major magnetic trend, where a carbonate rock belt and carbonate/black shale contact were thought to coincide with a magnetic source.

2) LOCATION AND ACCESS, RELIEF AND DRAINAGE, VEGETATION

Access was developed from the road and baseline cut in the previous field season. The soil geochemical work was within the area for which comments on the relief, drainage and vegetation in the 1981-1982 field season report are applicable, mainly the large crowned Nothofagus forest (with sassafras) and horizontal thickets common in the understorey. The area of the Southern copper anomaly was unusually open and, for once, it was possible to put in the soil sampling lines without resorting to the chainsaw.

3) GEOLOGY

In this summer field season little attention was paid to the post Precambrian geology and no evidence was found to compel modification of last season's interpretations.

Within the Precambrian, however, the facing of the sequence was considered to be westward last season, on the basis of a sample which appeared to be a west facing graded bed; however petrological examination did not confirm the apparent graded nature of the sample. In this season's work several East facing graded beds, scour and fill, and flame structures, were found, so it is now considered that the sequence faces East and is overturned to give the westerly dips so prominent in the McAuliffe Creek-central copper anomaly area. This interpretation makes the area compatible with the regional interpretation of Gee (1967).

In detail work, the dolomite unit inferred to exist from indirect local evidence and extrapolation from distant outcrops was found in outcrop in a cenote (water filled doline/[sinkhole]) in the bed of a creek tributary to the "Little" Donaldson River.

The dolomite unit is located further east than previously thought, and there is more slate country between it and the sandstone/conglomerate bearing beds equated with Spry's Donaldson "Group". These slate beds were explored in a traverse of the Donaldson River. The dolomite is probably the Savage Dolomite. The current interpretation is shown in Plan 1.4.

Note: A mapping error is indicated in the terms 'Donaldson" and 'Little Donaldson' Rivers. The Little Donaldson is much bigger than the Donaldson. With respect to Spry's Donaldson Group, this would be better termed a Formation, with the units into which it is divided at Mt Donaldson given member, lens or tongue status.

4) SAMPLE PREPARATION AND ANALYSIS PROCEDURE

Samples were sieved to -80 mesh prior to analysis by Analabs, Burnie. The method used for preparation was perchloric acid digestion and for analysis, atomic absorption spectrometry.

5) SAMPLING PROJECTS

A. THE CENTRAL ANOMALY

As outlined in the 1981-82 Field Report:

"An area prospective for copper mineralisation has been established with support from magnetics, stream mud geochemistry and soil geochemistry."

This prospective area had been broadly delineated by four (4) equally spaced cut lines that ran E-W from the main base line (Easting 49).

As a result, the 1982-83 field investigations centred upon further delineating this central copper anomaly by way of soil sampling on a closer grid. A further eleven (11) E-W cut lines were established in order to intersect the axis of the anomaly ridge at right angles, and, along these lines the sample spacing was 25 m.

As outlined in last year's report, the samples were collected using a 1 m hand auger. However, this field season a 1.5 m auger was implemented in the hope of achieving a more desirable level of penetration, hence a more realistic and worthwhile sample in terms of element concentration.

Results

As a result of sampling on a closer grid, last season's peak copper value of 1400 ppm was supported by twenty-three (23) sample locations where the copper values exceeded 400 ppm. Of these 23 samples, the vast majority (87%) have a value between 400-565 ppm, thus defining a region of elevated copper concentration. These 'elevated' copper values appear to broadly support each other along strike.

This season's peak copper value was 1050 ppm, the next highest value 935 ppm and the third highest value was 810 ppm. The results are plotted on Plans 2.1 - 2.7.

Conclusion and recommendation

All viable field techniques have been utilized in defining the central copper anomaly. It is now envisaged that geophysics be incorporated in order to delineate a drilling target or targets.

B. SOUTHERN ANOMALY

Introduction

As outlined in last season's soil sampling programme, a peak copper value of 1000 ppm was found in the axis of the Southern anomaly at grid reference point 490 110. During this field season a small scale grid was implemented to further investigate this peak copper value. (The structure of this grid is outlined in Plan 3.1.)

Results

A value of 880 ppm Cu was obtained in close proximity to last season's peak value. There are 3 supporting values of 400+ ppm. Results are plotted on Plans 3.1 - 3.7.

Conclusion and recommendation

The area seems less promising than the Central anomaly, but would warrant one or two E-M traverses if there is any encouragement from E-M work on the central anomaly. The anomaly has not been closed off, and is easy terrain to work in, so two lines are proposed to extend coverage South and three lines to the North.

C. PINEAPPLE CREEK ANOMALY

Introduction

East of the pipeline service road, in the drainage basin of Pineapple Creek, a magnetic anomaly was selected for sampling. Access was achieved by two cut lines, termed 16.7 and 16.4 respectively.

Results

Tertiary basalt was the dominant lithology along both cut lines; however on the eastern fringe of the anomaly Precambrian greenschist re-emerged, and this area was sampled. However in the vast majority of cases it was not possible to achieve a satisfactory sample due to the presence of Tertiary quartz gravels which blanketed the underlying greenschist.

As was to be expected, the element concentration was low ($<$100 ppm in all cases except one isolated high Zn value of 215 ppm).

Conclusion and recommendation

Unless a satisfactory method of penetrating the overlying gravels can be implemented, no further investigation is warranted.

D. LINE 12.5

Introduction

A magnetic anomaly 1.5 km west of Camp One (grid line 12.5) was selected for soil sampling due to its position occupying an inferred carbonate bed, hence the possibility of replacement mineralisation.

Results

Copper Zn values across this anomaly are considered low with copper, having a range of 25 - 120 ppm. The notion of replacement mineralisation along the carbonate bed is supported to some extent. The lead values throughout IMI's Northern Area are consistently <10 ppm. However, on line 12.5 40% of all values were >20 ppm with a peak value of 35 ppm.

Conclusion and recommendation

Admittedly these Pb values are low, however Line 12.5 is the only instance where this carbonate bed has been sampled. Further delineating the areal extent of this bed and follow-up sampling is proposed.

E. LEAD ANOMALY

As outlined in last year's report "a solitary extreme value of 1.25%" was found east of the central magnetic anomaly. Follow-up investigations by way of a small scale grid were undertaken.

Results

The exact location which produced the 1.25% Pb value was sampled again; this season's value was 20 ppm. However 5 m to the east of this location the Pb value was 135 ppm with three surrounding values of 35, 30 and 40 ppm.

Conclusion and recommendation

The solitary very high Pb value obtained was probably the result of a small isolated Pb rich vein, hence no further investigation is warranted.

(b) NORTHERN AREA STREAM SEDIMENTS GEOCHEMICAL SURVEY

1) INTRODUCTION

The area covered this season extended West and North of the area previously sampled, sections being (a) the Donaldson River and tributaries in the NW quarter of the area; (b) the lower reaches and tributaries of the 'Little' Donaldson River; and (c) South from here to the boundary of the Arthur River map sheet, small tributaries of the Donaldson and Savage Rivers.

2) LOCATION AND ACCESS

The road constructed last season was upgraded and extended to a new camp located 8 km NW of Savage River. Remaining access was by cut lines, mostly following grid line 45E.

3) RELIEF AND DRAINAGE

The area is dominated by a pair of sub-parallel strike ridges of modest relief flanked by a plain in which the main rivers are entrenched by about 10-20 metres. The two Donaldsons run WSW about 2 km apart, piercing the strike ridges with a largish tributary system entering from the North passing Pyramid Hill. Another collection of unnamed creeks in the SW [(c) above] run west to join the combined Donaldson Rivers outside EL 4/61. A small area in the S.W. of the sampling project area drains to the Little Savage River.

4) VEGETATION

The area included small crowned Nothofagus forest with celery top pine, etc., and relatively dense horizontal understorey with belts of tall ti tree/Bauera and Eucalyptus/Bauera marginal to relatively open heathland with ti tree and buttongrass. Pure buttongrass areas were rare. In the South of the area some genuinely open country occurred, coinciding with an area burnt shortly before the Burnie concession colour photography was flown. The heathland which escaped this fire now includes areas of dense ti tree up to 5 m high which is difficult to penetrate. In these areas the pre-contact buttongrass appears to be dying out.

5) GEOLOGY

The stream sediment work extended west into some ground not discussed in last season's report. There appear to be two definable units: (a) The presumed Donaldson Group, distinguished by the presence of some thickish sandstone beds, some conglomerate, and some cross bedding, although outcrop is poor, so that most of the unit may well be pelites - even 95% pelite. (b) The underlying rocks, perhaps the Interview siltstone, comprising an alternation of pelites with thin graded sandstones. Good east facing, east dipping outcrops were found at Camp 2 (flame structures) and on the Little Donaldson at 450 111. Some black pyritic shale is exposed on the Camp 2 access track, also some pink weathering metavolcanic rock ("amphibolite") which appears to be the source of a broad local magnetic anomaly.

6) SAMPLE PREPARATION AND ANALYSIS PROCEDURE

The samples were sieved to -80 mesh and the fine fraction analysed at Analabs, Burnie. Preparation was by perchloric acid digestion and analysis by atomic absorption spectrometry. The -40+80 fraction has been retained at Savage River.

7) SAMPLING PROJECTS

A. DONALDSON RIVER AREA

Introduction

A stream sediment programme was undertaken in the Donaldson River drainage basin during the months of February, March and April 1983. All tributaries of the Donaldson River were sampled for freshly deposited silts in an attempt to provide a broad geochemical base. Specific magnetic anomaly targets were selected within the Donaldson River drainage basin, and the small streams and larger creeks draining these anomalies were sampled in an attempt to find whether or not a quantative relationship existed.

Results

Copper (N = 63)

- Mode (measurement which occurs most frequently) = 5 ppm.
- Median (irregular distribution of data hence median is used in preference to mean) = 5 ppm.
- Anomalous samples: DS 317 = 185 ppm; DS 327 = 180 ppm

Zinc (N = 63)

- Mode (polymodal) = 10, 15 ppm
- Median = 25 ppm
- Anomalous samples: DS 311 = 115 ppm; DS 317 = 135 ppm; DS 327 = 110 ppm

Background values were (as defined by median):

Cu	10 ppm	(74% of samples below this)
Zn	25 ppm	(74% " " ")
Pb	<5-10 ppm.	

Two sample locations yielded anomalous values for both copper and zinc. They were DS 317 (G.R. 475152) and DS 327 (G.R. 463147).

DS 317 has values of 185 Cu, x Pb, and 135 Zn. However this result appears of little interest when one considers that:

- Sample DS 323 which is at the head of this stream has low Cu and Zn values (10 ppm and 45 ppm respectively).

- Thick, Tertiary conglomerate and basalt outcrop along Grid line 15.0 which is in very close proximity to the sample location.

- The catchment of the stream does not drain any magnetic anomaly.

This isolated copper and zinc value may represent a sample taken at point source - that is, a window through the overlying basalt into the underlying Precambrian metasediments.

DS 327 has values of 180 Cu, x Pb, 110 Zn. This sample was taken in a large tributary of the Donaldson River, 20 m downstream of a junction between two creeks. Samples were also taken in each of the creeks yet both returned very poor copper and zinc values.

Ferric hydroxide "flowstones" derived from groundwater springs were encountered in two locations, DS 330 and DS 339, and were thought to be a "scavenging" environment for metal ions; however the Cu, Pb and Zn values were poor.

The main geochemical trend noted was that downstream of sample location DS 335 all zinc values are <25 ppm, whereas upstream of this location, 16 out of 24, or 66%, have values >25 ppm.

This "Zn rich province" peaks at sample locations:

DS 310 - 75 ppm
DS 311 - 115 ppm
DS 317 - 135 ppm
DS 327 - 110 ppm.

Perhaps the most interesting point to note is that in this province, Zn values outstrip copper values in every case.

Conclusion and recommendation

Stream sediment values were poor and failed to adequately delineate any substantial anomaly; therefore no further investigation is warranted.

B. LITTLE DONALDSON RIVER

Introduction

The stream sediment sampling programme during the 1981-82 Summer Field Season had succeeded in sampling approximately half of the Little Donaldson River within EL 4/61. Further investigations during the month of April 1983 successfuly completed the remainder of the sampling programme up to the western boundary of the lease.

Results

Copper (N = 19)	Zinc (N = 19)
- Mode = 5 ppm	- Mode (polymodal) 10,15,20.
- Median = 5 ppm	- Median = 20 ppm
- No anomalous values.	Anomalous Zn values L.D.S. 301 = 140 ppm " 303 = 140 ppm " 304 = 130 ppm " 306 = 145 ppm

For the remainder of the Little Donaldson River the values obtained were very poor, especially in Cu where 78% of all values were <15 ppm. The majority of zinc values were also low.

Conclusion and recommendation

The only feature worthy of note was a group of four samples (LDS 303, 304, 301 and 306, G.R. 484 139) whose Zn values were in the range of 130 to 145 ppm. This zinc "anomaly" is also supported by a substantial "kick" in copper at these locations (60-85 ppm). However it is felt no further work is warranted here.

C. THE MINOR DONALDSON TRIBUTARIES AREA

Introduction

A general reconnaissance plus the presence of two small magnetic highs prompted a stream sampling programme in this area. The majority of streams sampled within this region were of minor size. Access consisted of a cut baseline (Line 45) which was cut south for a distance of 4 km and by the less overgrown streams.

The vegetation on the lower slopes and plains surrounding the "buttongrass" ridges consisted of eucalypts, Bauera and ti-tree and was extremely difficult to traverse. This problem was significantly overcome by use of aerial photographs which highlighted the more open areas for easier access.

Results

The work in this area tested a different geological terrain. Prior work in IMI's Northern area had been in Precambrian metasediments and metavolcanics, whereas in this new area the few outcrops were sandstones and pebbly sandstones, with rare slate/ mudstones in gully sections.

The area did seem less promising than the metavolcanic area to the east, despite some potentially hopeful magnetic features (the magnetic anomalies could easily be only igneous intrusions), and some pyritic black shales.

The results indicate generally very low backgrounds: the peak copper value was 35 ppm, and from 59 samples collected, 91% had Cu values <10 ppm. The magnetic features which were tested showed no change from the prevailing background.

Conclusion and recommendation

The area sampled is considered to be "barren", hence no further investigations are warranted.

1) INTRODUCTION

Work in the area was targeted on the examination of areas north and south along strike from the proven magnesite area of Main Creek (drillholes MC1 and MC2). A series of tracks comprising some 5 km were constructed across the area of inferred magnesite subcrop, with some work also on upgrading the old magnetic survey baseline track which is the connecting link between the new tracks.

Considerable work was expended in geological traverses along roads, both with the idea of elucidating the local geology and checking out indirect indicators of the presence of carbonate rock. The work is not complete but the main access track and several of the branch tracks are plotted up with the traverse data on Plan 5. This work was of assistance when some very discouraging indications came out of track construction work in Spring 1982.

Other surface geological work involved reconnaissance of creek sections. Several new outcrops of magnesite were discovered in this work, with analysis values given in Table 1. The creek sections extending west of the magnesite area expose a change in character of the sequence which may prove useful as a formation boundary (see Plan 4.1).

It was intended to use the roads mainly as access for a drilling rig for an overburden assessment and magnesite sampling programme, but as the surface data indicated lack of magnesite in some areas where it was expected, and the drilling rig proved unable to cope with the prevailing thickness of overburden, the drilling programme was recast into a 2-hole deep core drilling programme. This was successful in proving up a major northward extension of the magnesite area, although the second hole was abandoned well short of target. Logs are shown in Appendix I, profiles in Figures 1 and 2.

A summary of the overburden drilling data is presented in Table 2.

2) LOCATION AND ACCESS

The prospect is located 6 km south-west of Savage River and access is by an old magnetometer survey track. Much of the track is poorly designed, and, with a bedrock which weathers to deep clays, access is often lost in wet weather.

3) GEOLOGY

3.1 Introduction

Since the previous report, more detailed work on the artificial and natural exposures of the area have compelled some changes in the interpretation of the area, as regards the Precambrian geology. It is now considered that facing is to the east, and the section where the regional strike approximates 170°-350° is made up of segments of basically 150°-330° trend displaced by faulting (see plan 4.2). Direct indications of facing are reasonably common in the quartzite rich section of the "Whyte Schist" which is now considered a relatively metamorphosed variant of the Oonah Formation (N.J. Turner pers. comm.). One not quite conclusive example of cut and fill structure was found inside the greenschist belt, just east of the Main Creek Magnesite area at 470993, also facing east. The preservation of grading is often poor in rocks west of the magnesite area and despite good outcrop the facing is ambiguous. The interpretation of surficial geology in the previous report requires little modification. One point is that the "floating spongy clay" from MC 19 drill hole is now interpreted as an in situ leaching product of magnesite rock.

3.2 Stratigraphy and Petrology

3.2.1 Quaternary

The Quaternary deposits are described in sufficient detail in Shannon et al (1982), pp 11-13. Broadly speaking, there is a thin strip of modern alluvium along the major creeks. Older alluvial deposits flank the modern alluvial strip and fill karstic depressions in the underlying deposits, which include thick residual deposits over magnesite where the magnesite rock is present at depth.

In ridge top situations, the magnesite residual cover tends to be sandy. This whole complex is buried by extensive slump breccias with large clasts of weathered greenschist, which, since they have propagated over level lacustrine deposits in places, are considered to be periglacial. Some angular quartz gravels overlying this material are of uncertain origin, possibly a residual deposit from leaching beneath a peat cover rather than the allochthonous slump deposit proposed previously. A new feature discovered in the north of the magnesite area was a gravel deposit apparently reworked from a sub-basalt gravel source.

3.2.2 Tertiary

An area of ridge top basalt capping occurs in the North of the Plan 4.2 area. It is underlain by siliceous cobble gravel. A reasonably large extent is implied by the quantity of reworked, well rounded gravel in small creeks draining the area.

3.2.3 Precambrian - quartzite/schist unit

Occurring extensively along the Corinna Road, this unit consists mainly of white weathering quartzite, black graphitic phyllite, chlorite schist and muscovite schist with a degree of gradation between the various lithologies. It constitutes a boundary to the area of interest on the east.

3.2.4 Precambrian - greenschist/magnetite/ siliceous carbonate unit.

This is a unit comprised mainly of purple weathering fissile to non-fissile schists, some of which are schistose (chlorite dominant?) and some slightly to non-foliated (and hence possibly amphibolites with actinolite). It is not really possible to distinguish these minerals without a local reference slide collection and descriptions (see comments below in next section). The unit is also host to the Long Plains South magnetite bodies, and some magnesite.
A distinctive very siliceous carbonate lens occurs near the base (West) of the unit. (See Plan 4.2). There are also sandstone bearing lenses near the top.

3.2.5 Precambrian - magnesite/greenschist unit

The unit contains magnesite rock with some dolostone, often bounded by talc schist inter-bedded with fissile to equigranular greenschist. The equigranular and less schistose varieties have been termed amphibolites under the impression that the lack of fissility pointed to the presence of actinolite as the dark mineral, with albite as the commonly occurring white mineral. However this is not necessarily the case, since all the white minerals in the MC 27 core appear to be carbonates. It was found also that banded rocks which in the surface appeared to be actinolite/feldspar rocks may equate with dolomite/chlorite? rocks in the drill core. This could occur if the kaolin in the surface rock was an 'illuvial' replacement mineral.

3.2.6 Precambrian - magnetite-bearing greenschist/ sandstone unit.

Drillhole evidence suggests that there is a sharp boundary at which magnetite becomes prominent in the greenschists, and carbonate becomes less abundant. A 1 metre carbonate bed encountered consisted mainly of dolomite. Within this interval there is a distinctive pale green equigranular magnetite bearing rock which occurs close to magnetite mineralization both in the MC 27 core and at surface at 463999. This distinctive rock also occurs at the Savage River Mine. Thus this outcrop establishes the probable correlation of the Savage River magnesite with the Main Creek magnesite, and the non correlation of the Long Plains magnetite with Savage River magnetite. The outcrop appears to be the extreme southern limit of the Savage River magnetite mineralization.

Some thin sandstones are present close to the top, but in creek sections the sandstones become more abundant down sequence with certain beds up to 1 metre in thickness. Typically the sandstones are 4 cm to 10cm in thickness. The sandstones contribute to the resistant character of the unit. Some black shales up to 4 m thick have been observed. At the base of the unit there are lenses of a white weathering breccia, matrix supported, with occasional rounded clasts. Where the maximum development has been noted (476960) the breccia is overlain by fine grained massive sandstone.

3.2.7 Precambrian - thinbedded sandstone unit

The sandstones of this unit are certainly turbidites but facing is difficult to be sure of. Partings of chlorite schist separate the beds which are mainly in the 0.5-2.0 cm thickness range. Only the top section of the unit has been examined. It provides a distinctive western limit to the area of interest for magnesite.

3.3 Structural Geology

The main refinements to the model proposed last year are the addition of two N-S trending faults with dextral slip. These have the effect of stretching out the terrain and thus make the overall 170°-350° trend of the link between the Main Creek and Bowry Creek outcrops compatible with the measured local trends on the ground which approximate 150°-330°. There is some air photo support for the positions proposed for the faults. Another fault in the North is an air photo feature emphasized for convenience of mapping. The curving feature in which regional strike swings in the North around to 020°-200°, noted by Urquhart (1966), has been confirmed on the ground.

4) DRILLING

4.1 Introduction

A track-mounted, modified Warman 250 supplied by Overland Drilling was used for the work.

4.2 Shallow air blast drilling

Attemptswere made to penetrate to bedrock in two areas: (a) at Main Creek, in the NW corner of the area drilled last year, where the drilling had proved ineffective; and (b) in the next valley north of Main Creek. In neither area was it possible to penetrate to magnesite bedrock, and sometimes there is doubt as to whether non-magnesite bedrock may have been encountered.

Results are summarised in Table 2.

The depth figures give minimum estimates of overburden thickness which require some correction as the holes were often inclined. Once the inadequacy of the rig for this type of drilling was demonstrated, it was decided to commit resources to diamond drilling instead.

4.3 Diamond drilling

Drillhole MC 27 was sited at a spot some 20 metres from the inferred margin of the magnesite belt, in order to give some solid ground above the initial portion of the drillhole. The hole was successful in penetrating to magnetite bearing material inferred to be west of the magnesite belt. Carbonate intersection of 167 m was obtained but numerous bodies of greenschist were interbedded with the magnesite. In places the core bedding angle is low and this is interpreted as indicating intervals with westerly overturned dip. During the winter recess it is intended to cut the core for analysis and other research work to be handled by CSIRO. The profile in Fig. 1 is a rough log version only. Detailed logging has been completed but was done after 24-5-83 and therefore will be included in the next quarterly report.

Drillhole MC 28 was situated in an analogous position to MC 27 with respect to the magnesite boundary, but further away since the ridgetop site was considered likely to have more problems. This did happen and the intersection of a 4 m cavity at 174-178 m led to abandonment of the hole on the drillers' recommendation. The profile of the hole based on the field log is shown in Fig. 2.

CARBONATE ROCK SAMPLES

	Comments	Carbonate rock analyses					
		Fe	Mn	CaO	SiO_2*	MgO	
B1	Magnesite, Bowry Creek tributary	1.22%	1125	8350	0.2%	43.5%	
B2	Impure magnesite with Mn/Fe oxide coating. Bowry Creek.	16.9%	4.25%	5.45%	0.2%	20.5%	
B3	Impure dolomite from small carbonate lens. Bowry Creek.	3.02%	3312	21.5%	0.2%	14.5%	
B4	Dolomite from cenote outcrop, Little Donaldson R. area.	3787	337	28.5%	0.2%	21.0%	
	Detection	50	25	50	0.2	50	
	Digestion	104	104	104	104	104	
	Method	104	104	204	204	204	
		Fe_2O_3 %	MnO%	CaO%	SiO_2 %	MgO	Loss on Ignition
B5	Magnesite, SW of MC 27.	1.10	0.09	2.00	0.6	44.7	51.1
B6	Magnesite with dolomite vein, N of MC 27.	4.45	0.13	12.10	0.7	34.2	47.9
B7	Magnesite, N of MC 27.	2.00	0.09	2.40	0.3	44.6	50.7
B8	Magnesite, N of MC 27.	9.20	0.16	0.20	1.5	41.2	46.9
B9	Magnesite, N of MC 27, start of creek section outcrop.	2.85	0.15	2.75	0.2	44.1	50.5
B10	Magnesite, N of MC 27, creek section outcrop.	1.40	0.09	1.20	10.0	41.5	45.7
B11	Magnesite, N of MC 27, creek section outcrop.	2.50	0.09	3.70	0.3	43.7	50.0
B12	Magnesite, N of MC 27, end of creek section outcrop.	2.95	0.12	2.25	0.5	43.8	49.0
B13	Magnesite, W of MC 27.	1.90	0.16	2.70	2.9	43.9	49.1
B14	Impure magnesite with talc. S end of MC outcrops.	1.70	0.07	7.00	27.6	33.6	29.8
	Detection	0.05	0.01	0.01	0.1	0.1	0.1
	Digestion) Method)	405	405	405	405	405	405

* SiO_2 values in this batch improbable (all 0.2%!)

TABLE 2

MAIN CREEK MAGNESITE:

DRILLING DATA FOR OVERBURDEN PROGRAMME, 1982-83 SEASON.

Drillhole No.	Total depth	Comments
MC 20A	18m	No recovery below 9m periglacial greenschist/clay breccia. Hole collapsed.
MC 20B	18m	Purplish brown clay below greenschist/ clay breccia. Hard at 18m (possibly magnesite). Lost bit.
MC 20C	18m	Mud (light brown, obscured by cavings) below greenschist/clay breccia. Hole abandoned due to caving.
MC 21	45m	Greenschist ground to sand size, weathered, but with pyrite. Breccia or greenschist bedrock. Hole intended to locate edge of magnesite area. Partially successful. Drilled with hammer drill.
MC 22	4m	Green feldspathic amphibolite, interpreted as non carbonate bedrock (interbed within magnesite zone). Hole abandoned.
MC 23A	15m	Alluvium with gravel above yellow brown clay, interpreted as magnesite relict material. Poor recovery then caving problems stopped hole.
MC 23B	18m	As above. Lower samples too contaminated with cavings to be useful. Hole stopped because of caving.
MC 24	42m	Ex magnesite relict yellow clay with talc, spongy quartz and Fe oxide sponge below periglacial clay/greenschist breccia. Hole abandoned due to caving and poor recovery.
MC 25	14.5m	Ex magnesite yellow clay below alluvium. Hole abandoned because of non recovery and caving.
MC 26	14m	Alluvium - organic rich mud - below periglacial greenschist/clay breccia. Possibly sinkhole filling. Hole abandoned because of nil recovery.

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5. Webster, S.S., and Skey, E.H. 1979.
Geophysical and Geochemical Case History of the Que River Deposit, Tasmania, Australia. In "Geophysics and Geochemistry in the search for Metallic Ores" - Peter J. Hood, editor : Geological Survey of Canada, Economic Geology Report 31, pp 697-720.

APPENDIX 1

LOGS FOR DIAMOND DRILL HOLES MC 27 AND MC 28

Rig: Modified Warman 250, track mounted.
Contractor: Overland Drilling.

MC 27: Location - Corinna 46650018, RL 170M. Bearing 280°mag. (291½° grid). Declination 47°. Commenced 18-3-83, finished 6-4-83. Final depth 370.4m.

LOG OF MC 27

0 - 33	Non core drilling, weathered greenschist, possibly with some clay/ferric oxide relicts after magnesite near base, where water losses occurred.
33 - 33.15	greenschist
33.15 - 61.8	magnesite (some grey patches may be dolomite)
61.8 - 64.3	pyritic greenschist
64.3 - 67.2	magnesite, basal 10 cm (dark grey) probably dolomite
67.2 - 68.4	greenschist and amphibolite dyke rock.
68.4 - 68.6	magnesite and dolomite
68.6 - 70.5	greenschist
70.5 - 70.8	weathered magnesite, including cavity
70.8 - 76.6	magnesite
76.6 - 76.65	greenschist
76.65 - 77.9	magnesite
77.9 - 78.0	greenschist
78.0 - 78.8	magnesite
78.8 - 79.1	greenschist
79.1 - 79.3	magnesite
79.3 - 79.5	greenschist
79.5 - 80.2	magnesite
80.2 - 88.3	greenschist and amphibolite with carbonate

continued -
MC 27

88.3	- 88.8	magnesite
88.8	- 93.3	greenschist
93.3	- 93.4	magnesite
93.4	- 97.9	greenschist
97.9	- 98.2	magnesite with dolomite
98.2	- 99.9	greenschist
99.9	- 100.9	magnesite
100.9	- 101.7	greenschist
101.7	- 102.6	magnesite
102.6	- 104.1	greenschist
104.1	- 104.3	magnesite
104.3	- 111.1	greenschist
111.1	- 120.2	magnesite
120.2	- 129.0	greenschist
129.0	- 134.7	magnesite
134.7	- 136.5	greenschist
136.5	- 178.1	magnesite
178.1	- 178.5	greenschist
178.5	- 190.0	magnesite
190.0	- 237.3	greenschist and amphibolite
237.3	- 238.4	greenschist with quartz and talc
238.4	- 238.6	magnesite
238.6	- 238.7	greenschist and quartz
238.7	- 241.4	magnesite
241.4	- 247.5	greenschist - some contorted with low core bedding angle
247.5	- 266.8	amphibolite with carbonate gash veins
266.8	- 267.1	magnesite

continued -
MC 27

267.1	- 273.4	amphibolite with carbonate gash veins, greenschist
273.4	- 298.4	magnesite
298.4	- 308.1	amphibolite, some with coarse grained feldspar.
308.1	- 310.7	magnesite (with dolomite?)
310.7	- 313.0	amphibolite
313.0	- 326.2	magnesite
326.2	- 336.0	amphibolite
336.0	- 353.2	greenschist and amphibolite, pyritic, coarse feldspar, metamorphic and/or sedimentary layering
353.2	- 357.0	pale green equigranular greenschist with abundant euhedral magnetite and pyrite
357.0	- 360.1	greenschist with feldspar porphyroblasts, pyrite and magnetite
360.1	- 365.7	banded feldspathic greenschist with magnetite
365.7	- 366.8	carbonates with magnetite and pyrite
366.8	- 370.4	laminated feldspathic greenschist
	END	NQ 33.0 - 215.9, BQ 215.9 - 370.4.
		Carbonate intersection 167.4m.

MC 28: Location Corinna 46779965, RL 200m. Bearing 245°mag. (256½ grid) Declination 47°. Commenced 8-4-83, finished 22-4-83. Final depth 178.4m. NQ 16 - 106.1 BQ 106.1 - 178.4.

LOG OF MC 28

0 - 16	Non core drilling : purple brown and minor greenish yellow weather greenschist. No recovery 11-16m.
16 - 262	Mostly pale green weathered greenschist (possibly talc schist) core broken .
26.2 - 39.5	Quartz in clasts up to 25 cm. 5 cm orange sandy clay, representative of matrix generally lost. Poor recovery.
39.5 - 41.1	Brown clay/iron oxide sponge; ex magnesite leached residue.
41.1 - 46.3	Extensive core loss, cavings only recovered. Possibly cf above.
46.3 - 50.2	Grey 'sandy' chert (ghost sand grains?). Interpreted as siliceous replacement of magnesite.
50.2 - 50.6	core loss
50.6 - 52.3	chlorite phyllite (greenschist)
52.3 - 60.3	magnesite with minor talc schist at top
60.3 - 60.6	chlorite phyllite
60.6 - 69.5	magnesite, some with talc; minor chlorite phyllite with quartz.
69.5 - 70.6	chlorite phyllite.
70.6 - 90.0	magnesite
90.0 - 93.5	greenschist
93.5 - 97.0	magnesite
97.0 - 100.7	greenschist
100.7 - 103.0	magnesite
103.0 - 103.5	greenschist
103.5 - 109.7	magnesite
109.7 - 111.9	greenschist

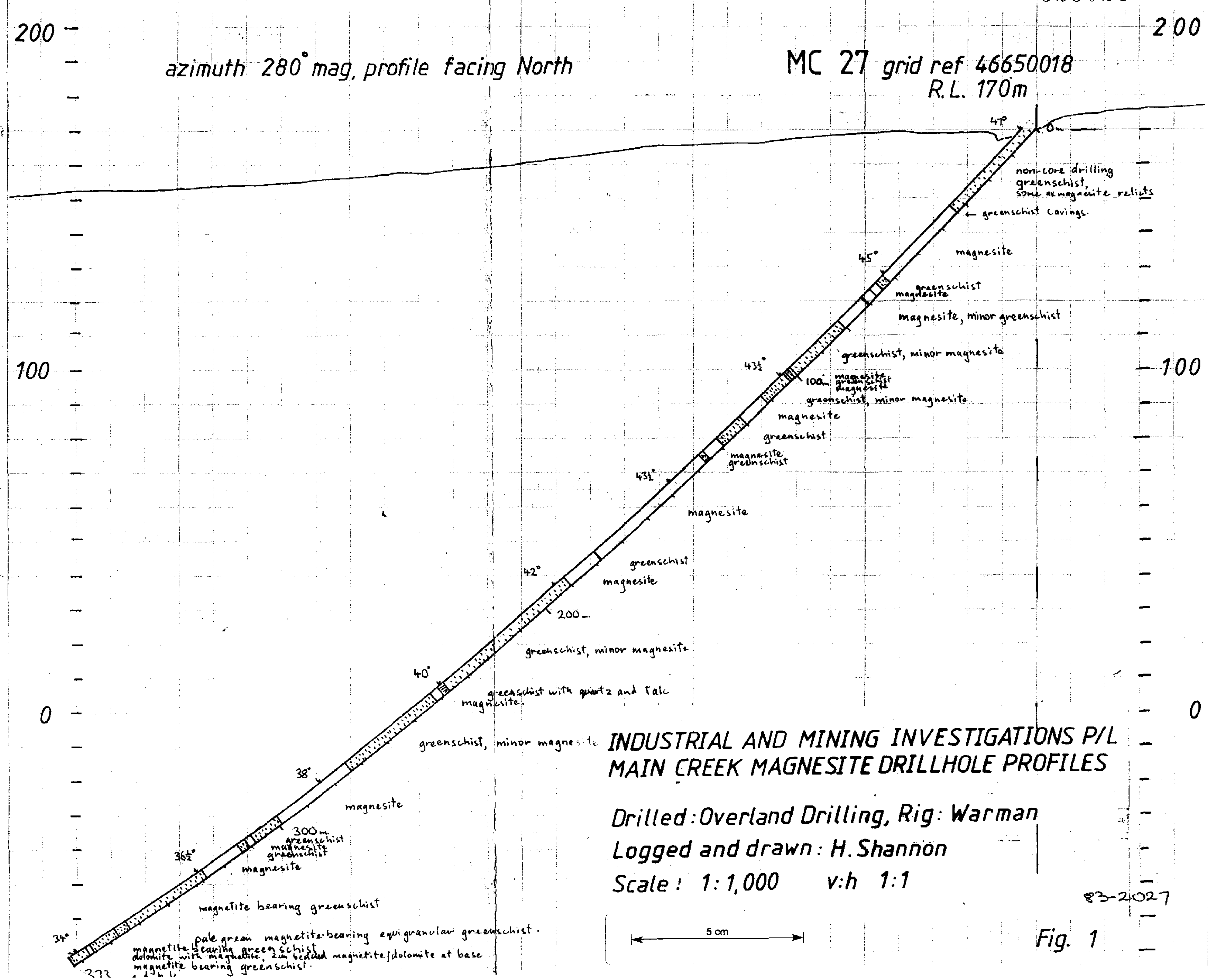
continued -
MC 28

111.9	-	114.1	magnesite
114.1	-	114.3	Extensive core loss. 5cm magnesite, 3 cm white clay, 1 cm grey phyllite; cavings?
114.3	-	114.7	magnesite
114.7	-	115.2	grey phyllite
115.2	-	116.0	(core losses) magnesite?
116.0	-	120.3	magnesite
120.3	-	123.0	greenschist
123.0	-	123.6	magnesite
123.6	-	133.3	greenschist
133.3	-	135.8	magnesite
135.8	-	137.8	greenschist
137.8	-	160.0	magnesite
160.0	-	161.0	greenschist
161.0	-	163.9	magnesite
163.9	-	168.8	6 m open cavity + 0.7 m magnesite
168.8	-	169.2	greenschist with some magnesite; some cavings or debris in cavity.
169.2	-	178.1	greenschist, fractured, poor recovery (owing to vibration of rods).
178.1	-	178.4	magnesite

END

Carbonate intersection 96.1 m.

525028



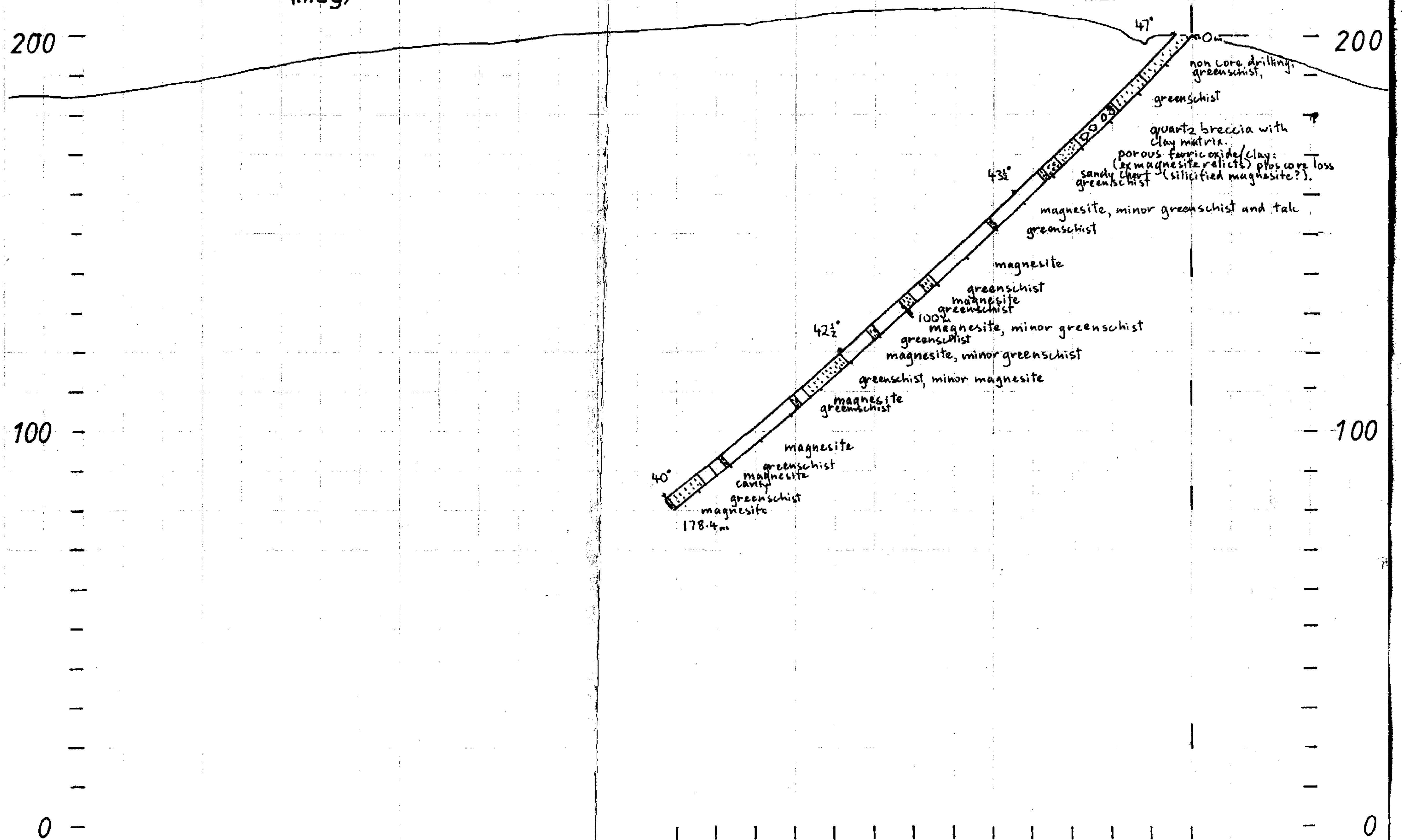
83-2027

Fig. 1

azimuth 245°, profile facing North
(mag)

MC 28 grid ref 467/9968
R.L. 200 m

525029



INDUSTRIAL AND MINING INVESTIGATIONS P/L
MAIN CREEK MAGNESITE DRILLHOLE PROFILES 83-2027.

Drilled: Overland Drilling, Rig: Warman
Logged and drawn: H. Shannon
Scale: 1:1 000 v:h 1:1

5 cm

Fig. 2

CSIRO Report No 10 : accompanying Report on Field Investigations within EL 4/61, WEST COAST, TASMANIA, SUMMER FIELD SEASON, 1982-83 by INDUSTRIAL & MINING INVESTIGATIONS PTY LIMITED.

APPENDIX 2

525030

MCC 499

83-2027A

CSIRO

Institute of Energy and Earth Resources

Division of Mineral Chemistry

PRODUCTION OF MAGNESIA FROM SAVAGE RIVER MAGNESITE

Progress Report No. 10: October 1982-June 1983

J.H. Canterford and C. Moorrees

OPEN FILE

July 1983

83-2027A

Mineral Chemistry Communication

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01

525031

CONTENTS

02

525032

PRODUCTION OF MAGNESIA FROM SAVAGE RIVER MAGNESITE
PROGRESS REPORT NO. 10: OCTOBER 1982-JUNE 1983

SUMMARY

This report gives details of a range of tests designed to (i) establish reproducibility, and (ii) minimize iron dissolution. With respect to the former, it has been established that a good standard of reproducibility can be achieved so that data obtained in the present study can be used for cost estimation and pilot plant design purposes.

With respect to the minimization of iron dissolution tests, no conditions have been found that will give zero iron in the pregnant leach liquor. However, the iron concentration can be reduced to a low level by leaching at 45°C, less than 2% solids pulp density, and an extended leaching time (about 1-2 h). As a guide to the Fe_2O_3 content of the final magnesia product, a liquor containing 0.0006 g/l Fe per 1.0 g/l Mg will give a product containing 0.05% Fe_2O_3. From the resultant liquors it is possible to recover at least part of the dissolved magnesium as a final product with a very low iron content (<0.02% Fe_2O_3).

On the basis of information received from magnesia producers it is evident that purity and hence market price is governed more by the B_2O_3 content and the CaO/SiO_2 ratio than by the Fe_2O_3 content. If the B_2O_3 content and the CaO/SiO_2 ratio of magnesia produced from Savage River magnesite can be kept below 0.005% and greater than 2.0, respectively, then it is probable that the iron content can be as high as 0.2% Fe_2O_3. Analytical data obtained so far indicate that the above B_2O_3 content can be bettered.

INTRODUCTION

As outlined in our previous report [1], the CSIRO Division of Mineral Chemistry has been investigating many aspects of the production of high-purity magnesia from the Savage River magnesite deposit via the calcination/carbon dioxide leach process. During technical discussions with officers of Industrial and Mining Investigations Pty Ltd (IMI), it was made clear that development of the Savage River deposit would be on a Joint Venture basis. In order for IMI to enter into Joint Venture discussions with appropriate companies, IMI would need to be able to present data obtained on the laboratory scale that would satisfy potential partners with respect to reproducibility and product grade. For the latter, IMI, on the basis of discussions with the magnesia producers and potential customers, took the position that the product should contain less than 0.05% Fe_2O_3. At IMI's request, proposed technical-scale studies and the generation of a reactivity index based upon the examination of other bulk samples were held over and efforts directed towards provision of reproducibility data and elucidation of leaching or calcination plus leaching conditions that gave a magnesia product containing less than 0.05% Fe_2O_3. The results of this phase of our study are presented in this report.

REPRODUCIBILITY DATA

The feed for these tests was taken from a batch of bulk calcine prepared from drill core magnesite [2-4]. About 80% of the bulk calcine was produced in the rotary kiln [2], with the remaining 20% being produced on a batch basis in a laboratory muffle furnace [3]. All calcine was blended, screened and re-blended [3,4]. Because of difficulties experienced with the rotary kiln, it was considered that the bulk calcine was in fact under-calcined. This was confirmed by X-ray diffraction analysis of the final product, which showed the presence of undecomposed magnesite. Despite this, it was considered that the bulk calcine would be suitable for reproducibility tests.

For these tests, a drum of bulk calcine was coned and quartered, and split (by riffling) into 15 lots. Grab samples from 12 lots were used for leach tests, with a thirteenth grab sample used for chemical and mineralogical characterization. Two sets of leaching conditions were used:

Series I : 2% solids, 0.5 h slake, 45°C, 100 psig CO_2, 900 rpm
Series II: 2% solids, 0.5 h slake, 45°C, 100 psig CO_2, 1200 rpm

Samples of leach slurry for chemical analysis were recovered after 0.25, 0.5 and 1.0 h from the commencement of leaching. After collection of the 1.0 h samples, the carbon dioxide pressure was released and the remaining slurry collected. After liquid-solid separation by vacuum filtration (no washing), the mother liquors (~900 ml) were boiled for 1 h. The precipitates were collected by vacuum filtration, washed with 3 bed volumes of cold distilled water, air-dried at room temperature for 2 days and then at 105°C for 24 h. These products were then chemically analysed.

The results of the leaching tests are given in Table 1. Also included are the % Mg and % Fe extraction data for the 1 h samples, the data being based upon a calcine composition of 61.22% MgO and 3.85% Fe_2O_3. The following points are to be noted.

- Maximum magnesium extraction is achieved at 1200 rpm in less than 0.5 h, whereas at 900 rpm reaction is not complete after 1 h. This observation is consistent with previously reported kinetic data [5] and is related to the rate of transfer of carbon dioxide from the gaseous to the liquid phase, and the contact between dissolved carbon dioxide and the solid calcine particles.
- At the higher agitation rate, the iron concentration of the leachate decreases with increasing leaching time. As previously reported [6], this only occurs at low pulp densities and elevated leaching temperatures.
- Reproducibility of magnesium extraction is better for the Series II tests than for the Series I tests, consistent with the fact that the for latter dissolution of the magnesium oxide component of the calcine is not complete.
- For the Series II tests, the average magnesium extraction is 74.6 ± 1.2%. This is consistent with previously reported data [3] on magnesium extraction as a function of calcine MgO content.
- Reproducibility of leach liquor iron concentrations is excellent for all twelve tests.

In summary, although the feed and leaching conditions may not have been optimum, reproducibility with respect to magnesium and iron dissolution, at least on the batch-laboratory scale, can be readily achieved.*

Analytical data of the precipitates (intermediate products) derived from clarified leach liquors, and shown by X-ray diffraction analysis to be predominantly hydromagnesite, together with the calculated data for MgO produced by calcination of the precipitates, are given in Table 2. It can be seen that the final products all contain greater than 99% MgO and, with the exception of two samples, contain less than 0.1% Fe_2O_3. It is considered that the data presented in Tables 1 and 2 clearly indicate that reproducibility of an acceptable level, and products containing $\leq$0.1% Fe_2O_3 can be achieved using the calcination/carbon dioxide leach process.†

MINIMIZATION OF IRON DISSOLUTION

In order to meet IMI's requirements with respect to the maximum Fe_2O_3 content, the clarified leach liquor must contain no more than 0.0006 g/l iron per 1.0 g/l magnesium. An alternative measure is that the [Fe×100/Mg] concentration ratio should be less than 0.06. For convenience in the following discussion, the iron concentration data (rounded to the nearest 0.0001 g/l) below can be used to give an immediate first order indication of the final product (magnesia) Fe_2O_3 content.

---

*As has been indicated above, evidence was obtained for BC2 being undercalcined. It was decided that it would be advisable to carry out several reproducibility checks with a more reactive calcine. The latter was prepared by re-calcining BC2 for 3 h. Four sample of this calcine were leached under the following conditions: 2% solids, 0.5 h slake, 45.0°C, 100 psig CO_2 and 1200 rpm. The resultant leach liquors contained 8.10 ± 0.10 g/l magnesium and 0.009 ± 0.002 g/l iron, indicating good reproducibility of leaching behaviour of a more reactive calcine.

†This Fe_2O_3 content applies strictly only to the BC2 calcines. It will be demonstrated later in this report that more reactive calcines, producing higher magnesium concentrations in the leach liquor will have somewhat higher Fe_2O_3 contents.

Liquor Mg content (g/l)	Liquor Fe content (g/l) for product containing x% Fe_2O_3			
	x = 0.01	x = 0.05	x = 0.10	x = 0.20
1.0	0.0001	0.0006	0.0012	0.0024
2.0	0.0002	0.0012	0.0024	0.0048
3.0	0.0004	0.0018	0.0036	0.0072
4.0	0.0005	0.0024	0.0048	0.0096
5.0	0.0006	0.0030	0.0060	0.0120
6.0	0.0007	0.0036	0.0072	0.0144
7.0	0.0008	0.0042	0.0084	0.0168
8.0	0.0010	0.0048	0.0096	0.0192
9.0	0.0011	0.0054	0.0104	0.0208
10.0	0.0012	0.0060	0.0120	0.0240

GROUP A TESTS

These tests were designed to establish iron levels in the intermediate precipitate and final magnesia products derived from clarified leach liquors produced from a series of calcines. The calcines themselves were derived from four different batches of magnesite ore, covering the widest possible ranges of magnesite to dolomite ratio in the feed, and degree of calcination. The details of the magnesite feeds are given in Table 3.

Each calcine was leached under 3 sets of conditions:

		A	B	C
Pulp density	(% solids)	2.0	2.0	2.0
Temperature	(°C)	40.0	45.0	45.0
Slake time	(h)	0.5	0.5	0.5
CO_2 pressure	(psig)	100	100	100
Agitation	(rpm)	1200	1200	900

Each slurry was sampled 0.25, 0.50 and 1.00 h after the commencement of leaching. At the completion of each test (1 h leach), the carbon dioxide pressure was released, the slurry recovered and filtered immediately without washing. After clarification, each liquor was allowed to stand at room temperature for several days before being heated at 70 ± 5°C for 1 h to precipitate a mixture of nesquehonite and hydromagnesite. The precipitates were collected by vacuum filtration (no washing) and dried at 110°C for 1 h. These precipitates are termed the Series I intermediate precipitates. The mother liquors were then allowed to stand for 2 weeks and then boiled for 1 h. The precipitates were noticeably "whiter" than the the first precipitates after drying at 110°C for 1 h - these are the Series II intermediate products. Samples of all Series I and Series II intermediate products were dissolved in dilute hydrochloric acid for determination of the MgO and Fe_2O_3 contents. About half of the remaining sample was retained for reference, the remainder being calcined at 1000°C in a muffle furnace to determine the weight loss on ignition. Samples of the final product, magnesia, were analysed for their MgO and Fe_2O_3 contents. Boron, calcium and silica contents of selected final products were also determined.

Details of the leaching tests are not presented here since they were consistent with previously reported observations. In summary, however, the following points were observed.

- Maximum magnesium dissolution had been achieved when using an agitation rate of 1200 rpm, whereas at 900 rpm reaction was still proceeding.
- If the magnesium concentration of the slurry was relatively low (≤4 g/l), the iron concentration increased and then remained constant throughout the 1 h leaching period. For a higher magnesium concentration, the iron concentration either passed through a maximum and then decreased, or decreased as leaching proceeded. Thus, although maximum magnesium dissolution could be achieved in a short time (<0.5 h), it was advantageous to maintain the slurry under the prevailing conditions to reduce the iron concentration to a more acceptable level.

Analytical data for the leach liquors after 1 h, and for the Series I, Series II and composite intermediate (precipitate) and final (MgO) products are given in Tables 4-17. Also included are the actual weights of MgO recovered, the percent MgO recovered,* and the percentage of the product that has a Fe_2O_3 content <0.05%.†

The following conclusions can be drawn from the data given in Tables 4-17.

- As expected, the magnesium and iron concentrations of the leach liquors vary considerably according to the composition of the original feed and the calcination conditions. As a general rule, the higher the magnesium concentration, the higher the iron concentration. The relationship between the magnesium and iron concentrations is discussed more fully later in this report. Under no conditions, however, was it possible to produce a leach liquor that contained no soluble iron.**
- Variation of leaching conditions had little effect on magnesium dissolution kinetics of calcines derived from high-dolomite ore (MAG1) or from calcines considered to be under-calcined (BM/600/3, BM/700/1). For the remaining calcines, use of a lower agitation rate led to a decrease in dissolution kinetics. This is consistent with the observations reported in the previous section on reproducibility.
- The bulk of the magnesium and iron is precipitated from clarified leach liquors as the Series I intermediate products. These products have lower magnesium and higher iron contents than do the corresponding Series II products. This is consistent with previously reported precipitation data [5].

---

*This is based upon the assumption that the intermediate product was precipitated from 900 ml clarified magnesium bicarbonate leach liquor.

†This percentage is based on the weights of Series I and/or Series II final products with Fe_2O_3 <0.05%. A different percentage could result if precipitation conditions were altered to give different weights of Series I and Series II intermediate products.

**With respect to runs 19 and 127 (equivalent to 153) reported previously [6,7], it is now concluded that the calcines and/or leaching conditions used were not responsible for the zero iron result. Rather, it is now concluded that analytical error led to the erroneous result.

- For all calcines and leaching conditions, the Series II final products all contain Fe_2O_3 contents in the range 0.007-0.022%, thus meeting IMI's target of a Fe_2O_3 content less than 0.05%. These Series II products constitute between about 10 and 45% of the total product. For calcines derived from high-dolomite ore (MAG1), the Series I products have Fe_2O_3 contents in the range 0.052-0.080% so that all but one of the composite final products have Fe_2O_3 contents less than 0.05%.
- As a general rule, there is good agreement between the measured Fe_2O_3 content in the final MgO product and that expected on the basis of the iron and magnesium contents of the clarified leach liquors - see p. 5 for approximate correlation data.
- By alteration of the precipitation conditions it may be possible to reduce the amount of magnesium precipitated as the high-iron Series I precipitate, thereby increasing the amount of product produced having a Fe_2O_3 content <0.05%.
- Analysis of the filtrates from the Series II precipitations gave magnesium contents less than 0.05 g/l, indicating >95% precipitation of the magnesium content of the leach liquors. Consistent with this is the observation that the weight of MgO recovered from the original clarified leach liquor, assumed to be 900 ml, falls in the range 90-110%.*

GROUP B TESTS

It has previously been established that over calcination leads to a significant reduction in the rate of leaching [5,7] whereas an increase in leaching temperature results in an increase in magnesium dissolution kinetics [6]. More importantly, however, the actual amount of iron dissolved decreases with increasing leaching temperature. The following tests were designed to determine if iron dissolution could be minimized by a combination of a high calcination temperature and a high leaching temperature. The calcines used in these tests were prepared from the

*Because of a misunderstanding, actual filtrate volumes, although measured to fall in the range 850-960 ml, were not ascribed to a particular leach test.

bulk sample BC2 by re-calcination under specified conditions on a batch basis in a muffle furnace. Each calcine was characterized chemically and mineralogically, and with only one or two exceptions, were leached at 15.5 and 45.0°C at 2% solids, 0.5 h slake, 100 psig carbon dioxide, and 1200 rpm. The analytical data of the calcines and the leach results are given in Tables 18 and 19, respectively.

The data presented in Tables 18 and 19 confirm previously reported effects of calcination conditions and leaching temperature on magnesium and iron dissolution kinetics. More importantly, however, they show that advantage cannot be taken of the interaction of the variables to reduce the dissolved iron content of the leach liquor below the required maximum value.

GROUP C TESTS

It has previously [6] been clearly demonstrated that a reduction in the slurry pulp density leads to an appreciable reduction in the iron content of the leach liquor. In other words, the [Fe×100/Mg] concentration ratios decrease as the pulp density decreases. For example, using MAG3/700/3 at 35°C, the iron concentrations after a 1 h leach period for 4, 3 and 2% solids are 0.020, 0.011 and 0.008 g/l, respectively. The corresponding [Fe×100/Mg] concentration ratios are 0.212, 0.141 and 0.130, respectively.

As none of the Group B tests at 2% solids gave iron concentrations below the maximum acceptable level, it was decided to investigate how far the pulp density would have to be lowered in order to obtain this result. For these tests the BC2/700/5 calcine was chosen since this had an acceptable dissolution rate and an acceptable maximum magnesium dissolution yield. The results are summarized in Table 20. These show that for the particular calcine and set of leaching conditions, reduction of the pulp density to 1.6% solids will yield a leach liquor from which magnesium oxide of the desired purity can be produced. The commercial viability of operating at such a low pulp density will have to be established.

GROUP D TESTS

At the suggestion of Mr F.R. Beggs of IMI, a series of tests was undertaken in which the impeller speed was varied. For these tests, the results of which are given in Table 21, three different calcines (all derived from BC2) were leached at 2% solids, 0.5 h slake, 30.0°C and 100 psig carbon dioxide. The results confirm previously reported observations [5] that at low agitation rates the ratio of magnesium dissolution is substantially reduced. In addition, the data indicate that it is not possible to markedly reduce the iron concentration of the leach liquor to a level that would produce a final product containing less than 0.05% Fe_2O_3.

GROUP E TESTS

In order to be confident that conditions under which iron dissolution was apparently "zero" had not been overlooked in the tests reported above, several additional leaches were carried out using different calcines, carbon dioxide pressures, pulp densities, agitation rates and temperatures. The results of these tests are given in Table 22.

The results presented are consistent with previously reported observations with respect to the effects of leaching variables on the magnesium and iron concentrations as a function of leaching time. The only previously unreported observation is that at high temperatures (45°C) and low carbon dioxide pressures (25-50 psig) the magnesium concentrations pass through a maximum, indicating precipitation of an insoluble basic magnesium carbonate.

GENERAL COMMENTS

All the above data indicate that there is a complex relationship between the iron and magnesium concentrations of the leach liquors and that no conditions (ore type, calcination conditions, leaching conditions) have been found that will give zero iron dissolution. As noted previously, it is now concluded that the results of Tests 19 and 127 (equal to 153) reported previously [6,7] are in error.

The relationship between iron and magnesium concentrations is dependent upon the leaching conditions but, as can be seen from Fig. 1, iron concentration increases as the magnesium concentration increases. This is consistent with

- previously reported results (see, for example, Fig. 2 in Ref. 3), and
- the observation that leaching fresh calcine with a magnesium-containing leachate results in increased iron dissolution (see Table 9 in Ref. 5).

Leaching temperature has the greatest effect on iron concentration, as is shown by the data in Fig. 2. The relationship between iron and magnesium concentration as a function of leaching conditions is complicated by the facts that under certain conditions the solubility of magnesium bicarbonate is exceeded, thereby giving artificially low magnesium concentrations, and that the iron concentration decreases with increasing leaching time. Whether the latter is due to an unusual equilibrium effect or to the the metastable nature of the soluble iron species (presumably a ferric iron bicarbonate complex) is not clear at this stage. What is clear, however, is that to minimize iron dissolution there has to be a compromise between pulp density, leach time and temperature, agitation rate and carbon dioxide pressure. This compromise has been discussed previously [6] but is not as clear-cut as one would hope. For example, although an increase in leaching temperature decreases the time required to reach maximum magnesium dissolution, it will be advantageous to use a longer retention time to utilize the fact that under such conditions the iron concentration decreases with increasing leaching time.

The optimum conditions will of necessity be those that produce a pregnant leach liquor containing a low enough iron-to-magnesium concentration ratio to give a final product (magnesia) of the desired purity. As noted previously, for a maximum Fe_2O_3 content of 0.05%, the leach liquor must have a [Fe×100/Mg] concentration ratio of less than than 0.06. This is equivalent to a maximum iron concentration of 0.0006 g/l Fe per 1.0 g/l Mg. The only conditions found to yield such a liquor when using a magnesite-rich feed at an acceptable recovery rate (>70%) involve a lower pulp density and a higher leaching temperature than those used in the preliminary cost estimates calculated by Wright Engineers Pty Ltd [8].

REFRACTORY GRADE MAGNESIA - SOME GENERAL COMMENTS

As a result of verbal and written communications with a number of magnesia producers, the following points have been noted.

- Most producers market a range of products with differing levels of impurity contents in order to meet the requirements of the end users. Table 23 gives typical specifications of a number of products from a range of producers. As one would expect, the higher the purity, the higher the production costs and hence the higher the marked price. For a basic oxygen furnace (BOF), at least 3 grades of refractory brick are used, with the less pure bricks being placed in the less corrosive regions of the furnace.
- From a purity point of view, the critical components are boron, calcium and silica, expressed as B_2O_3, CaO and SiO_2 respectively. These impurities affect such physical properties as thermal expansion, thermal conductivity and mean specific heat, which in turn affect the hot strength of the briquetted magnesia, and the degree of crystal development and crystal-to-crystal contact [9].
- The critical factors in determining the product grade are the MgO and B_2O_3 contents and the CaO/SiO_2 ratio. Magnesia suitable for the most corrosive regions of a BOF furnace is required to have the following composition [10].

MgO	$\geq 98.5\%$
B_2O_3	0.01-0.03%
CaO/SiO_2	2-3

  The Fe_2O_3 content of this grade of magnesia is less critical, but will generally be less than 0.5%. BHP purchase low-iron magnesia from Japanese producers since that is what they produce at a competitive price.

In view of the above comments, it would seem that the exploitation of the Savage River magnesite deposit will involve the production of a number of grades of magnesia and that, provided the B_2O_3 content is below about 0.01% (100 ppm) and the CaO/SiO_2 ratio is ≥ 2, a good marketing position could be obtained, especially if the Fe_2O_3 content is held to less than say 0.2%. In other words, it would seem that reduction of the Fe_2O_3 content to less than 0.05% would not create any substantial advantage provided the B_2O_3 content was substantially less than competitors' products.

Because the boron content of the Savage River magnesite is known [11] to be low, typically 1-6 ppm B_2O_3, it could be expected that magnesia produced by the calcination/carbon dioxide leach dioxide would also have very low boron contents. This has been confirmed by analysis of a number of intermediate and final products by AMDEL and the Analytical Services Section of the Division of Mineral Chemistry. The products were recovered from the reproducibility and Group A minimization of iron tests and were shown to contain 2-10 ppm B_2O_3 (0.0002-0.0010% B_2O_3).* The same products also contained >98.5% MgO.

FUTURE WORK PROGRAMME

In the coming 6-month period, it is anticipated that the following will be undertaken.

- Preparation of a "state-of-the-art" review covering salient features of the calcination/carbon dioxide leach process, product specifications and recommended optimum processing conditions.
- Investigation of the 2-stage precipitation unit process in an attempt to recover more of the dissolved magnesium as the higher-purity second-stage product.
- Examination of the relationship between iron and magnesium concentration using synthetic mixtures, calcined Savage River magnesite, and calcined siderite-magnesite from Kambalda, W.A.
- Preparation of "demonstration" quantities of magnesium oxide with full analytical data (MgO, CaO, B_2O_3, Al_2O_3, Fe_2O_3, SiO_2).
- Further testwork on minimization of iron dissolution.

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*The first sets of data received gave high (up to 100 ppm) and variable B_2O_3 contents and it was shown that this was caused by contamination during product calcination in a muffle furnace.

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Table 1. Leach test data - reproducibility.

Calcine: BC2 - 61.22% MgO, 3.85% Fe_2O_3

Leaching conditions: Series I - 2% solids, 0.5 h slake, 45°C, 100 psig CO_2, 900 rpm

Series II - 2% solids, 0.5 h slake, 45°C, 100 psig CO_2, 1200 rpm

Leach time (h)		0.25		0.50		1.00			
		Composition (g/l)		Composition (g/l)		Composition (g/l		Extraction (%)	
Series	Test	Mg	Fe	Mg	Fe	Mg	Fe	Mg	Fe
I	RC1	1.73	0.002	2.73	0.002	4.94	0.004	66.9	0.74
	RC2	1.18	0.001	1.55	0.001	4.71	0.004	63.8	0.74
	RC3	1.65	0.001	1.55	0.002	4.80	0.005	65.0	0.93
	RC4	1.84	0.001	2.75	0.001	4.75	0.005	64.4	0.93
	RC5	1.85	0.001	2.63	0.002	5.35	0.004	72.5	0.74
	RC6	1.21	0.001	1.78	0.001	4.65	0.004	63.0	0.74
II	RC7	5.30	0.003	5.42	0.004	5.46	0.004	73.4	0.74
	RC8	5.43	0.005	5.57	0.004	5.56	0.004	75.3	0.74
	RC9	5.38	0.008	5.43	0.004	5.42	0.004	73.4	0.74
	RC10	5.51	0.007	5.52	0.004	5.42	0.004	74.8	0.74
	RC11	5.49	0.006	5.58	0.004	5.59	0.004	75.7	0.74
	RC12	5.49	0.004	5.52	0.004	5.52	0.004	74.8	0.74

Table 2. Analytical data (%) of intermediate precipitates and MgO products.

Test	Precipitate			MgO product	
	MgO	Fe_2O_3	LOI*	MgO	Fe_2O_3
RC1	41.03	0.034	58.93	99.90	0.083
RC2	41.40	0.030	58.54	99.85	0.072
RC3	40.72	0.029	59.04	99.41	0.071
RC4	41.08	0.043	58.65	99.35	0.104
RC5	41.50	0.033	58.46	99.90	0.079
RC6	40.62	0.032	59.33	99.98	0.079
RC7	40.87	0.042	59.07	99.85	0.103
RC8	41.34	0.041	58.60	99.86	0.099
RC9	41.74	0.040	58.16	99.76	0.096
RC10	41.92	0.041	57.96	99.71	0.098
RC11	41.68	0.040	59.15	99.27	0.098
RC12	40.55	0.040	59.15	99.27	0.098

*Weight loss on ignition at 1000°C.

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Table 3. Details of magnesite ores and calcination conditions.

MAG 1	- High-dolomite ore, diamond drill core, calcined on a batch basis in a laboratory muffle furnace.
MAG 3	- High-magnesite ore, diamond drill core, calcined on a batch basis in a laboratory muffle furnace.
BC2/BC4	- High-magnesite ore, diamond drill core, 80% calcined on a continuous basis in a rotary kiln, 20% calcined on a batch basis in a laboratory muffle furnace, calcines bulked, blended, screened and re-blended.
BM	- High-magnesite ore recovered from the banks of Main Creek, calcined on a batch basis in a laboratory muffle furnace.

Table 4. Minimization of iron dissolution. Group A tests.

Calcine: MAG 1 - 25.04% MgO, 1.94% Fe_2O_3

Calcination conditions: 700°C/1 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg	(g/l)	1.72	1.83	1.72
	Fe	(g/l)	0.001	0.001	0.001
	[Fe×100/Mg]		0.058	0.055	0.058
	Mg extraction	(%)	57.0	60.6	57.3
	Fe extraction	(%)	0.37	0.37	0.37
Intermediate product					
Series I:	Wt	(g)	4.21	3.83	3.41
	MgO	(%)	35.89	36.75	39.71
	Fe_2O_3	(%)	0.021	0.021	0.027
	LOI	(%)	63.52	62.73	60.13
Series II:	Wt	(g)	2.93	3.35	3.37
	MgO	(%)	41.80	42.51	42.14
	Fe_2O_3	(%)	0.006	0.003	0.003
	LOI	(%)	58.07	57.43	57.83
Composite:	Wt	(g)	7.14	7.18	6.78
	MgO	(%)	33.38	39.28	40.86
	Fe_2O_3	(%)	0.015	0.013	0.014
	LOI	(%)	61.28	60.26	58.99
Final product					
Series I:	Wt	(g)	1.53	1.43	1.36
	MgO	(%)	98.7	98.6	99.3
	Fe_2O_3	(%)	0.058	0.056	0.067
Series II:	Wt	(g)	1.23	1.42	1.42
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.014	0.007	0.007
Composite:	Wt	(g)	2.76	2.85	2.78
	MgO	(%)	99.3	99.3	99.6
	Fe_2O_3	(%)	0.038	0.032	0.036
MgO recovery					
Series I	(g)		1.51	1.41	1.335
Series II	(g)		1.23	1.42	1.42
Composite	(g)		2.74	2.83	2.77
Product with <0.05% Fe_2O_3 (%)			100.0	100.0	100.0
Total recovery		(%)*	106.6	103.2	107.2

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 5. Minimization of iron dissolution. Group A tests.
Calcine: MAG 1 - 27.52% MgO, 1.99% Fe_2O_3
Calcination conditions: 700°C/3 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		2.39	2.47	2.42
	Fe (g/l)		0.001	0.002	0.002
	[Fe×100/Mg]		0.042	0.081	0.083
	Mg extraction (%)		72.0	74.4	72.9
	Fe extraction (%)		0.36	0.72	0.72
Intermediate product					
Series I:	Wt	(g)	7.30	6.57	5.92
	MgO	(%)	36.25	38.12	38.45
	Fe_2O_3	(%)	0.023	0.022	0.020
	LOI	(%)	63.38	61.78	61.37
Series II:	Wt	(g)	2.97	3.30	3.38
	MgO	(%)	42.00	42.18	43.24
	Fe_2O_3	(%)	0.004	0.003	0.003
	LOI	(%)	57.92	57.62	56.87
Composite:	Wt	(g)	10.27	9.87	9.30
	MgO	(%)	37.97	39.41	40.22
	Fe_2O_3	(%)	0.018	0.016	0.014
	LOI	(%)	61.80	60.39	59.73
Final product					
Series I:	Wt	(g)	2.68	2.51	2.29
	MgO	(%)	98.9	99.6	99.6
	Fe_2O_3	(%)	0.060	0.058	0.052
Series II:	Wt	(g)	1.25	1.40	1.46
	MgO	(%)	100.0	99.3	100.0
	Fe_2O_3	(%)	0.010	0.007	0.007
Composite:	Wt	(g)	3.93	3.91	3.75
	MgO	(%)	99.2	99.6	99.7
	Fe_2O_3	(%)	0.044	0.040	0.034
MgO recovery					
Series I	(g)		2.65	2.50	2.28
Series II	(g)		1.25	1.39	1.46
Composite	(g)		3.90	3.89	3.74
Product with <0.05 Fe_2O_3 (%)			100.0	100.0	100.0
Total recovery	(%)*		109.4	105.6	103.6

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 6. Minimization of iron dissolution. Group A tests.
Calcine: MAG 1 - 29.18% MgO, 2.14% Fe_2O_3
Calcination conditions: 850°C/1 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		2.39	2.47	2.50
	Fe (g/l)		0.001	0.002	0.002
	[Fe×100/Mg]		0.042	0.081	0.080
	Mg extraction (%)		67.9	70.2	71.0
	Fe extraction (%)		0.34	0.67	0.67
Intermediate product					
Series I:	Wt	(g)	7.44	6.30	6.13
	MgO	(%)	36.88	35.02	38.51
	Fe_2O_3	(%)	0.023	0.023	0.031
	LOI	(%)	62.68	65.12	61.41
Series II:	Wt	(g)	2.48	3.98	3.65
	MgO	(%)	42.21	42.84	42.90
	Fe_2O_3	(%)	0.005	0.003	0.003
	LOI	(%)	57.60	57.19	57.10
Composite:	Wt	(g)	9.92	10.28	9.78
	MgO	(%)	39.21	38.13	40.18
	Fe_2O_3	(%)	0.019	0.015	0.021
	LOI	(%)	61.41	62.05	59.80
Final product					
Series I:	Wt	(g)	2.77	2.20	2.36
	MgO	(%)	98.9	100.0	100.0
	Fe_2O_3	(%)	0.061	0.066	0.080
Series II:	Wt	(g)	1.05	1.71	1.57
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.02	0.007	0.007
Composite:	Wt	(g)	3.82	3.91	3.93
	MgO	(%)	99.2	100.0	100.0
	Fe_2O_3	(%)	0.048	0.040	0.051
MgO recovery					
Series I		(g)	2.74	2.21	2.36
Series II		(g)	1.05	1.71	1.57
Composite		(g)	3.79	3.92	3.93
Product with <0.05% Fe_2O_3 (%)			100.0	100.0	39.9
Total recovery		(%)*			

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 7. Minimization of iron dissolution. Group A tests.
Calcine: MAG 3 - 72.12% MgO, 4.36¢ Fe_2O_3
Calcination conditions: 700°C/2 h in muffle furnace

	40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions			
Leach liquor: Mg (g/l)	6.85	7.02	4.38
Fe (g/l)	0.010	0.010	0.008
[Fe×100/Mg]	0.146	0.142	0.183
Mg extraction (%)	78.7	80.7	50.3
Fe extraction (%)	1.65	1.65	1.32
Intermediate product			
Series I: Wt (g)	24.41	23.84	13.03
MgO (%)	39.45	39.83	39.87
Fe_2O_3 (%)	0.084	0.064	0.048
LOI (%)	60.20	60.04	60.13
Series II: Wt (g)	3.00	3.90	3.84
MgO (%)	43.01	42.08	42.14
Fe_2O_3 (%)	0.004	0.005	0.003
LOI (%)	56.76	57.88	57.96
Composite: Wt (g)	27.41	27.74	16.87
MgO (%)	39.84	40.16	40.43
Fe_2O_3 (%)	0.075	0.056	0.038
LOI (%)	59.82	59.74	59.58
Final product			
Series I: Wt (g)	9.72	9.53	5.20
MgO (%)	99.1	99.7	100.0
Fe_2O_3 (%)	0.211	0.160	0.120
Series II: Wt (g)	1.30	1.64	1.62
MgO (%)	99.2	100.0	100.0
Fe_2O_3 (%)	0.009	0.012	0.007
Composite: Wt (g)	11.02	11.17	6.82
MgO (%)	99.1	99.7	100.0
Fe_2O_3 (%)	0.187	0.138	0.093
MgO recovery			
Series I (g)	9.63	9.50	5.20
Series II (g)	1.29	1.64	1.62
Composite (g)	10.92	11.14	6.82
Product with <0.05% Fe_2O_3 (%)	11.8	14.7	23.8
Total recovery (%)*	106.9	106.3	104.4

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 8. Minimization of iron dissolution. Group A tests.
Calcine: MAG 3 - 72.93% MgO, 4.36% Fe_2O_3
Calcination conditions: 700°C/10 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		6.56	6.59	3.73
	Fe (g/l)		0.010	0.010	0.005
	[Fe×100/Mg]		0.152	0.152	0.134
	Mg extraction (%)		74.5	74.9	42.4
	Fe extraction (%)		1.65	1.65	0.83
Intermediate product					
Series I:	Wt	(g)	22.26	21.93	11.31
	MgO	(%)	38.67	37.63	37.92
	Fe_2O_3	(%)	0.094	0.078	0.049
	LOI	(%)	60.63	62.65	62.07
Series II:	Wt	(g)	2.80	4.29	3.93
	MgO	(%)	42.31	42.53	42.25
	Fe_2O_3	(%)	0.004	0.003	0.004
	LOI	(%)	57.75	57.35	57.74
Composite:	Wt	(g)	25.06	26.22	15.24
	MgO	(%)	39.07	38.44	39.04
	Fe_2O_3	(%)	0.084	0.066	0.037
	LOI	(%)	60.31	61.78	60.95
Final product					
Series I:	Wt	(g)	8.77	8.19	4.29
	MgO	(%)	98.6	100.0	100.0
	Fe_2O_3	(%)	0.239	0.208	0.129
Series II:	Wt	(g)	1.18	1.83	1.66
	MgO	(%)	100.0	99.5	100.0
	Fe_2O_3	(%)	0.009	0.007	0.009
Composite:	Wt	(g)	9.95	10.02	5.95
	MgO	(%)	98.6	99.9	100.0
	Fe_2O_3	(%)	0.211	0.171	0.096
MgO recovery					
Series I	(g)		8.61	8.25	4.29
Series II	(g)		1.18	1.82	1.66
Composite	(g)		9.79	10.07	5.95
Product with <0.05% Fe_2O_3 (%)			13.5	18.3	27.9
Total recovery	(%)*		99.9	102.4	106.8

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 9. Minimization of iron dissolution. Group A tests.
Calcine: MAG 3 - 73.28% MgO, 4.42% Fe_2O_3
Calcination conditions: 850°C/0.5 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg	(g/l)	7.01	7.28	4.64
	Fe	(g/l)	0.011	0.010	0.007
	[Fe×100/Mg]		0.157	0.137	0.151
	Mg extraction	(%)	79.3	82.4	52.5
	Fe extraction	(%)	1.79	1.63	1.14
Intermediate product					
Series I:	Wt	(g)	23.64	22.85	13.22
	MgO	(%)	38.99	37.22	37.83
	Fe_2O_3	(%)	0.097	0.050	0.067
	LOI	(%)	61.10	63.00	62.23
Series II:	Wt	(g)	3.18	4.46	5.05
	MgO	(%)	41.60	42.60	42.13
	Fe_2O_3	(%)	0.003	0.003	0.006
	LOI	(%)	58.49	57.26	57.93
Composite:	Wt	(g)	26.82	27.31	18.27
	MgO	(%)	38.48	38.08	38.31
	Fe_2O_3	(%)	0.086	0.042	0.050
	LOI	(%)	60.79	62.06	61.04
Final product					
Series I:	Wt	(g)	8.99	8.48	4.86
	MgO	(%)	99.9	99.9	99.9
	Fe_2O_3	(%)	0.249	0.135	0.177
Series II:	Wt	(g)	1.32	1.90	2.13
	MgO	(%)	100.00	100.0	100.0
	Fe_2O_3	(%)	0.007	0.007	0.014
Composite:	Wt	(g)	10.31	10.38	6.99
	MgO	(%)	99.9	99.9	99.9
	Fe_2O_3	(%)	0.218	0.112	0.127
MgO recovery					
Series I		(g)	9.00	8.50	4.87
Series II		(g)	1.32	1.90	2.13
Composite		(g)	10.32	10.40	7.00
Product with <0.05% Fe_2O_3		(%)	12.8	18.3	30.5
Total recovery		(%)*	98.6	95.0	101.1

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 10. Minimization of iron dissolution. Group A tests.
Calcine: BC2 - 61.20% MgO, 3.85% Fe_2O_3
Calcination conditions: Rotary kiln product

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		5.35	5.36	4.91
	Fe (g/l)		0.005	0.006	0.004
	[Fe×100/Mg]		0.093	0.112	0.081
	Mg extraction (%)		72.5	72.6	66.5
	Fe extraction (%)		0.94	0.99	0.66
Intermediate product					
Series I:	Wt	(g)	17.21	15.59	14.32
	MgO	(%)	36.53	35.98	37.05
	Fe_2O_3	(%)	0.051	0.037	0.035
	LOI	(%)	63.01	64.02	62.85
Series II:	Wt	(g)	4.11	4.33	2.78
	MgO	(%)	41.61	41.34	41.97
	Fe_2O_3	(%)	0.004	0.003	0.006
	LOI	(%)	58.31	58.51	57.96
Composite:	Wt	(g)	21.32	19.22	17.10
	MgO	(%)	37.52	37.15	37.85
	Fe_2O_3	(%)	0.042	0.031	0.030
	LOI	(%)	62.10	62.82	62.05
Final product					
Series I:	Wt	(g)	6.37	5.61	5.32
	MgO	(%)	98.8	100.0	99.7
	Fe_2O_3	(%)	0.138	0.102	0.094
Series II:	Wt	(g)	1.70	1.80	1.17
	MgO	(%)	100.0	99.4	99.8
	Fe_2O_3	(%)	0.010	0.007	0.014
Composite:	Wt	(g)	8.08	7.41	6.49
	MgO	(%)	99.0	99.9	99.7
	Fe_2O_3	(%)	0.111	0.084	0.080
MgO recovery					
Series I	(g)		6.29	5.61	5.31
Series II	(g)		1.71	1.79	1.17
Composite	(g)		8.00	7.40	6.48
Product with <0.05% Fe_2O_3 (%)			21.2	24.3	18.0
Total recovery		(%)*	100.1	92.7	88.5

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 11. Minimization of iron dissolution. Group A tests.
Calcine: BC4 - 62.22% MgO, 3.42% Fe_2O_3
Calcination conditions: Rotary kiln product

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		5.49	5.47	4.39
	Fe (g/l)		0.005	0.006	0.004
	[Fe×100]		0.091	0.110	0.091
	Mg extraction (%)		73.2	72.9	60.6
	Fe extraction (%)		1.05	1.26	0.63
Intermediate product					
Series I:	Wt	(g)	18.53	18.78	14.18
	MgO	(%)	36.80	37.03	40.00
	Fe_2O_3	(%)	0.043	0.040	0.039
	LOI	(%)	63.17	62.67	59.89
Series II:	Wt	(g)	2.65	2.82	3.36
	MgO	(%)	41.51	41.21	41.80
	Fe_2O_3	(%)	0.009	0.003	0.005
	LOI	(%)	58.40	58.49	58.19
Composite:	Wt	(g)	21.18	21.60	17.54
	MgO	(%)	37.39	37.41	40.31
	Fe_2O_3	(%)	0.039	0.035	0.032
	LOI	(%)	62.63	62.12	59.56
Final product					
Series I:	Wt	(g)	6.83	6.97	5.69
	MgO	(%)	99.9	99.3	99.6
	Fe_2O_3	(%)	0.117	0.107	0.097
Series II:	Wt	(g)	1.10	1.18	1.40
	MgO	(%)	100.0	99.2	100.0
	Fe_2O_3	(%)	0.022	0.007	0.012
Composite:	Wt	(g)	7.92	8.15	7.09
	MgO	(%)	99.9	99.2	99.7
	Fe_2O_3	(%)	0.104	0.093	0.080
MgO recovery					
Series I	(g)		6.82	6.91	5.67
Series II	(g)		1.10	1.17	1.40
Composite	(g)		7.92	8.08	7.07
Product with <0.05% Fe_2O_3 (%)			13.9	14.5	19.7
Total recovery		(%)*	96.6	99.0	104.2

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 12. Minimization of iron dissolution. Group A tests.
Calcine: BM - 50.61% MgO, 3.50% Fe_2O_3
Calcination conditions: 600°C/3 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		2.05	2.11	2.08
	Fe (g/l)		0.003	0.002	0.002
	[Fe×100/Mg]		0.146	0.095	0.096
	Mg extraction (%)		33.6	34.6	34.1
	Fe extraction (%)		0.62	0.41	0.41
Intermediate product					
Series I:	Wt	(g)	5.83	5.24	4.51
	MgO	(%)	36.91	38.56	38.81
	Fe_2O_3	(%)	0.026	0.029	0.033
	LOI	(%)	63.07	61.02	61.23
Series II:	Wt	(g)	2.14	3.02	3.53
	MgO	(%)	41.94	41.80	41.79
	Fe_2O_3	(%)	0.007	0.004	0.005
	LOI	(%)	58.22	58.11	58.43
Composite:	Wt	(g)	7.97	8.26	8.04
	MgO	(%)	38.27	39.71	40.17
	Fe_2O_3	(%)	0.021	0.020	0.021
	LOI	(%)	61.77	59.98	60.00
Final product					
Series I:	Wt	(g)	2.15	2.04	1.75
	MgO	(%)	100.0	99.0	100.0
	Fe_2O_3	(%)	0.070	0.074	0.085
Series II:	Wt	(g)	0.90	1.26	1.48
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.017	0.010	0.019
Composite:	Wt	(g)	3.05	3.30	3.23
	MgO	(%)	100.0	99.4	100.0
	Fe_2O_3	(%)	0.054	0.050	0.055
MgO recovery					
Series I	(g)		2.15	2.02	1.75
Series II	(g)		0.90	1.26	1.48
Composite	(g)		3.05	3.28	3.23
Product with <0.05% Fe_2O_3 (%)			29.5	100.0	45.8
Total recovery	(%)*		99.6	104.0	103.9

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 13. Minimization of iron dissolution. Group A tests.
Calcine: BM - 49.37% MgO, 3.18% Fe_2O_3
Calcination conditions: 700°C/1 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		2.05	2.14	2.16
	Fe (g/l)		0.002	0.001	0.001
	[Fe×100/Mg]		0.098	0.047	0.047
	Mg extraction (%)		34.4	35.9	36.2
	Fe extraction (%)		0.45	0.23	0.23
Intermediate product					
Series I:	Wt	(g)	6.74	5.29	5.33
	MgO	(%)	35.08	35.82	37.40
	Fe_2O_3	(%)	0.030	0.017	0.024
	LOI	(%)	64.60	64.14	62.62
Series II:	Wt	(g)	2.39	3.73	3.43
	MgO	(%)	42.51	41.40	41.65
	Fe_2O_3	(%)	0.007	0.004	0.004
	LOI	(%)	59.94	58.66	58.42
Composite:	Wt	(g)	9.13	9.02	8.76
	MgO	(%)	37.02	38.03	39.04
	Fe_2O_3	(%)	0.024	0.012	0.016
	LOI	(%)	62.86	61.87	60.98
Final product					
Series I:	Wt	(g)	2.38	1.89	1.99
	MgO	(%)	99.2	100.0	100.0
	Fe_2O_3	(%)	0.085	0.047	0.064
Series II:	Wt	(g)	1.01	1.54	1.43
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.016	0.010	0.010
Composite:	Wt	(g)	3.39	3.43	3.42
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.065	0.030	0.041
MgO recovery					
Series I	(g)		2.36	1.89	1.99
Series II	(g)		1.02	1.54	1.43
Composite	(g)		3.38	3.43	3.42
Product with <0.05% Fe_2O_3 (%)			29.8	100.0	100.0
Total recovery		(%)*	110.6	107.5	106.3

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 14. Minimization of iron dissolution. Group A tests.
Calcine: BM - 73.16% MgO, 3.31% Fe_2O_3
Calcination conditions: 700°C/3 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		6.49	6.65	5.23
	Fe (g/l)		0.009	0.009	0.007
	[Fe×100/Mg]		0.139	10.35	0.134
	Mg extraction (%)		73.5	75.3	59.2
	Fe extraction (%)		1.96	1.96	1.52
Intermediate product					
Series I:	Wt	(g)	24.60	23.35	15.15
	MgO	(%)	38.38	38.12	37.40
	Fe_2O_3	(%)	0.104	0.057	0.043
	LOI	(%)	61.21	61.76	62.72
Series II:	Wt	(g)	3.32	4.13	3.55
	MgO	(%)	41.51	41.60	41.80
	Fe_2O_3	(%)	0.006	0.003	0.005
	LOI	(%)	58.54	58.45	58.20
Composite:	Wt	(g)	27.92	27.48	18.70
	MgO	(%)	38.75	38.65	38.24
	Fe_2O_3	(%)	0.092	0.049	0.036
	LOI	(%)	60.89	61.26	61.86
Final product					
Series I:	Wt	(g)	9.54	8.93	5.65
	MgO	(%)	99.0	99.7	99.6
	Fe_2O_3	(%)	0.268	0.149	0.115
Series II:	Wt	(g)	1.38	1.72	1.48
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.014	0.007	0.012
Composite:	Wt	(g)	10.92	10.65	7.13
	MgO	(%)	99.1	99.7	99.7
	Fe_2O_3	(%)	0.236	0.126	
MgO recovery					
Series I	(g)		9.44	8.90	5.67
Series II	(g)		1.38	1.72	1.48
Composite	(g)		10.82	10.62	7.15
Product with <0.05% Fe_2O_3 (%)			12.6	16.2	20.8
Total recovery	(%)*		110.0	107.1	91.3

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 15. Minimization of iron dissolution. Group A tests.
Calcine: 64.57 % MgO, 2.92% Fe_2O_3
Calcination conditions: 800°C/1 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg	(g/l)	5.20	5.06	4.65
	Fe	(g/l)	0.007	0.007	0.007
	[Fe×100/Mg]		0.135	0.139	0.151
	Mg extraction	(%)	66.8	65.0	59.7
	Fe extraction	(%)	1.72	1.72	1.72
Intermediate product					
Series I:	Wt	(g)	19.18	17.13	14.15
	MgO	(%)	35.84	40.68	39.92
	Fe_2O_3	(%)	0.052	0.048	0.042
	LOI	(%)1	63.95	59.42	60.01
Series II:	Wt	(g)	3.46	3.29	3.24
	MgO	(%)	42.05	41.93	41.11
	Fe_2O_3	(%)	0.006	0.003	0.004
	LOI	(%)	58.00	57.93	58.79
Composite:	Wt	(g)	22.64	20.42	17.39
	MgO	(%)	36.75	40.89	40.14
	Fe_2O_3	(%)	0.045	0.041	0.035
	LOI	(%)	63.04	59.18	59.78
Final product					
Series I:	Wt	(g)	6.91	6.95	5.66
	MgO	(%)	99.4	100.0	99.8
	Fe_2O_3	(%)	0.144	0.118	0.105
Series II:	Wt	(g)	1.45	1.38	1.33
	MgO	(%)	100.0	100.0	100.0
	Fe_2O_3	(%)	0.014	0.007	0.010
Composite:	Wt	(g)	8.36	8.33	6.99
	MgO	(%)	99.5	100.0	99.8
	Fe_2O_3	(%)	0.121	0.100	0.087
MgO recovery					
Series I	(g)		6.87	6.97	5.65
Series II	(g)		1.45	1.38	1.33
Composite	(g)		8.32	8.35	6.98
Product with <0.05% Fe_2O_3 (%)			17.3	16.6	19.0
Total recovery	(%)*		106.9	110.5	100.6

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

Table 16. Minimization of iron dissolution. Group A tests.
Calcine: BM - 80.08% MgO, 3.64% Fe_2O_3
Calcination conditions: 800°C/3 h in muffle furnace

			40.0°C/1200 rpm	45.0°C/1200 rpm	45.0°C/900 rpm
Leaching conditions					
Leach liquor:	Mg (g/l)		8.20	8.18	7.53
	Fe (g/l)		0.010	0.010	0.008
	[Fe×100/Mg]		0.122	0.122	0.106
	Mg extraction (%)		85.0	84.7	78.0
	Fe extraction (%)		1.98	1.98	1.58
Intermediate product					
Series I:	Wt	(g)	31.03	27.39	17.57
	MgO	(%)	38.97	40.15	37.63
	Fe_2O_3	(%)	0.078	0.079	0.054
	LOI	(%)	60.76	59.62	62.27
Series II:	Wt	(g)	3.13	3.60	2.69
	MgO	(%)	41.82	42.04	42.00
	Fe_2O_3	(%)	0.004	0.003	0.004
	LOI	(%)	58.05	57.76	57.81
Composite:	Wt	(g)	34.16	30.99	20.26
	MgO	(%)	39.23	40.37	38.20
	Fe_2O_3	(%)	0.072	0.070	0.047
	LOI	(%)			
Final product					
Series I:	Wt	(g)	12.17	11.06	6.63
	MgO	(%)	99.3	99.5	99.7
	Fe_2O_3	(%)	0.199	0.195	0.143
Series II:	Wt	(g)	1.31	1.52	1.14
	MgO	(%)	100.0	99.3	99.1
	Fe_2O_3	(%)	0.009	0.007	0.009
Composite:	Wt	(g)	13.48	12.58	7.77
	MgO	(%)	99.4	99.4	99.6
	Fe_2O_3	(%)	0.181	0.172	0.123
MgO recovery					
Series I	(g)		12.09	11.00	6.61
Series II	(g)		1.31	1.51	1.13
Composite	(g)		13.40	12.51	7.74
Product with <0.05% Fe_2O_3 (%)			9.72	12.1	14.7
Total recovery	(%)*		109.0	102.3	69.3

*Based on precipitation from 900 ml clarified magnesium bicarbonate leach liquor.

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Table 17. Summary of product (magnesia) analytical data (%).

Feed	Calcination conditions (°C/h)	Leaching conditions (°C/rpm)	Series I		Series II		Composite	
			MgO	Fe_2O_3	MgO	Fe_2O_3	MgO	Fe_2O_3
MAG1	700/1	40.0/1200	98.7	0.058	100.0	0.014	99.3	0.038
		45.0/1200	98.6	0.056	100.0	0.007	99.3	0.032
		45.0/900	99.3	0.067	100.0	0.007	99.6	0.036
MAG1	700/3	40.0/1200	98.9	0.060	100.0	0.010	99.2	0.044
		45.0/1200	99.6	0.058	99.3	0.007	99.6	0.040
		45.0/900	99.6	0.052	100.0	0.007	99.7	0.034
MAG1	850/1	40.0/1200	98.9	0.061	100.0	0.012	99.2	0.048
		45.0/1200	100.0	0.066	100.0	0.007	100.0	0.040
		45.0/900	100.0	0.080	100.0	0.007	100.0	0.051
MAG3	700/2	40.0/1200	99.1	0.211	99.2	0.009	99.1	0.187
		45.0/1200	99.7	0.160	100.0	0.012	99.7	0.138
		45.0/900	100.0	0.120	100.0	0.007	100.0	0.096
MAG3	700/10	40.0/1200	98.6	0.239	100.0	0.009	98.6	0.211
		45.0/1200	100.0	0.208	99.5	0.007	99.9	0.171
		45.0/900	100.0	0.129	100.0	0.009	100.0	0.096
MAG3	850/0.5	40.0/1200	99.9	0.249	100.0	0.007	99.9	0.218
		45.0/1200	99.9	0.135	100.0	0.007	99.9	0.218
		45.0/900	99.9	0.177	100.0	0.014	99.9	0.127
BC2	Rotary kiln	40.0/1200	98.8	0.138	100.0	0.010	99.0	0.111
		45.0/1200	100.0	0.102	99.4	0.007	99.9	0.084
		45.0/900	99.7	0.094	99.8	0.014	99.7	0.080
BC4	Rotary kiln	40.0/1200	99.9	0.117	100.0	0.022	99.9	0.104
		45.0/1200	99.3	0.107	99.2	0.007	99.2	0.093
		45.0/900	99.6	0.097	100.0	0.012	99.7	0.080
BM	600/3	40.0/1200	100.0	0.070	100.0	0.017	100.0	0.054
		45.0/1200	99.0	0.074	100.0	0.010	99.4	0.050
		45.0/900	100.0	0.085	100.0	0.019	100.0	0.055
BM	700/1	40.0/1200	99.2	0.085	100.0	0.016	100.0	0.065
		45.0/1200	100.0	0.047	100.0	0.010	100.0	0.030
		45.0/900	100.0	0.064	100.0	0.010	100.0	0.041
BM	700/3	40.0/1200	99.0	0.268	100.0	0.014	99.1	0.236
		45.0/1200	99.7	0.149	100.0	0.007	99.7	0.126
		45.0/900	99.6	0.115	100.0	0.012	99.7	0.094
BM	800/1	40.0/1200	99.4	0.144	100.0	0.014	99.5	0.121
		45.0/1200	100.0	0.118	100.0	0.007	100.0	0.100
		45.0/900	99.8	0.105	100.0	0.010	99.8	0.087
BM	800/3	40.0/1200	99.3	0.199	100.0	0.009	99.4	0.181
		45.0/1200	99.5	0.195	99.3	0.007	99.4	0.172
		45.0/900	99.7	0.143	99.1	0.009	99.6	0.123

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Table 18. Chemical composition of calcine used in Group B minimization of iron dissolution tests.

	Calcination conditions		Composition (%)			
Calcine	(°C)	(h)	MgO	CaO	Fe_2O_3	Balance*
BC2	Original rotary kiln product		61.22	5.22	3.85	29.71
BC2/700/3	700	3	Not determined			
BC2/700/5	700	5	76.43	6.73	4.27	12.57
BC2/700/10	700	10	78.42	7.04	4.32	10.22
BC2/800/1	800	1	75.94	7.00	4.36	12.70
BC2/800/3	800	3	82.07	7.05	4.49	6.39
BC2/800/5	800	5	83.40	7.06	4.42	5.12
BC2/900/1	900	1	82.73	7.15	4.45	5.67
BC2/900/3	900	3	79.09	7.27	4.48	9.16
BC2/900/5	900	5	79.42	7.16	4.66	8.76
BC2/900/18	900	18	81.91	7.16	4.68	6.25
BC2/1000/1	1000	1	81.74	7.40	4.58	6.28
BC2/1000/3	1000	3	80.08	7.47	4.81	7.64
BC2/1000/5	1000	5	82.24	7.27	4.65	5.84

*Principally quartz and carbon dioxide.

Table 19. Minimization of iron dissolution. Group B Tests.

Leach time (h)		0.25		0.50		1.00		1.50		2.50		
	Leach temperature	Composition (g/l)		Composition (g/l)		Composition (g/l		Composition (g/l)		Composition (g/l)		Extraction (%)
Calcine	(°C)	Mg	Fe	Mg	Fe	Mg	Fe	Mg	Fe	Mg	Fe	Mg
BC2	15.5	Not carried out										
BC2/700/3	15.5	Not carried out										
BC2/700/5	15.5	3.65	0.006	4.82	0.012	6.06	0.016	6.70	0.018	7.29	0.020	79.07
BC2/700/10	15.5	2.94	0.004	4.09	0.008	5.32	0.016	6.19	0.019	7.24	0.024	76.53
BC2/800/1	15.5	4.00	0.010	4.70	0.012	5.75	0.018	6.44	0.020	7.22	0.020	78.82
BC2/800/3	15.5	2.87	0.002	4.57	0.008	5.95	0.015	6.66	0.021	7.35	0.025	74.24
BC2/800/5	15.5	1.52	0.002	3.56	0.003	4.57	0.004	5.15	0.008	5.92	0.012	58.85
BC2/900/1	15.5	2.32	0.002	3.50	0.003	4.81	0.010	5.79	0.009	6.80	0.011	68.14
BC2/900/3	15.5	0.51	0.000	1.04	0.000	1.91	0.002	2.60	0.002	3.24	0.003	33.96
BC2/900/5	15.5	0.57	0.000	0.95	0.000	1.74	0.001	2.29	0.002	2.86	0.002	26.11
BC2/900/18	15.5	0.37	0.000	0.67	0.000	1.31	0.001	1.79	0.001	2.58	0.002	29.85
BC2/1000/1	15.5	1.00	0.001	1.60	0.001	2.31	0.001	2.88	0.002	3.80	0.002	38.54
BC2/1000/3	15.5	0.33	0.000	0.69	0.000	0.96	0.000	1.23	0.000	1.73	0.001	17.91
BC2/1000/5	15.5	0.21	0.000	0.40	0.000	0.72	0.000	1.01	0.000	1.39	0.000	14.01
BC2	45.0	5.49	0.004	5.52	0.004	5.52	0.000					
BC2/700/3	45.0	7.05	0.013	7.62	0.012	7.81	0.009	8.01	0.008			
BC2/700/5	45.0	7.30	0.013	7.31	0.013	7.34	0.008	7.32	0.008	7.33	0.007	79.50
BC2/700/10	45.0	7.20	0.012	7.27	0.009	7.29	0.008	7.24	0.008	7.19	0.008	76.00
BC2/800/1	45.0	6.89	0.017	7.50	0.014	7.48	0.011	7.50	0.009	7.50	0.009	81.88
BC2/800/3	45.0	7.12	0.012	7.63	0.012	7.62	0.008	7.61	0.008	7.61	0.008	76.87
BC2/800/5	45.0	6.67	0.012	7.55	0.012	7.65	0.010	7.67	0.009	7.69	0.009	76.44
BC2/900/1	45.0	7.23	0.007	7.53	0.007	7.56	0.007	7.63	0.007	7.73	0.007	77.45
BC2/900/3	45.0	5.91	0.003	6.67	0.007	7.24	0.013	7.81	0.012	7.91	0.010	82.91
BC2/900/5	45.0	3.52	0.001	6.73	0.002	7.29	0.008	7.83	0.009	7.85	0.012	81.94
BC2/900/18	45.0	3.43	0.000	4.95	0.002	6.10	0.010	6.67	0.012	7.12	0.013	72.06
BC2/1000/1	45.0	4.63	0.004	6.52	0.004	7.24	0.006	7.39	0.008	7.43	0.008	75.35
BC2/1000/3	45.0	1.47	0.001	2.86	0.001	4.55	0.004	5.05	0.007	5.26	0.012	54.45
BC2/1000/5	45.0	1.02	0.001	2.03	0.002	3.45	0.004	4.20	0.007	4.61	0.008	46.47

Table 20. Minimization of iron dissolution. Group C tests.
Calcine: BC2/700/5 - 76.43% MgO, 4.27% Fe_2O_3
Leaching conditions: 0.5 h slake, 45.0°C, 100 psig CO_2, 1200 rpm, leached for 1.5 h

Pulp density (% solids)	Leach liquor			
	Mg (g/l)	Fe (g/l)	[Fe×100/Mg]	Mg extraction (%)
2.0	7.32	0.008	0.109	79.39
1.8	7.10	0.006	0.085	85.56
1.6	6.30	0.004	0.063	85.41
1.4	5.52	0.002	0.036	85.52
1.0	3.81	0.002	0.052	82.65

Table 23. Specifications of commercial refractory-grade magnesia.*

		Composition (%)							
Producer	Product	MgO	CaO	B_2O_3	Al_2O_3	Cr_2O_3	Fe_2O_3	SiO_2	CaO/SiO_2
Fimisco	SCALIMAG MFS	95.5	2.60	n.s.	0.05	n.s.	0.70	1.30	2.00
	SCALIMAG MF1	94.0	3.10	n.s.	0.10	n.s.	0.80	2.00	1.55
	SCALIMAG MF4	91.0	3.60	n.s.	0.20	n.s.	1.20	3.50	1.03
	SCALIMAG MFG	94.0	2.20	n.s.	0.10	n.s.	0.80	2.80	0.79
	SCALIMAG MFW	91.0	2.50	n.s.	0.20	n.s.	1.30	5.00	0.50
	SCALIMAG MFS	95.5	2.60	n.s.	0.05	n.s.	0.70	1.40	1.86
	SCALIMAG 503	93.5	3.30	n.s.	0.10	n.s.	0.90	2.20	1.50
	SCALIMAG MCF-6	83.0	2.30	n.s.	3.30	6.00	3.40	1.80	1.28
	SCALIMAG TBS	95.5	2.40	n.s.	0.05	n.s.	0.70	1.20	2.00
Dead Sea Periclase	CHD	99.2	0.55	0.001	0.03	0.07	0.10	0.05	11.0
Van Mannekus	CC	92.67	1.30	n.s.	0.77	n.s.	0.93	3.86	0.34
	CF	91.33	2.31	n.s.	0.81	n.s.	1.38	3.57	0.65
Billiton	NEDMAG 99.445	98.50	0.60	0.020	0.13	n.s.	0.45	0.17	3.53
Martin Marietta	Mag Chem 10-200	98.40	0.85	n.s.	0.17	n.s.	0.20	0.37	3.15
Steetley	BRITMAG 212PT	94.00	2.20	0.175	0.50	n.s.	1.40	1.00	2.20
	BRITMAG 215PT	92.00	1.80	0.175	0.50	n.s.	5.00	0.90	2.00
	BRITMAG 112P	96.50	0.95	0.175	0.50	n.s.	1.40	0.90	1.06
	BRITMAG 5CP	87.00	0.90	0.175	2.35	4.20	3.85	0.90	1.00
	BRITMAG 3/P-LB	96.70	2.25	0.035	0.20	n.s.	0.10	0.70	3.21
UBE	UBE 99-S	99.10	0.50	0.030	0.05	n.s.	0.05	0.20	2.50
	UBE 98	98.05	0.90	0.100	0.07	n.s.	0.07	0.90	1.00
	UBE GREEN	98.25	0.90	0.475	0.07	0.20	0.07	0.30	3.00
	UBE 90F	91.50	1.50	n.s.	0.35	n.s.	4.00	1.75	0.86

*Average composition when range given; n.s. = not specified.

Table 21. Minimization of iron dissolution Group D tests.

Leaching conditions: 2.0% solids, 0.5 h slake, 30.0°C, 100 psig CO_2, 1200 rpm

Leach time (h)		0.5		1.0		1.5		2.0			
		Composition (g/l)		Composition (g/l)		Composition (g/l)		Composition (g/l)			Extraction (%)
Calcine	Agitation (rpm)	Mg	Fe	Mg	Fe	Mg	Fe	Mg	Fe	[Fe×100/Mg]	Mg
BC2/700/5	810	0.95	0.000	0.76	0.000	4.38	0.004	6.86	0.010	74.40	0.146
	920	2.21	0.000	6.18	0.010	6.63	0.010	7.02	0.010	76.14	0.142
	1200	6.83	0.014	7.32	0.013	7.35	0.012	7.35	0.012	79.72	0.163
BC2/800/1	920	2.11	0.000	6.52	0.008	6.96	0.012	7.39	0.012	80.68	0.162
	1200	6.31	0.014	7.41	0.014	7.40	0.014	7.42	0.008	81.00	0.108
BC2/900/1	920	1.52	0.000	4.00	0.002	5.71	0.006	7.05	0.008	70.64	0.113
	1200	5.99	0.007	7.49	0.012	7.58	0.010	7.59	0.009	76.05	0.119

Table 22. Minimization of iron dissolution. Group E tests.

					0.25 h		0.5 h		1.0 h		2.0 h	
Calcine	Pulp density (% solids)	CO_2 pressure (psig)	Agitation (rpm)	Temperature (°C)	Mg (g/l)	Fe (g/l)	Mg (g/l)	Fe (g/l)	Mg (g/l)	Fe (g/l)	Mg (g/l)	Fe (g/l)
BC2/800/1	2	25	1200	45.0	3.36	0.005	4.11	0.004	4.21	0.003	4.10	0.002
	2	50	1200	45.0	6.32	0.016	7.42	0.018	6.74	0.008	5.68	0.004
	2	100	1200	45.0	6.89	0.017	7.50	0.014	7.48	0.011	7.49	0.010
BC2/700/2	2	100	1200	30.0			7.24	0.017	7.59	0.017	7.60	0.012
	2	100	1200	45.0			7.65	0.020	7.66	0.015	7.63	0.010
BC2/700/5	1.5	100	900	30.0			3.79	0.008	5.31	0.004	5.50	0.002
BC2/700/5	2	100	900	45.0			4.42	0.002	7.16	0.005	7.25	0.005

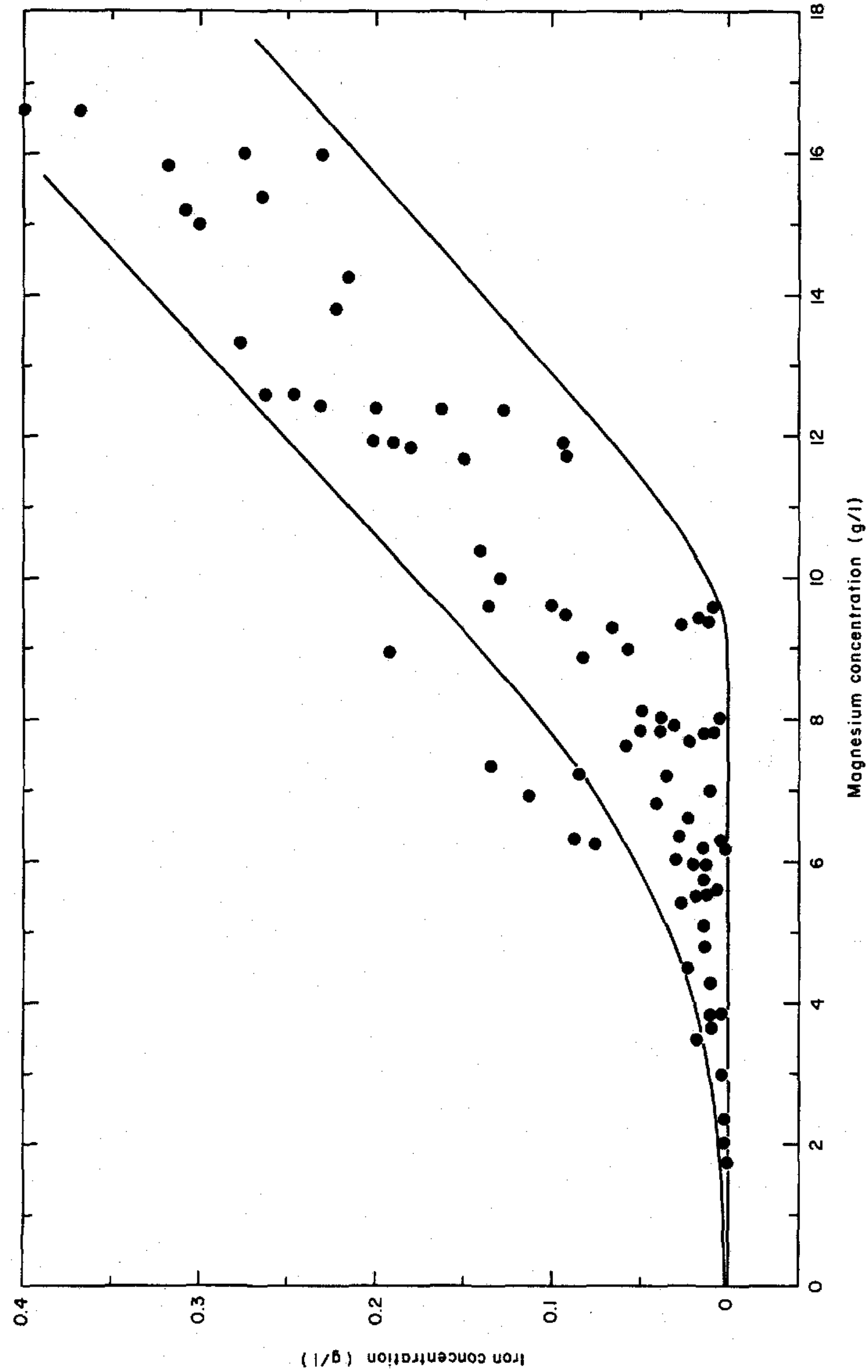


Fig. 1. Leach liquor composition: iron concentration as a function of magnesium concentration. Data taken from Reference 6.

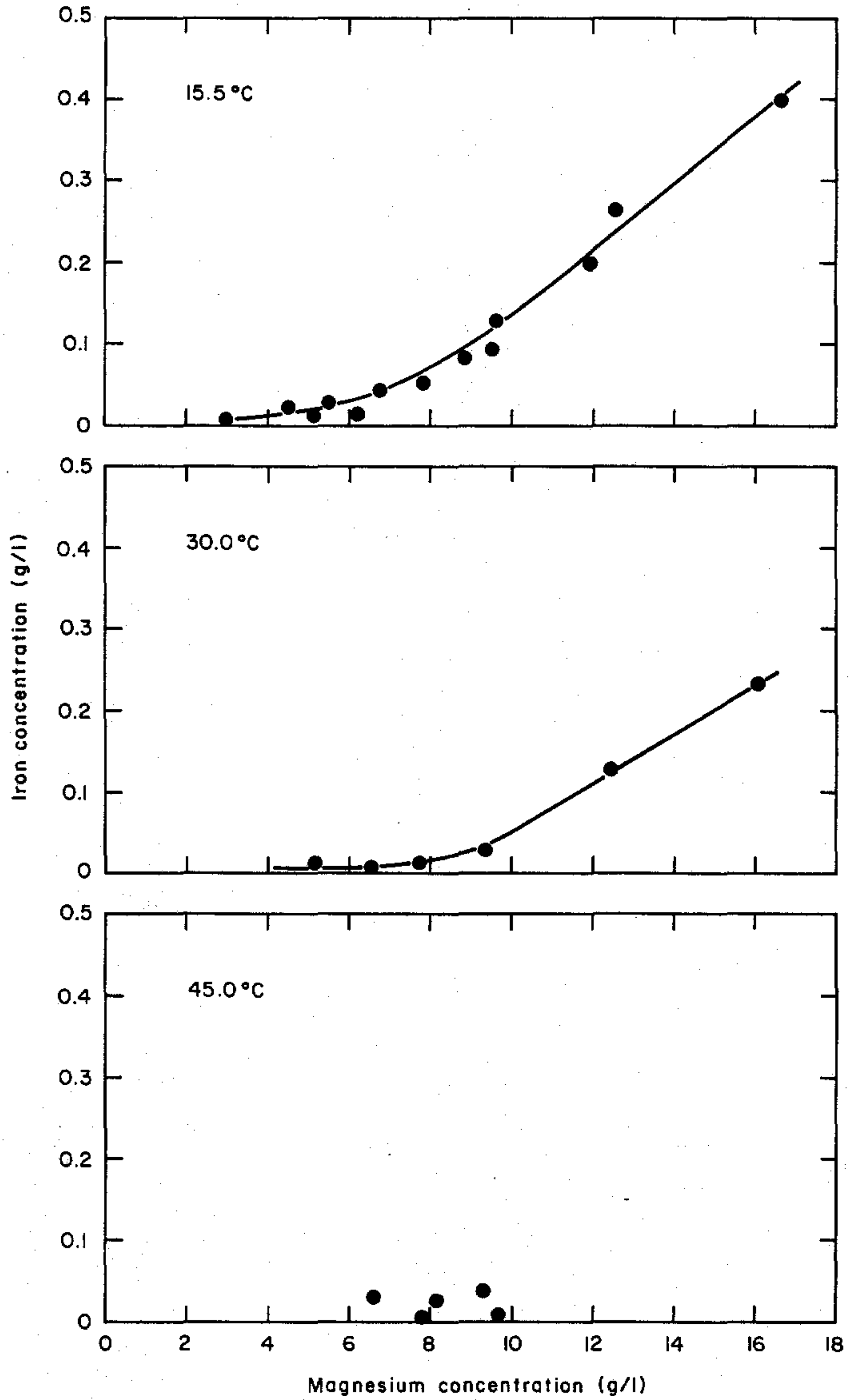
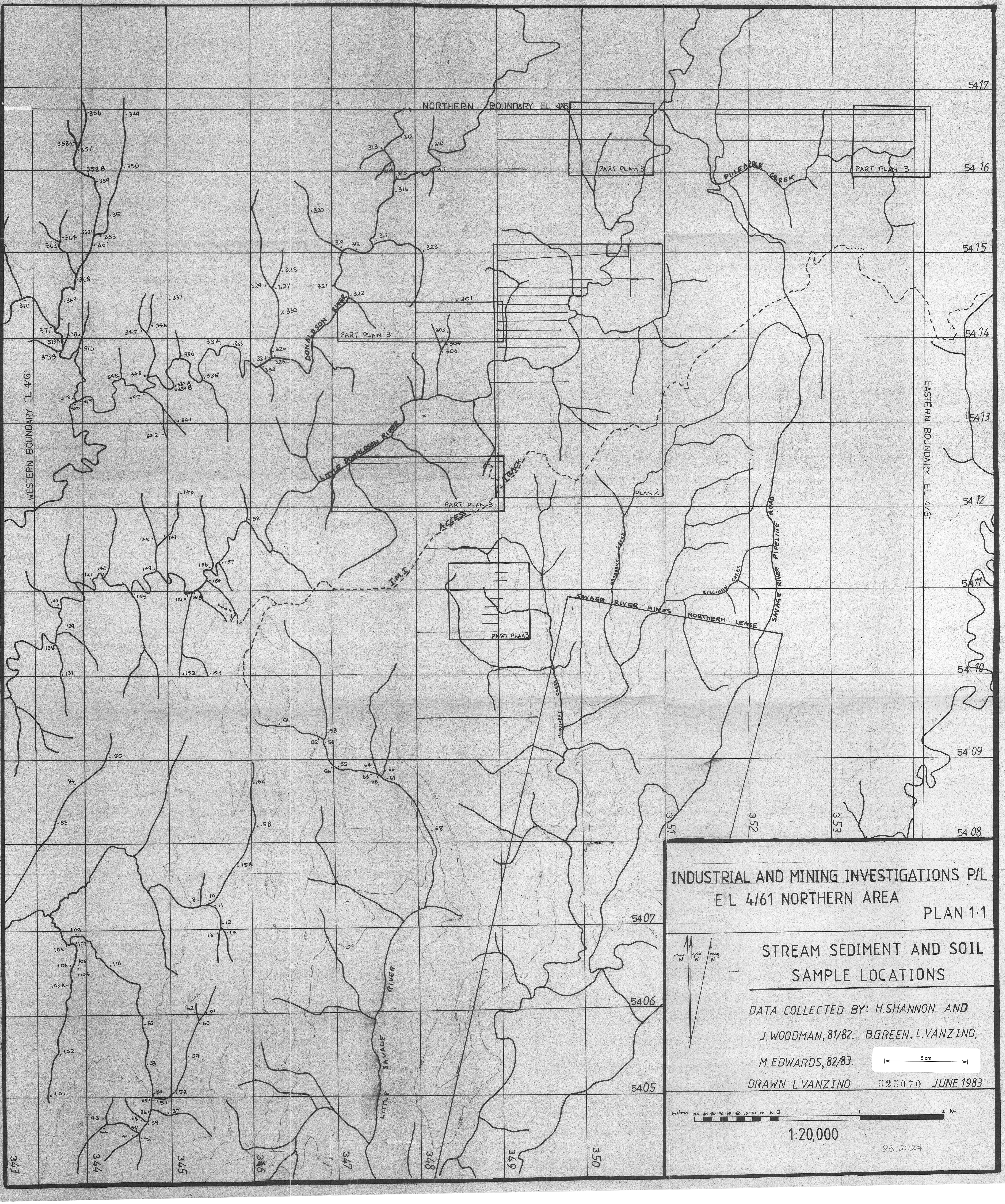


Fig. 2. Iron concentration as a function of magnesium concentration for different leaching conditions. Data for conditions under which iron concentration decreases with increasing leaching time and under which magnesium bicarbonate solubility is exceeded are not included. Data taken from Reference 6.



INDUSTRIAL AND MINING INVESTIGATIONS P/L
E L 4/61 NORTHERN AREA
PLAN 1·1
STREAM SEDIMENT AND SOIL
SAMPLE LOCATIONS
DATA COLLECTED BY: H.SHANNON AND
J.WOODMAN, 81/82. B.GREEN, L.VANZINO,
M.EDWARDS, 82/83.
DRAWN: L VANZINO
525070
JUNE 1983
1:20,000
5 cm
true N
grid N
mag N
metres
83-2027
NORTHERN BOUNDARY EL 4/61
WESTERN BOUNDARY EL 4/61
EASTERN BOUNDARY EL 4/61
PINEAPPLE CREEK
DONALDSON RIVER
LITTLE DONALDSON RIVER
I.M.I. ACCESS TRACK
SAVAGE RIVER MINES NORTHERN LEASE
SAVAGE RIVER PIPELINE ROAD
BRODERICK CREEK
SPECIMEN CREEK
LITTLE SAVAGE RIVER
PART PLAN 3
PLAN 2
5417
5416
5415
5414
5413
5412
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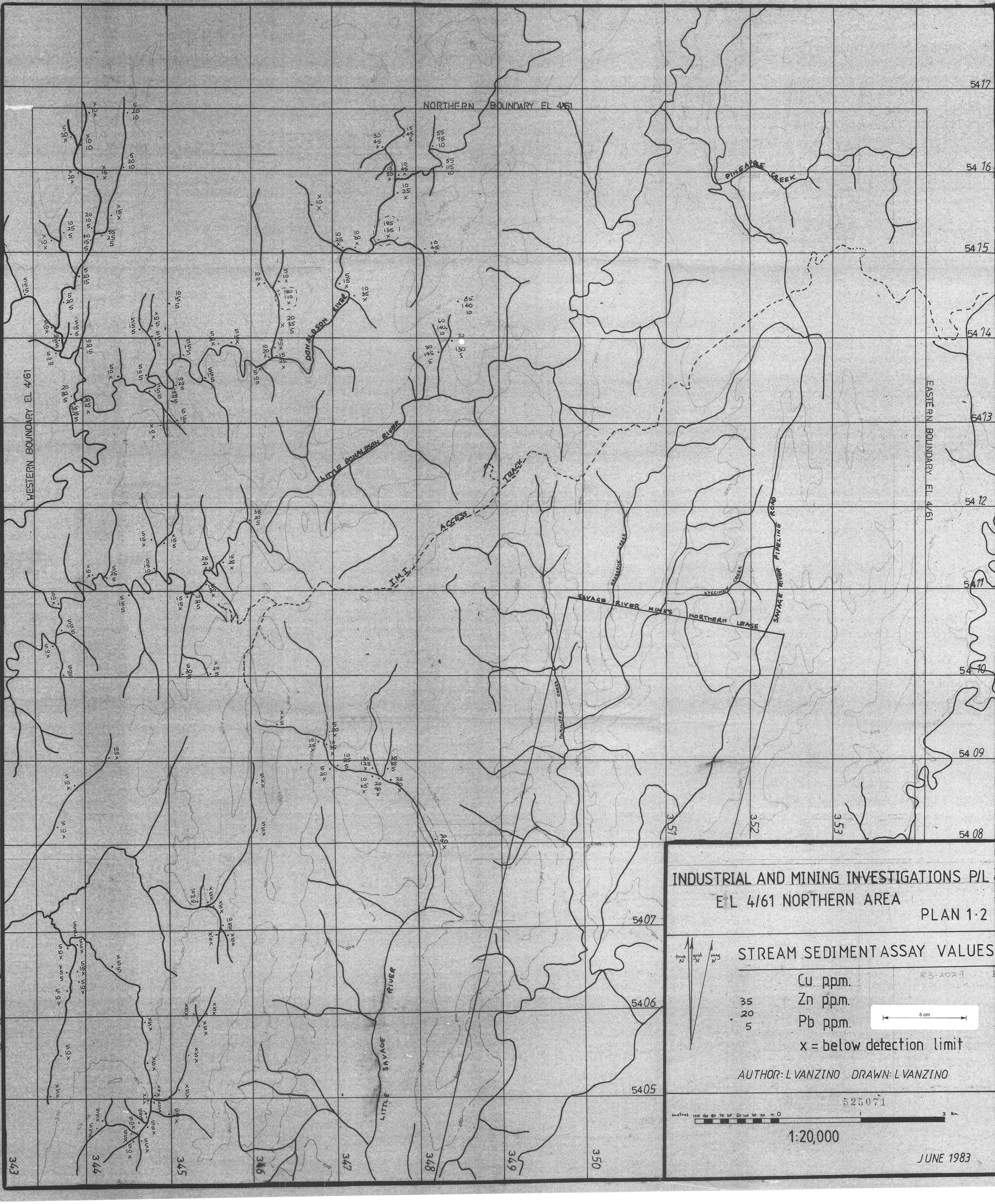

INDUSTRIAL AND MINING INVESTIGATIONS P/L
E L 4/61 NORTHERN AREA
PLAN 1·2
STREAM SEDIMENT ASSAY VALUES
35 Cu p.p.m.
20 Zn p.p.m.
5 Pb p.p.m.
x = below detection limit
83-2027
AUTHOR: L VANZINO DRAWN: L VANZINO
525071
1:20,000
JUNE 1983
NORTHERN BOUNDARY EL 4/61
WESTERN BOUNDARY EL 4/61
EASTERN BOUNDARY EL 4/61
PINEAPPLE CREEK
DONALDSON RIVER
LITTLE DONALDSON RIVER
I.M.I. ACCESS TRACK
BRODERICK CREEK
SPECIMEN CREEK
SAVAGE RIVER PIPELINE ROAD
SAVAGE RIVER MINES NORTHERN LEASE
LITTLE SAVAGE RIVER
5417
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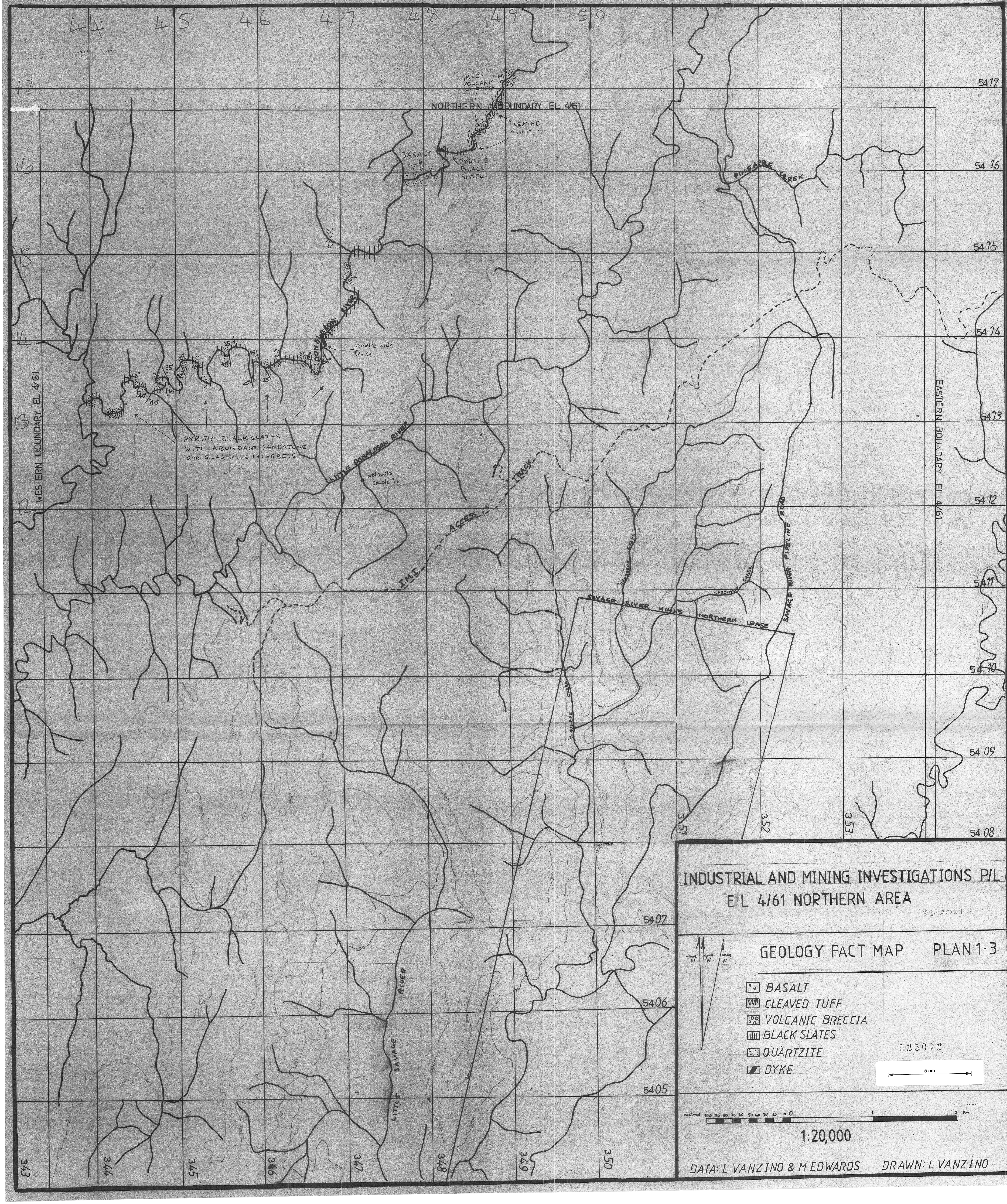

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5406
5405
343 344 345 346 347 348 349 350 351 352 353
NORTHERN BOUNDARY EL 4/61
WESTERN BOUNDARY EL 4/61
EASTERN BOUNDARY EL 4/61
GREEN VOLCANIC BRECCIA
CLEAVED TUFF
BASALT
PYRITIC BLACK SLATE
PINEAPPLE CREEK
DONALDSON RIVER
5metre wide Dyke
PYRITIC BLACK SLATES WITH ABUNDANT SANDSTONE and QUARTZITE INTERBEDS
LITTLE DONALDSON RIVER
dolomite Sample B4
I.M.I. ACCESS TRACK
SAVAGE RIVER PIPELINE ROAD
SAVAGE RIVER MINES NORTHERN LEASE
SPECIMEN CREEK
LITTLE SAVAGE RIVER
INDUSTRIAL AND MINING INVESTIGATIONS P/L
E L 4/61 NORTHERN AREA
83-2027
GEOLOGY FACT MAP
PLAN 1·3
true N
grid N
mag N
BASALT
CLEAVED TUFF
VOLCANIC BRECCIA
BLACK SLATES
QUARTZITE
DYKE
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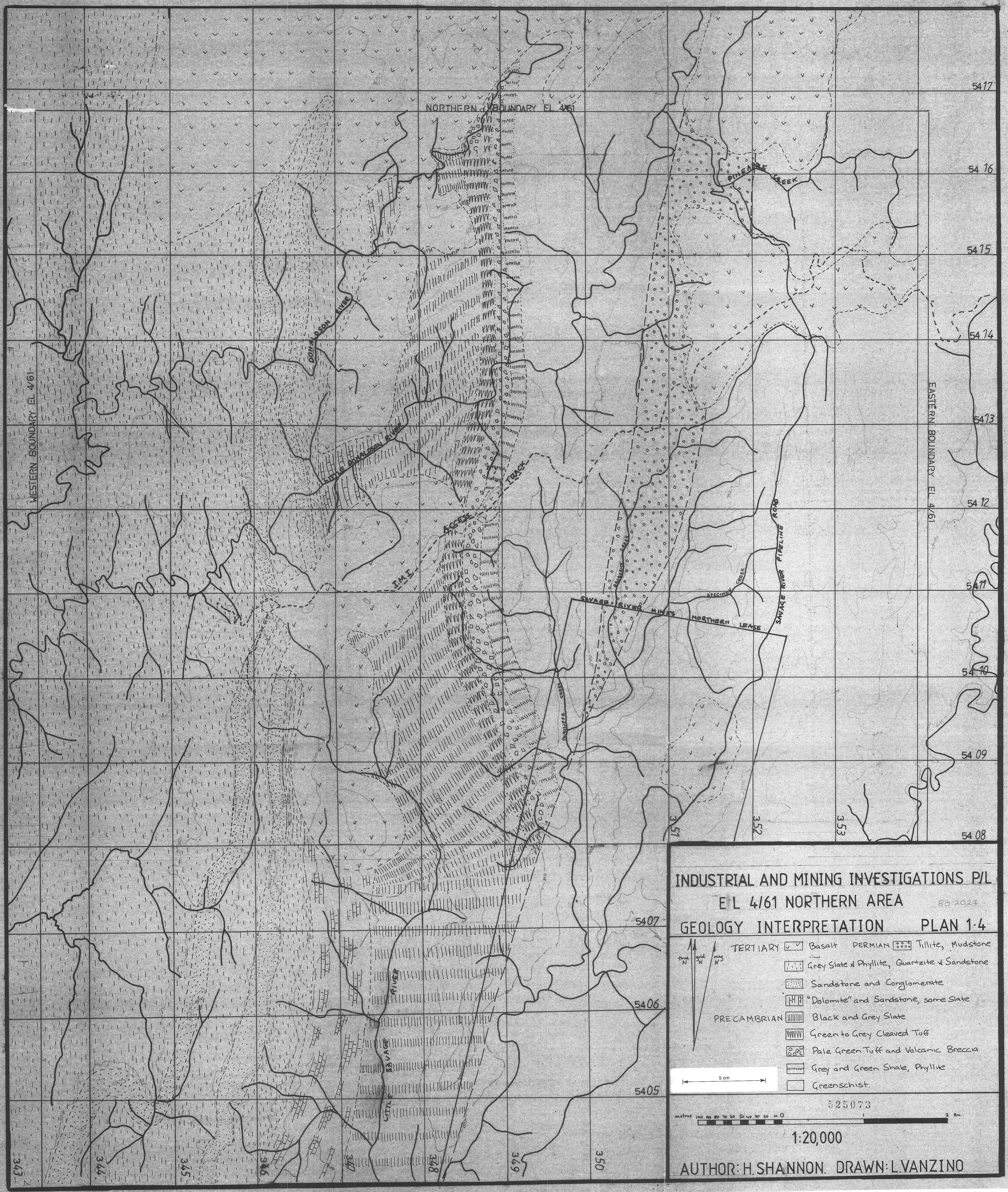
1:20,000
DATA: L VANZINO & M EDWARDS
DRAWN: L VANZINO



INDUSTRIAL AND MINING INVESTIGATIONS P/L
E L 4/61 NORTHERN AREA
83-2027
GEOLOGY INTERPRETATION PLAN 1·4
true N
grid N
mag N
TERTIARY
Basalt
PERMIAN
Tillite, Mudstone
Grey Slate & Phyllite, Quartzite & Sandstone
Sandstone and Conglomerate
"Dolomite" and Sandstone, some Slate
PRECAMBRIAN
Black and Grey Slate
Green to Grey Cleaved Tuff
Pale Green Tuff and Volcanic Breccia
Grey and Green Shale, Phyllite
Greenschist
5 cm
525073
metres 100 90 80 70 60 50 40 30 20 10 0 1 2 km.
1:20,000
AUTHOR: H.SHANNON. DRAWN: L.VANZINO
NORTHERN BOUNDARY EL 4/61
WESTERN BOUNDARY EL 4/61
EASTERN BOUNDARY EL 4/61
DONALDSON RIVER
LITTLE DONALDSON RIVER
I.M.I. ACCESS TRACK
PIEMAN CREEK
SAVAGE RIVER MINES NORTHERN LEASE
SAVAGE RIVER PIPELINE ROAD
LITTLE SAVAGE RIVER
5417
5416
5415
5414
5413
5412
5411
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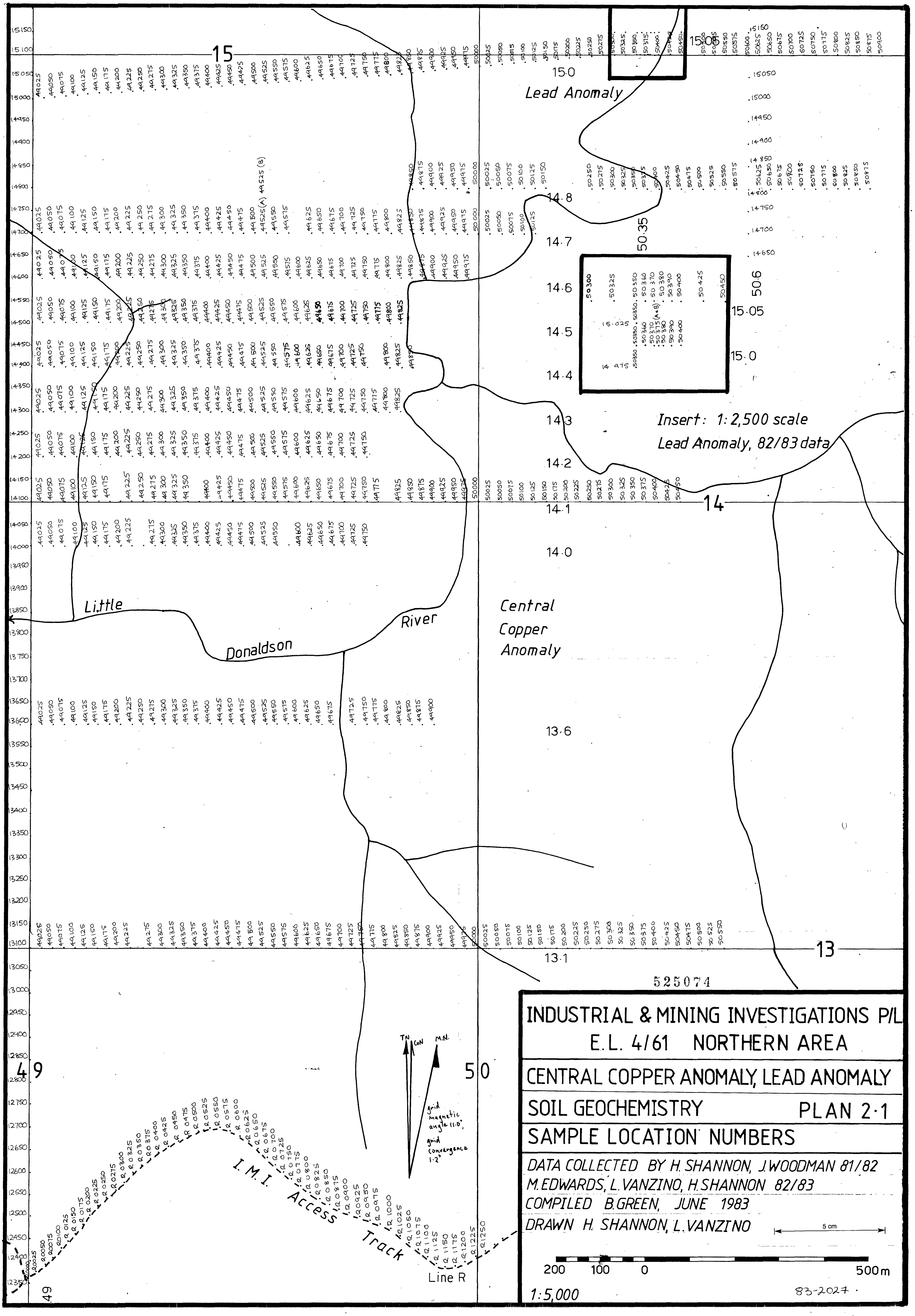
353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Lead Anomaly
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50.6
15.05
15.0
14.8
14.7
14.6
14.5
14.4
14.3
14.2
14.1
14.0
13.6
13.1
14
13
Insert: 1:2,500 scale
Lead Anomaly, 82/83 data
Little Donaldson River
Central Copper Anomaly
I.M.I. Access Track
Line R
49
50
TN
GN
M.N.
grid magnetic angle 11.0°
grid convergence 1.2°
525074
INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
CENTRAL COPPER ANOMALY, LEAD ANOMALY
SOIL GEOCHEMISTRY
PLAN 2·1
SAMPLE LOCATION NUMBERS
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON, L. VANZINO
5 cm
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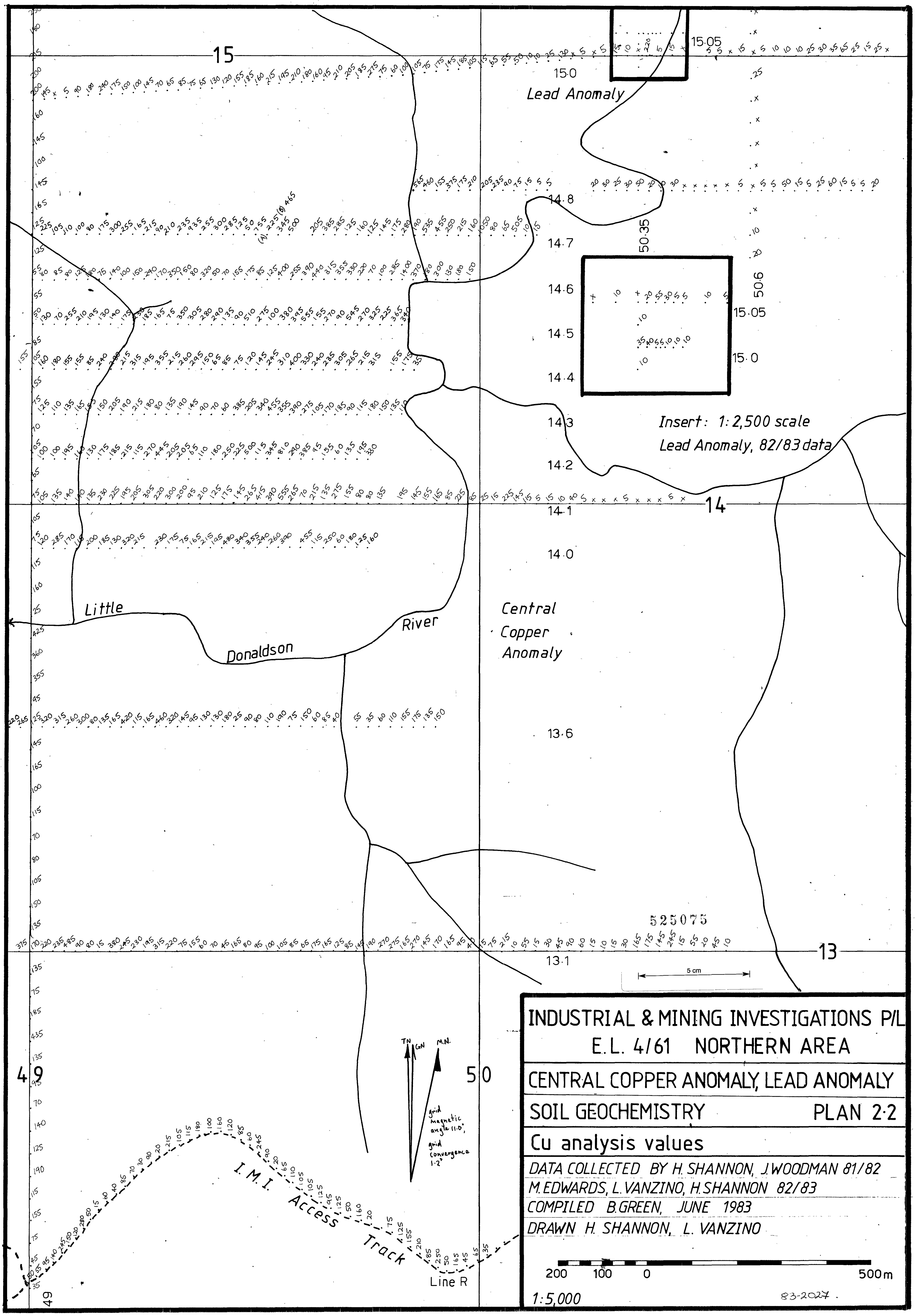
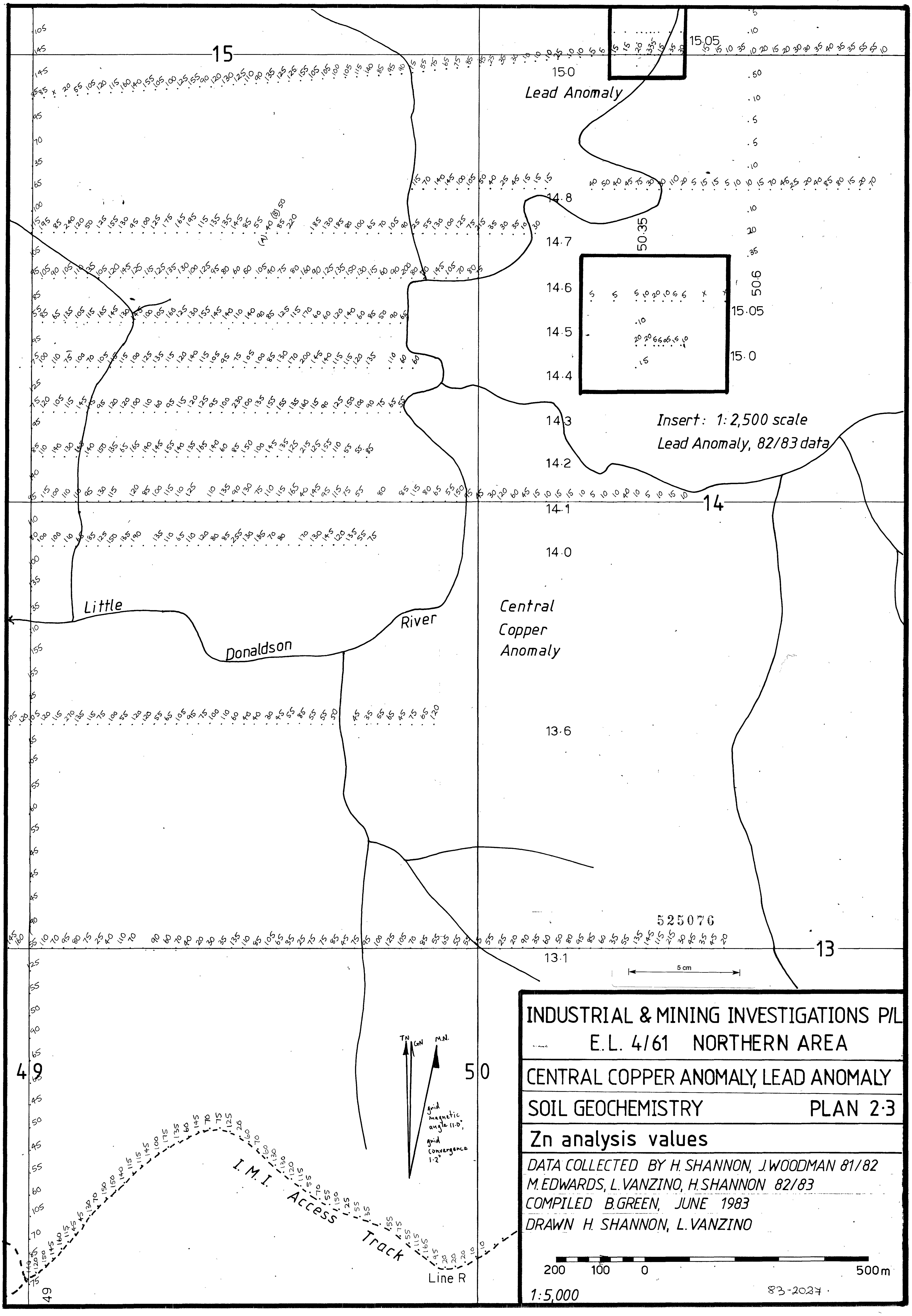
1:5,000
83-2027



INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
CENTRAL COPPER ANOMALY, LEAD ANOMALY
SOIL GEOCHEMISTRY PLAN 2·2
Cu analysis values
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON, L. VANZINO
200 100 0 500m
1:5,000
83-2027
Lead Anomaly
Insert: 1:2,500 scale
Lead Anomaly, 82/83 data
Central Copper Anomaly
Little Donaldson River
I.M.I. Access Track
Line R
TN GN M.N.
grid magnetic angle 11.0°, grid convergence 1.2°
15
14
13
49
50
15·05
15·0
14·8
14·7
14·6
14·5
14·4
14·3
14·2
14·1
14·0
13·6
13·1
50·35
50·6
5 cm
525075



INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA

CENTRAL COPPER ANOMALY, LEAD ANOMALY

SOIL GEOCHEMISTRY PLAN 2·3

Zn analysis values

DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON, L. VANZINO

200 100 0 500m

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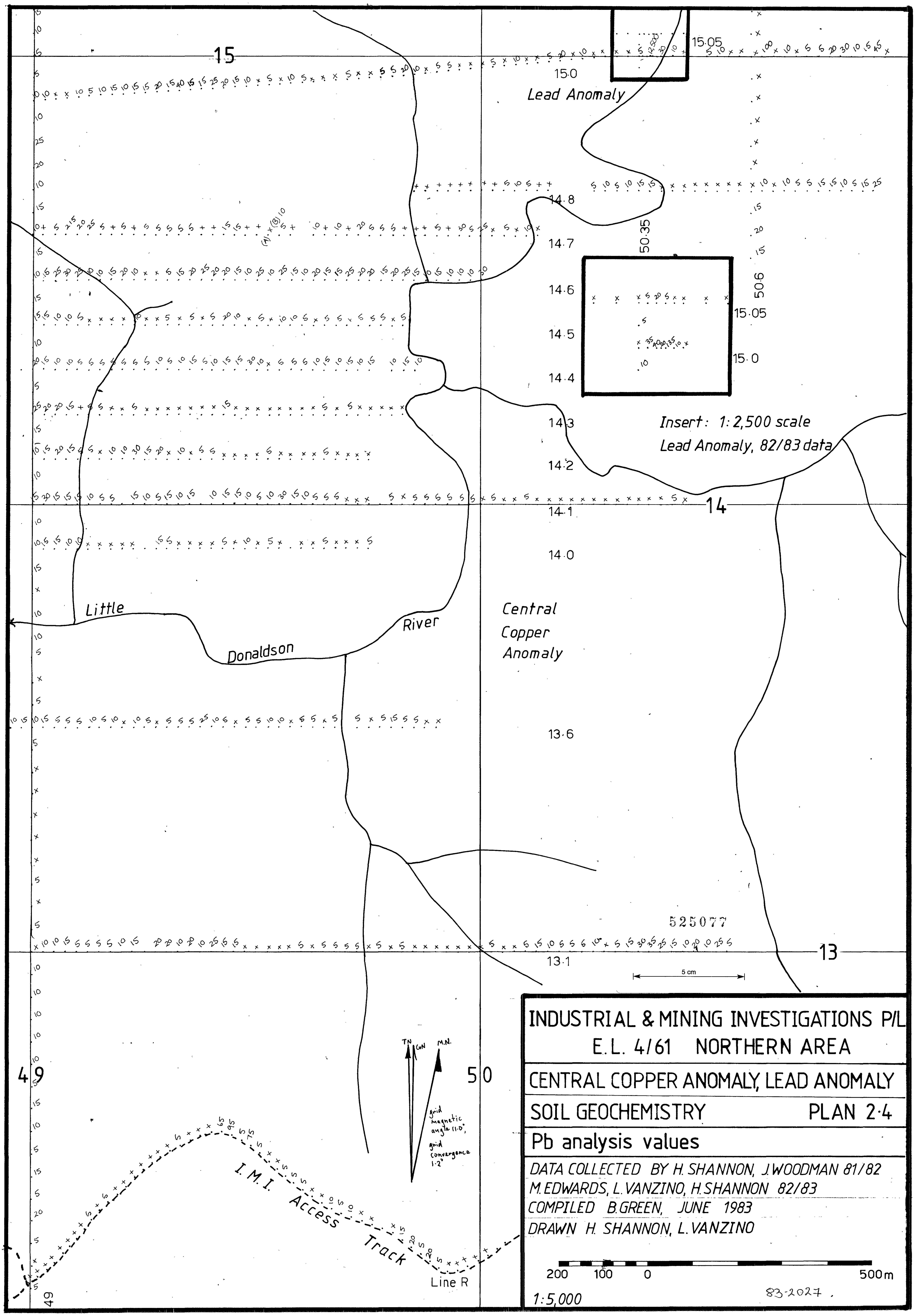
83-2027



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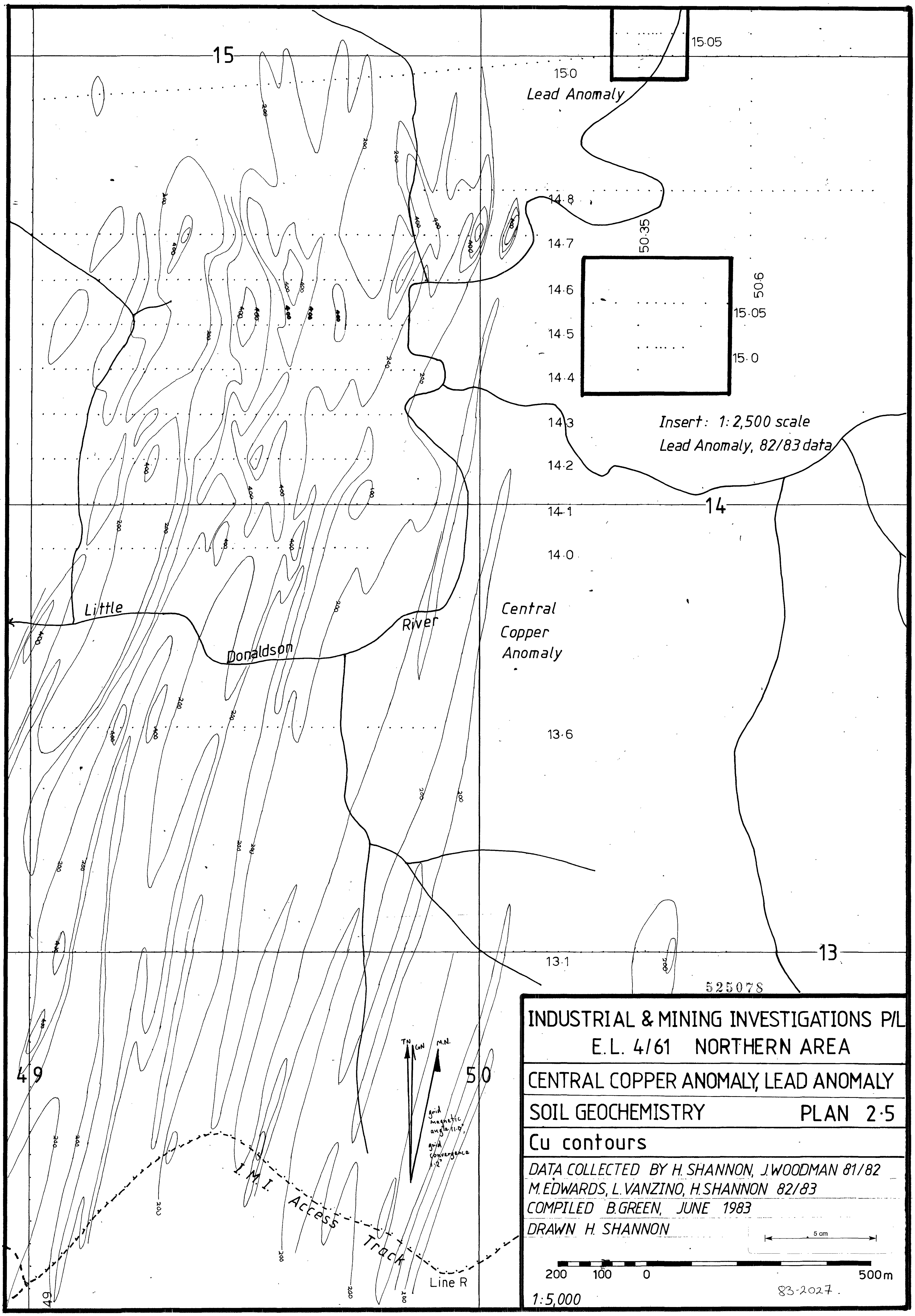
14
13
49
50
Lead Anomaly
Insert: 1:2,500 scale
Lead Anomaly, 82/83 data
Central
Copper
Anomaly
Little
Donaldson
River
I.M.I. Access Track
Line R
525077
5 cm
TN
GN
M.N.
INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
CENTRAL COPPER ANOMALY, LEAD ANOMALY
SOIL GEOCHEMISTRY
PLAN 2·4
Pb analysis values
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON, L. VANZINO
200 100 0 500m
1:5,000
83-2027



INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA

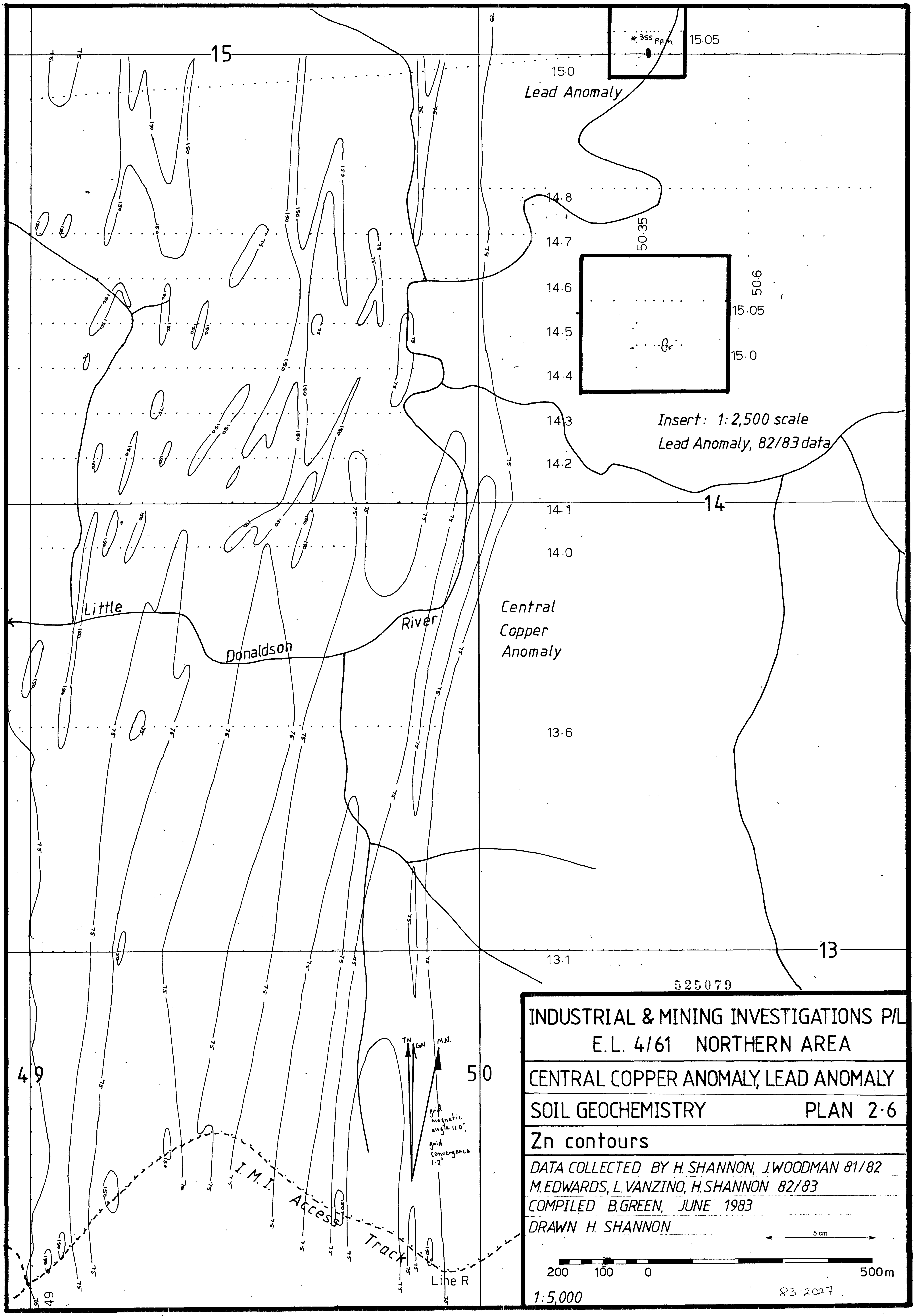
CENTRAL COPPER ANOMALY, LEAD ANOMALY

SOIL GEOCHEMISTRY PLAN 2·5

Cu contours

DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON

1:5,000



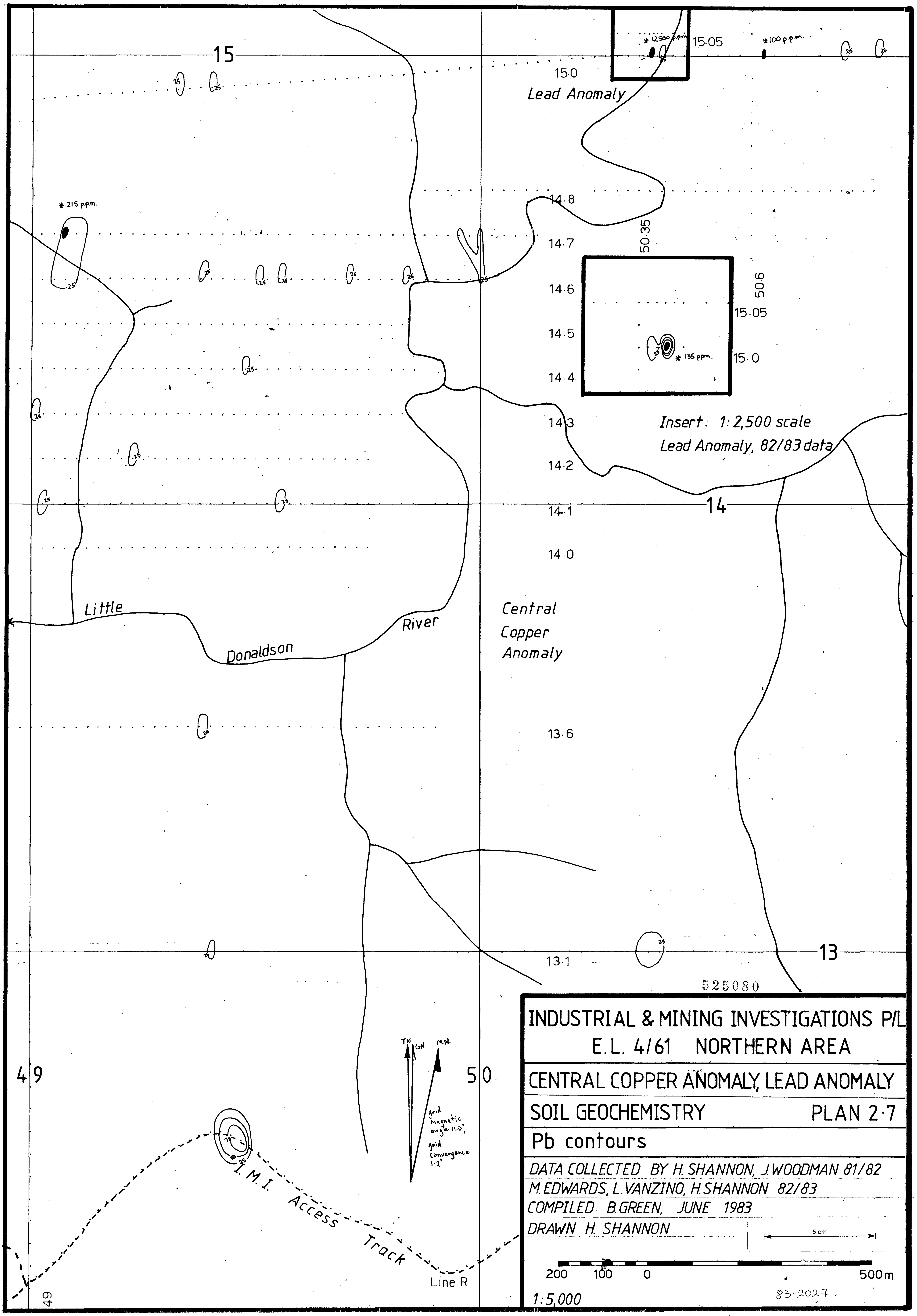
INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA

CENTRAL COPPER ANOMALY, LEAD ANOMALY

SOIL GEOCHEMISTRY PLAN 2·6

Zn contours

DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON



525080

INDUSTRIAL & MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA

CENTRAL COPPER ANOMALY, LEAD ANOMALY

SOIL GEOCHEMISTRY — PLAN 2·7

Pb contours

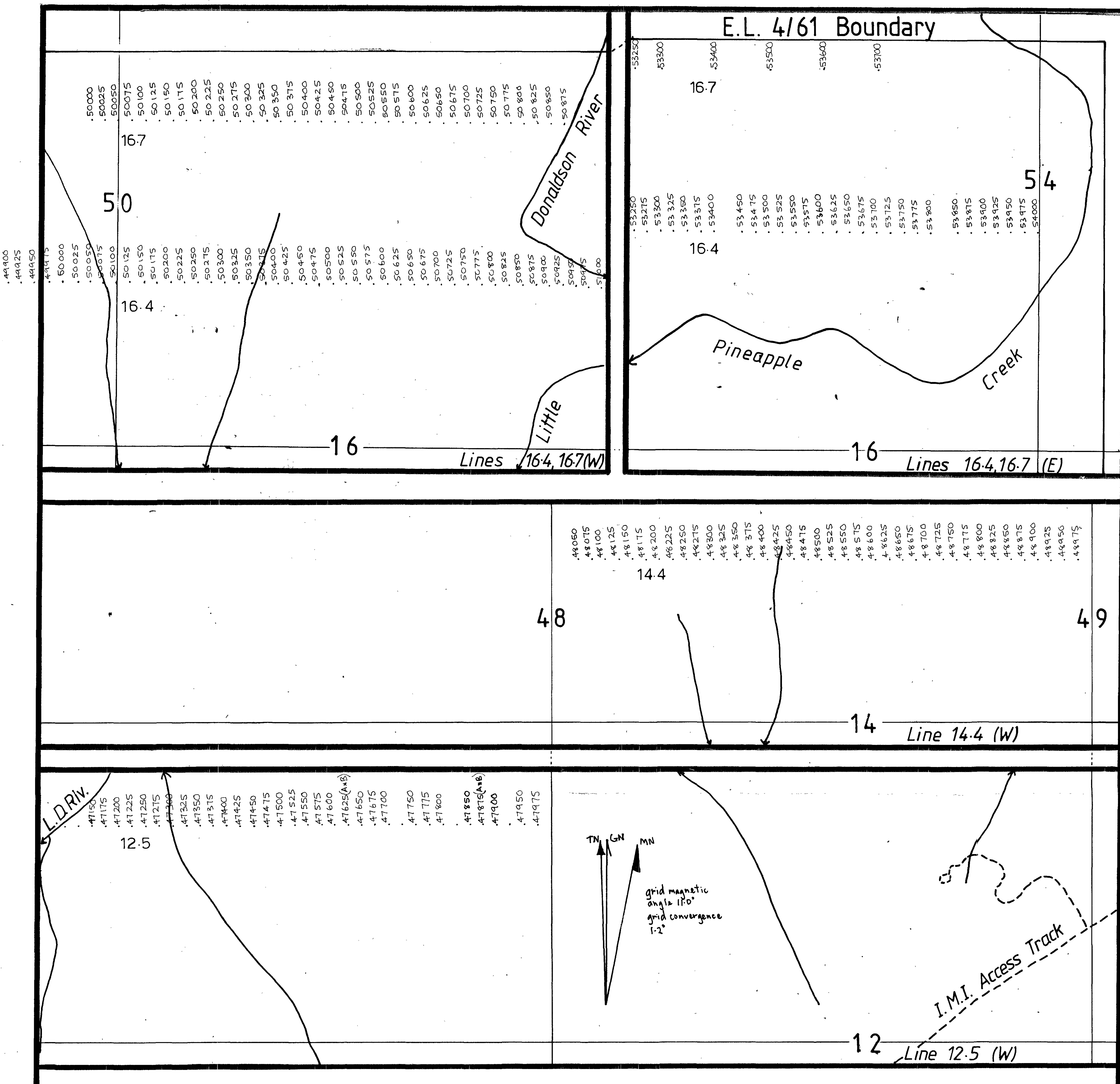
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82
M. EDWARDS, L. VANZINO, H. SHANNON 82/83
COMPILED B. GREEN, JUNE 1983
DRAWN H. SHANNON

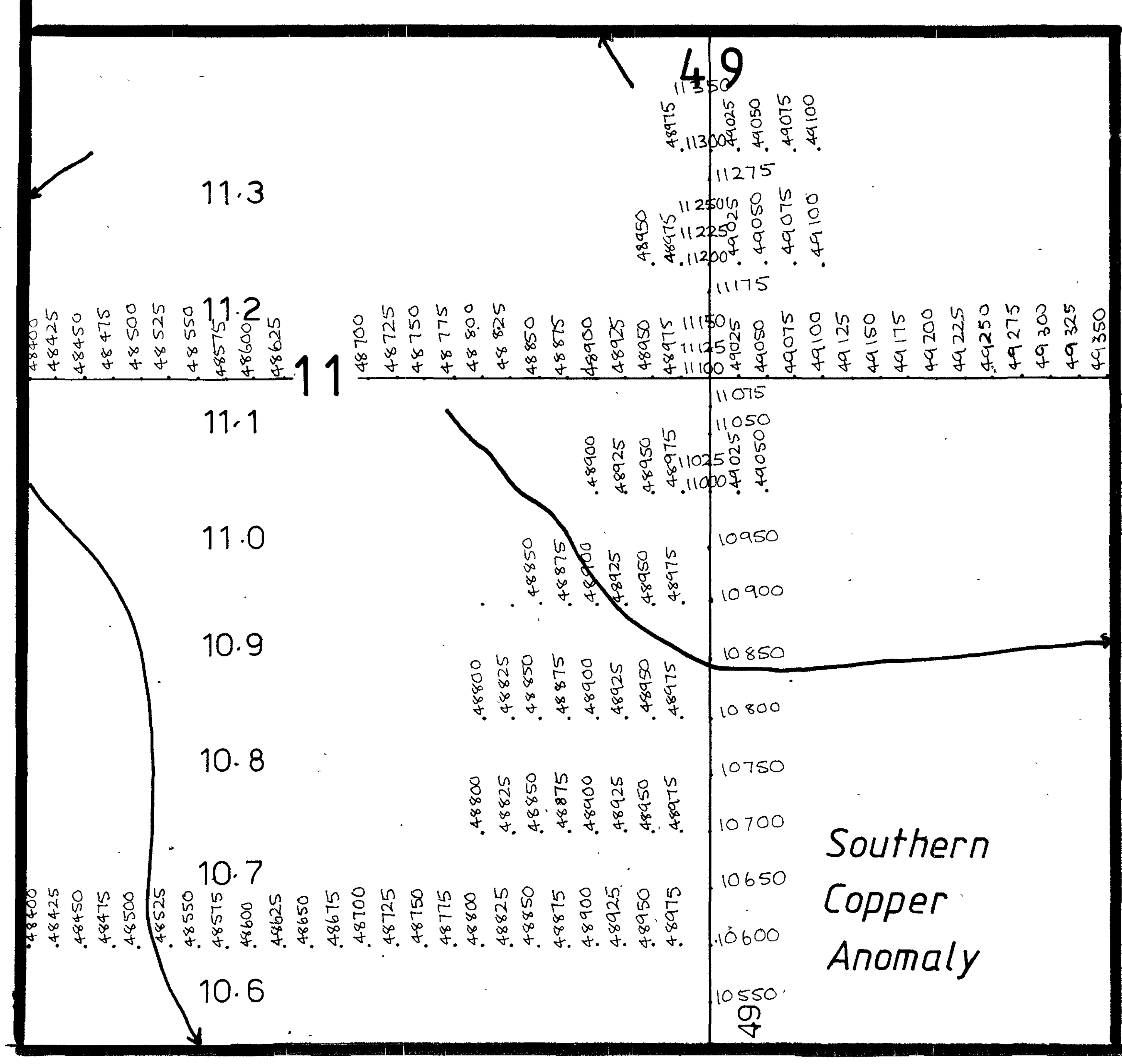
5 cm

200 100 0 500m

1:5,000

83-2027





525081

5 cm

INDUSTRIAL AND MINING INVESTIGATIONS P/L

E.L. 4/61 NORTHERN AREA

SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.

SOIL GEOCHEMISTRY PLAN 3·1

SAMPLE LOCATION NUMBERS

DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10·6, 11·1 : M. EDWARDS, L. VANZINO 82/83

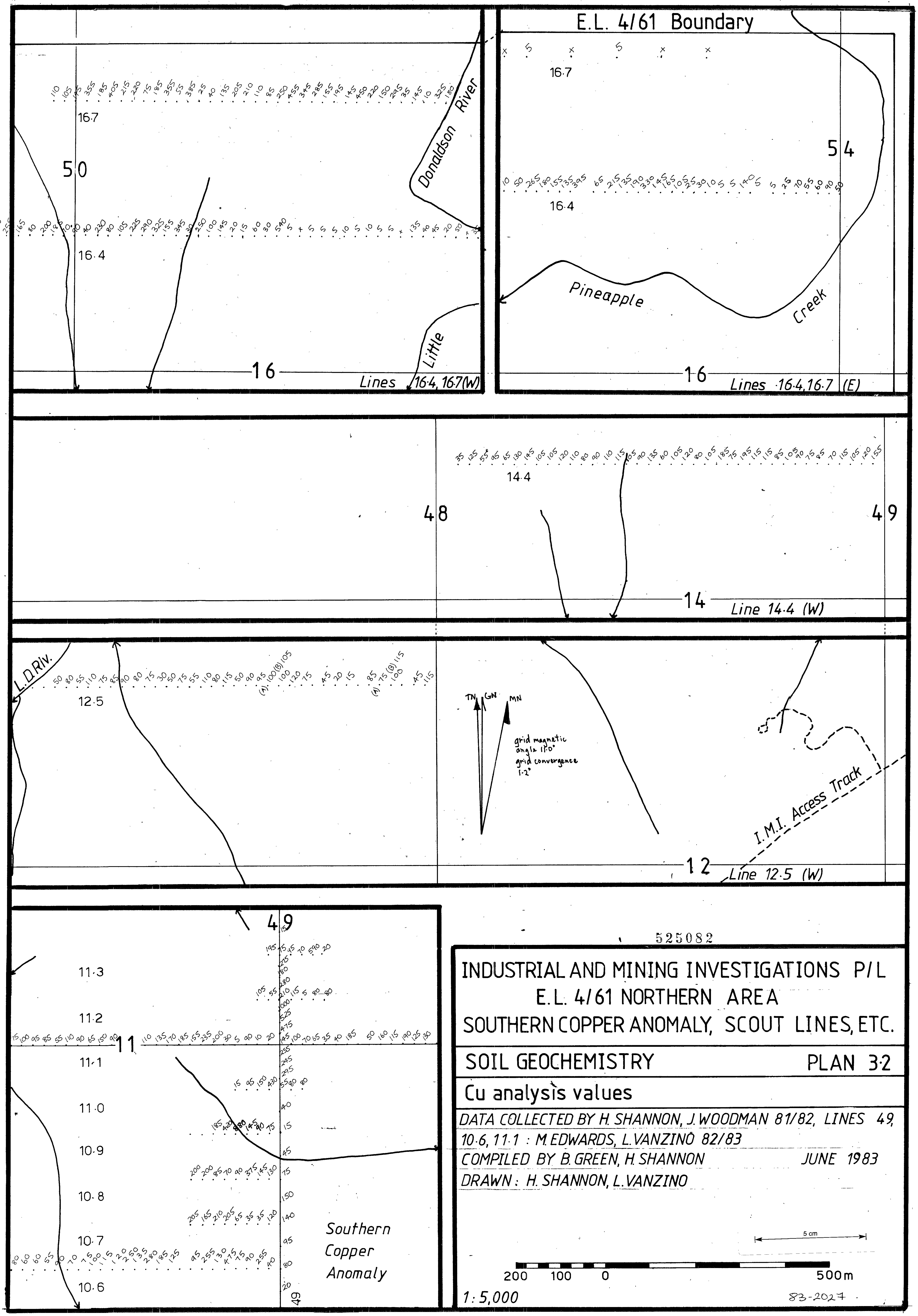
COMPILED BY B. GREEN, H. SHANNON JUNE 1983

DRAWN: H. SHANNON, L. VANZINO

200 100 0 500m

1: 5,000

83-2027



525082

INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.

SOIL GEOCHEMISTRY — PLAN 3·2

Cu analysis values

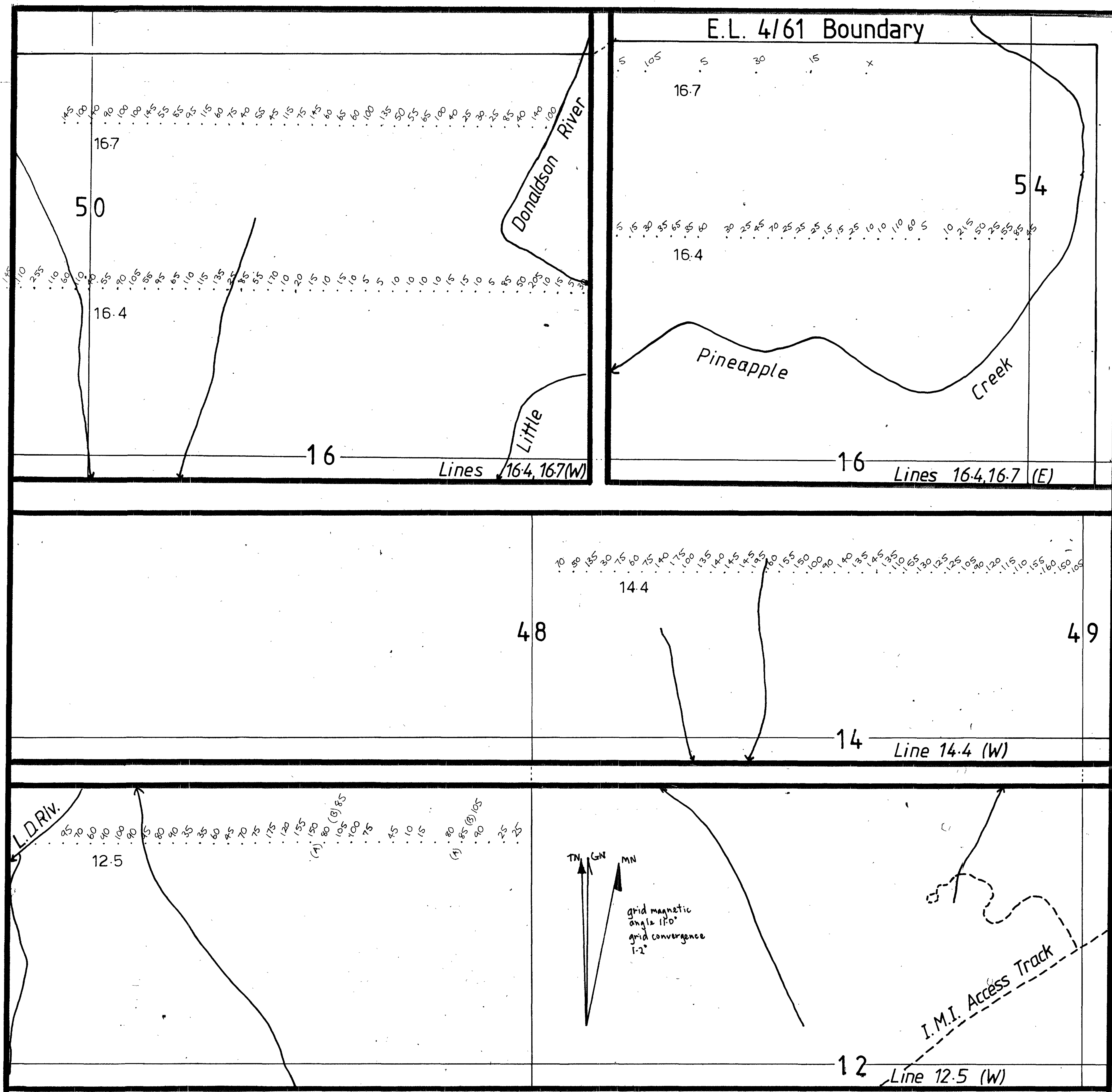
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10·6, 11·1 : M. EDWARDS, L. VANZINO 82/83

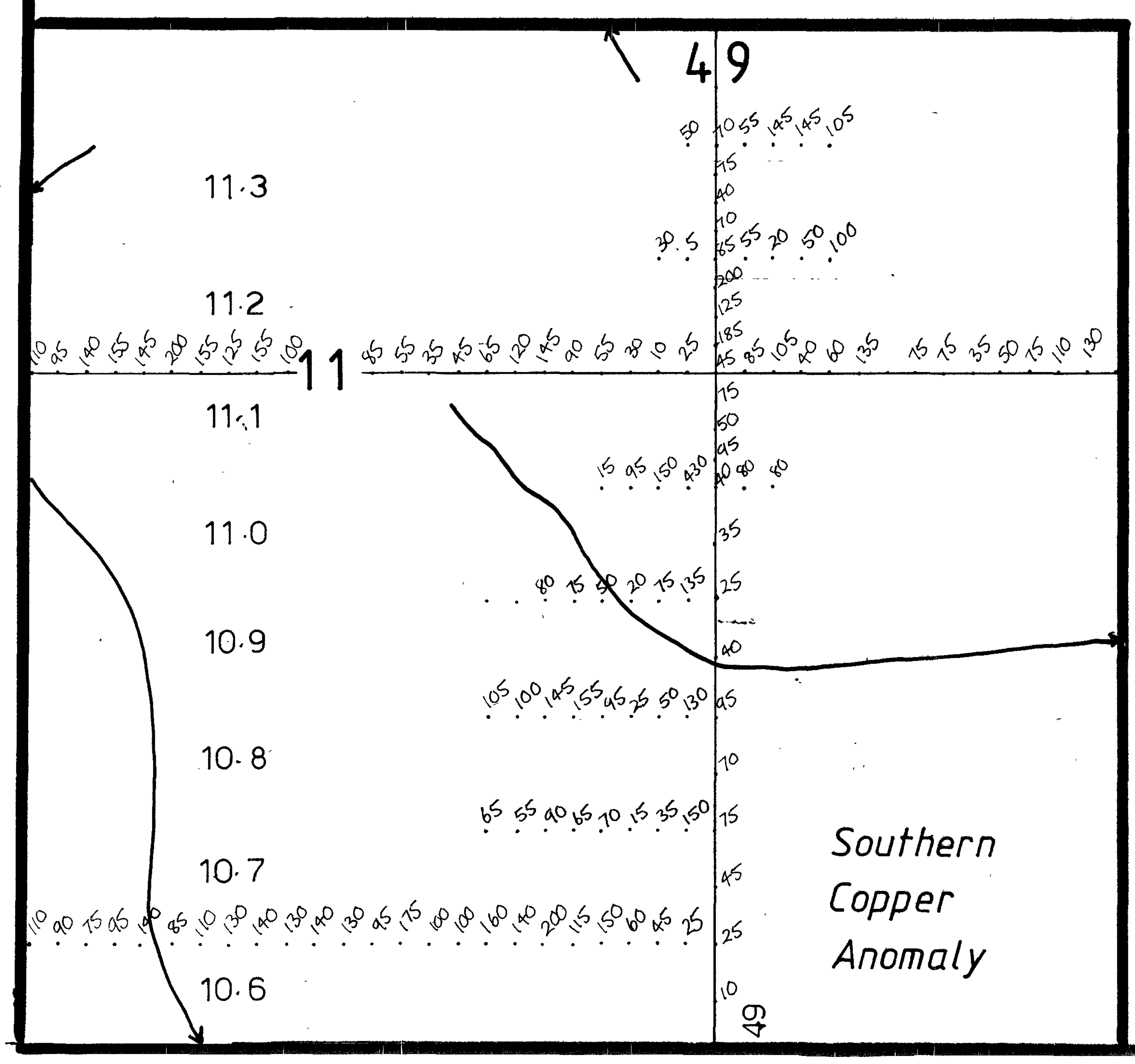
COMPILED BY B. GREEN, H. SHANNON — JUNE 1983

DRAWN : H. SHANNON, L. VANZINO

1 : 5,000

83-2027





525083

INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.

SOIL GEOCHEMISTRY — PLAN 3·3

Zn analysis values

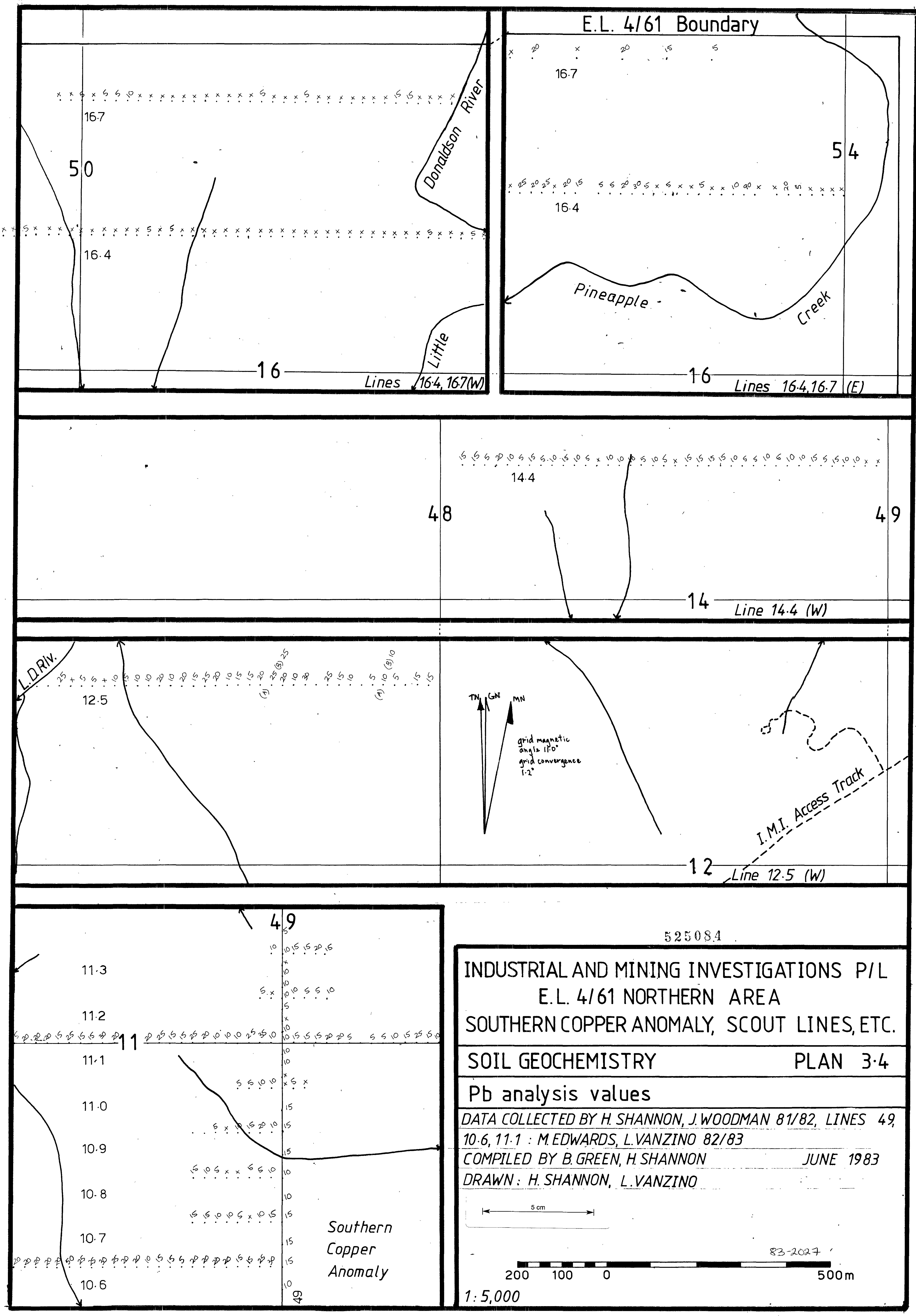
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10·6, 11·1 : M. EDWARDS, L. VANZINO 82/83
COMPILED BY B. GREEN, H. SHANNON — JUNE 1983
DRAWN: H. SHANNON, L. VANZINO

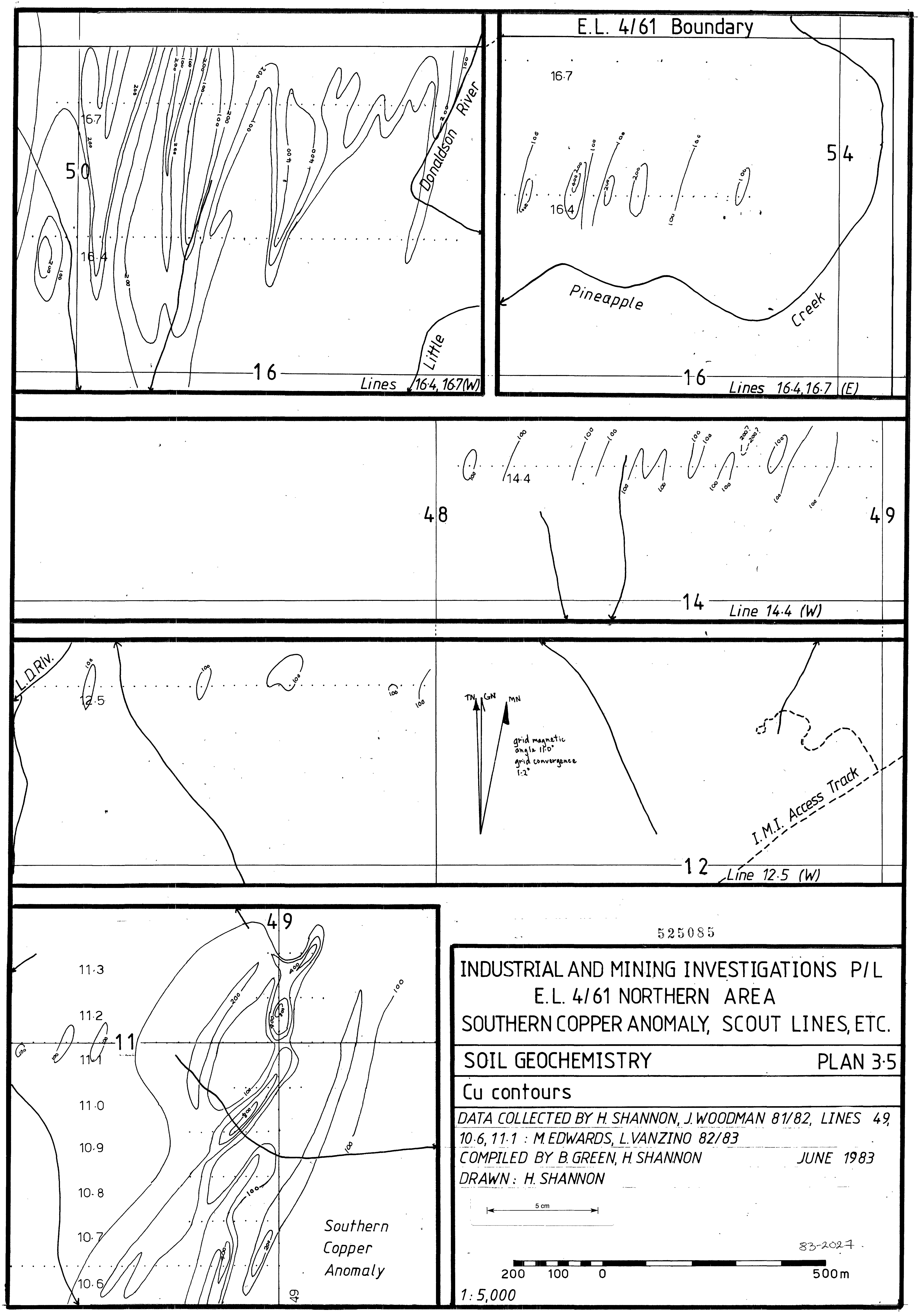
5 cm

200 100 0 500m

1: 5,000

83-2027


E.L. 4/61 Boundary
Donaldson River
Little
Pineapple
Creek
16.7
16.4
50
54
16
Lines 16.4, 16.7 (W)
Lines 16.4, 16.7 (E)
14.4
48
49
14
Line 14.4 (W)
L.D.Riv.
12.5
TN
GN
MN
grid magnetic angle 11.0°
grid convergence 1.2°
I.M.I. Access Track
12
Line 12.5 (W)
49
11.3
11.2
11
11.1
11.0
10.9
10.8
10.7
10.6
Southern
Copper
Anomaly
525084
INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.
SOIL GEOCHEMISTRY
PLAN 3·4
Pb analysis values
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10.6, 11.1 : M. EDWARDS, L. VANZINO 82/83
COMPILED BY B. GREEN, H. SHANNON
JUNE 1983
DRAWN: H. SHANNON, L. VANZINO
5 cm
83-2027
200
100
0
500m
1: 5,000



E.L. 4/61 Boundary
16·7
16·4
50
54
Donaldson River
Pineapple
Creek
Little
16
Lines 16·4, 16·7 (W)
Lines 16·4, 16·7 (E)
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48
49
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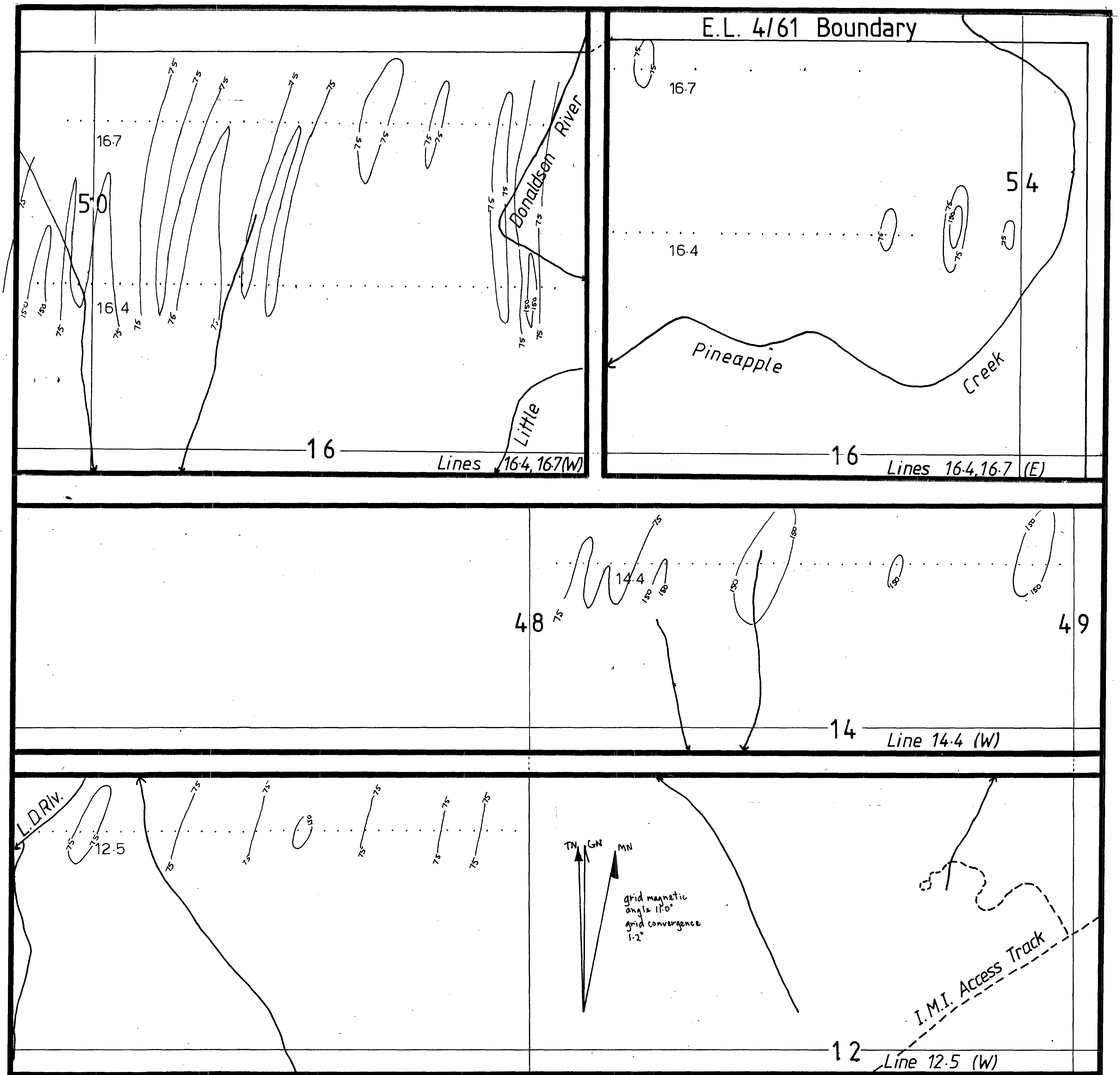
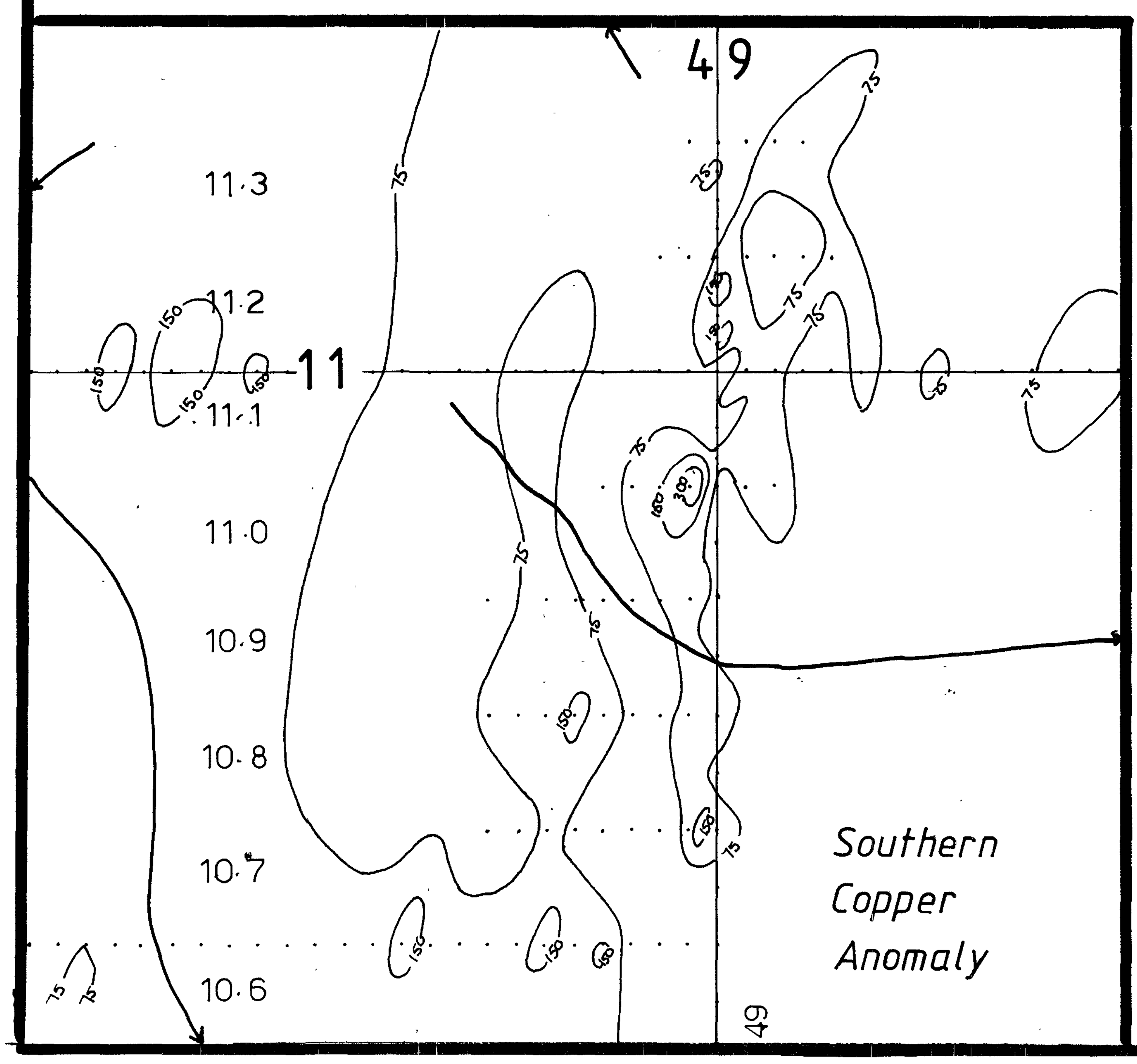
I.M.I. Access Track
12
Line 12·5 (W)
49
11·3
11·2
11
11·1
11·0
10·9
10·8
10·7
10·6
Southern
Copper
Anomaly
525085
INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.
SOIL GEOCHEMISTRY
PLAN 3·5
Cu contours
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10·6, 11·1 : M. EDWARDS, L. VANZINO 82/83
COMPILED BY B. GREEN, H. SHANNON
JUNE 1983
DRAWN: H. SHANNON
5 cm
83-2027
200 100 0
500m
1: 5,000





525086

INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.

SOIL GEOCHEMISTRY PLAN 3·6

Zn contours

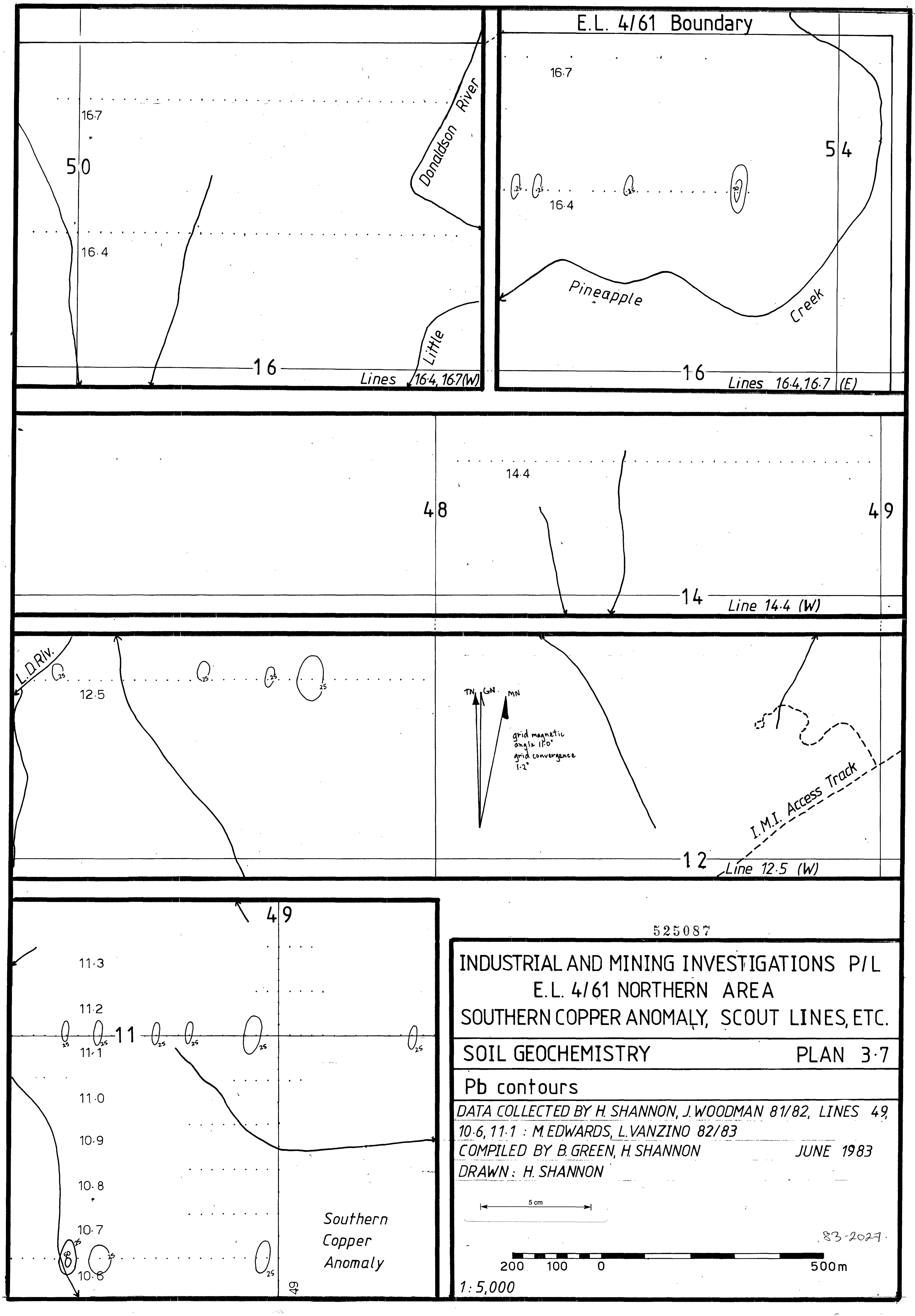
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10·6, 11·1 : M. EDWARDS, L. VANZINO 82/83
COMPILED BY B. GREEN, H. SHANNON JUNE 1983
DRAWN : H. SHANNON

5 cm

83-2027

200 100 0 500m

1: 5,000



525087

INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 NORTHERN AREA
SOUTHERN COPPER ANOMALY, SCOUT LINES, ETC.

SOIL GEOCHEMISTRY — PLAN 3·7

Pb contours

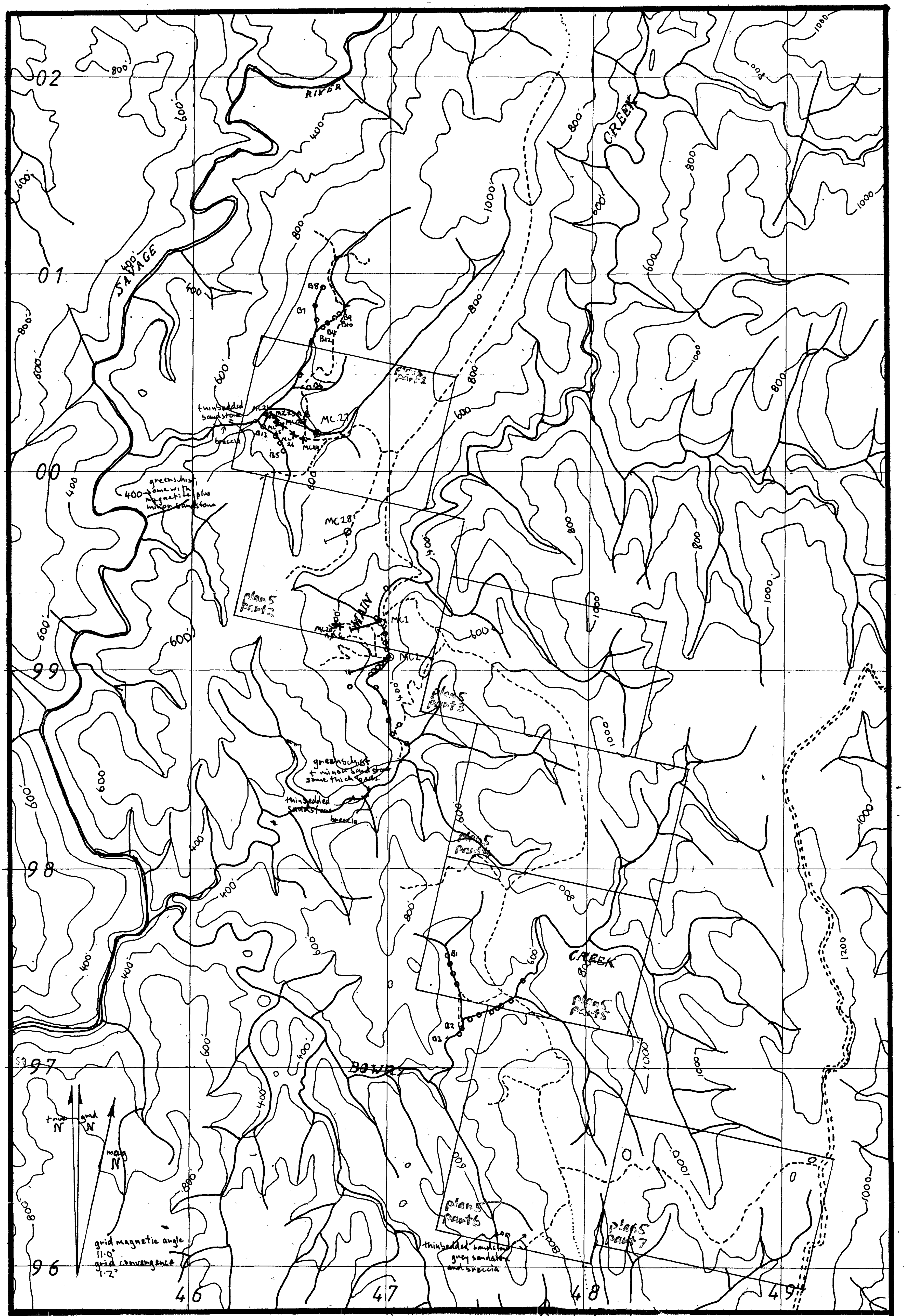
DATA COLLECTED BY H. SHANNON, J. WOODMAN 81/82, LINES 49, 10·6, 11·1 : M. EDWARDS, L. VANZINO 82/83

COMPILED BY B. GREEN, H. SHANNON — *JUNE 1983*

DRAWN : H. SHANNON

83-2027

1 : 5,000



347°°

INDUSTRIAL AND MINING INVESTIGATIONS P/L

E.L. 4/61 MAIN CREEK AREA

MAGNESITE PROSPECT

1 0 1 2 3km

LOCATION AND OUTCROP DATA
GEOLOGY: H. SHANNON

COMPILED AND DRAWN: H. SHANNON June 1983
BASE PLAN: part CORINNA 1:15840 sheets B+D

- o magnesite outcrop area
- B5 carbonate rock sample point
- MC24+ shallow drillhole (Rotary air blast)
- MC2 diamond drillhole

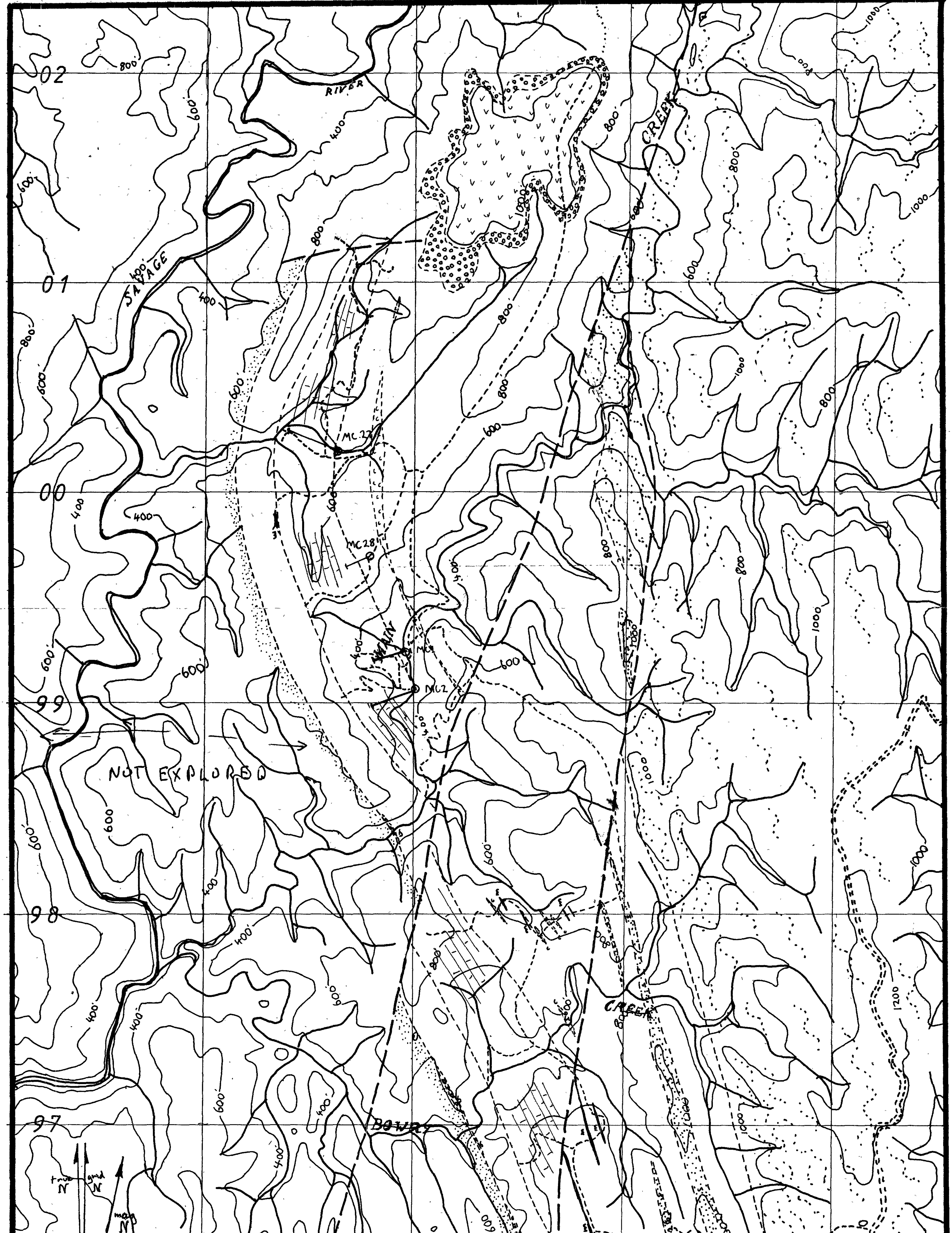
PLAN 4·1

525088

scale 1:15840

5 cm

83-2029



INDUSTRIAL AND MINING INVESTIGATIONS P/L

E.L. 4/61 MAIN CREEK AREA

MAGNESITE PROSPECT

5 cm

1 0 1 2 3km

Legend.

- Basalt, with basal gravel.
- Schistose quartzite, muscovite/chlorite schist, minor graphite schist.
- greenschist grading to "amphibolite, with turbidite sandstone (s), siliceous carbonate (c) and magnetite (m)
- magnesite rock with interbedded greenschist (grading to "amphibolite")
- greenschist and magnetite-bearing greenschist, magnetite (m), minor dolomite, and basal breccia/sandstone (b).
- thinbedded sandstone with chlorite partings.
- F — — F inferred fault

GEOLOGY - INTERPRETATION

COMPILED AND DRAWN: H. SHANNON, June 1983

BASE PLAN: PART CORINNA 1:15840 sheets B+D.

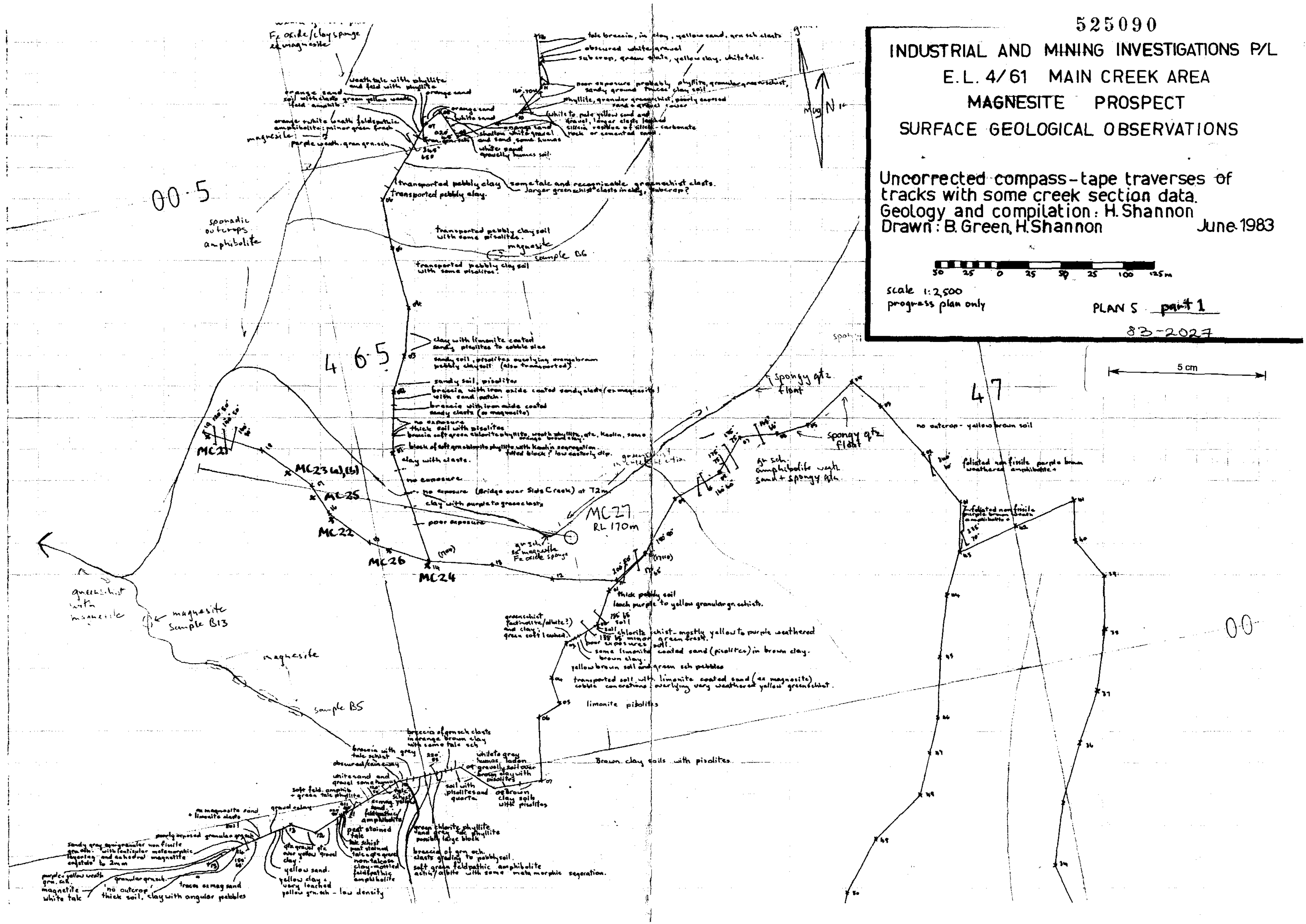
INTERPRETATION: H. SHANNON.

525089

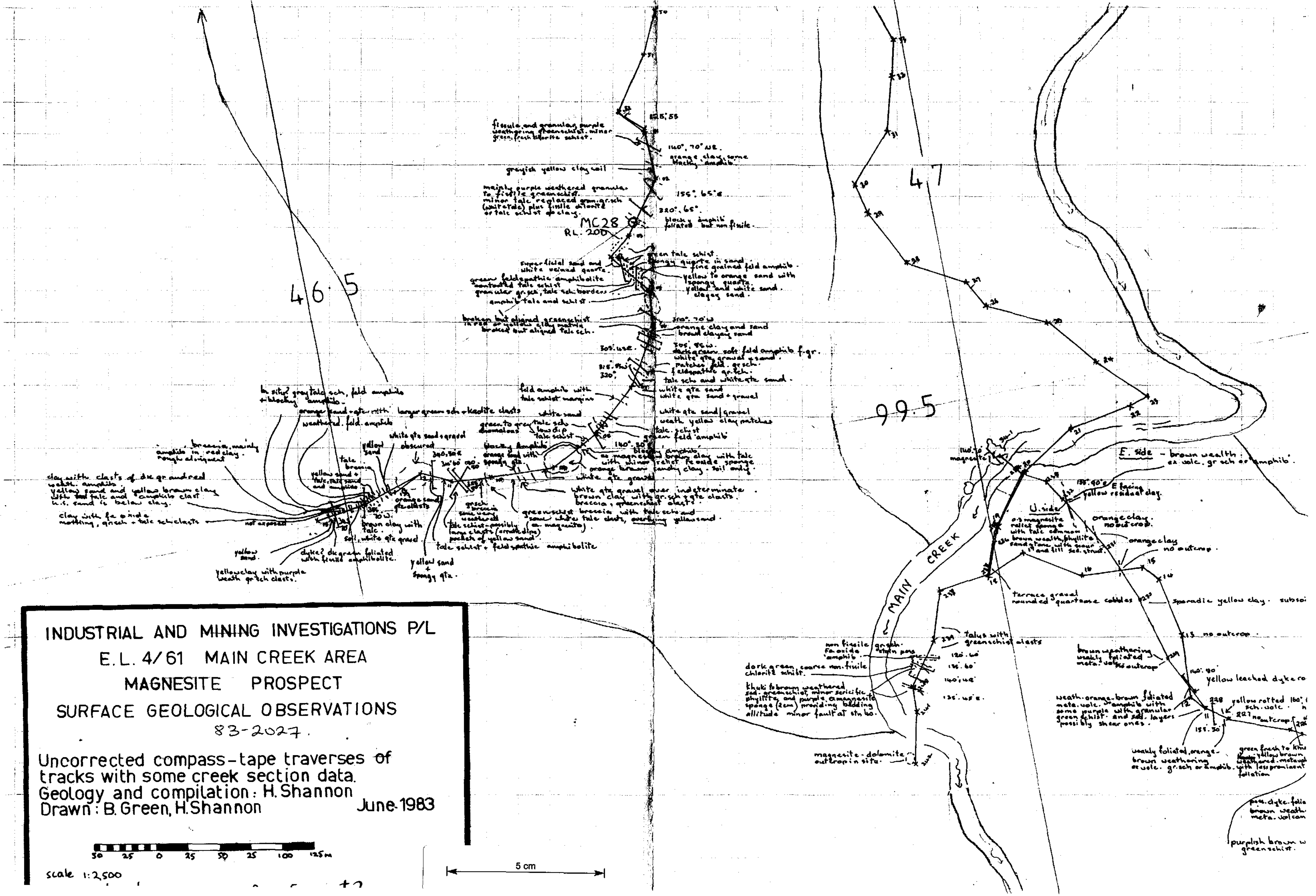
PLAN 4.2

83-2027

scale 1:15840


525090
INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 MAIN CREEK AREA
MAGNESITE PROSPECT
SURFACE GEOLOGICAL OBSERVATIONS
Uncorrected compass-tape traverses of tracks with some creek section data.
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon
June 1983
50 25 0 25 50 75 100 125m
scale 1:2,500
progress plan only
PLAN 5 part 1
83-2027
5 cm
00·5
465
47
00
MC21
MC23 (a),(b)
MC25
MC22
MC26
MC24
MC27
RL 170m
sporadic outcrops amphibolite
magnesite
sample B6
sample B13
sample B5
Spongy qtz float
no outcrop - yellow brown soil
limonite pisolites
Brown clay soils with pisolites.
Fe oxide/clay sponge ex magnesite
transported pebbly clay
transported pebbly clay soil with some pisolites.
no exposure
no exposure (Bridge over Sids Creek) at 72m
clay with purple to green clasts
poor exposure
thick pebbly soil
greenschist with magnesite

525091



INDUSTRIAL AND MINING INVESTIGATIONS P/L

E.L. 4/61 MAIN CREEK AREA

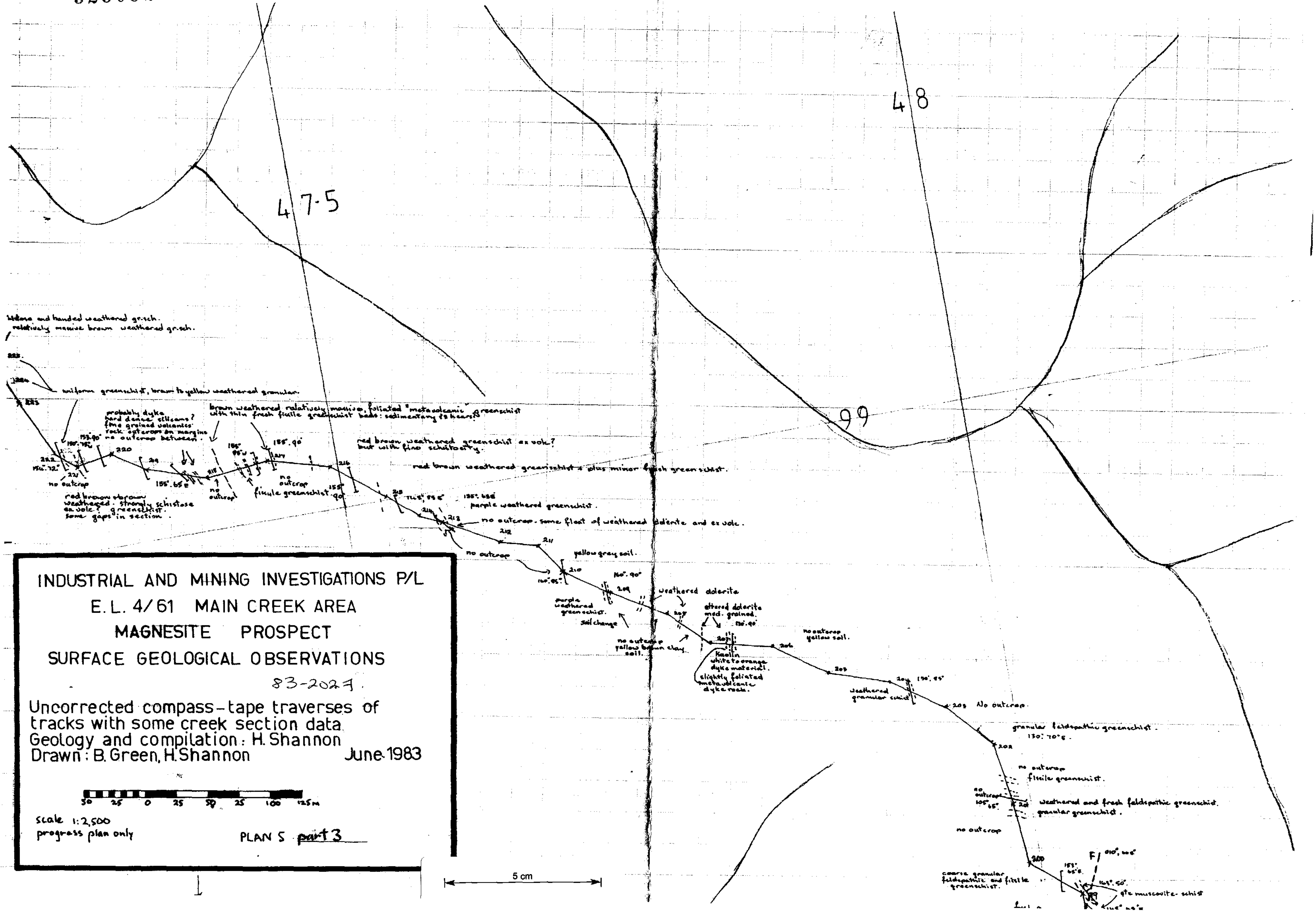
MAGNESITE PROSPECT

SURFACE GEOLOGICAL OBSERVATIONS

83-2027.

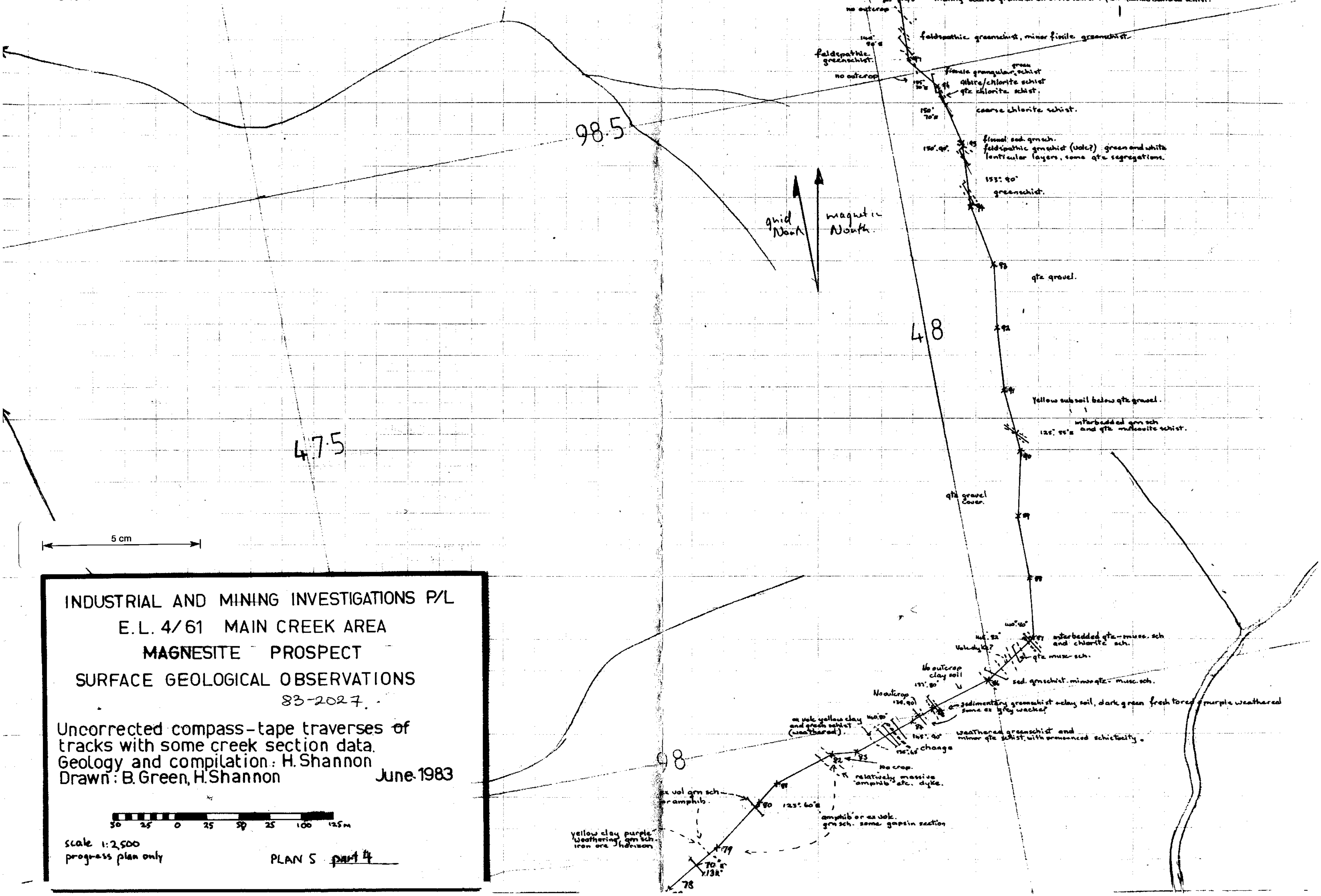
Uncorrected compass-tape traverses of tracks with some creek section data.
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon June 1983

525092



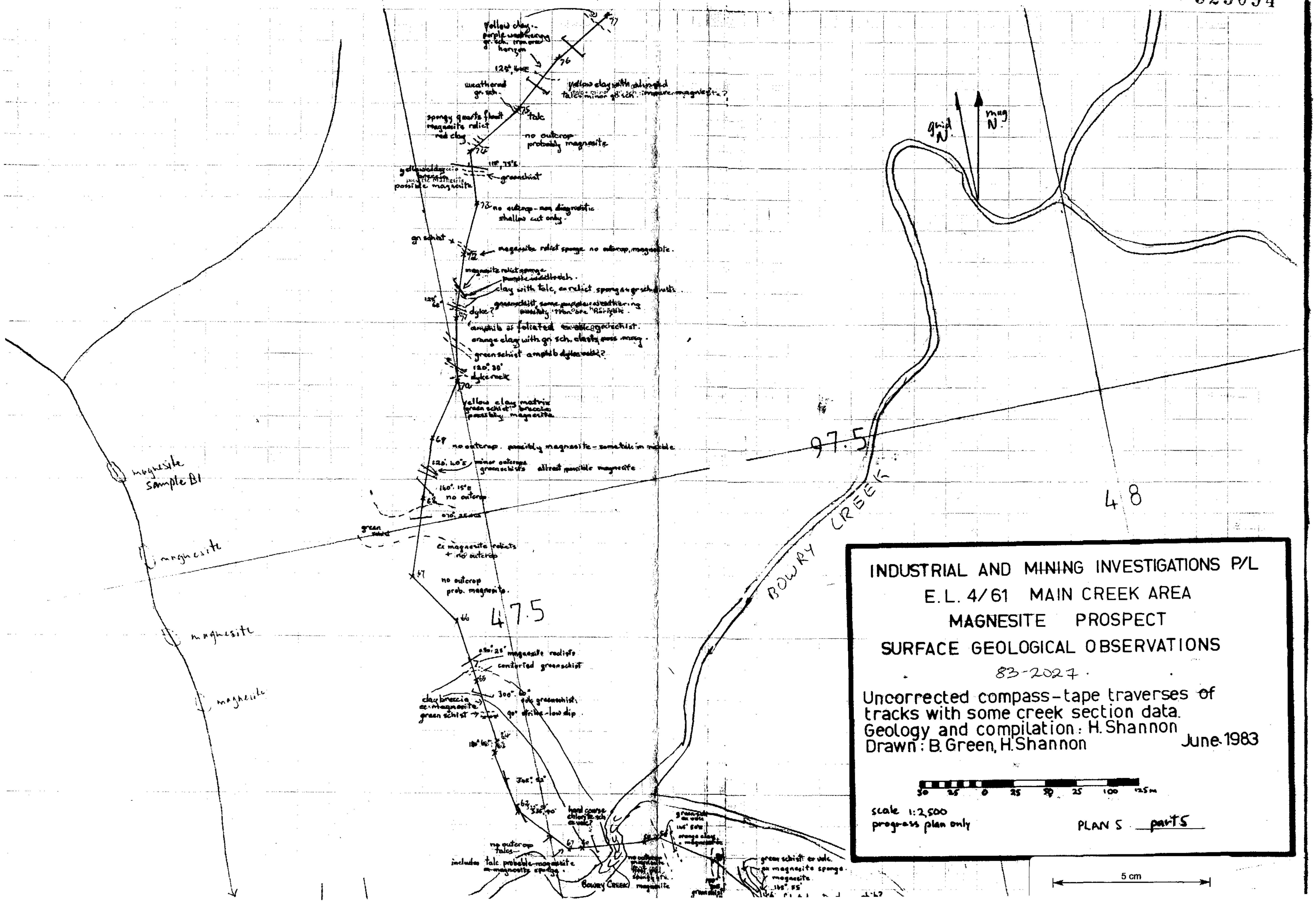
INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 MAIN CREEK AREA
MAGNESITE PROSPECT
SURFACE GEOLOGICAL OBSERVATIONS
83-2027
Uncorrected compass-tape traverses of tracks with some creek section data
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon
June 1983
50 25 0 25 50 75 100 125m
scale 1:2,500
progress plan only
PLAN 5 part 3
5 cm
47·5
48
99
relatively massive brown weathered gr.sch.
uniform greenschist, brown to yellow weathered granular.
probably dyke
hard dense silicous?
fine grained volcanics
rock outcrops on margins
no outcrop between.
brown weathered relatively massive, foliated "metavolcanic" greenschist with thin fresh fissile greenschist beds: sedimentary to heavy?
red brown weathered greenschist ex volc?
but with fine schistosity.
red brown weathered greenschist & plus minor fresh green schist.
no outcrop
red brown strongly weathered, strongly schistose ex volc? greenschist.
some gaps in section.
fissile greenschist
purple weathered greenschist.
no outcrop - some float of weathered dolerite and ex volc.
yellow grey soil.
weathered dolerite
altered dolerite med. grained.
purple weathered greenschist.
soil change
no outcrop yellow brown clay soil.
kaolin white to orange dyke material.
slightly foliated metavolcanic dyke rock.
no outcrop yellow soil.
weathered granular schist
No outcrop.
granular feldspathic greenschist.
no outcrop
fissile greenschist.
weathered and fresh feldspathic greenschist.
granular greenschist.
coarse granular feldspathic and fissile greenschist.
qtz muscovite schist

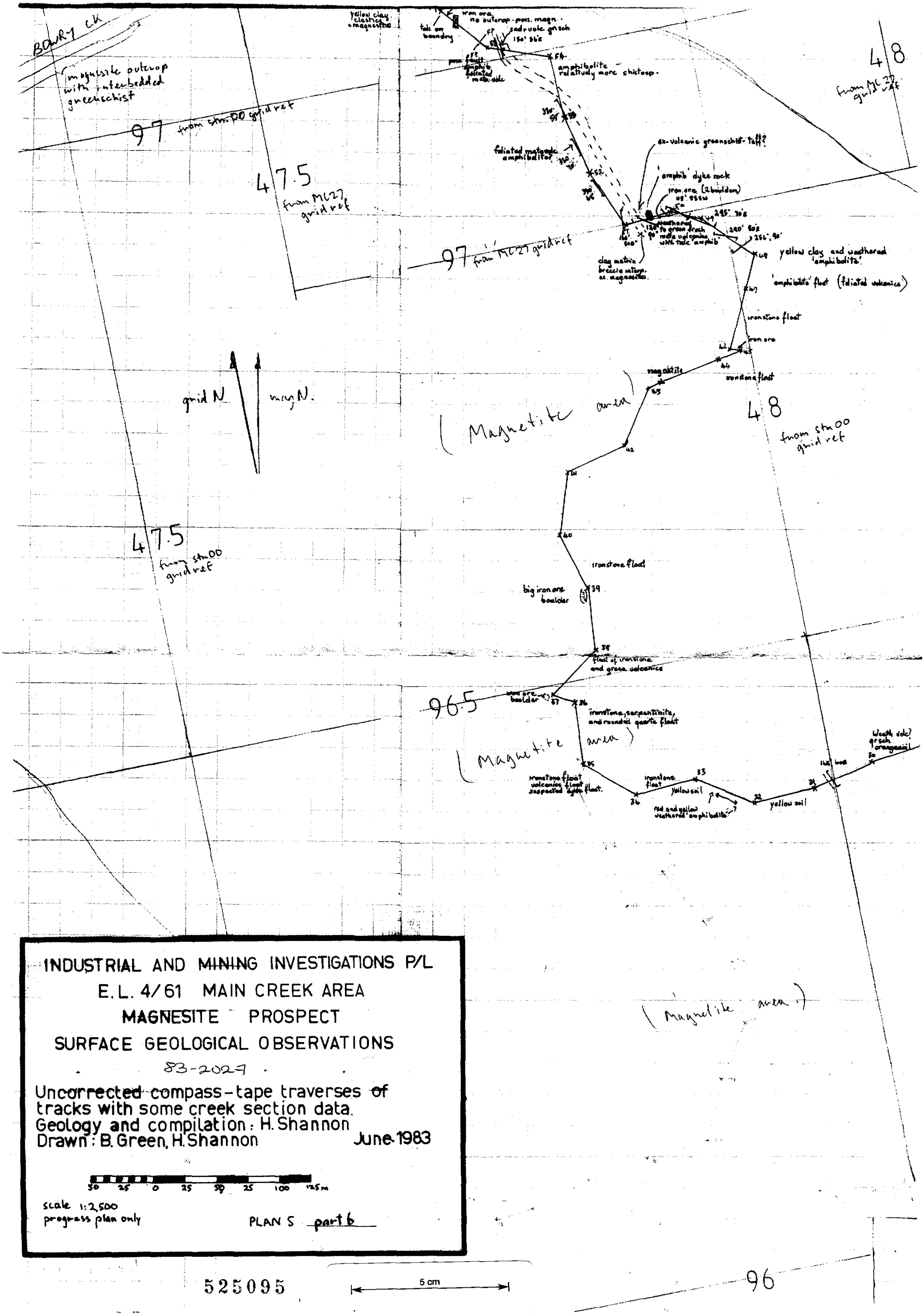
525093



mainly coarse granular chlorite schist + feldspathic banded schist.
no outcrop
feldspathic greenschist, minor fissile greenschist.
feldspathic greenschist.
no outcrop
fissile granular green schist
albite/chlorite schist
qtz chlorite schist.
coarse chlorite schist.
fissil sed. grnsch.
feldspathic grnschist (volc?) green and white lenticular layers, some qtz segregations.
greenschist.
98.5
grid North
magnetic North
qtz gravel.
48
Yellow subsoil below qtz gravel.
interbedded grn sch and qtz muscovite schist.
475
qtz gravel cover.
5 cm
interbedded qtz-musc. sch and chlorite sch.
qtz musc-sch.
No outcrop clay soil
sed. grnschist. minor qtz - musc. sch.
No outcrop
sedimentary greenschist + clay soil, dark green fresh tored + purple weathered some ex grey wacke?
ex volc yellow clay and green schist (weathered).
weathered greenschist and minor qtz schist with pronounced schistocity.
change
98
No crop.
relatively massive 'amphib' etc. dyke.
ex vol grn sch or amphib.
amphib or ex volc. grn sch. some gaps in section
yellow clay purple weathering grn sch. iron ore horizon
INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 MAIN CREEK AREA
MAGNESITE PROSPECT
SURFACE GEOLOGICAL OBSERVATIONS
83-2027.
Uncorrected compass-tape traverses of tracks with some creek section data.
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon
June 1983
50 25 0 25 50 25 100 125m
scale 1:2,500
progress plan only
PLAN 5 part 4

525094


INDUSTRIAL AND MINING INVESTIGATIONS P/L
E.L. 4/61 MAIN CREEK AREA
MAGNESITE PROSPECT
SURFACE GEOLOGICAL OBSERVATIONS
83-2027
Uncorrected compass-tape traverses of tracks with some creek section data.
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon
June 1983
scale 1:2,500
progress plan only
PLAN 5 part 5
5 cm
grid N
mag N
BOWRY CREEK
97.5
48
47.5
magnesite sample B1
magnesite
yellow clay matrix
no outcrop prob. magnesite
contorted greenschist
Bowry Creek



INDUSTRIAL AND MINING INVESTIGATIONS P/L

E.L. 4/61 MAIN CREEK AREA

MAGNESITE PROSPECT

SURFACE GEOLOGICAL OBSERVATIONS

83-2024

Uncorrected compass-tape traverses of tracks with some creek section data.
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon — June 1983

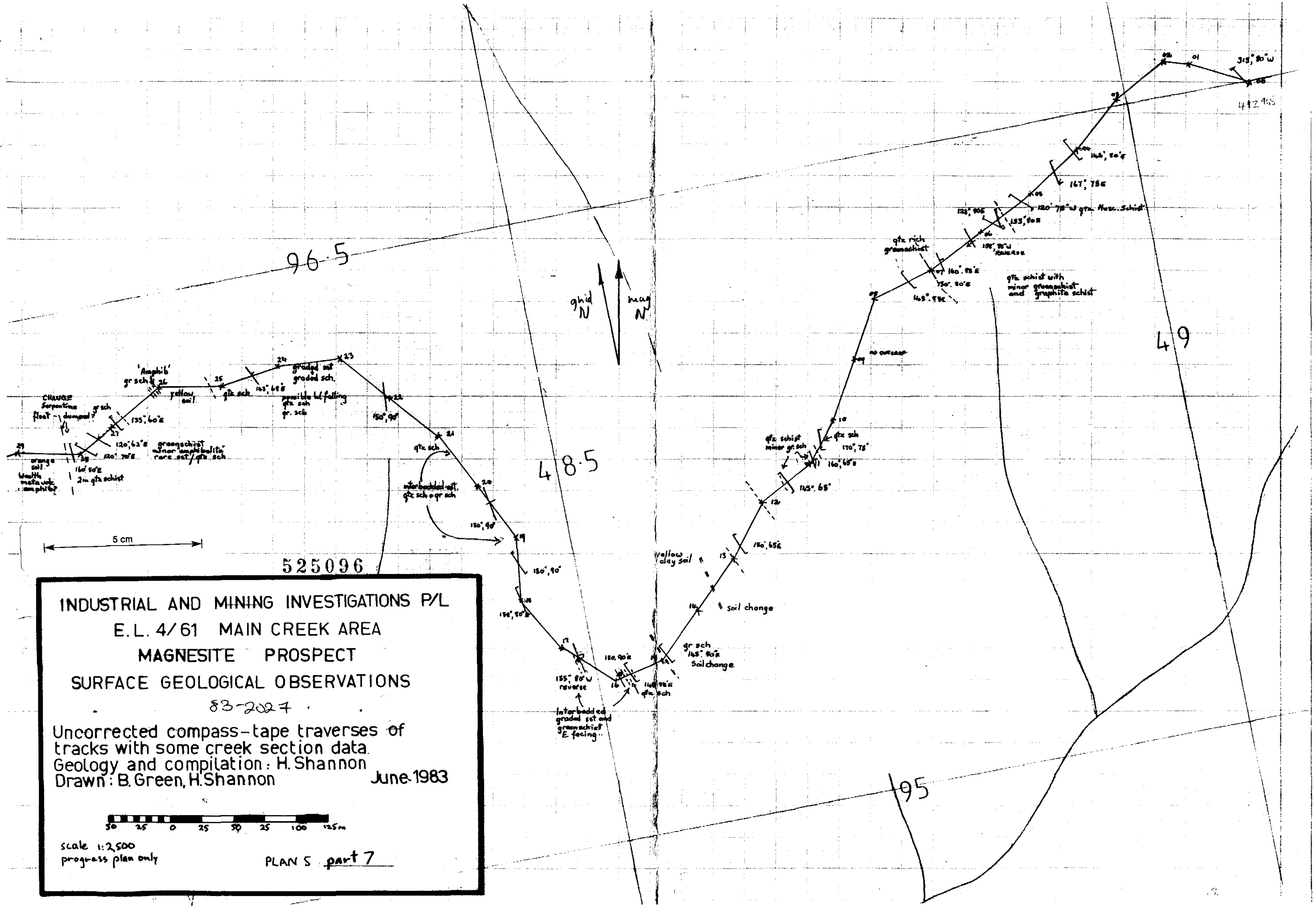
50 25 0 25 50 75 100 125m

scale 1:2,500
progress plan only

PLAN 5 part 6

525095

5 cm



INDUSTRIAL AND MINING INVESTIGATIONS P/L

E.L. 4/61 MAIN CREEK AREA

MAGNESITE PROSPECT

SURFACE GEOLOGICAL OBSERVATIONS

83-2027

Uncorrected compass-tape traverses of tracks with some creek section data.
Geology and compilation: H. Shannon
Drawn: B. Green, H. Shannon

June 1983

50 25 0 25 50 75 100 125m

scale 1:2,500
progress plan only

PLAN 5 part 7