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PROSPECT 7612

CSR LIMITED
MINERALS EXPLORATION AND DEVELOPMENT GROUP

EL 39/85, BULGOBAC RIVER, TASMANIA
PROGRESS REPORT
FOR THE PERIOD
ENDING 31 MARCH, 1987

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KEYWORDS

BULGOBAC

QUE RIVER

MT. READ

DUNDAS

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HELLYER

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8014

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EL 39/85

GEOLOGY

GEOPHYSICS

AEROMAGNETICS

GRAVITY

INDUCED POLARISATION

RESISTIVITY

VLF-EM

CSAMT

DRILLING

CONTENTS

	<u>PAGE NO.</u>
1. INTRODUCTION	1
2. SUMMARY	2
3. PREVIOUS EXPLORATION	4
4. REGIONAL GEOLOGY AND MINERALISATION	6
5. ACCESS, GRIDDING AND SURVEY CONTROL	8
6. GEOLOGICAL MAPPING	9
7. GEOPHYSICS	11
7.1 Aeromagnetics	11
7.2 VLF-EM	12
7.3 Induced Polarisation	13
7.4 CSAMT	14
7.5 Gravity	14
8. PROPOSED EXPLORATION PROGRAMME	16
8.1 Diamond Drilling	16
8.2 Grid Extension	17
8.3 Laboratory Studies	18
9. CONCLUSIONS AND RECOMMENDATIONS	19
10. REFERENCES	20

APPENDICES

- I PETROLOGY
- II GEOPHYSICAL INTERPRETATION
- III GRAVITY SURVEY

004

LIST OF ILLUSTRATIONS

<u>FIGURES</u>		<u>FACING PAGE NO.</u>
1	LOCATION MAP	1
2	CSAMT INTERPRETATION - LINE 7600N	14
3	GRAVITY SURVEY - BOUGUER ANOMALY	15
<u>PLAN (in pocket)</u>		
<u>DRG NO.</u>		<u>SCALE</u>
7612-2	BULGOBAC CREEK, GRAVITY VALUES AND CONTOURS	1:5,000
7612-3	BULGOBAC CREEK, AEROMAGNETIC CONTOURS	1:10,000
7612-4	BULGOBAC CREEK, FLIGHT PATH RECOVERY MAP	1:10,000
7612-5	BULGOBAC CREEK, QUE ROAD VLF PROFILES	1:5,000
7612-6	BULGOBAC CREEK, IP CHARGEABILITY	1:5,000
7612-7	BULGOBAC CREEK, IP RESISTIVITY	1:5,000
7612-8	BULGOBAC CREEK, REGIONAL GRAVITY	1:25,000
7612-9	BULGOBAC CREEK, CSAMT CAGNIARD RESISTIVITIES	1:5,000
7612-10	BULGOBAC CREEK, INTERPRETATION MAP	1:5,000
7612-11	BULGOBAC RIVER, RECONNAISSANCE MAPPING PHASE, ACCESS AND CO-ORDINATES	1:10,000
7612-12	BULGOBAC RIVER, GRID LINES CUT TO MARCH 1987	1:10,000
7612-13	BULGOBAC RIVER, GEOLOGICAL MAPPING TO MARCH 1987	1:5,000

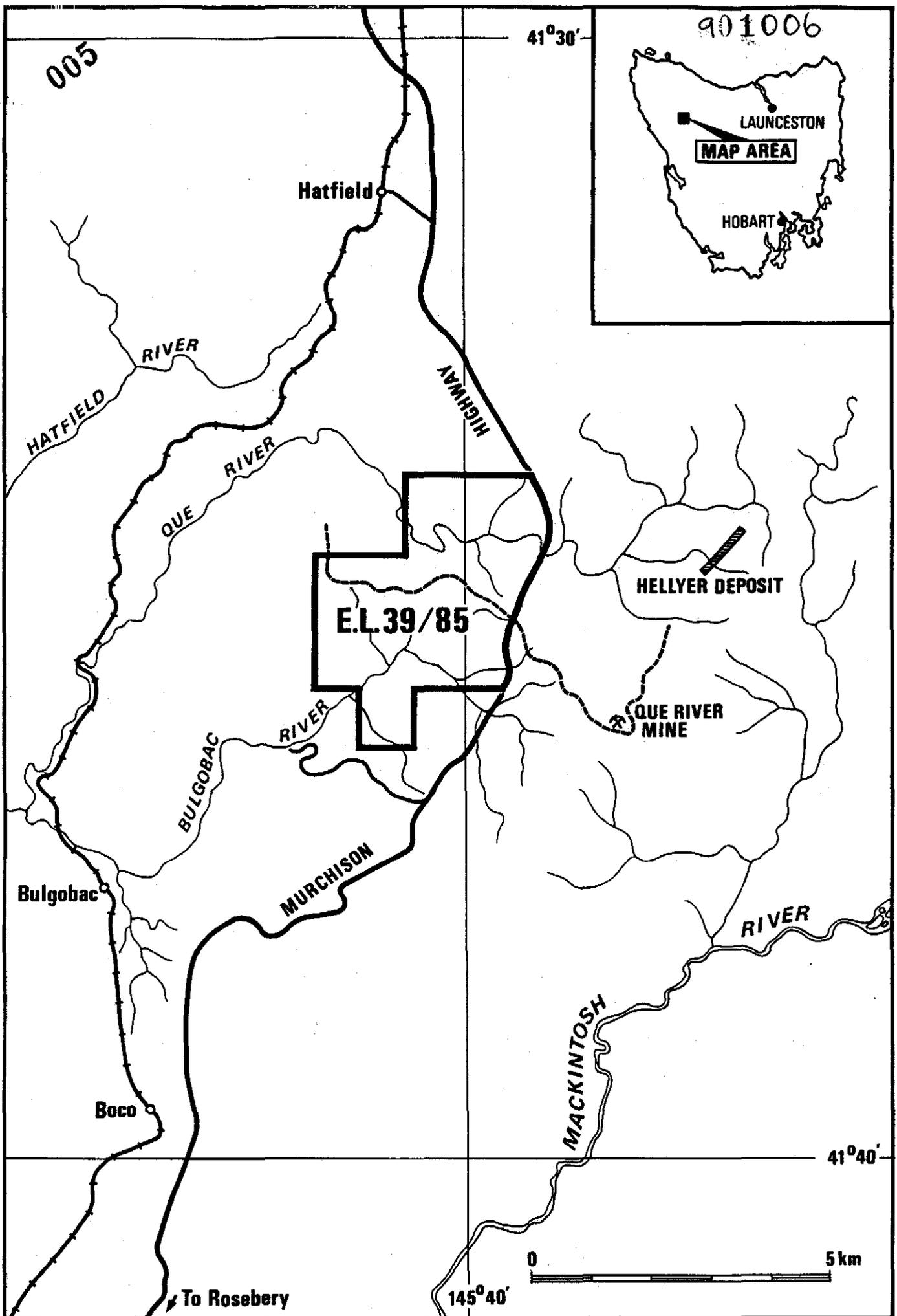


FIG. 1 LOCATION MAP E.L.39/85 BULGOBAC RIVER TAS.

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1. INTRODUCTION

EL 39/85, "Bulgobac River", is located 60 km SSW of Burnie, a major industrial town and port on the NW coast of Tasmania. The Murchison Highway forms the eastern boundary of the 11 km² title which was granted on 14 February, 1986. Aberfoyle's Que River and Hellyer mines are located immediately east of the adjacent Murchison Highway (Figure 1).

The EL was granted after an application under the recently introduced tender system. The area, which had been held by Comstaff Pty. Ltd. as part of EL 5/63, became available when EL 5/63 was reduced to the maximum allowable area of 125 km².

The exploration target in EL 39/85 is a volcanogenic polymetallic base and precious metal deposit similar to the nearby Hellyer deposit. The Hellyer deposit has a published ore resource of 15M tonnes indicated at 13.0% Zn, 6.9% Pb, 0.4% Cu, 156 g/t Ag and 2.3 g/t Au, and a further 4.0M tonnes inferred, Aberfoyle (1987).

2. SUMMARY

EL 39/85, "Bulgobac River", of 11 km² is located on the western side of the Murchison Highway, 60 km south-southwest of Burnie. The exploration target is a massive base metal sulphide deposit, similar to the Hellyer and Que River deposits located immediately to the east of the Licence.

The majority of the Cambrian rocks exposed on the Licence are higher in the stratigraphy than those hosting the Que River and Hellyer deposits, but the relatively flat-lying geology suggested potential existed for the location of blind ore deposits.

Exploration completed to the end of March 1987 by CSR has included the following:

- (i) aeromagnetic survey at 100 m line spacing
- (ii) reconnaissance geological mapping of tracks and streams
- (iii) cutting of access grid lines and streams for (ii) above
- (iv) cutting of a high-quality survey grid using the same grid orientation and co-ordinate system as used by Aberfoyle to the east of the Murchison Highway.
- (v) coverage of sections of the above grid with the following geophysical techniques:
 - (a) VLF-EM
 - (b) gradient array IP
 - (c) CSAMT
 - (d) gravity

- (vi) to enable reduction of the gravity survey, the majority of the grid was accurately surveyed by contract surveyors and the remainder of the gravity stations levelled by CSR employees.
- (vii) drill targets were selected.
- (viii) tracks were constructed to permit access for diamond drill testing of the above targets.

The geology and geophysics have supported the presence of a flat-lying synclinal structure with the potentially mineralised stratigraphy hosting the Hellyer and Que River ore deposits being expected at several hundred metres depth over an area of several square kilometres. Within this area, two drill targets have been selected for immediate testing. Both targets involve combinations of gravity and CSAMT phase anomalies.

Grid-based geological and geophysical surveys will be continued during the next summer field season.

3. PREVIOUS EXPLORATION

The Gold Hill prospect, located immediately north of the Que River mine, was located by prospecting activity in the 1920's. Prospectors followed panned gold upstream from the Que River to locate Gold Hill. Consequently, it is probable that prospecting activity extended into EL 39/85. However, no mineral occurrences are recorded within EL 39/85 and exploration to date has not located any evidence of early prospecting.

Forrestry operations were undertaken in the late 1960's-early 1970's in the plateau area on the western section of EL 39/85. The area logged was the myrtle rainforest growing on red soils developed over Tertiary basalt. Access to this area was by a gravelled road, the "Que Road", from the Murchison Highway.

Geological mapping of the area was undertaken on a limited basis by geologists employed by Rio Tinto as part of a joint venture with EZ in the 1950's. Department of Mines' geologists mapped part of the area as shown on the published Mackintosh 1"=1 mile geological map.

In 1969-1971, Comstaff Pty. Ltd. completed stream sediment and geological mapping of the area as part of a reconnaissance programme on EL 5/63. Results for this stream sediment sampling are available on open-file reports at the Department of Mines. Evidence of this sampling programme was observed during geological mapping of EL 39/85.

The programme undertaken by Comstaff consisted of detailed -80 mesh stream sediment sampling and limited heavy mineral concentrate stream sediment sampling. This sampling produced two areas in or adjacent to EL 39/85 which were followed-up:

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- (i) Debussey Creek resulted from an anomalous gold assay in a heavy mineral concentrate stream sediment sample, and
 - (ii) Sock Creek area resulted from anomalous -80 mesh stream sediment samples.

The Debussey Creek anomaly was followed-up with additional stream sediment geochemistry and A⁰ horizon soil sampling with negative results. Additional follow-up in 1984 located only one sample with detectable gold in a heavy mineral concentrate, Comstaff Pty. Ltd. (1985).

The Sock Creek anomalies were followed-up and the Sock Creek vein type Ag-Pb-Zn mineralisation discovered. The Sock Creek prospect is located 1 km southwest of the southwest corner of EL 39/85. The follow-up sampling programme in the Sock Creek area extended into EL 39/85 with grid lines being cut into the Hash and Joint Creek areas. It is believed that geological mapping, soil geochemistry and a moving loop EM system was undertaken on these grid lines, but no data for this work are available on open-file reports at the Department of Mines.

In 1975, as part of a larger programme on EL 5/63, an INPUT EM and magnetics survey was flown over the area. Within EL 39/85, no follow-up to this survey was undertaken as the major conductive zones located were interpreted to be due to surficial or stratigraphic conductors, Butt et al (1975).

4. REGIONAL GEOLOGY AND MINERALISATION

The lithologies of exploration interest are the Cambrian calc-alkaline Mt. Read Volcanics which host important base metal deposits at Mt. Lyell, Hercules, Rosebery, Que River and Hellyer. The regional geology is described in numerous publications, e.g. Corbett and Lees (1987).

Prior to the discovery of the Que River Deposit in 1974, the geology of the area of EL 39/85 was poorly investigated. Knowledge of the geology and structure of the area progressed with exploration undertaken by Aberfoyle, Comstaff and EZ on various ELs within the general area. Mapping was undertaken by the Department of Mines prior to preparation of the explanatory notes on the Mackintosh 1 mile map (Collins et al, 1981).

Collins (op cit) postulated the following sub-division of the Mt. Read Volcanics in the Que River area:

- (i) a western volcano-sedimentary sequence of which the Que River Beds (Que River Shales), of late Middle Cambrian age, were interpreted as the basal sediments in the Que River area, and
- (ii) an eastern (central) volcanic sequence which in the Que River area was dominantly andesitic.

The boundary between the two sequences was interpreted to be discordant and in places in faulted contact.

With the discovery of the Hellyer deposit in the early 1980's, and the consequent generation of more detailed knowledge of the stratigraphy and structure, the Que River Shale was interpreted to be in conformable contact with the underlying volcanics. Thus, the stratigraphy hosting the Hellyer deposit could be projected down dip into the eastern area of EL 39/85.

Regional studies by CSR included the following data pertinent to EL 39/85:

- (i) A major thrust fault was interpreted, on aerial photographs; to cut E-W immediately south of Mt. Charter as subsequently shown on the recently published 1:25,000 scale Department of Mines mapping.
- (ii) A systematic pattern of Landsat linears was interpreted as possible structural controls on the Que River and, to a lesser extent, the Hellyer deposits. Similar intersecting linears were identified within the area subsequently granted as EL 39/85. This interpretation, which was undertaken on images generated after geometrical correction of the digital data to the Australian Metric Grid, was undertaken as part of a regional study and consequently is not included in this report on EL 39/85.

5. ACCESS, GRIDDING AND SURVEY CONTROL

Pre-existing vehicular access to the EL was good with the eastern boundary being the Murchison Highway, the "Que Road" logging track running east to west through the centre of the title and other logging tracks providing access into the SW corner.

A 100 m wide Scenic Reserve occurs along the side of the Murchison Highway. Discussions with the Department of Mines indicate that the National Parks and Wildlife Service will not allow any access construction for exploration purposes through this Scenic Reserve.

Initial geological mapping was undertaken along creeks and several grid lines cut on the AMG orientation (see DRG No. 7612-11). Creek names shown on plans produced by Comstaff have been utilised where no evidence of a previous name exists.

This phase of geological mapping indicated a grid orientation similar to that used by Aberfoyle over the adjacent ELs would be suitable for geophysical surveys. The mathematical formula for transformation of the Aberfoyle grid from AMG was obtained from the Department of Mines and a base line at 2400E establishing using Forestry Department survey points on Que Road. The extent of grid lines cut to March 1987 is shown on DRG No. 7612-12.

In order to provide accurate survey locations for a detailed gravity survey, a closed traverse was completed along the 2400E base line and the Murchison Highway by Peacock, Darcy and Anderson, consulting surveyors. During this closed traverse, all visible grid pegs were co-ordinated. Subsequently, all the remaining gravity stations were levelled by CSR personnel.

Following discussions with the Department of Mines, bulldozed access tracks were constructed to the north and south of Que Road to provide access for diamond drilling. Accurate survey locations of these tracks was not available at the end of March 1987.

6. GEOLOGICAL MAPPING

The first phase of geological mapping was undertaken with the following objectives:

- (i) to improve geological knowledge and thus
- (ii) the more prospective sections of the EL could be identified for early geophysical testing, and
- (iii) the structure could be determined to select the most applicable grid orientation.

This mapping identified the following important aspects of the geology as shown on DRG No. 7612-13:

- (i) Shale units in the Bulgobac River downstream of the Murchison Highway and in southward flowing tributaries of the Bulgobac River identified a flat-lying synclinal structure within the acid pyroclastics overlying the Que River Shales.
- (ii) Mapping in Mutter Creek, a major SSW flowing tributary of the Bulgobac River, located shales and pyritised and altered acid to intermediate volcanics. These rocks were interpreted as correlates of the Que River Shales and the volcanics footwall to the Que River Shales. A single thin sediment horizon within the volcanics indicated a 20° dip to the SE.
- (iii) Mapping on a grid line cut along AMG 5395000mN between 388000mE and 389000mE located shallow, SE-dipping shales to the east of Mutter Creek. These shales were also considered to be correlates of the Que River Shales, thus supporting a flat-lying syncline with a SW-NE

axis in the area between Mutter Creek and the Murchison Highway. The western side of this syncline had potential for the location of mineralisation at a shallow depth.

- (iv) The stratigraphy hosting the Sock Creek mineralisation to the SW of the EL continues NE into the SW corner of the EL and must be truncated by the presumed continuation of the Mt. Charter fault as shown on the Department of Mines recent 1:25,000 scale mapping.

Subsequently, the geophysical grid was cut and mapping completed on these lines to the south of Que Road. This mapping produced limited extra geology and confirmed the previously interpreted geology.

Geological mapping was supported with petrological examination of 54 samples. This petrology is included as Appendix I.

7. GEOPHYSICS

7.1 Aeromagnetics

Although a very subtle response can be demonstrated for the massive sulphide deposits of Western Tasmania (Leaman, 1987), aeromagnetics was not considered as a direct search method but only as an aid to geological interpretation. In the summer of 1985-1986, CSR had arranged a contractor to fly aeromagnetics on another project in western Tasmania and thus EL 39/85 was flown at marginal extra cost. Previous reprocessing of the 1981 Department of Mines aeromagnetic survey had suggested a vague linear distortion of the magnetics which was interpreted as demagnetising alteration of a possible fracture zone within EL 39/85.

The low-level detailed aeromagnetic survey, completed early in 1986, used the GeoMetrics gradiometer system and was flown at a nominal terrain clearance of 70 m and a flight line spacing of 100 m. The data presented as DRG No. 7612-3 is the contouring of the tail boom magnetometer data as the pitch and roll measurement/corrections are inadequate for the full gradiometer data in relation to the detail obtained by 100 m line spacing. Contouring of the gradiometer data results in distortions due to altitude and levelling difficulties. DRG No. 7612-4 indicates the flight path recovery of the survey.

As shown on DRG No. 7612-3, the aeromagnetic responses can be divided into the following:

- (i) an intense pattern of highs and lows over Tertiary basalt, and
- (ii) over the Cambrian rocks a flat magnetic field over which a strong regional gradient increasing to the SW is observed.

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- (iii) a high/low dipole in the southern 1 km² projection of the EL is probably straddling the NW continuation of the Mt. Charter Fault

- (iv) a NE-SW trending ridge in the contouring on the eastern side of the Murchison Highway is considered to result from a +3-4 Nt response over the Hellyer Basalt which is footwall to the Que River Shales.

The only ground follow-up of the aeromagnetics has been a single short traverse along 388350mE AMG south from 5395000mN to locate an intense magnetic high. Tertiary basalt located on this traverse coincides with this magnetic high and is considered to be the source of the magnetic anomaly.

7.2 VLF-EM

With the exception of the areas covered by Tertiary basalt and the swampy area around the confluence of Mutter Creek with the Bulgobac River, soil cover is probably less than 1.0 m depth over the EL. Thus it was considered that VLF-EM could provide a technique to map conductive shale units within resistive volcanics. Consequently, CSR's VLF-EM 16 unit using the NW Cape frequency, was run on the grid lines south of Que Road.

The orientation of the NW Cape signal to the orientation of the relatively flat-lying lithologies is far from ideal and has added to the circumspection with which the VLF data were regarded. The signal from the Japanese transmitter is almost inaudible, and consequently could not be utilised.

The VLF data are presented in Fraser filtered form as DRG No. 7612-5.

7.3 Induced Polarisation

With the interpretation of a synclinal structure between Mutter Creek and the Murchison Highway, it was decided to use gradient array IP to outline the extent of the chargeable and low resistivity shale unit with the more resistive volcanics. In addition, the extent of the pyritised volcanics in Mutter Creek could be determined and any other zone of chargeable volcanics located.

Zonge Engineering undertook this work in December 1986 and January 1987 using a current electrode separation of 3.5 km and energisation with a 7.5 KVA generator. Potential electrode measurements were made at 25 m dipole separation. The data are presented as apparent resistivity (in ohm metres) and as phase (in milliradians) on DRG Nos. 7612-7 and 7612-6 respectively.

Results for this survey indicate the following:

- (i) a western zone of high resistivity and low chargeability (phase response) except over the pyritised volcanics in Mutter Creek, and
- (ii) an eastern zone of low resistivities and moderate to high chargeabilities.

The western zone is interpreted to represent volcanic rocks footwall to the Que River Shale horizon. The eastern zone is dominated by the response from the Que River Shale horizon which is interpreted to have a shallower dip than indicated by the geological mapping. Due to the effects of current channelling in such a flat-lying conductive lithology, it is doubtful that the gradient array would have penetrated beneath the Que River Shale horizon. Depth penetration in the resistive western zone is estimated as a maximum of 100 m.

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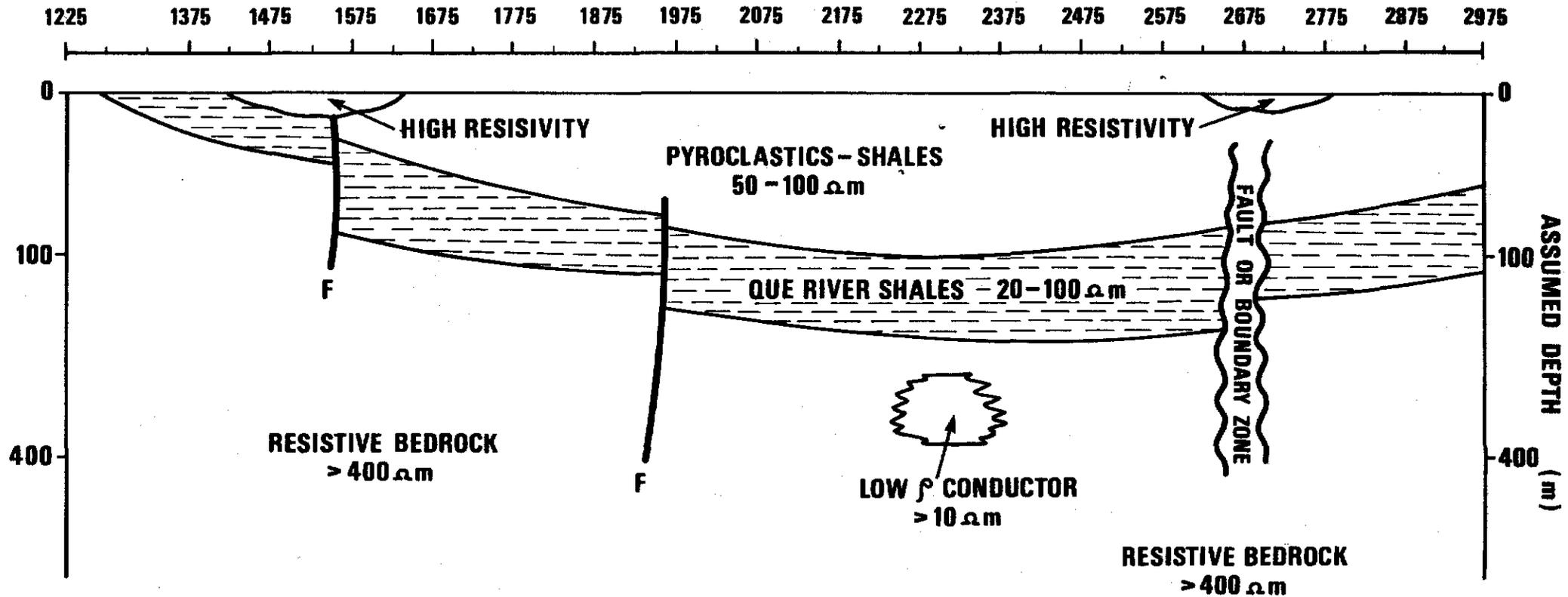


FIG. 2 CSAMT INTERPRETATION - LINE 7600N, BULGOBAC RIVER TAS.

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7.4 CSAMT

The INPUT EM survey flown in 1975 (op cit) indicated that the near-surface bedrock immediately west of the Murchison Highway was of sufficiently low resistivity to generate strong EM anomalies. The extent of these anomalies indicated probable flat-lying Que River Shales. Consequently, application of a large, fixed loop EM system, was not regarded as an optimal exploration technique in the search for a conductive massive sulphide body beneath the Que River Shales. Previous experience with the CSAMT technique, offered by Zonge Engineering, suggested this could be applicable in the search for a conductive body beneath a flat-lying conductive horizon.

Line 7600N was selected as a test line to confirm the application of CSAMT to the area. This test line confirmed the geological interpretation of the flat-lying synclinal structure, and additionally, located a phase anomaly at depth beneath the Que River Shales. Geophysical interpretation suggested this anomaly at 2350E/7600N was a drill target regardless of the gravity data (Figure 2).

With the success of the test line of CSAMT, an extended programme was undertaken during February/March 1987. Appendix II includes data on this survey and its interpretation. A further phase anomaly similar to that at 2350E/7600N was located at 2750E/7400N.

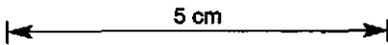
7.5 Gravity

A gravity survey undertaken by the Department of Mines (Hudspeth and Richardson, 1985) indicated a significant gravity anomaly over the Hellyer deposit. With this encouragement, a gravity survey was undertaken over the gridded area immediately west of the Murchison Highway to cover the areas of favourable stratigraphy delineated by the

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DOM = Dept. of Mines Gravity Stn.
Density = 2.67 t/cu m
15 mGal added to all values
SCALE 1:10,000



5396 000 N

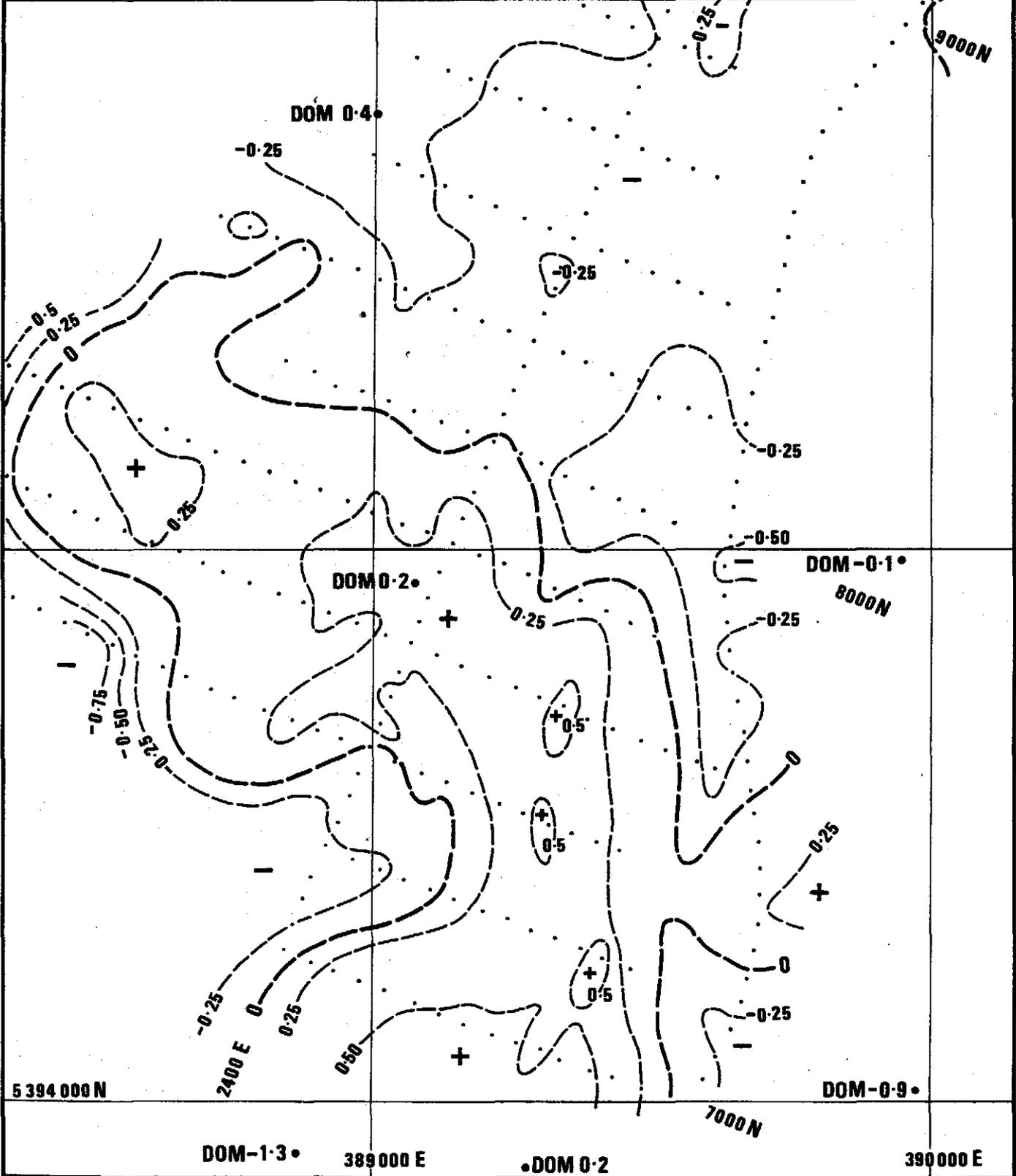


FIG.3 CSR QUE ROAD BOUGUER ANOMALY GRAVITY SURVEY

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available geological mapping. Except for the westward extensions on Lines 7400N, 7600N and 7800N, this survey was undertaken where the terrain was not adverse for topographic surveying.

Technical details on this survey are included in Appendix III and results are presented in map form in DRG No. 7612-2.

North of 7800N, the gravity data do not suggest the presence of any ore deposits. However, a major positive gravity anomaly occurs in a zone extending through 2800E/7000N; 2800E/7200N; 2750E/7400N; 2700E/7600N and 2400E/7700N. Although this anomaly is, on the detailed data, open to the south, the Department of Mines' data suggest a rapid closure must exist (Figure 3).

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8. PROPOSED EXPLORATION PROGRAMME

During the period, April 1987 to February 1988, the following programmes are proposed:

- (i) diamond drilling of targets generated to March 1987,
- (ii) grid extension and further geological and geophysical surveys,
- (iii) laboratory studies.

Due to the potential of the EL to host blind massive sulphide deposits, exploration is reliant on geological interpretation and geophysics. Work completed from February 1986 to March 1987 has located a major positive gravity anomaly, possibly caused by the density contrast of a massive sulphide deposit. Several phase anomalies in the CSAMT data coincide with the gravity data. However, further application of these geophysical techniques must await the results of drill testing of the anomalies generated to date. Thus, a final decision on the geophysical surveys to be undertaken in the summer of 1987/88 can not be made until drilling has been completed and the results assessed.

8.1 Diamond Drilling

The following programme is proposed:

DDH BRD 001 : a vertical hole at 2350E/7600N to a depth of 450 m. The target is a CSAMT-phase anomaly at a depth of 370 m. This anomaly is located in the less intense flank of the gravity high.

DDH BRD 002 : a vertical hole at 2750E/7400N to a depth of 500 m. The hole is centred on a gravity high and a CSAMT-phase anomaly at a depth of 400 m.

Both BRD 001 and BRD 002 should pass down through the following stratigraphy:

	BRD 001	BRD 002
Acid pyroclastics	0- 50 m	0- 50 m
Que River Shale	50-200 m	50-200 m
Volcanics	200-EOH	200-EOH
Drill Target	370 m	400 m

DDH BRD 003 : an angled-hole on a westerly azimuth to test the pyritised and altered volcanic stratigraphy west of 1750E on Line 7600N. Estimated total hole depth is 250 m.

If the budget allows, a stratigraphic hole may be drilled in the area immediately south of the Que River and west of the Murchison Highway.

Where applicable, downhole EM surveys will be undertaken.

8.2 Grid Extension

Grid-based surveys during 1987/88 will concentrate on the area of the Licence north of Que Road. The line spacing of 200 m will be continued and, where necessary, grid N-S base lines will be cut at 1000 or 800 m intervals to allow laying of UTEM loops. Approximately 30 line km of grid will be cut in 1987/88 resulting in about 8 km² of the 11 km² Licence being covered with E-W grid lines at 200 m intervals.

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Unless the terrain becomes too adverse for a cost-efficient survey, the grid will be covered with a continuation of the gravity survey. The type of electrical geophysics will be determined by the results of the drill testing of the CSAMT anomalies located to date. An alternative to CSAMT will be a large, fixed-loop EM survey.

8.3 Laboratory Studies

In addition to analysis directed on the detection of the target mineralisation (viz Cu, Pb, Zn, Ag, Au), the following analyses may be required:

- (i) whole rock and trace element analyses to categorise rock types and to determine alteration patterns.
- (ii) oxygen and carbon isotopes to determine maximum temperatures of hydrothermal fluids.
- (iii) lead isotopes to confirm source of lead mineralisation.

9. CONCLUSIONS AND RECOMMENDATIONS

Exploration of EL 39/85 has been directed at the testing of the down-dip projection of the stratigraphy hosting the nearby Hellyer deposit.

A synclinal structure trending NNE-SSW with relatively flat-lying stratigraphy has increased the area of target stratigraphy amenable to geophysical testing.

Gravity and CSAMT surveys have generated two high-priority drill targets in interpreted favourable stratigraphic positions. These targets will be drilled in April-August, 1987. Testing of these drill targets will allow assessment of the geophysical technique.

It is recommended that, in addition to the proposed diamond drilling, the programme of gridding, geological mapping and geophysical surveys be continued over the remainder of the title area considered to have potential for the target mineralisation.

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REW/SGL

June 1987

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APPENDIX I

PETROLOGY

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B.J. BARRON, B.Sc., Ph.D., (Sydney)

PETROLOGIST

901030

7 Fairview Ave.,
St. Ives,
SYDNEY NSW 2075
Tel. (02) 449 5839

Our ref: C7/85/333a

Your ref: Purchase Order 30832,
Field sample despatch sheet 16582.

PETROGRAPHIC EXAMINATION OF
TWENTY ROCK SAMPLES

Report No: C7/85/333a

16th March, 1986.

For: CSR Limited, Minerals Division.


Dr. B.J. Barron,
Consulting Petrologist.

SUMMARY

Tuffaceous rocks from an acidic to acid-intermediate source greatly predominate in the twenty samples of the present suite, with subordinate igneous lithologies and two clastic sedimentary samples.

The tuffaceous lithologies include poorly sorted acidic crystal tuff with subordinate lithic fragments (A 162201, A 162202), in which broken angular quartz chips and albitised feldspar cleavage fragments generally account for more than a quarter of the total thin section area. The lithic component of these rocks includes altered, once-glassy quartz and feldspar porphyritic acidic volcanic types, and clasts that are themselves fragmental. The acidic tuffaceous lithologies in which lithic fragments predominate include A 162204, A 162208 and A 162209. These rocks contain major proportions of once glassy to fine grained ?flow banded, perlitic, vesicular and pumiceous volcanic lithic fragments, as well as subordinate broken phenocrystic quartz and albitised feldspar fragments. Glass shard outlines are scarce in the samples A 162208 and A 162209. On the other hand, clear relict textures of glass shards predominate in the following samples of vitric tuff; A 162210, A 162212, A 162215, A 162216, A 162217, A 162218, and A 162219. In these rocks selective argillic alteration and/or albitisation has enhanced outlines of unflattened cusped to angular shards, once-glassy flow banded, and pumiceous strongly vesicular fragments. Accessory small lithic fragments in the vitric tuffs include very fine grained carbonaceous mudstone.

Igneous lithologies include coarsely quartz- and albite porphyritic types such as the strongly silicified sample A 162203 in which there are minor altered mafic (?amphibole) phenocryst sites, and A 162205 in which medium to coarse phenocrysts also include quartz, albitised plagioclase and amphibole crystal sites, suggesting a dacitic rather than rhyolitic parent type. The samples A 162206 and A 162207 have similar dacitic igneous textures and mineralogy, and the finely polygonised felsic groundmass component of several of these equally may be due to rather coarse devitrification, or else very shallow intrusive rather than extrusive emplacement. In contrast with the above lithologies, are the microporphyritic trachytic flow rocks A 162213 and A 162214 in which prismatic albite microphenocrysts are set in a voluminous groundmass

031

with ubiquitous flow aligned felted albite microlites. Distinct perlitic cracks are preserved in the once partly glassy groundmass of A 162213, while altered vesicle sites (amygdales) are preserved in A 162214.

The two sedimentary samples A 162211 and A 162220 are of very fine grained finely banded silty mudstone/siltstone with variable proportions of carbonaceous dust.

Possible banding in certain vitric tuff samples (e.g. A 162218) and variation in density and grain size of shards, as well as the presence of some carbonate and sparse fine grained banded carbonaceous silty sediments could indicate deposition in a shallow marine environment. Alteration of these rocks is dominantly selective and rarely pervasive, with excellent preservation of fine grained and once glassy volcanic and tuffaceous textures. Secondary assemblages are common amongst the phases quartz, albite, "sericite" (including illite, ?pyrophyllite etc.), montmorillonite, chlorite and carbonate. Alunite was specifically looked for but this phase is not significant in the present group of samples.

032

SAMPLE NUMBER	ROCK TYPE	DIAGNOSTIC RELICT TEXTURES	SECONDARY MINERALOGY
A 162201	Altered poorly sorted crystal tuff with subordinate lithic fragments.	Unsorted broken angular quartz, albitised plagioclase. Altered acid volcanic lithic clasts.	"Sericite", ?Montmorillonite, albite, limonitic oxides after minor sulphides. Vein-quartz-chlorite-sericite. Traces of carbonate.
A 162202	Altered, veined unsorted crystal tuff of 'acidic affinity.	Unsorted broken phenocrystic quartz and albitised feldspar. Altered quartz and feldspar porphyritic lithic clasts as well as tuffaceous lithic clasts.	Low birefringent cherty (or feldspathic) matrix intergrown with chlorite, carbonate and clay, "sericite" (or ?pyrophyllite etc.) in altered feldspar sites. Albite/chlorite-quartz-carbonate/quartz, veins.
A 162203	Altered, veined, strongly porphyritic acid igneous (or partly fragmental) rock.	Coarse unbroken quartz and albitised feldspar crystals. Minor altered mafic phenocryst sites. Vague outlines may define lithic ?fragments.	Intense silicification. Veins contain quartz, carbonate ± chlorite. Microfractures contain chlorite and sphene granules.
A 162204	Altered unsorted lithic tuff containing coarsely porphyritic acidic volcanic debris.	Unsorted lithic fragmental. Most are coarsely quartz- and feldspar porphyritic with rare altered mafic sites. Broken phenocrystic quartz, albitised plagioclase.	Albite, chlorite, ?montmorillonite vein quartz, albite.
A 162205	Altered, coarsely porphyritic ?dacitic igneous rock. (?Flow or <u>very</u> shallow intrusive type).	Medium to coarse grained phenocrysts, quartz, plagioclase, amphibole. Groundmass mosaic of microgranular quartz and clouded ?K-feldspar.	"Sericite" in albitised plagioclase phenocryst sites. Quartz, chlorite ± ?montmorillonite.
A 162206	Altered porphyritic dacitic igneous rock. Flow or <u>very</u> shallow intrusive type.	Unbroken coarse quartz and plagioclase, fewer altered amphibole crystal sites. Polygonised felsic groundmass, some ?K-feldspar.	Albite, sericite, chlorite, ?montmorillonite, sphene. Limonitic oxide dust.
A 162207	Altered porphyritic and vesicular dacitic igneous rock.	Unbroken phenocrysts of plagioclase, quartz, amphibole. Microlite textures in polygonised groundmass felsic mosaic. Flattened quartz-chlorite-filled vesicle sites.	Albite, sericite, chlorite, sphene. Accessory sulphides. Veinlets of quartz, "sericite".

033

SAMPLE NUMBER	ROCK TYPE	DIAGNOSTIC RELICT TEXTURES	SECONDARY MINERALOGY
A 162208	Altered lithic/crystal tuff of acidic affinity.	Once glassy to fine grained flow banded, perlitic, vesicular volcanic lithic fragments. Rare sites of altered glass shards. Broken phenocrystic quartz, plagioclase, rare degraded mica flakes, mafic crystal sites.	Polygonised K-feldspar and cherty quartz. Patchy albite, clay (?montmorillonite).
A 162209	Altered, poorly sorted lithic tuff derived from a porphyritic to once-glassy acidic source.	Once glassy ?rhyolitic and vesicular lithic fragments. Broken phenocrystic quartz, albitised plagioclase debris. Rare glass shard outlines.	Veins of granular albite, quartz, ?montmorillonite.
A 162210	Altered vitric tuff with volcanic lithic and crystal debris of acidic to acid-intermediate affinity.	Excellent relict glass shard textures + once-glassy vesicular and porphyritic lithic fragments. Others retain perlitic or trachytic textures and magmatic flow lines. Quartz, albite broken crystal debris.	Polygonised K-feldspar, quartz, albite, "sericite", quartz, chlorite, ?montmorillonite. Accessory sulphides.
A 162211	Finely banded siltstone/silty mudstone stained by limonitic oxides.	Clastic sedimentary texture, silt sized quartz, lithic clasts. Deformed detrital mica flakes, tourmaline, zircon.	"Sericite" (or illite) ?kaolinite, limonitic oxides.
A 162212	Altered vitric tuff with lithic and crystal debris from acid volcanic source.	Abundant glass shards, volcanic and tuffaceous lithic fragments. Broken crystal debris, quartz plagioclase, biotite.	Albite, chlorite, felsic material including ?K-feldspar, albite, quartz.
A 162213	Altered microporphyrific trachytic volcanic rock with perlitic cracks.	K-feldspar and albitised plagioclase phenocrysts, ubiquitous feldspar microlites. Perlitic cracks.	Albite, chlorite, sphene, quartz, minor birefringent clay.
A 162214	Altered microporphyrific albite-rich trachyte with sparse amygdales.	Trachytic texture, albite microphenocrysts, altered vesicle sites.	Polygonised quartz, albite, pale green "sericite".

034

SAMPLE NUMBER	ROCK TYPE	DIAGNOSTIC RELICT TEXTURES	SECONDARY MINERALOGY
A 162215	Clay-altered vitric tuff with broken phenocrystic quartz fragments.	Distinct relict glass shard and pumiceous textures. Broken phenocrystic quartz chips.	"Sericite" (illite, pyrophyllite etc.), cherty quartz, ?kaolinite. Limonitic oxides.
A 162216	Argillically altered and albitised vitric tuff, with acidic volcanic lithic and crystal debris.	Glass shards and broken vesicular, flow banded lithic fragments.	Albite, "sericite", (?pyrophyllite etc.), chert, carbonate. Limonitic oxides after traces of sulphides.
A 162217	Argillically altered albitised vitric tuff.	Abundant glass shards once glassy volcanic lithic fragments, sparse fine grained sedimentary carbonaceous fragments. Broken phenocrystic quartz, rarely feldspar.	"Sericite", ?montmorillonite, albite, quartz, ?kaolinite. Minor limonitic oxides.
A 162218	Argillically altered vitric tuff with some broken crystal and acid volcanic lithic debris.	Ubiquitous glass shard outlines, broken phenocrystic quartz, mica, clay altered, weakly flow banded volcanic lithic debris. Minor clasts of carbonaceous mudstone.	Cherty felsic mosaic ?albite ± quartz, "sericite". Limonitic oxides partly replace traces of sulphides.
A 162219	Argillically altered vitric tuff with lithic and some crystal debris.	Abundant glass shards and pumiceous fragments. Accessory quartz chips, albite cleavage fragments, and carbonaceous mudstone fragments.	"Sericite", albite, quartz, minor limonitic oxides.
A 162220	Weakly mineralised, distinctly banded silty mudstone/silty carbonaceous mudstone, with lenses of quartz and plagioclase-rich siltstone.	Clastic sedimentary texture. Distinct banding. Detritus includes quartz, albite, minor tourmaline, ?epidote, sphene, zircon. Carbonaceous dust.	"Sericite", ?kaolinite, accessory pyritic sulphides, chlorite, quartz.

035

Sample No. Al62201

Rock Type. Partly altered and albitised, poorly sorted crystal tuff, containing broken angular crystal and fewer lithic fragments from a porphyritic acidic igneous sources.

Hand Specimen A compact dark grey fine grained sample containing abundant irregularly distributed conspicuous coarse to medium grained white to pale pink crystals and aggregates. K-feldspar staining proved negative.

Thin Section. This is an unsorted tuffaceous rock containing almost equally abundant broken angular to shattered quartz crystals, and cleavage fragments of clouded and albitised plagioclase phenocryst debris. Vague outlines of unsorted irregular shaped lithic fragments, that are mostly less than 3 mm across, include fine grained but polygonised altered and albitised and partly oxidised acidic igneous types, several of which are sparsely quartz-porphyritic, as well as rare clasts that once may have been flow banded and ?rhyolitic. The exceptionally fine grained rock matrix comprises mainly low birefringent argillic and cherty secondary products enclosing very small but recognisable angular crystal chips.

Very strong alteration has affected the rock with selective patches of very fine wispy "sericite" developed in albitised plagioclase crystal sites. Wispy, pale yellow brown ?montmorillonite is concentrated along narrow branching fractures and veinlets, and also present are irregular patches and veinlets of secondary albite crystals ± quartz intergrown with the argillic material and clusters of limonitic oxides. At least some of the latter appear to pseudomorph previous sulphides. Elsewhere are patches of strained and deformed vein quartz partly intergrown with patchy chlorite and sericite. Traces of fine grained carbonate are accessory.

The rock is a partly altered and albitised, poorly sorted crystal tuff containing angular crystal and fewer lithic fragments from a porphyritic acidic igneous source.

Sample No. A 162202

Rock Type. Substantially altered and veined, unsorted crystal tuff of acidic affinity.

Hand Specimen A mottled fine grained mid-grey compact sample with scattered pale grey medium grained crystal sites and irregular pale grey veins, several of which react strongly with cold dilute HCl. K-feldspar staining gave weak positive results for sparse crystal sites.

Thin Section. Unsorted fragmental texture is clearly preserved in this crystal-tuffaceous rock which is clearly related to the previous sample A 162201. Once again broken angular quartz chips and albitised feldspar cleavage fragments are present in approximately equal major proportions, and crystal debris accounts for roughly a quarter of the total thin section area. Several coarse quartz grains exhibit magmatically well rounded and embayed shapes, while others appear to have been shattered in situ. Sparse altered lithic fragments include altered but once-glassy quartz and feldspar porphyritic volcanic types, and types that are themselves fragmental, including broken chips of quartz and feldspar. The voluminous but exceptionally fine grained low birefringent rock matrix appears to be mostly cherty (or feldspathic) with patchy chlorite, carbonate and clay.

Alteration includes development of dense sericite in clouded and albitised feldspar crystal sites, while vein-like patches comprise fine grained secondary albite clear of inclusions; chlorite ± quartz ± carbonate; microgranular quartz; and almost monomineralic carbonate (calcite - see reaction above). Partial deformation of this rock has produced branching zones of polygonisation in certain coarse quartz grains.

The sample may be described as a substantially altered and veined unsorted crystal tuff of acidic affinity.

037

Sample No. A 162203

Rock Type. Quartz-albite-sericite-carbonate altered and significantly veined, strongly porphyritic acid igneous (or partly fragmental) rock.

Hand Specimen A fine grained compact mid grey sample containing scattered, very coarse grained pale grey crystals that is cut by a branching network of narrow dark grey to pale grey veinlets. K-feldspar staining gave weak positive results for patches in the matrix fraction of the rock.

Thin Section. This sample retains a strongly porphyritic texture defined by coarse quartz and albitised feldspar crystals and aggregates, most of which are apparently unbroken. These crystals comprise about a quarter of the thin section area, and quartz and feldspar are almost equally well represented. The quartz grains have deeply embayed and magmatically corroded shapes, while prismatic to subrounded shapes are characteristic of the albitised and sericitised feldspar crystals. Several of the latter have simple twins and once may have comprised K-feldspar. Rare sites of previous mafic (?amphibole) microphenocrysts now contain abundant sphene and carbonate. The abundant matrix of this sample comprises a microgranular mosaic of intergrown quartz and altered feldspar crystal sites, at least some of which are most likely K-feldspar - see staining. Slight differences in grain size are characteristic in the matrix fraction, suggesting the possible presence of lithic ?fragments.

The rock has undergone patchy intense silicification, and a network of narrow branching veins contain intergrown granular to subhedral quartz and carbonate ± minor chlorite. Elsewhere microfractures contain chlorite and discontinuous trails of sphene granules.

The rock may be only tentatively identified as a strongly porphyritic acid igneous or partly fragmental type, that is partly silicified, albitised and carbonated.

038

Sample No. A 162204

Rock Type. Partly altered unsorted lithic tuff containing coarsely porphyritic volcanic debris of acidic primary composition.

Hand Specimen Poorly sorted, distinctly lithic fragmental rock containing large and small dark grey porphyritic fragments and pale grey crystal sites, set in a mid-green-grey, fine grained matrix. K-feldspar staining proved negative.

Thin Section. Unsorted lithic fragmental texture in this rock is defined by a variety of angular volcanic lithic fragments up to 1.5 cm across. These account for almost half of the present thin section area. Very strongly porphyritic types predominate, containing coarse magmatically well rounded and embayed quartz phenocrysts, and albitised, lightly sericitised plagioclase laths and aggregates. Rare mafic crystal sites are pseudomorphed by chlorite and clusters of sphene granules. Relict textures in the groundmass fractions of most fragments suggest that they were once glassy, but have been replaced by fine to medium grained secondary albite, intergrown with chlorite and/or a montmorillonite type clay. As well as the lithic debris there is present abundant angular and broken phenocrystic debris, again including mainly quartz and albitised plagioclase cleavage fragments, and accessory zircon, sphene and degraded oxide crystal sites. The rock matrix in this sample comprises a finely polygonised mosaic of cherty quartz ± albite, chlorite and clay (mostly a birefringent montmorillonite type).

Vein-like branching to irregular shaped patches contain dense granular secondary quartz intergrown with water-clear secondary albite, indicating significant introduction or at least redistribution of this material.

The rock may be described as a partly altered unsorted lithic tuff containing coarsely porphyritic volcanic debris of acidic primary composition.

039

Sample No. A 162205

Rock Type. Partly altered, coarsely porphyritic igneous rock of acidic (?dacitic) affinity.

Hand Specimen A pale grey fine grained sample containing abundant pale pink and mid-grey coarse phenocrysts. K-feldspar staining gave positive results for the fine grained groundmass fraction.

Thin Section. A coarsely porphyritic igneous texture is marked by medium to coarse grained phenocrysts which comprise about a quarter of the total thin section area. These phenocrysts include almost equally abundant quartz and feldspar with subordinate degraded sites of previous mafic microphenocrysts. The quartz phenocrysts exhibit characteristic magmatic rounding and embayment while albitised plagioclase crystals show strong patchy development of fine grained sericite. Shapes of certain degraded mafic crystal sites indicate the presence of previous amphibole. Intense polygonisation and development of a fine grained secondary assemblage has largely obscured the primary textural features of the groundmass fraction which equally may have been glassy, or very fine grained but holocrystalline. It now comprises a microgranular mosaic of intergrown quartz-rich and clouded ?K-feldspar-rich domains, as well as others that are crammed with very fine grained flakes of chlorite ± montmorillonite. Minor narrow branching veinlets contain monomineralic granular quartz.

This rock could represent a volcanic flow or very shallow intrusive phase of a partly altered, very strongly quartz- and feldspar-porphyritic igneous rock of acidic primary composition.

Sample No. A 162206

Rock Type. Partly altered, strongly porphyritic igneous rock most likely of dacitic primary affinity.

Hand Specimen A distinctly porphyritic sample containing evenly scattered coarse pink feldspar laths and dark grey quartz phenocrysts

040

set in a fine grained pale brown matrix. K-feldspar staining gave positive results for the matrix fraction.

Thin Section. Evenly distributed unbroken coarse phenocrysts are characteristic of this acidic igneous rock, with coarse magmatically rounded and embayed quartz crystals almost equally as abundant as albitised and partly sericitised plagioclase laths and glomeroporphyritic aggregates. Completely altered mafic microphenocryst sites have subhedral shapes suggesting the presence of previous amphibole, but these are now filled with yellow-green stained and oxidised chlorite ± montmorillonite and sphene granules. Other microphenocryst sites that almost certainly once contained titaniferous oxides now contain dense small sphene crystals ± chlorite. The abundant fine grained groundmass fraction has a microgranular polygonised texture comprising a mosaic of intergrown quartz and clay-altered feldspar crystal sites, most likely containing some K-feldspar since this fraction gave positive staining results. Other intergrown fine grained fibrous secondary products include chlorite and sparse wispy sericite and red-brown limonitic oxide-dust.

The fine polygonisation of the groundmass fraction of this rock most likely is due to the effects of cooling of a once-glassy flow, or else very shallow intrusive type. It may be described as a partly altered, strongly porphyritic igneous rock, most likely of dacitic primary affinity.

Sample No. A 162207

Rock Type. Partly altered, strongly porphyritic and vesicular acidic igneous rock, most likely of dacitic primary composition.

Hand Specimen A pale grey compact fine grained sample enclosing abundant and coarse grained, very pale grey feldspar crystal sites and fewer dark green-grey mafic crystal sites. Minor fine grained patchy sulphide mineralisation is not particularly conspicuous, but K-feldspar staining gave positive results for the fine grained matrix fraction.

041

Thin Section. This rock exhibits a distinct porphyritic texture in which unbroken phenocrysts occupy about a quarter of the total thin section area. Most of these lie within the size range 1 mm up to 3 mm, and weakly clouded albitised and sericitised plagioclase laths and aggregates predominate over slightly subordinate deeply embayed and magmatically rounded quartz crystals. Several of the latter are surrounded by narrow coronas of very fine grained material which could represent once glassy attached rims of lithic fragmental material but more likely are reaction rims between the quartz phenocrysts and enclosing melt. As in previous samples, the subhedral shapes of relict mafic phenocrysts and aggregates suggests the presence of an amphibole. These sites are now completely filled with dense chlorite, argillic patches, sphene granules, zircon grains, and sparse small euhedral crystals and aggregates of pyrite.

The voluminous groundmass fraction contains ubiquitous vague outlines of microlites, but comprises a microcrystalline mosaic of polygonised and clouded K-feldspar (see staining), quartz, chlorite and wispy "sericite". Accessory very small sulphide euhedra are sparsely scattered throughout the groundmass fraction of the rock. Numerous elongate flattened but somewhat irregular vesicles contain granular quartz centrally with discontinuous chlorite rims, minor veinlets also contain granular quartz and patchy sericite.

The sample may be identified as a partly altered, strongly porphyritic and vesicular acidic-igneous rock, most likely of dacitic primary affinity.

Sample No. A 162208

Rock Type. Partly altered lithic/crystal tuff of acidic affinity.

Hand Specimen A mottled and partly oxidised and stained unsorted fragmental sample in which dark grey to pale grey fragments and crystals are set in a fine grained pale grey to red-brown stained matrix. K-feldspar staining gave positive results for the matrix and particularly for sparse small fragments.

042

Thin Section. Fragmental texture is clearly displayed in this unsorted pyroclastic lithology. Very fine grained to once glassy volcanic lithic fragments predominate, many of which retain vague outlines of ?flow lines, while others show evidence of alteration along perlitic cracks and a few are vesicular. Rare recognisable cusped glass shards are pseudomorphed by a birefringent clay (?montmorillonite). Much of the fine grained lithic material now is replaced by argillically clouded low birefringent microgranular K-feldspar and cherty quartz, and the rock is cut by abundant narrow branching domains of water-clear secondary albite. Some have central zones filled with granular quartz. Crystal debris is subordinate but quite common, and includes broken and angular phenocrystic quartz, albitised lightly sericitised plagioclase, rare deformed and degraded mica flakes, and mafic crystal sites now marked only by clusters of sphene granules.

The rock is strongly altered, mostly to albite and argillic products, but clearly contains dominant once-glassy lithic debris and significant quartz and feldspar crystal debris. It may be classed as a partly altered lithic/crystal tuff of acidic affinity.

Sample No. A 162209

Rock Type. Partly altered, poorly sorted lithic tuff containing material from a fine grained to porphyritic acidic igneous source.

Hand Specimen A pale grey sample containing abundant fine grained very pale pink, and fewer elongate and somewhat subparallel dark green fine grained fragments. K-feldspar staining gave weak positive results for the fine grained rock matrix.

Thin Section. Once-glassy and exceptionally fine grained unsorted lithic fragments predominate in this pyroclastic rock, and relict textural features within these fragments are poorly preserved indeed. Vague outlines of ?magmatic flow lines are present in several of these, while others contain poorly preserved and deformed vesicle sites, but

043

mostly they consist of intergrown low birefringent clay, ?K-feldspar and variable proportions of wispy birefringent montmorillonite. Angular to cusped sherd shaped outlines are poorly preserved in some parts of the thin section, and broken angular crystals of quartz and albitised plagioclase are common. Narrow branching vein-like domains of secondary granular albite intergrown with subordinate quartz form a discontinuous infill enclosing the numerous lithic and crystal fragments. Elsewhere in the sample the meagre rock matrix comprises dense wispy fine grained birefringent pale green ?montmorillonite. There is no evidence of sulphide mineralisation.

This sample comprises a poorly sorted lithic tuff containing abundant once-glassy (?rhyolitic) fragments and some glass shards, as well as quartz and feldspar crystal debris, that has undergone albitisation and partial argillic alteration.

<u>Sample No.</u>	A 162210
<u>Rock Type.</u>	Partly altered vitric tuff with scattered volcanic lithic and crystal debris of acidic to acid-intermediate primary affinity.
<u>Hand Specimen</u>	A compact fine grained mid-grey coloured sample containing conspicuous unsorted pale grey to pale green-grey lithic fragments and abundant medium grained pale pink to white crystal debris. Several small patches of fine grained sulphide mineralisation are present. K-feldspar staining gave patchy positive results for the fine grained matrix and also for sparse broken crystal and lithic debris.
<u>Thin Section.</u>	In this sample are preserved excellent relict textures of cusped and angular devitrified glass shards. The ubiquitous shard-rich matrix encloses altered and deformed once-glassy lithic fragments, several of which retain vesicular and/or porphyritic igneous textures. Elsewhere are angular once-glassy lithic fragments retaining textures of previous perlitic cracking and still others showing distinct lines

044

of magmatic flow. Sparse unsorted crystal debris also is present, and this includes angular and broken to subhedral quartz, as well as prismatic shaped to broken cleavage fragments of albitised feldspar. Several lithic fragments that contain plagioclase microphenocrysts and abundant microlites could have had trachytic parent types.

Alteration of the rock is intense with a microgranular K-feldspar and quartz mosaic predominating in volcanic lithic material, while branching narrow patches and trails of granular secondary albite-"sericite" ± quartz ± chlorite comprise a rather meagre rock matrix. Certain shard sites are pseudomorphed by dense granular albite ± quartz and chlorite while deformed fine grained lithic fragments are pseudomorphed by dense pale green ?montmorillonite ± "sericite" (pyrophyllite, illite etc.). Accessory sulphides are selectively located in certain altered lithic and crystal sites.

This rock may be described as a partly altered vitric tuff of acidic to acid-intermediate composition containing scattered lithic and crystal debris.

<u>Sample No.</u>	A 162211
<u>Rock Type.</u>	Finely banded siltstone/silty mudstone which has been variably stained by yellow-brown limonitic oxides.
<u>Hand Specimen</u>	A fine grained pale grey to variously stained yellow-brown and oxidised finely banded argillic sample with sparse small weathered-out voids. K-feldspar staining proved negative.
<u>Thin Section.</u>	This sample exhibits a fine grained clastic sedimentary texture, particularly defined by more or less evenly but sparsely scattered angular silt-sized quartz chips and sparse conspicuous degraded and flattened fine grained lithic clasts. The latter include carbonaceous mudstone, and types that are now converted to a dense fine

C 045

grained wispy birefringent clay. Also present are deformed and degraded detrital mica flakes and accessory heavy detrital grains including blue tourmaline, and zircon. The voluminous rock matrix is extremely fine grained and consists mostly of low birefringent pale yellow-brown clouded clay (?kaolinite), intergrown with subordinate wispy birefringent clay and elongate patches of yellow-brown limonitic oxides. The elongate lithic clasts and altered crystal debris is oriented subparallel to a weak grain size layering defining original narrow bedding.

This sample may be simply described as a finely banded siltstone/silty mudstone which has been variably stained by yellow-brown limonitic oxides.

Sample No. A 162212

Rock Type. Altered vitric tuff enclosing sparse lithic and crystal debris from an acidic volcanic source.

Hand Specimen A mid-grey fine grained compact sample containing abundant conspicuous angular dark grey to pale grey lithic clasts, as well as numerous white and pale yellow-brown oxidised crystal sites. K-feldspar staining gave weak positive results for the matrix fraction and for sparse fragments.

Thin Section. As in the previous sample A 162210 outlines of very abundant cusped and branching glass shards are characteristic in the matrix of this sample. Also present are sparse recognisable unsorted lithic fragments including completely altered, finely banded once glassy types, flattened aggregates of shards that most likely represent clasts of welded vitric tuff (or ignimbrite), and plagioclase-microporphyritic ?trachytic types with abundant poorly defined minute feldspar microlites, set in a chlorite-altered matrix. The scattered medium to coarse grained broken crystal debris includes subhedral to angular and broken crystals of quartz, equally abundant broken crystals of albitised plagioclase

046

with accessory deformed and partly altered flakes of biotite, as well as sphene-albite-altered mafic crystal sites. Fine grained ?sedimentary lithic fragments are accessory.

The glass shards now are selectively altered to granular albite with narrow rims of pale green fine grained chlorite in turn set in a microgranular felsic mosaic - most likely intergrown K-feldspar (see staining) albite and quartz.

The rock may be identified as an altered vitric tuff enclosing sparse lithic and crystal debris from an acidic volcanic source.

<u>Sample No.</u>	A 162213
<u>Rock Type.</u>	Partly altered microporphyritic trachytic volcanic rock with distinct perlitic cracks.
<u>Hand Specimen</u>	A mottled pale greenish grey to yellow-brown oxidised fine grained sample that is cut by a network of very narrow curving to branching fractures filled with dark green-grey material. K-feldspar staining gives weak patchy positive results.
<u>Thin Section.</u>	Well preserved relict textural features in this once-glassy volcanic rock include sparse euhedral prismatic microphenocrysts and glomeroporphyritic aggregates of untwinned clouded K-feldspar and albitised plagioclase, as well as abundant wispy feldspar microlites aligned subparallel to the previous direction of magmatic flow. Quartz phenocrysts are conspicuously absent. The voluminous micro-litic rock matrix is cut by abundant curving and branching perlitic cracks, clearly resulting from rapid chilling of a once glassy lithology, that are now filled with dense concentrations of fine grained chlorite, minute sphene clusters, and in some are developed microgranular aggregates of secondary albite ± quartz. The abundant wispy albitised feldspar microlites in this groundmass, are in turn "suspended" in a devitrified mosaic of clouded ?K-feldspar, albite, chlorite, sphene and patchy low birefringent clay.

047

Clear microporphyritic, and trachytic textures outlined by feldspar microlites, as well as the development of conspicuous perlitic cracking indicates that this rock had a partly glassy volcanic parent of microporphyritic trachytic primary affinity.

Sample No. A 162214

Rock Type. Partly altered, sparsely microporphyritic albite-rich trachyte enclosing sparse flattened amygdales filled with quartz.

Hand Specimen A fine grained pale grey sample with scattered mid-green-grey patches. Sparse narrow elongate subparallel dark grey lenses are present. K-feldspar staining proved negative.

Thin Section. This fine grained volcanic rock retains a distinct trachytic texture defined by ubiquitous minute "felted" to "feathery" feldspar microlites aligned subparallel to the direction of magmatic flow. This felted mat largely consists of albitised microlites intergrown with numerous, more or less evenly distributed clusters of oxidised sphene granules and irregular shaped patches of chlorite. The voluminous groundmass fraction encloses sparse albitised lath shaped plagioclase microphenocrysts, once again set subparallel to the direction of magmatic flow. Rare small glomeroporphyritic clusters of feldspar, once again comprise albitised plagioclase. The narrow elongate subparallel lenses of the hand specimen prove to be flattened vesicle sites that are now filled with monomineralic polygonised secondary quartz. The latter encloses trails of minute dusty inclusions suggesting original colloform banded deposition of the silica. Later narrow veinlets are also filled with microgranular quartz and albite, while even later microfractures that are subparallel to the trachytic flow direction are filled with minute flakes of a very fine grained pale green birefringent clay.

This sample may be described rather simply as a partly altered, sparsely microporphyritic albite-rich trachyte, enclosing sparse flattened amygdales filled with quartz.

048

Sample No. A 162215

Rock Type. Clay-altered vitric tuff enclosing sparse unsorted angular and broken fragments of phenocrystic quartz.

Hand Specimen A compact fine grained pale grey sample containing abundant medium grained dark green-grey, pale yellow and clay-altered to partly void crystal sites. Several microfractures are partly coated with red-brown limonitic oxides. No K-feldspar was detected by staining.

Thin Section. Intense selective alteration of this rock has outlined clearly a relict vitric pyroclastic texture defined by abundant cusped and angular shards and broken pumiceous fragments. This material accounts for at least half of the total thin section area, and shows selective alteration to almost monomineralic very fine grained dense clusters of "sericite" (or illite, pyrophyllite etc.). The contrasting low birefringent matrix fraction is also extremely fine grained and largely consists of clouded cherty quartz and low birefringent clay. Sparse medium grained broken crystal clasts have broken angular shapes and include abundant quartz. Scattered voids partly coated with limonitic oxides once may have contained feldspathic crystal debris. Several narrow veinlets are filled with microgranular quartz and sparse partial voids lined with patchy limonitic oxides. The shapes of at least some of these patches suggest the previous presence of minor sulphides.

Clear outlines of ubiquitous glass shards in this altered sample indicate a vitric tuff parent enclosing sparse unsorted broken quartz debris from an acidic volcanic source.

Sample No. A 162216

Rock Type. Argillically altered and albitised vitric tuff, with sparse lithic and crystal debris from an acid volcanic source.

049

Hand Specimen A compact fine grained mid brown-grey coloured to mottled dark brown, partly oxidised sample that appears to be coarsely banded. No K-feldspar was detected by staining.

Thin Section. As in the previous sample A 162215, the present rock has undergone intense but partly selective argillic alteration defining abundant deformed angular to cusped glass shards and fewer once-vesicular to flow banded lithic fragments. This material is now pseudomorphed by microgranular pale brown clouded secondary albite, while the contrasting matrix fraction now is replaced by very abundant wispy fine grained "sericite" (or illite, pyrophyllite etc.), as well as a cherty felsic mosaic and sparse patches of very fine grained carbonate. The latter is partly oxidised to dark red-brown limonitic material and once may have included an iron carbonate, as well as calcite. Sparse broken angular crystal debris comprises dominant medium to fine grained quartz, subordinate albitised plagioclase crystals and rare deformed and degraded, barely recognisable sites that once may have contained biotite. Accessory small sulphide grains are almost completely converted to red-brown limonitic oxides.

Relict textural features in this argillically altered and albitised sample confirm a vitric tuffaceous parent lithology with clear outlines of abundant glass shards, as well as sparse recognisable lithic and crystal debris from an acidic volcanic source.

Sample No. A 162217

Rock Type. Argillically altered and albitised vitric tuff, containing ubiquitous glass shards, once-glassy volcanic lithic fragments, and sparse quartz ± feldspar crystal debris.

Hand Specimen A pale yellow-brown compact fine to medium grained sample that appears to contain poorly defined mid grey bands. Scattered red-brown and pale yellow-brown medium grained ? crystal sites are present. K-feldspar staining proved negative.

050

Thin Section. The outlines of abundant unflattened glass shards are clearly preserved in this sample, together with subordinate recognisable once glassy flow banded volcanic lithic fragments and broken vesicular pumiceous fragments. Elsewhere are present sparse, small angular, very fine grained sedimentary lithic fragments that contain abundant carbonaceous dust, and sparse angular chips of phenocrystic quartz. Recognisable albitised feldspar fragments are rarely preserved.

The ubiquitous cusped glass shards and broken pumiceous fragments in this sample are outlined by very narrow but continuous rims of microgranular felsic material (?albite), with central cores of dense birefringent, "sericite" (?illite, pyrophyllite etc.), and minor pale green ?montmorillonite, all set in a matrix also comprising a cherty microcrystalline mosaic of secondary albite \pm quartz, and ?low birefringent clay. The birefringent clay is variously stained by yellow-brown limonitic oxides but fresh carbonate is not present in the thin section. Sparse small oxidised patches once may have contained accessory sulphides.

This sample may be described as an argillically altered and albitised vitric tuff, containing ubiquitous glass shards, angular once-glassy volcanic lithic fragments and sparse quartz \pm feldspar crystal debris from an acidic volcanic source.

Sample No. A 162218

Rock Type. Argillically altered vitric tuff with sparse broken angular crystal and lithic debris, mainly from an acid volcanic source.

Hand Specimen A pale grey fine to medium grained sample that contains poorly defined mid grey discontinuous bands. The rock contains sparse pale grey and dark brown medium grained ?crystal sites. No K-feldspar was detected by staining.

051

Thin Section. Outlines of ubiquitous glass shards once again are clearly preserved in this vitric tuffaceous sample. The cusped and angular shards have narrow, more or less continuous rims of microcrystalline cherty felsic material which could be secondary albite rather than quartz. This material encloses central zones of dense birefringent flakes of "sericite" (or illite, pyrophyllite etc.), while the subordinate matrix comprises an extremely fine grained cherty mosaic of felsic material that is partly clouded by dusty inclusions. Sparse broken phenocrystic quartz debris is accessory as is clay-altered, weakly flow banded, once-glassy volcanic lithic debris, rare deformed mica flakes, and rare small fragments of carbonaceous mudstone.

Patchy yellow-brown limonitic oxide staining coats narrow subparallel but discontinuous fractures, and certain small patches have central cores of relict sulphides. The weak banding of the hand specimen is not at all evident in the present thin section.

The well preserved relict outlines of ubiquitous glass shards in this sample clearly indicate its pyroclastic origin. It may be described simply as an argillically altered vitric tuff with sparse broken angular crystal and lithic debris, mainly from an acid volcanic source.

<u>Sample No.</u>	A 162219
<u>Rock Type.</u>	Selectively argillically altered vitric tuff containing ubiquitous altered shards and once-glassy lithic fragments, as well as sparse angular and broken phenocrystic quartz ± feldspar debris.
<u>Hand Specimen</u>	A pale grey to mid-grey mottled fine grained sample with a poorly defined disrupted ?banding. Sparse scattered pale grey and brown stained medium grained crystal sites are present. K-feldspar staining proved negative.

052

Thin Section.

Clear relict textures of abundant glass shards and pumiceous fragments are well preserved in this sample of vitric tuff. Such shards and fragments are selectively replaced by birefringent fine grained "sericite" (?illite-pyrophyllite etc.), while fewer now contain microgranular albite, and their distribution is somewhat patchy and uneven, possibly defining the poor, disrupted banding of the hand specimen. Cusped shards and broken pumiceous fragments account for more than half of certain patches and bands. As in the previous samples, angular medium grained quartz chips are accessory, and rare cleavage fragments of albitised plagioclase also are accessory. Rare small lithic fragments are of exceptionally fine grained carbonaceous sedimentary types (carbonaceous ?mudstone), are also present. All this material is set in a matrix of exceptionally fine grained low birefringent cherty felsic material (most likely intergrown secondary albite and quartz).

Several narrow veinlets that cut across the rock contain almost monomineralic granular quartz or else monomineralic dense fine grained wispy sericite. Elsewhere, however, are narrow wavy fractures coated with red-brown limonitic oxides. Similar oxides pseudomorph sparse very small subhedral crystal sites that almost certainly once contained sulphides.

This sample may be described as a selectively argillically altered vitric tuff containing ubiquitous altered shards and once glassy lithic fragments, as well as sparse broken phenocrystic quartz ± feldspar debris.

Sample No.

A 162220

Rock Type.

Weakly mineralised, distinctly banded silty mudstone/silty carbonaceous mudstone with narrow lensed bands of quartz and albitised plagioclase-rich siltstone.

Hand Specimen

A fine grained compact mid-grey sample with conspicuous subparallel dark grey and pale grey bands and lenses developed at irregular intervals. No K-feldspar was detected by staining.

Thin Section.

In contrast to the previous samples, the present rock exhibits a clastic sedimentary texture with conspicuous compositional and grain size layering. The mid-grey host material that forms the majority of the sample is a silty mudstone in which sparse, angular silt sized quartz grains are "suspended" in a voluminous, exceptionally fine grained low birefringent "matrix" most likely comprising intergrown cherty quartz, ?albite, low birefringent clay (?kaolinite), wispy unoriented flakes of "sericite" and a light dusting of carbonaceous particles. The dark grey subparallel narrow bands and lenses of the hand specimen have a similar composition except for an increased proportion of carbonaceous dust. The narrow pale grey bands and lenses of the hand specimen contain a high proportion of angular silt sized detrital quartz and albitised plagioclase grains, together with subordinate recognisable but degraded detrital mica flakes, accessory heavy detrital grains of variegated tourmaline, ?epidote, sphene and zircon. Several of the siltstone bands show a weak grain size layering or grading.

This rock contains abundant accessory fine grained disseminated pyritic sulphides as single subhedral crystals and aggregates, many of which are closely associated with traces of secondary chlorite.

Clastic textures are clearly evident in this fine grained sedimentary rock which may be described simply as a weakly mineralised, distinctly banded silty mudstone/silty carbonaceous mudstone with narrow lensed bands of quartz and albitised plagioclase-rich siltstone.

054
B.J. BARRON, B.Sc., Ph.D., (Sydney)

PETROLOGIST

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PETROGRAPHIC EXAMINATION OF TWENTY

FIVE ROCK SAMPLES.

Report No: C7/85/337a

2nd May, 1986.

For: CSR Limited


Dr. B.J. Barron,
Consulting Petrologist

055

SUMMARY

The twenty five samples A-162221 to A-162245 may be subdivided into five groups of lithologies. Firstly are those which are clearly clastic sedimentary types including the texturally similar carbonaceous quartz-rich arenite/siltstone samples A-162221, A-162236, and the sample A-162238, a fine grained carbonaceous slate.

A second group include the mixed sedimentary/tuffaceous or tuffaceous samples partly reworked in a sedimentary environment. These are generally conglomeratic rocks containing a variety of volcanic lithic fragments or clasts such as A-162226, A-162230, A-162237 and A-162244. The volcanic debris includes microlitic trachytic, perlitic once-glassy, flow banded micro-porphyrific trachytic, and strongly vesicular once-glassy types, as well as sedimentary clasts of carbonaceous siltstone, fine grained quartz-rich arenite and quartzite. The high carbon content in several of these rocks suggests a terrestrial rather than marine environment.

A third lithic type comprises the vitric tuffaceous samples A-162223, A-162224, A-162225, A-162243, and possibly A-162231, in which there are clearly preserved relict textures of previous glass shards, as well as sparsely porphyritic, vesicular and flow banded lithic fragments. Glass shards are also present in the samples A-162227, A-162228 and A-162229, but these are most likely of mixed tuffaceous/sedimentary origin since they contain in addition, clasts of carbonaceous siltstone. Such rocks most likely are the result of catastrophic earth movements in response to explosive volcanic activity.

Lithic/crystal tuffaceous samples lacking clear evidence of cusped glass shards contain unsorted angular to irregular shaped altered lithic fragments of vesicular, quartz and albitised plagioclase porphyritic, trachytic, flow-banded rhyolitic and perlitic once-glassy volcanic types. Samples in this group include A-162232, A-162234 and A-162240. The sample A-162245 is also a lithic tuff with fragments of clinopyroxene-porphyrific ?trachyandesitic, and trachytic types.

A final group includes those rocks that appear to be volcanic flows or autobrecciated flows such as A-162222 which is a porphyritic and vesicular

056

lithology of acidic primary composition. Other samples in this group include A-162233 which contains unbroken albitised plagioclase and quartz phenocrysts and numerous relict vesicle sites, while the sample A-162235 is plagioclase porphyritic with a once vesicular and ?microlitic groundmass. The samples A-162239, A-162241 and A-162242 are ?autobrecciated or later brecciated trachytic, or trachytic to perlitic volcanic rocks.

Alteration of this acidic fragmental suite of samples is mainly to simple assemblages amongst the phases albite, quartz, ?montmorillonite, "sericite" (or ?pyrophyllite), chlorite and quartz. More definitive secondary assemblages, however, are developed in the rare more basic lithologies represented in the samples A-162226 and A-162245, in which the secondary phases include prehnite, pumpellyite, quartz, albite, epidote, carbonate and chlorite. Such assemblages show adjustment in a low grade "burial metamorphic" environment.

* * * *

SUMMARY TABLE

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057

SAMPLE NUMBER	ROCK TYPE	RELICT TEXTURAL FEATURES	SECONDARY ASSEMBLAGE
A-162221	Veined carbonaceous quartz-rich arenite (or greywacke).	Fine to medium grained clastic sedimentary textures.	Sericite, quartz chlorite. Trace oxidised sulphides.
A-162222	Altered unsorted lithic fragmental rock. ?Autobrecciated porphyritic vesicular flow.	Altered angular porphyritic vesicular fragments of acidic composition. Cherty matrix.	Albite, "sericite" quartz. Traces of oxidised sulphides.
A-162223	Partly altered, unsorted lithic/vitric tuff of acidic affinity.	Porphyritic, strongly vesicular fragments. Quartz and albitised plagioclase phenocrysts and angular debris. Cherty rock matrix with glass shards.	Quartz, albite, chlorite, sericite. Minor limonitic oxides.
A-162224	Partly altered acidic vitric tuff, with sparse lithic and crystal debris.	Abundant glass shards. Strongly vesicular and microlitic and flow banded lithic fragments.	Albite "sericite" quartz, ?montmorillonite.
A-162225	Partly altered acidic vitric tuff with sparse volcanic lithic and crystal debris.	Abundant glass shards and once-glassy vesicular and flow banded lithic fragments.	Quartz, albite, montmorillonite, chlorite, "sericite" (or pyrophyllite etc.).
A-162226	Altered, poorly sorted volcanic conglomerate.	Porphyritic and vesicular volcanic lithic fragments, sub-rounded to well rounded.	Prehnite, quartz, pumpellyite, albite, epidote, carbonate, chlorite.
A-162227	Altered mixed acidic tuffaceous sediment with fine grained porphyritic fragments, glass shards and carbonaceous sedimentary material.	Poorly sorted fragmental volcanic lithic, and carbonaceous siltstone. Flow banded porphyritic, once glassy types and phenocrystic debris, glass shards.	Albite, ?pyrophyllite, quartz, carbonate, chlorite.
A-162228	Altered acidic lithic/vitric tuff with intermixed sedimentary material.	Unsorted fragmental. Glassy trachytic vesicular, vitric tuffaceous, lithic fragments. Albite and quartz debris, carbonaceous silty material.	?Pyrophyllite ?montmorillonite, albite, quartz.

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SAMPLE NUMBER	ROCK TYPE	RELICT TEXTURAL FEATURES	SECONDARY ASSEMBLAGES
A-162229	Altered lithic/vitric tuff with mixed carbonaceous sedimentary material.	Unsorted fragmental once glassy vesicular and flow banded lithic types. Glass shards in carbonaceous pelitic host. Albite and quartz crystal debris.	?Montmorillonite albite, chlorite, cherty quartz. Traces of sulphides.
A-162230	Partly altered, poorly sorted volcanic conglomerate.	Pebbles well to sub-rounded. Microlitic trachytic, vesicular porphyritic volcanic, and carbonaceous siltstone and arenite.	Chlorite, albite, wispy sericite, clay.
A-162231	Altered, veined, unsorted lithic/vitric, acidic tuff.	Flow banded rhyolitic, plagioclase porphyritic, vesicular lithic fragments. Plagioclase/quartz phenocrystic debris. Possible glass shards.	Quartz, albite, chlorite, pyrophyllite, limonitic oxides, traces of ?sulphides.
A-162232	Altered, veined, mineralised acidic lithic tuff.	Vesicular, sparsely quartz and plagioclase porphyritic fragments. Broken albite, quartz debris.	Albite, quartz, chlorite, sphene, ?pyrophyllite. Traces sulphides.
A-162233	Altered, silicified, porphyritic vesicular acidic volcanic rock.	Unbroken albite phenocrysts, aggregates and quartz phenocrysts. Numerous vesicles.	Chlorite, "sericite" sphene, quartz, 5% - 7% sulphides.
A-162234	Altered unsorted acidic to trachytic lithic tuff.	Unsorted lithic fragmental. Types are plagioclase and/or quartz porphyritic trachytic, vesicular; perlitic once-glassy.	Albite, chlorite, cherty quartz minor wispy "sericite".
A-162235	Altered silicified porphyritic acidic volcanic rock.	Plagioclase, porphyritic ?microlitic ?vesicular	Quartz, albite, wispy ?pyrophyllite chlorite. Trace sulphides.
A-162236	Weakly foliated, banded medium grained quartz-rich arenite/carbonaceous siltstone similar to A-162221.	Clastic sedimentary quartz and mica-rich detritus, lithic clasts, quartzite siltstone.	"Sericite", chlorite. Traces sulphides.

SAMPLE NUMBER	ROCK TYPE	RELICT TEXTURAL FEATURES	SECONDARY ASSEMBLAGES
A-162237	Partly altered lithic tuffaceous conglomerate.	Clasts include vesicular once glassy types, microlitic trachyte, vitric tuff, crystal tuff, carbonaceous siltstone, broken plagioclase and quartz phenocrysts.	?Montmorillonite, albite, cherty quartz.
A-162238	Fine grained silty carbonaceous slate.	Fine grained clastic texture with quartz silt set in a carbonaceous matrix. ?Radiolaria.	Cherty quartz, sericite, low birefringent clay (?kaolinite). Rare sulphides.
A-162239	Partly brecciated or autobrecciated, sparsely porphyritic microlitic and once glassy ?trachytic volcanic rock.	Numerous similar angular microporphyratic trachytic lithic fragments.	Cherty quartz, albite, chlorite, limonitic oxide dust.
A-162240	Altered, poorly sorted lithic/crystal tuff.	Poorly sorted fragments of coarsely porphyritic albite and quartz-rich acidic volcanic material, also vesicular or flow banded once-glassy fragments. Clouded ?K-feldspar, ?oxides. Albite and quartz crystal debris.	Albite, "sericite" quartz, chlorite, ?montmorillonite, sphene.
A-162241	Partly altered once-vesicular trachyte.	Fine grained microlitic, vesicular trachytic volcanic rock. Sparse albite microphenocrysts.	Quartz, albite, chlorite, sphene.
A-162242	Partly altered and devitrified autobrecciated trachytic volcanic rock.	Trachytic and perlitic lithic fragments.	Albite, chlorite, quartz.
A-162243	Partly altered acidic vitric tuff with lithic and crystal fragments.	Unsorted fragmental broken quartz, albite ± K-feldspar crystal debris. Once glassy ?flow banded, perlitic vesicular fragments. Glass shards in rock matrix.	Albite, quartz, ?montmorillonite, chlorite.

060

SAMPLE NUMBER	ROCK TYPE	RELICT TEXTURAL FEATURES	SECONDARY ASSEMBLAGES
A-162244	Altered poorly sorted volcanic (or tuffaceous) conglomerate with acidic to trachytic clasts.	Clastic poorly sorted lithic clasts include microlitic trachytic, perlitic, flow banded microporphyritic trachyte, vesicular carbonaceous siltstone; arenite, quartzite. Albite, quartz debris.	Albite, quartz, chlorite, ?montmorillonite.
A-162245	Altered, poorly sorted lithic tuff, with clinopyroxene-plagioclase porphyritic ?trachy-andesitic fragments.	Fragmental pyroclastic. Coarse clinopyroxene and albitised plagioclase phenocrysts in fine trachytic and vesicular fragments.	Pumpellyite, ?prehnite, albite, epidote, quartz, chlorite, sphene, carbonate.

061

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1.

Sample No. A-162221

Rock Type. Veined, medium grained quartz-rich greywacke or carbonaceous quartz-rich arenite.

Hand Specimen A massive compact mid-grey fine to medium grained sample that is cut by a series of narrow branching but subparallel white veins. K-feldspar staining proved negative.

Thin Section. Clastic texture is clearly evident in this immature sedimentary sample which contains abundant fine and medium grained angular detritus. The latter accounts for more than half of the total thin section area and comprises dominant angular quartz grains, with subordinate, but unusually abundant bleached degraded and deformed mica flakes that are largely pseudomorphed by sericite and oxide dust ± sphene, marking former cleavage traces. Sparse recognisable lithic fragments include fine grained quartz-sericite schist with a kink folded foliation; very fine grained quartzite; very fine grained sericite-rich foliated carbonaceous siltstone and foliated carbonaceous claystone. Accessory detrital grains include chlorite flakes, and a suite of heavy detrital grains, including zircon, olive green tourmaline, apatite, rutile and a single grain of brown spinel. The rather meagre matrix comprises microcrystalline cherty quartz ± feldspars, strongly clouded by carbonaceous dust and wispy sericite defining a poor wavy foliation.

The narrow veins that cut across this rock are essentially monomineralic granular quartz with traces of red-brown limonitic oxides (including goethite) pseudomorphing previous sulphides.

The rock may be described as a veined medium grained quartz-rich greywacke or carbonaceous quartz-rich arenite.

Sample No. A-162222

Rock Type. Altered unsorted lithic fragmental rock containing material from a strongly vesicular sparsely porphyritic acidic volcanic source.

062

Hand Specimen

A buff coloured partly oxidised sample with numerous angular to irregular pale grey patches or fragments. The rock is cut by narrow branching fractures that are partly void and partly coated with dark red-brown limonitic oxides. K-feldspar staining proved negative except for weak positive results in certain patches or fragments.

Thin Section.

Fragmental texture is quite well preserved in this rock in spite of its strong alteration, partial oxidation and weathering. The majority of large irregular shaped volcanic lithic fragments comprise a sparsely plagioclase porphyritic, strongly vesicular type with sparse magmatically rounded and embayed quartz phenocrysts. Smaller lithic fragments are of a similar lithology and sparse domains contain broken angular chips of quartz and plagioclase phenocrysts. The debris is set in a meagre felsic cherty matrix.

All phenocrystic plagioclase crystals are albitised with a light dusting and dense small patches of a colourless birefringent layer silicate (? "sericite" or pyrophyllite etc.). The ubiquitous vesicle sites are now filled with granular secondary quartz that is clear of inclusions, while the previous fine grained groundmass fraction of the fragments comprises a diffuse polygonised quartz-rich felsic mosaic which is intergrown with fine grained wispy "sericite" (or pyrophyllite etc.). The felsic mosaic could include some K-feldspar (see patchy staining of offcut). Clusters of small rutile needles mark sites of former opaque oxide microphenocrysts. Patchy limonitic oxides coat certain grain boundaries and fractures and pseudomorph rare small ?sulphide crystal sites.

The sample could represent an altered auto-brecciated, strongly vesicular volcanic flow rock of acidic primary composition, or else it is a pyroclastic rock "crowded" with fragments of a similar parent type.

Sample No.

A-162223

Rock Type.

Partly altered unsorted lithic/vitric tuff of acidic composition containing material from a strongly vesicular, sparsely porphyritic source.

Hand Specimen

A rather massive compact siliceous mottled pale grey sample with vague outlines of possible fragments. The rock is cut by a network of narrow branching veinlets, several of which are partly void. K-feldspar staining proved negative.

Thin Section.

An unsorted lithic and crystal fragmental texture of pyroclastic origin is defined by scattered volcanic lithic fragments (mostly less than 5 mm across), set in a voluminous fine grained altered matrix in which there are poorly preserved outlines of numerous glass shards. The lithic fragments are distinctly pumiceous with sparse stout plagioclase phenocrysts and glomeroporphyritic aggregates, as well as rare coarse phenocrysts of magmatically resorbed and embayed quartz. Broken angular crystal debris includes albitised plagioclase, quartz chips, and rare altered mafic crystal sites. The very abundant rock matrix fraction now consists of a cherty polygonised quartz-rich mosaic intergrown with wispy patches of chlorite and "sericite". The groundmass fraction of fragments, on the other hand, is clouded by abundant minute flakes of chlorite and "sericite" outlining the well rounded vesicle sites that are now filled with almost monomineralic granular quartz. Clusters of sphene granules and chlorite generally pseudomorph mafic crystal sites. Several narrow veins contain assemblages including quartz, albite, chlorite ± limonitic oxides.

Unsorted lithic fragmental texture in this rock and the presence of possible glass shards confirms its pyroclastic origin. The lithic and crystal material is derived from a strongly vesicular sparsely porphyritic acidic volcanic source similar to that in A-162222.

Sample No.

A-162224

Rock Type.

Partly altered vitric tuff of acidic primary composition, also containing sparse lithic and crystal debris.

Hand Specimen

A compact fine grained siliceous pale grey sample enclosing scattered mid-grey as well as white to very pale grey

064
 patches or fragments. K-feldspar staining gave strong patchy positive results.

Thin Section. The presence of abundant conspicuous glass shards in this rock, as well as sparse unsorted lithic and crystal fragments clearly indicates its pyroclastic origin. Sparse small volcanic lithic fragments include several texturally different types that were strongly vesicular and once glassy. These are now converted to dense pale green birefringent ?montmorillonite. Elsewhere are microlitic volcanic types now converted to strongly clouded argillic material, while deformed finely ?flow banded fragments (or fiammé) have alternate bands altered to fine grained ?montmorillonite and ?K-feldspar-bearing cherty material respectively. Sparse angular and broken phenocrystic debris includes mostly quartz, with subordinate albitised and "sericite"-bearing plagioclase cleavage fragments.

The abundant glass shards are remarkably clearly preserved by their selective alteration to microgranular albite + quartz, while interspaces are filled with almost cryptocrystalline "chert", including abundant K-feldspar (see staining). Branching trails and veinlets of wispy pale green montmorillonite are common, while patches of chlorite, and colourless "sericite" (or pyrophyllite etc.) are accessory.

The selective alteration in this vitric tuffaceous rock clearly outlines abundant glass shards, broken phenocrysts and lithic fragments, the source material for which is distinctly acidic.

<u>Sample No.</u>	A-162225
<u>Rock Type.</u>	Partly altered and devitrified vitric tuff, with sparse lithic and phenocrystic debris from an acid volcanic source.
<u>Hand Specimen</u>	A fine grained mid-green-grey sample with pale brown patches (?fragments) and crystal sites. K-feldspar staining gave strong positive results for sparse small elongate to irregular shaped ?fragments.

065

Thin Section. As in the previous sample A-162224, selective alteration clearly outlines a fragmental pyroclastic texture with very abundant glass shards and sparse once-glassy vesicular and finely flow banded lithic fragments. The latter are of acidic primary composition and comprise polygonised K-feldspar-rich material. Also present are scattered angular and broken chips of phenocrystic quartz and albitised plagioclase, as well as deformed and degraded sites (now containing yellow-brown stained wispy ?montmorillonite), that once could have been phenocrystic biotite. Individual glass shards and pumiceous fragments are pseudomorphed by polygonised water-clear secondary albite, and are in turn set in a contrasting, exceptionally fine grained, almost cryptocrystalline low birefringent cherty matrix with narrow lensed trails of wispy "sericite" (and/or pyrophyllite etc.). Accessory angular lithic debris includes fine grained clasts rich in carbonaceous dust, small clusters of sphene granules, small grains of zircon and apatite, and rare small patches of red-brown oxides pseudomorphing previous ?sulphides, traces of which remain in the unoxidised part of the rock. Several narrow veins contain chlorite ± quartz ± albite and dusty oxides.

The rock may be accurately described as a partly altered and devitrified vitric tuff with sparse lithic and crystal debris from an acidic (rhyolitic) volcanic source.

Sample No. A-162226

Rock Type. Altered, prehnite-pumpellyite-bearing poorly sorted volcanic conglomerate.

Hand Specimen A patchy rock containing abundant large unsorted lithic fragments of fine grained dark green-grey, pale green-grey and pale grey types. Pale grey patches could represent medium grained phenocryst sites. K-feldspar staining gave positive results for sparse small patches.

Thin Section. Irregular to subrounded volcanic lithic clasts or fragments in this rock are of several different types suggesting

066

possible sedimentary reworking. These are all considerably altered and little original igneous mineralogy remains. Several retain stout phenocrysts and glomeroporphyritic aggregates of albitised plagioclase enclosing granules of epidote and small patches of prehnite. Sparse euhedral mafic phenocryst sites in other fragments have shapes that suggest previous pyroxene, but this phase is pseudomorphed by dense fine grained blue-green pumpellyite. Still other euhedra now contain granular secondary quartz ± epidote and partly oxidised ?carbonate. Certain fragments contain assemblages amongst the phases chlorite, quartz, epidote and pumpellyite in abundant vesicle sites. Sparse wispy feldspar microlites are present in the altered groundmass fraction of most fragments, certain of which contain dense fine grained chlorite and patchy sphene dust. Other more felsic fragments retain strongly trachytic textures defined by ubiquitous flow-aligned microlites with patches of sphene dust.

The rather coarse grained vein-like rock matrix suggests a porous conglomeratic parent. This matrix comprises abundant subradiating aggregates of prehnite intergrown with fine granular to very coarse vein quartz ± accessory pumpellyite.

This rock most likely had a volcanic conglomerate parent that has undergone low grade "burial" metamorphism to prehnite-pumpellyite facies.

<u>Sample No.</u>	A-162227
<u>Rock Type.</u>	Substantially altered mixed tuffaceous sediment, comprising fine grained and porphyritic acidic volcanic fragments and glass shards and fine grained carbonaceous sedimentary material.
<u>Hand Specimen</u>	A poorly sorted fragmental rock with small to medium sized fine grained pale grey, dark grey and rare brown fragments, set in a mid-grey fine grained matrix. K-feldspar staining gave patchy positive results for scattered fragments and some matrix material.

Thin Section. Unsorted fragmental texture in this rock combines a variety of volcanic lithic fragments with fine grained carbonaceous terrestrial material. Altered volcanic lithic fragments predominate and these include once-glassy types with distinct flow banding and/or flattened vesicle sites, as well as quartz and plagioclase porphyritic types. Broken phenocrystic quartz chips, albitised plagioclase and deformed partly altered biotite flakes are common. The volcanic lithic fragments are generally quite poorly defined and commonly have deformed shapes. These are set in a meagre matrix that comprises dusty dark grey fine grained carbonaceous silty material throughout which are located numerous cusped branching glass shards that are converted to microgranular secondary albite.

Alteration of the rock is patchy and partly selective, with dense fine grained wispy birefringent layer silicates (?pyrophyllite) replacing certain once-glassy volcanic lithic fragments, while others now comprise cherty or granular quartz ± albite. Carbonate and chlorite are accessory.

This is an altered, unsorted fragmental sample, possibly resulting from an explosive volcanic event mixing volcanic fragments and glass shards with fine grained carbonaceous sedimentary material.

<u>Sample No.</u>	A-162228
<u>Rock Type.</u>	Altered acidic lithic/vitric tuff with some intermixed fine grained carbonaceous sedimentary material.
<u>Hand Specimen</u>	A fragmental sample with medium to small fine grained irregular shaped mid-grey pale gray and dark grey fragments in a mid-grey fine grained matrix. Weak positive K-feldspar staining outlines several small fragments and a patchy matrix fraction.
<u>Thin Section.</u>	Unsorted fragmental (pyroclastic) textures are characteristic in this sample, and poorly defined fine grained to

068

once glassy vesicular lithic types predominate. Also present are trachytic and vesicular types, abundant glass shards and possible lithic fragments that are themselves vitric tuffs. Scattered angular and broken phenocrystic debris includes approximately equal major proportions of quartz and albitised plagioclase with barely recognisable altered mafic crystal sites, most likely including biotite and an ?amphibole. Irregular shaped deformed patches of fine grained carbonaceous sedimentary material suggests that the rock has a mixed tuffaceous/sedimentary origin.

Alteration of the sample is advanced but selective with wispy birefringent colourless (?pyrophyllite) and pale green (?montmorillonite) layer silicates predominating in finely banded once-glassy lithic fragments, while sites of previous cusped glass shards are largely pseudomorphed by aggregates of clear microgranular albite ± quartz.

This unsorted fragmental rock has a dominant tuffaceous component defined by abundant once glassy vesicular and microlitic lithic fragments of acidic primary composition and equally abundant poorly defined cusped glass shards and broken crystal debris with relatively minor recognisable fine grained carbonaceous sedimentary material, possibly representing a meagre matrix.

<u>Sample No.</u>	A-162229
<u>Rock Type.</u>	Altered lithic/vitric tuff with mixed fine grained carbonaceous sedimentary material.
<u>Hand Specimen</u>	A mottled sample containing poorly defined deformed lithic fragments of dark green-grey mid-grey and pale grey types set in a mid-blue-grey, very fine grained matrix. No K-feldspar was detected by staining.
<u>Thin Section.</u>	Unsorted fragmental texture once again is characteristic in this rock. The lithic fragments mostly have poorly defined margins but once-glassy and vesicular altered types are common,

069

in which pale green wispy birefringent ?montmorillonite predominates, and trails of dusty limonitic oxides mark sites of previous vesicles. Other types clearly contain cusped glass shards pseudomorphed by microgranular albite, set in an extremely fine grained carbonaceous ?pelitic host. Still other clasts are carbonaceous siltstone, while similar material elsewhere contain angular and broken quartz and albitised plagioclase crystal debris. Still other once-glassy polygonised felsic to cherty fragments exhibit distinct narrow flow banding. Wispy deformed lensed narrow carbonaceous layers in this rock partly outline the altered fragments and appear to comprise a meagre fine grained matrix fraction.

Alteration of selected fragments is to dense pale green birefringent ?montmorillonite, while others contain dominant wispy colourless sericite (or montmorillonite), still other patches contain green chlorite ± granular albite. Branching narrow veinlets are filled with granular quartz and patchy chlorite. Traces of sulphides are accessory.

In this sample the poorly defined unsorted lithic fragments include porphyritic to once-glassy acidic volcanic types, as well as vitric tuffaceous types containing abundant devitrified glass shards. The presence of fragments and matrix material with carbonaceous dust suggests a mixed tuffaceous/sedimentary origin.

<u>Sample No.</u>	A-162230
<u>Rock Type.</u>	Partly altered, poorly sorted volcanic conglomerate with traces of sulphide mineralisation.
<u>Hand Specimen</u>	A poorly sorted coarse grained conglomeratic rock containing abundant pebbles (some of which are well rounded), of dark grey, pale grey and green-grey fine grained material set in a mid-grey fine grained matrix. K-feldspar staining proved negative.
<u>Thin Section.</u>	A variety of lithic and crystal material is represented in this poorly sorted conglomeratic rock. Many of the coarse pebble sized clasts are quite well rounded, while others are angular

to irregular. Lithologies represented include the following; microlitic tachytic, once glassy volcanic types; completely altered once-vesicular glassy material; partly altered trachyte; chlorite and clay altered volcanic glassy types with perlitic cracks marked by trails of opaque oxides; plagioclase-porphyritic igneous types of intermediate primary composition, clay-altered flow banded glassy volcanic material, quartz-porphyritic altered volcanic glassy types, scattered clasts of fine grained carbonaceous siltstone and medium grained quartz-rich arenite. Coarse broken angular crystal debris includes phenocrystic quartz and albitised and lightly sericitised plagioclase. Rare mafic crystal sites are converted to dense fine grained chlorite. The rock matrix comprises crystal debris and finer grained lithic clasts similar to those above, in turn set in exceptionally fine grained carbonaceous cherty material ± voids. Sparse accessory pyritic sulphides are located in the rock matrix and also is concentrated in certain clay-altered volcanic lithic clasts.

The rock may be described as a partly altered, poorly sorted volcanic conglomerate with traces of sulphide mineralisation.

<u>Sample No.</u>	A-162231
<u>Rock Type.</u>	Altered and veined unsorted lithic/vitric tuff of acidic primary composition.
<u>Hand Specimen</u>	A very fine grained mottled pale grey to mid grey sample with vague outlines of lithic fragments and a single well defined dark grey fragment enclosing numerous small white (?feldspar) phenocryst sites. K-feldspar staining proved negative.
<u>Thin Section.</u>	Polygonisation and development of a secondary assemblage partly obscures relict textural features of this rock. Nevertheless vague outlines of unsorted angular lithic fragments define a lithic fragmental pyroclastic texture. The lithic fragments mostly include ?rhyolitic types with fine ?magmatic flow banding, sparse

071

albitised plagioclase phenocrysts and flattened elongate vesicle sites, while other fragments appear to have had crowded porphyritic textures. Scattered broken angular phenocrystic debris includes mostly angular albitised plagioclase and subordinate quartz chips. Some glass shards may be present in the voluminous fine grained matrix, as well as small once-glassy volcanic lithic fragments, but mostly this fraction consists of microcrystalline cherty quartz.

Alteration of fragments is to a polygonised quartz-albite mosaic, with trails of chlorite and wispy sericite (or ?pyrophyllite etc.) partly outlining relict textural features. A conspicuous wide vein contains very abundant granular quartz with subordinate chlorite and minor staining by limonitic oxides. Minute cubic patches of limonitic oxides could represent sites of previous trace proportions of sulphides.

The sample may be identified as an altered and veined, unsorted lithic/vitric tuff of acidic primary composition.

<u>Sample No.</u>	A-162232
<u>Rock Type.</u>	Altered, weakly veined and mineralised lithic tuff, containing abundant angular lithic fragments from a strongly vesicular, sparsely porphyritic volcanic source.
<u>Hand Specimen</u>	A massive compact pale grey ?siliceous sample with outlines of scattered medium grained mid grey ?phenocryst sites. K-feldspar staining gave weak positive results outlining the possible phenocrysts and narrow branching veinlets.
<u>Thin Section.</u>	Coarse lithic fragments are characteristic of this pyroclastic rock. Most fragments enclose numerous stout albitised plagioclase phenocrysts and clusters, as well as slightly subordinate subhedral to magmatically rounded and embayed quartz phenocrysts. These are set in a matrix comprising a coarsely devitrified mosaic of granular

072

quartz with chlorite-rich interstitial sites. Narrow branching "zones" of cherty felsic material and ubiquitous angular quartz and albite chips form a rather meagre rock matrix.

The sample is altered to simple assemblages amongst the phases quartz, albite, chlorite and sphene with accessory wispy trails of sericite (?or pyrophyllite etc.). It contains sparse, very fine grained disseminated sulphide mineralisation, particularly along matrix zones rich in albite and quartz chips. The sulphide mineralisation which accounts for about 5% of the total thin section area, is conspicuously absent from several narrow crosscutting veins.

Strongly vesicular and sparsely porphyritic lithic fragments of acidic primary composition, as well as minor broken crystal debris defines a lithic fragmental pyroclastic parent of acidic primary composition. The simple quartz-albite-chlorite alteration accompanies the weak sulphide mineralisation.

<u>Sample No.</u>	A-162233
<u>Rock Type.</u>	Weakly mineralised, altered and silicified, sparsely porphyritic and vesicular acidic volcanic rock.
<u>Hand Specimen</u>	A fine grained compact "siliceous" pale green-grey sample containing numerous small pale grey patches (?phenocryst sites). No K-feldspar was detected by staining but disseminated sulphides are not particularly obvious due to their fine grain size.
<u>Thin Section.</u>	This sample could represent a single volcanic flow lithology. It contains more or less evenly scattered unbroken albitised plagioclase phenocrysts and glomeroporphyritic aggregates, as well as coarse magmatically rounded and embayed quartz phenocrysts, and numerous sites of subrounded to irregular shaped vesicles now filled with clear granular quartz. The former groundmass fraction of this sample now comprises a mosaic of granular secondary quartz crowded with patchy

inclusions of extremely fine grained chlorite and wispy "sericite", (or ?pyrophyllite, illite etc.). Accessory ?mafic crystal sites are now filled with dense ?sericite" and sphene ± quartz, and primary accessory phases include zircon and apatite.

The disseminated fine grained sulphides comprise about 5% to 7% of the sample, and several clusters are selectively located along narrow veinlets filled with "sericite". Otherwise these subhedral cubic and irregular shaped grains are more or less evenly distributed throughout the rock.

This sample has been polygonised and silicified to form a quartz-rich granular mosaic enclosing patchy fine grained chlorite and wispy "sericite", but retaining relict textures of a sparsely plagioclase- and quartz-porphyritic, vesicular, once-glassy acidic volcanic parent.

<u>Sample No.</u>	A-162234
<u>Rock Type.</u>	Partly altered unsorted lithic tuff, comprising debris from a porphyritic acidic to trachytic volcanic source.
<u>Hand Specimen</u>	A mottled pale grey pale brown (partly oxidised) and dark grey fine grained ?cherty sample comprising abundant unsorted fragments (up to 4 cm across). Certain of these exhibit distinct porphyritic texture. No K-feldspar was detected by staining.
<u>Thin Section.</u>	Unsorted lithic fragmental textures are clearly evident in this pyroclastic rock. Lithic fragments account for about half the present thin section area, and these include blocks 4 cm across, as well as smaller material. The fragments show a range of relict textures including the following; strongly plagioclase-porphyritic types with dense flow oriented albitic microlitic (trachytic) groundmass textures and sparse elongate quartz-filled vesicle sites. A pattern of perlitic cracks in the groundmass of certain fragments is outlined by trails of

074

limonitic oxide dust and minute chlorite flakes. Elsewhere are similar fragments with subhedral to rounded and embayed quartz phenocrysts. Still other fragments are fine grained trachytic types with dense chlorite in the groundmass fractions, and some lithic fragments appear themselves to be fragmental. The rock matrix contains sparse smaller volcanic lithic fragments, as well as abundant albitised plagioclase cleavage fragments (some with deformed and bent twin lamellae) and subordinate quartz chips. This debris is set in a silicified cherty matrix intergrown with patches of chlorite and minor wispy birefringent layer silicates.

The sample may be described as a partly altered, unsorted lithic tuff comprising debris from a porphyritic acidic to trachytic volcanic source.

<u>Sample No.</u>	A-162235
<u>Rock Type.</u>	Substantially altered, silicified and weakly mineralised porphyritic volcanic rock of acidic primary composition.
<u>Hand Specimen</u>	A massive fine grained cherty siliceous mid-grey sample containing numerous medium grained pale grey ?phenocryst sites. Fine grained sulphide mineralisation is not particularly obvious in hand specimen. K-feldspar staining proved negative.
<u>Thin Section.</u>	Relict porphyritic texture is preserved in this sample in spite of its strong silicification and partial argillic alteration. Unlike previous samples it does not appear to be fragmental. It contains sparse albitised and strongly argillically clouded stout plagioclase phenocrysts and aggregates, and barely recognisable sites of previous ?mafic microphenocrysts now converted to patchy secondary quartz and sphene granules. Quartz phenocrysts are lacking. Vague outlines of possible minute microlites can be barely recognised in the dusty silicified groundmass fraction. Small apatite crystals are accessory.

Certain phenocryst sites and branching patches

075

(?vesicle sites) now are filled with very dense fine grained ?pyrophyllite centrally with partial rims of granular secondary quartz and small central zones filled with chlorite. Certain radiating quartz patches retain inclusions marking a colloform banded ?chalcedony or ?opaline precursor. The voluminous groundmass fraction now is pseudomorphed by a more or less equigranular quartz-rich ?albite-bearing mosaic crammed with minute dusty inclusions of ?pyrophyllite, chlorite and dusty sulphides. The latter (mostly pyrite) comprise about 3% of the thin section area. Minor quartz veins are barren.

The sample may be described as a substantially altered silicified and weakly mineralised porphyritic volcanic rock of acidic primary composition.

<u>Sample No.</u>	A-162236
<u>Rock Type.</u>	Weakly foliated, distinctly banded medium grained carbonaceous quartz-rich arenite (or quartz-rich greywacke)/foliated carbonaceous siltstone.
<u>Hand Specimen</u>	A mid-grey banded sample comprising a thick medium to fine grained band with subordinate lenses and narrow bands of fine grained dark grey material. No K-feldspar was detected by K-feldspar staining.
<u>Thin Section.</u>	The majority of this sample consists of a medium grained quartz-rich arenaceous sediment. This fraction contains at least 50% of crystal debris, the majority of which is angular quartz and slightly subordinate degraded and deformed mica flakes (now converted to "sericite") and dusty opaque oxides. Rare flakes retain brown biotite pleochroism. Accessory crystal debris includes rare mafic crystal sites (chlorite), subrounded grains of olive green to yellow-green tourmaline, red-brown spinel, zircon, sphene and rutile. Lithic clasts include fine grained recrystallised weakly foliated quartzite and carbonaceous sericite-rich siltstone. The clouded matrix fraction of this rock includes wispy sericite

076

and dusty carbonaceous-rich cherty material. The layer silicates define a weak wavy foliation.

Subordinate fine grained lensed bands include abundant wispy sericite ± chlorite intergrown with carbonaceous dust and silt sized relict quartz detritus. The wavy foliation of these bands is subparallel to the primary layering. Clusters of fine grained sulphides are mainly located along certain fine grained carbonaceous bands.

This rock is quite similar to the previous sample A-162221, except that the present sample is more carbonaceous and is distinctly banded. It may be described as a weakly foliated, distinctly banded medium grained carbonaceous quartz-rich arenite (or quartz-rich greywacke)/foliated carbonaceous siltstone, with traces of sulphide mineralisation.

<u>Sample No.</u>	A-162237
<u>Rock Type.</u>	Partly altered and weakly foliated, poorly sorted lithic tuffaceous conglomerate containing abundant vitric and sparsely porphyritic volcanic clasts from an acidic to trachytic source.
<u>Hand Specimen</u>	An unsorted coarse grained sample with abundant lithic debris including fine grained pale grey to white, fewer mid-green-grey and dark grey deformed fine grained types set in a pale grey fine grained matrix. Elongate dark grey carbonaceous lenses define a poor foliation. Rare small fragments except a weak positive K-feldspar stain.
<u>Thin Section.</u>	A wide variety of mainly volcanic textural types are represented amongst the coarse lithic debris of this poorly sorted sample. And most material is in the size range of very coarse sand to small pebbles. Shapes of the debris range from quite well rounded to irregular and flattened. Volcanic clasts include the following types; strongly vesicular glassy material now converted to dense fine grained pale green ?montmorillonite; clouded albite-rich fine grained trachyte

077

with albite microphenocrysts; argillically altered and albitised vitric tuff with clear outlines of cusped glass shards; and crystal tuffaceous types comprising angular chips of albitised plagioclase and quartz in a cherty ?shard-bearing matrix. Elsewhere are clasts of fine grained, weakly foliated carbonaceous siltstone and angular, broken phenocrystic debris including mainly coarse grains of albitised plagioclase and quartz. The meagre fine grained rock matrix includes deformed carbonaceous pelitic lenses and several wavy stylolites are present. Deformed vein-like patches of pale green ?montmorillonite and rare sulphides are accessory.

Clastic sedimentary texture is evident in this partly altered, poorly sorted lithic tuffaceous conglomerate that contains abundant vitric tuff, and sparsely porphyritic volcanic debris from an acidic to trachytic source.

<u>Sample No.</u>	A-162238
<u>Rock Type.</u>	Fine grained silty carbonaceous slate with a weak foliation parallel to a narrow poorly defined primary layering.
<u>Hand Specimen</u>	A dark grey fine grained weakly fissile slaty rock with narrow joints containing fine grained sulphides. K-feldspar staining proved negative.
<u>Thin Section.</u>	This is a very fine grained, weakly banded and foliated carbonaceous sediment. It contains scattered silt sized angular quartz and some ?albite chips, as well as sparse small well rounded sites of previous microfossils (?radiolaria), also now filled with microgranular cherty quartz. These small grains are "suspended" in a voluminous matrix fraction of dense carbonaceous dust and wispy ?sericite flakes, well oriented parallel to the foliation. The latter appears to be subparallel to a weak primary banding defined by somewhat variable proportions of carbonaceous dust. The rock is cut by several narrow veinlets filled with granular quartz, low birefringent clay and clusters of minute cubic sulphide crystals.

The rock may be simply described as a fine grained silty carbonaceous slate with a weak foliation parallel to a narrow poorly defined primary layering.

Sample No. A-162239

Rock Type Partly brecciated or autobrecciated, sparsely porphyritic microlitic and once-glassy volcanic rock of intermediate, possibly trachytic, affinity.

Hand Specimen A pale yellow-brown stained fine grained mottled sample with distinct outlines of abundant angular to irregular shaped lithic fragments. K-feldspar staining proved negative. The rock is cut by several joints coated with limonitic oxides. No K-feldspar was detected by staining.

Thin Section. Partial fragmental texture in this sample most likely represents autobrecciation of a single flow rather than a pyroclastic feature. All the angular fragments comprise a single lithology, and interfragment material comprises a branching vein-like network of fine grained cherty quartz. The volcanic lithology contains sparse stout prismatic crystals and glomeroporphyritic aggregates of albitised plagioclase, as well as sparse plagioclase microphenocrysts, these are set throughout a substantially altered groundmass with wispy unoriented plagioclase microlites set in a devitrified mat of equigranular quartz patches intergrown with patches rich in partly oxidised and clouded chlorite. The rock matrix comprises a cherty mosaic of intergrown quartz and albite with previous voids lined with chlorite, peripherally and granular quartz centrally.

Trails and patches of red-brown limonitic oxides are mostly located within the branching cherty interfragment domains, and certain of these once may have comprised sulphides.

The exact primary composition of this sample is masked by its intense alteration and devitrification. However,

079

it may be tentatively described as a partly brecciated or autobrecciated, sparsely porphyritic microlitic and once-glassy volcanic rock of intermediate, possibly trachytic, affinity.

Sample No. A-162240

Rock Type. Substantially altered, poorly sorted lithic/crystal tuff containing debris from a fine grained but coarsely plagioclase-quartz-porphyritic acidic volcanic source.

Hand Specimen. A poorly sorted medium to coarse grained distinctly fragmental rock with abundant angular to irregular shaped "buff" coloured fragments, as well as sparse dark green-grey deformed fragments set in a poorly defined fine grained pale grey matrix. K-feldspar staining gave strong positive results for sparse coarse crystal clasts and parts of the fine grained matrix.

Thin Section. Poorly sorted fragmental texture is characteristic of this sample and all the recognisable debris is of volcanic origin. The rock contains almost equal major proportions of crystal and fine grained volcanic lithic fragments, most of which are less than 5 mm across. The crystal fragments include dominant cleavage fragments of albitised and lightly sericitised plagioclase with slightly subordinate angular and broken quartz chips. The volcanic lithic fragments are all very fine grained to once-glassy altered types and recognisable relict textures in these include sparse albite microphenocrysts and small quartz-filled vesicle sites, vague outlines of possible glass shards and several finely polygonised quartz and chlorite ± montmorillonite-rich fragments that once may have been magmatically flow banded. Accessory crystal debris includes strongly clouded perthitic ?K-feldspar and sparse degraded ?oxide sites now containing dense sphene and chlorite. The rather meagre rock matrix contains abundant chlorite intergrown with a cherty quartz-rich mosaic. Parts of this material could include K-feldspar - see staining of offcut.

080

Alteration has obscured the finer textural features of this rock, but it may be described generally as a poorly sorted lithic/crystal tuff containing debris from a fine grained but coarsely plagioclase-quartz-porphyrific acidic volcanic source.

Sample No. A-162241

Rock Type. Partly altered, fine grained once-vesicular trachyte.

Hand Specimen A fine grained rather massive pale grey sample with buff coloured elongate mottled patches and elongate flattened mid-grey vesicle sites defining a possible magmatic flow direction. K-feldspar staining gave positive results for the majority of this fine grained sample.

Thin Section. Microlitic trachytic texture is well defined in this fine grained volcanic rock, and sparse narrow elongate vesicle sites are also drawn out parallel to the direction of magmatic flow. The ubiquitous wispy feldspar microlites are albitised, and these are set throughout a matrix comprising microcrystalline felsic domains (possibly intergrown quartz and K-feldspar), and chlorite-rich domains. The elongate almond-shaped vesicle sites contrast with the fine grained host since they are filled with relatively coarse granular quartz with partial rims of oxidised chlorite and sphene. Sparse microphenocrysts of albite are accessory. The rock is cut by narrow branching quartz filled veins, but these are unmineralised.

Unlike most of the fragmental samples in this suite the present rock comprises a trachytic and sparsely vesicular volcanic flow rock, most likely of trachytic primary composition. Alteration of the rock has included albitisation of feldspars and development of patchy quartz and chlorite.

081

Sample No.

A-162242

Rock Type.

Partly altered and devitrified autobrecciated volcanic flow rock containing fragments of a once glassy microlitic trachytic type with conspicuous perlitic cracks.

Hand Specimen

A massive fine grained pale grey ?siliceous sample with vague outlines of possible mid-grey coloured fragments. Numerous small pale yellow-brown patches could represent crystal sites. K-feldspar staining proved negative.

Thin Section.

This sample most likely represents an auto-brecciated once-glassy volcanic flow rock rather than a fragmental pyroclastic type since it contains ubiquitous angular to irregular shaped lithic fragments of a single distinctive lithology. The fragments exhibit conspicuous perlitic cracks now marked by concentrations of minute green chlorite flakes, and these cracks enclose domains of mottled microgranular albite ± quartz. Albitised plagioclase microlites define a clear direction of magmatic flow, and adjacent elongate "fragments" commonly exhibit similar orientations of microlites. Sparse subhedral prismatic microphenocrysts and glomeroporphyritic aggregates are of albitised plagioclase. Rare crystals of this phase that are located in the matrix fraction appear to be angular and broken suggesting at least some brecciation. Clusters of sphene granules are a common accessory phase.

The rock matrix is a "cherty" mottled mosaic of intergrown quartz, albite and relatively minor chlorite.

This sample almost certainly represents an auto-brecciated flow of a sparsely microporphyritic once-glassy microlitic trachytic type with ubiquitous chlorite-filled perlitic cracks.

082

Sample No. A-162243

Rock Type. Partly altered (particularly albitised) vitric tuff with numerous lithic and crystal fragments from an acidic volcanic source.

Hand Specimen A pale grey fine grained sample containing numerous almost white (?feldspathic) and fewer dark grey fragments. K-feldspar staining gave strong positive results for sparse crystal and lithic debris.

Thin Section. Once again this sample exhibits unsorted fragmental (pyroclastic) textures defined by abundant broken crystal and lithic debris set in a matrix containing numerous outlines of previous glass shards. The broken phenocrystic debris includes almost equal major proportions of quartz and albitised plagioclase, as well as minor strongly clouded perthitic K-feldspar. The poorly defined fine grained volcanic lithic debris includes once-glassy types now converted to monomineralic wispy pale green birefringent ?montmorillonite, barely recognisable types with fine wavy ?flow banding, devitrified felsic material with fine perlitic cracks marked by wispy chlorite (these fragments could accept a positive K-feldspar stain), still other finely devitrified fragments once were strongly vesicular. Much of the exceptionally fine grained "cherty" felsic rock matrix lacks recognisable relict textures but in certain domains clear outlines of previous cusped glass shards are preserved. The shards are pseudomorphed by granular albite which is clear of inclusions, while the enclosing "cherty" matrix is strongly clouded.

The rock may be described as a partly altered (albitised) vitric tuff with numerous lithic and crystal fragments from an acidic volcanic source.

Sample No. A-162244

Rock Type. Partly altered and poorly sorted volcanic (or tuffaceous) conglomerate containing predominant fine grained volcanic lithic and crystal clasts from an acidic (rhyolitic) to trachytic source.

083

Hand Specimen A poorly sorted conglomeratic sample containing abundant pale grey and fewer dark grey subrounded to irregular shaped lithic clasts, set in a much finer grained pale grey ?arenaceous matrix. K-feldspar staining gave positive results for scattered fine grained debris.

Thin Section. Poorly sorted clastic texture is evident in this tuffaceous but partly conglomeratic sample. Lithic clasts commonly exhibit subrounded to well rounded outlines and include the following types; once partly glassy fine grained microlitic trachyte with well defined perlitic cracks; dense once-glassy material that is converted to pale green ?montmorillonite; devitrified albite and cherty quartz-rich finely ?flow banded ?rhyolite; strongly microporphyritic trachyte; albite-altered once-vesicular types; sparse deformed clasts of weakly foliated carbonaceous siltstone; fine grained quartz-rich arenite and weakly foliated fine grained quartzite. The abundant crystal debris in this rock includes approximately equal proportions of angular albitised plagioclase cleavage fragments and quartz chips with rare grains of clouded ?K-feldspar. The poorly defined rock matrix of this sample comprises fine grained lithic and crystal debris similar to that described above.

The rock may be described as a partly altered, poorly sorted volcanic (or tuffaceous) conglomerate, containing predominant fine grained volcanic lithic and crystal clasts from an acidic (rhyolitic) to trachytic source.

Sample No. A-162245

Rock Type. Considerably altered, poorly sorted lithic tuff containing abundant clinopyroxene and plagioclase porphyritic fragments from an intermediate (?trachy-andesitic) volcanic source.

Hand Specimen A mid- to dark-green grey fine grained sample with scattered pale grey patches or fragments. K-feldspar staining gave positive results for parts of certain large (?phenocrystic) feldspars.

084

Thin Section. This sample, both texturally and compositionally, is unlike the previous fragmental rocks of acidic affinity. It is fragmental, however, and almost certainly is pyroclastic. The most striking difference is the presence of scattered coarse euhedral grains of zoned pale green to pale yellow clinopyroxene. Certain of these have central zones of clear colourless clinopyroxene. They are remarkably unaltered. Several clinopyroxene-rich glomeroporphyritic clusters are intergrown with coarse grains of albitised plagioclase with exsolved patches of K-feldspar. Albitised plagioclase microphenocrysts are subordinate and in part of the rock these are converted to patchy clouded ?prehenite ± minor pumpellyite. Several large lithic fragments clearly were once glassy and very strongly vesicular but now these are converted to assemblages amongst the phases albite, quartz, chlorite, epidote and sphene. On the other hand other fragments are partly carbonated, while sparse volcanic fragments retain albitised microlitic trachytic textures. Numerous small fragments, some of which carry fresh phenocrystic clinopyroxene and albitised plagioclase now are converted to very dense fine grained pumpellyite.

The primary composition of volcanic lithic fragments in this rock is partly masked by its intense alteration. Nevertheless it may be tentatively described as a poorly sorted lithic tuff, containing abundant clinopyroxene and plagioclase porphyritic and vesicular fragments from an intermediate (?trachy-andesitic) volcanic source.

085

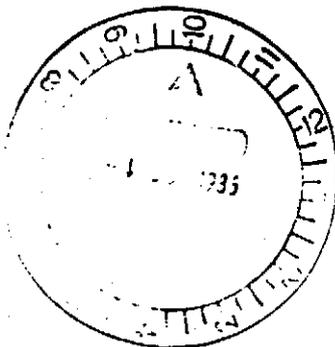
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NINE ROCK SAMPLES

Report No: C7/85/352a

1st July, 1986.

For: CSR Limited.

Dr. B.J. Barron,
Consulting Petrologist.

086

1.

Sample No.

A 162246

Rock Type.

Partly altered and veined, unsorted lithic tuff containing a variety of mostly once-glassy debris from an acidic source.

Hand Specimen

An unsorted fragmental sample with fine grained pale brown, white, mid-grey and dark grey lithic fragments up to 1 cm across, set in a fine grained matrix with a weak wavy lamination. K-feldspar staining gave strong positive results for individual coarse phenocryst debris, wispy narrow bands in flow-banded lithic fragments and also for a narrow branching veinlet.

Thin Section.

Unsorted fragmental texture is clearly developed in this pyroclastic rock. Recognisable lithic clasts have angular shapes and include flow banded and once-glassy vesicular volcanic types, as well as types containing sparse quartz phenocrysts including doubly terminated (high temperature) quartz and albitised plagioclase, while elsewhere are phenocrysts of clouded K-feldspar. The abundant rock matrix contains outlines of cusped glass shards, broken vesicular lithic fragments and types with perlitic cracks as well as scattered broken angular crystal debris including quartz chips, plagioclase chips, degraded mafic phases, and oxide microphenocryst sites.

Alteration is patchy and includes montmorillonite, wispy "sericite" (or pyrophyllite), patches of minute chlorite flakes, minor carbonate, aggregates of albite, cherty quartz, and sparse narrow branching veinlets of albite and K-feldspar (most likely adularia), with patches of limonitic oxides, possibly partly replacing previous sulphides but also pseudomorphing iron-bearing carbonate.

The sample may be described as a partly altered and veined, unsorted lithic tuff containing a variety of mostly once-glassy debris from an acidic volcanic source.

087

Sample No. 162247

Rock Type. Partly altered vesicular and microporphyritic acidic volcanic rock with ubiquitous minute feldspar microlites.

Hand Specimen A massive fine grained mid-grey sample containing sparse scattered elongate subparallel dark green-grey patches. K-feldspar staining gives weak positive results for most of the sample and particularly for narrow rims around vesicle sites.

Thin Section. This is a devitrified once-glassy volcanic flow rock containing very abundant minute feldspar microlites that are partly decussate and partly trachytic (oriented parallel to the direction of magmatic flow). They are set in a matrix that now comprises an equigranular mosaic of intergrown anhedral domains of quartz and albite ± K-feldspar ± wispy chlorite and "sericite", as well as small clusters and trails of sphene dust. Sparse microphenocrysts include euhedral prismatic crystals of plagioclase and titaniferous opaque oxides that are now converted to clouded leucoxene ± sphene. Crystals of apatite and zircon are accessory. Numerous small vesicle sites which are drawn out parallel to the direction of magmatic flow are now filled with granular quartz, and subordinate patches of sphene, chlorite, K-feldspar and traces of microgranular epidote. Sparse subhedral mafic crystal sites now are filled with chlorite, quartz, sphene, and small patches of "sericite".

The exact composition of this sample is partly masked by its fine grain size and patchy alteration. It may be tentatively identified as a partly altered vesicular and microporphyritic acidic volcanic rock with ubiquitous minute feldspar microlites.

Sample No. A 162248

Rock Type. Partly altered, very fine grained microlitic and once partly glassy vesicular trachytic volcanic rock.

088

Hand Specimen A compact massive fine grained mid-brown sample with sparse patches of grey oxides. Staining gave very strong positive results for K-feldspar outlining numerous minute patches (or ?vesicle sites) that lack K-feldspar.

Thin Section. Fine grained trachytic texture is well defined in this igneous rock which is also strongly vesicular. Sparse microphenocrysts of albitised plagioclase exhibit zoning structures, with chlorite centrally and wispy sericite inclusions throughout, while rare euhedral mafic crystal sites (?amphibole) now contain aggregates of chlorite, sphene and epidote. The dense mat of groundmass feldspar microlites are set in a meagre granular devitrified mosaic of intergrown K-feldspar ± quartz ± patches of chlorite and sphene dust.

The abundant small irregular shaped vesicle sites now are filled mainly with granular secondary quartz with wispy sericite marking original outlines. Accessory secondary phases in the vesicle sites include aggregates of epidote, chlorite and sphene. Several large anhedral patches and veins are filled with dense chlorite, pale yellow "sericite" and almost opaque to red-brown translucent limonitic oxides centrally, that most likely comprise oxidised carbonate rather than sulphides.

This sample is strongly potassic, lacks phenocrystic quartz but contains microphenocrysts of plagioclase and rarely altered mafic sites. It may be tentatively identified as a partly altered, very fine grained microlitic and once partly glassy vesicular trachytic volcanic rock.

Sample No.

A 162249

Rock Type.

Perlitic vesicular sodic trachyte, with patchy selective alteration and quartz veining.

Hand Specimen

A massive fine grained mid grey sample cut by an irregular system of veinlets and sparse narrow fractures that are coated with red-brown oxides. K-feldspar staining proved negative.

Thin Section. Felted trachytic texture is very well developed in this extremely fine grained volcanic rock. Minute wispy elongate feldspar microlites are well aligned parallel to a direction of previous flow. In addition the sample contains sparse euhedral to subhedral microphenocrysts of albite that are lightly dusted with wispy sericite. Accessory microphenocryst sites include leucoxene-sphene altered euhedral opaque oxide crystal sites, and rare mafic crystal sites that are now converted to dense chlorite and sphene. Ubiquitous small clusters of sphene granules are evenly distributed throughout. Also present are numerous small, irregular shaped vesicle sites that now are filled with almost monomineralic microgranular quartz ± chlorite, while a dense pattern of narrow curving perlitic cracks are filled with trails of chlorite. The conspicuous branching veins of the offcut are filled with microgranular and prismatic quartz crystals.

The perlitic cracks in this sample attest to its origin as a partly glassy quickly cooled volcanic flow rock, and its trachytic texture with ubiquitous sodic feldspars suggests a sodic trachyte composition.

Sample No. A 162250

Rock Type. Partly altered unsorted lithic/crystal tuff, containing debris from a porphyritic acid volcanic source.

Hand Specimen A fragmental mottled sample containing pale grey mid-grey and pale brown fragments (mainly less than 5 mm across), set in a pale red-brown poorly defined fine grained matrix. No K-feldspar was detected by staining.

Thin Section. Altered angular unsorted lithic fragments and coarse broken crystal debris are characteristic of this sample, and are present in approximately equal major proportions. The one lithic type represented is extremely altered and coarsely devitrified but still retains

barely recognisable textures of flow banding, vesicle sites and perlitic cracks. This material is converted to granular albite, abundant chlorite and minor cherty quartz. Certain clasts enclose magmatically rounded and embayed quartz and albite phenocrysts. The abundant phenocrystic debris includes almost equal proportions of angular quartz chips and albite cleavage fragments that are quite heavily dusted with minute sericite flakes. Rare mafic crystal sites now are filled with secondary assemblages amongst the phases chlorite, albite, cherty quartz and sphene. The abundant rock matrix lacks recognisable relict textures and consists of a microcrystalline felsic or cherty mosaic intergrown with small patches of chlorite and dusty sphene.

Unsorted fragmental texture is defined by broken phenocrystic lithic and crystal debris from an acidic volcanic source. The rock may be described as a partly altered, unsorted lithic/crystal tuff.

<u>Sample No.</u>	A 161951
<u>Rock Type.</u>	Partly altered and oxidised vitric tuff, with sparse lithic and crystal debris from an acidic volcanic source.
<u>Hand Specimen</u>	A massive pale brown grey, very fine grained sample with outlines of somewhat rounded patchy mottled (?alteration) domains. No K-feldspar was detected by staining.

Thin Section. In contrast to the previous sample the present rock contains conspicuous well preserved outlines of cusped glass shards forming the voluminous matrix fraction. The latter encloses sparse partly altered but recognisable lithic and crystal debris. The lithic clasts are extremely fine grained types with angular to irregular shapes and vague outlines of relict vesicular textures. Several contain albitised plagioclase microphenocrysts that are set in dense pale brown wispy montmorillonite. The sparse broken angular crystal debris rarely exceeds 0.2 mm across, and includes approximately equal major proportions of albite and quartz.

Alteration in the fine grained matrix includes selective alteration of the glass shards to microgranular secondary albite, and these are set in a cherty to felsic microgranular mosaic variously stained by red-brown limonitic oxides. Narrow crosscutting veinlets contain almost monomineralic granular quartz.

This sample may be described as a partly altered and oxidised vitric tuff, with sparse lithic and crystal debris from an acidic volcanic source.

<u>Sample No.</u>	A 161952
<u>Rock Type.</u>	Partly altered mixed tuffaceous sediment, containing abundant lithic, crystal and glass shard material of acidic composition, set in a meagre ?carbonaceous cherty matrix.

<u>Hand Specimen</u>	An unsorted fragmental sample with mottled pale grey, dark grey and pale brown angular and irregular lithic and crystal debris set in a mid-grey fine grained matrix. K-feldspar staining gave positive results for small angular crystal clasts and weak results for irregular shaped lithic debris.
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<u>Thin Section.</u>	This sample is somewhat similar to the previous sample A 161951. It is an unsorted fragmental rock in which lithic clasts and broken crystal debris are more or less equally abundant. The lithic clasts rarely exceed 5 mm across, and these include the following types; quartz porphyritic once-glassy rhyolite. Strongly vesicular once-glassy types now converted to wispy pale yellow montmorillonite ± albite, albite-porphyritic once-glassy types, and sparse clasts of silty carbonaceous mudstone. The broken phenocrystic debris includes angular chips and shattered cleavage fragments of weakly sericitised albite and fewer of clouded K-feldspar. All the fragments are "suspended" in a voluminous rock matrix that retains well preserved relict textures of cusped glass shards (now converted to microgranular albite), that are in turn enclosed
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within dusty (?carbonaceous) cherty material with patches of chlorite and carbonate. This most likely requires incorporation of the tuffaceous debris into fine grained carbonaceous sedimentary material.

The sample may be identified as a partly altered mixed tuffaceous sediment, containing abundant lithic, crystal and glass shard material of acidic composition, set in a meagre ?carbonaceous cherty matrix.

<u>Sample No.</u>	A 161953
<u>Rock Type.</u>	Well sorted medium grained quartz-rich arenite, with a moderately carbonaceous chlorite-rich meagre matrix.
<u>Hand Specimen</u>	A mid green-grey medium grained fairly massive sample that exhibits a very weak layering or lamination. K-feldspar staining proved negative.
<u>Thin Section.</u>	Well sorted clastic sedimentary texture is characteristic in this rock which has an average grain size of about 0.3 mm (medium grained sand). Angular quartz debris greatly predominates with slightly less abundant deformed mica flakes. Also present are quite common small lithic fragments, also in the medium sand size range, of quartzite (with wispy chlorite flakes, carbonaceous chert, kinked carbonaceous sericite-rich siltstone, and carbonaceous claystone. Accessory detritus includes prismatic grains of olive green to straw coloured tourmaline, zircon, apatite, rutile and rare grains of translucent red-brown spinel. The meagre rock matrix comprises finely polygonised quartz intergrown with minor wispy sericite, relatively abundant green chlorite and patchy carbonaceous dust.

This sample may be simply classed as a well sorted medium grained quartz-rich arenite, with a moderately carbonaceous chlorite-rich meagre matrix.

093

Sample No. A 161954

Rock Type. Altered and devitrified ?autobrecciated plagioclase-porphyrritic flow of acid-intermediate primary composition.

Hand Specimen A mid green-grey very fine grained somewhat mottled sample with sparse poorly defined medium grained pale grey patches (?phenocrysts). K-feldspar staining proved negative.

Thin Section. Relict textures are not very clearly preserved in this altered, partly fragmental rock. Vague outlines of albite-porphyritic fragments in several parts of the rock are defined by changes in matrix grain size across such boundaries, but the fragment lithologies are similar and related to the enclosing host type. Scattered coarse subhedral to magmatically rounded and partly broken angular weakly sericitised albite phenocrysts and glomeroporphyritic aggregates are common, but rare small mafic phenocryst sites now are pseudomorphed by aggregates of carbonate, sericite and sphene dust. Several of the mafic crystal sites retain shapes indicating the presence of previous amphibole.

Apart from the presence of possible lithic fragments, patchy grain size variation throughout the matrix appears to outline elongate discontinuous subparallel compositional domains that most likely reflect original magmatic flow banding. In addition the coarse to fine granular felsic and chlorite-rich devitrified bands and patches also enclose ubiquitous unoriented wispy feldspar microlites and abundant small irregular patches of granular quartz ± carbonate that most likely represent previous sites of numerous small vesicles. Elsewhere are patches and narrow veinlets filled with microgranular quartz and traces of carbonate ± secondary albite.

The poorly defined discontinuous layering in this sample almost certainly represents a magmatic flow banding but possible fragmental outlines are not clear and the rock may be only tentatively identified as an altered and devitrified ?autobrecciated plagioclase-porphyritic flow of acid-intermediate primary composition.

APPENDIX II

GEOPHYSICAL INTERPRETATION

(AEROMAGNETIC, IP, GRAVITY, CSAMT)

P.R. GIDLEY

095
Minerals Exploration And Development Group

TO R WILLIAMS

REFERENCE PRG/JM 39:12

FROM P R GIDLEY

DATE 2ND APRIL, 1987

RE BULGOBAC CREEK - GEOPHYSICS

A collation of the results of geophysical surveys covering the Bulgobac Creek tenement is presented. Some of this work has been contained in Leaman (1987). Additional and confirmatory information is given here.

Aeromagnetics

The proposition of magnetic anomalism was first mentioned by Leaman in his appraisal report for the Bulgobac area. Reprocessed data as shown in Drawing No. 7612-3. Two profiles taken NNE-SSW and ESE-WNW over the ground grid are indicated in Figures 2 and 3. The east-west profile of Figure 3 overlies gridline 7600N and is influenced at its western end by the occurrence of a small cap of Tertiary basalt. No information relating to mineralisation or geology could be drawn from this profile although a small zone of reduced magnetic response is observed between 2100 and 2500E. Figure 2 however, equating to ground base line 2400E suggests a subtle magnetic low, of about 1.0 nT amplitude centred slightly north of 7600N. This effect is clearly shown when a residual profile is derived from regional effects.

It is suggested by Leaman, and verified here, that the described magnetic pattern is consistent with a localised source at moderate depth (2-300m) in which magnetic contrasts are reduced relative to host lithologies. Such a situation may exist if alteration effects are present.

096

-2-

IP

A gradient array induced polarisation survey was undertaken by CSR over the area. Zonge Engineering were contracted to undertake the work which they completed during December 1986. The survey used a current electrode separation of about 3.5 km being energised by a 7.5 kVA trailer mounted generator set. Potential electrode readings were made using 25m dipole separation over the grid area shown in Drawing Nos. 7612-7 and 6. These two figures present data as apparent resistivity (in ohm metres) and phase (in milliradians) respectively.

Results from this work indicate the layered, shallowly dipping electrical contrasts associated with the Que River Shales (QRS) and adjacent lithologies in the area. The original proposal to undertake gradient IP was to investigate the possibility of 'seeing through' the conductive QRS. It was then thought this unit was more steeply dipping and would hence present a traceable depth marker unit to determine structure. The results however have only indicated the near-surface occurrence of QRS with associated high pyrite content and that the lithology shallowly dips east beneath the area. The high resistivities at the western half of the grid reflect conformable andesitic basement formations. Depth of penetration of this survey appears restricted to the depth of QRS in the east, and about 80-100 metres in the west.

Regional Gravity

A 1:25000 scale gravity map presented as Drawing No. 7612-8 and contoured at 0.5 mGal was derived from data released as part of the Tasmanian Dept of Mines Mt. Read Volcanic Project. The data values are plotted, and have been reduced using standard elevation free-air, latitude and terrain corrections. A density contrast of 2.67 t/cu m has been adopted for Bouguer reduction.

097

-3-

Results indicate a 'V' shaped positive gravity feature described by the -16 mGal contour.' The eastern side of the 'V' coincides with the Que River and Hellyer mineralisation zones. The western side of the anomaly corresponds to the Bulgobac Creek survey area. A 0.75 mGal anomaly would be expected within this area based on the regional data alone and this amplitude lies above that of estimated noise due to elevation and terrain errors (approximately 0.1 mGal).

Local Gravity

The Bulgobac Creek (Que Road) gravity survey was undertaken during Jan/Feb 1987 by Solo Geophysics with results processed by Leaman. The reduction, precision and corrections are reported in his summary. Results were tied to the Tasmanian Department of Mines data and have an RMS error of ± 0.05 mGal. The results, contoured at 0.25 mGal are presented in Drawing No. 7612-2.

The contours reveal an arcuate gravity high trending E-W across lines 7600N/7800N and then turning south from 7400N to 7000N. The amplitude of the anomaly ranges from 0.2 to 0.7 mGal. Two closures exist along this high trend. A western closure occurs between 7800N/7600N at 1800E with an amplitude of 0.2 mGal. The second closure, east on 7600N occurs at 2400-2600N and has amplitude of about 0.5 mGal. These two anomalies can be more easily seen in profile form on Figure 8 of Line 7600N. A regional gradient is difficult to isolate based on this data so the profile along the baseline 2400 E was selected. This profile and residual is shown in Figure 9. The residual-regional profile indicates a gravity feature of about 0.6 mGal. Preliminary modelling was undertaken by Leaman and CSR as a check. Based on the residual as calculated above, a similar density/depth combination was determined. The proposed body at about 270 metres requires a density contrast of 1.7 t/cu m which approximates to that of massive ore at Hellyer. The source estimate places the model at a depth conforming to that structurally and

098

stratigraphically supposed as containing Hellyer and Que River hosts.

Away from the main defined anomalies there is little interest. A relatively flat gravity field is observed north of 7800N. At the extreme west of the survey on 7600N-7800N a steeply falling gradient suggests a downthrown fault or significant change of lithology.

CSAMT

The controlled source audio-frequency magnetotelluric (CSAMT) technique was employed along grid lines at Bulgobac Creek to investigate the presence of deep conductors similar in physical character to that of Hellyer and Que River. This technique utilises a fixed remote current source providing a predictable signal where apparent resistivity and phase angle soundings are measured. The technique provides high lateral resolution with excellent depth penetration. Penetration depth is proportional to the square root of the ratio of the resistivity to the signal frequency. This means at Bulgobac Creek, maximum depths being examined were up to 450-500 metres since background resistivities of 4-5000 ohm metres are common.

The CSAMT survey used an east-west transmitting dipole of 1500m length about 10km south of the prospect. Initially a test line along 7600N was read and a deep conductor was defined. Additional lines north and south were then read. A collection of Cagniard resistivities determined from this work is shown in Drawing No. 7612-9. Interpretation of CSAMT data can be complex due to the extensive volume of data produced plus the number of data transformations which can be performed. These computer enhancements have enabled a detailed interpretation to be made which is shown in Figures 11-16.

Interpretation

The major interpreted elements of the CSAMT work are indicated in Drawing No. 7612-10 and in conjunction with the gravity data. The work reveals a conductor (<10 ohm metres) being detected on adjacent lines beneath 2375E/7600N and 2725E/7400N. The conductor on 7400N appears next to a major fault/lithological boundary which strikes consistently between lines in a north-south direction and beneath the eastern gravity gradient of the gravity high. It is possible this boundary represents a fault or lithological change suggesting a possible feeder for mineralisation. On line 7800N the conductor is not observed and the boundary zone is less well defined than to the south. Additionally, on 7800N there is some suggestion of a lowered resistivity at depth at about 2525E indicating an 'off-line' conductor. The depth to the conductor is estimated at about 250-300m on line 7600N but deepening south to about 350m on line 7400N. The primary evidence for the defined deep conductor comes from high phase values in long period frequencies. This effect has been shown at Marionoak (Eadie, 1987) and Mt. Lyell (Bishop, 1987) to be indicative of low conductivity units. The technique is unable to discriminate between sulphides and graphitic conductors but the high phase responses suggest the conductor is probably polarisable, and therefore more likely to be due to sulphides.

Stratigraphically the CSAMT accurately defines the main lithologic units of the area and indicates disconformities which may be associated with faults or changes of lithology. The boundary zone mentioned above appears continuous and in general strikes north-south. The feature is present on nearly all lines and may represent a target for follow-up in the future.

In general the interpreted sections suggest a broad shallow syncline in the south with some discontinuities and faults causing changes in apparent resistivity along a sequence. This is not evident in the QRS response due to its

high conductivity (20-100 ohm metres). Lying above the shales are higher resistivity interbedded shales and graded sediment layers with resistivities of 50-150 ohm metres. Beneath the shales is high resistivity bedrock with apparent resistivities from 400 to 4-5000 ohm metres. These bedrock units probably equate to andesitic and pyroclastic rocks and represent the host rocks for Hellyer. Frequent discontinuities/faults are observed within these basement rocks.

Recommendations

Early drill targetting on the defined conductor is obviously desirable. Line 7600N represents the best opportunity at shallowest depth to test the anomaly. An easting of 2350E, with a vertical hole to approximately 350 metres will provide sufficient lithological information to test the model and explain both the CSAMT and gravity anomalism at this location. Additional holes must be prepared for in the event of mineralisation being intersected. Additionally steps must be made to permit the hole to be logged for both resistivity and EM. Should no mineralisation be intersected, downhole EM must be run to ascertain the presence of any nearby conductors.

A second target would be the defined deep conductor on line 7400N, at 2725E. Again a vertical hole would be used, but to 400m depth. Additional drilling should be scheduled in the light of results from these first two holes.



P R Gidley

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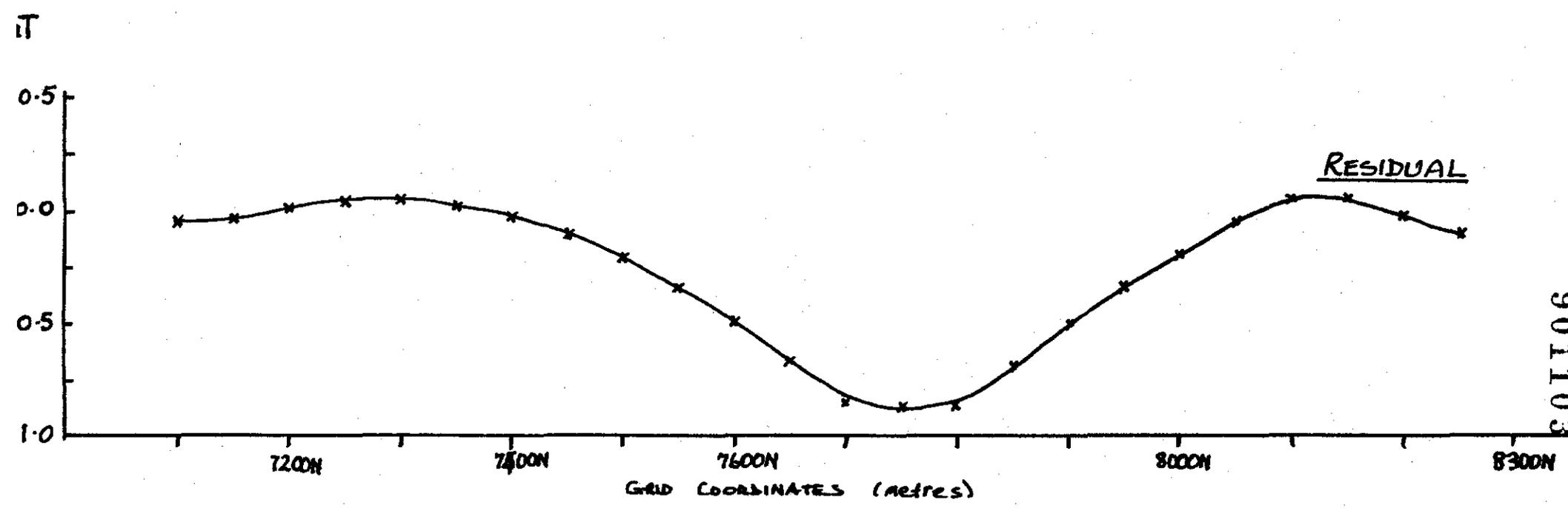
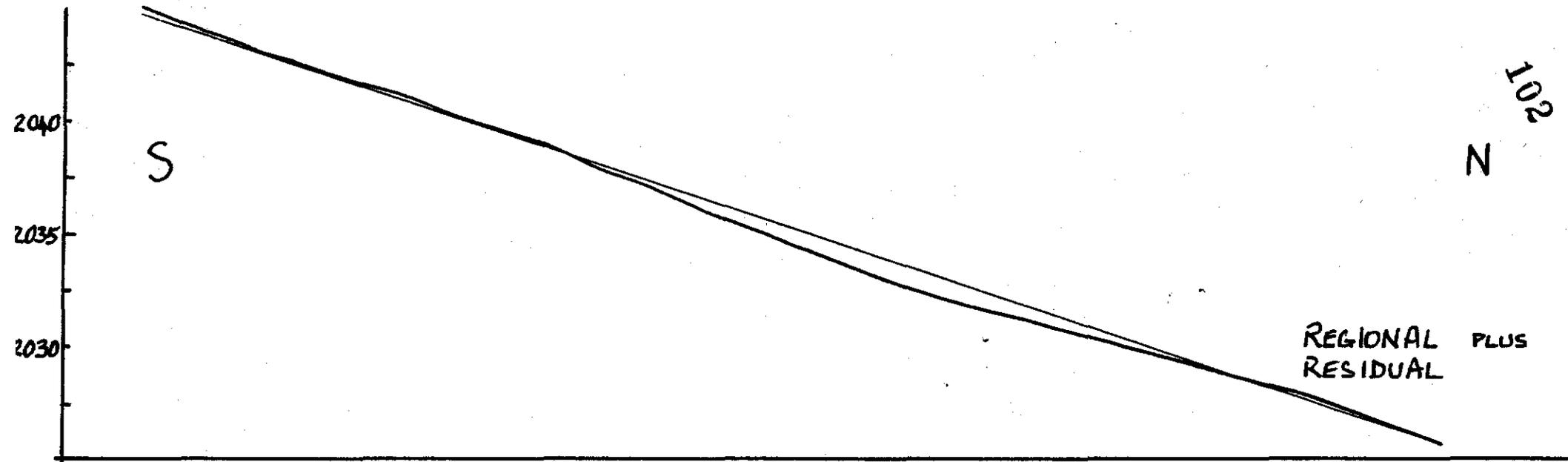
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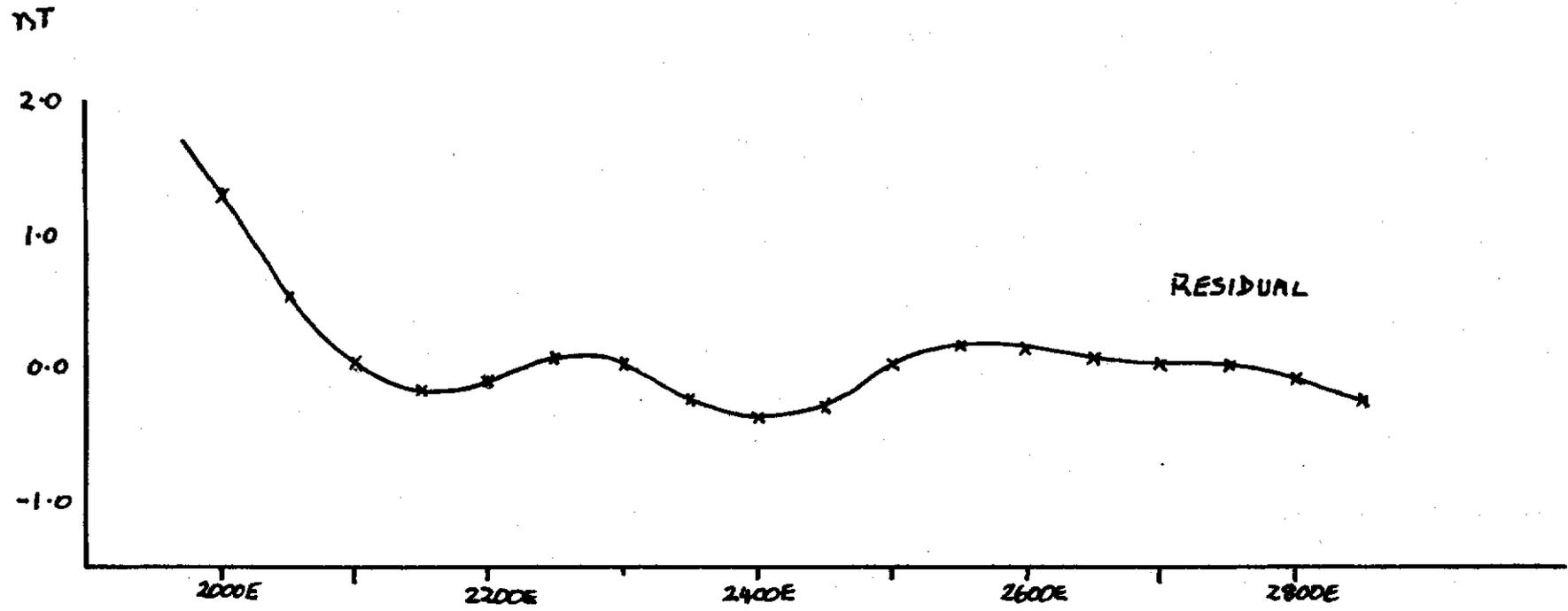
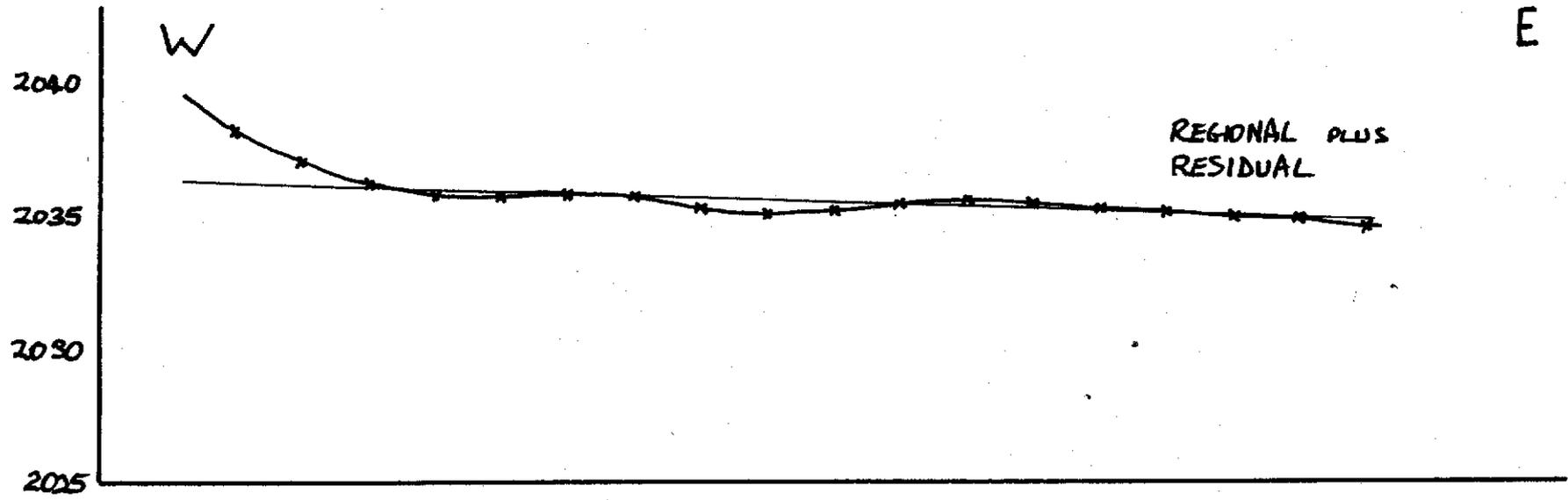
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Internal Report.



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AEROMAGNETICS - BASELINE PROFILE
2400E

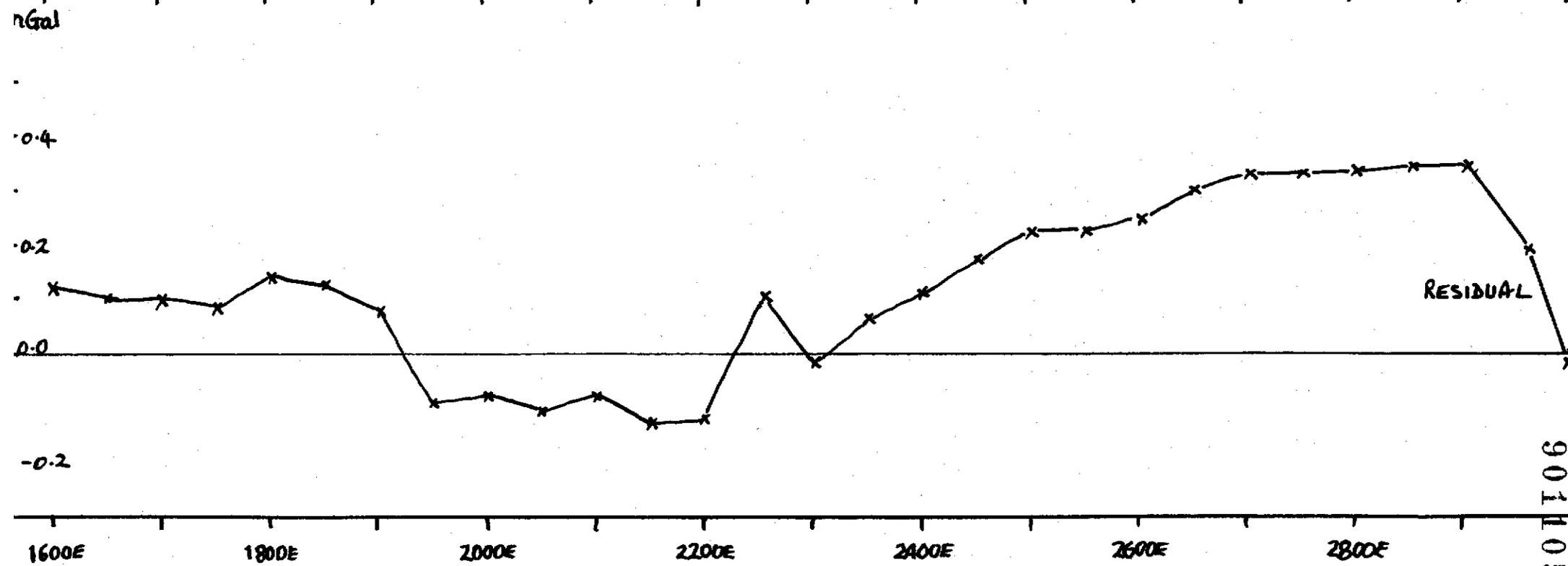
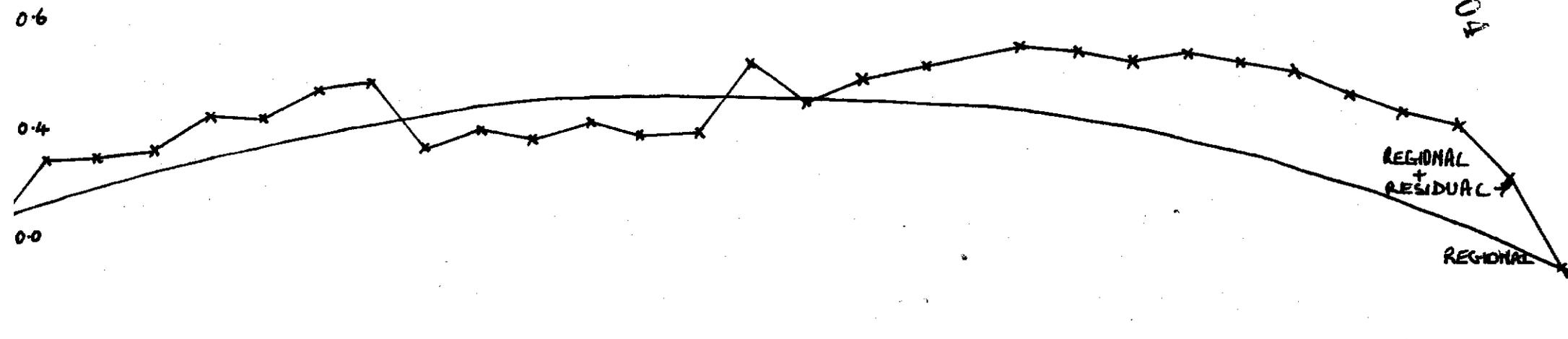
FIG 7



AEROMAGNETICS - LINE 7600N

FIG. 3.

901104



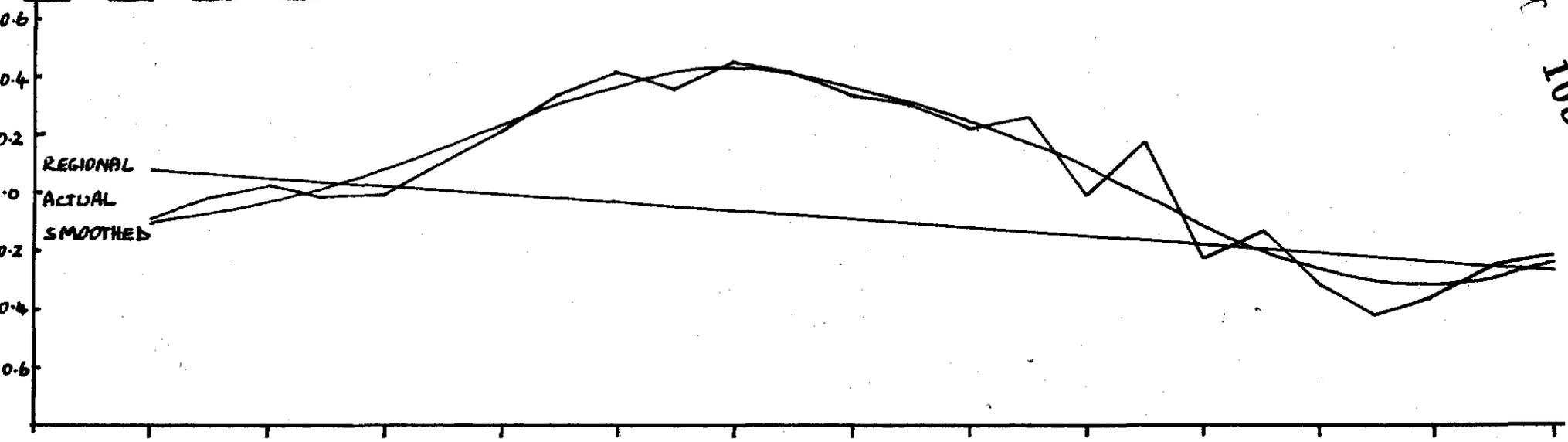
1600E 1800E 2000E 2200E 2400E 2600E 2800E

GRAVITY - LINE 7600N

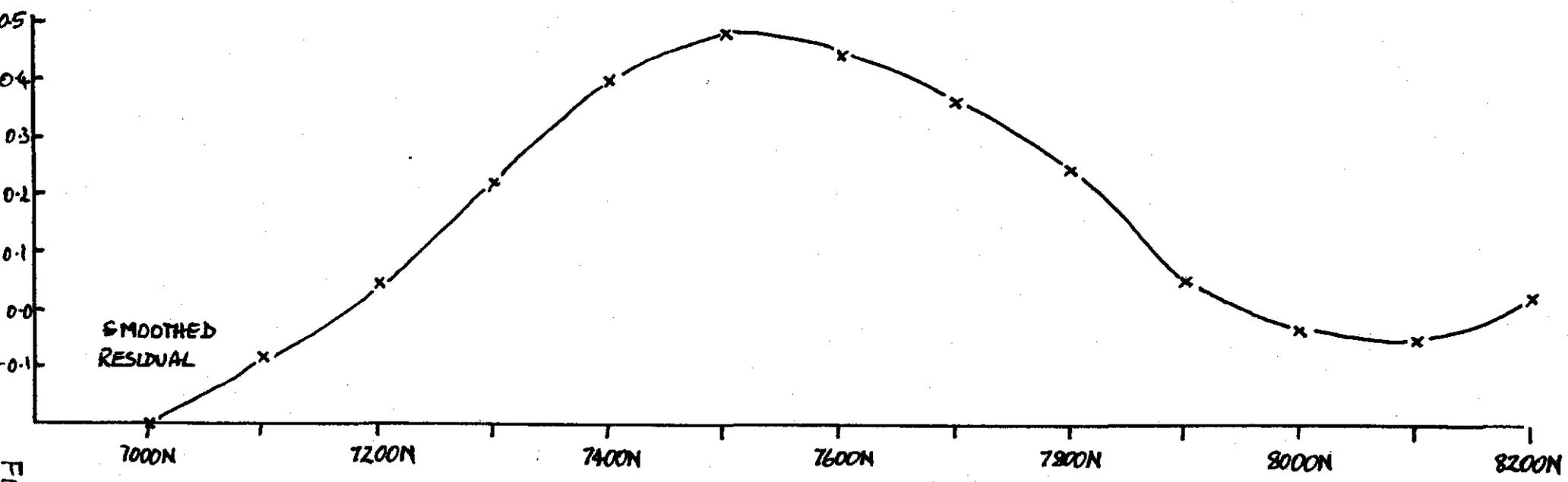
104

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C 105



mGal.

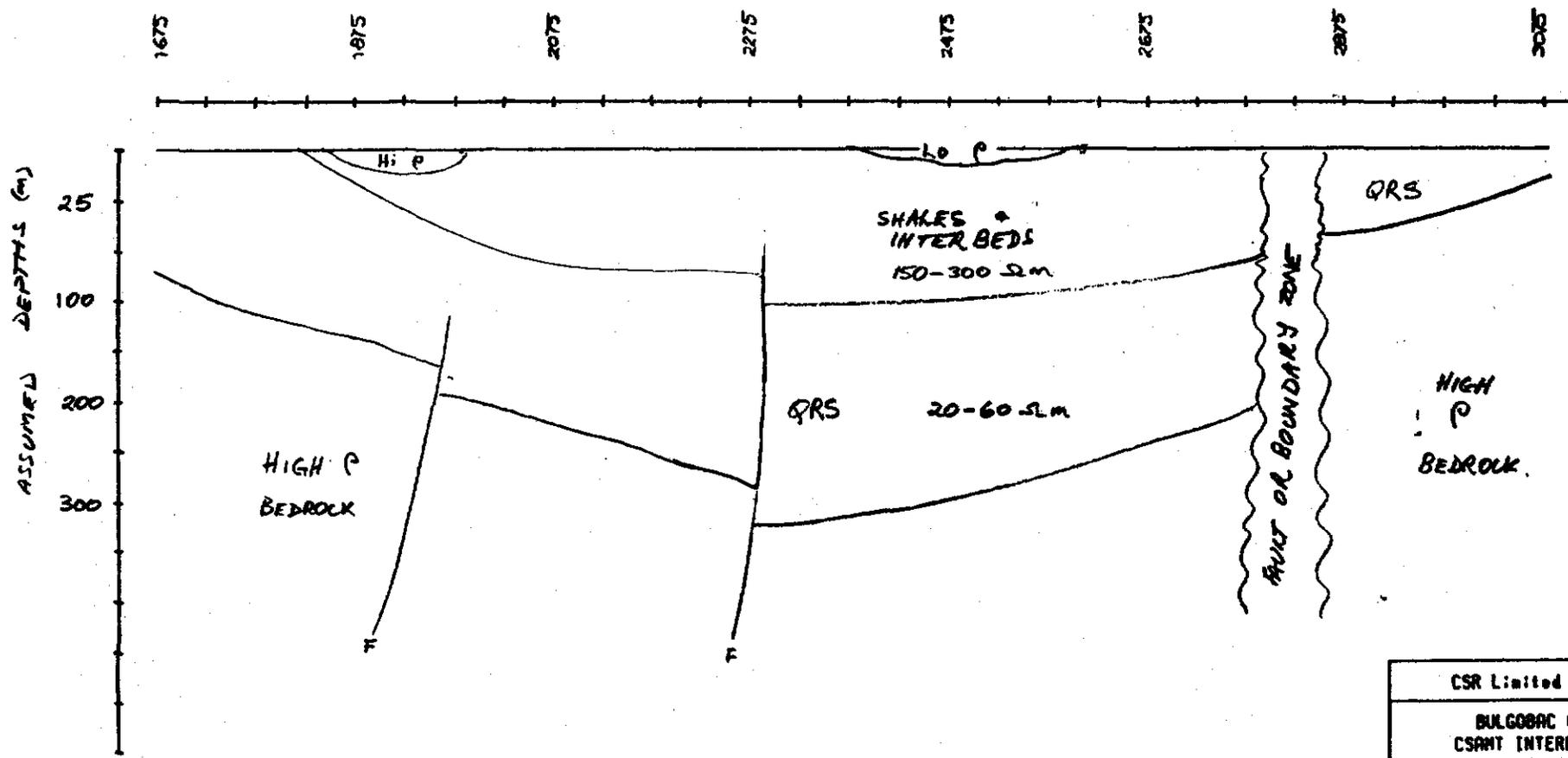


GRAVITY - LINE 2400E

FIG 9

901106

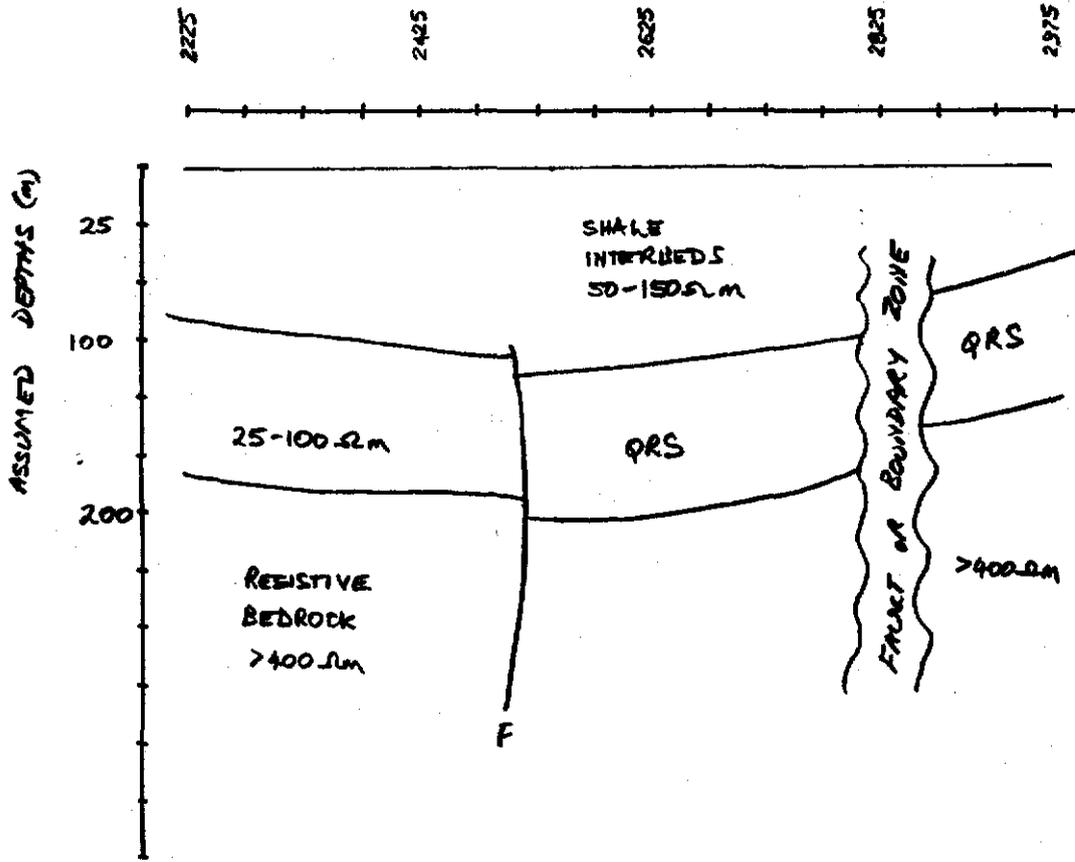
LINE 7000 ¹⁰⁶



CSR Limited - MEDG		
BULGOBAC CREEK CSANT INTERPRETATION LINE 7000N		
SCALE:	DATE:	4/3/1987
DRAWN: PDS	REV:	PLD 00
CHECKED:		Fig. 11
APPROVED: PDS		

LINE 7200N

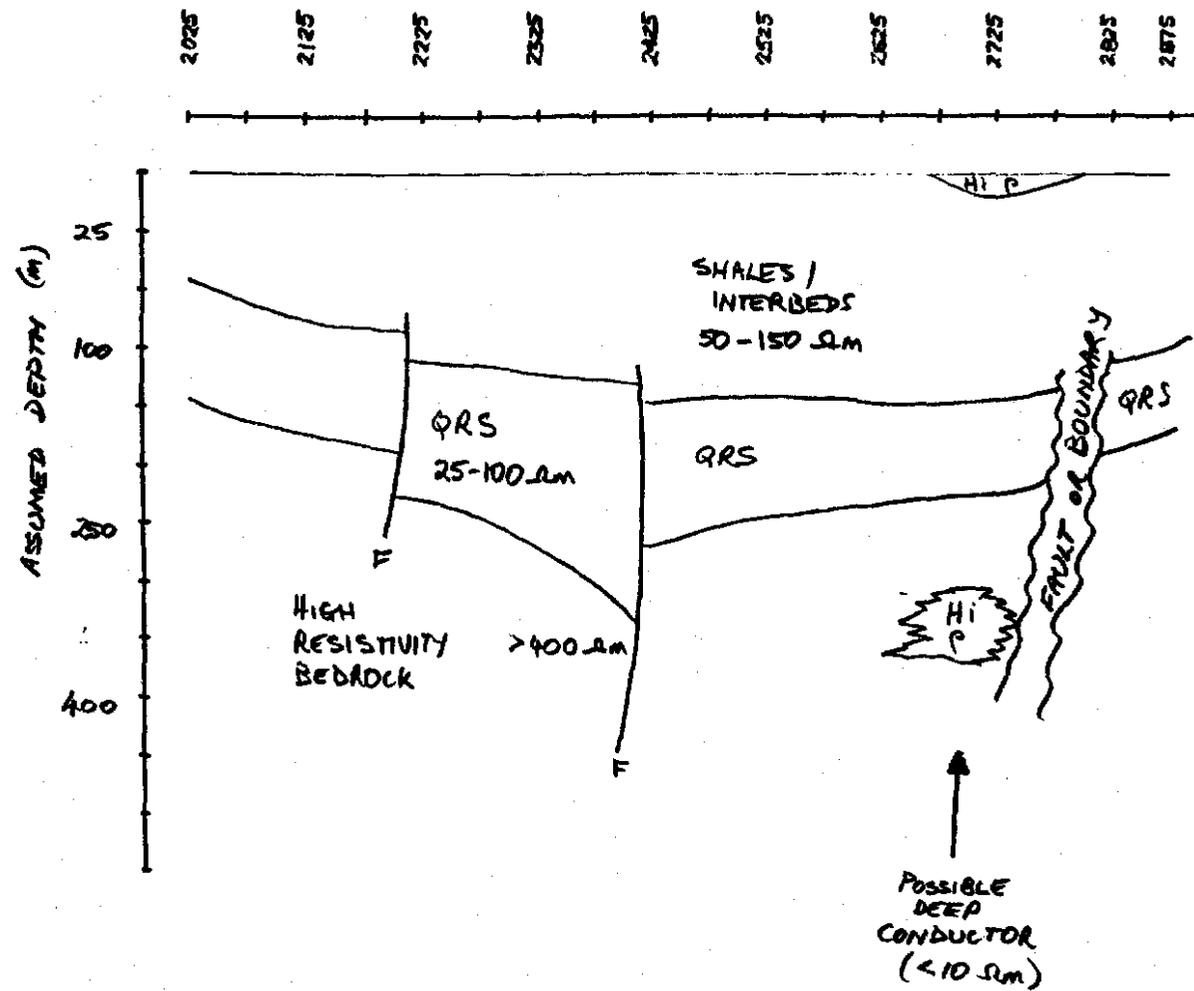
107



CSR Limited - MEDG			
BULGOBAC CREEK CSAMT INTERPRETATION LINE 7200N			
SCALE:		DATE:	4/3/2007
DRAWN:	PMG	REV:	PLAN 00
CHECKED:			Fig. 12
APPROVED:	PMG		

LINE 7400N

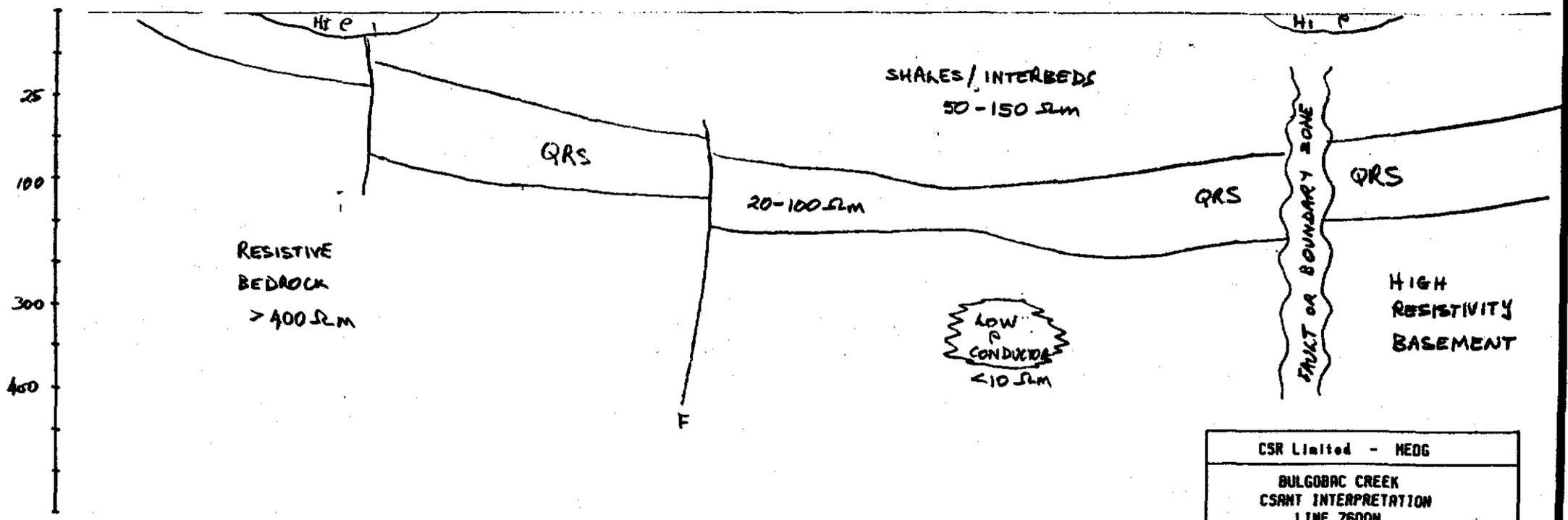
108



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BULGOBAC CREEK CSANT INTERPRETATION LINE 7400N			
SCALE:		DATE:	6/3/1987
DRAWN:	PGC	REV:	PLAN 00
CHECKED:			Fig. 58
APPROVED:	PGC		

LINE 7600N 109

1225 1375 1475 1575 1675 1775 1875 1975 2075 2175 2275 2375 2475 2575 2675 2775 2875 2975



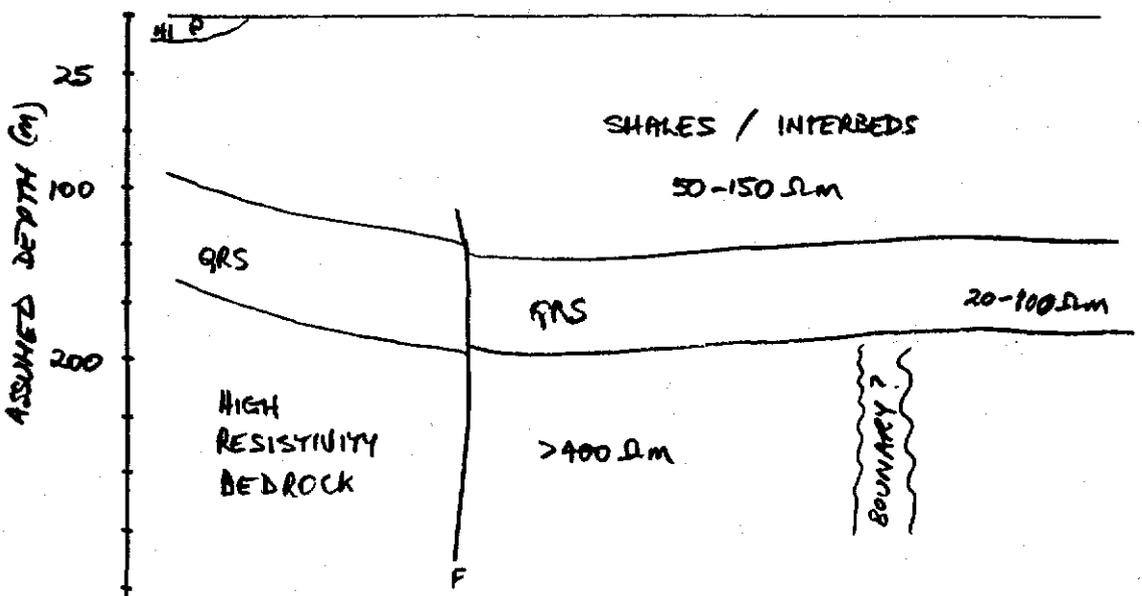
CSR Limited - MEOG		
BULGOBAC CREEK CSAMT INTERPRETATION LINE 7600N		
SCALE:	DATE: 4/3/1987	
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CHECKED:		Fig. 10
APPROVED: PUC		

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110

LINE 7800N

1975 2075 2175 2275 2375 2475 2575 2675 2775

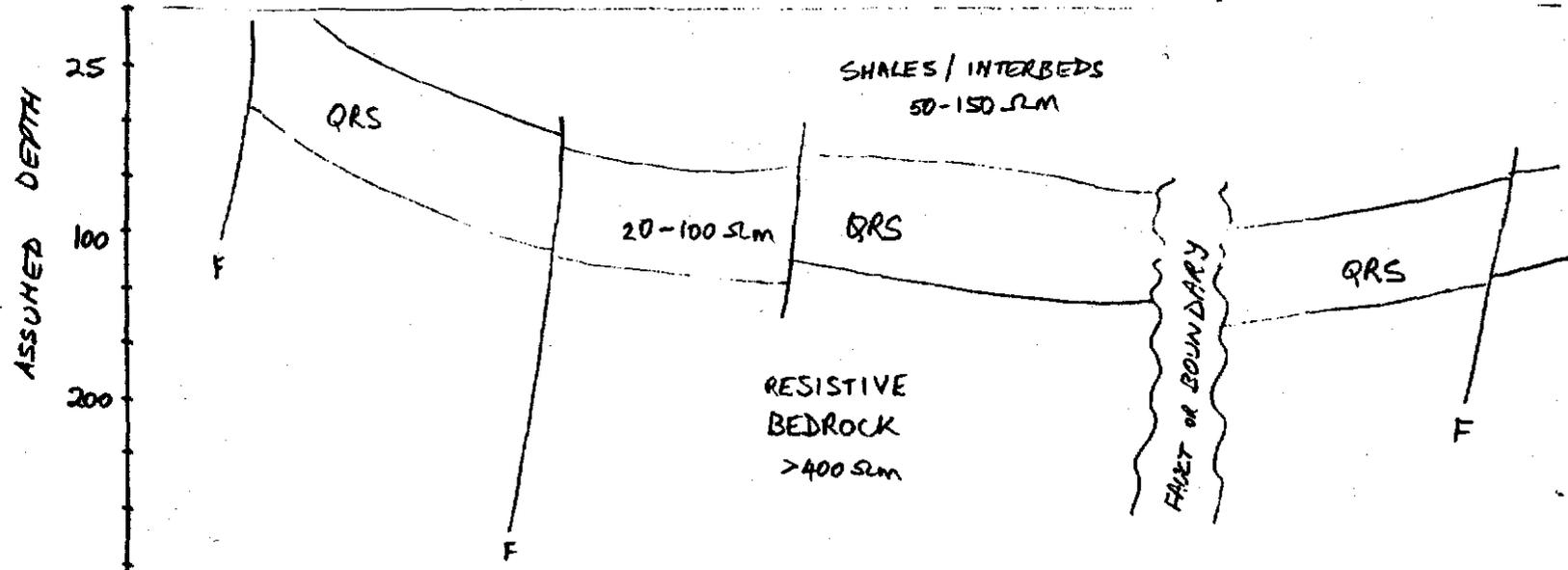


CSR Limited - MEDG			
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CHECKED:			Fig. 15
APPROVED:	FRS		

LINE 8200N

1525 1625 1725 1825 1925 2025 2125 2225 2325 2425 2525 2625 2725

III



CSR Limited - MEDG			
BULGOBAC CREEK CSAMT INTERPRETATION LINE 8000N			
SCALE:	DATE: 4/3/1997		
DRAWN: FPG	REV:	PLAN NO:	
CHECKED:			FIG. NO:
APPROVED: FPG			

901112

APPENDIX III
GRAVITY SURVEY
(D.E. LEAMAN)

QUE ROAD GRAVITY SURVEY
REDUCTION AND APPRAISAL REPORT

for
CSR LTD MINERALS DIVISION

by
Dr. D.E. Leaman

March 1987

LOCATION:

The area surveyed lies within EL 39/85 held by CSR Limited and is located on the western side of the Murchison Highway adjacent to the mining leases held by Aberfoyle Ltd for the Que River Mine.

THE GRAVITY SURVEY:

The observations were made by G.L. Rau of Solo Geophysics between January 30 and February 6, 1987. La Coste and Romberg meter number 561 with a scale constant of 1.00928 was used.

The survey was tied to Mines Department Que River alternate base; station 8551.9976, 980177.5 mGal.

The grid used was surveyed and levelled and the coverage was based on a station spacing of 50 m on lines 200 m apart. The base line was 2400 E. The grid was oriented to match the larger Aberfoyle grids in the region. The highway was used as a subsidiary base line.

Five tie points were used, each linked by drift controlled multiple observations.

1. Que River base
2. 2400E,8300N -3.1 divisions with respect to base
3. 2400E,7600N -0.19 divisions
4. 2400E,8800N -0.38 divisions
5. highway,9300N 7.7 divisions

COMMENTS:

Two variants from normal practice were noted.

1. Due to unstable surface conditions many stations were observed at tripod levels some 700 to 900 mm above ground level.
2. Some loops were not completed in balanced formats; i.e., they were terminated on a tie point different from the start point. Although all loops were referred to tie points and all differences were properly established this is not ideal practice and complicates corrections for loops affected. Some residual uncertainty is inevitable.

THE REDUCTION:

The reduction was completed using a density of 2.67 t/cu m and the old ellipsoid (for compatibility with the TASGRAV data base). Terrain corrections were applied up to Hammer zone M. Near station compensation was based on special notes of the conditions up to 50 m from the observation point.

Compensation for the raised meter levels at some stations was included within the terrain correction since the Free-Air effect can be directly applied to the height of the meter but the Bouguer correction is inadequate by an amount equal to the elevation of the meter above ground. This means that should the reduction density be changed any adjustment can be simply applied to the correction column as a scalar correction.

PRECISION:

The gravity observations were found to be reproducible within 0.02 mGal after loop and drift corrections in most cases; exceptions were always restricted to loops not closed to the starting point. No misclosure greater than 0.04 mGal was found.

Errors due to position or height errors are not believed to exceed 0.01 mGal. The terrain and, where necessary, Bouguer slab adjustment corrections range between 0.2 and 0.8 mGal for this relatively low relief area. Possible errors are considered to lie in the range 0.02 to 0.04 mGal.

The RMS error is thus of the order of 0.05 mGal or less and the values can be safely contoured at intervals of 0.15 mGal.

PRESENTATION:

Figure 1 presents the distribution of stations and assigned station numbering. The body of the number system is derived from surveyor loops rather than line references. This was done to avoid, or at least minimise, risk of confusion from any attempt to renumber or recode the coordinate or level information when combining it with the observed gravity and gravity correction information. It is recommended that future surveys be coded on a line basis and that surveyors note the peg numbers as a cross check on location.

Figure 2 presents a plot of the reduced gravity field presented in Bouguer anomaly form for a density of 2.67 t/cu m.

Tables 1 and 2 (Appendix) contain the observations prepared for reduction and the reduced results of the Bouguer anomaly. The numbering system should be referred to the above comments and Figure 1.

INTREPRETIVE COMMENTS:

The following comments are based largely on inspection of the gravity and magnetic fields and are not the result of complete analysis.

The gravity field, as displayed in Figure 2, is relatively flat north of 8000 N but contains a distinct positive feature trending along 7700 N and N-S south of 7800 N. This character is not consistent with surface geology as known or any reasonable structural interpretation of it. Although dip patterns are not established in detail and there is a possibility of second order structuring this region lies near the axis of a syncline with very shallow dips. The axis of the syncline, however, trends NE rather than SSE, passing through 2400E, 7800N approx, and no lithological or structural features are suspected which could account for the effect. Some intraformational density variation is implied but the affected unit is not obviously exposed. A source depth in excess of 150 m is implied by the defined gradients. The likely source depth is quite consistent with the probable position of the Que River host rocks presuming few complications within the regional syncline (discussion below). A section drawn across this area suggests that these units could lie at no more than 250 m below surface if the effect of plunge is ignored.

The pattern on lines 7600 and 7800N is consistent with an intraformational source folded into the limbs of the primary syncline. This does not account for the anomalous extension southward near 2800E on lines 7000-7400N. Again it is difficult to propose simple, satisfactory geological explanations. Could the raised anomaly reflect a pod of massive lava, fault blocking or mineralisation? There is little evidence of faulting with the orientations required within surrounding mapping.

Possible sources have been evaluated with respect to contrast and depth. Simple assumptions have been made which lead in all cases to an underestimate of real contrast or overestimate of volume.

Four conditions have been tested based on possible stratigraphic controls at levels inferred on a section acute to strike across the eastern limb of the syncline and N-S anomaly extension. The profile shown in Figure 3 is derived from data of this survey and the Tasgrav data base (Figure 4). Profile position is marked in Figure 2. The gross regional effects and the local nature of the target anomalies are evident. Gross effects have been ignored here. The shapes modelled are not critical and simply suggest the volumes involved at the given contrast. The profile shown is for the third body in the section. All yield comparable results.

The upper body was designed to test local near surface lithologic variations in the tuff unit. A lava pod might have been feasible but the implied contrast of 0.5 t/cu m and a thickness of 40 m is not realistic. Two bodies/formational variations near the top and bottom of the shales could also yield this profile at contrasts of 0.75 or 1 t/cu m respectively. No normal geological conditions could be responsible. Similarly the fourth body at about 250 m requires a contrast of 1.7 t/cu m. This contrast approximates that

of massive ore of the Hellyer type and is placed at the inferred position for the top of the Que River host units in my construction of this section. It should be noted that thinner, high density distributions are possible at other points in the section but larger volumes are unlikely at deeper levels since the ultimate contrast of 1.7 is the maximum probable and deeper sources would lead to more diffuse gradients.

Regional values from the Tasgrav data base (marked DOM*(value) on Figure 2) are certainly within the tolerances required of regional data and support the general raised anomaly effect which is mirrored in the Que-Hellyer region - see dumbbell shaped feature in Figure 4. The Que Road anomaly forms the western half of the pattern and it may be reasonably concluded on present information that both halves of the pattern have the same origin (the host suite) and that some mineralisation is present.

A portion of the aeromagnetic survey of the area is shown in Figure 5. Although the magnetic field is dominated by the effects of Tertiary basalts to the north and a large source to the south subtle deviations can be observed in the region of the Que Road gravity survey. These may be summarised as shown in Figure 6. Three profile styles are evident. Within the east-west set there are two patterns; essentially uniform gradient or concave profile forms. The uniform gradient pattern is noted north of 5395700 mN. The third form, represented by the NE-SW profile demonstrates that the regional gradients have been locally modified - but only in the region presenting concave forms on other orientations. This pattern is wholly consistent with a localised source at moderate depth in which magnetic contrasts are reduced in relation to surrounding lithologies.

The simpler structural alternative of magnetic field mirroring the syncline is not supported by all lines and cannot be the origin of this effect. It should be noted that the profiles have been inferred from the detailed contour plot and may not be accurate in all details; nor have they been checked or corrected for clearance deviations or geometric effects from the andesites east of the highway. The magnitude of the response is, however, very similar to that observed at Hellyer.

The more positive gravity field effects correlate almost directly with the zone of implied magnetic contrast reduction. Other sites within the Mt Read Volcanic belt with this type of signature are mineralised with the mass effect reflecting sulphide concentration and the magnetic effect reflecting alteration around it. The zone defined by the raised Bouguer values is clearly worth drilling and in view of the nature of the local structuring and the defined mass anomaly vertical holes to 300m are recommended.

118

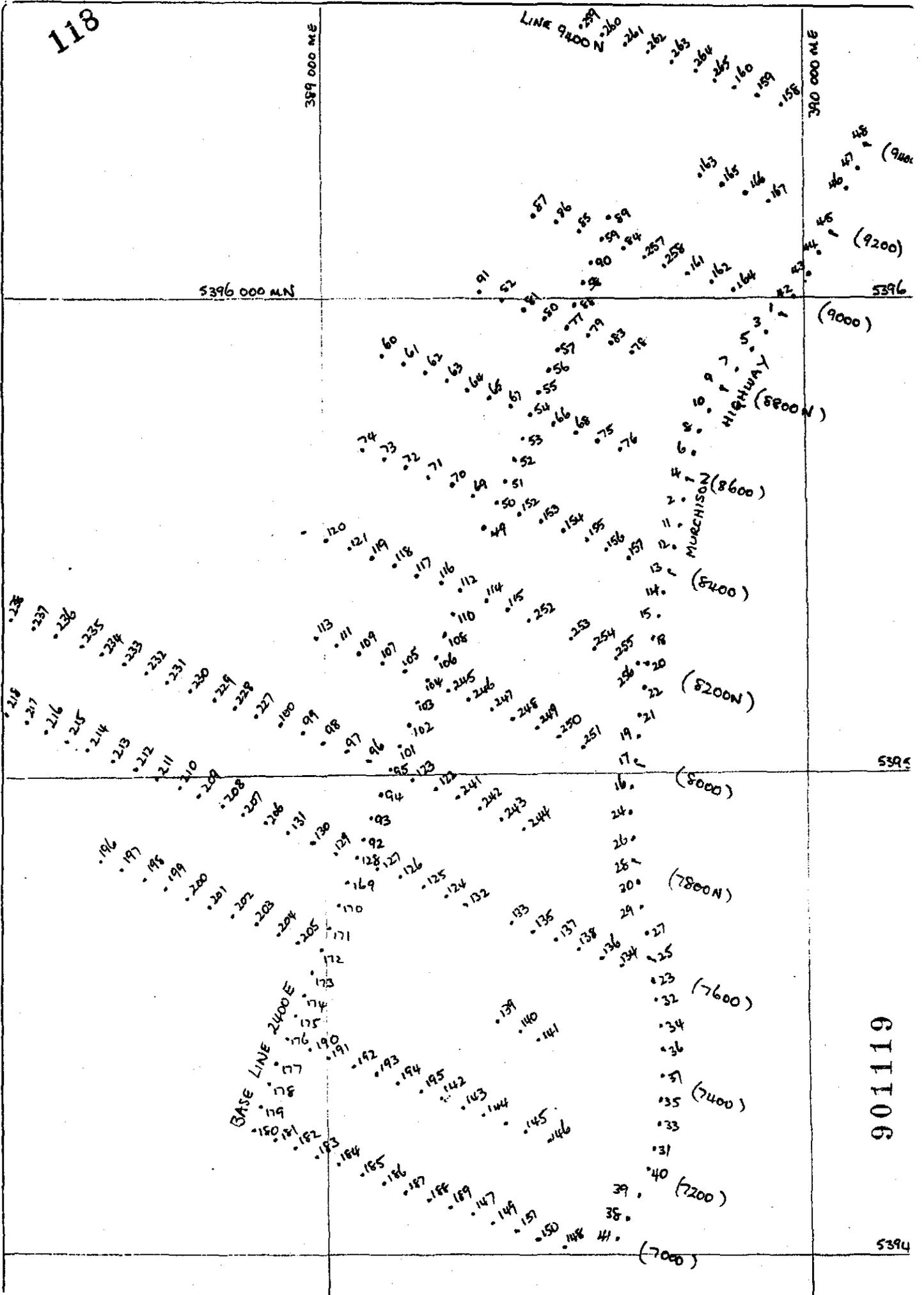


FIGURE 1

CSR QUE ROAD GRAVITY SURVEY - STATION NUMBERING

119

389 000 m E

388 000 m E

15 mGal added to all values

5396 000 m N

5395 000 m N

*DOM-0.1



901120

5394 000 m N

*DOM-0.4

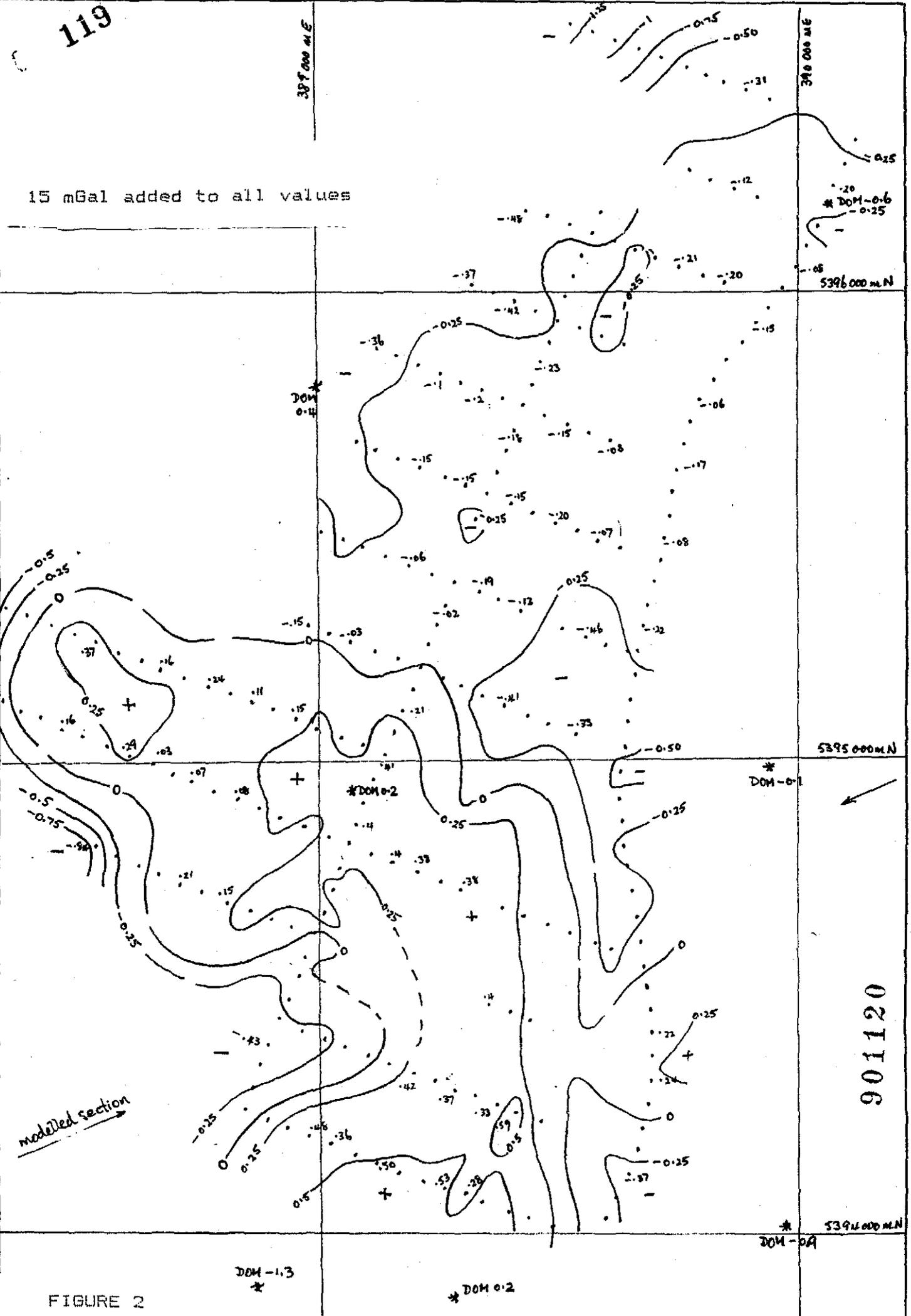
*DOM-1.3

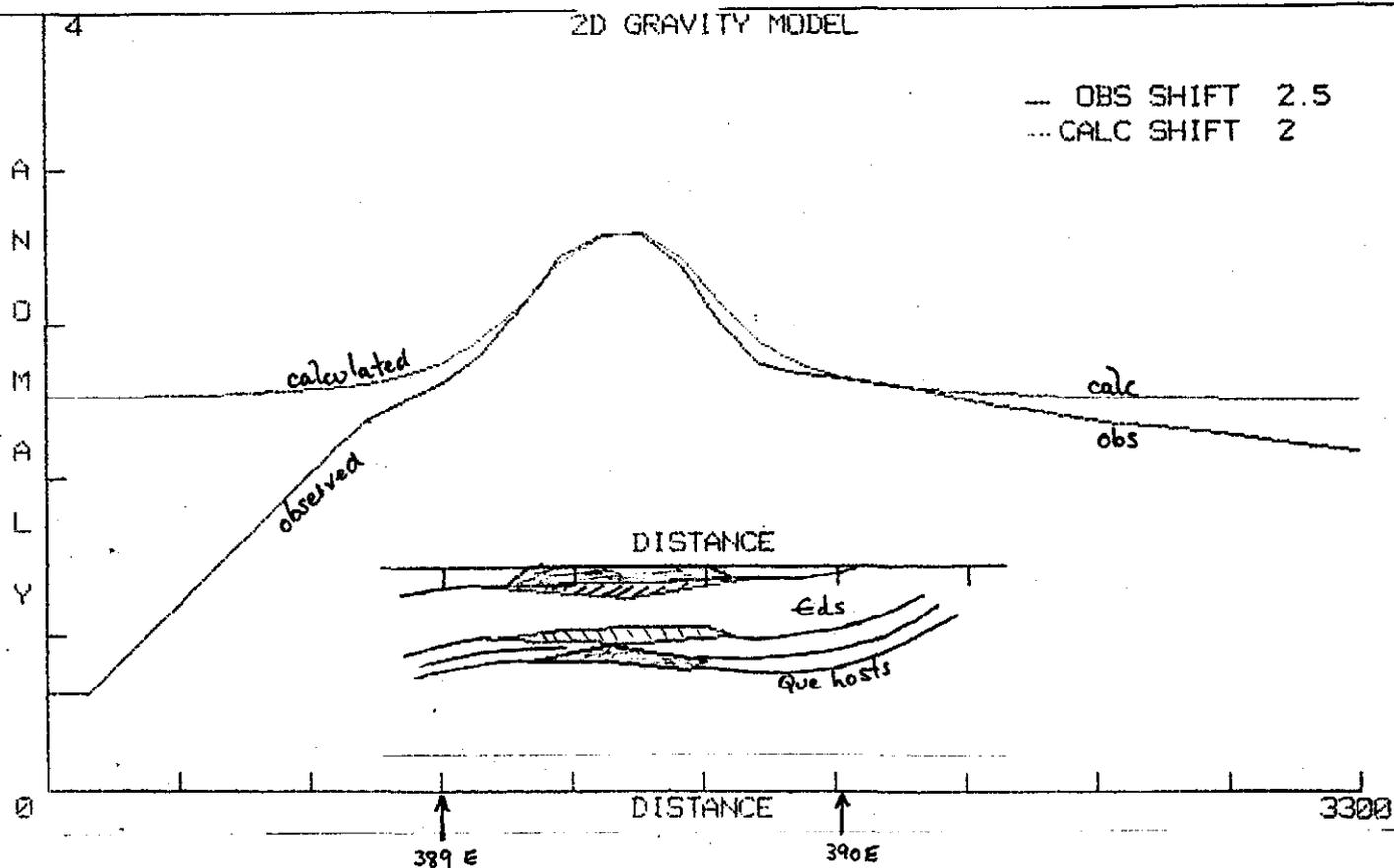
*DOM-0.2

modelled section

FIGURE 2

CSR QUE ROAD GRAVITY SURVEY - BOUGUER ANOMALY (2.67 t/cu m)





QUE ROAD ANOMALY PROFILE QUEGRAVI

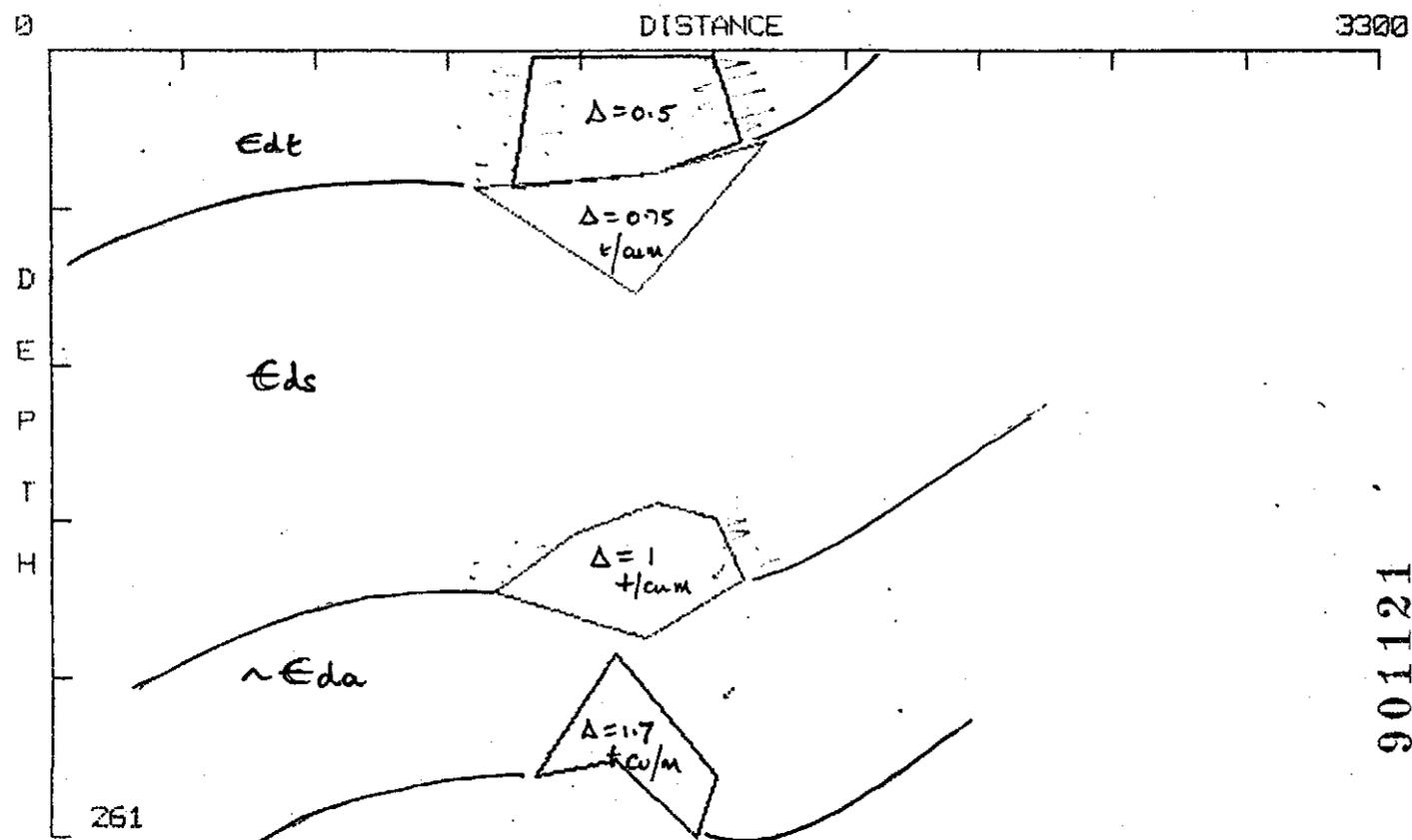


FIGURE 3

POSSIBLE SECTIONAL INTERPRETATION FOR VARIOUS SOURCE DISTRIBUTIONS
Section located in Figure 2. Note exaggerated vertical scale -

901121

390 000 ME

5400 000 MN

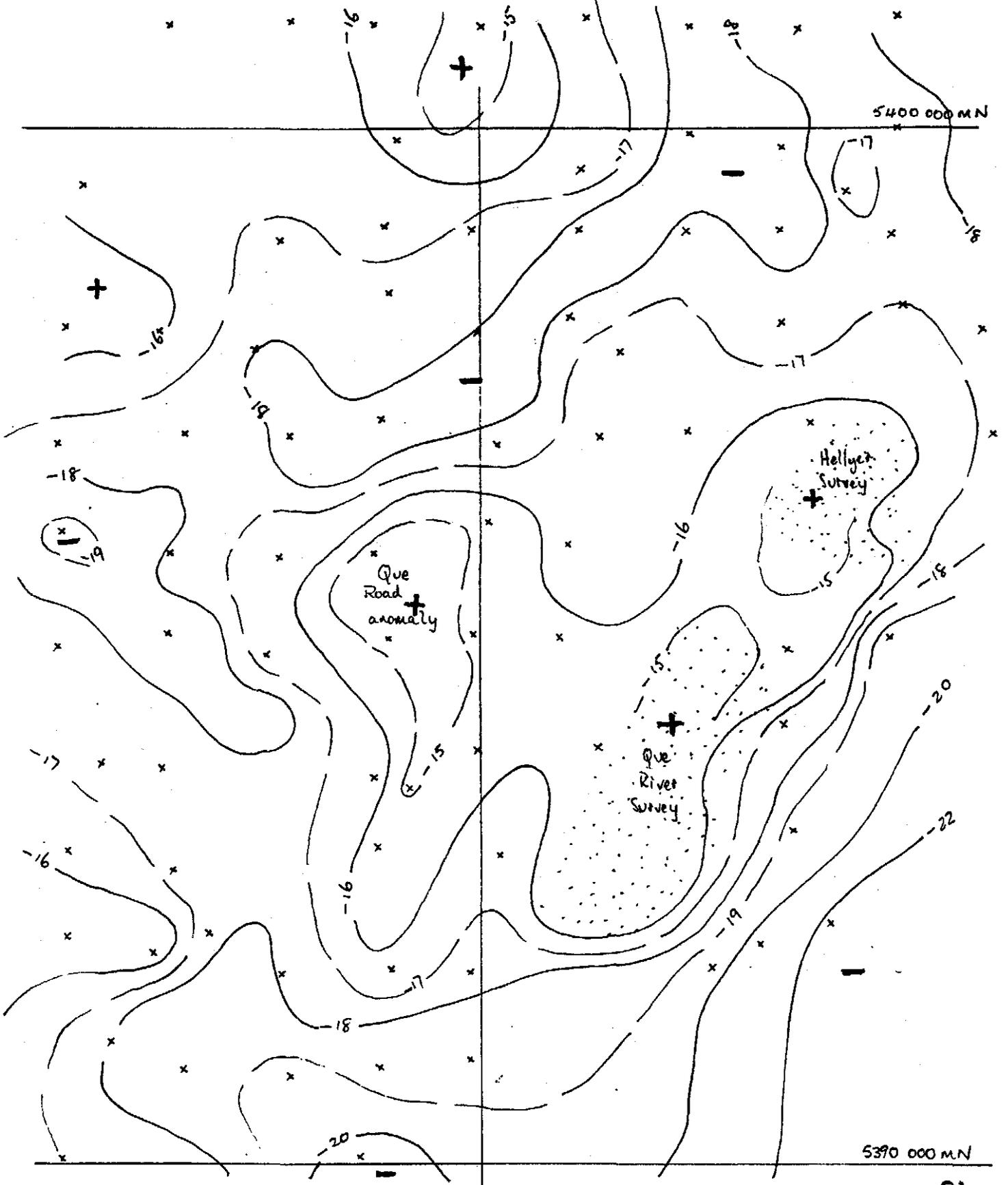


FIGURE 4

REGIONAL GRAVITY FIELD BASED ON TASGRAV DATA (MINES DEPARTMENT)

901122

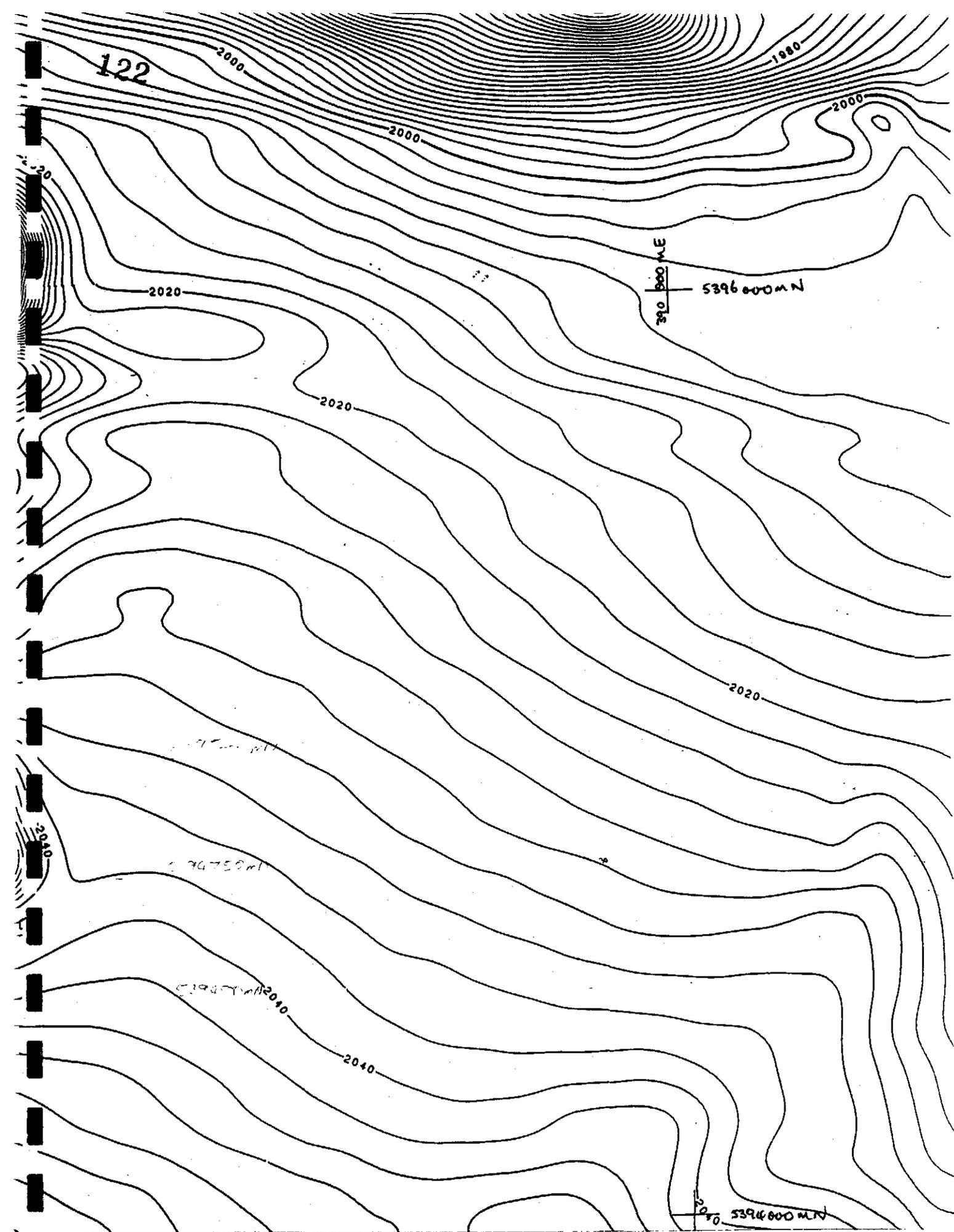


FIGURE 5

901123

CSR QUE ROAD AREA EL 39/85 - PORTION OF AEROMAGNETIC SURVEY
 Contour interval 2 nT, height approx 70 m.

123

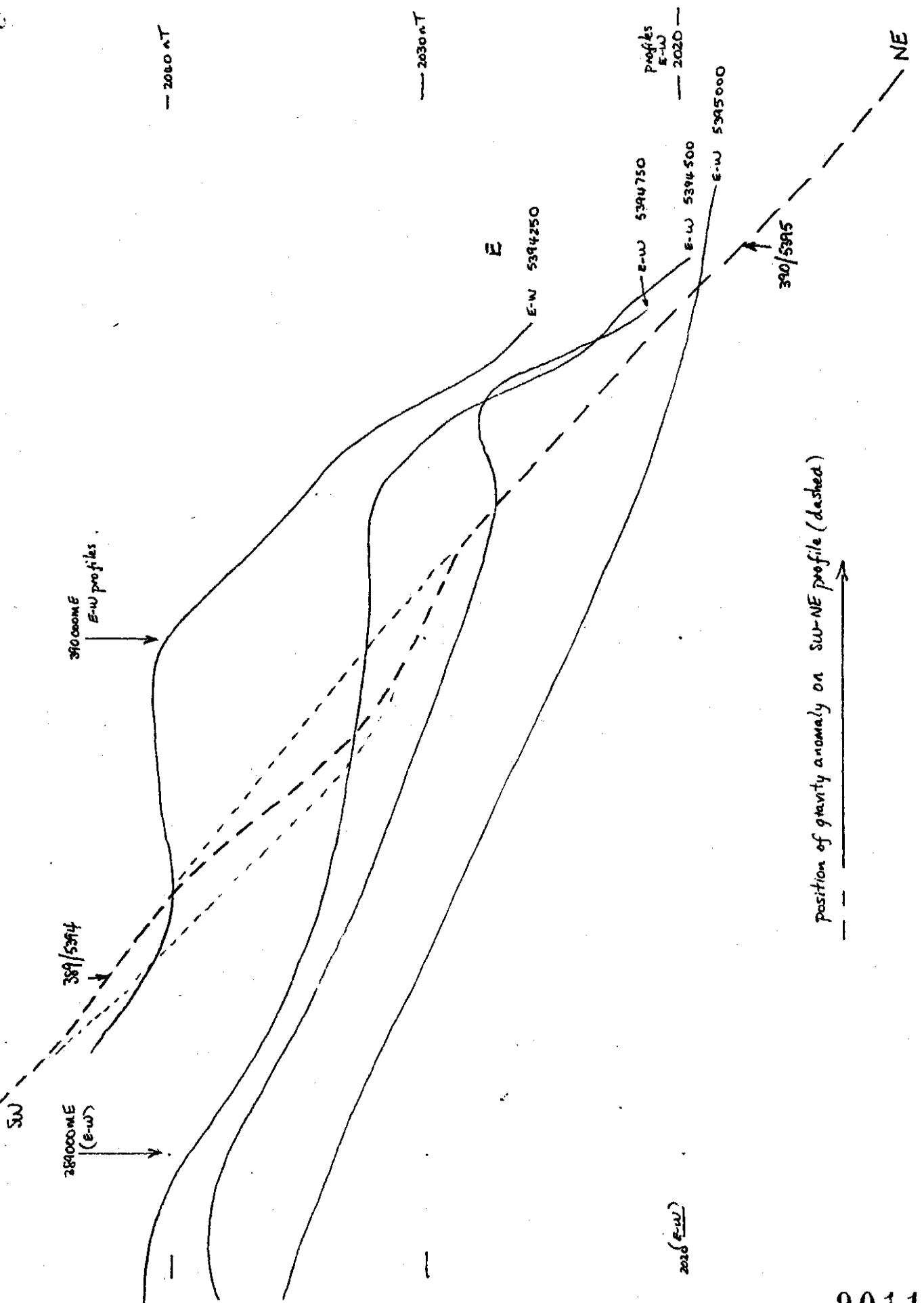


FIGURE 6

901124

APPENDIX

Table 1: File CSRQUERD gravity data prepared for reduction

incl station number, coordinates, elevation, gravity difference with respect to base station, combined terrain correction and Bouguer adjustment for raised meter.

Table 2: File CSRQUEBA reduced gravity values at density 2.67

incl number, coordinates, elevation, gravity values, correction and Bouguer anomaly.

GRAVITY DATA

CSR QUE ROAD GRAVITY SURVEY FEB 1987

980177.50 8551.9976 1.00928 561 10187

0	1	0	1	1	1	8700			
1	1	389951	5395964	626.47	5.30	0.36			
2	2	389748	5395572	661.69	-1.22	0.35			
3	3	389921	5395924	630.19	4.51	0.36			
4	4	389753	5395618	658.72	-0.83	0.36			
5	5	389890	5395886	634.32	3.71	0.37			
6	6	389770	5395668	655.33	-0.14	0.36			
7	7	389859	5395846	638.37	2.96	0.38			
8	8	389784	5395716	651.48	0.60	0.38			
9	9	389830	5395805	642.66	2.20	0.39			
10	10	389804	5395762	647.21	1.38	0.39			
11	11	389738	5395523	664.32	-1.70	0.31			
12	12	389730	5395474	666.72	-2.12	0.30			
13	13	389716	5395425	669.07	-2.52	0.29			
14	14	389707	5395375	672.30	-3.16	0.28			
15	15	389699	5395327	674.51	-3.58	0.28			
16	16	389634	5394973	681.25	-4.96	0.28			
17	17	389640	5395026	681.40	-4.88	0.28			
18	18	389681	5395280	679.52	-4.57	0.27			
19	19	389648	5395875	680.85	-4.73	0.29			
20	20	389674	5395230	677.81	-4.21	0.27			
21	21	389658	5395125	680.00	-4.69	0.29			
22	22	389668	5395175	678.74	-4.47	0.29			
23	23	389676	5394571	666.15	-1.27	0.36			
24	24	389631	5394923	680.68	-4.65	0.28			
25	25	389666	5394620	669.01	-1.87	0.33			
26	26	389635	5394872	679.63	-4.38	0.29			
27	27	389659	5394672	672.01	-2.65	0.33			
28	28	389640	5394822	678.43	-3.95	0.30			
29	29	389651	5394726	676.01	-3.56	0.32			
30	30	389645	5394776	678.28	-3.91	0.30			
31	31	389674	5394222	657.05	0.80	0.32			
32	32	389684	5394522	662.55	-0.33	0.36			
33	33	389684	5394271	655.55	1.16	0.33			
34	34	389690	5394472	658.82	0.45	0.37			
35	35	389690	5394320	653.64	1.64	0.33			
36	36	389692	5394421	656.12	1.05	0.33			
37	37	389694	5394371	653.89	1.50	0.33			
38	38	389622	5394081	660.09	0.11	0.30			
39	39	389644	5394126	658.97	0.17	0.31			
40	40	389660	5394174	658.15	0.46	0.32			
41	41	389595	5394037	659.94	0.27	0.30			
42	42	389983	5396004	623.01	5.99	0.37			
43	43	390011	5396045	619.48	6.58	0.35			
44	44	390035	5396089	615.83	7.20	0.34			
45	45	390058	5396134	612.87	7.66	0.31			
46	46	390086	5396230	612.69	7.68	0.31			
47	47	390112	5396271	614.74	7.23	0.32			
48	48	390130	5396321	617.49	6.54	0.36			
49	49	389341	5395520	670.35	-3.15	0.39			
50	50	389360	5395567	665.09	-2.08	0.39			
51	51	389379	5395613	665.44	-2.11	0.41			

52	52	389398	5395659	666.98	-2.52	0.42
53	53	389417	5395705	668.61	-2.92	0.44
54	54	389435	5395752	667.57	-2.72	0.43
55	55	389454	5395798	664.05	-2.11	0.41
56	56	389472	5395844	662.96	-1.91	0.38
57	57	389490	5395891	660.46	-1.46	0.37
58	58	389545	5396030	652.23	0.00	0.37
59	59	389582	5396122	648.91	0.48	0.41
60	60	389125	5395876	648.49	0.73	0.40
61	61	389169	5395858	649.82	0.57	0.39
62	62	389214	5395840	647.62	1.19	0.37
63	63	389259	5395822	650.12	0.73	0.38
64	64	389303	5395804	652.17	0.31	0.38
65	65	389347	5395787	657.22	-0.74	0.40
66	66	389480	5395734	670.79	-3.35	0.43
67	67	389391	5395769	662.66	-1.76	0.42
68	68	389525	5395716	671.30	-3.39	0.41
69	69	389314	5395585	663.28	-1.70	0.39
70	70	389268	5395605	667.08	-2.42	0.39
71	71	389222	5395624	666.32	-2.33	0.39
72	72	389175	5395643	665.10	-2.09	0.39
73	73	389129	5395661	663.83	-1.89	0.38
74	74	389083	5395680	659.81	-1.22	0.37
75	75	389570	5395699	669.61	-3.02	0.41
76	76	389614	5395681	666.78	-2.41	0.41
77	77	389508	5395937	654.99	-0.38	0.28
78	78	389643	5395885	661.21	-1.61	0.38
79	79	389553	5395919	657.41	-0.83	0.37
80	80	389464	5395955	656.54	-0.76	0.35
81	81	389419	5395972	655.72	-0.78	0.36
82	82	389374	5395990	654.99	-0.67	0.36
83	83	389598	5395902	659.88	-1.38	0.37
84	84	389626	5396102	652.04	-0.85	0.44
85	85	389536	5396139	644.83	1.33	0.40
86	86	389489	5396156	640.06	2.20	0.40
87	87	389442	5396172	640.23	1.99	0.39
88	88	389527	5395983	653.74	-0.13	0.37
89	89	389600	5396169	650.37	0.18	0.42
90	90	389563	5396076	648.65	0.66	0.40
91	91	389330	5396007	652.06	-0.06	0.38
92	92	389079	5394873	663.62	-0.57	0.30
93	93	389097	5394919	664.49	-0.81	0.38
94	94	389116	5394966	664.12	-0.87	0.38
95	95	389135	5395012	664.08	-0.84	0.38
96	96	389090	5395030	661.75	-0.61	0.31
97	97	389044	5395049	659.70	-0.23	0.38
98	98	388998	5395067	658.07	0.16	0.37
99	99	388952	5395086	657.35	0.19	0.34
100	100	388907	5395105	658.04	-0.01	0.40
101	101	389153	5395058	663.40	-0.82	0.38
102	102	389172	5395104	662.83	-0.85	0.36
103	103	389191	5395150	663.51	-1.11	0.35
104	104	389210	5395197	663.56	-1.28	0.36
105	105	389165	5395216	661.96	-1.05	0.36
106	106	389229	5395243	661.23	-0.88	0.37
107	107	389120	5395234	657.40	-0.88	0.36

108	108	389248	5395289	658.55	-0.37	0.39
109	109	389074	5395252	654.97	0.30	0.39
110	110	389267	5395335	658.97	-0.52	0.38
111	111	389030	5395270	651.04	1.08	0.38
112	112	389285	5395382	665.72	-1.93	0.37
113	113	388986	5395288	653.97	0.35	0.38
114	114	389333	5395363	669.26	-2.71	0.37
115	115	389379	5395344	672.54	-3.34	0.38
116	116	389239	5395400	661.20	-0.89	0.36
117	117	389194	5395419	659.80	-0.76	0.35
118	118	389148	5395437	661.91	-1.33	0.34
119	119	389102	5395455	663.03	-1.60	0.35
120	120	389008	5395493	658.80	-0.81	0.36
121	121	389056	5395474	661.97	-1.48	0.37
122	122	389226	5394974	669.59	-2.05	0.38
123	123	389181	5394993	666.85	-1.44	0.38
124	124	389243	5394752	658.88	0.30	0.40
125	125	389197	5394772	659.25	0.25	0.40
126	126	389152	5394790	659.59	0.18	0.41
127	127	389105	5394810	660.29	0.00	0.40
128	128	389060	5394827	661.03	-0.19	0.39
129	129	389014	5394846	662.46	-0.53	0.39
130	130	388968	5394866	665.60	-1.25	0.40
131	131	388923	5394885	667.43	-1.48	0.41
132	132	389289	5394733	658.16	0.47	0.42
133	133	389380	5394697	661.31	-0.17	0.41
134	134	389610	5394602	673.96	-3.32	0.41
135	135	389426	5394678	665.23	-1.00	0.41
136	136	389564	5394621	673.35	-2.85	0.40
137	137	389472	5394659	667.81	-1.54	0.39
138	138	389518	5394640	671.13	-2.24	0.41
139	139	389347	5394487	647.38	2.75	0.46
140	140	389392	5394466	653.48	1.57	0.45
141	141	389438	5394446	655.28	1.07	0.44
142	142	389229	5394331	628.16	6.53	0.56
143	143	389275	5394310	630.90	6.03	0.50
144	144	389364	5394275	649.42	2.45	0.46
145	145	389410	5394256	654.29	1.80	0.44
146	146	389457	5394237	654.40	1.28	0.43
147	147	389297	5394089	647.80	2.80	0.45
148	148	389484	5394016	655.99	1.35	0.41
149	149	389344	5394072	650.19	2.76	0.44
150	150	389437	5394034	654.02	1.90	0.41
151	151	389390	5394053	652.48	2.26	0.42
152	152	389407	5395548	665.62	-2.13	0.39
153	153	389453	5395529	670.80	-3.15	0.38
154	154	389499	5395511	676.87	-4.33	0.38
155	155	389545	5395492	676.11	-4.08	0.37
156	156	389591	5395473	674.55	-3.71	0.37
157	157	389637	5395454	672.19	-3.24	0.38
158	158	389953	5396407	610.28	7.78	0.44
159	159	389906	5396424	609.97	7.79	0.47
160	160	389859	5396441	608.43	8.03	0.48
161	161	389765	5396051	636.81	3.00	0.42
162	162	389811	5396033	629.68	4.39	0.43
163	163	389789	5396255	622.91	5.50	0.46

164	164	389857	5396016	620.80	6.15	0.43
165	165	389835	5396237	620.32	6.11	0.45
166	166	389882	5396220	619.12	6.39	0.43
167	167	389928	5396202	622.17	6.03	0.44
168	168	388132	5395436	639.14	-0.72	0.49
169	169	389042	5394785	656.99	0.54	0.45
170	170	389023	5394738	654.52	0.94	0.49
171	171	389003	5394692	655.24	0.82	0.55
172	172	388984	5394648	659.91	-0.34	0.56
173	173	388965	5394603	667.28	-1.57	0.57
174	174	388947	5394556	668.42	-2.17	0.59
175	175	388927	5394510	667.24	-1.83	0.61
176	176	388908	5394464	671.23	-2.74	0.60
177	177	388889	5394415	671.53	-2.93	0.66
178	178	388871	5394368	667.04	-2.02	0.74
179	179	388852	5394321	661.55	-0.86	0.79
180	180	388834	5394272	653.06	0.85	0.81
181	181	388878	5394254	640.80	3.50	0.73
182	182	388926	5394235	626.48	6.70	0.70
183	183	388972	5394217	619.65	8.16	0.64
184	184	389018	5394198	625.78	7.11	0.60
185	185	389064	5394180	631.28	6.06	0.54
186	186	389111	5394163	634.67	5.47	0.50
187	187	389158	5394144	635.81	5.35	0.49
188	188	389203	5394126	639.82	4.50	0.46
189	189	389250	5394108	644.87	3.66	0.47
190	190	388953	5394444	672.34	-2.95	0.62
191	191	388999	5394426	668.80	-2.30	0.64
192	192	389045	5394407	660.77	-0.51	0.64
193	193	389091	5394388	650.86	1.49	0.62
194	194	389137	5394369	637.21	4.36	0.59
195	195	389183	5394351	629.99	5.98	0.58
196	196	388529	5394850	653.96	-0.24	0.64
197	197	388574	5394830	648.01	1.49	0.61
198	198	388619	5394810	643.46	2.66	0.60
199	199	388664	5394790	642.78	2.93	0.58
200	200	388710	5394770	643.53	2.97	0.57
201	201	388755	5394750	646.59	2.41	0.55
202	202	388802	5394729	649.31	1.92	0.47
203	203	388848	5394708	651.50	1.62	0.54
204	204	388893	5394688	655.25	0.77	0.53
205	205	388940	5394668	659.58	-0.24	0.56
206	206	388876	5394905	663.25	-0.96	0.43
207	207	388831	5394924	660.89	-0.52	0.42
208	208	388784	5394945	659.84	-0.29	0.43
209	209	388740	5394964	657.56	0.06	0.45
210	210	388692	5394984	653.08	0.91	0.49
211	211	388646	5395003	645.70	2.26	0.49
212	212	388600	5395023	635.42	4.48	0.51
213	213	388555	5395043	631.29	5.25	0.50
214	214	388508	5395063	630.51	5.29	0.49
215	215	388463	5395083	628.02	5.72	0.54
216	216	388408	5395103	624.67	6.19	0.58
217	217	388363	5395123	617.57	7.50	0.61
218	218	388318	5395143	606.18	9.71	0.61
219	219	388267	5395163	585.57	13.39	0.68

220	220	388222	5395183	584.84	13.54	0.70
221	221	398177	5395203	597.67	10.62	0.67
222	222	388132	5395223	608.80	8.16	0.68
223	223	388087	5395243	621.11	5.52	0.73
224	224	388042	5395263	629.18	3.69	0.72
225	225	387997	5395283	630.23	3.53	0.61
226	226	387952	5395303	628.60	3.74	0.67
227	227	388862	5395123	653.86	0.74	0.40
228	228	388815	5395142	643.81	2.71	0.43
229	229	388768	5395162	637.00	4.89	0.44
230	230	388722	5395181	648.84	3.23	0.46
231	231	388676	5395199	639.69	3.42	0.47
232	232	388630	5395208	633.85	4.54	0.47
233	233	388584	5395239	622.86	6.69	0.48
234	234	388537	5395258	618.72	7.57	0.57
235	235	388492	5395276	617.79	7.64	0.57
236	236	388447	5395296	609.81	9.02	0.58
237	237	388402	5395316	611.17	8.50	0.59
238	238	388357	5395336	622.28	5.91	0.60
239	239	388312	5395356	634.39	3.27	0.59
240	240	388267	5395376	649.84	-0.55	0.61
241	241	389272	5394955	674.72	-3.25	0.38
242	242	389319	5394936	673.87	-3.17	0.42
243	243	389366	5394917	665.12	-1.18	0.39
244	244	389412	5394898	663.62	-0.85	0.38
245	245	389258	5395178	667.34	-2.89	0.36
246	246	389304	5395161	671.38	-2.96	0.37
247	247	389350	5395142	674.64	-3.75	0.37
248	248	389396	5395123	677.62	-4.35	0.36
249	249	389442	5395104	678.90	-4.55	0.37
250	250	389489	5395086	679.45	-4.57	0.36
251	251	389535	5395066	680.09	-4.72	0.37
252	252	389426	5395324	675.66	-3.88	0.38
253	253	389518	5395287	682.26	-5.32	0.37
254	254	389564	5395267	683.89	-5.77	0.39
255	255	389610	5395248	685.56	-5.89	0.38
256	256	389656	5395229	680.81	-4.83	0.37
257	257	389672	5396086	649.94	0.27	0.46
258	258	389719	5396068	640.84	2.13	0.48
259	259	389530	5396558	637.62	1.11	0.61
260	260	389576	5396543	634.57	1.82	0.65
261	261	389623	5396525	630.60	2.75	0.64
262	262	389670	5396508	624.89	4.20	0.62
263	263	389718	5396492	614.52	6.45	0.62
264	264	389765	5396475	606.85	8.11	0.58
265	265	389813	5396458	606.80	8.16	0.53

130

LEAMAN GEOPHYSICS GRAVITY REDUCTION

CSR QUE ROAD GRAVITY SURVEY FEB 1987

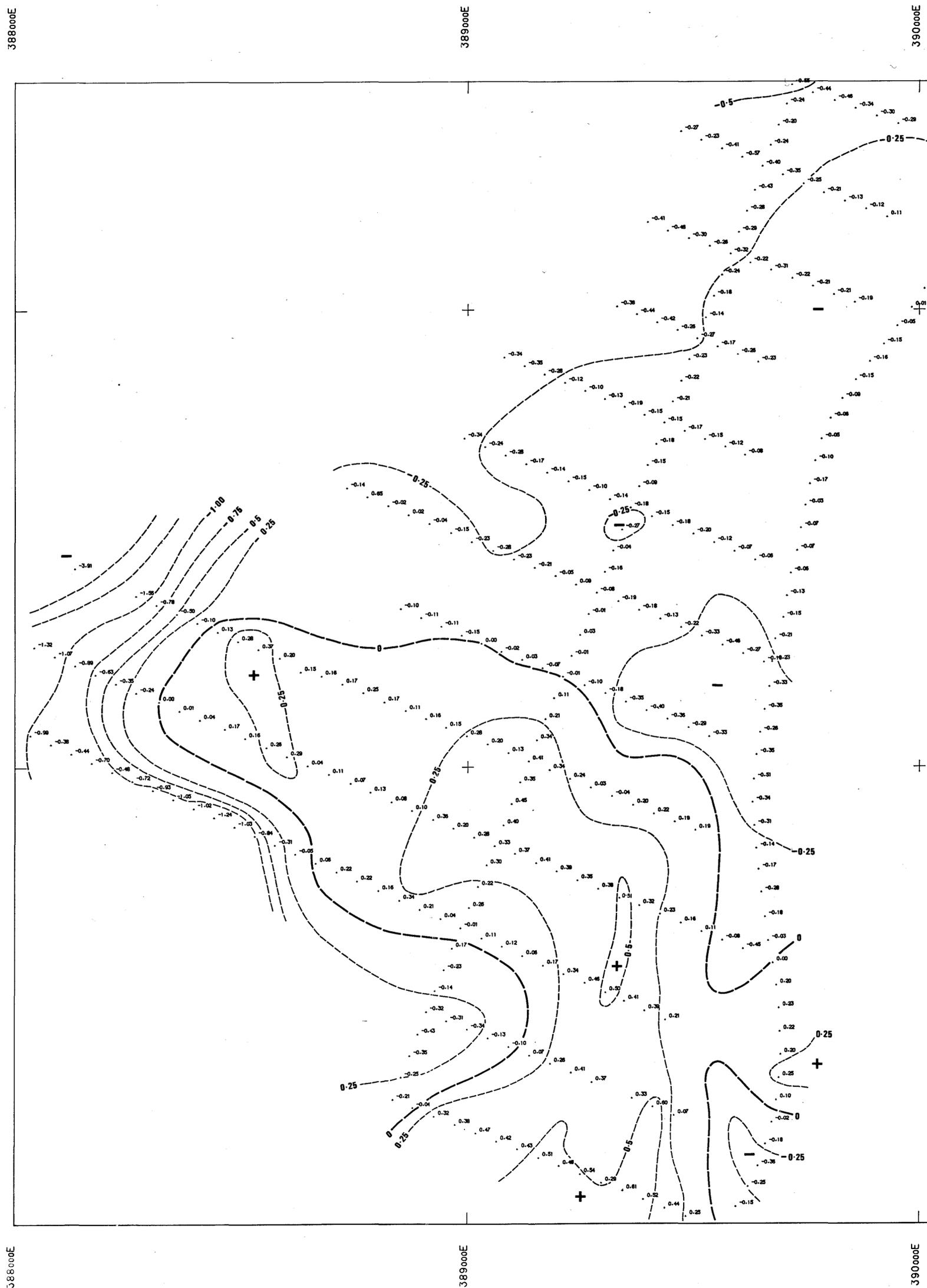
BASE VALUE	BASE NUMBER	METER	CAL DATE	SCALE	DENSITY	ELEV DATUM		
980177.50	8551.9976	561	10187	1.0093	2.67	0.00		
NUMBER	EASTING	NORTHING	HEIGHT	OBS GRAY	THEO GRAY	CORR	BOUG ANOM	
8700.0001	389951.0	5395964.0	626.47	980182.85	980321.49	0.36	-15.06	
8700.0002	389748.0	5395572.0	661.69	980176.27	980321.80	0.35	-15.03	
8700.0003	389921.0	5395924.0	630.19	980182.05	980321.52	0.36	-15.15	
8700.0004	389758.0	5395618.0	658.72	980176.66	980321.77	0.36	-15.17	
8700.0005	389890.0	5395886.0	634.32	980181.24	980321.55	0.37	-15.17	
8700.0006	389770.0	5395668.0	655.33	980177.36	980321.73	0.36	-15.11	
8700.0007	389859.0	5395846.0	638.37	980180.49	980321.59	0.38	-15.15	
8700.0008	389784.0	5395716.0	651.48	980178.11	980321.69	0.38	-15.06	
8700.0009	389830.0	5395805.0	642.66	980179.72	980321.62	0.39	-15.10	
8700.0010	389804.0	5395762.0	647.21	980178.89	980321.65	0.39	-15.06	
8700.0011	389738.0	5395523.0	664.32	980175.78	980321.84	0.31	-15.08	
8700.0012	389730.0	5395474.0	666.72	980175.36	980321.88	0.30	-15.08	
8700.0013	389716.0	5395425.0	669.07	980174.96	980321.92	0.29	-15.07	
8700.0014	389707.0	5395375.0	672.30	980174.31	980321.96	0.28	-15.13	
8700.0015	389699.0	5395327.0	674.51	980173.89	980322.00	0.28	-15.16	
8700.0016	389634.0	5394973.0	681.25	980172.49	980322.29	0.28	-15.51	
8700.0017	389640.0	5395026.0	681.40	980172.57	980322.24	0.28	-15.36	
8700.0018	389681.0	5395280.0	679.52	980172.89	980322.04	0.27	-15.22	
8700.0019	389648.0	5395075.0	680.85	980172.73	980322.20	0.29	-15.26	
8700.0020	389674.0	5395230.0	677.81	980173.25	980322.08	0.27	-15.23	
8700.0021	389658.0	5395125.0	680.00	980172.77	980322.16	0.29	-15.35	
8700.0022	389668.0	5395175.0	678.74	980172.99	980322.12	0.29	-15.34	
8700.0023	389676.0	5394571.0	666.15	980176.22	980322.61	0.36	-15.00	
8700.0024	389631.0	5394923.0	680.68	980172.81	980322.33	0.28	-15.35	
8700.0025	389666.0	5394620.0	669.01	980175.61	980322.57	0.33	-15.03	
8700.0026	389635.0	5394872.0	679.63	980173.08	980322.37	0.29	-15.32	
8700.0027	389659.0	5394672.0	672.01	980174.83	980322.53	0.33	-15.19	
8700.0028	389640.0	5394822.0	678.43	980173.51	980322.41	0.30	-15.15	
8700.0029	389651.0	5394726.0	676.01	980173.91	980322.49	0.32	-15.29	
8700.0030	389645.0	5394776.0	678.28	980173.55	980322.45	0.30	-15.17	
8700.0031	389674.0	5394222.0	657.05	980178.31	980322.89	0.32	-15.02	
8700.0032	389684.0	5394522.0	662.55	980177.17	980322.65	0.36	-14.80	
8700.0033	389684.0	5394271.0	655.55	980178.67	980322.85	0.33	-14.91	
8700.0034	389690.0	5394472.0	658.82	980177.95	980322.69	0.37	-14.78	
8700.0035	389690.0	5394320.0	653.64	980179.16	980322.81	0.33	-14.76	
8700.0036	389692.0	5394421.0	656.12	980178.56	980322.73	0.33	-14.78	
8700.0037	389694.0	5394371.0	653.89	980179.01	980322.77	0.33	-14.81	
8700.0038	389622.0	5394081.0	660.09	980177.61	980323.01	0.30	-15.25	
8700.0039	389644.0	5394126.0	658.97	980177.67	980322.97	0.31	-15.37	
8700.0040	389660.0	5394174.0	658.15	980177.96	980322.93	0.32	-15.19	
8700.0041	389595.0	5394037.0	659.94	980177.77	980323.04	0.30	-15.16	
8700.0042	389983.0	5396004.0	623.01	980183.55	980321.46	0.37	-15.00	
8700.0043	390011.0	5396045.0	619.48	980184.14	980321.43	0.35	-15.08	
8700.0044	390035.0	5396089.0	615.83	980184.77	980321.39	0.34	-15.15	
8700.0045	390058.0	5396134.0	612.87	980185.23	980321.35	0.31	-15.26	
8700.0046	390086.0	5396230.0	612.69	980185.25	980321.28	0.31	-15.20	
8700.0047	390112.0	5396271.0	614.74	980184.80	980321.25	0.32	-15.21	
8700.0048	390130.0	5396321.0	617.49	980184.10	980321.20	0.36	-15.28	

NUMBER	EASTING	NORTHING	HEIGHT	OBS GRAY	THEO GRAY	CORR	BOUG ANOM
8700.0049	389341.0	5395520.0	670.35	980174.32	980321.84	0.39	-15.27
8700.0050	389360.0	5395567.0	665.09	980175.40	980321.80	0.39	-15.19
8700.0051	389379.0	5395613.0	665.44	980175.37	980321.77	0.41	-15.09
8700.0052	389398.0	5395659.0	666.98	980174.96	980321.73	0.42	-15.16
8700.0053	389417.0	5395705.0	668.61	980174.55	980321.69	0.44	-15.18
8700.0054	389435.0	5395752.0	667.57	980174.75	980321.66	0.43	-15.16
8700.0055	389454.0	5395798.0	664.05	980175.37	980321.62	0.41	-15.22
8700.0056	389472.0	5395844.0	662.96	980175.57	980321.58	0.38	-15.23
8700.0057	389490.0	5395891.0	660.46	980176.03	980321.54	0.37	-15.24
8700.0058	389545.0	5396030.0	652.23	980177.58	980321.43	0.37	-15.19
8700.0059	389582.0	5396122.0	648.91	980177.98	980321.36	0.41	-15.32
8700.0060	389125.0	5395876.0	648.49	980178.24	980321.55	0.40	-15.36
8700.0061	389169.0	5395858.0	649.82	980178.08	980321.57	0.39	-15.28
8700.0062	389214.0	5395840.0	647.62	980178.70	980321.58	0.37	-15.12
8700.0063	389259.0	5395822.0	650.12	980178.24	980321.60	0.38	-15.10
8700.0064	389303.0	5395804.0	652.17	980177.81	980321.61	0.38	-15.14
8700.0065	389347.0	5395787.0	657.22	980176.75	980321.63	0.40	-15.20
8700.0066	389480.0	5395734.0	670.79	980174.12	980321.67	0.43	-15.18
8700.0067	389391.0	5395739.0	662.66	980175.72	980321.64	0.42	-15.15
8700.0068	389525.0	5395716.0	671.30	980174.08	980321.69	0.41	-15.15
8700.0069	389314.0	5395585.0	663.28	980175.78	980321.79	0.39	-15.15
8700.0070	389268.0	5395605.0	667.08	980175.06	980321.77	0.39	-15.11
8700.0071	389222.0	5395624.0	666.32	980175.15	980321.76	0.39	-15.15
8700.0072	390175.0	5395643.0	665.10	980175.39	980321.75	0.39	-15.15
8700.0073	389129.0	5395661.0	663.83	980175.59	980321.73	0.38	-15.18
8700.0074	389083.0	5395680.0	659.81	980176.27	980321.71	0.37	-15.29
8700.0075	389570.0	5395699.0	669.61	980174.45	980321.70	0.41	-15.13
8700.0076	389614.0	5395681.0	666.78	980175.07	980321.71	0.41	-15.08
8700.0077	389508.0	5395937.0	654.99	980177.12	980321.51	0.28	-15.27
8700.0078	389643.0	5395885.0	661.21	980175.88	980321.55	0.38	-15.24
8700.0079	389553.0	5395919.0	657.41	980176.66	980321.52	0.37	-15.18
8700.0080	389464.0	5395955.0	656.54	980176.73	980321.49	0.35	-15.27
8700.0081	389419.0	5395972.0	655.72	980176.71	980321.48	0.36	-15.42
8700.0082	389374.0	5395990.0	654.99	980176.82	980321.46	0.36	-15.44
8700.0083	389598.0	5395982.0	659.88	980176.11	980321.54	0.37	-15.26
8700.0084	389626.0	5396102.0	652.04	980177.45	980321.38	0.44	-15.23
8700.0085	389536.0	5396139.0	644.83	980178.84	980321.34	0.40	-15.26
8700.0086	389489.0	5396156.0	640.06	980179.72	980321.33	0.40	-15.31
8700.0087	389442.0	5396172.0	640.23	980179.51	980321.32	0.39	-15.48
8700.0088	389527.0	5395983.0	653.74	980177.37	980321.47	0.37	-15.14
8700.0089	389600.0	5396169.0	650.37	980177.68	980321.32	0.42	-15.29
8700.0090	389563.0	5396076.0	648.65	980178.17	980321.40	0.40	-15.24
8700.0091	389330.0	5396007.0	652.06	980177.44	980321.45	0.38	-15.37
8700.0092	389079.0	5394873.0	663.62	980176.92	980322.36	0.30	-14.60
8700.0093	389097.0	5394919.0	664.49	980176.68	980322.32	0.38	-14.56
8700.0094	389116.0	5394966.0	664.12	980176.62	980322.29	0.38	-14.65
8700.0095	389135.0	5395012.0	664.08	980176.65	980322.25	0.38	-14.59
8700.0096	389090.0	5395030.0	661.75	980176.88	980322.23	0.31	-14.87
8700.0097	389044.0	5395049.0	659.70	980177.27	980322.22	0.38	-14.81
8700.0098	388998.0	5395067.0	658.07	980177.66	980322.20	0.37	-14.73
8700.0099	388952.0	5395086.0	657.35	980177.69	980322.19	0.34	-14.85
8700.0100	388907.0	5395105.0	658.04	980177.49	980322.17	0.40	-14.84
8700.0101	389153.0	5395058.0	663.40	980176.67	980322.21	0.38	-14.67
8700.0102	389172.0	5395104.0	662.83	980176.64	980322.18	0.36	-14.79

NUMBER	EASTING	NORTHING	HEIGHT	DEM GRAY	THEO GRAY	CORR	BOUG ANOM
8700.0103	389191.0	5395150.0	663.51	980176.38	980322.14	0.35	-14.90
8700.0104	389210.0	5395197.0	663.56	980176.21	980322.10	0.36	-15.01
8700.0105	389165.0	5395216.0	661.96	980176.44	980322.08	0.36	-15.08
8700.0106	389229.0	5395243.0	661.23	980176.61	980322.06	0.37	-15.02
8700.0107	389120.0	5395234.0	657.40	980177.42	980322.07	0.36	-14.98
8700.0108	389248.0	5395289.0	658.55	980177.13	980322.03	0.39	-14.97
8700.0109	389074.0	5395252.0	654.97	980177.80	980322.05	0.39	-15.03
8700.0110	389267.0	5395335.0	658.97	980176.98	980321.99	0.38	-15.02
8700.0111	389030.0	5395270.0	651.04	980178.59	980322.04	0.38	-15.01
8700.0112	389285.0	5395382.0	665.72	980175.55	980321.95	0.37	-15.08
8700.0113	388986.0	5395288.0	653.97	980177.85	980322.02	0.38	-15.15
8700.0114	389333.0	5395363.0	669.26	980174.76	980321.97	0.37	-15.19
8700.0115	389379.0	5395344.0	672.54	980174.13	980321.98	0.38	-15.19
8700.0116	389239.0	5395400.0	661.20	980176.60	980321.94	0.36	-14.92
8700.0117	389194.0	5395419.0	659.80	980176.73	980321.92	0.35	-15.06
8700.0118	389148.0	5395437.0	661.91	980176.16	980321.91	0.34	-15.21
8700.0119	389102.0	5395455.0	663.03	980175.89	980321.89	0.35	-15.24
8700.0120	389008.0	5395493.0	658.80	980176.68	980321.86	0.36	-15.23
8700.0121	389056.0	5395474.0	661.97	980176.01	980321.88	0.37	-15.29
8700.0122	389226.0	5394974.0	669.59	980175.43	980322.28	0.38	-14.76
8700.0123	389181.0	5394993.0	666.85	980176.05	980322.26	0.38	-14.67
8700.0124	389243.0	5394752.0	658.88	980177.80	980322.46	0.40	-14.66
8700.0125	389197.0	5394772.0	659.25	980177.75	980322.44	0.40	-14.62
8700.0126	389152.0	5394790.0	659.59	980177.68	980322.43	0.41	-14.60
8700.0127	389105.0	5394810.0	660.29	980177.50	980322.41	0.40	-14.63
8700.0128	389060.0	5394827.0	661.03	980177.31	980322.40	0.39	-14.67
8700.0129	389014.0	5394846.0	662.46	980176.97	980322.38	0.39	-14.72
8700.0130	388968.0	5394866.0	665.60	980176.24	980322.36	0.40	-14.80
8700.0131	388923.0	5394885.0	667.43	980176.01	980322.35	0.41	-14.65
8700.0132	389289.0	5394733.0	658.16	980177.97	980322.48	0.42	-14.62
8700.0133	389380.0	5394697.0	661.31	980177.33	980322.51	0.41	-14.69
8700.0134	389610.0	5394602.0	673.96	980174.15	980322.59	0.41	-15.46
8700.0135	389426.0	5394678.0	665.23	980176.49	980322.52	0.41	-14.77
8700.0136	389564.0	5394621.0	673.35	980174.62	980322.57	0.40	-15.10
8700.0137	389472.0	5394659.0	667.81	980175.95	980322.54	0.39	-14.84
8700.0138	389518.0	5394640.0	671.13	980175.24	980322.55	0.41	-14.89
8700.0139	389347.0	5394487.0	647.38	980180.28	980322.67	0.46	-14.60
8700.0140	389392.0	5394466.0	653.48	980179.08	980322.69	0.45	-14.62
8700.0141	389438.0	5394446.0	655.28	980178.58	980322.71	0.44	-14.80
8700.0142	389229.0	5394331.0	628.16	980184.09	980322.80	0.56	-14.59
8700.0143	389275.0	5394310.0	630.90	980183.59	980322.82	0.50	-14.63
8700.0144	389364.0	5394275.0	649.42	980179.97	980322.85	0.46	-14.67
8700.0145	389410.0	5394256.0	654.29	980179.32	980322.86	0.44	-14.41
8700.0146	389457.0	5394237.0	654.40	980178.79	980322.88	0.43	-14.93
8700.0147	389297.0	5394089.0	647.80	980180.41	980323.00	0.45	-14.72
8700.0148	389484.0	5394016.0	655.99	980178.86	980323.06	0.41	-14.75
8700.0149	389344.0	5394072.0	650.19	980180.29	980323.01	0.44	-14.39
8700.0150	389437.0	5394034.0	654.02	980179.42	980323.04	0.41	-14.57
8700.0151	389390.0	5394053.0	652.48	980179.78	980323.03	0.42	-14.48
8700.0152	389407.0	5395548.0	665.62	980175.35	980321.82	0.39	-15.15
8700.0153	389453.0	5395529.0	670.80	980174.32	980321.84	0.39	-15.19
8700.0154	389499.0	5395511.0	676.87	980173.13	980321.85	0.38	-15.20
8700.0155	389545.0	5395492.0	676.11	980173.38	980321.87	0.37	-15.12
8700.0156	389591.0	5395473.0	674.55	980173.76	980321.88	0.37	-15.07

NUMBER	EASTING	NORTHING	HEIGHT	OBS GRAY	THEO GRAY	CORR	BOUG ANOM
8700.0157	389637.0	5395454.0	672.19	980174.23	980321.90	0.38	-15.07
8700.0158	389953.0	5396407.0	610.28	980185.35	980321.13	0.44	-15.30
8700.0159	389906.0	5396424.0	609.97	980185.36	980321.12	0.47	-15.31
8700.0160	389859.0	5396441.0	608.43	980185.60	980321.11	0.48	-15.34
8700.0161	389765.0	5396051.0	636.81	980180.53	980321.42	0.42	-15.21
8700.0162	389811.0	5396033.0	629.68	980181.93	980321.43	0.43	-15.21
8700.0163	389789.0	5396255.0	622.91	980183.05	980321.25	0.46	-15.22
8700.0164	389857.0	5396016.0	620.80	980183.71	980321.45	0.43	-15.20
8700.0165	389835.0	5396237.0	620.32	980183.67	980321.27	0.45	-15.14
8700.0166	389862.0	5396220.0	619.12	980183.95	980321.20	0.43	-15.12
8700.0167	389928.0	5396202.0	622.17	980183.59	980321.30	0.44	-14.89
8700.0168	388132.0	5395436.0	639.14	980176.77	980321.89	0.49	-18.91
8700.0169	389042.0	5394785.0	656.99	980178.05	980322.43	0.45	-14.71
8700.0170	389023.0	5394738.0	654.52	980178.45	980322.47	0.49	-14.79
8700.0171	389003.0	5394692.0	655.24	980178.33	980322.51	0.55	-14.74
8700.0172	388964.0	5394648.0	659.91	980177.16	980322.54	0.56	-15.02
8700.0173	388965.0	5394603.0	667.28	980175.92	980322.58	0.57	-14.84
8700.0174	388947.0	5394556.0	668.42	980175.31	980322.61	0.59	-15.24
8700.0175	388927.0	5394510.0	667.24	980175.65	980322.65	0.61	-15.14
8700.0176	388908.0	5394464.0	671.23	980174.73	980322.69	0.60	-15.32
8700.0177	388889.0	5394415.0	671.53	980174.54	980322.73	0.66	-15.43
8700.0178	388871.0	5394368.0	667.04	980175.46	980322.77	0.74	-15.36
8700.0179	388852.0	5394321.0	661.55	980176.63	980322.80	0.79	-15.25
8700.0180	388834.0	5394272.0	653.06	980178.36	980322.84	0.81	-15.22
8700.0181	388878.0	5394254.0	640.80	980181.03	980322.86	0.73	-15.05
8700.0182	388926.0	5394235.0	626.48	980184.26	980322.87	0.70	-14.68
8700.0183	388972.0	5394217.0	619.65	980185.74	980322.89	0.64	-14.63
8700.0184	389018.0	5394198.0	625.78	980184.68	980322.90	0.60	-14.54
8700.0185	389064.0	5394180.0	631.28	980183.62	980322.92	0.54	-14.59
8700.0186	389111.0	5394163.0	634.67	980183.02	980322.93	0.50	-14.57
8700.0187	389158.0	5394144.0	635.81	980182.90	980322.95	0.49	-14.50
8700.0188	389203.0	5394126.0	639.82	980182.12	980322.96	0.46	-14.53
8700.0189	389250.0	5394108.0	644.87	980181.19	980322.98	0.47	-14.47
8700.0190	388953.0	5394444.0	672.34	980174.52	980322.70	0.62	-15.31
8700.0191	388999.0	5394426.0	668.80	980175.18	980322.72	0.64	-15.35
8700.0192	389045.0	5394407.0	660.77	980176.99	980322.74	0.64	-15.14
8700.0193	389091.0	5394388.0	650.86	980179.00	980322.75	0.62	-15.10
8700.0194	389137.0	5394369.0	637.21	980181.90	980322.77	0.59	-14.94
8700.0195	389183.0	5394351.0	629.99	980183.54	980322.78	0.58	-14.75
8700.0196	388529.0	5394850.0	653.96	980177.26	980322.37	0.64	-15.84
8700.0197	388574.0	5394830.0	648.01	980179.00	980322.39	0.61	-15.31
8700.0198	388619.0	5394810.0	643.46	980180.18	980322.41	0.60	-15.05
8700.0199	388664.0	5394790.0	642.78	980180.46	980322.42	0.58	-14.95
8700.0200	388710.0	5394770.0	643.53	980180.50	980322.44	0.57	-14.79
8700.0201	388755.0	5394750.0	646.59	980179.93	980322.46	0.55	-14.79
8700.0202	388802.0	5394729.0	649.31	980179.44	980322.47	0.47	-14.85
8700.0203	388848.0	5394708.0	651.50	980179.14	980322.49	0.54	-14.67
8700.0204	388893.0	5394688.0	655.35	980178.28	980322.51	0.53	-14.79
8700.0205	388940.0	5394668.0	659.58	980177.26	980322.52	0.56	-14.97
8700.0206	388876.0	5394905.0	663.25	980176.53	980322.33	0.43	-14.91
8700.0207	388831.0	5394924.0	660.89	980176.98	980322.32	0.42	-14.92
8700.0208	388784.0	5394945.0	659.84	980177.21	980322.30	0.43	-14.87
8700.0209	388740.0	5394964.0	657.56	980177.56	980322.28	0.45	-14.93
8700.0210	388692.0	5394984.0	653.08	980178.42	980322.27	0.49	-14.90

NUMBER	EASTING	NORTHING	HEIGHT	OBS GRAV	THEO GRAV	CORR	BOUG ANOM
8700.0211	388646.0	5395003.0	645.70	980179.78	980322.25	0.49	-14.97
8700.0212	388600.0	5395023.0	635.42	980182.02	980322.23	0.51	-14.71
8700.0213	388555.0	5395043.0	631.29	980182.80	980322.22	0.50	-14.74
8700.0214	388508.0	5395063.0	630.51	980182.84	980322.20	0.49	-14.85
8700.0215	388463.0	5395083.0	628.02	980183.27	980322.18	0.54	-14.84
8700.0216	388408.0	5395103.0	624.67	980183.75	980322.17	0.58	-14.97
8700.0217	388363.0	5395123.0	617.57	980185.07	980322.15	0.61	-14.99
8700.0218	388318.0	5395143.0	606.10	980187.30	980322.13	0.61	-15.00
8700.0219	388267.0	5395163.0	585.57	980191.01	980322.12	0.68	-15.24
8700.0220	388222.0	5395183.0	584.04	980191.17	980322.10	0.70	-15.35
8700.0221	388177.0	5395203.0	597.67	980188.22	980322.08	0.67	-15.63
8700.0222	388132.0	5395223.0	608.80	980185.74	980322.07	0.68	-15.90
8700.0223	388087.0	5395243.0	621.11	980183.07	980322.05	0.73	-16.08
8700.0224	388042.0	5395263.0	629.18	980181.22	980322.03	0.72	-16.33
8700.0225	387997.0	5395283.0	630.23	980181.06	980322.02	0.61	-16.38
8700.0226	387952.0	5395303.0	628.60	980181.27	980322.00	0.67	-16.41
8700.0227	388862.0	5395123.0	653.86	980178.25	980322.16	0.40	-14.89
8700.0228	388815.0	5395142.0	643.81	980180.24	980322.14	0.43	-14.84
8700.0229	388768.0	5395162.0	637.00	980181.63	980322.12	0.44	-14.76
8700.0230	388722.0	5395181.0	640.84	980180.76	980322.11	0.46	-14.83
8700.0231	388676.0	5395199.0	639.69	980180.95	980322.09	0.47	-14.84
8700.0232	388630.0	5395208.0	633.85	980182.08	980322.08	0.47	-14.85
8700.0233	388584.0	5395239.0	622.86	980184.25	980322.06	0.48	-14.81
8700.0234	388537.0	5395258.0	618.72	980185.14	980322.04	0.57	-14.63
8700.0235	388492.0	5395276.0	617.79	980185.21	980322.03	0.57	-14.73
8700.0236	388447.0	5395296.0	609.81	980186.60	980322.01	0.58	-14.88
8700.0237	388402.0	5395316.0	611.17	980186.08	980322.00	0.59	-15.11
8700.0238	388357.0	5395336.0	622.28	980183.46	980321.98	0.60	-15.51
8700.0239	388312.0	5395356.0	634.39	980180.80	980321.96	0.59	-15.79
8700.0240	388267.0	5395376.0	649.84	980176.94	980321.94	0.61	-16.57
8700.0241	389272.0	5394955.0	674.72	980174.22	980322.30	0.38	-14.98
8700.0242	389319.0	5394936.0	673.87	980174.30	980322.31	0.42	-15.04
8700.0243	389366.0	5394917.0	665.12	980176.31	980322.33	0.39	-14.80
8700.0244	389412.0	5394898.0	663.62	980176.64	980322.34	0.38	-14.79
8700.0245	389258.0	5395178.0	667.34	980175.39	980322.12	0.36	-15.10
8700.0246	389304.0	5395161.0	671.38	980174.51	980322.13	0.37	-15.19
8700.0247	389350.0	5395142.0	674.64	980173.72	980322.15	0.37	-15.36
8700.0248	389396.0	5395123.0	677.62	980173.11	980322.16	0.36	-15.41
8700.0249	389442.0	5395104.0	678.90	980172.91	980322.18	0.37	-15.36
8700.0250	389489.0	5395086.0	679.45	980172.89	980322.19	0.36	-15.30
8700.0251	389535.0	5395066.0	680.09	980172.74	980322.21	0.37	-15.33
8700.0252	389426.0	5395324.0	675.66	980173.58	980322.00	0.38	-15.13
8700.0253	389518.0	5395287.0	682.26	980172.13	980322.03	0.37	-15.33
8700.0254	389564.0	5395267.0	683.89	980171.68	980322.05	0.39	-15.46
8700.0255	389610.0	5395248.0	685.56	980171.56	980322.06	0.38	-15.28
8700.0256	389656.0	5395229.0	680.81	980172.63	980322.08	0.37	-15.17
8700.0257	389672.0	5396086.0	649.94	980177.77	980321.39	0.46	-15.31
8700.0258	389719.0	5396068.0	640.84	980179.65	980321.40	0.48	-15.22
8700.0259	389530.0	5396558.0	637.62	980178.62	980321.01	0.61	-16.36
8700.0260	389576.0	5396543.0	634.57	980179.34	980321.02	0.65	-16.21
8700.0261	389623.0	5396525.0	630.60	980180.28	980321.03	0.64	-16.08
8700.0262	389670.0	5396508.0	624.89	980181.74	980321.05	0.62	-15.77
8700.0263	389718.0	5396492.0	614.52	980184.01	980321.06	0.62	-15.56
8700.0264	389765.0	5396475.0	606.85	980185.69	980321.08	0.58	-15.44
8700.0265	389813.0	5396458.0	606.80	980185.74	980321.09	0.53	-15.47



GRAVITY SURVEY SPECIFICATIONS

GRAVIMETER : LaCoste-Romberg Meter No. 561
 Scale constant = 1.00928.
 Readings by G.Rau (Solo Geophysics)

READING INTERVAL : Station spacing of 50 metres.
 Line separation of 200 metres
 used with five tie-points at
 1. Que River Base
 2. 2400E/8300N = -3.1 div.
 3. 2400E/7600N = -0.19 div.
 4. 2400E/8800N = -0.38 div.
 5. Highway/9300N = +7.70 div.

PRECISION : Data reproducible to 0.02 mGal.
 Errors due to elevation <0.01 mGal.
 Overall RMS error about 0.05 mGal.

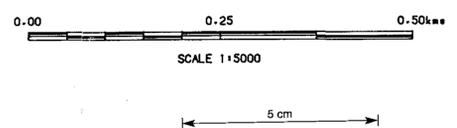
DATA PROCESSING

DATA REDUCTION : Bouguer reduction to 2.67 t/cu metre.
 Survey tied to Mines Department Que
 River alternate base at 8551.9976,
 980177.5 mGal.

ELEVATION : Readings from both base-plate and
 tripod. Accuracies of about 0.015m.

TERRAIN : Terrain corrections were applied up
 to Hammer zone M.

FREE-AIR : Free-air corrections have been applied
 with compensation for tripod readings.



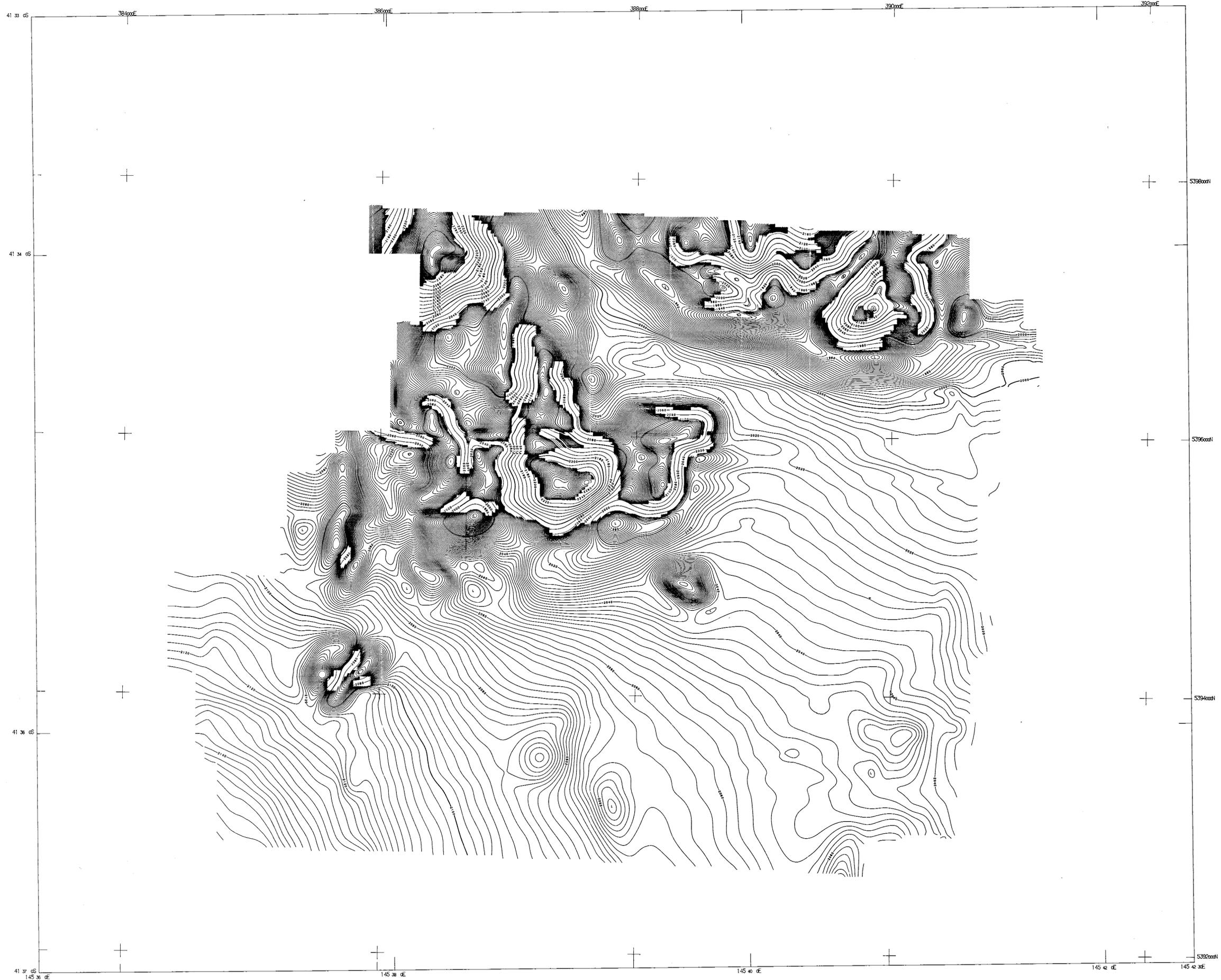
901136
87-2687

CSR LIMITED - MEDG

BULGOBAC RIVER EL 39/85

DENSITY CONTRAST = 2.67 t/cu.m.

SCALE	1: 5000	DRG No.
AUTHOR		7612-2
DATE	8-JUL-87	



AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER * 3 G-813 proton precession magnetometers in tail stinger and wing tips.
Sensitivity ± 0.2 nT
30m sampling

RECORDING INTERVAL *

SPECTROMETER * GR - 800 gamma ray spectrometer
Volume ± 16.8 litres
0.8 - 3.00 MeV

TOTAL COUNT WINDOW *

POTASSIUM WINDOW * 1.36 - 1.56 MeV

URANIUM WINDOW * 1.66 - 1.86 MeV

THORIUM WINDOW * 2.42 - 2.82 MeV

RECORDING INTERVAL * 60m sampling

DATA RECORDING * Geometrics 714 acquisition system.
Digital to magnetic tape.

NOMINAL TERRAIN CLEARANCE * All detectors in aircraft at 70m.

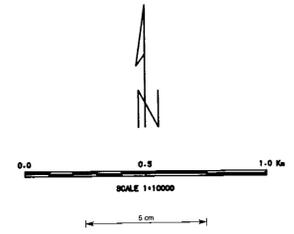
NOMINAL LINE SPACING * Traverse lines 100 metres.
Tie lines 300 metres.

FLIGHT PATH RECORD * continuous tracking colour video.

FLIGHT LINE RECOVERY * Visually to 1:80,000 enlarged photos

RESIDUAL MAGNETIC CONTOURS

Grid notation refers to Australian Map Grid Zone 55
Digitised from colour photos at 1:8000
Magnetics * Tie line levelled and
diurnal removed
IGRF (1980) * Updated to December 1985
IGRF (1980) * Removed, Datum 2000 m added
Grid mesh size * 25 x 25 metres
Grid filter * Polynomial, radius 50 metres
Contour interval 2,20,100 and 200 m



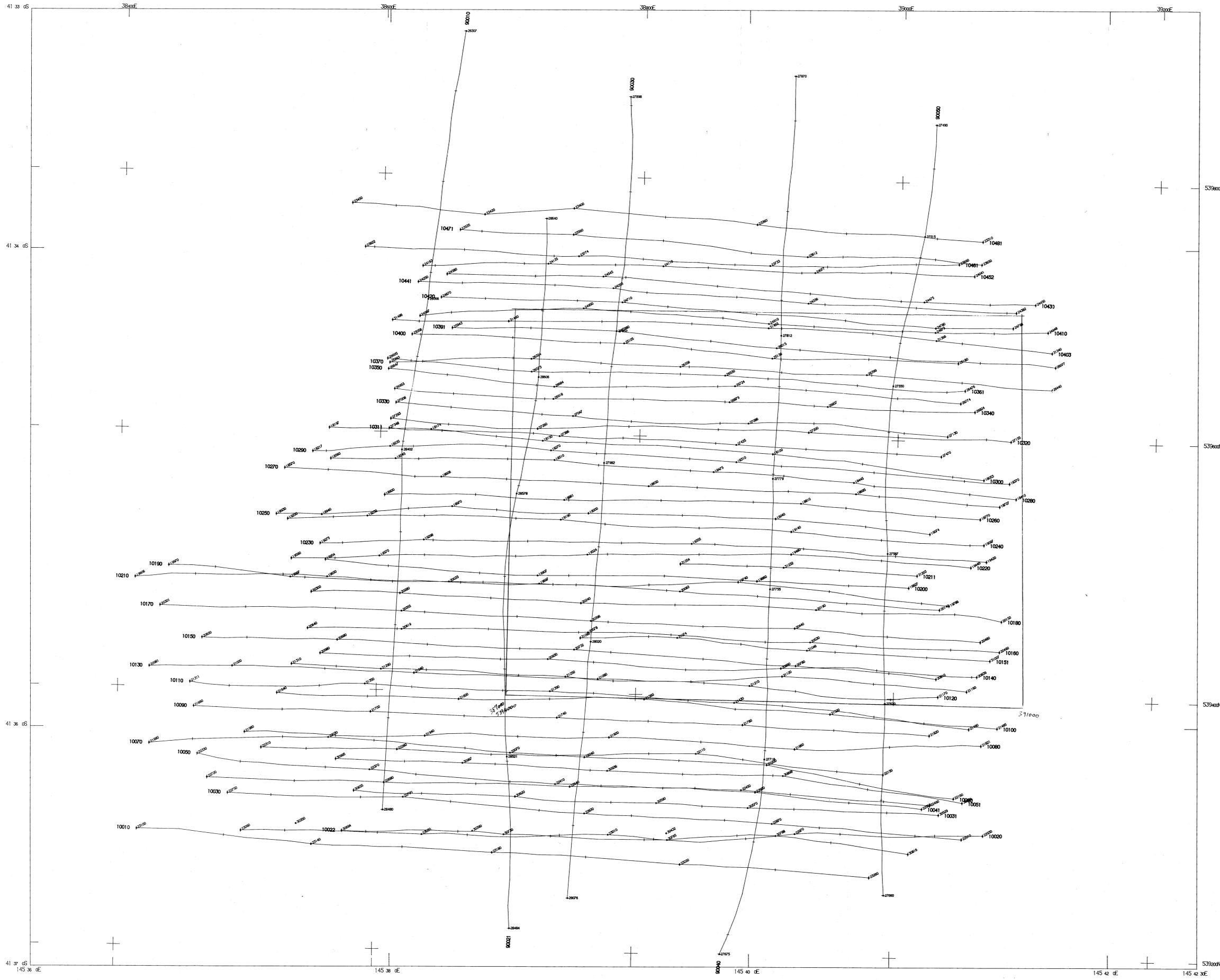
JOB NO * 9316
Flown by Geometrics International Corporation
November 1985
Processed by Engineering Computer Services, Bowral

CSR AUSTRALIA LTD.

**QUE RIVER
RESIDUAL MAGNETIC CONTOURS**

901137

DRG. No. 7812-3 DATE: 20-MAR-86



AIRBORNE SURVEY SPECIFICATIONS

MAGNETOMETER : 3 G-813 proton precession magnetometers
in tail stinger and wing tips.
Sensitivity : 0.2 nT

RECORDING INTERVAL : 30m sampling

SPECTROMETER : OR - 800 gamma ray spectrometer
Volume : 16.8 litres

TOTAL COUNT WINDOW : 0.8 - 3.00 MeV
POTASSIUM WINDOW : 1.36 - 1.56 MeV
URANIUM WINDOW : 1.66 - 1.86 MeV
THORIUM WINDOW : 2.42 - 2.82 MeV

RECORDING INTERVAL : 60m sampling

DATA RECORDING : Geometrics 714 acquisition system.
Digital to magnetic tape.

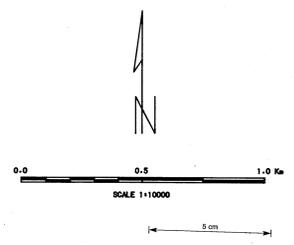
NOMINAL TERRAIN CLEARANCE : All detectors in aircraft at 70m.
NOMINAL LINE SPACING : Traverse lines 100 metres.

FLIGHT PATH RECORD : Tie lines 300 metres.
continuous tracking colour video

FLIGHT LINE RECOVERY : Visually to 1:80,000 enlarged photos

FLIGHT PATH RECOVERY

Grid notation refers to Australian Map Grid Zone 55
Digitized from colour photos at 1:80000



JOB NO : 9316
Flown by Geometrics International Corporation
November 1985
Processed by Engineering Computer Services, Bowral

CSR AUSTRALIA LTD.

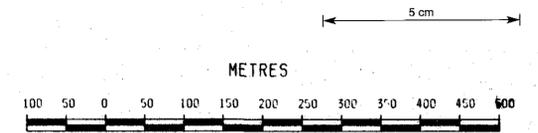
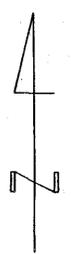
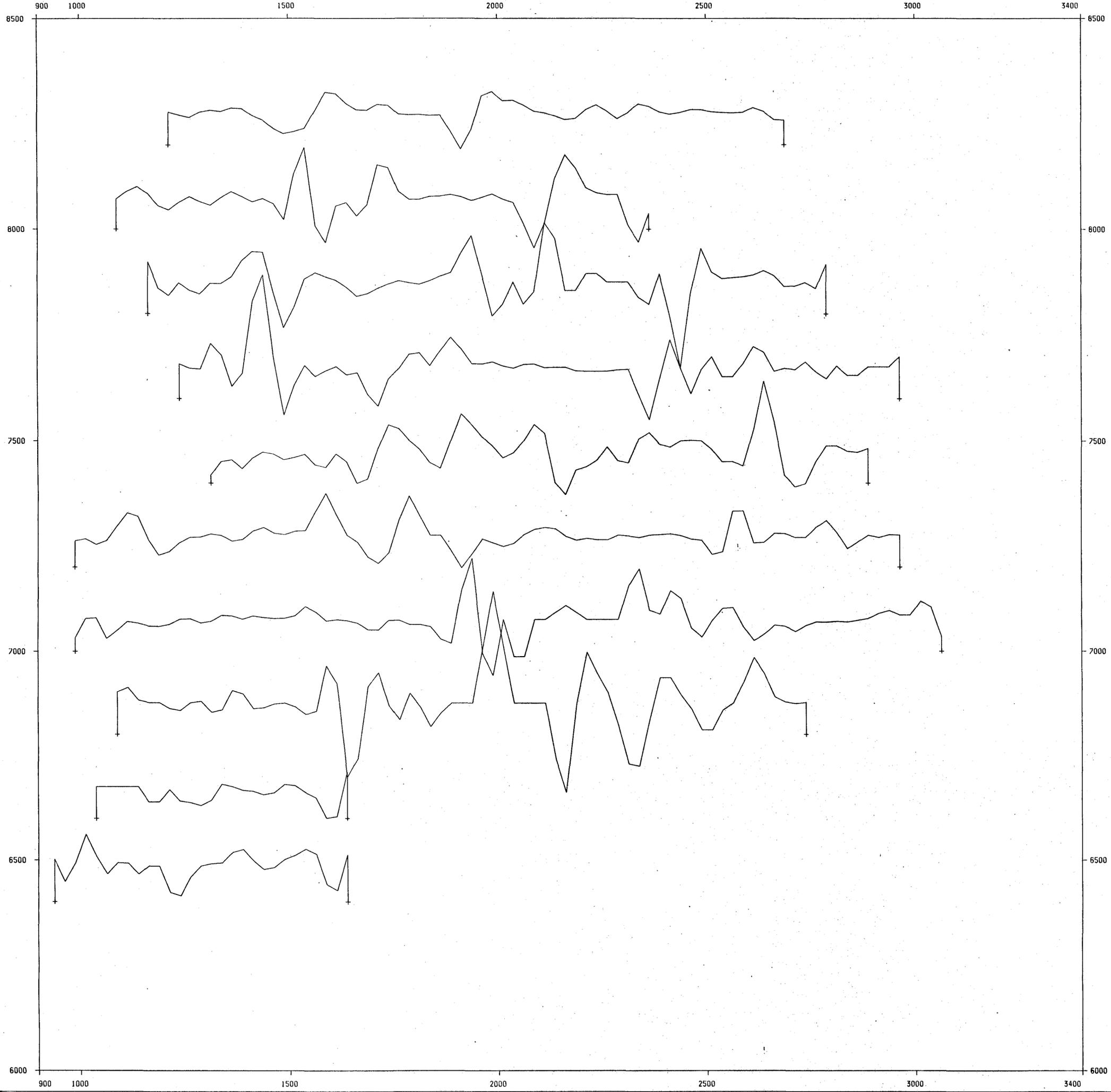
QUE RIVER
FLIGHT PATH RECOVERY

90113S **87-2687**

DRG. No. 7812-4 DATE: 20-MAR-86

6665

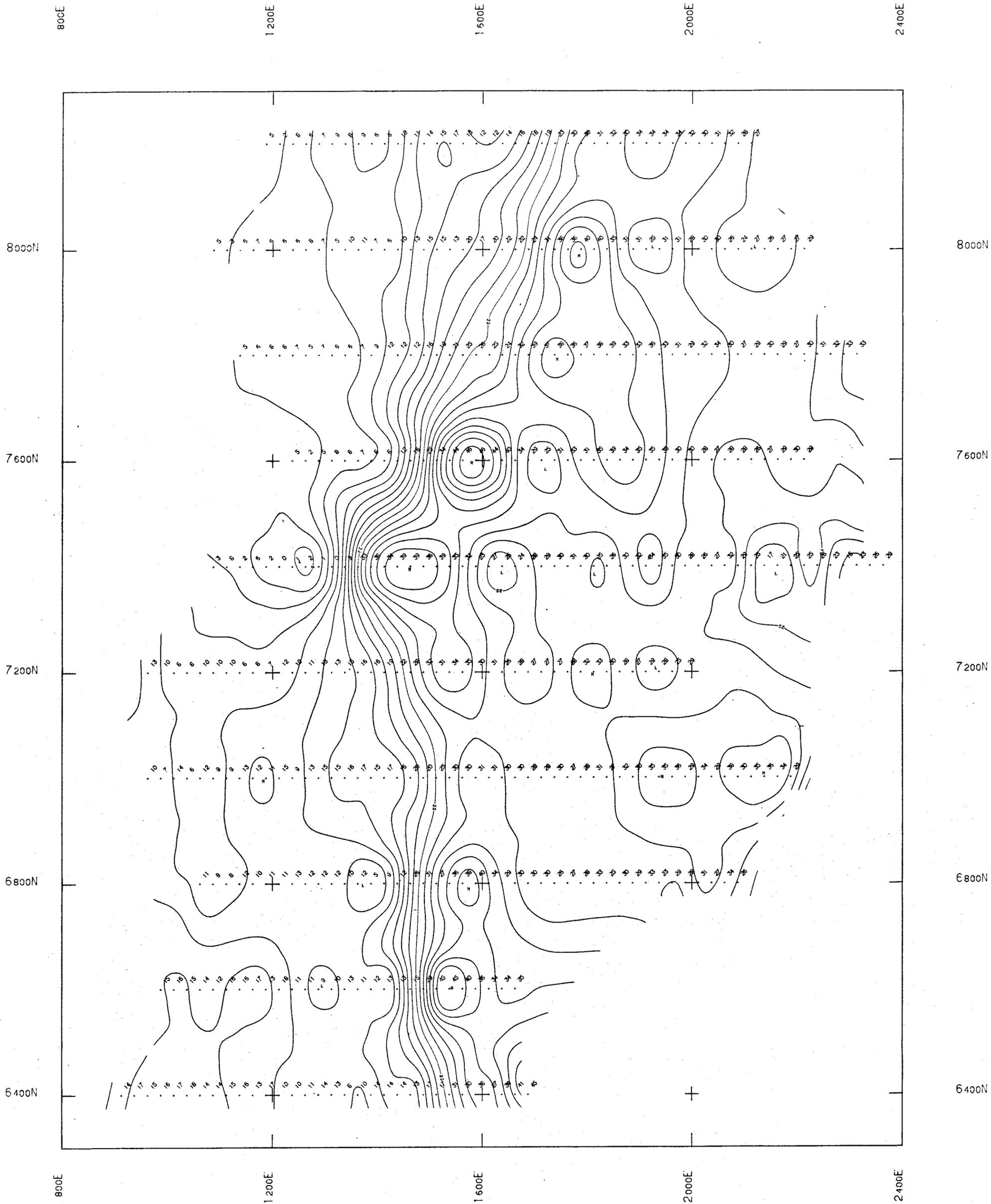
6665



CSR Limited - MEDG		
QUE ROAD PROSPECT FRASER FILTERED VLF PROFILES (150 DEG/CM.)		
SCALE: 1:5000	DATE: 8/1/1987	
DRAWN: prg	REVN	PLAN NO
CHECKED:		7612-5
APPROVED:		

901139

87-2687

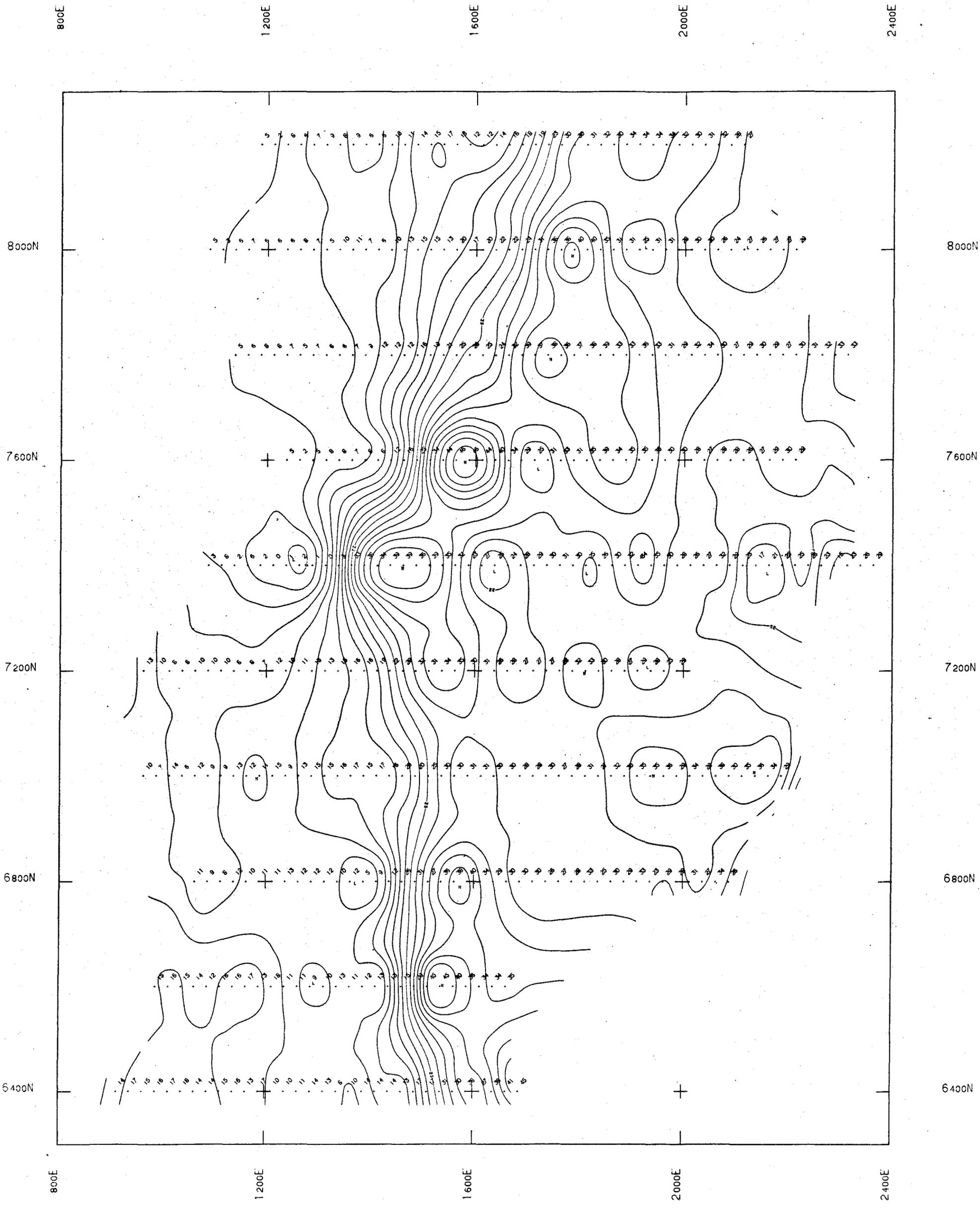


901140

CSR Limited - MEDG			
BULGOBAC CREEK IP - CHARGEABILITY Contour Int. = 5 milliradians.			
SCALE:	1:5000	DATE:	4/3/1987
DRAWN:	PRG	REVN	PLAN NO
CHECKED:			7612-6
APPROVED:	PRG		

5 cm

87-2687

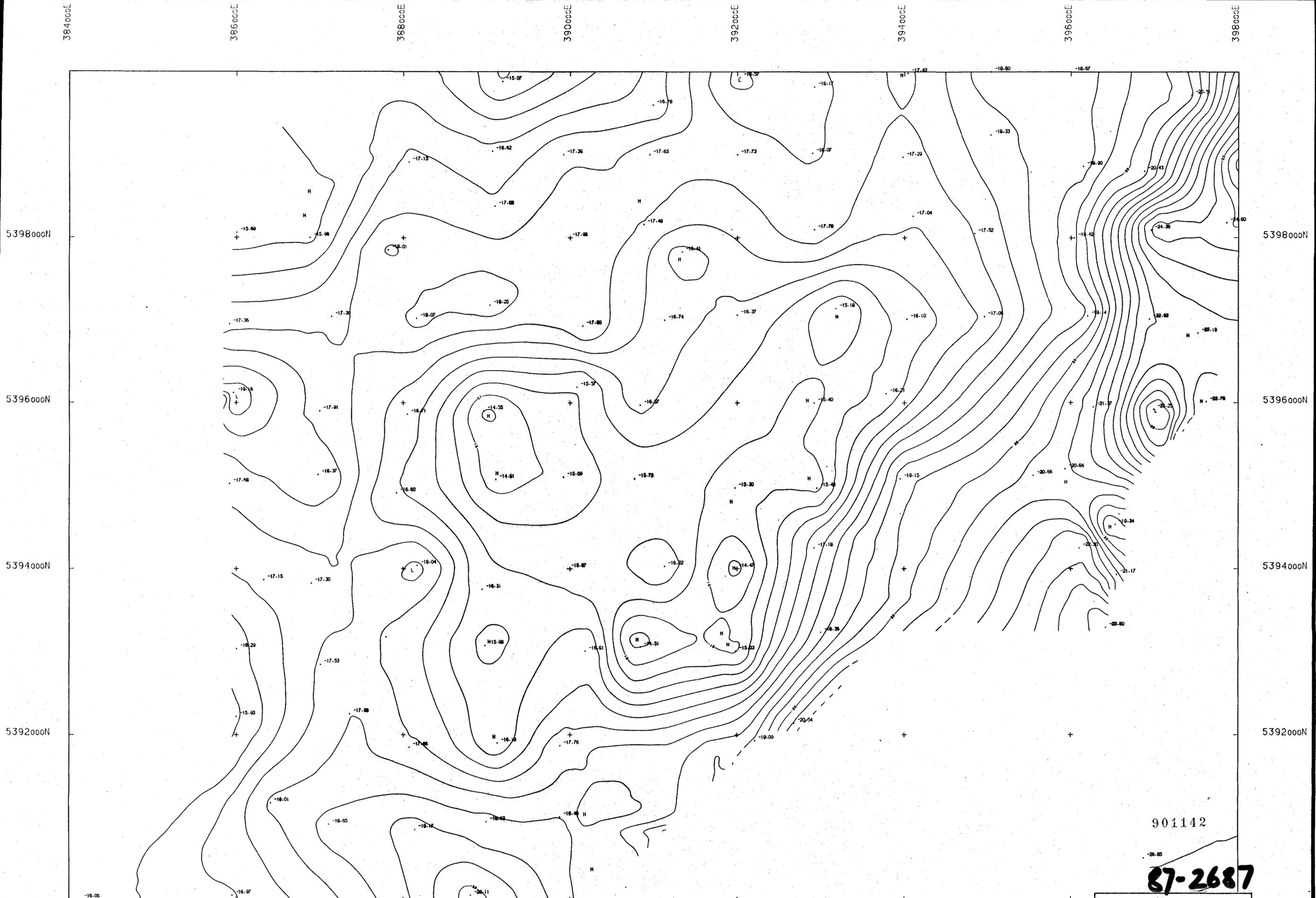


901141

CSR Limited - MEDG			
BULGOBAC CREEK IP - CHARGEABILITY			
Contour Int. = 5 milliradians.			
SCALE:	1:5000	DATE:	4/3/1987
DRAWN:	FRS	REVN:	PLAN NO
CHECKED:			7612-7
APPROVED:	FRS		

5 cm

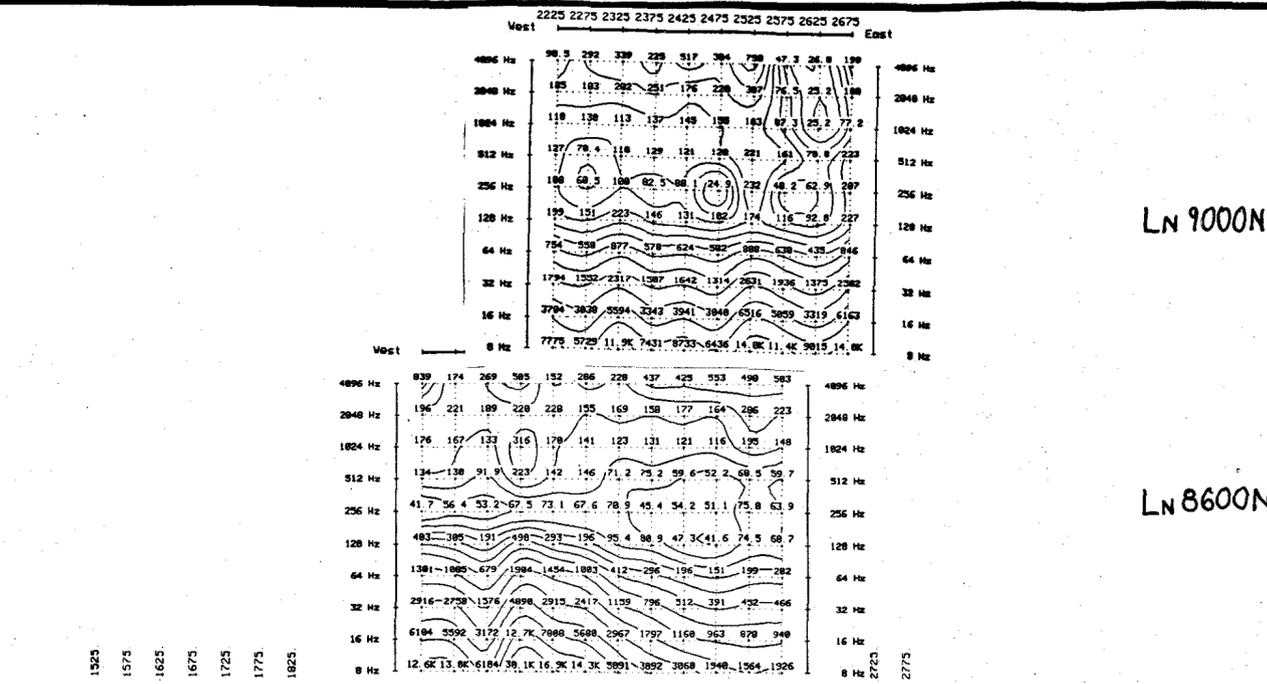
87-2687



901142
87-2687

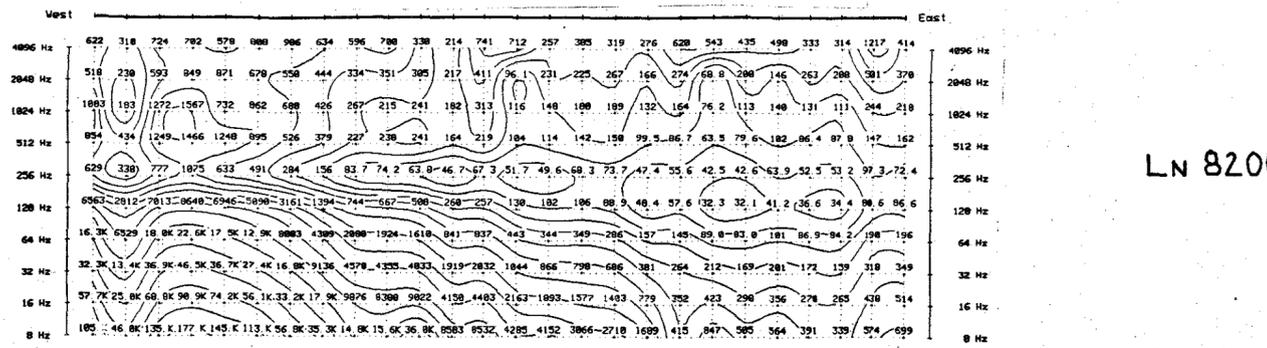
CSR Limited - MEDG			
BULGOBAC CREEK REGIONAL GRAVITY			
Contour Interval = 0.5 mGal.			
SCALE: 1:25000	DATE: 4/3/1987		
DRAWN: PMS	REV: 1	PLAN NO	
CHECKED: PMS			7612-8
APPROVED: PMS			

5 cm

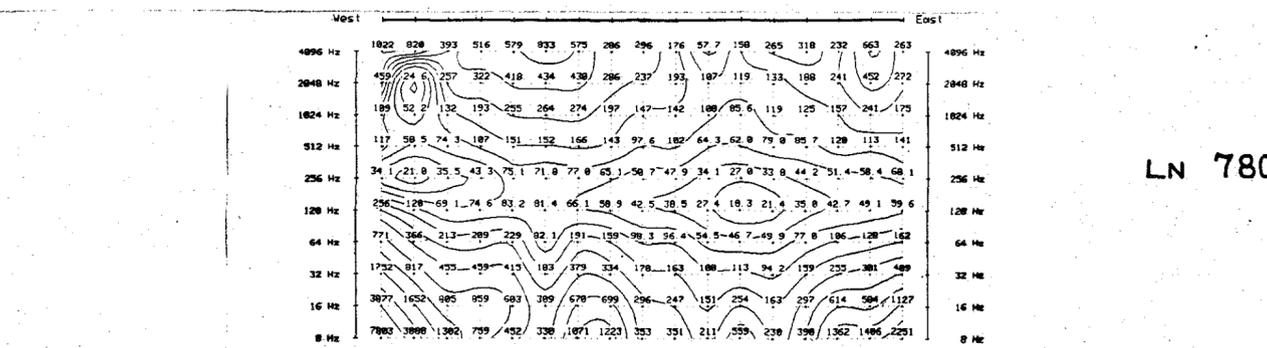


LN 9000

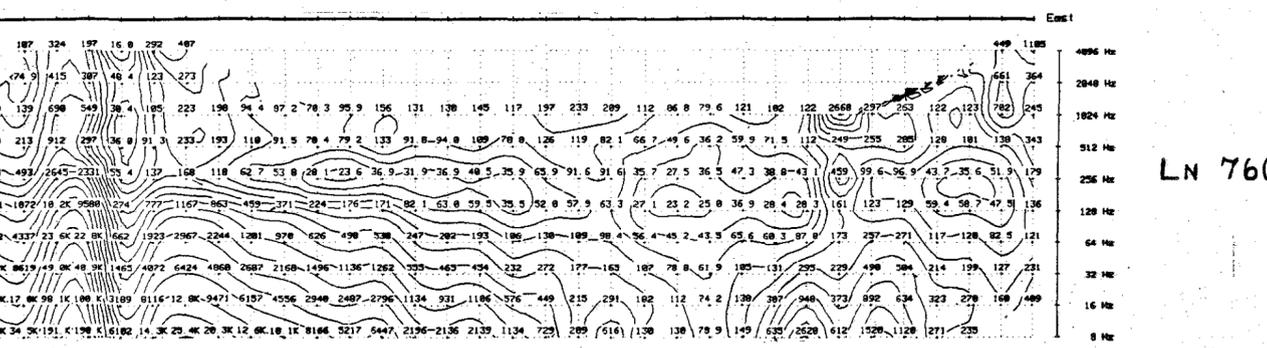
LN 8600N



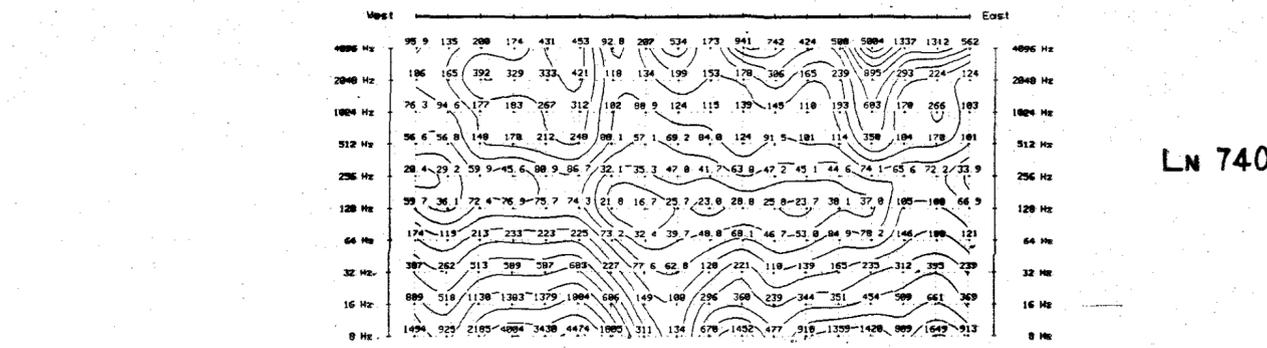
LN 8200N



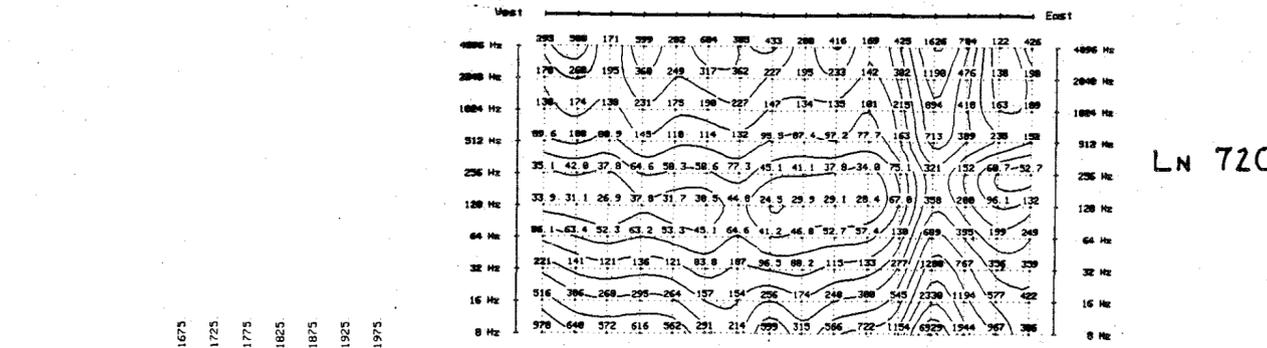
LN 7800N



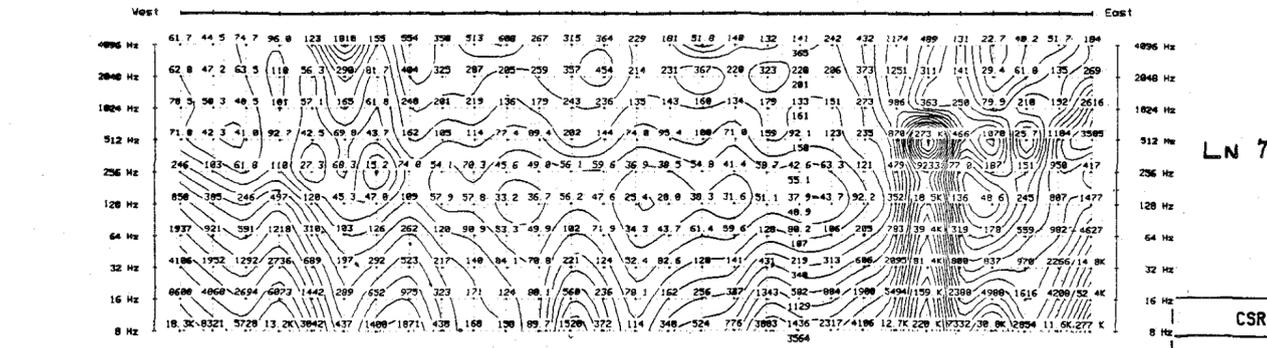
LN 7600N



LN 7400N



LN 7200N



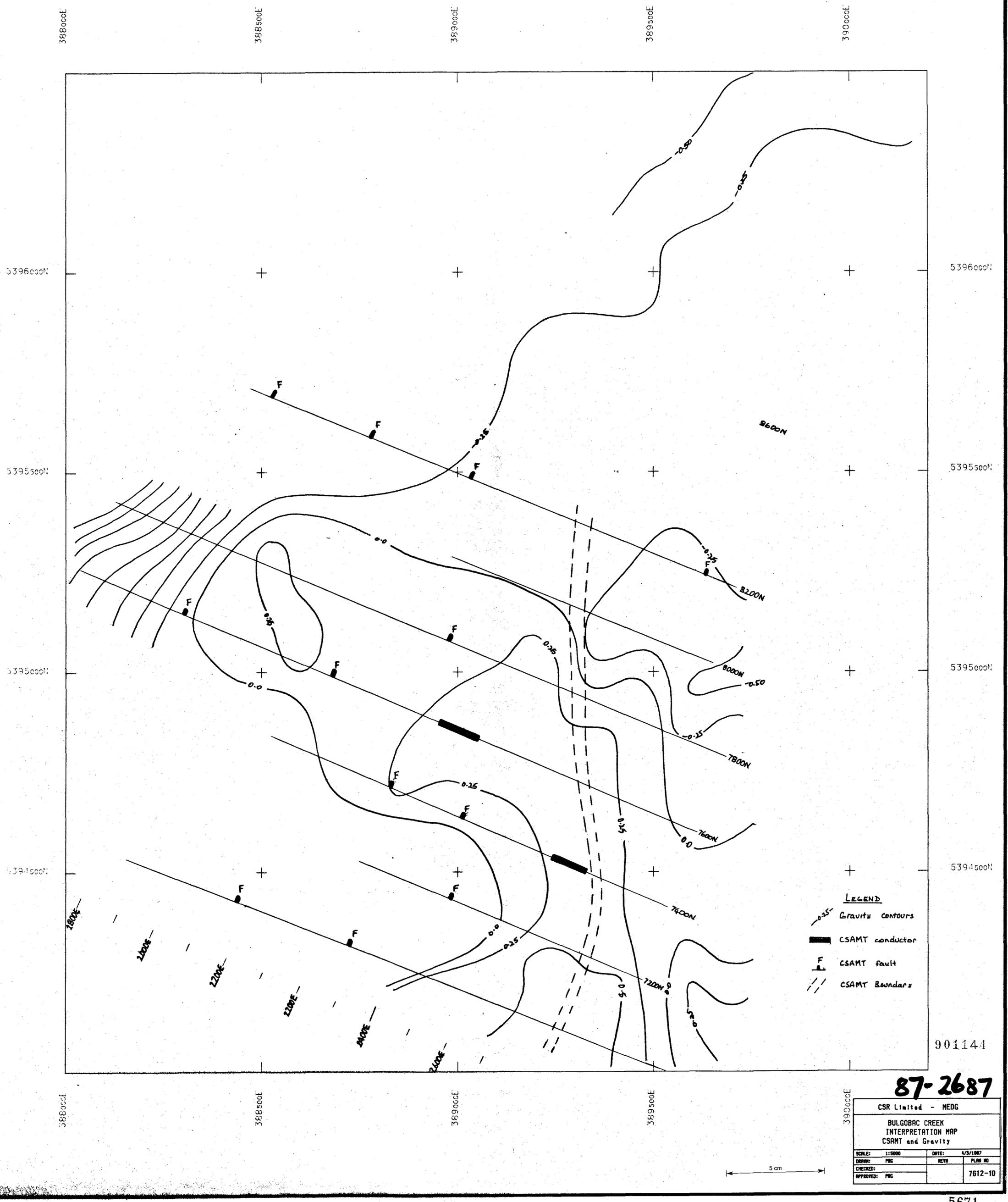
LN 7000N

901143

87-2687

1425E
1615E
1815E
2025E
2225E
2425E
2625E
2825E
3025E

CSR Limited - MEDG			
BULGOBAC CREEK CSAMT CAGNIARD RESISTIVITIES			
SCALE:	DATE:	1/3/1987	
DRAWN: PMS	REVW:	PLAN NO	
CHECKED:	7612-9		
APPROVED: PMS			



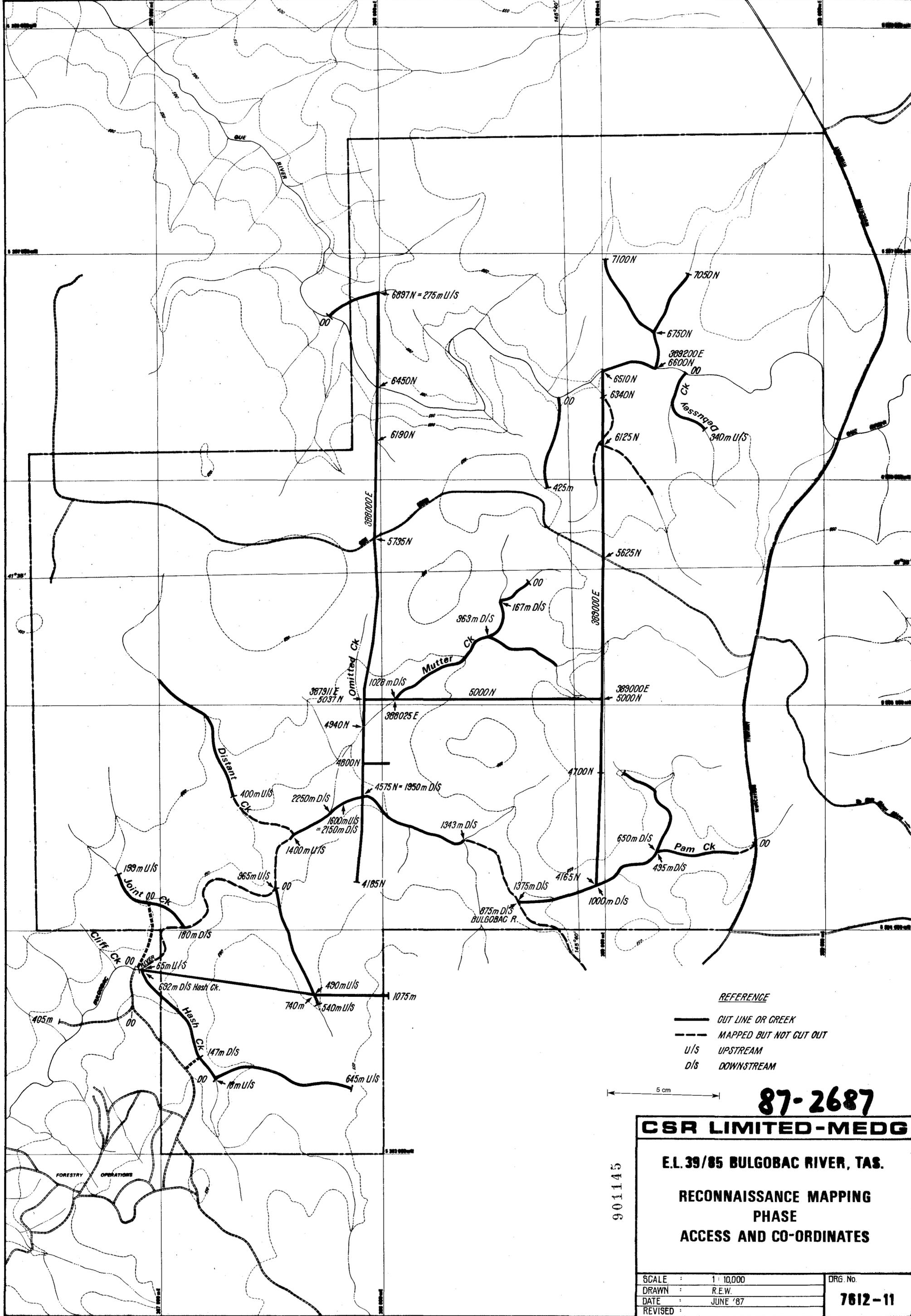
- LEGEND**
- Gravity contours
 - CSAMT conductor
 - CSAMT fault
 - CSAMT Boundary

87-2687

CSR Limited - MEDG			
BULGOBAC CREEK INTERPRETATION MAP CSAMT and Gravity			
SCALE: 1:5000	DATE: 4/3/2007		
DRAWN: PNG	REVR:	PLAN NO:	
CHECKED:			7612-10
APPROVED: PNG			

5 cm

901144



REFERENCE

- OUT LINE OR GREEK
- - - MAPPED BUT NOT CUT OUT
- U/S UPSTREAM
- D/S DOWNSTREAM

5 cm

87-2687

CSR LIMITED-MEDG

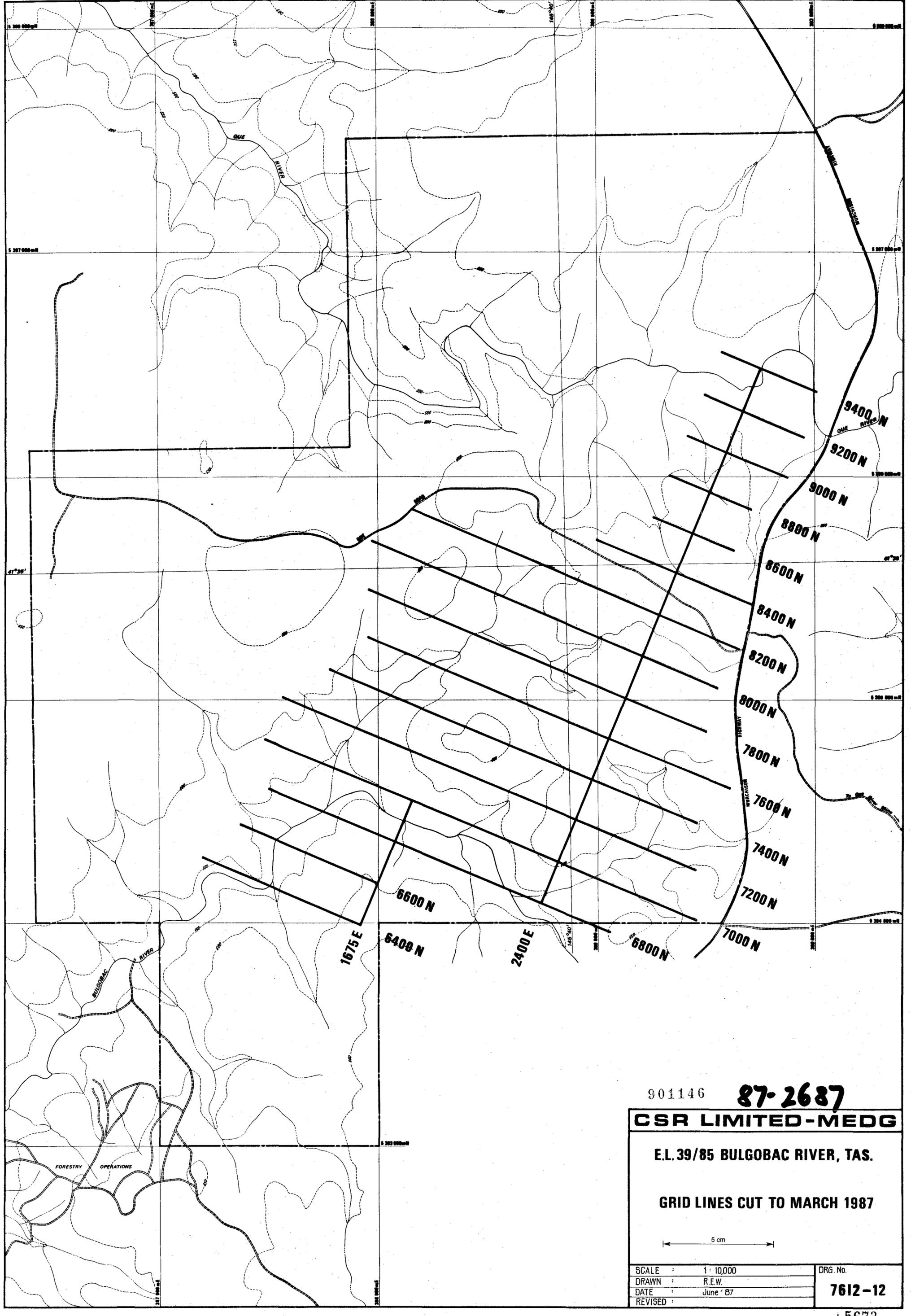
E.L. 39/85 BULGOBAC RIVER, TAS.

**RECONNAISSANCE MAPPING
PHASE
ACCESS AND CO-ORDINATES**

901145

SCALE	1 : 10,000
DRAWN	R.E.W.
DATE	JUNE '87
REVISED	

DRG. No.
7612-11

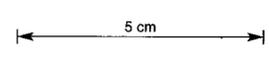


901146 **87-2687**

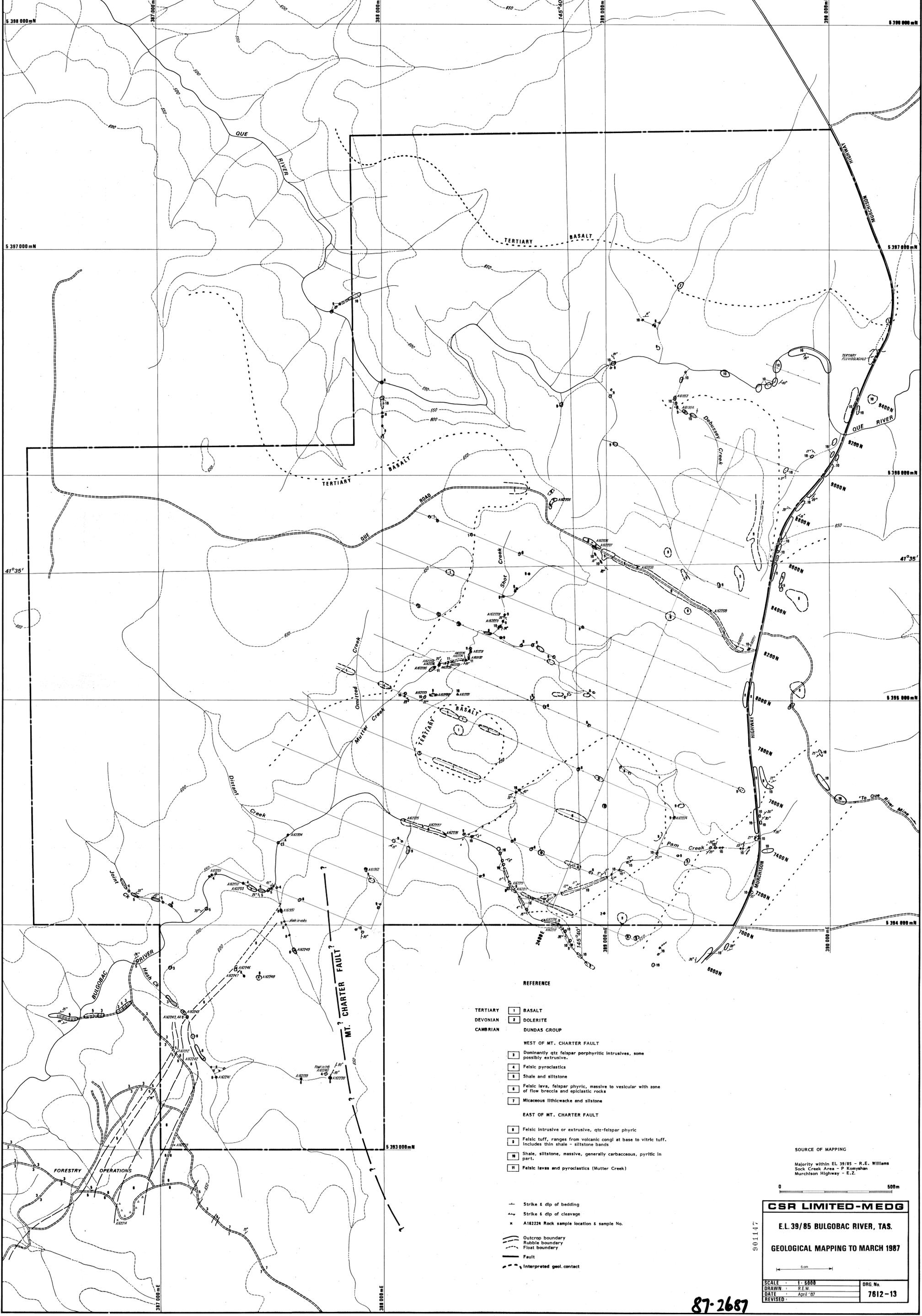
CSR LIMITED-MEDG

E.L. 39/85 BULGOBAC RIVER, TAS.

GRID LINES CUT TO MARCH 1987



SCALE :	1 : 10,000	DRG. No.
DRAWN :	R.E.W.	7612-12
DATE :	June '87	
REVISED :		



- REFERENCE**
- TERTIARY 1 BASALT
 - DEVONIAN 2 DOLERITE
 - CAMBRIAN 3 DUNDAS GROUP
- WEST OF MT. CHARTER FAULT**
- 4 Dominantly qtz felspar porphyritic intrusives, some possibly extrusive.
 - 5 Felsic pyroclastics
 - 6 Shale and siltstone
 - 7 Felsic lava, felspar phytic, massive to vesicular with zone of flow breccia and epiclastic rocks
 - 8 Micaceous lithicwacke and siltstone
- EAST OF MT. CHARTER FAULT**
- 9 Felsic intrusive or extrusive, qtz-felspar phytic
 - 10 Felsic tuff, ranges from volcanic congl at base to vitric tuff. Includes thin shale - siltstone bands
 - 11 Shale, siltstone, massive, generally carboaceous, pyritic in part.
 - 12 Felsic lavas and pyroclastics (Mutter Creek)

SOURCE OF MAPPING

Majority within EL 39/85 - R.E. Williams
 Sick Creek Area - P. Komyschan
 Murchison Highway - E.Z.



CSR LIMITED-MEDG

E.L. 39/85 BULGOBAC RIVER, TAS.

GEOLOGICAL MAPPING TO MARCH 1987

901147

SCALE 1:5000 DRG No. 7612-13
 DRAWN R.E.W.
 DATE April '87
 REVISED

87-2687