# BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

## RECORD



1980/52

# GRAVITY SURVEY ALONG TRAVERSES IN THE SOUTHWEST OF WESTERN AUSTRALIA, 1970 - OPERATIONAL REPORT

by

A.R. Fraser & W. Anfiloff

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## CONTENTS



## ILLUSTRATIONS

## SUMMARY

The Bureau of Mineral Resources, Geology and Geophysics (BMR) made gravity measurements along a number of traverses in the south-western part of Western Australia in 1970. The traverses were located across prominent Bouguer anomaly features revealed by the BMR reconnaissance helicopter gravity survey of 1969, as the objective was to provide detailed gravity information for assistance in the geological interpretation of these features.

The traverses, with station spacings of approximately 0.2, 0.4 or 0.8 km, were surveyed across greenstones in the Kalgoorlie, Southern Cross, and Ravensthorpe areas, basic granulites in the Fraser Range area, and granites and gneisses along the south coast. All traverses were optically levelled, and where possible, were straight and perpendicular to the trends of the particular features under investigation. In areas where dense scrub or rugged terrain prevented access, traverses were located along roads or tracks which crossed the features as close to the required direction as possible.

The operational details of the survey are described and the gravity and elevation data are presented as profiles. The interpretation of the gravity results is not discussed here.

## 1. INTRODUCTION

The Bureau of Mineral Resources, Geology and Geophysics (BMR) made gravity measurements along a number of traverses in the south-western part of Western Australia in 1970 (Plate 1). The main objective was to obtain more detailed gravity information on prominent Bouguer anomaly features revealed by the reconnaissance helicopter gravity survey by the BMR in 1969 (Fraser, 1974).

The traverses extended actoss Precambrian rocks of either the Archaean Yilgarn Block or the Proterozoic Albany-Fraser Province. All major Bouguer anomaly features investigated can be correlated with outcropping or subcropping rock masses, including greenstones of the Yilgarn Block and granulites, gneisses, or granites of the Albany-Fraser Province.

This report describes the operational details of the survey and presents the data for each traverse in profile form. The gravity results are discussed briefly in BMR (1972) and BMR (1974), and at greater length by Anfiloff (in prep.).

## 2. APPLICABILITY OF METHOD

The interpretation of gravity data is most reliable in areas where rock bodies of anomalous density crop out, as three parameters used in model studies can be accurately determined. These parameters are:

1. The bulk density of the anomalous rock body.
2. The depth of burial of the body.
3. The locations of the surface boundaries of the body.

In many parts of the West Australian Shield, all of these parameters can be determined. Parameter 1 can be determined from density measurements on unweathered surface samples. Parameter 2 is zero if the shield rocks are exposed, and negligibly small if, as in many areas of southwestern Australia, they are covered by only a thin veneer of Recent sediments or lateritic drift. Parameter 3 can be determined in areas where exposures are well defined.

Hence the gravity method is a potentially useful tool for investigating the subsurface extent of structures in the West Australian Shield.

## 3. SURVEY OPERATIONS

The survey statistics, details of traverses, and a summary of the survey procedure are given in Appendices 1, 2, and 4. Reference information is listed in Appendix 3.

### Planning of traverses

The main objective of the survey was to make gravity measurements at close spacing along traverses crossing particular Bouguer anomaly features indicated by the 1969 reconnaissance helicopter gravity survey. Ideally, traverses should have been straight and perpendicular to the trends of features under investigation; however, departures from this ideal were expected in areas where access would be severely hampered by dense scrub, rugged terrain, or cultivated land.

The following planning of procedures was adopted prior to the commencement of the survey to ensure that overall progress of the survey and adequate coverage of the individual Bouguer anomaly features would be satisfactory:

1. Straight, cross-country traverses, perpendicular to the features, were plotted on 1:250 000 Bouguer anomaly maps.
2. These traverses were transferred to 1:250 000 topographic maps.
3. Aerial photographs were examined to assess the likely access problems associated with each traverse.
4. Traverse locations were adjusted to follow roads or tracks shown on the topographic maps in areas where access appeared difficult.

5. The revised traverse locations were transferred from the topographic maps back on to the regional Bouguer anomaly maps to check that no serious loss of coverage of the Bouguer anomaly features would result from the adjustment of the traverse positions.

Traverses 2, 15, 17, and 18 (Plate 1) were repositioned to follow roads. The other traverses were as originally proposed although access difficulties were anticipated for some of them.

## Problems of access

In some areas access by vehicle was prevented by dense scrub, rugged terrain, or saltpans, and traverses were completed partly or totally on foot (Traverses 1, 2A, 3, 4, 5, and 11). In other areas, traverses were relocated along roads and tracks which crossed Bouguer anomaly features close to the required direction (Traverses 8, 9, 10, 12, 13, and 14).

## Gravity control

Gravity control on the survey was maintained by tying each traverse to an isogal station (Barlow, 1970). Absolute gravity values at isogal stations are considered accurate to better than $\pm$ 0.1 mGal. The isogal stations to which the traverses were tied are listed in Appendix 2. Gravity meter drift control was maintained by repeat readings at certain stations every 2-3 hours.

## Elevation control

All traverses were optically levelled by two surveying parties working under contract to the then Department of the Interior. Elevation control was maintained by tying to existing benchmarks located along road traverses previously levelled by the Department of the Interior. The elevation ties were optically levelled except for ties from Traverses 1 and 11 to benchmarks, which were made barometrically. The internal elevation error for each gravity traverse does not exceed $\pm$ 1 m for every 50 km surveyed, and the external elevation error for any traverse does not exceed $\pm$ 3 m.

Horizontal control

All gravity stations were plotted on 1:250 000 topographic maps and where possible on aerial photographs. They were plotted at 1:63 360 scale later. Traverses were surveyed using chain and compass where the traverses were not on roads shown on topographic maps. For road traverses shown on maps, bearings were not taken and station intervals were measured either by chaining or by calibrated vehicle speedometer.

Rock samples

A considerable number of rock smaples were collected for identificaion and density measurement along Traverses 2, 3, 4, and 15, and a few samples were collected along Traverses 1, 5, 8, and 9. No samples were collected along Traverses 11 to 14, 17, and 18 because of poor exposure of crystalline rocks. At each site an effort was made to obtain a representative selection of unweathered rocks in situ, but 'floating' samples were collected at some sites where exposures were poor.

## 4. RESULTS

Traverse plans showing station locations and profiles of elevation, observed gravity, and Bouguer anomaly values for each traverse are presented in Plates 2 to 12.

Among the more interesting features of the Bouguer anomaly profiles are the intense local highs observed on Traverses 4, 9, 10, and 18, the unexpectedly large amplitude of the gravity high in ESPERANCE 1:250 000 Sheet area (Traverse 1) and the notable smoothness of the gravity profile across the Fraser Range (Traverse 2A).

A detailed analysis of the gravity results and their interpretation in terms of geological significance are given by Anfiloff (in prep.).

## 5. REFERENCES

ANFILOFF, W., in prep. - Gravity survey along traverses in the southwest of Western Australia, 1970. Interpretation report. Bur. Miner. Resour. Aust. Rec. (in prep.).

BARLOW, B.C., 1970 - National report on gravity in Australia, July 1965 to June 1970. Bur. Miner. Resour. Aust. Rec. 1970/62 (unpubl.).

BMR, 1972 - Geophysical Branch Summary of Activities, 1972. Bur Miner. Resour. Aust. Rec. 1972/117 (unpubl.).

BMR, 1974 - Geophysical Branch Summary of Activities, 1974. Bur. Miner. Resour. Aust. Rec. 1974/174 (unpubl.).

FRASER, A.R., 1974 - Reconnaissance helicopter gravity survey of the southwest of Western Australia, 1969. Bur. Miner. Resour. Aust. Rec. 1974/26 (unpubl.).

# APPENDIX I

## SURVEY STATISTICS

**Personnel:** A.R. Fraser, Party Leader
W. Anfiloff, Geophysicist)
G.R. Pettifer, " ) part-time
I. Zadoroznyj, " ) 1 month each
M.J. Ward, Field Hand

**Surveyors:** M.M. Fisher and Associates ) contracted to
Steffanoni, Ewing and Cruickshank) Dept. of the Interior

**Equipment:** 'Sharpe' Gravity Meter, Ser. No. S145
4 'Mechanism' Microbarometers

**Vehicles:** 1 International C1300 Utility
1 Landrover Utility

**Period of Survey:** 2 June to 11 September 1970.

**Days lost due to bad weather:** 3 days.

**Days lost, other reasons:** 3 days

## APPENDIX 2

## DETAILS OF TRAVERSES

| Traverse | Station numbers | Isogal station tied | 1:250 000 areas | Description | Station interval (km) | Number of stations | Length of traverse(km) |
|---|---|---|---|---|---|---|---|
| 1 | 0005-0081 | 6490 0113 | Esperance | Cross country | 0.4023 | 77 | 30.6 |
| 2 | 0501-0639, 0650-0774 | 6491 9123 | Balladonia, Norseman | Road | 0.8046 | 264 | 211.6 |
| 2A | 0639-0649, 0775-0876 | 6491 9123 | Norseman | Cross country | 0.8046 0.2011, 0.1006 | 113 | 24.1 |
| 3 | 1001-1133 | 6491 9123 | Widgiemooltha | Tracks, cross country | 0.8046, 0.4023 | 133 | 53.1 |
| 4 | 1501-1695 | 6491 9123 | Widgiemooltha | Tracks, cross country | 0.4023 | 195 | 79.9 |
| 5 | 2001-2243 | 6491 0114 | Widgiemooltha | Tracks, cross country | 0.4023 | 243 | 98.2 |
| 6 | not surveyed | | | | | | |
| 7 | not surveyed | | | | | | |
| 8 | 3501-3570 | 6491 0114 | Kurnalpi | Tracks | 0.8046 | 70 | 56.3 |
| 8A | 3601-3647 | 6491 0114 | Kurnalpi | Tracks | 0.8046 | 47 | 37.0 |
| 9 | 4001-4170 | 6491 0114 | Kurnalpi | Road, tracks | 0.8046 | 170 | 136.8 |
| 10 | 4501-4638 | 6491 0114 | Kurnalpi | Tracks | 0.4023 | 138 | 56.3 |
| 11 | 5001-5086, 5101-5120 | 6491 9094 | Southern Cross | Tracks, cross country | 0.8046, 0.4023 | 106 | 49.9 |
| 12 | 5501-5551, 6901-6908 | 6491 9094 | Hyden | Tracks | 0.8046 | 59 | 48.3 |
| 13 | 6001-6062 | 6491 9094 | Hyden | Tracks | 0.4023 | 62 | 24.1 |
| 14 | 6501-6557, 6601-6641, 6702-6734 | 6491 9094 | Hyden | Tracks | 0.4023 | 131 | 51.5 |
| 15 | 7001-7143 | 6491 0113 | Newdegate, Ravensthorpe | Road | 0.8046 | 143 | 114.3 |
| 16 | not surveyed | | | | | | |
| 17 | 8003-8100 | 6491 9129 | Newdegate, Bremer Bay | Road | 0.8046, 0.4023 | 98 | 67.6 |
| 18 | 8501-8611 | 5099 9918 | Mt Barker, Albany | Road | 0.8046 | 111 | 88.5 |
| | | | | | Totals | 2160 | 1227.1 |

## APPENDIX 3

## REFERENCE INFORMATION

### Geological

Tectonic Map of Australia, 1960 - southwest quadrant

Geological Map of Western Australia (1966 Edition)

1:250 000 Geological Series Maps - Widgiemooltha and Kurnalpi

Metallogenic Map of Australia

### Geophysical

1:2 534 400 map showing Bouguer anomalies from reconnaissance gravity survey (Fraser, 1974).

1:250 000 Bouguer anomaly maps from reconnaissance gravity survey

1:2 534 400 magnetic map of Australia - southwest quadrant.

### Planimetric

1:250 000 topographic maps of the following areas:- Albany, Mount Barker, Newdegate, Bremer Bay, Ravensthorpe, Esperance, Balladonia, Norseman, Widgiemooltha, Kurnalpi, Southern Cross and Hyden.

### Photographs

Aerial photographs along each traverse

### Planning maps

A photo-centre compilation of each map sheet.

### Station descriptions and elevations

Station descriptions and elevations of Department of the Interior benchmarks located near traverses.

### Gravity control stations

Station descriptions and observed gravity values for the following isogal stations: Southern Cross, Kalgoorlie, Norseman, Perth (including calibration range) Albany, Bremer Bay, Esperance.

## APPENDIX 4

## SUMMARY OF SURVEY PROCEDURE

### Gravity Control

Gravity meter used on survey: Sharpe Ser. No. S145

Calibration range: Perth (6091 0117, Hazelmere - 6091 0317, Helena Valley)

Observed gravity interval: 53.98 mGal (Feb. 1963)

Dates of calibration; values obtained: 4 June, 1970; 510.6 sc.div.
9 September, 1970; 510.1 sc.div.

Calibration factor: 0.10577 $\pm$ 0.00006 mGal/sc.div.

Isogal stations tied to: Southern Cross, Kalgoorlie, Norseman, Albany, Bremer Bay, Esperance

Method of drift control: repeat readings at base stations every 2-3 hours

### Elevation control

Method of levelling: optical

Control points: Department of the Interior benchmarks

Tolerance: 1 m for every 50 km surveyed

### Horizontal control

Method of positioning: plotting on topographic maps and aerial photos

Measurement of station interval: vehicle speedometer (road traverses)
chaining (cross-country traverses)

### Computation

Density used for Bouguer corrections: 2.2 gm/cc

Terrain corrections: not applied

### Reference

Survey number: 7020

BMR file number: 1970/34

# SOUTHWEST WESTERN AUSTRALIA
# DETAIL GRAVITY SURVEY, 1970
# PLATE 1, TRAVERSE LOCATIONS AND BOUGUER ANOMALY CONTOURS

LEGEND

18 — No. of gravity traverse

-40 to -30 — Bouguer Anomaly in milligals ($\rho = 2{\cdot}2\ t/m^3$)

▲ — Primary Isogal Station

— — — Yandanooka — Cape Riche Lineament

50 0 100 200 KILOMETRES

LOCATION DIAGRAM

WA NT QLD SA NSW VIC



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WA/B2-41-1

Hill River Green Head Moora Watheroo Bencubbin Jackson Kalgoorlie Kurnalpi Cundeelee

Perth Kellerberrin Southern Cross Boorabbin Widgemooltha Zanthus

PERTH (CR) Pinjarra Corrigin Quairading Hyden Merredin Lake Johnston Norseman Balladonia

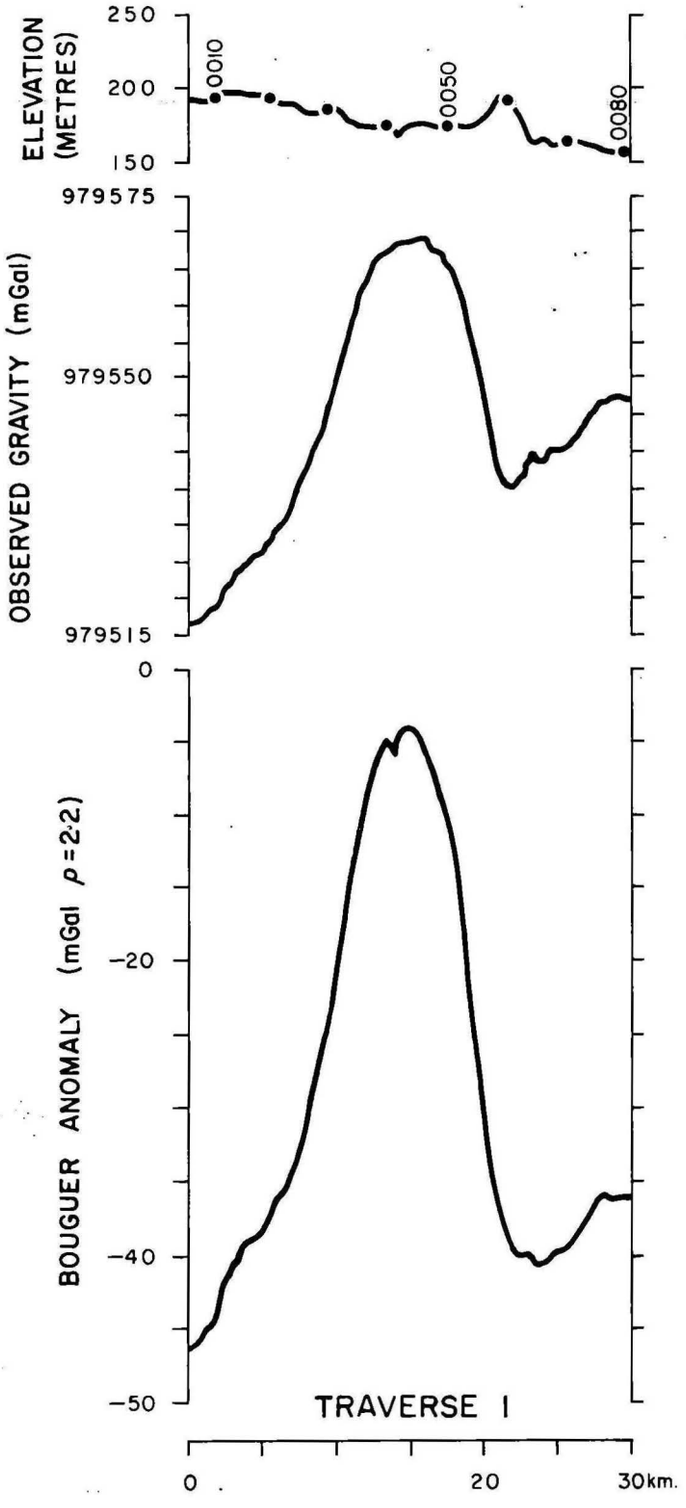
Busselton Collie Dumbleyung Newdegate Ravensthorpe Esperance Malcolm

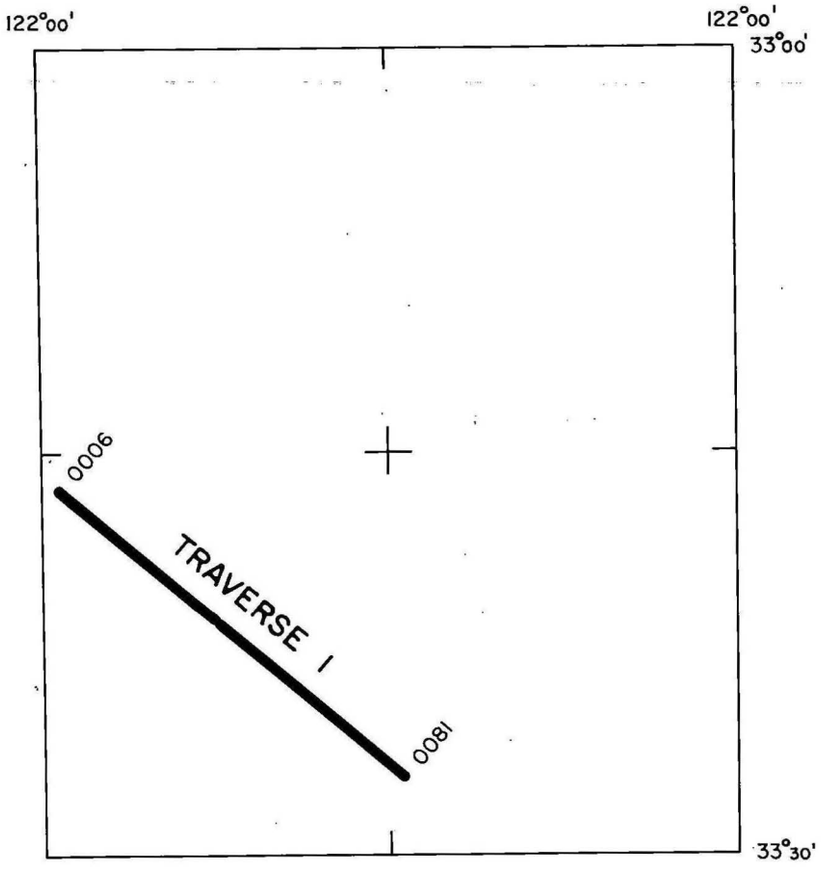
Augusta Pemberton Mount Barker Bremer Bay Mondrain Island Cape Arid

Irwin Inlet Albany

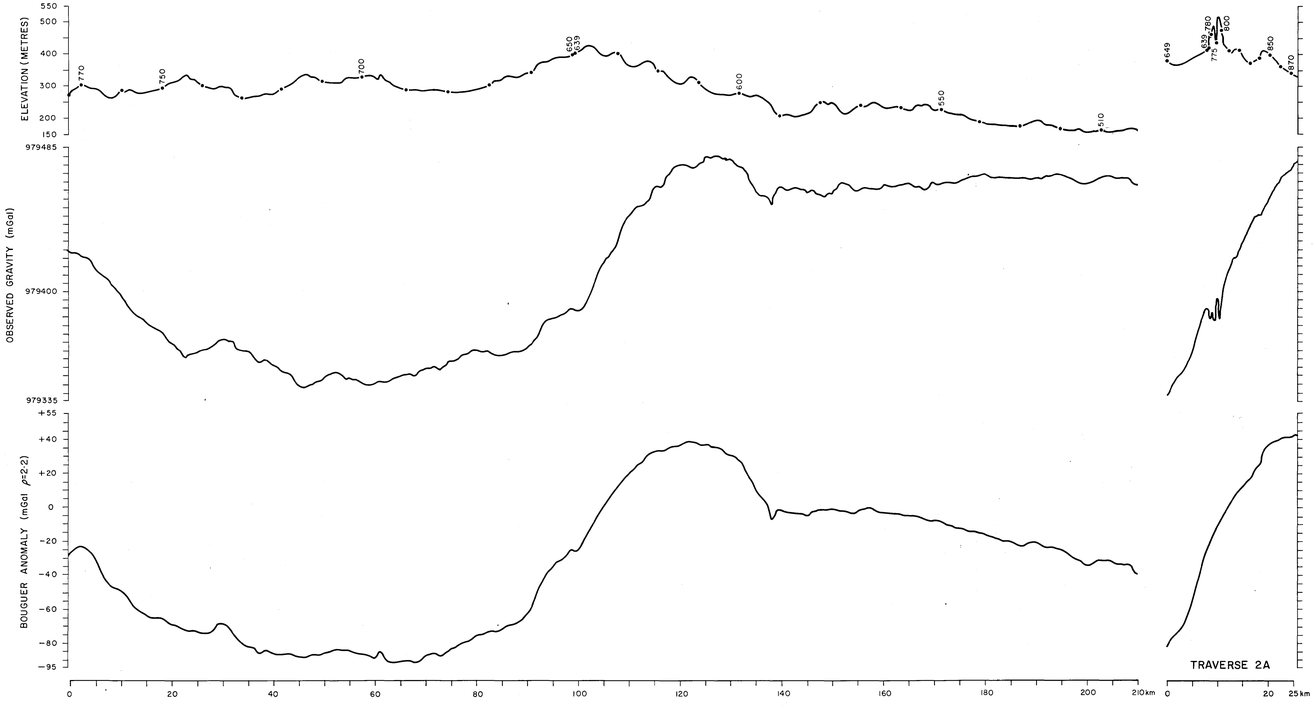
MT MONGER MT SHORT DOUBTFUL ISLAND BAY CAPE RICHE LOOKOUT POINT BALD ISLAND DUKE OF ORLEANS BAY Johnston Lakes

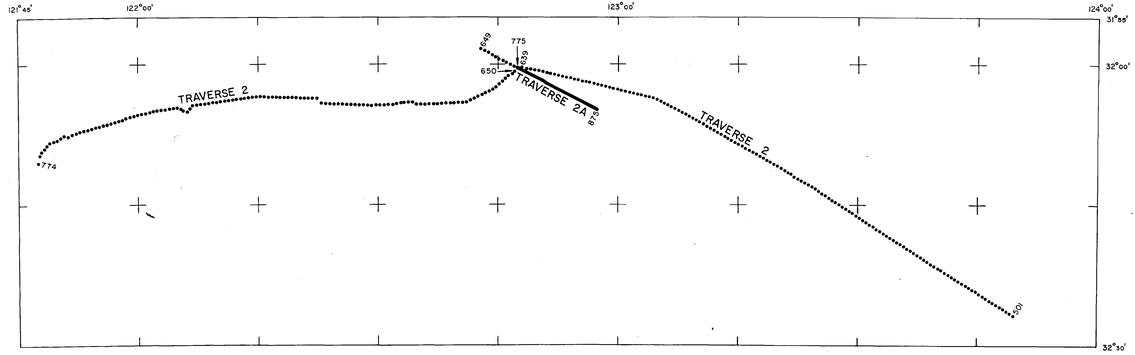
114° 117° 120° 123° 30° 33° 36°




# PLATE 2, TRAVERSE 1. LOCATION AND PROFILES




# PLATE 3, TRAVERSES 2 AND 2A LOCATIONS AND PROFILES



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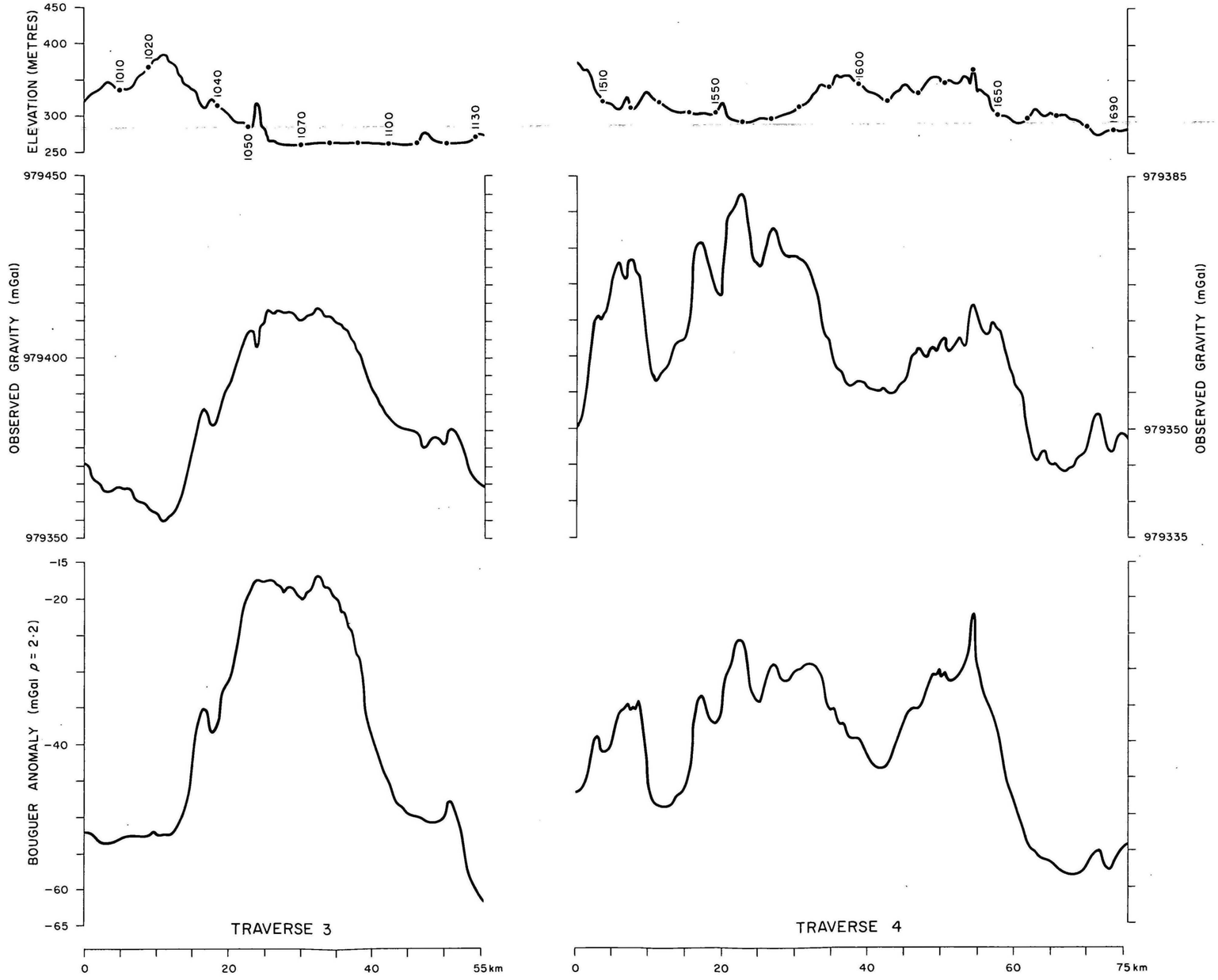


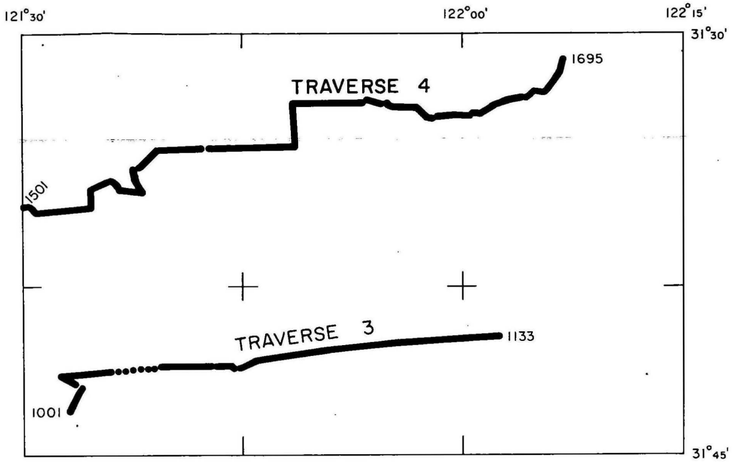


# PLATE 4, TRAVERSES 3 AND 4 LOCATIONS AND PROFILES



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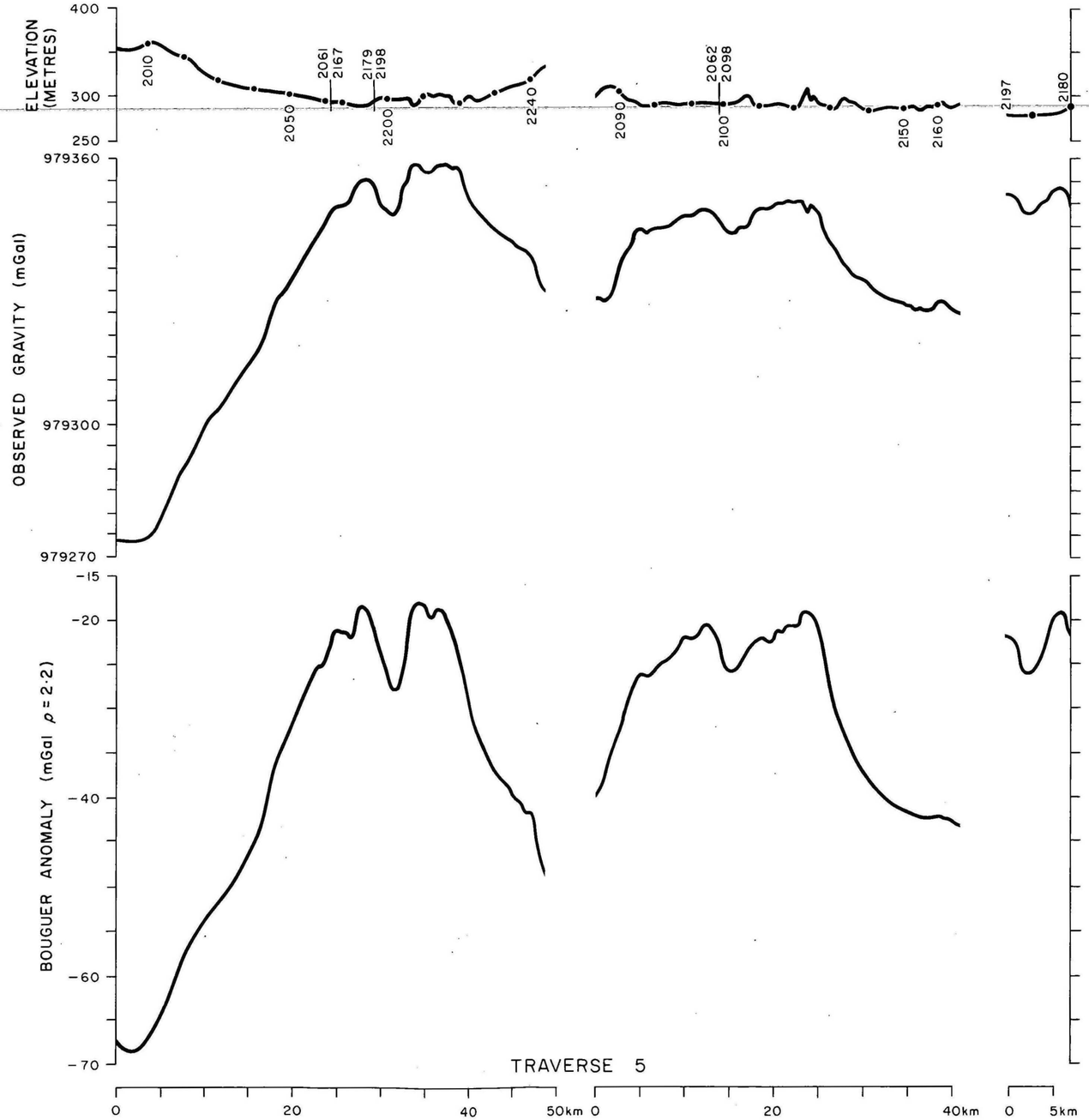
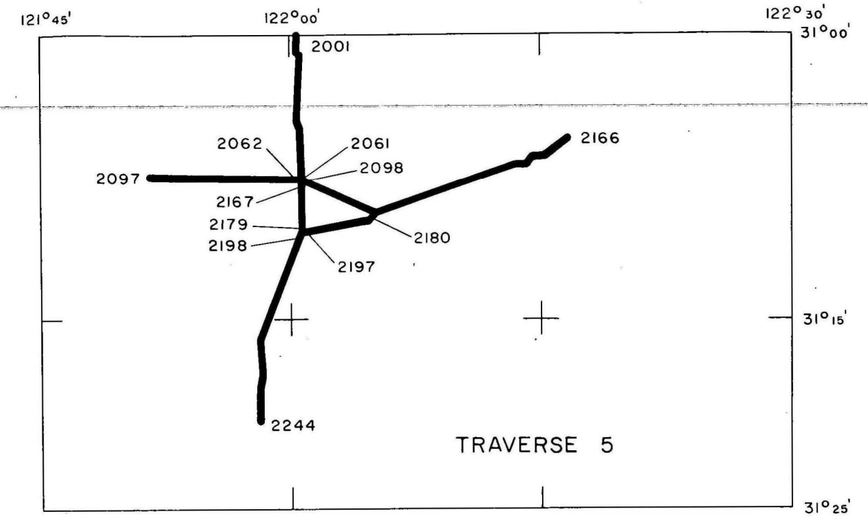
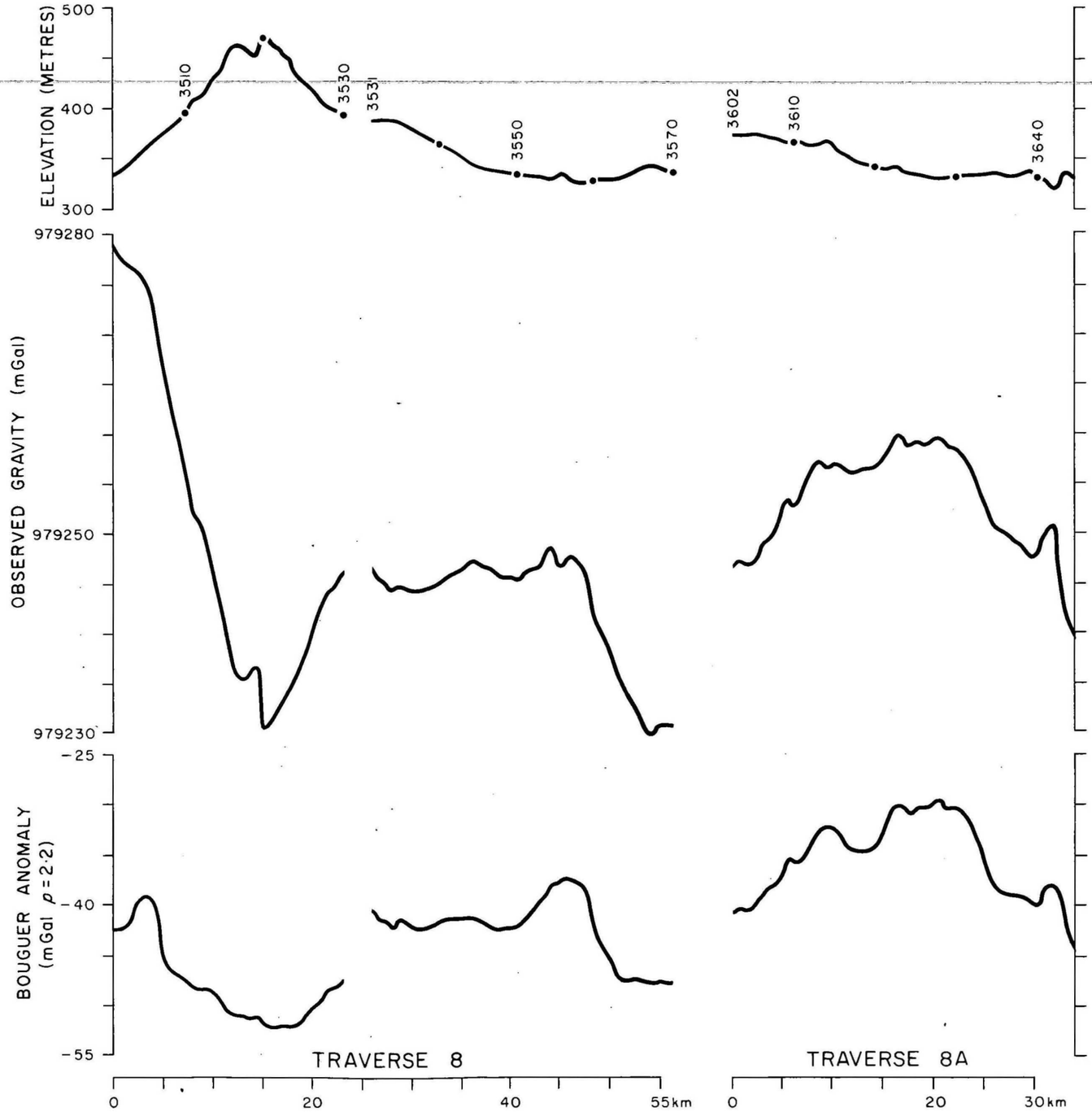
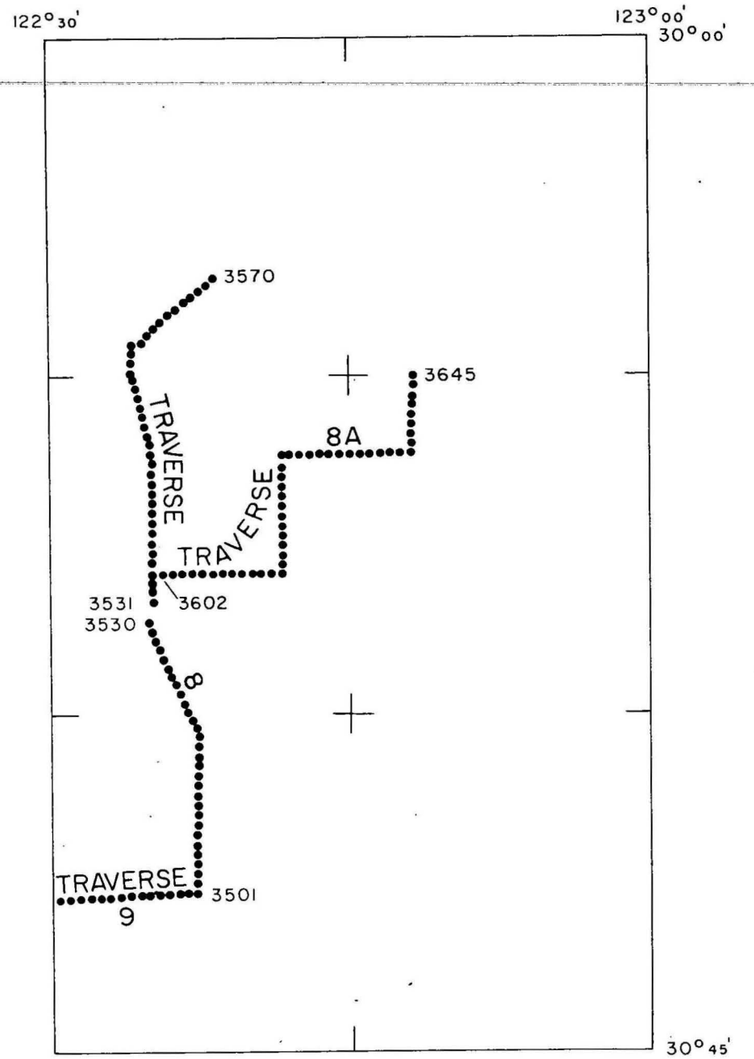


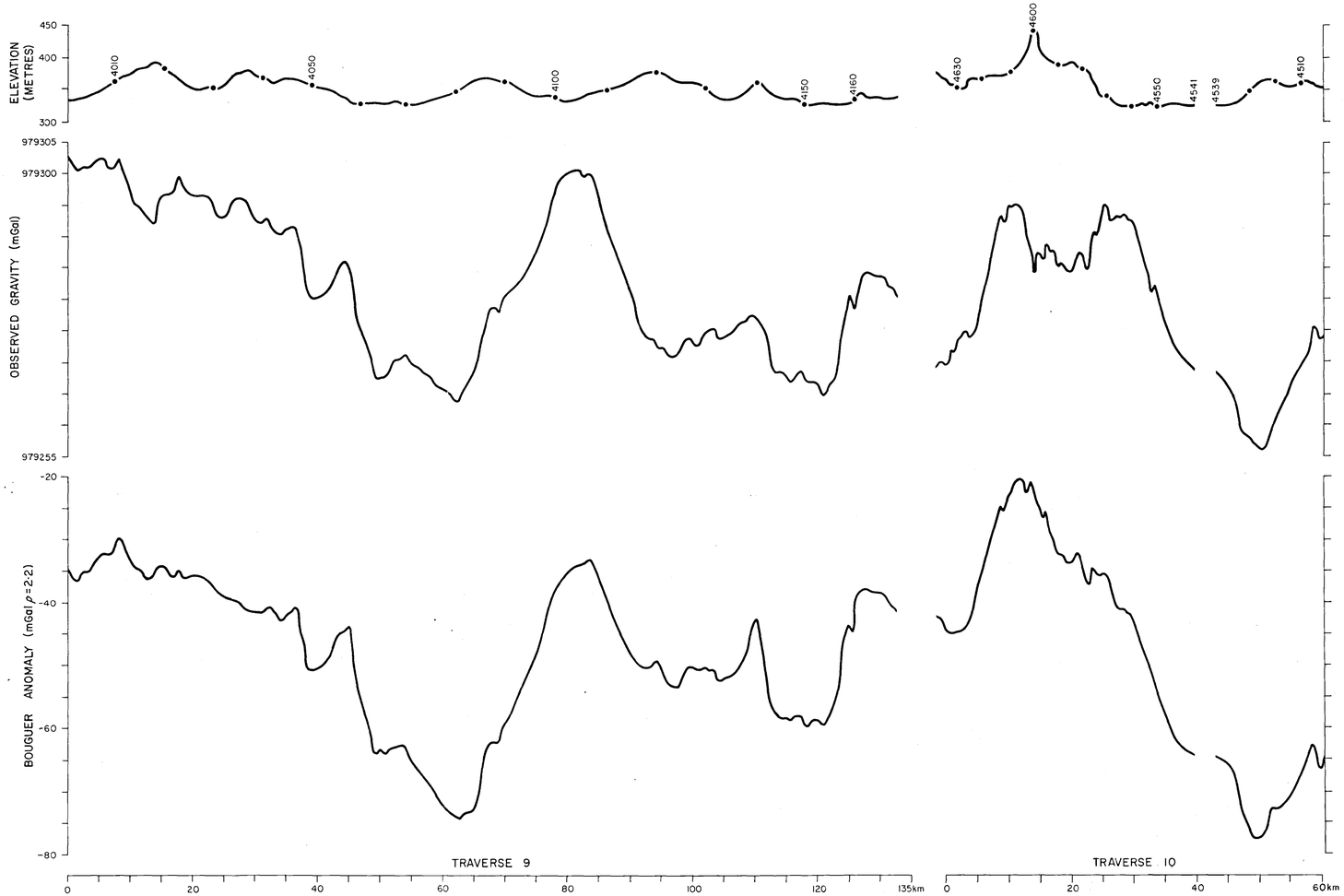



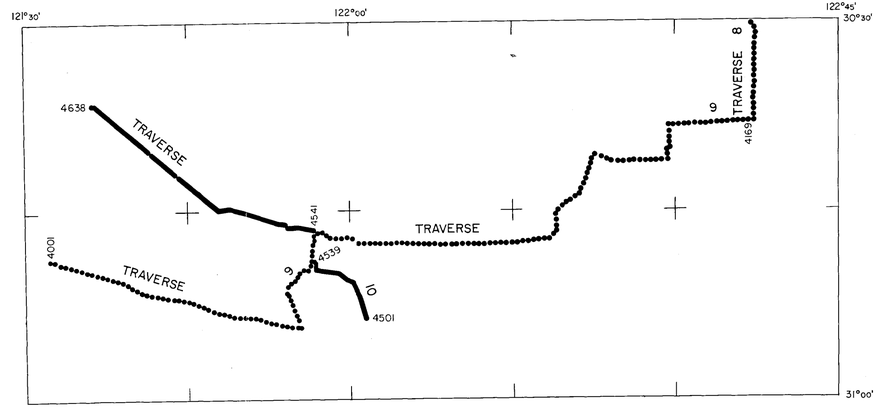

# PLATE 5, TRAVERSE 5
# LOCATION AND PROFILES




# PLATE 6, TRAVERSES 8 AND 8A LOCATIONS AND PROFILES




# PLATE 7, TRAVERSES 9 AND 10 LOCATIONS AND PROFILES



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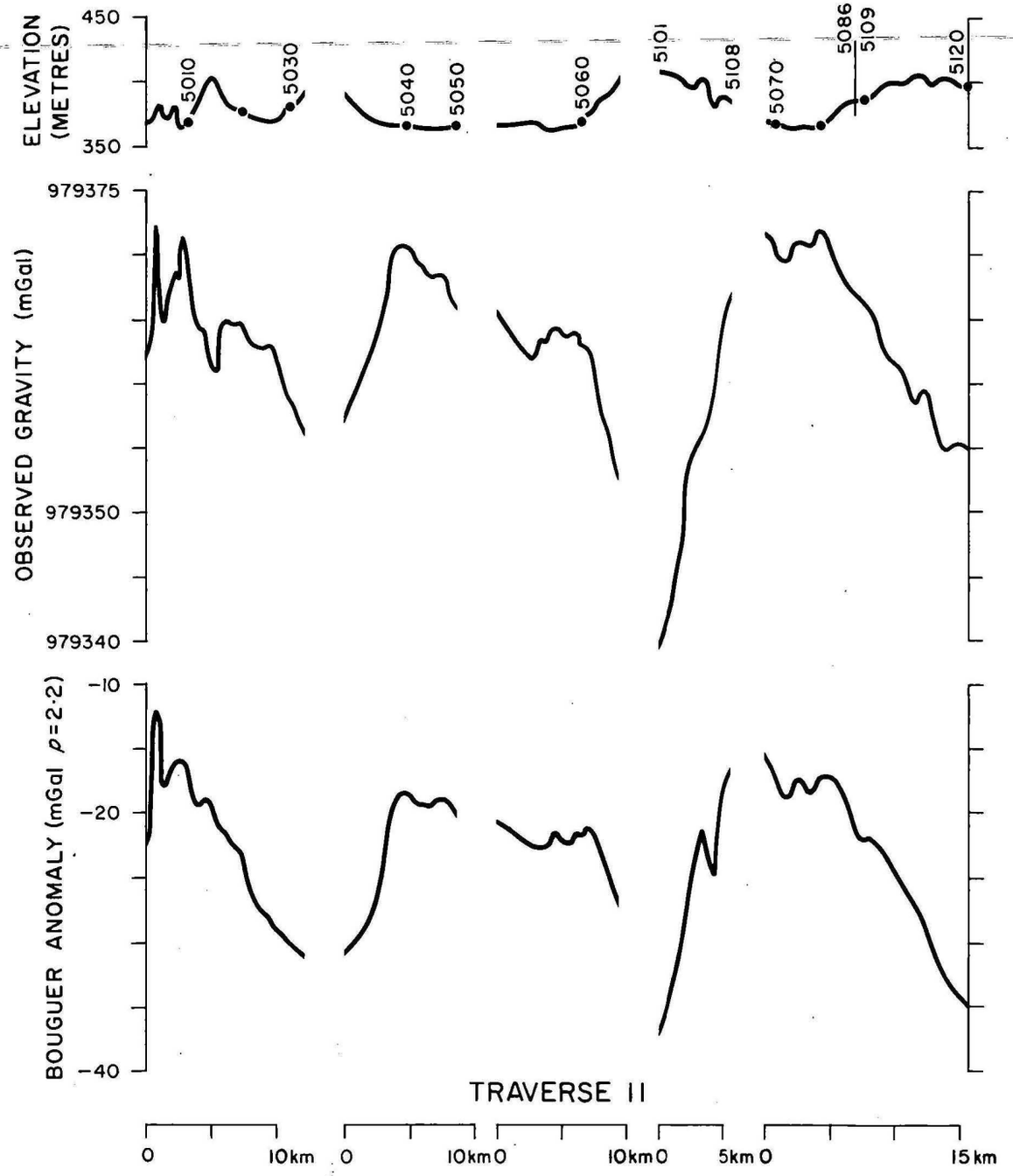
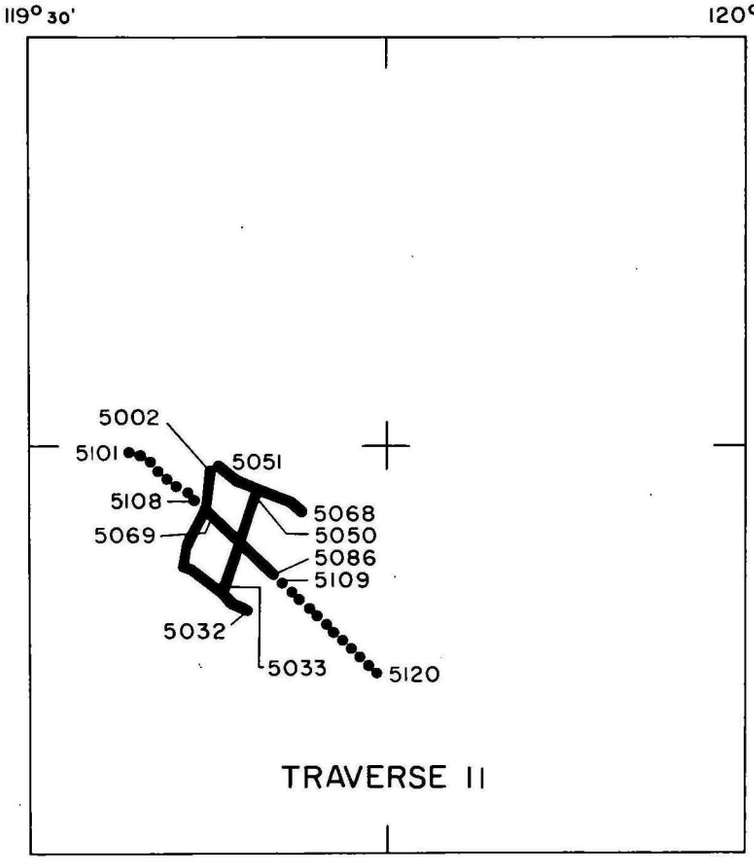
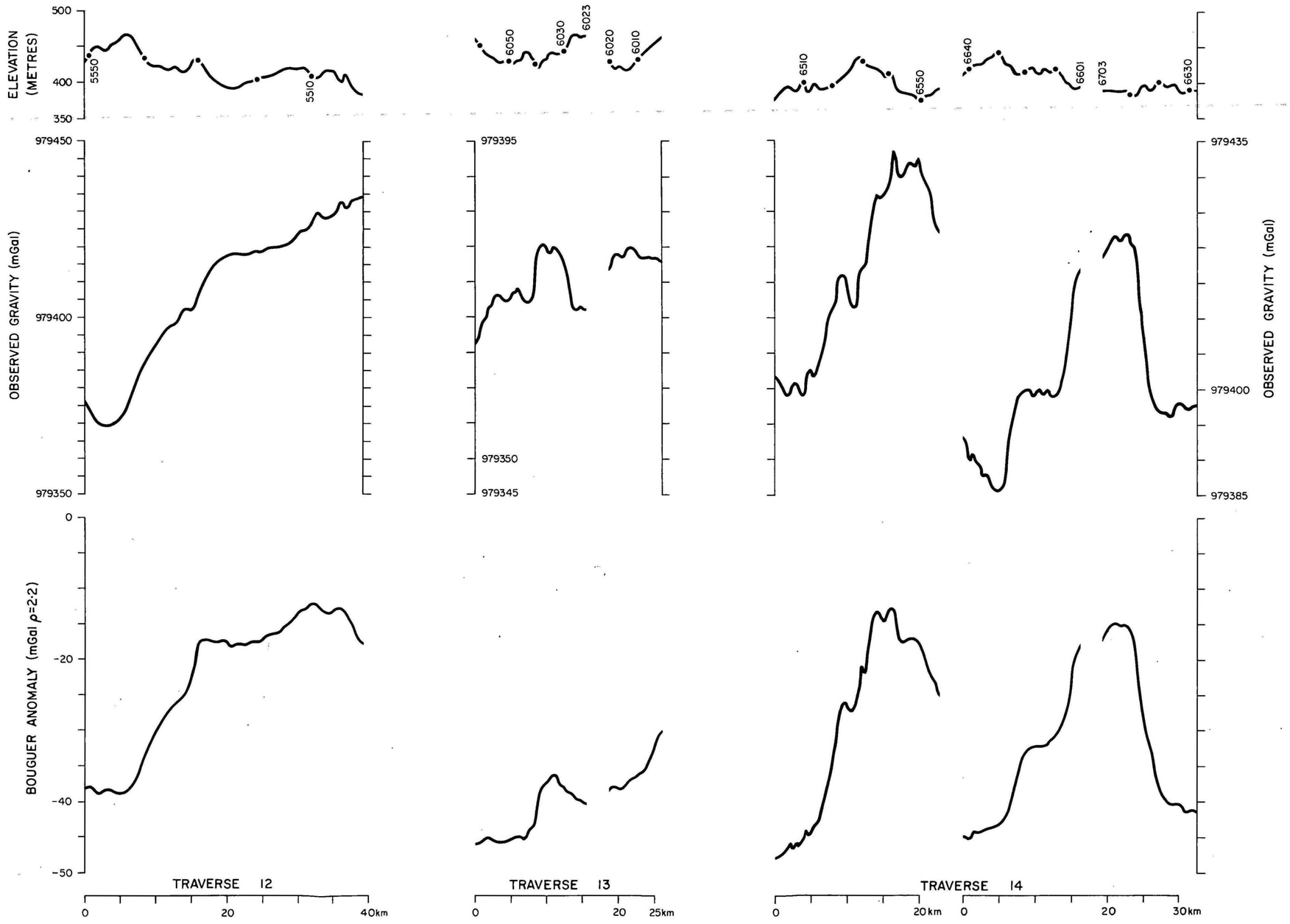
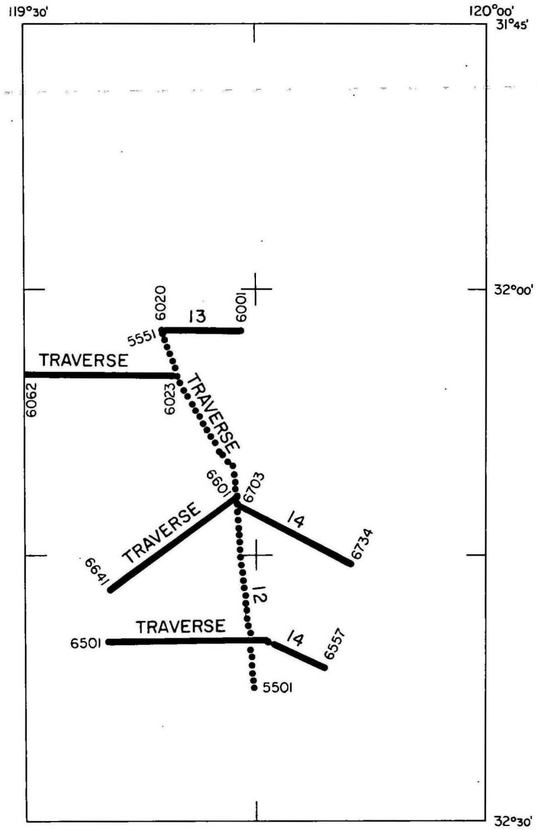



# PLATE 8, TRAVERSE 11 LOCATION AND PROFILES




# PLATE 9, TRAVERSES 12,13 AND 14 LOCATIONS AND PROFILES



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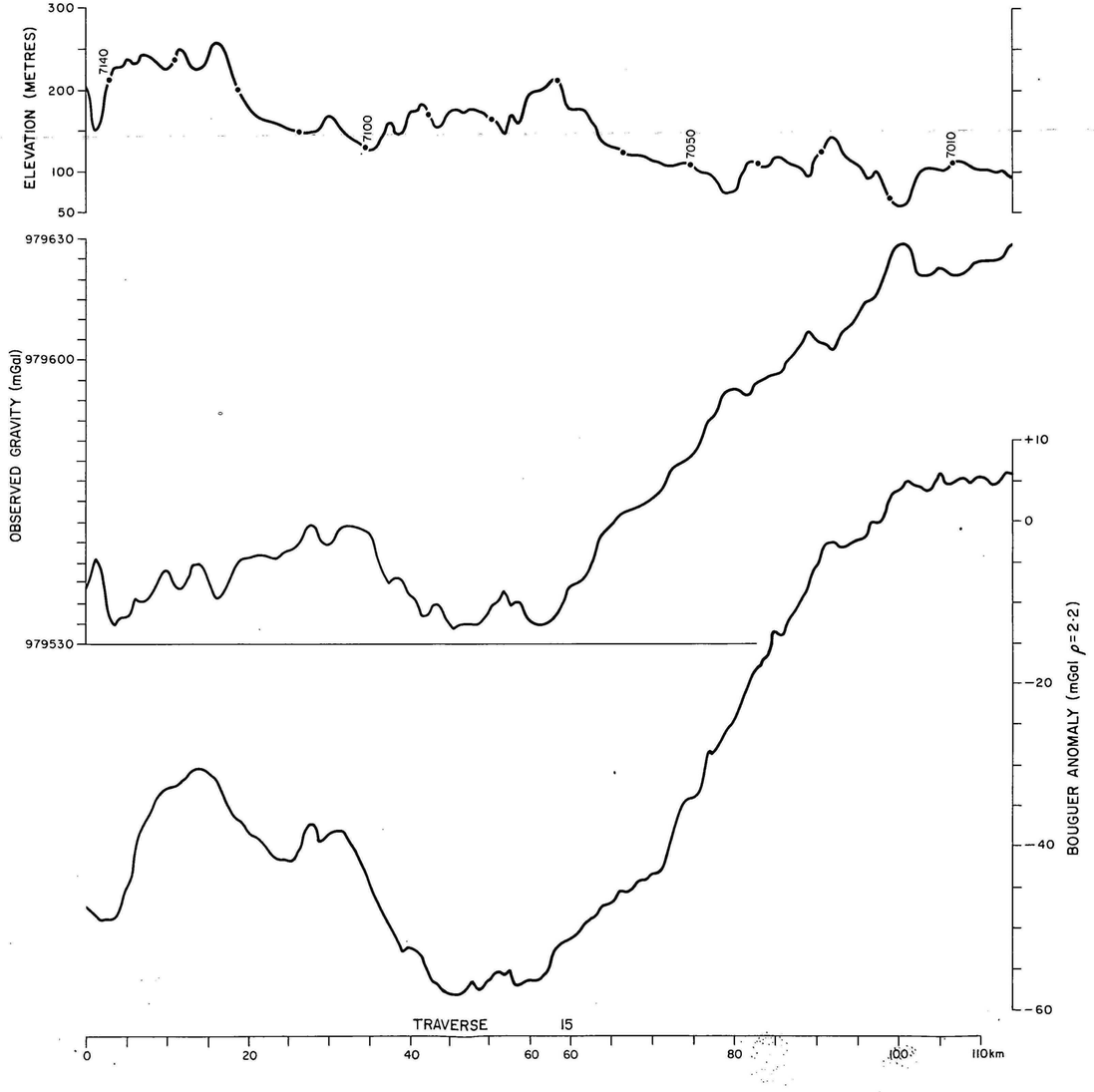
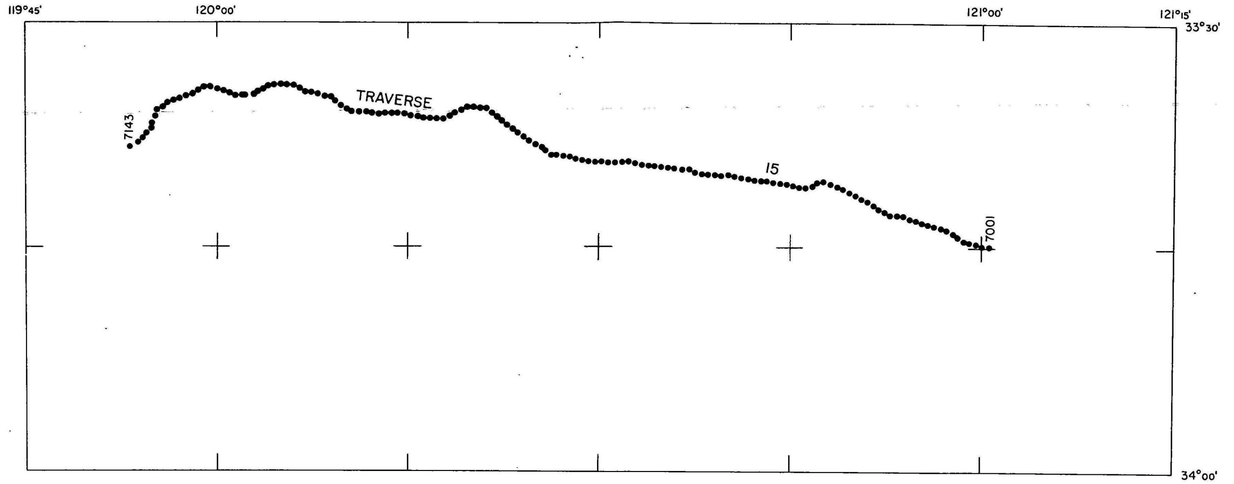
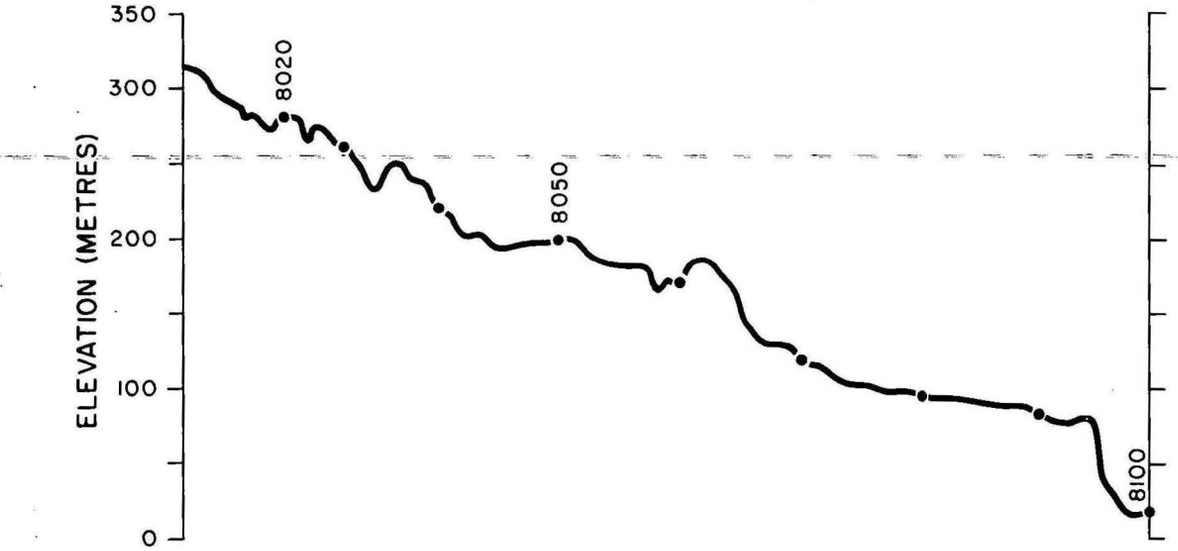
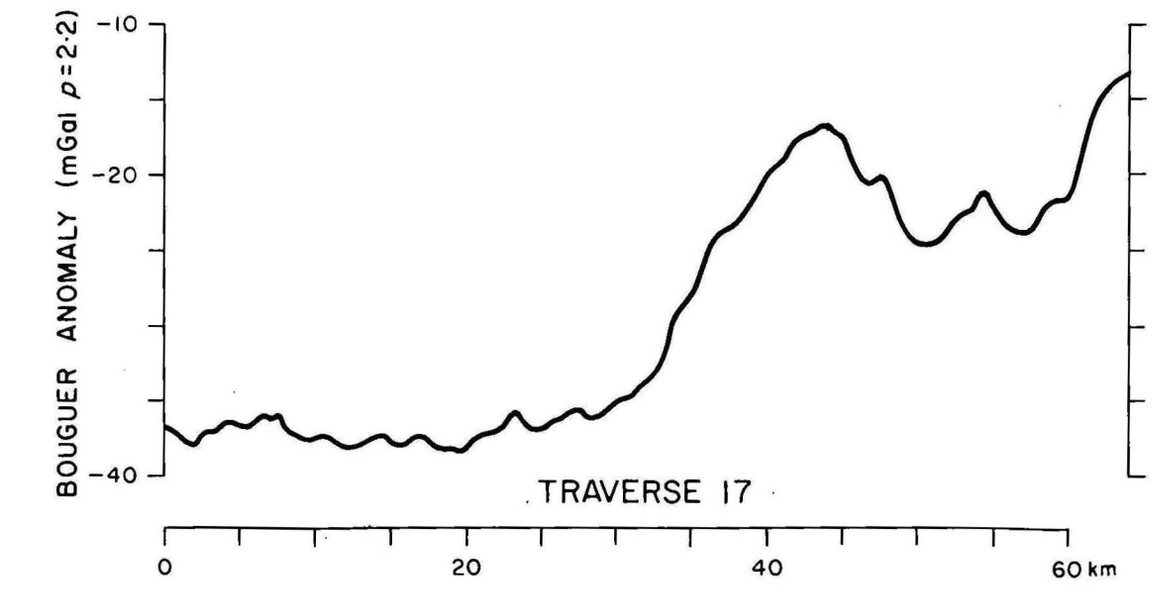


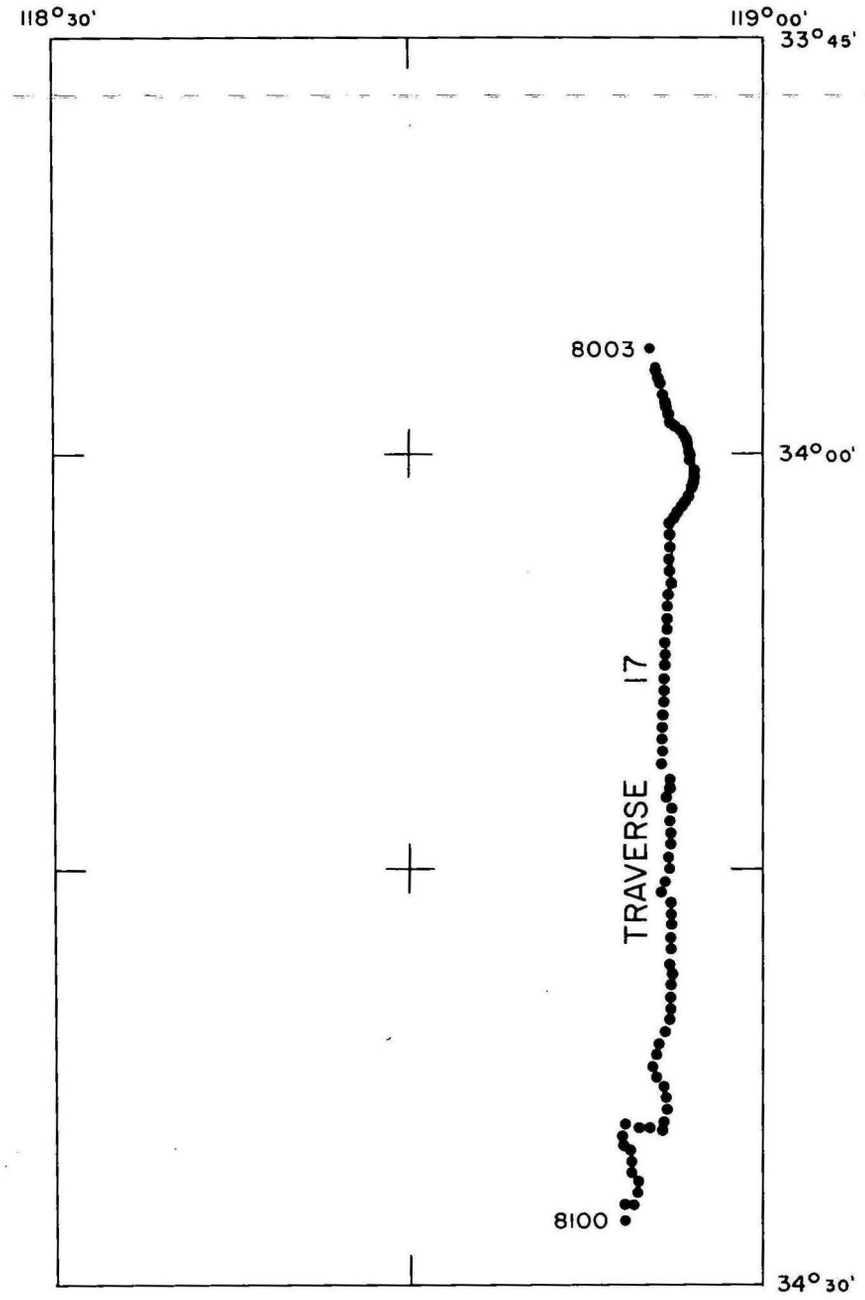




# PLATE 10, TRAVERSE 15
# LOCATION AND PROFILES

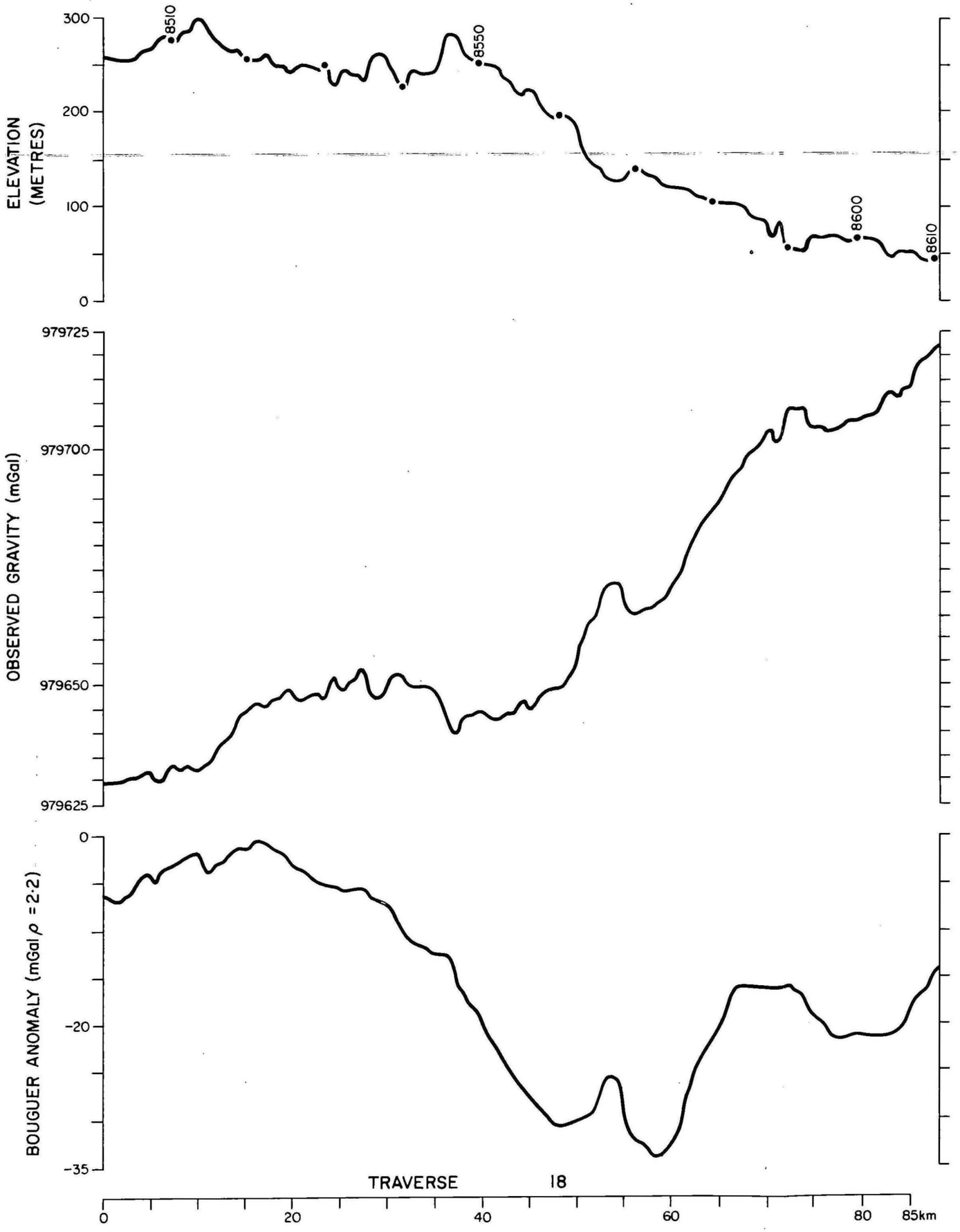


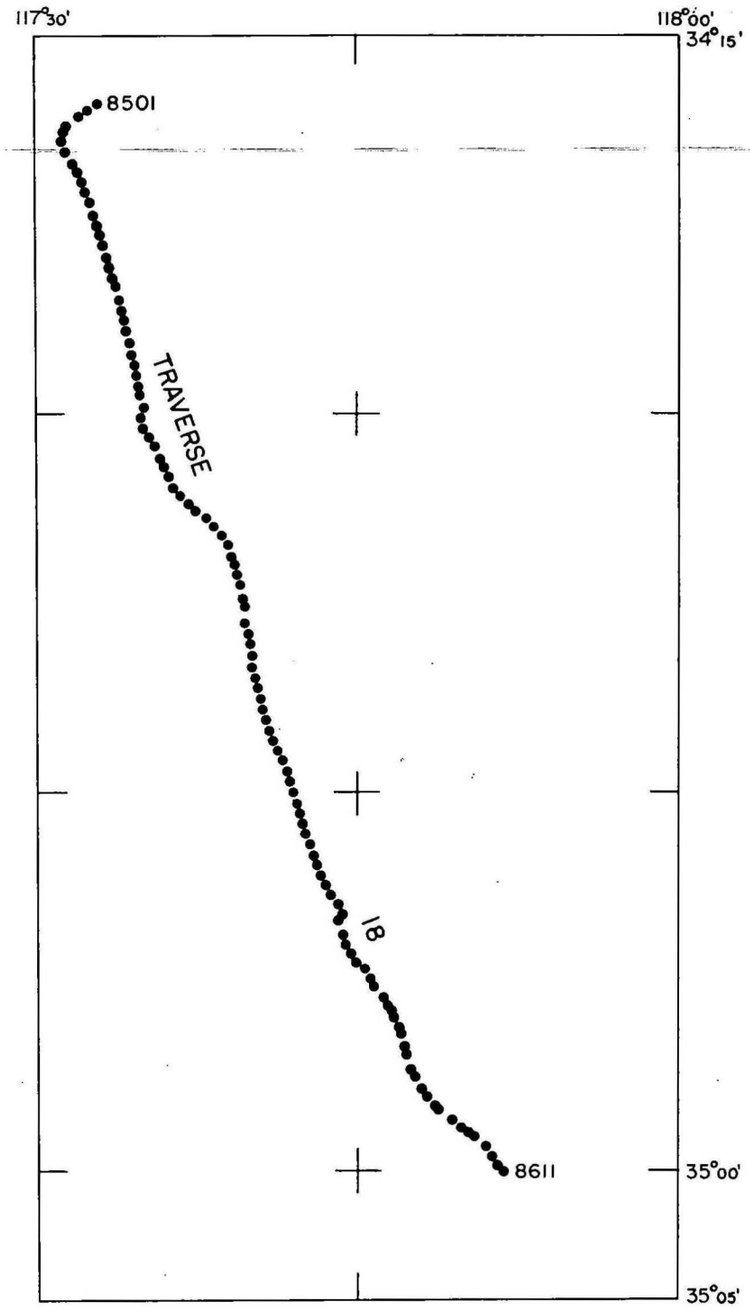





# PLATE 11, TRAVERSE 17 LOCATION AND PROFILES




# PLATE 12, TRAVERSE 18 LOCATION AND PROFILES