DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept.Bk.No. 81/65

GRAVITY SURVEY OF THE ST. KILDA SALTFIELDS.

GEOLOGICAL SURVEY

by

D. IVIC

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Department of Mines and Energy
South Australia

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GRAVITY SURVEY OF THE ST. KILDA SALTFIELDS

ABSTRACT

A detailed gravity survey in the St. Kilda area in the Northern Adelaide Plains of South Australia has indicated the existence of a Tertiary paleochannel incised into Cambrian-Precambrian bedrock. The northerly trending depression is difficult to correlate to bedrock depressions in the Port Gawler area to the north due to the limited area of gravity coverage. The paleochannel averages 1 km in width and may be of interest in terms of underground gas storage if size, reservoir and seal conditions are suitable.

A bedrock high adjacent to the coast appears to be laterally offset approximately 5 km north of St. Kilda which may be caused by the presence of the Redbanks Fault in the area. A follow-up detailed gravity survey with optical levelling and seismic control would be required to define the geometry of the paleochannel and its potential correlation to bedrock depressions further north.

INTRODUCTION

During the past five years a number of geophysical surveys and drilling programmes have been carried out over the Northern Adelaide Plains of South Australia in the search for potential underground gas storage targets. The history of exploration leading up to the present investigations in the Port Gawler - St. Kilda area (Fig. 1) are contained reports by Cockshell (1980 a,b). The storage targets in this area are Tertiary paleochannels incised into Cambrian-Precambrian bedrock similar to the paleochannel previously detected at Port Gawler.

The paleochannel at Port Gawler is approximately 1600 m wide and extents northeastward for about 1.5 km where it appears to terminate against a north-south bedrock ridge. The onshore size of the channel and the poorly completed drillhole at Port Gawler which allows hydraulic communication between the deep saline aquifers make this area unfavourable as a storage target. It was the aim of this gravity survey to define bedrock configuration south of Port Gawler to search for other potential Tertiary paleochannels.

SURVEY PROCEDURE

During January 1981 a detailed gravity survey was conducted over the ICI Saltfields between St. Kilda and Pt. Gawler. All gravity readings were taken along levees separating salt pans. Throughout the survey a Sharpe gravimeter (model 201) was used which had a calibration constant of 0.100. The 298 observed gravity values derived from the survey are stored on the State gravity file 81A1. The location of the gravity stations is shown in Fig. 2.

A spacing of 200 m was used between most stations but many were located at levee junctions, bench marks and 79A1 survey stations for convenience of locating and elevation and gravity control. Distances between stations were measured with a pedometer which has an accuracy of ±20 cm. The stations were plotted onto 1:10 000 scale orthophotographs from which Northing and Easting co-ordinates were obtained. These co-ordinates were converted to latitudes and longitudes using the Cyber computer. The accuracy of station positioning is ±10 m.

Elevations were obtained from orthophotograph spot heights, Bench Marks and ICI Temporary Bench Marks. Linear interpolation was used to obtain elevations for stations between levelled points because the flat-lying nature of the area would suggest that the interpolation error in elevation would be less than 0.5 m. Optically levelled 79A1 gravity survey stations were re-occupied in most cases and used for further height control. All elevations are referred to the Australian Height Datum.

Each line was measured and pegged simultaneously and when the whole line was pegged, gravity readings were taken at each station. Base stations were established generally at the ends of each line and were re-occupied after reading the stations along the line. Along lines with many stations loop readings were restricted to 90 minutes duration, after which the base was re-occupied, and the last intermediate station was incorporated in the next loop along the line. Where lines intersected, readings were taken on one or two stations on adjoining lines to form tie points for network closure. In some cases, variations in the system of base station re-occupation were employed as shown in Fig. 3. This was adopted because of poor meter drifts and inconsistent readings.

Drift curves were plotted for separate loops and when more than one loop was completed in a day a composite drift curve was constructed. This was not possible in all cases as some loops had bad drifts and were left as separate loops. Exceptionally bad drift curves were obtained for line 16 which was read on 21st January and line 17 which was read on the 22nd January. The drift values were 0.40 mgal in 90 minutes and 0.30 mgal in 30 minutes respectively. The cause of these bad drifts was probably the large variation in temperature experienced on these days.

The data, corrected for drift, were adjusted for network misclosure by a graphic least squares method. The network, with the adjustments, is shown in Fig. 4. The whole survey was tied to station 81A1-1004 which coincides with station 79A1-0147. The observed gravity at this station is 979707.50 mgal as calculated by Flis (1979) during the 79A1 survey. This value was used as a known datum to generate all other observed gravity values for the present survey.

After all the observed gravity values were tied-in, latitude, free-air and Bouguer corrections were applied. No terrain corrections were applied as the local topography is very flat. Earth-tide corrections were incorporated in the instrument drift curve and were therefore not separately calculated.

Bouguer anomaly values were obtained using the Cyber computer for Bouguer densities 1.90, 2.20, 2.40 and 2.67 g/cc. A Bouguer density of 1.90 g/cc is expected to be most representative of local near surface clays, silts and sands and Bouguer anomaly values using this density are used in the interpretation of the data.

Data Accuracy

Station Elevation Error	± 0.11 mgal (from ± 0.5 m height)
Station Latitude Error	± 0.01 mgal (from ± 10 m in position)
Instrument Reading Error	± 0.01 mgal
Data Reduction Precision	± 0.01 mgal
Total Accuracy	± 0.14 mgal

SURVEY RESULTS

The Bouguer anomaly values are plotted on Fig. 5 and contoured with a 0.25 mgal interval. The main feature of the plan is the strong and relatively uniform regional trend toward the northwest with a gradient of 0.69 mgal/km. Preliminary study of the plan indicates that bedrock topography may be reflected by variation of the contours from the regional trend. Two gravity highs between the -12.5 to -13 mgal contours and the -13.75 to -14 mgal contours are easily detected, suggesting that they are sites of strong gravity anomalies. The contorted shape of the contours flanking the inland edge of the survey area drew particular interest as sites of possible gravity lows. To highlight these features a residual anomaly plan was prepared (fig. 6).

As the area covered by the survey and the total number of stations was relatively small, a graphical approach was used in the preparation of the residual anomaly plan. The regional trend shown in Fig. 6 was obtained by combining the features of the Bouguer anomaly plan from this survey with those of the 79A1 survey (Flis, 1979) to give a much more accurate indication of the orientation and nature of the large scale trends.

The regional contours (Fig. 6) are parallel and have a northeasterly trend in the southern part of the map but swing around in the northern section to a northerly orientation. To obtain the residual anomaly for each station the regional value was interpolated from the contours in Fig. 6 and then subtracted from the Bouguer Anomaly value as shown in Fig. 5. The residual anomaly values thus obtained were contoured at a 0.25 mgal interval and are shown in Fig. 6.

The main feature of the residual plan is the presence of a series of highs and lows which are tentatively correlated to bedrock highs and lows respectively, although other conditions may affect this broad correlation. In detail, it appears that the northwest trending high in the northwest of the map has been offset approximately 2 km toward the east in the lower part of the map which corresponds to the area of directional change of the regional contours. It is inferred that this may indicate the position of the Redbanks Fault in the area but there is only limited evidence from other sources to verify this. The ridge is approximately 1500 m wide either side of the inferred fault but thins to about 800 m in its vicinity.

A distinct northerly trending low in the eastern part of the survey area may indicate a paleochannel incised within the bedrock. The feature which averages 1 km in width is somewhat difficult to correlate with the lows in the northern part of the area but it is possible that it is corrected to the bedrock low zone further north intersected by Buckland Park No. 2 (Cockshell, 1980, b).

CONCLUSIONS AND RECOMMENDATIONS

A northwesterly trending high adjacent to the coast appears to be offset by approximately 2 km in an east-west direction approximately 5 km north of St Kilda. It is inferred that the Redbanks Fault may be partially responsible for this phenomenon. A northerly trending low in the southern part of the area adjacent the ridge may indicate the presence of a Tertiary paleochannel incised in the bedrock which may be connected to the bedrock low further north intersected by Buckland Park No. 2.

It is recommended that the existence of this trough should be verified by conducting a follow-up gravity survey over the trough and over the area northeast of the area covered by this survey up to Buckland Park No. 2 It is also suggested that stations in this survey as well as all future surveys should be optically levelled to provide better accuracy for the residual gravity plan. More detailed follow-up work including seismic refraction and high resolution reflection traverses would provide greater control for gravity modelling.

for D. Fric.

REFERENCES

Cockshell, C.D., 1979. Investigations of a Possible Site for Underground Gas Storage in the Northern Adelaide Plains. Unpublished Report S.A. Dept. Mines, Rept. Bk. 79/62.

Cockshell, C.D., 1980a. Exploration for Underground Gas Storage Targets in South Australia. Unpublished Report S.A. Dept. Mines, Rept. Bk. 79/146.

Cockshell, C.D., 1980b. Northern Adelaide Plains Underground Gas Storage Study, Two Wells Area. Unpublished Report, S.A. Dept. Mines Rept. Bk. 80/90.

Flis, M.F., 1979. Geophysical Mapping of a Stratigraphic Trap, Northern Adelaide Plains, S.A. Unpublished University of Adelaide Honours Thesis.

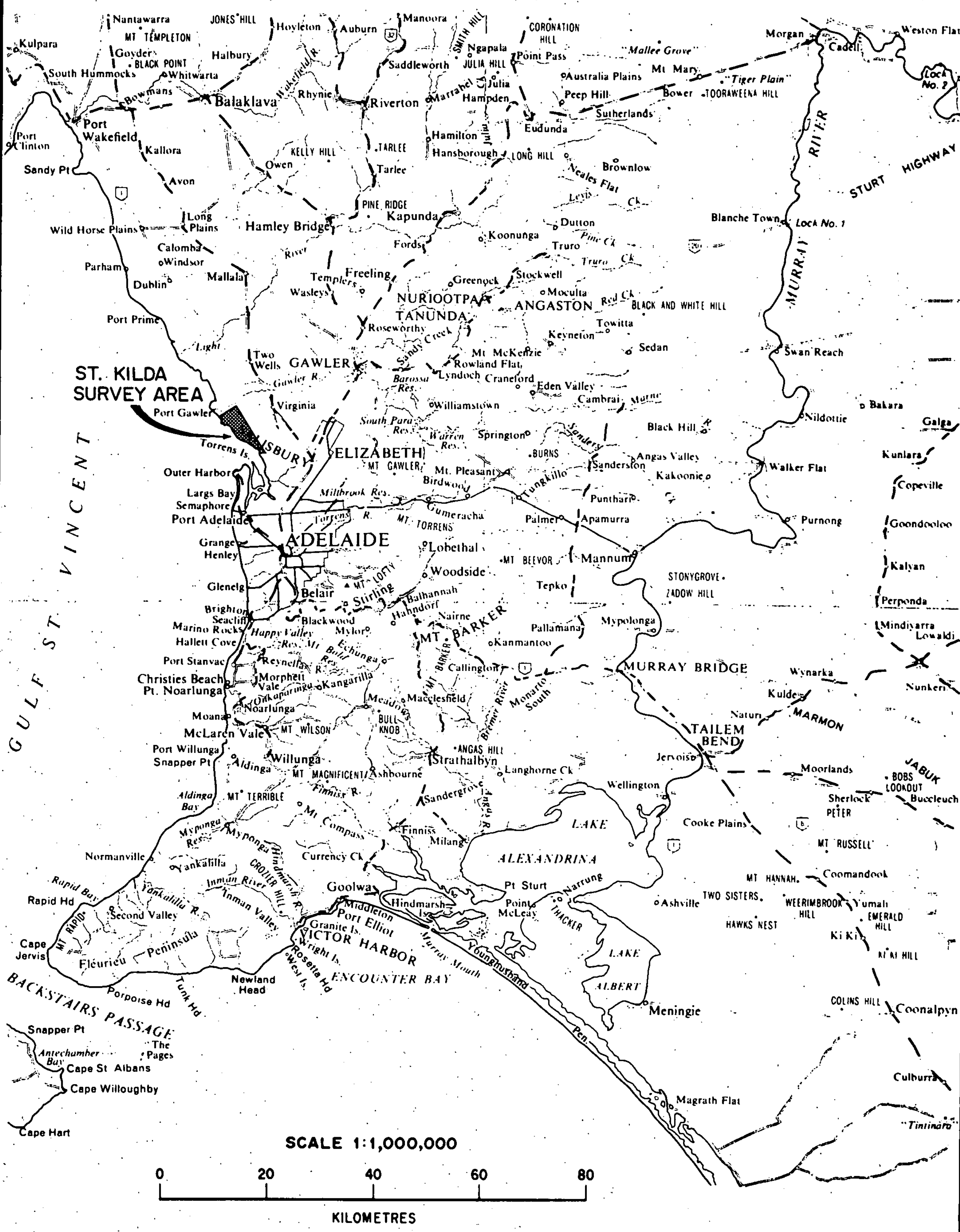

Fig.1

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COMPILED D. I.	ST. KILDA SALTFIELDS GRAVITY SURVEY	DATE 24·4·81
DRN M.B. CKD	LOCALITY PLAN	PLAN NUMBER S15519

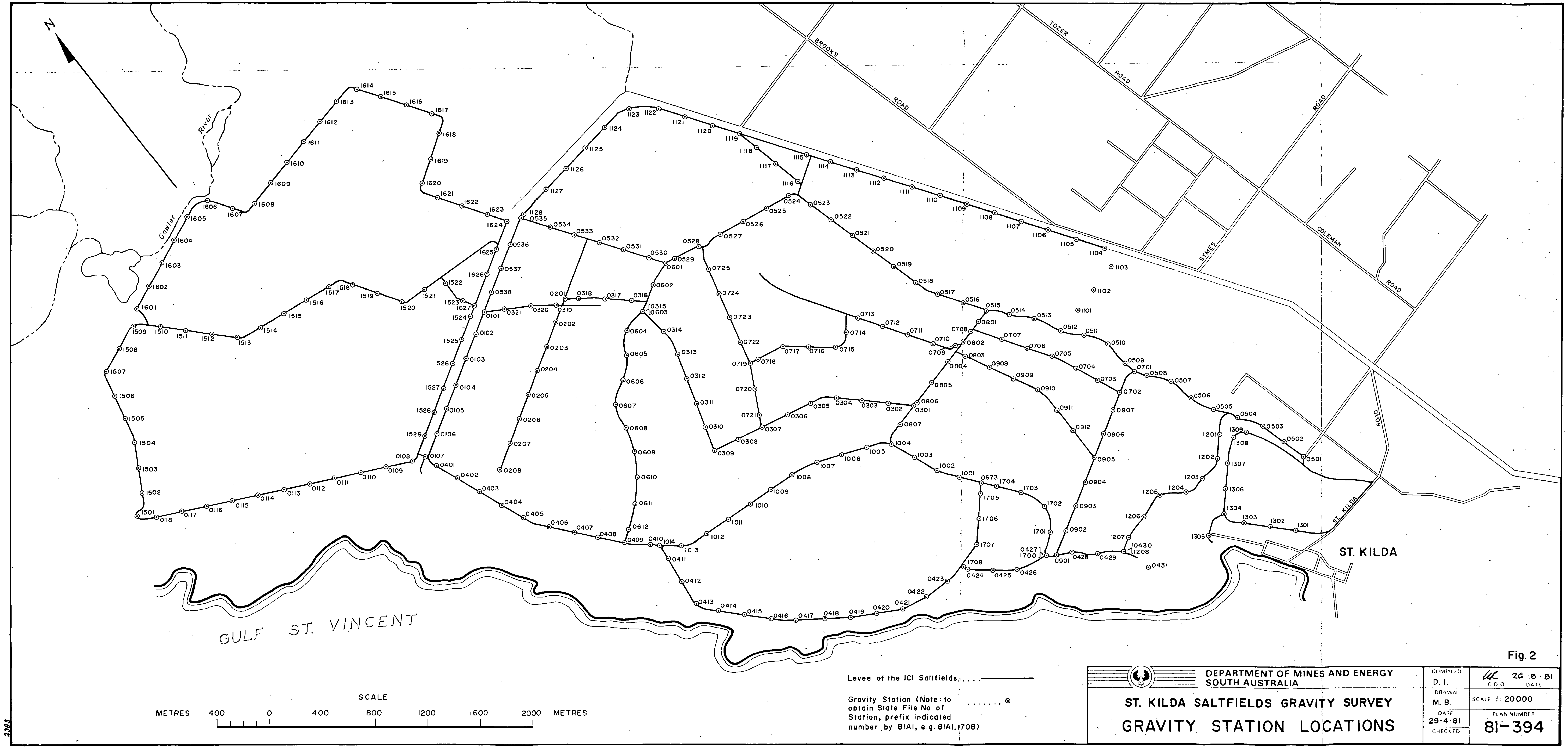


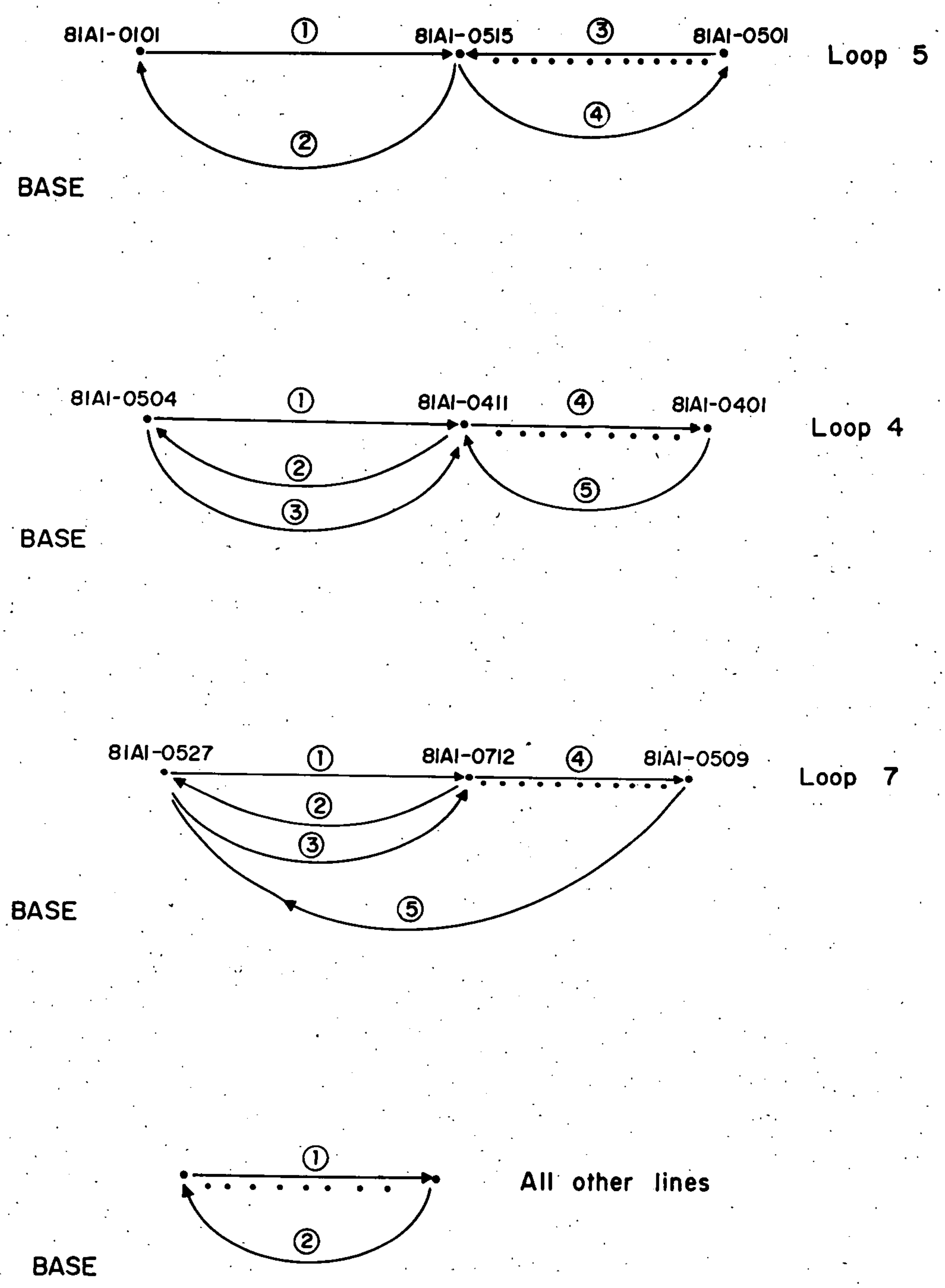
Fig. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

ST. KILDA SALTFIELDS GRAVITY SURVEY

GRAVITY STATION LOCATIONS

COMPILED D. I.	CDO 26·8·81 DATE
DRAWN M. B.	SCALE 1: 20000
DATE 29·4·81	PLAN NUMBER 81–394
CHECKED	



Tie Station	....	81A1-0101 •
Intermediate Station	....	•
Order of Tie Reading	....	①

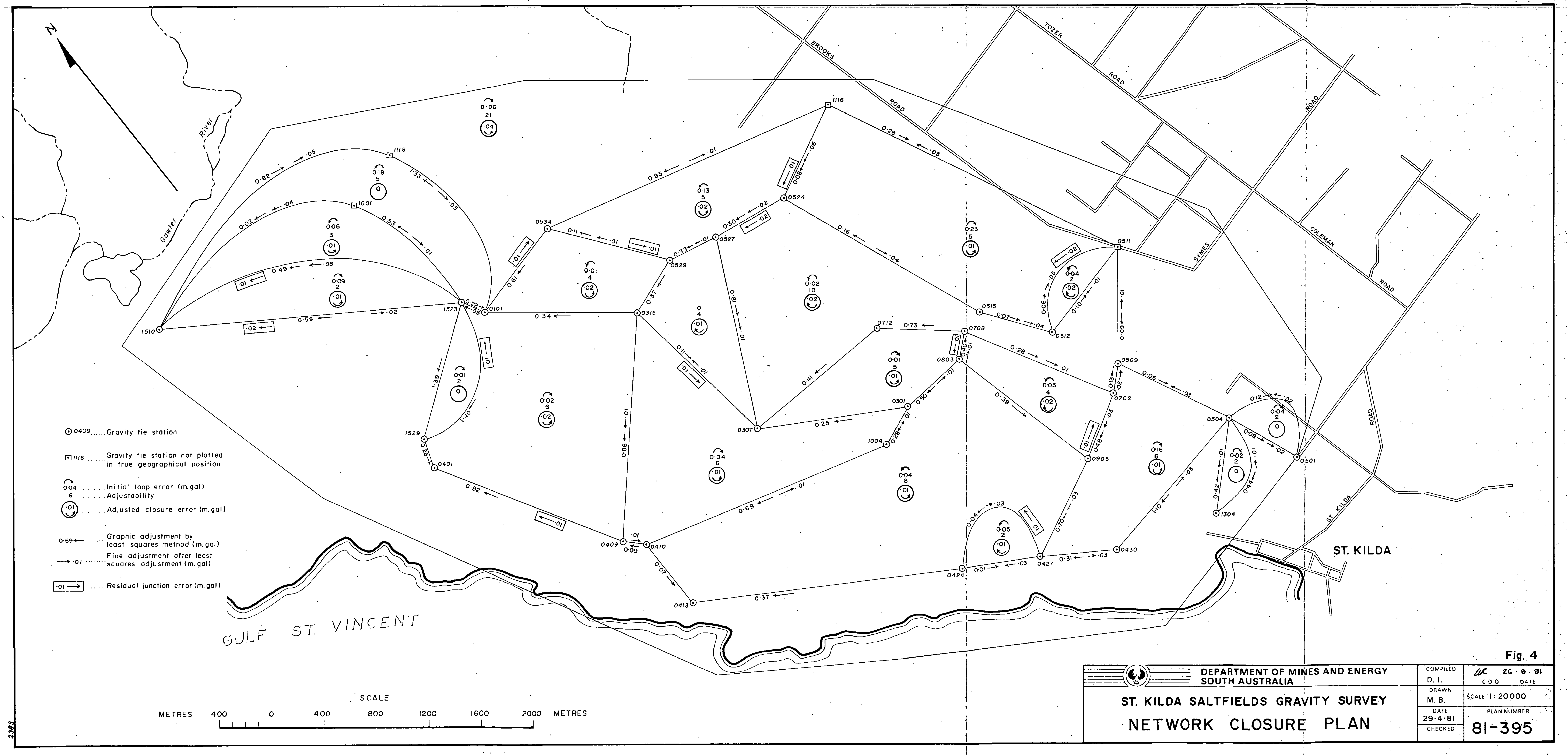
Fig. 3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

ST. KILDA SALTFIELDS GRAVITY SURVEY
DRIFT CONTROL DIAGRAM

COMPILED D. I.	C.D.O 26·8·81 DATE	
DRAWN M. B.	SCALE	
DATE 24·4·81	PLAN NUMBER	
CHECKED	S15520	

2383


N
Gawler
River
GULF ST. VINCENT
ST. KILDA
BROOKS ROAD
TOZER ROAD
ROAD
SYMES
COLEMAN ROAD
ST. KILDA ROAD
ROAD
0409 ......Gravity tie station
1116 ......Gravity tie station not plotted in true geographical position
0·04 ......Initial loop error (m.gal)
6 ......Adjustability
·01 ......Adjusted closure error (m.gal)
0·69 ← ......Graphic adjustment by least squares method (m.gal)
→ ·01 ......Fine adjustment after least squares adjustment (m.gal)
·01 → ......Residual junction error (m.gal)
SCALE
METRES 400 0 400 800 1200 1600 2000 METRES
DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA
ST. KILDA SALTFIELDS GRAVITY SURVEY
NETWORK CLOSURE PLAN
COMPILED D. I.
DRAWN M. B.
DATE 29·4·81
CHECKED
26·8·81
CDO DATE
SCALE 1:20000
PLAN NUMBER
81-395
2383
Fig. 4

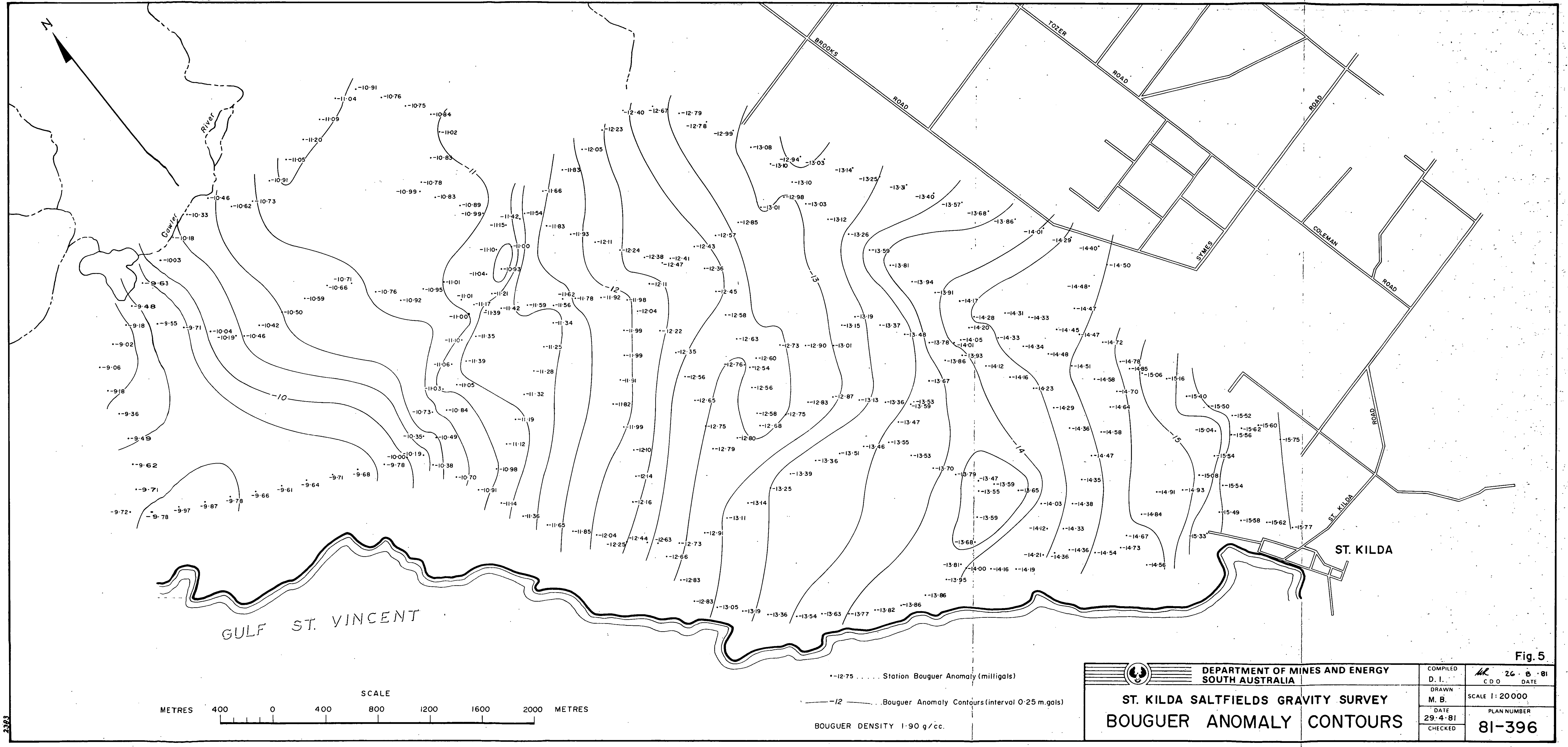


Fig. 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED D. I.	C.D.O. 26·8·81 DATE
ST. KILDA SALTFIELDS GRAVITY SURVEY	DRAWN M. B.	SCALE 1:20000
BOUGUER ANOMALY CONTOURS	DATE 29·4·81 CHECKED	PLAN NUMBER 81-396

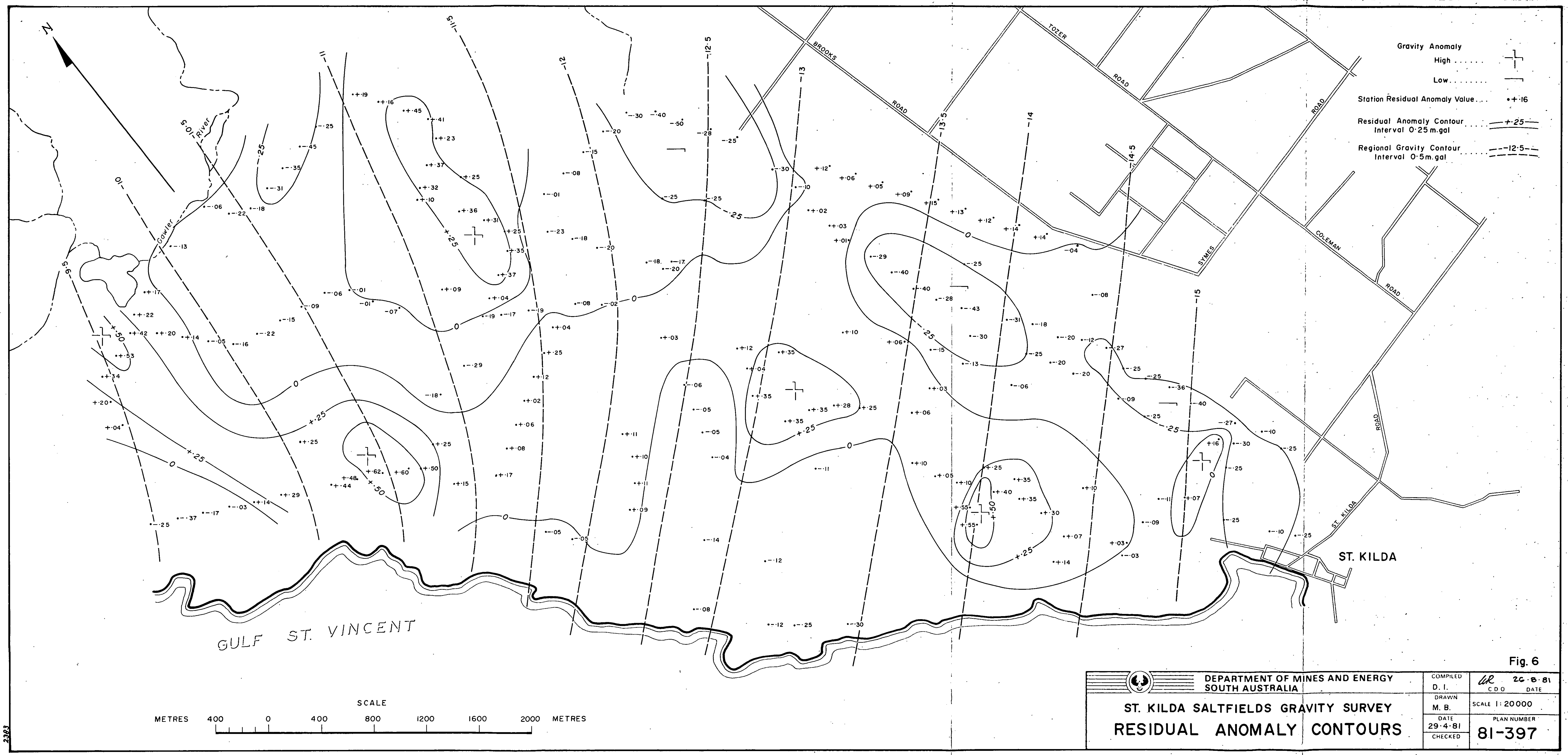


Fig. 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED D. I.	CDO 26·8·81 DATE
ST. KILDA SALTFIELDS GRAVITY SURVEY	DRAWN M. B.	SCALE 1:20000
RESIDUAL ANOMALY CONTOURS	DATE 29·4·81 CHECKED	PLAN NUMBER 81-397

2383