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No. 3821

EPP 5, EPP 6, EPP 7, EPP 10 AND EPP 11

EUCLA BASIN, BIGHT BASIN AND DUNTROON BASIN

1971 SHELL R 6 MARINE SEISMIC SURVEY

**NAVIGATION, DATA PROCESSING AND OPERATIONS
REPORTS FOR THE PERIOD OCTOBER 1971 TO APRIL
1972**

Submitted by

Shell Development (Australia) Pty Ltd
1972

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ENVELOPE 3821

TENEMENT: EPPs 5, 6, 10 and 11; Eucla, Bight and Duntroon Basins

TENEMENT HOLDER: Shell Development (Aust.) Pty Ltd (operator)

CONTENTS OF VOLUME ONE

REPORTS:	Schoof, R.W., 1971. Application for permission to conduct the 1971 R 6 Marine Seismic Survey in EPPs 5, 6, 7, 10 and 11 extending across the Great Australian Bight region (operator's letter to SA Dept of Mines as delegate of offshore Designated Authority, 6/9/71).	MESA NO. 3821 R 1 [3 pages]
	Schoof, R.W., 1971. Advice of expected time of commencement and planned line locations for the 1971 R 6 Marine Seismic Survey, plus further details of the proposed seismic contractor and marine equipment (operator's letter to SA Dept of Mines as delegate of offshore Designated Authority, 22/9/71).	3821 R 2 [2 pages]
PLANS	Scale	Company plan no.
Encl. 1	Shot point location map for proposed R 6 shallow water seismic programme lines within EPPs 6 and 7.	1:250 000 SDA-5217 3281-47 >A0
Encl. 2	Shot point location map for proposed R 6 deep water seismic programme lines within EPPs 5, 10 and 11 plus the western part of EPP 6.	1:500 000 SDA-5218 3821-48 A0
REPORT:	Easterbrook, I., 1971. Final [navigation and positioning] report [for Shell's R 6 Marine Seismic Survey] (Offshore Navigation, Inc. project 507 sub-contractor's report for Shell via GSI, December 1971).	3821 R 3 [33 pages]
ADDENDUM:	Sub-contractor's note concerning causes of original mis-positioning of 5 seismic lines recorded on 29/10/71 (these lines were subsequently re-shot).	[4 pages]
REPORT:	Pailthorpe, W.J. and Graybill, K.W., 1972. Data processing final report, [1971-72 R 6 shallow water programme] Marine Seismic Survey, SA offshore EPPs 6 and 7 (Geophysical Service International, Party 854, seismic processing contractors' report for Shell Development, February 1972).	3821 R 4 [28 pages]
APPENDIX A:	Line index; GSI vs Shell shotpoints.	
REPORT:	Pailthorpe, W.J. and Graybill, K.W., 1972. Data processing final report, [1971-72 R 6 deep water programme] Marine Seismic Survey, SA offshore EPPs 5, 6, 10 and 11 (Geophysical Service International, Party 854, seismic processing contractors' report for Shell Development, April 1972).	3821 R 5 [27 pages]
APPENDIX A:	Line and shotpoint index.	

REPORT:	Pailthorpe, W.J. and Graybill, K.W., 1972. Operations report, [1971-72 R 6 shallow water programme] Marine Seismic Survey, SA offshore EPPs 6 and 7; 29 October - 12 November 1971 and 14 - 15 January 1972 (Geophysical Service International, Party 909, seismic acquisition contractors' report for Shell Development, November 1972.	MESA NO. 3821 R 6 [33 pages]
APPENDIX A:	Line and shotpoint index.	
APPENDIX B:	Key personnel.	
APPENDIX C:	Equipment.	
APPENDIX D:	Operations statistics.	

REPORT:	Pailthorpe, W.J. and Graybill, K.W., 1972. Operations report, [1971-72 R 6 deep water programme] Marine Seismic Survey, SA offshore EPPs 5, 6, 10 and 11; 14 - 15 November 1971 and 25 January - 11 February 1972 (Geophysical Service International, Party 909, seismic acquisition contractors' report for Shell Development, November 1972.	3821 R 7 [30 pages]
APPENDIX A:	Line and shotpoint index.	
APPENDIX B:	Key personnel.	
APPENDIX C:	Equipment.	
APPENDIX D:	Operations statistics.	

CONTENTS OF VOLUME TWO

REPORT:	Hack, A.G., 1972. Survey operator's letter of transmittal for all summary technical data relating to R 6 Seismic Survey, including a listing of unattached seismic sections and shotpoint plans (Shell Development letter to SADM, 16/11/72).	MESA NO. 3821 R 8 [4 pages]		
PLANS	Scale			
	Shotpoint location maps:			
Encl.	Sheet no. 4731.	1:100 000	3821-1	A1
Encl.	Sheet no. 4831.	1:100 000	3821-2	A1
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Encl.	Bathymetric contour map, Great Australian Bight Basin.	1:500 000	3821-46	<i>>A0</i>

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SHELL DEVELOPMENT (AUSTRALIA) PROPRIETARY LIMITED

INCORPORATED IN QUEENSLAND

SHELL CORNER · 155 WILLIAM STREET · PO BOX 872K · MELBOURNE 3001 · TELEPHONE 600 0000 · CABLE ADDRESS "SHELL" · TELEX No. 30 560

PLEASE ADDRESS ALL COMMUNICATIONS TO THE COMPANY

YOUR REF.

OUR REF. **E&P:RWS:57.32**



22nd September, 1971

The Delegate of the Designated Authority,
State of South Australia,
Government Offices,
Box 38, Rundle Street Post Office,
ADELAIDE, S.A. 5001.

Dear Sir,

PETROLEUM (SUBMERGED LANDS) ACT
SOUTH AUSTRALIA PERMITS SA. 5,6,7,10 AND 11
RG MARINE SEISMIC SURVEY 1971-1972

Further to our letter of 6th September 1971 and your letter SR 27/1/14 of 10th September we are sending you 2 programme maps and a more detailed outline of the survey parameters.

- a) The survey is planned to commence on or about 10th October 1971 and will take approximately 4 - 6 weeks to complete. This early start date would enable us to gain additional information prior to the drilling of our first well expected to begin in early December,
- b) The total programme comprises approximately 2449 miles distributed as follows : SA. 5, 652 miles; SA 6, 497 miles; SA.7, 314 miles; SA. 10, 454 miles; SA.11, 532 miles. Programme location maps are enclosed.
It is planned to start the survey in SA. 6 and SA. 7 and unless unforeseen delays occur the survey vessel should be out of SA.6/7 before 1st November.
- c) The survey will be conducted by Geophysical Service International on behalf of Shell Development (Australia) Pty. Ltd. The survey vessel, M.V. Dunlap is 165 feet long and uses a 48 trace 2400 m long hydrophone cable. The energy source is a tuned airgun array of 1300 cu. in. capacity. No explosives will be used. The ship carries Radar, Sonar and echosounding equipment. The radio positioning system will be Shoran.

The objectives of the survey are:

- in SA.5 the delineation of stratigraphic and structural traps on either side of the Elliston trough,
- in SA. 6, 7 the detailing of structural leads found in the 1970 survey to provide future drilling locations,
- in SA. 10, 11 the confirmation of structural trends observed in the 1969 and 1970 surveys.

A copy of this letter has been sent to :

The Secretary,
Department of Primary Industry,
Fisheries Section,
CANBERRA, A.C.T. 2600.

and to,

The Director,
Department of Fisheries and Fauna Conservation,
Box 901,
ADELAIDE, S.A. 5001.

Yours faithfully,
For SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

W. Schap

NOTED

RM
/Director of Mines



SHELL DEVELOPMENT (AUSTRALIA) PROPRIETARY LIMITED

INCORPORATED IN QUEENSLAND

SHELL CORNER · 155 WILLIAM STREET · PO BOX 872K · MELBOURNE 3001 · TELEPHONE 60 0201 · CABLE ADDRESS "SHELL" · TELEX No. 30 560

PLEASE ADDRESS ALL COMMUNICATIONS TO THE COMPANY

YOUR REF.

OUR REF. E&P:JF:35.32.

6th September, 1971.

The Delegate of the Designated Authority,
State of South Australia,
Government Offices,
Box 38, Rundle Street Post Office,
ADELAIDE, S.A. 5001.

Dear Sir,

RG MARINE SEISMIC SURVEY
PERMITS S.A. 5,6,7,10 AND 11.



We are proposing to conduct a Seismic Survey in the area of Oil Exploration Permits S.A. 5,6,7,10 and 11 (Enclosure 1).

The programme comprises approximately 2,000 miles of reflection seismic profiles and should take four to six weeks to complete. The seismic energy source will be an array of air guns or aquapulse guns. It has generally been accepted that either sources causes little concern to fisheries or fishermen. We do not plan to use dynamite charges on this survey.

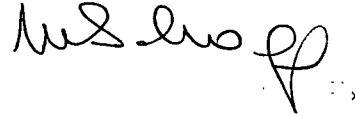
Tenders for the contract have not yet been fully evaluated; however, they indicate that the contractors would be prepared to commence operations on October, 1st. 1971. As this commencement date suits our operational requirements we respectfully request your approval to commence the survey on this date, notwithstanding that we have been unable to give the two (2) months prior notice specified in the "Conditions to be Observed In Seismic Operations for the Safeguarding of Fisheries and Fisheries Activities in Areas beyond Territorial Limits."

We would be pleased to supply any further details you might require and will advise you when a contract has been awarded.

A copy of our letter of 6th September, 1971 to the Department of Primary Industry, Canberra is attached for your information.

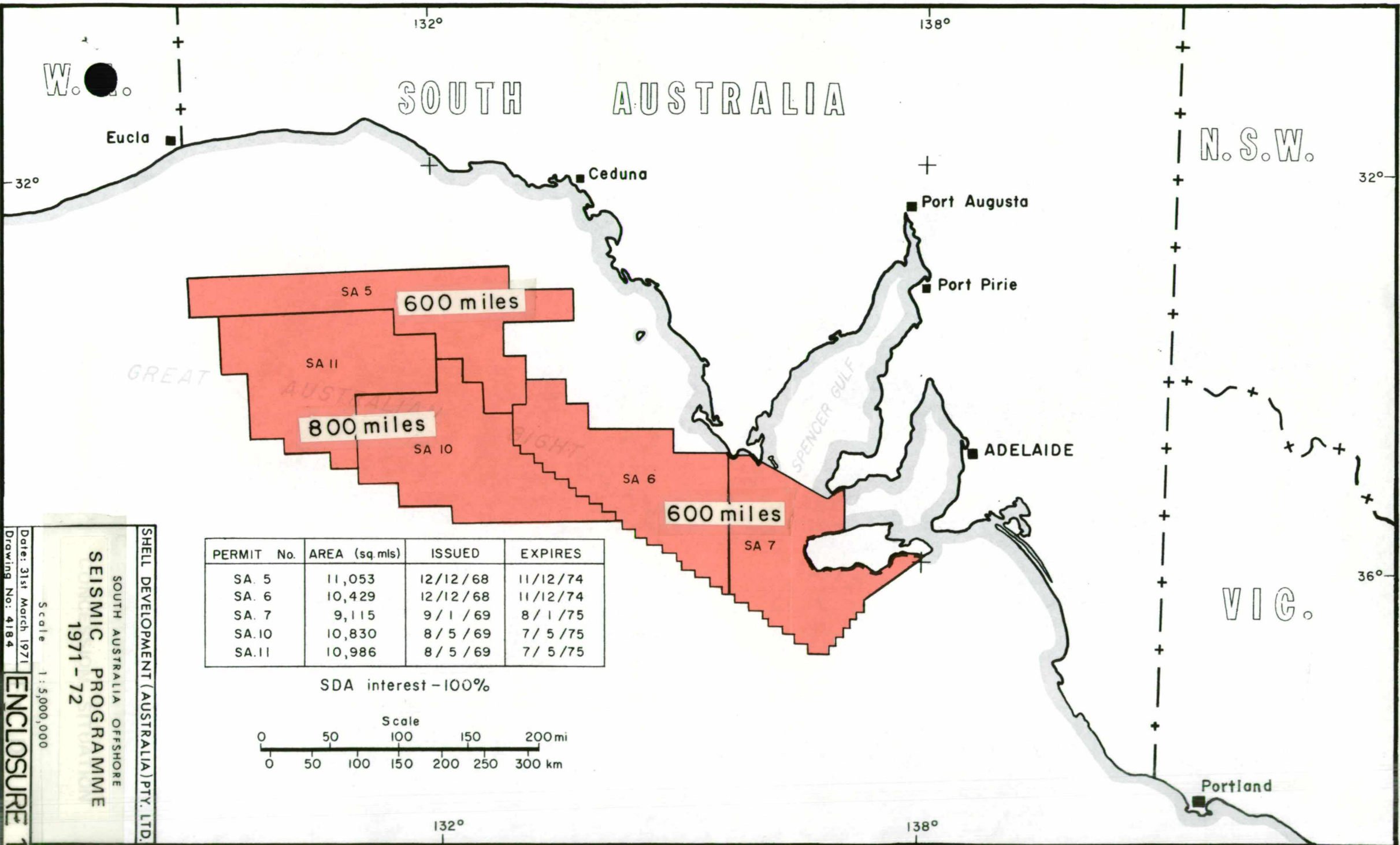
Yours faithfully,

For SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

A handwritten signature in dark ink, appearing to be 'M. S. L. P.', written in a cursive style.

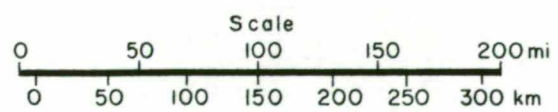
Encl.

Mr. [Signature] Director of [Signature]

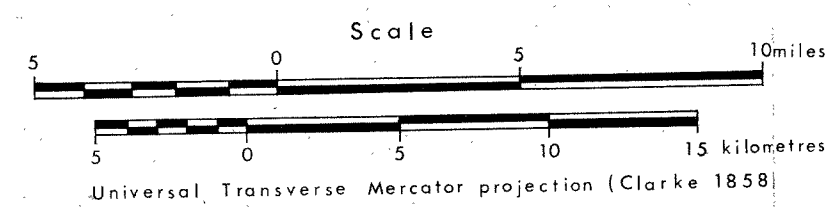
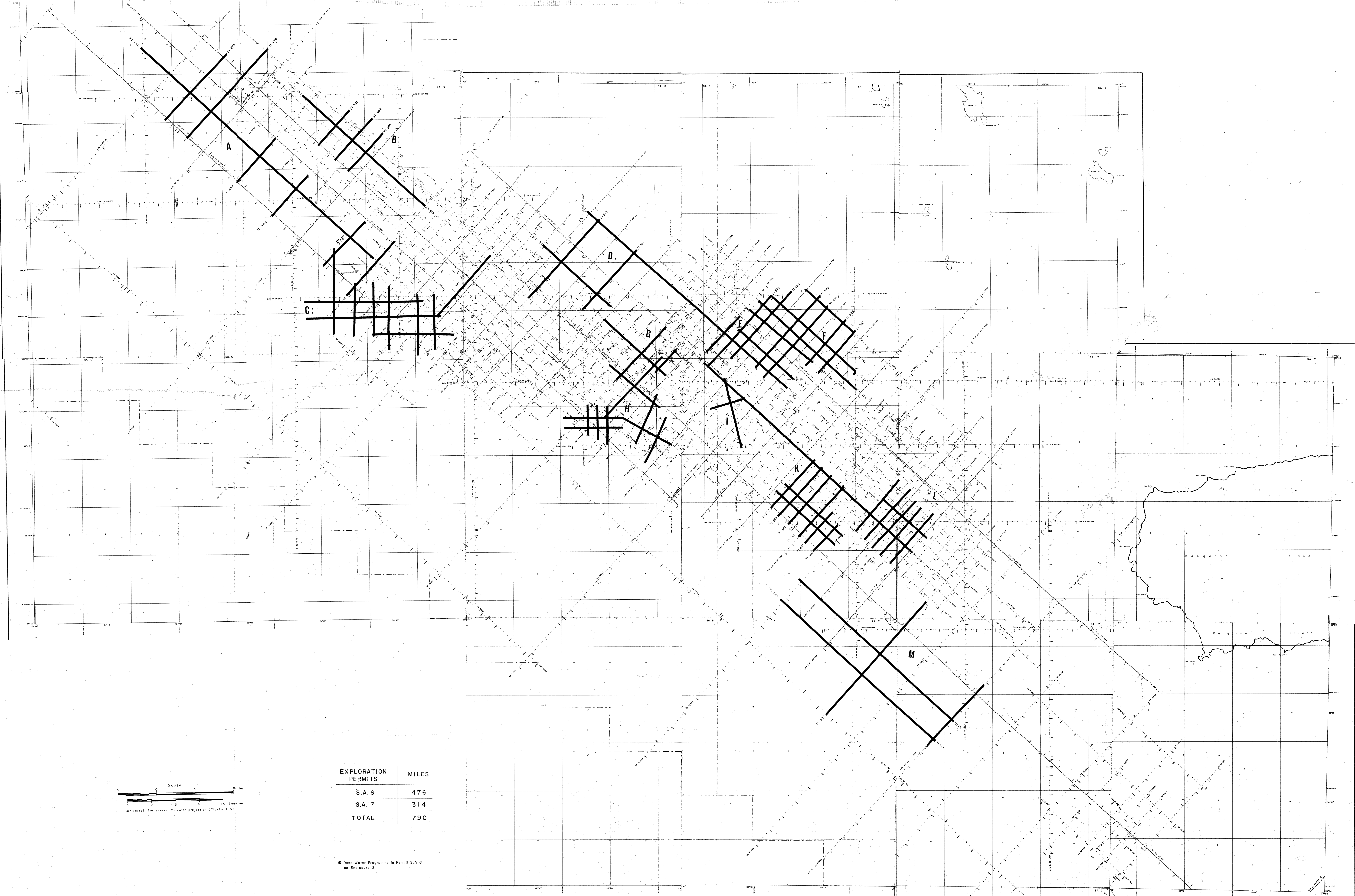


PERMIT No.	AREA (sq.mls)	ISSUED	EXPIRES
SA. 5	11,053	12/12/68	11/12/74
SA. 6	10,429	12/12/68	11/12/74
SA. 7	9,115	9/1/69	8/1/75
SA.10	10,830	8/5/69	7/5/75
SA.11	10,986	8/5/69	7/5/75

SDA interest - 100%



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE
SEISMIC PROGRAMME
1971 - 72
Scale 1:5,000,000
Date: 31st March 1971
Drawing No: 4184
ENCLOSURE 1



EXPLORATION PERMITS	MILES
S.A. 6	476
S.A. 7	314
TOTAL	790

* Deep Water Programme in Permit S.A. 6 on Enclosure 2

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SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE
SHALLOW WATER

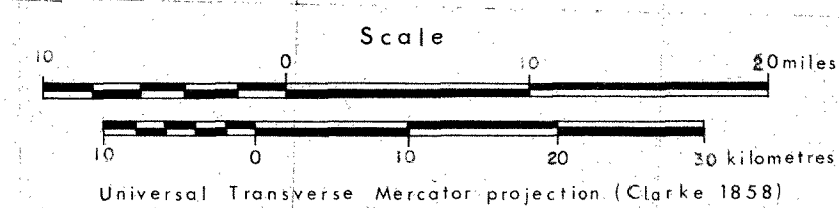
SEISMIC PROGRAMME 1971

Scale 1:250,000

Author: _____ Date: August 1971

Report: _____ Encl: 1 Drawing No. 38217

Exploration Permit	Miles
S.A. 5	652
S.A. 6	21
S.A. II	532
S.A. 10	454
Total	1659



3821-48

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.	
SOUTH AUSTRALIA OFFSHORE	
DEEP WATER	
SEISMIC PROGRAMME 1971	
SCALE: 1:500,000	
Author:	Date: AUGUST 1971
Report:	Encl: 2 Drawing No. 5218

003

FINAL REPORT
OFFSHORE NAVIGATION, INC.
PROJECT 507

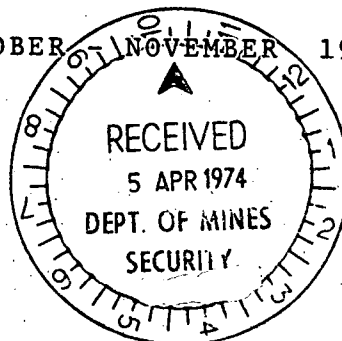
GEOPHYSICAL SERVICE INTERNATIONAL
PARTY 909

FOR

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

SOUTH AUSTRALIA

OCTOBER NOVEMBER 1971



OFFSHORE NAVIGATION, INC.

3821-I

004

A B S T R A C T

Project 507 was a Shoran positioned and controlled marine seismic survey for potential mineral deposits in the Great Australian Bight off the coast of South Australia.

The principal was Shell Development (Australia) Pty. Ltd. (SHELL).

Geophysical Service International (GSI) was the prime contractor and operator.

Offshore Navigation, Inc. (ONI) employed a Shoran radiolocation system to provide horizontal control for the survey.

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006

I. THE SHORAN RADIOPOSITIONING SYSTEM

The Shoran system is a radar transponder type of radio-positioning system. The Shoran mobile station equipment measures the distance from its location to those of two fixed ground beacon stations. The position of the mobile unit is thus fixed at the intersection of the two circular distance or range arcs so determined. The position of the ground beacon stations or base stations is normally accurately known, so that the corresponding position of the mobile station can be accurately computed or determined by graphical methods. Should the position coordinates of the base stations not be accurately known, the mobile station may still be positioned relative to the baseline determined by the base station locations.

The Shoran mobile unit measures the distance of the two base stations by measuring the time required for pulses of radio signals to travel from the mobile station to each base station and return. The time intervals so measured are related to the corresponding distances by using the highly constant velocity characteristic of radio waves in air through the simple relationship:

Total distance covered = Elapsed time x velocity.

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I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

Because of this relationship, it is possible to graduate the indicating dials in the mobile unit in terms of distance rather than elapsed time. For example, using radio waves which have a velocity of approximately 186,000 miles per second, the scale of the time-interval measuring system is graduated so that when the time interval required for a round trip of the signal is $1/1000$ second, the scale reads 93 miles. (The total distance traveled by the radio signals in $1/1000$ second is 186 miles. Since this is round trip distance, it must be halved to obtain the distance between mobile and base stations.) The Shoran dials are graduated in terms of statute miles rather than nautical miles.

The basic equipment units used to create the round trip signals paths originating and terminating at the mobile station are shown in Figure 1. This equipment consists of a signal source (labeled pulse generator in Figure 1), a transmitter, receiver and indicator unit comprising the mobile station, and a receiver coupled to a transmitter at each base station.

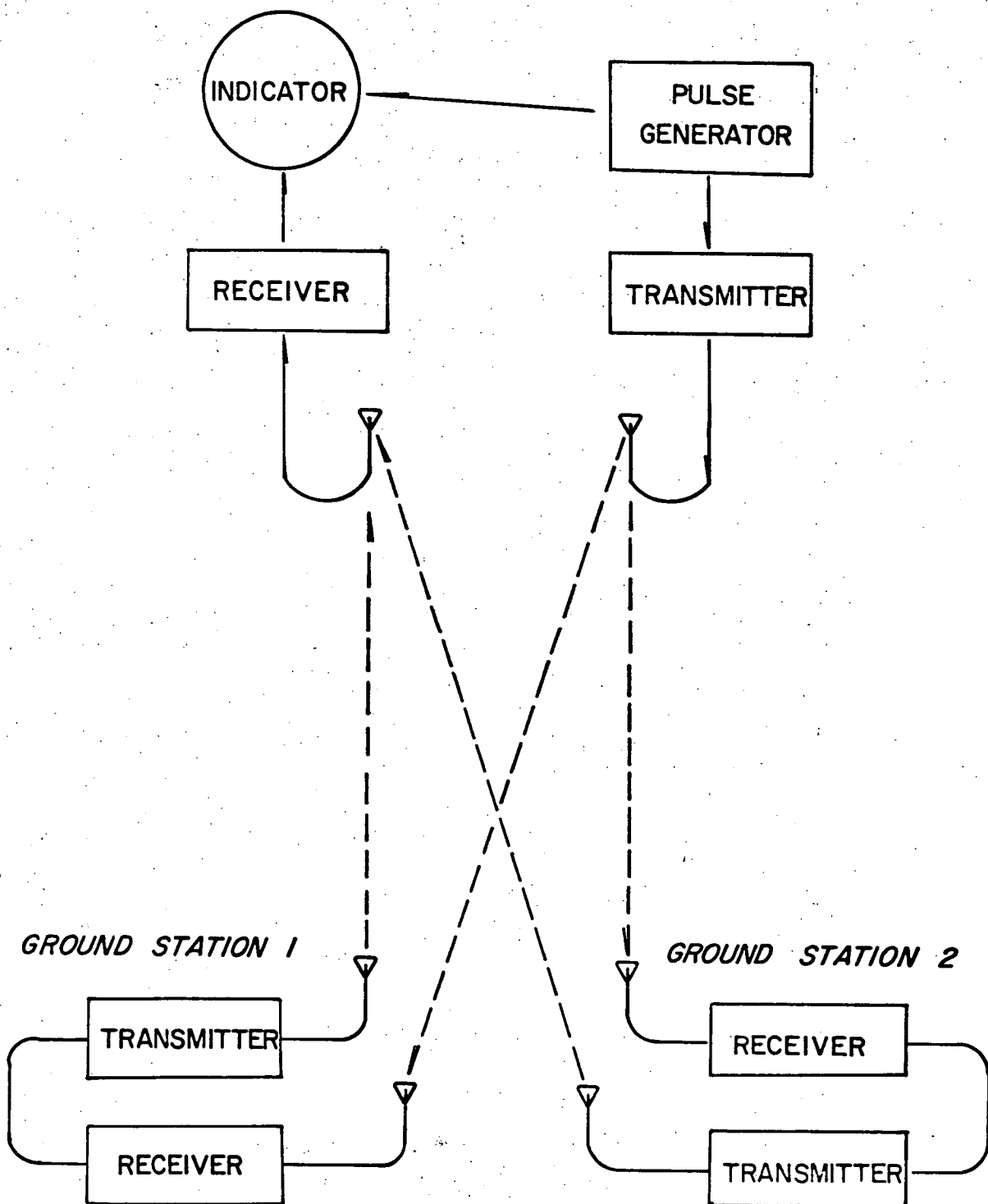


FIGURE 1
SIMPLIFIED BLOCK DIAGRAM OF BASIC RADIO
EQUIPMENT OF A SHORAN SYSTEM

009

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

Pulse signals originating at the mobile station are radiated from the mobile transmitter and received by one of the base stations. At this base station, the pulse is sent from the output of the receiver to the input of the transmitter, and is then retransmitted back to the mobile station. After passing through the mobile receiver, the pulse is routed to an indicating circuit where its time lag, or lapse, with respect to the original outgoing pulse is determined, and indicated in terms of distance rather than units of time.

Other pulses are transmitted to the second base station, using a different radio frequency to permit their discrimination from those intended for the first base station. These pulses are received and retransmitted by the second base station, and on their return to the mobile station are similarly sent through the indicating circuits for measurement of the time required for their round trip and the indication of corresponding distance. Thus, the equipment provides continuous, essentially simultaneous, indications of the distances to both base stations.

The Shoran system operates in the VHF/UHF portion of the

010

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

radio spectrum. Normally, three separate frequencies are used. Two of these are transmitted alternately by the mobile station to interrogate each base station in turn, as previously described. The third frequency is utilized by the base stations to retransmit the received pulses back to the mobile station. Both base stations transmit on the single frequency in order to utilize a single receiver at the mobile station.

The propagation characteristics of VHF/UHF radio signals is such that they tend to travel in straight lines. While they are refracted in the atmosphere to some small extent, they do not tend to follow the earth's curvature as do radio signals of considerable lower frequency. They lack the ability to "see" beyond the radio horizon. Thus the Shoran system is essentially a "line of sight" system, with the maximum range being limited, to a large extent, by the heights of the mobile and base station antennas.

The range of the system under particular conditions may be estimated from the relationship

$$d = k (\sqrt{h_1} + \sqrt{h_2})$$

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I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

where,

- d = estimated maximum range, in miles
- h_1 = height of mobile station antenna, in feet, above sea level
- h_2 = height of base station antenna, in feet, above sea level
- k = empirical range factor

The factor, k, depends upon several factors among which are included antenna gain, receiver sensitivity, transmitter power and atmospheric refractive index. It will vary in value from 1.5 to 2.5, under normally encountered conditions.

The range formula presumes no obstructions between mobile and base stations. The presence of intervening hills or other obstructions can reduce the otherwise obtainable range.

Under certain conditions, abnormally long Shoran ranges can be obtained by exploiting the existence of an atmospheric phenomenon known as a temperature inversion layer. This is a layer of high refractive index occurring with the first few thousand feet of the atmosphere. It has the effect of confining the radio waves near the earth's

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

surface, and acts as a duct to bend radio waves around the curvature of the earth. Under these conditions the factor, k , may be several times greater than normal. In some marine areas of the world, this phenomenon occurs quite regularly during certain seasons.

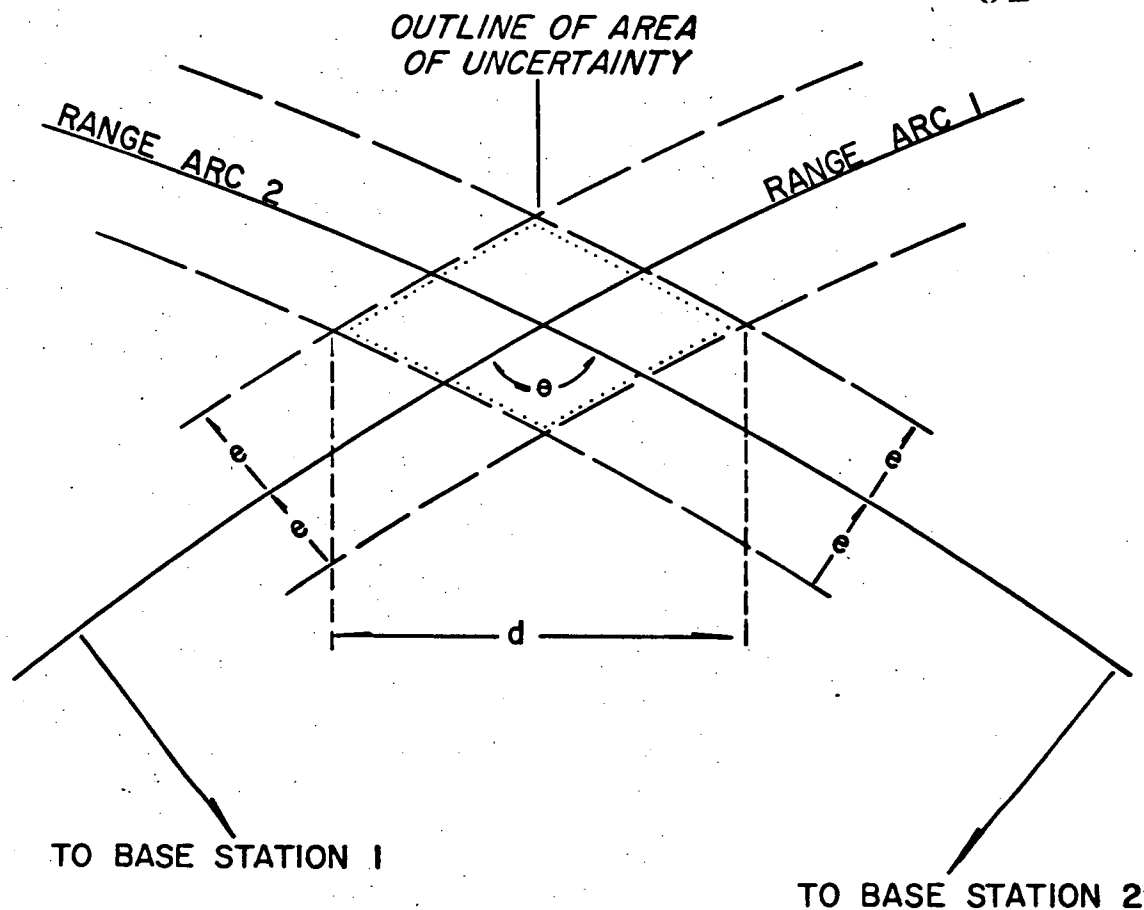
The instrumental accuracy of the Shoran equipment, when properly calibrated, is $\pm 50-75$ feet on a single range. The overall position accuracy is related to the range accuracy by the angle of intersection, at the mobile station, between the two Shoran range circles. This is illustrated in Figure 2. In normal geophysical operations, this angle of intersection is held between 30 and 150 degrees. Refer to Appendix A for examples of areas of coverage for different angles of intersection of the Shoran range circles.

The range accuracy of the Shoran system can be improved, possibly by a factor of 2, by correcting the propagation velocity slightly under varying meteorological conditions, and by the application of more rigid calibration and operating specifications. For most operations, this

I. THE SHORAN RADIOPOSITIONING SYSTEM (continued)

additional accuracy cannot be economically justified.

In computing (or determining graphically) the position from a pair of Shoran ranges, cognizance must be maintained that a position ambiguity may exist. Each pair of ranges (one to each base station) actually determines two independent positions, one on each side of the Shoran baseline, as illustrated in Figure 3. One position is the "mirror image," so to speak, of the other. Further, the Shoran mileage dials repeat every 100 miles of range. To eliminate this ambiguity one must know, from other means, the correct side of the baseline and the distance to each base station within the proper multiple of 100 miles.



$$d = \frac{2e}{\sin \frac{\theta}{2}} \text{ where}$$

e = RANGE ERROR

θ = INTERSECTION ANGLE OF RANGE CIRCLES

FIGURE 2

AREA OF UNCERTAINTY OF POSITION
DUE TO ERROR IN RANGE MEASUREMENT

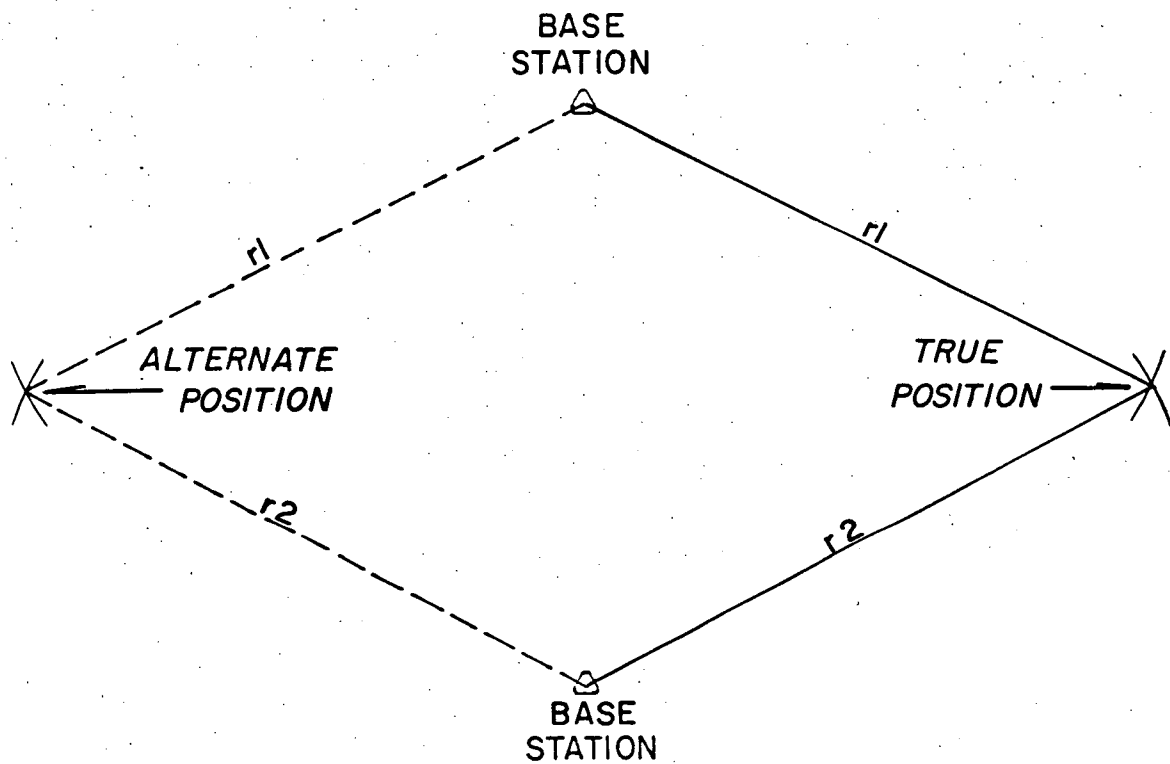
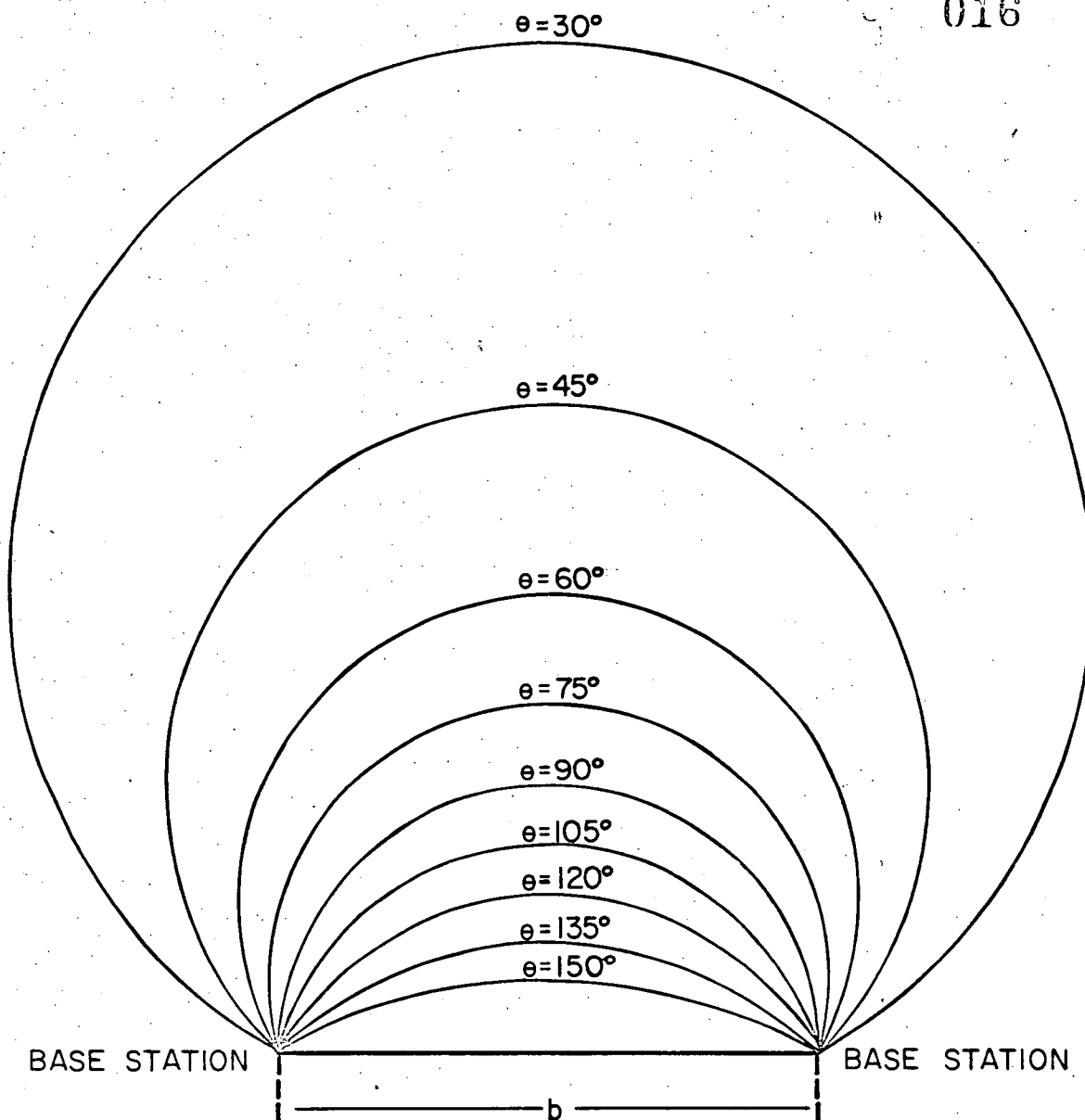


FIGURE 3

POSITION AMBIGUITY IN CIRCULAR RANGE
SYSTEM



ALL ARCS ARE PORTIONS OF CIRCLES THROUGH BASE STATION POSITIONS OF RADIUS GIVEN BY

$$r = \frac{b}{2 \sin \theta}$$

WHERE θ IS ANGLE OF INTERSECTION BETWEEN RANGE CIRCLES

APPENDIX A

RELATIVE AREA OF COVERAGE CIRCULAR RANGING SYSTEM

017

II. AREA OF OPERATIONS

Operations were conducted off the coast of South Australia in the Great Australian Bight. The work area was located east of the Great Australian Bight, at the mouth of the Spencer Gulf from Kangaroo Island to Point Avoid, South Australia.

The ONI base of operation for this survey was established at Port Lincoln 8 October 1971. From this location, communications were maintained with the recording vessel and the Shoran base stations throughout the survey period.

III. FIELD OPERATIONS RECAP

The ONI advance personnel for this operation commenced working 8 October 1971 in Port Lincoln, South Australia. At the request of SHELL, a calibration of all Shoran base station equipment was accomplished 14 October 1971 using Shoran Stations Point Avoid and Wedge Island.

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III. FIELD OPERATIONS RECAP (continued)

The recording vessel, M/V R.C. DUNLAP, arrived at Port Lincoln from Singapore 11 October 1971. Installation of the Shoran mobile indicating equipment on board the vessel began 16 October and was completed 18 October 1971.

At the conclusion of the Shoran calibration, the Shoran base station equipment was removed from Wedge Island to their respective sites. All stations were operational 23 October 1971. Due to adverse weather conditions, the first readings for the client's field production were not observed until 29 October 1971.

Geophysical operations continued until 16 November 1971 when the final readings were observed. On this date, the M/V R.C. DUNLAP proceeded to Devonport, Tasmania for another survey in that area.

Dismantling of the Shoran base stations began 16 November 1971 and was completed 17 November 1971. All of the Shoran base station equipment was stored at Port Lincoln in anticipation of a return to this area for

III. FIELD OPERATIONS RECAP (continued)

a further survey in the near future. All ONI personnel were retained for further operations under the control of GSI in the Bass Strait area.

The ONI base of operations in Port Lincoln was closed 16 November 1971.

020

IV. GENERAL INFORMATION

A. Shoran frequencies used were:

Mobile Transmitter 230/250 Mhz

Base Transmitter 300 Mhz

B. Satisfactory radiotelephone communications between all Shoran installations were maintained on the frequency of 4637.5 kilocycles.

C. The Shoran field data was turned over to Mr. B. Schafer, GSI representative, as completed.

D. Three Shoran base station installations were provided by ONI for this survey.

D. Four Shoran base station sites were occupied during this operation. They were:

STATION CAPE DU COUEDIC

STATION POINT AVOID

STATION STREAKY BAY (OFFSET
TORAN)

STATION WEDGE ISLAND

IV. GENERAL INFORMATION (continued)

- F. Maximum Shoran range observed during the survey was 190 miles.
- G. In addition to the standard Shoran system, Range Extension (XR) equipment was provided by ONI for this survey. The XR components provided consisted primarily of improved antenna system, transmission lines, receivers, signal processing and power system. All stations were also provided with a solid state pre-amplifier.
- H. Shoran base station equipment was checked for proper calibration prior to its departure from New Orleans, Louisiana by use of a Range Calibration from a surveyed site at the ONI New Orleans office and a site located on the new municipal water tower in Mandeville, Louisiana. The base station equipment was adjusted to read the computed range of 29.893 miles.

022

IV. GENERAL INFORMATION (continued)

I. The Shoran mobile indicating unit was checked daily during the operation for proper zero set.

J. ONI provided the following peripheral equipment for this survey:

Pulse Follower

Digital Printer

Digital Trackplotter

Dual Antenna System

K. There was no lost operation time due to Shoran equipment malfunction during the survey.

V. MAPPING

Prior to the commencement of the field operations, machine computed preplots, showing the Shoran and grid coordinates of each shotpoint location to be occupied, were provided to the field by the ONI New Orleans, Louisiana office.

No final mapping of this survey was accomplished by ONI. All Shoran data was submitted to Mr. B. Schafer, GSI representative, as completed.

For preplotting of the survey, the Universal Transverse Mercator Projection, Clarke 1858 Spheroid of Reference, Zone 53, Central Meridian 135° East was used.

VI. BASIC CONTROL

The following Shoran base stations, along with their coordinates, were occupied to control this survey.

Universal Transverse Mercator Projection
Clarke 1858 Spheroid
Zone 53
Central Meridian 135° East

STATION CAPE DU COUEDIC:

Latitude	36°03'31"01 S	N = 6,008,408 meters
Longitude	136°42'12"63 E	E = 653,433 meters
Elevation	88 meters	

STATION POINT AVOID:

Latitude	34°40'48"54 S	N = 6,162,571 meters
Longitude	135°20'14"32 E	E = 530,901 meters
Elevation	33 meters	

STATION STREAKY BAY (OFFSET TORAN):

Latitude	32°53'51"70 S	N = 6,359,878 meters
Longitude	134°05'16"76 E	E = 414,701 meters
Elevation	100 meters	

STATION WEDGE ISLAND:

Latitude	35°10'31"35 S	N = 6,106,694 meters
Longitude	136°29'14"79 E	E = 635,452 meters
Elevation	217 meters	

VII. SHORAN THREE-WAY FIXES

The following Shoran Three-Way Fixes were observed during the survey period:

25 October 1971 - 0650 hours

Wedge Island	102.068 miles
Point Avoid	63.093 miles
Cape Du Couedic	119.969 miles

2 November 1971 - 0700 hours

Wedge Island	40.655 miles
Point Avoid	52.771 miles
Cape Du Couedic	70.750 miles

VIII. SHORAN BASELINE MEASUREMENTS

The following Shoran Baseline Measurements were observed during the survey period:

Stations Cape Du Couedic/Wedge Island Baseline:

First observed range 62.096 miles

Second observed range 62.097 miles

Stations Wedge Island/Point Avoid Baseline:

Observed range 73.689 miles

IX. PERSONNEL

NAME	POSITION
Easterbrook, I.	Party Chief
Barnes, G.	Mobile Operator
Carney, P.	Mobile Operator
Forsyth, J.	Base Operator
McLean, A.	Base Operator
Rolfe-Smith, G.	Base Operator

X. DISTRIBUTION

Geophysical Service International
Post Office Box 437
Crows Nest, N.S.W. 2065
AUSTRALIA

Four copies

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Post Office Box 23504
New Orleans, Louisiana 70123

Two copies

Offshore Navigation, Inc.
Post Office Box 21
Ramsgate, N.S.W. 2217
AUSTRALIA

One copy

STATION: CAPE DUE COUEDIC

ACCESS: From Kingscote, take main road north to Parndana and continue to signpost (Rocky River and Flinders Chase), turn left and follow road to Flinders Chase Post Office (contact the Reserve Ranger there). Then go through the gate and follow the track to the lighthouse at Cape Due Couedic. Turn right after passing the stone bungalows to the station site, which is on a hill overlooking the southern ocean.

ELEVATION: 88 meters

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., CLARKE 1858 SPHEROID ZONE 53, C.M. 135° EAST	
Latitude	Longitude	North	East
36°03'31"01 S	136°42'12"63 W	6,008,408 meters	653,433 meters

STA. CAPE DU COUEDIC—AUSTRALIA

LAT. $36^{\circ}03'31''01$ SLONG. $136^{\circ}42'12''63$ W

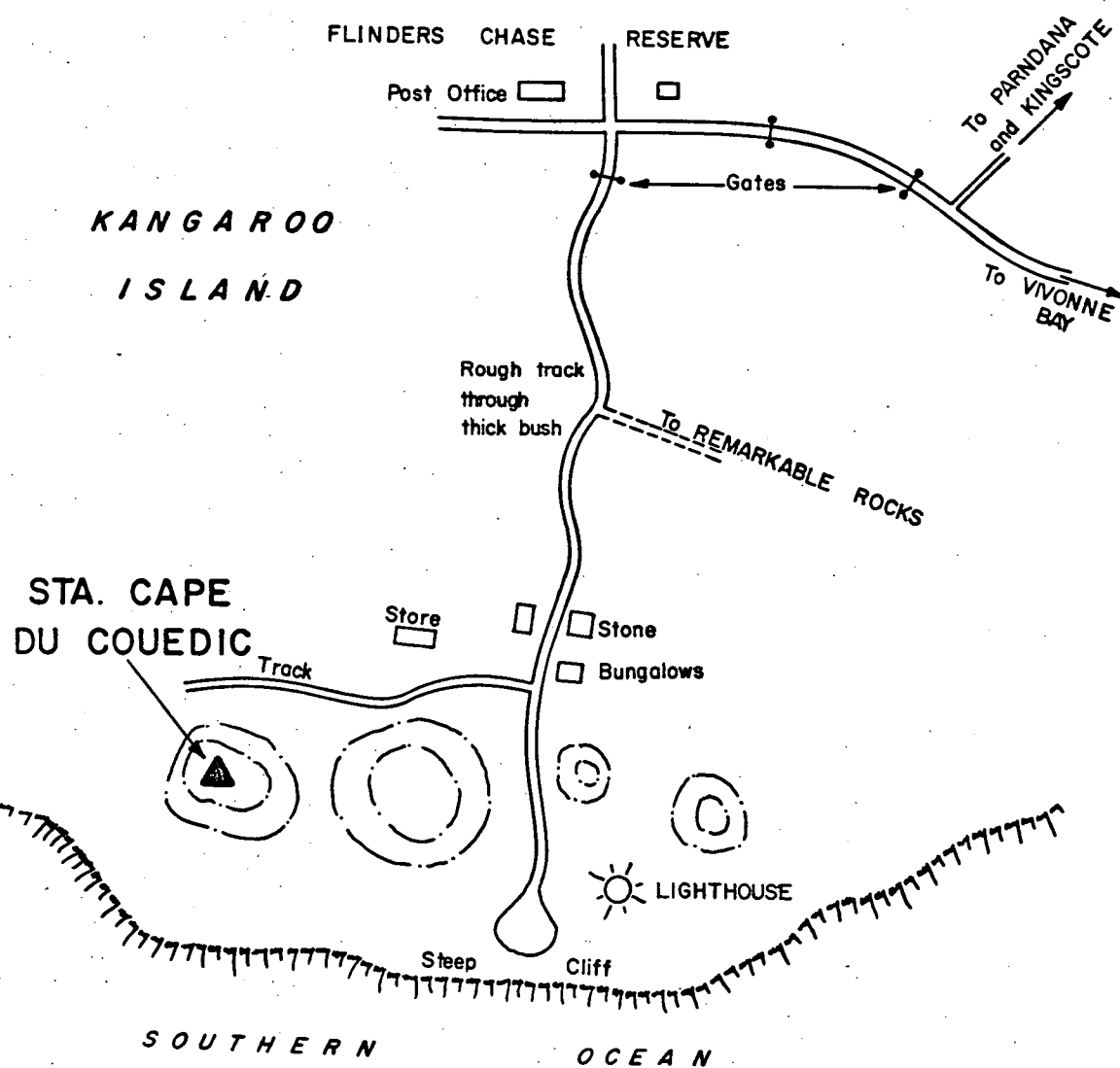
ELEV. 88 meters

N. 6,008,408 meters

E. 653,433 meters

U.T.M. PROJECTION, CLARKE 1858 SPHEROID

ZONE 53

C.M. 135° E.

030

STATION: POINT AVOID

ACCESS: From Port Lincoln, take the Flinders Highway towards Elliston to the signpost "Coffin Bay 9 miles". Turn left and continue through Coffin Bay along the edge of the bay until the road ends at the beach. Travel along the beach, across the first headland and along the second beach for about two miles, bear left and follow narrow bush track to Point Avoid.

The station is about twelve miles from main fishing jetty at Coffin Bay and about one hour's drive in a four-wheel drive vehicle. Do not drive below high water mark on the beach.

Due to the many side tracks from Coffin Bay to the site, local information is essential. Contact Mr. N. Owen of the B.P. Garage, Port Lincoln.

MARKER: The site marker bears the inscription "SHELL 66/15".

ELEVATION: 33 meters

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., CLARKE 1858 SPHEROID ZONE 53, C.M. 135° EAST	
Latitude	Longitude	North	East
34°40'48"54 S	135°20'14"32 E	6,162,571 meters	530,901 meters

STA. POINT AVOID — AUSTRALIA

LAT. 34° 40' 48" 54 S

N 6,162,571 meters

LONG. 135° 20' 14" 32 E

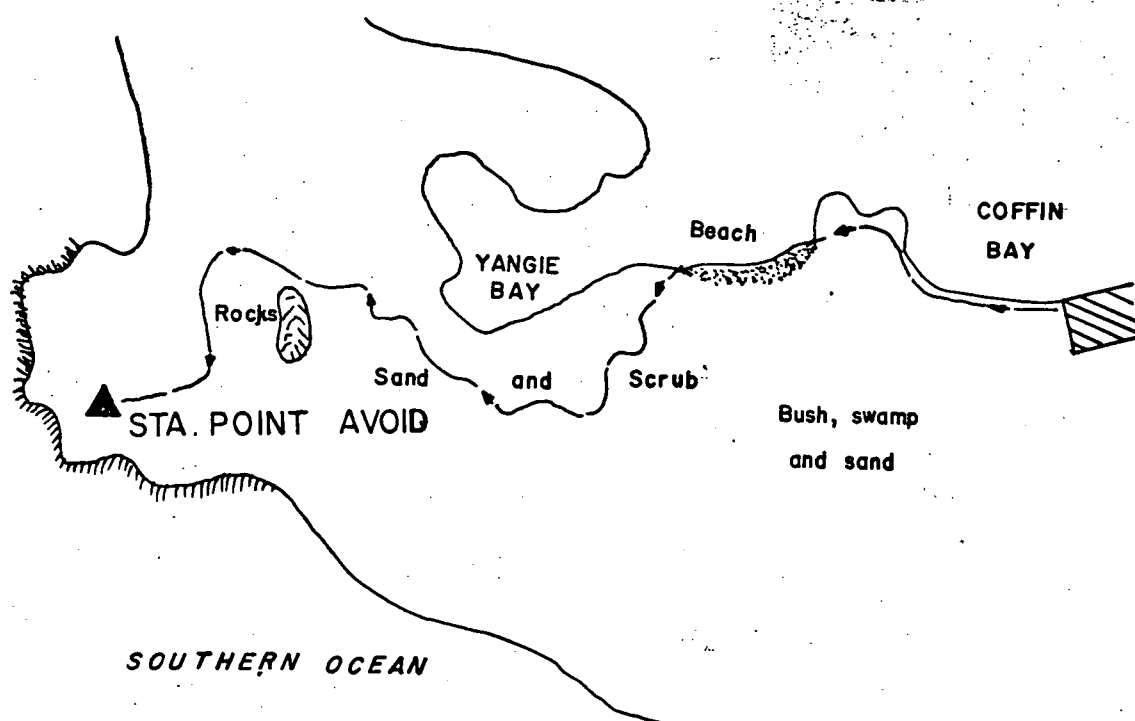
E 530,901 meters

ELEV. 33 meters

U.T.M. PROJECTION, CLARKE 1858 SPHEROID

ZONE 53

C. M. 135° E



032

STATION: STREAKY BAY (OFFSET TORAN)

ACCESS: From Streaky Bay, take Flinders Highway towards Elliston. Turn right at war memorial and bear left past the cemetery (0.3 miles). Continue for six miles to signpost (Smooth Pools 5 miles), turn right and continue for 4.3 miles. Turn right again before the grid and follow the track to the station site.

MARKER: The Shoran station was set up on the Toran 1968/69 site which was offset 40 yards at 154° from the army peg on the hill adjacent to the Shell 66/13 marker.

ELEVATION: 100 meters

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., CLARKE 1858 SPHEROID ZONE 53, C.M. 135° EAST	
Latitude	Longitude	North	East
32°53'51"70 S	134°05'16"76 E	6,359,878 meters	414,701 meters

STA. Streaky Bay (Offset Toran) — AUSTRALIA

LAT. 32° 53' 51" 70 S

N 6,359,878 meters

LONG. 134° 05' 16" 76 E

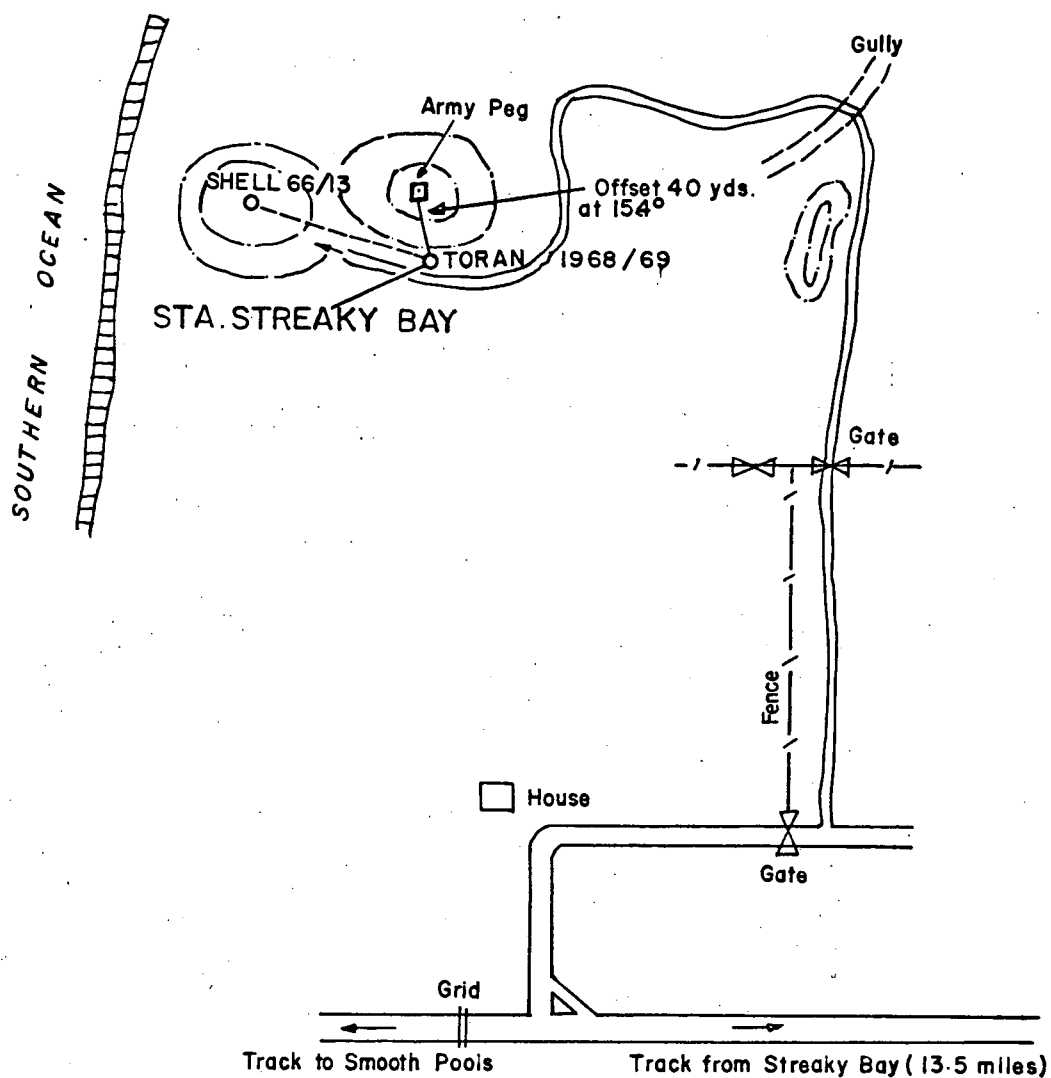
E 414,701 meters

ELEV. 100 meters

U.T.M. PROJECTION, CLARKE 1858 SPHEROID

ZONE 53

C.M. 135° E



STATION: WEDGE ISLAND

ACCESS: From Port Lincoln, fly by light aircraft and land on a grass strip on the northern half of Wedge Island. Mr. Norman Growden (phone 44230 Koppio, S.A.), the owner of the island, has a landrover which is kept in a building near the airstrip. Follow the track to the homestead and continue for about two miles to the lighthouse on the southeast point of the island.

Landing by dinghy at the jetty or on the sandy beach on the northeast coast is possible in fair weather.

ELEVATION: 217 meters

SKETCH: See next page.

GEOGRAPHICAL COORDINATES		UTM PROJ., CLARKE 1858 SPHEROID ZONE 53, C.M. 135° EAST	
Latitude	Longitude	North	East
35°10'31"35 S	136°29'14"79 E	6,106,694 meters	635,452 meters

STA. WEDGE ISLAND — AUSTRALIA

LAT. $35^{\circ}10'31''35$ S

N 6,106,694 meters

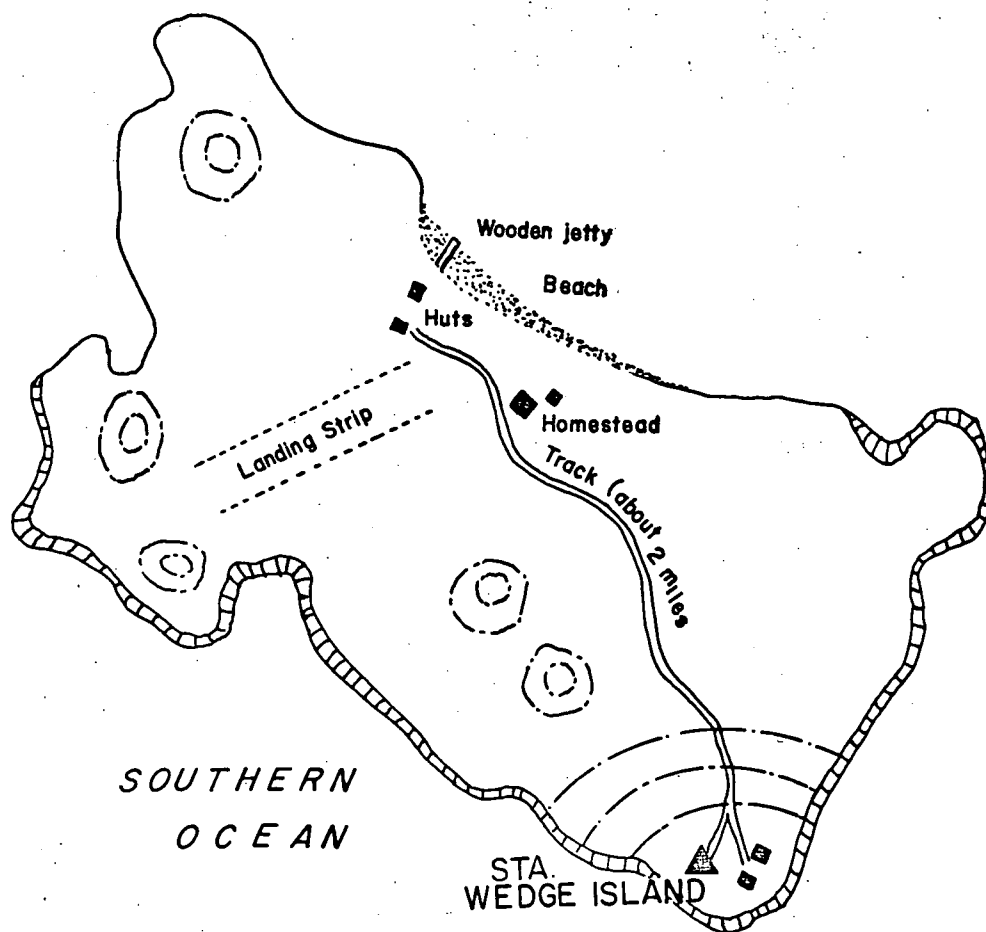
LONG. $136^{\circ}29'14''79$ E

E 635,452 meters

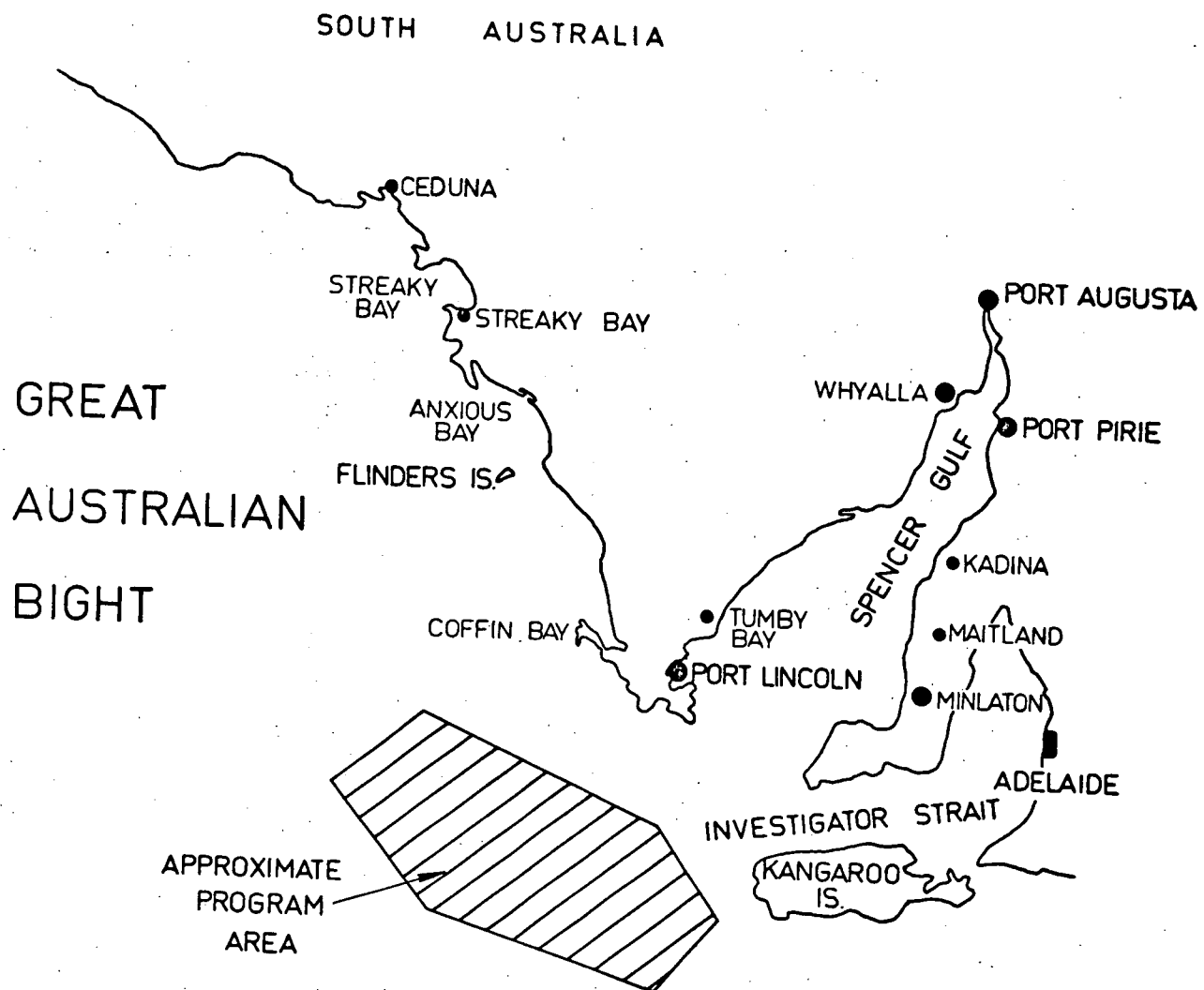
ELEV. 217 meters

U.T.M. PROJECTION, CLARKE 1858 SPHEROID

ZONE 53

C.M. 135° E

AREA OF OPERATIONS



037

ADDENDUM

TO

FINAL REPORT
OFFSHORE NAVIGATION, INC.
PROJECT 507

for
GEOPHYSICAL SERVICE INTERNATIONAL
SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

SOUTH AUSTRALIA
OCTOBER - NOVEMBER 1971



3821-1

OFFSHORE NAVIGATION, INC.

ADDENDUM

038

On the evening of 28 October 1971, the M/V R.C. DUNLAP attempted a Shoran baseline crossing between Shoran Stations Point Avoid and Cape Du Coudic. This attempt was unsuccessful due to weather conditions. The vessel anchored for the day at approximately 2400 hours. Instructions to the Shoran stations were to return to operate at 0600 hours the following morning.

Shoran system was operational at 0600 hours 29 October 1971, but workable signals were not received by the recording vessel until 0830 hours. During the time period of 0600 to 0830 hours, the Shoran mobile indicating station became inoperative due to a faulty Shoran monitor. This monitor was replaced with the backup monitor on board. Upon replacing the Shoran monitor, Shoran signals were received and the mobile operator did not take time to go through the proper sequence of checking out the backup monitor since geophysical operations was being delayed due to the Shoran difficulties.

After surveying approximately five lines, the recording vessel made a circle for reasons other than Shoran. At this time, proper checking out was accomplished on the backup monitor and was discovered to be one mile off on

ADDENDUM . (continued)

039

one of its ranges. This difficulty was corrected in the field by adjustments by the Shoran mobile operator.

All geophysical survey involved with this one mile discrepancy was re-surveyed at a later date.

DISTRIBUTION

040

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041

OPERATIONS REPORT
MARINE SEISMIC SURVEY
SOUTH AUSTRALIA OFFSHORE PROGRAM
1971
DUNTROON BASIN SA6, SA7

For

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
G.P.O. Box 872K, Melbourne, Victoria.

Client Representative : B. Tiger

By

GEOPHYSICAL SERVICE INTERNATIONAL
P.O. Box 437, Crows Nest, N.S.W.
Party 909 M.V. "R.C. Dunlap"

Operations Supervisor : J. Quisenberry
Quality Control Seismologist : A. Chan

29th October - 12th November, 1971

14th January - 15th January, 1972

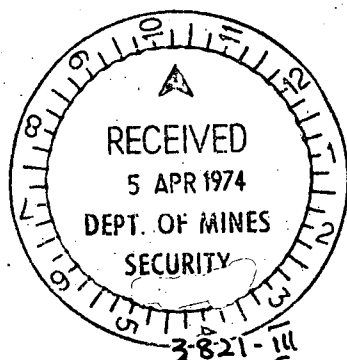




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	(B) Instrument and Noise Tests	2
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	(D) Recording	6
	(E) Survey	10
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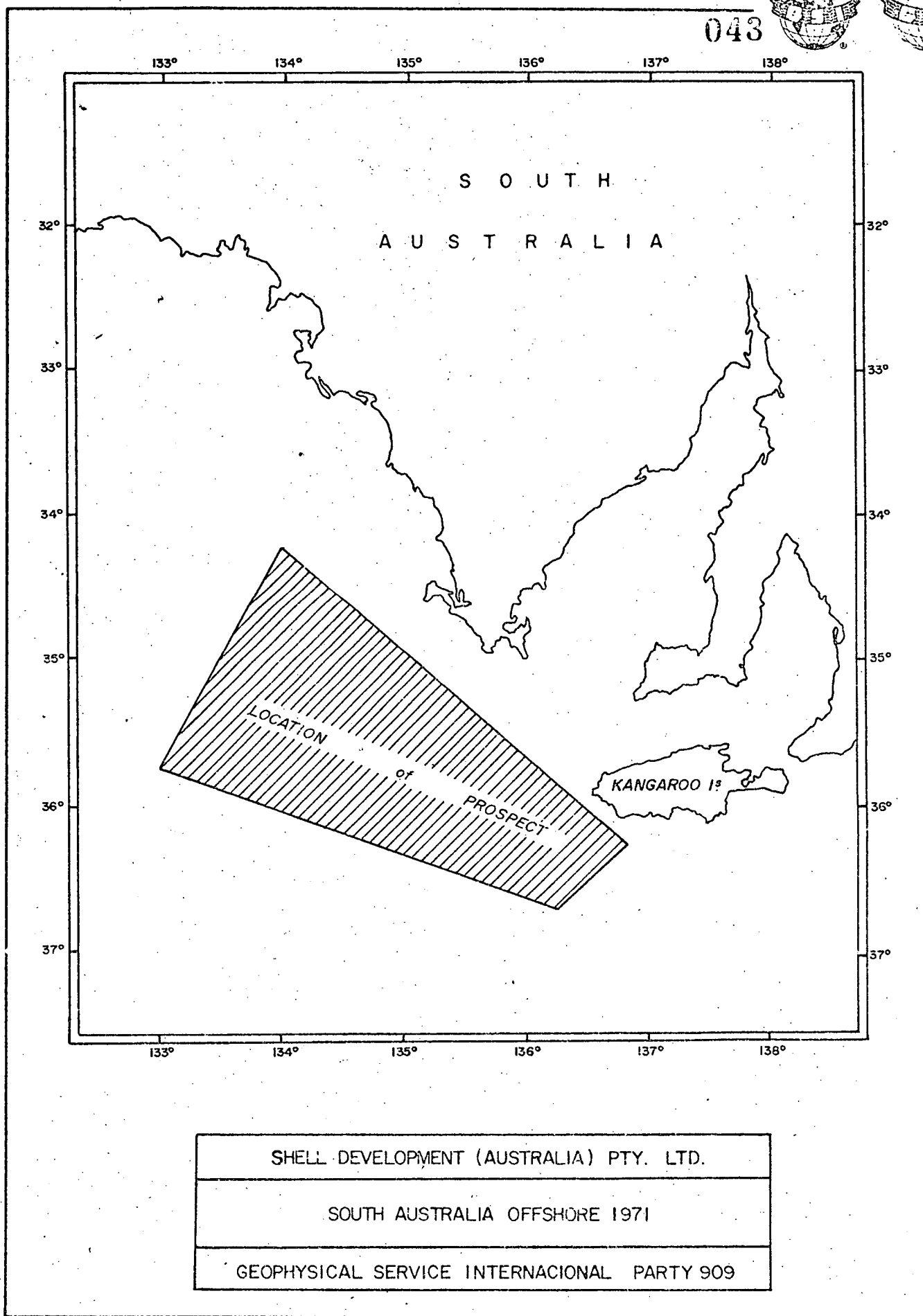
LIST OF APPENDICES

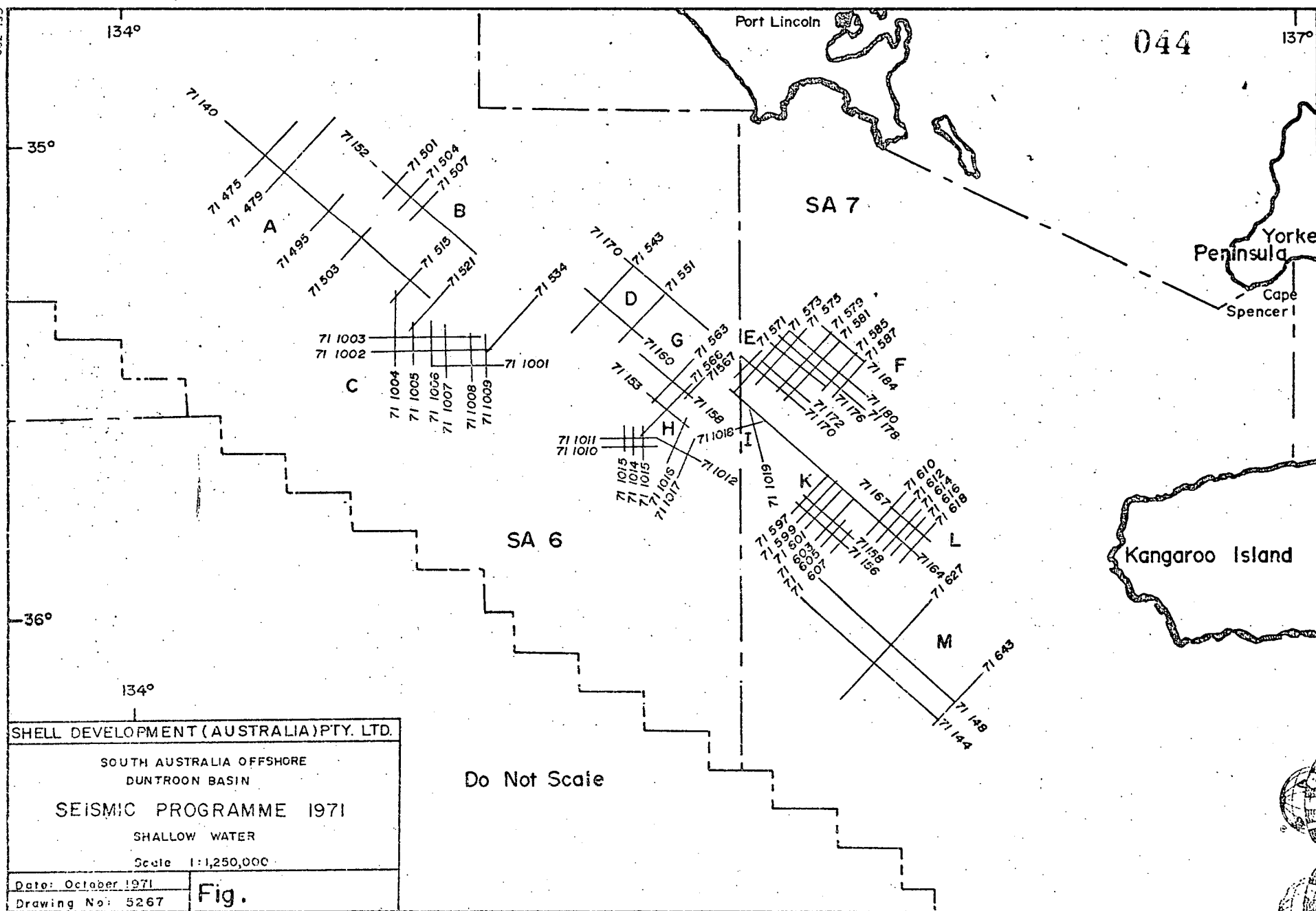
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B	KEY PERSONNEL
C	EQUIPMENT
D	OPERATIONS STATISTICS

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1	LOCATION AND INDEX MAP
2	DETAIL LOCATION MAP
3	CABLE AND SPREAD ARRANGEMENT
4	AIRGUN ARRAY
5	PULSE AND AMPLITUDE SPECTRUM

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SECTION I

045

INTRODUCTION

A seismic reflection survey was conducted by the M.V. "R.C. Dunlap" in the Duntroon Basin SA6, SA7 off South Australia (29th October - 12th November, 1971).

Approximately 1,400 kilometers of 24-fold reflection coverage were shot utilizing a 2400 meter, 48 live group streamer under continuous tow in conjunction with a pneumatic acoustic energy source (a tuned array of airguns). The ship's position was determined by Offshore Navigation Inc.'s XR Shoran system occupying shore-based stations specified by Shell.

All recordings were made using two sets of DFS III's, with three tape transports recording on 1" tape in 21 track TIAC* Binary Gain Digital Format. Normal recording length was 5 seconds with increased record length in deeper water. In all instances, the sample rate was 4 milliseconds.

Due to an error in survey, six lines (1004-1009) were shot in the wrong position. These were shifted approximately one mile towards the west. The "Dunlap" returned on the 14th January, 1972 and re-shot these lines in the correct position.

* Trademark of Texas Instruments



SECTION II

046

OPERATION PROCEDURES

(A) Fathometer Survey :

Two fathometers were used, a Ross Continuous Recording Echo Sounder (0 - 400 fathoms) in water depths up to 400 fathoms and an ELAC DENEb LAZ-17DDL (0 - 2200 fathoms) in water depths greater than 400 fathoms. Each fathogram was identified by line number, direction shot, time and date of first shotpoint and scale used. An automatic mark was made on the fathograms every fourth airgun "pop" starting with the first "pop" on the line. The fathograms were labelled every 10 shotpoints; i.e., 40 airgun "pops".

The transducers for the fathometers are located 8.6 meters forward from two XR Shoran Antennae, and 11 feet below the mean water line of the vessel. The zero line for the Ross fathometer fathograms was not corrected for the ship's draught. The zero line for the ELAC fathometer fathograms was corrected for the ship's draught.

(B) Instrument and Noise Tests :

Instrument tests were carried out prior to each day's operations and the results examined in an analogue form in the field. These tests consisted of Dynamic Range Determination, Amplifier Noise Test and an Automatic Gain Control (AGC) Oscillator Test.



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Monthly instrument tests were recorded on tape and forwarded to G.S.I.'s Sydney Processing Center for computer analysis.

These tests or measurements included Harmonic Distortion, Gain Linearity, Periodic Calibration Checks, Skew Checks and the aforementioned daily instrument tests.

A Streamer Noise Analysis was made at the beginning and at the end of each line shot. Some of these tests were recorded on tape.

(C) Energy Source (Airguns) :

An Electro-Pneumatic Acoustic Energy Source known as "Airguns" was used for all reflection work.

The airgun has basically two moving parts, the shuttle and the solenoid. Compressed air is supplied to this unit at a pressure of 2000 lbs. per square inch. The shuttle is forced to close on initial application of pressure. Compressed air fills the reservoir chamber through a central orifice in the shuttle. To discharge the gun an electrical current activates the solenoid and retracts a plunger thus enabling compressed air to pass through a port hole to the underside of a flange at the top of the shuttle. The pressure difference above and below the shuttle then thrusts it open.



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The air from the chamber then escapes through four port holes near the center of the gun and expands rapidly through the water producing a single bubble and resultant shock wave. The air bubble collapses in a manner similar to that caused by explosives with one notable exception that its period is controllable and is placed in the desired seismic frequency band.

There are three variables used to control the frequency content of the shock wave :

- i) the depth of the airgun in the water
- ii) the pressure at which the gun is operated, and
- iii) the size of the chambers used on the gun.

Using different guns of various chamber sizes broadens and flattens the frequency spectrum of the pulse.

The depth of the airguns was 30 feet and were operated at a pressure of 1800 lbs. per square inch. The individual airguns were arranged to produce a 1300 cubic inch array. This array consisted of :

- i) 1 x 400 cubic inch array; using
4 x 100 cubic inch guns.
- ii) 1 x 240 cubic inch array; using
2 x 100 cubic inch guns, plus
1 x 40 cubic inch gun.



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- iii) 2 x 120 cubic inch array; using
1 x 100 cubic inch gun, plus
1 x 20 cubic inch gun.
- iv) 2 x 80 cubic inch array; using
1 x 80 cubic inch guns.
- v) 4 x 40 cubic inch array; using
1 x 40 cubic inch gun.
- vi) 4 x 20 cubic inch array; using
1 x 20 cubic inch gun.
- vii) 2 x 10 cubic inch array; using
1 x 10 cubic inch gun.

These arrays were arranged and spaced so as to operate as a tuned array which yielded a flat frequency spectrum between 8 and 60 Hz. (Plate 5.)

The time co-ordinator unit triggered the Digital Field System which in turn discharged the Texas Instrument Airgun Control Unit (blaster) causing a current to flow simultaneously through all the solenoids, resulting in the guns firing. The guns were fired every 50 meters giving a 24-fold coverage using the 2400 meter streamer. The airgun array was mounted on two, one port astern and the other starboard astern, metal frames (Fish) and towed behind the recording vessel at a distance of 62 feet.



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(D) Recording :

The recording was done using a Texas Instruments Digital Field System, two sets of DFS III's, with 3 tape transports. Direct (RAW) monitors were generated every shotpoint and Amplifier monitors every tenth shotpoint for quality control purposes.

The 2400 meter, neutrally buoyant, continuous tow streamer consisted of 48 live sections each 50 meters in length and 6 Waterbreak/Depth Transducer sections each 2 meters in length, placed immediately in front of group 48, between groups 40 and 41, 30 and 31, 20 and 21, 10 and 11 and 2 and 3. Six nylon stretch sections were placed between group 48 and the recording vessel to attenuate ship generated noise.

One nylon stretch section followed group 1 and was joined to the tailbuoy by 400 feet of nylon rope. Tailbuoy bearings were taken by radar every 10 shotpoints to ensure that the cable was inline. Five Condep* cable depth controllers were placed between the depth transducers on the streamer at the center of a live group where the hydrophone spacing is greatest.

The average streamer depth was 50 feet.

The setback (Shoran antenna to shot distance) was 49.4 meters for all shotpoints.

* Trademark of Continental Oil Company



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2400 Meter All Live Streamer (Plate 3)

Type cable : 48 live group,
neutrally buoyant
universal gland
streamer.

Type of Detector : Pavey acceleration
cancelling.

Length of live section : 50 meters

Length of depth transducer
section : 2 meters

Distance group 1 to 48
(centers) : 2360 meters

Group Interval : 50 meters

Seismometers per group : 30

Seismometer Interval : Linear, 3'9" except
center two which are
27'4".

Texas Instruments DFS III - Dual System

System I - ODD groups 1 to 47 Serial No. 105

System II - EVEN groups 2 to 48 Serial No. 106

Instrument settings were kept the same on both systems.



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Reflection recording settings :

Gain Mode	: Binary Gain
Record Length	: Normal 5.0 seconds, greater in deep water
Sample Rate	: 4 milliseconds
Gain Constant	: 30 db
Attack Rate	: 1500 db/sec.
Final Gain	: 120 db
Trip	: As necessary
Initial Gains	: 42 db
Upper Set Limit	: 62.5%
Lower Set Limit	: 18.75%
Filters -	
Low cut	: 8 Hz, 18 db/octave
High cut	: 62 Hz, 72 db/octave
Release Rate	: Fast 94 db/sec.
Delay time for RAW Monitors caused by displacement of RAW and record heads	: 13.3 milliseconds



Tape Channel Allocations :

053

<u>Function</u>	<u>Trace No.</u>	<u>System</u>	<u>Tape Channel</u>
Timing	-	both	0
Streamer Odd groups 1 - 47	1 - 24	System I	1 - 24
Streamer Even groups 2 - 48	31 - 54	System II	1 - 24
Water Break 1 (in front of 48)	30	both	31
Water Break 2 (between groups 40 and 41)	27	both	28
Water Break 3 (between groups 30 and 31)	28	both	29
Water Break 4 (between groups 20 and 21)	30	both	31
Water Break 5 (between groups 10 and 11)	26	both	27
Water Break 6 (between groups 2 and 3)	27	both	28
Field Time Break	4	System I	-
Field Time Break	34	System II	-
DFS Synthetic Time Break	8	System I	-
DFS Synthetic Time Break	36	System II	-



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(E) Survey :

Shoran Survey : A separate report has been provided by Offshore Navigation Inc.

Preplots and Postplots were provided by Engineering Computer Services of Sydney, Australia.

(F) Magnetometer Survey :

The magnetometer was not in operation at any time during this "shallow water" portion of the survey.



SECTION III:

RECORD QUALITY

055

From field observations, data quality was generally good. The total energy capacity of the 1300 cubic inch array was never down more than 40 cubic inches on any given line due to the arrangement and quantity of individual spare guns within the array.

At the start of shooting (late October - early November) the weather was consistently bad and hence cable noise was amplified in the near traces by boat noise.

In general, cable noise was acceptable, ranging from 16 uV for far traces to approximately 6 uV for near traces. Noise tests were run both before and after shooting a line to verify that noise levels were within acceptable limits.

Cable ballasting caused problems in some earlier lines. In particular, the front of the cable showed depth variations of up to 30 feet. The cable was soon stabilized by removing the pig and adding weights to the stretch sections. This adjustment produced a stable cable within the depth specifications (50' - 60').

During the reshoot of Lines 1004 - 1009 (January, 1972) major attention was paid to the surveying. A base line crossing was taken on 12th January, 1972 and three-way fixes were taken wherever possible. Although signals from the Wedge Island station were weak, results were satisfactory.



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Respectfully submitted,
GEOPHYSICAL SERVICE INTERNATIONAL

William J. Pailthorpe

William J. Pailthorpe
Party Chief.

Kenneth W. Graybill

Kenneth W. Graybill
Supervisor.

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APPENDIX ALINE INDEX; G.S.I. VS. SHELL SHOTPOINTS

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
29/10/71	71-1009	1-233	280-338	1001	1002
					1003
	71-1008	234-569	333-250	1001	1003
				1003	1004
				1005	1006
71-1007	570-869	280-354	1005	1006	
			1007		
30/10/71	71-1006	965-1260	280-353	1007	1008
				1009	
	71-1005	1261-1488	336-280	1009	1010
	71-1004	1489-1828	290-374	1009	1010
				1011	1012
	71-1003	1866-2317	1540-1652	1011	1012
				1012	1013
				1014	

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<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
30/10/71	71-1002	2318-2834	1669-1540	1014	1013
				1015	1015
				1017	1016
31/10/71	71-1001	2835-3202	1590-1681	1017	1016
				1018	1018
					1019
	71-160	3559-3975	730-834	1020	1019
				1021	1021
					1022
	71-158 (N)	3976-4344	830-922	1021	1022
				1023	1024
	71-1013	4469-4641	853-310	1024	1025
				1026	
1/11/71	71-1014	4642-4813	310-352	1026	1025
	71-1015	4814-5009	348-300	1026	1025
					1027
	71-1010	5010-5273	1675-1610	1027	1028
				1029	
	71-1011	5274-5546	1620-1688	1029	1028
					1030



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<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
1/11/71	71-1012	5547-5815	920-987	1029	1030
				1030	1031
				1032	
	71-1017	5816-6057	390-330	1032	1031
					1033
	71-1016	6058-6341	350-420	1032	1033
				1033	1034
	71-567	6342-6513	440-482	1033	1034
				1035	
				1035	1034
	71-566	6514-6886	453-360		1036
					1036
	71-563	6887-7215	430-512	1035	1036
				1036	1037
1038					
2/11/71	71-571	7216-7403	520-566	1038	1037
					1039
	71-573	7404-7855	582-470	1038	1039
				1039	1040
				1041	
	71-575	7856-8332	520-639	1041	1040
				1042	1042
				1044	1043

A-3



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<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>	
2/11/71	71-579	8333-8805	638-520	1044	1043	
				1045	1045	
					1046	
	71-581	8806-9306	520-645	1045	1046	
				1047	1048	
3/11/71	71-585	9307-9637	632-561	1047	1048	
				1048	1049	
				1050		
		71-587	9638-9906	560-627	1050	1049
						1051
	71-184	9967-10387	1025-920	1050	1051	
				1051	1052	
				1053		
	71-180	10388-10904	920-1049	1053	1052	
				1054	1054	
				1056	1055	
	71-597	10905-11125	447-392	1056	1055	
11180-11288B		380-407		1057		
71-599	11289-11609	380-460	1057	1058		
71-601	11610-11926	459-380	1059	1058		
				1060		



061

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
4/11/71	71-603	11927-12235	380-457	1059	1060
				1060	1061
				1062	
	71-605	12236-12436	430-380	1062	1061
					1063
	71-607	12437-12617	380-425	1062	1063
	71-167	12618-12942	1140-1221	1063	1064
				1065	
	71-618	12943-13251	497-420	1065	1066
	71-616	13252-13568	420-499	1065	1066
				1066	1067
				1068	
	71-614	13569-13877	497-420	1068	1067
				1069	1069
					1070
71-612	13878-14190	420-498	1069	1070	
			1071		
71-610	14191-14503	498-420	1071	1070	
				1072	
71-156	14504-14872	1162-1070	1072	1073	
			1074		

A-5



A-6

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>062 FIELD TAPE NO. (EVEN SYSTEM)</u>
4/11/71	71-158	14882-15238	1070-1159	1074 1075	1073 1075 1076
5/11/71	71-148	15239-16137	1140-1364	1077 1080 1081	1078 1079 1080 1082
	71-643	16138-16514	414-320	1081 1083	1082
	71-144	16515-17432	1363 ~~540-1140~~	1084 1086 1087	1083 1085 1086 1088
8/11/71	71-178	17457-18021	1061-920	1087 1089 1090	1088 1089
	71-176	18022-18402	920-1015	1090 1092	1089 1091
9/11/71	71-172	18403-18772	1004-920	1092 1093	1091 1092 1094



A-7

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>063 FIELD TAPE NO. (EVEN SYSTEM)</u>
9/11/71	71-1019	18773-19037	466-400	1093	1094
				1095	
	71-1018	19038-19222	440-486	1095	1094
				1096	1095
	71-170	19223-20247	1006-750	1096	1095
				1098	1097
				1099	1098
				1101	1100
				1101	1100
				1102	1101
10/11/71	71-543	20248-20616	430-522	1102	1103
				1104	
	71-551	20617-21021	541-440	1102	1104
				1105	1106
	71-153	21022-21322	860-935	1105	1106
				1107	1107
				1108	1109
				1110	1110
				1111	1112
				1111	1112
71-164	21323-22527	920-1221	1113	1113	
			1114	1115	
			1114		
			1114		
71-627	22528-23192	436-270			



064

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
11/11/71	71-140	23193-24529	614-280	1114	1115
				1116	1116
				1117	1118
				1119	1119
				1120	1121
	71-475	24530-24938	442-340	1120	1121
				1122	1122
				1123	
	71-479	24939-25479	340-475	1123	1122
				1125	1124
	71-152	25480-26204	430-611	1126	1125
				1128	1127
				1129	1128
	71-534	26205-26557	458-370	1129	1128
					1130
	71-521	26558-26926	340-423	1129	1130
				1131	1132
12/11/71	71-515	26927-27244	413-340	1132	1131
				1134	1133
	71-503	27245-27513	340-407	1134	1133
				1135	1134

A-8



<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>065 FIELD TAPE NO. (EVEN SYSTEM)</u>
12/11/71	71-507	27514-27798	430-501	1135	1134
					1136
	71-504	27799-28051	493-430	1135	1136
				1137	
	71-501	28052-28300	492-430	1138	1137
	71-495	28333-28605	408-340	1138	1139
				1140	
14/1/72	71-1009A	33001-33229	280-337	1161	1162
	71-1008A	33230-33562	333-250	1163	1162
				1164	1163
	71-1007A	33563-33859	280-354	1164	1163
				1166	1165
	71-1006A	33861-34145	351-280	1166	1165
				1167	1166
					1168
15/1/72	71-1005A	34145-34370	280-336	1167	1168
				1169	
	71-1004A	34371-34707	374-290	1169	1168
				1170	1169
					1171





APPENDIX B

066

KEY PERSONNEL

Operations Supervisor	J. Quisenberry
Administrator	B. Schaefer
Party Manager	T. Kerlin
Quality Control Seismologists	A. Chan
	B. Beer
Instrument Engineers	J. Stirling
	D. Lanyon
Airgun Mechanic	A. Raitano
Cableman	M. Tacticos
Captain	J.R. Bradley
O.N.I. Survey Party Chief	D. Easterbrook
O.N.I. Mobil Operators	M. Carney
	G. Barnes



APPENDIX C

067

EQUIPMENT

M.V. "R.C. DUNLAP"

Length (overall)	: 165 feet
Beam	: 36 feet
Draught	: 11 feet
Gross Tonnage (with helicopter deck)	: 475 tons
No. Shafts	: 2
Main Engines	: 2 - General Motors Diesels 1600 h.p. each
Berthing Facilities	: 30
Radar	: Decca RM-326. Range 48 miles Raymarc. Range 48 miles
Auto Pilot	
Radio Direction Finder	
Gyrocompass	: Sperry Rand MK-227 Geo Nav II.
Endurance	: 25 days
Radios	: (1) Collins SSB Model MR-102. 150; 400; 1000 watts. Direct contact with KUK Dallas. : (2) Simrad Radiotelephone (AM). : (3) RF 6 SFB-SSB radio; 125 watts 5 Crystal Frequencies. : (4) VHF RF Comm. Inc. Radiotelephone 14 channels.



068

- Fathometers
- : (1) Ross Continuous Recording Echo Sounder. 0 - 400 fathoms range.
 - : (2) Simrad Look-ahead Sonar Model SB-2. Sweep - straight ahead to 30° down. Azimuth 0 to 360°. Range approximately ½ mile.
 - : (3) ELAC DNEB LAZ-17 0 - 2200 fathoms.
- Ship's Crew
- : 10
- Seismic Crew
- : 14 to 16 including 2 Geo Nav II Operators.

RECORDING EQUIPMENT

- Digital Recording Instruments
- : 2 sets of 24 channel Texas Instruments DFS III's (Binary Gain) with three tape transports for 48 trace recording. 2500 foot one-inch tapes, 21 tracks, TIAC tape format.
- Streamers
- : (1) 2400 meter, 48 traces with 30 Pavey acceleration cancelling hydrophones per trace.
 - : (2) 1600 meter, 24 traces with 21 Texas Instruments Hydrophones per trace.
(Tapered array - convertible to 2400 meters.)
- Six waterbreak amplifiers.
- Six depth transducers with separate meters.
- Six Condep* Fins for depth control.

Tailbuoy with radar reflector

* Trademark of Continental Oil Company



069

Air Compressors : Three General Motors Model G71 diesels with three Chicago P.B.-44 Compressors (2000 psi).

Texas Instruments Airgun Control Unit - Model 30. : Pressure monitors for individual airguns.

Tuned Array of Airguns (diagram attached) : Consisting of 23 guns with spares mounted on two fish for 1300 cubic inch arrays.

Explosives Shooting : Radios, blasters and firing lines (capable of single boat explosives work).

Varian Marine Proton Magnetometer.

Texas Instruments Servo-writer II profiler unit providing an onboard single trace display.

SIE VRO-10 photo-oscillograph with 54 galvos - to provide field playbacks or monitors for quality control.

NAVIGATION EQUIPMENT

Geo Nav II Satellite Navigation or conventional shore based systems as required.



070

APPENDIX D

OPERATIONS STATISTICS

Prospect : Great Australian Bight,
South Australia.

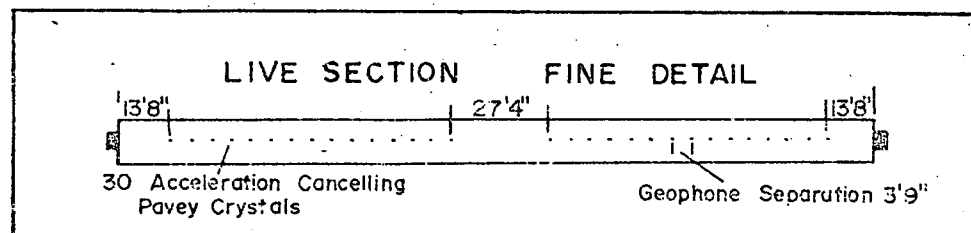
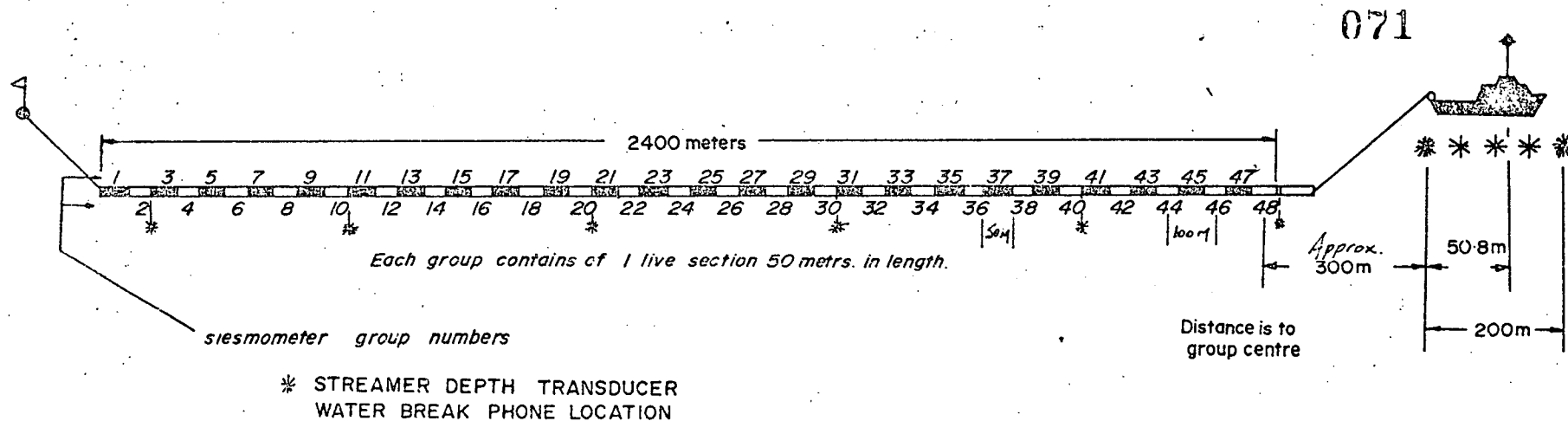
Operational Period : 29th October to 12th November, 1971.
14th January to 15th January, 1972
(reshoot).

Time Spent on Prospect : 17 days

Time Spent on Recording : 13 days

Time Lost due to Bad Weather: 3 days

Total Miles Shot : 859 miles



FISH STBD	cu. inch.	120	80	40	20	10	= 530 cu. inch.
	guns	2	2	2	2	1	
FISH PORT	cu. inch.	400	240	40	20	10	= 770 cu. inch.
	guns	1	1	2	2	1	

1300 cu. inch.

MARINE CABLE DIAGRAM 2400 METER

(OFF END SPREAD - 48 GROUPS)

GSI Party 909

Ship M/V DUNLAP

Client SHELL DEVELOPMENT

Area SOUTH AUSTRALIAN BIGHT

Date NOVEMBER 1971

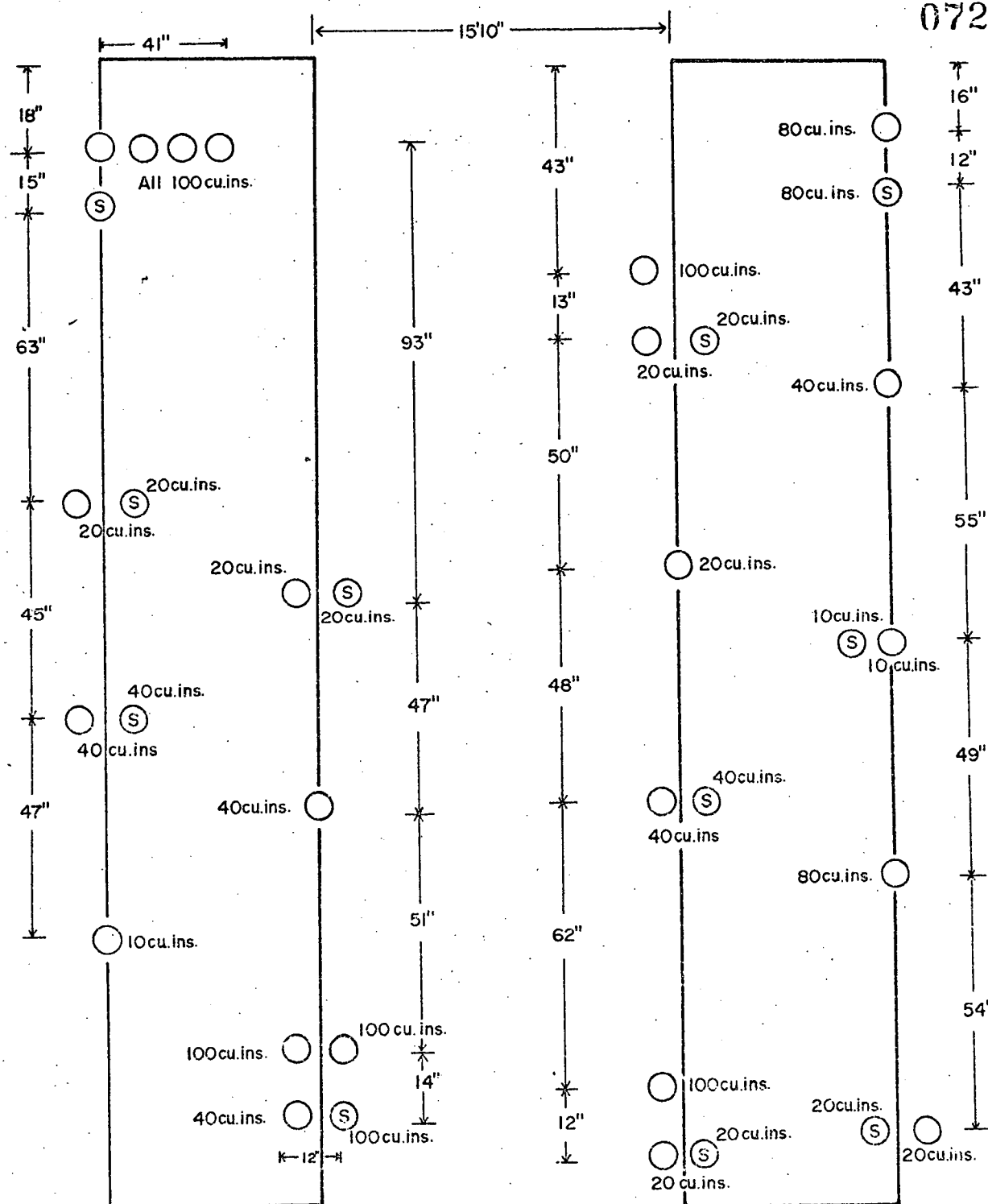




PORT

STARBOARD

072



S = Spare Gun

M.V. "R.C. DUNLAP"

Depth 30 ft.
Pressure 2000 psi.

1300 cubic inch

AIR GUN ARRAY

AMPLITUDE

PULSE

0 100 200
MILLISECONDSRELATIVE
AMPLITUDE (DB)AMPLITUDE
SPECTRUM-20 0 20
0 20 40 60 80 100
FREQUENCY (HZ)

GUN

1 X 400

1 X 240

2 X 120

2 X 80

4 X 40

4 X 20

2 X 10

SIZES

cubic inches.

" "

" "

" "

" "

" "

" "

AIRGUN ARRAY PULSE AND SPECTRUM

Vessel M/V R.C. DUNLAPArray Capacity 1300 cubic inchesRecording Filter out-248 HzDate 29th October 1971



074

OPERATIONS REPORT
MARINE SEISMIC SURVEY
SOUTH AUSTRALIA OFFSHORE PROGRAM
1971
SOUTH AUSTRALIAN BIGHT SA5, SA6, SA10, SA11.

FOR

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
G.P.O. Box 872K, Melbourne, Victoria.

Client Representative : George Watkins

BY

GEOPHYSICAL SERVICE INTERNATIONAL
P.O. Box 437, Crows Nest, N.S.W.

Party 909 M.V. "R.C. Dunlap"

Operations Supervisor : J. Quisenberry
Quality Control Seismologist : A. Chan

14th November - 16th November, 1971.

25th January - 11th February, 1972.

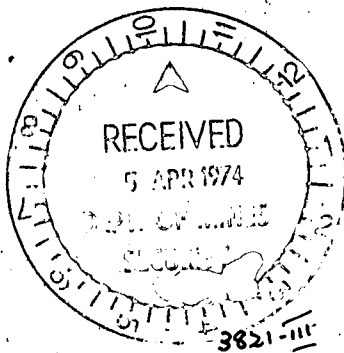




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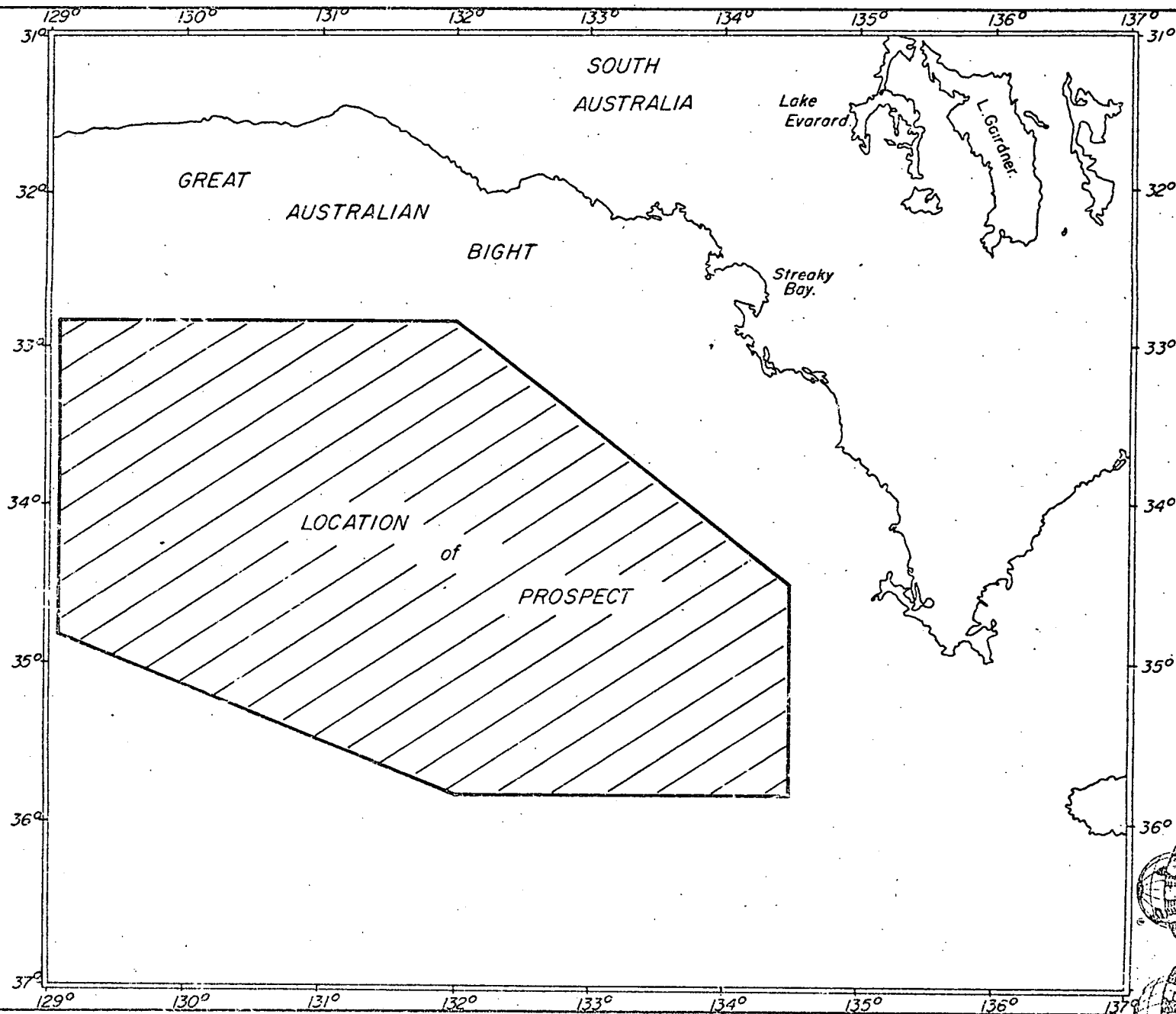
<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
I	INTRODUCTION	1
II	OPERATION PROCEDURES	
	(A) Fathometer Survey	2
	(B) Instrument and Noise Tests	2
	(C) Energy Source (Airguns)	3
	(D) Recording	6
	(E) Survey	9
	(F) Magnetometer Survey	9
III	RECORD QUALITY	10

LIST OF APPENDICES

<u>APPENDIX</u>	<u>TITLE</u>
A	LINE AND SHOTPOINT INDEX
B	KEY PERSONNEL
C	EQUIPMENT
D	OPERATIONS STATISTICS

LIST OF PLATES

<u>PLATE</u>	<u>DESCRIPTION</u>
1	LOCATION AND INDEX MAP
2	DETAIL LOCATION MAP
3	CABLE AND SPREAD ARRANGEMENT
4	AIRGUN ARRAY
5	PULSE AND AMPLITUDE SPECTRUM

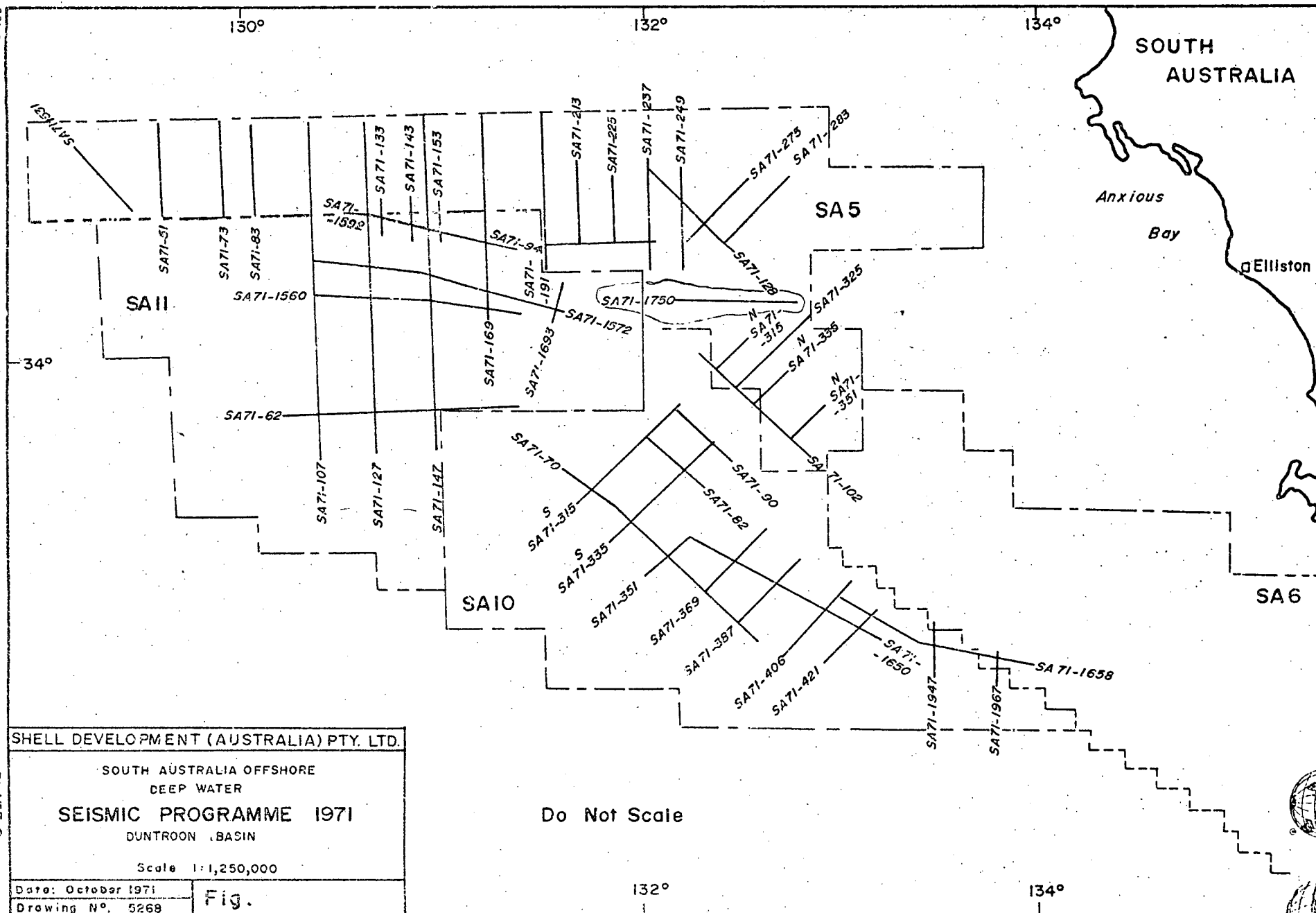


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

SOUTH AUSTRALIA OFFSHORE 1971

GEOPHYSICAL SERVICE INTERNATIONAL PARTY 909







SECTION I

INTRODUCTION

078

A seismic reflection survey was conducted by the M.V. "R.C. Dunlap" in the South Australian Bight (SA5, SA6, SA10, SA11) off South Australia. Five lines (170 kms) were shot in November 1971 and the remaining lines were shot between the 25th January and 11th February, 1972.

Approximately 2800 kilometers of 24-fold reflection coverage were shot utilizing a 2400 meter, 48 live group streamer under continuous tow in conjunction with a pneumatic acoustic energy source (a tuned array of air-guns). Forty-eight live groups were used for recording in less than 1,000 feet of water and 24 traces (either odd or even numbered groups) were used for recording in water depths exceeding 1,000 feet.

All recordings were made using two sets of DFS III's, with three tape transports recording on 1" tape in TIAC* Binary Gain Digital Format. Normal recording length was 5 seconds for the shallower water (500'); 6 seconds for 500' to 2500' and 7 seconds for water depths greater than 2500'. In all instances, the sample rate was 4 milliseconds.

The ship's position was determined by Offshore Navigation Inc's XR Shoran system occupying shore based stations specified by Shell.

* Trademark of Texas Instruments Inc.



SECTION II

079

OPERATION PROCEDURES

(A) Fathometer Survey :

Two fathometers were used, a Ross Continuous Recording Echo Sounder (0 - 400 fathoms) in water depths up to 400 fathoms and an ELAC DENEBA LAZ-17 DDL (0 - 2200 fathoms) in water depths greater than 400 fathoms. Each fathogram was identified by line number, direction shot, time and date of first shotpoint and scale used. An automatic mark was made on the fathograms every fourth airgun "pop" starting with the first "pop" on the line. The fathograms were labelled every 10 shotpoints; i.e., 40 airgun "pops".

The transducers for the fathometers are located 8.6 meters forward from two XR Shoran Antennae, and 11 feet below the mean water line of the vessel. The zero line for the Ross fathometer fathograms was not corrected for the ship's draught. The zero line for the ELAC fathometer fathograms was corrected for the ship's draught.

(B) Instrument and Noise Tests :

Instrument tests were carried out prior to each day's operations and the results examined in an analogue form in the field. These tests consisted of Dynamic Range Determination, Amplifier Noise Test and an Automatic Gain Control (AGC) Oscillator Test.



080

Monthly instrument tests were recorded on tape and forwarded to G.S.I.'s Sydney Processing Center for computer analysis.

These tests or measurements included Harmonic Distortion, Gain Linearity, Periodic Calibration Checks, Skew Checks and the aforementioned daily instrument tests.

A Streamer Noise Analysis was made at the beginning and at the end of each line shot. Some of these tests were recorded on tape.

(C) Energy Source (Airguns) :

An Electro-Pneumatic Acoustic Energy Source known as "Airguns" was used for all reflection work.

The airgun has basically two moving parts, the shuttle and the solenoid. Compressed air is supplied to this unit at a pressure of 2000 lbs. per square inch. The shuttle is forced to close on initial application of pressure. Compressed air fills the reservoir chamber through a central orifice in the shuttle. To discharge the gun an electrical current activates the solenoid and retracts a plunger thus enabling compressed air to pass through a port hole to the underside of a flange at the top of the shuttle. The pressure difference above and below the shuttle then thrusts it open.



081

The air from the chamber then escapes through four port holes near the center of the gun and expands rapidly through the water producing a single bubble and resultant shock wave. The air bubble collapses in a manner similar to that caused by explosives with one notable exception that its period is controllable and is placed in the desired seismic frequency band.

There are three variables used to control the frequency content of the shock wave :

- i) the depth of the airgun in the water
- ii) the pressure at which the gun is operated, and
- iii) the size of the chambers used on the gun.

Using different guns of various chamber sizes broadens and flattens the frequency spectrum of the pulse.

The depth of the airguns was 30 feet and were operated at a pressure of 1800 lbs. per square inch. The individual airguns were arranged to produce a 1300 cubic inch array. This array consisted of :

- i) 1 x 400 cubic inch array; using
4 x 100 cubic inch guns.
- ii) 1 x 240 cubic inch array; using
2 x 100 cubic inch guns, plus
1 x 40 cubic inch gun.



082

- iii) 2 x 120 cubic inch array; using
1 x 100 cubic inch gun, plus
1 x 20 cubic inch gun.
- iv) 2 x 80 cubic inch array; using
1 x 80 cubic inch gun.
- v) 4 x 40 cubic inch array; using
1 x 40 cubic inch gun.
- vi) 4 x 20 cubic inch array; using
1 x 20 cubic inch gun.
- vii) 2 x 10 cubic inch array; using
1 x 10 cubic inch gun.

These arrays were arranged and spaced so as to operate as a tuned array which yielded a flat frequency spectrum between 8 and 60 Hz. (Plate 5.)

The time co-ordinator unit triggered the Digital Field System which in turn discharged the Texas Instruments Airgun Control Unit (blaster) causing a current to flow simultaneously through all the solenoids, resulting in the guns firing. The guns were fired every 50 meters giving a 24-fold coverage using the 2400 meter streamer. The airgun array was mounted on two, one port astern and the other starboard astern, metal frames (Fish) and towed behind the recording vessel at a distance of 62 feet.



(D) Recording :

083

The recording was done using a Texas Instruments Digital Field System, two sets of DFS III's, with 3 tape transports. Direct (RAW) monitors were generated every shotpoint and Amplifier monitors every tenth shotpoint for quality control purposes.

The 2400 meter, neutrally buoyant, continuous tow streamer consisted of 48 live sections each 50 meters in length and 6 Waterbreak/Depth Transducer sections each 2 meters in length, placed immediately in front of group 48, between groups 40 and 41, 30 and 31, 20 and 21, 10 and 11 and 2 and 3. Six nylon stretch sections were placed between group 48 and the recording vessel to attenuate ship generated noise.

One nylon stretch section followed group 1 and was joined to the tailbuoy by 400 feet of nylon rope. Tailbuoy bearings were taken by radar every 10 shotpoints to ensure that the cable was inline. Five Condep** cable depth controllers were placed between the depth transducers on the streamer at the center of a live group where the hydrophone spacing is greatest.

The average streamer depth was 50 feet.

The setback (Shoran antenna to shot distance) was 49.4 meters for all shotpoints.

** Trademark of Continental Oil Company.



084

2400 Meter All Live Streamer (Plate 3)

Type cable : 48 live group,
neutrally buoyant
universal gland
streamer.

Type of Detector : Payey acceleration
cancelling.

Length of live section : 50 meters

Length of depth transducer
section : 2 meters

Distance group 1 to 48
(centers) : 2350 meters

Group Interval : 50 meters

Seismometers per group : 30

Seismometer Interval : Linear, 3'9" except
center two which are
27'4".

Texas Instruments DFS III - Dual System

System I - ODD groups 1 to 47 Serial No. 105

System II - EVEN groups 2 to 48 Serial No. 106

Instrument settings were kept the same on both systems.



035

Reflection recording settings :

Gain Mode	: Binary Gain
Record Length	: Normal 5.0 seconds, greater in deep water.
Sample Rate	: 4 milliseconds
Gain Constant	: 30 db
Attack Rate	: 1500 db/sec.
Final Gain	: 120 db
Trip	: As necessary
Initial Gains	: 42 db
Upper Set Limit	: 62.5%
Lower Set Limit	: 18.75%
Filters -	
Low cut	: 8 Hz, 18 db/octave
High cut	: 62 Hz, 72 db/octave
Release Rate	: Fast 94 db/sec.
Delay time for RAW Monitors caused by displacement of RAW and record heads	: 13.3 milliseconds



086

(E) Survey :

Shoran Survey: A separate report has been provided by Offshore Navigation Inc.

Preplots and Postplots were provided by Engineering Computer Services of Sydney, Australia.

(F) Magnetometer Survey :

The magnetometer survey was carried out using a Varian Marine Magnetometer Model V-4970. The sensor was towed 145 meters behind the Shoran antennae to avoid any possible distortion of the data by the ship's metal hull. The depth of the sensor was approximately 30 feet.

A base magnetometer was in operation in Port Lincoln, South Australia, during the survey.



087

SECTION III

RECORD QUALITY

From field observations, data quality was excellent. The total energy capacity of the 1300 cubic inch array was never down more than 40 cubic inches on any given line due to the arrangement and quantity of individual spare guns within the array.

Lines shot with a water depth of 1,000 feet or less used all 48 groups of the system. In water depths exceeding 1,000 feet only 24 groups were used (i.e. either the odd or even numbered groups).

Cable noise remained within acceptable limits throughout the prospect, ranging from a maximum of 6 μ V for the near traces and 16 μ V for the far traces. Noise tests were run both at the beginning and end of each line. On the very long lines (99 miles), noise tests were run between shots.

A base line crossing between stations, Point Avoid and Streaky Bay, was made before the start of the prospect. A base line crossing between Koonalda and Streaky Bay stations could not be done as Koonalda had not been assembled at this time.



038

Three-way fixes were made regularly, whenever possible, at the beginning, the end or during lines. Results were generally good. Some fixes were inconclusive due to local weather conditions.

Respectfully submitted,
GEOPHYSICAL SERVICE INTERNATIONAL

William J. Pailthorpe,
Party Chief.

089

APPENDIX ALINE INDEX: G.S.I. VS. SHELL SHOTPOINTS

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
14/1/71	71-102	28606-30050	1301-940	1140 1141 1143 1144 1146 1147	1139 1142 1143 1145 1146 1148
15/1/71	71-315N	30051-30211 30253-30544	913-800	1147 1149 1150	1148 1149
	71-325	30545-31533	800-1047	1150 1152 1153 1155 1156	1149 1151 1152 1154 1155
	71-335N	31534-31979	911-800	1156 1158	1155 1157
16/1/71	71-351N	31980-32432	800-913	1158 1159	1157 1158 1160

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090

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
25/1/72	71-1750	35056-36224	1300-1592	1170 1172 1173 1175	1171 1173 1174 1176
	71-315S	36225-37561	360-694	-	1176-1180
26/1/72	71-70	37562-39962	800-1400	-	1180-1187
	71-387	39963-40813	380-593	-	1187-1190
	71-369	40814-41770	380-599	-	1190-1193
29/1/72	71-351S	41771-42371	360-510	-	1193-1195
	71-335S	42372-43728	360-699	-	1195-1199
	71-90	43729-44517	1000-1197	1200-1202	-
30/1/72	71-82	44518-45278	1000-1190	1202-1204	-
	71-1650	45279-47352	1400-1897	1204-1211	-
	71-1658	47362-48218	1740-1954	1211-1214	-
31/1/72	71-406	48219-49207	627-380	1214-1217	-
	71-421	49208-49948	400-585	1217-1219	-
	71-1658	49949-51135	1955-2232	1220-1223	-
	71-1967	51136-51556	100-205	1223-1224	-

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091

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>SHOTPOINTS</u>	<u>SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
1/2/72	71-1947	51557-52117	100-240	1225-1226	-
	71-128	52118-53344	250-556	1227 1228 1230 1231 1233	1228 1229 1231 1232
	71-225	53345-54033	960-1072	1233 1234 1236	1234 1235
2/2/72	71-237	54034-55194	800-1090	1236 1237 1239 1240 1242	1235 1237 1238 1240 1241
	71-249	55195-56195	800-1050	1242 1243 1245	1241 1243 1244 1246
	71-283	56200-57140	1061-1296	1246 1248 1249 1251	1247 1249 1250

A-3



092

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>	
3/2/72	71-275	57141-58057	980-1209	1251	1250	
				1252	1252	
				1254	1253	
						1255
	71-94	58058-59118	1001-1266	1255	1256	
				1257	1258	
				1258	1259	
				1260		
	71-1592	59123-60791	580-997	1260	1259	
				1261	1261	
				1263	1262	
				1264	1264	
				1266	1265	
				1267	1267	
				1269	1268	
71-133	60792-61208	800-904	1269	1270		
			1270	1271		
			1272			
4/2/72	71-1572	61209-61657 62125-62364	652-480	-	1271	
					1273	
					1275	
					1276	
	71-1572	61674-62099	648R-754	-	1274	
				1275		

A-4



093

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
5/2/72	71-1560	62411-63651	480-790	-	1276-1280
	71-1693	64408-64955	700-829	-	1282-1284
	71-213	64956-65792	900-1109	1272	1284
				1285	1285
				1286	1287
				1288	
	71-191	65793-67317	820-1201	1288	1287
				1289	1288
				1291	1290
				1292	1291
1294				1293	
1295				1294	
				1296	
6/2/72	71-1572	67318-68686	1079-737R	-	1296-1300
	71-153	68744-69256	900-1028	1295	1300
				1301	1301
				1302	1303
	71-147	69282-69425 69426-71645	855-890 861-300	1305	1303
				-	1303
				-	1304
				-	1306
				-	1307
				-	1308
-				1309	
			-	1310	
			-	1311	

A-5



094

<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
7/2/72	71-127	71646-73975	300-877	-	1311-1318
	71-127	73953-74858	877-1103	1305 1319 1320 1322	1318 1319 1321
	71-107	74859-75847	759-1006	1323 1325 1326	1322 1324 1325 1327
	71-107	75824-78083	763-200	-	1327-1334
8/2/72	71-62	78084-80288	240-791	-	1334-1341
	71-1560	80289-80993	952-776R	-	1341-1343
9/2/72	71-169	80994-81919	720-951	-	1343-1346
		81920-82974	952-1215	1347 1349 1350	1346 1348 1349 1351
	71-147	82975-83819	1102-891	1352 1353 1355	1351 1352 1354
	71-143	83820-84264	800-911	1356	1355 1357

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<u>DATE SHOT</u>	<u>LINE NO.</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>FIELD TAPE NO. (ODD SYSTEM)</u>	<u>FIELD TAPE NO. (EVEN SYSTEM)</u>
10/2/72	71-83	84265-85225	800-1040	1358	1357
				1359	1358
				1361	1360
				1362	1361
	71-73	85226-86186	800-1040	1362	1361
				1364	1363
				1365	1364
				1367	1366
	71-51	86187-87151	800-1041	1367	1366
				1368	1367
				1370	1369
				1371	1370
11/2/72	71-1531	87152-88081	100-308	1371	1370
				1373	1372
				1374	1373
					1375

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APPENDIX B

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KEY PERSONNEL

Operations Supervisor	J. Quisenberry
Administrator	I. Jones
Party Manager	T. Kerlin
Quality Control Seismologists	A. Chan P. Keegan
Instrument Engineers	D. Lanyon K. Booth
Airgun Mechanic	A. Raitano
Cableman	M. Tacticos
Captain	J.R. Bradley
O.N.I. Survey Party Chief	D. Easterbrook
O.N.I. Mobile Operators	M. Carney K. Molloy



APPENDIX C

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EQUIPMENT

M.V. "R.C. DUNLAP"

Length (overall)	: 165 feet
Beam	: 36 feet
Draught	: 11 feet
Gross Tonnage (with helicopter deck)	: 475 tons
No. Shafts	: 2
Main Engines	: 2 - General Motors Diesels 1600 h.p. each
Berthing Facilities	: 30
Radar	: Decca RM-326. Range 48 miles. Raymarc. Range 48 miles.
Auto Pilot	
Radio Direction Finder	
Gyrocompass	: Sperry Rand MK-227 Geo Nav II.
Endurance	: 25 days
Radios	: (1) Collins SSB Model MR-102. 150; 400; 1000 watts Direct contact with KUK Dallas. : (2) Simrad Radiotelephone (AM). : (3) RF 6 SFB-SSB radio; 125 watts 5 Crystal Frequencies. : (4) VHF RF Comm. Inc. Radiotelephone 14 channels.



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Air Compressors : Three General Motors Model G71 diesels with three Chicago P.B.-44 Compressors (2000 psi).

Texas Instruments Airgun Control Unit - Model 30. : Pressure monitors for individual airguns.

Tuned Array of Airguns (diagram attached) : Consisting of 23 guns with spares mounted on two fish for 1300 cubic inch arrays.

Explosives Shooting : Radios, blasters and firing lines (capable of single boat explosives work).

Varian Marine Proton Magnetometer.

Texas Instruments Servo-writer II profiler unit providing an onboard single trace display.

SIE VRO-10 photo-oscillograph with 54 galvos - to provide field playbacks or monitors for quality control.

NAVIGATION EQUIPMENT

Geo Nav II Satellite Navigation or conventional shore based systems as required.



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- Fathometers : (1) Ross Continuous Recording Echo Sounder. 0 - 400 fathoms range.
- : (2) Simrad Look-ahead Sonar Model SB-2. Sweep - straight ahead to 30° down. Azimuth 0 to 360°. Range approximately ½ mile.
- : (3) ELAC DNEB LAZ-17 0 - 2200 fathoms.
- Ship's Crew : 10
- Seismic Crew : 14 to 16 including 2 Geo Nav II Operators.

RECORDING EQUIPMENT

- Digital Recording Instruments : 2 sets of 24 channel Texas Instruments DFS III's (Binary Gain) with three tape transports for 48 trace recording. 2500 foot one-inch tapes, 21 tracks, TIAC tape format.
- Streamers : (1) 2400 meter, 48 traces with 30 Payey acceleration cancelling hydrophones per trace.
- : (2) 1600 meter, 24 traces with 21 Texas Instruments Hydrophones per trace.
(Tapered array - convertible to 2400 meters.)
- Six waterbreak amplifiers.
- Six depth transducers with separate meters.
- Six Condep* Fins for depth control.
- Tailbuoy with radar reflector

* Trademark of Continental Oil Company.



APPENDIX D

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OPERATIONS STATISTICS

Prospect : Great Australian Bight (SA5,
SA6, SA10, SA11) South Australia.

Operational Period : 14th November to 16th November, 1971.
25th January to 11th February, 1972.

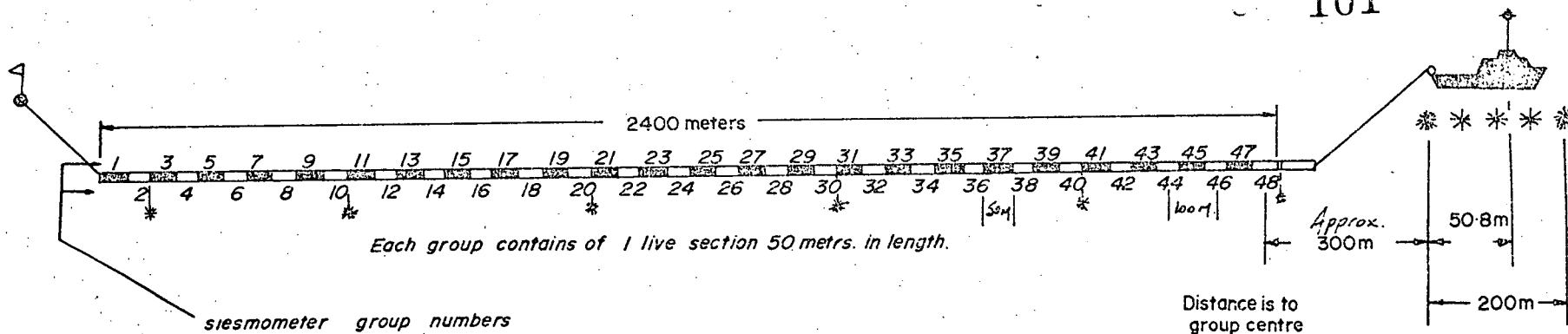
Time Spent on Prospect : 21 days

Time Spent on Recording : 19 days

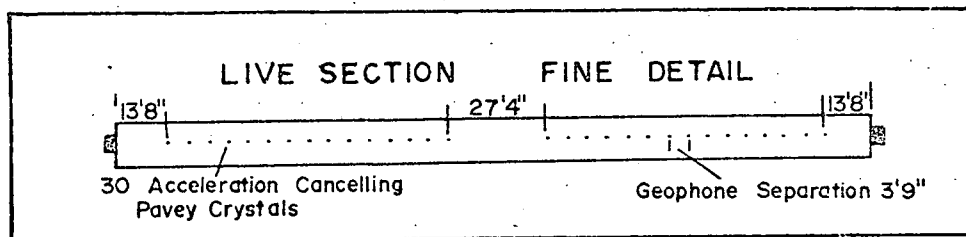
Time Lost due to Bad Weather : 2 days

Total Miles Shot : 1750 miles

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* STREAMER DEPTH TRANSDUCER
WATER BREAK PHONE LOCATION



FISH STBD	cu. inch.	120	80	40	20	10	= 530 cu. inch.
	guns	2	2	2	2	1	

FISH PORT	cu. inch.	400	240	40	20	10	= 770 cu. inch.
	guns	1	1	2	2	1	

1300 cu. inch.

MARINE CABLE DIAGRAM 2400 METER

(OFF END SPREAD - 48 GROUPS)

GSI Party 909

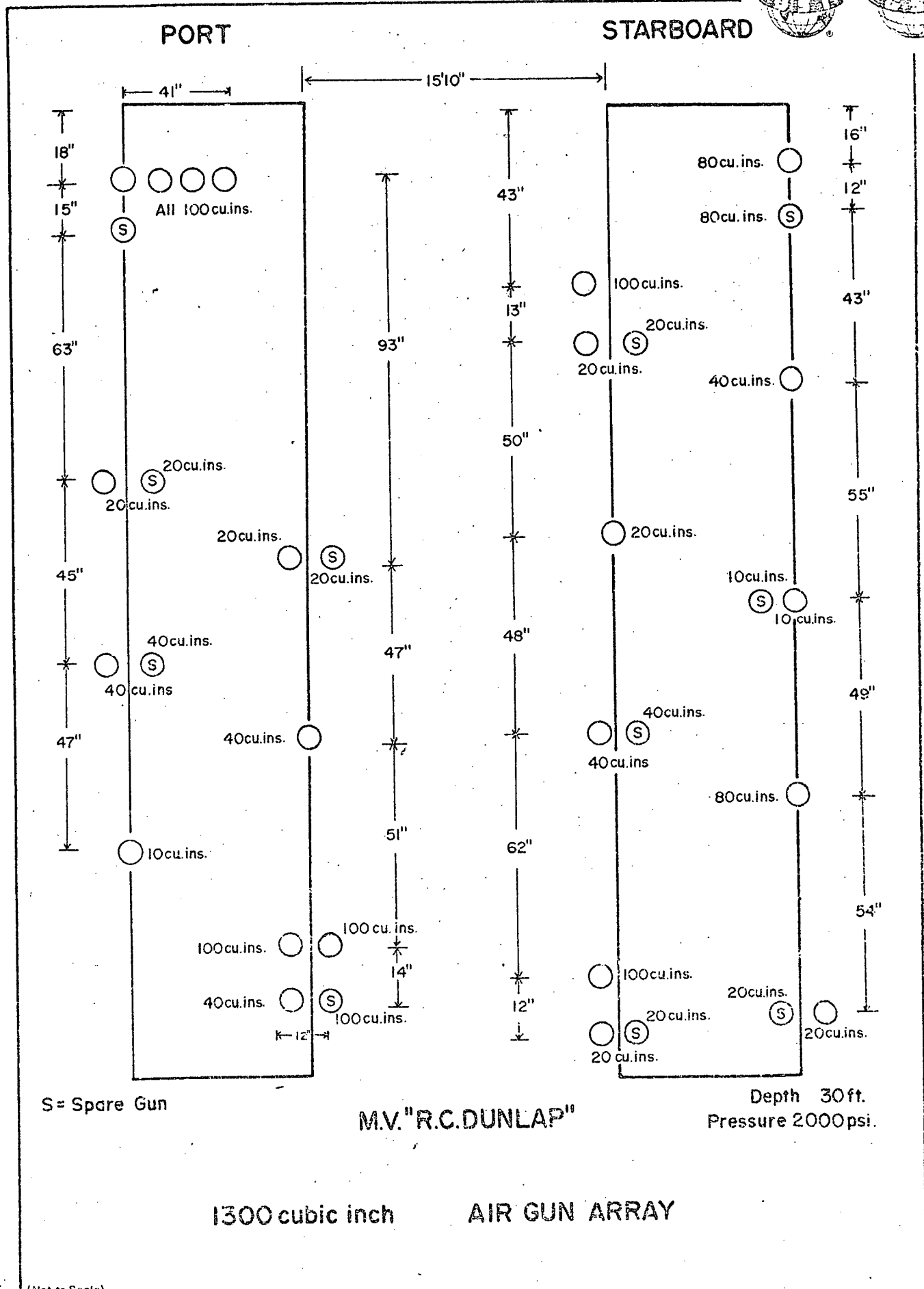
Ship M/V DUNLAP

Client SHELL DEVELOPMENT

Area SOUTH AUSTRALIAN BIGHT

Date NOVEMBER 1971.





AMPLITUDE

PULSE

0 100 200
MILLISECONDS

RELATIVE

AMPLITUDE (DB)

AMPLITUDE
SPECTRUM0 20 40 60 80 100
FREQUENCY (HZ)

GUN

1 X 400

1 X 240

2 X 120

2 X 80

4 X 40

4 X 20

2 X 10

SIZES

cubic inches.

" "

" "

" "

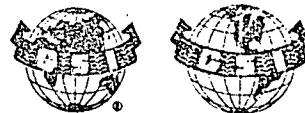
" "

" "

" "

AIRGUN ARRAY PULSE AND SPECTRUM

Vessel M/V R.C. DUNLAPArray Capacity 1300 cubic inchesRecording Filter out-248 HzDate 29th October 1971



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DATA PROCESSING
FINAL REPORT
SOUTH AUSTRALIA OFFSHORE
1971
DUNTROON BASIN SA6, SA7

For

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

155 William Street,
Melbourne. Victoria 3000

By

GEOPHYSICAL SERVICE INTERNATIONAL

120 Christie Street,
St. Leonards. N.S.W. 2065

PARTY 854

William J. Pailthorpe : Party Chief
Kenneth W. Graybill : Supervisor

February, 1972.

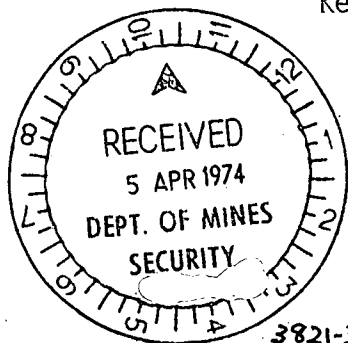




TABLE OF CONTENTS

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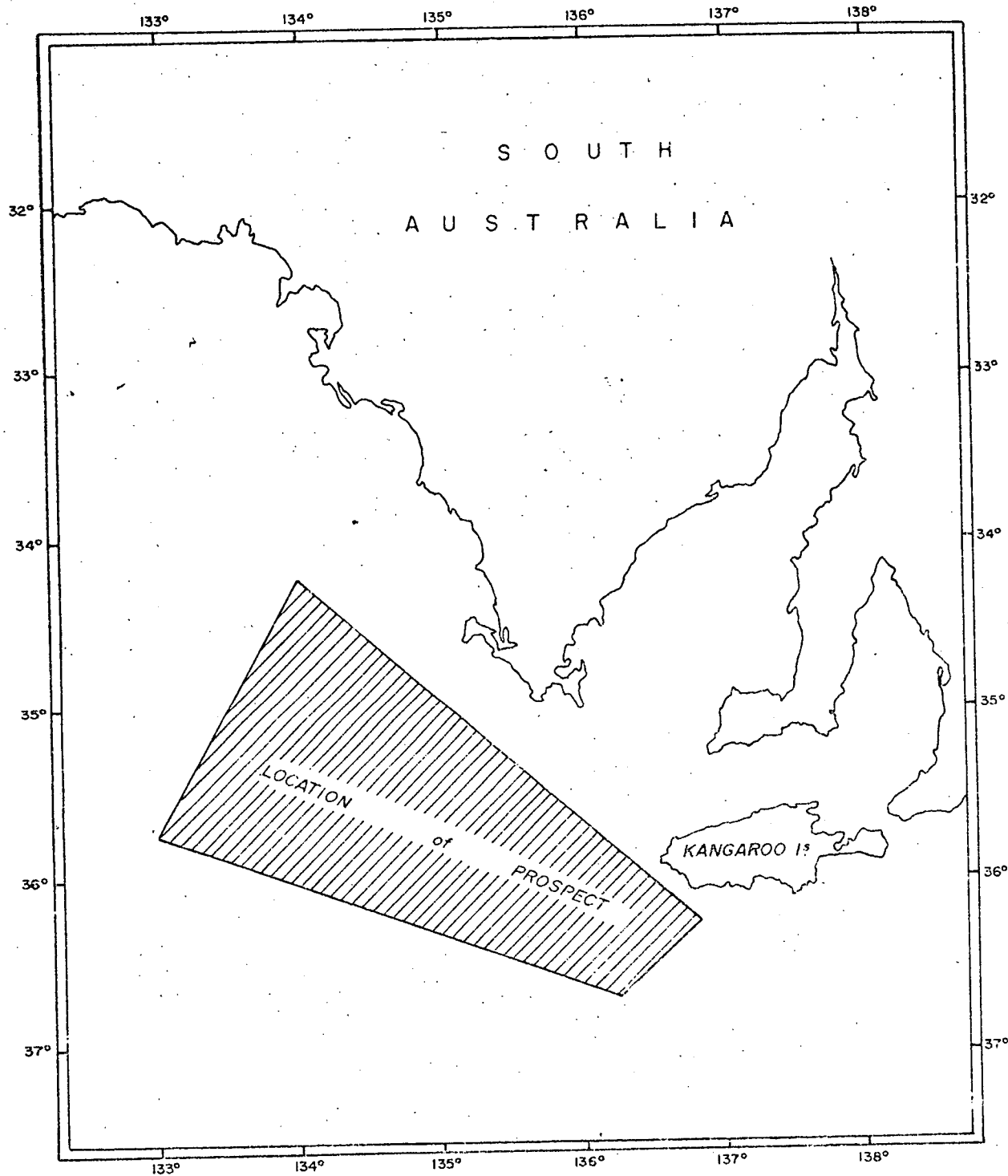
<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
I	ABSTRACT	1
II	INTRODUCTION	2
III	DISCUSSION	3
IV	EXPERIMENTAL PROCESSING	6
V	PRODUCTION PROCESSING	8

LIST OF APPENDICES

<u>APPENDIX</u>	<u>TITLE</u>
A	LINE INDEX; G.S.I. VS. SHELL SHOTPOINTS

LIST OF PLATES

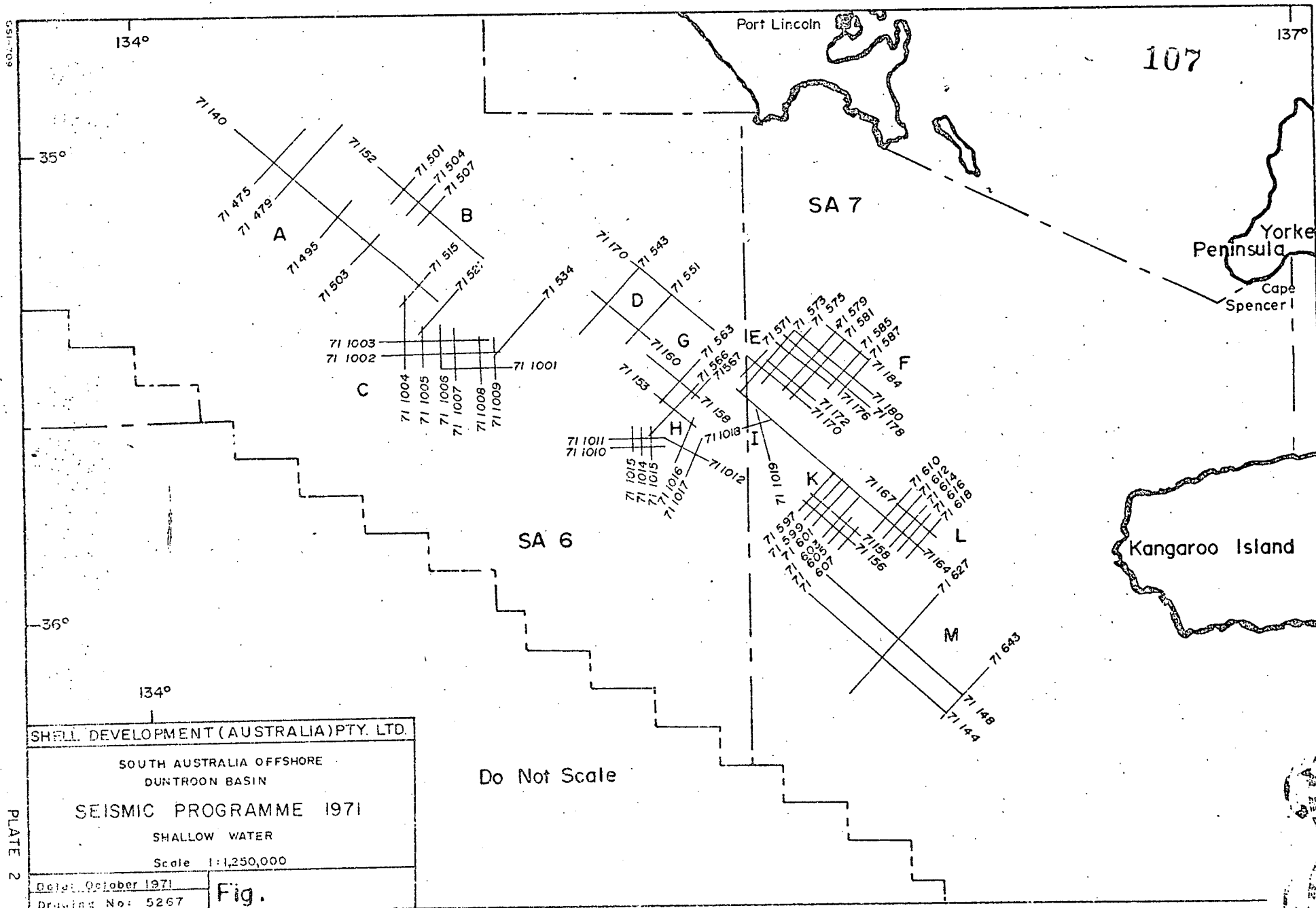
<u>PLATE</u>	<u>DESCRIPTION</u>
1	GENERAL LOCATION MAP
2	LINE LOCATION MAP
3	EXPERIMENT PROCESSING FLOW
4	PRODUCTION PROCESSING FLOW
5	DECONVOLUTION DESIGN



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

SOUTH AUSTRALIA OFFSHORE 1971

GEOPHYSICAL SERVICE INTERNACIONAL PARTY 909





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SECTION I

ABSTRACT

A seismic reflection survey was conducted by the M.V. "R.C. Dunlap" in the Duntroon Basin SA6, SA7, off South Australia (29th October - 12th November, 1971).

Approximately 1,400 kilometers of 24-fold reflection coverage were shot utilizing a 48 trace, 2400 meter streamer under continuous tow. A tuned array of air-guns (1300 cubic inches) was used as the acoustic energy source. The ship's position was determined by O.N.I.'s "Shoran" equipment. Field and survey reports are under separate covers.

Data enhancement using Pre and Post 700 Package digital processing was carried out in the Sydney Office of G.S.I. The data were processed 24-fold, with deconvolution before and after stacking.



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SECTION II

INTRODUCTION

PROSPECT : South Australian Shelf.

STATE : South Australia, Australia.

FOR : Shell Development (Australia) Pty. Ltd.

BY : Geophysical Service International

PARTY HEADQUARTERS : Processing - Sydney, New South Wales,
Australia.

Party 854

Field - Port Lincoln, S.A., Australia

Party 909

Vessel - M.V. "R.C. Dunlap".



SECTION III

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DISCUSSION

The South Australian Survey in the Duntroon Basin SA6, SA7 for 1971, was recorded and processed by Geophysical Service International (G.S.I.). The field work was conducted by Party 909, the M.V. "R.C. Dunlap", using a 48 trace streamer utilizing acceleration cancelling geophones. Texas Instruments' DFS III equipment recorded the data on one-inch tape in TIAC* format. A tuned array of airguns totalling 1300 cubic inches was used throughout the prospect. Recording time was normally five seconds, but was increased to six seconds for deeper water.

Processing was carried out in the Sydney Office of G.S.I. by Party 854 using the Texas Instruments' TIAC* 827A-2 computer and 870 integrated display system.

Five lines were chosen for an experimental processing sequence to determine the optimum processing flow. The principal aim was to determine whether deconvolution before stacking was advantageous. Once the processing sequence was determined, all lines were input to a pre-processing module. This module performed True Amplitude Recovery, Datum Statics, Deconvolution (if desired) and formed the Common Depth Point Gathers. Another output from this module was deconvolved, 100% coverage Near Trace Gathers. These gathers were displayed and used in positioning velocity analyses along the line.

* Trademark of Texas Instruments



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Due to an extensive velocity survey being performed last year (1970) in this area, it was decided that last year's velocities should be used on this year's data. To supplement last year's information, Constant Velocity Gathers were run at approximately 3.3 km intervals. These C.V.G.'s were necessary in areas where no old information was available. In poorer areas, some Constant Velocity Stacks were performed to give a clearer picture of the velocity variation. Where possible, the new and old velocities were tied together by area, prior to post-processing. The velocities used were drafted on the section headers, referenced to water surface.

The main velocity problem stems from a low velocity layer starting at an average reflection time of one second and extending for one to two seconds further into the data. The velocity of this material is quite difficult to determine since there are no strong events within it. The next good, consistent event is usually at basement. By taking advantage of a few random points on nearby C.V.G.'s, we were able to form the general shape of the function.

In general, the post-processing was not done until velocity functions for the area could be correlated together. The reference for co-ordinates of velocity functions at C.V.G. analysis locations was the surface. These velocity functions for each control point were converted by the routine to water bottom functions. For each intermediate depth point, a new function relative to water bottom was computed by linear spatial interpolation between functions for control points. These interpolated water bottom functions were converted back to surface functions and applied.



First break suppression was applied in the mixing process to eliminate water borne energy, refractions and low frequencies due to stretching in the Normal Moveout process. At least two traces were stacked at the water bottom. This was increased to six traces in the deeper water and on lines where the first break noise was not detrimental.

After the mixing of the C.D.P. Gathers, a two-gate deconvolution was performed. In areas where deconvolution was not applied before stack, a second deconvolution with a gapped operator was applied. Both operators were designed with the initial gate time approximately 250 milliseconds below the water bottom arrival.

Time Variant Digital Filtering was also applied in this post-processing module using filters specified by the Shell Development representatives. These were determined from filter analyses performed on the five test lines.

Three film displays were made of all production processing; these were :

1. 100% moveout corrected section with pre-stack deconvolution (if desired) and a band-pass filter of 8-50 Hz.
2. Stack without any filtering (out-out).
3. Deconvolved Stack with T.V.F.

All relevant processing parameters and velocity functions are drafted on the final sections.

SECTION IVEXPERIMENTAL PROCESSING

Before production processing could be initiated, experiments were performed on five entire lines to determine the best sequence possible for a particular area. The lines were :

SA71-1006 in Area C (see Plate 2)
SA71-1014 in Area H
SA71-614 in Area L
SA71-504 in Area B
SA71-1018 in Area I

The lines were processed with and without deconvolution before stacking and various types of deconvolution were performed on the resulting stacked sections. Displays were made of each step with a filter analysis over four stacked records (see Plate 3).

From these sections, it was decided that deconvolution before stacking was not necessary for areas C, H, B, I. By extension, this included areas A, G, D and M. However, two deconvolution operations were performed after stack. The first, a two-gate Time Variant Deconvolution using 240 millisecond operators, was used to whiten the frequency spectrum and remove short period reverberations. The second, a single section filter with a gapped operator (AR2), was employed to remove water bottom multiples.



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The tests also showed that deconvolution before stack was advantageous in area L and was applied to lines in areas K, L, E and F. The deconvolution before stack consisted of four short operators to whiten the frequency spectrum; this effectively equalizes the traces. This was followed by a two-gate Time Variant Deconvolution after stack to remove any short period reverberations.

The optimum display filters were determined from filter analyses run on these test lines.

SECTION VPRODUCTION PROCESSING(A) Sequence A :

(24-fold CSA deconvolution before stack performed on areas E, F, K, L.)

1. True Amplitude Recovery.
2. Datum Statics (sea level).
3. Time Variant Deconvolution.
4. Common Depth Point Gather.
5. Velocity Analysis: Constant Velocity Gatherers.
6. Normal Moveout.
7. Film Display (100%).
8. Mix of C.D.P. Gatherers with First Break Suppression.
9. Film Display (Brute Stack) (out-out).
10. Time Variant Deconvolution.
11. Time Varying Digital Filtering.
12. Filter Display (T.V.F.).

Steps 1 through 4 are in the pre-processing module.

Steps 6 through 11 are in the post-processing module.



(B) Sequence B :

(24-fold CSA deconvolution after stack performed on areas A, B, C, D, G, H, I, M.)

1. True Amplitude Recovery.
2. Datum Statics (sea level).
3. Common Depth Point Gather.
4. Velocity Analysis: Constant Velocity Gathers.
5. Normal Moveout.
6. Film Display (100%)
7. Mix of C.D.P. Gathers with First Break Suppression.
8. Film Display (Brute Stack) (out-out).
9. Time Variant Deconvolution.
10. Time Invariant Deconvolution with gapped operator.
11. Time Varying Digital Filtering.
12. Filter Display (T.V.F.).

Steps 1 through 3 are in the pre-processing module.

Steps 5 through 11 are in the post-processing module.



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(C) Program Details :

i. Pre-processing Module.

1. True Amplitude Recovery (T.A.R.).
2. Static Corrections for field multiplexing delays.
3. Static Corrections for shot and seismometer depths; i.e., sea level datum.
4. Deconvolution (optional).
5. Common Depth Point Gather.
6. Annotation of water depths and trace offsets of all output records for use in subsequent processing.

The True Amplitude Recovery (T.A.R.) process is applied to digital field records in order to produce output records on which relative amplitudes of reflections on each trace are approximately true and traces are properly modulated. The T.A.R. process removes the digital gain applied in the field and replaces this with corrections based on loss of energy due to spherical divergence and inelastic attenuation.

When a wave is generated in a homogeneous medium by a point energy source, spherical wave fronts diverge from the source. Waves are propagated perpendicular to the spherical wave fronts; therefore, wave energy in a spherical sector is distributed over an expanding area as distance from the source increases, and the amplitude of the wave decreases as the distance increases. Spherical divergence correction compensates



for this decrease in amplitude and is proportional to the velocity function in the area.

As seismic waves are transmitted through layers of the earth, absorption, scattering, reflection and other factors cause attenuation of wave energy. Absorption is loss of wave energy in the form of heat caused by friction between particles of a medium and is believed to be the principal factor of attenuation. Wave theory and observation show that after correction for spherical divergence, the amplitude of a harmonic of a reflection wave decreases approximately exponentially as a function of reflection time and the exponent is dependent on frequency of the harmonic and composition of material through which the wave travels. This attenuation of reflection energy or transmission loss is termed inelastic attenuation. The values used to recover this signal loss for this area were an exponential gain of 4 decibels per second from time zero to 4.5 seconds with a constant scaler of -2.5 decibels.

Static corrections of field multiplexing delays, shifts the traces to compensate for the difference in time of recording each individual trace. This results in better velocity determination and stacking of the 48 traces across the spread.



Static corrections for shot and seismometer depths, shift the traces to correct them to the specified datum (namely sea level). The average depths used for this computation were 30 feet for the airgun depth and 50 feet for the streamer depth. The water velocity was assumed to be 5,000 ft/sec.

Approximate reverberation deconvolution is a process by which a reverberation which has been linearly convolved with the impulse response of the earth is approximately removed by an inverse filter. The ultimate desired in a seismogram is a representation of the earth's acoustical boundaries with a series of sharply defined impulses. The approximate deconvolution is accomplished by the application of a whitening filter designed from auto-correlation functions which are derived from the trace to be deconvolved. (See Plate 5.) The filter will increase the band width of the shot functions, the near surface layering and the seismometer coupling.

Common Depth Point (C.D.P) Gathers are formed and output as 24 trace records.

The water depth at the depth point and the offset to each trace in the gather is annotated in channel 25 for use in further processing.



ii. Velocity Determination.

a) C.V.G.

Velocity determination was accomplished by the use of Constant Velocity Gatherers. This method takes one Common Depth Point Gather record, output from the pre-processing phase, and applies various velocities to the whole record. Velocity as a function of record time can be determined from alignments of reflection on traces of output records. This procedure is adequate only if the signal-to-noise ratio is good on input gather records.

b) C.V.S.

In areas where the signal-to-noise ratio was poor, Constant Velocity Stacks were run (Areas A, B, E, F, K, M).

Each trace of a C.V.S. record is produced by applying NMO corrections for a constant velocity to the 24 traces of a Common Depth Point record and then stacking these traces.

The final presentation is a series of records with various constant velocities applied over the whole record. Velocity as a function of record time can be determined from events having maximum amplitude and highest frequency.

The velocity functions thus determined were tied to last year's detailed velocity analysis.



iii. Post-Processing Module.

The processes performed in this module include :

1. Normal Moveout Corrections.
2. Output of single-fold coverage records.
3. Stack of C.D.P. records with First Break Suppression (or Muting).
4. Time Variant Deconvolution, AR II.
5. Demultiplexer Static Corrections for display.
6. Time Variant Filtering with Zero Phase Digital Filters.
7. Display with Automatic Gain Control.

Velocity functions determined from the C.V.G.'s were applied to the C.D.P. input records. These velocity functions are referenced to the surface. Velocities were only determined at discrete points and between these points velocity functions were spatially interpolated.

Single-fold or 100% coverage records were gathered from the C.D.P. gathers and output as a velocity check.



The moveout is computed from the equation :-

$$\Delta t = \sqrt{T_v^2 + \frac{x^2}{(\bar{V})^2}} - T_v$$

where

T_v = the vertical travel time to the reflector in question.

x = the distance from the shot to the seismometer group.

$\bar{V}$ = the average velocity obtained for the time T_v from the velocity function.

Δt = the moveout correction to be applied to the trace in question.

When Δt is not an integral multiple of the sample period, a high fidelity interpolation is used between the adjacent samples.

In depth point stack, the first break energy is scaled or ramped off prior to stacking.

Each trace is individually ramped. Each trace which contributes to an output trace is interrogated and the proper scaler applied to insure that the sum of the scalers applied to the live traces is 1.0.

The near traces were brought in together to yield a two-fold stack of the shallow data and to 24-fold



stack as soon as possible. First Break Suppression schedules vary with the water depth.

Approximate reverberation deconvolution designs inverse filters from time-gated auto-correlations for each trace. The time gate is variable from trace to trace to avoid interference from early water borne energy. Time Variant Deconvolution designs two or more filters per trace. Each filter design gate is overlapped by 50% and the application of the filters is on a true time variant basis such that as one filter tapers off the next filter is tapered on with the same 50% overlap. (See Plate 5.)

AR II is a single section operator designed on the data specifically for removal of reverberations. The number of points in the filter and the length of the operator is automatically computed in the program and is governed by the submitted water depth. The number of points (NPT) is computed using the equation :-

$$NPT = \frac{2 (Z_w + 10)}{4 \Delta T \times 10^3}$$

where

Z_w = water depth
 ΔT = sample period of the operator
(4 msec.)



Since NPT is restricted to a maximum of 128 points, the number of points was specified as 128 when the water depth exceeded 1200 ft.

The demultiplexer static correction for display shifts the data to compensate for the slight time shift across the record inherent in digital to analog displays.

Time Variant Filtering was applied to the data using filters derived and supplied by the representatives of Shell Development. Digital filter analyses were run on the five experimental lines and at other selected locations. These filters were modified across a line as required by the data (i.e., varying water bottom, dipping horizons).

The final display sections were plotted on film in the variable area format with 50% bias. The horizontal scale was 24 traces per inch and vertical scale of 5 cm per second. The top of each section was labelled with shotpoints, water depths, line intersections and velocity functions.

The side panel gives all pertinent field and processing information for ready reference.



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Respectfully submitted,
GEOPHYSICAL SERVICE INTERNATIONAL

William J. Pailthorpe
Party Chief. February 1972

Kenneth W. Graybill
Supervisor. February 1972

APPENDIX ALINE AND SHOTPOINT INDEX
G.S.I. VS. SHELL SHOTPOINTS

<u>Line SA71-</u>	<u>G.S.I.</u> <u>Shotpoints</u>	<u>Shell</u> <u>Shotpoints</u>	<u>Total</u> <u>Kilometers</u>
140	23193-24529	614-280	67.975
144	16515-17432	540-1140	45.775
148	15239-16137	1140-1364	46.075
152	25480-26204	430-611	37.375
153	21022-21322	860-935	16.175
156	14504-14872	1162-1070	19.575
158N	3976-4344	830-922	19.575
158S	14882-15238	1070-1159	18.975
160	3559-3975	730-834	21.975
164NW	21323-21731	920-1022	27.275
164SE	21732-22527	1023-1221	34.100
167	12618-12942	1140-1221	17.375
170SE	19223-19679	1006-892	23.975
170NW	19680-20247	891-750	28.400
172	18403-18772	1004-920	17.975
176	18022-18402	920-1015	20.175
178	17457-18021	1061-920	29.375
180	10388-10904	920-1049	26.975
184	9967-10387	1025-920	22.175
475	24530-24938	442-340	21.575
479	24939-25479	340-475	28.175
495	28333-28605	408-340	14.775
501	28052-28300	492-430	13.575



<u>Line SA71-</u>	<u>G.S.I. Shotpoints</u>	<u>Shell Shotpoints</u>	<u>Total Kilometers</u>
503	27245-27513	340-407	14.575
504	27799-28051	493-430	13.775
507	27514-27798	430-501	15.375
515	26927-27244	413-340	15.775
521	26558-26926	340-423	17.775
534	26205-26557	458-370	18.775
543	20248-20616	430-522	19.575
551	20617-21021	541-440	21.375
563	6887-7215	430-512	17.575
566	6514-6886	453-360	19.775
567	6342-6513	440-482	9.725
571	7216-7403	520-566	10.525
573	7404-7855	582-470	23.725
575	7856-8332	520-639	24.975
579	8333-8805	638-520	24.775
581	8806-9306	520-645	26.175
585	9307-9637	632-561	15.525
587	9638-9906	560-627	14.575
597 ~~SW~~ NE	10905-11125	447-392)	17.575
597 ~~NE~~ SW	11180-11288B	380-407)	
599	11289-11609	380-460	17.175
601	11610-11926	459-380	16.975
603	11927-12235	380-457	16.575
605	12236-12436	430-380	11.175
607	12437-12617	380-425	10.175
610	14191-14503	498-420	16.775
612	13878-14190	420-498	16.775
614	13569-13877	497-420	16.575
616	13252-13568	420-499	16.975
618	12943-13251	497-420	16.575



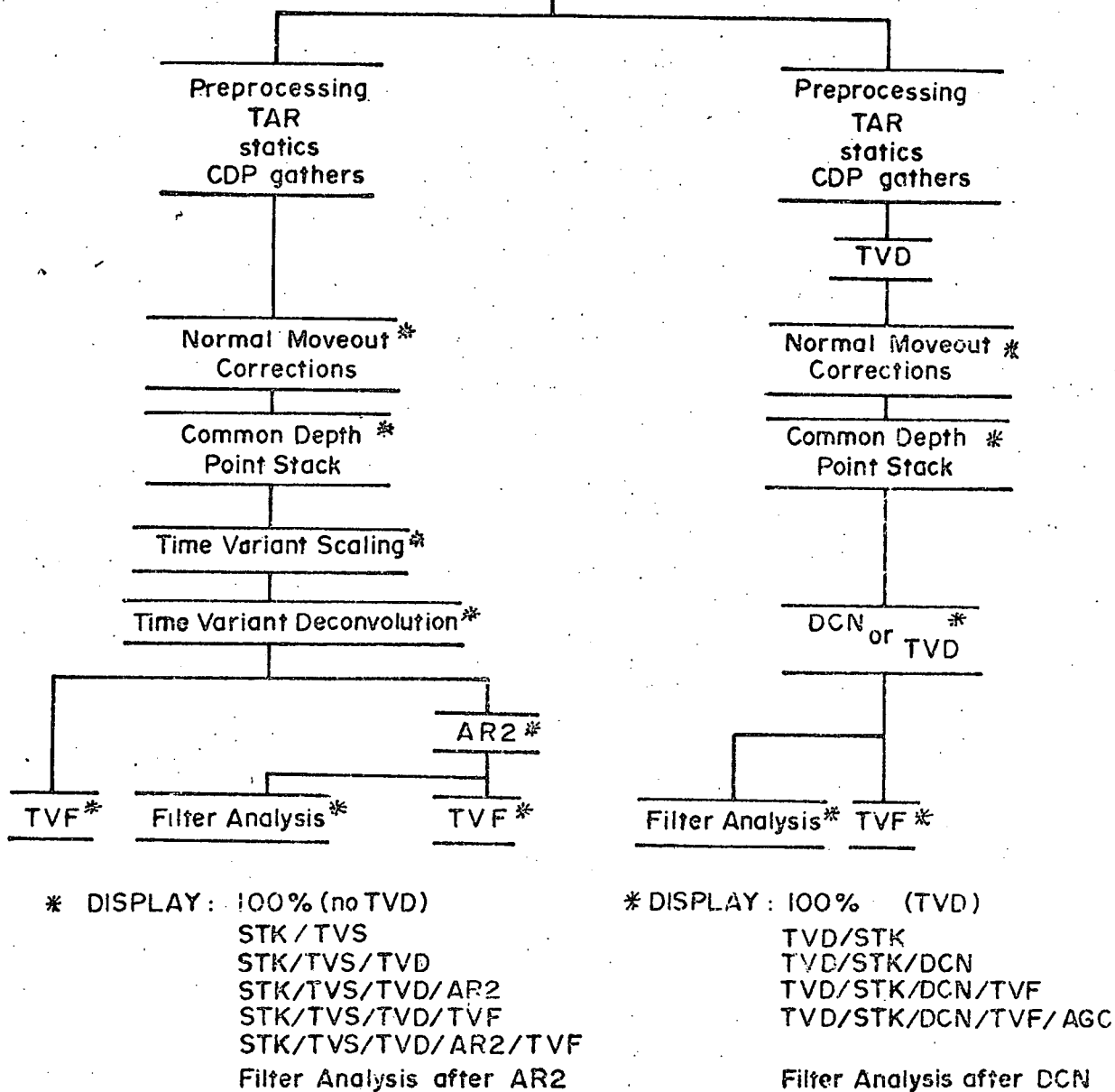
<u>Line SA71-</u>	<u>G.S.I. Shotpoints</u>	<u>Shell Shotpoints</u>	<u>Total Kilometers</u>
627	22528-23192	436-270	34.375
643	16138-16514	414-320	19.975
1001	2835-3202	1590-1681	19.525
1002	2318-2834	1669-1540	26.975
1003	1866-2317	1540-1652	23.725
1004	1489-1828	290-374	18.125
1005	1261-1488	336-280	12.525
1006	965-1260	280-353	15.925
1007	570-869	280-354	16.125
1008	234-569	333-250	17.925
1009	1-233	280-338	12.775
1010	5010-5273	1675-1610	14.325
1011	5274-5546	1620-1688	14.775
1012	5547-5815	920-987	14.575
1013	4469-4641	353-310	9.775
1014	4642-4813	310-352	9.725
1015	4814-5009	348-300	10.925
1016	6058-6341	350-420	15.325
1017	5816-6057	390-330	13.225
1018	19038-19222	440-486	10.375
1019	18773-19037	466-400	14.375
RESHOOT			
1004A	34371-34707	374-290	17.975
1005A	34145-34370	280-336	12.425
1006A	33861-34145	351-280	15.375
1007A	33563-33859	280-354	15.975
1008A	33230-33562	333-250	17.775
1009A	33001-33229	280-337	12.575



FIELD DATA (DFS III)

Recorded 48 trace

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24 FOLD EXPERIMENTAL
PROCESSING.



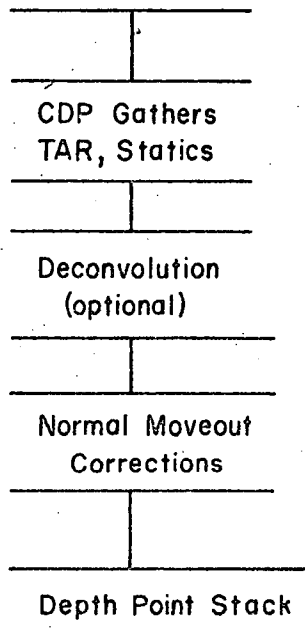
130

ODD TRACES

Field Records

System I

Odd Traces (1,3,5.....47)

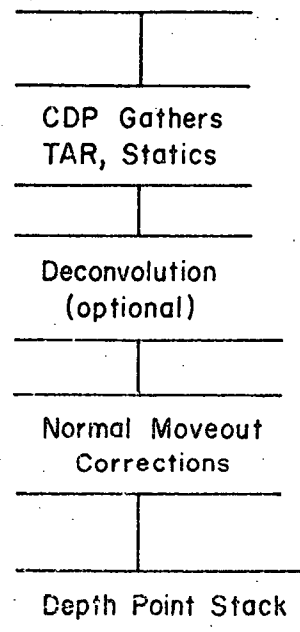


EVEN TRACES

Field Records

System II

Even Traces (2,4,6.....48)



MERGE

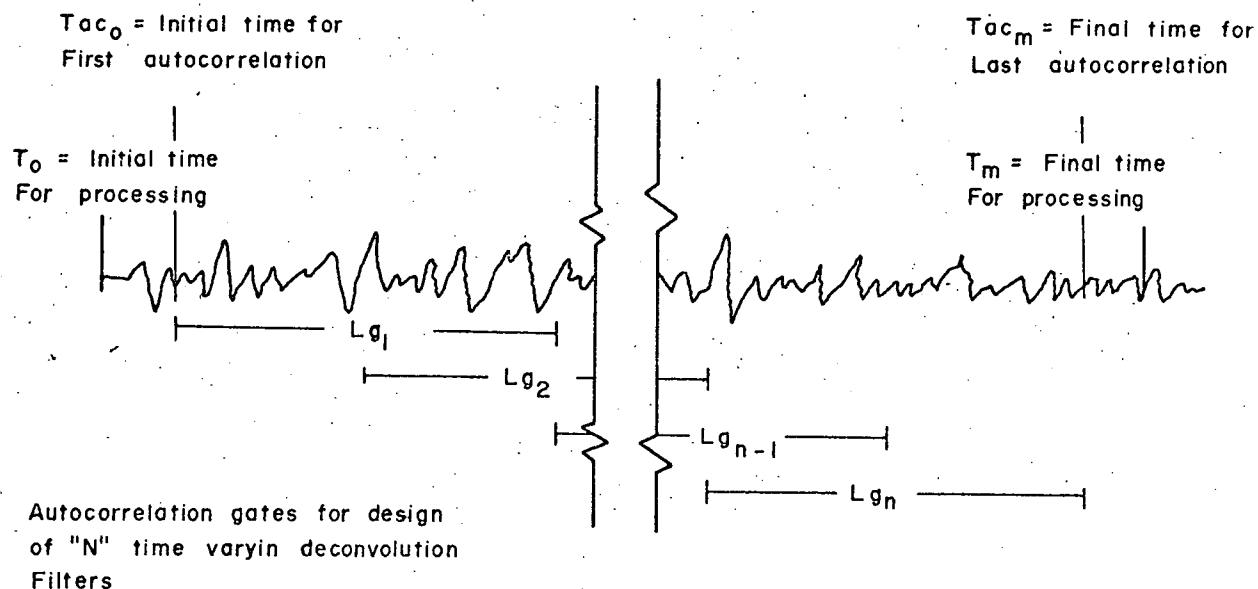
Deconvolution

Time Variant Filter

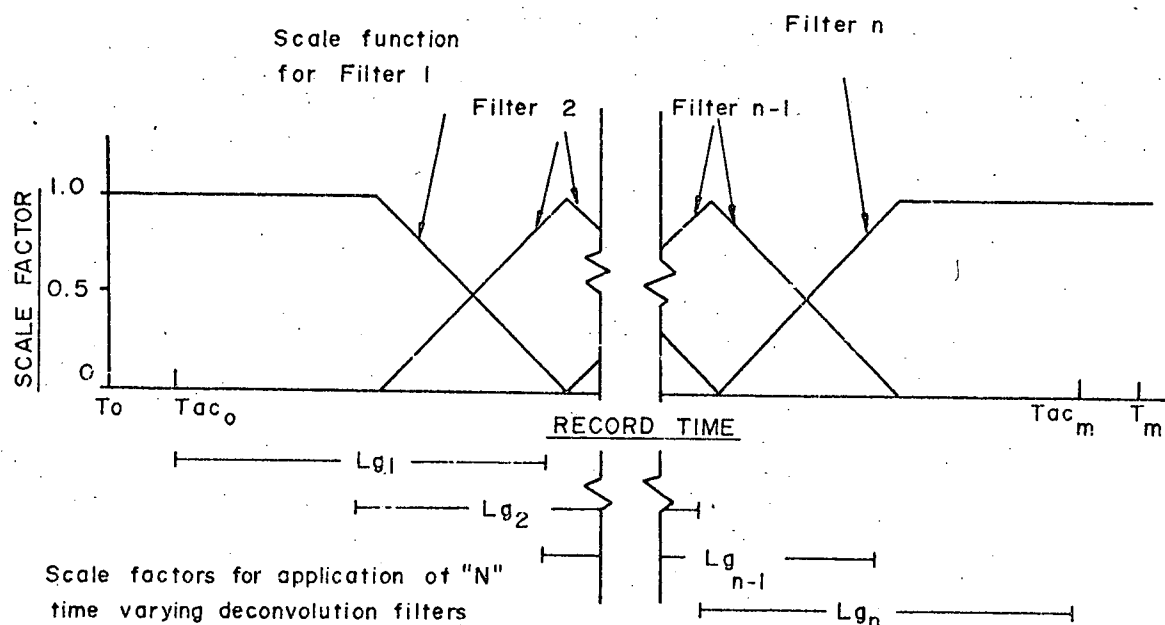
DISPLAY

48 Trace

Processing



$$Lg_1 = Lg_2 = \dots = Lg_n$$



DESIGN AND APPLICATION OF "N"
TIME VARYING DECONVOLUTION FILTERS

GEOPHYSICAL SERVICE INTERNATIONAL



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DATA PROCESSING
FINAL REPORT
SOUTH AUSTRALIA OFFSHORE
1971-72
SOUTH AUSTRALIAN BIGHT SA5, SA6, SA10, SA11

For

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
155 William Street,
Melbourne. Victoria 3000

By

GEOPHYSICAL SERVICE INTERNATIONAL
120 Christie Street,
St. Leonards. N.S.W. 2065

PARTY 854

William J. Pailthorpe : Party Chief
Kenneth W. Graybill : Supervisor

April, 1972





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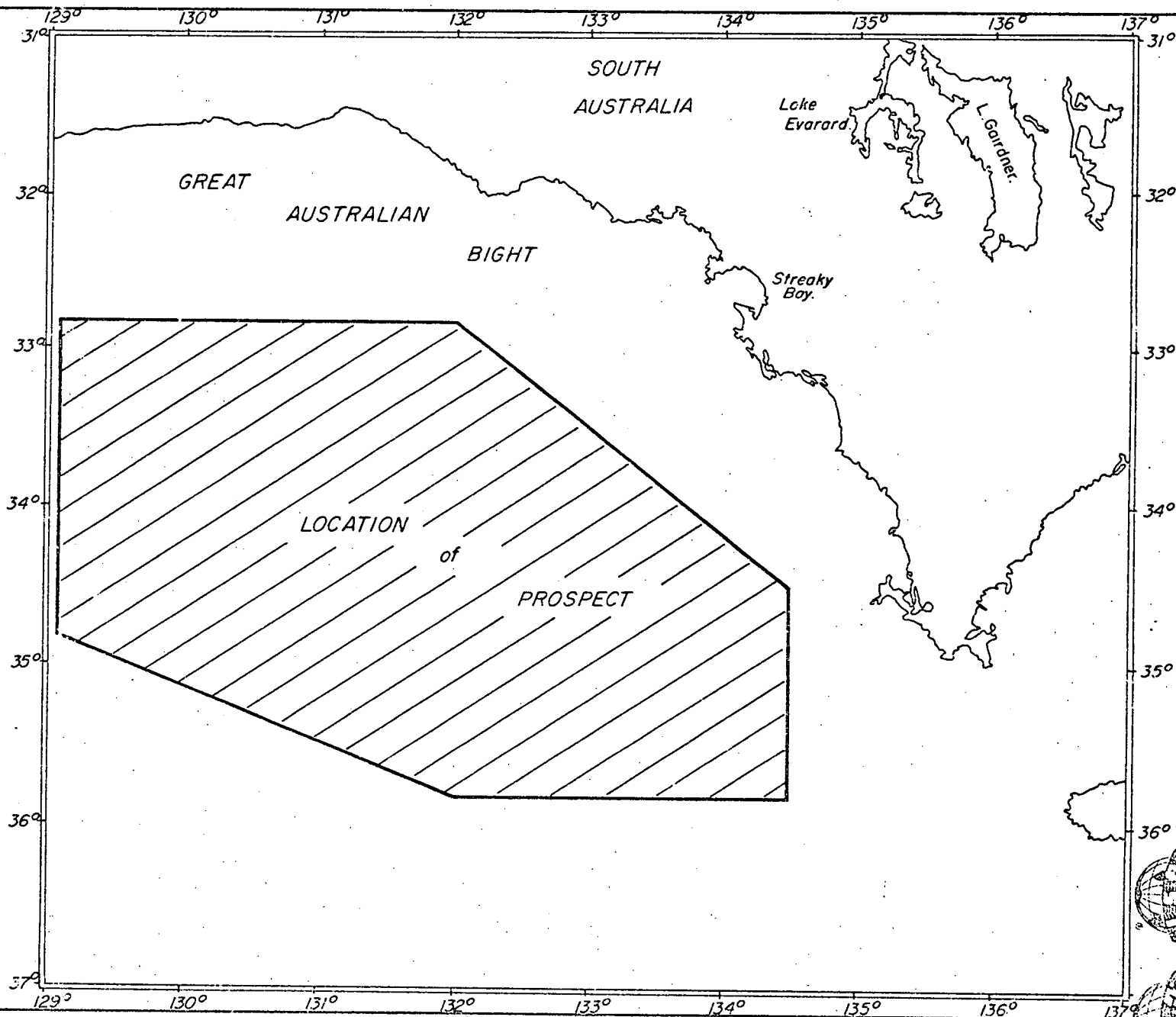
<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
I	ABSTRACT	1
II	INTRODUCTION	2
III	DISCUSSION	3
IV	EXPERIMENTAL PROCESSING	6
V	PRODUCTION PROCESSING	8

LIST OF APPENDICES

<u>APPENDIX</u>	<u>TITLE</u>
A	LINE INDEX; G.S.I. VS. SHELL SHOTPOINTS

LIST OF PLATES

<u>PLATE</u>	<u>DESCRIPTION</u>
1	GENERAL LOCATION MAP
2	LINE LOCATION MAP
3	EXPERIMENT PROCESSING FLOW
4	PRODUCTION PROCESSING FLOW
5	DECONVOLUTION DESIGN

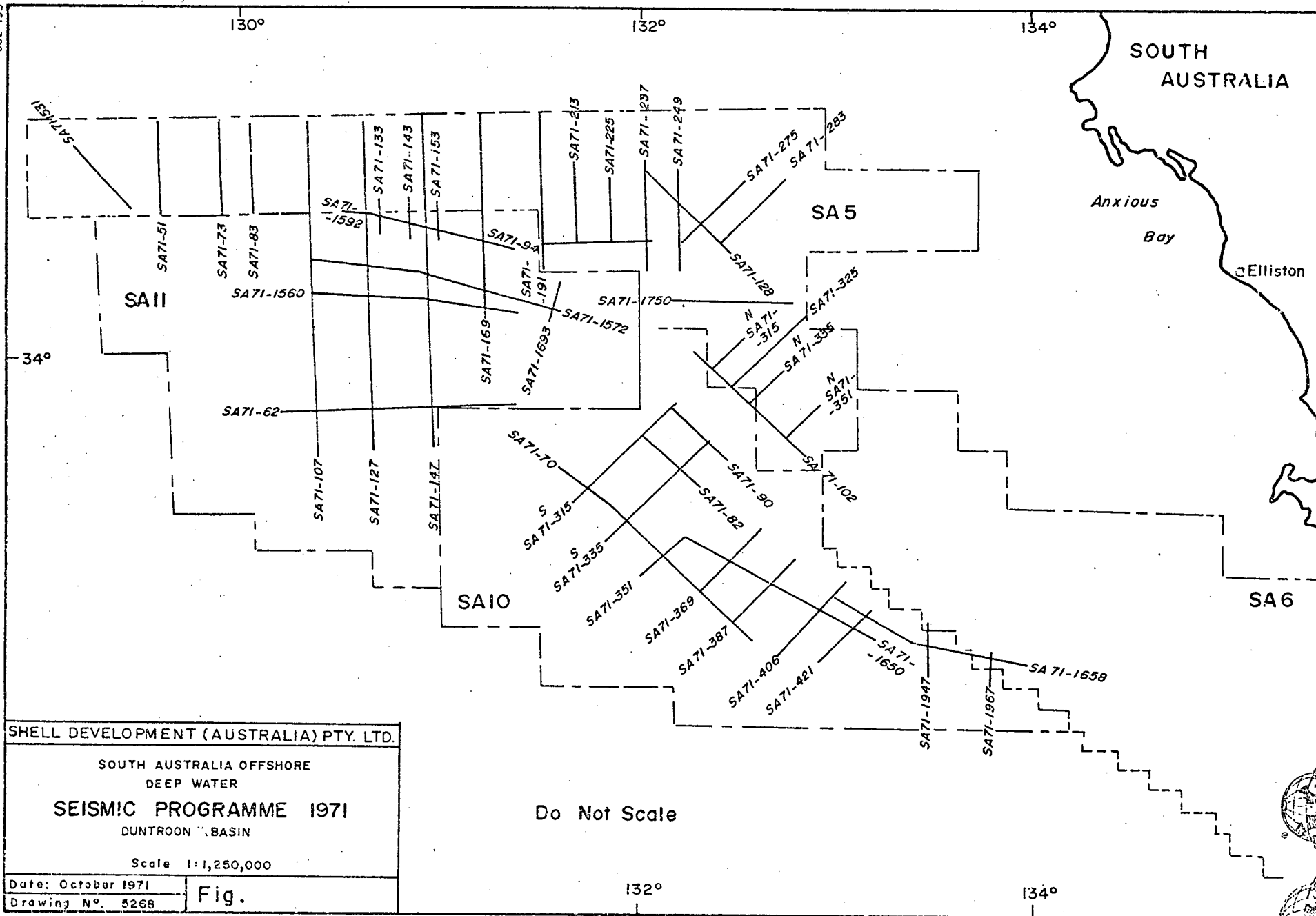


SHELL DEVELOPMENT(AUSTRALIA) PTY. LTD.

SOUTH AUSTRALIA OFFSHORE 1971

GEOPHYSICAL SERVICE INTERNATIONAL PARTY 909







SECTION I

136

ABSTRACT

A seismic reflection survey was conducted by G.S.I.'s M.V. "R.C. Dunlap" in the Great Australian Bight off South Australia (14th November - 16th November, 1971; 25th January - 11th February, 1972).

The survey, totalling approximately 2800 kilometers, was 24-fold reflection coverage utilizing a 48 trace, 2400 meter streamer under continuous tow. In water depths in excess of 1,000 feet, only 24 traces were used (either odd or even groups). A tuned array of airguns (1300 cubic inches) was used as the acoustic energy source. The ship's position was determined by Offshore Navigation Inc.'s "Shoran" equipment. Field and survey reports are under separate covers.

Data enhancement using Pre and Post 700 Package Digital Processing was carried out in the Sydney offices of G.S.I. The data were processed 24-fold, with deconvolution before and after stacking.



SECTION II

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INTRODUCTION

PROSPECT : South Australian Bight (SA5, SA6,
SA10, SA11).

STATE : South Australia, Australia.

FOR : Shell Development (Australia) Pty. Ltd.

BY : Geophysical Service International

PARTY HEADQUARTERS : Processing - Sydney, New South Wales,
Australia.

Party 854

Field - Port Lincoln, S.A., Australia

Party 909

Vessel - M.V. "R.C. Dunlap".



SECTION III

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DISCUSSION

The South Australian Survey in the Great Australian Bight for 1971 was recorded and processed by Geophysical Service International (G.S.I.). The field work was conducted by Party 909, the M.V. "R.C. Dunlap", using a 48 trace streamer utilizing acceleration cancelling geophones. Texas Instruments' DFS III equipment recorded the data on one inch tape in TIAC* format. A tuned array of airguns totalling 1300 cubic inches was used throughout the prospect. Recording time was normally five seconds for the shallower portion of the prospect and seven seconds for the deeper portion.

The survey, totalling 2800 kilometers, was broken into 1260 kilometers of 48 trace recording and 1540 kilometers of 24 trace recording. Where the water depth exceeded 1,000 feet, 24 trace recording was used.

Processing was carried out in the Sydney offices of G.S.I. by Party 854 using the Texas Instruments' TIAC* 827A-2 computer and 870 Integrated Display System. 700 Package velocity analysis was processed in G.S.I.'s Singapore offices on the Texas Instruments' 870A computer.

* Trademark of Texas Instruments Inc.



An experimental processing sequence was designed and applied to Line SA71-335N to determine the optimum processing flow. The principal aim was to determine whether deconvolution before stacking was advantageous. Once the processing sequence was established, all lines were input to a pre-processing module. This module performed True Amplitude Recovery, Datum Statics, Deconvolution (optional) and formed the Common Depth Point Gathers. Another output from this module was deconvolved, 100% coverage Near Trace Gathers. These gathers were displayed and used in positioning velocity analyses along the line.

For velocity information, Constant Velocity Gathers were run at approximately 3.3 km intervals. 700 Package, 6 depth velocity modules were run approximately every 10 miles or coincident with every fifth Constant Velocity Gather.

Where possible, velocities and final sections from previous years were used to give a clearer picture of the geology of the area.

In general, the post-processing was not done until velocity functions for the area could be correlated together. The reference for co-ordinates of velocity functions at C.V.G. locations was the surface. These functions were drafted on the section headers. The velocity functions for each control point were converted by the routine to water bottom functions. For each intermediate depth point, a new function relative to water bottom was computed by linear spatial interpolation between functions for control points. These interpolated water bottom functions were converted back to surface functions and applied.



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First break suppression was applied in the mixing process to eliminate water borne energy refractions and low frequencies due to stretching in the Normal Moveout process. At least two traces were stacked at the water bottom. This was increased to twelve traces in the very deep water and on lines where the first break noise was not detrimental. In the very deep water ($>3000'$), the six inside traces were removed from the stack to help attenuate the strong water bottom multiples.

After the mixing of the C.D.P. Gathers, a two gate deconvolution was performed. The operators were designed with the initial gate time approximately 250 milliseconds below the water bottom arrival time.

Time Variant Digital Filtering was also applied in this post-processing module using filters specified by the Shell Development representatives. These were determined from filter analyses performed on the two test lines.

Three film displays were made of all production processing; these were :

1. 100% moveout corrected section with pre-stack deconvolution and a band-pass filter of 8-50 Hz.
2. Stack without any filtering (out-out).
3. Deconvolved Stack with T.V.F.

All relevant processing parameters and velocity functions are drafted on the final sections.



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SECTION IV

EXPERIMENTAL PROCESSING

Before production processing could be initiated, experiments were performed on Line SA71-335N to determine the best possible processing sequence for the area.

The line was processed with and without deconvolution before stacking and various types of deconvolution were performed on the resulting stacked sections. Displays were made of each step with a filter analysis over four stacked records (see Plate 3).

These tests showed deconvolution before stack to be advantageous. This deconvolution before stack consisted of four short operators to whiten the frequency spectrum and to equalize the power spectrum from trace to trace, as well as to deconvolve reverberations. This was followed by a two-gate Time Variant Deconvolution (TVD) after stack to remove any short period reverberations.

The optimum display filter was determined from the filter analyses run on this line. This display filter was later modified for the deeper water, based on a filter analysis run on Line SA71-315S.



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From the Near Trace Gathers displayed on each line from the pre-processing module, it was apparent that a severe water bottom multiple problem existed in the deep water. A test was run on line SA71-406 to see if ramping out the inside traces would help attenuate the water bottom multiples. The normal moveout differences between primary energy and multiple energy at great depths are not sufficient to attenuate the water bottom multiple energy by the stacking response alone. So six inside traces were removed from the stack, making the coverage only 18-fold below the four-way water time. The test showed that inside trace ramping did attenuate water bottom multiple energy and improved the signal to noise ratio of the primary energy.

Inside trace ramping (6 traces) was adopted on all the deep water lines where the water depth exceeded 3,000 feet.

Time Variant Scaling was performed on Line SA71-1658 to reduce the high amplitude water bottom arrival in the deep water. It was decided from this test that further scaling was unnecessary.



SECTION V

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PRODUCTION PROCESSING

(A) Sequence :

(24-fold processing, deconvolution before stack.)

1. True Amplitude Recovery.
2. Datum Statics (sea level).
3. Time Variant Deconvolution.
4. Common Depth Point Gather.
5. Velocity Analysis: Constant Velocity
Gathers; 700 Pkg. 6. depth point
velocity modules.
6. Normal Moveout.
7. Film Display (100%).
8. Mix of CDP Gathers with First Break
Suppression.
9. Film Display (Brute Stack) (out-out).
10. Time Variant Deconvolution.
11. Time Varying Digital Filtering.
12. Filter Display (TVF).

Steps 1 through 4 are in the pre-processing module.
Steps 6 through 11 are in the post-processing
module.



(B) Program Details :

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i. Pre-processing Module.

1. True Amplitude Recovery (T.A.R.).
2. Static Corrections for field multiplexing delays.
3. Static Corrections for shot and seismometer depths; i.e., sea level datum.
4. Deconvolution (optional).
5. Common Depth Point Gather.
6. Annotation of water depths and trace offsets of all output records for use in subsequent processing.

The True Amplitude Recovery (T.A.R.) process is applied to digital field records in order to produce output records on which relative amplitudes of reflections on each trace are approximately true and traces are properly modulated. The T.A.R. process removes the digital gain applied in the field and replaces this with corrections based on loss of energy due to spherical divergence and inelastic attenuation.

When a wave is generated in a homogeneous medium by a point energy source, spherical wave fronts diverge from the source. Waves are propagated perpendicular to the spherical wave fronts; therefore, wave energy in a spherical sector is distributed over an expanding area as distance from the source increases, and the amplitude of the wave decreases as the distance increases. Spherical divergence correction compensates



for this decrease in amplitude and is proportional to the velocity function in the area.

As seismic waves are transmitted through layers of the earth, absorption, scattering, reflection and other factors cause attenuation of wave energy. Absorption is loss of wave energy in the form of heat caused by friction between particles of a medium and is believed to be the principal factor of attenuation. Wave theory and observation show that after correction for spherical divergence, the amplitude of a harmonic of a reflection wave decreases approximately exponentially as a function of reflection time and the exponent is dependent on frequency of the harmonic and composition of material through which the wave travels. This attenuation of reflection energy or transmission loss is termed inelastic attenuation. The values used to recover this signal loss for this area were an exponential gain of 4 decibels per second from time zero to 4.5 seconds with a constant scaler of -2.5 decibels.

Static corrections of field multiplexing delays, shifts the traces to compensate for the difference in time of recording each individual trace. This results in better velocity determination and stacking of the 48 traces across the spread.



Static corrections for shot and seismometer depths, shift the traces to correct them to the specified datum (namely, sea level). The average depths used for this computation were 30 feet for the airgun depth and 50 feet for the streamer depth. The water velocity was assumed to be 5,000 ft/sec.

Approximate reverberation deconvolution is a process by which a reverberation which has been linearly convolved with the impulse response of the earth is approximately removed by an inverse filter. The ultimate desired in a seismogram is a representation of the earth's acoustical boundaries with a series of sharply defined impulses. The approximate deconvolution is accomplished by the application of a whitening filter designed from auto-correlation functions which are derived from the trace to be deconvolved. (See Plate 5.) The filter will increase the band width of the shot functions, the near surface layering and the seismometer coupling. The time gate is variable from trace to trace to avoid interference from early water borne energy.

Common Depth Point (C.D.P.) Gathers are formed and output as 24 trace records.

The water depth at the depth point and the offset to each trace in the gather is annotated in channel 25 for use in further processing.



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ii. Velocity Determination.

A) C.V.G.

Velocity determination was accomplished by the use of Constant Velocity Gatherers (3 every 10 km). This method takes one 24 trace Common Depth Point Gather record, output from the pre-processing phase, and applies various velocities to the whole record. Velocity as a function of record time can be determined from alignments of reflections on traces of output records. This procedure is adequate only if the signal-to-noise ratio is good on input gather records.

B) 700 Package 6 Depth Point Velocity Modules.

a) Dip Scanning -

Dip scans are built by summing moveout scans from consecutive depth points along dip surfaces at automatically determined increments within a specified dip aperture. The number of consecutive moveout scans stacked together is termed the SMASH rate. The SMASH rate was held constant at two in all time gates.



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When summation takes place along the dip surface, which most nearly approximates the true geological time dip, maximum dip scan response will be achieved. Dip scan interpretation consists of locating three-dimensional maxima in the time-moveout-dip number field and interpolating the discrete sample values to an exact maxima by a three-dimensional contouring approach. The resulting "TAMD picks" represent the mean time, amplitude, moveout and dip of the seismic event over a space gate of width SMASH processed depth points.

A different SMASH rate may be employed for each processing gate.

Event files of the TAMD picks resulting from dip scan interpretation are output for each SMASH space gate of each processing time gate.

b) Work File Extension -

Each processing time gate is extended separately to produce a work file. Work file information includes the set of TAMD picks for each segment.



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Each TAMD pick in the first SMASH gate is projected forward along the measured dip to the gate boundary, where the specified time extension window is set up about the time of projection. The time zone at the next gate centre in which possible candidates for extension may reside is delineated by projecting forward along the dip scanning apertures from the upper and lower boundaries of the time extension window. TAMD picks residing in this zone are projected backwards to the gate boundary. If the backwards extension falls within the time extension window, the mean moveout, amplitude and dip of the pick are examined to determine whether they satisfy the respective extension criteria. If two or more picks satisfy all criteria, a joint prediction error consisting of the sum of the moveout and forward/backward prediction time differences normalized to the extension windows, is computed. The candidate with the least joint prediction error is chosen.



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c) Display -

The "scattergram" display provides a plot of each extended segment on an average time versus average velocity basis. Segments can be length graded or amplitude graded to aid interpretation. The highest amplitude pick within 100 ms. time gates is circled, and a plot of relative amplitude of segments is also supplied to aid interpretation.

iii. Post-Processing Module.

The processes performed in this module include :

1. Normal Moveout Corrections.
2. Output of single-fold coverage records.
3. Stack of C.D.P. records with First Break Suppression (or Muting).
4. Time Variant Deconvolution.
5. Demultiplexer Static Corrections for display.
6. Time Variant Filtering with Zero Phase Digital Filters.
7. Display.



Velocity functions determined from the C.V.G.'s were applied to the C.D.P. input records. These velocity functions are referenced to the surface. Velocities were only determined at discrete points and between these points velocity functions were spatially interpolated.

Single-fold or 100% coverage records were gathered from the C.D.P. gathers and output as a velocity check.

The moveout is computed from the equation :-

$$\Delta t = \sqrt{T_v^2 + \frac{x^2}{(\bar{V})^2}} - T_v$$

where

T_v = the vertical travel time to the reflector in question.

x = the distance from the shot to the seismometer group.

$\bar{V}$ = the average velocity obtained for the time T_v from the velocity function.

Δt = the moveout correction to be applied to the trace in question.



When Δt is not an integral multiple of the sample period, a high fidelity interpolation is used between the adjacent samples.

In depth point stack, the first break energy is scaled or ramped off prior to stacking. Each trace is individually ramped. Each trace which contributes to an output trace is interrogated and the proper scaler applied to ensure that the sum of the scalers applied to the live traces is 1.0. The near traces were brought in together to yield a two-fold stack of the shallow data and a 24-fold stack as soon as possible. First Break Suppression schedules vary with the water depth.

Approximate reverberation deconvolution designs inverse filters from time-gated auto-correlations for each trace. The time gate varies from trace to trace following 250 milliseconds below the water bottom. Time Variant Deconvolution designs two or more filters per trace. Each filter design gate is overlapped by 50% and the application of the filters is on a true time variant basis such that as one filter tapers off the next filter is tapered on with the same 50% overlap. (See Plate 5.)

The demultiplexer static correction for display shifts the data to compensate for the slight time shift across the record inherent in digital to analogue displays.



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Time Variant Filtering was applied to the data using filters derived and supplied by the representatives of Shell Development. Digital filter analyses were run on two experimental lines. These filters were modified across a line as required by the data (i.e., varying water bottom, dipping horizons).

The final sections were displayed on film in the variable area format with 50% bias. The horizontal scale was 24 traces per inch for the 48 trace processing and 16 traces per inch for the 24 trace processing. The vertical scale was 5 cm. per second. The top of each section was labelled with shotpoints, water depths, line intersections and velocity functions.

The side panel gives all pertinent field and processing information for ready reference.

Respectfully submitted,
GEOPHYSICAL SERVICE INTERNATIONAL

William J. Pailthorpe,
Party Chief.

APPENDIX ALINE AND SHOTPOINT INDEX
G.S.I. VS. SHELL SHOTPOINTS

<u>LINE SA71-</u>	<u>G.S.I.</u> <u>SHOTPOINTS</u>	<u>SHELL</u> <u>SHOTPOINTS</u>	<u>TOTAL</u> <u>KILOMETERS</u>
51	86187-87151	800-1041	49.375
62	78084-80288	240- 791	111.350
70	37562-39962	800-1400	121.150
73	85226-86186	800-1040	49.175
82	44518-45278	1000-1190	39.150
83	84265-85225	800-1040	49.175
90	43729-44517	1000-1197	40.550
94	58058-59118	1001-1266	54.175
102	28606-30050	1301- 940	73.375
107	74859-75847	759-1006	50.575
	75824-78083	763-200	112.950
127	73953-74858	877-1103	46.425
	71646-73975	300- 877	116.450
128	52118-53344	250- 556	62.475
133	60792-61208	800- 904	21.975
143	83820-84264	800- 911	70.600
147	69282-69425	1102-855	50.575
	82975-83819		
	69402-71645	861-300	112.250
153	68744-69256	900-1028	26.775
169	80994-81919	720- 951	47.400
	81920-82974	952-1215	53.875



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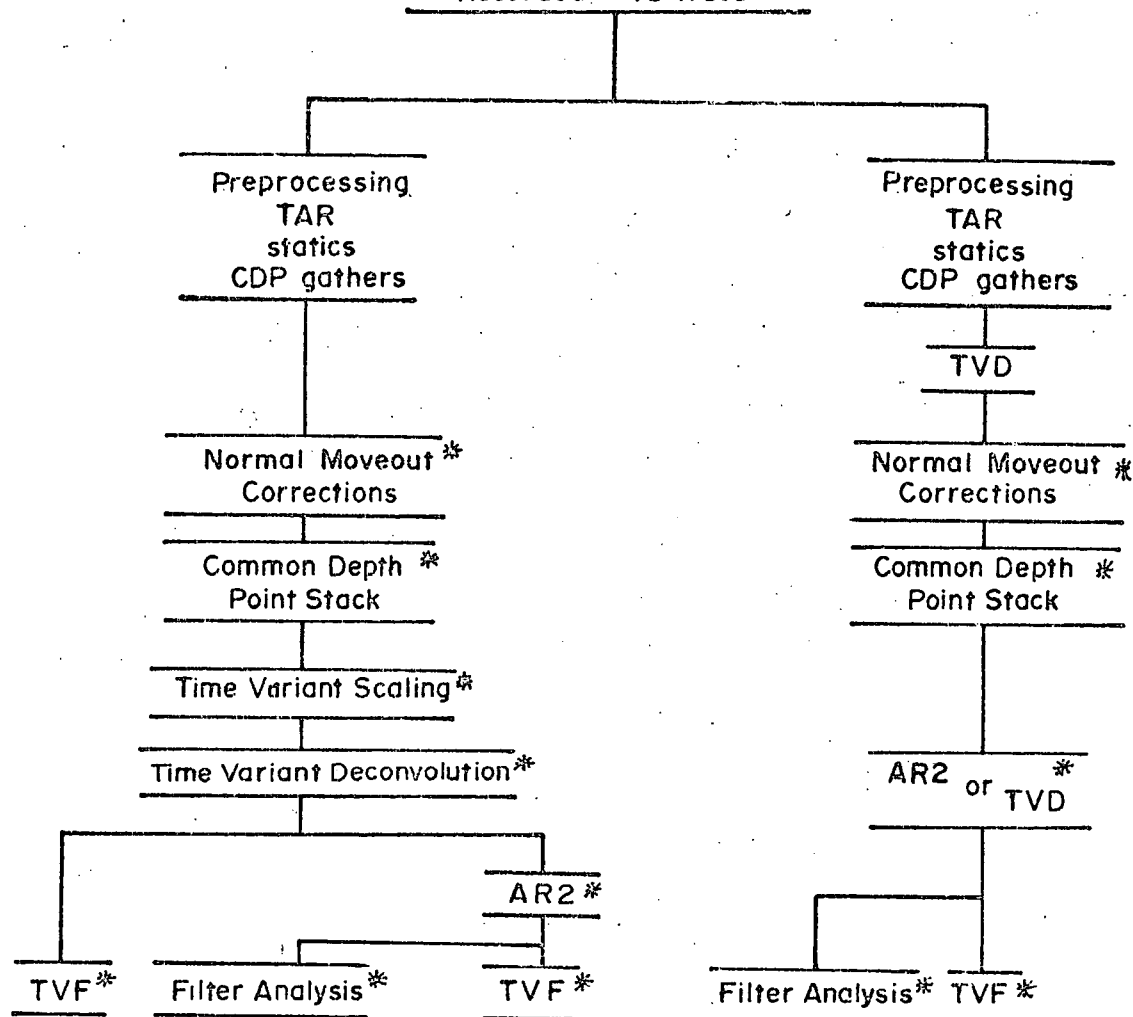
<u>LINE SA71-</u>	<u>G.S.I. SHOTPOINTS</u>	<u>SHELL SHOTPOINTS</u>	<u>TOTAL KILOMETERS</u>
191	65793-67317	820-1201	77.375
213	64956-65792	900-1109	42.975
225	53345-54033	960-1072	35.575
237	54034-55194	800-1090	59.175
249	55195-56195	800-1050	51.175
275	57141-58057	980-1209	46.975
283	56200-57140	1061-1296	48.175
315 (N)	30051-30211 30253-30544	913- 800	23.775
315 (N)	36225-37561	360- 694	67.950
325	30545-31533	800-1047	50.575
335 (N)	31534-31979	911- 800	23.425
335 (S)	42372-43728	360- 699	68.950
351 (N)	31980-32432	800- 913	23.775
351 (S)	41771-42371	360- 510	31.150
369	40814-41770	380- 599	44.950
387	39963-40813	380- 593	43.650
406	48219-49207	627- 380	50.550
421	49208-49948	400- 585	38.150
1531	87152-88081	100-308	42.775
1560	62411-63651	480- 790	63.150
	80289-80993	952-776R	36.350
1572	67318-68686	1079-737R	69.550
	61209-62364	652- 480	34.350
	61674-62099	648R- 754	21.250
1592	59123-60791	530- 997	84.575
1650	45279-47352	1400-1897	100.550
1658	49949-51135	1955-2232	56.550
	47362-48218	1740-1954	43.950
1693	64408-64955	700- 829	26.950
1750	35056-36224	1300-1592	59.575
1947	51557-52117	100- 240	29.150
1967	51136-51556	100- 205	22.150



FIELD DATA (DFS III)

Recorded 48 trace

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* DISPLAY: 100% (no TVD)
STK / TVS
STK / TVS / TVD
STK / TVS / TVD / AR2
STK / TVS / TVD / TVF
STK / TVS / TVD / AR2 / TVF
Filter Analysis after AR2

* DISPLAY: 100% (TVD)
TVD / STK
TVD / STK / TVD
TVD / STK / TVD / TVF
TVD / STK / TVD / TVF / AGC
Filter Analysis after TVD

24 FOLD EXPERIMENTAL
PROCESSING.

ODD TRACES

Field Records

System I

Odd Traces (1,3,5.....47)

CDP Gathers
TAR, StaticsDeconvolution
(optional)Normal Moveout
Corrections

Depth Point Stack

EVEN TRACES

Field Records

System II

Even Traces (2,4,6.....48)

CDP Gathers
TAR, StaticsDeconvolution
(optional)Normal Moveout
Corrections

Depth Point Stack

MERGE

Deconvolution

Time Variant Filter

DISPLAY

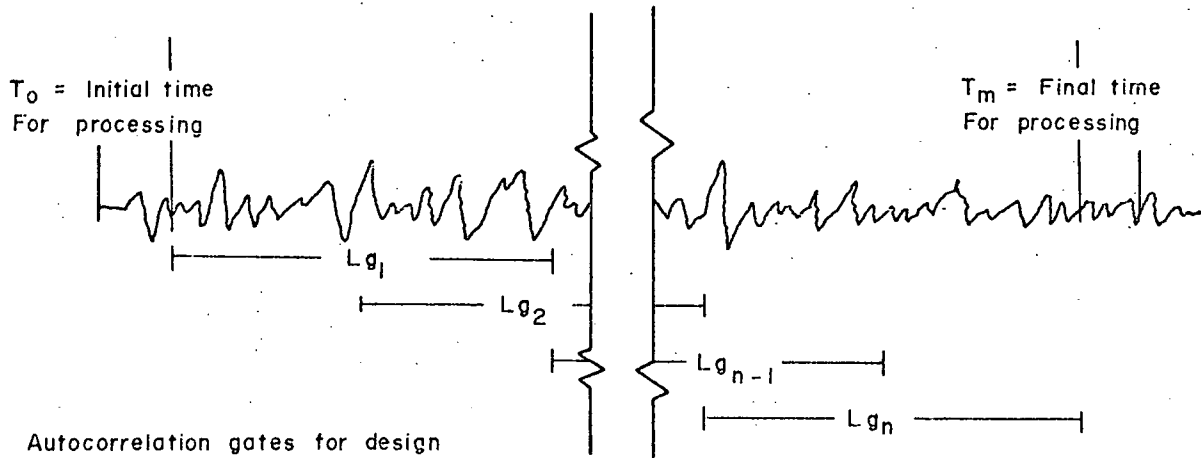


T_{ac_0} = Initial time for
First autocorrelation

T_{ac_m} = Final time for
Last autocorrelation

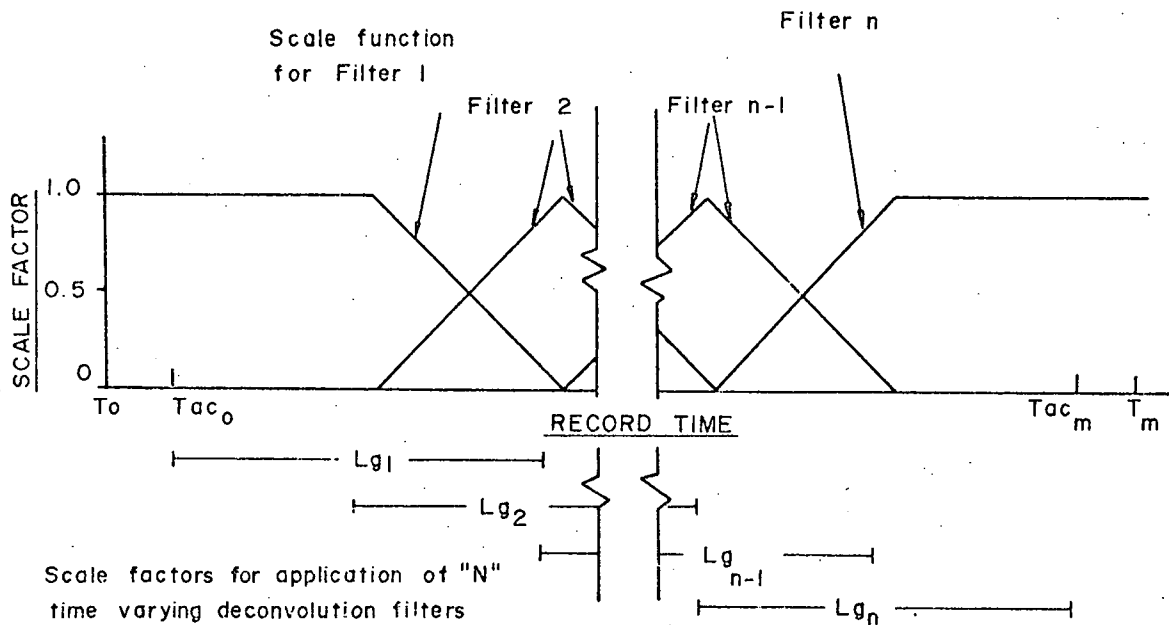
T_0 = Initial time
For processing

T_m = Final time
For processing



Autocorrelation gates for design
of "N" time varyin deconvolution
Filters

$$Lg_1 = Lg_2 = \dots = Lg_n$$



Scale factors for application of "N"
time varying deconvolution filters

DESIGN AND APPLICATION OF "N"
TIME VARYING DECONVOLUTION FILTERS

GEOPHYSICAL SERVICE INTERNATIONAL

REPORT:	Pailthorpe, W.J. and Graybill, K.W., 1972. Operations report, [1971-72 R 6 shallow water programme] Marine Seismic Survey, SA offshore EPPs 6 and 7; 29 October - 12 November 1971 and 14 - 15 January 1972 (Geophysical Service International, Party 909, seismic acquisition contractors' report for Shell Development, November 1972.	MESA NO. 3821 R 6 [33 pages]
APPENDIX A:	Line and shotpoint index.	
APPENDIX B:	Key personnel.	
APPENDIX C:	Equipment.	
APPENDIX D:	Operations statistics.	

REPORT:	Pailthorpe, W.J. and Graybill, K.W., 1972. Operations report, [1971-72 R 6 deep water programme] Marine Seismic Survey, SA offshore EPPs 5, 6, 10 and 11; 14 - 15 November 1971 and 25 January - 11 February 1972 (Geophysical Service International, Party 909, seismic acquisition contractors' report for Shell Development, November 1972.	3821 R 7 [30 pages]
APPENDIX A:	Line and shotpoint index.	
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APPENDIX C:	Equipment.	
APPENDIX D:	Operations statistics.	

CONTENTS OF VOLUME TWO

REPORT:	Hack, A.G., 1972. Survey operator's letter of transmittal for all summary technical data relating to R 6 Seismic Survey, including a listing of unattached seismic sections and shotpoint plans (Shell Development letter to SADM, 16/11/72).	MESA NO. 3821 R 8 [4 pages]
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PLANS		Scale		
Shotpoint location maps:				
Encl.	Sheet no. 4731.	1:100 000	3821-1	A1
Encl.	Sheet no. 4831.	1:100 000	3821-2	A1
Encl.	Sheet no. 4931.	1:100 000	3821-3	A1
Encl.	Sheet no. 5030.	1:100 000	3821-4	A1
Encl.	Sheet no. 5031.	1:100 000	3821-5	A1
Encl.	Sheet no. 5130.	1:100 000	3821-6	A1
Encl.	Sheet no. 5131.	1:100 000	3821-7	A1
Encl.	Sheet no. 5230.	1:100 000	3821-8	A1
Encl.	Sheet no. 5231.	1:100 000	3821-9	A1
Encl.	Sheet no. 5331.	1:100 000	3821-10	A1
Encl.	Sheet no. 5430.	1:100 000	3821-11	A1
Encl.	Sheet no. 5431.	1:100 000	3821-12	A1
Encl.	Sheet no. 4929.	1:100 000	3821-13	A1
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Encl.	Sheet no. 5328.	1:100 000	3821-21	A1
Encl.	Sheet no. 5329.	1:100 000	3821-22	A1
Encl.	Sheet no. 5330.	1:100 000	3821-23	A1



SHELL DEVELOPMENT (AUSTRALIA) PROPRIETARY LIMITED

INCORPORATED IN QUEENSLAND

SHELL CORNER · 155 WILLIAM STREET · PO BOX 872K · MELBOURNE 3001 · TELEPHONE 60 0201 · CABLE ADDRESS "SHELL" · TELEX No. 30 560

PLEASE ADDRESS ALL COMMUNICATIONS TO THE COMPANY

YOUR REF.

OUR REF. E&P:AGH:35.32

16th November, 1972

Office of the Designated Authority,
Box 38,
Rundle Street, Post Office,
ADELAIDE, S.A. 5000

Dear Sirs,

RG Survey
PETROLEUM (SUBMERGED LANDS) ACT, 1968
OFFSHORE/SOUTH AUSTRALIA
PERMITS SA-5,6,7,10 & 11

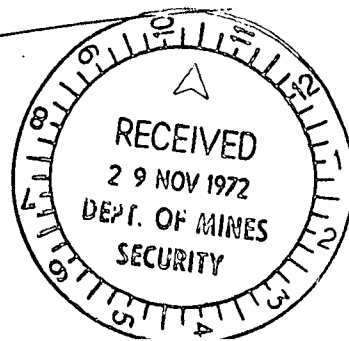
With apologies for a delayed submittance, we have pleasure in sending you under cover of this letter two copies of all data - as per list attached - related to the marine seismic survey carried out by Geophysical Services International earlier this year in the South Australia Offshore permits SA-5,6,7,10 and 11.

In addition we respectfully submit two printed copies and one transparent copy of the Continuous Dipmeter Survey results of the Echidna-1 well in permit SA-7.

We would like to take this opportunity to point out that these surveys were not carried out under the provisions of the Petroleum Search Subsidy Act.

Yours faithfully,
For SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

Seen by DBR
Director of Mines



1. Shot Point Location Maps

Scale 1:100,000

Sheet Nos:

4731, 4831, 4931, 5031, 5131, 5331, 5431
4930, 5030, 5130, 5230, 5330, 5430
4929, 5029, 5129, 5229, 5329, 5429, 5529
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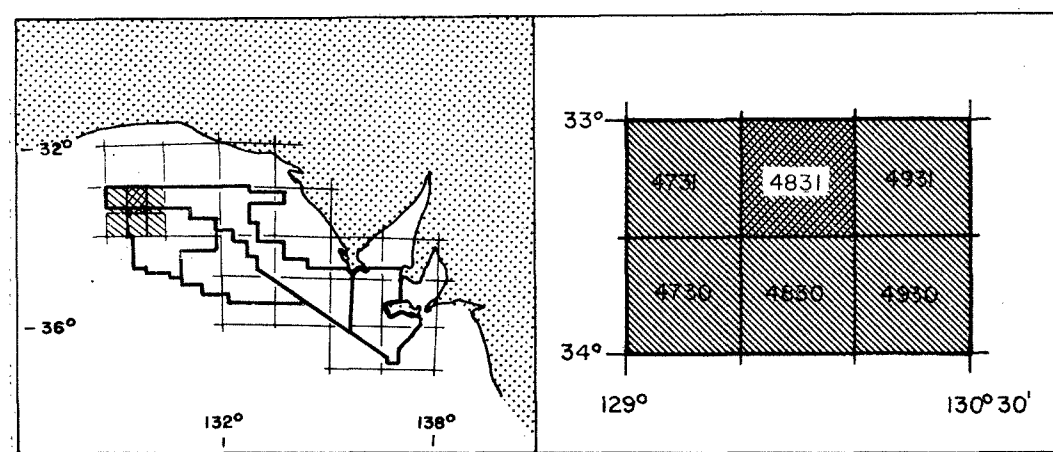
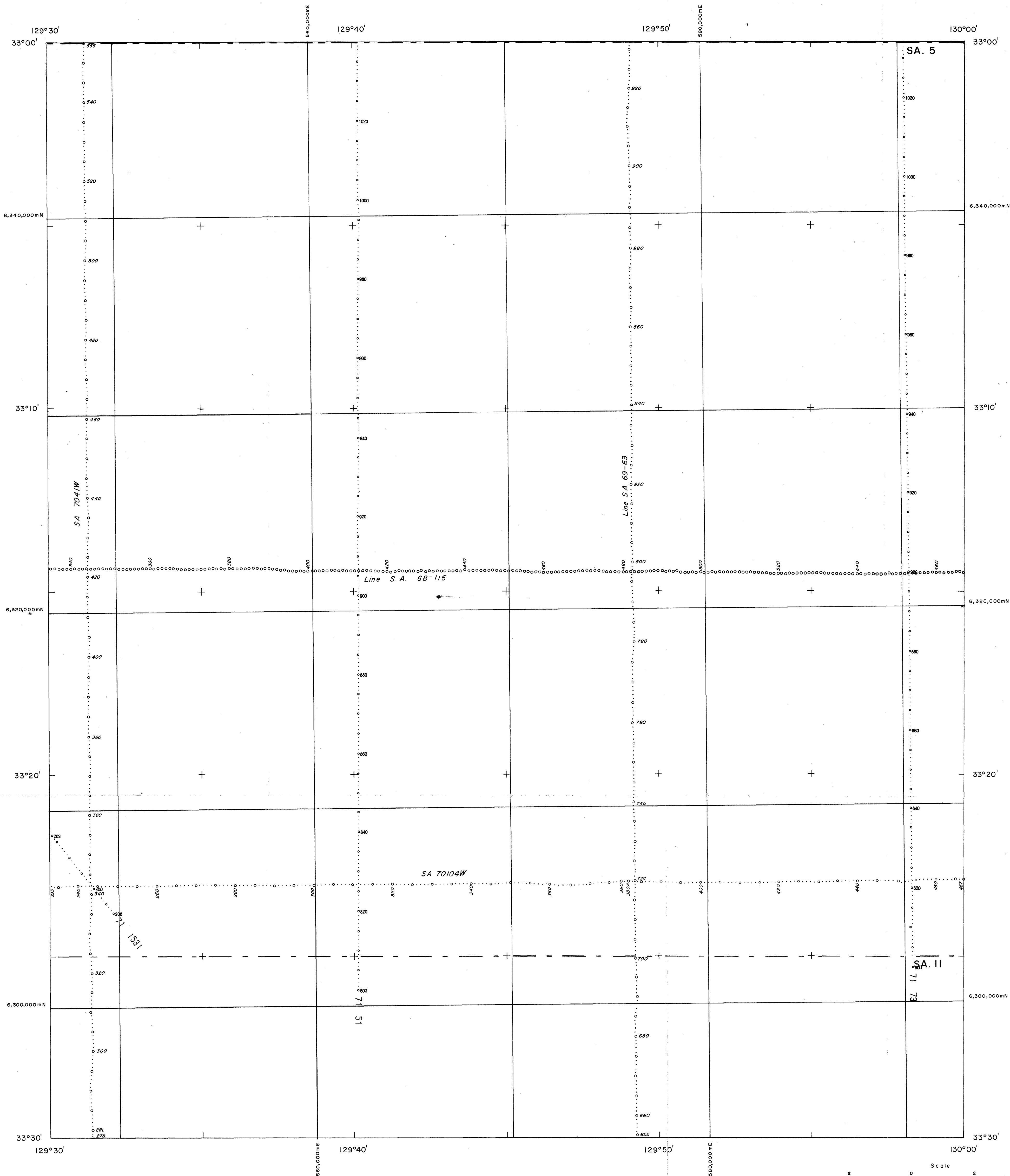
2. Operations Report - Marine Seismic Survey
South Australia Offshore Program 1971
Duntroon Basin SA-6, SA-7.
3. Operations Report - Marine Seismic Survey
South Australia Offshore Program 1971
South Australian Bight SA-5, SA-6, SA-10, SA-11
- 4a. Final Report, Offshore Navigation Inc. Project 507
for Geophysical Service International
Shell Development (Australia) Pty. Ltd.
South Australia October-November 1971.
- 4b. Addendum.
5. Data Processing Final Report
South Australia Offshore 1971
Duntroon Basin SA-6, SA-7
6. Data Processing Final Report
South Australia Offshore 1971-72
South Australian Bight SA-5, SA-6, SA-10, SA-11.

7.

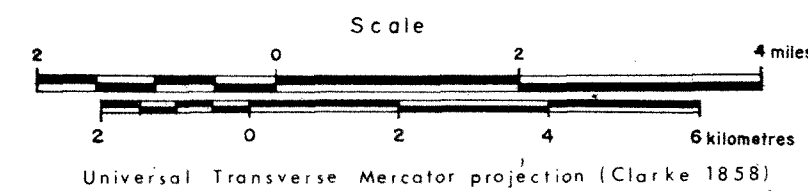
Seismic Sections

LINE	SHOTPOINTS	LINE	SHOTPOINTS
SA71-51	800-1041	SA71-178	920-1061
62	240- 791	180	920-1049
70	800-1400	184	920-1025
73	800-1040	191	820-1201
82	1000-1190	213	900-1109
83	800-1040	225	900-1072
90	1000-1197	237	800-1090
94	1001-1266	249	800-1050
102	940-1300	275	980-1209
107	200-1006	283	1061-1296
127	300-799 800-1103	315N	800- 913
128	250-556	315S	360- 555
133	800- 904	325N	800-1047
140	280- 614	335N	800- 911
143	800- 911	355S	360- 699
144	1140-1363	351N	800- 913
147	300-1102	351S	360- 510
148	1140-1362	369	380- 599
152	430- 611	387	380- 592C
153	860- 935	406	380- 627
153A	900-1028	421	400- 585
156	1070-1162	475	340- 442
158N	830- 922	479	340- 475
158	1070-1159	495	408- 340
160	730- 834	501	430- 492
164	920-1221	503	340- 407
167	1140-1221	504	430- 493
169	720-1215	507	430- 501
170	750-1006	515	413- 340
172	920-1004	521	340- 423
176	920-1015		

LINE	SHOTPOINTS	LINE	SHOTPOINTS
SA71-534	370- 450	SA71-1005	280- 336
543	430- 522	1005A	280- 336
551	440- 541	1006	280- 353
563	430- 512	1006A	280- 351
566	360- 453	1007A	280- 354
567	440- 482	1007A	280- 354
571	520- 566	1008	250- 333
573	470- 582	1008A	250- 333
575	520- 639	1009	280- 338
579	520- 638	1009A	280- 337
581	520- 645	1010	1610-1675
585	561- 632	1011	1620-1688
587	560- 627	1012	920- 987
597	392- 447 380- 407	1013	310- 353
599	380- 460	1014	310- 352
601	380- 459	1015	300- 348
603	380-457	1016	350- 420
605	380- 430	1017	330- 390
607	380- 425	1018	440- 486
610	420- 498	1019	466- 400
612	420- 498	1531	100- 305
614	420- 497	1560	480- 952
616	420- 499	1572	480-1079
618	490- 497	1592	580- 997
627	270- 436	1650	1400-1896
643	320- 414	1658	1740-2232
1001	1590-1681	1693	700- 829
1002	1540-1572	1750	1300-1592
1002	1073-1669	1947	100- 240
1003	1540-1652	1967	100- 205
1004	290- 374		
1004A	290- 374		



Location diagram
OEL 38

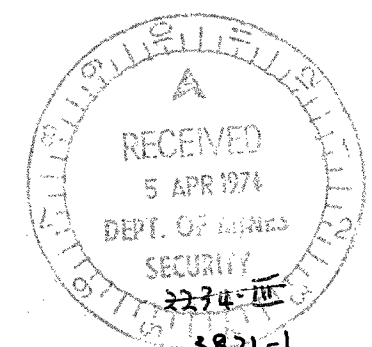


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

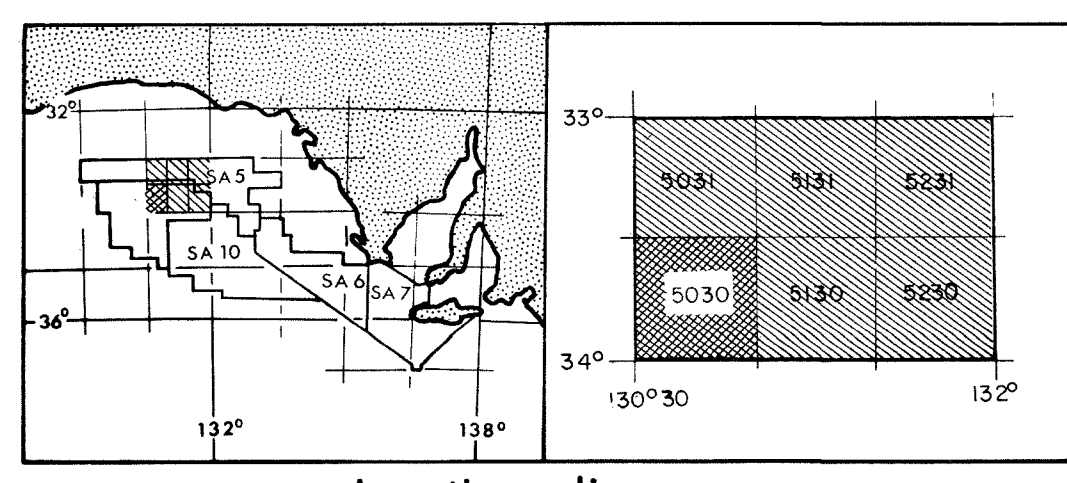
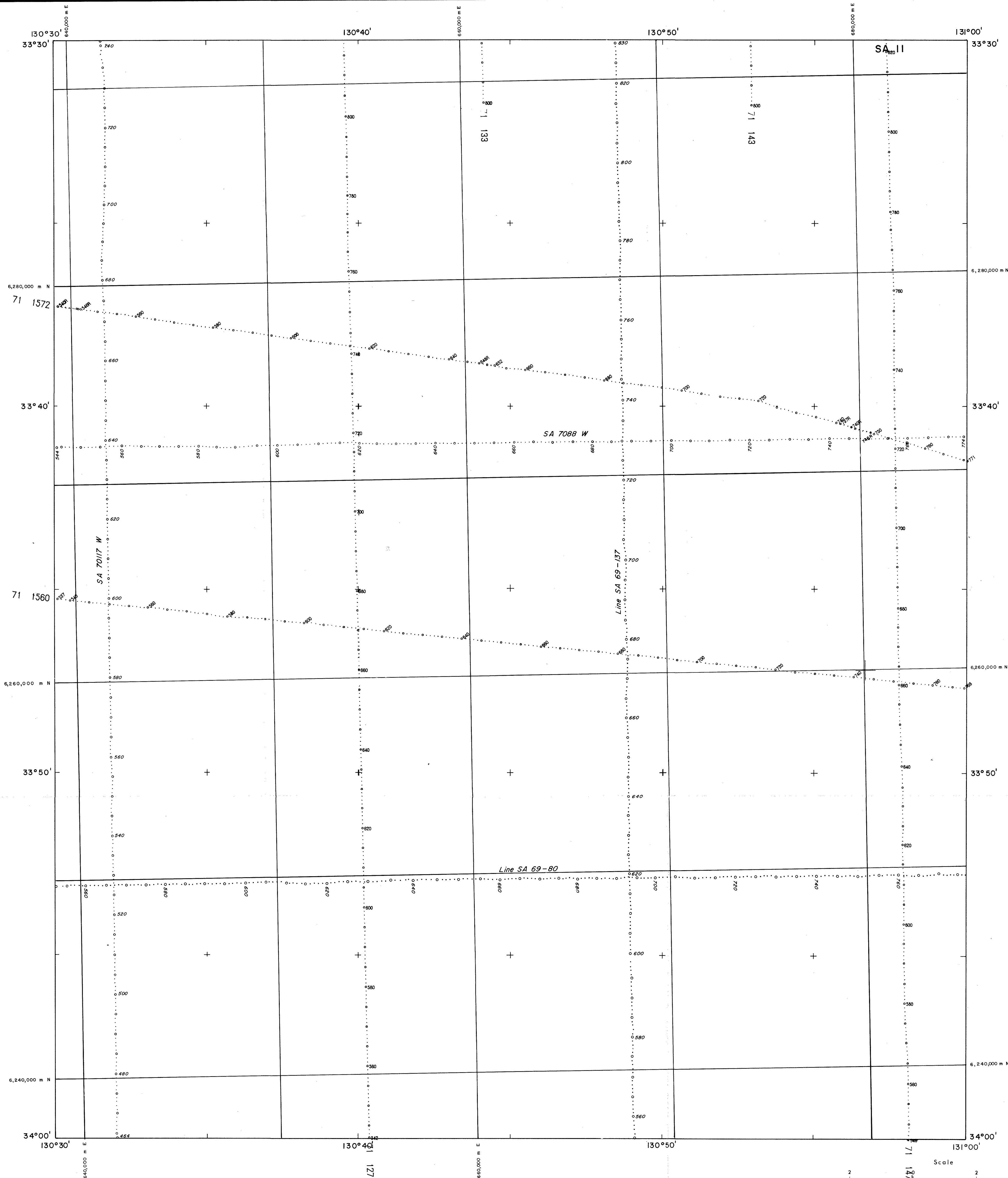
SHOT POINT LOCATIONS

Scale 1:100,000

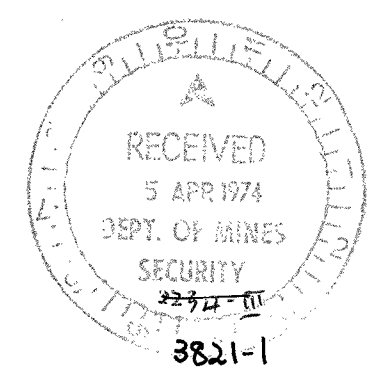
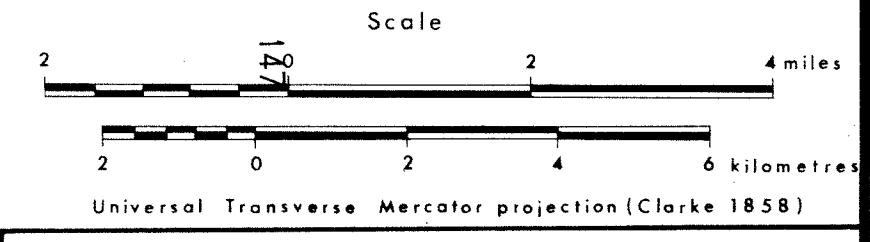
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Report SDA 100	End 208	Drawing No
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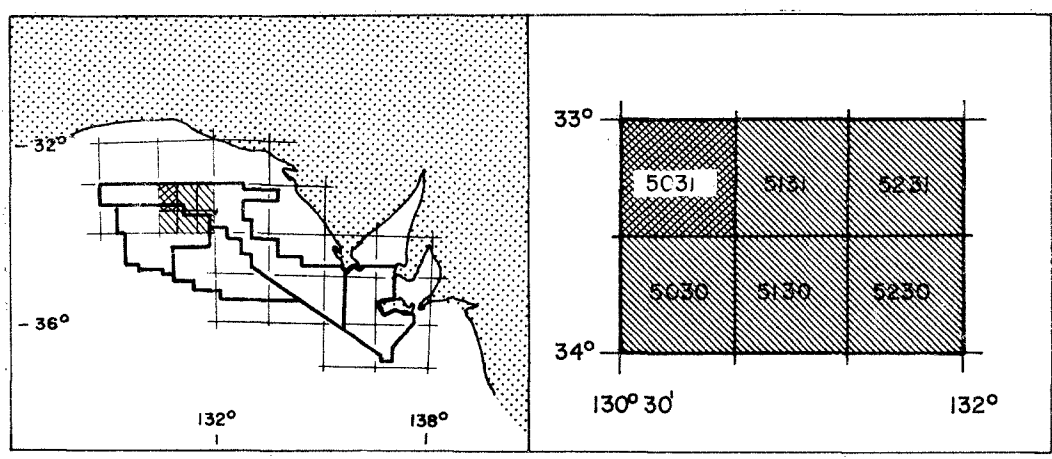
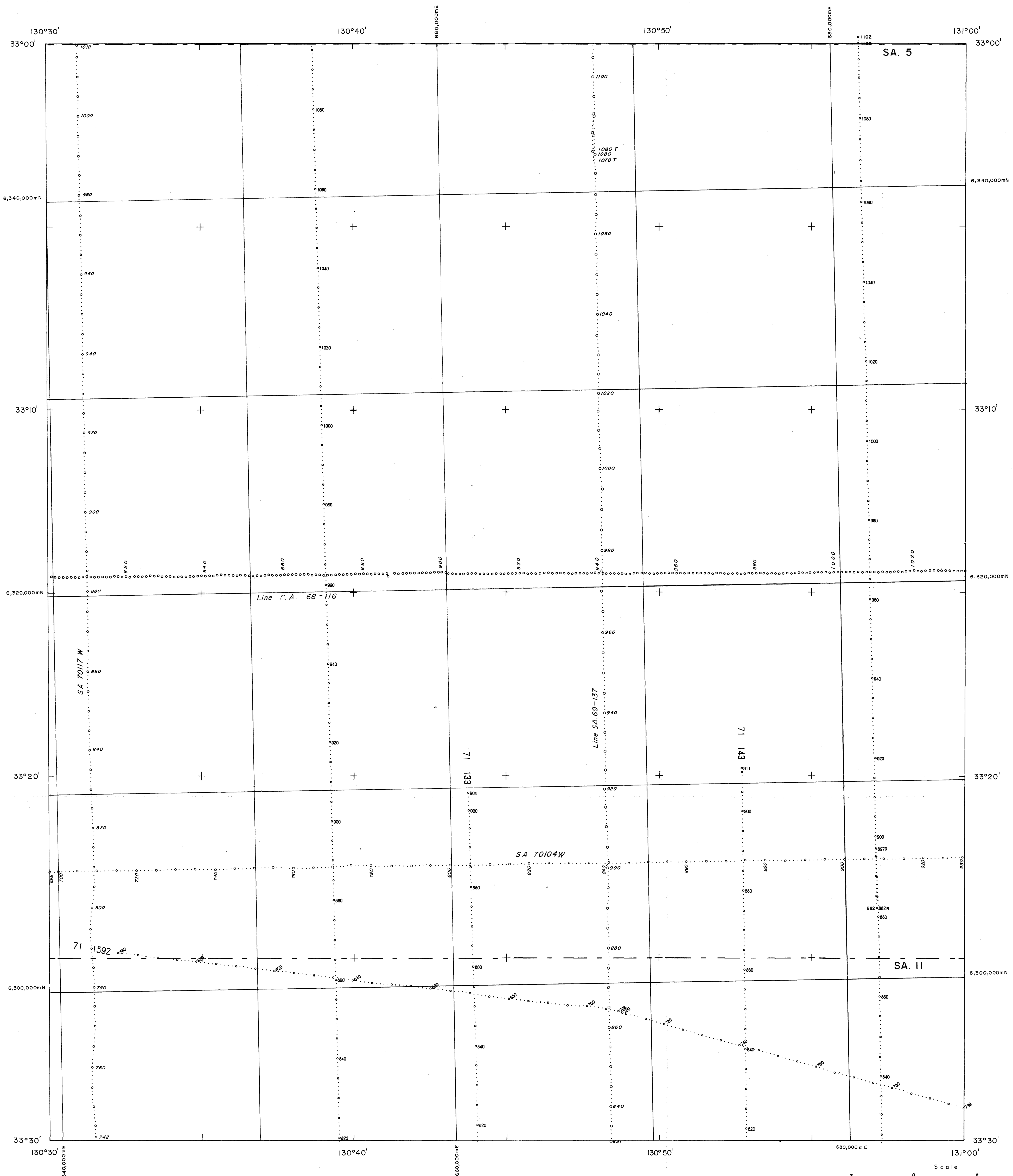


Location diagram

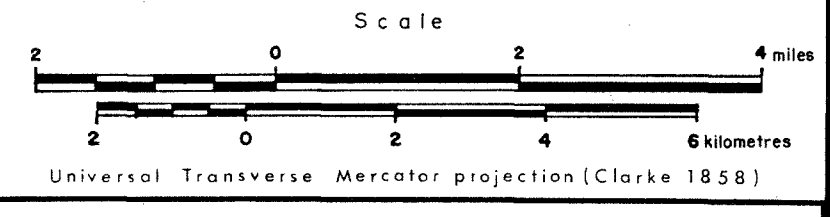


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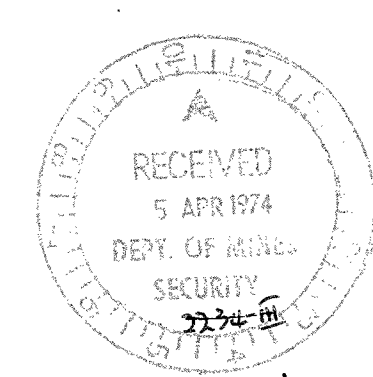
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Scale 1:100,000		
Author.	Date December 1974	Sheet No.
Report.	Encl.	Drawing No. 5030



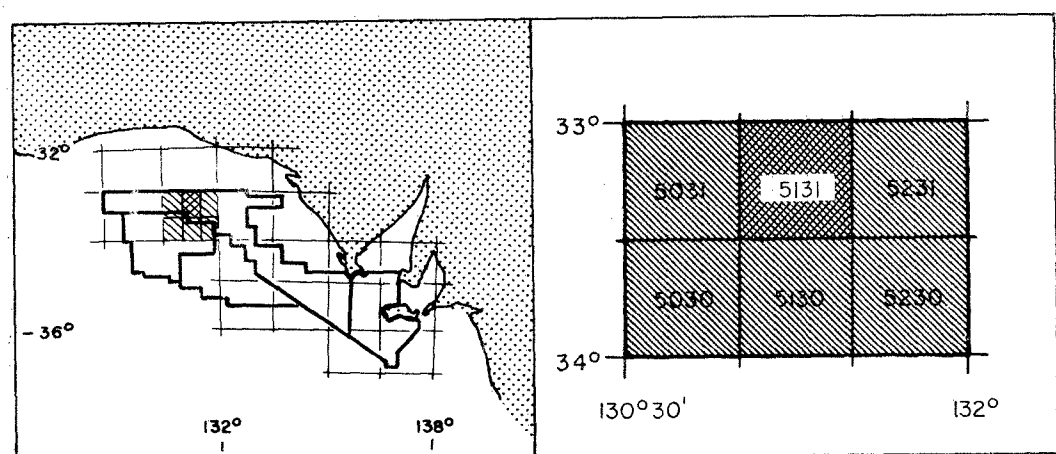
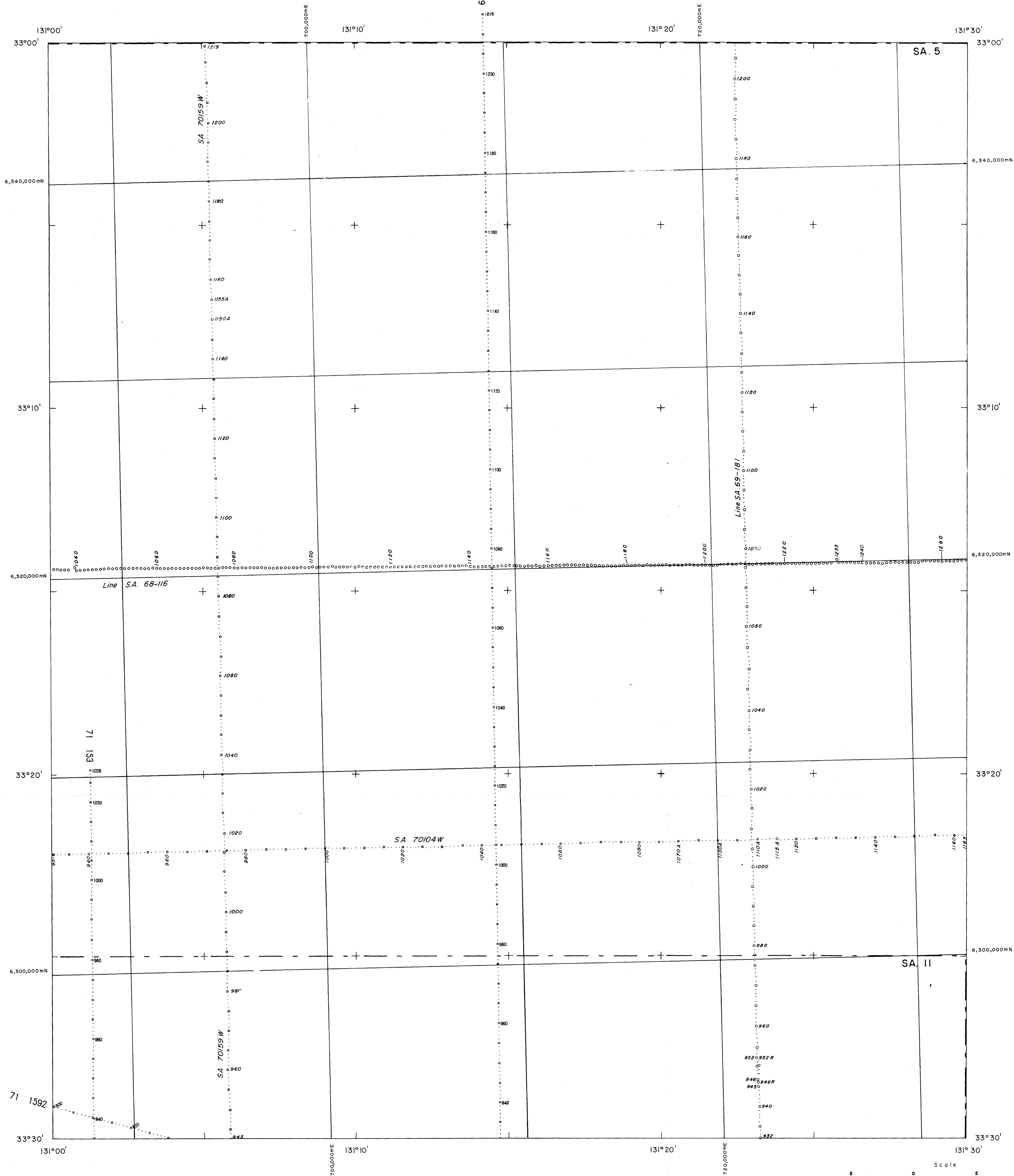
Location diagram
OEL 38



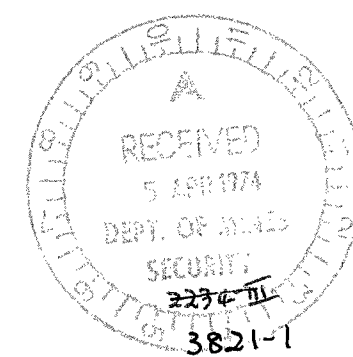
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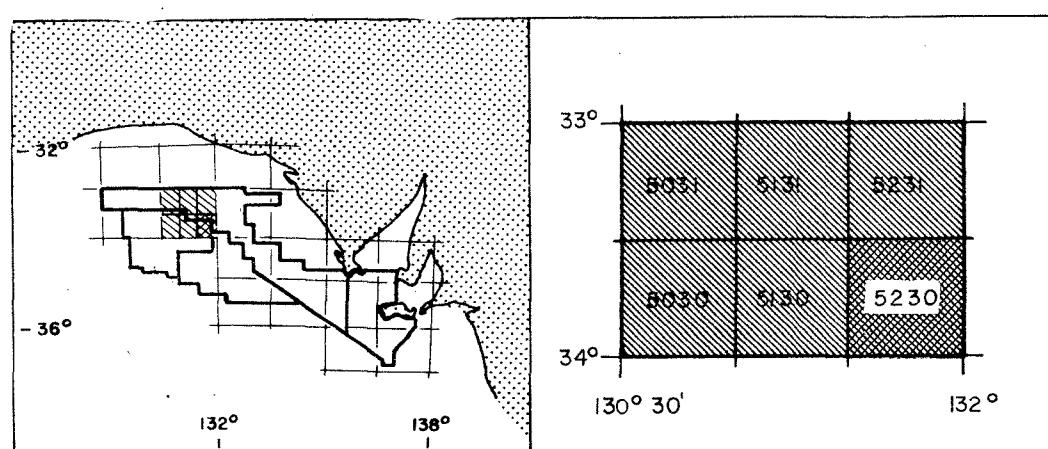
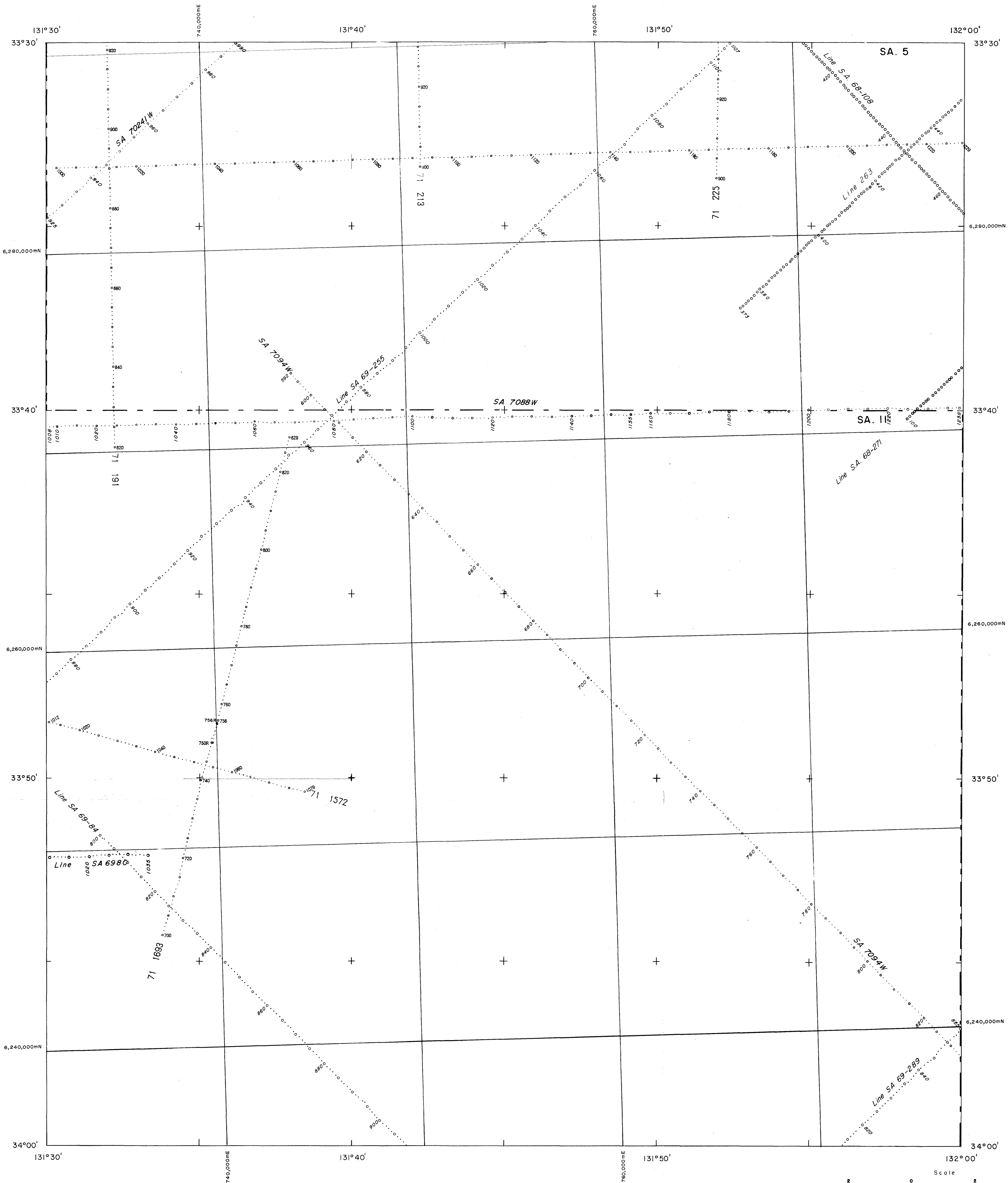


Location diagram
OEL 38

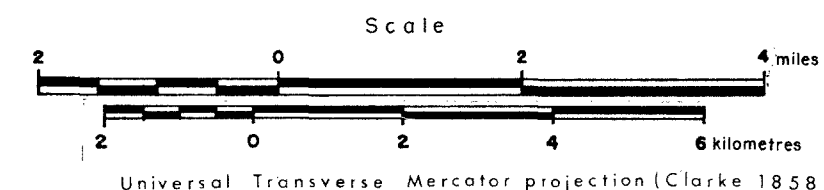


3821-7.

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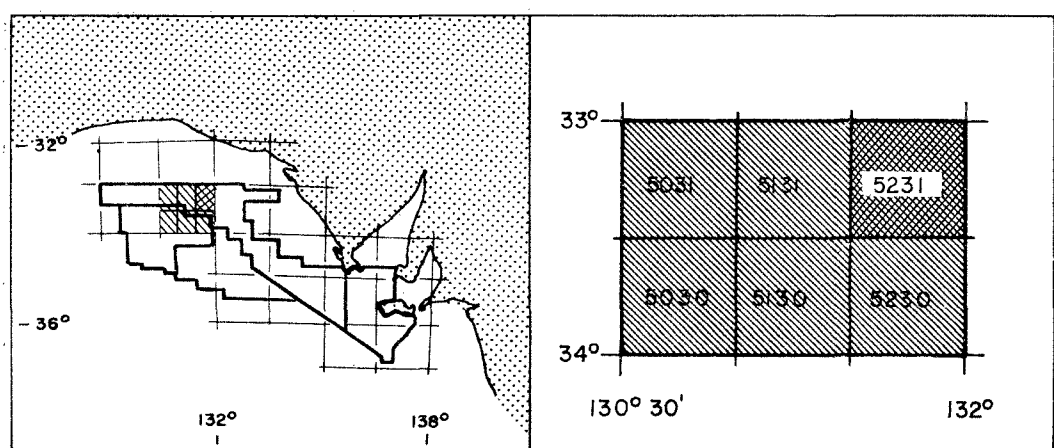
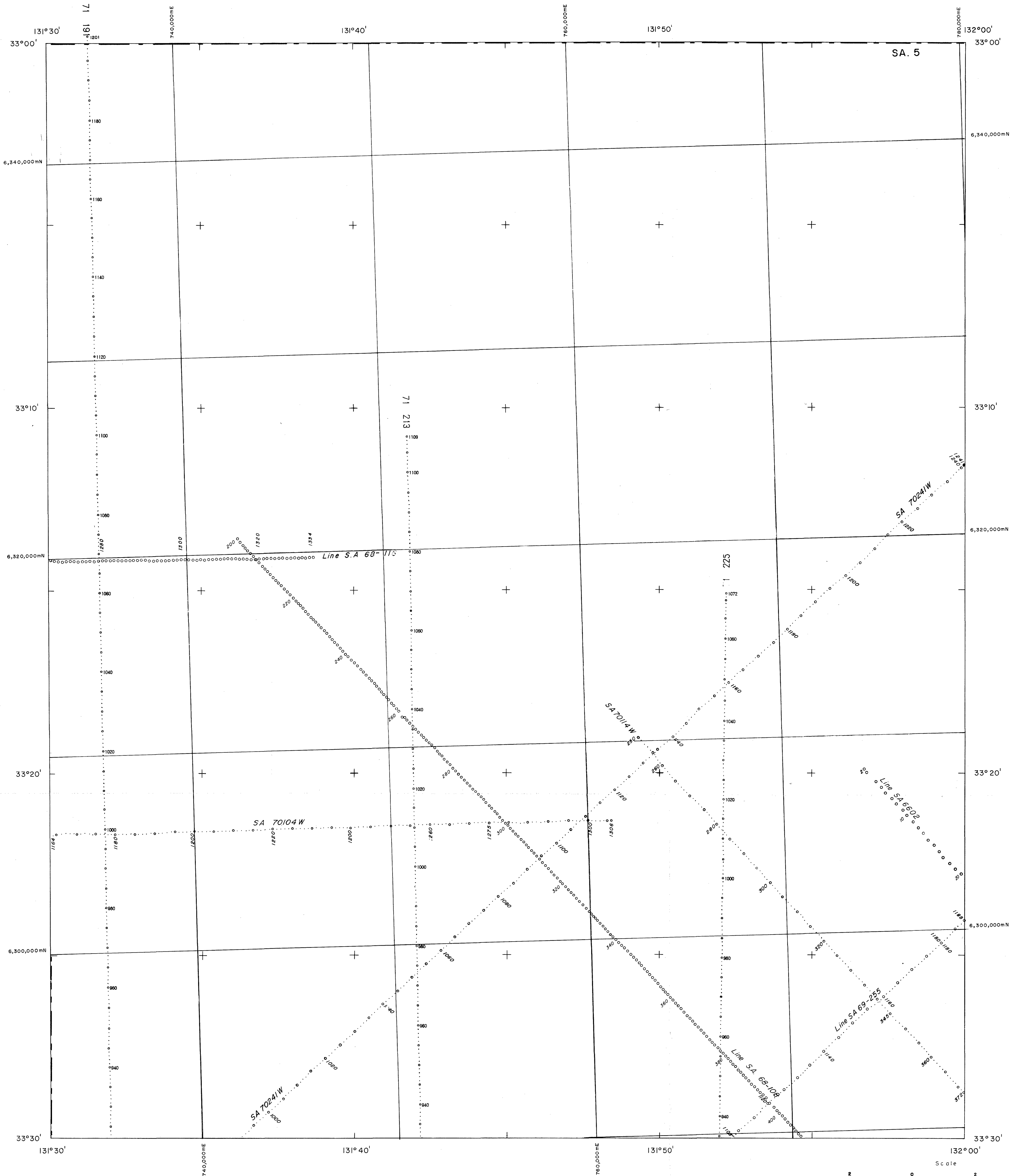


Location diagram
OEL 38

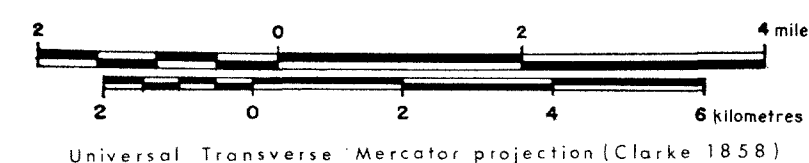


3821-8.

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Location diagram
OEL 38

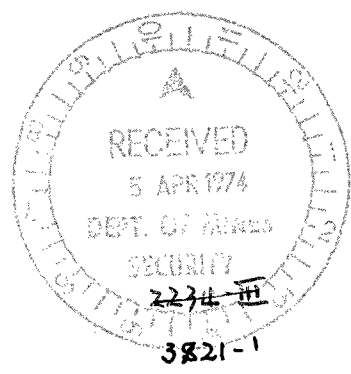


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

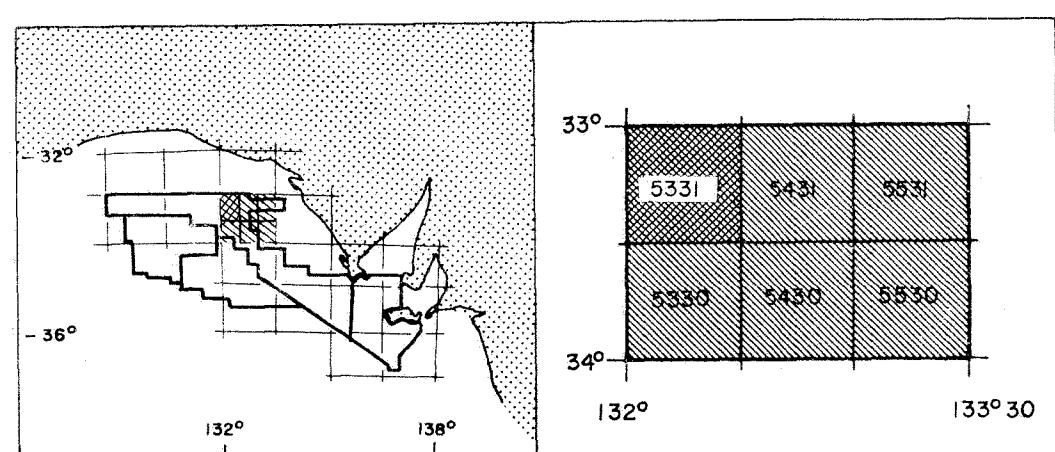
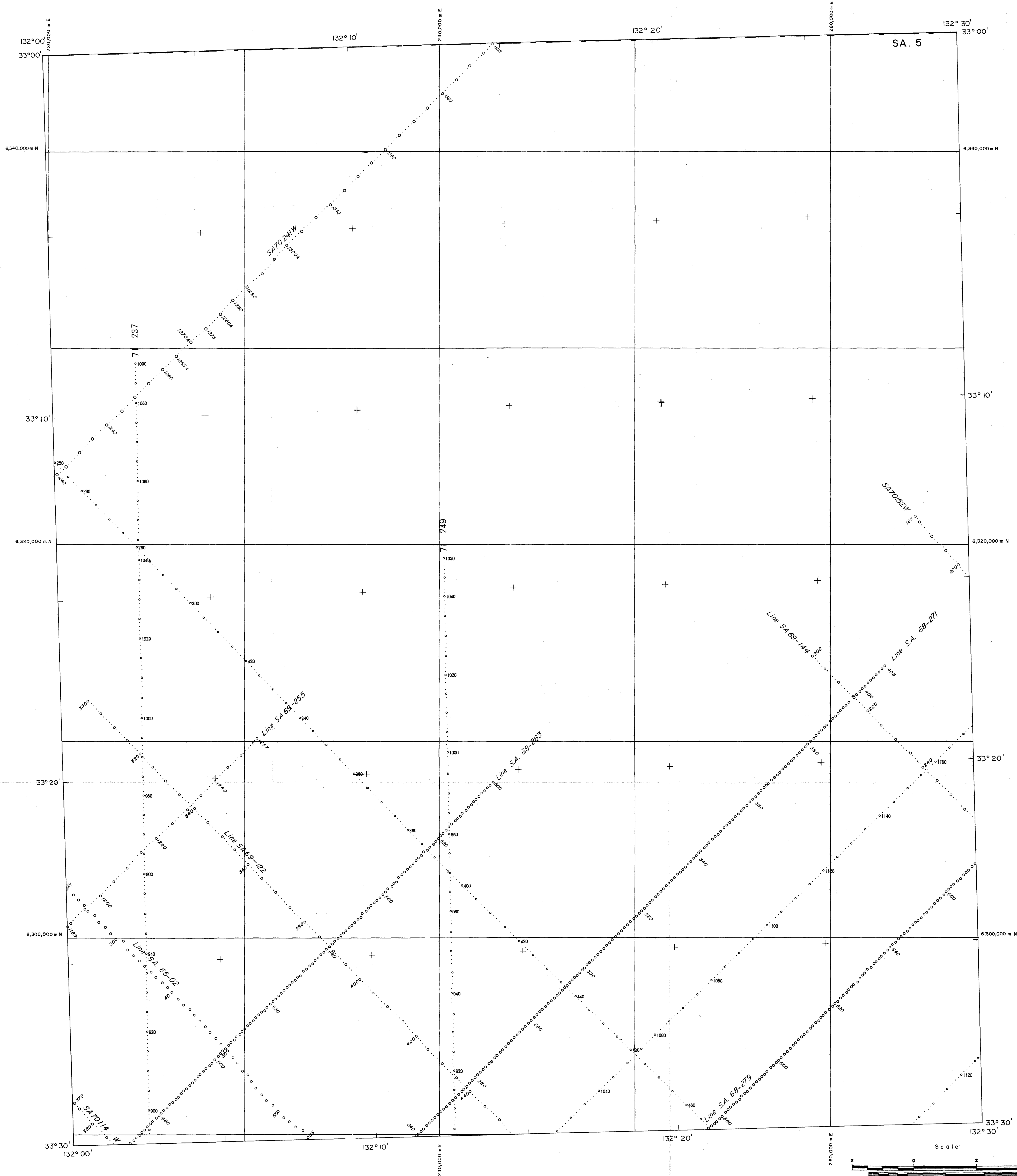
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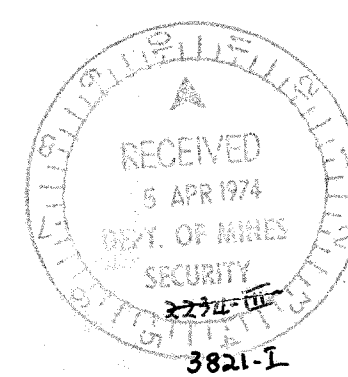
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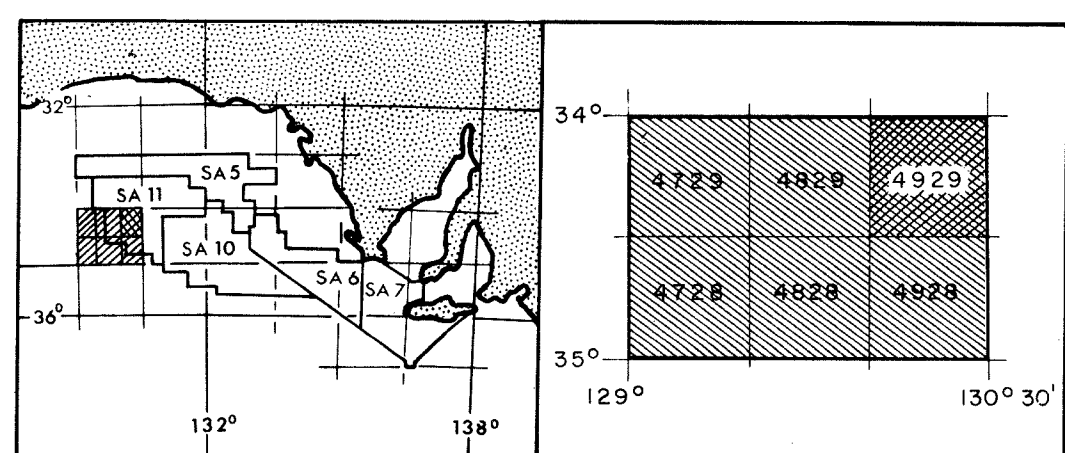
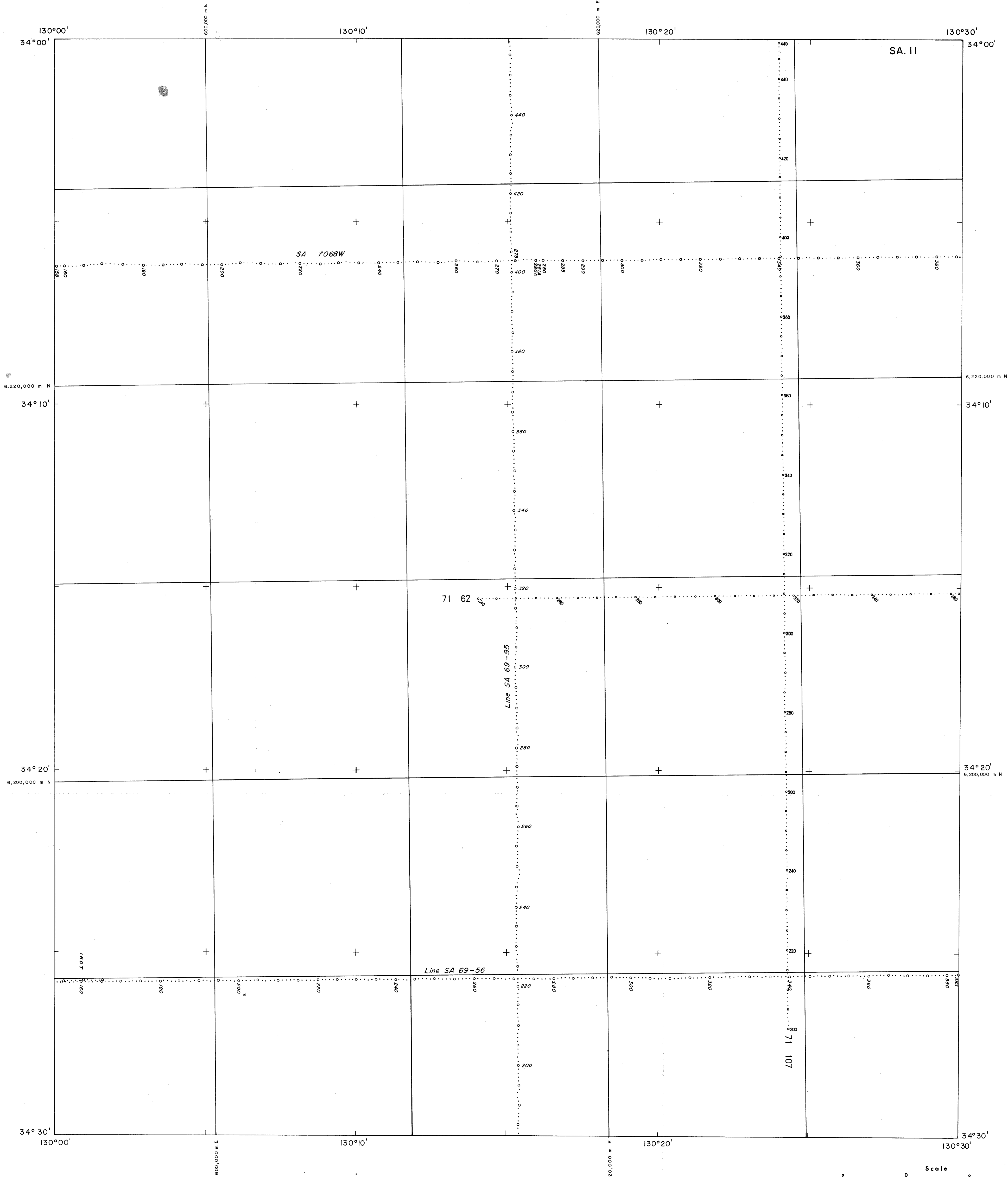


Location diagram
OEL 38

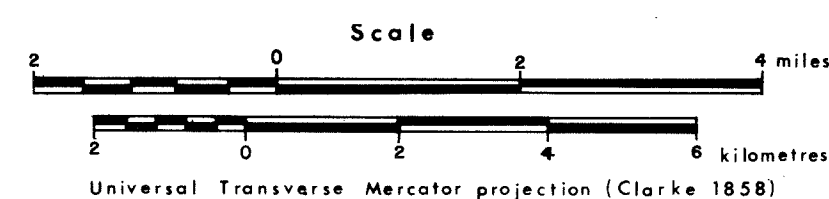


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Location diagram



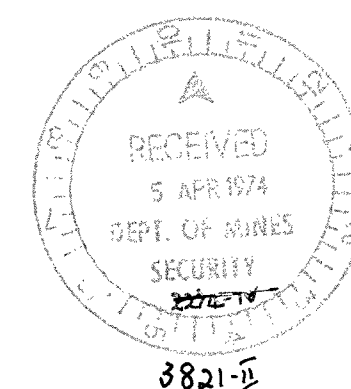
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SOUTH AUSTRALIA OFFSHORE

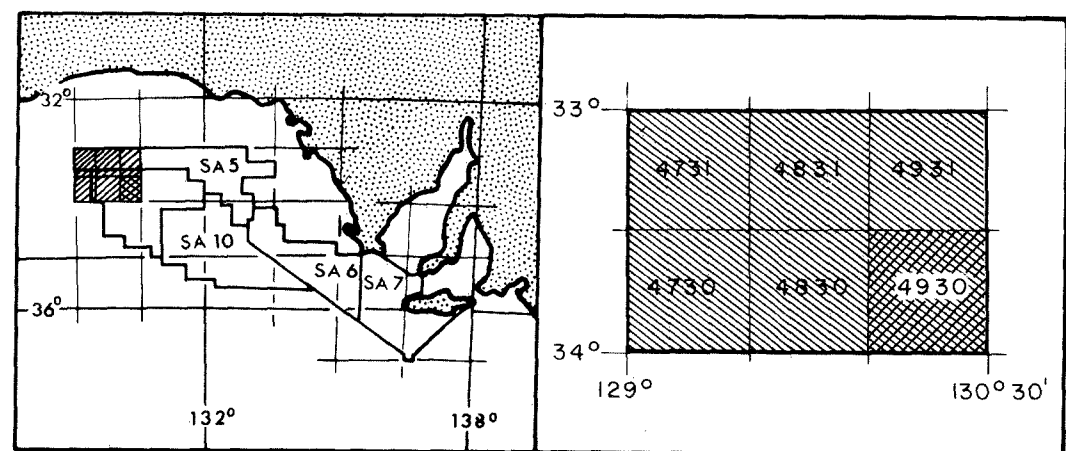
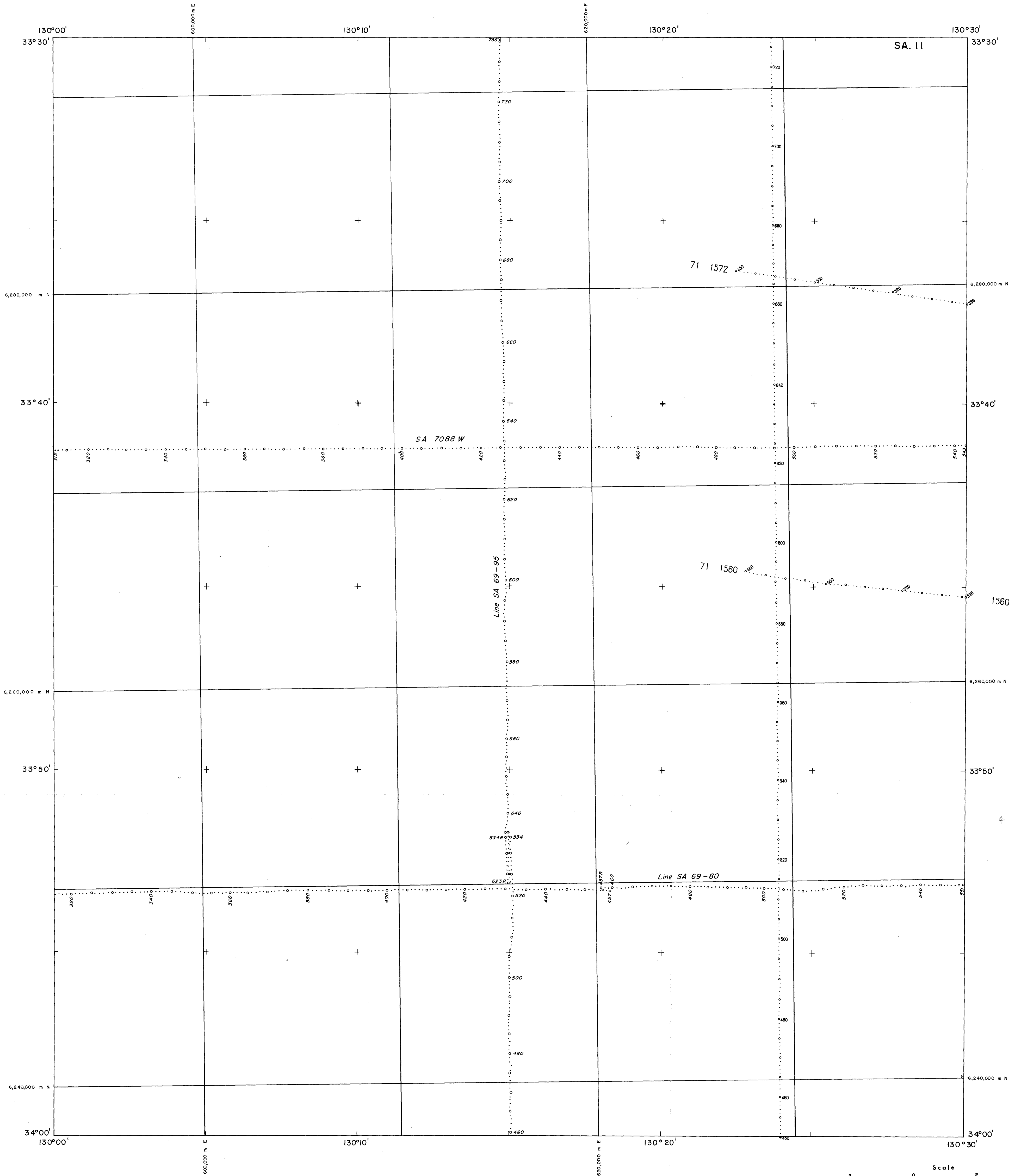
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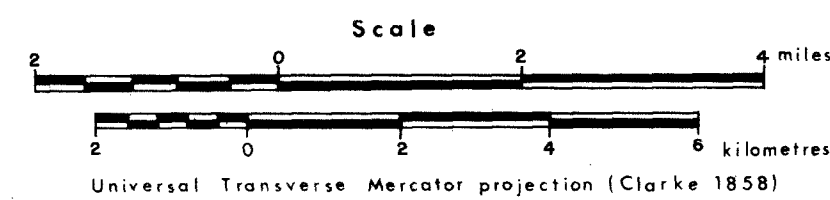
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3821-13.



Location diagram

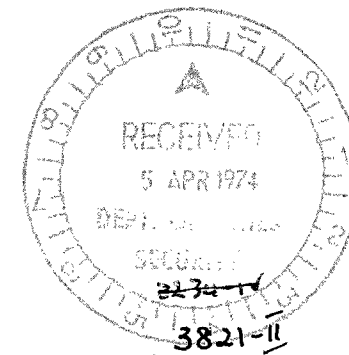


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

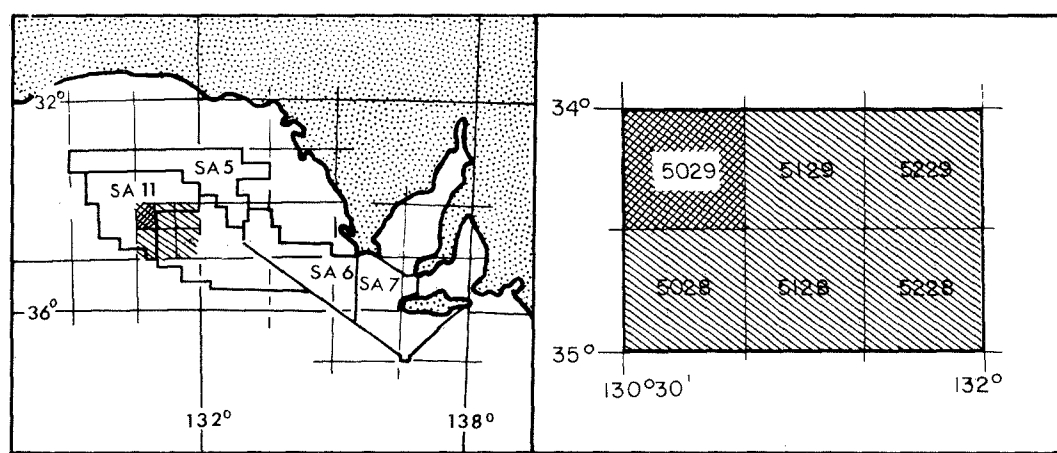
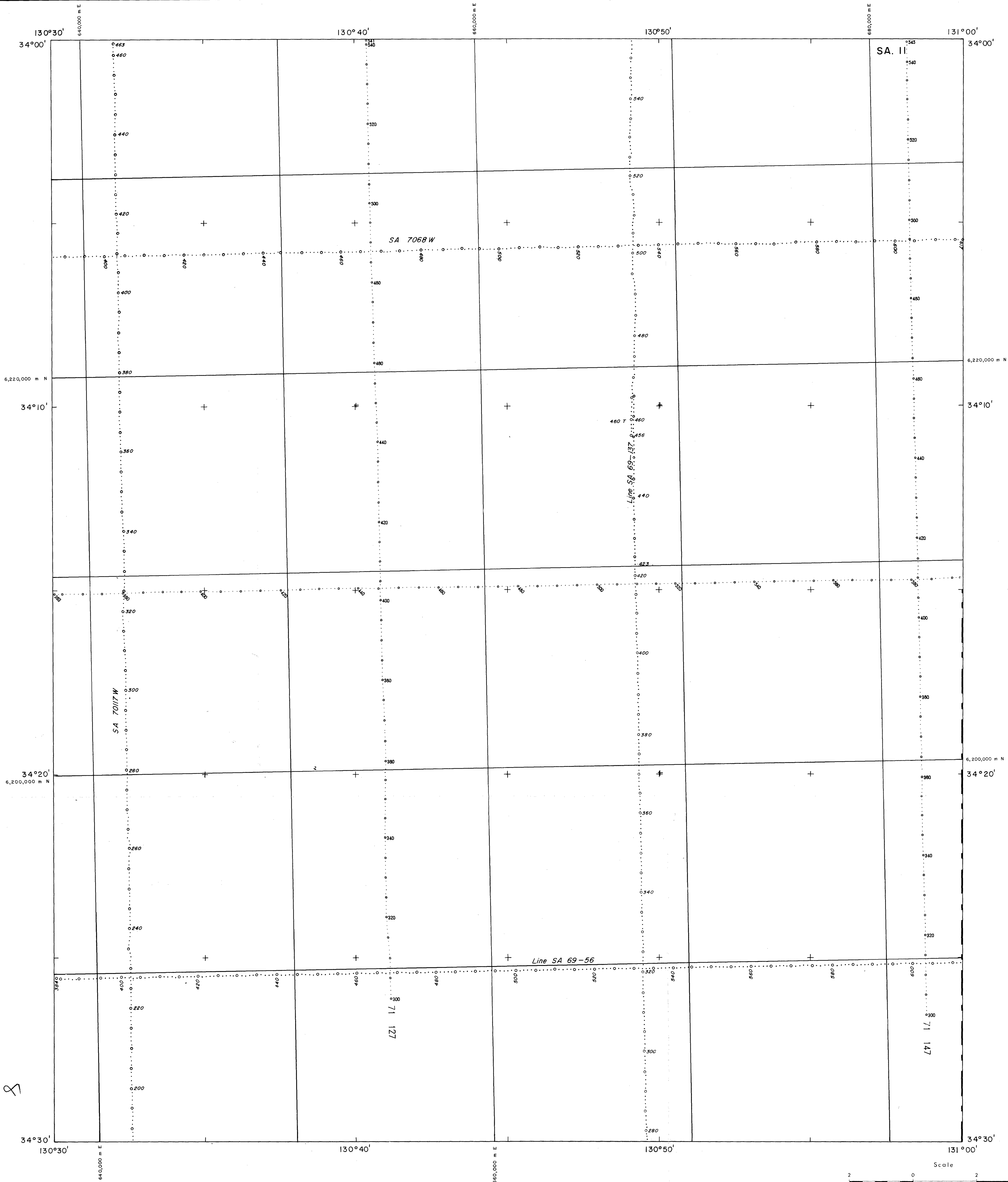
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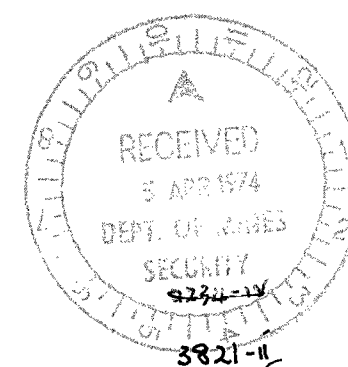
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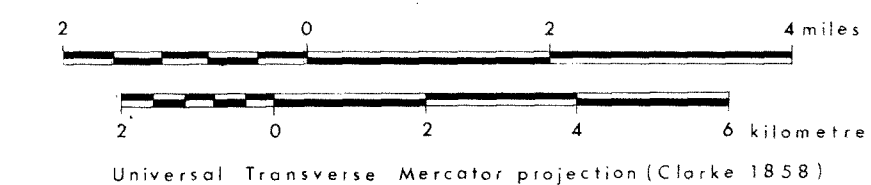
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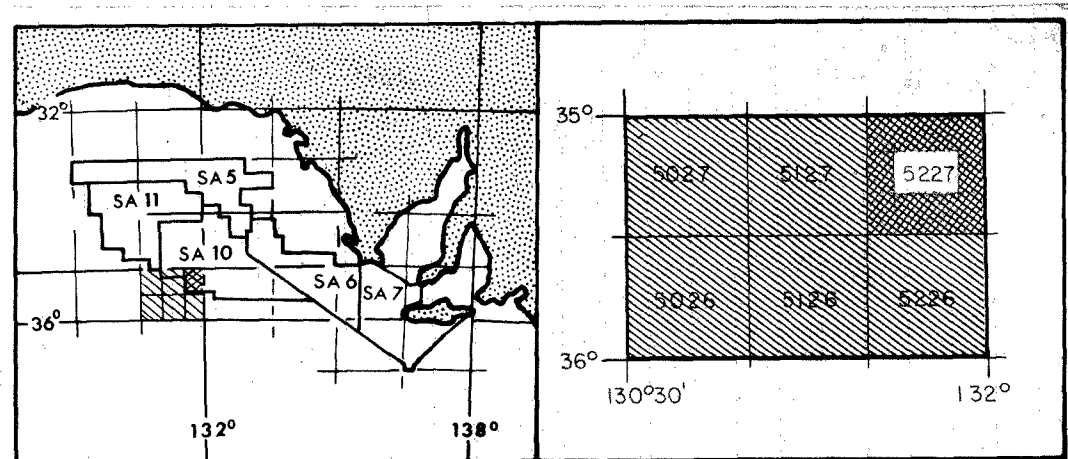
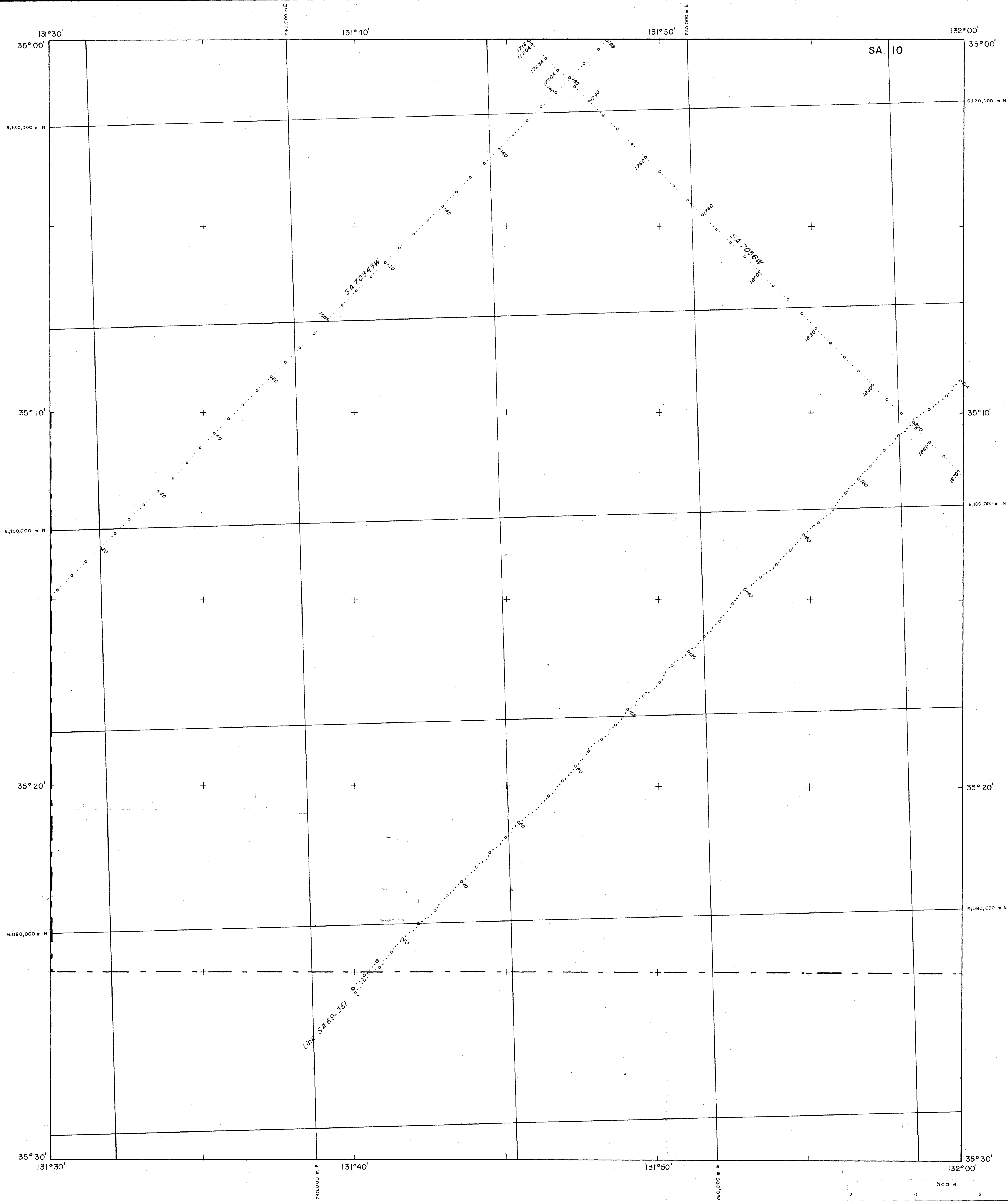
Location diagram



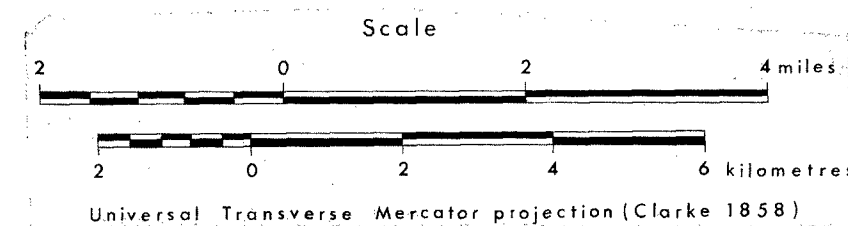
3821-15.



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
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Report	Encl.	Drawing No.	5029



Location diagram

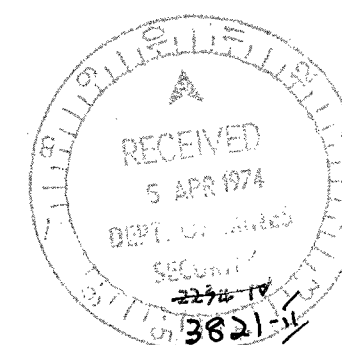


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

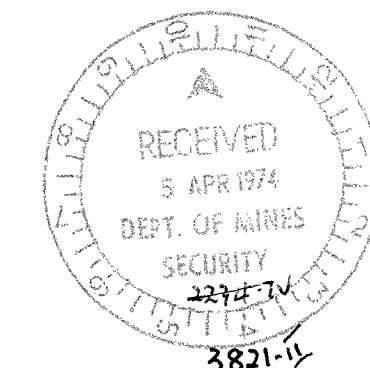
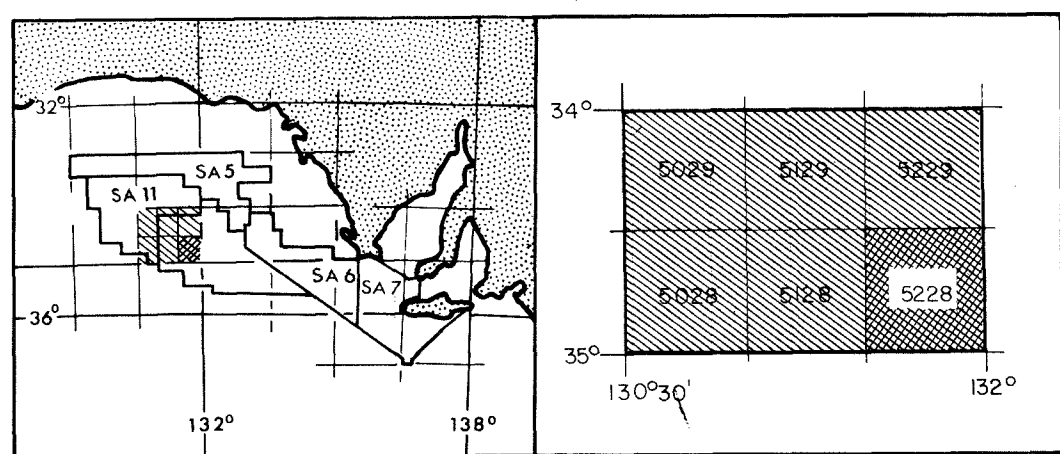
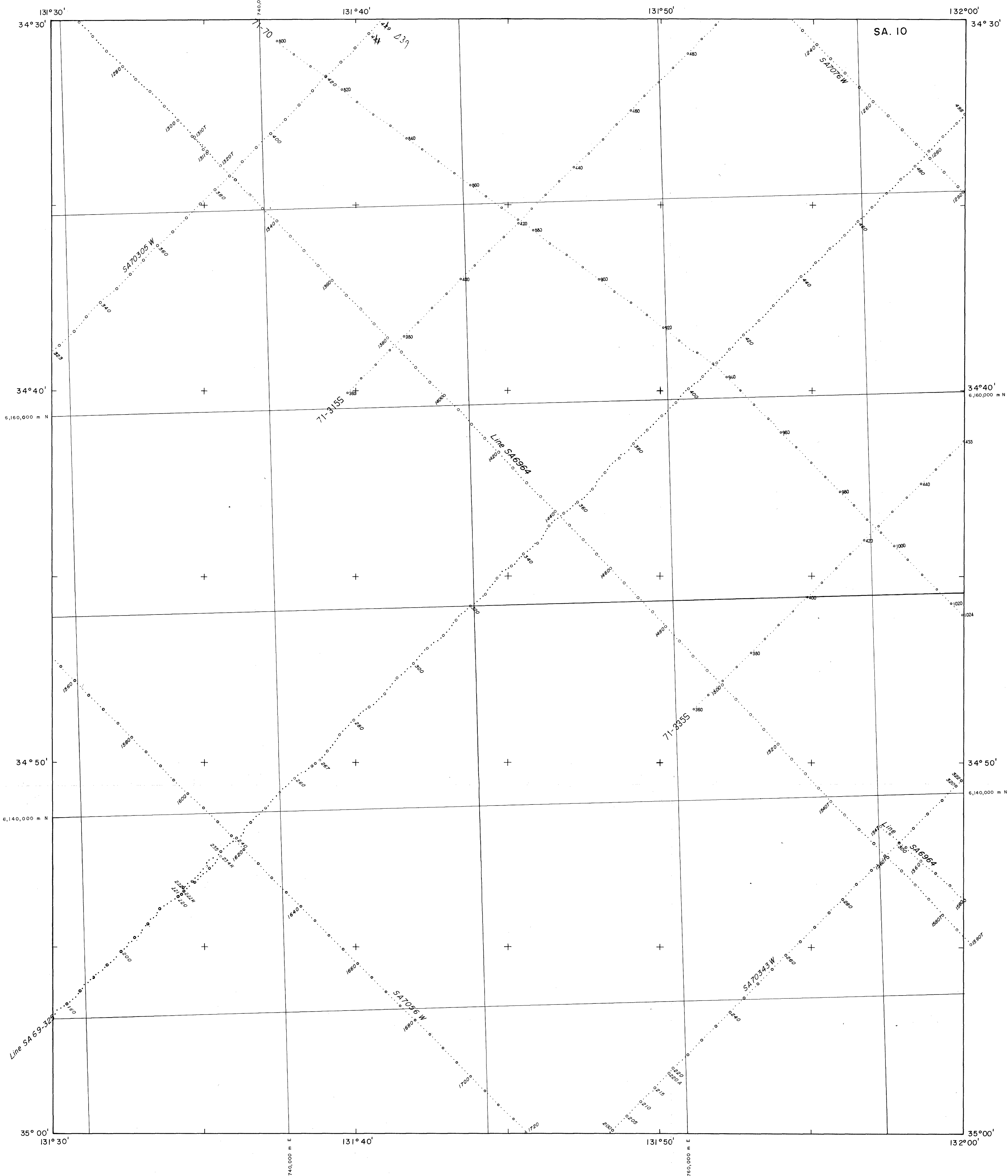
SHOT POINT LOCATIONS

Scale 1:100,000

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Report	Encl	Drawing No. 5227

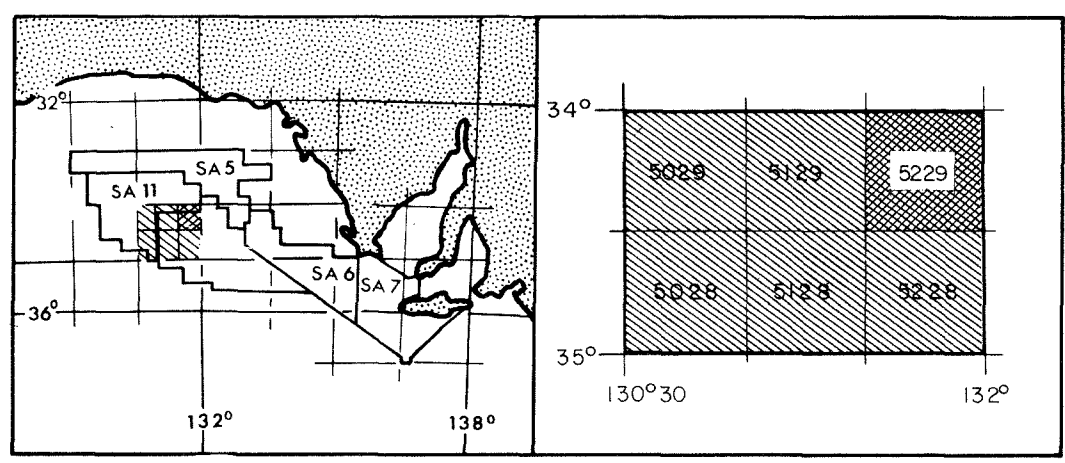
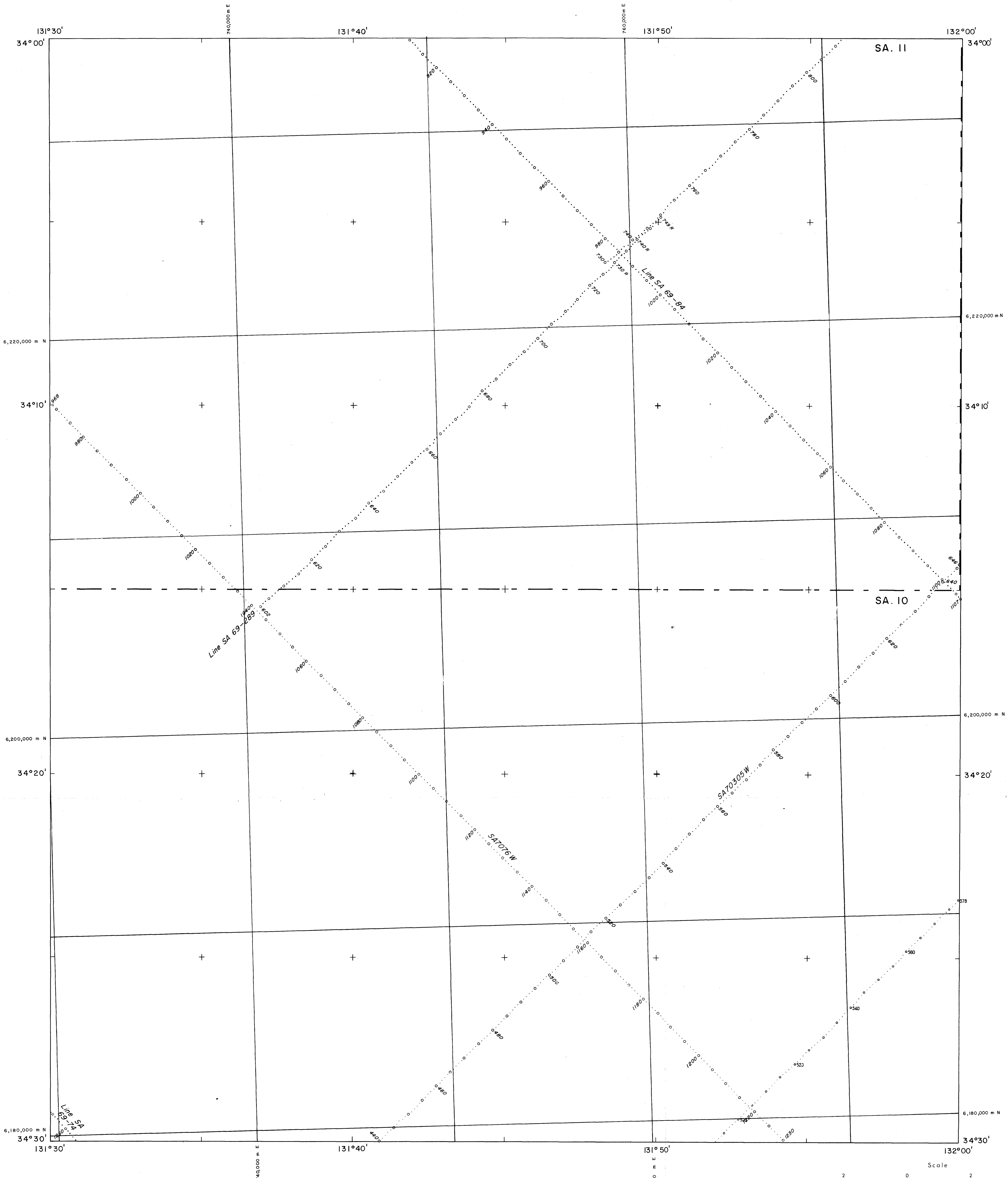


3821-17.

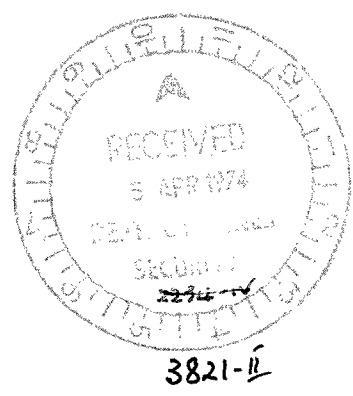
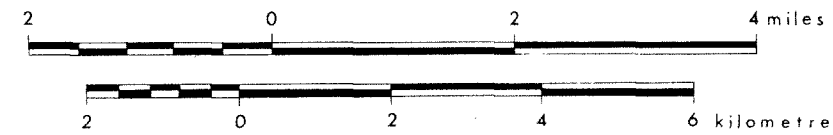


Universal Transverse Mercator projection (Clarke 1858)			
SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
Scale 1:100,000			
Author	Date: December 1970	Sheet No	
Report	Encl.	Drawing No.	5228

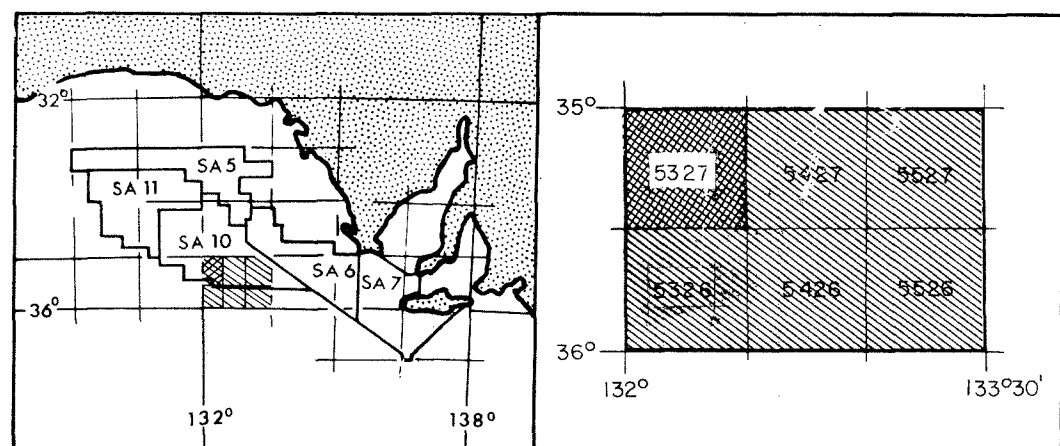
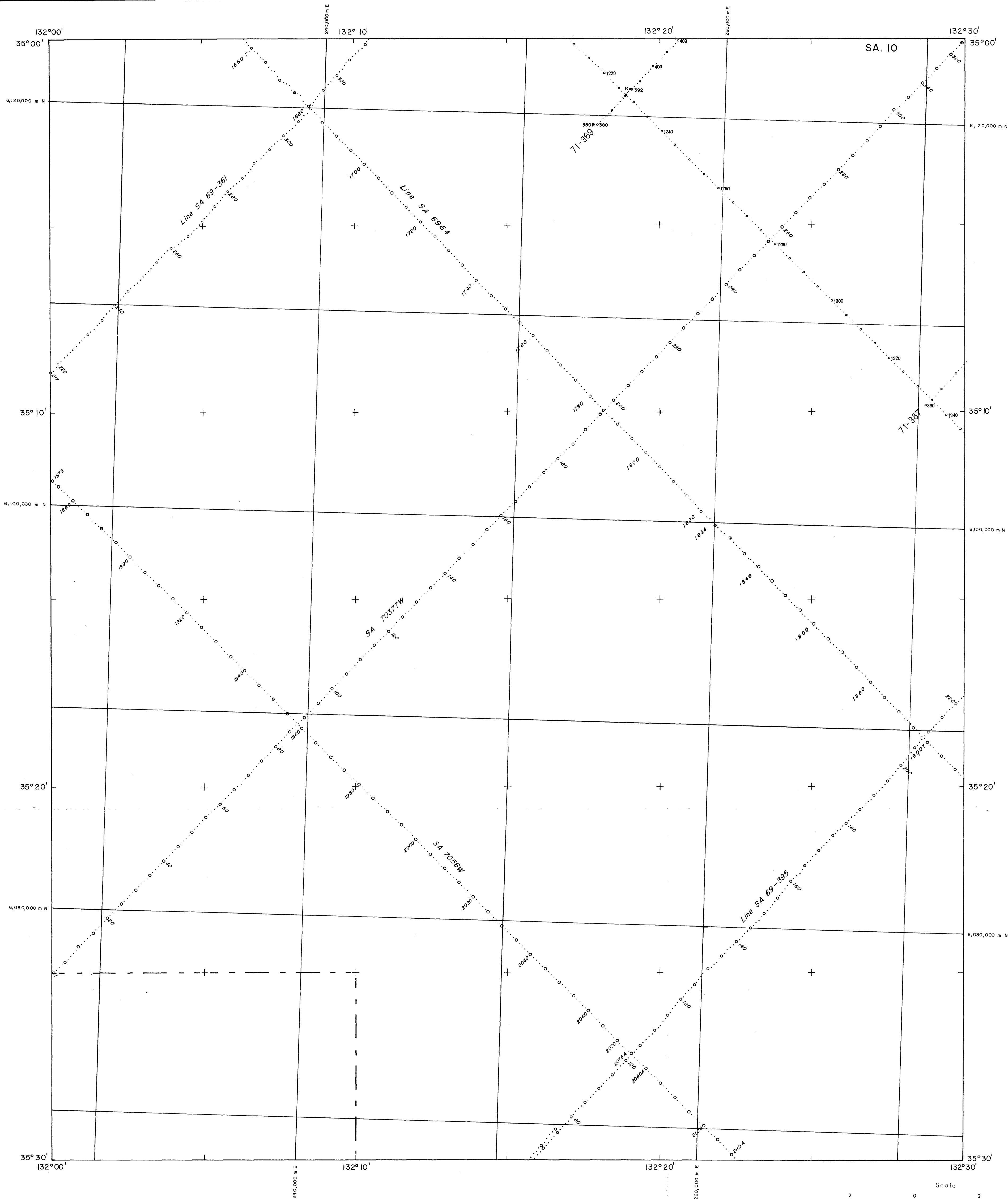
3821-18.



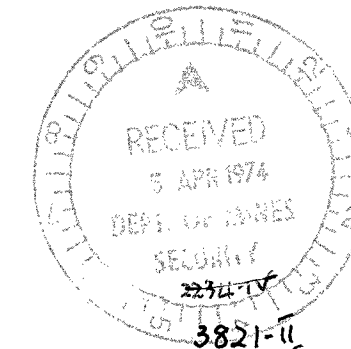
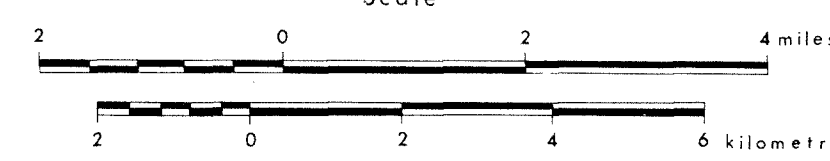
Location diagram



3821-19. 5229

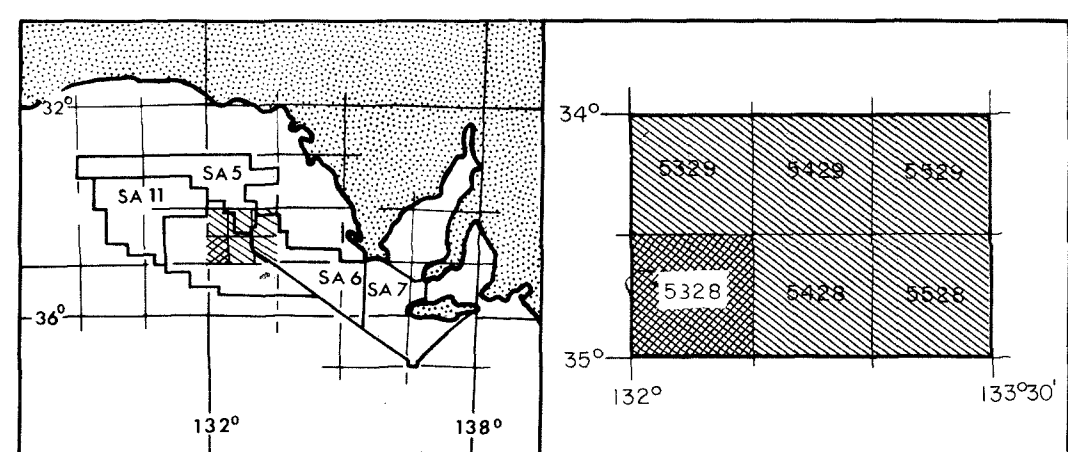
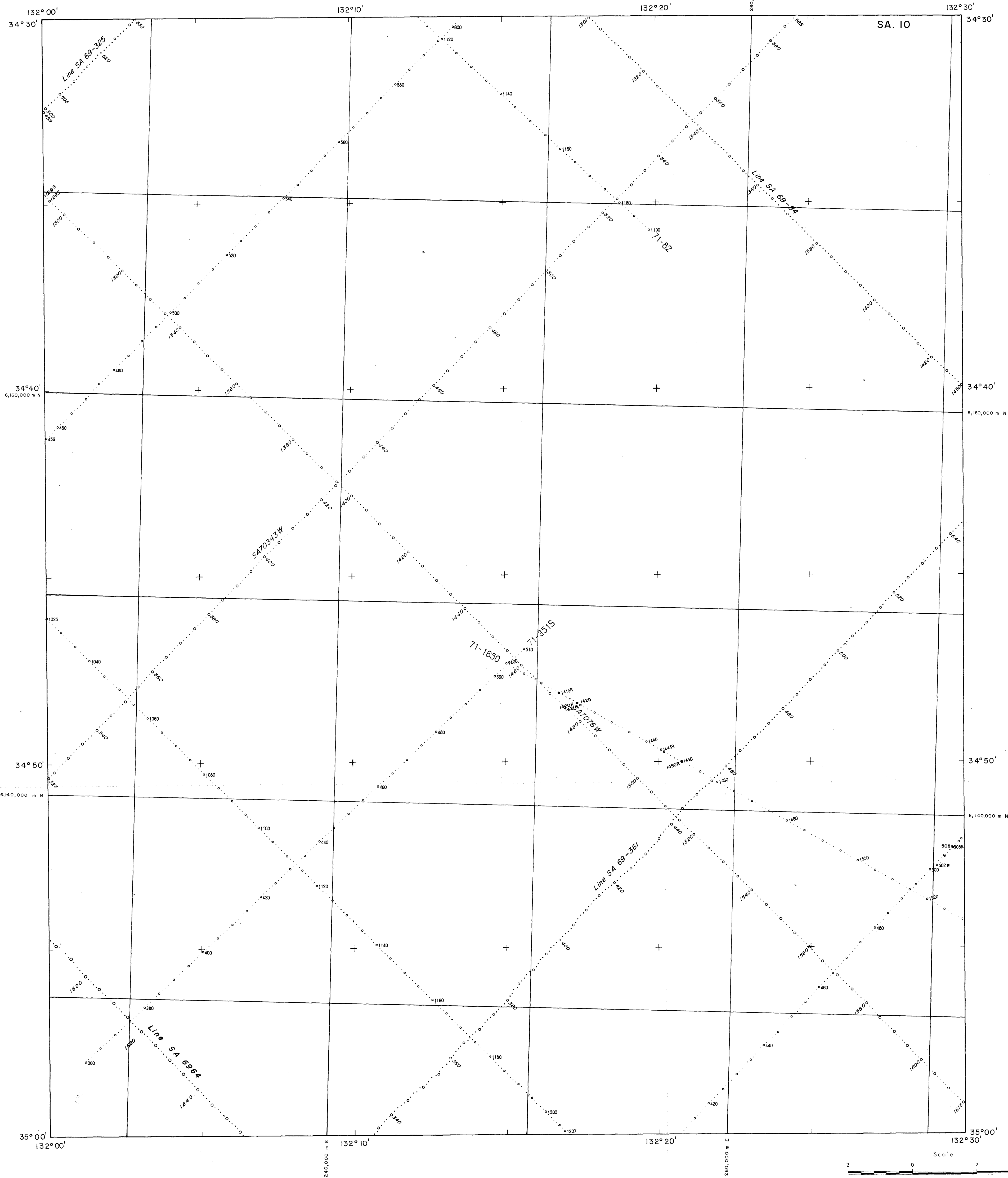


Location diagram

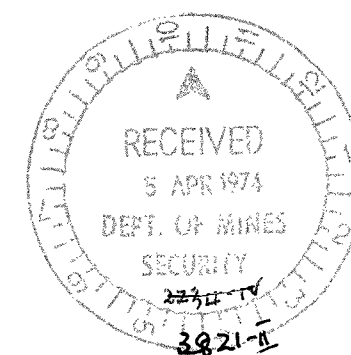


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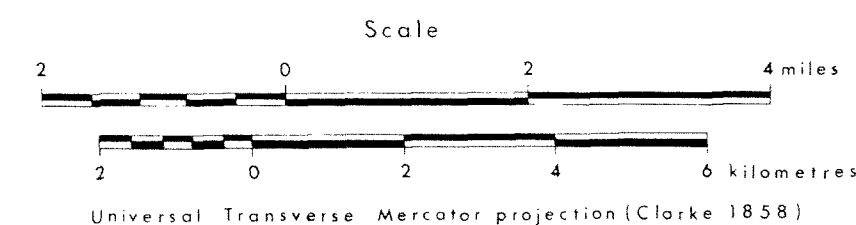
SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
Scale 1:100,000			
Author.	Date: December 1970	Sheet No	
Report.	Encl.	Drawing No.	5327



Location diagram



3821-21.

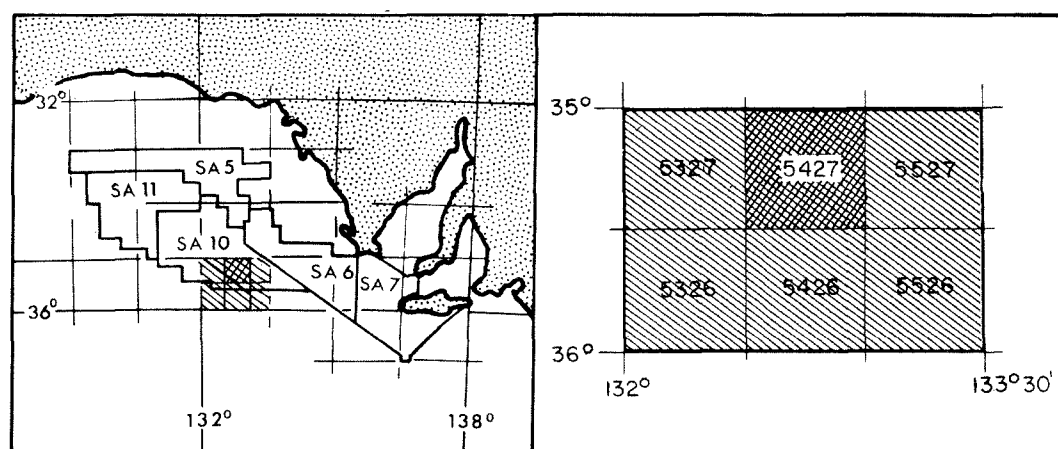
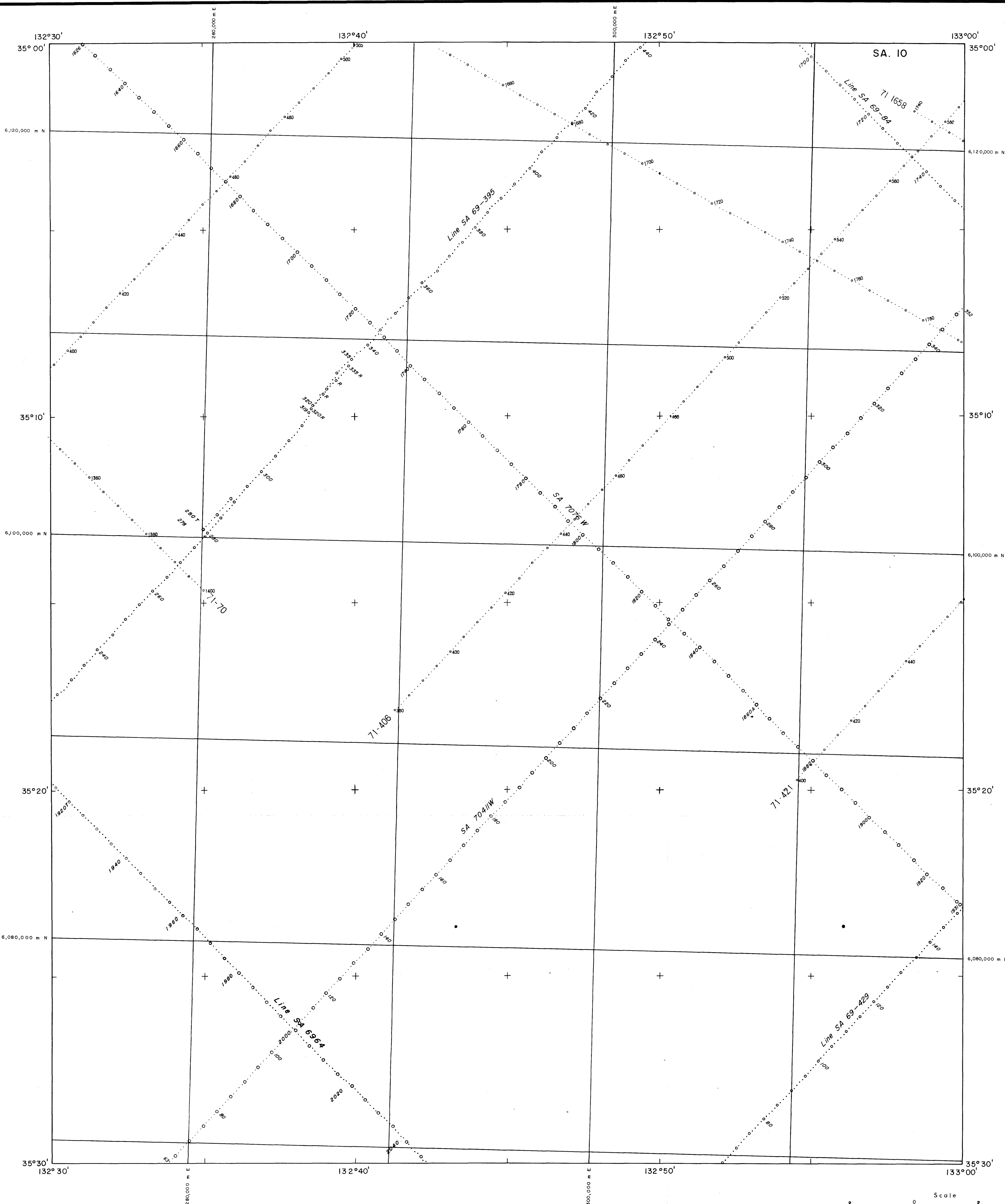


SHELL DEVELOPMENT (AUSTRALIA) PTY LTD			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
Scale 1:100,000			
Author	Date: December 1970	Sheet No	
Report	Encl	Drawing No	5328

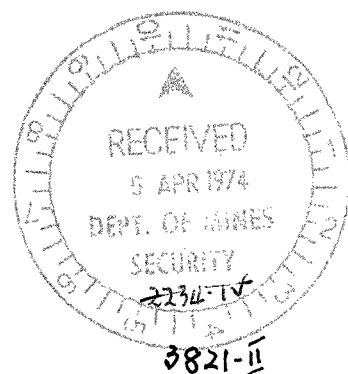
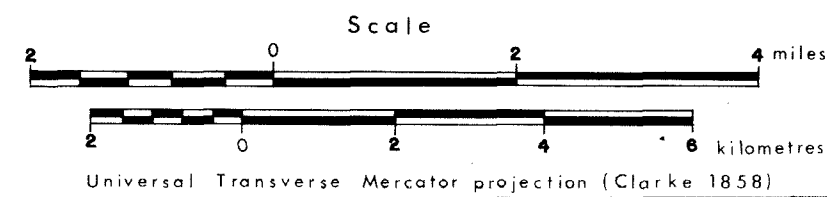
CONTENTS OF VOLUME THREE

PLANS (cont'd)		Scale	MESA NO.	
	Shotpoint location maps:			
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Encl.	Sheet no. 5428.	1:100 000	3821-25	<i>A1</i>
Encl.	Sheet no. 5429.	1:100 000	3821-26	<i>A1</i>
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Encl.	Sheet no. 5826.	1:100 000	3821-34	<i>A1</i>
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Encl.	Sheet no. 6126.	1:100 000	3821-44	<i>A1</i>
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Encl.	Bathymetric contour map, Great Australian Bight Basin.	1:500 000	3821-46	<i>>A0</i>

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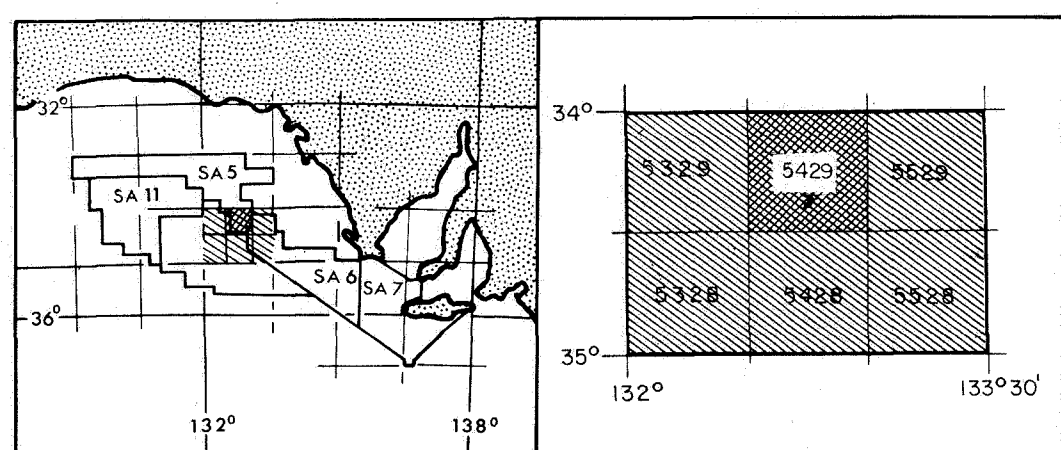
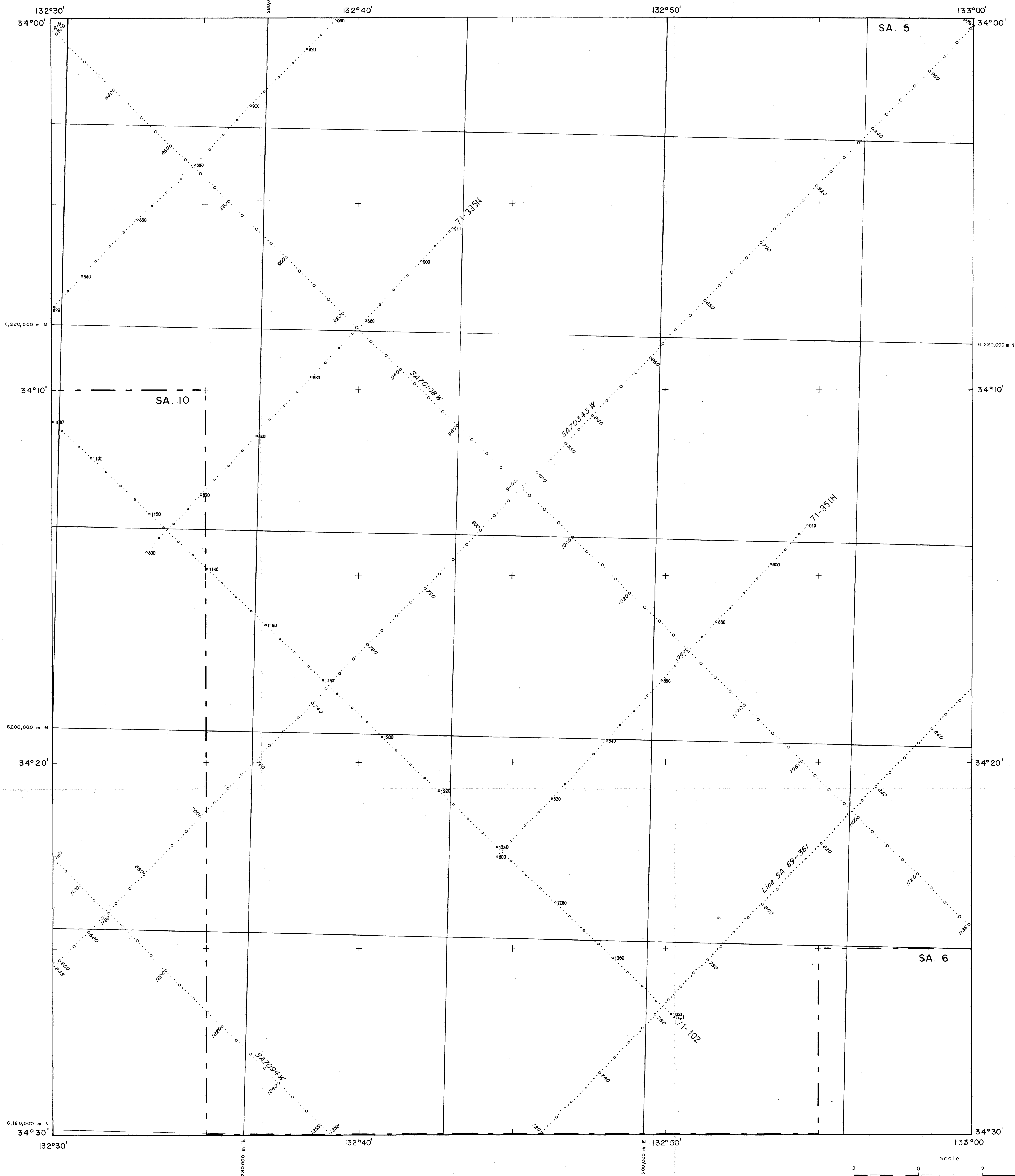


Location diagram

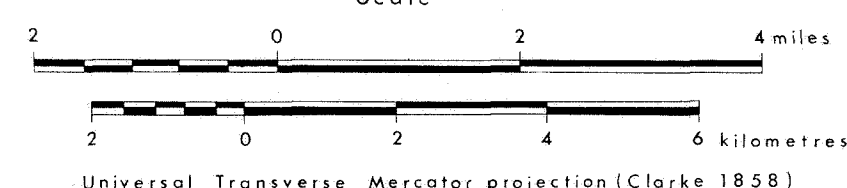


3821-24.

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
Scale 1:100,000			
Author	Date: December 1970	Sheet No	
Report	Encl.	Drawing No.	5427



Location diagram

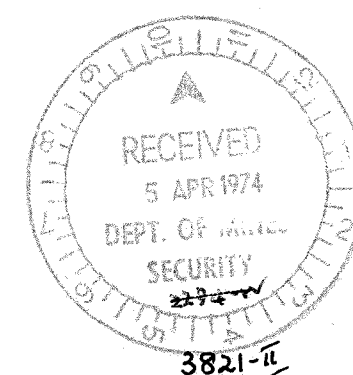


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

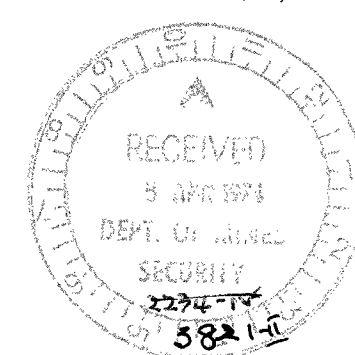
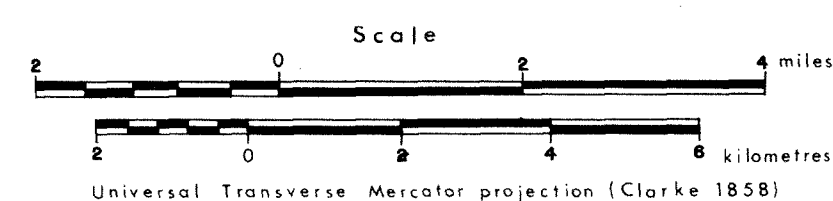
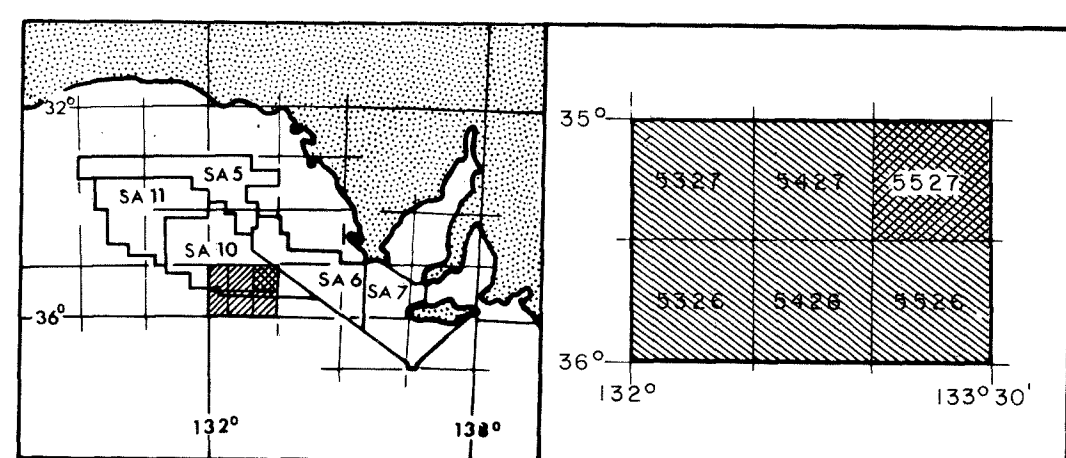
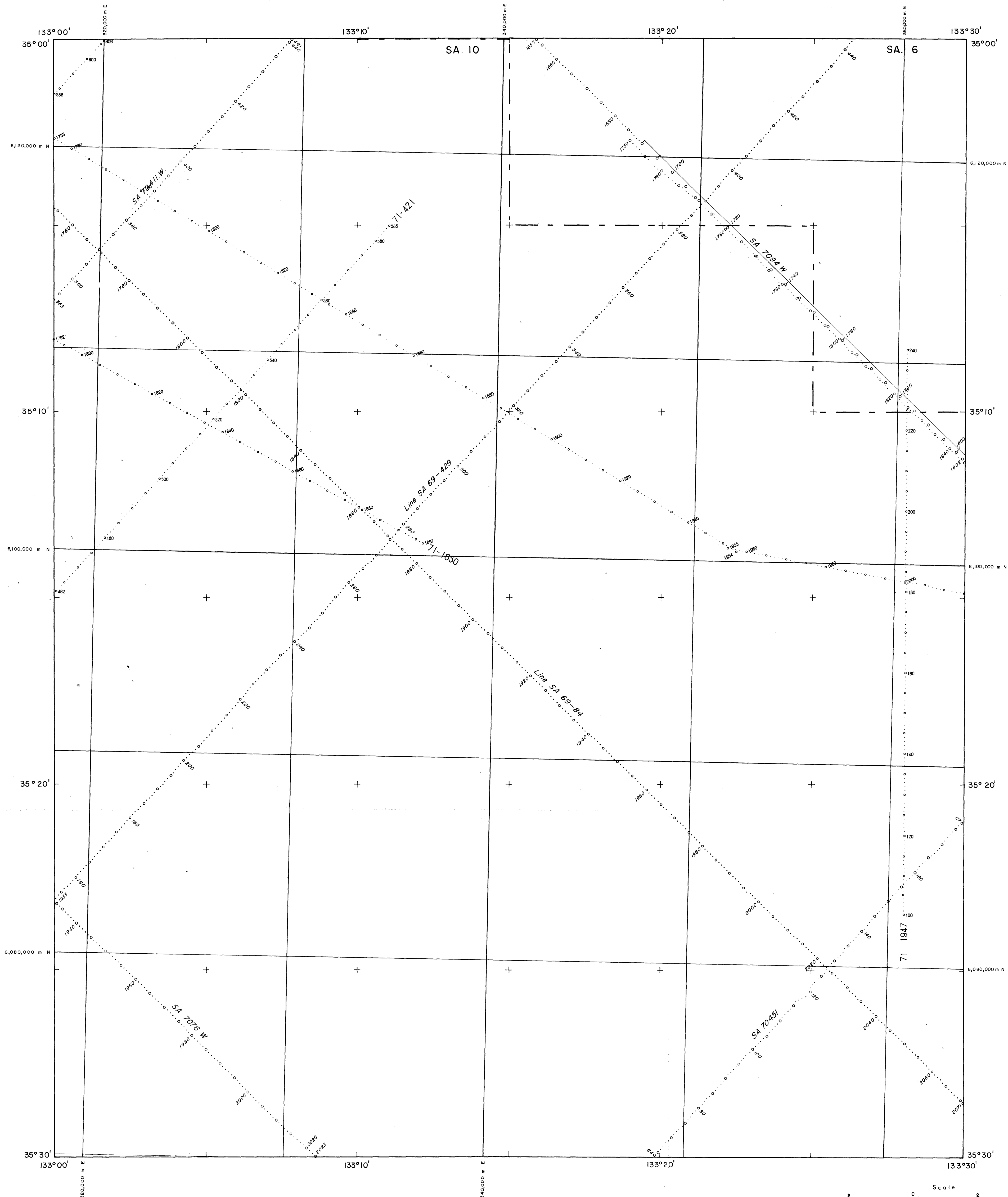
SHOT POINT LOCATIONS

Scale 1:100,000

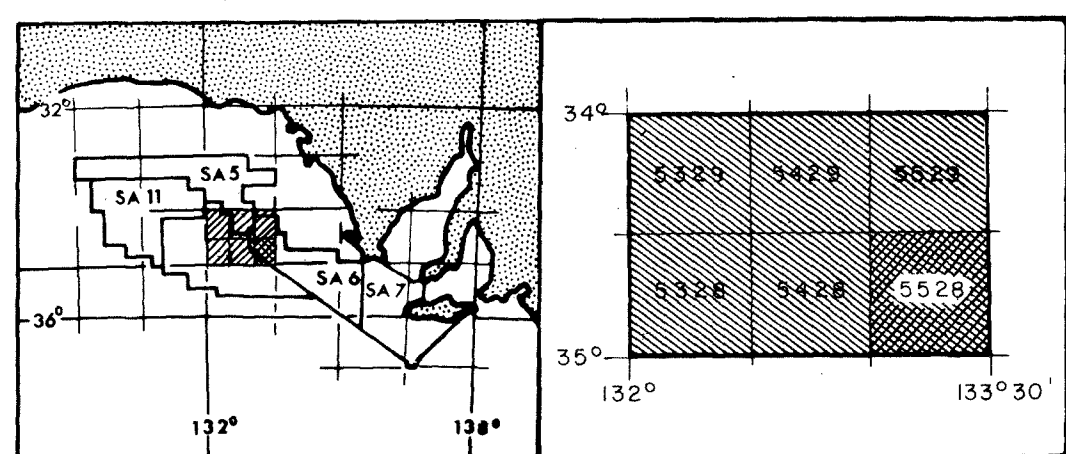
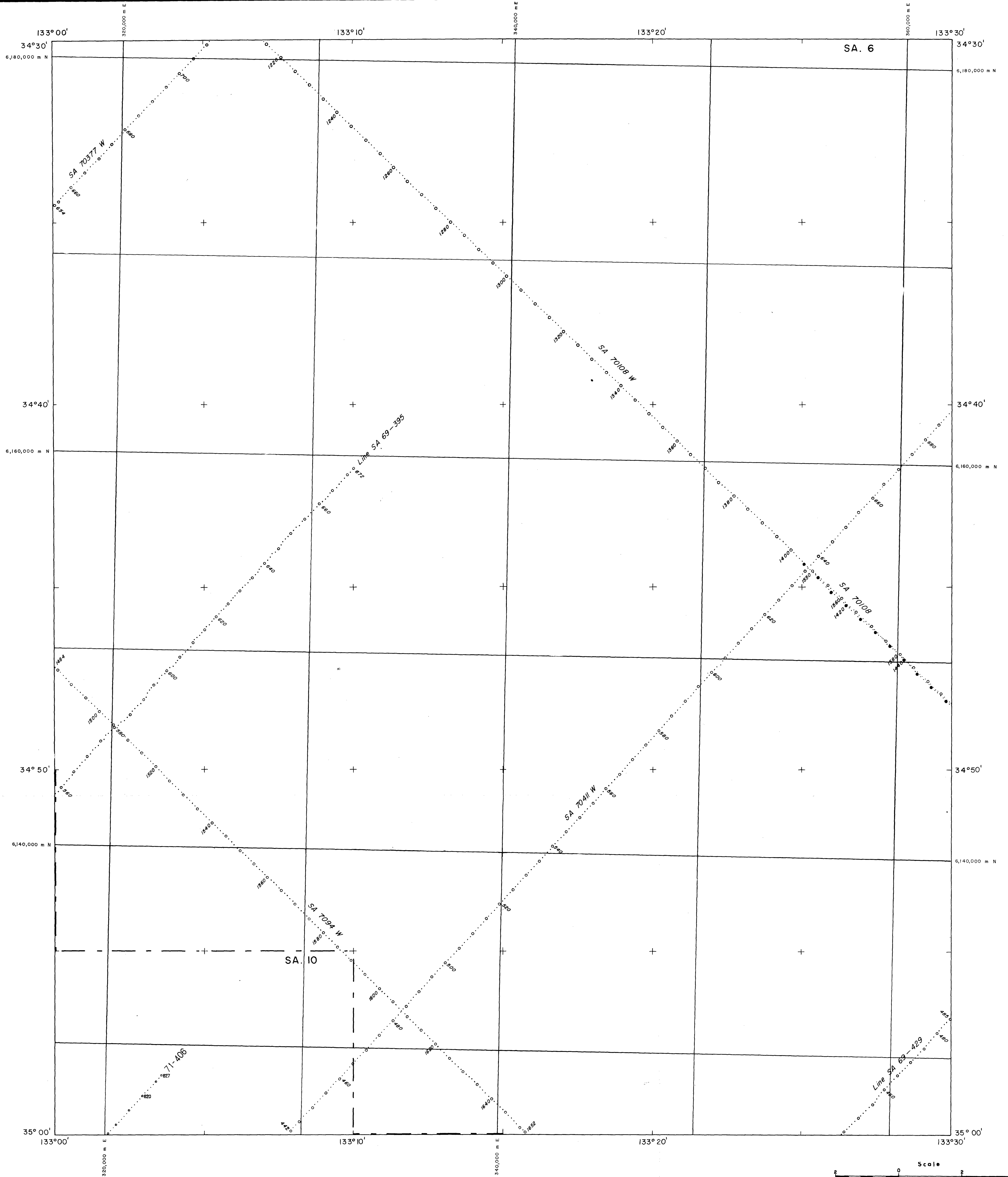
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Report: Encl. Drawing No.



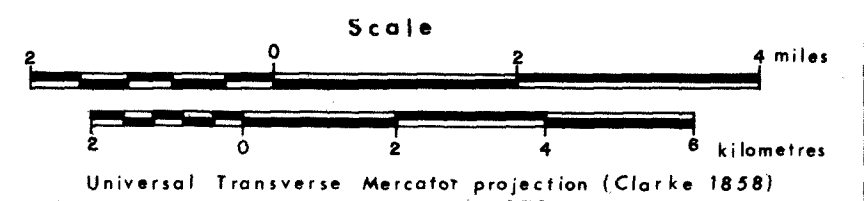
3821-26.



3821-27. 5527



Location diagram



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

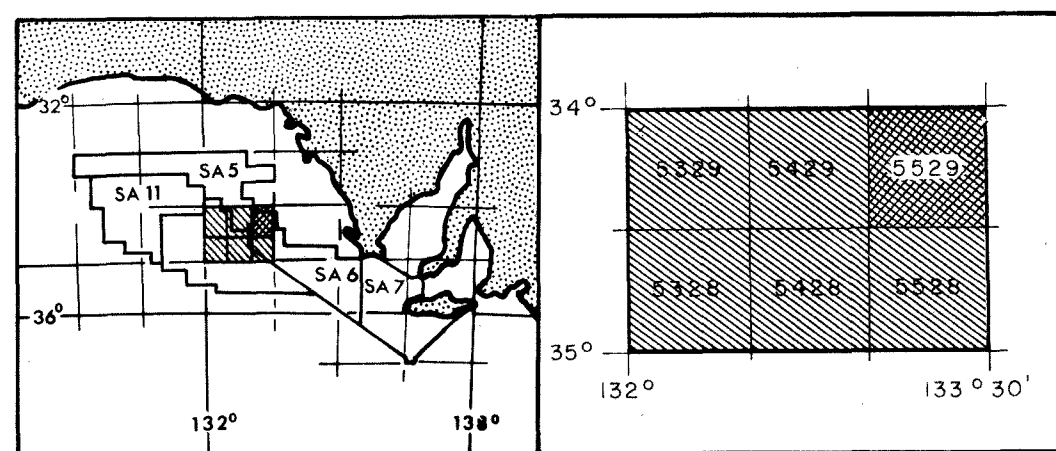
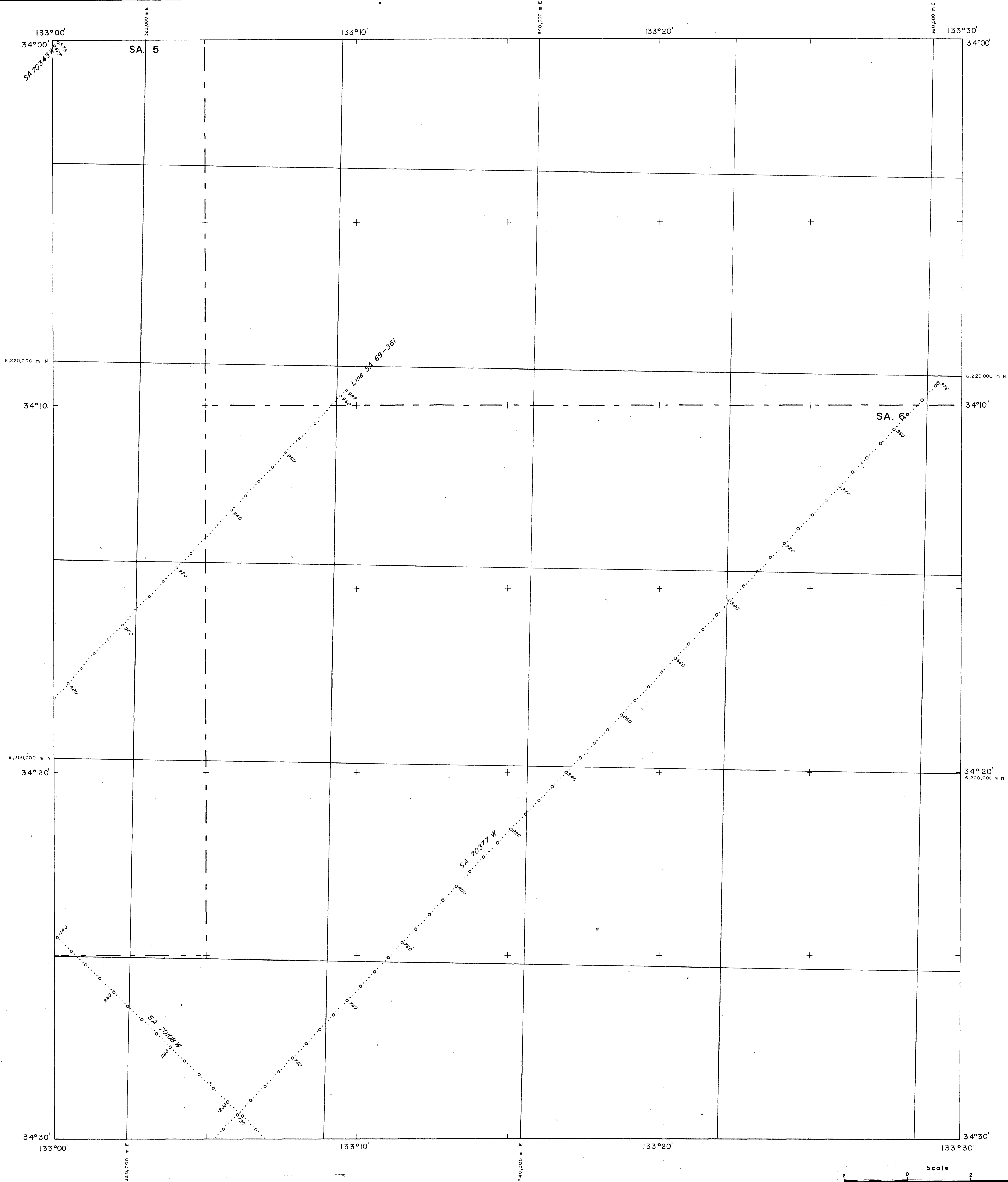
SHOT POINT LOCATIONS

Scale 1:100,000

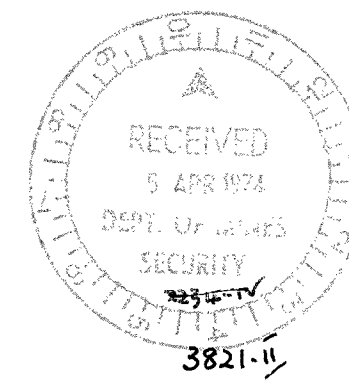
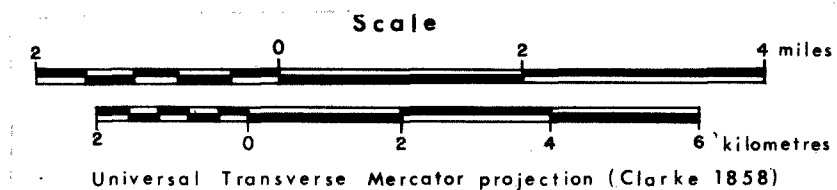
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Report:	Encl.	Drawing No. 5528



3821-28.

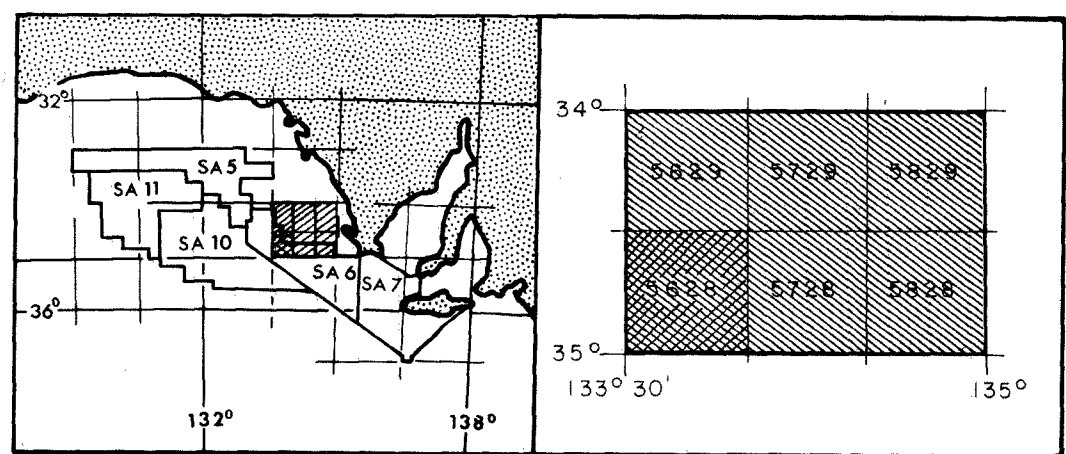
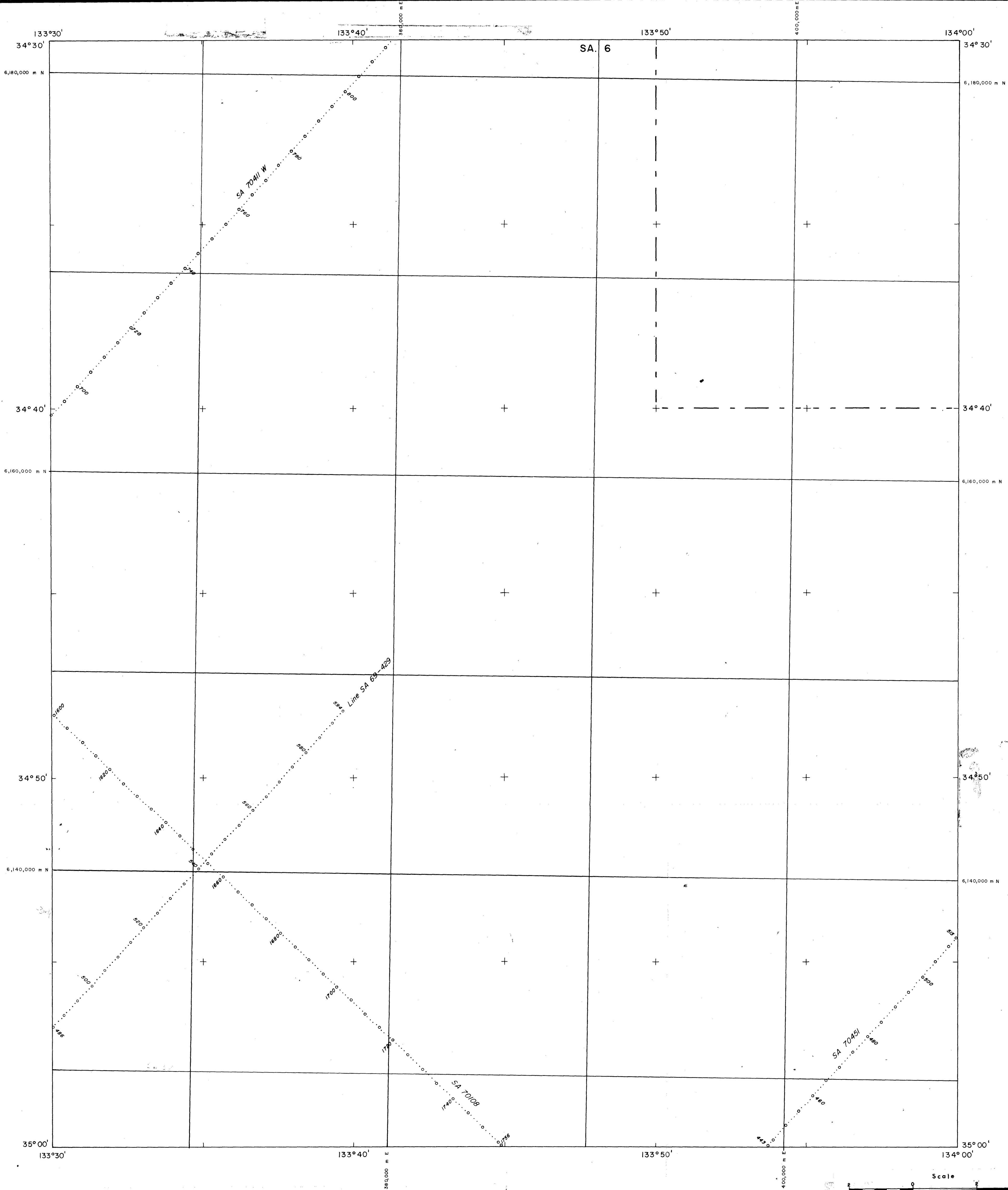


Location diagram

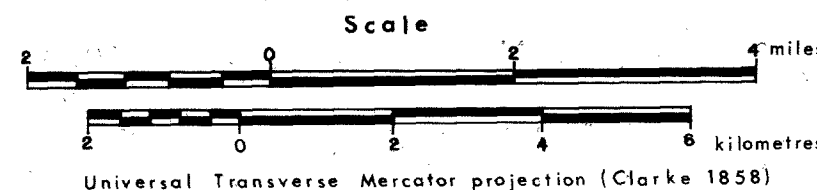


3821-29.

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
Scale 1:100,000			
Author:	Date: December 1970	Sheet No.	
Report:	Encl.	Drawing No.	5529



Location diagram



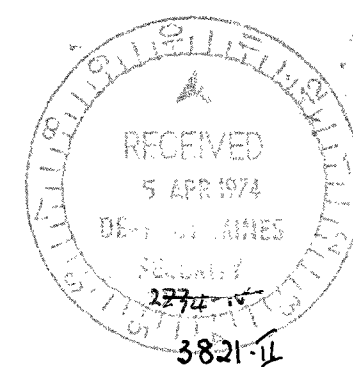
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SOUTH AUSTRALIA OFFSHORE

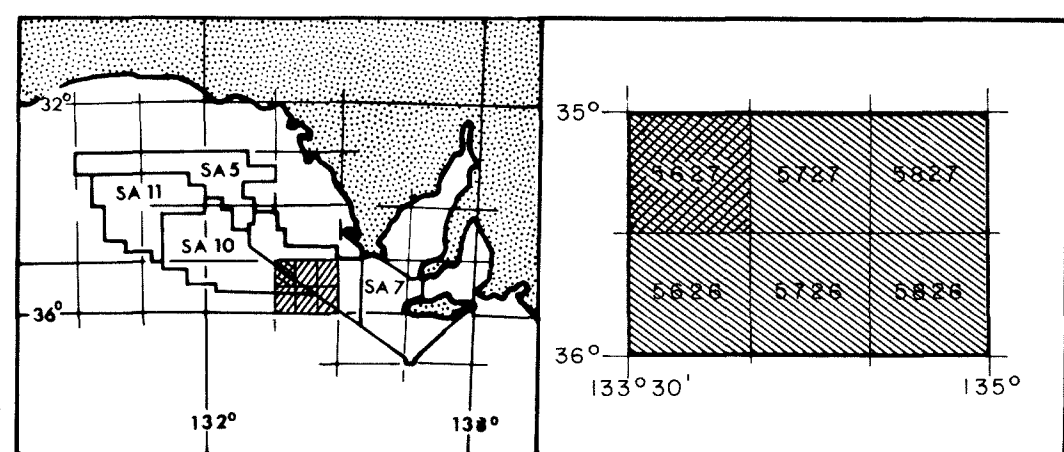
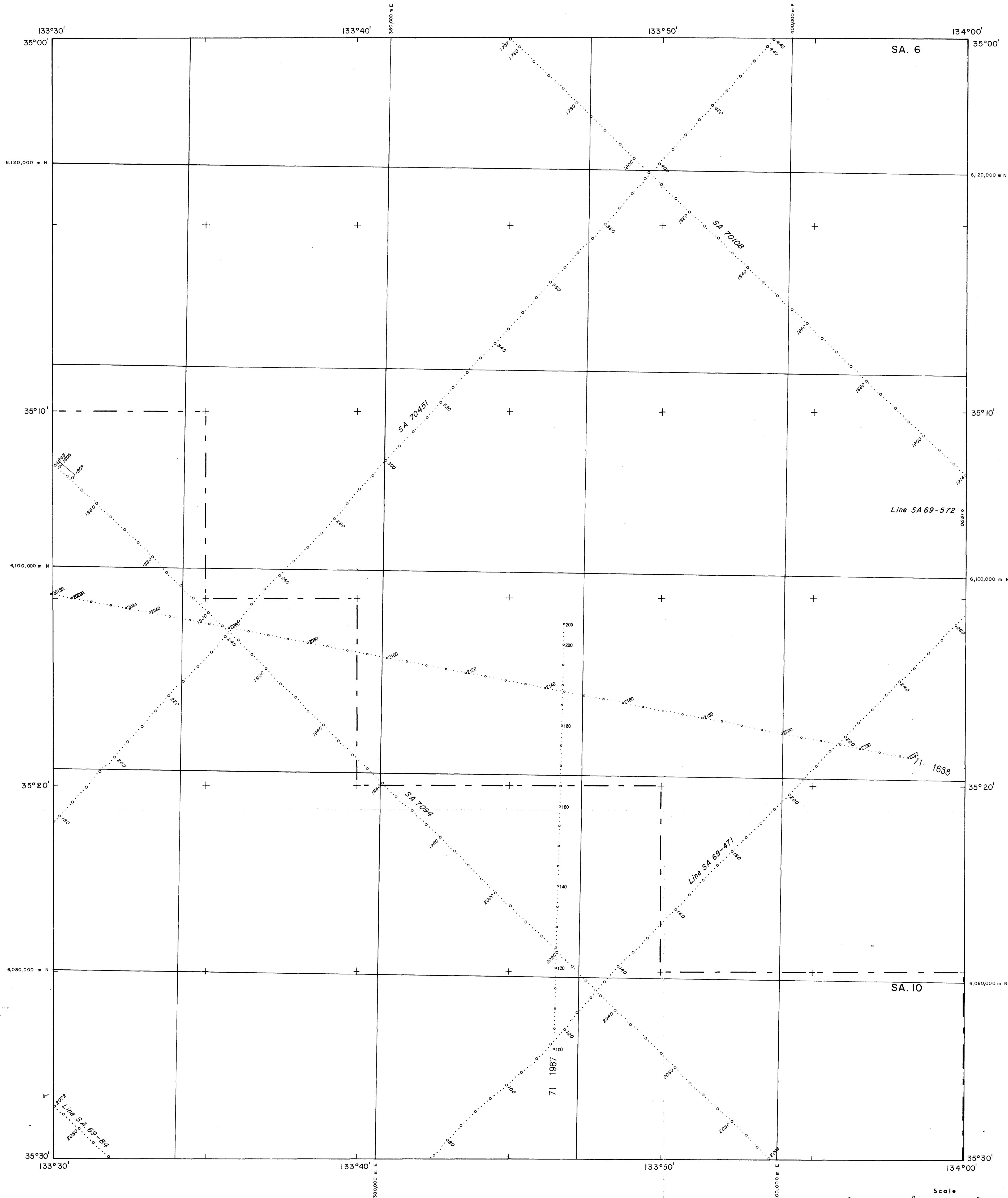
SHOT POINT LOCATIONS

Scale 1:100,000

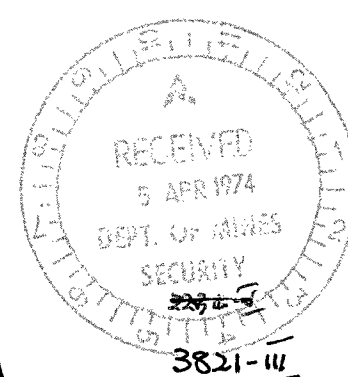
Author:	Date: December 1970	Sheet No
Report:	Encl.	Drawing No. 5628



3821-30.

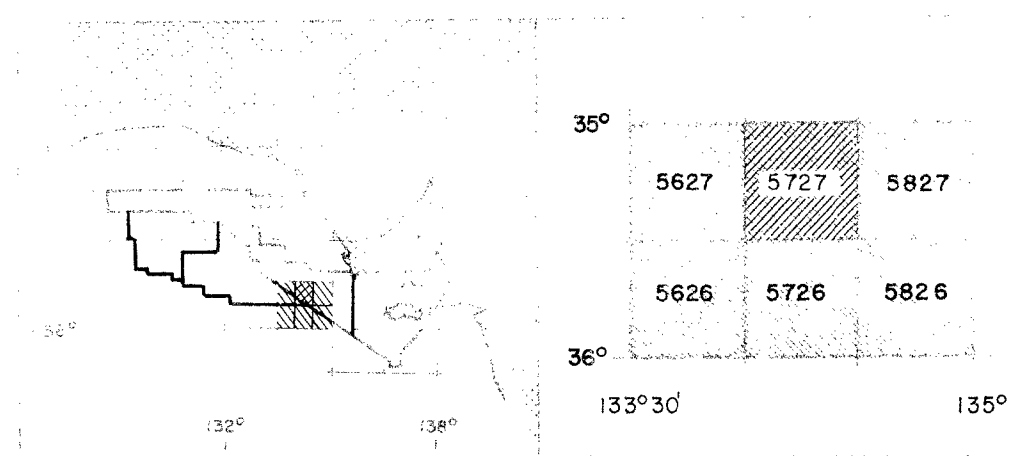
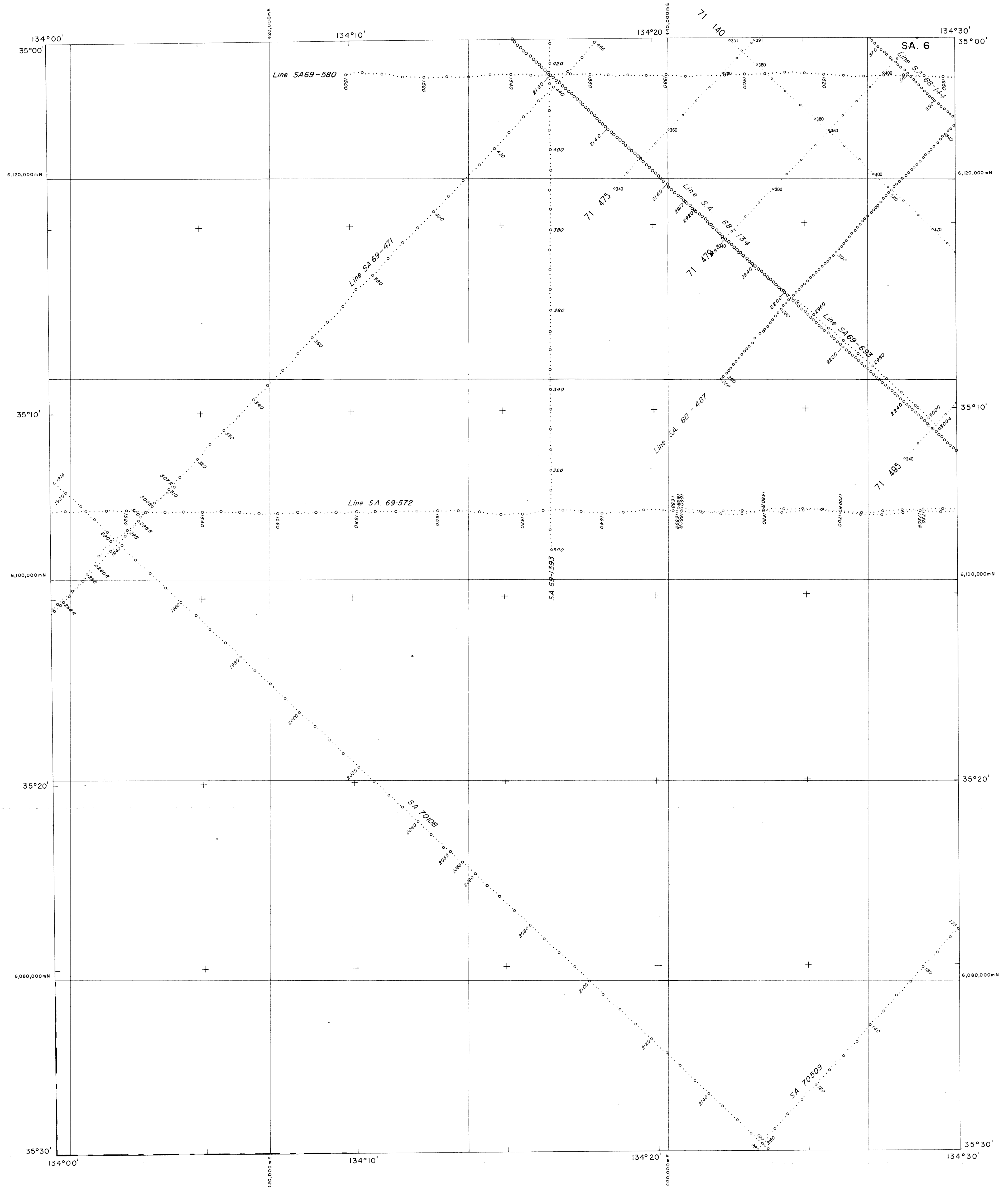


Location diagram

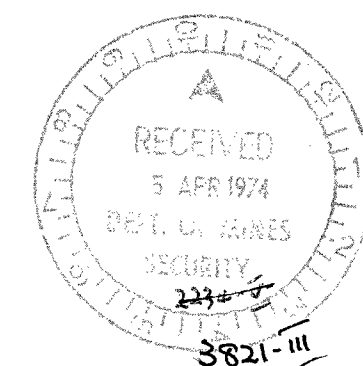
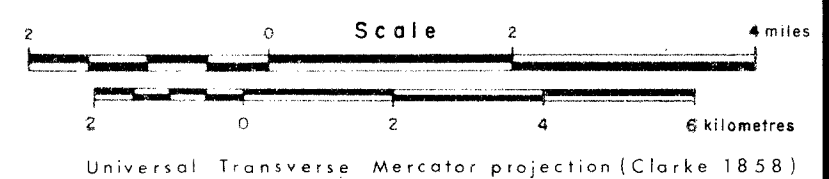


3821-31.

5627



Location diagram
OEL 38



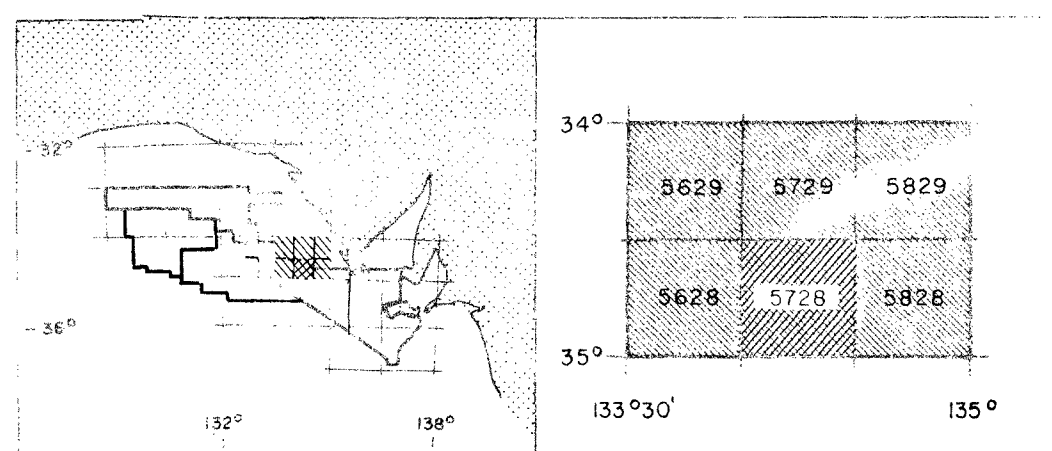
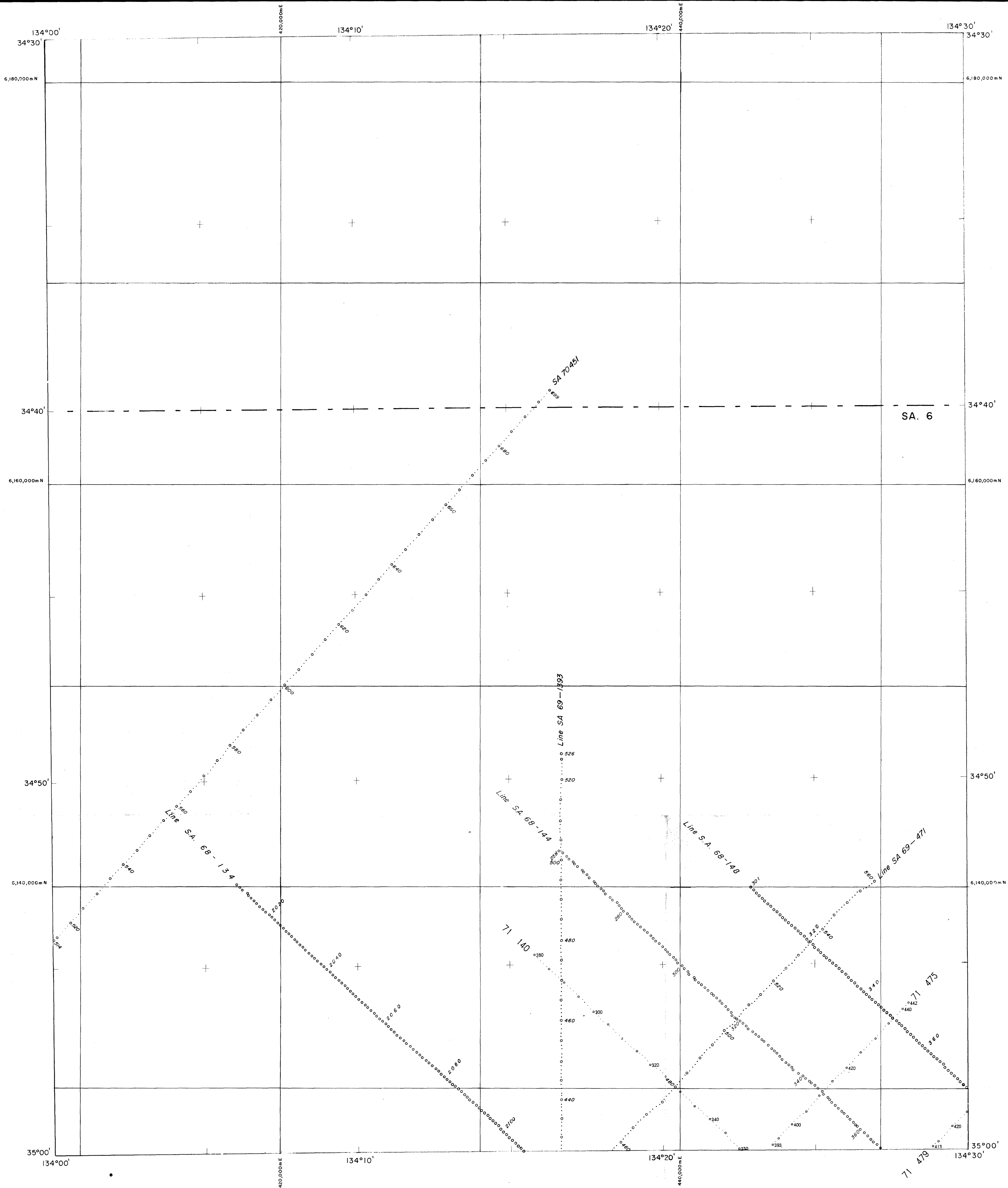
SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

SHOT POINT LOCATIONS

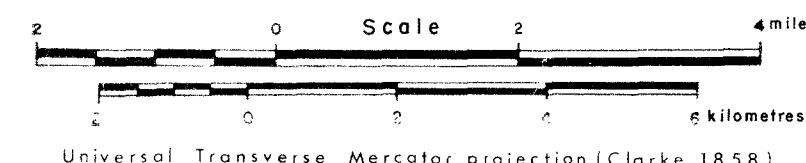
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Author: Geophysical Dept.	Date: May 1969	Sheet No
Report: SDA 100	Encl	Drawing No. 5727

3821-32.



Location diagram
OEL 38

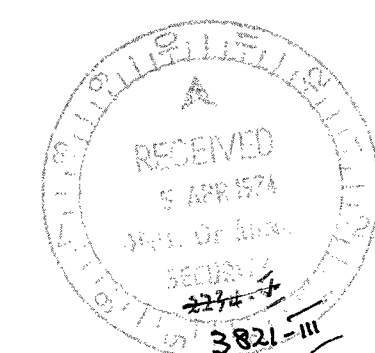


SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

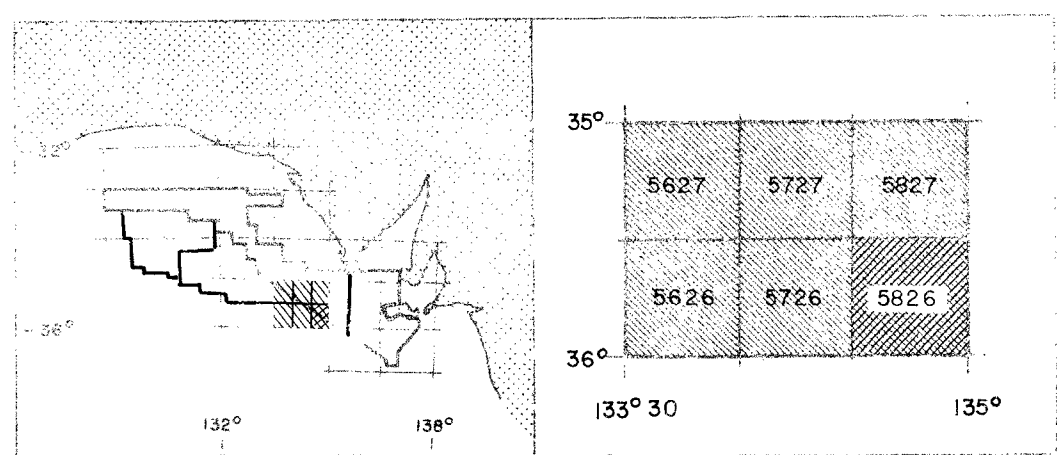
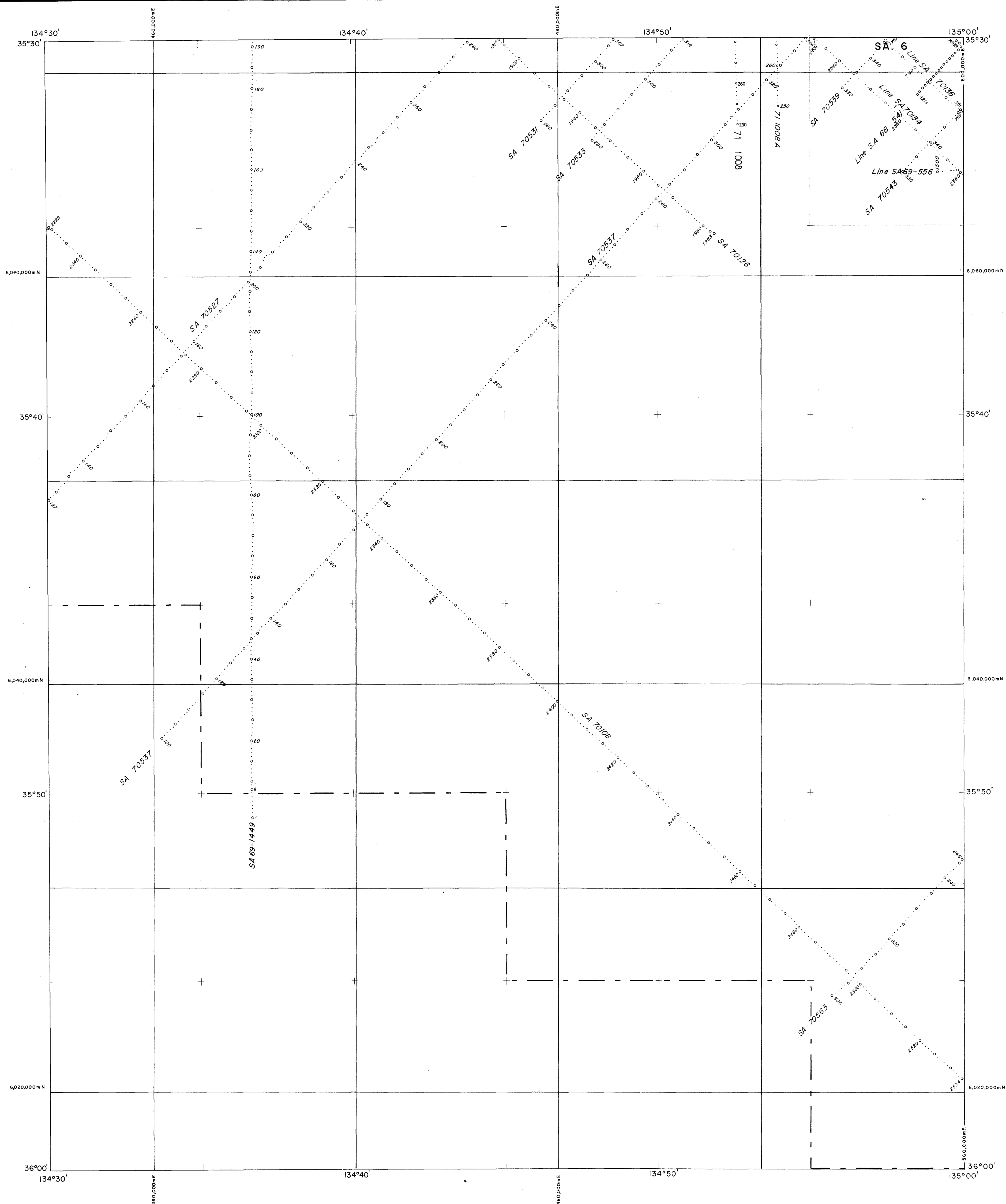
SHOT POINT LOCATIONS

Scale 1:100,000

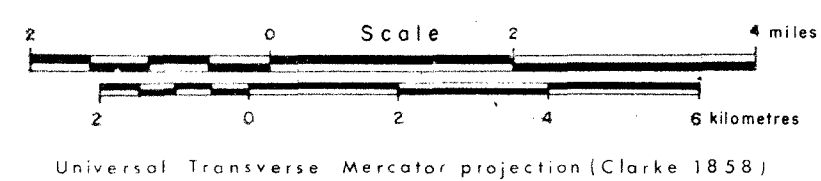
Author: Geophysical Dept	Date: May 1969	Sheet No.
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3821-33.



Location diagram
OEL 38



Universal Transverse Mercator projection (Clarke 1858)

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

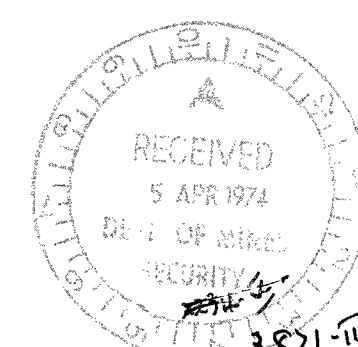
SOUTH AUSTRALIA OFFSHORE

SHOT POINT LOCATIONS

Scale 1:100,000

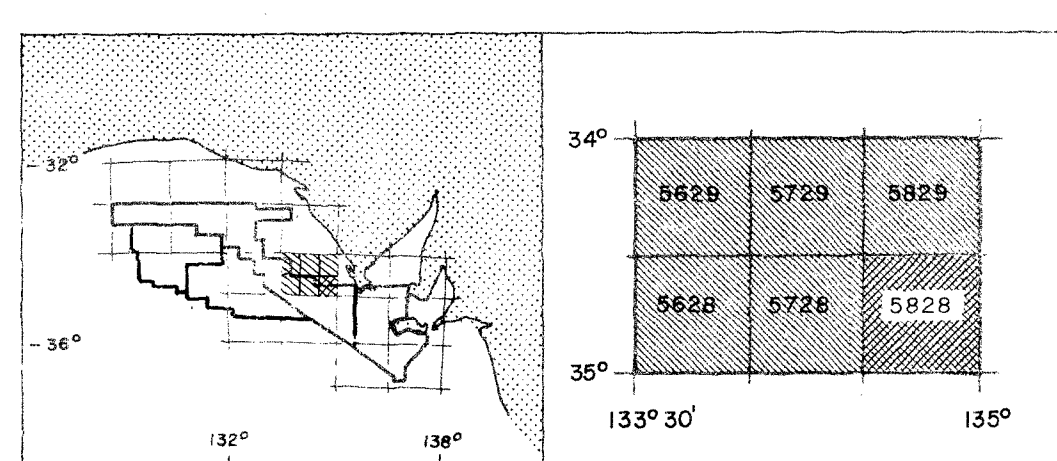
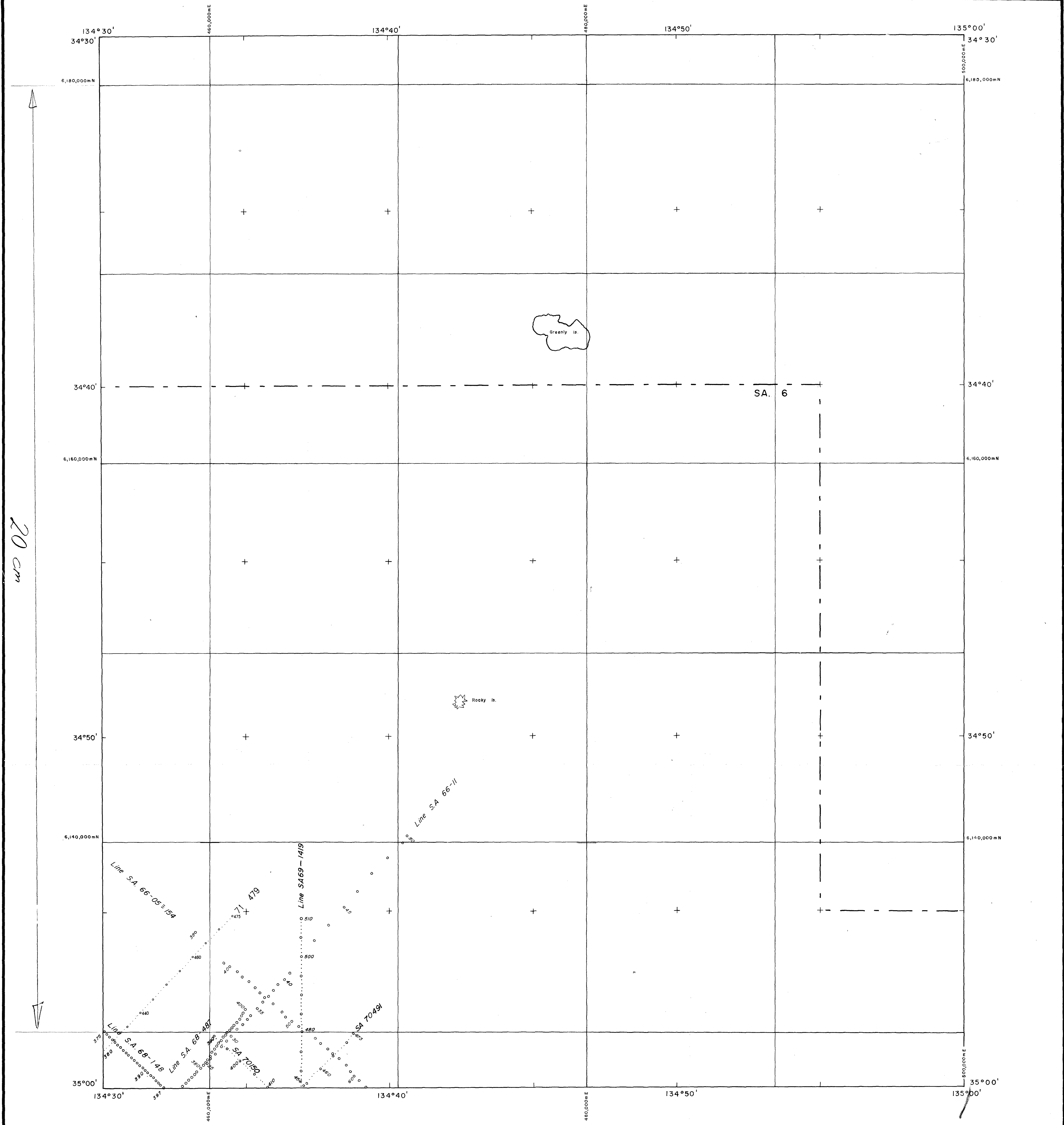
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Report: SDA 100	Encl: 2H	Drawing No

5826

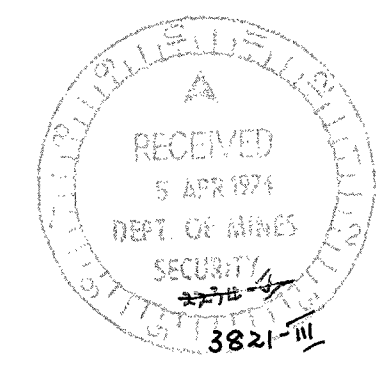
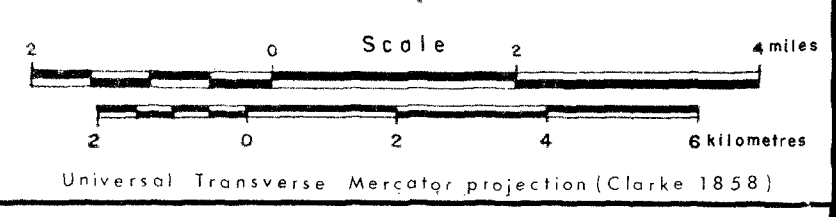


3821-34

Geoph 1-100

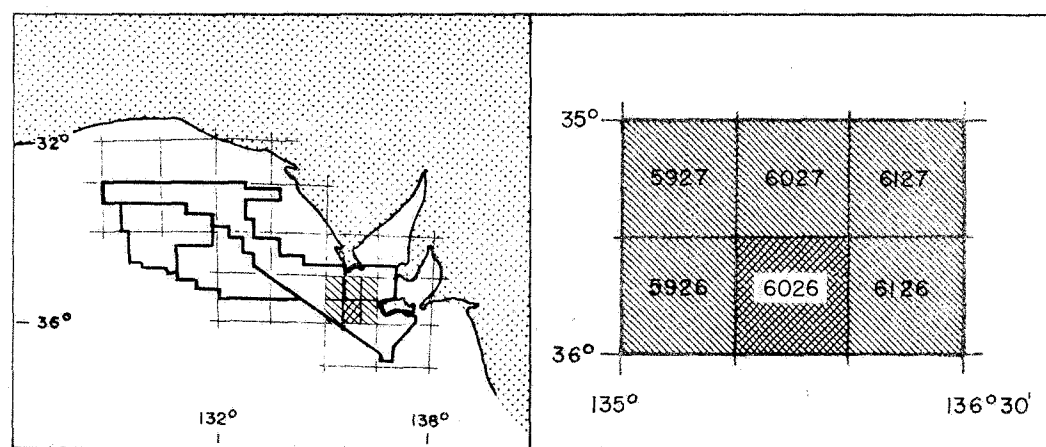
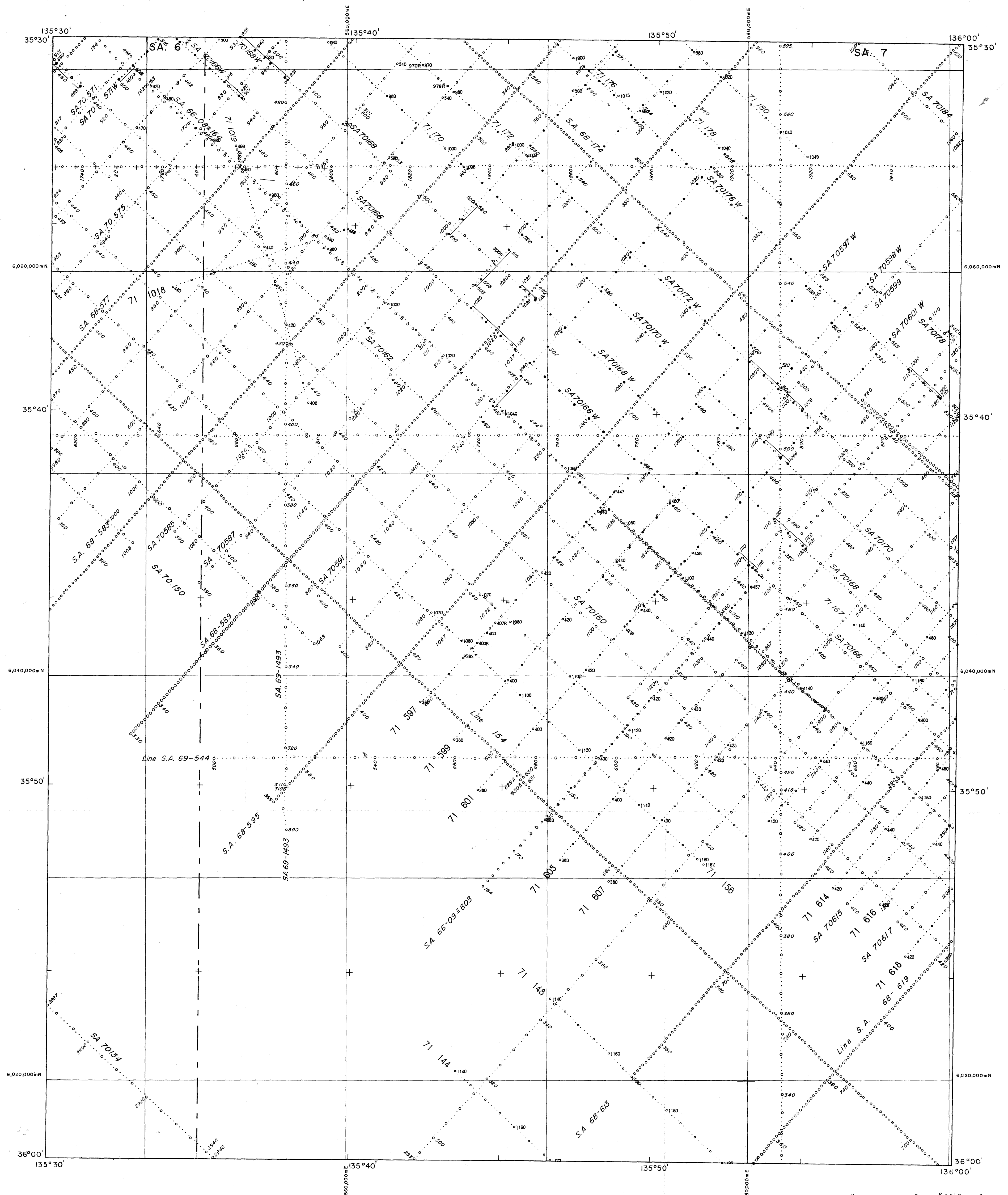


Location diagram
OEL 38



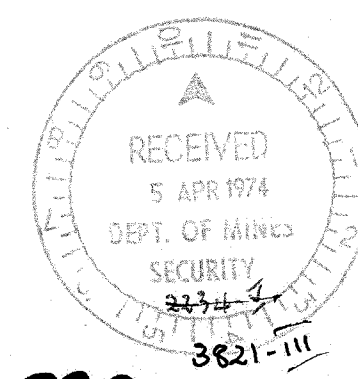
3821-36.

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.			
SOUTH AUSTRALIA OFFSHORE			
SHOT POINT LOCATIONS			
Scale 1:100,000			
Author: Geophysical Dept.	Date: May 1969	Sheet No	
Report: SDA 100	Encl.	Drawing No	5626

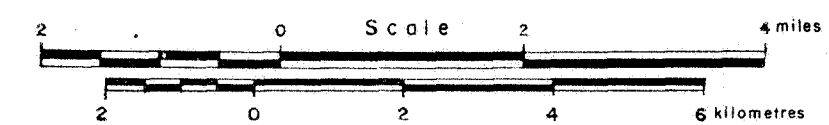


Location diagram

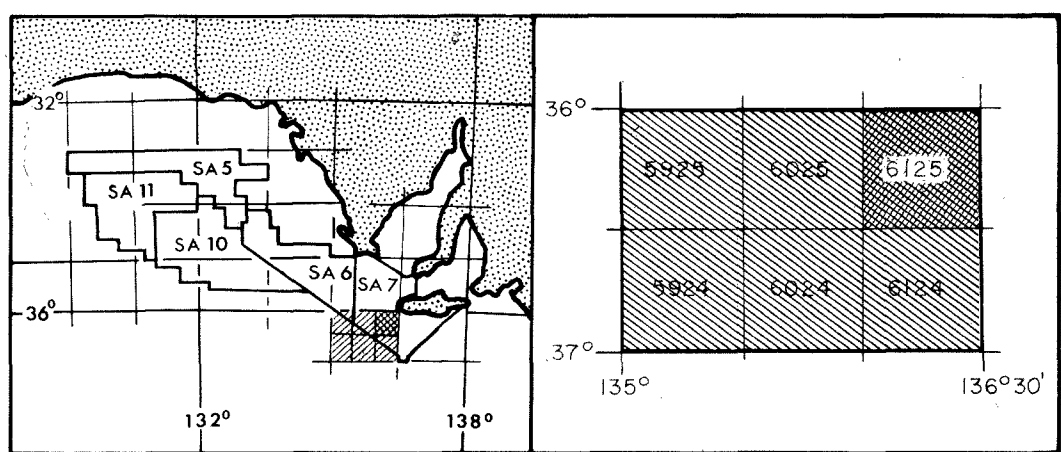
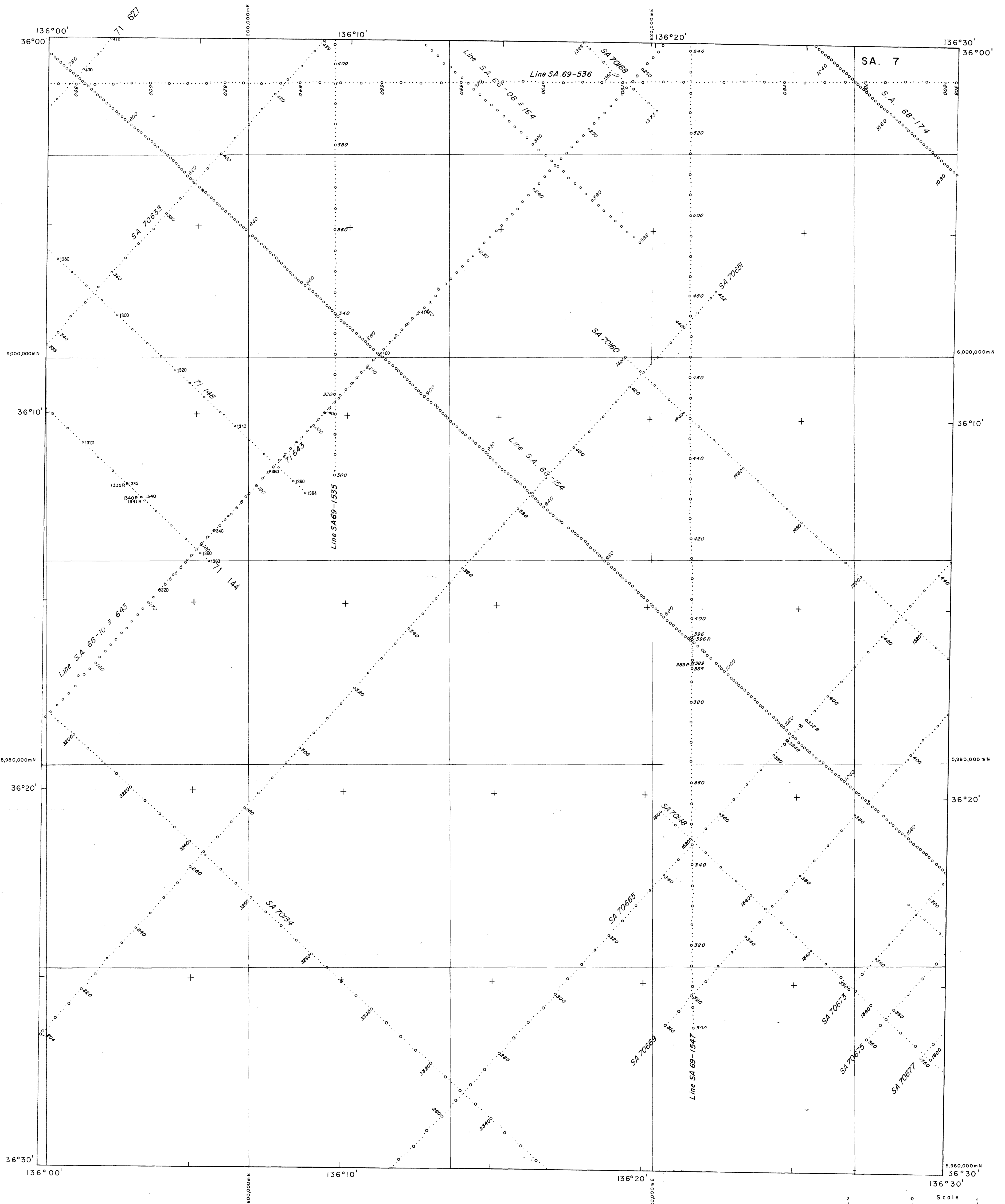
Note:
 - Overlapping Western Geophysical and G.S.I. Lines.
 + Reshot during 1970 Refraction program.



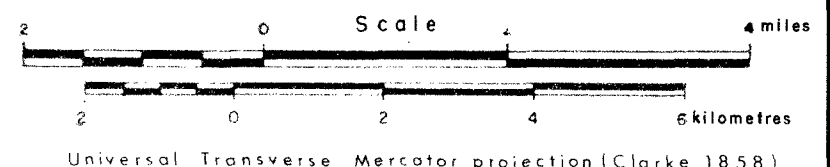
3821-41.



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.	
SOUTH AUSTRALIA OFFSHORE	
SHOT POINT LOCATIONS	
Scale 1:100,000	
Author: Geophysical Dept.	Date
Report: S.D.A. 100	Encl. 2J
Drawing No	Sheet No
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Location diagram
OEL 38



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

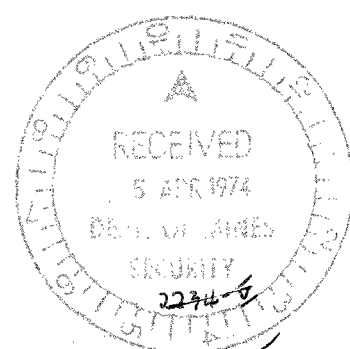
SOUTH AUSTRALIA OFFSHORE

SHOT POINT LOCATIONS

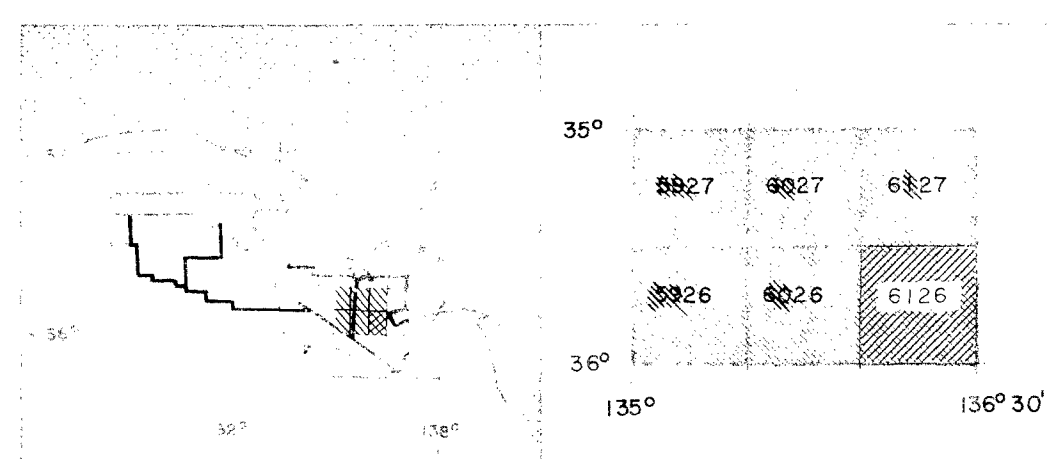
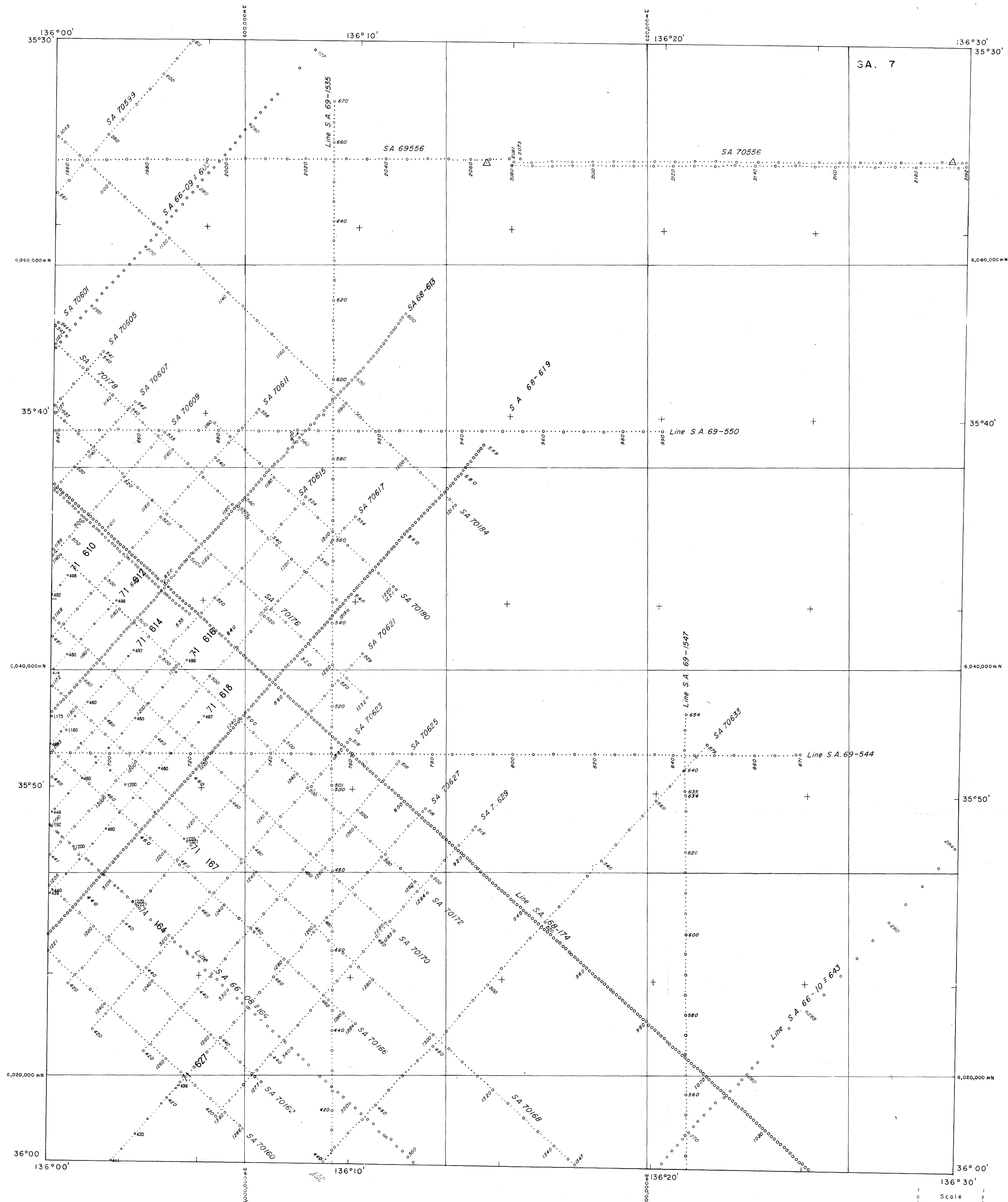
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Author: Geophysical Dept Date: May 1969
Report: S.D.A. 100 Encl: 2N Drawing No:

Sheet No
6125

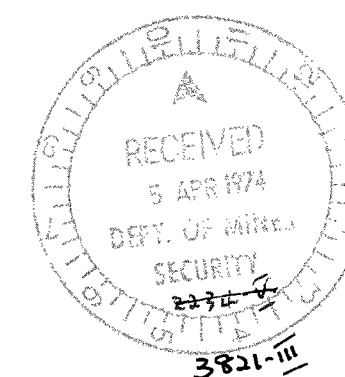


3821-43.



Location diagram
OEL 38

Note:
 Satellite Fix.



3821-44.

Scale

0 1 2 miles

0 2 4 kilometres

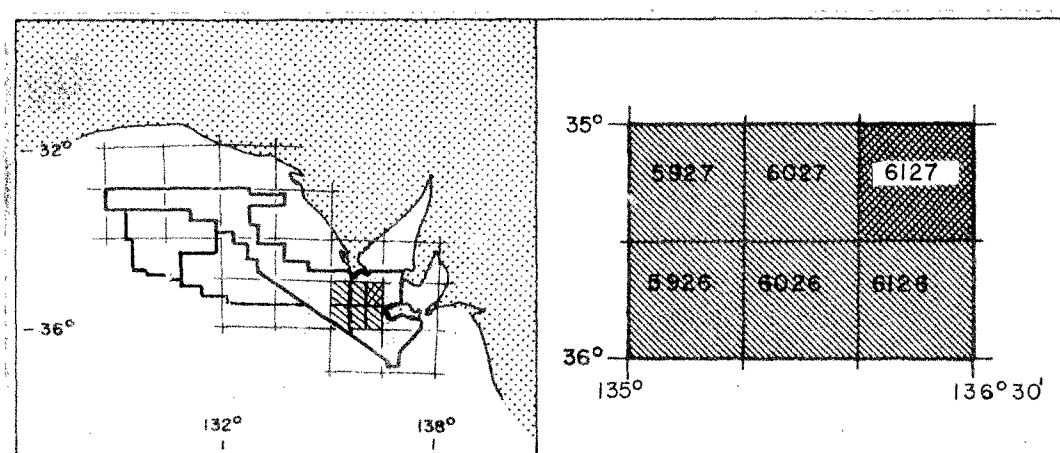
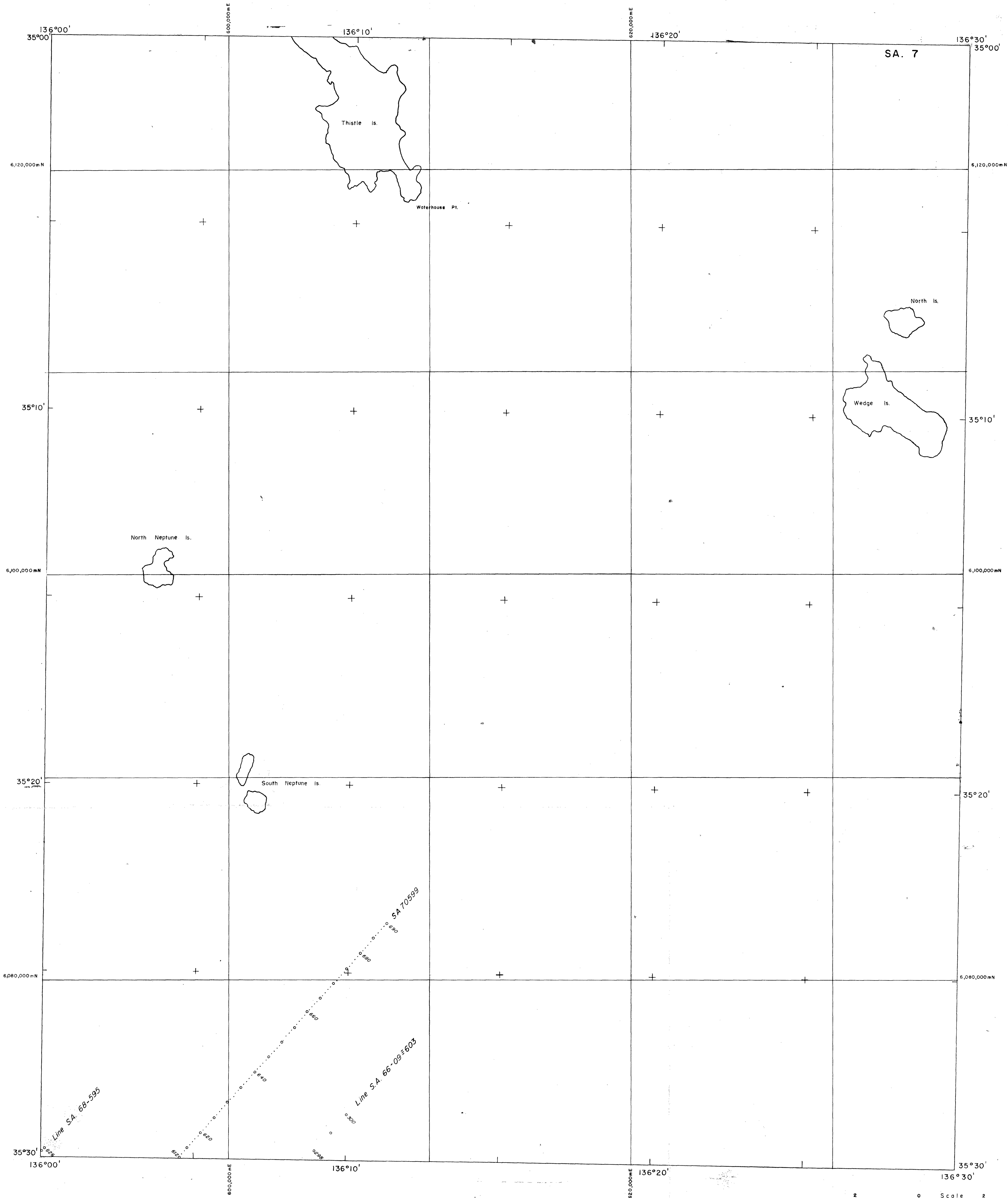
Universal Transverse Mercator projection (Clarke 1858)

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.
SOUTH AUSTRALIA OFFSHORE

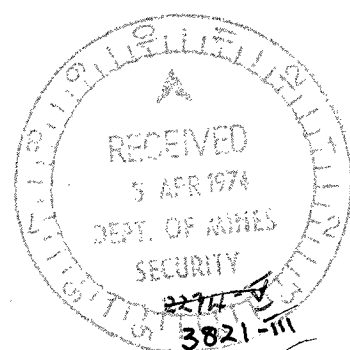
SHOT POINT LOCATIONS

Scale 1:100,000

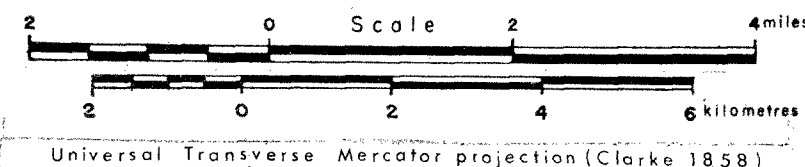
Author : Geophysical Dept.		Date		Sheet No
Report S.D.A. 100	Encl	Drawing No		6126



Location diagram
OEL 38



3821-45.



SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

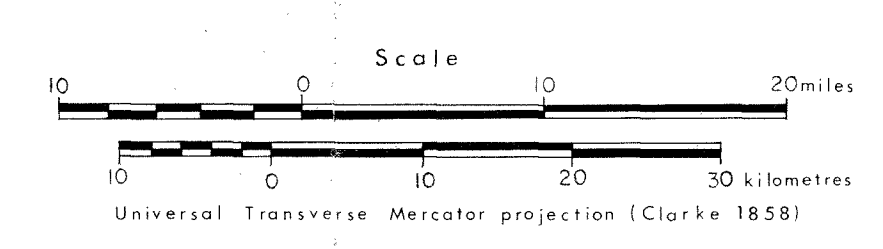
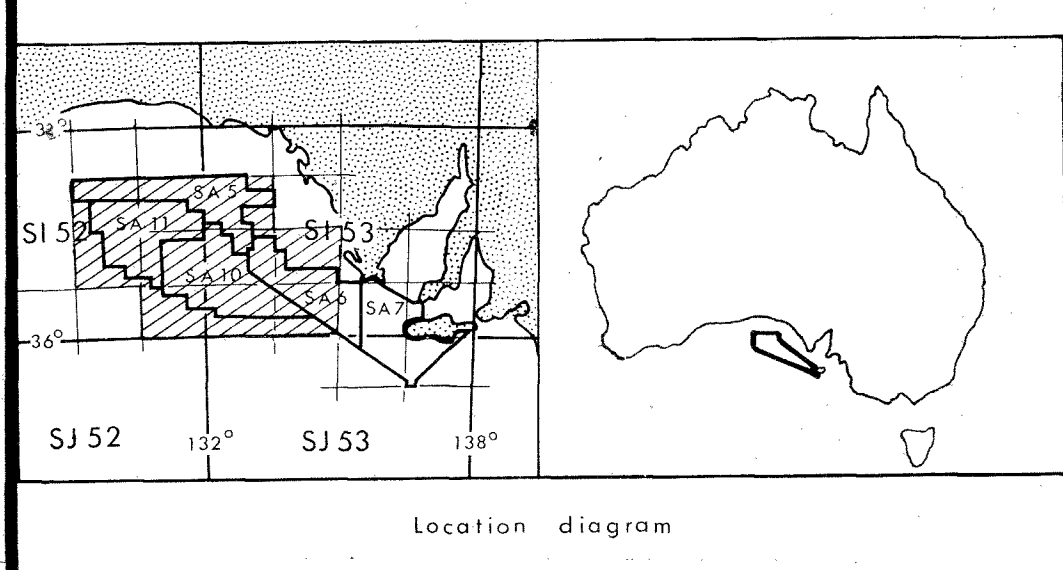
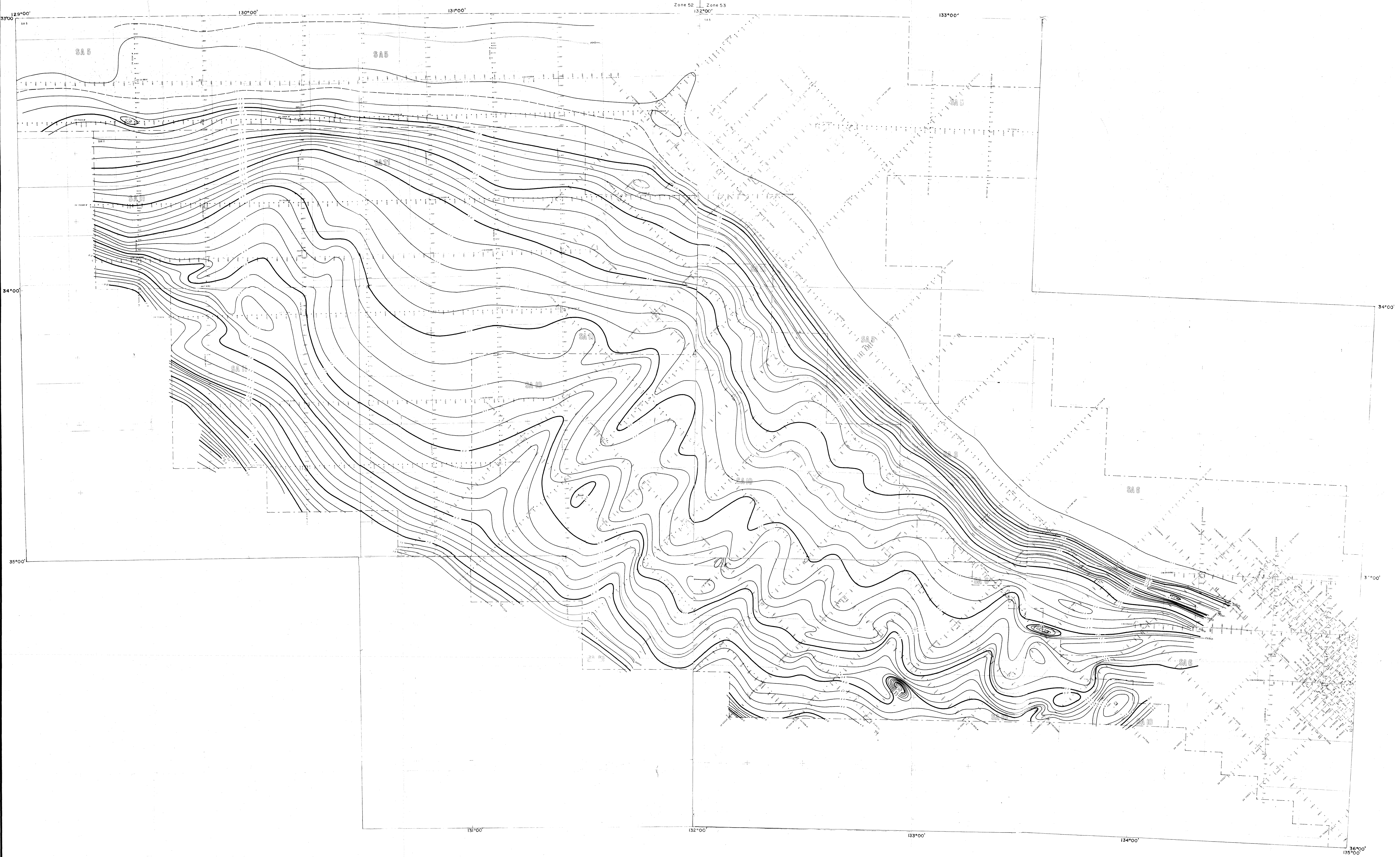
SOUTH AUSTRALIA OFFSHORE

SHOT POINT LOCATIONS

Scale 1:100,000

Author: Geophysical Dept.	Date: May 1969	Sheet No
Report: S.D.A. 100	End: 26	Drawing No

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Water depth in 1000 feet
Contour interval 200 feet

3821-46.

SHELL DEVELOPMENT (AUSTRALIA) PTY. LTD.

SOUTH AUSTRALIA OFFSHORE
GREAT AUSTRALIAN BIGHT BASIN

BATHYMETRIC CONTOUR MAP

3821-JL

Scale 1:500,000

Author: Geophysical Dept Date: August 1971

Report: SDA 120 Encl: 6 Drawing No. 5214