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A PRELIMINARY INVESTIGATION INTO THE APPLICABILITY OF GAMMA RAY SPECTROMETRY IN REGIONAL GEOLOGICAL MAPPING OF THE GAWLER CRATON

GEOLOGICAL SURVEY

by

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ABSTRACT

Applicability of radiometrics and the portable gamma ray spectrometer to regional geological mapping were tested over parts of the southern Gawler Craton (Archaean-Proterozoic) on Eyre Peninsula, South Australia. Use of total count and separate counts for potassium, uranium and thorium helped to distinguish lithologies. It was generally found possible to locate hidden contacts, such as that between Miltalie Gneiss and Warrow Quartzite. Rocks giving high readings include anatectic portions of the Carnot Gneisses, pegmatites, aplites and tabular feldspar granite of Mount Hope and Point Drummond. Further light was thrown on relationships between granitoid and volcanics on the west coast and St. Francis Island. Uranium concentration occured at a late magmatic stage. Greater use should be made of the portable gamma ray spectrometer to aid in regional geological mapping.

INTRODUCTION

The use of the portable gamma ray spectrometer in the field has long been valued by the prospector in the search for economic deposits of uranium. As exploration for uranium is becoming more widespread and sophisticated, both in technical and geological aspects, a greater number of geological provinces are being examined by gamma ray spectometry. The exploration geologist is primarily concerned with the distinguishing of potential targets from anomalous radiometric readings, but recently, some exploration geologists have utilised radiometrics in geological mapping to assist with the differentiation of similar-appearing rock units, to aid in mapping specific structural features, and to offer a clue in identifying lithologies covered by superficial overburden. However in the past, radiometrics have never been seriously considered as a valuable tool in field mapping by regional and academic geologists.

This study is an investigation into the applicability of radiometrics and the portable gamma ray spectrometer to regional mapping, and was initiated by Dr. A.J. Parker of the Regional Geology Section of the Department of Mines and Energy after discussions by both himself and the author with exploration geologists working in Eyre Peninsula, South Australia.

Because of the limited time in which this investigation was to be accomplished, only portions of crystalline complexes of the Gawler Craton were examined. Essentially three areas were studied; southern Eyre Peninsula, Saint Francis Island (off the coast of Ceduna), and the western coastal region of Eyre Peninsula around Ceduna and Streaky Bay (Fig. 1).

Radiometric readings, using a portable gamma ray spectrometer borrowed from the School of Geology, University of Adelaide, were recorded from specific lithologies at the various localities and grouped accordingly. The geology of the selected outcrops in southern Eyre Peninsula has been previously mapped in detail by Parker, Fanning and Flint (1980) and the groupings of lithologies was based on their work and in particular on base maps prepared by M. Fanning (Ph. D thesis in prep.). The geology of outcrops examined elsewhere had not been previously mapped in detail so that precise relationships between various crystalline lithologies was not completely understood. Preliminary accounts of the geology in the latter areas are contained in Flint and Crooks (1982) and Walker and Botham (1968), but a more detailed account is being prepared by the author and Rosier as part of their B.Sc. (Hons.) dissertations and by Flint and Parker (in prep.).

Readings were carefully taken on planar outcrop surfaces wherever possible in order to avoid exaggerated results from the mass effect of overhanging or adjacent rocks. Because no audiofrequency was available to rapidly determine anomalous radiometric variations, only truly random readings were recorded. Radiometric readings were tabulated according to lithology and outcrop, and the variations in the results were respectively evaluated and interpreted.

RADIOACTIVITY AND THE GAMMA RAY SPECTROMETER

Radioactivity may be defined as the spontaneous change of nuclei of unstable atoms to a more stable state. Radiation is the result of this adjustment and occurs in the form of emission of charged particles; alpha, beta and gamma rays. Alpha and beta rays are streams of high speed helium ions and electrons respectively, which cause a change in the atomic number of the original or 'parent' isotope and form a new or 'daughter' isotope (Fig. 2). Gamma rays are electromagnetic waves which are similar to but of higher energy and shorter wavelength than x-rays and light waves. They have certain energy levels which are characteristic of nuclei within a particular element group and are the most frequently measured type of radiation. Gamma rays do not change the atomic structure, but are produced as a part of any change in which the resultant nucleus is left in an excited state. When the nucleus returns to its ground state, energy is given off in the form of gamma rays.

The gamma ray spectrometer or scintillation counter essentially transforms gamma radiation into a visual display. A sodium iodide crystal converts gamma rays into faint flashes of light whose brilliance is proportional to the radioactive intensity or energy level. A high gain photomultiplier detects the light flashes as electrical impulses which are then amplified and screened through respective threshold analysers.

The accepted pulses are then counted and represented numerically on a digital display in counts per second (cps). The Geiger counter differs from the spectrometer in that it has no analysers and cannot independently measure different energy levels.

Because uranium 238 gamma ray energies are too low for practical detection, Bismuth 214, which is a daughter product of the uranium series, and which has a much higher gamma ray energy level of 1.76 Mev (million electron volts), is used to represent uranium (Fig. 3). Likewise, the daughter product thallium 208 which has a gamma ray energy level of 2.615 Mev is used to represent the parent element thorium. The stable form of potassium exists as potassium 39. Radioactive potassium 40 has an abundance of 0.0119% of the total amount of naturally occurring potassium and 88.8% of potassium 40 atoms decay to stable calcium 40. Potassium 40 emits gamma rays which have an energy level of 1.46 Mev.

NATURAL OCCURRENCES OF URANIUM AND THORIUM

Uranium and thorium occur in very minor quantities in the earth's crust. However, in the course of partial melting and fractional crystallisation of magmas, both uranium and thorium tend to concentrate into the late-stage, liquid phase differentiates and become incorporated into the more silica-rich rocks. Thus felsic granitoids usually have a higher content of radioelements than more mafic intrusives. The uranium content in igneous minerals varies from one to ten parts per million (Table 1). However, in minerals such as zircon and monazite, the uranium content can be as high as 6,000 ppm due to isomorphic substitution.

Uranium and thorium have similar atomic structure, both occurring in tetravalent oxidation state, and their ions have similar radii (U^{+4}1.05Å, Th^{+4}1.10Å) so that the two elements can substitute extensively for each other. Magmatic and pneumatolytic processes transport most of the radioelements including uranium and thorium as lighter volatile phases into the crust. Together, uranium and thorium fractionate towards the crust in complex silicates such as allanite and gadolinite, simple silicates including zircon and thorite, multiple oxides like euxenite and samarskite, and in phosphates such as monazite. These minerals are stable and refractory. Fractionation of uranium relative to thorium also occurs since uranium oxidizes to the uranyl valence state (UO_2 $^{+2}$) whereas thorium does not.

In the pneumatolytic process, further fractionation between uranium and thorium can occur because uranium is more abundant than thorium and more readily forms gases such as UF_6. Oxidation conditions may also preferentially mobilize uranium as uranyl complexes.

Temperature variation is very important in magmatic fractionation of uranium and thorium. As temperature decreases, the amount of thorium deposited decreases while the amount of uranium increases. Therefore, near-surface thorium-rich uranium veins have xenothermal characteristics representing high temperature fluids brought suddenly to surface. Once fixed in crustal rocks, only uranium is considered to be readily mobile.

Although most of the uranium in granites and related rocks is locked within refractory minerals, up to one third of the uranium occurs as cryptocrystalline aggregates or interstitial oxides, commonly uraninite, and as late stage hydrothermal or deuteric products. It is this fraction which is readily available for leaching by fluids travelling along grain boundaries and fractures planes.

The average concentrations of uranium and thorium in igneous and sedimentary rocks are displayed in Table 2.

TABLE 1

Uranium Content of Minerals, Southern California

Mineral	Average Uranium (ppm) Content	percentage of total uranium
*Plagioclase	1.6	
*Orthoclase	1.9	60%
*Quartz	2.2	
*Hypersthene	4.7	
*Biotite	5.4	
*Augite	7.7	35%
*Muscovite	8.0	
*Hornblende	18.0	
+Apatite	67	
+Allanite	180	
+Sphene	196	
+Monazite	820	
+Zircon	1367	
+Xenotime	6630	

* Molecular-ionic disseminations
\+ Isomorphic substitution in crystal lattice positions.

TABLE 2

Average Concentrations of Uranium and Thorium in Igneous and Sedimentary Rocks

Rock Type	U ppm	Th ppm
Low-Ca Granite	3.0	17
High-Ca Granite	3.0	8.15
Syenite	3.0	13
Basaltic rocks	1.0	4.0
Ultramafics	0.001	0.004
Shale	3.7	12.0
Sandstone	0.45	1.7
Carbonates	2.2	1.7
Deep sea clay	1.3	7.0
Sea water	0.0032	$1x10^{-5}$

Turekian and Wedepohl 1961

COMMENTS ON FIELD DATA

Southern Eyre Peninsula

Coles Point, Marble Range and South Block

Coles Point was examined to evaluate radiometric variations between the Warrow Quartzite, the basal quartz pebble conglomerate and the underlying gneissic granitoid and schist. It was found that the Warrow Quartzite and basal conglomerate recorded consistently low radiometric values (20-60 cps) compared to the underlying lithologies (150-280 cps).

A traverse was made across Archaean to Early Proterozoic granite gneiss of the Dutton suite on the west flanks of Marble Range. Readings were taken both on outcrop and at localities with a thin superficial sandy clay. The granite gneiss gave very high readings overall (300-800 cps) however, soil covered sample sites gave considerably reduced readings (328 cps compared to 702 cps).

Two traverses were undertaken across South Block to see if a contact between the Warrow Quartzite and Dutton suite granite gneiss could be distinguished radiometrically. In both cases, outcropping granite gneiss could not be found. Radiometric readings on the Warrow Quartzite were consistent with readings obtained at Coles Point, but there was no specific variation at the presumed basal unconformity to reveal a boundary. This was probably due to reduction of potentially higher readings of the granite gneiss due to soil cover.

Cape Carnot

The Carnot Gneisses were examined on coastal outcrops at Cape Carnot. Many of the layered and acid gneisses showed generally low radiometric values (less than 100 cps) while more mafic gneisses had even lower readings (less than 40 cps).

However, those gneisses which had undergone anatexis during deformation and metamorphism exhibited comparatively high values exceeding 300 cps. It is believed that metamorphism generally dispersed the radioelement content of the gneisses, while those gneisses which had undergone partial melting either concentrated or absorbed radioelements from surrounding rocks.

Plug Range, Kirton Point and Port Niel.

As a result of partial melting of Miltalie Gneiss at Plug Range during high grade metamorphism, pegmatitic segregations developed throughout the gneiss as narrow dykes or lenses. Although one five metre wide pegmatite dyke gave relatively high radiometric readings (600+ cps) indicating that there had been some mobilisation and concentration of radioelements during anatexis, the granite gneiss generally displayed fairly constant reading (200-300 cps) suggesting that the rock had not undergone significant depletion or enrichment of the radioelement content.

Traverses were undertaken to compare the radiometric characteristics of the Miltalie Gneiss with those of the overlying Warrow Quartzite. The quartzite gave very low readings (50-100 cps), consistent with previous outcrops of Warrow Quartzite examined, but unlike the South Block boundary between granite gneiss and quartzite, the contact could be easily distinguished both in outcrop and when partially concealed.

Granite gneisses of the Donington Granitoid Suite at Kirton Point have been intruded by a number of metadolerite and/or amphibolite dykes, and also by aplite dykes. The granite gneiss was characterised by relatively constant radiometric readings (186-208 cps), while the mafic dykes recorded lower readings (76-130 cps), and a higher reading was obtained from an aplite dyke (373 cps). These results were anticipated as there is a general depletion of radioelements in more mafic lithologies, yet a radioelement concentration in siliceous differentiates.

The consistent readings obtained from granite gneiss at both Kirton Point and Plug Range are contrasted by highly variable values recorded on mylonites at Port Neil. Although the more mafic lithologies in the mylonites had generally lower readings, the readings varied significantly between 55 and 420 cps. It is thought that pegmatite intrusions in and accompanying the mylonite deformation have affected the radiometric readings by apparently randomly concentrating radioelements regardless of lithology.

Point Drummond - Mount Hope.

Radiometric survey was undertaken across outcrops of tabular feldspar granite, a shear zone, a dolerite dyke and granodiorite. It was found that the tabular feldspar granite gave consistently high radiometric readings at both Mount Hope and Point Drummond, while the granodiorite gave comparatively low readings. The shear zone showed little definitive radiometric variations, but some pegmatite bodies within the zone gave relatively high readings, indicating a generally high potassium content and some radioelement concentration during their development. The high readings obtained from the tabular feldspar granite reflect a high potassium content, while the low readings from the granodiorite are explained by a low potassium content.

The very low readings from the dolerite dyke reflect the generally low potassium and radioelement content normally encountered in more mafic rocks.

Northwest Coast of Eyre Peninsula

Point Bell, Point James and Rocky Point.

At Point Bell, radiometric readings taken on various granitoid intrusives and granitic gneiss were too similar to successfully distinguish one lithology from another, perhaps indicating similar genetic relationships and little or no radioelement mobilisation during deformation and metamorphism. This was also experienced at Rocky Point and Point James granitic gneiss and medium-grained pink granite also displayed similar radiometric readings. However, a grey granite (84-99 cps) at Point James recorded distinctly lower readings, suggesting that the grey granite may represent an independent intrusive phase from the pink granite and granitic gneiss (145-165 cps). At Rocky Point, a biotite granodiorite containing abundant amphibolite xenoliths gave very low radiometric readings (22-34 cps) reflecting in particular a potassium and radioelement depleted chemistry.

Wadikee Rocks.

The grey migmatised gneiss at Wadikee rocks recorded very consistent radiometric values (211-216 cps), much higher than values for the Carnot Gneisses in southern Eyre Peninsula. This suggests that these two gneisses have evolved from different sources, or that migmitisation has retained some of the rock's radioelement content.

Point Brown and Smooth Pool.

Three types of granite were encountered at Point Brown; a coarse-grained pink granite composed mainly of potassium feldspar and quartz, a porphyritic biotite granite, and an even-grained granite. The porphyritic granite and the even-grained granite gave consistently higher total count readings (200-220 cps).

Both the radiometric results and field relationships indicate that the even-grained granite may be a more homogeneous phase of the porphyritic biotite granite, while the coarse-grained granite may represent a separate later intrusive phase.

A two-metre side dyke intruding the even-grained granite was examined radiometrically to determine if preferential crystallisation or migration of radioelements occurred along either the core or margins during emplacement. The dyke showed little or no radiometric zonation indicating that there was no pronounced radioelement concentration during crystallisation. However, a four metre wide garnet-bearing quartz-feldspar pegmatite shear zone exhibited very high radiometric readings (906-1307 cps) with uranium channel values exceeding forty times background levels. Such results indicate that there had been significant mobilisation and conentration of uranium along structurally controlled late-stage magmatic events in the crystalline complex.

At Smooth Pool, two separate granitoid intrusives could be distinguished radiometrically; a porphyritic pink granite and a pink coarse-grained gneissic granite. The coarse-grained gneissic granite was characterised by high potassium radiometric values (25-26 cps) compared to the moderate values obtained from the porphyritic pink granite (14-20 cps). Rafts of grey granodiorite within the porphyritic granite gave total count readings in between values from the porphyritic pink granite (99-142 cps) and the coarse-grained gneissic granite (181-277 cps), but was very similar to a well-foliated granite gneiss (170-171 cps). This may suggest that the foliated granite gneiss and the granodiorite may be genetically related.

Mount Hall, Anxious Bay and Mount Wudinna.

The pink medium-grained granites measured radiometrically at Mount Hall and Anxious Bay both display very similar radiometric readings on all channels, suggesting that these granites form part of the same intrusion. Their high potassium values (25-33 cps) suggest a high potassium feldspar content and contrast with radiometric measurements of the Mount Wudinna granite which have a higher total count reading, but a lower potassium reading (14-20 cps). This indicates that the Mount Wudinna granite may be a separate intrusive phase to the Mount Hall and Anxious Bay granites.

Talia Caves.

The Middle Proterozoic arkosic sandstones of the Blue Range Beds at Talia Caves is essentially undeformed red sandstone which evolved from erosion of the underlying crystalline complex of the Gawler Craton and deposition (of the sediment) in a fluvial environment.

Due to probable erosion and deposition in an oxidizing environment, almost all the uranium has been lost as indicated by the low readings obtained on the uranium channel (0-2 cps). The high potassic content of the sandstones is reflected in the high values obtained on the potassium channel (20-28 cps).

Slade Point and Point Westall.

The granitoid and gneissic lithologies measured radiometrically at Point Westall and Slade Point gave very similar readings and could not be successfully distinguished or related by their radiometrics alone.

Saint Francis Island.

In the course of regional mapping of the Isles of Saint Francis, a unique opportunity was obtained to measure the radioactivity of acid volcanics and associated granitoid intrusives. The acid volcanics, believed to be equivalent to the Gawler Range Volcanics, gave consistent total count radiometric readings (175-285 cps), while readings on the potassium channel (11-19 cps) indicated a possible rhyodacitic composition. High uranium values (4.1-12.5 cps) are consistent with the general observation that volcanic rocks usually contain 1.5 to 2 times as much uranium as plutonic equivalents. A small leucogranite pluton which intruded the acid volcanics gave very similar total count readings (227-282 cps). However, the two lithologies were easily distinguishable on the uranium channel. The acid volcanics recorded uranium readings two to three times greater than the leucogranite.

Shear zones within the acid volcanics showed a slight increase in radiometric values, possibly indicating minor uranium mobilisation along these structural planes.

DISCUSSION

In attempting to use gamma ray spectrometry in regional mapping, it was assumed that a given lithology would record fairly consistent radiometric readings. This was found to be true in all cases except for the mylonite at Port Neil which gave erratic readings.

The potassium content and the general radioelement content of a given lithology determines the radiometric reading, such that lithologies that are radioelement poor, such as mafic and ultramafic rocks, or those which are depleted in potassium would give low total count readings. So it is essentially possible for the gamma ray spectometer to give an indication of geochemistry. Although leaching action tends to redistribute uranium, surface weathering does not appear to seriously affect the gamma ray radiometric analyses which still remain representative of the underlying, unweathered rock.

The simplest way of distinguishing between the various lithologies was by comparing the total count values. However, these specific readings were often very similar and furthermore, in some instances, the radiometric readings of all channels were also too similar to effectively distinguish between lithologies. Such cases may indicate similar genetic origins. In other instances, lithologies with similar total count values showed significant variation in readings from the potassium, uranium or thorium channels, making is possible to distinguish them.

Soil cover tended to reduce radiometric values with respect to thickness of overburden. This severely hampered attempts to specify or map lithologies by radiometrics, especially when the cover thickness was excessive or unknown. However, for thin, superficially covered intervals, the portable gamma ray spectrometer proved to be helpful in identifying contacts across which there was an appreciable radiometric contrast.

This study has indicated that uranium mobilisation and concentration occurred within the crystalline basement complexes as late stage, structurally controlled, magmatic intrusions. Often pegmatites displayed anomalous readings due to a high potassium feldspar content and an appreciable uranium and thorium content. Elsewhere, there was little evidence to indicate significant radioelement mobilisation since crystallisation.

CONCLUSIONS

It was found that the portable gamma ray spectrometer can be a valuable aid in geological mapping if fully appreciated and operated properly. Variations in radiometric readings cannot determine lithological differences alone, but gamma ray spectrometry can help distinguish variations in general crystalline complexes with respect to the radioelement content, and determine whether or not an appreciable amount of the radioelements have been mobilised or concentrated. The gamma ray spectrometer has the ability to differentiate readings from specific radioelements, making it a superior instrument over the single total count Geiger counter.

Although gamma ray spectrometry will never be able to replace geochemical analyses, the readings from separate channels can be indicative of the chemical composition of the rock. Furthermore, because of its relative portability, the gamma ray spectrometer makes an invaluable piece of field equipment for not only the detection of uranium mineralisation, but for preliminary geochemical analyses and the identification of subtle chemical changes within or between lithologies such as multiphase granite complexes. By measuring the radioelement content, the gamma ray spectrometer can help define variations in Rb/Sr ratios and, by use of the uranium channel, can indicate lithologies more suitable for U-Th-Pb isotope geochronology.

It was hoped that the differences between values recorded on the uranium and thorium channels would help indicate the amount of uranium that has been leached from the host rock. Unfortunately, time did not permit closer investigation and the uranium and thorium values were very small, making it impractical at this stage of study to develop conclusive evidence on radioelement mobilisation.

RECOMMENDATIONS

Previous experience in exploration as well as results compiled in course of this study confirm the beneficial value of gamma ray spectrometry, not only to the exploration geologist but also to the regional mapping geologist.

Furthermore, since the public is becoming increasingly aware and concerned over issues regarding all forms of radiation, uranium, uranium mining and nuclear energy in South Australia, all geologists working with the Department of Mines and Energy should have a basic knowledge of the occurrence of radioelements in nature.

The portable gamma ray spectrometer is a superior device for detection of radioactivity as it can readily distinguish respective radioelement energy emissions. This is a very valuable feature as it can indicate a rock containing high portions of uranium and thorium from simply a potassium-rich rock.

It is recommended that the Department of Mines and Energy acquire a good portable gamma ray spectrometer for use in the field as a supplementary tool during regional and detailed mapping, as an aid in selection of rock samples for geochronology, and to generally increase the capabilities of the Department of Mines and Energy to detect and evaluate the various forms of radioactivity.

From previous experience in Canada, both Shell Canada Resources and AGIP Canada use exclusively the Urtec Minispec or Miniscint gamma ray spectrometer in all their exploration programmes. They have found this unit to be very durable, accurate, reliable, portable, sensitive and easy to operate. Specifically, AGIP Canada has done field tests on all available portable gamma ray spectrometers in North American, and they have found the Urtec system to be essentially the best field unit presently on the market.

Proposals for Future Study

(a) Geochemical evaluation of the potassium, thorium and uranium content of various selected lithologies in the Gawler Craton and comparison with radiometric results to determine accuracy of radiometric readings to actual radioelement content.

(b) Detailed petrology etc. to determine the form(s) in which uranium, thorium and potassium occur within given lithologies.

(c) Detailed mapping of crystalline complexes along the northwest coast of the Eyre Peninsula to evaluate relationships of various intrusives.

(d) Collaboration with uranium exploration companies presently operating in the Gawler Craton in order to produce detailed radiometric maps with respect to deformation, age, as well as lithological variations.

(e) Evaluation of the potential for mapping crystalline basement lithologies in regions of thin but extensive superficial cover.

(f) Evaluation of the use of radiometrics in determining more suitable lithologies for geochronological examination.

(g) U-Th-Pb isotope study of selected areas to determine quantity and time of uranium mobolisation in the Gawler Craton.

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APPENDIX I

Radiometric Readings (Counts per Second)

Point Drummond

Location	Total Count	Potassium	Uranium	Thorium	Lithology
1	228.7	27.5	5.6	2.5	tabular feldspar granite
2	131.7	17.5	0.9	1.2	pegmatite in granite
3	236.9	26.2	5.4	3.2	tabular feldspar granite
4	218.1	22.3	4.0	4.3	tabular feldspar granite
5	119.2	17.1	1.1	0.7	even grained granite
6	114.7	20.6	0.7	0.7	even grained granite
7	143.8	22.2	0.3	0.2	even grained granite
8	151.8	17.7	3.2	2.1	shear zone-micaceous schist
9	336.6	43.9	5.5	2.7	pegmatite in shear zone
10	165.8	17.5	3.8	2.7	shear zone
11	249.9	24.5	6.3	1.9	granitic body in shear zone
12	106.4	12.7	1.6	1.6	shear zone
13	66.8	7.7	1.5	0.3	shear zone
14	97.2	11.6	1.4	1.5	shear zone
15	47.6	5.8	1.0	0.7	dolerite dyke
16	129.1	14.5	2.8	2.2	granodiorite
17	115.2	14.0	2.4	1.1	granodiorite
18	50.3	5.8	0.5	0.7	dolerite dyke
19	42.6	6.6	0.8	0.7	dolerite dyke
20	87.1	9.1	1.2	1.4	granodiorite

Mount Hope

21	267.3	28.2	4.9	3.5	tabular feldspar granite
22	305.8	28.4	8.5	4.5	tabular feldspar granite
23	263.9	32.4	5.2	4.1	tabular feldspar granite

Coles Point

24	273.5	33.9	6.2	3.7	crenulated schist
25	43.4	4.3	1.2	0.4	Warrow Quartzite
26	59.9	5.8	1.8	1.2	Warrow Quartzite
27	214.9	25.1	4.7	3.7	crenulated schist
28	164.7	22.1	2.3	2.0	sheared gneissic granitoid
29	152.1	21.7	2.4	2.2	sheared gneissic granitoid
30	210.6	22.2	3.5	3.5	sheared gneissic granitoid
31	52.9	7.5	0.3	0.04	pegmatite
32	37.9	3.4	0.6	0.2	Warrow Quartzite
33	22.3	1.5	0.2	0.2	Warrow Quartzite
34	23.2	2.5	0.5	0.3	Warrow Quartzite
35	42.6	2.5	1.0	0.8	Warrow Quartzite

Marble Range

36	389.6	28.3	7.5	13.4	covered
37	625.6	44.5	13.1	22.1	float
38	584.4	49.8	11.2	18.3	covered
39	711.1	46.8	14.2	25.2	covered
40	668.1	50.5	12.1	20.3	float
	328.3	31.0	5.4	7.6	covered
41	701.5	52.4	13.2	22.2	outcrop
42	826.9	62.2	17.8	26.8	outcrop
43	450.8	37.9	7.9	11.4	float
44	686.5	48.4	14.3	21.7	float
45	682.7	49.9	16.3	19.1	outcrop
46	729.1	54.1	14.9	25.0	outcrop

South Block

47	111.9	11.9	1.3	2.3	covered
48	83.5	6.0	1.9	1.5	covered
49	79.1	6.8	1.4	1.4	covered
50	89.2	10.3	1.9	0.8	Warrow Quartzite
51	88.0	9.0	1.6	1.4	Warrow Quartzite
52	61.9	4.9	1.6	1.4	covered
53	97.6	9.8	1.9	1.9	covered
54	90.5	7.2	2.1	2.2	covered
55	55.0	3.7	1.5	1.5	road
56	49.1	4.0	0.7	1.4	road
57	46.4	3.7	1.0	1.3	road
58	43.7	3.3	1.1	1.3	road
59	39.2	3.8	0.8	0.8	road

Cape Carnot

60	32.3	2.5	0.4	0.6	basic granulite
61	347.2	36.2	7.3	8.9	layered garnet gneiss
62	355.5	32.3	7.1	10.5	augen gneiss
63	85.2	7.1	1.6	2.7	undifferentiated gneiss
64	87.2	9.8	1.9	1.6	cordierite garnet gneiss
65	110.3	17.9	1.1	1.7	leucogneiss
66	46.9	7.1	0.8	0.7	hypersthene gneiss
67	27.2	7.6	0.3	0.5	hypersthene gneiss
68	62.4	8.6	0.5	1.0	hypersthene gneiss
69	44.8	5.3	0.3	0.7	hypersthene gneiss
70	24.0	2.8	0.3	0.0	basic granulite
71	119.6	20.2	0.4	0.8	leucogneiss

Kirton Point

72	195.6	21.5	2.5	4.4	granite gneiss
73	76.4	7.9	1.6	1.5	meta dolerite
74	201.4	24.8	2.1	4.4	granite gneiss
75	116.6	13.1	1.6	2.7	amphibolite
76	202.2	22.4	5.2	4.2	granite gneiss
77	90.5	11.1	1.5	1.0	amphibolite
78	185.9	20.2	2.4	3.7	granite gneiss
79	95.1	11.8	2.0	2.2	amphibolite
80	372.6	35.7	7.8	9.8	granite dyke
81	130.3	14.2	2.1	2.9	metadolerite
82	207.8	22.6	3.6	4.8	granite gneiss

Port Neill

83	100.5	11.9	1.6	1.1	Q-F mylonite
84	55.2	8.4	0.7	0.4	Q-F mylonite
85	91.6	13.5	1.1	1.9	Q-F mylonite
86	199.3	26.3	3.1	4.6	Q-F mylonite
87	41.9	6.0	0.4	0.3	amphibolite
88	50.1	8.1	1.0	0.6	amphibolite
89	164.7	22.3	2.6	2.9	mylonite(?)
90	39.0	5.8	0.4	0.7	amphibolite
91	317.1	33.5	6.1	7.0	mylonite(?)
92	266.5	29.5	4.4	4.6	proto augen mylonite
93	209.8	28.9	3.0	3.8	proto augen mylonite
94	217.6	25.8	4.7	4.6	augen mylonite
95	181.7	21.2	2.9	3.6	augen mylonite
96	420.0	34.4	10.3	12.6	amphibolite ultramylonite
97	283.7	28.7	5.9	5.8	amphibolite ultramylonite
98	218.7	23.5	2.9	4.7	amphibolite ultramylonite
99	197.0	26.6	3.5	2.6	pegmatite
100	238.6	28.6	6.3	4.3	augen mylonite
101	235.0	25.2	5.3	5.3	augen mylonite

Plug Range

102	275.1	32.2	5.3	4.3	QFB gneiss
103	227.4	21.0	3.6	6.2	QFB gneiss
104	290.9	32.0	6.4	6.9	pegmatite/gneiss
105	283.1	29.1	5.6	5.1	pegmatite
106	245.1	25.0	5.6	5.6	pegmatite
107	252.5	27.9	5.7	5.4	pegmatite/gneiss
108	220.8	23.2	4.6	4.0	pegmatite/gneiss
109	171.4	17.1	3.1	3.5	pegmatite
	279.1	30.0	5.5	7.0	
110	224.1	26.0	4.4	3.4	pegmatite/gneiss
111	65.5	4.6	0.7	1.3	Warrow Quartzite
112	103.8	11.8	1.0	1.8	Warrow Quartzite
113	92.7	7.2	2.7	2.2	Warrow Quartzite
114	97.9	9.0	2.7	2.4	Warrow Quartzite
115	200.3	16.1	5.0	4.4	fault zone
116	250.4	30.6	3.5	5.7	gneiss
117	212.8	24.2	4.4	3.8	gneiss
118	250.4	29.6	4.5	3.9	pegmatite/gneiss
119	221.5	21.6	4.8	4.8	augen gneiss
120	206.3	20.9	4.1	3.3	augen gneiss
121	288.8	31.3	4.5	7.1	gneiss
122	100.0	6.6	2.3	1.9	Warrow Quartzite
123	54.1	3.4	1.1	1.5	Warrow Quartzite
124	83.5	6.2	1.9	2.5	Warrow Quartzite
125	52.7	3.2	1.1	1.2	Warrow Quartzite
126	268.0	26.1	6.1	6.3	gneiss
127	646.9	51.5	15.4	18.1	pegmatite
128	294.3	29.2	7.0	6.1	gneiss
129	242.1	26.6	5.9	4.1	gneiss
130	249.5	26.6	4.3	4.5	gneiss
131	134.2	14.0	2.4	3.2	covered
132	148.0	16.3	2.3	1.9	amphibolite(?)
133	129.2	18.4	1.8	1.1	granodiorite(?)

APPENDIX II

Radiometric Readings (Counts Per Second)

Point Bell

Location	Total Count	Potassium	Uranium	Thorium	Lithology
1	190.6	16.4	3.1	1.9	quartz vein in foliated granite
2	230.8	22.9	3.6	3.6	foliated granite
3	207.4	17.3	3.9	2.6	foliated granite
4	219.4	20.4	3.8	3.2	biotite granite gneiss shear zone
5	217.8	20.5	4.0	2.8	biotite granite gneiss shear zone
6	188.3	17.4	2.1	1.9	banded granite gneiss
7	161.9	15.6	2.6	2.5	banded granite gneiss
8	130.4	11.5	1.8	1.3	pegmatite vein
9	190.4	18.5	3.5	1.6	granite(?)
10	228.8	19.5	3.1	2.1	granite(?)

Rocky Point & adjacent area

Location	Total Count	Potassium	Uranium	Thorium	Lithology
11	116.8	9.2	1.6	1.9	granite gneiss (granodiorite)
12	97.1	9.4	2.6	0.8	" "
13	75.6	6.2	1.3	1.1	" "
14	87.0	6.6	1.8	1.3	amphibolite zenolith
15	79.6	5.5	1.0	0.9	amphibolite zenolith
16	149.6	11.5	2.1	2.4	granite segregations
17	217.0	18.0	3.6	3.4	granite segregations
18	118.1	10.6	1.6	1.7	massive, medium grained granite
19	105.6	10.4	0.8	1.0	" "
20	104.4	9.8	1.3	1.2	" "
21	106.4	9.8	1.7	1.3	" "
22	34.0	3.1	0.4	0.2)	biotite granodiorite with
23	22.1	1.3	0.2	0.1)	zenoliths of amphibolite

Point James

Location	Total Count	Potassium	Uranium	Thorium	Lithology
25	144.5	21.6	1.2	1.8	medium-grained granite
26	119.8	14.8	1.9	2.2	medium-grained granite
27	134.4	19.8	1.0	1.7	medium-grained granite
28	94.6	8.7	2.0	3.2	grey granite
29	98.5	10.3	1.7	1.7	grey granite
30	127.9	17.5	1.4	1.0	fine grained aplite dyke
31	160.6	21.5	2.3	2.9	(Pink) granite
32	145.4	17.7	2.0	1.7	pink granite
33	136.3	17.3	2.0	2.2	granitic dyke
34	128.6	15.6	1.4	1.7	granitic dyke
35	169.4	21.1	2.6	2.1	granitic dyke
36	109.8	13.2	1.1	1.5	dolerite
37	84.2	10.1	0.9	1.4	grey granite
38	95.0	13.8	1.1	0.9	pink granite intrusion
39	85.2	11.4	0.9	1.3	pink granite intrusion

Cont.

40	164.9	21.5	2.1	2.3	pink granite gneiss
41	150.4	19.5	2.7	3.1	pink granite gneiss
42	133.0	17.9	1.3	1.7	biotite granite
43	146.2	19.0	1.3	1.8	biotite granite

Point Brown

44	198.2	25.9	1.8	2.9	coarse grained granite
45	215.5	28.8	3.7	3.4	coarse grained granite
46	203.7	25.6	3.4	2.9	coarse grained granite
47	213.6	26.5	2.3	3.0	coarse grained granite
48	224.4	27.9	3.3	3.9	coarse grained granite
49	161.4	23.9	1.4	1.8	porphyritic biotite granite
50	139.5	17.8	1.6	2.7	" "
51	152.4	19.1	1.8	2.3	" "
52	143.3	18.8	2.0	2.2	equigranular granite
53	163.2	21.1	1.8	3.5	equigranular granite
54	124.6	14.1	1.9	1.7	equigranular granite
55	155.4	20.0	2.1	2.0	equigranular granite
56	173.6	21.8	2.1	4.0	pink granite
57	185.1	21.9	2.9	2.1	pink granite
58	179.7	20.7	3.3	2.9	pink granite
59	212.6	23.1	3.2	3.9	adjacent to grey porphyritic granodiorite dyke
60	178.5	21.0	3.0	2.5	" "
61	134.9	16.1	2.0	2.0	grey porphyritic granodiorite dyke
62	151.1	17.6	3.3	2.0	" "
63	211.9	26.5	5.1	2.4	east dyke margin
64	163.9	17.6	3.2	2.7	east dyke margin
65	120.8	15.4	1.3	1.9	dyke centre
66	157.8	19.1	1.1	2.3	west dyke margin
67	175.4	21.2	2.6	3.7	east dyke margin
68	157.1	18.5	2.7	1.6	east dyke margin
69	148.9	16.5	1.7	2.4	dyke centre
70	149.8	19.5	2.5	2.2	west dyke margin
71	163.9	20.4	1.6	1.3	east dyke margin
72	132.7	17.4	1.6	2.3	dyke centre
73	157.4	16.6	3.5	2.6	west dyke margin
74	136.6	15.7	1.9	2.6	east dyke margin
75	133.9	14.6	2.3	1.8	east dyke margin
76	114.8	14.3	1.3	2.0	east half of dyke
77	113.4	15.3	1.9	1.8	dyke centre
78	148.9	17.3	3.0	2.0	west dyke margin
79	139.4	21.4	1.1	1.8	pegmatite
80	166.2	15.1	3.7	2.4	east dyke margin
81	134.8	17.0	1.3	2.4	east dyke half
82	117.9	13.9	1.3	1.7	dyke centre
83	132.2	16.8	1.4	2.0	west dyke half
84	127.5	14.3	0.8	2.2	west dyke margin
85	104.9	14.0	0.9	2.0	biotite granodiorite?
86	105.8	13.8	2.5	1.1	dolerite dyke
87	81.1	8.4	1.1	1.2	porphyritic dolerite dyke (hornblende)
88	201.9	25.0	3.6	3.6	equigranular porphyritic granite

89	179.3	20.9	2.6	2.8	" "
90	101.2	12.2	1.2	1.0	grey porphyritic intrusive phase
91	906.0	75.8	29.4	6.6	very coarse grained pegmatite
92	1307.0	112.0	47.0	6.0	very coarse grained pegmatite
93	1239.0	96.0	46.0	11.2	" "

Smooth Pool

94	1369	194	16	17	porphyritic pink granite
95	1027	180	4	13	" "
96	990	138	8	15	" "
97	1422	197	16	17	" "
98	1250	196	17	14	" "
99	1383	195	13	11	" "
100	1345	187	16	15	" "
101	1260	204	8	12	" "
102	1689	222	30	41	foliated granite gneiss (?augen gran.)
103	1709	179	25	28	" "
104	1177	202	10	12	aphite vein (garnet)
105	2098	199	46	55	grey granodioritic rafts
106	1332	162	30	42	" "
107	1685	211	19	38	" "
108	1539	160	20	24	" "
109	1501	189	26	21	" "
110	2087	257	21	34	coarse-grained augen gneiss
111	1819	252	16	31	" "
112	2273	250	37	41	" "

North of Point Westall

113	113.7	15.4	1.2	1.7	augen gneiss with mafic xenoliths
114	102.5	13.0	1.8	1.5	" "
115	81.3	10.3	0.9	1.8	amphibolite
116	143.5	25.6	1.4	5.0	porphyritic granite
117	100.8	16.1	0.3	1.3	porphyritic granite
118	169.8	23.5	2.8	2.5	porphyritic granite augen gneiss

East Side of Slade point

119	181.1	19.0	3.1	3.0	grey adamellite
120	173.0	18.6	2.4	3.3	grey adamellite
121	140.7	17.2	1.9	2.7	grey adamellite
122	136.4	17.3	1.5	2.6	grey adamellite
123	149.2	17.7	2.5	2.1	pink adamellite
124	142.6	18.2	2.1	1.9	pink medium grained granite
125	167.1	23.3	1.3	2.0	" "
126	146.1	16.6	2.0	3.1	" "
127	174.8	20.9	2.6	2.7	pink fine grained granite

Mount Hall

128	283.3	32.8	3.6	5.6	pink medium grained granite
129	227.4	26.6	3.8	3.3	" "
130	221.4	24.3	3.3	3.6	" "
131	264.3	30.2	3.2	3.0	" "

Anxious Bay

132	223.8	24.8	2.8	6.2	pink medium grained granite
133	256.4	29.5	3.2	7.0	" "
134	239.6	26.7	3.5	5.9	" "
135	283.3	28.1	3.0	9.0	" "
136	231.2	29.1	2.4	4.8	pegmatite

Talia Caves

137	152.8	25.1	1.3	1.5	sandstone-arkose
138	158.3	24.1	1.5	1.8	" "
139	196.0	25.9	2.5	4.2	" "
140	108.7	20.4	0.5	0.8	" "
141	168.5	28.3	1.3	2.0	" "
142	175.5	27.2	0.7	2.7	" "
143	180.7	25.3	1.8	3.7	" "
144	110.7	20.1	0.6	0.4	" "

Mount Wundinna

145	258.4	17.4	3.5	3.6	pink porphyritic granite
146	256.5	17.2	2.3	5.3	" "
147	320.4	19.1	5.1	9.7	" "
148	297.4	15.9	4.0	7.1	" "
149	350.1	20.2	6.1	8.3	" "
150	221.1	13.7	2.8	4.6	" "

Wadikee Rocks

151	214.3	11.4	3.8	5.6	grey gneiss
152	216.2	11.6	2.8	6.9	" "
153	210.8	11.5	3.7	4.7	" "
154	220.4	12.5	4.3	4.5	" "
155	212.8	11.7	3.3	6.4	migmatite
156	210.9	10.3	3.4	4.3	migmatite

APPENDIX III

Radiometric Readings (in counts per second)

Saint Franics Island (North-east coast)

Location	Total Count	Potassium	Uranium	Thorium	Lithology
1	141.9	17.5	3.0	1.3	alkali granite
2	169.1	19.8	4.2	2.5	alkali granite
3	166.5	19.3	3.2	1.8	alkali granite
4	166.7	21.8	3.3	1.6	quartz iron oxide segregation in granite
5	163.7	14.2	4.4	2.0	" "
6	222.4	17.0	5.0	3.1	banded hornblende granite dyke
7	302.9	19.0	8.3	6.7	" "
8	224.1	17.3	5.1	4.1	" "
9	166.5	10.6	4.6	2.5	" "
10	187.1	13.6	5.3	3.0	alkali granite near dolerite dyke
11	177.6	12.1	4.3	1.4	" "
12	180.9	14.5	4.2	2.2	alkali granite - light coloured phase
13	209.8	15.9	5.8	3.0	alkali grnite grey coloured phase
14	216.2	14.0	5.5	2.2	alkali granite near pink granite dyke
15	187.3	12.9	4.0	2.9	" "
16	188.6	12.9	6.0	3.5	" "
17	270.6	18.2	7.7	4.1	alkali granite 3 m from dacite dyke
18	216.0	14.0	5.3	3.3	alkali granite 5 m from dacite dyke
19	220.7	14.6	6.4	3.4	alkali granite 3 m from dacite dyke
20	256.7	18.3	8.5	4.9	alkali granite 1 m from dacite dyke
21	148.9	9.9	3.2	2.3	dolerite dyke
22	134.6	7.4	3.4	1.5	dolerite dyke
23	116.4	8.5	3.0	1.6	dolerite dyke core
24	157.5	11.4	4.2	1.7	dolerite dyke margin
25	158.2	11.4	3.5	2.6	dolerite dyke minor

Saint Francis Island (North-west coast)

Location	Total Count	Potassium	Uranium	Thorium	Lithology
26	162.9	11.8	5.2	1.9	dolerite dyke
27	132.2	9.1	5.7	1.7	dolerite dyke
28	203.2	16.7	9.7	2.5	dolerite dyke
29	85.5	5.5	1.7	1.6	dolerite dyke
30	99.6	9.8	1.9	0.8	dolerite dyke
31	87.9	5.9	1.7	1.3	dolerite dyke
32	73.4	5.6	1.6	1.2	dolerite dyke
33	167.8	14.6	3.9	1.8	pink porphyritic granite dyke
34	209.4	15.1	4.8	2.7	" "
35	218.5	15.0	5.0	2.3	" "
36	143.4	11.9	4.7	1.0	" "
37	150.2	12.2	4.3	1.8	" "
38	141.8	4.6	4.8	1.1	" "

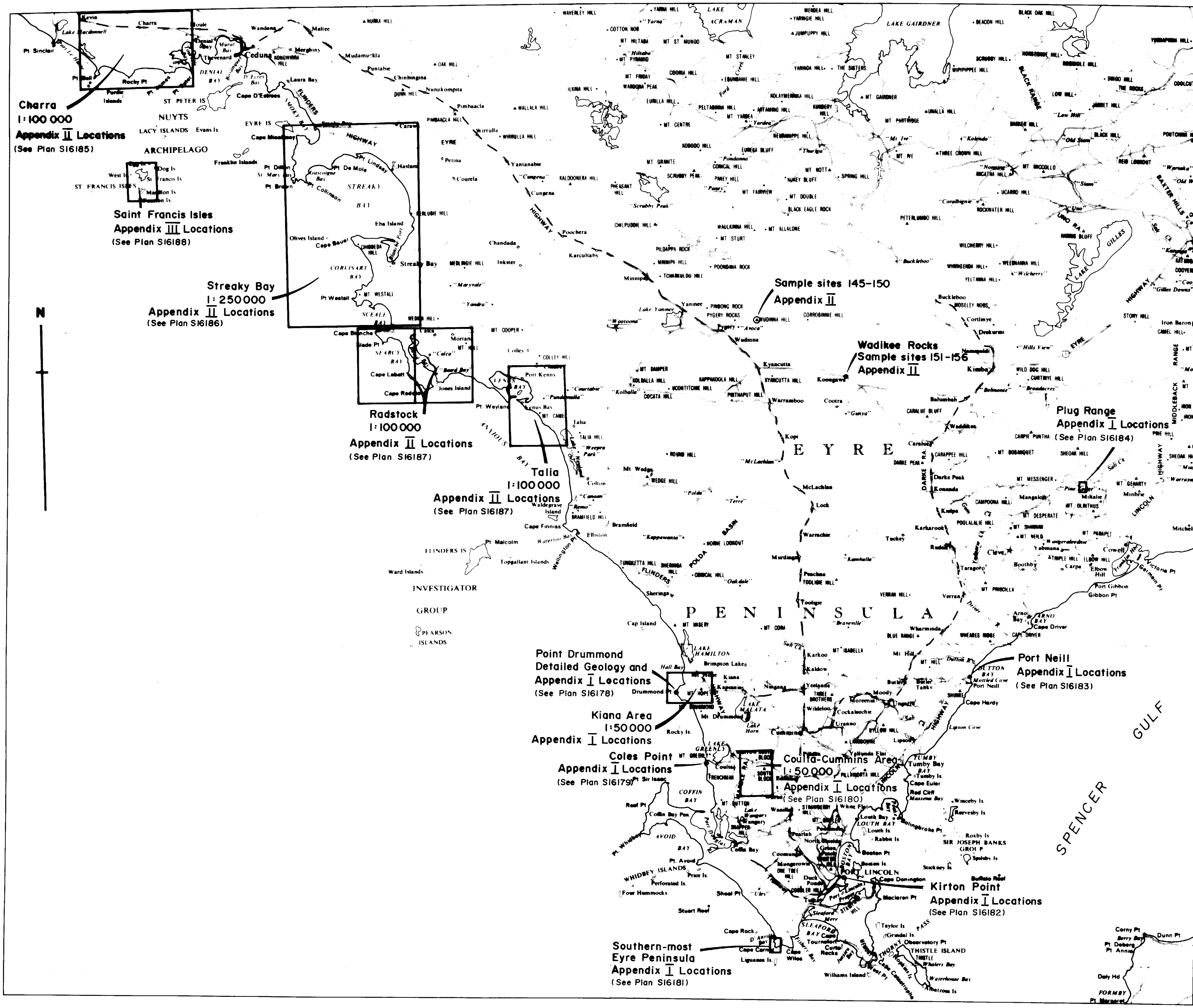
39	139.6	12.1	4.4	1.5	" "
40	161.1	10.9	5.4	1.9	" "
41	157.7	13.4	4.0	2.6	pink porphyritic granite dyke
42	224.9	17.4	7.0	2.7	black dacite dyke - margin
43	228.1	16.5	8.0	2.9	" "
44	168.4	12.7	5.2	2.2	black dacite dyke - core
45	164.9	11.6	5.8	1.1	" "
46	175.7	13.4	4.7	1.8	" "
47	209.7	16.7	7.0	2.9	black dacite dyke - margin

Saint Francis Island (North coast)

48	194.5	15.1	6.7	2.7	acid volcanics rhyodacites(?)
49	234.9	16.9	9.7	2.2	" "
50	218.8	15.8	7.8	2.5	" "
51	202.4	15.1	6.2	2.3	" "
52	203.4	13.2	6.7	2.9	" "
53	176.6	11.4	7.1	1.5	" "
54	190.1	12.2	7.9	2.8	" "
55	212.9	14.8	8.0	2.9	" "
56	227.6	15.6	8.0	3.9	" "
57	266.4	19.3	8.3	3.2	" "
58	215.6	16.2	7.9	3.7	" "
59	223.8	15.0	10.1	2.7	" "
60	223.3	15.5	8.1	3.0	" "
61	234.0	17.4	9.8	2.1	" "
62	186.3	12.8	7.2	1.9	" "
63	197.4	14.0	12.5	2.4	" "
64	284.9	19.0	12.5	3.1	" "
65	124.5	17.6	7.5	2.2	" "
66	194.4	14.6	4.1	2.7	" "
67	200.1	14.2	5.0	3.1	" "
68	287.1	20.2	10.3	5.1	shear zone in acid vol. well fractured
69	257.0	17.1	7.8	1.8	" "
70	269.6	18.8	8.0	3.2	" "
71	320.8	22.0	13.1	3.9	" "
72	320.8	22.0	13.1	3.9	quartz-feldspar shear in acid volcanics
73	245.5	15.5	10.9	2.7	" "
74	298.4	22.7	9.5	3.7	" "
75	285.4	23.2	11.4	2.5	" "
76	254.1	16.1	11.9	3.2	" "
77	293.8	21.0	12.2	3.9	shear zones in acid volcanics
78	312.4	22.6	11.6	4.0	" "
79	332.7	25.2	14.9	3.7	" "
80	287.9	21.9	11.9	3.7	" "
81	309.1	21.8	5.8	3.7	" "
82	247.9	18.1	4.4	3.6	leucogranite dyke
83	227.6	17.4	3.8	3.7	leucogranite dyke
84	276.2	18.9	6.0	4.3	leucogranite dyke
85	260.7	16.4	6.3	5.2	leucogranite main body
86	242.9	18.1	5.4	4.2	" "

Cont.

87	243.3	13.8	4.8	4.1	"	"
88	317.6	22.0	5.4	5.6	"	"
89	282.5	17.7	5.3	4.3	"	"
90	245.8	14.7	5.4	3.7	"	"
91	230.8	15.0	4.7	4.0	"	"



SCALE

20 0 20 40 60 80 100 KILOMETRES

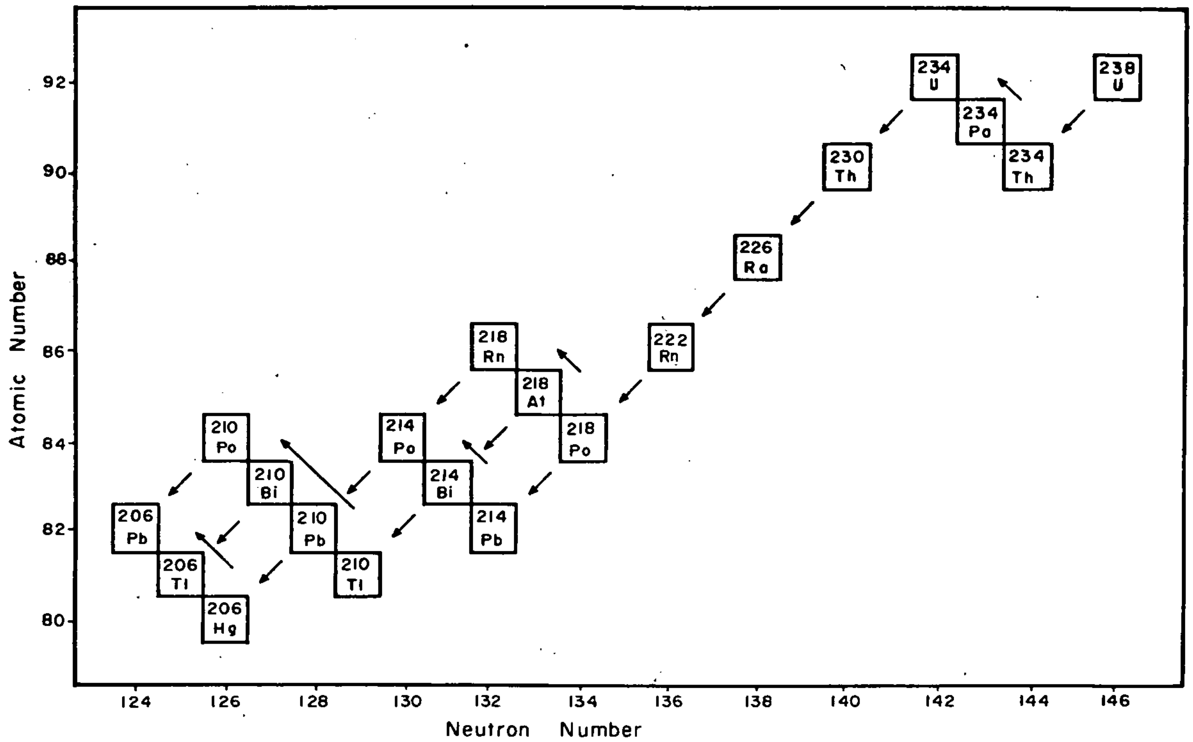
Fig. 1

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

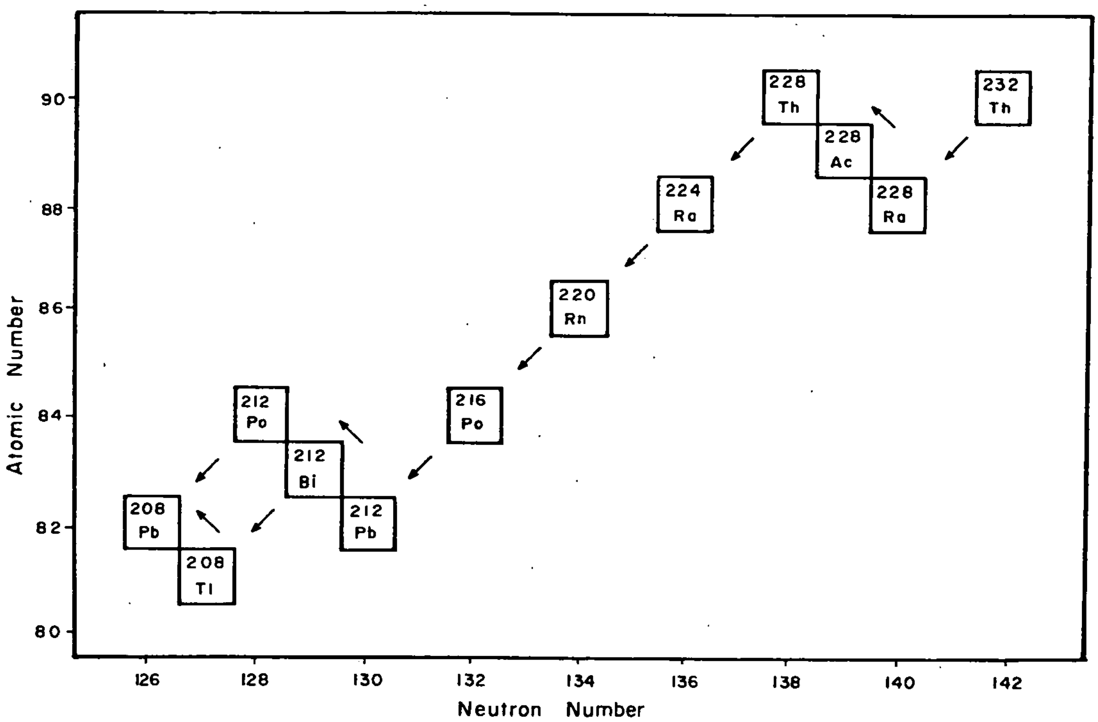
RADIOMETRICS OF THE GAWLER CRATON
LOCATION MAP
SAMPLE SITE LOCATION MAPS

COMPILED R.M.	C.D.O. 13.7.82	DATE
DRAWN M.B.	SCALE 1:1 000 000	
DATE May '82	PLAN NUMBER	
CHECKED	82-208	

2776



Decay of ^{238}U to ^{206}Pb



Decay of ^{232}Th to Stable ^{208}Pb

Fig. 2

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
GRAPHS SHOWING DECAY SEQUENCE OF
^{238}U to ^{206}Pb AND ^{232}Th to Stable ^{208}Pb

COMPILED R. M.	C.D.O. [signature] DATE 13 · 7 · 82
DRAWN M.B.	SCALE
DATE May '82	PLAN NUMBER S16176
CHECKED	

2716

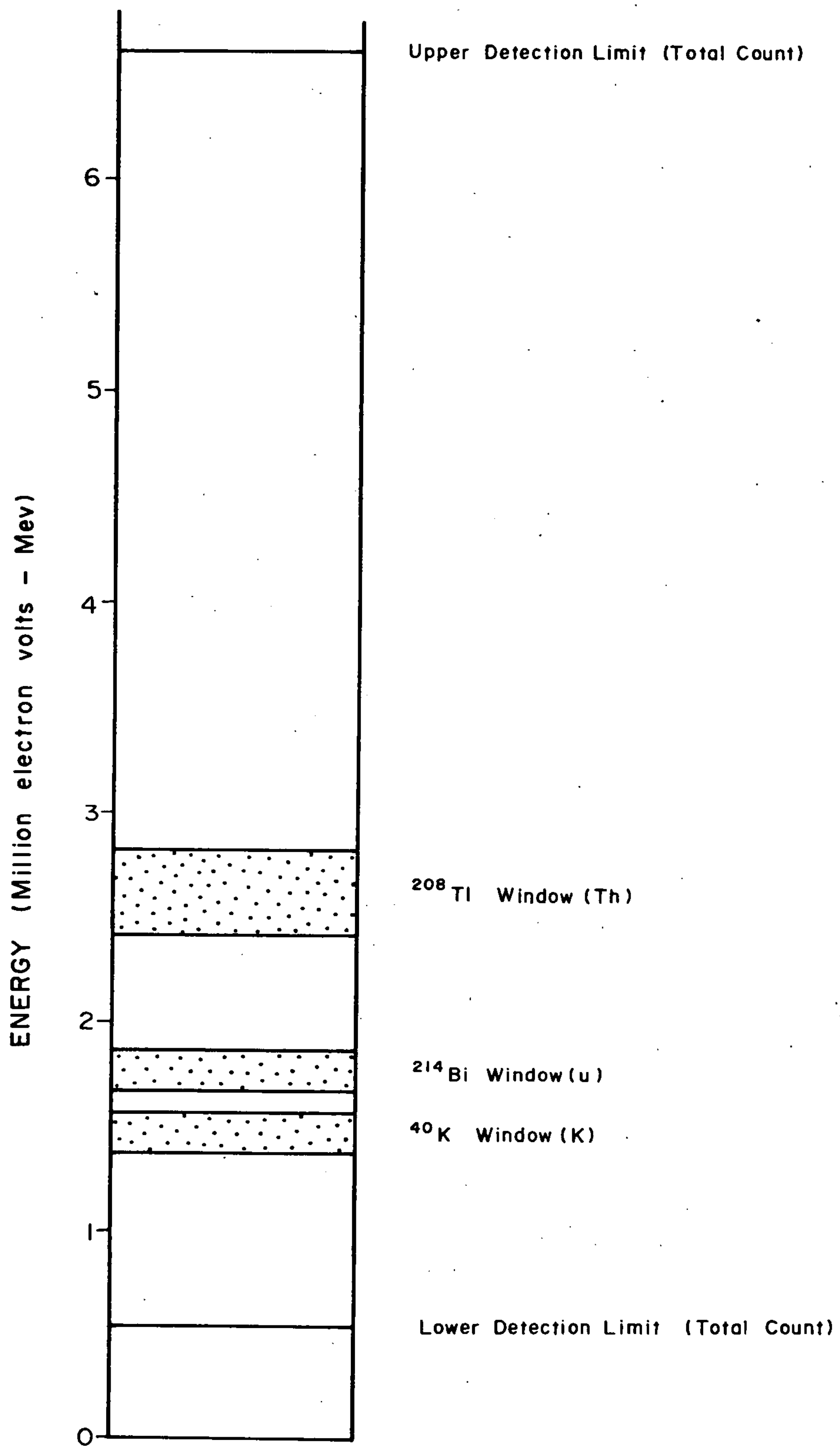


Fig.3

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
GRAPHICAL REPRESENTATION OF GAMMA RAY
SPECTROMETER DETECTION LIMITS
WITH RESPECTIVE CHANNEL THRESHOLD SETTINGS

COMPILED R.M.	C.D.O.	DATE 13·7·82
DRAWN M.B.	SCALE	
DATE May '82	PLAN NUMBER	
CHECKED	S16177	

2716

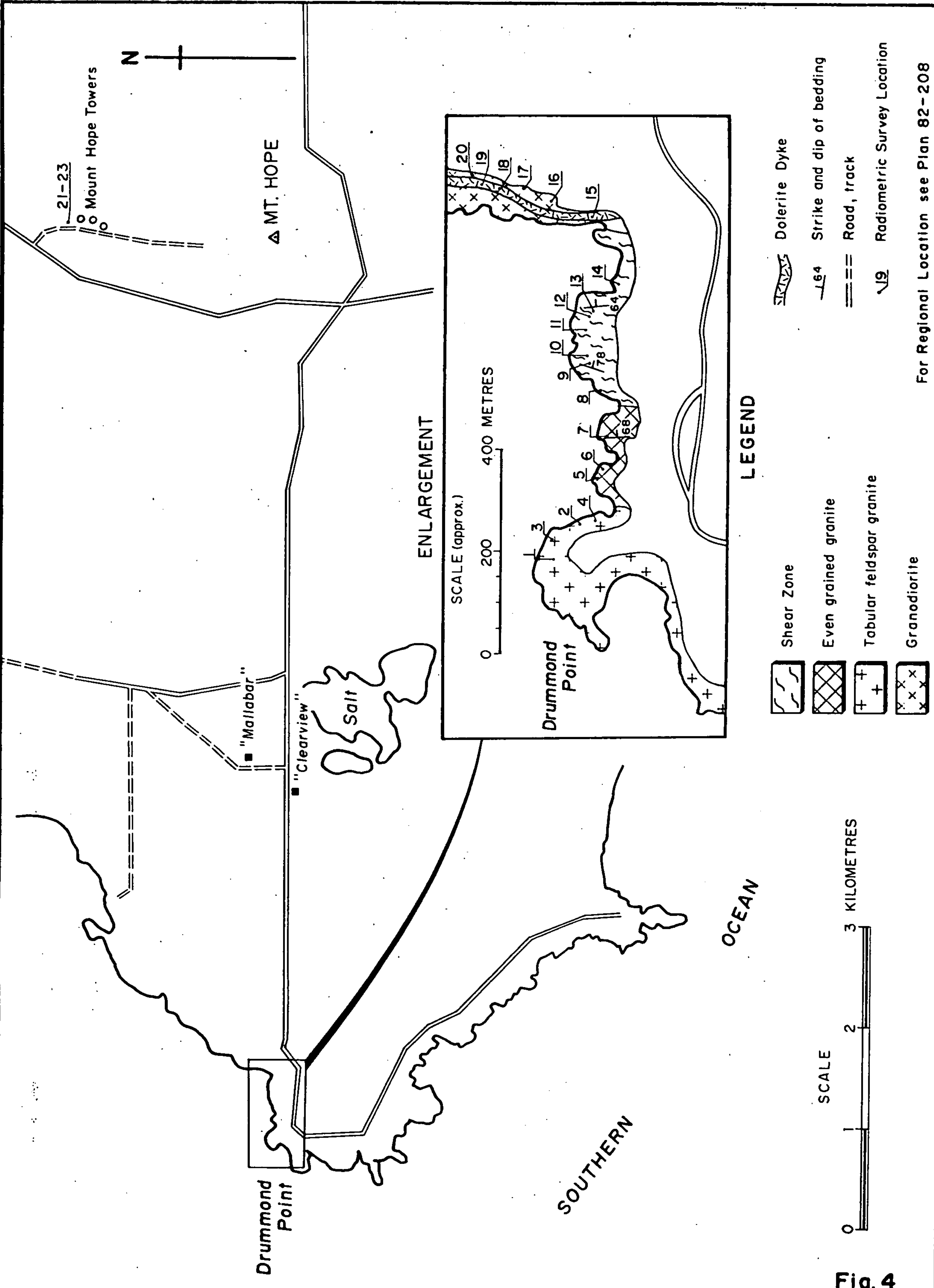


Fig. 4

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
DRUMMOND POINT
RADIOMETRIC SURVEY LOCATIONS

COMPILED R. M.	C.D.O. 13·7·82	DATE
DRAWN M.B.	SCALE 1:50 000	
DATE May '82	PLAN NUMBER	
CHECKED	S16178	

2716

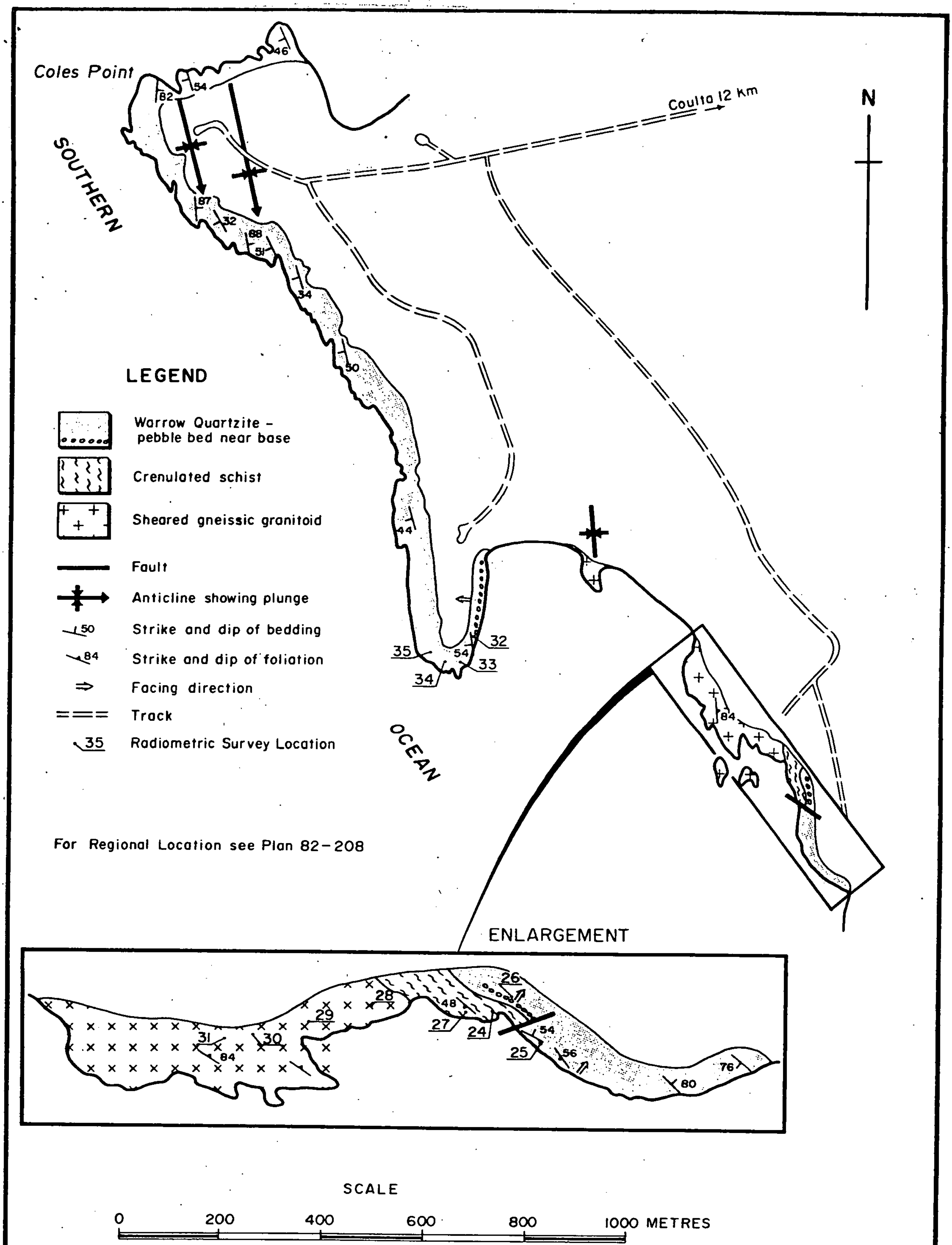


Fig. 5

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
COLES POINT
GEOLOGY AND RADIOMETRIC SURVEY LOCATIONS

COMPILED R.M.	C.D.O. 13-7-82 DATE
DRAWN M.B.	SCALE 1 : 10 000
DATE May '82	PLAN NUMBER
CHECKED	S16179

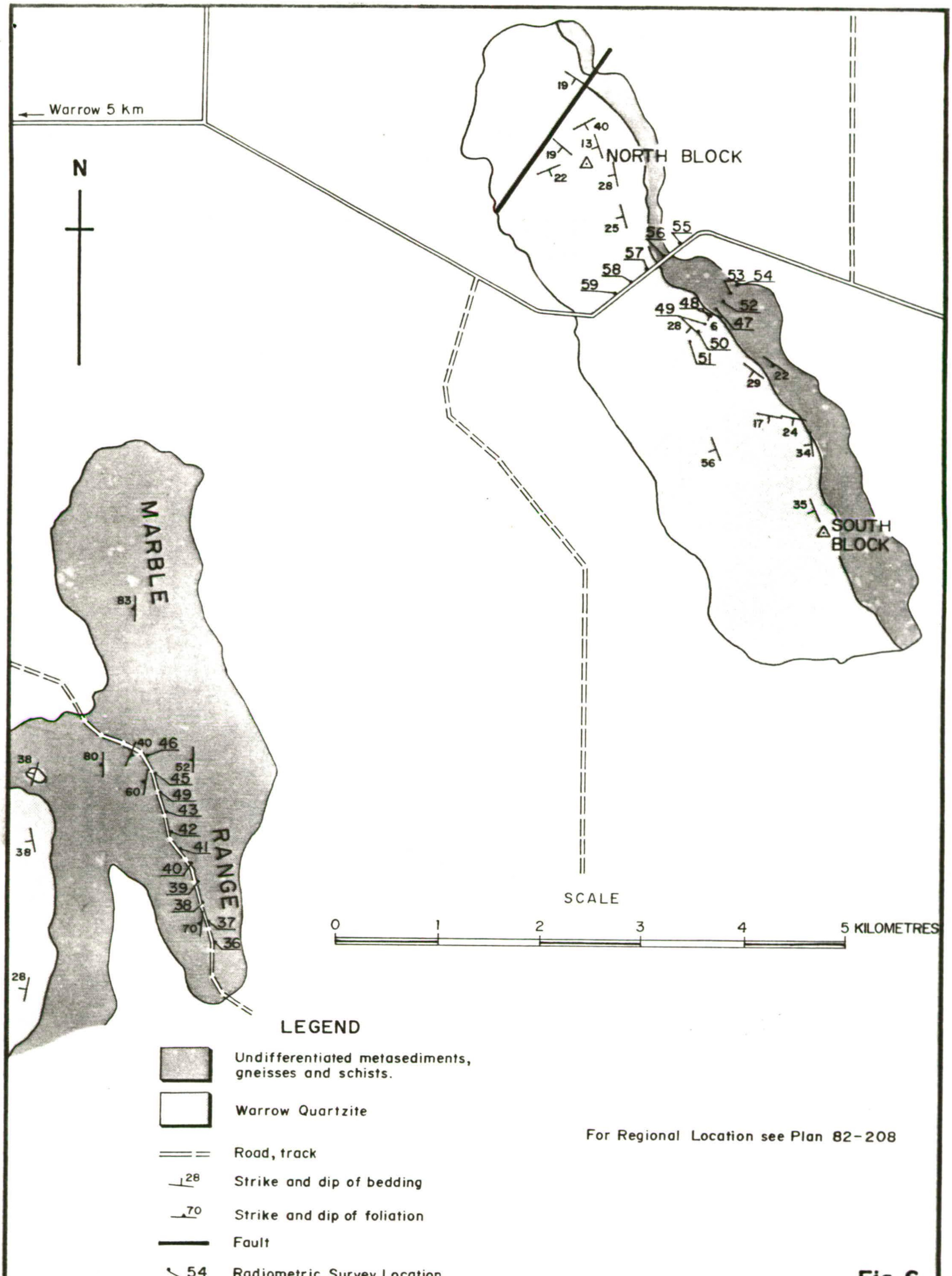


Fig. 6

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. M.	C.D.O 13 · 7 · 82 DATE
RADIOMETRICS OF THE GAWLER CRATON	DRAWN M.B.	SCALE 1 : 50 000
COULTA - CUMMINS AREA, EYRE PENINSULA	DATE May '82	PLAN NUMBER
GEOLOGY AND RADIOMETRIC SURVEY LOCATIONS	CHECKED	S16180

2776

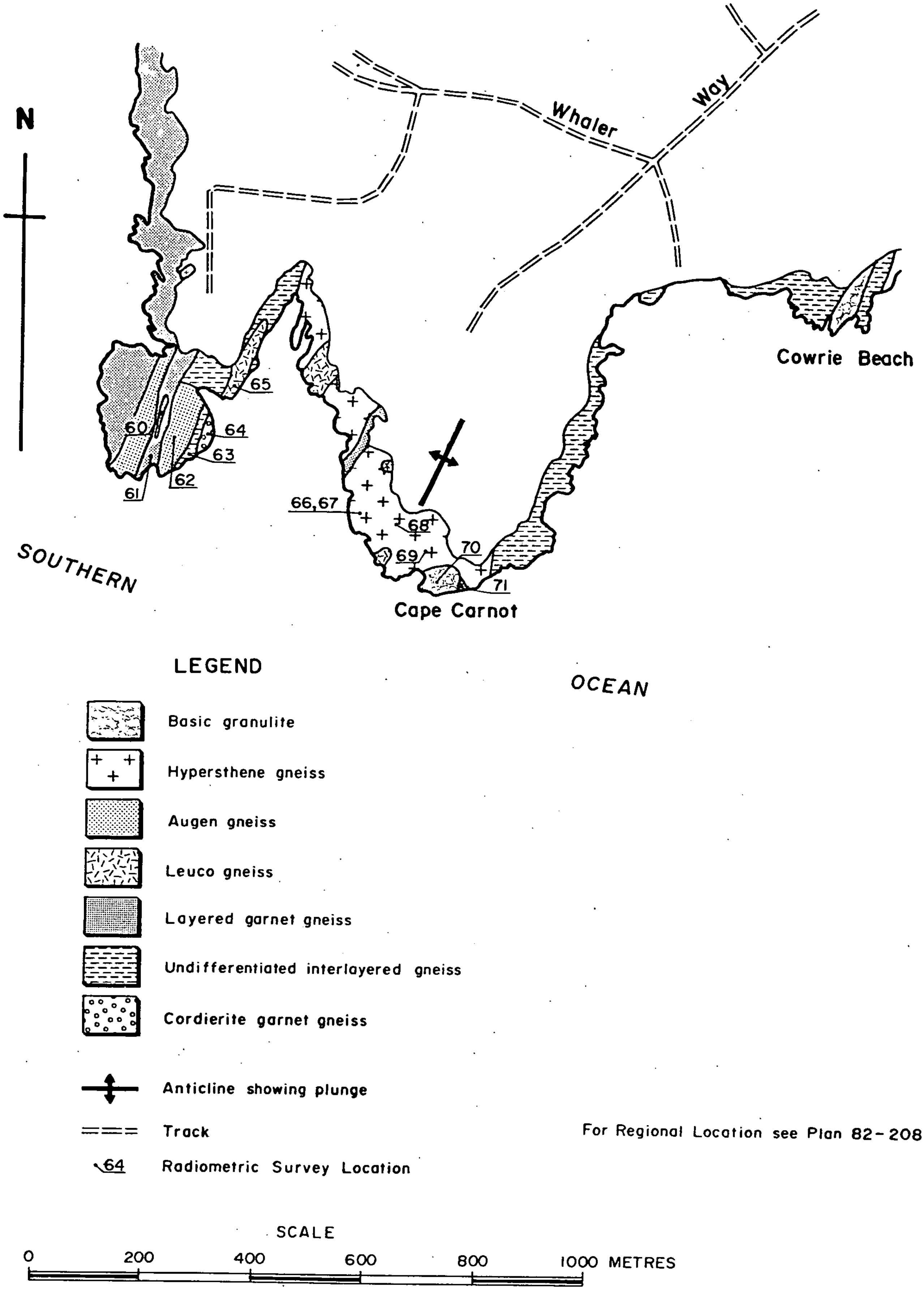
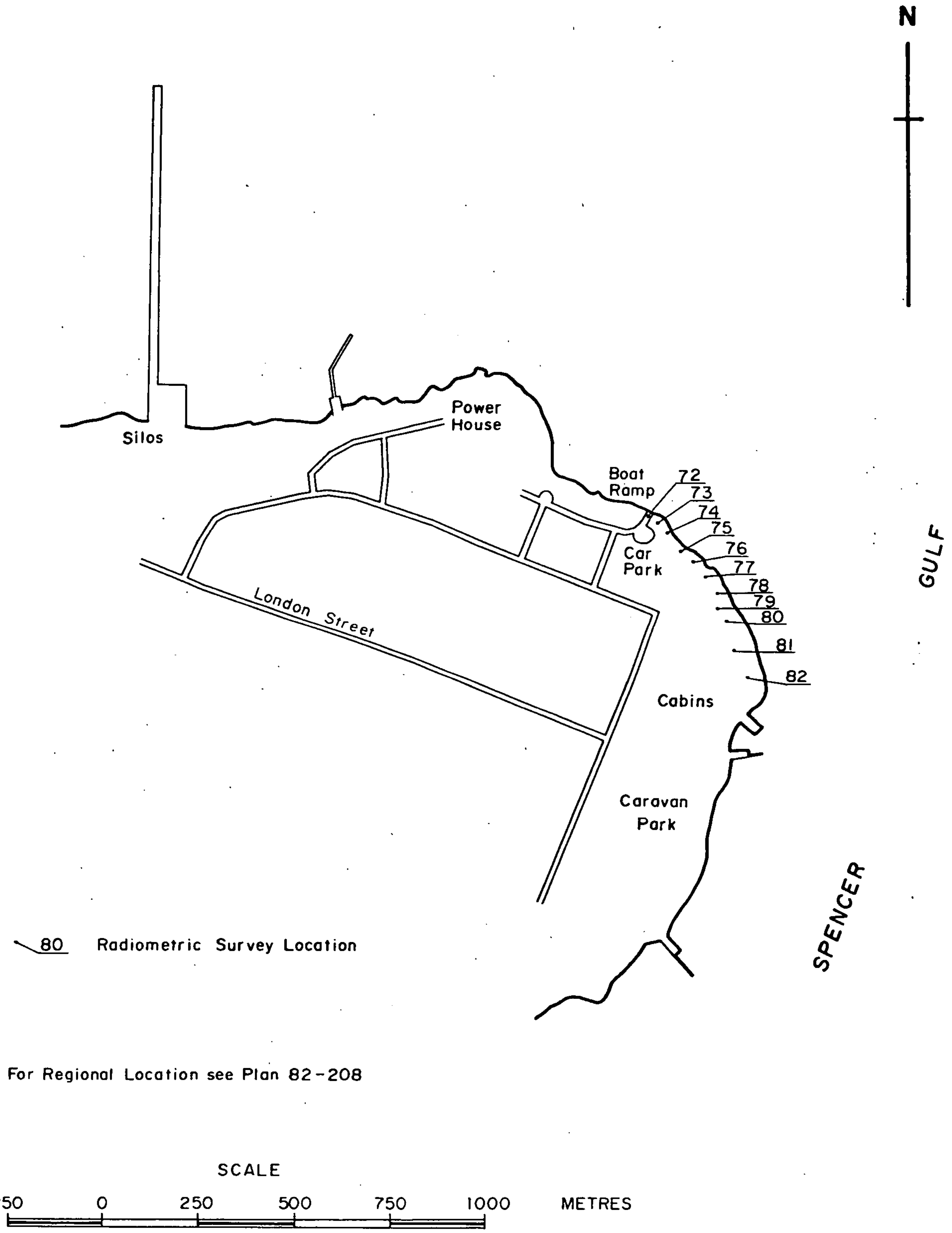


Fig. 7

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. M.	C.D.O. 13·7·82 DATE
RADIOMETRICS OF THE GAWLER CRATON	DRAWN M.B.	SCALE 1:10 000
SOUTHERN - MOST EYRE PENINSULA	DATE May '82	PLAN NUMBER
GEOLOGY AND RADIOMETRIC SURVEY LOCATIONS	CHECKED	S 16181



For Regional Location see Plan 82-208

Fig. 8

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
KIRTON POINT
RADIOMETRIC SURVEY LOCATIONS

COMPILED R. M.	13·7·82 C.D.O. DATE
DRAWN M.B.	SCALE As Shown
DATE May '82	PLAN NUMBER
CHECKED	S16182

2776

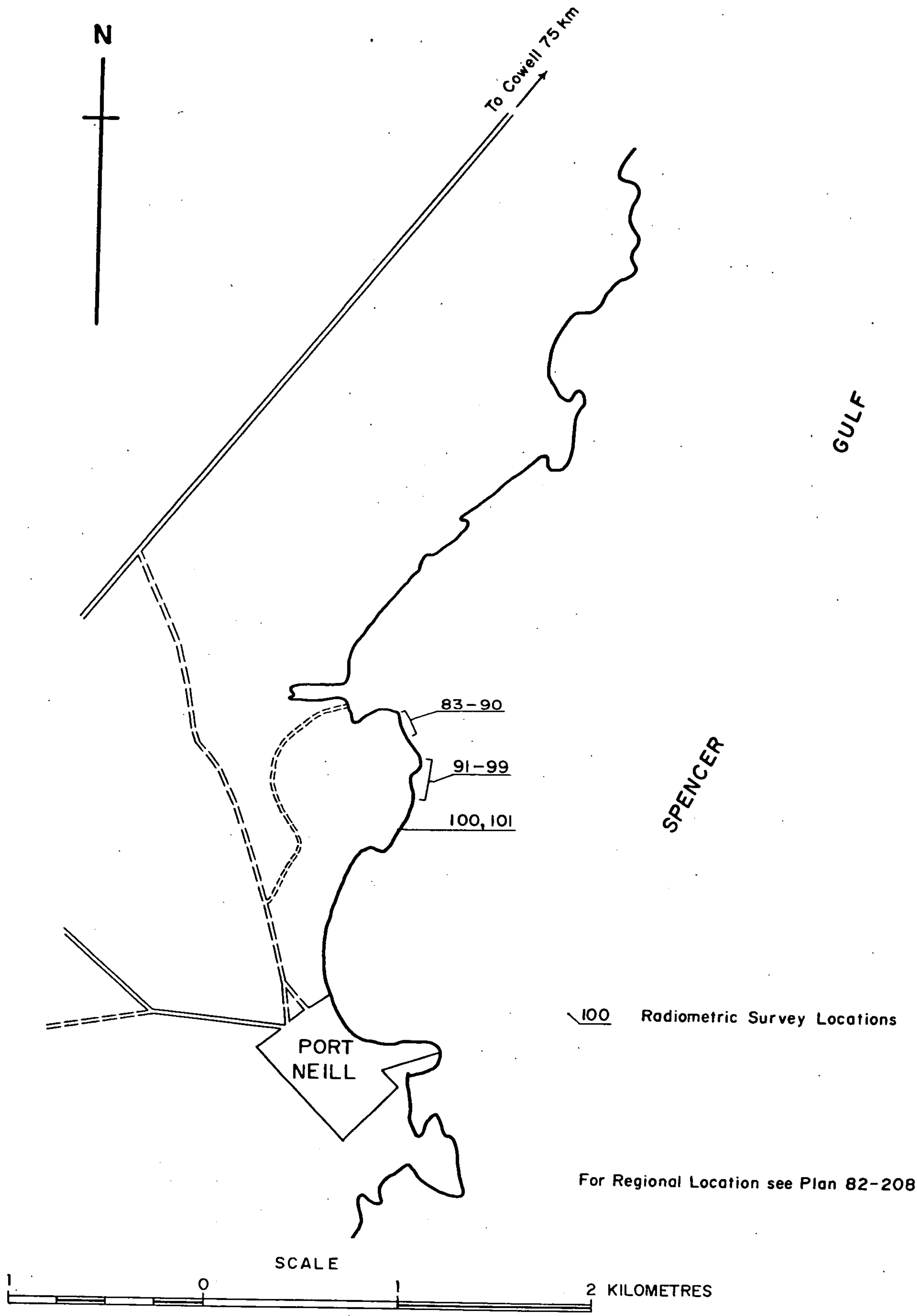
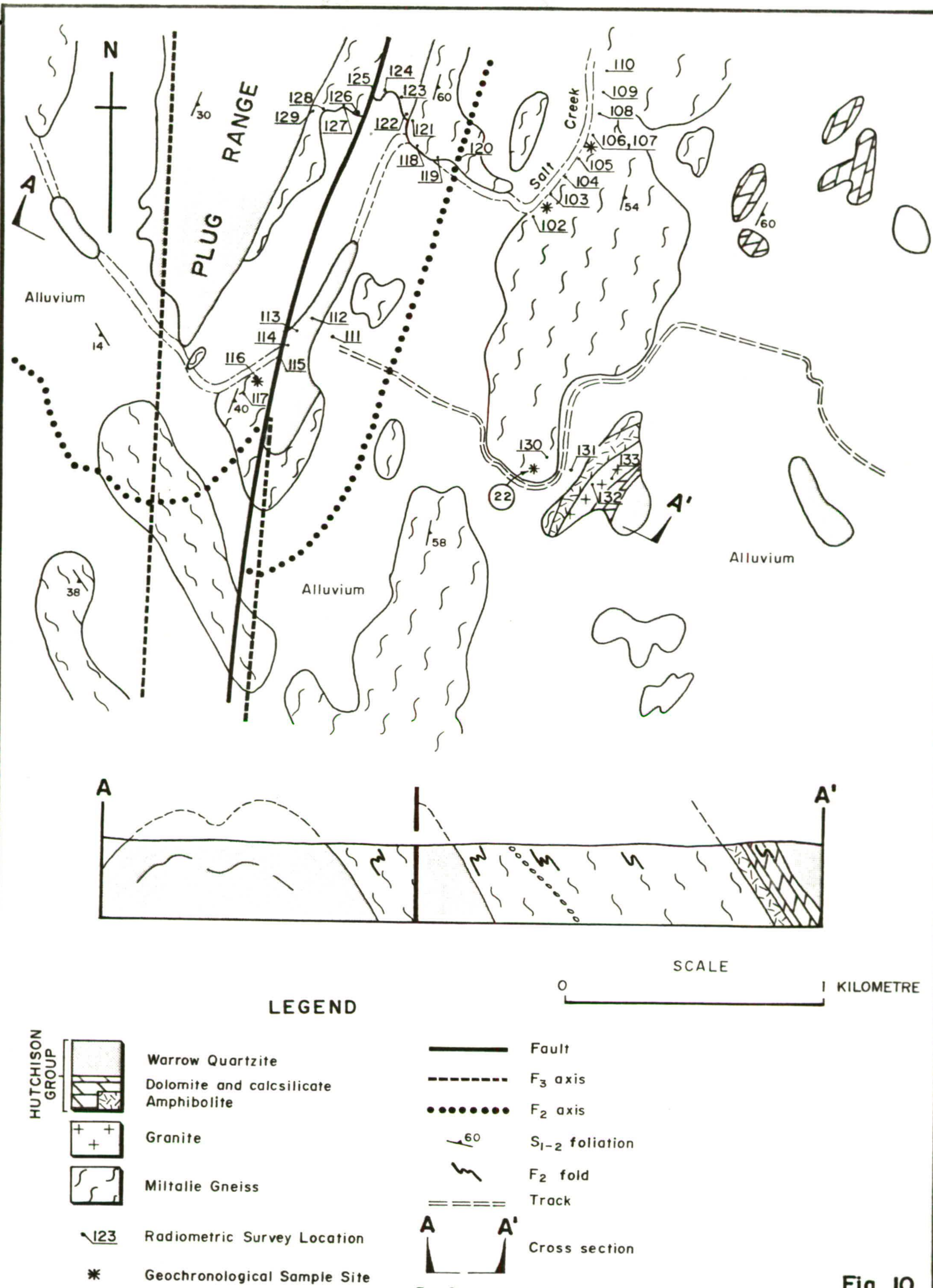


Fig. 9

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.M.	13·7·82 C.D.O. DATE
RADIOMETRICS OF THE GAWLER CRATON	DRAWN M.B.	SCALE As Shown
PORT NEILL	DATE May '82	PLAN NUMBER
RADIOMETRIC SURVEY LOCATIONS	CHECKED	S16183



For Regional Location see Plan 82-208

Fig. 10

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. M.	13 · 7 · 82 C.D.O DATE
RADIOMETRICS OF THE GAWLER CRATON	DRAWN M.B.	SCALE As Shown
PLUG RANGE	DATE May '82	PLAN NUMBER
GEOLOGY AND RADIOMETRIC SURVEY LOCATIONS	CHECKED	S16184

2776

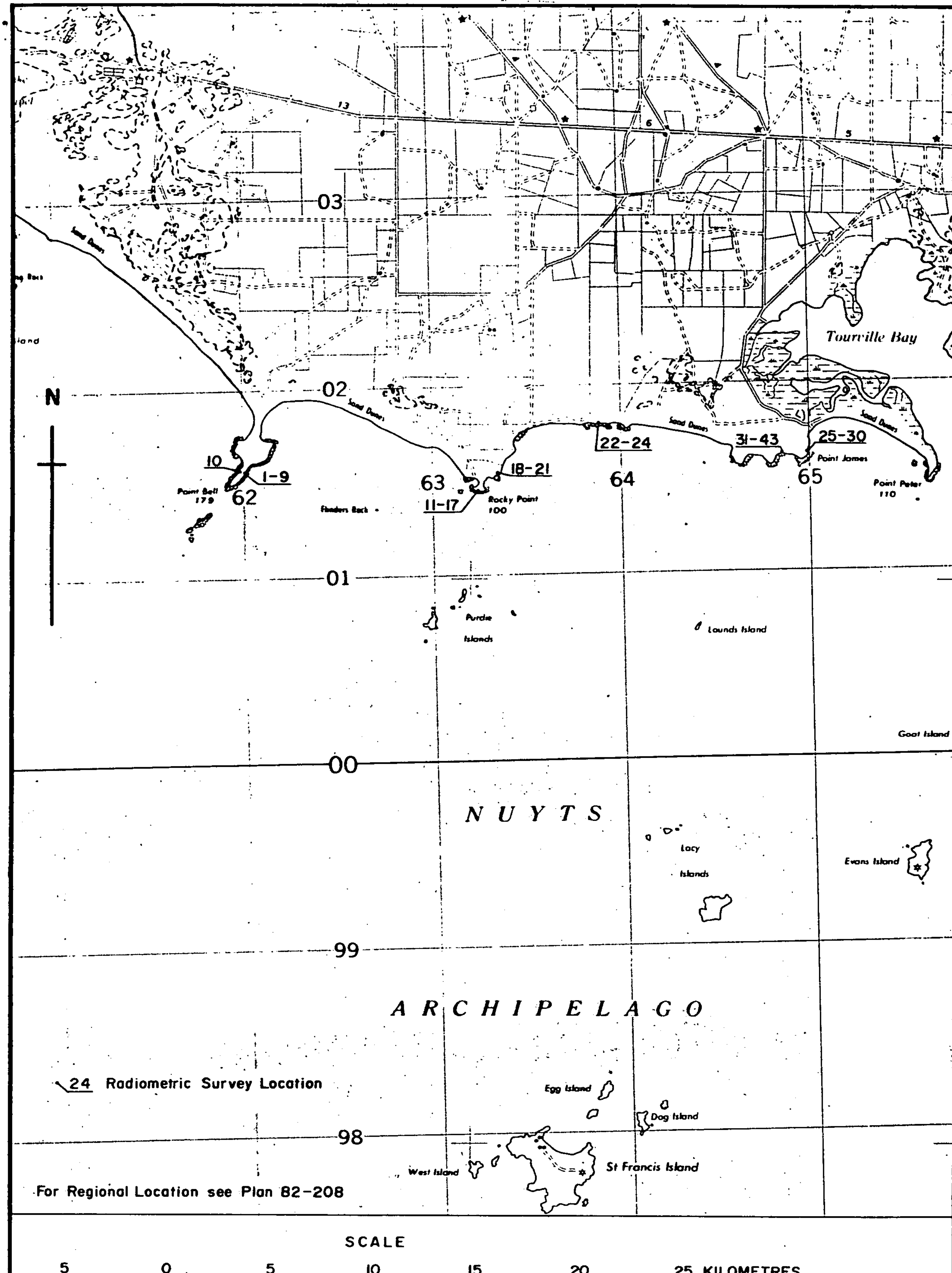
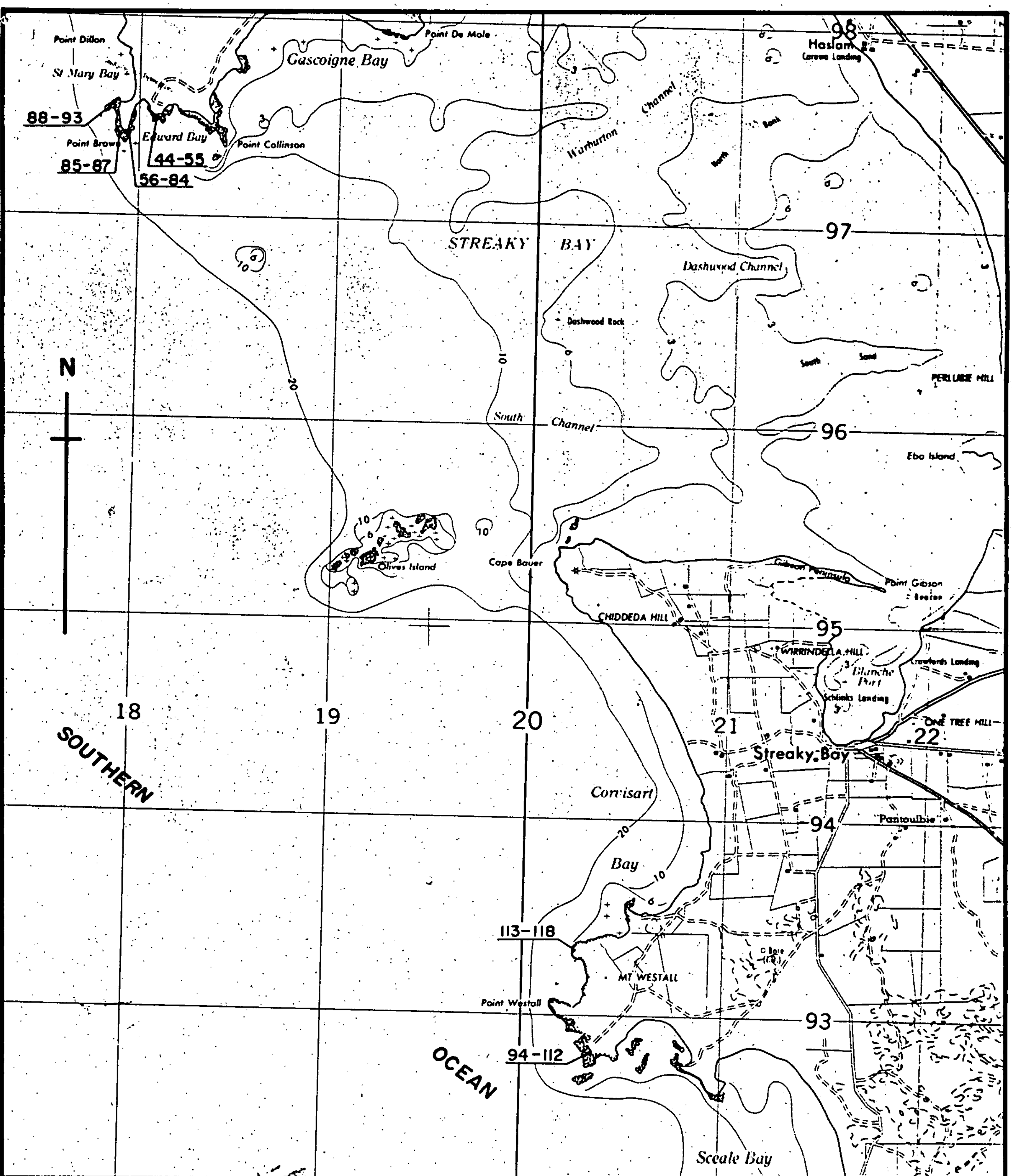


Fig. II

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R. M.	13 · 7 · 82 C.D.O. DATE
RADIOMETRICS OF THE GAWLER CRATON CHARRA RADIOMETRIC SURVEY LOCATIONS	DRAWN M. B.	SCALE 1 : 250000
	DATE May '82	PLAN NUMBER S16185
	CHECKED	

2776



113 Radiometric Survey Location

SCALE

5 0 5 10 15 20 25 KILOMETRES

For Regional Location see Plan 82-208

Fig. 12

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
STREAKY BAY
RADIOMETRIC SURVEY LOCATIONS

COMPILED R. M.	C.D.O. 13·7·82 DATE
DRAWN M. B.	SCALE 1:250 000
DATE May '82	PLAN NUMBER
CHECKED	S16186

2776

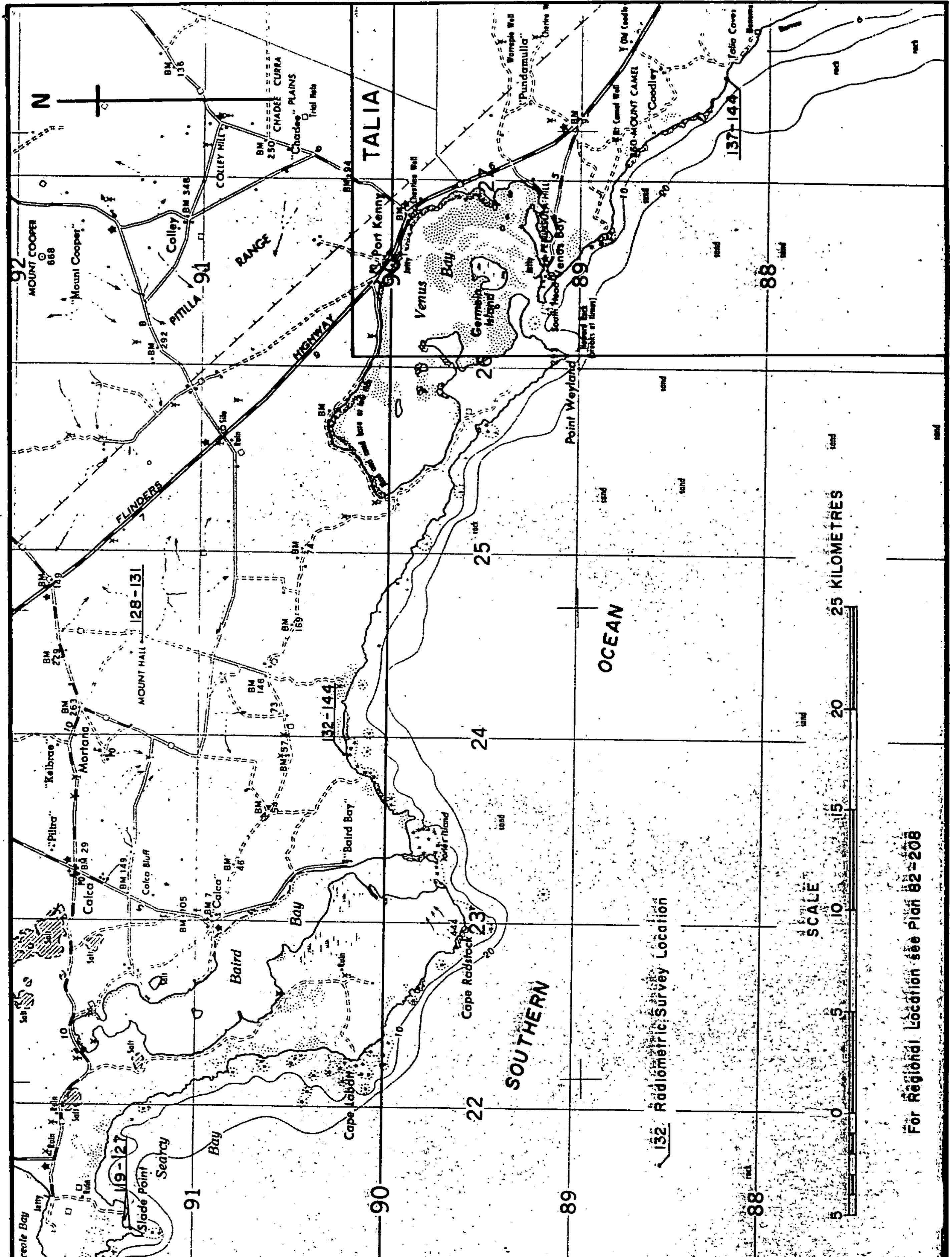


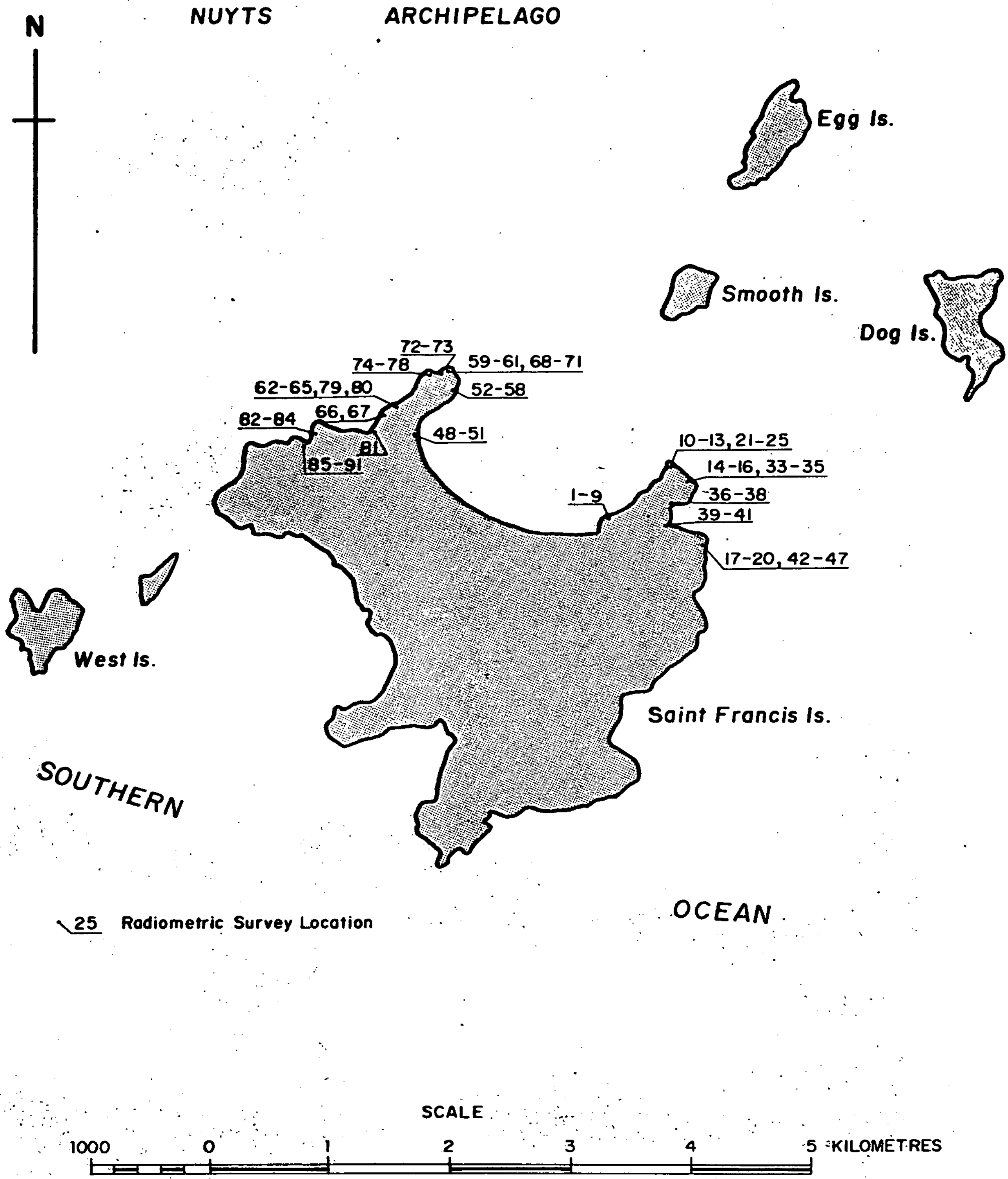
Fig.13

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

RADIOMETRICS OF THE GAWLER CRATON
RADSTOCK AND TALIA
RADIOMETRIC SURVEY LOCATIONS

COMPILED	R.M.	C.D.O.	DATE 13·7·82
DRAWN	M.B.	SCALE 1:250 000	
DATE	May '82	PLAN NUMBER	S16187
CHECKED			

2776



For Regional Location see Plan 82-208

Fig.14

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED R.M.	*(signature)* 13·7·82 C.D.O. DATE
RADIOMETRICS OF THE GAWLER CRATON	DRAWN M.B.	SCALE 1:50000
SAINT FRANCIS ISLES	DATE May '82	PLAN NUMBER
RADIOMETRIC SURVEY LOCATIONS	CHECKED	**S16188**

2716