DEPARTMENT OF MINES
SOUTH AUSTRALIA

INVESTIGATION OF RADIOACTIVE ANOMALIES BY VEHICLE MOUNTED SCINTILLOMETER

REPORT NO. 1

TESTING EQUIPMENT OVER KNOWN PHOSPHATE DEPOSITS

ORRORO AND BURRA

by

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ABSTRACT

In connection with the search for phosphate deposits a survey was carried out over portions of ORRORROO and BURRA. Areas were selected for two purposes, firstly it was desired to test the equipment over known phosphate deposits, and secondly to investigate areas of anomalous radioactivity detected by airborne scintillometer. After consideration of the results some modifications have been carried on to the instruments, and more detailed surveys recommended in some areas.

INTRODUCTION

It is known that some phosphate deposits contain significant amounts of uranium which can be detected by means of a scintillation counter. During June, 1967, a survey was carried out in three separate areas using a vehicle mounted scintillometer. The purpose of this survey was to check the reliability and sensitivity of the instrument, establish an efficient method of reconnaissance prospecting, examine the radioactive intensity of some known phosphate deposits, and fix more accurately the position of anomalies located by the airborne scintillometer. The areas selected were between Orroroo and Tarcowie; immediately south of Yongala; and Gladstone-Georgetown-Crystal Brook. (Plan Nos. 67-791, & 67-792,

S6226 &56227; 67-789 and 67-790.

Orroroo- Tarcowie

This area contains a number of phosphate deposits and there exists a good network of roads and tracks crossing the relevant geological formations. A report by the Bureau of Mineral Resources on the Orroroo-Parachilna Airborne Magnetic and Radiometric survey indicates that the intensity of the airborne radiometric measurement is generally of low relief over the known deposits. This survey was flown at a height of 500ft. and from these results it would seem only weak anomalies should be detected on the ground.

Yongala

In this location a fairly intense radioactive high was obvious from the airborne scintillometer results. It was anticipated that a ground survey would indicate whether this anomaly was real or an instrument fault, and if real accurately locate the anomaly on the ground.

Gladstone-Georgetown-Crystal Brook

The airborne radiometric profiles across this area are highly active. There are numerous highs of varying intensity on several flight lines. Again it was hoped to locate the anomalies more accurately, relate them to geological features, and obtain some measure of comparison between the intensity as recorded at 500ft., the intensity at ground level, and the phosphate content.

The three areas were covered in five days with 240 traverse miles of recording.

GEOLOGY

The areas worked in have been mapped by officers of the Department of Mines and The Zinc Corporation. In particular BURRA has been published and ORRoROO has been mapped and is in course of preparation. The Zinc Corporation mapping was in connection with the phosphorite deposits in the Orroroo district and was reported upon by W.A. Brook in 1962.

The area covered consisted of rocks of the Adelaide system which were mainly covered by soil. The main outcrop encountered was revealed in road cuttings or excavations. Some minor deposits of phosphate have been mapped and these have been worked from time to time.

PREVIOUS GEOPHYSICAL WORK

The area has been covered by the airborne group of the Bureau of Mineral Resources. The two sheets ORRoROO and BURRA were flown at a height of 500ft. with flight line spacing of one mile. Continuous profiles were obtained of magnetic and radioactive intensity. The magnetic data were reduced by the female computers of the South Australian Department of Mines, who also replotted the radiometric profiles.

METHODS USED

The scintillometer consisted of a 4½ inch diameter sodium iodide crystal with a photo-multiplier, connected through

amplifiers and noise filters to a ratemeter. The E.H.T. supply to the photo-multiplier was derived from a D.C. converter operating on dry batteries. Apart from the photo-multiplier and glow tube regulator in the E.H.T. supply the whole unit was transistorized. The output from the ratemeter was fed to the input of the Both recorder amplifiers which amplified the signal to operate two pen recorders, at differing sensitivities. The paper drive was operated directly from the vehicle gearbox, thus relating the record directly to distance. A gearbox on the recorder provided final drive ratios from 0.25 inches of paper per one mile of traverse to 200 inches of paper per one mile of traverse.

The sensing head was placed behind the passenger seats in the rear of the Land Rover. It was approximately four feet above the ground. An attempt was made to select tracks which crossed the strike of the beds and these traverses were marked on photo-mosaics. Outstanding landmarks were marked on the mosaic and a fiducial marked on the record. These fiducials were labelled according to traverse number and event number. Generally the events were marked at intervals of approximately one mile and where possible were related to such permanent features as bends in the road.

Wherever possible the vehicle was kept at a constant speed of 15-20 m.p.h. The crew consisted of two men, one who drove and marked mosaics, whilst the other marked the record and observed operation of the scintillometer.

RESULTS

Profiles along traverses are not included in this report, but are held in the Geophysics Exploration Section. Whilst examining these profiles it was necessary to adopt some criterion to separate significant anomalies from background count. This background was relatively high and tended to obscure weak anomalies. Over the course of a day a broad regional and instrumental drift could be recognized and removed, but in addition there remained a noisy random effect. An average of this background was then estimated as was the standard deviation from this value. The anomalies were then graded by relating their amplitude to this standard deviation. A grade I anomaly was considered to have an amplitude three times the standard deviation, or grade II anomaly to be twice the amplitude of a grade I etc.

The width of an anomaly was defined as being the width at one half of the peak amplitude.

To present the results the traverses and event marks were transferred to Aeromagnetic maps and the anomalies were marked.

Orroroo-Tarcowie

A total of 89 miles were traversed in this area (Plan No. 67-791 and 67-792). All were along roads and tracks except for a short traverse across a phosphate deposit immediately southwest of Orroroo (Traverse No. 2A Event No. 2-3). Across this deposit there is a broad anomaly of grade 1-2 whereas about one mile to the west there is a grade 3-4 anomaly (Traverse No. 2A Event No. 4).

An area of possible economic interest was located three miles southwest of Tarcowie (Traverse 2F Events 21 to 23). A grade 3 anomaly appears to be associated with material which assayed 26.6 percent P_2O_5 and 110 p.p.m. uranium (AMDEL). It may be possible to correlate this deposit with a series of anomalies across the same formation some four miles to the north.

A further series of anomalies (grades 1-1½) are located east of Pekina (Traverse 1A, 2C and 2C Events 13, 11, and 9 respectively). These occur over the Tapley Hill Slates near the contact with the Tindelpina member. This again is in a similar position to the known phosphate deposit near Orroroo.

All other anomalies are small in width and intensity. It is probable that they are related to small sources on or near the roads.

Yongala

Twenty five miles were traversed in this area and two radioactive zones delineated (Plan Nos. S6226 and S6227). These zones coincide with anomalies detected along one flight line during the airborne survey, but extend on the ground over the path of two other flight lines on which no significant anomalies are evident. One of these anomalies tends to follow trends in the Saddleworth Formation (Traverse Nos. Y3, K3 and Y1 Events Nos. 5-6, 7-8 and 5 respectively), whilst the other is on the Tindelpina member of the Tapley Hill slates.

All other anomalies are small which again suggests that they are related to discrete sources, and are probably not of interest in the search for phosphate.

Gladstone-Crystal Brook

In this area 122 miles were traversed (Plan Nos. 67-789 and 67-790), but no consistent relationship between airborne and ground radiometrics could be detected. A broad and intense high located southeast of Crystal Brook (Traverse 5P Events 1 to 3) probably originates from ballast used on the railway which was drawn from the Radium Hill crushings. Two anomalies which do coincide with the airborne survey are located near Crystal Brook. One lies in the town itself (Traverse No. 4L Events No. 13-14) and the other is some two miles to the east (Traverse No. 40 Event Nos. 3 to 5), both are of grade 2. Immediately east of Georgetown another anomaly on the ground (Traverse No. 4G Events Nos. 13 to 15) of grade 1-2 appears to coincide with an anomaly detected from the air. The only relationship between increased radioactivity and type of formation seems to be associated with the Wirrabanna Formation. Wherever traverses crossed this formation, there was an increase of radioactivity. In particular there exists a broad intense anomaly of grade 3 on Traverse No. 4N Events 2 to 4 . The only other anomaly of interest is that located approximately two miles southwest of Gladstone (Traverse No. 4M Events Nos. 2 to 4) of grade 1-2. This is over the Quaternary and Recent alluvium plains.

CONCLUSIONS AND RECOMMENDATIONS

Instrument

If the background noise level of the instrument could be

reduced then the significance of the weaker anomalies would become more apparent. This prdiem can be approached in two ways. Firstly in order to increase the signal to noise ratio of the output from the photo-multiplier, it is proposed to decrease the time constant on this output. This will have the effect of attenuating any photo-multiplier noise which is of lower frequency. Secondly, the time constant of the recorder amplifiers can be varied to vary the sampling rate. At this point an increase in time constant would reduce the standard deviation of the background but would also result in a reduction of overall sensitivity. This would be of value in showing general radioactive trends and defining the larger anomalies. A short time constant on the other hand, would be useful in locating small relatively intense sources since the background noise and sensitivity would both be high. In order to obtain the best estimate of radioactivity it is proposed to feed the signal into four pen recorders each with a different time constant. Comparison of the records should then enable the operator to arrive at a better radiometric map than was possible previously.

The positioning of the detector head would seem to be too low. If this can be elevated, a greater lateral area would be sampled. It would also lessen the effect of variations in radioactivity associated with the road metal. Thus the measurement of radioactivity would relate more closely to the formation which is being traversed. It is proposed to mount the head on a boom fixed to a Land Rover. This will place it approximately eight feet above the ground.

Method of traverse location

The method used in which vehicle position was related to photo-mosaics seems to be acceptable in the areas covered by this survey. Some difficulty could arise however where no tracks exist and the ground is of low relief. In these areas it will probably be necessary to work on pegged grids or by compass bearing.

Detection of phosphate bodies

It is apparent from the results obtained in the Tarcowie-Orroroo area that there is an abnormal amount of radioactivity associated with the known phosphate. The intensity recorded was at least twice as great as that recorded in the near vicinity. Thus it would seem that this method could form the basis of a reconnaissance survey in the preliminary part of any exploration programme. It should be noted, however, that not all phosphate deposits are radioactive and that substantial deposits could be overlooked if too much reliance is placed on this method.

Location on ground of anomalies detected by aerial scintillometer

In many instances the anomalies located by the airborne scintillometer have not been detected by the vehicle mounted instrument. This could probably be due to the vehicle instrument not being close enough to what must be a relatively localized source. Some of this problem will be overcome by mounting the detector head on a boom as described earlier. In some cases it is possible that the road is not close enough to the source of the anomaly and that some work will have to be done in the paddocks. It is likely that

such limited anomalies are of little significance in the search for phosphates.

Further Exploration

Tarcowie-Orroroo

It is recommended that additional detailed surveys be carried out over the favourable host beds in this area. This should be done by hand held scintillometer probably in conjunction with a geochemical sampling programme.

Yongala Area

In view of the fact that the anomalies detected here are of similar intensity to those associated with the known phosphate deposits near Tarcowie, and also that the eastern anomalous zone is associated with the same Tapley Hill Formation, it is considered that these anomalies merit further investigation. It is recommended that the area be examined by a geologist and that, depending on his report, further detailed radiometric and geochemical prospecting be carried out.

Crystal Brook-Gladstone

Again a number of broad anomalies have been located which could be associated with phosphate deposits. In particular the anomaly over the Wirrabarra Formation (Traverse No. 4N, Event No. 3) should be carefully examined. If any of these areas prove to be significant with respect to phosphate content, further detailed work should be carried out using the hand held scintillometer.

General Conclusions

Most of the difficulties encountered in this preliminary study can be overcome. The proposed modifications to the instrument will result in better sampling of the count data and improved presentation on the charts. Some problems are more fundamental and must be considered when planning future surveys. As mentioned before, all phosphate deposits do not contain uranium so this method does not provide an absolute test of the presence or absence of phosphates. Also if the phosphate is covered by more than a foot of overburden it is possible that even a significant deposit could be undetected. It is apparent that the method is more applicable to outcrop than soil covered areas. Care must be taken to relate the radiometric data to the geological features. It is feasible that a variation of thickness in soil cover could produce a broad anomaly similar to those produced by phosphate deposits. Also some rock types are, in themselves, more likely to be radioactive, and an apparent anomaly could be due to a change of rock type. Thus it is evident that this scintillometer should be used with great care and results studied very carefully by a geologist. Within certain limitations it is an extremely useful tool particularly for rapid initial prospecting.

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BJT:CM:SA
14.12.1967

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ORROROO 4 mile Geological Map. S.A. Dept. of Mines. Geology P. Binks (In course of preparation).

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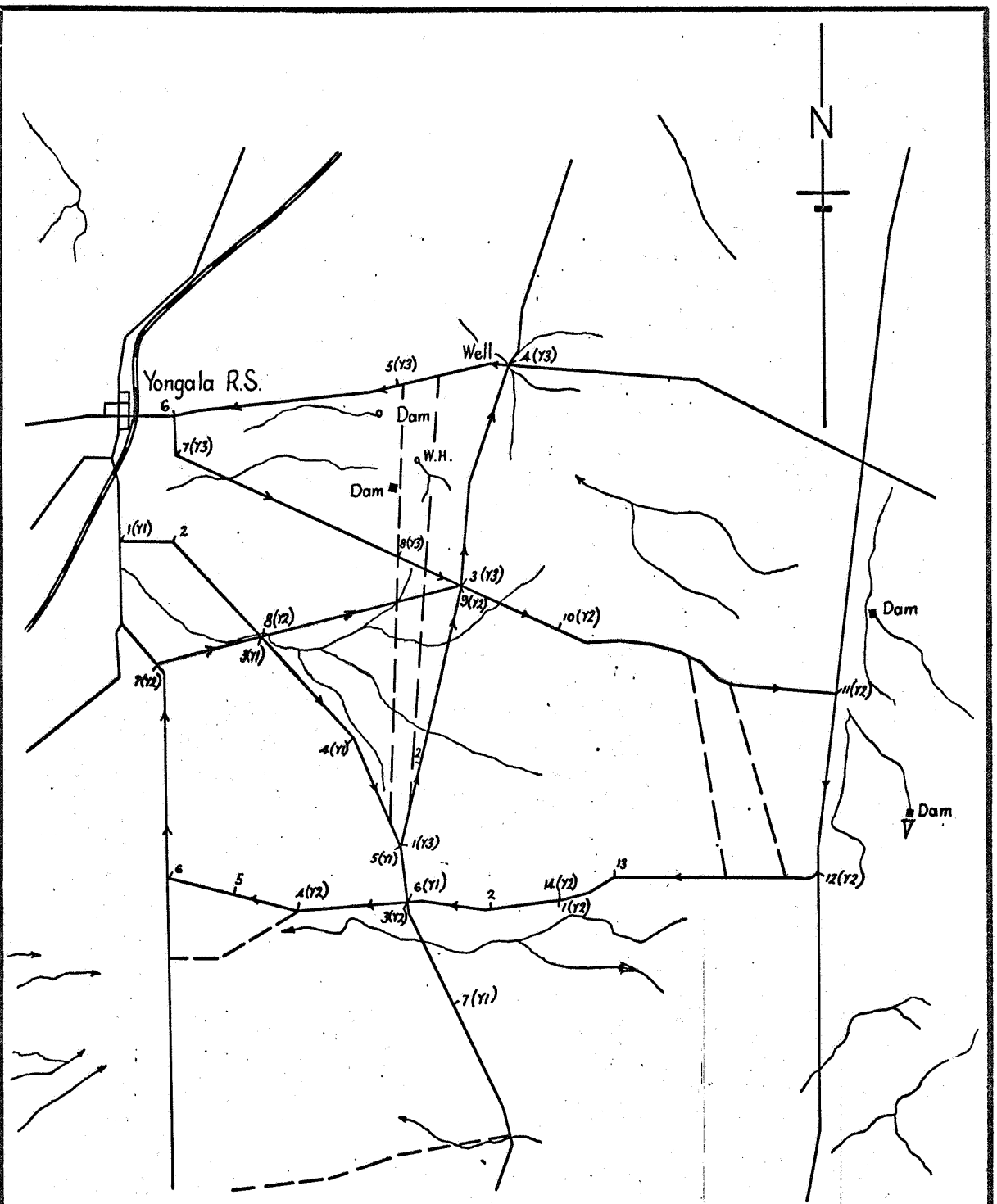
ORROROO-PARACHILNA Airborne Magnetic and Radiometric Survey, South Australia 1965. Bureau of Mineral Resources Geology and Geophysics. Record No. 1965/229 by D.B. Tipper and W.A. Finney.



Mobile Scintillometer Traverse

4(Y2) Event number and traverse number

For positions and intensities of Radioactivity see plan Nº S6227

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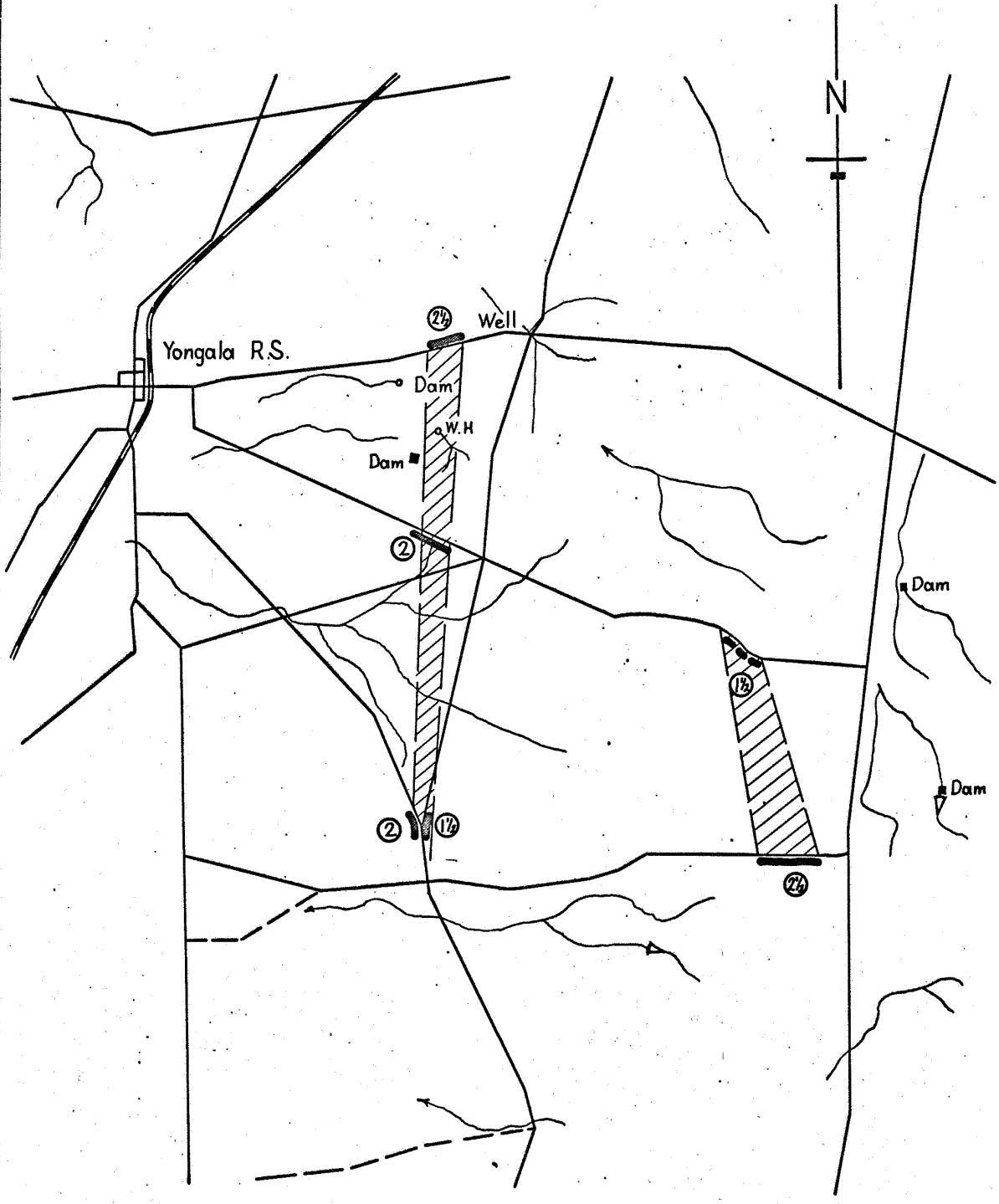
EXPLORATION GEOPHYSICS SECTION	Drn. B.T. Tcd. R.H. Ckd. L.V.W. Exd.	YONGALA AREA SCINTILLOMETER TRAVERSES AND POSITIONS OF EVENTS	SCALE: 1inch = 1mile S6226 FG DATE: 13·11·67



Radioactive anomaly

1½ Relative intensity of Radioactivity

Probable anomalous zone

For Scintillometer Traverses and positions of events see plan Nº S6226

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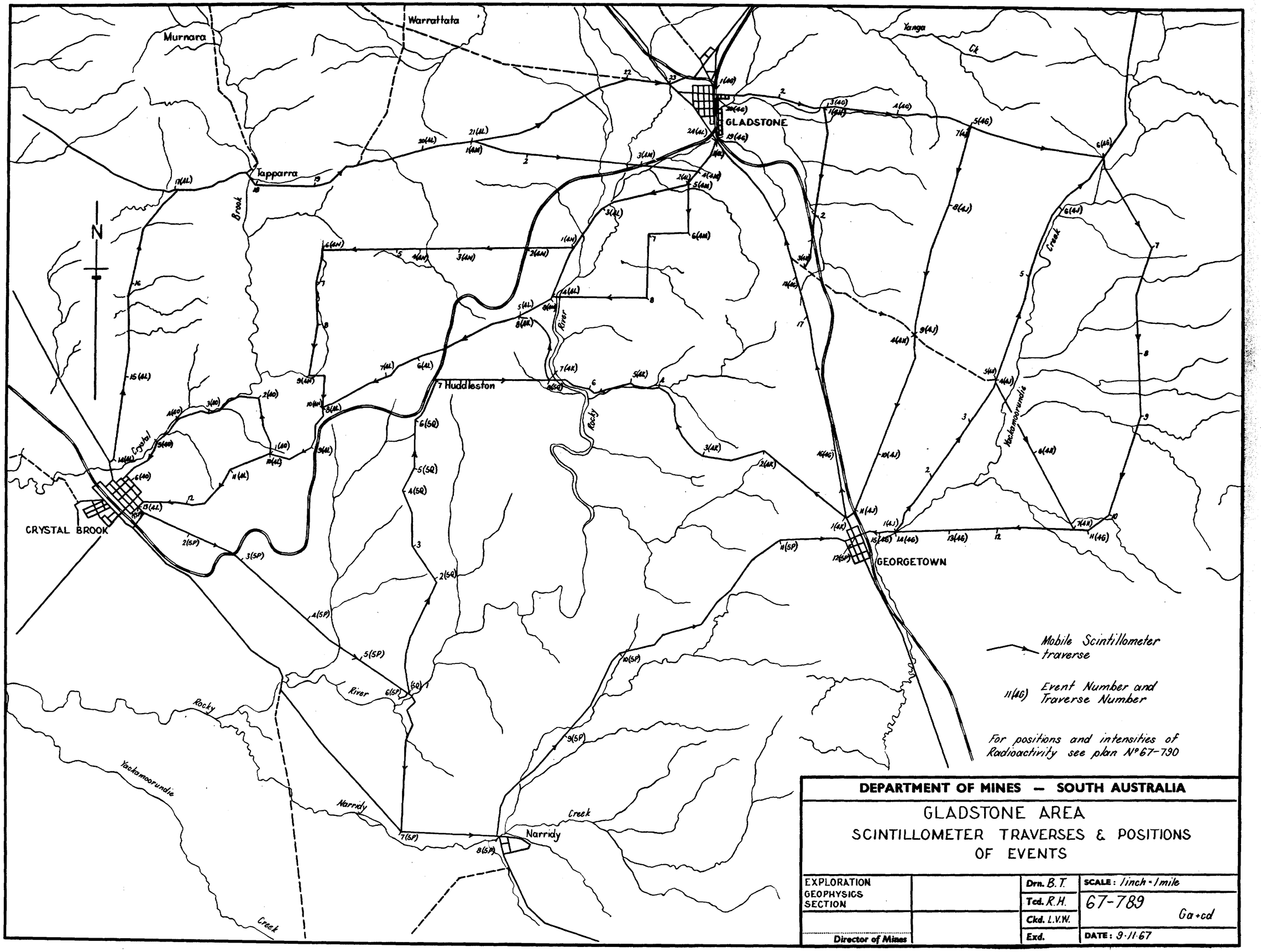
EXPLORATION GEOPHYSICS SECTION	Drn. B.T.	YONGALA AREA	SCALE: 1inch = 1mile
	Tcd. R.H.	POSITIONS & INTENSITIES OF RADIOACTIVITY	S6227 FG
	Ckd. L.V.W.		
	Exd.		DATE: 14·11·67



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GLADSTONE AREA
SCINTILLOMETER TRAVERSES & POSITIONS OF EVENTS

EXPLORATION GEOPHYSICS SECTION		Drn. B.T.	SCALE : 1inch = 1mile
		Tcd. R.H.	67-789 Ga+cd
		Ckd. L.V.W.	
Director of Mines		Exd.	DATE : 9.11.67

SCALE IN CHAINS

80 0 80 160 240 320 400 480

1000 0 5000 10000

SCALE IN METRES

18

Warrattata
Murnara
Tapparra
Brook
Pisant Ck.
Yanga Ck.
GLADSTONE
Creek
Huddleston
River
Rocky
Crystal
CRYSTAL BROOK
Yackamoorundie
Narridy
Creek
GEORGETOWN

Radioactive Anomaly

Small Source Anomaly

② Relative Intensity of Radioactivity

For Scintillometer Traverses and positions of Events see plan Nº 67-789

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GLADSTONE AREA
POSITIONS AND INTENSITIES OF RADIOACTIVITY

EXPLORATION GEOPHYSICS SECTION		Drn. B.T.	SCALE: 1 inch = 1 mile
		Tcd. R.H.	67-790 Ga+cd
		Ckd. L.V.W.	
Director of Mines		Exd.	DATE: 10·11·67

N

Orroroo

△ Pekina Hill

Yackama Creek

Wepowie Creek

Pekina Creek

Pekina

Mucra Hill

Black Rock

Black Rock

△ Maurice Hill

Hogshead Hill

Minvalara R.S.

Erupa Creek

Yatina

Tarcowie

Mobile Scintillometer Traverse

8(2F) Event number and Traverse number

For positions and intensities of Radioactivity see plan No 67-792

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TARCOWIE - ORRORO AREA

SCINTILLOMETER TRAVERSES AND POSITIONS OF EVENTS

EXPLORATION GEOPHYSICS SECTION		Drn. B.T.	SCALE : 1inch = 1mile
		Tcd. R.H.	67-791
		Ckd. L.V.W.	Fjk
Director of Mines		Exd.	DATE : 10·11·67

Orroroo

△ Pekina Hill

N

Yadlena Creek

Wepowie Creek

Pekina Creek

Pekina

Black Rock

"Black Rock"

Mucra Hill

△ Maurice Hill

Hogshead Hill

Minvalara R.S.

Yatina Creek

Erupa

Tarcowie

Radioactive anomaly

Small Source anomaly

Relative intensities of Radioactivity

For Scintillometer traverses and positions of events see plan N° 67-791

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TARCOWIE - ORRORO AREA

POSITIONS AND INTENSITIES OF RADIOACTIVITY

EXPLORATION GEOPHYSICS SECTION		Drn. B.T.	SCALE: 1inch - 1mile
		Tcd. R.H.	67-792 Fjk
		Ckd. L.V.W.	
Director of Mines		Exd.	DATE: 13-11-67