RB 33/64

DEPARTMENT OF MINES.

SOUTH AUSTRALIA.

JEEP MOUNTED SCINTILLOMETER SURVEY FOR COPPER LODES.

WALLAROO-MOONTA AREA.

by

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GEOPHYSICAL REPORT NO. 3/52

ASSOCIATED PLANS L 52-17
52-99
52-192

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Introduction:

A radiometric survey for copper lodes was carried out using a continuous recording instrument, in the Wallaroo-Moonta area during August-September, 1951 and January-February, 1952. The survey was carried out both from the air, using an airborne scintillometer, and with the same equipment mounted on a jeep. The results of the airborne survey are described in a report by the author earlier in this docket.

As a result of the survey four areas were selected for additional geophysical survey, two of which are completed and the reports on which are already filed in this docket.

Area.

The area prescribed for survey lay within the boundaries of "Special Mining Lease No. 1" of this district. It represents some 33 square miles of country and covers roughly the area between the Moonta and Wallaroo mining fields. The area is shown on the plan accompanying report.

The topography of the area is gently undulating with little relief; surface drainage is not apparent. The gentle nature of the topography made possible this type of survey.

Personnel.

The early part of the survey was carried out under the guidance of Dr. W. H. Gross, consultant geologist. After his departure for Canada the first part of survey was completed by the author. The remainder of the survey was completed, and the results coordinated into an overall plan by A.E. Tynam, a university student obtaining vacation experience with the Department.

The division of the survey into two parts became necessary due to the inability to traverse fields under crop during the first half of the survey, these having to be left until after harvest.

Geology.

The geology of this area is fully described in Bulletin No. 6 "The Geology of the Moonta and Wallaroo District" by R. Lockhart Jack; it may be summarised as follows:

The bedrock, of Pre-Cambrian age, consists of contorted and highly altered sediments. Into this complex has been intruded a felspar porphyry mass of assumed Pre-Cambrian age.

It is in this porphyry that the copper lodes of the Moonta mining district occur. These are orientated in a broad arcuate manner but the general trend is in the N-S direction.

The copper lodes in the Wallaroo mining district occur in the metamorphosed sediments and strike generally in an E-W direction.

Unconformably resting on the Pre-Cambrian complex are a number of isolated outliers of supposed Cambrian age. These sediments have suffered very little tectonic disturbance being in most cases very nearly horizontal.

However the geological feature of the area is the thick mantle of travertine and soil which almost completely masks the older series. This soil cover consists of "ancient soils" which are overlain by travertine and recent wind blown sands, the latter constituting the top soil cover.

Technique.

The use of an aerial scintillometer equipment mounted on a jeep was originally suggested by Dr. W. H. Gross, who was a consultant geologist to the Department in connection with aerial scintillometer surveys in 1951. The jeep-mounted survey was started prior to the airborne survey of the area, it being considered that the anomalies caused by cupriferous lodes or zones possibly only a few feet wide would be too detailed and insignificant to register on an aerial traverse even if flown at the relatively low altitude of 200 feet and low speed of 80 m.p.h. This indeed, proved to be so, the aerial survey defining only broad regions of greater activity which could be correlated with regions of porphyry intrusions.

The association of radio-active material with the copper lodes in this district is an established fact.(Geophysical Reports 2/48, 4/48, 6/48 and 65/48 by W. G. Fenner).

Gamma rays emanating from the radio-active material would result in "radio-active highs" on the surface which may be detectable by the scintillometer. It was hoped that by this means the presence of undisclosed lodes would be revealed.

However, as mentioned previously, an important feature of the area prospected is the mantle of soil and travertine which covers the older rocks. The effective range of gamma rays in such material is limited to a few feet and so, no great thickness of soil cover is necessary to prevent radiation originating directly from ore bodies reaching the detector. The method would therefore seem to be limited to such near surface cases if it were not for processes whereby shallow zones of radio-active material, derived from the more deep seated lodes provide an expression of them within the detecting range of the scintillometer.

These processes are speculative but nevertheless feasible, and the suppositions are supported in practice in some cases. They are:

(a) Surrounding the copper lodes are regions where traces of copper are to be found. These could exist as copper haloes within the country rock or as traces of copper in the residual soils overlying the copper lode and derived from it. The correlation of copper anomalies in the soil with lode formations during a geochemical survey of this region would seem to bear out the assumption.

In this regard the top soil cover and travertine beds would serve only as a blanket to the "ancient soils" and play no part in the contribution of copper anomalies, being unrelated genetically to bedrock. Since these rarely exceed a few feet in thickness they would not completely obscure the radio-active effect.

(b) During the process of radio-active decay certain of the radio-active disintergration products become mobile and move closer to the surface. These products would be in the form of soluble salts or the radio-active gas radon.

The transport of the soluble salts of uranium or its decomposition products done by the movements of ground water, while radon is transported either in solution or by gaseous diffusion or by a combination of both.

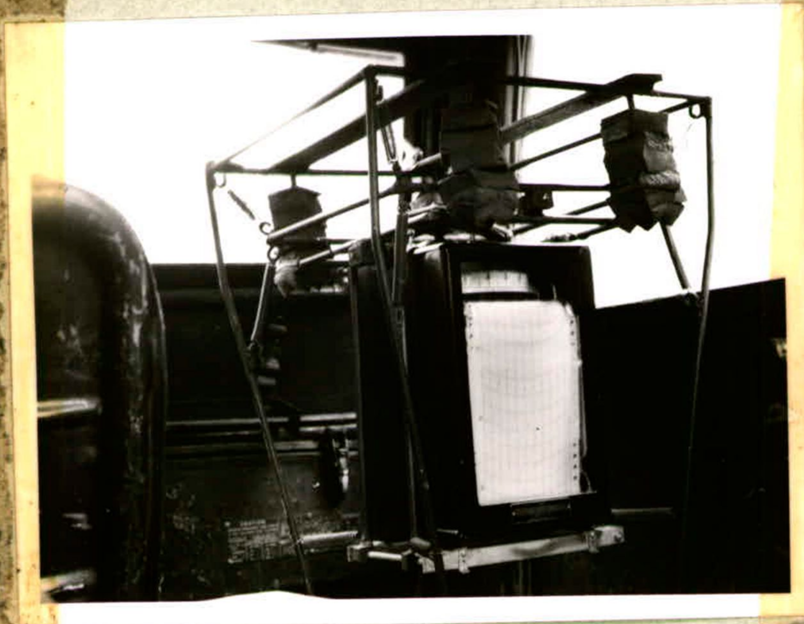

Fig. 1

However the gaseous diffusion of the radon gas can be prevented by a layer of wet clay and a further consideration is just how far it will diffuse in say, three times its half-life period (about ten days) when the majority of the gas would have disintegrated into the next lower member of the transition series which is solid.

In both (a) and (b) we must assume a vertical movement of the ground water i.e. a vertical rather than a lateral displacement of the "anomaly" by the ground water. In an area such as this, of flat topography and where the soil horizons are remarkably flat, the assumption is of reasonable validity.

The equipment used consisted of a standard airborne Scintillometer manufactured by Electronic Associates Ltd. of Toronto, Canada and adapted for operation by modifications to the jeep.

These modifications comprised elevating the detector head of the instrument to the end of a jib built on to the body of the jeep in order to increase the areal coverage in a traverse, and shock mounting the equipment to minimise the effects of the much greater vibration and irregular movement incurred ~~in movement~~ in a ground vehicle compared to an aircraft.

The detector head was mounted at the top of a jib built in front of the vehicle at a height of approximately twelve feet above the ground. It is generally assumed that the detector can pick up radiation from directions up to an effective 45° to 60° on either side of its axis. With the axis of the detector mounted vertically, this gives coverage over a strip 25 to 40 feet wide in a traverse. Traverses were normally run 100 feet apart, it being assumed that any significant body would be large enough to intersect at least one traversed strip. More closely spaced traverses were used to delineate any anomalies found.

In order to diminish the effect of jeep movement and vibration on the chart recorder this instrument already shock mounted for use in the aircraft was supported in a constrained gimbal type of suspension designed and constructed in the Department's workshops. This is shown in Fig. 1 The chart recorder was installed in the position normally occupied by the

Fig. 2.

Fig. 3

passenger seat, this was moved to the rear so that the operator could study the chart during the progress of the survey. The amplifier and power supply unit were mounted on standard aircraft shock mountings over the rear wheels on each side of the jeep. Fig. 2 shows the position of the amplifier and the operator's seat. A waterproof canvas cover was constructed for the detector head. Fig. 3 shows the jeep-mounted scintillometer in use.

The instrument comprises four main units, a power supply unit, a control and amplifier unit, the detector head, and an Esterline-Angus graph recorder, together with a push button switch on the end of an electric cable which can be used for making fiducial marks on the chart record by means of an auxiliary pen. The detector head consists of a 2" diameter Thallium activated sodium iodide crystal and a type 5819 photomultiplier tube; the pulses from the photomultiplier in the detector head are amplified, then passed through a discriminator which admits only pulses over a certain magnitude thus eliminating to a large extent the effects of electronic noise in the photomultiplier tube and amplifier, and finally passed through integrating and smoothing circuits to the chart recorder.

The resulting trace on the chart shows of course fluctuations due to the inherent random natures of radioactive disintegration and of cosmic rays, and other changes due to the variation of radioactivity caused by leaching in watercourses or variations in the soil and underlying rock in the content of uranium, thorium or potassium. The latter type of variation can usually be recognised by a slight variation in the general level of the reading; for instance in many cases small creek beds or watercourse are indicated by a minor dip in the reading, and likewise sand drifts are indicated by a lower general reading. In assessing the results account must be taken of these facts; only increases above the general level which persist across two or three traverses are considered worth further exploration. Since the effects sought are only of the order of the general "noise" level on the record, radioactive zones buried by even slight sand cover will be completely masked by it, and this method cannot hope to locate them.

To eliminate variation in the amplifier gain of the instrument the jeep was driven to a fixed locality daily before operation and the general level adjusted to 0.8 milliamperes reading on the chart scale. This setting was checked again in the middle of the day and again at the conclusion of work for the day.

Results.

A correlation between cupriferous material and radio-active anomalies was made in traverses through the mined area and near dumps. The anomalies obtained were due to mined material scattered on the surface, and in magnitude were of the order of three to four times background, i.e. the lode material was radio-active but not to any great extent. It was not possible to find a traverse across a known lode where the radio-active count was not affected greatly by scattered surface debris from the mines. Further, this waste material was found scattered throughout the mined area both at Moonta and Wallaroo Mines, and together with the tailing dumps gave rise to high but irregular counts. This made the survey of the mined area impracticable and it was early abandoned.

For the presentation of results a map was drawn with contours to show degrees of radio-activity. The full scale of the chart is 1 milli-amp and the contour interval chosen for the map was .05 milliamps; to save confusion with decimals these were drawn as .5, 1.0, 1.5 etc.

The interpretation did not involve the selection of areas above a given contour value as anomalies but rather the searching for deviations from a general background count, which varied from place to place. Considering the degree of radio-activity of the ore-bodies, deviations of double background were thought to warrant further investigation.

On completion of the survey four general levels of radio-activity were recognised. These are shown on the plan as regions where the chart reading was

(a) less than .10 milliamp (below the 1.0 contour)

(b) between .10 and .15 milliamps (between 1.0 and 1.5 contours)

(c) between .15 and .20 milliamps (between 1.5 and 2.0 contours)

(d) above .20 milliamps (above 2.0 contour)

Generally the levels of radio-activity can be attributed to the following effects:

The regions where chart reading is below .1 milliamps are those where radio-active bedrock is blanketed by a thicker layer of non-radio active recent deposits. These lesser readings are particularly evident when traversing the numerous radio-actively barren sandhills of aeolean origin which strike across the country in a S-E N-W direction. The 1.0 contour in many cases traces out the boundaries of these sandhills this being most noticeable where they traverse porphyry country. Some readings were obtained less than .05 milliamps where apparently the soil cover is thickest and these readings would approximate to the contribution to the background count by cosmic effects alone.

Probably the greatest representative area is that lying between the 1.0 and 1.5 contours. This is made up of both sedimentary bedrock terrain and those areas of porphyry bedrock where soil cover is thicker. The few areas of Cambrian outliers are noticeably of this level except the one case at Bald Hill which is partially less than one.

The next higher level, between the 1.5 and 2.0, occurs in three major zones. The first is over the felspar porphyry intrusive of the Moonta area. Here, these patches are discontinuous being interspaced by zones of lesser counts where apparently either soil cover is greater or radio-activity of the porphyry is less.

A less extensive area of similar counts and also discontinuous is to be found on the north-west corner of the area surveyed near Warburto crossing. This is surmised to be a second and previously unknown area of felspar porphyry intrusion proven in part by drilling.

The third area of these counts found in the vicinity of Wallaroo Mines and the area south is less easily explained. Dump material gives little indication of intrusion and while the higher counts must be in part due to the dump material and the like lying on the surface, the area well to the south of Wallaroo Mines cannot be explained in this way. Perhaps the presence of small pegmatitic intrusions and an increase in radio-activity of the metamorphosed bedrock result in this increase.

One of the four areas chosen for follow up work occurred in this contour interval.

Of the zones where the chart reading rose above 0.20 milliamps some were due extraneous lode material within the mined area, others were simply patches of greater radio-activity (or zones of more shallow cover) in the porphyry while three were considered anomalies. Special care was taken in eliminating or choosing these areas as favourable for further work. Each was inspected individually and selected for additional work if there was no sign of ~~lode~~ mine material on the surface or nearby.

The first of the four areas chosen for follow up work, as stated previously, lay in the 1.5 - 2.0 contour interval. The anomaly occurred in Sections 514 and 513 in the Hd. Wallaroo, well out of the mined area; it is elongated in the east-west direction for some two hundred yards. Additional geophysical work in the form of self potential, magnetic and gravimetric surveys was carried out and from the results two sites were chosen and drilled, when the anomaly was found to be due to a felspar porphyry intrusion which subsequent scintillometer work has shown to be quite extensive.

Two of the three anomalies where readings rose above the 2.0 contour were found on the outskirts of the Wallaroo mines while the third lay to be south west of the township of Moonta.

The first of the two near the Wallaroo mines lay in Section 1769 Hd. Wallaroo. It was a pronounced anomaly of double background, the highest counts occurring over a zone of about 100' long and 50' wide disposed in an east-west direction. The follow-up survey has been completed but no drilling has been undertaken to date.

The remaining two are at present under follow-up survey, having been disclosed in the second half of the survey. Both are zones of much higher counts than encountered previously rising in places above the 3.5 contour.

The anomaly on the outskirts of Moonta occurs in the town's parklands and here counts of almost triple background were found. The anomalous zone is orientated in N-W - S-E direction.

The final anomaly occurring in Section 203W Hd. of Wallaroo has no apparent orientation; it is a zone in extent approximately one hundred feet by seventy five feet where readings of above double background are encountered.

Conclusions and Recommendations.

The survey cannot be considered to have led directly to the location of copper lodes. The method is more suited to problems involving the detection of lodes of much higher radio-activity and less top-soil cover. However in areas where such conditions prevail and which are able to be traversed by jeep, the method is highly recommended for a rapid means of scintillometer survey.

Further, the location of another felspar porphyry intrusion in the vicinity of Warburto crossing is interesting as this is the host rock for the lodes at Moonta. Further consideration should be given to this area as a potential zone of copper lodes and geological geochemical or additional geophysical work might lead to the discovery of new prospects in this area.

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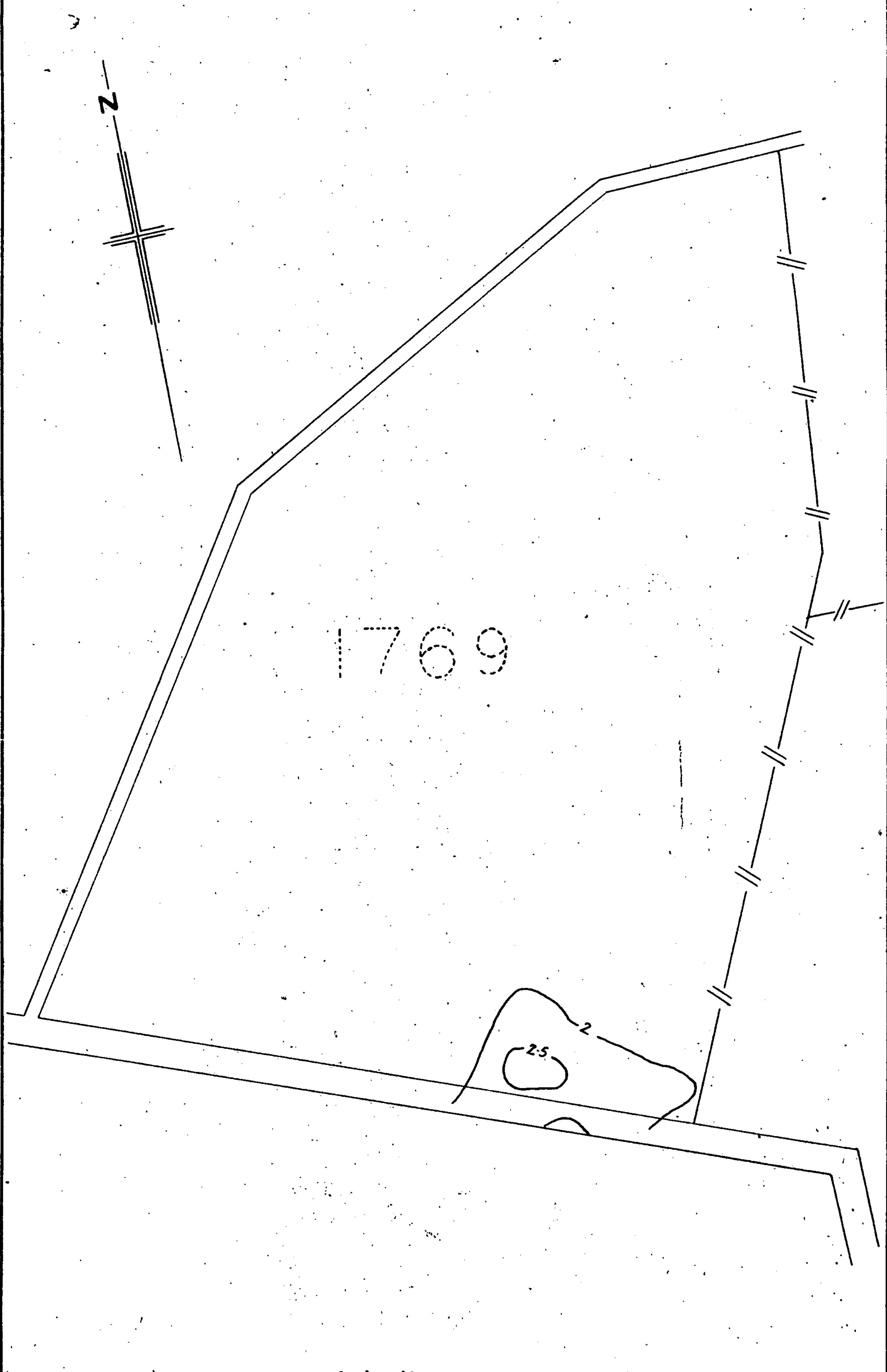
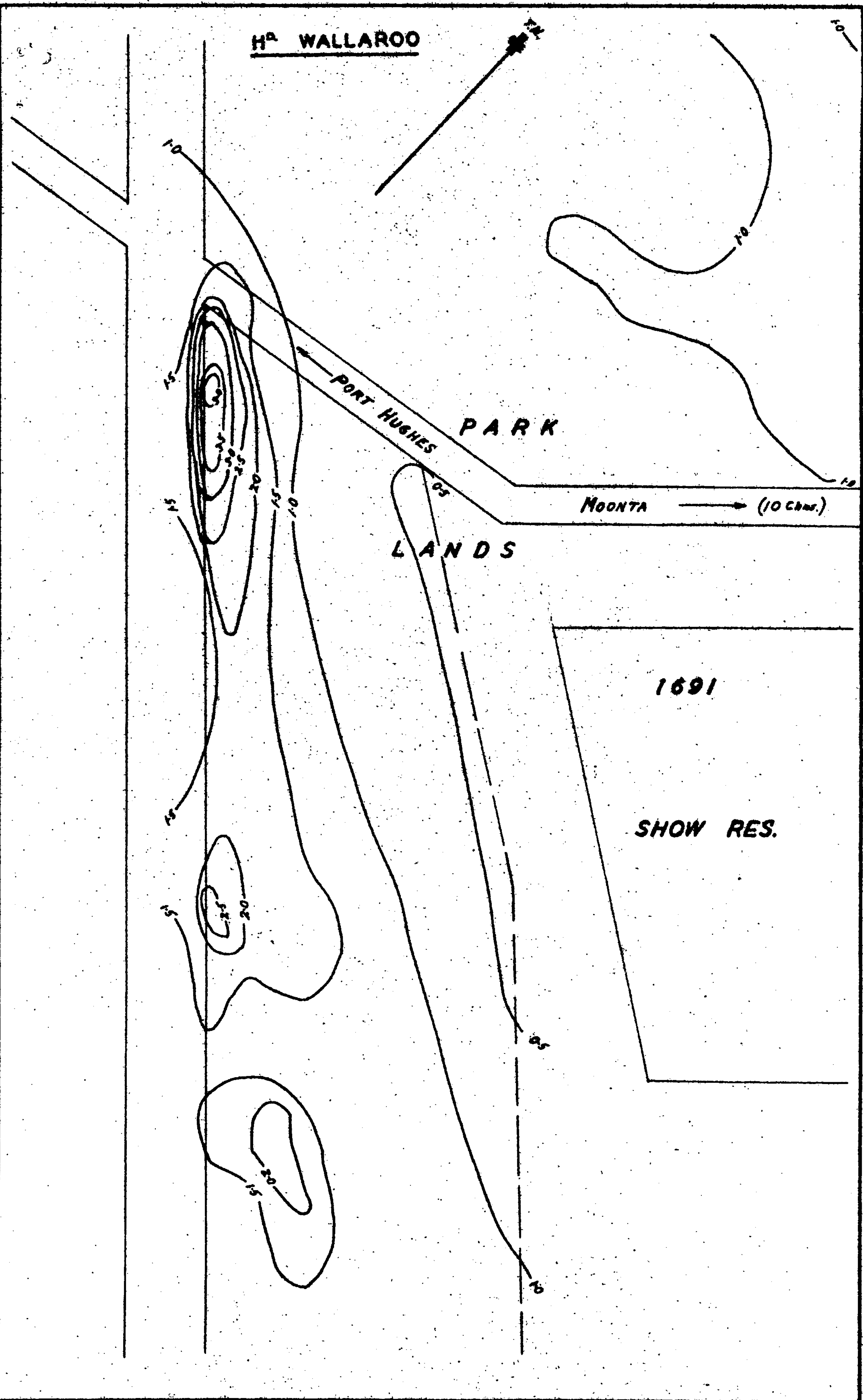


Jeep mounted Scintillometer survey by W. H. Knapman.

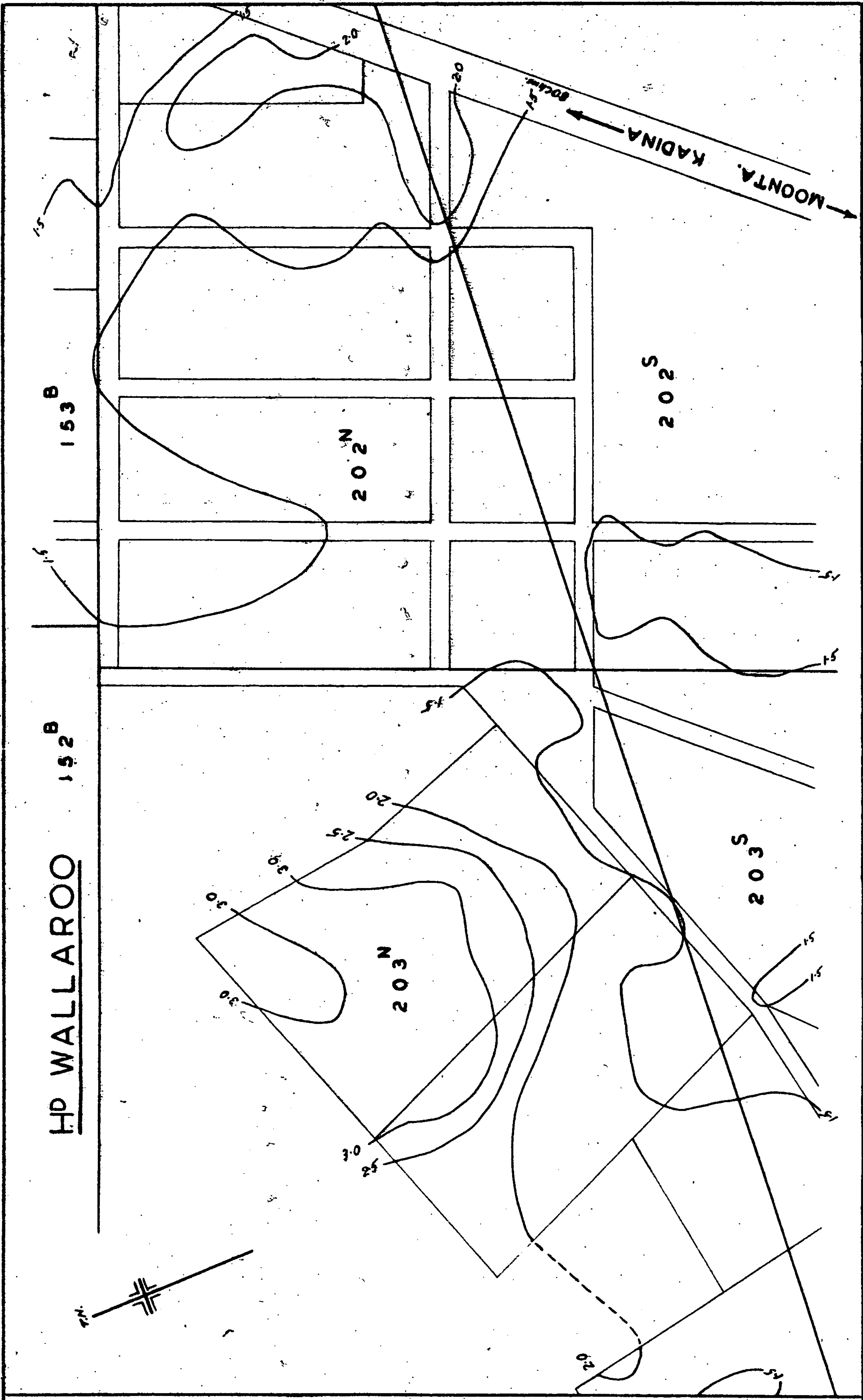
S. A. DEPT. OF MINES

Approved	Passed	Drn.	WALLAROO GEOPHYSICAL SURVEY SCINTILLOMETER CONTOUR PLAN	D.M.	Scale 250 Ft. to 1 in.
		Tcd.		Req.	S 557 GC6
		Ckd. R.R.			
Director	C.D.	Exd.	HD. WALLAROO SEC. 1769		Date 27-2-52



S. A. DEPT. OF MINES

Approved	Passed	Drn.	KADINA–MOONTA AREA	D.M.	Scale: 200 ft to 1 inch (approx)
		Tcd.	*JEEP MOUNTED SCINTILLOMETER*	Req.	S 606
		Ckd. R.R.	*ANOMALIES*		GcG/7
Director	C.D.	Exd.			Date: 15·5·52



S. A. DEPT. OF MINES

Approved	Passed	Drn.	KADINA-MOONTA AREA	D.M.	Scale : 200 ft to 1 in (approx)
		Tcd.	JEEP MOUNTED SCINTILLOMETER	Req.	S 607 GcG/7
		Ckd. R.R.	ANOMALIES		
Director	C.D.	Exd.			Date : 15·5·52

N
MAIN ROAD
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MAIN ROAD
RESERVOIR
Bald Hill
RESERVOIR
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PORT HUGHES
SCALE IN MILES
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S. A. DEPT. OF MINES
KADINA - MOONTA AREA
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Scale: 20 Chns to
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2-5-52


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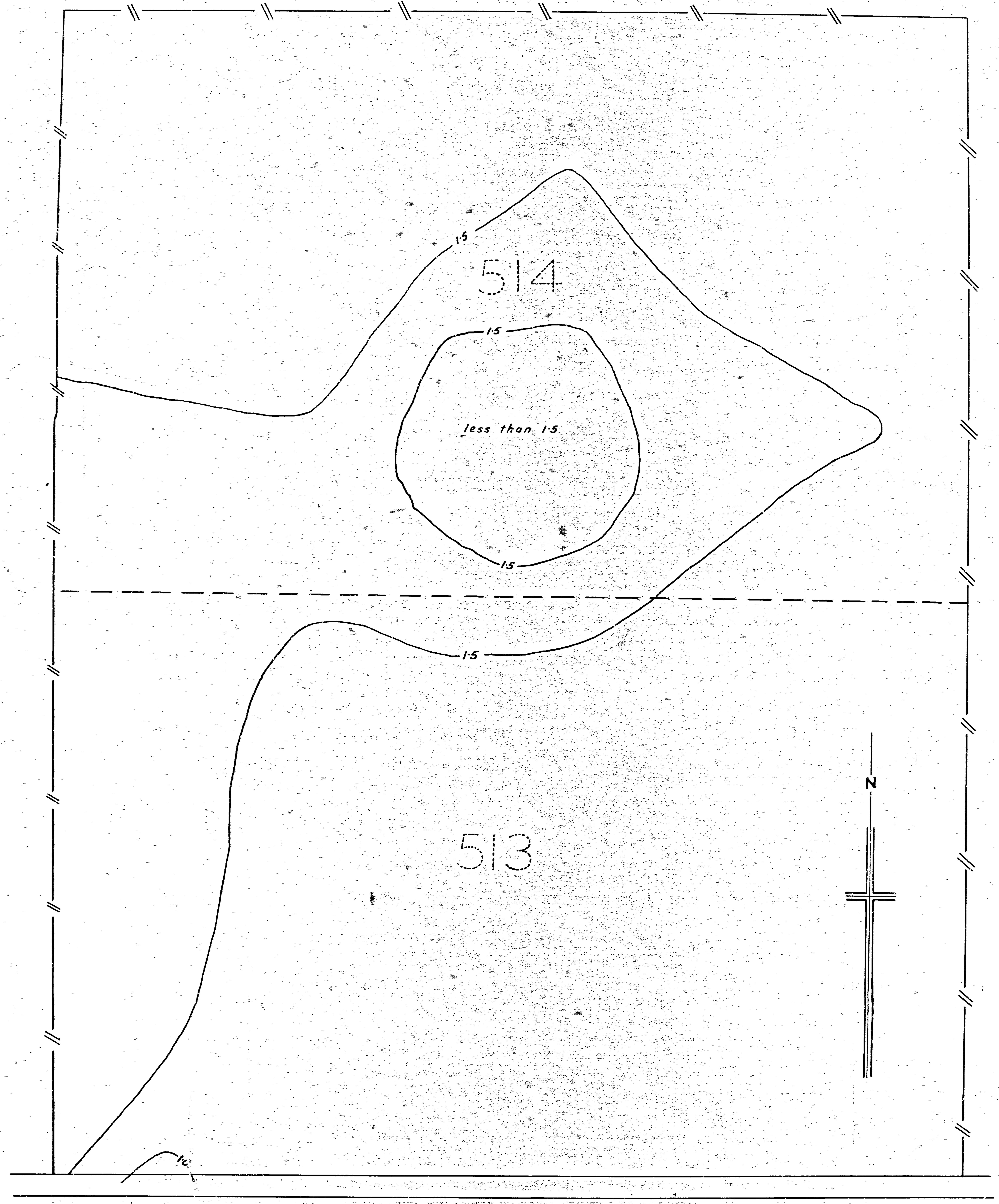
S. A. DEPT. OF MINES



Jeep mounted Scintillometer survey by W. H. Knapman.

S. A. DEPT. OF MINES

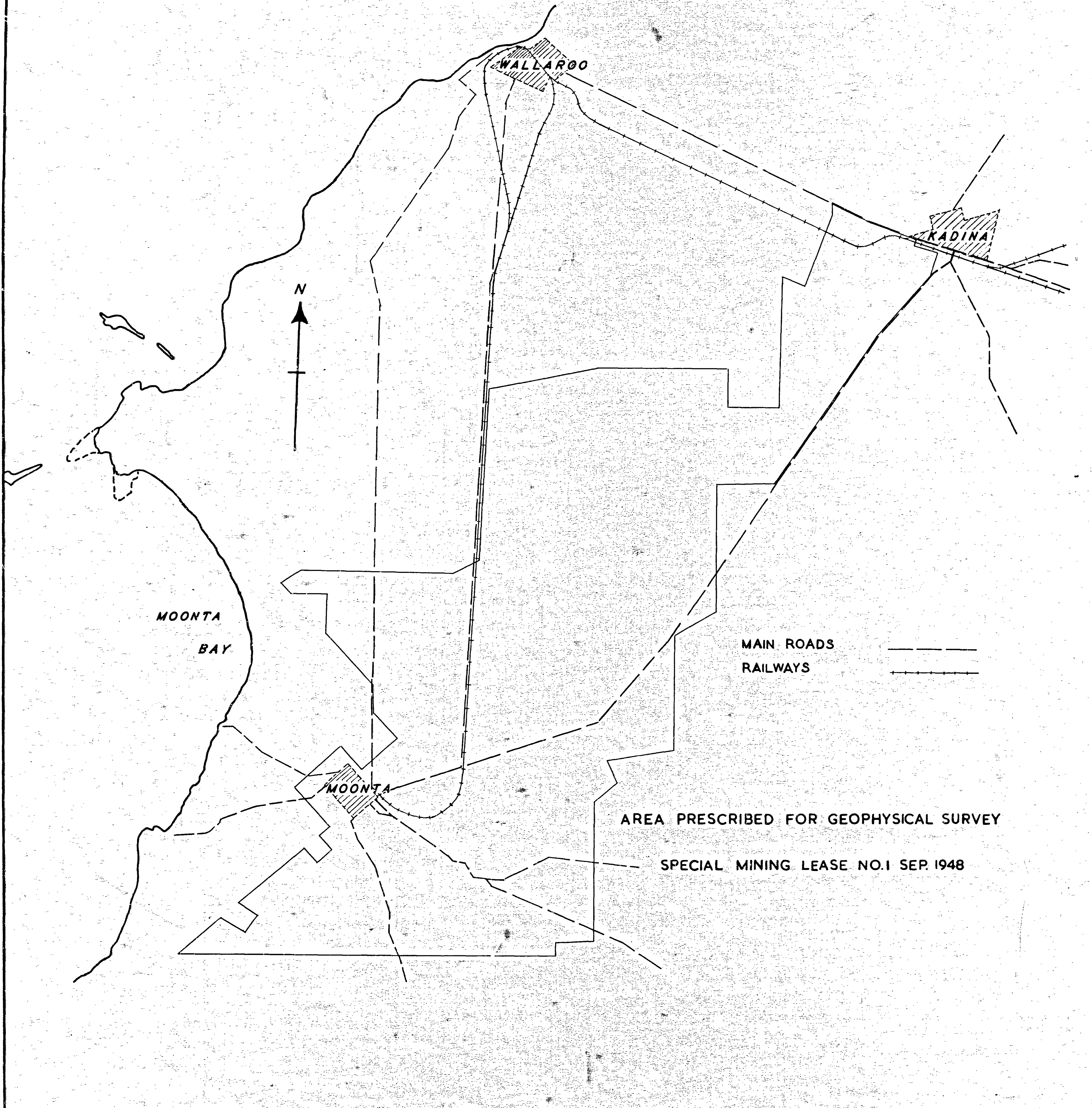
WALLAROO GEOPHYSICAL SURVEY

SCINTILLOMETER CONTOUR PLAN

HD. WALLAROO SECS. 513 & 514

No.	Amendment	Exd.	Date

Approved	Passed		Scale: 250 Ft. to 1 in.
for Director	C.D.	Drn. / Tcd. R.G.S. / Ckd. R.R. / Exd.	52–99 Gc6 Date 27-2-52



S. A. DEPT. OF MINES

GEOPHYSICAL SURVEY KADINA–MOONTA AREA
HD. WALLAROO
LOCALITY PLAN

No.	Amendment	Exd.	Date

Approved	Passed		Scale: 1inch – 1mile
Director	C.D.	Drn. / Tcd. A.T. / Ckd. R.R. / Exd.	52-192 Gc. 6/7
			Date: 20·5·52