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SCINTILLOMETER SURVEY IN THE ROSSARDEN AREA

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INTRODUCTION

With field assistant, B. Kingshott, a ground survey for radioactive minerals in the Avoca district was carried out for a period of about eight weeks. Previously a similar survey by Geologist A. B. Gulline had occupied two weeks in the area but owing to mishaps to the scintillometer the survey was abandoned temporarily.

An aerial scintillometer survey was carried out by the Bureau of Mineral Resources in 1955 and the purpose of this ground survey was to check the anomalies that had been indicated.

LOCATION AND ACCESS

The main area examined is situated between the Storeys Creek road and Aberfoyle Creek. The northern and southern boundaries are the road to Rossarden (which branches off the Storeys Creek road) and the South Esk River respectively. An area at Ormley was also traversed. A few traverses were made between the road to the Stanhope Coal Mine, and Storeys Creek road (to the south of Gipps Creek road). Areas where uranium has been reported were examined in some detail. These include Chwalczyk's Prospect on Story Creek, the Rex Hill Mine, the Great Republic Mine and the Castle Carey Creek deposit.

The western side of the area is accessible from the Storeys Creek road while the eastern side is served by a through track leading to a farm house. Roads over which a vehicle can be driven lead to all other areas except the last mile of the road to Chwalczyk's Prospect.

GENERAL GEOLOGY

The main rock type in the area is Devonian granite which is variable in texture and composition and intrudes the Mathinna Group. The Mathinna Group is tentatively regarded as being of Silurian age and consists of quartzites, slates and siltstones. Fossils are rare. Quartz veins associated with the intrusion of the granite are common and folding of the group is extensive. Comparatively flat-lying Permian rocks overlie the granite in some places while in others they unconformably overlie the Mathinna. The Permian in this area consists of shales, siltstones, grits, quartzites and conglomerates. Some of the siltstones and shales contain abundant fossils most of which are bryozoans with a few brachiopods.

Extensive faulting has taken place, the general trends of the faults being north-easterly and north-westerly.

To the north and east of the area examined, the Mathinna Group is exposed, while to the west and south outcrop the Triassic sediments intruded by Jurassic dolerite.

TOPOGRAPHY AND VEGETATION

The whole area is deeply dissected by creeks that flow into the South Esk River. These include Aberfoyle Rivulet and Story Creek and their tributaries, Buffalo Brook and creeks that run directly into the South Esk. The hills generally are steep and in some cases where rounded granite tors have formed with no or very little vegetation, they are very hard to traverse.

Most of the area is fairly open country, the vegetation being made up mainly of various kinds of stunted eucalypts, wattles, dogwoods and smaller heath-like bushes. Around the creeks the vegetation is sometimes thick and hard to penetrate while on some of the flat country composed of Permian strata bracken ferns often grow thickly.

INSTRUMENTATION AND METHOD

A Canadian made scintillometer was borrowed from the Bureau of Mineral Resources to carry out the survey. The scintillometer contained a crystal of sodium iodide activated with thallium. This type of crystal is used mainly for the detection of γ rays. A scintillometer is more sensitive than a Geiger counter in that up to 50% of the rays striking the crystal produce scintillations while reaction is shown by less than 1% of the rays entering a Geiger-Muller tube of a Geiger counter. Small changes of radioactivity are thus better indicated with a scintillometer and deposits can be detected from a greater distance. Another advantage is that the scintillometer has a lower relative cosmic ray background. The main disadvantage of a scintillometer appears to be that it is rather delicate and easily upset.

The method of covering the area was to take readings along traverse lines on a fixed compass bearing except that in some cases traverses were made along roads or creeks and a bearing was unnecessary. Readings were recorded every 200 feet along the traverse line, by placing the scintillometer on the ground. Most outcrops between the recordings were tested (usually from the standing position) although these readings were not recorded unless they were higher than usual. The heights were also recorded every 200 feet using an aneroid barometer, in order to see if there is any variation of radioactivity with height. The heights would be comparative only for atmospheric pressure was fluctuating and no base readings were taken.

Traverses were made at intervals of approximately 400 feet. Where the aerial anomalies are not very closely spaced, larger intervals were taken, e.g., in the northern part of the zone between Story Creek and Aberfoyle Rivulet the distance was a quarter of a mile, while traverses from the lower part of Storeys Creek road were spaced at intervals of approximately 800 feet.

RESULTS

Uranium is an oxyphile element and is concentrated during magmatic differentiation in residual magmas. In most economic deposits it has usually been transported by and deposited from hydrothermal solutions. The majority of uranium in igneous rocks occurs, however, in minerals with elements that it can replace by isomorphous substitution, e.g., calcium and rare-earth containing minerals such as zircon. To a lesser degree it occurs in igneous rocks as discrete minerals.

When uranium decays it gives rise to alpha particles only which cannot be detected with the type of meter used. However, the products of the decay are radioactive and the break down of these gives rise to gamma rays that can be detected. A good deal of the gamma radiation in granite is due to radioactive potassium, which is the most abundant radioactive element.

The background indicated by the scintillometer on the granite in the area, is from 150-200 while on the Permian and Silurian sediments it is about 50. Isorads drawn on a map of the area show large areas to be from one and a half to two times background. The area giving readings of from two to two and a half times the background count, however, is comparatively small. Readings greater than three to four times the background are found only in small isolated spots. The higher readings are usually obtained from joint and fracture planes in the granite—the solid unfractured granite usually giving lower readings. This is probably due to one or a combination of three things:—

(i) Up to 40% of the uranium occurring in most granites is leachable. This could be transported, and re-deposited in the joints in an insoluble form, more concentrated than in the surrounding granite.

(ii) Radon is a daughter product of the disintegration of uranium. It is gaseous and has three isotopes, all of which are radio-active. As a gas it would tend to migrate along paths of least resistance, e.g., joints, &c. The half life of radon is only a few days for one of the isotopes, and a matter of seconds for the other two and its disintegration gives rise to other radio-active elements. Apart from being gaseous, radon is comparatively soluble in water, particularly at low temperatures, and this also affords a method of migration.

(iii) The third possible reason is that fractures and joints tend to be attacked by weathering more than the solid unjointed granite. As the fractured granite becomes indented the solid angle effect probably has a slight tendency to make the readings higher.

The value of the readings varies with the type of granite. The highest readings were obtained on coarse grained granite with large phenocrysts of feldspar as exposed between Storeys Creek road and Story Creek. The granite between Aberfoyle Rivulet and Story Creek in the northern part of this zone is fine grained and readings were generally from about 80 to 130.

There does not seem to be any noticeable variation of radio-activity with height even though many of the high readings are obtained on hills. Many are also found in the valleys. The probable reason for this is that there are more outcrops in these places. Hill-slopes tend to be covered with granite gravel which blankets radiations coming from the underlying rocks.

In the area under consideration the increase in cosmic ray intensity with height is probably negligible. Changes are not expected to be appreciable below altitudes of 2000 feet above sea level but would be more rapid above that altitude.

Apart from investigations of previously discovered deposits, the highest reading obtained on the survey was 1160 on a traverse at 80° from the Storeys Creek road, leaving at about the 6-mile post and about one mile along the traverse. The reading was taken in a small fracture zone in the granite with very little indentation. The value dropped considerably when the instrument was moved about six inches in any direction but tended to be fairly high along the fracture. Readings of 700 were common in fractures up to three to four chains distant from the high reading and several of 800 were also obtained.

Uranium has been found in the Permian in Prospect Creek which is a small tributary of Castle Carey Creek at about 5.75 miles from Avoca on the Storeys Creek road. A reading of 2000 was obtained in a black carbonaceous shale outcropping in the creek bed. The shale bed is near the base of the Permian. A trench has been bulldozed and a hole dug in order to locate the bed, about 40 feet from the creek. Although the hole is now filled with silt, readings of up to 1500 were obtained on the dump. With a background of about 50 on the Permian, this bed therefore shows considerable concentration of uranium.

About three chains down Castle Carey Creek from its junction with Prospect Creek a quartzitic bed gives a reading of 700 while about 20 feet further down, a dark grey weathered siltstone reads 1000. About four and a half chains from the junction the carbonaceous shale reads 450. Further down the creek, outcrops of quartzitic beds give readings well above background, e.g., at about 10 chains from the junction—350. A reading of 190 was obtained in carbonaceous shale 20 chains from the junction.

The deposit is situated in a graben. On the top side of the road on the upthrown side of the fault the highest reading obtained by traversing around the base of the Permian was 300 in a grey slate.

In other parts of the world, particularly in U.S.A. the association of uranium with pre-Mesozoic, marine carbonaceous sediments is common. Uranium, dissolved during weathering, is removed from solution by (1) precipitation, (2) adsorption by clay minerals and some organic compounds and (3) precipitation in strongly reducing conditions. It is probable that this deposit was formed by a combination of the last two conditions. The uranium in this part of the area examined is usually finely disseminated and no deposits of economic importance have been reported. The mineralogy of this type of deposit is not known but it is in an acid soluble form.

The deposit of uranium found by Chwalczyk is in a small zone surrounded by a 300 isorad (see map). However, this may not be quite comparable with other results, as this area was tested with a different meter. Only two readings of over 500 were taken. One of these was 1300 at the entrance of the main adit from which the ore was mined. The deposit is located on Story Creek, not far above water level, and in a coarse granite with large feldspar phenocrysts. The area is situated in a shear zone, the extent of which is not known. Several traverses were made in the vicinity of the deposit but no new possibilities were found.

The Mount Rex tin mine, where radioactive minerals have been reported, was examined and showed no really high results. Several readings of over 500 were obtained in the open cut, the highest being 570. The dumps from the shafts averaged from 300 to 350. The granite is coarse grained with quite a lot of fluorite, galena, chalcopyrite, pyrite, &c., in veins.

Tobernite has been reported from the Great Republic Mine although no trace (in the form of high readings) was found when the dumps and the granite around the mine were tested. The highest reading was 320, while most were in the range of 150 to 250.

CONCLUSIONS

Although no new uranium deposits were discovered it is possible that such exist even where the traverses were closely spaced. For a deposit to be found, it would have to outcrop as the scintillometer is not capable of detecting sub-surface deposits. It is generally agreed that gamma rays will not penetrate solid unfractured rock for greater distances than about one foot and a large deposit could be easily passed over. The only method of finding such a deposit is to test fractures and joints for high counts. The interpretation of these high readings would require further work—it could be that they are due to concentration by leaching either from uranium containing minerals disseminated throughout the rock, or from a deposit of uranium.

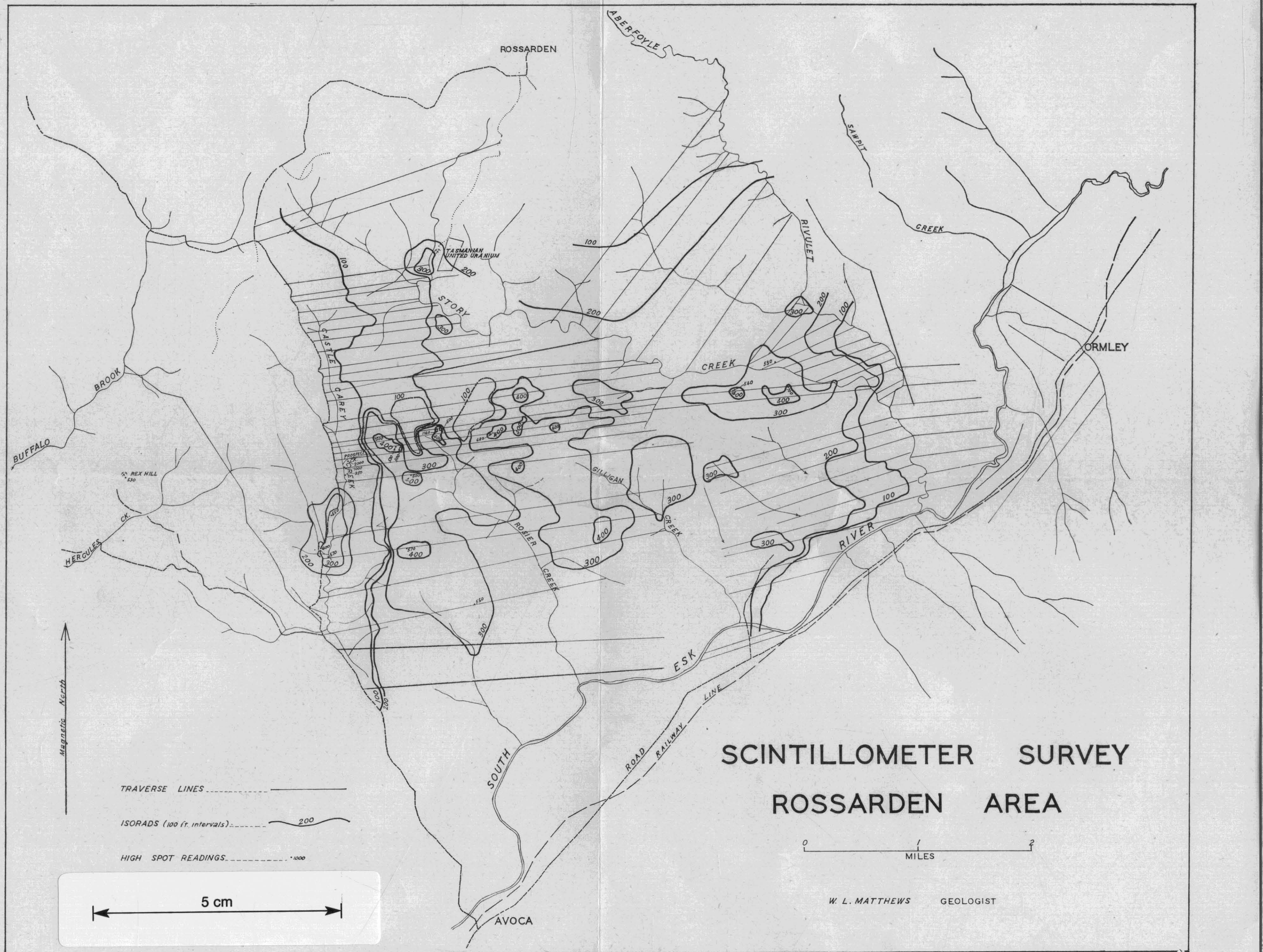

FIGURE 22.

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The areas bounded by 300 isorads are large and probably only represent granite with a slightly higher percentage of radioactive potassium, uranium and thorium. It is possible, but not very likely, that they represent deep deposits and leaching and radial deposition have increased the radioactive content. Any deposit found will probably be discovered because of concentration in joint planes, as was Chwalczyk's Prospect.

Since the outcrops predominate on the hills and in the creeks it would probably have been better to confine the search to these areas as many of the hillslopes are covered with gravel which inhibits the detection of radioactivity in the underlying rocks.

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Map Reference

Isorads are lines joining points of equal radioactivity. In this map the areas bounded by isorads are areas in which readings equal to or greater than the value written on the line were obtained. The two dotted boundaries are not really contours in the ordinary sense as they do not show gradation with the surrounding isorads. They represent a different rock type (Permian) on which lower readings were obtained. High spot readings represent small areas where high readings were obtained ($\leqq$ 300 for Permian, $\leqq$ 500 for granite are the only ones shown).