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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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The E.M.I. Type 59A Ratemeter as a Prospecting Instrument

by

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SUMMARY

An E.M.I. type 59A Ratemeter was field tested by the Darwin Uranium Group of the Bureau of Mineral Resources over several months including part of a 'wet' season. This report compares the features of the ratemeter with the requirements for a prospecting instrument.

The ratemeter has many excellent features, including good thermal stability, tropical proofing, rugged construction, and continuity between all ranges. The few poor features arise because the instrument was not designed for prospecting work.

Suggestions are made concerning modifications to the Type 59A Ratemeter so that it will meet the requirements of a prospecting instrument.

Current Model: Type 239
11/12/69 [initials]

1. INTRODUCTION

While attending a course in radioisotopes at the Australian Atomic Energy Commission (AAEC), Lucas Heights, in August-September 1966, the author became interested in a model Type 59A Ratemeter as a possible replacement for near-obsolete instruments at the Darwin Uranium Group of the Bureau of Mineral Resources (BMR). This ratemeter had been designed by the AAEC and built under licence by E.M.I. (Aust.) Ltd for use in field experiments with radioisotopes.

Arrangements were made with the AAEC to field test the ratemeter during the 1967 field season. Most of the tests were carried out in the Rum Jungle area, Northern Territory. Surface tests were abandoned in October when the photomultiplier tube broke. Subsequently four drill holes were investigated by using the ratemeter in conjunction with one of the BMR auger hole probes containing three Geiger-Müller tubes.

The equipment on loan from the AAEC consisted of:

Ratemeter type 59A
Jefferson Head
Scaler type AAEC. 60
Chart Recorder
Associated Leads, etc.

The co-operation of the AAEC in providing the equipment for a field testing programme by the BMR Darwin Uranium Group is gratefully acknowledged.

2. REQUIREMENTS FOR A PROSPECTING RATEMETER

The practical requirements which a ratemeter must fulfill in the type of work performed by the Darwin Uranium Group are as follows.

The most important requirement is tropical reliability, that is an ability to withstand high temperature and humidity without a drift in reading or a thermal runaway such as has been experienced with many transistorised ratemeters. Sealing against humidity needs to be effective, but elaborate sealing is valueless if the instrument must be frequently opened in the field to replace batteries or effect minor repairs and adjustments.

Mechanical shock resistance should be of a high order as prospecting work involves transport over terrain which can be very rough.

The levels of activity that may have to be accommodated range from as low as 0.01 mR/hr to as high as 30.0 mR/hr. The range of gamma particle energies which are mainly of interest in the naturally occuring radioactive sources is 0.05 to 3.0 MeV and a prospecting ratemeter must be able to detect all energies in this range. This means that several count-rate ranges must be provided. It is valuable to have mutual agreement between readings of the same activity on different ranges. In other words the calibration curve should be continuous from range to range. This condition is seldom available on prospecting ratemeters.

A low instrument weight is desirable when prolonged use of the instrument in the field is necessary. In addition, provision for carrying the instrument should afford maximum comfort. All too frequently geophysical equipment of otherwise high quality is spoilt by being unnecessarily uncomfortable to carry. This arises because carrying handles are frequently added as after-thoughts.

The ratemeter must have provision for the attachment of detecting heads to permit logging of diamond-drill and auger holes for radioactivity and is often required to drive a chart recorder. It is in this kind of work that the ratemeter may have to suffer prolonged exposure to direct sunlight, which can raise the temperature of metal fittings to greater than 60°C. This demands a high degree of thermal stability of the circuit components and a high thermal insulation of the instrument case.

In the event of breakdown it is of great assistance if all components are readily accessible and if detailed service manuals are available.

In field work it has been found that a standard deviation in meter readings of 2% or better is desirable.

3. THE E.M.I. TYPE 59A RATEMETER

This instrument is a very sensitive ratemeter capable of detecting very low levels of radioactivity and very low gamma energy levels. In these respects it exceeds our requirements.

It is normally used in field experiments with radioisotopes and was in no way modified for field trials as a prospecting ratemeter. In this form the detecting head is remote from the ratemeter. For normal prospecting work a 6-ft connecting cable is used. The detecting head consists of a scintillation detector using a sodium iodide crystal and photomultiplier tube inside a cylindrical aluminium housing.

External controls consist of a combined on-off battery-test and count-range switch, a standard deviation switch, sockets for outputs to scaler and recorder, a socket for external battery, a detecting head input socket, and a H.T. supply socket. Internal controls concern voltage supplies, gain, a window discriminator, and a function switch.

The instrument withstood prolonged exposures to sunlight and displayed no tendency to drift or thermal runaway. Apparently special attention was given to these features in the circuit and case design; for example the case is painted white to reflect radiant heat.

The sealing against humidity is excellent, but this feature is spoilt by the necessity to open the case to replace batteries and to reach a number of controls. It would be preferable if the battery container were sealed and isolated from the compartment containing circuitry so that it could be opened separately from the rest of the instrument. Most of the controls inside the sealed case need never be used in the field; however, the function switch is a possible exception and would be better mounted on the external control panel.

For the type of work carried out by the Darwin Uranium Group the discriminator window is of no value.

The use of a remote detecting head is inconvenient in much prospecting work; a detector contained within the instrument case is less liable to damage and connecting cables are eliminated. However, the provision of a socket for an external input from a remote detector is necessary if the ratemeter is to be used in drill hole probing.

From the point of view of circuit construction and mounting of electronic components the instrument appears to be very ruggedly constructed.

When investigating highly localised radiometric anomalies on rock outcrops an earphone output has been found to be very useful and such a provision would be a valuable addition on the Type 59A Ratemeter.

The controls and sockets on the top of the instrument appear to be open to damage even from moderate knocks. This could be improved by recessing all the external controls and sockets with provision for easy cleaning, as dirt and dust are encountered in abundance in prospecting work.

The carrying handles on the top of the panel are evidently arranged to provide some protection for the external controls and perhaps to act as a servicing stand, but they are not very practical from the point of view of the field observer. A single, large, comfortable handle is required in addition to a strap for carrying the instrument over long distances. A carrying strap alone is not satisfactory as it can contribute to damage of the instrument by allowing it to swing against rocks while being moved between closely spaced stations.

The count ranges provided show excellent continuity and would be able to cover levels of natural radioactivity normally encountered. However, if the instrument is used to investigate a diamond-drill hole that passes through high-grade uranium ore, then count rates could easily exceed the maximum of 10,000 c.p.m. provided for. Thus an extra range of 30,000 c.p.m. is needed.

It was found in field tests that the instrument case with its very sharp corners was not only uncomfortable for the observer but could in fact all too frequently inflict minor wounds on him. Elimination of all sharp features is therefore desirable.

The servicing facilities of this instrument are exceptionally good and the manual is a model of clarity and completeness.

The weight of the instrument is rather high and could be reduced in two main ways: the instrument case could be made of aluminium instead of steel without seriously affecting its qualitites; and the battery pack could be reduced to four instead of eight D cells. This reduction in cells would be acceptable in a prospecting instrument which seldom has to supply a scaler or recorder and which normally would experience only very low count rates. However, as stressed before, the frequent changing of batteries requires their container to be independent of the sealing of the rest of the instrument.

In the field tests some difficulty was experienced with the standard deviation setting. It was found that the 1% setting was the best for field use but it occasionally malfunctioned on the meter Serial No. 9861 which was tested. This malfunction consisted of the meter reading stability being worse at times on the 1% setting than on the 10% setting. This must have been due to an intermittent short circuit through the corresponding smoothing condenser.

4. CONCLUSIONS

The satisfactory features of the Type 59A Ratemeter and suggestions to make it a better prospecting instrument are summarised below.

Satisfactory features

1. Good tropical behaviour in being well sealed and insulated.
2. Capable of detecting lower gamma energies and activities than are really required.
3. Excellent continuity between count ranges.
4. Rugged electronic design.
5. Can be serviced easily and can be easily returned to manufacturer if necessary.
6. Provision for driving a recorder.
7. Provision for working with a remote detecting head.
8. Provision for use of external batteries.
9. Reading standard deviation as good as is needed.

Desirable developments

1. Addition of an internal detecting head within the sealed case.
2. Isolation of the battery pack in a seperate sealed compartment.
3. Reduce weight by using aluminium for the casing and by halving the number of batteries.
4. All controls which must be used in the field should be on the external control panel, i.e. reposition the function switch.
5. Recess all controls.
6. Provide for better means of carrying.
7. Provide an extra 30,000-c.p.m. scale.
8. Provide an earphone output.
9. Eliminate sharp corners and edges.
10. Abandon the discriminator window and scaler output socket.
11. A heavy canvas carrying case could lessen the chance of accidental damage.

A complete redesign of the case could be avoided if the internal scintillation detector were situated in the position of the present battery pack. If only four D cells were used they could probably be situated in the bottom of the instrument with only minor alteration of the base plate.

A photomultiplier tube of rugged design should be used as the type used in the field tests was found to be too fragile for prospecting work.