of tracks from the uraninite and then traverse the mount to look for the weaker centres of tracks. When these are found, it is only necessary to focus down to the rock slice in order to identify the mineral that has caused them. If the mineral is opaque, it is often possible to dig enough of it out of the section with a needle, to be mounted on a glass fibre coated with vaseline, for determination by *x*-ray diffraction.

A METHOD FOR QUANTITATIVE RADIOACTIVITY MEASUREMENTS OF SMALL AMOUNTS OF RADIOACTIVE MINERALS[1]

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The property of radioactivity possessed by minerals containing uranium and, or, thorium may be used as an aid in identifying them, for by accurate quantitative radioactivity determinations the minerals may be grouped according to their uranium and, or, thorium contents. In some instances it is possible by radiometric measurements to determine that the mineral in question is one of a group of only three or four minerals. Of the commoner species, for example, pitchblende, uraninite, and uranothorite all show a radioactivity very much higher than other primary radioactive minerals, whereas allanite, cyrtolite, zircon, and some fergusonites show relatively low activities and euxenites and similar complex minerals usually show an intermediate degree of activity.

In the course of investigations at the Radioactivity Laboratory it has been common experience to be able to obtain only a few, hand-picked grains of a radioactive mineral from the solid specimens or recover a small amount of the mineral by separation tests. The method here described has been used effectively for the measurements of 5–10 mg. samples. The sample powder is weighed, transferred to the tip of a small glass funnel, and counted with an ordinary laboratory-type, thin end-window, Beta tube in combination with a ratemeter or scaling unit. Comparison is made against uranium standards which, in this laboratory, are made up from pitchblende and inert material.

The glass funnel is illustrated in Figure 1; small variations in its dimensions are not important. The funnel-shaped mouth serves two purposes: (1) it allows easy filling of the tip with the sample powder, and (2) it provides a firm base during the counting period.

The funnel is made from a short length of 2 mm.-bore, soft glass tubing. One end of the tubing is heated to a small globule of glass, which is blown into a bubble with a diameter about equal to that of the funnel mouth. The outer half of the bubble is reheated and blown out, and the

[1] Published by permission of the Director-General of Scientific Services, Department of Mines and Technical Surveys, Ottawa.

funnel mouth shaped with a metal tool. The stem of the funnel is cut at the required length and the tip ground flat on a glass plate with a little carborundum powder. The mouth of the funnel is also ground flat to afford a firm vertical standing position. Other materials necessary are a tube of ambroid cement and a thin sheet of cellophane.

The choice of a uranium standard is determined by preliminary activity tests of the sample; the standard should, if possible, closely approximate the activity of the sample.

The samples and uranium standards are ground to pass a 200-mesh screen in order to produce a smooth sample surface and allow firm pack-

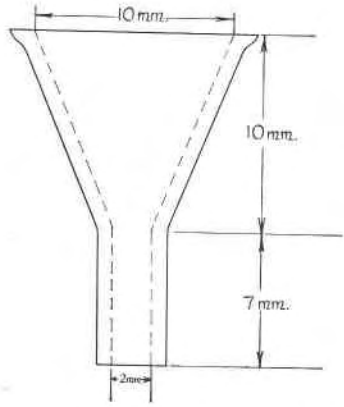

FIG. 1

ing of the materials in the funnel tip to prevent any loss of sample while handling the funnel. Using a chemical balance, equal portions of the sample and uranium standard are weighed out[2] on small sheets of glazed paper.

The technique for placing the powder in the funnel tip is as follows: a drop of ambroid cement is smeared thinly on a glass plate. The tip of the funnel is carefully touched to the ambroid and then immediately pressed firmly on a small square of cellophane. The powder is poured into the funnel and shaken down to the tip, after which the funnel is rapped sharply on the table several times to compress the powder. The cellophane is now removed as it offers some shielding to the radiation. The powder will not drop out if the funnel is handled carefully.

To carry out measurements, the funnel is inverted so that the surface

[2] A layer of sample powder 2–3 mm. thick absorbs most Beta radiation from the back layers and will not be obtained in the funnel tip with amounts as little as 5–10 mg. of sample. Accordingly, measurements are made by weight rather than volume because the latter cannot be estimated accurately and will vary with differences in the packing of the powders.

of the sample may be brought as close as possible to the mica window of the Geiger tube.[3] The time period for the sample count, or the pre-set number of impulses to be recorded, is dependent upon the activity of the sample and the desired accuracy,[4] and is left to the experience and discretion of the investigator. A background count is taken before and after a sample measurement and for a similar period of time. The average of these two background counts is subtracted from the sample count to obtain the net sample count. Calculations are made on the net sample counts.

From several samples of analysed radioactive minerals on hand, three were chosen for experimental tests by the above method. Descriptions of these three samples are given in the following table:

Product	Chemical analyses[1] UO_2	UO_3	ThO_2	Calculated approximate per cent U_3O_8 radiation equivalent[2]
No. 1—Euxenite Mattawan tp., Ont.	6.42	0.43	0.97	7.3
No. 2—Euxenite, Maberley tp., Ont.	7.25	1.51	2.64	9.7
No. 3—Uraninite, Parry Sound, Ont.	53.63	26.32	3.22	82.4

[1] Ellsworth, H. V.: Rare-element Minerals of Canada, Geological Survey of Canada, Economic Geology Series No. 11, 1932.

[2] $UO_2 \rightarrow U_3O_8 = 1.0395$
$UO_3 \rightarrow U_3O_8 = 0.98136$
$ThO_2 \rightarrow U_3O_8 = 0.25$ (approximate Beta radiation equivalent)

The samples were tested against uranium standards prepared by the Mines Branch, Department of Mines and Technical Surveys. Ten milligrams of both samples and standards were measured with an end-window

[3] The distance between the sample surface and the mica window is critical as the sample may be regarded as a point source and, therefore, obeys the inverse square law, that the intensity of radiation is inversely proportional to the square of the distance from the source. The distance should be equal in measurements of both samples and uranium standards.

[4] Since radiations from radioactive substances are random in their distribution, a large number of impulses must be recorded with the Geiger tube to ensure accuracy in sample measurements. The per cent probable error associated with counting rates is given by the formula: $67.45/\sqrt{n}$ where n is the number of recorded impulses. It may be seen from substitution in this formula that it is necessary to total approximately 4,000 impulses to reduce the statistical error to one per cent. (*See* also: Harris, R. F.: Statistical Variation Applied to Radioactive Counting, Mines Branch, Department of Mines and Technical Surveys, Topical Report No. 38, Sept. 1949.)

Beta tube in combination with a ratemeter. The mica window thickness of the Beta tube was 1–2 mg/cm². Results of measurements are as follows:

Product	Net counts/minute	Per cent U_3O_8 equivalent	Per cent U_3O_8 equivalent from chemical analyses
No. 1	190	7.6	7.3
No. 2	246	9.8	9.7
Standard sample, 8.72 per cent U_3O_8	218	—	—
No. 3	1668	82.2	82.4
Standard sample, 63.19 per cent U_3O_8	1283	—	—

The results of the uranium standards are not in agreement as measurements were made on different days and the powder surfaces were at different distances from the mica window of the Geiger tube.

The method described above is also used by the Radioactivity Laboratory of the Geological Survey of Canada for quantitative radioactivity measurements of the concentrates from concentration tests of low-grade radioactive materials.

Unaltered, primary radioactive minerals commonly have a higher specific gravity than the gangue minerals, and can often be concentrated by gravity separation. However, where a concentration of the radioactive constituents is effected on low grade samples the amount of concentrate separated is usually too small for quantitative radiometric measurements by previous methods using metal trays with small depressions to hold the sample powder. The radioactivity of concentrates in such instances was calculated from the activities and weights of the middlings and tails, and the head sample. Several errors were thus introduced which can now be eliminated by a radiometric measurement of the concentrate itself.

A METHOD FOR THE SEPARATION OF MINERAL GRAINS FROM SIZED PRODUCTS[1]

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In the course of laboratory investigations for the Radioactivity Division, Geological Survey of Canada, a quick and easy method has been

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