Age of Extremely Ancient Pegmatites from South-eastern Manitoba

In the determination of the geological ages of minerals by radioactivity methods, much attention is being given to those ages which are of the greatest antiquity. There are several reasons for this. The age of the oldest mineral sets a minimum value for the age of the earth; also a probable minimum age is set for the solar system and extra-terrestrial matter in general. A bottom 'rung' is given for any stratigraphical age column, and these great ages are of value when attempting to draw up possible maximum life-spans for the evolution of living organisms to their present state of complexity. In areas of extreme antiquity, suitable minerals may be used for the indirect determination of the decay constants of potassium[1]; furthermore, areas of greatest age are the most suitable places for seeking possible undetected radioactivities (for example, indium-115[2]). Consequently, it is highly desirable that these greatest ages be known accurately and that several checks be made.

Measurements made by the lead method (see discussion of several determinations by Holmes[3]) and the strontium method[4] show the age of pegmatites from south-eastern Manitoba as the greatest thus far measured. A like age is found by Hurley[5], using helium age determinations, for an east–west orogenic belt of infolded rocks in Ontario: the area of granites and pegmatites from south-eastern Manitoba lies on this east–west belt if extended westward. Holmes[3] calculates an age of 1,985 × 10^6 years from lead/uranium data, from uraninite, and Ahrens[4] finds 2,100 × 10^6 years based on the strontium/rubidium measurements on four specimens of lepidolite. The agreement is very good; but neither measurement can be regarded as wholly satisfactory. For the calculation of the lead age, some corrections have had to be applied[3], whereas the strontium ages, although undoubtedly of the right magnitude, are not precision measurements.

New measurements have been made, using the strontium method applied to a specimen of lepidolite. Recently developed spectrochemical methods (in preparation for publication) were used for the analysis of rubidium and of strontium.

Apart from the random error in any method of analysis, a spectrochemical procedure frequently introduces a systematic error because of the use of synthetic standards. In the present determinations, however, systematic error is believed to be absent, and there is only a relatively small random error (see below). Five determinations of rubidium and nine of strontium were made (see table).

Lepidolite from the Winnipeg River, South-eastern Manitoba

	Rubidium (%)	Strontium (%)
	2·56	0·020
	2·56	0·017
	2·60	0·023
	2·78	0·020
	2·64	0·014*
		0·019
Mean	2·64 (± 0·06)	0·025
		0·016
		0·030*
Mean		0·0205 (±0·0012)

* These two deviations are unusually large for this method; whether or not they are included in the calculation of the mean matters little, however.

Strontium concentrated from the specimen of lepidolite was shown by mass spectrographic analysis as more than 99 per cent radiogenic. This analysis was made by W. T. Leland in A. O. Nier's laboratory at the University of Minnesota.

For the calculation of the age of the specimen, the mean (5·9 × 10^{10} years) of the half-lives of rubidium-87 given by Eklund[6] (5·8 × 10^{10} years) and Haxel, Houtermans and Kemmerich[7] (6·0 × 10^{10} years) was employed. The age works out at 2,400(2,380) × 10^6 years.

This measurement replaces the earlier more approximate strontium measurements. Agreement is reasonably good with these earlier strontium measurements and with the lead measurements, and there seems no doubt whatever about the great age of the pegmatites.

The difference of 400 × 10^6 years between the new strontium age and the lead age does, however, seem large enough to be significant. At this stage the reason for the discrepancy is not apparent. Further lead age-determinations which are thoroughly reliable (no correction necessary) on relatively fresh uraninite are highly desirable; precise checking of the half-life of rubidium-87 is also desirable.

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[1] Ahrens, L. H., and Evans, Robley, D., *Phys. Rev.*, **74**, 279 (1948).
[2] Ahrens, L. H., *Nature*, **162**, 413 (1948).
[3] Holmes, Arthur, *Trans. Edin. Geol. Soc.*, **14**, 176 (1948).
[4] Ahrens, L. H., *Bull. Geol. Soc. Amer.*, **60**, 217 (1949).
[5] Hurley, Patrick, M., *Science*, **110**, 49 (1949).
[6] Eklund, S., *Arkiv. Mat., Astron., Fysik.*, A **33**, No. 14 (1946).
[7] Haxel, O., Houtermans, F. G., and Kemmerich, M., *Phys. Rev.*, **74**, 1886 (1948).

Use of Plastics in the Fresnel Rhomb

In this note the suitability of the new optical plastics for use in the Fresnel rhomb is discussed. Because the polarizing angle for a dielectric-to-air surface varies very little with change of frequency, and its polarizing properties are affected less by surface deterioration and the presence of films than is the case with metallic surfaces, polarization by internal reflexion remains the most satisfactory means of producing circularly polarized white light. The problem exists as to what is the most suitable non-metallic medium for this purpose. It is hoped that the following considerations will show that choice is not restricted to the classical glasses adopted since Fresnel's time.

The essential requirement of the polarizing medium is that its refractive properties will permit the realization of the necessary phase difference, $\pi/2$, between the components of the incident vibration, preferably at a single reflexion. This requires the satisfaction of the relationship[1]

$$\Delta = \frac{\pi}{2} = 2 \tan^{-1} \frac{\cos i \, (\sin^2 i - 1/n^2)^{1/2}}{\sin^2 i},$$

where i is the angle of incidence and n is the refractive index of the medium for light passing to it from air. It follows that Δ cannot exceed $2 \tan^{-1} (n^2 - 1)/2n$, and a phase difference $\pi/2$ can be produced by a single reflexion only when n is not less than 2·414. Diamond, $n_D = 2{\cdot}417$, is ideally suited for this purpose. Because of the inherent disadvantages of such