other gas and many hundred times greater than for argon, clearly proves that it is wrong to assume that the behaviour of a symmetrical molecule like methane towards slow electrons is fully similar to that of a symmetrical atom like argon, in spite of close resemblances in the Q-$\sqrt{V}$-curves.

Commenting on a recent paper by Brose and Saayman[5] in which Q-$\sqrt{V}$-curves obtained by Ramsauer's and Townsend's methods are compared, Ramsauer, after making friendly acknowledgment of the results obtained by Townsend's method, expresses the view that little credence would have been given to the results obtained by Townsend's method if this had not been confirmed by his own *direct* method. He also suggests that the writers of the paper just quoted convey the impression that their belief in the results obtained was also to some extent contingent on this confirmation.

We cannot agree with this view. The theory of Townsend's experiment is based on the ordinary kinetic theory of gases and no flaw has been detected in the calculation. The fact that k and W have been experimentally proved to depend only on Z/p gives striking confirmation of the theory.[6]

The above remarks concerning methane and argon show that Townsend's method possesses certain very decided advantages and gives considerably more information about the collision of electrons with gas atoms and molecules than Ramsauer's method, which, as in the present case, may easily lead to erroneous conclusions.

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[1] *Ann. d. Phys.*, p. 1065; 1927.
[2] *Phys. Rev.*, **25**, 636; 1925.
[3] *Ann. d. Phys.*, **4**, p. 97; 1930.
[4] *Phil. Mag.*, vol. 54, p. 1033; 1922.
[5] *Ann. d. Phys.*, **5**, p. 797; 1930.
[6] See also a recent paper by J. S. Townsend, *Phil. Mag.*, **9**, p. 1145; June 1930.

Helium Ratios of the Basic Rocks of the Gwalior Series.

IN collaboration with Prof. A. Holmes, I have already published estimates of the ages of the Whin Sill and the Cleveland Dyke based on the helium ratios of these rocks (NATURE, May 25, 1929, p. 794). We came to the conclusion that the method offers great scope for the correlation of fine-grained basic igneous rocks when direct geological evidence is lacking.

I have since undertaken a similar investigation of the basic lavas and intrusions of Gwalior with the intention of testing the effect of texture on the retention of helium and of estimating as closely as possible the geological age of the series. The uranium and thorium determinations were made in the laboratory of Prof. H. Mache at the Technische Hochschule, Vienna. For the determination of the helium contents in these samples, as well as in those of the Whin Sill and the Cleveland Dyke previously mentioned, I am indebted to Prof. F. Paneth, in whose laboratory a special technique for the measurement of very small quantities of helium has been developed (NATURE, June 1, 1929, p. 879; Mar. 29, 1930, p. 490). The results, obtained in Prof. Paneth's laboratory by his assistant, Dr. K. W. Peterson, are recorded in the adjoining table. The 'age' (in millions of years), which is to be regarded as a minimum in each case, is calculated from the formula $8{\cdot}5\text{He}/(\text{U}+0{\cdot}29\text{Th})$ where U and Th are percentages and He is the volume in c.c. at N.T.P. in 100 gm. of the mineral (A. Holmes and R. W. Lawson, *Am. Jour. Sci.*, April 1927, p. 334).

The four rocks investigated all come from the Morar group of the Gwalior Series and are geologically of the same age. No. 1 is from a fine-grained basalt flow. Nos. 2 and 3 are from sills and are medium-grained

Localities.	Ra $\times 10^{12}$ gm./gm.	U $\times 10^6$ gm./gm.	Th $\times 10^6$ gm./gm.	He $\times 10^6$ c.c./gm.	'Age' in 10^6 years.
1. Belaki-Bauri .	0·17	0·51	1·7	55	466
2. Santowa Temak	0·18	0·54	1·5	42	369
3. Paniar . .	0·23	0·69	2·4	31	190
4. Dhaneri . .	..	..	..	11	..

dolerites of much coarser grain than the first rock. No. 4 is also from an intrusion, but is very coarse-grained. From these results and those previously published, it is clear that helium is more satisfactorily retained by fine- rather than coarse-grained basaltic rocks. With a coarser grain, fractures tend to develop along the crystal boundaries, where the radioactive elements, and the helium liberated by them, tend to be concentrated. Thus the coarser rocks are more liable to lose part of their helium content than those of finer grain.

The Gwalior Series is included in the Purana group of India and is considered to be of Pre-Cambrian age, and possibly equivalent to the Keweenawan of North America. According to recent opinion, based on fossil evidence from the Suket shales near the junction of the Lower and Upper Vindhyan Series, much of the Vindhyans is now to be regarded as of Cambrian age (*Rec. Geol. Surv. India*, **61**, pt. 1, p. 21; 1928). In the Son Valley, acid lava flows are found in the Lower Vindhyans, while in Rajputana the flows are invaded by granites. It seems most probable that this manifestation of acid igneous activity marks the close of an igneous cycle that started with the basic lavas of the Gwalior Series. If so, the latter should be slightly older than the Lower Vindhyans. On the whole, the evidence supports the traditional view that the Gwalior lavas are of late Pre-Cambrian age.

I am indebted to Prof. Holmes for the information that an Upper Cambrian kolm from Sweden (investigated by the American Committee on the Measurement of Geological Time) gives a lead ratio of 0·056, pointing to an age of about 400 million years. No lead ratios are yet available for minerals known definitely to be of late Pre-Cambrian age; but the thorianites of Ceylon, the pitchblendes of Katanga, and the uraninites of Morogoro are all considered on general grounds to fall somewhere within the Upper Pre-Cambrian, and their ages as calculated from lead ratios are all near 580 million years. The most reliable of the Gwalior rocks (No. 1) gives an age of 466 million years, in reasonable agreement with the geological evidence, with such lead ratios as are available as a check, and with the probability that a little helium may have been lost even from this specimen.

The data so far available have given the following results:

Tertiary . . .	Cleveland Dyke	26 million years.
Late Carboniferous .	Whin Sill	182 ,, ,,
Late Pre-Cambrian .	Gwalior basalt	468 ,, ,,

These encourage the belief that, given suitable material, a method is now available for dating fine-grained basaltic rocks. Even though the 'ages' may be somewhat too low, and this is particularly to be expected in the case of older rocks, the method is sufficiently sensitive to distinguish the rocks of different igneous cycles, provided that these are not too close.

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