(2.1 Å. at 6563 Å.) in the lower chromosphere, but higher up it gives fringes which show self-reversal. In the corresponding centre spectrum (b) the absorption line of H_{α} is also too broad to show fringes, and D_3 is absent.

A fuller account of this work and of the profiles of the D_3 line in the latitude range covered will be communicated elsewhere.

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¹ Meissner, K. W., *J. Opt. Soc. Amer.*, **32**, 191 (1942). Kuhn, H., "Rep. Progress in Phys.", **14**, 80 (1951). Jarrett, A. H., and von Klüber, H., *Nature*, **169**, 790 (1952).

² Jarrett, A. H., and von Klüber, H., *International Astronomical Union Draft Reports* (1955), p. 93.

³ Brück, H. A., and Jackson, D. A., *Proc. Roy. Soc., A*, **216**, 183 (1953).

Palaeomagnetic Study of Rocks from the Grand Canyon of the Colorado River

DR. S. K. RUNCORN has recently described measurements of remanent magnetization made on sediments collected from the Colorado Plateau of Arizona¹ and has compared these results with those made on rocks of similar age from Great Britain. During the summer of 1954 I also collected from the Grand Canyon of the Colorado River for the purpose of making studies of remanent magnetism on these rocks. I wish here to compare my results with those obtained by Dr. Runcorn.

Of the many rocks exposed in the Grand Canyon, only those of the Supai Formation (Permian Age) and the Hakatai Shale (Algonkian Age) could be shown to have retained, up to the present, the magnetization they obtained on deposition. A comparison of the results obtained by Dr. Runcorn and myself is given in Table 1.

Table 1

Authority	Formation	Magnetic declination	Magnetic inclination	Rad. of 95% probability	Deduced pole position
Runcorn	Supai	S. 47.3° E.	+ 22.9°	7.5°	121° E., 26° N.
Doell	Supai	S. 34° E.	+ 8°	7°	115° E., 39° N.
Runcorn	Hakatai*	S. 87.7° W.	+ 72.8°	5.4°	150° W., 31° N.
Doell	Hakatai*	S. 66° W.	+ 72°	17.5°	144° W., 18° N.

* The magnetic directions are not corrected for geological dip (about 10°).

The angular difference between the average directions is 19° for the Supai rocks and 7° for the Hakatai rocks. It is very probable that Runcorn's direction for the Supai should be farther to the south with a smaller inclination², thus bringing the angular difference between the two sets of measurements within the probable error.

It is important to note that these measurements were made entirely independently. Runcorn restricted his collection to the Kaibab Trail, whereas my collections were taken equally from the Kaibab and Bright Angel Trails (separated by about 2½ miles). Further, Dr. Runcorn's measurements were made on an astatic type instrument, whereas mine were made on a 'rock generator' type magnetometer made available by the Stanolind Oil and Gas Co., Tulsa, Oklahoma. The comparison is very encouraging, in that the number of samples measured in each determination is of the order of ten to twenty.

No 'reversals' were found by Dr. Runcorn or me in either the Supai rocks or the Hakatai rocks. Thus,

if the main geomagnetic field reverses itself, as postulated by Hospers for the Tertiary³, and by Clegg *et al.* for the Triassic⁴, such reversals are not evident in the periods represented by the Supai and Hakatai rocks.

Details of this work will appear elsewhere after further studies of magnetic stability have been made.

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¹ Runcorn, S. K., *Nature*, **176**, 505 (1955).

² Greer, K. M., Irving, E., and Runcorn, S. K., *J. Geomag. and Geoelect.*, **6**, 163 (1954).

³ Runcorn, S. K., *Bull. Geol. Soc. Amer.* (in the press).

⁴ Hospers, J., *J. Geol.*, **63**, 59 (1955).

⁵ Clegg, J. A., Almond, M., and Stubbs, P. H. S., *Phil. Mag.*, **45**, 583 (1954).

Anisotropy of Effective Gas Diffusion Coefficients in Extruded Carbon Rods

It is well known that, in extruded cylindrical samples composed of either particles of amorphous carbon or graphitized carbon, the properties of thermal expansion, thermal conductivity and electrical conductivity are highly anisotropic¹. The anisotropy in these properties is caused by the orientation of the irregular particles with their long side parallel to the direction of extrusion and by the inherent anisotropic behaviour of the crystallites composing the particles.

The orientation of irregular particles would also be expected to produce anisotropy of effective gas diffusion coefficients in extruded carbon rods. To investigate this phenomenon, effective diffusion coefficients, D_{eff} (H_2 - N_2), were determined on three commercial samples, all using coal-tar pitch as a binder: a lampblack gas baked at about 1,000° C. (A), a petroleum coke graphitized at about 2,500° C. (B), and a petroleum coke graphitized at about 3,000° C. (C). The apparatus and procedure described by Weisz and Prater² and us³ were used. Samples $\frac{1}{8}$ in. long by $\frac{1}{8}$ in. in diameter were used; they were previously cut either parallel or perpendicular to the direction of extrusion from rods 2 in. long by $\frac{1}{2}$ in. in diameter. The results on each sample, shown in Table 1, represent at least three different specimens, with the individual values duplicated within ± 5 per cent.

D_{eff} (H_2 - N_2) was calculated on the basis of the external geometrical length of the cylinder. If the pores in the solid are completely random in direction, the average length of travel of gas is shown by Wheeler⁴ to be 1.41 times the external length of sample (tortuosity factor). However, if the particles composing the sample are oriented by extrusion, it is

Table 1. EFFECTIVE DIFFUSION COEFFICIENTS OF HYDROGEN-NITROGEN IN CARBON RODS PARALLEL AND PERPENDICULAR TO DIRECTION OF ROD EXTRUSION

Sample	D_{eff} (cm. ² /sec., S.T.P.)		Ratio of D_{eff}
A	0.049	0.038	1.29
B	0.044	0.039	1.13
C	0.088	0.053	1.66