A DYKE SWARM IN EAST GREENLAND.

SIR,—In connection with the important dyke swarm recorded by Messrs. L. A. Wager and W. A. Deer in the January number of the GEOLOGICAL MAGAZINE, it is striking to find the attendant phenomena so closely repeating those described by the writer for the meridional Lebombo monocline of the Eastern Transvaal.[1] There a basic swarm cuts, though not exactly at right angles, a thick group of lavas dipping seawards, and seemingly represents the feeder system to the upper effusions. The dykes become more numerous as the dip of the flows increases, and were introduced during the outpouring and downbending of the volcanics under considerable east-west tension.

The evidence cited by Wager and Deer incidentally constitutes strong support for the drifting of Greenland away from Scandinavia during the Tertiary with extensive downwarping, fracturing, and intrusion along the margin of the block.

It is unnecessary, however, to assume a deep-seated migration of sial towards the continent, as proposed by the authors, since the acceptance of the "paramorphic principle", developed elsewhere by the writer,[2] will readily explain both the super-elevation of the interior of Greenland and the sinking of the adjacent ocean floor. Their instructive paper provides, as a matter of fact, no small measure of support for that particular hypothesis of mineral transformation of a paramorphic nature in the sub-crust through loading and unloading of the earth's surface.

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14th February, 1938.

FLUORSPAR AND BARYTES IN THE NORTHERN PENNINES.

SIR,—A point of some general interest was raised by Mr. Arthur Russell in a discussion at a meeting of the Mineralogical Society on 11th March. In commenting on my published statement[3] that fluorspar in the Northern Pennine mineral field crystallized before barytes at the seventeen localities where those two minerals are found together, Mr. Russell stated that he has in his collection specimens from the Scordale mine, Westmorland (one of the localities in question), which show the opposite order of deposition. I was surprised at the time of my investigation of the Northern Pennine area not to be able to find any unambiguous evidence of fluorspar later than

[1] *Trans. Roy. Soc. S. Afr.*, xviii, 1929, 189.
[2] *Our Wandering Continents*, Edinburgh, 1937, x, xi.
[3] Dunham, K. C. "Genesis of the North Pennine Ore Deposits," *Quart. Jour. Geol. Soc.*, 90, 1934, 709.

barytes, in view of the frequent interbanding of these minerals to be seen in Derbyshire.[1] Mr. Russell's observations are therefore welcomed because they show that in the Northern, just as in the Southern, Pennine field, fluorspar may sometimes follow barytes in sequence.

This fact does not, of course, in any way prejudice my suggestion that the regular geographical disposition of the gangue and sulphide minerals in the area is due to temperature zoning. Mineral sequence in leptothermal deposits like those of the Pennines is notoriously unreliable on account of the common occurrence of banding ; it thus affords little guidance to the zonal relations to be expected.

The crystallization of barytes before fluorspar mentioned by Mr. Russell as occurring in some Cornish lodes in no way affects the correctness of the view that the barytes zone there represents lower temperature conditions than the fluorspar zone. Wolfram, though usually characteristic of the zone above the tin zone [2] nevertheless precedes cassiterite in order of deposition according to H. B. Cronshaw.[3] Similarly, Professor L. C. Graton has informed me that in the Butte district, Montana, sphalerite characteristic of the outer zones is sometimes found as the earliest sulphide mineral in the innermost enargite zone. This points to deposition while the temperature was rising, from which it may be suggested that barytes preceding fluorspar perhaps implies the same thing.

It follows that zoning provides the only safe guide to the temperature relations between vein minerals obtainable from field evidence. Mineral sequence at any particular place is likely to record both the rise and fall of temperature in the vein, as well as any fluctuations that may have occurred.

I should like to take this opportunity of expressing my regret that no reference was made in my 1934 paper to Mr. Russell's note recording his discovery of niccolite and ullmannite at Settlingstones.[4] The paper from which I was quoting also made no reference to this prior record.

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[1] Dunham, K. C. "Paragenesis and Colour of Fluorite in the English Pennines," *Amer. Min.*, 22, 1937, 473.

[2] Davison, E. H. "Mineral Associations in Cornish Tin Lodes," *Mining Mag.*, September, 1930, 2.

[3] Cronshaw, H. B. "Structure and Genesis of some tin-lodes in the Camborne district of Cornwall," *Trans. Inst. Min. Met.*, 30, 1920–1, 467.

[4] Russell, A. "Notice of an occurrence of niccolite and ullmannite at the Settlingstones Mine, Fourstones, Northumberland, etc.," *Min. Mag.*, 1927, 383–6.