

Kaeppler (Mrs. P. Gathercole) I am preparing an account of Humphrey's sale catalogue, the *Museum Humfredianum*, together with all that can be gleaned of his activities. This, and also a paper on the authorship of da Costa's *Conchology*, will be published in the *Journal of the Society for the Bibliography of Natural History*, London.

*Da Costa*: the eleven volumes of da Costa's letters in the British Museum seem to have been rather neglected but well repay study. Da Costa had extremely wide interests and corresponded with many of the prominent men of his day. These letters were at one time in the possession of John Nichols, who reproduced a number of them in his *Literary Anecdotes . . .* and also in his *Illustrations of the Literary History of the Eighteenth Century*.

*J. R. Forster*: Frondel (loc. cit.) referred to the possible relationship between Jacob Forster and Johann Reinhold Forster (1729–98), the much maligned naturalist and scholar who accompanied Captain Cook on his second voyage to the Pacific. More light on this may emerge from a biography of J. R. Forster now being prepared by Michael Hoare of the Australian National University, Canberra.

*Acknowledgement*. Historical papers relating to a particular discipline are frequently missed by an interested specialist in another field. I am indebted, therefore, to Mr. Peter G. Embrey of the Mineralogical Department of this Museum for drawing my attention to Dr. Frondel's useful study.

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#### REFERENCES

- FRONDEL (C.), 1972. Jacob Forster (1739–1806) and his connections with forsterite and palladium. *Min. Mag.* **38**, 545–50.  
HILL (D.), 1965. *Mr Gillray, the caricaturist: a biography*. Phaidon Publ., Greenwich, Connecticut, 266 pp.

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## Dichroic pigment-layers in Blue John fluorite

IN a recent contribution concerning the nature of the coloration in Blue John fluorite from Derbyshire and elsewhere, MacKenzie and Green (1971) reach certain conclusions that are incompatible with observations recorded by the present writer (Holgate, 1941, pp. 139–48). The writer's interest in the problem presented by this coloration stems from his earlier recognition of an unexpected dichroic effect in pigmented layers in fluorite crystals in a thin section of a fluorite-bearing dolomite originating from the

old Mam Tor lead mine near Castleton, Derbyshire. No reference to this phenomenon appears in the literature, and since the observations are relevant to the discussion of the nature of the coloration in this mineral, it appears to the writer that some record of his observations should be published without further delay.

The material studied included several thin sections of the fluorite-bearing dolomite (then in the collections of the Department of Geology, the University of Manchester) already referred to: thin sections were also made from crystallized Blue John fluorite from exposures in the neighbourhood of Treak Cliff, near Castleton, Derbyshire. In all of the sections examined, individual fluorite crystals showed alternating layers exhibiting varying depths of colour, all of which layers lay parallel to adjacent cube faces in such a manner as to suggest that they originated as successive layers deposited on those faces during the growth of the crystals. A finer structure, consisting of highly pigmented filaments orientated in a direction normal to the adjacent cube face, as noted by Nothhaft and Steinmetz (1930), was also recognized.

Examined under the microscope in plane-polarized transmitted light, a thin section of Blue John fluorite cut parallel to a cube face and passing through the centre of the crystal shows the characteristic pigmented zones or layers alternating with more feebly coloured or colourless bands. If a cube edge is set parallel to the plane of polarization of the transmitted light, coloured bands of similar orientation show absorption tints that differ from those exhibited by colour bands orientated at right-angles to the polarization direction. For a given pigmented band, the absorption colour seen when the transmitted light is polarized in a plane parallel to the edges of the band differs significantly from that shown when the plane of polarization lies transverse to the band. From observations on a number of suitably orientated sections of Blue John fluorite crystals, the dichroic scheme for a given coloured layer parallel to a cube face bounding the crystal section is:

plane of polarization *normal* to trace of cube edge: pinkish lilac to purplish magenta

plane of polarization *parallel* to trace of cube edge: greyish blue to indigo

the absorption corresponding to the latter orientation being distinctly the stronger. Less strongly coloured areas in the crystal, or thinner sections, show correspondingly weaker tints, but a similar relation holds. Deeply coloured areas often behave as if there were present, in addition, a strong non-dichroic component of coloration of bluish or indigo tint. Sections of Blue John fluorite that pass close to, and parallel with, a cube face exhibit, subject to complications resulting from imperfections of crystal growth (an important factor here), uniform and apparently structureless masses of colour, which are non-dichroic and of a more or less intense blue.

Apart from the clear dichroism exhibited by cross-sections of the coloured layers, the fluorite appears to be entirely normal in its optical properties; it shows no anomalous birefringence between crossed polars. Since in the crystals examined the regions immediately adjacent to planes corresponding to the loci of the cube edges during growth are seen to be free from coloration, it is concluded that the pigment is not appreciably deposited on planes of the form  $\{110\}$ . Similarly, triangular sections (e.g. cleavage sections) parallel to the octahedron  $\{111\}$  show a small central area, and

parallel-sided bands radiating from it to the vertices of the section, free from noticeable coloration; the pigment is therefore not deposited on {111} planes to an appreciable extent. The colour, whatever its nature, is therefore preferentially deposited on the cube form {100} alone. The dichroism shown by the coloured layers, in its orientation with respect to the crystal, fulfils the symmetry requirements of the cube faces of the fluorite as though the coloration were caused by a preferred orientation of chromophores of molecular dimensions deposited on the several cube faces during the growth of the crystal.

Analogous phenomena in artificial crystals have been reported by Buckley (1939, pp. 51-6; 1951, pp. 419-27); in the cases cited by him the coloration of normally colourless crystals, deposited from aqueous solution in the presence of dissolved organic dyes, is certainly due to the deposition of organic chromophores on crystal surfaces during the growth of the host crystal. Adapting Buckley's reasoning to the present case, it seems probable that if all of the pigment molecules attached themselves to faces of the cube form, during growth of the fluorite, by similar parts of their molecular structure and retained this orientation as they were enveloped by the continuing growth of the host crystal, the resultant coloration, insofar as the pigment molecules are themselves asymmetric, might be expected to exhibit directional properties revealed in a dichroism of the kind observable in crystals of Blue John fluorite.

Having satisfied themselves that neither the hydrocarbon content characteristic of Blue John fluorite, nor the traces of manganese found in some samples, are responsible for the coloration of this mineral, MacKenzie and Green (1971, pp. 469-70) conclude that the chief, and by implication perhaps the only, colouring agent present in the fluorites examined by them is probably colloidal calcium. The present writer finds this conclusion unacceptable since no colloidal substance, and particularly none of elementary constitution and dispersed in a cubic crystal structure, is capable of producing the dichroic phenomenon herein described. While he is loth to reject the many items of evidence recorded by these authors, he believes that hydrocarbon material of some kind remains the most likely type of chromophore that is at the same time competent to produce dichroic effects in a fluorite host.

It is interesting to note that this type of phenomenon in natural allochromatic minerals is not confined to Blue John fluorite; a somewhat similar effect in banded amethystine quartz has been noted by the writer (Holgate 1941, pp. 148-51). In this anisotropic host mineral it has been observed that in rather thick (*ca.* 5 mm) sections cut normal to faces of the positive and negative rhombohedra and to the plane of principal section in the crystal, the dichroic phenomena in pigmented layers respectively parallel to faces of the two forms are noticeably dissimilar. Nevertheless, they are in a general way reminiscent of the dichroic colours met with in Blue John fluorite, so raising the question as to whether the pigments involved have more than superficial similarity.

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## REFERENCES

- BUCKLEY (H. E.), 1939. *Mem. Proc. Manchester Lit. Phil. Soc.*, **83**, 31–62.  
 — 1951. *Crystal growth*. New York and London.  
 HOLGATE (N.), 1941. *Thesis for the degree of Doctor of Philosophy in the University of Manchester*.  
 Presented 15 October 1941.  
 MACKENZIE (K. J. D.) and GREEN (J. M.), 1971. *Min. Mag.* **38**, 459–70.  
 NOTHHAFT (J.) and STEINMETZ (H.), 1930. *Chemie der Erde*, **5**, 225–32 [M.A. 4–352].

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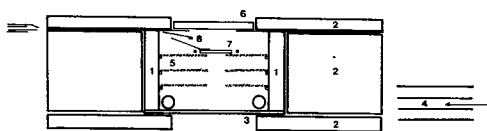
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## A simple microscope freezing stage

A SIMPLE and highly versatile microscope freezing stage has been developed for studies of fluid inclusions at temperatures down to  $-100^{\circ}\text{C}$ . The stage, utilizing cold gas as the heat exchange medium, has been in use for some time in the laboratories of the University of Durham and has proved to be both reliable and inexpensive to build, maintain, and use. It can be used in any working place with a supply of compressed air or inert gas.

*Construction.* The stage itself (fig. 1) is composed of a strong Perspex cylinder (1), encased in asbestos insulation (2) and sealed off at the bottom by a clear Perspex plate (3). Dry nitrogen, cooled by passing through a copper coil immersed in liquid nitrogen, is introduced to the chamber through a lagged stiff polythene tube (4). The tube is coiled around the base of the chamber and perforated by a series of upward



directed pinpricks. Three copper gauzes (5) supported within the chamber serve to thoroughly mix the gas as it vents upwards. The top gauze also supports the specimen holder—generally a small aluminium wire cage. Used gas escapes around the glass lid (6) which simply rests upon a flat card gasket. The lid thus forms a valve to prevent moist air from entering the chamber and causing frosting when the cold gas flow is reduced. A small jet of dry air directed on to the lid outer surface is sufficient to prevent external frosting. Nitrogen flow is controlled by a very fine needle-valve which can be adjusted to yield cooling rates up to about  $25^{\circ}\text{C}/\text{min}$ . The chamber temperature can be stabilized and maintained at any temperature down to about  $-100^{\circ}\text{C}$ .