Philosophical Magazine Series 3

ISSN: 1941-5966 (Print) 1941-5974 (Online) Journal homepage: http://www.tandfonline.com/loi/tphm14

XXXVI. On the cause of the colours in iridescent agate

Sir David Brewster K.H. D.C.L. F.R.S. V.P.R.S.

To cite this article: Sir David Brewster K.H. D.C.L. F.R.S. V.P.R.S. (1843) XXXVI. On the cause of the colours in iridescent agate , Philosophical Magazine Series 3, 22:144, 213-215, DOI: 10.1080/14786444308636355

To link to this article: http://dx.doi.org/10.1080/14786444308636355

XXXVI. *On the Cause of the Colours in Iridescent Agate. By* Sir David Brewster, *K.H., D.C.L., F.R.S., & V.P.R.S. Edin.**

IN the Philosophical Transactions for 1813 †, I have described the general phænomena of colours produced in iridescent agates of different kinds, but I was not able to discover the cause by which these colours were produced. The spectra which accompanied the colourless image of a luminous body seen through the agate had a decided resemblance to those produced by diffraction in grooved surfaces, but as no grooves existed on the surface of the agate, as in mother-of-pearl, and as no veins could be seen in the interior of the mineral by the most powerful microscope which I then possessed, I was not entitled to ascribe the colours to an invisible agency. In a subsequent examination ‡ of the coloured images produced by certain specimens of calcareous spar, inclosing oppositely crystallized veins, I was led to suppose, from the observation of some similarly placed veins in particular specimens of agate, that the colours were those of polarized light as in calcareous spar; but re-examination of the phænomena in new specimens of agate afterwards convinced me that this opinion was not correct.

In repeating all my early experiments, with a little more experience and knowledge of the subject, I soon perceived that the actual phænomena were identical with those of the diffraction spectra. The coloured spectra in the agate suffered no change by increasing or diminishing the thickness of the plate. The less refrangible half of the spectrum was greatly expanded, and, in some good specimens, I observed the repetition of the spectra *three* times at equal intervals, and with increasing dispersion. In the specimen represented in plate v. fig. 1. of the Philosophical Transactions for 1814 §, I had observed that the *second* spectrum was only a little further distant from the colourless image than the *first* spectrum, which was 28° distant from that image. This fact, as it then appeared to me, put an end to the supposition that two such consecutive spectra could be produced by diffraction; but upon re-examining this specimen, I find that, though my observation of the fact was correct, yet I was wrong in considering it as a *second* spectrum connected with the *first* spectrum of 28°. It was, in reality, a *first* spectrum distant 31° from

* Communicated by the Author.

† Phil. Trans. 1813, p. 102, 103; 1814, p. 197–199.

‡ Ibid. 1815, p. 287.

§ Ibid. 1814, p. 198, par. 2. [or Phil. Mag. S. 1. vol. xlii. p. 286, 287; xliv. p. 267, 268.]

the colourless image, and produced by a part of the stripe of agate which had a different structure from the part of it which gave the spectrum of 28° *.

Having removed this difficulty I submitted a variety of agates to the microscope, and I found some which gave very faint diffraction spectra exceedingly close to the colourless image, and in those cases I could distinctly see the edges of the thin veins of which that part of the agate was composed, the number of these veins in an inch corresponding with the distance of the diffraction spectra. This result encouraged me to examine the beautiful specimen represented in fig. 2. plate v. of the paper already referred to, in which the part that produced the spectra exhibited no other difference from the part which did not produce them, than that of having a coarser rippled structure. I employed for this purpose a very fine achromatic microscope made by Messrs. A. Ross and Co., and after an accurate adjustment of the illuminating apparatus, I succeeded in discovering that the whole portion of the agate which produced the prismatic spectra consisted of veins so exceedingly minute that *seventeen thousand* of them would be required to make an inch. If, using Fraunhofer's letters, we call the thickness of a vein δ, the interval between the veins γ, and $\delta + \gamma = \varepsilon$, then $\varepsilon = \frac{1}{8610}$ of an inch; and as δ is nearly equal to γ we have $\delta = \frac{1}{17220}$dths part of an inch. In other specimens I have obtained the following results:—

Values of ε.	Thickness of each vein or δ.
$\frac{1}{8610}$ of an inch.	$\frac{1}{17220}$ of an inch.
$\frac{1}{11070}$	$\frac{1}{22140}$
$\frac{1}{22960}$	$\frac{1}{45920}$
$\frac{1}{25420}$	$\frac{1}{50840}$
$\frac{1}{27880}$	$\frac{1}{55760}$

As it is only in the first of these specimens that I have yet been able to discover the veined structure, we may consider these iridescent agates, when cut into thin plates, so that the veins are perpendicular to the two parallel faces, as affording the most difficult tests in microscopical observations.

In diffraction experiments this property of the agate may

* In fig. 1, plate v. of the Phil. Trans. 1814, A B is the stripe which produced these two spectra, the one of 28° being produced by the part *m o p n*, and the other of 31° by the part *o w x p*.

be found very useful. In one specimen which I have examined, having its faces inclined 2° or 3° to each other, I can distinctly see the line D of the spectrum formed from the light of a candle with a salted wick; and I have no doubt that specimens of agate will be found, and may be so nicely prepared in extremely thin plates, with their surfaces perpendicular to the veins, as to give diffraction spectra more perfect, and much more enlarged than it is possible to obtain from any system of parallel grooves that can be produced by art.

To the mineralogist this determination of the structure of the agate cannot fail to be interesting. The difference in the colour of the veins and their intervals, and their singular equality of thickness, is very remarkable. In the structure of mother-of-pearl, the succession of strata or veins marks the period of rest during which the animal has ceased to labour; and in the structure of *nacrite*, the artificial mother-of-pearl formed upon the dash-wheel at the cotton-works at Catrine*, the passage of one stratum into another indicates the daily rest of the wheel, and of the operations to which it gives rise; but it is not easy to understand how an aqueous solution of silex contained in the cavity of a solid rock, should deposit its solid contents with that uniformity and regularity which are found in structures depending on the periods of animal life or human labour.

St. Leonard's College, St. Andrew's,
February 13, 1843.

XXXVII. *On the Geology of Egypt.* *By* Lieut. Newbold, *F.R.S., of the Madras Army* †.

Mr. Newbold first describes the physical features of Egypt, and 2ndly, the formations of which the country is composed.

I. *Physical Features.*—After alluding to the natural boundaries of Egypt, namely, the Mediterranean on the north, the Libyan desert on the west, the mountains of Nubia on the south, and the Red Sea, with the Isthmus of Suez, on the east, and stating that the area thus circumscribed comprises about 100,000 square miles, the author shows that Egypt has three great physical divisions: 1. the mountainous region extending between the Red Sea and the Nile; 2. the deserts east and west of the Nile; and 3. the fertile valley of that river, with its delta.

The mountainous region is naked and dreary in aspect, on account of the deficiency of springs, rain, and dew; and it presents bare or

* Phil. Trans., 1836, p. 49, and this Journal, S. 3. vol. x. p. 201.

† From the Proceedings of the Geological Society, vol. iii. part 2, being an abstract of a paper read June 29, 1842.