On some crystals of Quartz from De Aar (Cape Colony) and other localities.

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A SMALL set of quartz crystals of somewhat peculiar habit, collected by Lieut. E. G. Spencer-Churchill near De Aar, South Africa, and given by him to the Mineral Department of the University Museum, present some features of interest; two crystals, in particular, are remarkable as exhibiting faces seldom observed on quartz. The first has a face X lying in the zone $[mz]$ (or $[mr]$?), the other a well-developed face in the zone $[rz]$.

The crystal bearing the former face, X, is depicted in fig. 1. As regards habit and other features, it is in all respects similar to the second crystal (fig. 2).

The faces r and z cannot be distinguished with certainty, but cleavage-cracks within the crystal point to the lettering shown in fig. 1. The polariscope proves the presence of both right- and left-handed material.

The face X gave on the goniometer two indifferent images (X_1, X_2), neither of which could be preferred to the other; the measured angle leads to the indices $(77\bar{5})$ and $(33\bar{2})$ if the faces are below z, or to $(11.\bar{1}.\bar{1})$ and $(14.\bar{1}.\bar{1})$ if they are below r. All four faces have been found by Des Cloizeaux on crystals from Traversella.

	Angle to m. Observed.	Calculated.	Miller.	Bravais.	Des Cloizeaux.
X_1	30° 14′	30° 34′	$(77\bar{5})$ or $(11.\bar{1}.\bar{1})$	$(\bar{4}403)$ $(04\bar{4}3)$	$e^{\frac{5}{7}}$ e^{11}
X_2	32° 13′	32° 12½′	$(33\bar{2})$ or $(14.\bar{1}.\bar{1})$	$(\bar{5}504)$ $(05\bar{5}4)$	$e^{\frac{2}{5}}$ e^{14}

The other crystal is exhibited in fig. 2. The habit is slightly tabular parallel to r. The crystal is somewhat smoky and contains liquid inclusions, one of which shows a bubble. The surface is much corroded. There is no marked cleavage, and the crystal does not exhibit any s-faces. It is therefore not possible to identify r and z. On immersion in oil and examination in convergent polarized light, the crystal exhibits Airy's spirals, and is therefore an interpenetration-twin of right- and left-handed

material; the right-handed portion, however, appears to predominate. The lower end of the crystal is broken.

There is a single face on an edge [rz], which lies to the left of a rhombohedron-face, and corresponds to d_4 (13.$\bar{1}$.2) (13.11.$\bar{14}$.14) or to its inverse (11.31.22) (3.11.14.14). Measurement of the angle between this face, which is slightly rounded and gives a small band of images,

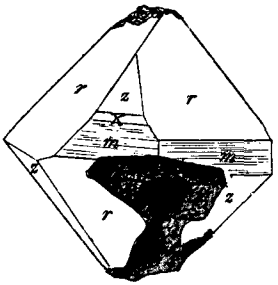

FIG. 1.

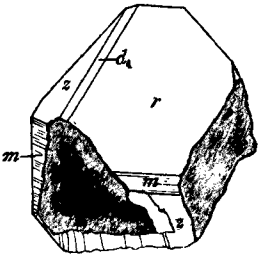

FIG. 2.

Quartz crystals from De Aar, Cape Colony.

and the rhombohedron-face, r or z, gave, as the mean observed value, 9° 30′, the corresponding calculated value being 9° 25′.

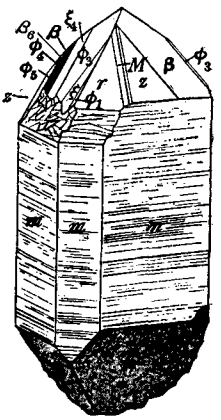

FIG. 3.—Quartz. (Locality unknown.)

The face d_4 was first observed by Websky[1] on a crystal of unknown origin; on this crystal, too, it was not accompanied by any other face of this series. The inverse form does not appear to have been observed.

The other crystals from this locality contain liquid inclusions, in small spaces which are either negative crystals or flattened cavities; and the crystals, when broken, yield a smell somewhat resembling that of petroleum.

On examining other crystals in the Oxford collection, one of unknown locality was found, also showing faces in the zone [rz]. It is depicted in fig. 3. The lower end of the crystal is broken away by cleavages parallel to the rhombohedron r; the m-faces are horizontally striated. The face s is present (at the back of the crystal), and its

[1] Ann. Phys. Chem. (Poggendorff), 1856, vol. xcix, p. 296.

position with respect to r proves the crystal to be left-handed. To the left of z, at M in the figure, there is a re-entrant angle. The r-faces are smooth, the z-faces rough. The lower end of the crystal is opaque, so that optical observations were not possible without mutilation.

The zones $[rz]$ are corroded, some of the corrosion-faces giving distinct images, while there is also a band of images approximating to a face β (20.$\bar{7}$.14). The faces occur on two edges $[rz]$—A and B, and the measured angles between them and r are given in the following table, together with the corresponding calculated angles and indices. The angles are calculated for an axial ratio $a:c = 1:1{\cdot}09997$ ($rr' = 85°\ 46'$).

Face.	(hkl) : 100.		Miller.	Bravais.
	Observed.	Calculated.		
		On the edge A.		
	° ′	° ′		
ϕ_1	13 48	13 50	121.$\bar{1}$4.28	14.31.$\bar{4}$5.45
ξ	22 52	23 8	5$\bar{1}$2	11$\bar{2}$2
ϕ_3	27 44	27 43	77.$\bar{1}$9.38	19.13.$\bar{3}$2.32
ξ_4	33 38	33 30	16.$\bar{5}$.10	52$\bar{7}$7
A band of faces	35 5 to 38 13	35 11 to 38 14	3$\bar{1}$2 to 83.3$\bar{1}$.62	31$\bar{4}$4 to 31.7.$\bar{3}$8.38
β (centre of the band)	36 39	36 29	20.$\bar{7}$.14	72$\bar{9}$9
β_6	43 40	43 38	11.$\bar{5}$.10	15.1.$\bar{1}$6.16
ϕ_4	44 49	44 46	19.$\bar{9}$.18	27.1.$\bar{2}$8.28
ϕ_5	45 29	45 28	35.$\bar{1}$7.34	51.1.$\bar{5}$2.52
		On the edge B.		
ϕ_3	27 46	27 43	77.$\bar{1}$9.38	19.13.$\bar{3}$2.32
A band of faces	34 27 to 37 26	34 27 to 37 26	149.$\bar{1}$7.94 to 257.$\bar{9}$1.182	141.55.$\bar{1}$96.196 to 91.25.$\bar{1}$16.116

It is noteworthy that we have a band of images about β in both cases. ξ was first observed by Des Cloizeaux, ξ_4 by Gonnard, β by Des Cloizeaux, and β_6 by Gonnard.

The crystal appears to be very similar to some described by Lacroix [1], in which the surfaces between r and z were curved and gave sometimes separate images, sometimes groups of images. Thus on a crystal from Allevard in the department of Isère, he found images indicating faces inclined to r at angles varying between the values 9° 30′ and 11° 0′; also between 22° 0′ and 27° 2′: finally, the faces β_1 (3$\bar{1}$2) and β_6 (11.$\bar{5}$.10) gave distinct images. Again, a crystal from La Gardette showed a large undulating surface with triangular cavities. The author

[1] 'Minéralogie de la France,' 1901, Tome iii, Fasc. 1, p. 100.

observes that—'It gives almost uninterrupted reflections between H_0 and ξ, which are most clear in the neighbourhood of H_1. These are without doubt due to natural corrosion.'

The following is a list, partly compiled from that given by Gonnard[1], of the faces hitherto observed between r and z in the zone $[rz]$ on quartz. The indices are here all given as for faces lying to the left of r or to the right of z.

Symbol.	Calc. angle $(hkl):(100)$.	Miller.	Bravais.	Observer[2].
d_{10}	3° 1′	41.$\bar{1}$.2	1.13.$\bar{14}$.14	Websky.
γ_3	3 16	38.$\bar{1}$.2	1.12.$\bar{13}$.13	vom Rath.
d_9	4 16	29.$\bar{1}$.2	1.9.$\bar{10}$.10	Websky.
d_8	5 22	23.$\bar{1}$.2	1788	,,
d_7 } H }	7 14	17.$\bar{1}$.2	1566	Websky. Des Cloizeaux.
d_6 } H_0 }	8 11	15.$\bar{1}$.2	3.13.$\bar{16}$.16	Websky. Gonnard.
d_5 } H_1 }	8 45	14.$\bar{1}$.2	1455	Websky. Des Cloizeaux.
d_4	9 25	13.$\bar{1}$.2	3.11.$\bar{14}$.14	Websky.
d_3 } H_2 }	11 5	11.$\bar{1}$.2	1344	Websky. Des Cloizeaux.
γ_{11}	12 9	10.$\bar{1}$.2	3.8.$\bar{11}$.11	vom Rath.
d_2	13 26	9$\bar{1}$2	3.7.$\bar{10}$.10	Websky.
ϕ_1	13 50	121.$\bar{14}$.28	14.31.$\bar{45}$.45	Barker.
H_4	14 21	42.$\bar{5}$.10	15.32.$\bar{47}$.47	Gonnard.
d_1 } γ }	15 2	8$\bar{1}$2	1233	Websky. Des Cloizeaux.
H_5	19 38	6$\bar{1}$2	3477	Gonnard.
H_6	22 9	21.$\bar{4}$.8	12.13.$\bar{25}$.25	,,
ξ	23 8	5$\bar{1}$2	1122	Des Cloizeaux.
ξ_1	26 38	17.$\bar{4}$.8	4377	Termier.
ϕ_3	27 43	77.$\bar{19}$.38	19.13.$\bar{32}$.32	Barker.
γ_0	28 1	4$\bar{1}$2	3255	Termier.
ξ_2	29 14	19.$\bar{5}$.10	5388	Gonnard.
ξ_3	30 32	18.$\bar{5}$.10	15.8.$\bar{23}$.23	,,
γ_1	31 14	7$\bar{2}$4	2133	Des Cloizeaux.
γ_2	32 50	23.$\bar{7}$.14	7.3.$\bar{10}$.10	,,
ξ_4	33 30	16.$\bar{5}$.10	5277	Gonnard.
β	35 11	3$\bar{1}$2	3144	vom Rath.
β_1	36 29	20.$\bar{7}$.14	7299	Des Cloizeaux.
γ_4	40 6	5$\bar{2}$4	6177	Gonnard.
β_5	41 14	12.$\bar{5}$.10	15.2.$\bar{17}$.17	,,
β_6	43 38	11.$\bar{5}$.10	15.1.$\bar{16}$.16	,,
ϕ_4	44 46	19.$\bar{9}$.18	27.1.$\bar{28}$.28	Barker.
ϕ_5	45 28	35.$\bar{17}$.34	51.1.$\bar{52}$.52	,,

[1] Bull. Soc. franç. Min., 1902, vol. xxv, p. 62.

[2] Authorities cited in the table:—

M. Websky, Ann. Phys. Chem. (Poggendorff), 1856, vol. xcix, p. 296; and Neues Jahrb. Min., 1871, p. 908.

A. Des Cloizeaux, Ann. Chim. Phys., 1855, ser. 3, vol. xlv, p. 129; and 'Mém.

It appears from the statements of previous authors, and from my own observations, that of the above faces d_{10}, ϕ_1, H_4, H_5, H_6, ϕ_3, γ_0, ξ_2, ξ_4, β_5, β_6, ϕ_4, and ϕ_5 occur on the left of r, their indices being of the form $\{h\bar{l}\bar{k}\}$, where $k = 2l$; while γ_3, $H(d_7)$, $H_0(d_6)$, $H_1(d_5)$, $H_2(d_3)$, ξ_1, β_1, and γ_4, lie on the right of r, their indices being of the form $\{hk\bar{l}\}$; finally, γ_{11}, d_2, $\gamma(d_1)$, γ_1, and β occur both on the right and left of r. It is impossible to determine the positions of the remaining forms.

Gonnard[1] identifies his face γ_0 (3255) with a face Γ_1 (32.$\bar{1}$7.$\bar{1}$5.62) found by Termier. It may be seen, however, that Γ_1 does not lie in the zone $[rz]$. The error probably arose from the similarity of angles. $[r\Gamma_1 = 28° 14', r\gamma_0 = 28° 20'$ (observed values)].

Again in fig. 2[2] of crystal *A* (quartz from Meylan) the faces ξ_2, H_5, β_6 appear to be wrongly lettered, since the order of the faces in the zone should from the indices be z, β_6, ξ_2, H_5.

In two cases Gonnard[3] describes as 'dextrogyre,' crystals showing *s*-faces with left-handed striations, and again on p. 112 he seems to invert the ordinary use of the terms right- and left-handed.

The relative position of the Millerian and Bravais axes used above, is that adopted by Professor Miers[4] and Professor Lewis[5], in which the lateral hexagonal axes xyz are perpendicular to the planes containing the vertical axis w and the rhombohedral axes XYZ respectively. The axes XYZ, xyz (seen from above) are arranged counter-clockwise—the order being $+x$, $-z$, X, $+y$, $-x$, Y, $+z$, $-y$, Z.

sur la crist. et la structure intérieure du quartz' (Mém. prés. à l'Acad. Paris, 1858, vol. xv).

G. vom Rath, Zeits. Kryst. Min., 1881, vol. v, p. 1; and 1885, vol. x, p. 156.

P. Termier, Bull. Soc. franç. Min., 1895, vol. xviii, p. 443.

F. Gonnard, Bull. Soc. franç. Min., 1899, vol. xxii, pp. 92, 94; and 1902, vol. xxv, pp. 56, 90.

[1] Bull. Soc. franç. Min., 1902, vol. xxv, p. 61.

[2] Bull. Soc. franç. Min., 1899, vol. xxii, p. 97.

[3] Ibid., p. 93, fig. 1, and p. 124, fig. 1.

[4] Mineralogy, 1902, p. 66.

[5] Crystallography, 1899, p. 454.