Note on a large crystal of Anatase from the Binnenthal.[1]

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LAST year (1911) the Trustees of the British Museum acquired a large isolated crystal of anatase,[2] which is of interest not only on account of its unusual size, but also because of the vicissitudes that, to judge from the furrowed appearance of certain faces, it had undergone in the course of growth. It was by far the largest of the many crystals of this species that were found in the previous year (1910) near the ridge Kollergraben in the district known to early mineralogists as Alp Lercheltini, probably at a spot named Spissen.[3]

Honey-yellow in colour and translucent near the surface, the crystal (fig. 1) measures about 26 mm. in length and 20 mm. in its greatest width. The development is imperfect underneath, especially at the back, where cling a few small crystals of anatase of similar habit as well as a little magnetite, adularia, and mica. In habit the crystal is similar to one from Spissen recently described by Desbuissons[4] and another from an earlier find in Alp Lercheltini described by Seligmann,[5] and like them it is remarkable for the predominance of a ditetragonal form. Crystals somewhat similarly distinguished were described from the Ofenhorn by Solly.[6]

[1] Communicated by permission of the Trustees of the British Museum.

[2] Registered number 1911, 182.

[3] Compare L. Desbuissons, 'Contribution à l'étude des minéraux de la vallée de Binn. 2° Anatase de Spissen.' Bull. Soc. franç. Min., 1911, vol. xxxiv, pp. 245-251. The number, though bearing date November, 1911, was not received at the Museum till February 8, 1912.

[4] Fig. 2, loc. cit.

[5] G. Seligmann, 'Anatas von der Alp Lercheltini im Binnenthal.' Zeits. Kryst. Min., 1886, vol. xi, pp. 337-343, plate V, fig. 3.

[6] R. H. Solly, 'On various minerals (Anatase, &c.) from the Binnenthal.' Mineralogical Magazine, 1904, vol. xiv, p. 16.

The unusual habit of the crystal and the curious contrast in the character of the surfaces of the various faces led me to examine it and determine the indices of the faces. The top (fig. 1) is formed of four brilliant faces which measurement proved to belong to the form *z*(113). Smaller in size but equal in brilliancy were faces which in the same way proved to belong to the forms *e*(101) and *k*(112). In striking contrast as regards brilliancy are the faces of the ditetragonal form referred to and the large faces—obviously belonging to the form *a*(100)—that lie in the prism-zone; their surfaces are extremely rough, as indicated by the stippling in the figure, and such reflections as they afford of object-slit on the goniometer occur in unexpected directions: this peculiarity is more fully discussed below. The indices of the ditetragonal form may easily be determined from the directions of the edges of its faces. They must be of the type (*h*13) on account of the parallelism of the opposite edges of *z*(113) (fig. 1). Again, since the faces lying on opposite sides of *e*(101) meet in parallel edges, the latter lies in the zone connecting *h*13 and *h*$\bar{1}$3, and therefore $h = 3$ and the faces belong to the form *τ*(313), which is also the dominating form of the crystals described by Desbuissons and Seligmann.

The crystal was measured on a one-circle goniometer as far as was necessary to establish the indices of the faces, and altogether the following ten forms were observed:

- *a*(100), large, rough, no reflections corresponding to its apparent position.
- *τ*(313), very large, rough, no reflections corresponding to its apparent position.
- *z*(113), fairly large, bright, excellent reflections.
- *k*(112), small, bright, good reflections.
- *p*(111), very small, bright, good reflections.
- *e*(101), small, bright, good reflections.
- *m*(110), minute, bright, distinct reflections.
- *δ*(331), minute, bright, distinct reflections.
- *ϑ*(532), minute, dull, faint reflections.
- *h*(513), minute, dull, faint reflections.

The measurements made are tabulated below and compared with the corresponding values calculated from the axial ratio quoted in Dana's 'System of Mineralogy', sixth edition. The want of close agreement which will be noticed in certain instances is due partly to the indistinctness of the corresponding reflections, and partly to the slight distortion which exists, as in large crystals generally.

Form.	Calculated Values.		Observed Values.			
$zz'' = (113):(\bar{1}\bar{1}3)$	79°	54½′	79°	54′		
$kk'' = (112):(\bar{1}\bar{1}2)$	102	58½	103	4,	103°	30′
$pp'' = (111):(\bar{1}\bar{1}1)$	136	36	136	34,	136	46
$ee'' = (101):(\bar{1}01)$	121	16	120	3		
$zz' = (113):(\bar{1}13)$	54	1	54	19		
$hh' = (513):(513)$	136	52	137	9		
$pe = (111):(101)$	41	4	40	54		
$\vartheta m = (532):(110)$	17	43	18	15		

The form ϑ was determined from the angle quoted and the fact that it lay in the zone connecting *m*(110) and *e*(101); it occurs on the crystal described by Seligmann.

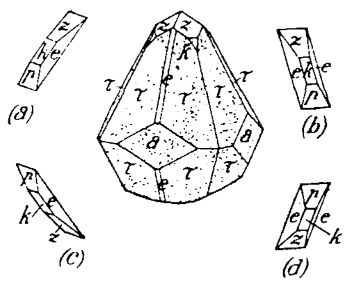

FIG. 1.—Crystal of Anatase. The smaller figures show the nature of the secondary development on the surfaces τ.

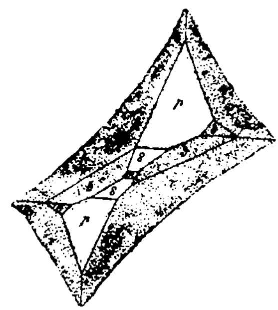

FIG. 2.—One coign of the same crystal.

The arrangement of the small faces lying near *m*(110) (fig. 2) is interesting and suggests that the full tetragonal symmetry is lacking. The other coign shown in the figure is imperfect and those that should be at the back have not been developed, so that the evidence is insufficient to be conclusive.

It has been stated above that the reflections from the ditetragonal faces are not such as would be expected. They, as a matter of fact, correspond to the forms *z*(113), *k*(112), *p*(111), and *e*(101), and examination with a lens shows that each face has been replaced by numberless tiny crystals characterized by these forms and having the same orientation as the main crystal, but without any regularity in size or arrangement. The development on each pair of faces in the same octant is identical in character; thus (fig. 1) crystals of the type (*a*) lie on both (3$\bar{1}$3) and (133), crystals (*b*) on (313) and (133), and so on in each of the four octants to the front. The reflections from $a(100)$ are simpler and correspond to $e(101)$ only.

It may be surmised that at some stage in the development of the crystal the growth was checked and slight dissolution took place, the forms τ and a proving susceptible to attack. Eventually growth was resumed, but under changed conditions which favoured the formation of crystals of a different habit.

The Trustees recently (1912) acquired smaller examples of anatase of the same occurrence, which are similar in habit to the large crystal just described. The forms observed comprise a τ z k p e δ ϑ. The excrescent development on the faces of the form τ is, however, slightly different, the reflections obtained corresponding to the forms p and e in pairs, so that, for instance, the face (313) gave reflections corresponding to (101) and (111).