

ART. XXXII.—*Twinned Crystals of Zircon from North Carolina*; by W. E. HIDDEN and J. H. PRATT.

THE zircon crystals to be described in this paper were found at the Meredeth Freeman Zircon Mine in Henderson County, North Carolina. The mine is located near Green River and about two miles nearly south from the railroad station now known as Zirconia. This is the mine from which Gen. Thomas Clingman procured one thousand pounds of zircons as early as 1869 and which became later a large producer. The crystals occur in a saprolitic rock that was probably a biotite gneiss.

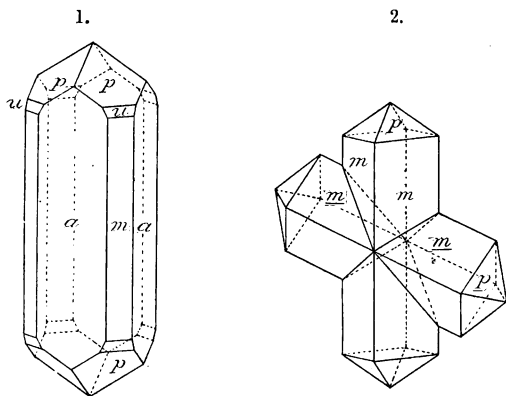
The attention of one of us was drawn to some peculiar crystals of zircon in May, 1888, by a miner who was then regularly employed in washing out zircons from the rock of this region. This miner stated that some of the men were finding "zircon-crosses" which they were wearing as ornaments, some having them "sewed to the lapels of their coats" and others "using them as watch charms." At first, no serious attention was paid to the miner's statement, for at that time it was impossible to visit the mine and verify it and besides staurolite seemed suggested by this description. Specimens of these "crosses" were received during the same month, but unfortunately they were badly broken in transit.

During the following summer the locality was visited by one of us, but all work had ceased at the mines. The dump was carefully searched over for the "zircon-crosses" but without success. The miners, while they well remembered the finding of these crystals, had not saved any specimens of them. The foreman, Mr. Edward H. Freeman, had fortunately preserved a small collection of different crystals found at this mine and it was from this collection that the crystals described in this paper were selected. Mr. Freeman stated that the "zircon-crosses" were obtained from only one portion of the mine and that some were found about $1\frac{1}{2}$ in. long by $\frac{3}{8}$ in. thick. He also said that they were very easily broken if carelessly handled.

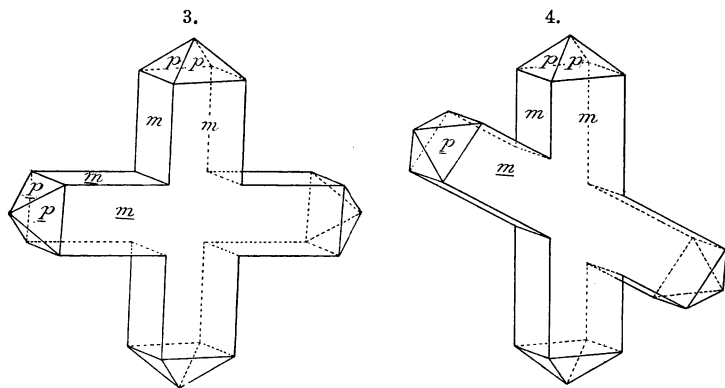
All the zircon from this region occurs as crystals which vary in size from 1^{mm} to 30^{mm} in the direction of the c axis and from 1^{mm} to 25^{mm} in that of the horizontal axes. The color varies from gray to grayish and reddish brown.

The common type is the prism of the first order, m , 110, terminated by the unit pyramid of the same order, p , 111. A few crystals have been observed with the prism terminated by the steeper pyramid, u , 331 alone and also a combination of

this form with the unit pyramid. Rarely the crystals have the ditetragonal pyramid x , 311, in combination with the unit pyramid. Fig. 1 represents one of a rarer type of crystals which is a combination of the prisms of both orders, m , 110 and a , 100, terminated by the unit pyramid, p , 111 and the more acute pyramid u , 331.



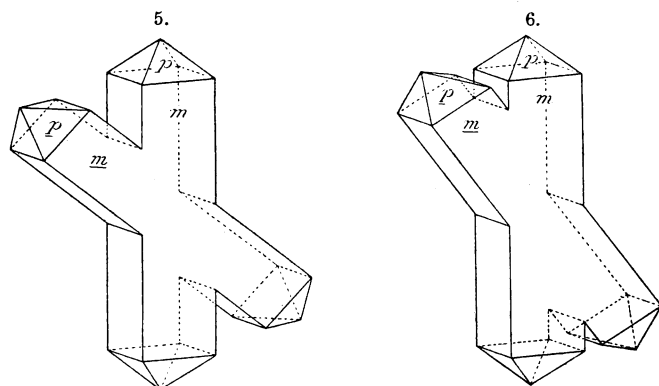
The only type of twinning heretofore known for zircon* is that with e , 101 as twinning plane, forming geniculations like those of rutile and cassiterite. The same law of twinning was observed on the Henderson County zircons, but the crystals are cruciform as shown in fig. 2.



* This Journal, xxi, 507, 1891, Hidden; Phil. Mag., xii, 26, 1881, Fletcher; and Dana's Mineralogy, sixth edition, 1892, p. 486.

Besides this type the Henderson County zircon exhibits a series of twin crystals in which the twinning planes are parallel to pyramids of the first order. Five new twinning planes have been identified by us. Of these, four are parallel to the pyramidal faces, p , 111; d , 553; v , 221 and u , 331, and are represented by figs. 3, 4, 5 and 6 respectively; the fifth is parallel to the pyramid ϕ (774).*

The twin crystals are usually well developed and doubly terminated, the faces being somewhat vicinal but with sharp edges, thus enabling the faces and twinning planes to be



readily identified by means of the contact goniometer. The measurements were very satisfactory and close to the calculated angles, as shown in the following table:

Twinning planes.	Measured angles $m \wedge m$.				Calculated angle.	
	95° 10';	96° 30';	95°	Average	95° 33'	95° 40'
p (111, 1)	112 10;	113 20';	111 40'	"	112 23	112 50
d (553, 5)	116 30;	116;	115° 30';	115° 15'	"	115 49
ϕ (774, 4)	121 30;	122 30		"	122	122 12
v (221, 2)	138;	139° 10';	140;	139° 30'	"	139 10
u (331, 3)						139 35

The re-entrant angle formed by $m \wedge m$ over the twinning plane is the same as the angle of divergence of $c' \wedge c'$. These prismatic edges being very sharp, the re-entrant angle could be measured very accurately with the contact goniometer, the measured angles agreeing within half a degree of the calculated angles.

The minerals associated with the zircon are the following: Pyrite, in cubes partially changed into limonite; fluorite, pale

* Dana's Mineralogy, sixth edition, 1892, p. 482.

purple etched fragments; quartz crystals; ilmenite, in minute grains (rare); small octahedrons of magnetite; orthoclase; massive garnet; parallel growths of auralite upon unaltered gray and brown zircon; very good crystallized green epidote; allanite in masses, as large as 50 pounds; well crystallized brown sphene, most of the crystals are altered to xanthitane; and vermiculites with broad foliæ often four to six inches in diameter.

The thanks of the writers are due to Mr. Freeman, who generously presented the crystals used in the preparation of this paper.