

A LARGE MONAZITE CRYSTAL FROM NORTH CAROLINA¹

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In a recent number of this journal Palache² has given the dimensions of a number of large crystals of various minerals and has asked for information concerning others. The largest crystal of monazite (nearly a foot high) known to the writer is here described, with some notes on the occurrence. It is hoped that others, as requested by Palache, will place on record what information they have on the largest known crystals of the different mineral species so that eventually the compilation will be fairly complete and have considerable value.

For many years monazite has been known to occur about 15 miles north of Asheville, N. C. Many of the crystals found are of unusual size, those as large as one's hand being rather abundant. The large crystal here described may be the "large rough crystal that weighed almost exactly 60 pounds" mentioned by Pratt.³ The occurrence is generally known as Mars Hill, being in Madison County, N. C., $5\frac{1}{2}$ miles due east of Marshall, 3 miles southwest of Mars Hill, midway between Sexton and Outlook, on the road from Halewood to Jupiter, a mile north of where the road, going south, first abuts White Oak Creek. The deposit is on the farm of the late Rev. N. P. M. Corn who very graciously afforded the writer all opportunities for studying the occurrence.

The locality was visited in 1918 as part of the War program on conservation of domestic mineral supplies. The large crystal here described was then in the possession of Mr. Corn and has only recently been acquired by Mr. Burnham S. Colburn of Biltmore Forest, N. C., who very kindly has permitted the writer to publish this note. As far as known it is the largest crystal of monazite preserved in any collection. It is shown in Fig. 1. It measures $6\frac{1}{2}$ inches ($18\frac{1}{2}$ centimeters) along the *a*-axis, $9\frac{1}{2}$ inches (26 centimeters) along the *b*-axis, and 11 inches ($31\frac{1}{2}$ centimeters) along the *c*-axis. Its present weight is $58\frac{3}{4}$ pounds. Cleavage fragments break

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² Palache, Charles, The largest crystal: *Am. Mineralogist*, 17, pp. 362-363, 1932.

³ Pratt, J. H., New occurrences of monazite in North Carolina: *Journ. Elisha Mitchell Sci. Soc.*, 28, pp. 153-156, 1913. Zircon, monazite and other minerals, etc., *North Carolina Geol. and Econ. Survey, Bull.* 25, p. 47, 1916.

off very easily and the crystal may have originally weighed somewhat more. The crystal is incomplete and is bounded on one side (the left vertical side in Fig. 1) by a fairly smooth cleavage face of m''' ($\bar{1}10$), showing the traces of many parallel cleavages parallel to the other face (m (110)) of the unit prism and to the base c (001). There are also indications of a cleavage parallel to the face of v ($11\bar{1}$). The faces of the large crystal are uneven and the entire crystal is somewhat warped, but the measured interfacial angles serve to identify the crystal forms. In further confirmation of the orientation as given, a thin section was cut from a small piece cleaved off parallel to the base c (001). This section showed the emergence of the acute bisectrix with the axial plane diagonal to the two cleavages m and m''' . The axial plane is normal to b (010).

The large front face shown in Fig. 1 is m (110) with the negative pyramid v ($11\bar{1}$) below it. The faces on the right are b (010) and e (011). The large cleavage face on the left, perpendicular to the page and therefore not showing, is m''' ($\bar{1}10$). Small cleavages parallel to c (001) may be seen in the upper left corner. The crystal evidently was originally much larger and may have weighed nearly a hundred pounds.



FIG. 1.—Large crystal of monazite from near Mars Hill, Madison County, North Carolina. The large face is m (110). The scale is in inches.

The crystal of monazite was obtained from a pegmatite dike, striking NE-SW, inclosed in Cranberry granite containing parallel tongues of Carolina gneiss. According to local report, the deposit of monazite was discovered in 1902 by Paul S. Corn and limited operations continued for two years, several large crystals and masses being obtained. About half way up the hillside a shaft 45 feet deep was sunk by Mr. F. M. Salyer of Johnson City, Tenn., and monazite was reported as found all the way. Early in 1918, a six foot deep open cut and several small prospect holes were dug by Mr. Gitt of Roanoke, Va.

Several hundred pounds of crystals and of cleavage pieces have been carried away by visitors and in 1918 a large box on the property still contained several hundred pounds of such specimens, many of which were as large as one's hand. Possibly a ton or so of monazite was obtained altogether.

The rocks on the farm are much decomposed but seem to be largely Cranberry granite. Most of the rocks in the open cut have been covered with loose dirt but the presence of a pegmatite, at least several feet wide, could be seen. In addition to at least one distinct pegmatite dike, there are numerous parallel stringers in the adjoining rock, parts of which are so pegmatized that on decomposition the lighter color of the pegmatite stringers is about the only criterion of their former presence. Masses of decomposed feldspar, of massive quartz and of compact dark green mica, each of which is several feet thick, testify to the presence of at least one definite pegmatite dike of workable size. The determined length of the pegmatite is not over a few feet although it presumably extends southward for several hundred feet over the brow of the hill, as monazite cleavage fragments and imperfect crystals have been found abundantly on the eastern slope of the hill, at least that distance from the open cut. No exposures of the pegmatite were seen on the brow of the hill.

The entire pegmatite zone is not over 15 feet wide and is probably much less. The dike is said to have dipped slightly to the northwest from the vertical. If the open cut paralleled the dike, as seems probable, then its strike was about N 30° E, about parallel to the contact of the tongues of Carolina gneiss with the Cranberry granite. The eastern side of the pegmatite, or at least parts of it, for about a foot in width, is composed essentially of dark green mica. Typical massive quartz, one to two feet thick, adjoins the

green mica. The remainder of the pegmatite apparently consisted chiefly of feldspar, now decomposed.

In the mica seam is a zone, averaging from one to four inches in width but locally becoming much thicker, which is very rich in monazite and which has furnished much of the monazite obtained from this locality. There may have been more than one such zone rich in monazite in the mica seam. It also seems probable that there were several lens-like zones rich in monazite rather than a single continuous zone but the available exposure of only a few feet did not permit of a definite determination of the character of these zones.

The pegmatite contains monazite outside of the mica seam but not in quantity. A few isolated crystals of monazite, not larger than a pea, were dug out of the decomposed feldspar and also out of the entire mica seam but none was found in the massive quartz.

At the time the deposit was visited (1918) the writer did not appreciate the genetic significance of determining the character of the feldspar, particularly the "decomposed feldspar" containing the small size crystals of monazite, so that it is not known if this feldspar was microcline or an albitic plagioclase. It may be noted however that the immediate matrix of most of the monazite found was a dark green mica.

Samples were collected of: (1) The zone of pegmatized country rock, that is of rock too decomposed for positive identification, but apparently granite or gneiss with numerous white or light colored pegmatite stringers, not over an inch thick; (2) The white decomposed feldspar; (3) The mica seam across its entire width; (4) The monazite-rich zone in the seam of mica. The samples were taken regularly from areas four inches square, a total of 48 samples being collected. They were mixed and quartered on the ground; the samples, when air dried, weighed about one pound each.

The mica samples were not crushed but were screened (10-mesh) to see if much finely disseminated monazite was present. It was found that nearly all of the monazite present is coarse enough to be caught on a 10-mesh screen, and can readily be picked out by hand.

The samples were then ground and treated with HF and HCl. Trial tests showed that about 20 per cent of the monazite present in the crushed samples was dissolved and lost. The insoluble residue contained besides the monazite, small quantities of ilmenite

and zircon. Their approximate percentage was estimated by microscopic examination and allowed for. The greater part of the monazite present was removed from the samples by the 10-mesh screen, before grinding.

Although the method of procedure was not very exact it served to show the quantity of monazite present in the different samples from which the feasibility of a commercial extraction of monazite can readily be determined.

The results are given below, indicating that only the monazite zone in the mica seam contains any appreciable quantity.

PERCENTAGE OF MONAZITE IN SAMPLES

Pegmatized country rock	0.05
Decomposed feldspar	0.33
Mica seam, coarse ^a	0.91
Mica seam, fine ^a	0.15
Monazite zone in mica seam, coarse ^a	35.04
Monazite zone in mica seam, fine ^a	1.86

^a Coarse is held by a 10-mesh screen and fine passes through.

Although different determinations of the thoria content of the monazite from this locality show some variation, they all agree in showing that at least 5 per cent of thoria, ThO₂, is present and probably more. Pratt states⁴ that a determination showed 5.06 per cent thoria, the writer found 6.06 per cent, another analyst reports 7 per cent, and determinations with the electroscope indicated that some samples contain slightly more.

⁴ Pratt, J. H., Zircon, monazite and other minerals, etc.: *North Carolina Geol. & Econ. Survey, Bull.* 25, p. 48, 1916.