ART. XXXIII.—*Notes on the Occurrence of certain Minerals in Amelia County, Virginia*; by WM. F. FONTAINE.

IN Amelia County, Virginia, near the county-seat, a considerable amount of excavation has been made during the past few years for the purpose of obtaining mica. This work has brought to light a number of interesting, and some very rare minerals. I have several times visited this locality and noted the occurrence of the minerals found there. It is my purpose in this paper to make known some of the facts observed.

All the minerals noticed in this paper occur in so-called veins of gigantic granite, situated in the immediate vicinity of Amelia Court House. These granite veins have the same general features as those that in other regions afford marketable mica. They are not fissure veins, but are ruptured portions of the country rock, into which the components of the granite have been introduced, most probably, by solution in hot water. The vein matter is chiefly a mixture of quartz and feldspar which serves as a gangue in which the masses and crystals of mica occur in a porphyritic manner. Sometimes, however, all of these minerals occur forming a confused web or entangled mass.

This material forms bosses, or irregular and interrupted veins in a thinly-bedded, highly micaceous gneiss that alternates with or graduates into mica-schist. The rocks are thoroughly metamorphosed, and their constituents occur in well individualized and rather coarse particles. These rocks form a belt that has the character attributed to the typical Montalban formation. The belt now in question may be traced for a long distance to the northeast and southwest of Amelia, and is usually marked by the occurrence of the veins of gigantic granite. It lies just west of the granitoid gneiss that is so extensively quarried near Richmond.

The vein-like deposits of granitic matter seem to occur in a pretty well defined band, but are not continuous over long distances. They occur more commonly "en echelon," sometimes overlapping each other. Some of them, over limited distances at least, seem at one time to have been open crevices. Some have remained undisturbed since their first filling, but others have evidently been reopened or disturbed more than once, and have received new materials.

The feldspar, mica and quartz, the essential minerals of these deposits, appear to have pretty constantly consolidated and crystallized in the same order of succession. The mica was the first to crystallize; the feldspar came next; and the quartz was the last to assume the solid form.

It is quite evident that some of these deposits near Amelia C. H. have in prehistoric times been worked to some extent. On opening the deposit near the village that has afforded the largest amount of mica, I am informed it was found that the outcrop had been removed for the depth of about ten feet. Refuse mica, stones and clay were then thrown back into the excavation. At a spot about two miles distant from this, I saw myself indications that the outcrop of a mica deposit had been disturbed. For the depth of ten or twelve feet, the earth had either been thrown in, or washed in upon the deposit which had been removed to that depth. On the top of the undisturbed deposit, and under about twelve feet of foreign earth, small bits of charcoal could be found.

Plates of mica that have an accurate rhombic shape, may be found here. They appear to have been trimmed into that form.

It is quite possible that these slight excavations were made by Indians, perhaps from curiosity. About two miles from this spot is a considerable outcrop of potstone that has been quite extensively worked by Indians, for the manufacture of pots and other utensils. This locality has been explored by the Smithsonian Institution, and has yielded quite a number of relics.

The most extensive excavations for mica have been made on the land of Mr. Rutherford, about one mile north of the Court House. Here two pits were dug, one on a hill of small altitude, and the other about one hundred yards distant, on a small stream. Both openings seem to be on the same deposit, but, as they show considerable differences in the occurrence of the minerals, it will be necessary to distinguish them. The one on the hill may be called No. 1, and that on the stream No. 2. Neither exceeds eighty feet in depth. From these two pits all the rare minerals have been taken.

The quartz found here shows no points worthy of mention. The mica is mostly muscovite. It is clear, and without color. Occasionally small particles of a beautiful rose-red mica are found. More commonly, but still rarely, a pale, yellowish green mica occurs that looks as if it were colored by uranium. The muscovite is sometimes bent, showing movements in the vein.

Feldspar.—The feldspar presents some points worthy of note. Much the larger part of the feldspar found in both pits is orthoclase. That found in pit No. 1 is mostly, when fresh, light-greenish in color. The feldspar of pit No. 2 is mainly yellowish-white. The orthoclase in both of these pits is nearly always found in crystalline masses. At an opening made some two miles to the northeast of these pits, which may be called pit No. 3, a nest of very large orthoclase crystals was

found. One of them, which is not the largest, is in the form of a rectangular prism, formed of the faces *O* and *i* much prolonged. It has at one end several prismatic faces, while the other end is broken, since it formed the place of attachment. This crystal is 50 centimeters long, while the cross-section shows in one direction the dimension of $22\frac{1}{2}$ centimeters, and in the other 20 centimeters.

Pit No. 1 shows but little feldspar other than orthoclase, but a considerable amount of albite occurs in pit No. 2. The larger part of this albite occurs in forms that I have seen assumed sometimes by stalagmitic deposits when they fill up vertical crevices in limestone, and there is little doubt but that this albite results from a secondary deposition of material, that made its way into an open crevice in the mass of material first deposited. This albite, for a depth of over twenty feet, formed a portion of the deposit composed of a closely-interlocked network of plates of a beautiful bluish-white material. Often angular cavities and cells were left from the incomplete filling of the space. At the bottom of this cellular mass, an open cavity was found, four or five feet long and high, and one or two feet wide. In the bluish white albite, and in the walls of this cavity, some minerals were found that do not occur elsewhere. Numerous crystals of smoky quartz lined the walls of this cavity along with pure white crystals of albite, some as transparent as glass. The quartz has often mingled with it a greenish powder that is evidently a decomposition product. The minerals found here were evidently deposited after the formation of the mass of granitic material, forming the bulk of the vein.

A small amount of labradorite occurs dispersed in a porphyritic manner in the masses of orthoclase. It is usually of a smoke-gray color, and sometimes shows a slight change of color on turning the specimens.

A considerable amount of amazon stone is found, but most of it occurs in pit No. 2. It ranges in color from bluish-green to verdigris green. The mode of occurrence of this feldspar strongly suggests the idea that the color comes from solutions infiltrating into the deposit from the surface, and making their way through the crevices of the vein. The green color most commonly is deepest in the portions of a mass of spar next to a fissure, or line of dislocation, and fades gradually until it is entirely lost in the mass of the material. Hence, often, hand specimens will be only partly colored.

Beryl.—The beryls, which occur of large size and quite commonly, are found almost wholly in pit No. 2. Some of them are surpassed in size only by those of New Hampshire. They are found sometimes three or four feet in length, and as much

as eighteen inches in diameter. The most common colors are pale bluish green and dingy yellow. The latter color is so much like that of some of the feldspar, that it is sometimes difficult to distinguish the two minerals. The beryls seem to have crystallized at the same time with the feldspar and after the mica. Some masses are formed of the yellowish feldspar and beryl so closely consolidated, that they seem to shade off into each other. In the quartz, however, the beryl crystals are easily separated, and leave sharp imprints of their crystalline form. I have seen one beryl crystal that shows crystals of mica projecting from its prismatic faces, and in several places, where the mica had fallen out, a distinct imprint of its crystalline form was left in the beryl.

All the beryls found in the two pits are opaque, but in pockets of quartz found in the vicinity, small transparent crystals, half a centimeter thick and under occur, that have a good luster, but not a deep color.

Fluorite.—This mineral occurs not rarely, and mostly in pit No. 2. I have never seen it in crystals. It is found always in crystalline masses that shatter easily into small fragments. Only a few particles show good cleavage. The mineral is usually found occupying the irregular angular spaces left between the particles of the feldspar, mica and quartz. Two colors predominate, a pale purple and a pale green. Some fragments show a very deep, dark green color. The fluorite is remarkable for the great beauty and brilliancy of the phosphorescent light that it gives out at quite low temperatures. The light is rich bluish green in color. After decrepitation it no longer gives out light.

Columbite.—This mineral occurs quite commonly, and it is more abundant in pit No. 2 than in pit No. 1. It is found quite often in crystals, some of them being of large size. They are, however, very easily broken, and can almost never be gotten entire from the feldspar, which is always the mineral that contains them. Some crystalline masses weighing six to eight pounds exist. I have one mass which is an aggregation of crystals that shows the following dimensions: length 12 centimeters, width $11\frac{1}{2}$ centimeters and thickness 11 centimeters. It appears to be a mass formed by the aggregation of crystals that have a flat shape from the predominance of the *iz* faces. All of the masses of columbite found here are friable and easily break up into angular fragments.

A variety of columbite occurs here rather rarely, that differs from the normal mineral both in chemical and physical characters.* This, as Professor Dunnington has shown, contains con-

* A somewhat similar mineral had been previously found at Branchville, Conn., and analyzed by Comstock.

siderably more manganese than iron, and has the ratio of columbic to tantalic acid 1:1. In mass it has a dark chestnut-brown to dark reddish brown color. Some particles tend to assume a fibrous structure, and then the color is somewhat lighter. In very thin splinters the color is a rich hyacinth-red. The normal columbite, so far as known, is the only kind that occurs in the upper part of the vein. The variety now in question is found only in pit No. 2, and becomes more abundant with increasing depth. Mr. Search, a gentleman connected with the mining operations and a zealous collector of the rare minerals found there, informs me that just before the pit was abandoned he found in the walls, a few feet above the bottom, a mass of this variety of columbite that weighed about five pounds. Portions of this mass in my possession show the tendency to assume a fibrous structure. These fragments are much like some kinds of rutile. For the analysis of this variety of columbite, the reader may consult the account of it given by Professor Dunnington, in the *Am. Chem. Jour.*, vol. iv, p. 138. The columbite crystallized before the feldspar, and leaves in it well-defined imprints of its form.

Garnet.—In pit No. 2, garnet of the variety spessartite is quite common, forming one of the primitive minerals of the vein. This garnet occurs in poorly formed crystals that are penetrated with a multitude of fissures, so that the mineral readily shatters to pieces. This form has a hyacinth-red to brownish red color, and is imbedded in the ordinary feldspar of the vein stuff. This mention is made of it to distinguish this kind of garnet from another of the same variety, viz: spessartite, that shows quite a different mode of occurrence, and which is specially noteworthy on account of its intimate connection with helvite. This second form of spessartite occurs in the form of a loosely aggregated mass, composed of granules and angular particles, but never in crystals. The granular mass is intimately mixed with helvite, the latter filling the interstices between the particles of spessartite. The compound is inserted in the cavities left between the interlacing crystals of albite that were formed on the walls of the large cavity discovered in pit No. 2. Both this spessartite and the helvite are clearly minerals deposited in the vein after the filling of the greater portion of it by the more abundant materials composing the vein stuff. The order of deposition seems to have been as follows. First, the beautifully clear albite crystals were formed on the walls of the cavity, producing an open network with large interstices. In some of these the spessartite was loosely deposited, and lastly, in some of the cavities between the particles of spessartite helvite was laid down. The helvite is very rare, and does not occur associated with all of the spessartite.

The spessartite thus associated with helvite has the following characters. Fusibility = 3 ; hardness = 6·5 ; sp. gr. = 4·20. Composition :

SiO ₂	36·34
Al ₂ O ₃	12·63
FeO	4·57
MnO	44·20
CaO	1·49
MgO	·47
Water	a faint trace.
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	99·70

The color is pale pink to flesh-red. Some fragments are brownish purple. The mineral looks more like some rhodonite than like garnet. It will be noted that the manganese is unusually high, and the iron and alumina unusually low.

The above analysis, with the determination of the specific gravity and hardness, was made by Mr. C. M. Bradbury in the laboratory of the University of Virginia.

Orthite.—Orthite is found in great abundance at the locality, pit No. 3, that furnishes the very large feldspar crystals mentioned above. Here some of the thin-bladed crystals may be seen more than fifteen inches long. It is also not rare in pit No. 2, but here the crystals rarely show lengths exceeding six to eight inches. In all cases both ends are broken off. Those of the greatest length do not exceed in thickness 4^{mm} and in width 2 to 2½^{cm}. In shape they are much like an ordinary ivory paper cutter.

The mineral, so far as I have observed, always occurs imbedded in feldspar or a mixture of feldspar and quartz. It usually has a decomposition crust of varying thickness, and sometimes the whole crystal is altered. The crust has an ash-gray color and is without luster. It is sharply distinct from the fresh interior. The internal sound portion has a velvet-black color and a high pitchy luster.

This mineral has been analyzed, independently, by Professors Koenig and Dunnington. For the analysis of Professor Koenig, see Proc. Acad. Nat. Sci. Philadelphia, 1882, p. 103 ; for that of Professor Dunnington, the Am. Chem. Jour., vol. iv, p. 138, may be consulted.

Microhite.—This is the most interesting of the minerals found in the mica mines of Amelia County. It occurs only at pits Nos. 1 and 2. I have carefully looked for it at the other openings made for mica in the vicinity without finding it. The largest masses were found in pit No. 1, some twenty feet below the surface. These masses occurred in the northern end

of the pit, and occupied the interstices left in the tangled mass of quartz, feldspar and mica that forms the main portion of the vein-stuff. The microlite, whether in crystalline masses, or in distinct crystals, was one of the original minerals of the vein. It crystallized after the mica, for some of the specimens have the faces distinctly marked by the overlapping edges of plates of mica, but before the feldspar, for the crystals are usually imbedded in feldspar, and leave sharp impressions in it. The larger masses of the mineral are aggregates of crystals, and show often on the component parts several crystal faces. The single crystals, which are most numerous in pit No. 2, occur imbedded mostly in feldspar, but they are sometimes found in quartz, or in a web of quartz and mica. It is noteworthy that minute crystals are very rare. I have seen a few from 3 to 5^{mm} in diameter, imbedded in quartz. The well-formed single crystals have usually the diameter of 1 to 1½^{cm}. Microlite occurs also in the walls of the cavity that was found in pit No. 2, along with the albite crystals.

At the first discovery of the microlite of Amelia, the existence of monazite was overlooked, because the specimens that had then been found were much like microlite. The slight difference in appearance was accounted for by the assumption that the microlite had been decomposed or altered to some extent. Hence, in the publication of his article on microlite, in the *Am. Chem. Jour.*, III, ii, 130, Professor Dunnington gave as the weight of one mass of microlite eight pounds. This specimen was really monazite, as subsequent analysis showed. This mistake, however, would not lead to erroneous conclusions concerning the size that some of the microlite specimens attain. I have a fragment of microlite that, no doubt, was originally not inferior in weight to the above-mentioned specimen of monazite. This fragment of microlite when found had been broken off from a much larger mass, as is shown by the surface of fresh fracture. The portion in my possession weighs four pounds fifteen ounces. The whole mass must have weighed over eight pounds. This specimen is an interesting one. It is composed of a number of distorted octahedral crystals of large size, united in an irregular manner. On one side the surface is marked with imprints caused by the overlapping plates of mica, under the edges of which the microlite was deposited. The color of the microlite varies a good deal. The colors range from pale yellowish gray, through brownish yellow to dark hair-brown. The brownish yellow color is that of the best characterized fresh material. This color, with the high resinous luster, and the broad, shallow conchoidal fracture, often causes the mineral to look like some of the gums. The single crystals show constantly the same forms.

They are octahedrons, modified by small faces of *O*, *I*, and *m-m*. All the faces of the same form are not always present, and when present, they are usually not equally developed. The largest single crystal that I have seen is slightly distorted. The longest axis has the dimension of $4\frac{1}{2}^{\text{mm}}$. In the direction of the other axes, it measures about 3^{mm} less. This crystal in forming has caught up, and partially imbedded some columbite. This would indicate the prior formation of the columbite, but this is not true of all the columbite, for it sometimes imbeds portions of microlite. This difference results from the fact that microlite was deposited at different times, some being found as stated, with the albite, helvite, etc., in the walls of the cavity previously mentioned.

The microlite seems to be a very durable substance. As illustrating this, the fact may be mentioned that a fragment of feldspar was found containing a number of crystals of microlite. The feldspar was almost wholly changed to kaolin, while the microlite retained its luster and hardness. Professor Dunnington, in the article above mentioned, has given the analysis and description of this mineral.

Monazite.—Monazite has been found nowhere except at pits 1 and 2. It occurs much as the microlite does, and is often so much like it that it requires close inspection to distinguish the two minerals. It exists usually in larger masses than the microlite, and what is peculiar, never in single or small crystals. The masses, however, are aggregations of distorted crystals, and often show on the constituent parts, well-formed crystal faces. Another noteworthy fact may be mentioned. Cleavage is either wholly absent, or present only in traces. The fracture is very uneven and rough. This is the best means to distinguish it from microlite. The large masses are often formed by the aggregation of imperfect flattened crystals, the plane of junction being the *ii* faces. Some of these masses have much the shape of some of the aggregations of columbite.

Two colors are common in this mineral. One is yellowish brown, and the other dark grayish brown. In the mineral with the latter color, numerous fine particles of silvery-white mica are often found. Besides the above, an orange color is sometimes seen. The different colors often occur together, the same specimen showing them in different parts. This mineral does not seem to have formed one of the later deposited ones, as it is not found in the cavity associated with albite, etc. The monazite is decidedly more prone to alteration than the microlite. It is sometimes found with an earthy texture, having lost its luster and become more gray in color.

Professor G. A. Koenig first recognized monazite among the Amelia minerals. For his analysis, see *Proc. Acad. Nat. Sci.*

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Philad., June 24, 1882. Professor Dunnington has analyzed this monazite also. For his results, see *Am. Chem. Jour.*, vol. iv, p. 138. The most noteworthy feature of this analysis is the considerable amount of thorina found.*

Helvite.—This mineral occurs very rarely, and is found only in pit No. 2. It seems to occur only in the walls of the cavity in this pit, and is deposited in the interstices of the light pink spessartite mentioned above, which is itself found in the openings between the albite crystals that formed on the walls of the open space. The helvite seems to have been the last mineral to be deposited in the vein, and its constant association with such a highly manganiferous garnet, is an interesting feature. It seems to have been deposited in the form of crystalline granular particles, that rarely show crystal faces or forms. A good deal of it is now in a pulverulent condition that may result from partial alteration. This mineral has been carefully examined in the laboratory of the University of Virginia by Mr. B. E. Sloan, pure material being taken. I extract the results of this examination from the "Notes of Work of Students," etc., etc., published originally in the *London Chemical News*.

"Color, wax- to lemon-yellow; streak, very pale lemon-yellow; luster, vitreous; translucent; hardness = 6; sp. gr. = 3.25. Fusible before the blowpipe flame with intumescence. Decomposed by hydrochloric acid with the formation of gelatinous silicic acid, and the liberation of sulphuretted hydrogen. Analysis gave—

SiO ₂ ,	31.42
BeO,	10.97
MnO,	40.56
FeO,	2.99
Al ₂ O ₃ ,	0.36
Mn,	8.59
S,	4.90 = 99.88

Another interesting mineral was found in pit No. 2, but unfortunately in so very small amounts that a complete quantitative analysis of it could not be made without using all of the material. It shows no crystal faces, but the structure is much like that of the normal columbite that occurs at this mine. The color is pinchbeck-brown, with a tinge of purple, causing the mineral to look like bornite. The purple may be a color from partial alteration, as it is quite intense on some particles. The streak is very pale yellowish brown to flesh-red. Hardness = 6.5. Sp. gr. = 6.82. In composition it is a tantalate,

* Mr. S. L. Penfield, in his analyses published in this *Journal* in October, 1882 (xxiv, 250), concludes that the thorina present is from mixture with thorite.—Eds.

mainly of manganese, with a large amount of lime, and a small amount of iron. The examination was made by Mr. Dunnington who ascertained with certainty the absence of columbic acid. Possibly this mineral may be allied to Nordenskjöld's mangantantalite.

The following minerals also occur, but very rarely :

Galena.—Small fragments of galena are found sometimes in pit No. 2. The largest particles seen by me have the dimensions of from 3 to 5^{cm}. This galena is said to be argentiferous. It has not been tested here.

Stibnite.—Mr. G. W. Fiss, of Philadelphia, who has taken great interest in collecting the minerals of the Amelia mica mines, informs me that he has found stibnite among them in one piece. I have seen no pure stibnite, but have in my possession some fragments of mixed galena and stibnite.

Pyrochlore.—Mr. Fiss informs me that he has found a piece of pyrochlore also at these mines. I have seen none.

Apatite and black tourmaline occur very rarely in pits No. 1 and 2. A brick-red mineral also is found in very minute particles in pit No. 2. It has the hardness of fluorite, and gave Mr. W. H. Seamon reactions for cerium, indicating the presence of fluocerite.

One or two additional minerals from this locality remain to be more fully examined, and they will probably prove to be of interest.

University of Virginia, Jan. 27, 1883.