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GEARKSUTITE FROM VIRGINIA.[1]

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INTRODUCTION

A sample of a white clay-like material sent in by Mr. Noah George of Hot Springs, Virginia, for identification was found to be the rare mineral gearksutite, a hydrous fluoride of calcium and aluminum. The locality, about midway between Hot Springs and Warm Springs, Va., on the main highway, was later visited by the writer in the company of Mr. George and a more extensive collection of material was made, which is now deposited in the U. S. National Museum, at Washington, D. C. Gearksutite had previously been found only in Greenland and Colorado.

GEOLOGICAL OCCURRENCE

Gearksutite occurs in a clay bed in the Trenton limestone of Ordovican age. This clay bed is about 500 ft. above the limestone (Lowville) from which the hot springs of the district issue. The thickness of this bed of clay was not accurately determined because of the nature of the exposure, but it appears to be less then 3 feet, perhaps nearer one foot.

Most of the clay is brown, but on digging a small trench through it, several masses of a white greasy appearing clay were encountered. This light colored clay has the appearance of bentonite—however it contains abundant angular grains of detrital quartz and also fails to show, in thin section, the volcanic-ash structure typical of most bentonites. Since its physical properties, color, and swelling in water, are like those of true bentonites and also this same geologic horizon has produced some material which was determined as a bentonite this white clay in this paper will be referred to as a bentonite. The volcanic-ash structure is commonly destroyed by weathering processes, hence its absence is not conclusive evidence that this clay is not a bentonite.

[1] Published by permission of the Director, U. S. Geological Survey.

The gearksutite occurs in this white clay as rounded masses of snowy white material, some of which measures about 5 cm. in diameter, though most of the nodules are much smaller. It also appears as an efflorescence in the seams and on the surface of the clay. Such an occurrence suggests that it has been deposited from a solution, as the associated gypsum has certainly been formed in such a manner. The only other mineral noticeable in any quantity is iron pyrites and this has undergone partial alteration to limonite. No other fluorine mineral was found.

Two occurrences of gearksutite in the United States, both in Colorado, have been previously noted and the first occurrence was described by Cross and Hillebrand,[2] who stated: "Among the minerals from St. Peter's Dome gearksutite is quite abundant. It is not formed from other minerals by molecular replacement, but is deposited from solution in cavities upon fresh crystals of pachnolite, etc. The smaller cavities are sometimes filled by it, and on the contact with the quartz it is especially developed."

A second deposit was later found at Wagon Wheel Gap, Colorado, and described by Larsen and Wells,[3] who stated: "The vein is entirely in tertiary volcanic rocks made up of lava flows and tuff beds of rhyolite and quartz latite, with subordinate andesite." "The lower tunnel of the mine, whose portal is about 100 ft. east of one of the hot springs, follows the vein and some distance from the portal it passes through a large body of soft, highly altered rock, which carries very abundant balls up to several inches across, of snow white, powdery gearksutite. These balls are easily separated from the altered rock and resemble a fragile chalk or kaolinite."

Chemical Composition.

A ball of gearksutite, from the Virginia locality was gently crushed and the powder passed through a sixty mesh screen. Only a portion finer than this mesh was used for the analysis. Further purification was obtained by washing the powder in a tall cylinder, the gearksutite, being very light of weight, remains suspended in solution longer than the clay, and by siphoning off the suspended material and repeating this water treatment, three times, a sample was obtained.

[2] *U. S. Geol. Survey, Bull.* **20**, p. 59, 1885.

[3] *Proc. Nat. Academy Scienes,* vol. **2**, p. 360, 1916.

The material consists of extremely minute matted fibers, with a mean index of about 1.45.

ANALYSIS AND RATIOS OF GEARKSUTITE FROM VIRGINIA

Analysis		Ratios	
Insol.	0.96		
Al	15.09		.559
Ca	22.15	.552	.562
Na	0.20	.009	
K	0.05	.001	
O	5.42		.339
H_2O	15.52		.862
F[a]	40.20		2.116
	99.59		

[a] Direct determination made by Mr. H. W. V. Willems, a visiting chemist in the U. S. Geological Survey.

The ratios are treated in the same manner as given by Hillebrand, namely, subtracting from the ratio for water an amount equal to that for oxygen which is necessary to form the hydroxyl. The ratios then obtained are:

READJUSTED RATIOS OF THE ANALYSIS

Al	.559	1.00	1
Ca	.562	1.01	1
H_2O	.523	0.94	1
(OH)	.678 } 2.794	5.00	5
F	2.116		

These ratios agree with the simple formula already established, namely, $Ca \cdot Al \cdot 5(F,OH) \cdot H_2O$. In this material the fluorine and hydroxyl combined with the aluminum are in the ratio of 99:68 (nearly 3:2) instead of 2:1 as found by Hillebrand.

The fluorine percentage in this Virginia occurrence is lower than in any of the other analyzed samples of gearksutite. It is commonly considered that the fluorine and hydroxyl are isomorphous. If this be true then it is remarkable that in the published analyses of this mineral, from four different localities, the percentages of both fluorine and water are unusually constant.

PERCENTAGES OF FLUORINE AND WATER IN GEARKSUTITE.

Analyst Locality	Hagemann[a] Greenland	Hillebrand[c] Colorado	Lindström[d] Greenland	Wells[e] Colorado	Henderson Virginia	Calculated[f]
F	41.18	42.07	41.81	41.00	40.20	42.9
H_2O	16.83[b]	15.46	15.03	15.20	15.52	15.1

[a] Dana, System of Mineralogy, 5th ed., p. 130.

[b] See following text remarks about Hagemann's analysis. The value here given has been recalculated as explained below.

[c] *U. S. Geol. Survey, Bull.* **20**, p. 59, 1885.

[d] *Geol. För. Förh.*, vol. **7**, p. 687, 1885.

[e] *Proc. Nat. Academy Sciences*, vol. **2**, p. 360, 1916.

[f] As given by Wells, based on a 2:1 ratio of F to (OH) combined with the aluminum.

The determinations of fluorine and water as given by Hagemann and Flight[4] were considered to be incorrect by Hillebrand. If the fluorine determination made by Hagemann be taken as correct, his results can be recalculated for water as follows: His summation without water and without the oxygen addition is 78.41 per cent. The quantity of oxygen added (based on the percentage of Al) is 4.76 per cent, which brings the summation (without water) to 83.17 per cent. Determining the water by difference gives 16.83 per cent for water. Flight determined only the bases and assumed that they were fully combined with fluorine, thus obtaining by difference an erroneous percentage of water.

The recalculated values given for Hagemann's analysis are of uncertain value yet they agree rather well with the others. The remaining determinations given show a remarkable constancy for the percentage of fluorine and hydroxyl and agree rather closely with the 2:1 ratio. It would seem that such a series of determinations made upon gearksutite from four separate places would not be in such close agreement with each other if the fluorine and hydroxyl are isomorphous with each other.

Determinations of water (by loss) at different temperatures gave the following results:

Temperature C.	Per cent loss	Total loss
250°	0.62	0.62
250–275	1.18	1.80
275–300	1.02	2.82
300–350	10.55	13.37

[4] *Jour. Chem. Soc.*, vol. **43**, p. 140, 1883.

These results agree with those of Hillebrand in showing that gearksutite suffers practically no loss below 200°. Hillebrand obtained a considerable loss at 250°–300°, whereas the results found on the mineral from Virginia indicate that the first large loss takes place above 300°.

Origin of the Virginia Gearksutite

This mineral has doubtless been deposited from circulating waters, and an analysis of water from different hot springs of this district, shows a small amount of calcium fluoride in solution. The hot springs carry larger quantities than the cooler springs perhaps due to the fact that the water of hot springs circulate at greater depths and naturally becones heated which increases the solubility of calcium fluoride, also the water issuing from hot springs has been in contact with the rocks longer, and so more calcium fluoride has been dissolved.

The source of the fluorine is undoubtedly in the limestone and possibly from fossils contained therein.

The circulating underground waters carrying the calcium fluoride in solution could migrate to the bentonite bed and here a reaction would take place whereby gearksutite is formed, the aluminum being supplied by the clay bed and the calcium and the fluorine by the ground waters.

The above explanation of the origin would indicate that gearksutite should be a rather common mineral in the clay beds of this district. This, however, does not seem to be true as beds of clay were found in this same geologic horizon that were apparently free from gearksutite. The fact that it is a white, clay-like mineral and can be readily overlooked may account for the reason that it has not been more widely found. Again the hot springs issue from a very restricted outlet and the present location of the gearksutite in the clay may be near an extinct hot spring channel.