

NOTES AND NEWS

AN OCCURRENCE OF NARSARSUKITE IN MONTANA

WILLIAM A. P. GRAHAM,¹ *Ohio State University.*²

During the summer of 1932 an occurrence of a yellow mineral associated with quartz veins cutting a green syenite was noted on the northwest finger of the main stock of East Butte, Sweet Grass Hills, Montana, in the center of Section 24, T 36 N, R 4 E. At some earlier date a shallow prospect pit had been sunk in the syenite at this point.

The main uplift of East Butte was caused by the injection of a Tertiary stock which sharply upturned the Madison limestone, of Mississippian age, and the successively younger beds. From the northwest portion of the stock a finger of syenite extends in a direction N 47° W, cutting through the Madison limestone and the basal portion of the Ellis formation. Several small xenoliths of Madison limestone are still present on the ridge formed by the projecting syenite finger. Dikes of vogesite radiate from the stock for several miles but their relation to the quartz veins is not clear though both seem to be of late magmatic origin.

The narsarsukite was seen only in the quartz veins in the roof rock and upper part of the intrusive. Fresh material was found at the old prospect pit on one of the veins, and was associated with a little galena, alunite, epidote, clinozoisite, apatite, and feldspar. Where the veins cut the syenite the magma had apparently assimilated a block of limestone, for there are shreds and irregular fine-grained aggregates of recrystallized calcite. Many calcite grains separated by other minerals in this section, extinguish together as if a large grain had been mostly replaced. Feldspar, dusty with kaolinite, is the only essential mineral of the original syenite that remains near the veins.

The physical properties of the narsarsukite are as follows: mostly fresh but slightly attacked along cracks, forming an opaque dusty aggregate, perhaps leucoxene; tetragonal (?); prismatic; brittle;

¹ A paper left by Mr. Graham in nearly finished form at the time of his death in 1934.

² Appreciation is here expressed to Mr. C. E. Erdmann of the United States Geological Survey for his invitation to the writer to study the rocks of the Sweet Grass Hills, Montana, in a joint effort to solve their petrologic problems.

cleavages good, 100 and 010;³ irregular fracture along the base; hardness $5.5 \pm$; specific gravity by pycnometer $2.75 \pm$. The inclusions in the slightly weathered material make it impossible to determine the specific gravity more accurately.

Optical characters: uniaxial positive; elongation positive; $\epsilon = 1.653 \pm .003$, $\omega = 1.612 \pm .003$; pleochroic, ϵ -honey yellow, ω -colorless.

A chemical analysis of the Montana narsarsukite by R. B. Ellestad was made possible by a grant from the Graduate School of Ohio State University. This is tabulated beside an analysis of the same mineral from the type locality in Greenland as recorded by Dana.⁴

TABLE 1
ANALYSES OF NARSARSUKITE

	Montana	Greenland
SiO ₂	62.30	61.63
Al ₂ O ₃	0.32	0.28
Fe ₂ O ₃	3.46	6.30
FeO		
MgO	0.46	0.24
MnO	—	0.47
CaO	0.18	—
Na ₂ O	15.31	16.12
K ₂ O	0.41	—
F	—	0.71
H ₂ O	Not det.	0.29
TiO ₂	16.80	14.00
Total	99.24	100.04

The optical and chemical data on this mineral have been checked and supplemented by Dr. W. T. Schaller and Miss Jewell J. Glass of the United States Geological Survey and through their kindness the following tabulation may be made to call attention to certain peculiarities of narsarsukite. On the basis of differences between the Montana data and the records of older work on the original

³ This change in the designation of cleavage faces is reported in recent x-ray studies; Waters, B. E., and Amberg, C. R., X-ray Study of Narsarsukite: *Am. Mineral.*, vol. 19, pp. 546-48, 1934; and an earlier paper by Gossner and Strunz, *Zeit. Kryst.*, vol. 82, p. 151, 1932.

⁴ Dana's System of Mineralogy, p. 73, Appendix 2, 1914 ed., analysis by Christensen.

TABLE 2
DETERMINATIONS BY W. T. SCHALLER ON RECENTLY ACQUIRED NARSARSUKITE

	Montana	Greenland
FeO	0.47	0.19
Fe ₂ O ₃	3.13	6.36
ε	1.655	1.628 to 1.633
ω	1.609	1.606 to 1.608
Biref.	.046	.022 to .025

material,⁵ it seemed desirable to test Greenland narsarsukite, and some was contributed by the United States National Museum, by the Philadelphia Academy of Natural Science, and by Columbia University. Some yellow transparent grains gave constant values, whereas brownish grains, apparently altered and less transparent, gave variable and slightly higher indices and birefringence.

TABLE 3
DIFFERENCES IN NARSARSUKITE SPECIMENS

Montana			Greenland		
Honey yellow, pleochroic Prismatic Cleavages good, 100, 010 Hardness 5.5			Colorless, yellow, and brown, non- pleochroic Tabular, rarely cubic Cleavage perfect, 110? Hardness 7-7.5		
ε	ω	Biref.	ε	ω	Biref.
1.653	1.612	.041	1.630	1.609	.021*
1.653	1.608	.045	1.625	1.604	.021
1.654	1.608	.046	1.625	1.604	.021
1.655	1.609	.046	1.630	1.609	.021
			1.628	1.605	.023
			1.636	1.607	.029
			1.633	1.608	.025
			1.628	1.606	.022

* Larsen and Berman, *Bulletin U. S. Geol. Survey*, **848**.

⁵ Dana's System of Mineralogy records as results of the original description: ε=1.5842, ω=1.5532. These seem to be incorrect.

The Montana mineral agrees with the original in being tetragonal, with two cleavage directions, uniaxial, positive, transparent to translucent. Both have a specific gravity about $2.75 \pm$. The pattern (x-ray) of the narsarsukite from Narsarsuk in the Columbia University collection agreed with that of the Montana material according to a report from Professor P. F. Kerr of Columbia University to Dr. Schaller.

Note that whereas the values of the lower index are about the same in the two occurrences, the index of the extraordinary ray of the Montana mineral is so much higher than that of the Greenland mineral that the birefringence is doubled. Clearly the mineral has a range of indices and birefringence suggesting differences in composition at least as great as those shown in Table 1. High index and birefringence are commonly suggestive of high iron in mineral series, but are here found in the Montana samples which have low iron and a low ratio of ferric to ferrous oxides. Whether the differences in titanium and in sodium are sufficient to account for the different optical constants is not clear.

ON THE APPLICATION OF DETERMINANTS TO CRYSTALLOGRAPHY

J. D. H. DONNAY, *Johns Hopkins University.*

Our distinguished colleague of the University of Florence, Professor P. Aloisi, published a short note under the above title in the May 1935 issue of this journal, in which he reminds us that priority in the matter of introducing determinants in crystallography belongs to Quintino Sella (1857). Professor Aloisi calls attention to this historical point on the occasion of the publication of my paper on the use of determinants in crystallography.¹ He makes the statement that it does not appear from my article whether I consider the application of determinants to crystallography as something new or not. He adds that "in any case the author does not mention anything to that effect."

I was well aware that I was not the first to apply the theory of determinants to crystallography, for this method used in Italian university courses and treatises on morphological crystallography can be found in textbooks of many other lands as well, although I am sorry to say it has not been currently adopted in America. My

¹ *Am. Mineral.*, vol. 19, pp. 593-599, 1934.