ART. XIII.—*Chemical and Optical Study of a Labradorite;*
by W. E. FORD and W. M. BRADLEY.

THROUGH the courtesy of Dr. George F. Kunz the Brush Mineral Collection received some time ago a suite of water-worn pebbles of a perfectly clear and almost colorless mineral which on investigation proved to be a labradorite. The locality from which the specimen came is given by a correspondent of Dr. Kunz as the Altai Mountains, in Mexico, just across the international boundary from New Mexico. The specimens offered ideal material for chemical and optical study, and as plagioclase feldspars of this composition are not very frequent in occurrence, it was thought that a brief description of the mineral would be of interest.

The analysis by Bradley gave the following results:

	I	II	Average	Molecular Ratios
SiO ₂	51·27	51·21	51·24	·8483
Al ₂ O ₃	30·89	30·79	30·84	·3017
CaO	13·52	13·65	13·59	·2422
Na ₂ O	3·74	3·78	3·76	·0605
K ₂ O	0·18	0·16	0·17	·0018
Fe ₂ O ₃	0·71	0·75	0·73	----
Ign	0·24	0·15	0·24	----
	<hr/> 100·55	<hr/> 100·59	<hr/> 100·57	

	Molecular Ratios	Albite Molecule	Anorthite Molecule
SiO ₂	·8483	·3738 (or 6·00)	·4745 (or 2·00)
Al ₂ O ₃	·3017	·0623 (or 1·00)	·2348 (or 1·009)
Na ₂ O + K ₂ O	·0623	·0623 (or 1·00)	
CaO	·2422		·2422 (or 1·021)

Ratio of albite molecule to anorthite molecule, 1: 1·918.

The small amount of water is considered to be hygroscopic and the 0·7 per cent of ferric oxide is assumed to be due to small inclusions of hematite as explained in a later paragraph. On calculation the analysis gives, as is shown above, the ratio of the albite molecule to that of anorthite as 1: 1·918. This places the mineral in about the middle of the labradorite series.

The specific gravity of the material analyzed was found to be 2·718. The theoretical value for the specific gravity of a mixture corresponding to Ab₁An_{1.918} obtained by using the values of the specific gravities for the end members of the

series as given by Day and Allen,* (Albite = 2.605; Anorthite = 2.765) was found to be 2.710.

The mineral was water-clear and almost colorless, showing only in the larger pieces a faint tinge of yellow. In some cleavage fragments, when viewed perpendicular to the poorer cleavage face $b(010)$, a copper-like reflection was seen, similar to that in the sun-stone from Tvedestrand, Norway. It was evidently due to minute tabular inclusions of some iron oxide, probable hematite, which lay in planes parallel to $b(010)$. On examination under the microscope with a high-power lens these inclusions were seen to be very minute and without crystal outline, many of them possessing a curved shape similar to that of a comma. One fragment showed larger inclusions which in this case were arranged parallel to both cleavage directions. These larger inclusions were more regular in shape, being in general like very thin wafers with a circular or slightly elliptical outline and having a lens-shaped cross-section. A thin section of this specimen ground parallel to one of its cleavage surfaces showed under the microscope, first a series of nearly circular inclusions of a copper color scattered irregularly over the field and which were lying parallel to the plane of the section, and second, a series of thin, lens-shaped inclusions arranged in parallel lines, these latter being the cross sections of the inclusions lying in the cleavage plane perpendicular to the section.

Of the two cleavages, the one parallel to the base, $c(001)$, was excellent, while, as is usually the case with the feldspars near the anorthite end of the plagioclase series, the cleavage parallel to $b(010)$ was imperfect and difficult to obtain. Several measurements of the cleavage angle were made on different fragments, the two best giving the following closely agreeing angles, $85^{\circ} 49'$ and $85^{\circ} 50'$.

Sections were ground parallel to each cleavage face and the angles of extinction were measured in sodium light with the trace of the cleavage of the other face. On account of the imperfect cleavage parallel to $b(010)$, the two sections that were made parallel to this face were carefully adjusted so that in each case they made with the basal cleavage an angle having a value within a few minutes of theory. Sections parallel to $c(001)$ were easily made, but because of the imperfect nature of the cleavage parallel to $b(010)$ it was not always possible to be certain of this direction in the section. The method adopted was to find a cleavage fragment that showed both cleavages present, as proven by the measured angle between them, and then to grind the section parallel to

*The Isomorphism and Thermal Properties of the Feldspars; Carnegie Institution Publication, No. 31, p. 74, 1905.

c (001), making note of the direction of the line of cleavage of *b* (010).

The average values of a series of readings of the extinction angles of the two sections made in each case with the direction of cleavage of the other face were as follows :

	Measured	Calculated
on <i>b</i> (010) =	—24° 37	—25° 33
on <i>c</i> (001) =	—12° 13	—11° 58

In the second column are given the theoretical values of the extinction angles of the respective sections, calculated by Mallard's formula, as given by Schuster.* The agreement of the measured and calculated values is fairly satisfactory. Both sections when viewed in convergent polarized light show the emergence of an optic axis just beyond the field of the microscope.

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* Min. Petr. Mitth., v, 192, 1892.