refraction comparable with that of calcite and gives an interference figure with a large number of leminiscate rings. For fine grained material of low double refraction the increased area of the interference figure reduces the light intensity and makes the figure somewhat more indistinct. It should also be pointed out that for direct vision of the object the magnification is reduced to one-half that of the 4 mm. objective and the field of vision has twice the diameter.

The use of the new objective for teaching purposes has been found to offer distinct advantages because the larger interference figure greatly aids the untrained eye of the beginner. In developing the theory of certain fundamental characteristics of the interference figure the diaphragm may be used to point out the features under discussion. It is hoped also that the advantages of a variable diaphragm in the objective when using the microscope for direct observation may increase the usefulness of the polarizing microscope.

NOTES AND NEWS

SODALITE FROM BOLIVIA

WOLFGANG BRENDLER, *Hamburg, Germany.*

Beads and carved images of sodalite have been found in ancient Indian ruins at numerous places on the Bolivian and Peruvian highlands of the Andes. A. Stuebel was the first to collect relics of sodalite in the ruins of Tihuanacu (Tiahuanaco), a settlement of the Aymara Indians near La Paz, Bolivia. These were examined and described by H. Fischer,[1] E. Bamberger and H. Feussner.[2] Prodgers who visited Bolivia in 1905–1906 makes the statement that the "Cura of Palca" told him that the early Jesuits had found "lapis lazuli" in the northern part of the Cerrania of Palca, and that the archbishops adorned themselves with chains of this material.

During his journeys through the Andes Fr. Ahlfeld of Marburg saw specimens of blue sodalite in several Bolivian collections labeled from "Ayopaya, Cochabamba" or "Cerro Sapo." In 1928

[1] *Zeit. f. Kryst.*, **4**, 370, 1880.
[2] *Zeit. f. Kryst.*, **5**, 580, 1881.

he prospected in this general vicinity and rediscovered the old sodalite mines.[3]

The locality is in the northern part of "Cerrania of Palca," which belongs to the east Cordillera of Cochabamba. The path to the sodalite mines reaches the locality, situated on the east side of the Cerro Sapo, after crossing the ridge of mountains at an elevation of 13,000 feet. The sodalite occurs in a large dike that accompanies a small stock of nephelite syenite which cuts through lower Devonian sandstones. The sodalite occurs in large, irregular shaped veins associated with greenish white ankerite and yellowish barite.

At various places along the dike Fr. Ahlfeld observed large caves and tunnels. The largest cave measured nearly 300 ft. in length and 16 feet in height. It seems quite likely that the larger openings represent the primitive operations of the Indians who appreciated the beauty of the fine blue mineral. Later the Jesuits continued the work of the Indians at several of the most promising localities. Since no other occurrences for sodalite in the Andes are known, it is highly probable that all the material now found in the ruins of Indian settlements was derived from this one locality. Another proof for this belief is the uniform microscopical structure of all the sodalite carvings found in the various ruins.

The Cerro Sapo sodalite is always coarsely crystalline and shows good dodecahedral cleavage. The color of the fresh material is a fine dark ultramarine blue. Single crystals, found in veins, are often unusually large, measuring at times up to $3\frac{1}{2} \times 2\frac{1}{2} \times 2\frac{1}{2}$ inches. Numerous inclusions are scattered throughout the sodalite mass. Especially on the surfaces of the larger crystals are found minute galena cubes (up to 6 mm. in diameter), small sphenoidal crystals of chalcopyrite, cubes of pyrite and, sparingly, small tetrahedrons of sphalerite. On specimens taken from the exposed parts of the dike the ankerite, siderite and pyrite are altered to limonite, often forming pseudomorphs, while the sodalite is weathered to a mixture of zeolitic minerals.

Thin sections of the fresh sodalite show microscopic inclusions consisting mainly of very thin plates of a red translucent mineral. Plates of a greater thickness are opaque and reflect the light with a greenish color. These inclusions are probably hematite which also

[3] Fr. Ahlfeld and R. N. Wegner, Ueber die Herkunft der im Bereich altperuanischer Kulturen gefundenen Schmuckstuecke aus Sodalith: *Zeit. f. Ethnologie*, **63**, 288–296, 1931.

explains the relatively high content of iron oxide in this sodalite. Also, sparingly, needles of a greenish translucent mineral were observed, representing perhaps an alkaline amphibole.

The specific gravity of selected pure material was found to be 2.295 ± 0.001 at 14.5°C., which is in close agreement with the value of 2.290 found by L. Pauling[4] using *x*-ray methods.

The refractive indices were determined on a polished plate of fresh material using an Abbe refractometer and monochromatic light. The average values obtained were as follows: $N_{Li} = 1.4806$; $N_{Na} = 1.4837$; $N_{Tl} = 1.4868$. These are in good accord with the values found by H. Feussner on sodalite from Mount Vesuvius: $N_{Li} = 1.4808$; $N_{Na} = 1.4839$; $N_{Tl} = 1.4869$.

The following three chemical analyses were made by the author on carefully selected material from Cerro Sapo. The analysis of E. Bamberger, on material collected by A. Stuebel from the ruins of Tihuanacu (Tiahuanaco) is given in the fourth column.

ANALYSES OF SODALITE FROM BOLIVIA

	I	II	III	IV
Na_2O	24.54%	24.53%	24.51%	22.93%
K_2O	1.01	1.13	1.16	0.74
CaO	—	—	—	0.46
Fe_2O_3	1.06	0.70	0.81	0.85
Al_2O_3	31.08	31.17	31.14	30.96
SiO_2	36.63	36.72	36.70	37.96
Cl	7.20	7.22	7.21	5.34
H_2O (110°C.)	0.31	0.23	0.19	1.10
	101.83	101.70	101.72	100.34
$-O=Cl_2$	1.63	1.63	1.63	1.21
	100.20	100.07	100.09	99.13

It is not possible to determine the water content of sodalite by heating to a red heat as it was shown by E. Bamberger that sodium chloride is driven off in noticeable amounts when powdered sodalite is strongly heated. For the same reason alkalie determinations according to the Lawrence Smith method should be avoided.

No traces of FeO, S, or TiO_2 were found in the Cerro Sapo sodalite. The small content of water and the high percentages of sodium, potassium and chlorine indicate the purity of the analyzed

[4] *Zeit. f. Kryst.*, **74**, 213, 1930.

material. On the contrary, analysis IV by E. Bamberger, shows that the amounts of alkalies and chlorine decrease when sodalite weathers while the water content increases.

The following ratio of Cl:Si in the analyses I–III is in good accord with the formula $3NaAlSiO_4 \cdot NaCl$:

I	II	III	$3NaAlSiO_4 \cdot NaCl$
1:3.00	1:3.00	1:3.00	1:3.00

As many sodalites contain very little or no iron oxide it is probable that the iron oxide found in the pure Bolivian material is due to microscopic impurities, in this case most likely hematite. If we omit the iron oxide and recalculate the analyses we obtain the following compositions which are in very good agreement with the given formula which is also the one accepted by L. Pauling as a result of his x-ray investigations.

	I	II	III	$3NaAlSiO_4 \cdot NaCl$
Na_2O	25.59	25.59	25.60	25.59
Al_2O_3	31.56	31.56	31.55	31.56
SiO_2	37.19	37.18	37.19	37.18
Cl	7.31	7.32	7.31	7.32
	101.65	101.65	101.65	101.65

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences of Philadelphia, September 7, 1933.

President Trudell presided at a stated meeting, 45 members and 15 visitors being present. Mr. Clifton Mimms was elected a member, and Messrs. John H. Turri and Henry Moor, junior members.

Nineteen reports were made of summer excursions, with exhibits of specimens: Mr. Yost (Franklin, N. J.); Mr. MacNelly (Texas, Pa.); Mr. Moyd (Bridgeport, Pa.,—clear quartz crystals); Mr. Knabe (Wood's Chrome Mine, Line Pit, and Huntingdon Valley, Pa.); Mr. Dornblum (Wood's Chrome Mine, Pa. and Franklin, N. J.); Mr. Vanartsdalen (Holland, Pa.); Messrs. Arndt and Frankenfield (Scotch Plains, N. J.,—calcite, heulandite, and prehnite); Dr. Gillson (Birmingham, Alabama,—barite and fluorite in limestone; Pensacola, Florida,—ilmenite sands); Dr. Cajori (Devil's Head, Tarryall, and Stone Mountain, Colorado); Mr. Gordon (Vesuvius, Italy); Mr. Toothaker (Moore Station, N. J., and New Galena, Pa.); Mr. Knorr (Bridgeport, Pa.); Mr. Cienkowski (western United States); Mr. Trudell (Mexico City, Vera Cruz and Pueblo). Mr. Toothaker described some mineral exhibits at the Century of Progress in Chicago.