LAPIS LAZULI FROM SAN BERNARDINO COUNTY, CALIFORNIA

AUSTIN F. ROGERS, *Stanford University, California.*

So far as known there is only one locality for lapis lazuli in the whole continent of North America. This locality is in San Bernardino County, California, on the north slope of the south fork of Cascade Canyon, which is a branch of San Antonio Canyon and distant about twelve miles from the city of Upland.

This occurrence first became generally known about 1912,[1] but it must have been discovered at a much earlier date. However, it is not mentioned by Henry G. Hanks in his list of California minerals in the Fourth Annual Report of the California State Mining Bureau, Sacramento, 1884. And no mention of it is made in G. F. Kunz's *Gems and Precious Stones of North America*, New York, 1890. Mr. F. J. Sperisen of San Francisco has called my attention to a statement in a book[2] by C. W. King which reads: "Although plentifully found [he is speaking of "sapphirus" or lapis lazuli] in China, and of late years in California, the product of both these countries is too full of pyrites and white veins to be available for the Glyptic art and is only good for calcination." This is the first mention of California lapis lazuli that I know of; it seems reasonably certain that the Cascade Canyon locality furnished the material.

The lapis lazuli was at first mistaken for a silver ore by prospectors. When its true nature became known, a company was formed to exploit it under the name "Lapis Lazuli Mining Company." The mining does not seem to have been a successful business venture, but some of the lapis has been mined and cut from time to time.

NATURE OF THE BLUE MINERAL

Lapis lazuli is a rock made up of a mixture of minerals, including the blue mineral to which it owes its attractiveness. The writer[3] reported the blue constituent to be lazurite largely on account of its association with pyrite. Sterrett[4] also called it lazurite.

Eakle[5] stated: "The optical properties of the so-called lazurite from San Antonio Creek indicate that it is sodalite and not lazurite."

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[1] The most complete article of this period is one by Gordon Surr, *Mining and Engineering World*, vol. **39**, pp. 1153–4, 1913.

[2] *The Natural History of Gems or Decorative Stones*, London, **1867**, footnote p. 273.

[3] *School of Mines* [Columbia] *Quarterly*, vol. **33**, p. 377, 1912.

[4] *U. S. Geol. Surv., Min. Resources for 1913*, p. 675, 1914.

[5] *California State Mining Bureau*, Bull. **91**, p. 170, 1922.

Difference of opinion as to the nature of the blue mineral led the writer to a study of the material. Before the blue mineral is discussed in detail the other constituents of the lapis will be mentioned.

DESCRIPTION OF THE ROCK

The lapis lazuli is a blue to bluish gray, more or less banded rock. Often the blue mineral is concentrated in layers from one to 3 or 4 mm. thick as shown in the accompanying figure (Fig. 1).

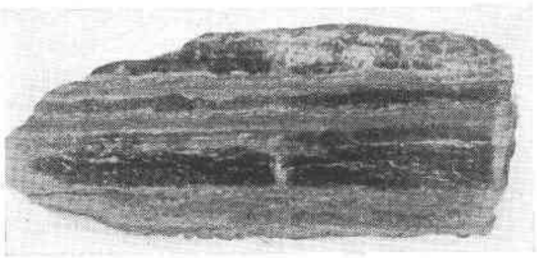

FIG. 1. (Natural size.) Polished surface of gneissoid lapis lazuli from Cascade Canyon, Los Angeles County, California. The dark layers are rich in haüyne.

The only mineral that can be readily determined at sight is pyrite which is sprinkled throughout the specimens in small anhedral crystals and often occurs in bands.

The most abundant mineral of the rock is diopside, which also occurs in anhedral crystals with a high relief.

Muscovite is found in minute tabular crystals.

Some specimens contain abundant calcite, but in others it is entirely absent.

No field study of the Cascade Canyon rock has been made by the writer, but from the specimens available it may be designated as an haüyne-bearing diopside-muscovite gneiss which grades into a gneissoid limestone.

THE BLUE MINERAL

The most interesting mineral of the lapis is of course the blue-colored one, the name of which is in doubt.

In thin sections it occurs in rather small anhedral crystals which average about 0.07 mm. in size. The color in thin sections varies from an intense blue to pale greenish blue and is not always uniform even within the small anhedral crystals. The mineral is usually optically isotropic but the pale greenish blue crystals show weak birefringence (about 0.004). Inclusions are occasionally present. The index of refraction determined by the immersion method is 1.503±0.003. (The index of refraction is too high for sodalite.)

The blue mineral is soluble in dilute HCl with gelatinization and the generation of a little H_2S, which may be recognized by placing a small piece of filter paper moistened with lead acetate solution over the end of a test-tube containing the powdered mineral and the acid. After a little time the paper turns black due to the formation of lead sulfide. This is proof that the blue mineral contains sulfide sulfur, since pyrite is not appreciably soluble in dilute HCl.

With HCl the blue mineral, free from calcite, gives abundant calcium sulfate hemihydrate[6] as well as some microchemical gypsum and also isotropic crystals of NaCl. This is proof that sulfate sulfur as well as calcium and sodium is present. Sulfate sulfur is apparently present in larger amount than sulfide sulfur.

The mineral gelatinizes with dilute HNO_3 and a faint test for chlorine was obtained with $AgNO_3$.

The blue mineral is evidently an isomorphous mixture of the haüyne molecule and a sodium aluminum sulfide-silicate. The formula of haüyne given by Borgström[7] is equivalent to $3NaAlSiO_4 \cdot CaSO_4$. Barth's[8] formula is: $(Na,Ca)_{4-8}Al_6Si_6O_{24} \cdot (SO_4)_{1-2}$, but neither Borgström nor Barth take into account the sulfide molecule.

The sulfide-silicate molecule of the blue mineral of lapis lazuli is $Na_4(Al \cdot (S_3Na)) \cdot Al_2(SiO_4)_3$ (abbreviated $U(S_3)$), according to Brögger and Bäckström.[9] Chemical analyses of the blue mineral of lapis lazuli in general prove that the haüyne molecule predominates. Brögger and Bäckström introduced the name lazurite (lasurite) and used it for specimens in which the molecule $U(S_3)$ constitutes from one-fifth to one-tenth of the whole. They recognize two kinds of lapis lazuli (lasursteine): haüyne lapis lazuli and lazurite lapis lazuli. There is a tendency in the literature to use haüyne for the mineral that occurs in lavas and lazurite for the blue mineral of lapis lazuli. A mineral, however, should be defined by its intrinsic characters and not by its mode of occurrence.

It seems clear that the blue mineral of lapis lazuli is simply a sulfide-bearing haüyne. Since the sulfide molecule never predominates in any natural minerals, so far as known, and since the name lazurite is easily confused with the name lazulite, why not abandon lazurite as a mineral name? Instead it may be used as the name of the sulfide molecule. To this Strunz[10] assigns the formula: $[(SiAlO_4)_6 | S_2]Na_8$.

[6] See Staples, L. W., *Am. Mineral.*, vol. **21**, p. 625, 1936.

[7] *Zeits. Kryst.*, vol. **74**, p. 119, 1930.

[8] *Am. Mineral.*, vol. **17**, pp. 466–471, 1932; *Zeits. Kryst.*, (A), vol. **83**, pp. 405–414, 1932.

[9] *Zeits. Kryst.*, vol. **18**, p. 238, 1890.

[10] *Zeits. Kryst.*, (A), vol. **98**, p. 66, 1937.

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NOTES AND NEWS

A METHOD FOR PHOTOGRAPHING PETROGRAPHIC THIN SECTIONS AT LOW MAGNIFICATIONS

WELTON J. CROOK, *Professor of Metallurgy,*
Stanford University, California.

In cases where it is desired to record the more gross characteristics displayed in petrographic thin sections, it becomes necessary to produce photographs at comparatively low magnifications, say from 5× to 10×. With the photomicrographic equipment ordinarily available, such operations often present considerable difficulties, particularly when a large field is desired.

It is suggested that the problem may be readily solved by the following methods:

The thin section is placed in a Leica enlarger (or similar apparatus used for enlarging Contax and Leica 35 mm. films) and the focussed projected image of the section adjusted to the magnification desired. Instead of printing the image on bromide paper which would result in a reversed picture, it is necessary to substitute a photographic plate or film, and in this way obtain a negative which may be used later to produce contact prints.

Experience has shown that process panchromatic emulsions are suitable for this purpose, especially where the thin section contains colored constituent minerals. Using a Leica enlarger with a 50-mm. lens, stopped to f:22 and a projection enlargement of 10×, exposure times will range from, say 20 seconds to 60 seconds, depending upon the thickness and color of the thin section, using Eastman Process Panchromatic cut film.

D-11 developer will give excellent contrast but if softer results are desired, D-72, diluted with two parts of water, may be substituted.

An alternate procedure may be adopted which, although more economical in negative materials, does not give as sharp and clear prints as the preceding method. In the alternate method a contact negative is produced by printing the slide directly onto a small strip of Process film. After processing, this strip is then placed in the enlarger and used as a negative.

From an optical point of view, it may be objected that even the first method proposed will not give the same resolution, for a given magnification, as would be obtained if the slide were photographed in the usual