A Pleochroic Variety of Gem Labradorite From the Rabbit Hills Area, Lake County, Oregon*

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Introduction

Labradorite rarely is considered to be a gemstone. One important but poorly known occurrence is found about 22 miles north of Plush in east-central Lake County, Oregon *(Figure 1)*. It lies in the northwest part of the Rabbit Hills NE quadrangle map of the U.S. Geological Survey. The material is called sunstone locally, and the site of the occurrence is designated as the "Sunstone Area" on this map.

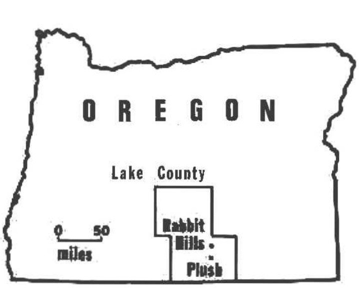

Figure 1. Gem labradorite locality in the Rabbit Hills area, Lake County, Oregon.

The Rabbit Hills area lies within the southern portion of an extensive province of volcanic rocks that passes north and east into Washington and Idaho. Stewart, and others (1966, p. 178-180) note that labradorite occurs as phenocrysts in porphyritic lava flows in the vicinity of the Rabbit Hills. They described crystals as large as 86 x 26 x 8 mm.

A parcel of cut stones and rough material from the Rabbit Hills area was investigated by the writers. Transparent gem quality stones as large as 13 x 7 x 5 mm were examined. The discovery of some previously undescribed properties led to the work upon which this report is based. The assistance of James Pettit, Assistant Manager of J.R. Rodgers, Ltd., Sherman, Oregon, who supplied all the specimens, is gratefully acknowledged.

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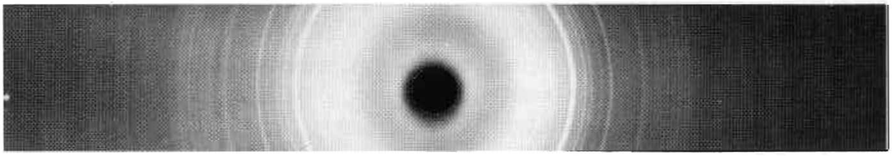

Figure 2. Debye-Scherrer x-ray diffraction photograph of labradorite from the Rabbit Hills area, Oregon.

Previous work on the properties of gem labradorite from southern Oregon is scant. Aitkens (1931, p.8) noted the occurrence of a labradorite that is remarkably similar to the material described here, from an unspecified locality in southern Oregon. Bank (1970, p. 134-136; 1973, p. 58-59) described similar feldspars (bytownite, labradorite) from an unspecified pegmatite locality near Plush. Gem labradorite from the Rabbit Hills locality has been noted recently by Rodgers (1976, p. 120).

X-Ray Diffraction

Positive identification was made from a powder sample, using a Debye-Scherrer camera of 114.7 mm diameter, and a filtered copper radiation source. The resulting pattern is shown in *Figure 2*. Twenty reflections were measured and the corresponding d-spacings are listed in *Table 1*. Intensities were estimated visually on a scale of 10. The pattern is typical of plagioclase and no reflections due to impurities were recognized.

The structural state of the plagioclase was determined by accurately measuring the $2\theta_{\bar{1}31} - 2\theta_{131}$ spacing with a Norelco diffractometer. The spacing was found to be 2.10 degrees. From the determinative curve given by Bambauer, and others (1967, p. 342), a high structural state for the plagioclase is indicated. This result is consistent with a volcanic origin.

Table 1. Intensity and measured d-spacing for labradorite from the Rabbit Hills, Oregon

Indices	Intensity	d-spacing (Angstroms)	Indices	Intensity	d-spacing (Angstroms)
$0\bar{2}1$	1/2	4.68	131	2	2.82
$\bar{2}01$	3	4.03	$\bar{1}32$	1	2.64
$1\bar{1}1$	1/2	3.88	$\bar{2}\bar{4}1$	4	2.51
$\bar{1}30$, 111	3	3.75	$2\bar{4}1$	2	2.13
130	2	3.62	151	1	2.09
$\bar{1}\bar{1}2$	1/2	3.47	$\bar{4}22$, $\bar{4}22$	1/2	1.92
$\bar{1}12$	1	3.35	333, $\bar{2}60$	1	1.87
040, $\bar{2}02$, 002	10	3.19 (broad)	400	1	1.83
$1\bar{3}1$	1	3.02	113	1/2	1.79
$0\bar{4}1$, $0\bar{2}2$	3	2.93	$\bar{2}04$	1	1.77

Refractive Indices and Specific Gravity

Refractive indices were determined in sodium light using a Duplex II refractometer. From eleven determinations, $n\alpha$ ranged from 1.560 to 1.563, averaging 1.562, and $n\gamma$ ranged from 1.569 to 1.570, averaging 1.570. The average birefringence was 0.008.

Specific gravity determinations were made using an Ainsworth, double pan, analytical balance, and toluene as the displacement fluid. For seven determinations, the specific gravity averaged 2.713, ranging from 2.711 to 2.717. The accuracy of the determinations is estimated to be $\pm$ 0.010.

The composition of the plagioclase, in terms of the percent albite (Ab) and anorthite (An), can be determined from its structural state, refractive indices and specific gravity. Using the determinative curves of Barth (1969, p. 159) and Smith (1958, p. 1189), the composition was found to be calcic labradorite (Ab_{32}–An_{68}). All of the above data is in close agreement with the results of Stewart and others, (1966, p. 182-185), seeming to indicate that their material and ours correspond.

Color and Pleochroism

Colors of varying tone and intensity were observed in the labradorite from the Rabbit Hills. The variations in color, as observed in diffuse south daylight during January, are given in *Table 2.* The color descriptions used follow standard North American gemological nomenclature. In addition, the color was noted to vary slightly with the source of illumination – a red-orange color being more predominant under incandescent light, and a bluish-green predominating under fluorescent light.

One of the most unusual properties of the labradorite is its pleochroic character. This pleochroism, which is weak in the pale yellow material, increases in strength with depth of color. In more deeply colored specimens the strong pleochroism imparts a multicolored effect that can be seen

Table 2. Color and pleochroic character of labradorite from the Rabbit Hills, Oregon.

Color of Stone	Pleochroism
yellow	colorless; light yellow
red-orange and blue-green (multicolored effect)	bluish-green; light red-violet; reddish-orange or orange
bluish-green	bluish-green; light orange; colorless
red-orange	orange; light reddish-purple
yellowish green	bluish-green; light orange
orange	orange; reddish-orange
bluish-green and violet (parti-colored)	red-violet; reddish-orange; bluish-green

Figure 3. Saucer-shaped clustered inclusions (x25).

without the aid of a dichroscope or polariscope as the stone is rotated. This effect is similar to that observed in transparent andalusite. The data given in *Table 2* were obtained from a gem dichroscope with the base of an Illuminator Polariscope serving as the light source. The pleochroism undoubtedly is due to a unique combination of the high transparency, deep coloration and relatively large size of the crystals of the Rabbit Hills material.

The labradorite lacked fluorescence in both short- and long-wavelength ultraviolet radiation. No characteristic absorption spectra were recognized with a Rayner Prism Spectroscope.

Inclusions

Inclusions of microscopic size are common in the Rabbit Hills labradorite. With the unaided eye, the presence of inclusions in some specimens is indicated by an aventurescent effect similar to that of sunstone. As viewed with dark-field illumination under magnification, the inclusions are seen to reflect light strongly and to be oriented in planes. The distribution of the inclusions is irregular and they often occur in clusters (see *Figure 3**). The inclusions sometimes appear as a series of minute, parallel streaks that form a zigzag pattern when viewed along an edge (see *Figure 4**). When rotated from this position, reflective surfaces of the inclusions appear, indicating a plate-like habit (see *Figures 5**, *6**, and *7**). The size of the

Figure 4. Zigzag patterns viewed on edge (x25).

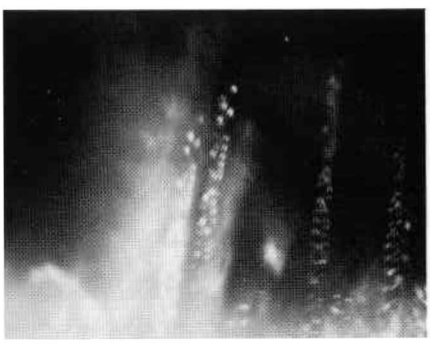

Figure 5. Reflections from plate-like inclusions (x100).

Figure 6. Reflections from plate-like inclusions (x25).

inclusions is approximately the same in a given plane, but may vary between adjacent planes and from specimen to specimen. In one specimen of rough material, sheets of inclusions were seen to lie parallel to a prominent direction of cleavage. This cleavage was established to be the $\{001\}$ direction since it was cut by broadly spaced albite twin lamellae. It was not possible to identify the platy inclusions with the available equipment. The strong doubling effect under magnification, which is readily apparent in the photomicrographs, increased the difficulty of resolution.

In one stone, a solitary inclusion was resolved at 100 power magnification *(Figure 8*)*. This inclusion has the equant habit and color that are characteristic of pyrite, and is obviously protogenetic in origin. Noting the size of other inclusions in this photograph, one clearly can see why this particular specimen presented a cloudy appearance under low magnification.

Gem Potential

The limitations to the use of this gemstone in jewelry stem from its low hardness relative to other gem materials and its ability to cleave easily in two directions. Similar factors have been overcome in other gemstones with careful attention to the type of mounting used, and by exercising care in setting the stone. Examples of

*References to magnification refer to the original size of the negative (24 x 36 mm)., All photographs were taken under dark-field illumination.

Figure 7. Strong reflections from inclusions viewed perpendicular to plates (x25).

Figure 8. Large solitary inclusion surrounded by minute inclusions (x100).

gemstones of a similar nature are kunzite and opal, both of which are used widely in jewelry.

The quantity of better material that is potentially available is unknown at the present time. Since there may be a limited supply of quality stones, probably the appeal will be restricted. The high degree of transparency and the unusual pleochroism displayed by the Rabbit Hills material, however, combine to form an exceptional gemstone for the collector or other discriminating individual.

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