
THE ANDRADITES OF SAN BENITO COUNTY, CALIFORNIA

By Tedd Payne

Discoveries in 1949 of andradite garnet in San Benito County, California, led to the formation in 1978 of a partnership to mine, cut, and market gem-quality andradite. These andradites are found in situ in serpentine outcrops and also in dry alluvial deposits. SEM microprobe analysis and X-ray powder diffraction show the chemistry and unit cell, respectively, to be nearly pure andradite. Cut stones and mineral specimens are produced in green, yellow, brown, and in combinations of these colors. Cut stones are generally under three carats and some are chatoyant. This is believed to be the only reported source of chatoyant garnet.

In 1949, Gemologist William Culver found a few water-worn andradite pebbles in a streambed in San Benito County, California. These first pieces were green and yellowish brown; some of the latter were chatoyant. In 1952, Bob and Ruth Getz found small amounts of rich, "emerald-green" and yellow-brown andradite in another nearby stream. The next few years brought no new discovery of deposits, but Culver sent earlier material to such gemological notables as Basil Anderson, Count Taaffe, and Richard Liddicoat for examination.

In 1978, Phil Maddox discovered a small in-situ deposit of andradite which later acquired the name *greenfire* because of its green color and high dispersion. In July of the next year, Maddox discovered a new deposit of this material. These small, pale, yellowish-green crystals were found in veins and proved to be suitable for faceting as well as for mineral specimens. That same year, Maddox, Culver, Dick Quackenbush, and Steve Bouch formed a partnership called Greenfire Mining.

Since July of 1979, numerous other in-situ and dry alluvial deposits have been found. The claims, 10 in all at this writing, are surrounded by private property and the partners do not want the location made public. These andradites commonly occur in situ as vein deposits in crevices and fractures in serpentine and as dry alluvial deposits at and near the surface, often downslope from serpentine outcrops. Other metamorphic minerals

found in the area include grossularite garnet (some of which is a gem-quality yellow brown), idocrase, diopside, chlorite, calcite, magnetite, and chromite.

CHEMISTRY

The "ideal" composition for pure andradite is $\text{Ca}_3\text{Fe}_2\text{Si}_3\text{O}_{12}$, but varying amounts of manganese, magnesium, and iron may substitute for the calcium; chromium, vanadium, and aluminum may substitute for the iron; and some titanium may substitute for the silicon or iron or both. It is exactly this game of "musical elements" (known in geologic circles as isomorphous replacement) which leads to the fascinating diversity of the garnets in general as well as to the difficulty encountered in classifying many of the various garnets.

Two representative pieces, one green (a demantoid) and one brown (a golden cat's-eye), were examined by means of a scanning electron microscope (SEM) with microprobe analysis. The chemical compositions obtained for each are given in table 1. X-ray powder diffraction analysis gave the following cubic unit-cell dimensions for the above samples: demantoid, $a=12.057 \text{ \AA}$; golden cat's-eye, $a=12.053 \text{ \AA}$.

DESCRIPTION OF THE MATERIAL AND ITS IDENTIFYING PROPERTIES

The rough material recovered thus far has yielded faceted (transparent to translucent) stones averaging 20 points to one carat and cabochons (translucent to opaque) averaging one-half to three carats. The basic colors and transparencies of this material are summarized in table 2. In conjunc-

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tion with this table, figures 1 and 2 illustrate the emerald-green andradite and green-brown "topazolite," respectively, found in San Benito County. Figure 3 presents some of the cat's-eye cabochons formed from the chatoyant material.

Andradite found in situ often occurs as well-formed rhombic dodecahedral crystals. Alluvial

material may be found as worn crystals, broken pieces, or rounded pebbles.

A variety of these andradites were tested for the usual gemological properties. The refractive index ranges from approximately 1.851 for the greenfire material to 1.888 for the darker green (demantoid) stones, with the brownish andradite giving intermediate indices. The specific gravity ranges between 3.77 and 3.85, with no observed relation to color. Common inclusions are "fingerprints," included crystals, and coarse, needle-

TABLE 1. Composition of two andradite samples showing weight percentages of the metallic elements expressed as oxides.^a

Oxide	Demantoid (weight %)	Golden cat's-eye (weight %)
CaO	33.09	33.30
MnO	0.01	0.09
MgO	0.03	0.27
FeO	— ^b	— ^b
Fe ₂ O ₃	29.75	28.37
Cr ₂ O ₃	0.97	0.30
V ₂ O ₃	0.04	0.02
Al ₂ O ₃	0.06	0.44
SiO ₂	36.03	36.88
TiO ₂	0.02	0.33
	100%	100%

^aThe figures have been adjusted slightly to total 100.

^bNone detected.

Figure 1. Green (demantoid) andradite rough from San Benito County, California.

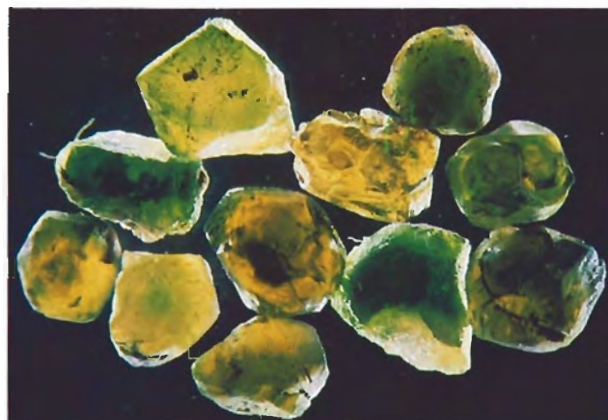


TABLE 2. Color description, size, and relative abundance of the faceted and cabochon andradites from San Benito County, California.

Cut and transparency	Color	Usual size	Relative abundance (% cutable material found thus far) ^a
Faceted stones, transparent to translucent	Emerald green, medium to dark (demantoid)	To ¼ ct.	5
	Orange-brown, yellow-brown, green-brown (all "topazolite")	To ¾ ct.	28
	Yellow	To ¾ ct.	2
	Yellow-green, pale, "greenfire"	To 1 ct.	35
Cabochons, translucent to opaque	Emerald green, medium to dark (very rarely chatoyant)	To 1 ct.	5
	Banded green	To 3 cts.	5
	Yellowish brown, "golden cat's-eye"	To 3 cts.	20
	Black (melanite)	Crystals to 1 ct.	N/A

^aRough estimates.



Figure 2. Orange-brown ("topazolite") andradite rough from San Benito County, California.



Figure 3. Cat's eye andradite cabochons from San Benito County, California.

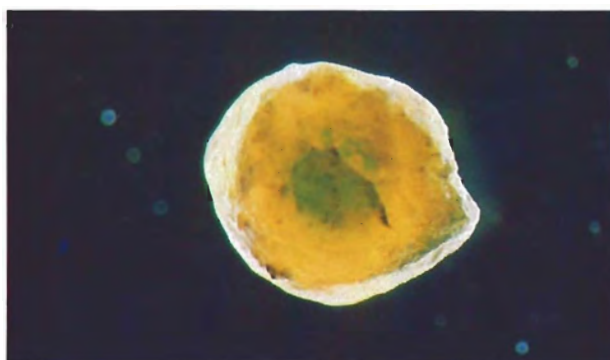


Figure 4. Color-zoned piece of andradite rough from San Benito County, California.

TABLE 3. Properties of the samples of greenfire, golden cat's-eye, and demantoid types of andradite found in San Benito County, California.

Type of andradite	Color	R.I. ^a	S.G. ^b	Inclusions	Chelsea filter	Ultraviolet fluorescence
Greenfire	Pale, semitransparent yellow-green	1.855	3.77	"Feathers" forming "rhombic corners," strings or clusters of round, white inclusions, coarse whitish needles	Pale orange	Inert ^c
Golden cat's-eye ^d	Translucent yellowish brown, resembles tiger's-eye quartz	1.877	3.81	Silky or fibrous	Brownish orange	Inert ^c
Demantoid ^d	Translucent, medium to dark green	1.882	3.81	"Fingerprints," included crystals, coarse, needle-like to fine silk inclusions	Orange-red	Inert ^c

^aRefractive index (all the sample stones are singly refractive).

^bSpecific gravity.

^cBoth long and short wave.

^dSame samples as in table 1.

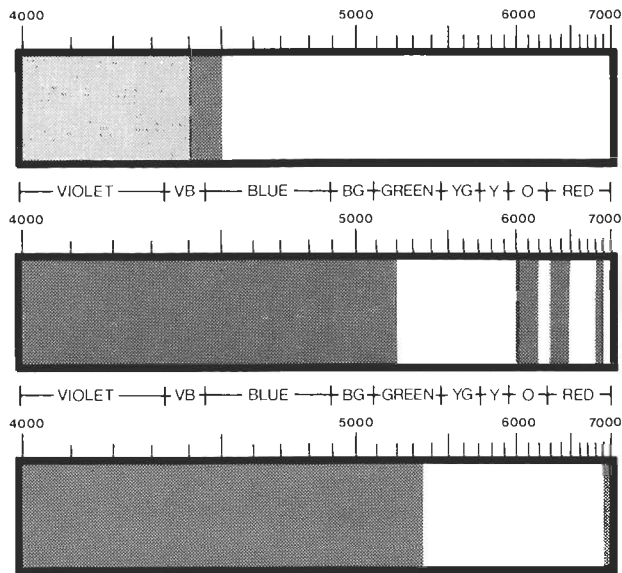


Figure 5. Color spectra for the "greenfire" (top), demantoid (center), and golden cat's-eye (bottom) andradites found in San Benito County, California.

like to fine silk inclusions. Some material shows color zoning, typically a green spot in the center of the crystal (see figure 4).

Table 3 presents the properties for three representative andradite samples, including the golden cat's-eye and demantoid types described above. The relevant spectra for these three samples appear in figure 5.

CONCLUSION

The San Benito County, California, deposit is unique both because it represents a new source of gem-quality andradite and because it is the only reported source of chatoyant garnet. The golden cat's-eyes, small demantoids, and especially the very rare cat's-eye demantoids make these deposits of keen interest to scientist and gemstone enthusiast alike.