INTERESTING RED TOURMALINE FROM ZAMBIA

By John I. Koivula and C. W. Fryer

This note describes the study of five small, gem-quality crystals and crystal fragments of a brownish red to red tourmaline from a new locality near Chipata, Zambia. The mineralogical nature of these tourmalines is briefly discussed. X-ray diffraction indicates that these tourmalines belong to the schorl-dravite series. Refractive indices, birefringence, specific gravity, and other gemological properties are given, as well as comments on the inclusions. This material is very similar in appearance, gemological characteristics, and chemistry to the red tourmalines from Kenya.

The Gemological Institute of America recently received a gift of five small (1.17–3.44 ct) transparent, gem-quality crystals and crystal sections of a most unusual, deep red to brownish red, tourmaline that was reportedly mined near Chipata, Zambia (E. Petsch, pers. comm.). These specimens strongly resemble tourmalines from Kenya. Two of the crystals are terminated with trigonal pyramids. The others, although broken, show a few sharp, well-defined prism faces that suggest an eluvial or in-situ, rather than alluvial, source.

The fact that the intense red to brownish red color (figure 1) is almost identical to the red tourmalines previously reported from Kenya (Bank, 1974; Dunn et al., 1975), and the fact that this material came from a new locality approximately 1,000 km south of where the Kenyan material was discovered (Dunn et al., 1975), suggests that there might be a connection between the two occurrences. Accordingly, a number of tests were conducted on the Zambian crystals both to provide further information about this material and to compare it with the red tourmalines of Kenya.

Figure 1. Of the five tourmaline samples used in this study, the one shown here (8.5 mm long) exhibited the best crystal form.

GEMOLOGICAL PROPERTIES

The refractive indices were measured with a monochromatic light source and a Rayner Dialdex refractometer as 1.624 and 1.654. This birefringence, 0.030, is fairly high for tourmaline and is usually associated with the schorl-dravite series. Refractive indices varying from 1.623–1.654 to 1.626–1.657 (birefringence 0.031) were reported for the Kenyan dravite (Dunn et al., 1975).

Specific gravities of the five samples were determined hydrostatically on a Voland double-pan balance at room temperature. They ranged from 3.03 to 3.07; the average specific gravity of the five samples was 3.05. Again, these results do not differ significantly from these obtained by Dunn et al. on dravite from Kenya; these authors found a specific gravity range of 3.07 to 3.08 in the material they examined.

The tourmalines were next studied with a Beck prism spectroscope to determine if any characteristic absorption lines were visible. In the optic axis direction, extreme absorption precluded a spectral analysis. Perpendicular to the optic axis,

however, we observed a strong broad band between 520 nm and 590 nm, another weaker band between 460 nm and 470 nm, and a 445 nm cutoff of the blue and violet (figure 2).

The pleochroic colors observed with the dichroscope are a dull, dark brownish red and a bright red. The stones appeared inert when exposed to both long-wave and short-wave ultraviolet radiation.

Although one of the authors had previously examined tourmalines found as inclusions in Zambian emeralds (Koivula, 1982), this was our first opportunity to study larger tourmaline crystals from Zambia. X-ray diffraction of the dark orangy brown to black tourmaline inclusions in emerald proved that the inclusions are from the schorl-dravite series. Interestingly, the X-ray diffraction pattern of the red dravite crystals studied in this report closely resembles the dravite pattern obtained from the schorl-dravite inclusions found in the Zambian emeralds.

None of the studies published to date on the dravite from Kenya reported on the inclusions in this material; even so, we decided to examine the Zambian crystals under magnification to study any associated minerals that might be found adhering to the crystals, and to see if any inclusions could be resolved. Two of the crystal fragments have small white to pale brown patches of an associated mineral on them. The X-ray diffraction pattern obtained from a powder sample of this mineral matches that of talc. One of the two specimens with this talc also has a colorless crystalline material attached to one end; X-ray diffraction proved this mineral to be quartz. The largest crystal fragment contains two-phase inclusions. The fourth piece has no associated minerals or inclusions visible at 50× or lower magnification. The best terminated crystal, shown in figure 1, contains inclusions of what appear to be tourmaline as well as a small grouping of very fine acicular inclusions. We decided to polish a window in this crystal so that we could study these inclusions more closely.

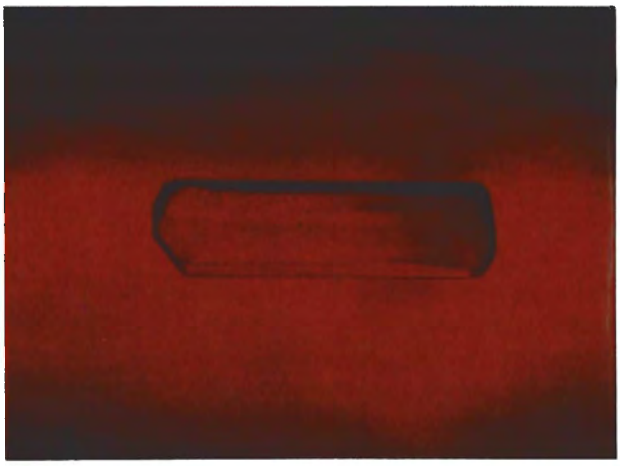
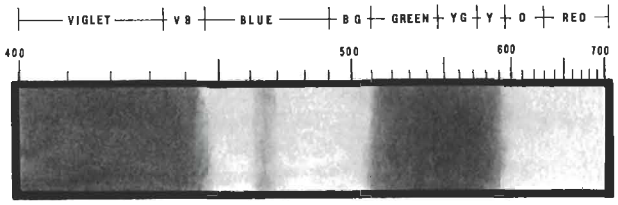


Figure 3. An inclusion of tourmaline in the tourmaline shown in figure 1. Even with shadowing, the relief is quite low. Magnified 50×.

First, we observed included euhedral crystals of a hemimorphic form that appeared to have very low relief, which indicates a refractive index very close to the host tourmaline. The most easily visible of these inclusions is shown in figure 3. The crystal habit (hemimorphic terminations) together with the low relief serve to identify these inclusions as tourmaline. Also scattered throughout the host, isolated and in groups, are very short, extremely fine, acicular inclusions of high relief (figure 4). These inclusions remain unidentified, although they may be fibrous talc. Phantom growth zones that trace the developmental stages of the host were also observed throughout the crystal, although they could be seen only at certain angles.

Figure 2. Diagram of the absorption spectrum shown by the tourmaline crystal illustrated in figure 1.



ABOUT THE AUTHORS

Mr. Koivula is senior gemologist, and Mr. Fryer is chief gemologist, in the Applied Gemology Department of the Gemological Institute of America, Santa Monica, California.

Acknowledgments: The authors would like to thank Julius Petsch for donating the tourmalines used in this study, and Dr. Peter Keller for helping arrange the donation. Thanks also go to William Kerr for polishing the flats on one of the crystals for the refractive index and inclusion studies. Chemical analysis was provided by Dr. George Rossman and Stephanie Mattson of the California Institute of Technology, Pasadena, California.

CHEMISTRY

After detailed gemological examination and X-ray diffraction were completed, the tourmalines were given to Dr. George Rossman, of the California Institute of Technology, for chemical analysis on the electron microprobe. Dr. Rossman had previously analyzed the tourmaline from Kenya, and his analyses agree with those previously reported in the gemological literature (Bank, 1974; Dunn et al., 1975). His findings on the Zambian tourmaline are very similar to the previous analyses on the Kenyan dravites. Table 1 compares the chemical compositions of the Kenyan and Zambian dravites.

CONCLUSION

All of the physical and optical properties of this Zambian tourmaline indicate that it is very similar to a rare type of gem-quality red dravite previously found only in one small locality in Kenya. This similarity suggests that a common geologic origin exists between these two areas even though they are a thousand kilometers apart. The localities are situated at opposite ends of the East African Mozambique belt. In studying the general geology of eastern Africa, it becomes apparent that these two areas are linked by a system of major faults known as the Great Rift System, extending as far north as Ethiopia and as far south as Zimbabwe (Derry, 1980). The fact that both types of tourmalines are so rare and yet so similar, in conjunction with the geologic evidence available, suggests that perhaps the Kenyan and Zambian dravites were generated by the same geologic event. If so, similar areas of mineralization might exist along the entire length of the fault system.

Figure 4. A small group of extremely fine acicular inclusions found in the crystal shown in figure 1. Transmitted light, magnified 50×.

TABLE 1. Partial chemical comparison (in wt.%) of dravite from Kenya[a] and Zambia.[b]

	Element										
Location	K_2O	Na_2O	CaO	MgO	MnO	FeO	TiO_2	SiO_2	Al_2O_3	Cr_2O_3	V_2O_3
Kenya	0.06	2.7	0.06	9.4	0.03	4.4	0.3	37.9	31.1	*[c]	*[c]
Zambia	0.02	2.3	0.14	10.0	0.05	2.1	0.2	36.7	33.9	**[d]	**[d]

[a] *As provided by Dunn et al., 1975.*
[b] *Electron microprobe analysis of one specimen by George Rossman, of the California Institute of Technology.*
[c] *Data not included in the analysis.*
[d] *Below the detection limit (0.02%).*

The discovery of gem-quality tourmalines in Zambia is gemologically exciting. If this new source for red dravite should produce even larger cuttable pieces of rough, another unusual and beautiful color of tourmaline could appear in the world's gem markets.

REFERENCES

Bank H. (1974) Rote Turmaline mit hoher Licht—und Doppelbrechung aus Kenya. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 23, No. 2, pp. 89–92.

Derry D. (1980) *World Atlas of Geology and Mineral Deposits.* John Wiley and Sons, New York, NY.

Dunn P.J., Arem J.E., Saul J. (1975) Red dravite from Kenya. *Journal of Gemmology*, Vol. 14, No. 8, pp. 386–387.

Koivula J.I. (1982) Tourmaline as an inclusion in Zambian emeralds. *Gems & Gemology*, Vol. 18, No. 4, pp. 225–227.