ELBAITE

PHYSICAL PROPERTIES
Chemistry: $Na(Al_{1.5},Li_{1.5})Al_6(BO_3)_3(Si_6O_{18})(OH)_4$ Basic Sodium Aluminum Lithium Borosilicate (Sodium Aluminum Lithium Borosilicate Hydroxide), usually containing small amounts of iron, magnesium, manganese, and calcium.
Class: Silicates
Subclass: Cyclosilicates
Group: Tourmaline
Crystal System: Hexagonal (Trigonal Subsystem)
Crystal Habits: Usually as short-to-long, hexagonal prisms with rounded, triangular cross sections, flat terminations, and lengthwise striations; also radiating, columnar, compact, and massive.
Color: Pink, reddish-pink, green, blue, blue-green; occasionally yellow and colorless.
Luster: Vitreous
Transparency: Transparent to translucent
Streak: White
Refractive Index: 1.615-1.651
Cleavage: None
Fracture: Irregular to uneven
Hardness: 7.0-7.5
Specific Gravity: 2.9-3.2
Luminescence: Often exhibits a weak, bluish-white or blue fluorescence under shortwave ultraviolet light.
Distinctive Features and Tests: Best field marks are prismatic habit with rounded, triangular cross sections and flat terminations; lengthwise striations on prism faces; absence of cleavage; and occurrence in lithium-rich, granite pegmatites.
Dana Classification Number: 61.3.1.8

NAME: The word “elbaite,” pronounced ELL-buh-ite, stems from the mineral’s type locality on the island of Elba in Italy. Elbaite’s color varieties are known as “red tourmaline,” “pink tourmaline,” “green tourmaline,” and “blue tourmaline.” Other names are “lithia tourmaline,” “watermelon tourmaline,” and “gem tourmaline.” In European mineralogical literature, elbaite appears as *Elbait* and *elbaita*. The word “tourmaline,” pronounced TOUR-muh-leen, comes from the Sinhalese *toramalli*, which referred generally to any of the colored gemstones of Sri Lanka (formerly Ceylon).

COMPOSITION: Elbaite, one of the 27 members of the tourmaline-mineral group, is the primary tourmaline gemstone. Its molecular weight is made up of 2.51 percent sodium (Na), 19.13 percent aluminum (Al), 1.89 percent lithium (Li), 3.54 percent boron (B), 54.11 percent oxygen (O), 18.38 percent silicon (Si), and 0.44 percent hydrogen (H). Elbaite’s chemical formula $Na(Al_{1.5},Li_{1.5})Al_6(BO_3)_3(Si_6O_{18})(OH)_4$ is broken down into positively charged cations and negatively charged anions. Elbaite’s cation $[Na(Al_{1.5},Li_{1.5})Al_6]^{25+}$ has a +25 charge; its anion $[(BO_3)_3(Si_6O_{18})(OH)_4]^{25-}$ has a -25 charge, which balances the cationic charge to provide the elbaite molecule with electrical stability.

As a silicate mineral, the basic building block of elbaite is the silica tetrahedron $(SiO_4)^{4-}$. As its name implies, it consists of a silicon ion surrounded by four equally spaced oxygen ions positioned at the corners of a tetrahedron (a four-faced polyhedron). Elbaite and the other tourmaline-group minerals are subclassified as ring silicates or cyclosilicates, in which silica tetrahedra share two of their oxygen ions with adjacent tetrahedra. Because each tetrahedron effectively loses one of its oxygen ions, this arrangement creates groups of linked $(SiO_3)^{2-}$ units that form ring-type structures. In elbaite, each ring consists of six $(SiO_3)^{2-}$ units, hence the "Si_6O_{18}" designation of the silica radical in the elbaite chemical formula. This six-sided geometry is modified in the cross section of elbaite crystals, in which three alternating prism edges are rounded to resemble a triangle. Elbaite and other tourmaline minerals crystallize in the trigonal system (a subsystem of the hexagonal system) with three-fold symmetry and four crystal axes.

Elbaite's six-sided silica rings are arranged in stacks of flat sheets. Borate ions $(BO_3)^{3-}$ are arranged within the ring structures, while hydroxyl ions and the ions of sodium, aluminum, and lithium are bound ionically between the sheets. Because its inter-sheet bonding is strong, elbaite exhibits no cleavage. Like most cyclosilicates, elbaite is hard, durable, and forms elongated, longitudinally striated crystals. Due to its unusually strong ionic and covalent bonding, elbaite (Mohs 7.0-7.5), elbaite is harder than quartz. The low atomic weights of elbaite's essential elements account for its moderate specific gravity of 2.9-3.2. Elbaite occurs primarily in lithium-rich granite pegmatites with quartz [silicon dioxide, SiO_2], lepidolite (a series of basic potassium lithium aluminum fluorosilicates of the mica group), and albite [sodium aluminum silicate, $NaAlSi_3O_8$].

Elbaite's colors have both allochromatic (other-colored) and idiochromatic (self-colored) origins. When pure or nearly pure, elbaite is colorless. But when the crystal lattice is distorted, the essential element lithium can function as a chromophore (color-causing agent). Displaced lithium ions within the lattice can create pinks, reds, blues, greens, and yellows. Accessory elements can also contribute to coloration. Traces of the accessory element manganese, along with the effects of natural geophysical radiation, can intensify the pink colors. Pink or reddish elbaite is known as rubellite, blue as indicolite, green as verdelite, and colorless as achroite. Elbaite crystals can become multicolored when chemistry varies during the crystallization process. Some multicolored crystals may display three or more different color bands. Elbaite crystals with internal, concentric color-zoning exhibit cross sections of green "rinds" with pink interiors and are called "watermelon tourmaline."

The Dana mineral classification number 61.3.1.8 identifies elbaite as a cyclosilicate with six-membered rings (61). The subclassification (3) defines elbaite as a six-membered, ring-structured cyclosilicate containing borate groups $(BO_3)^{3-}$. Elbaite is then assigned to the tourmaline group (1) as the eighth (8) member.

COLLECTING LOCALITIES: The pegmatites of Brazil's Minas Gerais state are the world's leading sources of elbaite, with such notable localities as Agua Boa, Consulheiro, Galiléia, Governador Valadares, Itambacuri, and Mendes Pimentel in the Doce Valley; and Araçuai, Coronel Muria, Diamantina, Itinga, Marlica, and Mucuri in the Jequitinhonha Valley. Other

Brazilian sources are the Borborema mineral complex near Equador and Parelhas in Rio Grande do Norte state, and Salgadinho and Frei Martinho in Paraiba state.

Much elbaite also comes from Afghanistan, where localities include the mines of the Wama, Nuristan, Kamdesh, and Du Ab pegmatite districts in Nuristan Province; and the Chapa Dara district in Konar Province. Pakistan's sources, all in Gilgit-Balistan (Northern Areas), are the Haramosh Mountains in the Gilgit District; Raikot and Chilas in the Diamar District; the Shigar, Haramosh, Skardu, and Braidu valleys in the Balistan District; and the Astore Valley mines in the Astore District.

Elbaite is also collected in Angola, Myanmar, Italy, Madagascar, Mexico, Mozambique, Namibia, Nepal, Russia, South Africa, and Sri Lanka. In the United States, elbaite occurs in California in San Diego County at the Tourmaline Queen Mine at Pala Mountain, the Hiriat and Vanderberg mines at Hiriat Mountain, and the Elizabeth R. and Ocean View mines in the Pala district; the Cota, Green Ledge, Himalaya, Mesa Grande and San Diego mines at Gem Hill in the Mesa Grande district; the Mountain Lily and Maple Lode mines at Aguanga Mountain in the Aguanga Mountain district; and the Ramona and Rincón mines in the Ramona district. Maine's elbaite specimens come from pegmatites near Albany, Buckfield, Greenwood, Hebron, Newry, Norway, Paris, Rumford, and West Paris, all in Oxford County.

JEWELRY & DECORATIVE USES: With its substantial hardness (Mohs 7.0-7.5), a lack of cleavage that enhances durability and facilitates cutting, moderately high index of refraction (1.615-1.651) that imparts brilliance to well-cut stones, and wide array of colors, elbaite makes a fine gemstone. Elbaite gems, which are usually faceted in rectangular styles to maximize cutting retention of the long, prismatic crystals, are used in rings and earrings, and as pendants. Color intensity and clarity determine the value of elbaite gems. The most desirable colors are the reddish-pinks of the rubellite variety and the greens of the verdelite variety. Color-zoned elbaite, especially "watermelon tourmaline" with its green "rinds" and pink interiors, is also cut into gems. Heavily included, translucent, chatoyant, pink and green elbaite crystals are fashioned into cabochons. Jewelers rarely use the word "elbaite," however, preferring such terms as "pink tourmaline" and "green tourmaline."

Composite specimens, with elbaite in association with such other pegmatite minerals as albite, lepidolite, and quartz, can be spectacular. Composite cabinet specimens of large elbaite crystals with matrix minerals can cost tens and even hundreds of thousands of dollars. The privately owned "Rose of Itatiaia," considered the world's most valuable elbaite specimen, is a 14-inch-long, 5-inch-wide prism of gem-quality, raspberry-colored elbaite on a gleaming matrix of white albite. Mineral collectors value elbaite, with its wide range of colors and excellent crystal development, as both individual crystals and as composite specimens for study, display, and investment purposes.

HISTORY & LORE: Elbaite has served as a gemstone since at least 2000 B.C. Because of its many colors, the ancient Egyptians knew tourmaline as "rainbow rock," believing that it gathered rainbow colors as it rose upward through the Earth. Early mineralogists failed to recognize elbaite as a mineral species because of its chemical complexity. In 1913, Russian geochemist and philosopher Vladimir Vernadsky (1863-1945) studied tourmaline specimens from Fonte del Prete, Campo nell'Elba, Elba, Livorno Province, Tuscany, Italy, and determined its chemical composition with sufficient accuracy to recognize a new mineral species, which he named "elbaite" after the island of Elba.

Metaphysical practitioners believe that pink elbaite overcomes fear and negativity, calms the nerves, provides inspiration, and dispels grief, while green elbaite promotes compassion and emotional healing, aids in connecting with the Earth, and is especially valuable in helping herbalists understand the flow of energy between minerals and plants. Elbaite is the official state mineral of Maine (where it is called "tourmaline"). It has appeared on the postage stamps of Brazil, Kenya, Switzerland, the United States, and the Comoros Islands.

THE TOURMALINE-GROUP MINERALS: The term "tourmaline" initially referred to various colored gemstones that had no common mineralogical ties. Today, the term refers specifically to a group of structurally and chemically related minerals. The first tourmaline mineral to be recognized as a species was black, opaque, iron-rich schorl [basic sodium iron aluminum borosilicate, $NaFe_3Al_6(BO_3)_3(Si_6O_{18})(OH)_4$]. During the Victorian era, schorl was popular as a gemstone, especially in mourning jewelry. Schorl, the most common tourmaline mineral, still serves as a minor gemstone today. Dravite [basic sodium magnesium aluminum borosilicate, $NaMg_3Al_6(BO_3)_3(Si_6O_{18})(OH)_4$], was recognized as the second tourmaline species. In 1913, elbaite became the third recognized tourmaline mineral. Despite the radically different colors and degrees of transparency of schorl, dravite, and elbaite, mineralogists nevertheless began to classify these minerals as members of a "tourmaline group." During the 1920s, newly developed, X-ray diffraction analysis methods confirmed their similar cyclosilicate structures. By the 1950s, mineralogists had recognized six tourmaline minerals. As a result of a major revision of tourmaline-classification standards in 2009, the tourmaline group now has 27 members. With the exception of schorl, dravite, and elbaite, which together comprise about 98 percent of all tourmaline minerals, the remaining 24 members are rare and difficult to chemically differentiate. Although new members will likely be added to the tourmaline group, the "big three," in order of gem importance and general familiarity, will most likely continue to be elbaite, schorl, and dravite.

TECHNOLOGICAL USES: Elbaite and other tourmaline minerals exhibit pyroelectrical and piezoelectrical properties. Pyroelectricity (from the Greek *pyr* or "fire") refers to voltage generated by heat; piezoelectricity (from the Greek *piezein*, "to press") is voltage generated by pressure. Elbaite's piezoelectrical properties were put to use in the early 1900s as pressure sensors in hydraulic presses; elbaite crystals later became the standard sensors for electrical pressure gauges. In these applications, the mechanical pressure on elbaite crystals generates a proportional amount of electrical potential (current) that can be read directly on electrical gauges. An especially critical use of elbaite during World War II was as pressure sensors in submarine hulls. During the post-World War II technological boom, elbaite's piezoelectrical properties were put to use in microphones, transducers, oscillators, amplifiers, and phonograph-record pickup sensors. Today, these applications employ synthetic, piezoceramic materials.

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