Tourmalines From Erzgebirge, Germany: Schorl and Fluor-Schorl From the Type Localities and Oxy-Schorl From Diamond-Bearing Rocks

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Tourmalines from Erzgebirge, Germany: schorl and fluor-schorl from the type localities and oxy-schorl from diamond-bearing rocks

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The early history of the mineral schorl shows that this name was in use prior to the year 1400 AD because a village known today as Zschorlau (in Saxony, Germany) was then named ‘‘Schorl’’ (or minor variants of this name). This village had a nearby tin mine where, in addition to cassiterite, a lot of black tourmaline was found (Ertl, 2006). There are historical mining dumps where schorl can still be found (Fig. 1). Around 200 years later the first relatively detailed description of schorl and its occurrence (various alluvial tin deposits and tin mines in the Erzgebirge) was published by Johannes Mathesius in 1562 (Ertl, 2006). He described schorl originally as “schürl”, with the properties black, a lighter weight than cassiterite (“zynstein”) and that it breaks easily.

Figure 1. Historical mining dumps near the village Zschorlau, Saxony, Germany. Type locality for schorl and fluor-schorl. Photo was taken in 2006.

Today the generalized formula of tourmaline-supergroup minerals can be written $XY_3Z_6(T_6O_{18})(BO_3)_3V_3W$, as proposed by Henry et al. (2011). Usually the X site is occupied by Na and Ca, the Y and Z sites by Al, Fe, Mn, and Mg. The T site is usually occupied by Si (sometimes also by Al and B) and the V and W sites are OH sites. The schorl endmember has the formula $^{X}Na\ ^{Y}Fe^{2+}_3\ ^{Z}Al_6\ ^{T}Si_6O_{18}\ (BO_3)_3\ ^{V}(OH)_3\ ^{W}(OH)$. A reinvestigation of black tourmalines from the Erzgebirge localities has shown that most of these tourmalines have a distinctly F-dominant W site (Ertl et al., 2009 DMG). Thus, surprisingly, many of the examined tourmalines from the area of the schorl type locality can be assigned to a fluorine-dominant tourmaline, which was given the name fluor-schorl (see following paragraph). However, the presence of a significant proportion of fluorine in the samples is not that surprising given the occurrence of fluorite and “pyknite” (stem-like variety of topaz) in many tin deposits in Saxony, where the pyknite is known to have formed from the reaction of potassium feldspar with pneumatolytic fluids (mainly HF). An investigation of the water and fluorine content in melt inclusions of highly differentiated granite from the Erzgebirge revealed very high fluorine values in some cases.

Fluor-schorl, $^{X}Na\ ^{Y}Fe^{2+}_3\ ^{Z}Al_6\ ^{T}Si_6O_{18}\ (BO_3)_3\ ^{V}(OH)_3\ ^{W}F$, is a mineral species of the tourmaline supergroup (Ertl et al., 2016), from which the German type locality has been described as alluvial tin deposits at Steinberg, Zschorlau, Erzgebirge (Saxonian Ore Mountains), Saxony, Germany (Fig. 2). Indeed the structural formulae of these black tourmalines ranges from $^{X}(Na_{0.5}\square_{0.5})$

$^{Y}(Fe^{2+}_{1.8}Al_{0.9}Mg_{0.2}\square_{0.1})$ $^{Z}(Al_{5.8}Fe^{3+}_{0.1}Ti^{4+}_{0.1})$ $^{T}(Si_{5.7}Al_{0.3}O_{18})$ $(BO_3)_3$ $^{V}(OH)_3$ $^{W}[(OH)_{0.9}F_{0.1}]$ to $^{X}(Na_{0.8}\square_{0.2})$ $^{Y}(Fe^{2+}_{2.3}Al_{0.4}Mg_{0.3})$ $^{Z}(Al_{5.8}Fe^{3+}_{0.1}Ti^{4+}_{0.1})$ $^{T}(Si_{5.8}Al_{0.2}O_{18})$ $(BO_3)_3$ $^{V}(OH)_3$ $^{W}[F_{0.7}(OH)_{0.3}]$. The investigated tourmalines from the Erzgebirge show that there exists a complete fluor-schorl – schorl solid-solution series. Correlations indicate that Fe^{2+}-rich tourmalines clearly tend to have a F-rich or F-dominant composition (Ertl et al., 2016).

Figure 2. Sprays of schorl crystals intergrown with fluor-schorl from the type locality Zschorlau (formerly known as a village named Schorl), Saxony, Germany. 10 × 6 cm.

A tourmaline-bearing gneiss from an ultrahigh-pressure unit in the Erzgebirge at the northwestern margin of the Bohemian Massif, is exposed in Saxony and the northern Czech Republic. This is part of the Devonian-Carboniferous metamorphic basement of the Mid-European Variscides. A stack of different tectono-metamorphic units, each with distinct pressure-temperature histories, characterizes the region. The investigated sample is from the diamond- and coesite-bearing gneiss-eclogite unit. The occurrence of diamond in the felsic gneisses requires pressures in excess of 4 GPa (Fig. 3). Peak metamorphic conditions may have been even higher (8 GPa at >1050 °C; Massonne, 2003). The sample was collected as a loose decimeter-sized block from a small creek near Forchheim, Pockau, Erzgebirge, Saxony, Germany. It is a felsic, medium-grained, granulite-facies mylonite displaying strongly elongated quartz and feldspar with black tourmaline porphyroclasts and minor garnet.

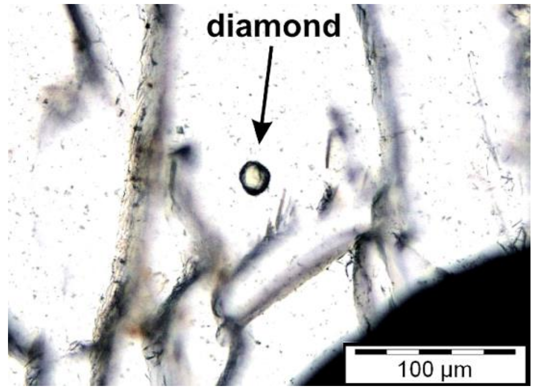

Figure 3. Microdiamond in garnet from Saidenbach reservoir, Forchheim, Erzgebirge, Saxony, Germany. Transmitted light photograph by Franz Bernhard, Graz, Austria.

Short, prismatic tourmaline crystals are up to 3 mm in length. In thin section, the tourmaline crystals show three distinct color zones: a blue core, a brownish mantle, and a greenish-gray rim (Fig. 4). Coesite and kyanite inclusions have been described from the tourmaline mantle zone (Marschall et al., 2009). This tourmaline, which contains almost no F, is a Mg-bearing oxy-schorl with the structural formula $^{X}(Na_{0.9}\square_{0.1})$ $^{Y}(Al_{1.7}Fe^{2+}_{1.2}Ti^{4+}_{0.1})$ $^{Z}(Al_5Mg)$ $^{T}Si_6O_{18}$ $(BO_3)_3$ $^{V}(OH)_3$ $^{W}[O_{0.8}F_{0.1}(OH)_{0.1}]$ (Ertl et al., 2010). This tourmaline most likely formed during exhumation at >3 GPa, 870 °C. It is interesting that this Fe-rich tourmaline contains more Al than Fe^{2+} at the Y site. This could be explained by the very high formation temperature.

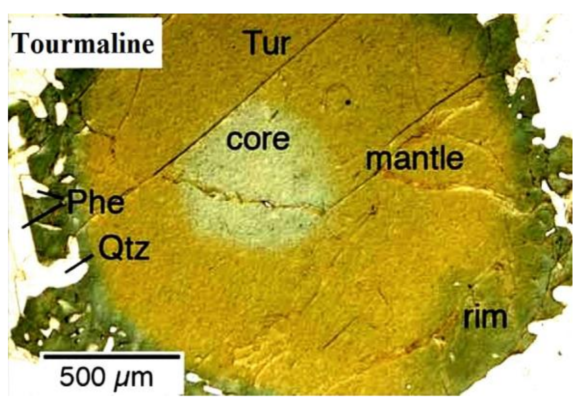

Figure 4. Zoned ultrahigh-pressure tourmaline

porphyroclast in phengite (Phe)–quartz (Qtz) gneiss from the Erzgebirge, Saxony, Germany (Marschall et al., 2009).

It can be concluded that black tourmaline from the Erzgebirge in Germany is not always schorl, but that the composition depends on the host rock composition and the conditions under which it was formed.

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