Todorokite \((\text{Mn}^{2+}, \text{Ca}, \text{Na}, \text{K})(\text{Mn}^{4+}, \text{Mn}^{2+}, \text{Mg})_6\text{O}_{12} \cdot 3\text{H}_2\text{O}\)

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Crystal Data: Monoclinic. \(\text{Point Group: } 2/m\). Crystals poor, lathlike, fibrous, elongated || [001] and flattened || [010], to 15 cm; in banded, reniform, or stalactitic aggregates of crystals; may be very porous. \(\text{Twinning: }\) As contact twins or trillings on an unknown law.

Physical Properties: \(\text{Cleavage: }\) \{100\} and \{010\}, perfect. Hardness = Soft.

Optical Properties: \(\beta\) = 9.5684(14) \(\beta\). Anisotropism: \(2V(\text{meas.}) = \text{n.d.}\). Absorption: \(Z > X\). \(n = > 2.00\).

Streak: \(\text{black; in transmitted light, brown; in reflected light, gray-white.}\)

Opaque, transparent in thinnest slivers.

Optical Properties:

\(\beta\): (400) 13.9–24.7; (420) 13.2–24.2; (440) 12.5–23.7; (460) 11.7–22.0; (480) 11.1–20.6; (500) 10.6–19.4; (520) 10.2–18.6; (540) 10.0–17.9; (560) 9.7–17.3; (580) 9.5–16.8; (600) 9.3–16.4; (620) 9.1–16.1; (640) 9.0–15.8; (660) 9.0–15.5; (680) 8.9–15.3; (700) 8.9–15.1

Cell Data: \(\text{Space Group: } P2/m\) (ICDD 38-475). \(a = 9.7570(15)\) \(b = 2.8419(5)\) \(c = 9.5684(14)\) \(\beta = 94.074(14)^\circ\) \(Z = 1\)

X-ray Powder Pattern: \(\text{N’Chwaning mine, Kuruman district, South Africa. (ICDD 38-475).}\)


Chemistry:

\[
\begin{array}{cccccc}
\text{Chemistry} & (1) & (2) & (1) & (2) & (1) & (2) \\
\text{SiO}_2 & 0.45 & 0.24 & \text{CaO} & 3.28 & 1.52 & \text{H}_2\text{O}^{-} & 1.56 \\
\text{MnO}_2 & 65.89 & 72.15 & \text{BaO} & 2.05 & 0.20 & \text{H}_2\text{O} & 10.61 \\
\text{Al}_2\text{O}_3 & 0.28 & 0.14 & \text{SrO} & 0.24 & & \text{CO}_2 & \text{trace} \\
\text{Fe}_2\text{O}_3 & 0.20 & 0.06 & \text{Na}_2\text{O} & 0.21 & 1.23 & \text{P}_2\text{O}_5 & 0.42 \\
\text{MnO} & 8.87 & & \text{K}_2\text{O} & 0.54 & 0.48 & \text{SO}_3 & 0.28 \\
\text{CoO} & 0.02 & & \text{O} & 12.07 & & \text{insol} & 1.28 \\
\text{MgO} & 1.01 & 3.51 & \text{H}_2\text{O}^{+} & 9.72 & & & \\
\end{array}
\]

Total 99.24 99.27

(1) Todoroki mine, Japan; corresponds to \((\text{Ca}_{0.49}\text{Mn}_{2+0.06}\text{K}_{0.05}\text{Na}_{0.05})^{2+} \cdot \Sigma^{-1.00}\text{Mn}_{4+0.06}^{4+}\text{Mn}_{2+0.77}^{2+}\text{Mg}_{0.17}^{2+} \Sigma=6.00\text{O}_2 \cdot 3.62\text{H}_2\text{O}\). (2) Tarantana mine, Cuba; corresponds to \((\text{Mn}_{2+0.49}\text{Na}_{0.25}^{2+}\text{Ca}_{0.19}^{2+}\text{K}_{0.06}^{2+}) \Sigma=0.99 \cdot \Sigma^{-1.00}\text{Mn}_{4+0.54}^{4+}\text{Mn}_{2+0.29}^{2+} \Sigma=6.00\text{O}_2 \cdot 3.06\text{H}_2\text{O}\).

Occurrence: A secondary mineral produced from weathering or hydrothermal alteration of other manganese-bearing species; in sedimentary marine fumarolic deposits; the principal manganese oxide in deep-sea manganese nodules.

Association: Pyrolusite, cryptomelane, romanèchite, mangaite, rhodochrosite, quartz, “opal”.

Distribution: Widespread. Well-characterized material from: the Todoroki mine, south of Ginzan, Hokkaido, Japan. On Groote Eylandt, Northern Territory, Australia. In Cuba, an ore in the Charco Redondo–Taratana district, and elsewhere in Oriente Province. In the USA, at Sterling Hill, Ogdensburg, Sussex Co., New Jersey, and the Tip Top mine, 8.5 km southwest of Custer, Custer Co., South Dakota. From Urandi, Bahia, Brazil. At Nsuta, Ghana. Large crystals from the Smartt mine and elsewhere in the Kuruman district, Cape Province, South Africa. At Romanèche, Saône-et-Loire, France. From Bleiberg and Hüttenberg, Carinthia, Austria.

Name: For its first-noted occurrence in the Todoroki mine, Japan.

Type Material: Harvard University, Cambridge, Massachusetts, 106214; National Museum of Natural History, Washington, D.C., USA.


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