Watanabeite $Cu_4(As, Sb)_2S_5$

Crystal Data: Orthorhombic. *Point Group*: n.d. As a mosaic of nearly rectangular grains and elongate grains to 50 μm.

Physical Properties: *Cleavage*: None. *Fracture*: Uneven. *Tenacity*: Brittle. Hardness = n.d. VHN = 253-306 (100 g load). D(meas.) = 4.66(2) D(calc.) = 4.66 Megascopically indistinguishable from tetrahedrite-group minerals.

Optical Properties: Opaque. *Color*: Silvery lead gray; gray in reflected light, resembling tetrahedrite. *Streak*: Lead-gray. *Luster*: Metallic.
Optical Class: *Anisotropism*: Weak.
R_1-R_2: (470) 32.5-31.5 $(17.7\text{-}17.0)_{oil}$, (546) 32.0-31.1 $(17.0\text{-}16.3)_{oil}$, (589) 31.1-30.3 $(16.1\text{-}15.5)_{oil}$, (650) 30.0-29.3 $(15.0\text{-}14.5)_{oil}$

Cell Data: *Space Group*: n.d. a = 14.51(1) b = 13.30(1) c = 17.96(1) Z = 16

X-ray Powder Pattern: Teine mine, Sapporo, Hokkaido, Japan.
2.999 (100), 1.833 (40), 2.594 (20), 1.564 (15b), 3.36 (7), 2.238 (5), 1.975 (5)

Chemistry:

	(1)	(2)
Cu	41.1	41.59
Ag	0.1	
Mn	0.3	
As	15.4	12.26
Sb	14.3	19.92
Bi	2.4	
S	26.2	26.23
Total	99.8	100.00

(1) Teine mine, Sapporo, Hokkaido, Japan; average of 6 electron microprobe analyses; corresponds to $(Cu_{0.93}Mn_{0.03}Ag_{0.01})_{\Sigma=3.98}(As_{1.25}Sb_{0.72}Bi_{0.07})_{\Sigma=2.04}S_{4.98}$. (2) Cu_4AsSbS_5.

Occurrence: In a hydrothermal quartz vein (Teine mine); in a high sulfidation epithermal deposit (Kamchatka).

Association: Emplectite, native bismuth, tennantite, quartz (Teine mine)

Distribution: From the Teine mine, Sapporo, Hokkaido, Japan [TL]. In the Gaching high-sulfidation epithermal deposit in the Maletoyvayam ore field, Kamchatka, Russia. In the Pagoni Rachi/Kirki Cu-Mo ± Re ± Au deposit, southeastern Rhodope Massif, southern Bulgaria and northern Greece.

Name: Honors Professor Takeo Watanabe (1907-1986), University of Tokyo (1944-1968), Nagoya University (1968-1971), President of the Akita University (1971-1976), who first reported native tellurium and sylvanite at the Teine mine.

Type Material: National Science Museum, Tokyo (M26138) and the University Museum of the University of Tokyo, Japan and the Natural History Museum, London, England (E.1400, BM 1992, 238).

References: (1) Shimizu, M., A. Kato, S. Matsubara, A.J. Criddle, and C.J. Stanley (1993) Watanabeite, $Cu_4(As, Sb)_2S_5$, a new mineral from the Teine mine, Sapporo, Hokkaido, Japan. Mineral. Mag., 57(4), 643-650. (2) (1994) Amer. Mineral., 79, 1014 (abs. ref. 1). (3) Tolstykh, N., A. Vymazalová, M. Tuhý, and M. Shapovalova (2018) Conditions of formation of Au-Se-Te mineralization in the Gaching ore occurrence (Maletoyvayam ore field), Kamchatka, Russia. Mineral. Mag., 82(3), 649-674. (4) Melfos, V., P.G. Spry, T. Kartal, H. Schleicher, R. Moritz, and M. Ortelli (2013) The Pagoni Rachi/Kirki Cu-Mo±Re±Au deposit, Northern Greece: mineralogical and fluid inclusion constraints on the evolution of a telescoped porphyry-epithermal system. Can. Mineral., 51(2), 253-284.