Tondiite $Cu_3Mg(OH)_6Cl_2$

Crystal Data: Hexagonal. *Point Group*: $\bar{3}\,2/m$. As irregularly shaped crystals dominated by {101} and {012}, to ~ 0.2 mm, often with stepped faces.

Physical Properties: *Cleavage*: n.d. *Fracture*: n.d. *Tenacity*: n.d. Hardness = 3-3.5 D(meas.) = n.d. D(calc.) = 3.503

Optical Properties: Transparent. *Color*: Emerald green to bright green. *Streak*: n.d. *Luster*: Vitreous. *Pleochroism*: Slight, green to faintly green. *Optical Class*: Uniaxial (+). ω = 1.749(6) ε = 1.766 (7)

Cell Data: *Space Group*: $R\bar{3}\,m$. a = 6.8377(7) c = 14.088(2) Z = n.d.

X-ray Powder Pattern: Calculated pattern.
2.764 (100), 5.459 (88), 2.266 (54), 1.709 (26), 3.419 (22), 1.820 (19), 2.898 (15)

Chemistry:

	(1)	(2)	(3)
CuO	65.90	66.78	61.52
MnO	0.94		
MgO	6.61	6.12	10.39
Cl	16.79	17.05	18.28
H_2O	13.84	13.52	13.94
–O=Cl	3.79	3.85	4.12
Total	100.29	99.62	100.00

(1) Vesuvius, Italy; average of 15 electron microprobe analyses, H_2O calculated from stoichiometry assuming Cl^- and OH^- as the only anions; corresponding to $Cu_{3.29}Mg_{0.65}Mn_{0.05}(OH)_{6.11}Cl_{1.89}$. (2) Santo Domingo Cu Mine, Chile; average of 20 electron microprobe analyses, H_2O calculated from stoichiometry assuming Cl^- and OH^- as the only anions; corresponding to $Cu_{3.38}Mg_{0.62}(OH)_{6.06}Cl_{1.94}$. (3) $Cu_3Mg(OH)_6Cl_2$.

Occurrence: A secondary mineral in vesicles in phonolitic tephrite (Vesuvius); a secondary oxidation product of chalcocite, bornite and chalcopyrite in an environment rich in Cl in andesitic porphyric lavas and lava tuff (Chile).

Association: Leucite, sodalite, nepheline, sanidine, Fe oxides and hydroxides (Vesuvius); haydeeite, anhydrite, atacamite (Chile).

Distribution: From Vesuvius volcano, Italy, and from the Santo Domingo Cu Mine, Caleta Vitor district, Arica Province, Chile.

Name: Honors Matteo Tondi (1762-1835), an Italian mineralogist and co-author with R.J. Haüy of the classic *Traité de Minéralogie*.

Type Material: Collezione Vesuviana of the Real Museo Mineralogico, University of Naples, Italy (# 1178R), labeled as "1906 lava", and at the Mineralogical Museum, University of Hamburg, Germany (MD480).

References: (1) Malcherek, T., L. Bindi, M. Dini, M.R. Ghiara, A. Molina Donoso, F. Nestola, M. Rossi, and J. Schlüter (2014) Tondiite, $Cu_3Mg(OH)_6Cl_2$, the Mg-analog of herbertsmithite. Mineral. Mag., 78(3), 583-590. (2) (2015) Amer. Mineral., 100, 662-663 (abs. ref. 1).