

Tululite

Crystal Data: Cubic. *Point Group:* 23. As irregular grains to 100 μm with indented outlines or less frequently as roundish grains. Grains exhibit open-work textures with numerous inclusions.

Physical Properties: *Cleavage:* None. *Tenacity:* Brittle. *Fracture:* Irregular. Hardness = 6.5 VHN = 715-740, 729 average (50 g load). D(meas.) = n.d. D(calc.) = 3.826 Nonfluorescent.

Optical Properties: Transparent. *Color:* Yellow with greenish tint. *Streak:* White.

Luster: Vitreous.

Optical Class: Isotropic. $n = 1.746(2)$

Cell Data: *Space Group:* F23. $a = 14.9346(4)$ $Z = 4$

X-ray Powder Pattern: Tulul Al Hammam area, northern Siwaqa complex, central Jordan. 2.640 (100), 2.874 (57), 1.760 (54), 2.524 (42), 2.278 (41), 1.524 (33), 1.500(33)

Chemistry:	(1)	(2)
SiO ₂	2.96	3.36
Al ₂ O ₃	14.50	25.62
Fe ₂ O ₃	9.25	4.46
MgO	1.64	
CaO	38.80	43.84
ZnO	22.04	22.72
CdO	5.04	
Mn ₂ O ₃	4.17	
<u>P₂O₅</u>	<u>1.51</u>	<u> </u>
Total	99.91	100.00

(1) Tulul Al Hammam area, northern Siwaqa complex, central Jordan; average electron microprobe analysis supplemented by Raman spectroscopy; corresponds to $(\text{Ca}_{13.29}\text{Cd}_{0.75})_{\Sigma=14.04}(\text{Al}_{5.46}\text{Zn}_{5.20}\text{Fe}^{3+}_{2.23}\text{Si}_{0.95}\text{Mn}^{3+}_{1.01}\text{Mg}_{0.78}\text{P}_{0.41})_{\Sigma=16.04}\text{O}_{36}$. (2) $\text{Ca}_{14}\{\text{Fe}^{3+}\text{O}_6\}[\text{SiO}_4][\text{Zn}_5\text{Al}_9]\text{O}_{26}$ for the endmember.

Occurrence: An abundant accessory mineral in combustion metamorphic (800-850 °C) spurrite-fluorellestadite marbles derived from bitumen-rich chalky marine sediments.

Association: Calcite, spurrite, fluorellestadite, Zn-rich periclase, lime-monteponite solid solution, zincite.

Distribution: From the Tulul Al Hammam area, northern Siwaqa complex, central Jordan.

Name: After *Tulul Al Hammam* (Arabic for “Pigeon Hills”) where the mineral was found.

Type Material: Central Siberian Geological Museum, V.S. Sobolev Institute of Geology and Mineralogy, Novosibirsk, Russia (VII-91/1. I).

References: (1) Khoury, H.N., E.V. Sokol, S.N. Kokh, Y.V. Seryotkin, E.N. Nigmatulina, S.V. Goryainov, E.V. Belogub, and I.D. Clark (2016) Tululite, $\text{Ca}_{14}(\text{Fe}^{3+}, \text{Al})(\text{Al}, \text{Zn}, \text{Fe}^{3+}, \text{Si}, \text{P}, \text{Mn}, \text{Mg})_{15}\text{O}_{36}$: a new Ca zincate-aluminate from combustion metamorphic marbles, central Jordan. *Mineralogy and Petrology* 110, 125-140.