Thermaerogenite $CuAl_2O_4$

Crystal Data: Cubic. *Point Group*: $4/m\ \bar{3}\ 2/m$. As octahedral crystals to 0.02 mm displaying {111} modified by {110}, sometimes skeletal.

Physical Properties: *Cleavage*: None. *Fracture*: Conchoidal. *Tenacity*: Brittle. Hardness = ~7 D(calc.) = 4.870

Optical Properties: Transparent to translucent. *Color*: Brown, yellow-brown, red-brown, brown-yellow, or brown-red; gray with yellowish internal reflections in reflected light. S*treak*: Yellow. *Luster*: Vitreous.
Optical Class: Isotropic.
R_1-R_2: (400) 16.4, (420) 16.0, (440) 15.7, (460) 15.4, (470) 15.2, (480) 15.1, (500) 14.8, (520) 14.5, (540) 14.2, (546) 14.2, (560) 14.0, (580) 13.7, (589) 13.6, (600) 13.2, (620) 13.2, (640) 13.0, (650) 12.9, (660) 12.8, (680) 12.5, (700) 12.3

Cell Data: Space Group: $Fd\ \bar{3}\ m$. $a = 8.093(9)$ Z = [8]

X-ray Powder Pattern: Arsenatnaya fumarole, Tolbachik volcano, Kamchatka Peninsula, Russia. 2.451 (100), 2.873 (65), 1.438 (30), 1.565 (28), 1.660 (16), 2.033 (10), 1.865 (6)

Chemistry:

	(1)	(2)
CuO	25.01	43.83
ZnO	17.45	
Al_2O_3	39.43	56.17
Cr_2O_3	0.27	
Fe_2O_3	17.96	
Total	100.12	100.00

(1) Arsenatnaya fumarole, Tolbachik volcano, Kamchatka Peninsula, Russia; average of 4 electron microprobe analyses supplemented by Raman spectroscopy; corresponds to $(Cu_{0.62}Zn_{0.42})_{\Sigma=1.04}(Al_{1.52}Fe^{3+}_{0.44}Cr_{0.01})_{\Sigma=1.97}O_4$. (2) $CuAl_2O_4$.

Polymorphism & Series: Continuous series with gahnite, discontinuous with cuprospinel.

Mineral Group: Spinel supergroup.

Occurrence: In cavities and overgrown on earlier oxide minerals, often epitaxially, as sublimates around a volcanic fumarole.

Association: Tenorite, hematite, orthoclase (As-bearing), fluorophlogopite, langbeinite, anhydrite, calciolangbeinite, aphthitalite-type sulfates, krasheninnikovite, vanthoffite, fluoborite, sylvite, halite, pseudobrookite, rutile, corundum, urusovite, johillerite, ericlaxmanite, kozyrevskite, popovite, lammerite, lammerite-β, tilasite, svabite, nickenichite, bradaczekite, dmisokolovite, shchurovskyite.

Distribution: From the Arsenatnaya fumarole, Second scoria cone, Northern Breakthrough, Great Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka Peninsula, Far-Eastern Region, Russia.

Name: A combination of the Greek θερμός for "hot", αέριον for "gas" and γενής for "born by", which together "*born by hot gas"*, alludes to the fumarolic origin of the mineral.

Type Material: A.E. Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia (5192/1).

References: (1) Pekov, I.V., F.D. Sandalov, N.N. Koshlyakova, M.F. Vigasina, Y.S. Polekhovsky, S.N. Britvin, E.G. Sidorov, and A.G. Turchkova (2018) Copper in natural oxide spinels: the new mineral thermaerogenite $CuAl_2O_4$, cuprospinel and Cu-enriched varieties of other spinel-group members from fumaroles of the Tolbachik Volcano, Kamchatka, Russia. Minerals, 8(11), 498.
(2) (2020) Amer. Mineral., 105(8), 1283-1284 (abs. ref. 1).