

**Crystal Data:** Orthorhombic. *Point Group:*  $2/m\ 2/m\ 2/m$ . As crystals, equant or dipyrarnidal {111}, prismatic [001] or [100], with {101}, {201}, many others, to 3 mm, in drusy crusts, botryoidal, usually granular to compact, massive.

**Physical Properties:** *Fracture:* Small conchoidal to uneven. *Tenacity:* Brittle. Hardness = 3–3.5 D(meas.) = ~5.9 D(calc.) = 6.187

**Optical Properties:** Transparent to nearly opaque. *Color:* Grass-green, olive-green, yellow-green, siskin-green, blackish brown, nearly black. *Streak:* Yellowish green. *Luster:* Greasy. *Optical Class:* Biaxial (-), rarely biaxial (+). *Pleochroism:* Weak to strong;  $X = Y =$  canary-yellow to greenish yellow;  $Z =$  brownish yellow. *Orientation:*  $X = c$ ;  $Y = b$ ;  $Z = a$ . *Dispersion:*  $r > v$ , strong; rarely  $r < v$ .  $\alpha = 2.17(2)$   $\beta = 2.26(2)$   $\gamma = 2.32(2)$   $2V(\text{meas.}) = \sim 73^\circ$

**Cell Data:** *Space Group:*  $Pnma$ .  $a = 7.667\text{--}7.730$   $b = 6.034\text{--}6.067$   $c = 9.278\text{--}9.332$   
 $Z = 4$

**X-ray Powder Pattern:** Mottram St. Andrew, England; close to descloizite. 3.24 (vvs), 5.07 (vs), 2.87 (vs), 2.68 (vs), 2.66 (vs), 2.59 (vs), 1.648 (vs)

Chemistry:	(1)	(2)	(1)	(2)
CrO <sub>3</sub>	0.50		ZnO	10.08
P <sub>2</sub> O <sub>5</sub>	0.24		PbO	55.30
As <sub>2</sub> O <sub>5</sub>	1.33		H <sub>2</sub> O	2.23
V <sub>2</sub> O <sub>5</sub>	21.21	22.53	insol.	0.17
CuO	17.05	9.86	Total	100.00

(1) Bisbee, Arizona, USA; average of three analyses. (2) Pb(Cu, Zn)(VO<sub>4</sub>)(OH) with Zn:Cu = 1:1.

**Polymorphism & Series:** Forms a series with descloizite.

**Mineral Group:** Descloizite group.

**Occurrence:** A secondary mineral in the oxidized zone of vanadium-bearing base metal deposits.

**Association:** Descloizite, duftite, mimetite, wulfenite, cerussite, azurite, diopside.

**Distribution:** Many localities. From Mottram St. Andrew, Cheshire, England. In the USA, at the Mammoth-St. Anthony mine, Tiger, Pinal Co., from Bisbee, Cochise Co., at the Total Wreck mine, Pinal Co., in the Apache mine, near Globe, and from the 79 mine, near Hayden, Gila Co., Arizona; at the Mayflower mine, Socorro Peak district, Socorro Co., New Mexico; from the Whale mine, Goodsprings district, Clark Co., Nevada. At Mina Grande, Arqueros, Coquimbo, Chile. Abundant at Tsumeb and elsewhere in the Otavi district, Namibia. At Kabwe (Broken Hill), Zambia.

**Name:** For an occurrence in England, ore stockpiled at Mottram St. Andrew, Cheshire; likely mined from the nearby Pim Hill mine, Shrewsbury, Shropshire.

**Type Material:** The Natural History Museum, London, England, 52314–52315.

**References:** (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 811–815. (2) Kingsbury, A.W.G. and J. Hartley (1956) New occurrences of vanadium minerals (mottramite, descloizite, and vanadinite) in the Caldbeck area of Cumberland. Mineral. Mag., 31, 289–295. (3) van der Westhuizen, W.A., H. de Bruijn, E.A.W. Tordiffe, and B.J.V. Botha (1986) The descloizite–mottramite series of vanadates from the Otavi Mountain Land, South West Africa: an X-ray study. Mineral. Mag., 50, 137–140. (4) Cooper, M.A. and F.C. Hawthorne (1995) The crystal structure of mottramite, and the nature of  $\text{Cu} \rightleftharpoons \text{Zn}$  solid solution in the mottramite-descloizite series. Can. Mineral., 33, 1119–1124.

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