Brockite $(Ca, Th, Ce)(PO_4)\cdot H_2O$

Crystal Data: Hexagonal. *Point Group:* 622 (?). Rarely as stubby hexagonal prisms, to 50 μm; commonly granular radial, in very fine-grained massive aggregates, cryptocrystalline earthy.

Physical Properties: *Fracture:* Conchoidal. Hardness = n.d. D(meas.) = 3.9(2) D(calc.) = [3.81] Radioactive.

Optical Properties: Translucent to opaque. *Color:* Pale yellow on thin edges; red-brown in reflected light, principally from included hematite. *Luster:* Greasy to vitreous. *Optical Class:* Uniaxial (+). *Orientation:* Parallel extinction, positive elongation. $\omega = 1.680(2)$ $\epsilon = 1.695(2)$

Cell Data: *Space Group:* $P6_222$ (?). $a = 6.96(3)$ $c = 6.40(3)$ $Z = 3$

X-ray Powder Pattern: Wet Mountains, Colorado, USA; cannot be distinguished from other members of the rhabdophane group.
3.03 (vsb), 4.37 (s), 2.83 (s), 2.15 (s), 3.47 (m), 1.86 (m), 6.06 (mw)

Chemistry:

	(1)	(2)		(1)	(2)
P_2O_5	24.7	34.6	RE_2O_3	6.9	23.8
CO_2	3.2		CaO	10.2	10.6
UO_2		3.1	SrO	1.4	
ThO_2	44.7	23.9	BaO	1.1	
ZrO_2		4.0	H_2O	7.8	
			Total	[100.0]	100.0

(1) Wet Mountains, Colorado, USA; $RE_2O_3 = Y_2O_3$ 1.27%, CeO_2 1.23%, La_2O_3 0.49%, Pr_6O_{11} 0.06%, Nd_2O_3 1.52%, Sm_2O_3 0.72%, Eu_2O_3 0.30%, Gd_2O_3 0.99%, Tb_4O_7 0.35%, Dy_2O_3 0.64%, Ho_2O_3 0.16%, Er_2O_3 0.19%, Tm_2O_3 0.01%, Yb_2O_3 0.02%, Lu_2O_3 0.01% [= 7.9%]; H_2O and CO_2 by CHN analyzer, recalculated to 100% from an original total of 102.2% after deduction of hematite 4.6% and insoluble 2.0%; corresponds to $(Ca_{0.43}Th_{0.41}RE_{0.11}Sr_{0.03}Ba_{0.02})_{\Sigma=1.00}$ $[(PO_4)_{0.83}(CO_3)_{0.17}]_{\Sigma=1.00}\cdot 0.87H_2O$. (2) Ishikawa, Japan; $RE_2O_3 = Y_2O_3$ 7.5%, La_2O_3 3.8%, Ce_2O_3 7.5%, Nd_2O_3 5.0%; corresponds to $(Ca_{0.39}Th_{0.19}Y_{0.14}Ce_{0.09}Zr_{0.07}Nd_{0.06}La_{0.05})_{\Sigma=0.99}$ $PO_4\cdot H_2O$.

Mineral Group: Rhabdophane group.

Occurrence: A rare accessory mineral in granite and granite pegmatites.

Association: Monazite, bastnäsite, xenotime, thorite, zircon, apatite, rutile, hematite.

Distribution: In the USA, in a prospect pit about 1 km east of the Bassick mine, Querida, Wet Mountains, and at the Hardwick mine and Nightingale shaft, Custer Co., Colorado; in the Bear Lodge Mountains, Crook Co., Wyoming; from the Diamond Creek district, Lemhi Co., Idaho and the Lemhi Pass district, Idaho-Montana; found in Monroe Canyon, Sevier Co., Utah; from the Laughlin Peak area, Colfax Co., New Mexico; in the Rawhide Mountains, Mohave Co., Arizona. At Mont Saint-Hilaire, Quebec, Canada. From Kizilcaoren, Turkey. In Japan, from Atagoyama, Shionhira, Shin-yashikiike, and Ishizuka, Ishikawa district, Fukushima Prefecture, Japan. A few other minor localities are known.

Name: To honor Maurice R. Brock, U.S. Geological Survey, who supplied the first specimen.

Type Material: National Museum of Natural History, Washington, D.C., USA, 121952.

References: (1) Fisher, F.G. and R. Meyrowitz (1962) Brockite, a new calcium thorium phosphate from the Wet Mountains, Colorado. Amer. Mineral., 47, 1346–1355. (2) Staatz, M.H. (1985) Geology and description of the thorium and rare-earth veins in the Laughlin Peak area, Colfax County, New Mexico. U.S. Geol. Survey Prof. Paper 1049-E, 32 pp. (3) Shogi, H. and J. Akai (1994) Brockite from Ishikawa, Fukushima Prefecture, Japan. Science Reports, Niigata University, Series E (Geology and Mineralogy), 9, 89–96.