

Monazite-(Ce)**(Ce, La, Nd, Th)PO₄**

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Crystal Data: Monoclinic; metamict if thorium-rich. *Point Group:* 2/m. Crystals typically tabular on {100}, may be prismatic, equant or wedge-shaped, to 27 cm; granular, massive. *Twinning:* Common, {100} as twin and composition plane, as contact twins.

Physical Properties: *Cleavage:* {100}, distinct; {010}, poor; parting on {001} or {111}. *Fracture:* Conchoidal to uneven. *Tenacity:* Brittle. Hardness = 5–5.5 D(meas.) = 4.98–5.43 D(calc.) = 5.26 Radioactive if thorium-rich. Dull brown cathodoluminescence. Paramagnetic.

Optical Properties: Translucent to opaque. *Color:* Reddish brown, brown, pale yellow, pink, gray; yellowish brown to yellow in transmitted light. *Luster:* Resinous, waxy, vitreous to adamantine.

Optical Class: Biaxial (+). *Pleochroism:* Weak; in pale yellows. *Orientation:* X = b; Z ⊥ c = 2°–6°. *Dispersion:* r < v, r > v, weak, horizontal. *Absorption:* Distinct; Y > X = Z. α = 1.770–1.793 β = 1.778–1.800 γ = 1.823–1.860 2V(meas.) = 10°–26°

Cell Data: *Space Group:* P2₁/n. a = 6.7902(10) b = 7.0203(6) c = 6.4674(7) β = 103.38(1)° Z = 4

X-ray Powder Pattern: Sri Lanka.

2.862 (100), 3.078 (80), 1.963 (50), 2.151 (40), 1.738 (40b), 3.285 (35), 1.876 (30)

Chemistry:	(1)	(1)	(1)
P ₂ O ₅	27.4	ThO ₂	11.6
U ₃ O ₈	0.4	Al ₂ O ₃	0.02
SiO ₂	0.4	RE ₂ O ₃	59.24
		<u>CaO</u>	<u>1.0</u>
		Total	100.16

(1) Sri Lanka; by electron microprobe, RE₂O₃ = La₂O₃ 21.7%, Ce₂O₃ 28.7%, Pr₆O₁₁ 1.9%, Nd₂O₃ 6.0%, Sm₂O₃ 0.6%, Gd₂O₃ 0.09%, Dy₂O₃ 0.2%, Ho₂O₃ 0.05%; corresponding to (Ce_{0.43}La_{0.33}Th_{0.11}Nd_{0.09}Ca_{0.04}Pr_{0.03}Sm_{0.01})_{Σ=1.04}(P_{0.94}Si_{0.02})_{Σ=0.96}O₄.

Mineral Group: Monazite group.

Occurrence: An accessory mineral in granites, syenites, and their pegmatites; in carbonatites and volcanoclastic rocks; in fissure veins and high-grade metamorphic rocks; commonly detrital in river and beach sands; rarely authigenic in shales and intense weathering zones.

Association: Zircon, xenotime, titanite, thorite, allanite, columbite, wolframite (pegmatites and Alpine fissures); rhabdophane, cerianite, florencite, churchite (Mt. Weld, Australia).

Distribution: Widespread, but uncommon in fine crystals. In the Ilmen Mountains, Southern Ural Mountains, Russia, at Miass. At Arendal and many other places in Norway. In Madagascar, at Ambatofotsikely, Ampangabe, and Ampatakala. From the Kangankunde Hill carbonatite, 30 km west of Lalaka, Malawi. In the USA, large crystals from Mars Hill, Madison Co., near Double Shoals, Cleveland Co., and elsewhere in North Carolina. Fine twins from the Joaquim Felicio mine, near Buenopolis, and large crystals in the José Pinto pegmatite, at Jaguaracú, near Coronel Fabriciano, Minas Gerais, Brazil. Good crystals from the Ishikawa district, Fukushima Prefecture, Japan. In the Bayan Obo Fe–Nb–RE deposit, 130 km north of Baotou, Inner Mongolia, China, 35 million tons estimated. At the Mt. Weld carbonatite, 35 km south of Laverton, Western Australia, 15 million tons estimated. The principal source of Ce, RE, Th, from heavy mineral sands in North and South Carolina and Florida, USA; also Australia, Sri Lanka, India, Brazil.

Name: From the Greek for *solitary*, for its initial apparent rarity, and dominant *cerium*.

Type Material: Mining Academy, Freiberg, Germany, 19539.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 691–696. (2) Chang, L.L.Y., R.A. Howie, and J. Zussman (1996) Rock-forming minerals, (2nd edition), v. 5B, non-silicates, 335–352. (3) Jobbins, E.A., A.E. Tresham, and B.R. Young (1977) Gem monazite from Sri Lanka. J. Gemmol., 15, 295–299. (4) Y. Ni, J.M. Hughes, and A.N. Mariano (1995) Crystal chemistry of the monazite and xenotime structures. Amer. Mineral., 80, 21–26.

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