

Zirkelite**(Ca, Th, Ce)Zr(Zr, Ti)₂O₇**

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Crystal Data: Cubic; commonly metamict. *Point Group:* $4/m\bar{3}2/m$. Crystals are flattened octahedra, to 3 cm. *Twinning:* On {111}, very common, as complex fourlings and polysynthetic.

Physical Properties: *Fracture:* Conchoidal. *Tenacity:* Brittle. Hardness = 5.5
D(meas.) = 4.741 D(calc.) = n.d. Commonly radioactive.

Optical Properties: Opaque, transparent in very thin fragments. *Color:* Black; reddish brown to dark brown in transmitted light. *Luster:* Resinous.
Optical Class: Isotropic. $n = 2.19(1)$

Cell Data: *Space Group:* $Fm\bar{3}m$. $a = 5.02\text{--}5.06$ $Z = 2$

X-ray Powder Pattern: Arbarastkh massif, Russia; after heating at 700–800 °C.
2.98 (100), 1.82 (50), 2.53 (30), 1.75 (30), 2.84 (20), 2.30 (10), 1.51 (10)

Chemistry:	(1)
	TiO ₂ 14.95
	ZrO ₂ 52.89
	ThO ₂ 7.31
	UO ₂ 1.40
	Y ₂ O ₃ 0.21
	CeO ₂ 2.64
	FeO 7.72
	MgO 0.22
	CaO 10.79
	LOI 1.02
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	Total 99.15

(1) Jacupiranga, Brazil; corresponds to $[(\text{Ca, Na})_{0.82}\text{Th}_{0.12}\text{RE}_{0.07}\text{U}_{0.02}]_{\Sigma=1.03}[\text{Zr}_{1.84}\text{Ti}_{0.80}(\text{Fe, Mn, Mg, Al})_{0.48}]_{\Sigma=3.12}\text{O}_7$.

Polymorphism & Series: Dimorphous with calciobetafite.

Occurrence: In a magnetite-pyroxenite carbonatite (Jacupiranga, Brazil); a late-stage differentiate in a layered intrusion (Rhum, Scotland).

Association: Perovskite, baddeleyite.

Distribution: From the Jacupiranga carbonatite, São Paulo, Brazil. On St. Kilda, Outer Hebrides, and Rhum, Inner Hebrides, Scotland. In Russia, in the Vouriyarvi and Kovdor massifs, and in the Sevlyavr carbonatite complex, Kola Peninsula; from the Arbarastkh massif, Aldan Shield, Sakha. At Phalaborwa, Transvaal, South Africa. From Walawada, Sri Lanka. In some soils and breccia derived from granophyre on the Moon.

Name: Honors Ferdinand Zirkel (1838–1912), German petrographer, Professor of Mineralogy, University of Leipzig, Leipzig, Germany.

Type Material: The Natural History Museum, London, England, 80142.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 740. (2) Mazzi, F. and R. Munno (1983) Calciobetafite (new mineral of the pyrochlore group) and related minerals from Campi Flegrei, Italy; crystal structures of polymignyte and zirkelite: comparison with pyrochlore and zirconolite. *Amer. Mineral.*, 68, 262–276. (3) Bayliss, P., F. Mazzi, R. Munno, and T.J. White (1989) Mineral nomenclature: zirconolite. *Mineral. Mag.*, 53, 565–569. (4) Borodin, L.S., A.B. Bykova, T.A. Kapitonova, and Y.A. Pyatenko (1960) New data on zirconolite and its niobium variety. *Doklady Acad. Nauk SSSR*, 134, 1188–1191.

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