Baddeleyite ZrO_2

Crystal Data: Monoclinic. *Point Group:* $2/m$. Crystals commonly tabular on {100} and somewhat elongated on [010], or short to long prismatic along [001], to 6 cm; rarely equant; prism faces striated ‖ [001]; radially fibrous with concentric banding in botryoidal masses. *Twinning:* Ubiquitous; on {100} and {110}, both may be polysynthetic; rare on {201}.

Physical Properties: *Cleavage:* {001} nearly perfect, {010} and {110} less perfect. *Fracture:* Subconchoidal to uneven. *Tenacity:* Brittle. Hardness = 6.5 D(meas.) = 5.40–6.02 D(calc.) = [5.83] Blue-green cathodoluminescence.

Optical Properties: Transparent; in dark-colored specimens, only in thin fragments. *Color:* Colorless to yellow, green, greenish or reddish brown, brown, iron-black; colorless to brown in transmitted light. *Streak:* White to brownish white. *Luster:* Greasy to vitreous; nearly submetallic in black crystals.
Optical Class: Biaxial (–). *Pleochroism:* X = yellow, reddish brown, oil-green; Y = oil-green, reddish brown; Z = brown, light brown. *Orientation:* $X \wedge c = 13°$; $Y = b$. *Dispersion:* $r > v$, rather strong. *Absorption:* $X > Y > Z$. $\alpha = 2.13(1)$ $\beta = 2.19(1)$ $\gamma = 2.20(1)$
2V(meas.) = 30(1)° 2V(calc.) = 28°

Cell Data: *Space Group:* $P2_1/c$ (synthetic). $a = 5.1505(1)$ $b = 5.2116(1)$ $c = 5.3173(1)$ $\beta = 99.230(1)°$ Z = 4

X-ray Powder Pattern: Phalaborwa, South Africa.
3.15 (10), 2.835 (9), 2.62 (5), 1.817 (5), 3.66 (4), 3.51 (4), 1.847 (4)

Chemistry:	(1)	(2)		(1)	(2)		(1)	(2)
SiO_2	0.19	0.08	HfO_2		0.93	CaO	0.06	
TiO_2		0.56	Fe_2O_3	0.82		LOI	0.28	
ZrO_2	98.90	97.8	FeO		1.3	Total	100.25	100.67

(1) Balangoda, Sri Lanka. (2) Axel Heiberg Island, Canadian Arctic Archipelago; by electron microprobe, average of 35 analyses.

Occurrence: An accessory mineral in carbonatites and kimberlites; in syenites, diabases, gabbros, anorthosites; detrital in gem gravels. In lunar basalt, tektites, and meteorites.

Association: Ilmenite, zirkelite, apatite, magnetite, perovskite (Jacupiranga mine, Brazil); fluorite, nepheline, pyrochlore, allanite (Monte Somma, Italy).

Distribution: At Rakwana and Balangoda, Sri Lanka. From Monte Somma, Campania, Italy. In Russia, large crystals from the Kovdor massif, and in the Gulinskii massif, the Vuoriyarvi carbonatite complex, and the Imandrovsky layered intrusion, Kola Peninsula; in the Lukkulaisvaara layered intrusion, Karelia. At the Jacupiranga mine, São Paulo, and at Poços de Caldas, Minas Gerais, Brazil. From Bozeman, Gallatin Co., Montana, USA. In the Bingo deposit, Kivu Province, Congo (Zaire). From Catanda, Angola. At Benfontein, and in large crystals from Phalaborwa, Transvaal, South Africa. Other minor occurrences are known.

Name: For Joseph Baddeley, who first called attention to the Sri Lankan material.

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

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 608–610. (2) Heimstra, S.A. (1955) Baddeleyite from Phalaborwra, Eastern Transvaal. Amer. Mineral., 40, 275–282. (3) Keil, K. and P.E. Fricker (1974) Baddeleyite (ZrO_2) in gabbroic rocks from Axel Heiberg Island, Canadian Arctic Archipelago. Amer. Mineral., 59, 249–253. (4) Scatena-Wachel, D.E. and A.P. Jones (1984) Primary baddeleyite (ZrO_2) in kimberlite from Benfontein, South Africa. Mineral. Mag., 48, 257–261. (5) Heaman, L.M. and A.N. LeCheminant (1993) Paragenesis and U–Pb systematics of baddeleyite (ZrO_2). Chem. Geol., 110, 95–126. (6) Howard, C.J., R.J. Hill, and B.E. Reichert (1988) Structures of the ZrO_2 polymorphs at room temperature by high-resolution neutron powder diffraction. Acta Cryst., 44, 116–120.