Rutile TiO_2

Crystal Data: Tetragonal. *Point Group:* $4/m\ 2/m\ 2/m$. Crystals prismatic, elongated and striated ‖ [001], to 25 cm, showing {110}, {010}, terminated by {101} or {111}, many others; equant, rarely dipyramidal; massive. *Twinning:* On {011}, common, or {031}, geniculated, reticulated; as contact twins with two, six, or eight individuals, cyclic, polysynthetic.

Physical Properties: *Cleavage:* {110}, good; {100}, moderate; {111}, in traces. *Fracture:* Conchoidal, subconchoidal, uneven. *Tenacity:* Brittle. Hardness = 6–6.5 VHN = 894–974 (100 g load). D(meas.) = 4.23(2), increasing with Nb–Ta content. D(calc.) = 4.25 Photosensitive.

Optical Properties: Opaque, transparent in thin fragments. *Color:* Reddish brown, red, pale yellow, pale blue, violet, rarely grass-green; black if high in Nb–Ta; red to brownish red, pale yellow in transmitted light, deep brown to green with high Nb–Ta; in reflected light, gray with bluish tint, with white, yellow, or red internal reflections. *Streak:* Pale brown, yellowish brown; gray, greenish black with high Nb–Ta. *Luster:* Adamantine to submetallic. *Optical Class:* Uniaxial (+). *Pleochroism:* Distinct; red, brown, yellow, green. *Dispersion:* Strong. *Absorption:* $E > O$. $\omega = 2.605$–2.613 $\epsilon = 2.899$–2.901 *Anisotropism:* Strong. R_1–R_2: (400) 23.7–27.0, (420) 23.2–26.5, (440) 22.7–26.0, (460) 22.2–25.5, (480) 21.7–25.1, (500) 21.3–24.7, (520) 20.9–24.3, (540) 20.6–24.0, (560) 20.2–23.6, (580) 20.0–23.4, (600) 19.7–23.1, (620) 19.5–22.9, (640) 19.2–22.8, (660) 19.1–22.6, (680) 19.0–22.5, (700) 18.9–22.5

Cell Data: *Space Group:* $P4_2/mnm$ (synthetic). $a = 4.5937$ $c = 2.9587$ Z = 2

X-ray Powder Pattern: Synthetic.
3.247 (100), 1.6874 (60), 2.487 (50), 2.188 (25), 1.6237 (20), 1.3598 (20), 1.3465 (12)

Chemistry:

	(1)
TiO_2	97.46
Fe_2O_3	2.62
Total	100.08

(1) Graves Mountain, Georgia, USA.

Polymorphism & Series: Trimorphous with anatase and brookite.

Mineral Group: Rutile group.

Occurrence: A common high-temperature, high-pressure accessory mineral in igneous rocks, anorthosite, and granite pegmatite; in hydrothermally-altered rocks; in gneiss, schist, contact metamorphosed limestone; in clays, shales; a common detrital mineral.

Association: Anatase, brookite, hematite, ilmenite, apatite, adularia, albite, titanite, chlorite, pyrophyllite, calcite, quartz.

Distribution: Many localities; a few for fine crystals include: in Switzerland, at Cavradi, Tavetsch, Graübunden, and Lodrino, Tessin. From the Pfitschtal, Trentino-Alto Adige, Italy. On the Saualpe, and at Herzogberg, near Modriach, Styria, Austria. From Kassoi Brod, Ural Mountains, Russia. In the USA, at Magnet Cove, Hot Spring Co., Arkansas; on Graves Mountain, Washington, Lincoln Co., Georgia; at Stony Point, Alexander Co., North Carolina; from Parkesburg and elsewhere, Chester Co., Pennsylvania; in the Champion mine, White Mountains, Mono Co., California. In Brazil, large crystals from Conquista, and at Ibitiara, Bahia. At the Giftkuppe mine, Omaruru, Namibia.

Name: From the Latin *rutilus*, for *red*, a common color of the mineral.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 554–561. (2) Deer, W.A., R.A. Howie, and J. Zussman (1962) Rock-forming minerals, v. 5, non-silicates, 34–39. (3) Howard, C.J., T.M. Sabine, and F. Dickson (1992) Structural and thermal parameters for rutile and anatase. Acta Cryst., 47, 462–468. (4) (1969) NBS Mono. 25, 7, 83.