Heterogenite $Co^{3+}O(OH)$

Crystal Data: Hexagonal. *Point Group:* $\overline{3}2/m$ or $6/m2/m2/m$. Crystals very rare, hexagonal, prismatic, to 1 mm; commonly massive, globular to reniform, stalactitic; as thin coatings, earthy. *Twinning:* Commonly observed in polished section.

Physical Properties: *Cleavage:* In crystals, {0001}. *Fracture:* Conchoidal. Hardness = 3–5 VHN = 420–640 (100 g load). D(meas.) = 3.07–4.32; 4.72 (synthetic). D(calc.) = 4.92

Optical Properties: Opaque. *Color:* Black, blackish brown, reddish brown; in reflected light, white with brownish tinge. *Streak:* Dark brown. *Luster:* Dull to vitreous.
Optical Class: Uniaxial. *Anisotropism:* Strong; bluish to yellowish white, browns.
Bireflectance: Very strong.
R_1–R_2: (400) 15.0–30.4, (420) 15.8–30.4, (440) 16.6–30.4, (460) 16.7–29.8, (480) 16.6–28.8, (500) 16.3–27.8, (520) 16.2–27.0, (540) 16.3–26.4, (560) 16.6–26.0, (580) 16.7–25.6, (600) 16.7–25.3, (620) 16.5–25.0, (640) 16.4–24.8, (660) 16.2–24.5, (680) 16.0–24.2, (700) 15.8–23.8 (3R).

Cell Data: *Space Group:* $R\overline{3}m$,synthetic (3R), with $a = 2.855$ $c = 13.156$ Z = 3, or
Space Group: $P6_3/mmc$(2H), with $a = 2.855(5)$ $c = 8.805(5)$ Z = 2

X-ray Powder Pattern: Katanga (Shaba Province), Congo (3R).
4.40 (vvs), 2.315 (vs), 1.427 (ms), 1.804 (s), 2.428 (m), 1.356 (m), 1.979 (mw)

X-ray Powder Pattern: Mindigi, Congo (2H).
4.39 (vvs), 1.236 (vs), 2.472 (ms), 1.262 (ms), 2.158 (s), 1.644 (s), 2.381 (mw)

Chemistry:	(1)	(2)	(3)		(1)	(2)	(3)
Al_2O_3	0.2			NiO	0.3	2.0	
Fe_2O_3	0.5			CuO	3.6		
Co_2O_3	74.7	88.1	90.20	H_2O	[20.7]	9.9	9.80
CoO	0.0			Total	[100.0]	100.0	100.00

(1) Katanga (Shaba Province), Congo; H_2O by difference. (2) Mindigi, Congo; by electron microprobe, H_2O by TGA. (3) CoO(OH).

Polymorphism & Series: 3R and 2H polytypes.

Occurrence: A weathering product of smaltite (Schneeberg, Germany); an alteration product of linnaeite, constituting an important ore of cobalt (Shaba Province, Congo); widespread in residual soils above ultramafic rocks (New Caledonia).

Association: Smaltite, pharmacosiderite, calcite (Schneeberg, Germany); linnaeite, sphaerocobaltite, malachite, cuprite (Shaba Province, Congo).

Distribution: Localities for well-characterized material include: at Schneeberg, Saxony; at the Anton mine, Heubachtal, and Wittichen, Black Forest; and at Richelsdorf, Hesse, Germany. From Congo (Zaire), in Katanga (Shaba) Province, in the Star of the Congo mine, near Lubumbashi; from Shinkolobwe; and at Mindigi. From Tsumeb, Namibia. At Bou Azzer, Morocco. In the Pabellón mine, Rio Copiapó, Atacama, Chile. In the USA, from Goodsprings, Clark Co., Nevada. At the Nanganobori Co–Ni mine, Yamaguchi Prefecture, Japan. Found in Rocky's Reward pit, near Agnew, Western Australia. Many occurrences in New Caledonia.

Name: From the Greek for *of another kind*, as differing in composition from similar minerals.

Type Material: Mining Academy, Freiberg, Germany, 11752; Royal Museum of Central Africa, Tervuren, Belgium, RGM10800.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 652 [heterogenite, trieuite, boodtite], 650–651 [stainierite]. (2) Ramdohr, P. (1969) The ore minerals and their intergrowths, (3rd edition), 1057–1059 [heterogenite-stainierite]. (3) Hey, M. (1962) Cobaltic hydroxide in nature. Mineral. Mag., 33, 253–259. (4) Deliens, M. and H. Goethals (1973) Polytypism of heterogenite. Mineral. Mag., 39, 152–157. (5) Llorca, S. and P. Monchoux (1991) Supergene cobalt minerals from New Caledonia. Can. Mineral., 29, 149–161.