Skutterudite $CoAs_{2-3}$

Crystal Data: Cubic. *Point Group:* $2/m\ \overline{3}$. Crystals are cubes, octahedra, dodecahedra, to 9 cm; rarely prismatic; in skeletal growth forms, distorted aggregates; also massive, granular and dense. *Twinning:* On {112} as sixlings and complex shapes; also reported on {011}.

Physical Properties: *Cleavage:* Distinct on {001} and {111}; in traces on {011}. *Fracture:* Conchoidal to uneven. Hardness = 5.5–6 VHN = 606–824; 810–915 (100 g load). D(meas.) = 6.5 D(calc.) = 6.821

Optical Properties: Opaque. *Color:* Tin-white to silver-gray, tarnishes gray or iridescent; in polished section, gray, creamy or golden white. *Streak:* Black. *Luster:* Metallic.
R: (400) 55.3, (420) 56.0, (440) 56.4, (460) 56.6, (480) 56.4, (500) 56.1, (520) 55.7, (540) 55.3, (560) 55.0, (580) 54.7, (600) 54.4, (620) 54.1, (640) 53.8, (660) 53.5, (680) 53.1, (700) 52.7

Cell Data: *Space Group:* $Im3$. $a = 8.195(3)$ $Z = 8$

X-ray Powder Pattern: Synthetic $CoAs_3$.
2.592 (100), 2.193 (35), 1.835 (35), 1.609 (30), 1.675 (20), 0.9537 (20), 3.35 (18)

Chemistry:

	(1)	(2)	(3)	(4)
Co	19.70	19.0	28.23	20.77
Fe	2.80	2.0		
Ni		1.8		
As	76.41	75.7	71.77	79.23
S	1.03	2.1		
Total	[99.94]	100.6	100.00	100.00

(1) Skutterud, Norway; recalculated after deduction of SiO_2 5.63%; corresponding to $(Co_{0.87}Fe_{0.13})_{\Sigma=1.00}(As_{2.65}S_{0.08})_{\Sigma=2.73}$. (2) Cobalt, Canada; by electron microprobe, corresponding to $(Co_{0.83}Fe_{0.09}Ni_{0.08})_{\Sigma=1.00}(As_{2.60}S_{0.17})_{\Sigma=2.77}$. (3) $CoAs_2$. (4) $CoAs_3$.

Polymorphism & Series: Forms a series with nickel-skutterudite.

Occurrence: Typically in medium- to high-temperature hydrothermal veins with other Ni–Co sulfide minerals.

Association: Nickeline, cobaltite, arsenopyrite, silver, silver sulfosalts, bismuth, calcite, siderite, barite, quartz.

Distribution: From many localities as an accessory mineral, only rarely as an important ore or in fine specimens. In Norway, from Skutterud, Modum [TL]. At Schneeberg, Annaberg, and Freiberg, Saxony, Germany. From Austria, at Lölling, Carinthia. In Spain, in the valley of Gistain, Huesca Province. From France, at Riomanou, Hautes-Pyrénées, and on Mount Chalanches, Isère. At Talnotry, Kirkcudbrightshire, Scotland. From a number of mines in Cornwall, England. At Khovu-Akay, Tuva, Russia. Well-crystallized from the Aghbar (Arhbar) and Irhtem (Ightem) mines, Bou Azzer district, Morocco. In the USA, in Connecticut, at Chatham, Middlesex Co.; and from Mine la Motte, Madison Co., Missouri. In Canada, in large amounts at Cobalt; in South Lorrain Township; at Sudbury; and Gowganda, Ontario.

Name: For the Norwegian locality at Skutterud.

Type Material: Mining Academy, Freiberg, Germany, 3910.

References: (1) Palache, C., H. Berman, and C. Frondel (1944) Dana's system of mineralogy, (7th edition), v. I, 342–346. (2) Roseboom, E.H., Jr. (1962) Skutterudites $(Co, Ni, Fe)As_{3-x}$: composition and cell dimensions. Amer. Mineral., 47, 310–327. (3) Radcliffe, D. (1971) Structural formula and composition of skutterudite. Can. Mineral., 9, 559–563. (4) Mandel, N. and J. Donohue (1971) The refinement of the crystal structure of skutterudite, $CoAs_3$. Acta Cryst., 27, 2288–2289. (5) Pauling, L. (1978) Covalent chemical bonding of transition metals in pyrite, cobaltite, skutterudite, millerite and related minerals. Can. Mineral., 16, 447–452. (6) (1960) NBS Circ. 539, 10, 21. (7) Criddle, A.J. and C.J. Stanley, Eds. (1993) Quantitative data file for ore minerals, 3rd ed. Chapman & Hall, London, 515, 516.