Ludlockite $PbFe_4^{3+}As_{10}^{3+}O_{22}$

Crystal Data: Triclinic. *Point Group:* $\overline{1}$. Commonly as simply terminated laths, elongated along [100], and flattened on $\{0\overline{1}1\}$, less commonly prismatic with almost equant cross sections, to 4 cm; may be slightly twisted. In divergent bundles of such hairlike crystals. *Twinning:* Lamellar twinning on $\{0\overline{1}1\}$, common.

Physical Properties: *Cleavage:* Perfect micaceous on $\{0\overline{1}1\}$, perfect on {021}.
Tenacity: Very flexible and sectile. Hardness = 1.5–2 D(meas.) = 4.33–4.40 D(calc.) = 4.58

Optical Properties: Semitransparent. *Color:* Red, red-brown, orange-brown, yellow.
Streak: Pale brown. *Luster:* Subadamantine.
Optical Class: Biaxial (+). *Pleochroism:* X = yellow; Y = deep yellow; Z = yellow-orange.
Orientation: $Z \wedge a \simeq 3°$. *Absorption:* $Z > Y > X$. $\alpha = 1.96$ $\beta = 2.055$ $\gamma = > 2.11$
2V(meas.) = n.d.

Cell Data: *Space Group:* $P\overline{1}$. $a = 10.426(4)$ $b = 11.972(5)$ $c = 9.894(4)$ $\alpha = 113.76(3)°$ $\beta = 99.83(3)°$ $\gamma = 82.50(3)°$ Z = 2

X-ray Powder Pattern: Tsumeb, Namibia.
8.81 (vvs), 2.935 (vs), 3.330 (ms), 3.160 (ms), 2.863 (ms), 10.90 (m), 4.74 (mb)

Chemistry:

	(1)	(2)	(3)
As_2O_5	70.82		
Fe_2O_3	21.63	19.96	20.85
As_2O_3		60.67	64.58
PbO	9.32	14.41	14.57
H_2O	0.00		
$-O$	1.69		
Total	100.08	95.04	100.00

(1) Tsumeb, Namibia; predominant Fe^{3+} confirmed by Mössbauer spectroscopy, total As as As_2O_5. (2) Do.; by electron microprobe, total Fe as Fe_2O_3, total As as As_2O_3, both confirmed by crystal-structure analysis; corresponding to $Pb_{1.04}Fe^{3+}_{4.04}As^{3+}_{9.93}O_{22}$. (3) $PbFe_4^{3+}As_{10}^{3+}O_{22}$.

Occurrence: In sulfide ore from a complex polymetallic hydrothermal ore deposit (Tsumeb, Namibia).

Association: Zincian siderite, tennantite, chalcocite, pyrite, bornite, germanite, quartz; leiteite, reniérite, stolzite, schneiderhöhnite (Tsumeb, Namibia).

Distribution: From Tsumeb, Namibia. At Laurium, Greece, in slag. From one km north of Campiglia, Tuscany, Italy, in slag. At Zarehehuran, near Takap, Takht-e-Suleiman massif, Azerbaijan.

Name: For Fredrick LUDlow Smith III, (1939–) and Charles LOCKe Key (1935–), American mineral dealers then resident in New Jersey, USA, who supplied the first specimens for study.

Type Material: The Natural History Museum, London, England, 1969,215 and 216; Harvard University, Cambridge, Massachusetts, USA, 127927.

References: (1) Embrey, P.G., M.H. Hey, and R.J. Davis (1977) Ludlockite: a new mineral from Tsumeb. Mineral. Record, 8(3), 91–94. (2) Cooper, M.A. and F.C. Hawthorne (1996) The crystal structure of ludlockite, $PbFe_4^{3+}As_{10}^{3+}O_{22}$, the mineral with pentameric arsenite groups and orange hair. Can. Mineral., 34, 79–89.