

**Loveringite****(Ca, Ce)(Ti, Fe<sup>3+</sup>, Cr, Mg)<sub>21</sub>O<sub>38</sub>**

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**Crystal Data:** Hexagonal; metamict in part. *Point Group:*  $\bar{3}$ . Commonly anhedral, to 120  $\mu\text{m}$ ; may be acicular; as inclusions in other minerals.

**Physical Properties:** Hardness = n.d. VHN = 421–464; 870–933 (100 g load). D(meas.) = n.d. D(calc.) = 4.42

**Optical Properties:** Opaque. *Color:* Black; white to grayish white in reflected light.

*Streak:* Iron-gray. *Luster:* Metallic to submetallic.

*Optical Class:* Uniaxial.

R: (400) —, (420) 18.2, (440) 17.7, (460) 17.4, (480) 17.0, (500) 16.8, (520) 16.5, (540) 16.4, (560) 16.4, (580) 16.5, (600) 16.5, (620) 16.5, (640) 16.5, (660) 16.5, (680) 16.6, (700) 16.5

**Cell Data:** *Space Group:*  $R\bar{3}$ .  $a = 10.337(6)$   $c = 20.677(12)$   $Z = 3$

**X-ray Powder Pattern:** Near Norseman, Western Australia; after heating in air at 800° C. 1.433 (100), 3.037 (93), 1.589 (92), 3.384 (87), 2.465 (72), 1.791 (71), 2.129 (68)

<b>Chemistry:</b>	(1)	(2)	(1)	(2)	(1)	(2)
V <sub>2</sub> O <sub>5</sub>	1.10		Y <sub>2</sub> O <sub>3</sub>	0.09	MnO	0.17
TiO <sub>2</sub>	58.34	72.22	La <sub>2</sub> O <sub>3</sub>	1.22	NiO	0.08
ZrO <sub>2</sub>	4.18	0.14	CeO <sub>2</sub>	1.28	PbO	0.22
HfO <sub>2</sub>	0.35		Nd <sub>2</sub> O <sub>3</sub>	0.24	MgO	2.18
ThO <sub>2</sub>	0.09		RE <sub>2</sub> O <sub>3</sub>	0.26	CaO	2.37
UO <sub>2</sub>	0.18		Fe <sub>2</sub> O <sub>3</sub>	15.77	15.81	99.21
Al <sub>2</sub> O <sub>3</sub>	1.15	0.88	Cr <sub>2</sub> O <sub>3</sub>	9.94	4.76	99.85
						Total

(1) Near Norseman, Western Australia; by electron microprobe, average of five analyses, total Fe as Fe<sub>2</sub>O<sub>3</sub>, total V as V<sub>2</sub>O<sub>5</sub>, RE<sub>2</sub>O<sub>3</sub> estimated from chondrite-normalized rare earth patterns; corresponds to [Ca<sub>0.72</sub>RE<sub>0.33</sub>(Y, Th, U, Pb)<sub>0.05</sub>]<sub>Σ=1.10</sub>(Ti<sub>12.48</sub>Fe<sub>3.38</sub>Cr<sub>2.24</sub>Mg<sub>0.92</sub>Zr<sub>0.58</sub>Al<sub>0.39</sub>V<sub>0.21</sub>Mn<sub>0.04</sub>)<sub>Σ=20.24</sub>O<sub>38</sub>. (2) Western Laouni massif, Algeria; by electron microprobe, total Fe as Fe<sub>2</sub>O<sub>3</sub>; corresponds to [Ca<sub>1.13</sub>(Ti<sub>14.66</sub>Fe<sub>3.21</sub>Cr<sub>1.02</sub>Mg<sub>0.71</sub>Al<sub>0.28</sub>Mn<sub>0.08</sub>Zr<sub>0.02</sub>)<sub>Σ=19.98</sub>O<sub>38.04</sub>].

**Mineral Group:** Crichtonite group.

**Occurrence:** A late-stage mineral from residual intercumulus magma in the pyroxene, olivine-chromite, or plagioclase-rich layers of mafic intrusions.

**Association:** Quartz, potassium feldspar, phlogopite, enstatite, baddeleyite, apatite, zircon, titanite, rutile, ilmenite, chromite (near Norseman, Australia); rutile, pseudobrookite, ilmenite, zirconolite, spinel, pargasite, phlogopite (Western Laouni massif, Algeria).

**Distribution:** In the Jimberlana intrusion, near Norseman, Western Australia. From St. Christophe and La Grave, near Bourg d'Oisans, Isère, France. In Austria, in the Lohning quarry, Rayris Valley. From the Koitelainen intrusion, Lapland, Finland. In the Western Laouni massif, Hoggar Mountains, Algeria.

**Name:** Honors Professor John Francis Lovering (1930–), Australian geochemist, University of Melbourne, Melbourne, Australia, for his work on fission-track methods in geochemistry.

**Type Material:** Museum Victoria, Melbourne, Australia, M34208; National Museum of Natural History, Washington, D.C., USA, 143350.

**References:** (1) Gatehouse, B.M., I.E. Grey, I.H. Campbell, and P. Kelly (1978) The crystal structure of loveringite – a new member of the crichtonite group. *Amer. Mineral.*, 63, 28–36. (2) Kelly, P.R., I.H. Campbell, I.E. Grey, and B.M. Gatehouse (1979) Additional data on loveringite (Ca, REE)(Ti, Fe, Cr)<sub>21</sub>O<sub>38</sub> and mohsite discredited. *Can. Mineral.*, 17, 635–638. (3) Lorand, J.-P., J.-Y. Cottin, and G.C. Parodi (1987) Occurrence and petrological significance of loveringite in the Western Laouni layered complex, southern Hoggar, Algeria. *Can. Mineral.*, 25, 683–693.

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