# *The nomenclature of the natural alloys of osmium and iridium*

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*Summary.* An historical review of the nomenclature of the natural Os-Ir alloys suggests that the most suitable names are: For the cubic alloys, *osmiridium* (Steffens, 1824), i.e. osmian iridium; and for the hexagonal alloys, *iridosmine* (Breithaupt, 1827), i.e. iridian osmium, for alloys with 20% or more Ir, and native *osmium* for the very rare alloys with little or no Ir. Iridosmine may, if desired, be divided into two varieties. *nevyanskite* and *sysertskite*, following Rose and Haidinger.

NATURAL alloys of osmium and iridium have been known since 1805 (W. H. Wollaston), but their nomenclature is still confused. Wollaston called the mineral 'Ore of Iridium', although he knew osmium was an important constituent, and a number of later authors called it Iridium (e.g. R. Jameson (1816), J. F. L. Hausmann (1816), and W. Haidinger (1845)).

A. Aikin (1815) referred to it as Alloy of Iridium and Osmium,[1] J. J. Berzelius (1819) as Osmiure d'Iridium, and R. J. Haüy (1822) as Iridium osmié, and the last two terms were widely used, especially in France,[2] for the next sixty years, but were gradually ousted by more conventional species names.

K. C. von Leonhard (1821) introduced the name Osmium-Iridium, shortened by H. Steffens (1824) to Osm-Iridium and modified to Osmiridium by C. F. Naumann (1828)[3] and to Osmium-Irid by G. Rose (1833); these terms, like Berzelius's and Haüy's, emphasize the iridium content.

The osmium content is emphasized in A. Breithaupt's name Iridosmin (1827) or iridisches Osmin (1832), modified by C. F. Naumann (1828) to Iridosmin, and in W. Whewell's Iridium-Osmium (1828).

[1] This term is attributed by C. Hintze (1904) and by C. Palache, H. Berman, and C. Frondel (1944) to W. Phillips (1819).

[2] F.-S. Beudant (1832) wrote Osmiure d'Irridium.

[3] Naumann did not consider his name new, attributing it to von Leonhard. C. Hintze (1904) and C. Palache, H. Berman, and C. Frondel (1944) attributed it to E. F. Glocker (1831).

C. U. Shepard (1832) wrote Irid-Osmium and appears to attribute this term to Schwetzau,[1] while E. F. Glocker (1839) preferred Iridosmium.[2]

The first, and during this initial period of nomenclature development the only analysis of the mineral was made by T. Thomson (1826), who found, on Brazilian material supplied by Wollaston, Ir 72·9, Os 24·5, Fe 2·6 %; but his method would gravely underestimate the osmium content.

In 1833 G. Rose found that material from the Urals consisted for the most part of a light-coloured mineral agreeing in crystal form and general properties with the Brazilian, mixed with rare fragments of a much darker coloured mineral with the same crystal form but which were appreciably denser and which gave a strong smell of osmium tetroxide when heated before the blowpipe, and thus presumably contained more osmium; this was confirmed by analyses by J. J. Berzelius (1834), which showed up to 50 % Os in the light-coloured mineral and about 75 % in the dark.

Both varieties were included by Rose and Berzelius under the name Osmium-Iridium, and by E. F. Glocker (1839) under Iridosmium, but W. Haidinger (1845) called the species Iridium (despite its high osmium-content), and named the two varieties: the lighter and whiter, osmium-poor Newjanskit, and the denser, darker, osmium-rich Sisserskit;[3] Sysertskite is much the rarer variety.

J. F. L. Hausmann (1847) and C. Hintze (1904) accepted this division, but preferred the names Osmiridium (Os-poor) and Iridosmium (Os-rich); in the 5th (1868) and 6th (1892) editions of Dana's 'System', there is one species, Iridosmine, with Newjanskite and Sisserskite (5th) or Nevyanskite and Siserskite (6th) as varieties, but in the 7th (1944) edition Iridosmine is used for the Os-poor material and Siserskite for the Os-rich. V. I. Vernadsky (1909) and A. E. Fersman and A. G. Betekhtin (1941) use Nevyanskite (Невьянскит) and Sysertskite (Сысертскит) but add a third variety, Osmite,[4] with 80 % or more Os, the natural existence of which was doubtful.

All the natural alloys examined prior to 1938 appear to have been

[1] I have not been able to trace this author, beyond a mention in Breithaupt (1827), to whom he supplied platinum concentrates.

[2] C. Hintze (1904) and C. Palache, H. Berman, and C. Frondel (1944) attribute the name Iridosmium to J. F. L. Hausman (1847).

[3] As the localities are Невьянск (Nevyansk) and Сысерть (Sysert), the correct English forms of these names are Nevyanskite and Sysertskite; many other spellings have been used.

[4] Osmite had already been used by R. Hermann (1836) for the supposed compound $Ir_2Os$, a Nevyanskite in Vernadsky's nomenclature.

hexagonal and isomorphous with pure osmium,[1] whereas the natural platinum–iridium alloys had long been known to be cubic, and pure iridium was shown by A. W. Hull and W. P. Davey (1920) to be cubic. Then in 1938 O. E. Zvyagintsev discovered a natural cubic Os–Ir alloy, with 31 % Os; he showed that the break in the mix-crystal series falls at about 32–35 % Os, and wrote:

> According to the classification of V. I. Vernadsky osmiridium[2] should be divided into two varieties: nevanskite and syssertskite. The boundary of these two varieties lies in the region of a 50 % content [of Os]. In the author's opinion it would be more expedient to refer the boundary between syssertskite and nevyanskite to the region of 35% osmium content and to consider as nevyanskite the cubic varieties of osmiridium and as syssertskite the hexagonal ones. However, lest the already established classification should be altered, it seems better to subdivide the system of natural osmium–iridium alloys into three parts: (1) from 0 to 35 % osmium—minerals of the native iridium group, (2) from 35 to 50 % osmium–nevyanskite, (3) from 50 to 70 % osmium—syssertskite. (No minerals have been found with an osmium content above 70 %).

Modern conventions of nomenclature would distinguish two species in the osmium–iridium alloys, cubic and hexagonal, but neither A. E. Fersman and A. G. Betekhtin (1941) nor C. Palache, H. Berman, and C. Frondel (1944) make any mention of O. E. Zvyagintsev's cubic phase. The present author (M. H. Hey, 1950) and F. V. Chukhrov (1960) use Iridosmine for the hexagonal phase (with Nevyanskite and Sysertskite as varieties) and Osmiridium for the cubic phase; this nomenclature recognizes the isomorphism of Iridosmine and Osmium on the one hand and of Osmiridium and Iridium on the other.

Recently C. Lévy and P. Picot (1961) have extended the known series of natural Os-Ir alloys to an almost pure osmium, and have confirmed O. E. Zvyagintsev's results, but unfortunately they propose a new system of nomenclature: they drop the names Iridosmine, Nevyanskite, Sysertskite, and Osmite. They use Iridium osmifère for the cubic alloys, and Osmium iridifère and Osmiridium for hexagonal alloys with more and less than 49·75 % Os (by weight; 50 % atomic proportions), and and they write:

> Nous redéfinissons ainsi le terme d'osmiridium qui originellement avait été appliqué à un composé contenant Ir 72,9, Os 24,5 et Fe 2,6 (Glocker, 1831). . . .

[1] H. Debray (1882) and W. Prinz (1893) obtained artificial octahedral crystals of Os, Ir, and intermediate alloys; but these may have been paramorphs after a high-temperature cubic modification.

[2] In this paper Zvyagintsev apparently uses the term Osmiridium to cover all Os-Ir alloys, but I have only seen the foreign language edition; in an earlier paper (1934) he uses Osmiridium in the German summary, but Осмистий иридий [osmian iridium] in the Russian text, although he is referring to the hexagonal phase.

Iridosmine (iridosmium) qui vient d'iridisches osmium et qui a été employé par Breithaupt (1827, 1832) pour des composés contenant plus de 50% d'osmium. C'est à tort que Beudant (1832) a appliqué ce nom à un iridium osmié analysé par Thomson.

This passage is inaccurate in several respects: the name Osm-Iridium was originally assigned (by Steffens, 1824) to a hexagonal alloy from Brazil, of then unknown quantitative composition, the same as Haüy (1822) had termed 'Iridium osmié'; this alloy was later analysed by Thomson (1826), who found 24·5 % Os but almost certainly underestimated this element. The name Irid-Osmin was applied by Breithaupt (1827) to unanalysed material from Nizhne-Tagilsk, and was clearly regarded by him as synonymous with Osmium-Iridium and Iridium osmié (1832); there is no evidence that it contained more than 50 % Os.

In 1831, when the only available quantitative analysis was Thomson's and the existence of separate cubic and hexagonal phases and of a series of mix-crystals from 32 to 100 % Os was unsuspected, E. F. Glocker's footnote was clearly justified:

Da das Iridium der vorherrschende Bestandtheil ist, so kann auch nach den bekannten Gesetzen der Zusammensetzung der Wörter die oben gebrauchte Benennung dieser Gattung 'Osmiridium' allein als die richtige angenommen werden.

But with our present knowledge of the system separate names for the cubic and hexagonal phases are required. For the latter Iridosmine, that is, iridian osmium, seems preferable, since the crystal structure is the same as that of osmium whether osmium or iridium predominates; the very rare material near the osmium end of the series may best be termed Osmium, but to divide the series at 50 atomic per cent calls for accurate analyses and is undesirable; if any subdivision of Iridosmine (taken to cover 32 to ~ 80 % Os) is desired, Haidinger's names, and his distinction according to colour and behaviour when heated, seem quite suitable.

For the cubic phase, Iridium could be adopted, distinguishing platinian, osmian, and aurian-osmian varieties; but since the iridium–platinum and iridium–osmium (cubic) alloys are fairly readily distinguished, retention of the names Platiniridium and Osmiridium seems preferable. If the name Osmiridium is not to be used for the cubic phase, it should be rejected altogether.

| Cubic series: | Hexagonal series: | |
|---|---|---|
| Platiniridium | Iridosmine (Os > 32%) | Nevyanskite |
| Iridium (not known in nature) | Osmium (Os > ~80%) | Sysertskite |
| Osmiridium (Os < 32%) | | |

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*Added in proof.* Dr. G. M. Koen has kindly drawn my attention to a paper by H. C. Vacher, C. J. Bechtoldt, and E. Maxwell (Journ. Metals, Amer. Inst. Min. Eng., 1954, vol. 60, p. 80), who prepared a series of Os–Ir alloys by fusion and air-cooling. They found, in agreement with Zvyagintsev (1938), that the cubic phase extends to at least 24 % Os, but their alloys with 39, 59, and 79 % Os were all two-phase, whereas Zvyagintsev reported a hexagonal mineral with as little as 35 % Os, and A. D. Westland and F. E. Beamish (1958) one with 38 % Os.

Of 17 studied grains of 'nevyanskite' from the British Museum collections, one, from the Transvaal (part of B.M. 1922, 151), consisted of comparable amounts of osmiridium and iridosmine; three were iridosmine with traces of osmiridium, two were osmiridium, and eleven iridosmine. These grains had been selected in a search for osmiridium for exhibition, and were all light-coloured and presumably Ir–rich; though none of them has yet been analysed, the preponderance of purely hexagonal-phase grains tends to support the conclusion of Zvyagintsev (1932, 1934) and of Westland and Beamish (1958) that the natural hexagonal phase (Iridosmine) may contain well under 50 % Os. Of course, this material may be metastable, but it seems more likely that the rapidly cooled, unannealed alloys examined by Vacher, Bechtoldt, and Maxwell had only partially inverted from a high-temperature cubic phase, for the probable existence of which the results of Debray (1882) and Prinz (1893) afford some evidence.