Nineteenth Century Platinum Coins

AN EARLY INDUSTRIAL USE OF POWDER METALLURGY

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Powder metallurgy is the metallurgist's answer to the production of ductile metals of high melting point by methods differing from conventional melting and casting. The history of platinum, extensively and vividly recorded by McDonald and Hunt (1), gives examples of how platinum was worked into objects from earliest times onwards. However, the first real melting of platinum was achieved only as late as 1782, when Lavoisier successfully reached the temperature of 1769°C necessary to melt this metal on a very small scale with the aid of an oxygen torch (2). Three years earlier, Franz Karl Achard (1753–1821), whose contributions to metallurgy have only recently been fully realised (3), made use of the property of platinum to form low-melting point alloys with elements such as phosphorus, mercury and arsenic. A mixture of 13 weight per cent of arsenic and 87 per cent of platinum (equivalent to 28 atomic per cent of arsenic) gives a eutectic with a melting point of 597°C (4, 5). Achard melted this mixture of arsenic and platinum with the addition of potash as flux, and after evaporation of the volatile arsenic he obtained platinum sponge which he was able to shape into objects, such as crucibles. This process remained in use until 1810.

In the meantime Wollaston produced the first malleable platinum by a "wet" method. As early as 1801 he solved the problem of how to get rid of the impurities normally accompanying naturally occurring placer platinum. By careful adjustment of the proportions of hydrochloric and nitric acid in aqua regia, and later by using more dilute mixtures, he separated platinum from its associated palladium and rhodium. The solution, containing only hexachloroplatinate, H_2PtCl_6, was subsequently treated with sal ammoniac, resulting in a precipitate of ammonium hexachloroplatinate, $(NH_4)_2[PtCl_6]$. On heating this decomposed to platinum sponge, and thus an economical method was found to produce the pure metal in sufficiently large quantities for industrial use (6).

On a limited scale platinum was already turned into commemorative coins and medals—often surface-gilded—in Spain in 1780 and in France in 1799. About 1825 a new source of platinum group metals was discovered

Fig. 1 Russian 3-rouble coins minted in 1829 and 1843, respectively. Between 1828 and 1845 many hundreds of thousands of platinum coins were struck in the mint at St. Petersburg

Fig. 2 Modern platinum coins were struck between 1977 and 1980 to commemorate the Olympic Games held in Moscow in 1980. The obverse shown here (left) is common to the five coins. In addition to the runners illustrated, other coins show the Olympic emblem, discus throwing, wrestling and chariot racing

in the Russian Urals, these extensive and rich placer deposits making large quantities of platinum available. As there was no significant industrial use for the metal in those days, it was decided to employ it for coinage purposes. By imperial decree of Tsar Nicholas I (1825–1855), dated April 24, 1828, the platinum coinage was initiated for circulation, starting with 3-rouble denominations, followed in 1829 by coins of 6-roubles, and finally in 1830 by those of 12-rouble denomination (7). The person responsible for introduction of the Russian platinum coinage was Count Georg von Cancrinus (1775–1845), Minister of Finance to Tsar Nicholas I from 1824 to 1844. He belonged to a famous mining family that had immigrated to Russia from Germany (8).

The crude metal was refined by a "wet" method developed by the chemist Peter Grigorievich Sobolevsky (1781–1841) at St. Petersburg (9), and the resulting platinum sponge was compressed under high pressure to circular blanks. After sintering, they were again compressed, heated and struck into coins (10). Between 1828 and 1844 some 485,000 ounces of platinum were thus converted into coins, employing for the first time in history powder metallurgical methods on a large scale. The platinum roubles were intended to be circulated in lieu of the traditional silver and gold coinage and the Russian law fixed the ratio between platinum and silver at 1:5.21459 (11). The 3-, 6- and 12-rouble platinum coins weighed 0.333, 0.666 and 1.332 ounces troy each, respectively. Examples of 3-rouble pieces, minted in 1829 and 1843, are illustrated in Figure 1.

However, the platinum coins met with little approval by the public. They came to be known as the "little grey ones" (in Russian: serenkije, серенькие, also meaning "little donkey") and the acceptance of these coins was more and more refused, the Russian government finally having to call back all the coins still in circulation. The full story of the introduction and the cessation of platinum coining in Russia has been recorded in detail by McDonald and Hunt (12), and need not be repeated here.

The whole stock of demonetised roubles was stored in the vaults of the Imperial State Bank until 1872, when George Matthey's partner, John Sellon, managed to secure the whole lot, then amounting to 378,000 ounces. This bulk was distributed among the three refiners: Johnson Matthey in London, Desmoutis Quennessen in Paris and Heraeus in Hanau, near Frankfurt, West Germany (13). Today, very few of these Russian platinum coins still exist, they are collectors' items and fetch high prices at coin auctions. At the time, when the large shipments of the Russian stock were distributed among the refineries mentioned, the small establishment of Wilhelm Siebert (1862–1927), like Heraeus also situated in Hanau, was able to secure a share of the Russian coinage from Johnson Matthey, and after 1884 Wilhelm Siebert travelled to Russia and as a result was able to acquire additional raw material (platinum "sand" and nuggets) for his refinery. From this time—either through purchase from Johnson Matthey or through his own dealings—a few cherished platinum coins and platinum nuggets were salvaged from the

Table I

Analysis of Platinum from Russian Placer Deposits

Weight per cent. after Hintze (14)

Analysis Number	Pt	Fe	Pd	Rh	Ir	Cu	(Ir, Os)	Sum	Remarks	Locality	Analyst	(Reference)
20	80.87	2.30	1.64	11.07	trace	2.05	—	98.83	0.79 S, 0.11 residue	Ural (coinage metal)	Osann	(a)
21	77.50	9.60	0.85	2.80	1.45	2.15	2.35	97.70	? Au, 1.00 sand	"	Deville & Debray	(b)
22	76.40	11.70	1.40	0.30	4.30	4.10	0.50	100.50	0.40 Au, 1.40 sand	"	"	"
23	76.97	10.97	?	?	?	1.04	?	90.43	1.45 insoluble	"	Frenzel	(c)
24	86.50	8.32	1.10	1.15	—	0.45	1.40	98.92		Kushvinsk, Blagodat	Berzelius	(d)
25	83.49	8.98	1.94	3.17	trace	—	0.93	98.51		"	Muchin	(e)
26	76.22	17.30	1.87	2.50	trace	0.36	0.50	98.75		"	"	"
27	85.97	6.54	0.75	0.96	0.98	0.86	2.10	98.70	0.54 Os	"	Claus	(f)
28	78.94	11.04	0.28	0.86	4.97	0.70	1.96	98.75		Nishne-Tagilsk	Berzelius	(d)
29	73.58	12.98	0.30	1.15	2.35	5.20	2.30	97.86		"	"	"
30	83.07	10.79	0.26	0.59	1.91	1.30	—	99.72	1.80 insoluble	"	Osann	(g)
31	81.34	11.48	0.30	2.14	2.42	1.13	0.57	99.38		"	Muchin	(e)
32	82.46	11.23	0.23	2.35	1.21	0.64	1.38	99.50		"	"	"
33	70.15	18.90	0.20	3.61	1.03	1.16	3.87	98.92		"	"	"
34	73.70	16.65	0.23	3.12	1.15	1.47	2.56	98.88		"	"	"
35	68.95	18.93	0.21	3.30	1.34	1.59	3.75	98.07		"	"	"
36	78.38	11.72	0.17	2.79	5.32	0.28	0.32	98.98		"	"	"
37	82.16	11.50	0.25	2.19	1.00	0.21	1.89	99.20		"	"	"
38	71.20	17.73	0.18	3.46	1.15	0.50	3.85	98.07		"	"	"
39	74.67	15.54	0.18	2.26	0.83	1.98	2.30	97.76		"	"	"
40	71.94	15.79	0.14	2.76	1.18	3.72	2.87	98.40		"	"	"
41	68.72	15.58	0.20	2.48	4.73	0.30	—	98.37	6.36 insoluble, including (Ir, Os)	"	"	"
42	77.14	12.13	0.22	2.74	5.10	0.34	—	98.65	0.98 insoluble, including (Ir, Os)	"	"	"

(a) *Ann. Phys. (Poggendorff)*, 1826, **8**, 510. (b) *Ann. chim. phys.*, 1859, **56**, 449; *Am. J. Sc.*, 1860, **29**, 379. (c) *Neues Jahrb. Mineral.*, 1874, 684. (d) *Ak. Handl. Stockh.*, 1828, 113; *Ann. Phys. (Poggendorff)*, 1828, **13**, 564. (e) *Koksharov's Min. Russl.*, **5**, 183. (f) *Platinmet. Dorpat*, 1854, 60. (g) *Ann. Phys. (Poggendorff)*, 1828, **13**, 286

Fig. 3 These two platinum nuggets from placer deposits in the Urals are reproduced here at approximately twice actual size. The results of an analysis made on the smaller nugget are given in Table II

dissolving acid baths and kept in the company's archives. In 1906, Degussa (Deutsche Gold- und Silberscheideanstalt vormals Roessler) became a shareholder in the Siebert plant and in 1930 its sole owner. Fortunately, a few coins and nuggets even survived this transaction and all other events of time and we were thus able to carry out the non-destructive investigations described below.

After an interval of more than a century, Russia again issued platinum coins as legal tender of the Union of Soviet Socialist Republics. The 150-rouble coin commemorating the 1980 Olympic Games in Moscow, shown in Figure 2, was struck at the State Mint of Goznak from 999.3 pure platinum, as stated on the certificate accompanying each coin.

Table II

Analyses of a Platinum Nugget and a 3-Rouble Coin

(atomic per cent)

Element	Nugget from the Urals, exact locality unknown	3-rouble coin dated 1829
Platinum	~ 85	~ 99
Palladium	~ 2	0.1
Iridium	trace	—
Rhodium	0.5	0.1
Ruthenium	trace	—
Osmium	trace	—
Iron	~ 2	0.5
Chromium	~ 10	0.2
Nickel	trace	—
Titanium	trace	—
Lead	—	<0.1
Rhenium	trace	—
Tungsten	trace	—
Vanadium	trace	—
Specific gravity	16.44 g/cm^3	20.72 g/cm^3

To bring the story of platinum coinage up to date, mention must be made of the attempts to introduce a "Platirand" in the Republic of South Africa during 1983, while Ayrton Metals Ltd., the London bullion dealer, successfully launched a platinum coin, known as the "Noble" on November 3rd, 1983, accepted as legal tender on the Isle of Man.

To return to the 19th century, the raw material for the production of early Russian platinum coinage came entirely from placer deposits in the Urals. The most complete summary of analyses of placer platinum from this area is found in Hintze (14), together with a comprehensive description of the nature of the numerous placer deposits known up to the beginning of this century. Hintze's compilation of Russian sites is reproduced in Table I together with the original references.

To appreciate the technique of refining placer platinum and the multi-step production method at the commencement of platinum coining, we have investigated a 3-rouble piece minted in 1829. The results of non-destructive X-ray fluorescence analysis of this coin, compared with that of a platinum nugget, shown in Figure 3, are given in Table II. While the overall composition of the nugget is comparable with the data given for coining metal in Table I

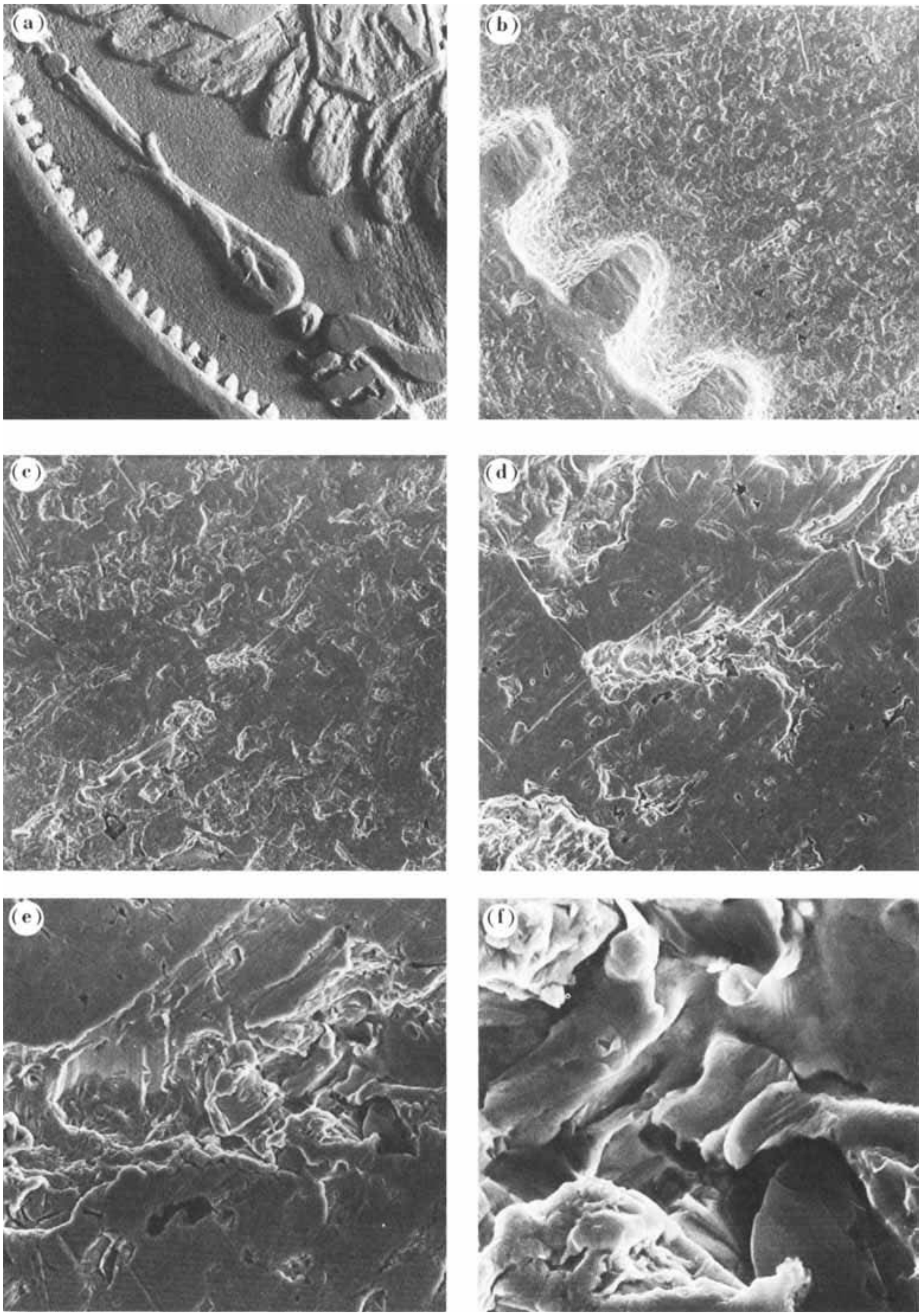

Fig. 4 This set of scanning electron microscope photographs taken of a 3-rouble coin, minted in 1829, at progressively higher magnifications clearly shows the many irregularities in the surface that resulted in the dull, unattractive appearance. As reproduced here, the magnifications are approximately: (a) ×17, (b) ×55, (c) ×170, (d) ×550, (e) ×1700, and (f) ×5500

(with the exception of a high chromium content in our specimen), the coin itself is of remarkably pure platinum. The purity as well as the successful production of the blank by powder metallurgical procedures is further reflected by the specific weight of the coin; with a value of 20.72 g/cm^3 it approaches that of pure, massive platinum, that is 21.43 g/cm^3.

The coin analysed, shown in Figure 1, has a somewhat striated surface, obviously not the influence of wear, but of production. A set of micrographs, taken under a scanning electron microscope, from low to very high magnifications (Figures 4a–f) clearly reveals the limits and shortcomings of early powder metallurgy. Despite the efforts to compact the platinum sponge by various stages of pressing and sintering, it was not possible to eliminate small vesicles and voids. Particularly at high magnifications the pitted surface with holes and cavities, separating individual metal grains, is clearly visible. No wonder that the resulting dull appearance of the coins made them less attractive compared to silver coins, thus attributing to their seemingly inferior quality in public opinion. Though the issues of later years were of much better quality (Figure 1, right), this could not prevent their rejection. The reason for the final withdrawal of the Russian platinum coinage from circulation was, however, a rapid fall in the price of platinum. The nominal value of the coins was exceeding their metal value, and fears of counterfeiting were imminent, though perhaps—in view of the complicated process of coining—not fully justified.

Considering the numerous modern technical applications of platinum—the latest being its role as one of the active constituents in automobile exhaust gas catalysts—modern platinum coinage is but another attempt to interest investors. We should, however, remember that abundant supplies of the then practically useless metal and the intention to introduce it as a substitute for silver (!) helped to initiate what came to be known as powder metallurgy.

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