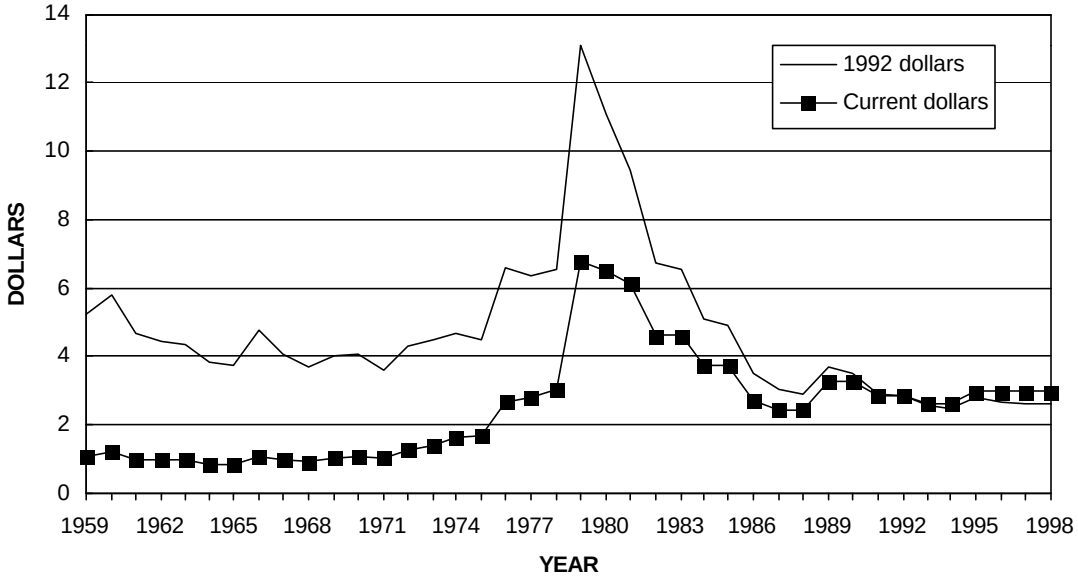
Columbium (Niobium)

by Larry D. Cunningham

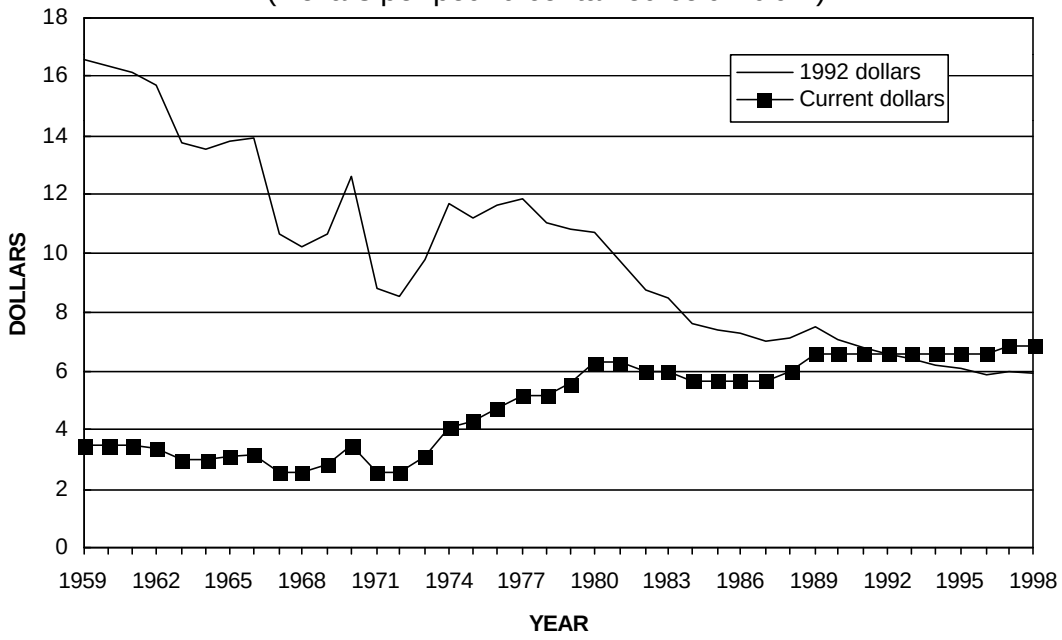
Yearend Average Columbium (Niobium) Concentrate Price

(Dollars per pound contained columbium pentoxide)



Yearend Average Ferrocolumbium (Ferroniobium) Price

(Dollars per pound contained columbium)



Significant events affecting columbium prices since 1958

1960-70	Development of pyrochlore deposits in Brazil and Canada
1970-79	Increased demand
1980	Columbium oxide produced from pyrochlore-based feed material
1981	Exports of Brazilian pyrochlore ceased
1994	Production of ferrocolumbium began in Canada
1997-98	Sales of ferrocolumbium from the National Defense Stockpile (NDS)
1998	Expansion of ferrocolumbium production capacity in Brazil

Columbium is a refractory metal that conducts heat and electricity well and is characterized by a high melting point, resistance to corrosion, and ease of fabrication. Columbium, in the form of ferrocolumbium, is used worldwide mostly as an alloying element in steels and in superalloys. Little commercial application was found for columbium until the 1930's, when metallurgists began using it in the form of ferrocolumbium in steel and as columbium carbide in high-speed cutting tools (Cunningham, 1985a). Acceptable substitutes, such as molybdenum, tantalum, titanium, tungsten, and vanadium, are available for some columbium applications, but substitution may lower performance and/or cost-effectiveness.

The columbium price is driven by the availability of columbium mineral feed materials, recycling being an insignificant source of supply. Thus, the events affecting the supply of columbium mineral concentrates are discussed herein. A price table and graph, however, are included for standard-grade ferrocolumbium, the dominant form in which columbium is consumed. In 1979, the increase in demand for "high-purity" ferrocolumbium in superalloys was significant. This increased columbium demand affected the prices for high-purity ferrocolumbium and for columbite, but had no real impact on the price for standard ferrocolumbium. The feed material for production of high-purity ferrocolumbium was columbite, and standard ferrocolumbium was produced from pyrochlore. In 1998, the price for columbium contained in concentrate was $4.29 per pound compared with $6.88 per pound for columbium contained in standard ferrocolumbium.

Brazil and Canada are the major producers of columbium mineral concentrates and converters of the material to ferrocolumbium. The U.S. columbium-mining industry has not been significant since 1959. The United States satisfies its columbium requirements primarily by importing ferrocolumbium and columbium oxide from Brazil, ferrocolumbium from Canada, and lesser amounts of columbium concentrates for processing from various countries. Many of the applications for columbium are either directly or indirectly defense related because of its use in the aerospace, communications, energy, and transportation industries. Thus, columbium is classified as critical and strategic, and, over the years, various columbium materials have been purchased for the NDS.

A significant activity during the 1950's was the U.S. Government's worldwide program for the purchase of about 6,800 metric tons (t) of combined columbium and tantalum oxides contained in columbium-tantalum ores and concentrates. The purchase program was terminated in 1959 (Cunningham, 1985a, b). The program, which was initiated to encourage increased production of columbium-tantalum ores and concentrates of domestic and foreign origin, largely governed the market price for columbium ores and concentrates. It also resulted in the discovery of large low-grade domestic and foreign deposits of columbium minerals. The program, however, was less successful in developing domestic columbium mineral production. The low grade of the discoveries precluded their development at current or expected future prices. Termination of the program was followed by lower market prices, resulting in reduced production worldwide. Marginal producers, who could not operate profitably at lower prices, halted production.

Reshaping of columbium supply and demand began in the 1960's. Discovery of the strengthening effect of small amounts of columbium in structural carbon steel eventually led to a widespread and growing use for columbium in high-strength low-alloy steels. Until the mid-1960's, the world's needs for columbium were provided for mostly by columbite concentrates mined in Nigeria; the Nigerian columbite was produced as a byproduct of tin mining. Development of pyrochlore deposits in Brazil and Canada during this period, however, greatly increased columbium availability (Cunningham, 1985a; Miller, Fantel, and Buckingham, 1986, p. 8; Crockett and Sutphin, 1993, p. 4-5). Pyrochlore deposits are mined primarily for columbium, and columbite and tantalite are recovered mostly as a byproduct/coproduct of other minerals, principally tin. The shift in columbium supply from Nigeria to Brazil and Canada did not have an adverse impact on the columbium price, which changed little or not at all during the 1960's owing to the readily available supplies of pyrochlore.

During the 1970's, increased demand, mostly in the form of ferrocolumbium for steelmaking, continued to be met by the large quantities of pyrochlore concentrates produced in Brazil and Canada. Pyrochlore became the standard material for the manufacture of ferrocolumbium for steelmaking.

Columbite-tantalite remained as the source material for the production of columbium oxide used in high-purity columbium products. As demand increased in the 1970's, prices began to escalate for columbium concentrates and columbium products. With continued strong demand for columbium in the manufacture of steels and especially high-purity columbium products, the price for columbium concentrates peaked in 1979.

In 1980, an important change in columbium supply took place when plants that produced columbium oxide from pyrochlore-based feed materials were established in Brazil and the United States, which resulted in lower prices for columbium oxide and high-purity columbium products (Jones, 1981). This change greatly diminished the need for columbite ores. Until 1980, columbium oxide had been produced mostly from columbite- and tantalite-based materials. Columbium concentrate prices fell during most of the 1980's owing to the large quantities of pyrochlore produced in Brazil and Canada and the columbium products produced from this feed material, especially in Brazil.

Brazil's production of columbium concentrates, mostly pyrochlore, accounts for more than 85% of total world production of columbium. Pyrochlore concentrates, however, have not been exported from Brazil since 1981. Pyrochlore concentrates produced in Brazil are processed locally, and some of the upgraded columbium products are consumed domestically, with the majority of the products exported. As the dominant columbium producer/supplier, Brazil has maintained a marketing strategy of stable supply and moderate price changes.

A significant change took place in the columbium industry in late 1994. The sole Canadian columbium concentrate producer began ferrocolumbium production at its columbium mine in Quebec (Teck Corp., 1994, p. 13, 32). The plant converts basically all pyrochlore concentrates produced at the mine to ferrocolumbium. Prior to commissioning of the plant, columbium concentrates produced at the mine were shipped mostly to the United States, Europe, and Japan for conversion to ferrocolumbium.

In 1997, the U.S. Department of Defense initiated the sale of ferrocolumbium from the NDS. From March 1997 through December 1998, the Defense Logistics Agency sold about 211 t of columbium contained in ferrocolumbium valued at about $2.98 million (Cunningham, 1998a, b, p. 1; Defense National Stockpile Center, 1998a, b). The overall average unit price for the sales, about $6.40 per pound of contained columbium, was somewhat less than that quoted for ferrocolumbium, $6.88 per pound of contained columbium.

In 1998, the leading Brazilian columbium producer initiated plans to raise its ferrocolumbium production capacity by about 50% by 2000. The expansion is aimed at maintaining the stability of world supply and pricing of ferrocolumbium in response to growing international demand (Metal Bulletin, 1998).

For most of the 1990's, the price for columbium remained stable as the demand for and supply of columbium continued to increase.

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Yearend Average Columbium (Niobium) Concentrate Price

(Dollars per pound contained columbium pentoxide[1])

Year	Price	Year	Price	Year	Price	Year	Price
1940	0.35	1955	3.40	1970	1.12	1985	3.75
1941	0.35	1956	3.40	1971	1.04	1986	2.75
1942	0.53	1957	3.40	1972	1.29	1987	2.43
1943	0.25	1958	3.40	1973	1.42	1988	2.43
1944	0.25	1959	1.08	1974	1.64	1989	3.25
1945	0.60	1960	1.22	1975	1.71	1990	3.25
1946	0.54	1961	1.00	1976	2.69	1991	2.83
1947	0.65	1962	0.95	1977	2.76	1992	2.83
1948	0.73	1963	0.95	1978	3.03	1993	2.60
1949	1.13	1964	0.85	1979	6.78	1994	2.60
1950	2.55	1965	0.85	1980	6.50	1995	3.00
1951	2.56	1966	1.11	1981	6.13	1996	3.00
1952	3.40	1967	0.97	1982	4.63	1997	3.00
1953	3.40	1968	0.92	1983	4.63	1998	3.00
1954	3.40	1969	1.05	1984	3.75		

[1] To convert to dollars per kilogram, multiply by 2.20462.

Sources: Metal Bulletin (1946-51), U.S. Government purchase (1952-58), E&MJ Metal and Mineral Markets (1959-66), Metals Week (1967-90), and Metal Bulletin (1991-98). Prices before 1946 were published by the U.S. Bureau of Mines; origins are unknown.

Yearend Average Ferrocolumbium (Ferroniobium) Price[1]

(Dollars per pound contained columbium[2])

Year	Price	Year	Price	Year	Price	Year	Price
1940	2.30	1955	6.90	1970	3.49	1985	5.66
1941	2.30	1956	6.90	1971	2.55	1986	5.66
1942	2.28	1957	4.90	1972	2.55	1987	5.66
1943	2.28	1958	3.73	1973	3.10	1988	6.00
1944	2.28	1959	3.45	1974	4.12	1989	6.58
1945	2.28	1960	3.45	1975	4.30	1990	6.58
1946	2.28	1961	3.45	1976	4.73	1991	6.58
1947	2.55	1962	3.40	1977	5.12	1992	6.58
1948	2.90	1963	3.00	1978	5.12	1993	6.58
1949	2.90	1964	3.00	1979	5.58	1994	6.58
1950	4.90	1965	3.10	1980	6.29	1995	6.58
1951	4.90	1966	3.21	1981	6.29	1996	6.58
1952	4.90	1967	2.53	1982	6.00	1997	6.88
1953	6.40	1968	2.53	1983	6.00	1998	6.88
1954	12.00	1969	2.79	1984	5.66		

[1] Standard (steelmaking) grade, 65% contained columbium (1997-98).

[2] To convert to dollars per kilogram, multiply by 2.20462.

Sources: Mostly E&MJ Metal and Mineral Markets (1940-66), Metals Week (1967-92), Platt's Metals Week (1993-96), and American Metal Market (1997-98).