International Strategic Mineral Issues Summary Report—Tungsten

By Antony B.T. Werner, W. David Sinclair, and
Earle B. Amey

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Prepared as a cooperative effort among earth-science and mineral-resource agencies of Australia, Canada, the Federal Republic of Germany, the Republic of South Africa, the United Kingdom, and the United States of America

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PREFACE

Earth-science and mineral-resource agencies from several countries started the International Strategic Minerals Inventory, later renamed International Strategic Mineral Issues, in order to cooperatively gather information about major sources of mineral raw materials. This circular summarizes inventory information about major deposits of tungsten.

The report was prepared by Antony B.T. Werner, Canadian Department of Natural Resources (NRCan), Minerals and Metals Sector (MMS) (retired); W. David Sinclair, NRCan, Geological Survey of Canada (GSC); and Earle B. Amey, United States Geological Survey (USGS). Tungsten inventory information was compiled by James E. Elliott, USGS; S. Warren Hobbs, USGS; Alfred Johnson and L.S. Jen, NRCan/MMS; Nerida Knight and John Olley, Australian Geological Survey Organisation; W. David Sinclair and A. Pasitschniak, NRCan/GSC; and Klaus Fesefeldt and Ilse Häusser, German Federal Institute for Geosciences and Natural Resources.

Additional contributions to the report were made by Jan Zwartendyk, NRCan/MMS (retired); Stuart Girvan and Ian Lambert, Bureau of Resource Sciences of the Australian Department of Primary Industries and Energy; Erik C.I. Hammerbeck, South African Council for Geoscience; Michael Bowles, Geological Survey of South Africa; Gregory R. Chapman, Peter Harris, and Gordon Riddler, British Geological Survey; John H. DeYoung, Jr., Ebraham Shekarchi, and David M. Sutphin, USGS; and T.F. Anstett, U.S. Bureau of Mines (USBM), and P.T. Stafford, USBM (deceased).

FIGURES

TABLES

CONVERSION FACTORS

Multiply	By	To obtain
gram (g)	0.03527	ounce avoirdupois
gram per metric ton (g/t)	0.0292	ounce per ton (2,000 pounds)
kilogram (kg)	2.205	pound
kilometer (km)	0.6214	mile
meter (m)	3.281	foot
metric ton (t)	1.102	short ton (2,000 pounds)

INTERNATIONAL STRATEGIC MINERAL ISSUES SUMMARY REPORT—TUNGSTEN

By Antony B.T. Werner,[1] W. David Sinclair,[2] and Earle B. Amey[3]

ABSTRACT

Scheelite and wolframite are the principal minerals currently mined for tungsten. Both occur in hard-rock deposits; wolframite is also recovered from placer deposits. Most current mine production of tungsten is from vein/stockwork, skarn, porphyry, and strata-bound deposits. Minor amounts are produced from disseminated, pegmatite, breccia, and placer deposits.

Most tungsten is used to make tungsten carbide and tungsten alloys for use in machine tools and drilling equipment. Other important applications are in lamp filaments and cathodes, high-speed steels, textile dyes, paints, and catalysts.

The world is well endowed with tungsten resources. China and the former Soviet Union have 8 of the world's 10 largest deposits; these 8 contain about half of the world's resources of tungsten. If economic conditions are suitable, world tungsten resources in known deposits and their extensions (categories R1 and R2), including economic, marginal, and subeconomic resources, are sufficient to permit world production to continue at 1995 levels until well into the 21st century.

World tungsten resources in identified deposits and districts that are currently economically exploitable (category R1E) appear to be sufficient to meet world demand at 1995 levels only until the year 2007. However, the figure for resources of this kind does not include or reflect resources whose economic parameters are unknown in major producing areas in the former Soviet Union, China, and other nonmarket-economy countries and thus severely underestimates future tungsten availability.

In 1995, China and the former Soviet Union accounted for over three-fourths of the world's mine production of tungsten. China alone produced about two-thirds of world output. Given its vast resources, China will likely maintain its prominent role in world tungsten supply. By the year 2020, changes in supply patterns are likely to result from declining output from individual deposits in Australia, Austria, and Portugal and the opening of new mines in Canada, China, and the United Kingdom.

PART I—OVERVIEW

INTRODUCTION

The reliability of future supplies of minerals is of concern to many nations. This widespread concern has led to duplication of effort in the gathering of information on the world's major sources of minerals. With the aim of pooling such information, a cooperative effort named International Strategic Minerals Inventory (ISMI) was started in 1981 by officials of the governments of the United States, Canada, and West Germany. It was subsequently joined by South Africa, Australia, and the United Kingdom. In 1997, ISMI was renamed International Strategic Mineral Issues.

The objective of ISMI reports is to make publicly available, in convenient form, nonproprietary data and characteristics of major deposits of mineral commodities for policy considerations in regard to short-term, medium-term, and long-term world supply. This report provides a summary statement of the data compiled and an overview of the supply aspects of tungsten in a format designed to be of benefit to policy analysts and geologists. Knowledge of the geologic aspects of mineral resources is essential in order to discover and develop mineral deposits. However, technical, financial, and political decisions must be made, and often transportation and marketing systems must be constructed, before ore can be mined and processed and the products

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[1] Retired from Canadian Department of Natural Resources, Minerals and Metals Sector.

[2] Canadian Department of Natural Resources, Geological Survey of Canada (the GSC component of this document is recognized as Geological Survey of Canada Contribution 34988), 675–601 Booth Street, Ottawa, ON, Canada K1A 0E8.

[3] U.S. Geological Survey, 989 National Center, Reston, VA 20192 U.S.A.

transported to the consumer; the technical, financial, and political aspects of mineral-resource development are not specifically addressed in this report. The report addresses the primary stages in the supply process for tungsten and does not include considerations of tungsten demand.

To date, the ISMI Working Group has published studies on chromium, cobalt, graphite, lithium, manganese, nickel, niobium (columbium), phosphate, platinum-group metals, rare-earth oxides, tantalum, tin, titanium, tungsten (this report), vanadium, and zirconium; these studies are chapters A–O of U.S. Geological Survey Circular 930. A regional survey of the strategic minerals of subequatorial Africa has been published (Coakley and others, 1991), and a survey of mineral resources in eastern Europe is underway. Deposits (or districts) were selected for the inventory on the basis of their present or expected future contribution to world supply.

Data in the ISMI tungsten inventory were mostly collected from November 1984 to March 1987. The report had some additional updating to March 1996 and was submitted for review and publication May 19, 1997. Information used was the best available to the various agencies of the countries that contributed to the preparation of this report. Those agencies were the U.S. Geological Survey of the U.S. Department of the Interior; the Geological Survey of Canada and the Minerals and Metals Sector of the Canadian Department of Natural Resources; the Federal Institute for Geosciences and Natural Resources of Germany; the Council for Geoscience and the Minerals Bureau of the Department of Mineral and Energy Affairs of South Africa; the Bureau of Resource Sciences of the Australian Department of Primary Industries and Energy and the Australian Geological Survey Organisation; and the British Geological Survey.

The ISMI record collection and this report on tungsten use the international classification system for mineral resources recommended by the United Nations Group of Experts on Definitions and Terminology for Mineral Resources (United Nations Economic and Social Council, 1979; Schanz, 1980). The terms, definitions, and resource categories of this system were established in 1979 to facilitate international exchange of mineral-resource data; the United Nations experts sought a system that would be compatible with the several systems already in use in several countries. Figure 1 shows the United Nations (U.N.) resource classification used in this report. The term “reserves,“ which many would consider to be equivalent to category r1E or R1E, has been interpreted inconsistently and thus has been deliberately avoided in the U.N. classification. Category R3, undiscovered deposits, is not dealt with in this report.

Not all companies or countries report resource data in the same way. Little information is available on tungsten resources in China and the former Soviet Union. Most of the production and resource numbers for these two countries, which together probably have more than half of the world’s resources of tungsten, are estimates.

In this report, almost all resource data are quoted as being in place. Mining recovery from an orebody depends on individual conditions and may vary considerably. It typically ranges from 75 to 90 percent for underground mining; that is, 10 to 25 percent of the in-place resources are not recovered from the ground. After mining, additional amounts of economic mineral content are lost in processing (concentrating, milling, and chemical treatment).

Overall, an assessment made of mines in market-economy countries has shown that, on average, nearly 69 percent of the tungsten trioxide (WO_3) contained in the ground was recovered in marketable form (Anstett and others, 1985, p. 40). Tungsten resource information is reported by industry in terms of either “percent W” or “percent WO_3.” Unless otherwise specified, information in this report is expressed in percent W. Where necessary, the factor 0.7931 has been used to convert amounts expressed in WO_3 to amounts of W.

The World Bank economic classification of countries (World Bank, 1996), which is based primarily on gross national product (GNP) per capita, has been used in this and other ISMI reports to illustrate distribution of resources and production according to economic groupings of countries. This classification was chosen because it relies primarily on objective economic criteria and does not contain political-bloc labels that might be perceived differently by different countries.

USES AND SUPPLY ASPECTS

Tungsten is a dense, corrosion-resistant metal and has the highest melting point among metals. When alloyed with other metals or combined with carbon, it increases hardness, durability, and resistance to corrosion for the resultant alloy or compound. Because of these desirable properties, industrialized countries consider tungsten essential in metal-cutting and oil-well-drilling tools, in ordnance, and in specialized high-temperature items and alloys for the aerospace industry.

The world’s metallurgical and chemical industries annually use some 33,000 metric tons of tungsten (U.S. Geological Survey, 1996). Most tungsten goes into tungsten carbide and tungsten alloys for use in machine tools and oil-well-drilling equipment. In the United States, for example, 55 percent of the tungsten consumed in 1995 was used in cutting and wear-resistant materials in welding and hardfacing rods (tungsten carbide). An additional 10 percent was used, in the form of tungsten metal, principally to make lamp filaments, cathodes, and ammunition. The remaining 35 percent went primarily into the manufacture of high-speed and tool-and-die steels, high-temperature and oxidation-resistant superalloys, textile dyes, paints, and catalysts.

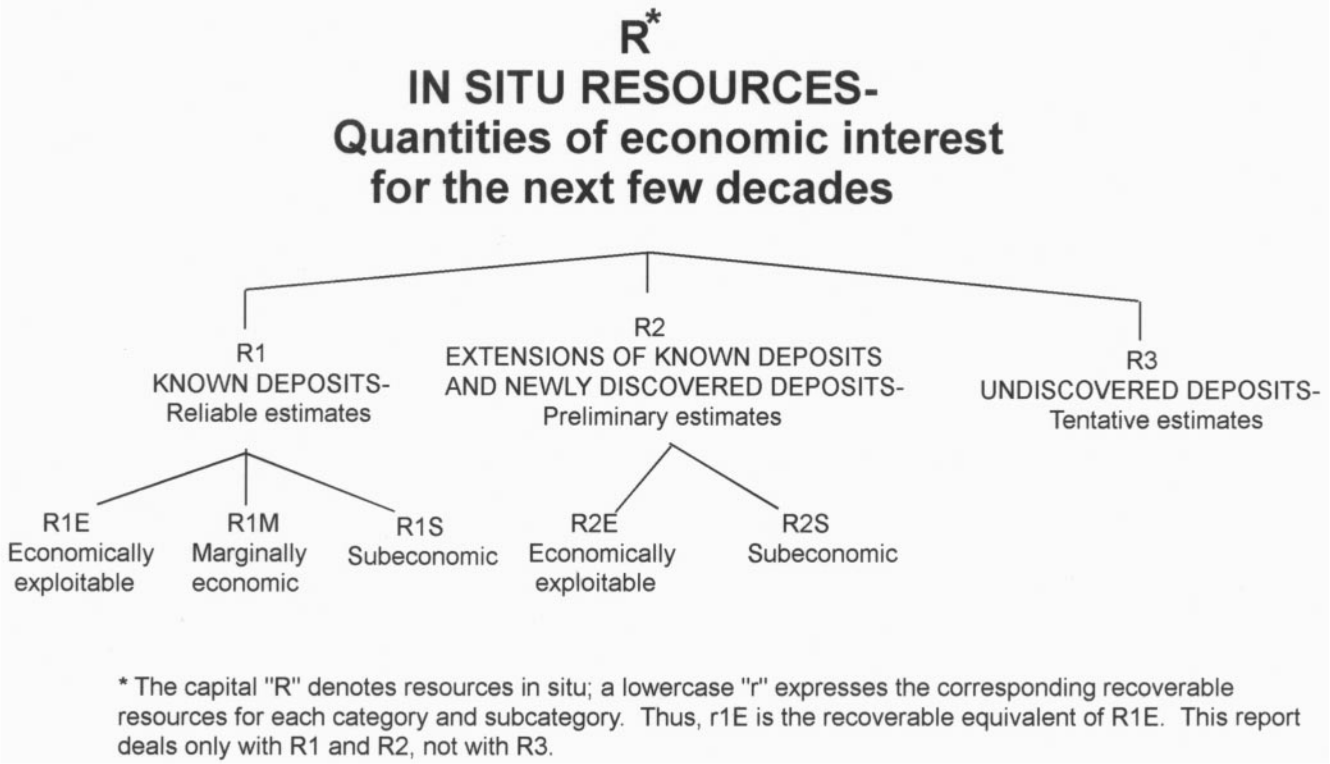


Figure 1. United Nations resource categories used in this report (modified from Schanz, 1980, p. 313).

(For a further discussion of tungsten uses, see Stafford (1985).)

Scheelite ($CaWO_4$), often called “white ore,” and wolframite ($(Fe,Mn)WO_4$), commonly known as “black ore,” are the predominant ore minerals of tungsten. Pure scheelite contains 63.9 percent tungsten by weight. The composition of wolframite ranges from the iron-rich variety, ferberite, containing 60.5 percent tungsten, to the manganese-rich variety, huebnerite, which contains 60.8 percent tungsten. Molybdenum can substitute for some of the tungsten in scheelite (up to 2.0 percent molybdenum) and in wolframite (up to 0.1 percent molybdenum).

The molybdenum content and amounts of other impurities usually determine the end use of a particular tungsten concentrate. Most chemical processors making ammonium paratungstate, an intermediate product in the preparation of ferrotungsten and tungsten carbide, prefer to use concentrates with low molybdenum content (Ho, 1987), whereas scheelite with a relatively high molybdenum content is attractive to tool-steel makers, who can charge it directly to their steelmaking furnaces.

Several materials could take the place of tungsten in most of its applications. Substitution does, however, generally require time for testing and retooling and, in most cases, entails some sacrifice in physical and chemical properties. This affects the performance and overall cost of the product made from the replacement material. Present and potential substitutes for tungsten carbide are titanium carbide, ceramics, and polycrystalline diamond. The use of coatings of these materials on tungsten carbide inserts in cutting or drilling tools prolongs the life of those items, thus reducing the demand for tungsten.

A profitable substitution, made possible by metallurgical advances, is the use of molybdenum to replace tungsten in the manufacture of high-speed steels. Starting in the 1970’s, this substitution greatly reduced the quantity of tungsten used to make these steels, mainly in North America.

Table 1. Tungsten resources in the world's deposits and districts, by geologic deposit type and resource category.

[Resource data are in thousands of metric tons of contained tungsten; figures may not add to totals shown due to rounding. Figures in parentheses denote percentage of column total]

Geologic deposit type[1]	Number of records[2]	Resource category	
		R1E[3]	All other R1 and R2[4]
Skarn[5]	52	183 (48)	1,764 (40)
Vein/stockwork[5]	119	166 (44)	1,475 (34)
Porphyry	7	– (–)	679 (15)
Strata-bound	4	18 (5)	118 (3)
Pegmatite	1	9 (2)	– (–)
Breccia	4	3 (1)	1 (–)
Brine/evaporite	1	– (–)	64 (2)
Placer	2	– (–)	32 (1)
Disseminated	10	– (–)	217 (5)
Unknown	4	–(–)	– (–)
Total	204	379 (100)	4,349 (100)

[1] Locations and deposit types of the world's major tungsten deposits are shown in figure 2.

[2] Records are summarized in tables 9 and 10.

[3] Reliable estimates from identified deposits with economically exploitable resources (fig. 1).

[4] Reliable and preliminary estimates of resources in the R1M, R1S, R2E, and R2S categories (fig. 1).

[5] In this table only, the Shizhuyuan deposit, China, and the Dedova Gora deposit, former Soviet Union, are considered to consist of two types: a vein/stockwork zone and a skarn zone.

As subsequent sections of this report show, tungsten resources, production, and processing plants are irregularly distributed around the world. The natural distribution of tungsten deposits and the geographical history of economic development are such that many industrialized nations import tungsten in a raw form (scheelite or wolframite concentrate) or an intermediate form (synthetic scheelite, ammonium paratungstate, ferrotungsten, or tungsten metal powder). Historically, two main economic factors have determined world demand for tungsten and consequently world supply: (1) the needs of defense industries, which consider tungsten essential for producing machine tools, ordnance, and superalloys for aircraft engineers, and (2) the requirements of the world's metal-fabricating and oil-drilling industries.

During World War I, the first widespread use of tungsten in armaments, which was eventually accompanied by very high prices, stimulated production in the United States and launched the Chinese tungsten mining industry. Rearmament in the 1930's and interruptions to supplies from Burma and China during World War II led to the opening of new mines in Brazil and boosted production in Bolivia, Japan, and Spain.

In the 1950's, during and after the Korean War, the U.S. stockpiling program spurred the development of tungsten deposits, especially in Australia, Peru, Portugal, and the United States, through its offer of purchase contracts to U.S. and foreign suppliers.

Since the early 1970's, the levels and patterns of world tungsten supply also have been influenced by—

- sales of tungsten from the U.S. stockpile;
- the increasingly preeminent role of China in world tungsten production; and
- the growing tendency of a number of major producing nations, notably South Korea and China, to shift from the export of concentrates to the production and export of tungsten in intermediate and upgraded/value-added forms such as synthetic scheelite, ammonium paratungstate, ferrotungsten, and tungsten metal powder.

In the 1980's, industrial intermediate and upgraded/value-added products from China and South Korea were sold to consumers in industrial market countries at prices well below those charged by domestic processors, causing plant closures in those countries. In 1986, for example, all production of ferrotungsten ceased in France and West Germany, because it could be imported more cheaply from China (Bunting, 1987). Over the years, tungsten prices have fluctuated to a greater extent than prices for any other widely traded mineral commodity. This fluctuation has led many producers of scheelite and wolframite to open and close their operations in response to price changes. For example, the decline in price of a metric ton unit (7.93 kg tungsten) of wolframite concentrate from a high of US$144 in 1980 to US$20 (not adjusted for inflation) in August 1993 resulted in numerous mine closures (estimated at 85 percent of Western world mine capacity). In some cases, however, tungsten is produced as a coproduct with other commodities such as tin, or as a byproduct in the mining of molybdenum, copper, lead, and zinc. Such mining operations are, of course, less sensitive to fluctuations in the price of tungsten.

TYPES OF TUNGSTEN DEPOSITS

Major tungsten deposits in this report are classified as seven types: vein/stockwork, skarn, porphyry, strata-bound, disseminated, placer, and brine/evaporite (table 1). Of relatively minor interest are pegmatite, breccia, pipe, and hot spring deposits. All are discussed below. Most of the current mine production of tungsten is from vein/stockwork, skarn, porphyry, and strata-bound deposits. Minor amounts of tungsten are produced from disseminated, pegmatite, breccia, and placer deposits. The tungsten content of brine/evaporite deposits is large, but no tungsten is currently produced from such deposits.

Vein/stockwork deposits.—Collectively, vein/stockwork deposits accounted for more than 50 percent of world tungsten production in 1986, mainly from deposits in China (southern Jiangxi region), Bolivia, Peru, Portugal, and the former Soviet Union. These deposits typically consist of tungsten-bearing quartz veins or vein stockworks that occur in or near granitic intrusions. Wolframite is commonly the principal tungsten mineral; scheelite is important in some deposits. Tin, copper, molybdenum, and bismuth minerals are also present in some vein/stockwork tungsten deposits and may be economically important.

Most vein deposits are relatively small, on the order of a few hundred thousand metric tons of ore; few vein deposits contain more than 1 million metric tons of ore. Large vein deposits may contain hundreds of minable veins. In stockwork deposits, swarms of parallel to subparallel veins, commonly with interconnecting veins and veinlets, form “sheeted” veins or stockworks that can be exploited by bulk mining methods (as at Mount Carbine, Australia). Such deposits may contain tens to hundreds of millions of metric tons of ore but are generally of low grade (the Mount Carbine deposit in Australia, for example, contains 0.1 percent WO_3). The world's largest known deposit, Verkhne-Kayrakty in the former Soviet Union (872,000 metric tons of tungsten in 1.1 million metric tons of WO_3 in the ore), which is shown as a vein/stockwork deposit in figures 2 and 3, consists mainly of a scheelite-bearing stockwork in a granite pluton. In some vein/stockwork deposits, tungsten minerals may also replace altered wall rocks adjacent to veins. The extent of such replacement is generally minor, with the exception of some deposits in carbonate host rocks (such as Morococha, Peru).

Skarn deposits.—Skarn deposits accounted for about 30 percent of world tungsten production in 1986, mainly from deposits in Brazil, Canada, the former Soviet Union, Australia, South Korea, Turkey, and the United States. In this report, the term “skarn” refers generally to an assemblage of calcium-iron-magnesium-aluminum-silicate minerals that have developed in carbonate-bearing rocks at or near contacts with granitic intrusions. Scheelite is the principal tungsten mineral in skarn deposits and occurs both as disseminated grains and in veinlets or fractures. In some tungsten-bearing skarn deposits, copper, molybdenum, and bismuth minerals are also present and may be economically recoverable.

Exploitable skarn deposits generally contain 0.3 to 1.5 percent WO_3 and range in size from hundreds to millions of metric tons of ore. They include some of the world's largest tungsten deposits, such as Mactung in Canada and Tyrnyauz and Vostok-2 in the former Soviet Union.

Porphyry deposits.—Porphyry deposits overall accounted for about 6 percent of world tungsten production in 1986. Such deposits consist of large, equidimensional to irregular stockwork zones of tungsten-bearing veins, veinlets, and fractures that occur in or near epizonal to subvolcanic felsic granitic intrusions. Mineralized breccia zones, either irregular or pipe shaped, may also be present. Tungsten occurs as wolframite or scheelite, and in some deposits both minerals may be present. Molybdenum is commonly present in porphyry tungsten deposits and may represent a viable coproduct or byproduct. Small amounts of tungsten are present in some porphyry molybdenum deposits (such as Climax, United States, where it has been an important byproduct) and in porphyry tin deposits (such as Chorolque, Bolivia).

Porphyry deposits typically are hundreds of meters across and tens to hundreds of meters thick and contain tens to hundreds of millions of metric tons of ore. Nonetheless, such deposits are currently only of marginal economic interest because their average grade is low (about 0.1 to 0.4 percent WO_3); for example, a mining operation in the Mount Pleasant deposit in Canada started in April 1984 and closed in July 1985 even though it still contains more than 8 million metric tons of material averaging 0.4 percent WO_3 as well as molybdenum, tin, and other potentially recoverable metals. Yet, because of their large size, porphyry deposits represent significant tungsten resources for the future. Important examples are the Lianhuashan, Yangchuling, and Xingluokeng deposits in China (fig. 4). The Logtung deposit in Yukon Territory, Canada, containing 168,000 metric tons of tungsten in 162 million metric tons of material averaging 0.13 percent WO_3, might be exploited some decades from now.

Strata-bound deposits.—Production from strata-bound deposits in 1986 was less than 5 percent of world tungsten production. Mittersill, Austria, and possibly Damingshan, China, where the current production status could not be ascertained, are the main deposits. In this report, the term “strata-bound” refers to deposits in which the distribution of tungsten minerals is strongly controlled by bedding in the host rocks and for which a syngenetic origin may be inferred. It does not include skarn deposits, which may be largely controlled by host-rock lithology but are essentially epigenetic. However, many strata-bound deposits appear to have been affected by later mobilization and reconcentration, and a syngenetic origin for such deposits, including Mittersill, is questionable. Strata-bound deposits range in size from one to tens of millions of metric tons of ore, with average grade ranging from 0.2 to 1 percent WO_3.

Disseminated deposits.—Output from disseminated deposits in 1986 probably amounted to less than 1 percent of total world tungsten production, although some of the known deposits are moderately large. The best examples of this type of deposit are the Hub stock in the Krasno deposit in the Czech Republic, the Spokoinyi deposit in the former Soviet Union, and the Torrington deposit in Australia. Tungsten is recovered also from some disseminated tin deposits such as Zaaiplaats in South Africa. Most disseminated deposits consist of tungsten minerals disseminated in altered (greisenized) granite. Tungsten generally occurs as wolframite; scheelite may be important in some deposits. Disseminated deposits may contain tens of millions of met-

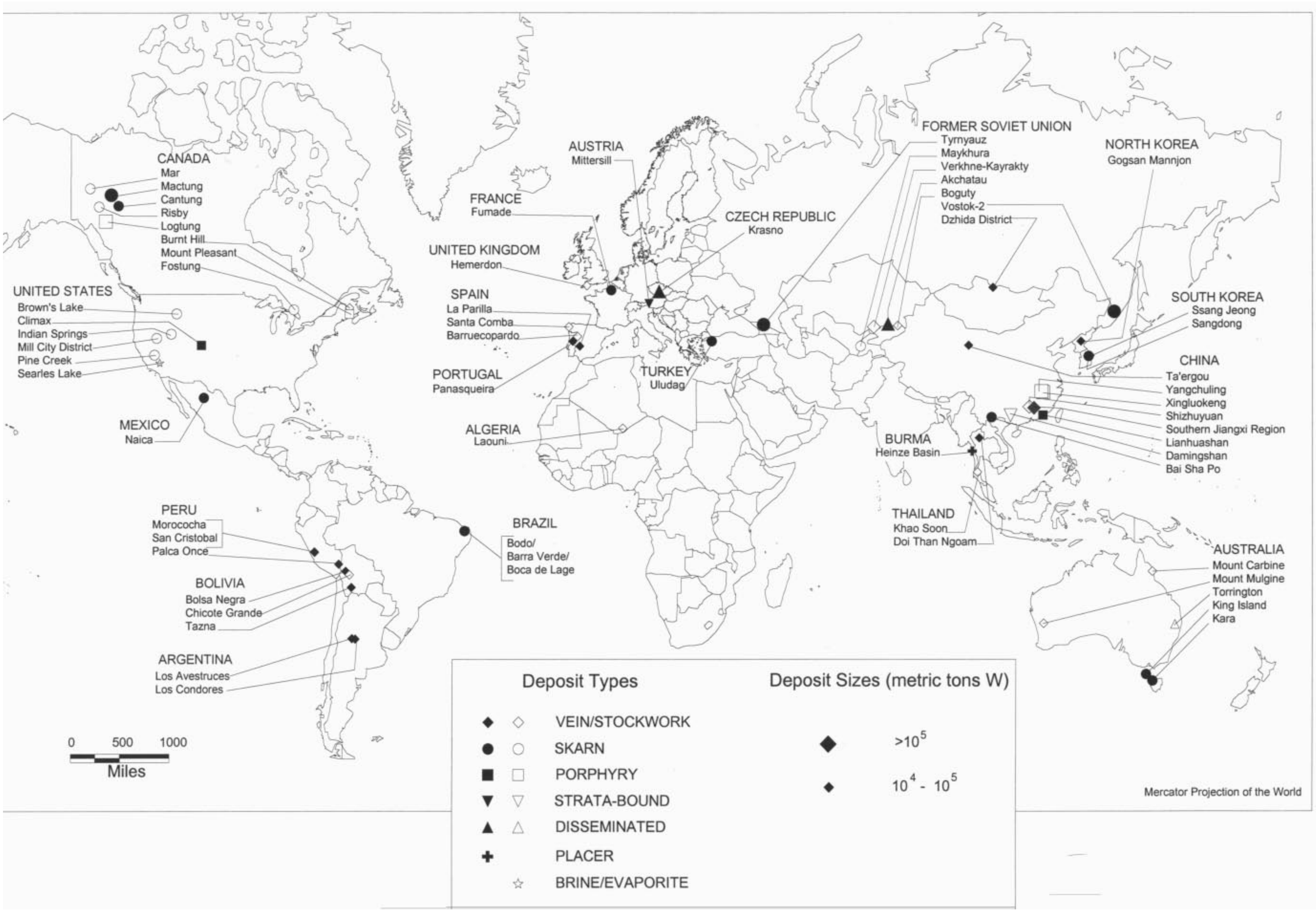


Figure 2. Location, type, and estimated resources of major tungsten deposits and districts in the world. Resource data are from tables 9 and 10. Boundaries and country names are not necessarily authoritative. Solid symbols indicate deposits in production in 1986; unfilled symbols indicate deposits not in production in 1986.

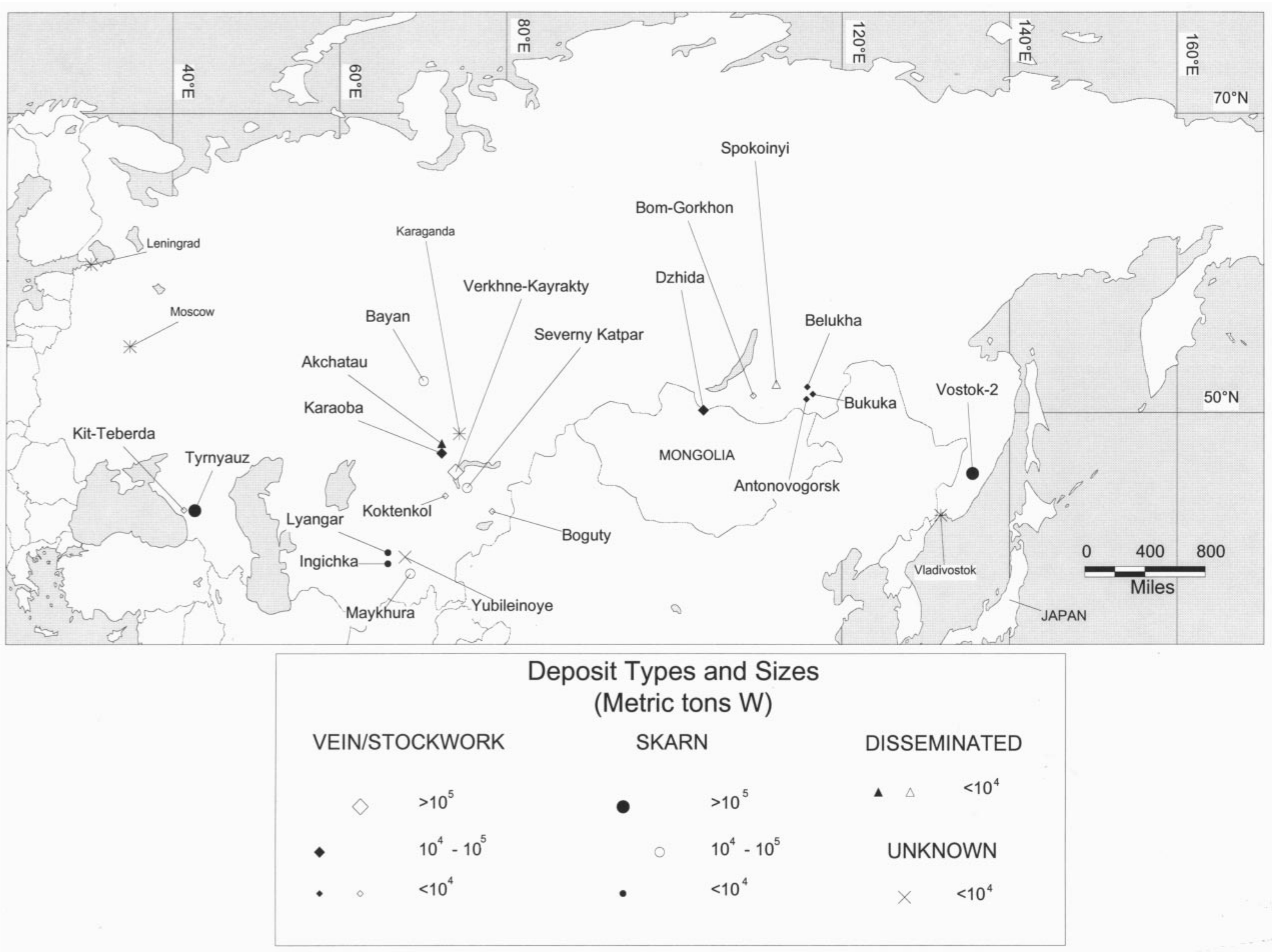


Figure 3. Location, type, and estimated resources of major tungsten deposits and districts in the former Soviet Union. Resource data are from tables 9 and 10. Boundaries are not necessarily authoritative. Solid symbols indicate deposits in production in 1986; unfilled symbols indicate deposits not in production in 1986.

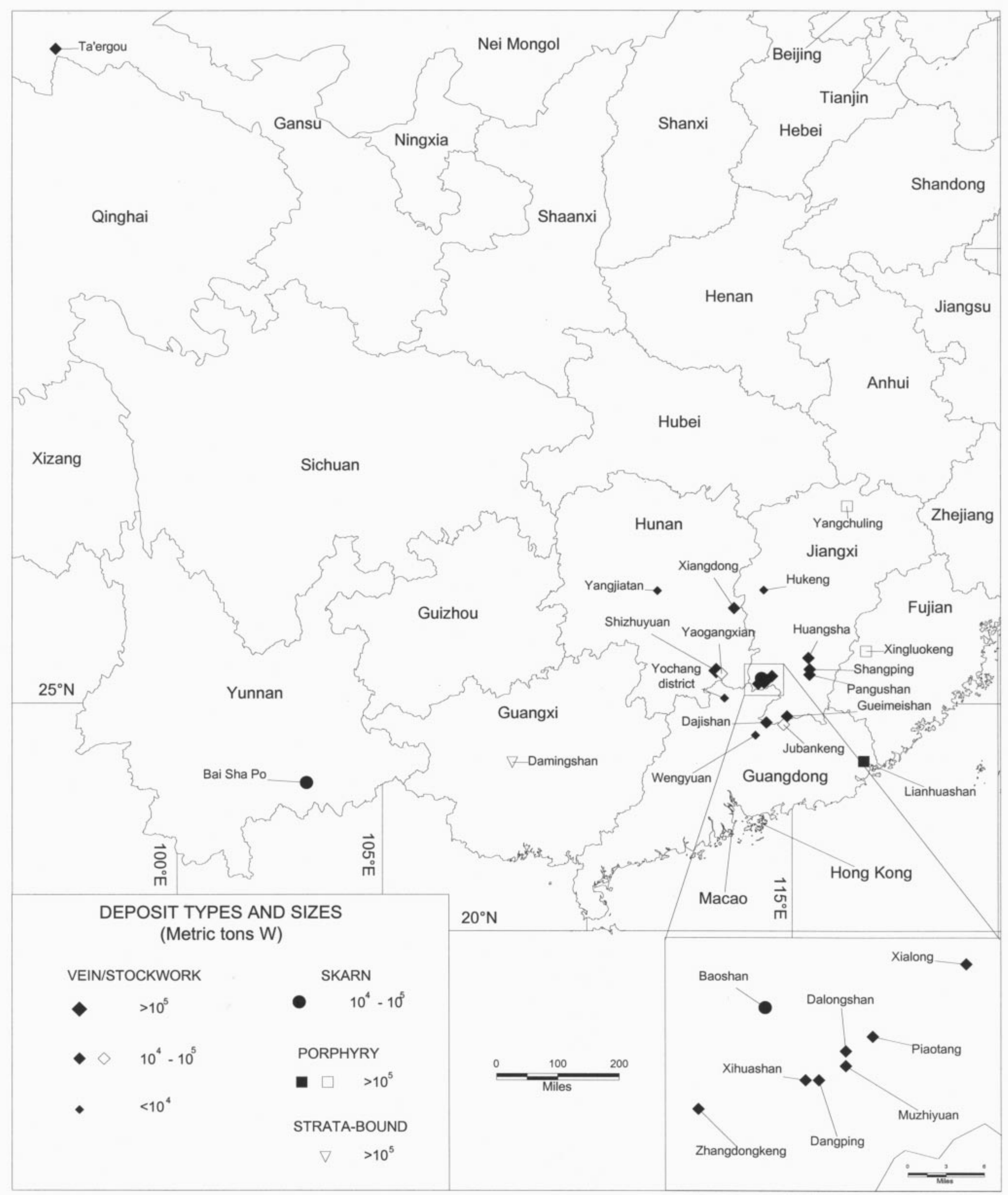


Figure 4. Location, type, and estimated resources of major tungsten deposits and districts in China. Resource data are from tables 9 and 10. Boundaries are not necessarily authoritative. Solid symbols indicate deposits in production in 1986; unfilled symbols indicate deposits not in production in 1986.

ric tons of material but are of low grade, generally averaging a few tenths of one percent WO_3.

Placer deposits.—Production of tungsten from placer deposits has been important historically, but 1986 production from such deposits was probably less than a few percent of total world production. Placer deposits consist of sedimentary concentrations of scheelite or wolframite in alluvial, eluvial, and, in some cases, marine sediments. Such deposits are typically associated with, or only slightly removed from, bedrock tungsten-bearing deposits from which they were derived by processes of weathering and erosion. Scheelite and even wolframite will eventually decompose upon weathering and hence, unlike cassiterite, tungsten minerals tend not to be preserved long enough to form widespread sedimentary deposits.

Some placer tungsten deposits may be large enough to warrant the use of heavy equipment for mining (such as Heinze Basin, Burma). Deposits in the former Soviet Union in the Dzhida district possibly are in this category. However, most placer deposits are relatively small, and in many places (such as China), tungsten is recovered by hand mining.

Brine/evaporite deposits.—Tungsten-bearing brines and evaporites occur in arid regions of the former Soviet Union and Western United States. For example, the Searles Lake deposit in California, which covers an area of 90 square kilometers, contains 70 parts per million of tungsten, or a total of 61,000 metric tons of tungsten (Anstett and others, 1985, p. 20) in highly concentrated brines. If tungsten could be recovered here profitably, which is not the case at present, this brine-charged lake bed would represent an important source of supply.

Pegmatite deposits.—Tungsten is not a common constituent of pegmatites, and significant pegmatite deposits of tungsten are rare. The Okbang deposit in South Korea is the only example of a deposit of this type of any significance in the context of current world production or potential supply.

Breccia deposits.—Breccia zones, consisting of rock fragments of varied shapes and sizes, commonly form integral parts of many vein/stockwork and porphyry deposits. However, some tungsten-bearing breccia bodies, many pipe shaped, appear to have formed independently of other deposit types. An example is the Washington breccia pipe in Sonora, Mexico, where tungsten (as scheelite) is associated with copper and molybdenum minerals.

Pipe deposits.—Pipe deposits range from almost perfectly cylindrical to irregular, elongated, bulbous masses of quartz that occur in the margins of granitic intrusions. Wolframite, along with molybdenite and native bismuth, is erratically distributed in high-grade shoots or pockets. Some of those pockets contain up to 20 percent wolframite. The deposits, however, are small, and although they are historically important, particularly in Australia (for example, the Wolfram Camp deposits in Queensland), there is little production from them at present.

Hot spring deposits.—Tungsten occurs in hot spring deposits of calcareous tuffs or travertine, such as Golconda, (Nevada, United States) and Uincia (Bolivia); these deposits are too small to be listed in tables 9 and 10. Hot spring deposits are commonly associated with bedrock tungsten deposits, from which they were probably derived by circulating hot ground water. The deposits are small, and although there has been minor production from them in the past, current production, if any, is insignificant.

GEOLOGIC AGES OF TUNGSTEN DEPOSITS

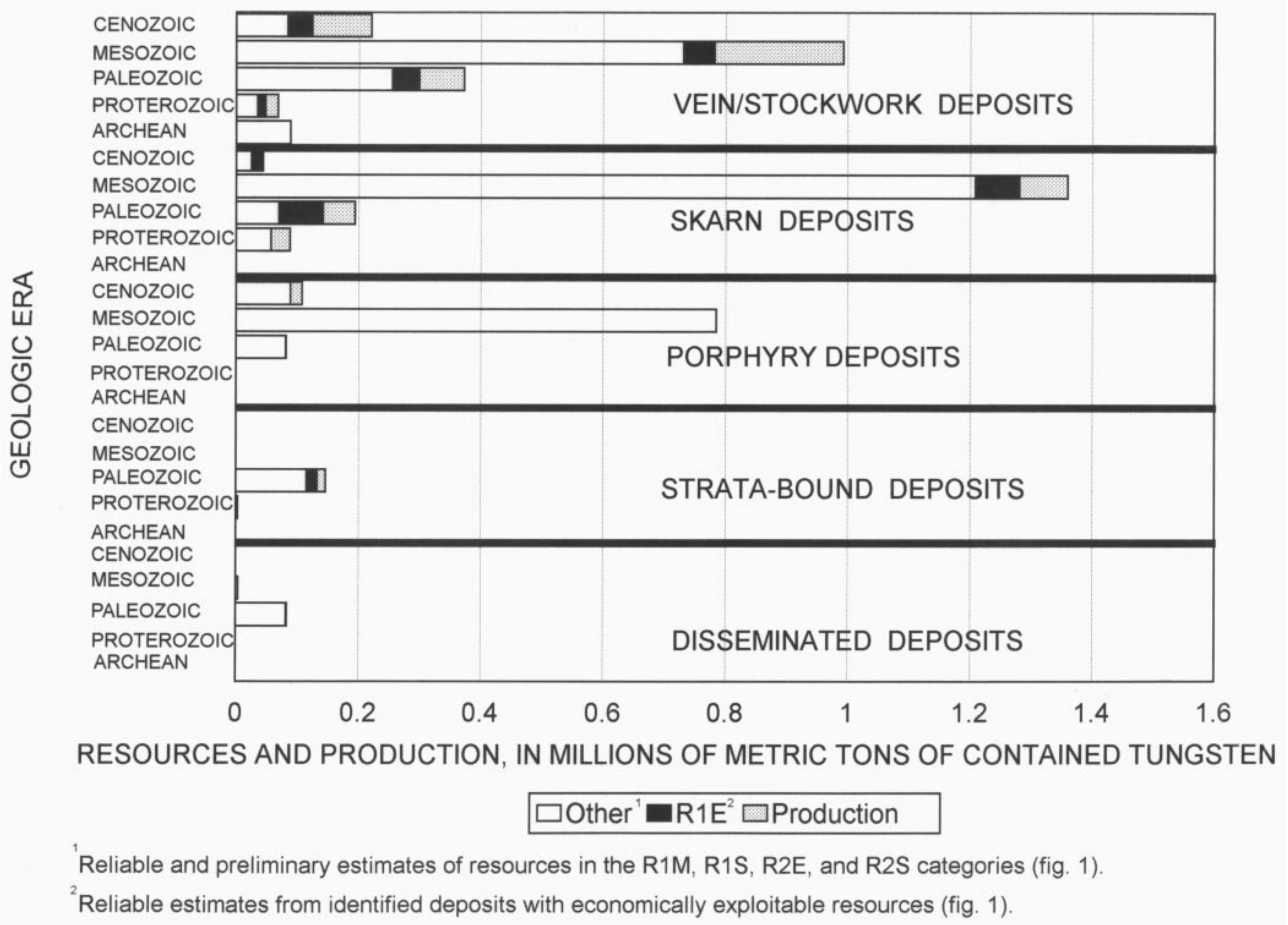
The geologic eons and eras in which tungsten deposits in the inventory were formed are shown in figure 5. Of the important deposit types, only vein/stockwork deposits of tungsten are represented in every time period; skarn deposits are Proterozoic or younger, porphyry deposits are Paleozoic or younger, and strata-bound deposits are either Proterozoic or Paleozoic in age. By far the largest proportion of the tungsten resources (70 percent), represented mainly by vein/stockwork, skarn, and porphyry-type tungsten deposits, is Mesozoic in age.

One of the main factors that determine where the tungsten deposits are located is not so much geologic age, but proximity to orogenic belts. Hence, many of the world's tungsten mines are found in the Rockies/Andes, Pyrenees, Alps, and Hercynian (Hemerdon) and Caledonian (Carrock) mountain belts.

GEOGRAPHIC DISTRIBUTION OF TUNGSTEN DEPOSITS AND DISTRICTS

Although tungsten deposits and districts are widespread, the largest deposits (those containing more than 100,000 metric tons of tungsten) are concentrated in China (foremost), the former Soviet Union (a distant second), and Canada (fig. 2 and table 2). Deposits of a lesser rank, but still economically important (10,000 to 100,000 metric tons of tungsten), are found in many countries, notably in the United States, Australia, Brazil, Burma, Peru, North Korea, South Korea, Turkey, Thailand, and in some western European countries such as the United Kingdom, Portugal, Spain, France, and Austria. Africa, despite its large size and diverse geology, is particularly lacking in large known tungsten deposits, although a medium-size deposit occurs in Algeria, and small deposits (less than 10,000 metric tons of tungsten) are reported in Namibia, Rwanda, South Africa, Sudan, Uganda, and Zimbabwe.

In China, the largest deposits are in southern Jiangxi Province and in adjacent areas in Hunan, Fujian, and Guangdong Provinces, in the southeastern part of the country (fig. 4). Except for a single deposit in the northeastern corner of Siberia, significant deposits in the former Soviet Union occur in a belt across the southern part of the country



[1] Reliable and preliminary estimates of resources in the R1M, R1S, R2E, and R2S categories (fig. 1).

[2] Reliable estimates from identified deposits with economically exploitable resources (fig. 1).

Figure 5. Tungsten resources in, and cumulative production from, the world's major deposits and districts according to geologic era of mineralization and geologic deposit type.

from the Caucasus Mountains in the west to the Primor'ye region on the Pacific coast (fig. 3).

TUNGSTEN RESOURCES

Resource Distribution by Economic Class of Country

Since World War I, China has had the largest known tungsten resources of any country in the world. In the period after World War I and until very recently, the opportunity to develop mines in the West was ultimately a result of the Chinese government's determination to minimize external trade. The strategic character of tungsten (Roush, 1935) and the inaccessibility of Chinese tungsten mines, especially during World War II, spurred the development of important tungsten resources in North America (Canada and the United States), South America (Bolivia, Brazil, and Peru), Europe (Portugal and Spain), Australia, and the former Soviet Union (fig. 3).

The 10 largest tungsten deposits or groups of deposits in the world (table 2) account for about three-fourths of the resources (R1 and R2) shown in table 1. Industrial market countries have the highest proportion (41 percent) of R1E resources and the second highest proportion (36 percent) of other categories of resources (table 3, fig. 6). These figures, however, reflect the almost total lack of information on the economic aspects of tungsten deposits in China and the former Soviet Union. Those two areas have 8 of the 10 largest deposits or districts in the world and probably about half of the world's demonstrated resources of tungsten; resource estimates given in table 10 of part II were used to calculate the resource totals in this "Tungsten Resources" section of part I.

A number of lower middle-income countries, notably Bolivia and Peru, long have been important producers of tungsten. The lower middle-income countries have 33 percent of the world's economically exploitable (R1E) resources but only 5 percent of resources in the "all other R1 and R2" category. In contrast, low-income countries show

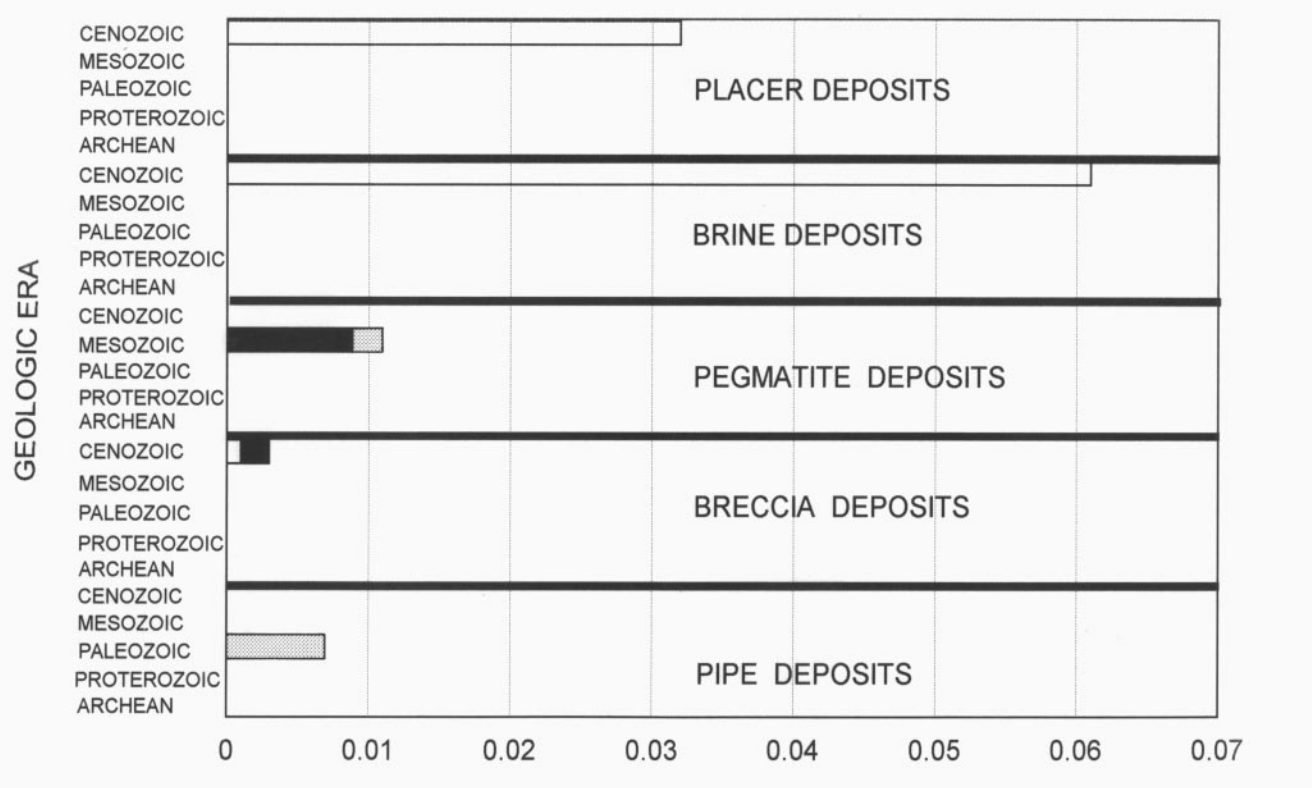


Figure 5. Continued.

only 4 percent of R1E resources, but 41 percent of resources in the “all other R1 and R2” category (table 3).

The former Soviet Union, the sole area with significant tungsten resources in the Eastern European nonmarket-economy class, accounts for about one-eighth of the total resources in the “all other R1 and R2” class (table 3). As in the case of China, all of its resources have been allocated to that category.

A comparison of the estimates of world R1E resources (table 3) and world tungsten production in 1995 (table 4) indicates that R1E resources would be expected to last at least until 2007. This projection does not, as indicated above, reflect resources whose economic parameters are unknown in major producing areas in China, the former Soviet Union, and other nonmarket-economy countries. Moreover, R1E is understated in this report because material of r1E and R1E quality was often reported together with less economically attractive (R1M, R1S, R2) grades of material. If economic conditions are suitable, the world resources in all R1 and R2 categories, including economic, marginal, and subeconomic resources, are sufficient to last well into the 21st century at 1995 rates of production.

Order of Deposit Discovery

The pattern of additions to world tungsten resources through the discovery of new deposits is shown in figure 7; dates of discovery for some of the deposits in China and the former Soviet Union were estimated because of the lack of information about these discoveries. Information for the 1980–89 period is not available.

More than half of the Western World’s known economic resources of tungsten were found before 1920, notably those in the Pine Creek mine and the Mill City district in the United States; the Borralha and Panasqueira deposits in Portugal; the King Island, Mount Carbine, and Mount Mulgine deposits in Australia; the deposits at Mawchi and in the Mergui and the Tavoy districts of Burma; the Yxsjoberg deposit in Sweden; and the Sangdong deposit in South Korea. The Yaogangxian and many of the Dayu district deposits in China were also discovered before 1920. These pre-1920 discoveries were mainly stimulated by famine-level prices that occurred during World War I.

Very few tungsten deposits were discovered in the 1920's and 1930's. Tyrnyauz, the second most important deposit in the former Soviet Union, was found in 1934; another potentially important find was the recognition in 1937 of tungsten in brines at Searles Lake in the United States. The next 20-year period (1940–59) saw the discovery of the Bodo/Barra Verde/Boca de Lage complex in Brazil; the Uludag mine in Turkey; the Shizhuyuan and Lianhuashan deposits in China; the Cantung deposit in Canada; and the Brown's Lake, Hamme, and Strawberry deposits in the United States. The possibility of economically producing tungsten as a byproduct of molybdenum mining at Climax in Colorado, United States, was recognized during these years. Major additions to the world's known resources of tungsten were made in the 1960's and 1970's with the discovery of the Mittersill mine in Austria; the Salau deposit in France; the Mount Pleasant, Mactung, Logtung, and Mar deposits in Canada; the Doi Mok and Khao Soon mines in Thailand; and the Damingshan and Yangchuling deposits in China.

Table 2. Ten largest tungsten deposits or groups of deposits in the world.

[This table does not include the Searles Lake brine/evaporite deposit in the United States, from which tungsten cannot be recovered profitably. Contained tungsten is calculated from resource data in table 10]

Deposit name (province)	Country	Contained tungsten (thousand metric tons)
Verkhne-Kayrakty (Dzhezkazgan Oblast).	Former Soviet Union.	872
Mactung (Yukon Territory and Northwest Territories).	Canada	617
Shizhuyuan (Hunan)	China	502
Tyrnyauz (former Kabardin-Balkar A.S.S.R.).	Former Soviet Union.	244
Logtung (Yukon Territory)	Canada	168
Yangchuling (Jiangxi)	China	160
Xingluokeng (Fujian)	China	144
Damingshan (Guangxi)	China	116
Vostok-2 (Primor'ye)	Former Soviet Union.	102
Ta'ergou (Gansu)	China	100
Total		3,025

Resource Distribution by Deposit Type

The minerals of tungsten were described in the section "Uses and Supply Aspects." Some two-thirds of the world's tungsten resources are in the form of scheelite, and almost one-third are in wolframite-group minerals. Of the known economic resources (R1E) of tungsten, about 48 percent are in skarn (mostly scheelite-bearing) deposits and 44 percent in vein/stockwork (principally wolframite-bearing) deposits (see table 1). Of the total tungsten contained in all other R1 and R2 resources together, about 38 percent is in skarn deposits, 33 percent in vein/stockwork deposits, 22 percent in porphyry deposits, and much of the remainder in disseminated deposits.

TUNGSTEN PRODUCTION

The 202 tungsten deposits and districts in the ISMI inventory occur in 37 countries. In 1995, two countries, China (69 percent) and the former Soviet Union (19 percent) accounted for over 80 percent of the world's production of tungsten.

Almost 67 percent of the world's cumulative output of tungsten since 1900 has come from five countries: China (34 percent), the former Soviet Union (15 percent), the United States (8 percent), and Bolivia and South Korea (5 percent each) (table 5). About 38 percent originated in low-income countries (primarily China) and some 20 percent in industrial market countries (table 4).

From a country-by-country view (figs. 8 and 9), the most notable features since 1930 are the following:

- a decrease in the proportion of world production accounted for by China from about 57 percent in 1930 to 19 percent in 1970, followed by significant upturns to the 29 and 62 percent levels in 1980 and 1990, respectively (for a further discussion of the decrease in China's proportion of world production, see U.S. Bureau of Mines (1993));
- steady growth in the output of the former Soviet Union since 1940;
- reemergence of Australia (an important producer in the late 1800's) as a major world producer between 1960 and 1980;
- a surge in the proportion of output from Canada between 1970 and 1980;
- a reduction of Burma's production after 1940;
- reductions in production in Canada, Australia, and Portugal (a long-time producer) in 1990; and
- by 1990, control of market shares for tungsten world production by the former Soviet Union and, especially, China.

Average figures for 10-year periods tend to confirm these general trends, at least in the cases of China and the former Soviet Union. China is estimated to have accounted

Table 3. Tungsten resources in the world's deposits and districts, by economic class of country and resource category.

[Resource data are in thousands of metric tons of contained tungsten; figures may not add to totals shown due to rounding. Figures in parentheses denote percentage of column total]

Economic class[1]	Number of records[2]	Resource category	
		R1E[3]	All other R1 and R2[4]
Low-income	47	13 (4)	1,790 (41)
Lower middle-income	36	127 (33)	216 (5)
Upper middle-income	32	85 (22)	220 (3)
Industrial market	54	155 (41)	1,563 (36)
High-income oil exporter	3	– (–)	9 (–)
Eastern European nonmarket	30	– (–)	551 (13)
Total	202	379 (100)	4,349 (100)

[1] Economic classes are based principally on gross national product per capita and, in some instances, on other distinguishing economic characteristics (World Bank, 1996). Countries where major tungsten deposits and districts occur are, by class: low-income economies—Burma, China, India, Rwanda, Sudan, Uganda, Vietnam, Zaire, and Zimbabwe; lower middle-income economies—Bolivia, Guatemala, Mongolia, Namibia, North Korea, Peru, Thailand, and Turkey; upper middle-income economies—Algeria, Argentina, Brazil, Chile, Mexico, Portugal, South Africa, and South Korea; industrial market economies—Australia, Austria, Canada, France, Japan, Spain, Sweden, United Kingdom, and the United States; high-income oil exporter economy—Saudi Arabia; and Eastern European nonmarket economies—Czech Republic and the former Soviet Union.

[2] Records are summarized in tables 9 and 10.

[3] Reliable estimates from identified deposits with economically exploitable resources (fig. 1).

[4] Reliable and preliminary estimates of resources in the R1M, R1S, R2E, and R2S categories (fig. 1).

Table 4. Estimated cumulative and annual mine production of tungsten contained in ore and concentrate by economic class of country for all countries having tungsten deposits or districts.

[Production figures are in metric tons of contained tungsten; figures may not add to totals shown due to rounding. Numbers in parentheses denote production rank of economic class]

Economic class[1]	Cumulative production 1905–95[2]	Annual production 1995[3]
Low-income	816,000 (1)	21,600 (1)
Lower middle-income	287,000 (4)	2,200 (3)
Upper middle-income	274,000 (5)	800 (4)
Industrial market	402,000 (2)	200 (5)
High-income oil exporter	0 (6)	0 (6)
Eastern European nonmarket	317,000 (3)	5,900 (2)
Total	2,096,000	30,700

[1] Economic classes are based principally on gross national product per capita and, in some instances, on other distinguishing economic characteristics (World Bank, 1996). Countries where major tungsten deposits and districts occur are, by class: low-income economies—Burma, China, India, Rwanda, Sudan, Uganda, Vietnam, Zaire, and Zimbabwe; lower middle-income economies—Bolivia, Guatemala, Mongolia, Namibia, North Korea, Peru, Thailand, and Turkey; upper middle-income economies—Algeria, Argentina, Brazil, Chile, Mexico, Portugal, South Africa, and South Korea; industrial market economies—Australia, Austria, Canada, France, Japan, Spain, Sweden, United Kingdom, and the United States; high-income oil exporter economy—Saudi Arabia; and Eastern European nonmarket economies—Czech Republic and the former Soviet Union.

[2] Reported production from countries in indicated economic class (U.S. Geological Survey, 1905–22, and U.S. Bureau of Mines, 1923–95).

[3] Estimated production.

for some 40 percent of average annual world output in the 1930's; 21 percent in the 1940's; and 25 percent, 31 percent, 21 percent, and 38 percent in the next four decades (U.S. Bureau of Mines, 1993). The proportions of average annual output supplied by the former Soviet Union are estimated to have increased from 7 percent in the 1940's to 13 percent in the 1950's, 19 percent in the 1960's, 20 percent in the 1970's, and 19 percent in the 1980's (U.S. Bureau of Mines, 1993).

Tungsten is produced both from surface and from underground mining operations (table 6). Most of the surface mining operations are either large-scale, relatively low-grade, open-pit operations (such as Heinda, Tavoy district, Burma). Some deposits are mined initially by surface mining of placers or of vein outcrops, followed by underground mining. Underground mines account for about half of the tungsten resources in the major deposits for which the mining method could be ascertained (table 6).

As can be seen from figures 2 and 10 and table 7, most of the world's most important producers of tungsten ores and concentrates now have facilities for making further processed forms of tungsten. There are, however, well-established processing plants in Japan, the former Soviet Union, the United States, and several countries in Western Europe.

In studies of the structure of industrial markets, the most direct way of measuring market concentration is by examining the number of supplier firms. A market concentration ratio—the percentage of total industry sales or output contributed by the largest few firms (Scherer, 1970, p. 50–5l)—can be calculated for supplier countries as well as for supplier firms. For tungsten, the increase in the four-country concentration ratio from about 73 percent in 1918 to 92 percent in 1994 is indicative of the concentration of tungsten production in comparison to other mineral commodities (DeYoung and others, 1984, p. 11). The eight-country ratio for tungsten during the same period rose from 88 percent to 96 percent.

It is not possible to predict either the levels or the patterns of demand for tungsten in 2020. However, deposit sizes and grades indicate that several of today's major producers (southern Jiangxi region, China; Tyrnyauz and Vostok-2, former Soviet Union; Sangdong, South Korea; and

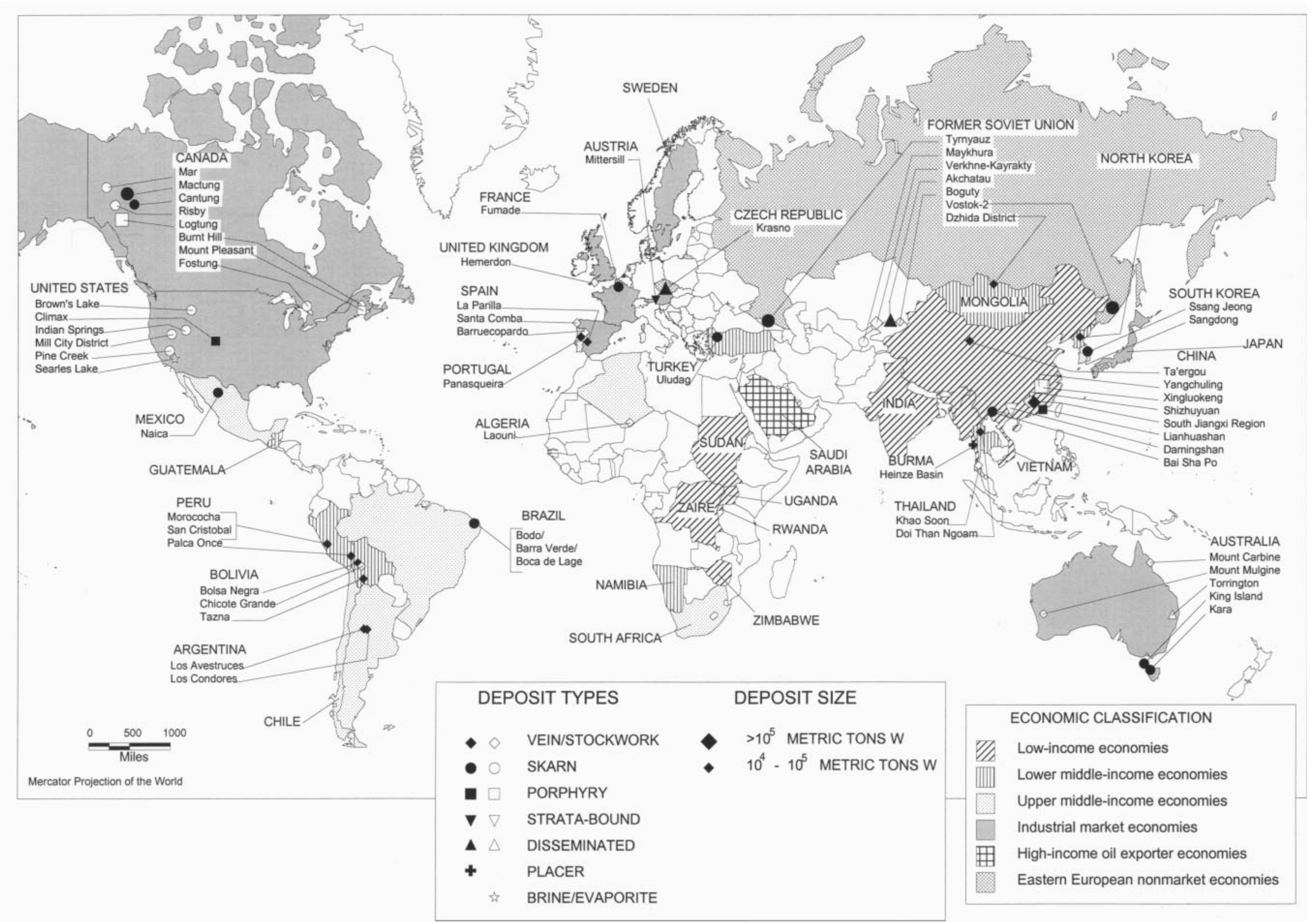


Figure 6. Economic classification by the World Bank (1996) for countries where the world's major tungsten deposits and districts occur. Resource data are the same as those in figure 2. Boundaries are not necessarily authoritative.

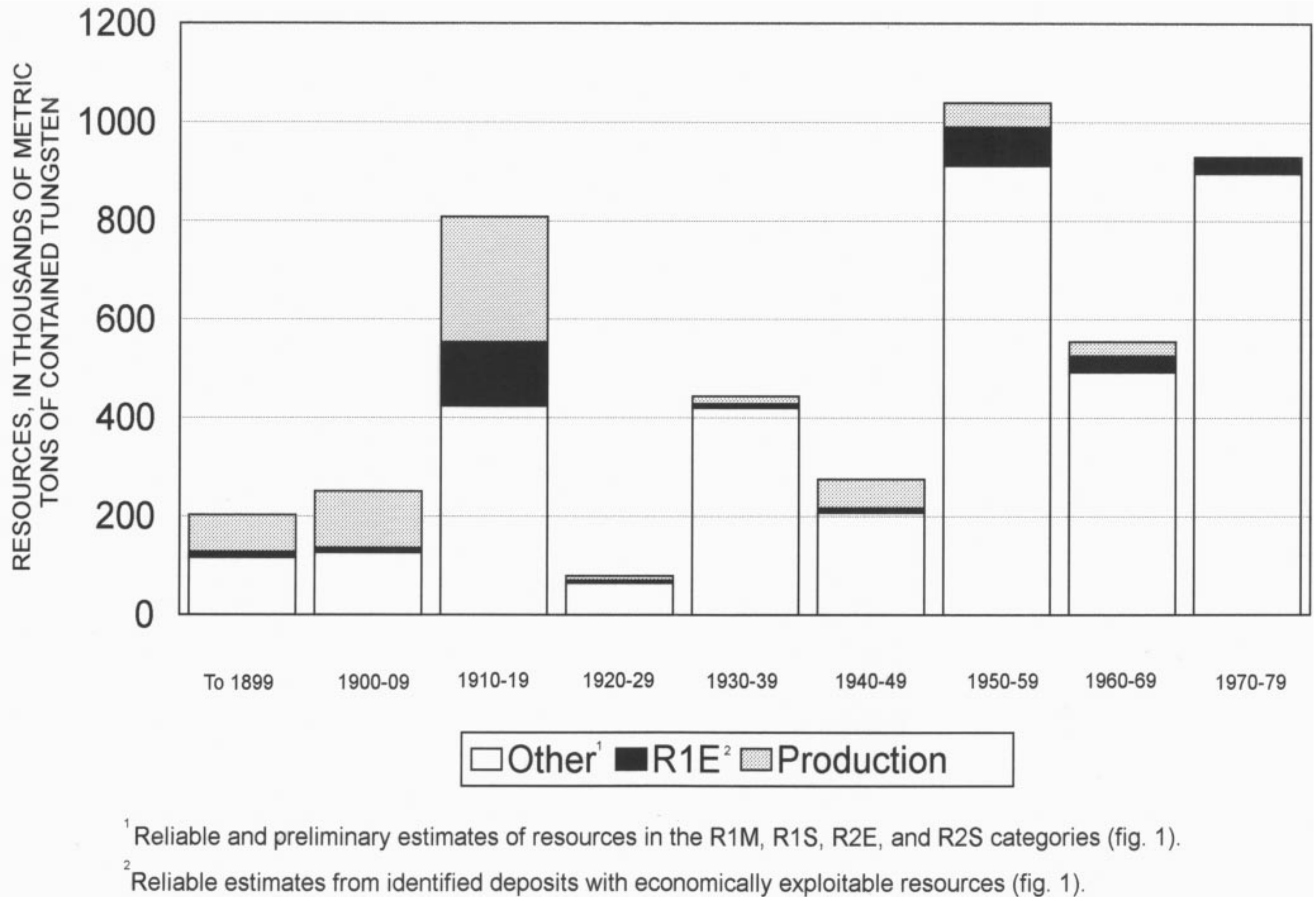


Figure 7. Tungsten resources in the world's deposits and districts according to their date of discovery. (If the year of discovery was not reported, the year of first production was used instead.) Years of discovery are listed in table 9.

Climax, United States) will probably continue to be important producers in the year 2020 (fig. 11). The period of 1990–2020 will likely see important changes in tungsten supply from other areas. Unless additional minable reserves are discovered, decreases in output can be expected from certain deposits (probably Mittersill, Austria; Kara, Australia; Panasqueira, Portugal; and some of the deposits in the southern Jiangxi region, China). Major deposits such as the Hemerdon deposit, United Kingdom; the former Cantung mine and the Mactung deposit, Canada; and the Damingshan, Shizhuyuan, and other deposits in China, now subeconomic, may become economically viable because of their large size and amenability to low-cost bulk mining. Production from large deposits in a limited number of low-income economy countries (such as China and Burma) may become relatively more important in the future, and the country concentration ratios for tungsten may accordingly increase. Large size and low-cost mining, however, will not help if the price is too low for profitable extraction. Because of the very speculative nature of tungsten metal prices, mines of low capital intensity that can be discontinued without much financial penalty in periods of economic downturn are in a better position to reopen when a market recovers.

Tungsten is also recovered as a coproduct or byproduct of mining operations in deposits that are mined primarily for other metals, such as tin, molybdenum, copper, lead, zinc, or bismuth. In the future, such deposits may become more important sources of tungsten, especially if new mines are opened in large deposits, such as those of the molybdenum-tungsten porphyry variety.

The largest proportion of world tungsten resources identified in this inventory is in China; Canada and the former Soviet Union also have significant resources. Because China and, at the time of the inventory, the former Soviet Union do not provide details of their tungsten resources, the quality and degree of minability of their deposits could not be ascertained. Other countries with important tungsten resources are Australia, Bolivia, Brazil, Peru, Portugal, Spain, South Korea, and the United Kingdom. In these countries, the geologic and economic aspects of the local deposits are more widely known and often better defined.

Table 5. Estimated cumulative and annual mine production of tungsten contained in ore and concentrate for each country having a tungsten deposit or district listed in the ISMI tungsten inventory (table 10).

[Production figures are in metric tons of contained tungsten. Numbers in parentheses denote production rank of country. —, production not reported]

Country[1]	Cumulative production 1905–95[2]	Annual production 1995[2]
China	712,000 (1)	21,000 (1)
Former Soviet Union[3]	317,000 (2)	5,900 (2)
United States	168,600 (3)	—
Bolivia	111,700 (4)	780 (4)
South Korea[4]	105,500 (5)	—
Portugal	96,200 (6)	500 (6)
North Korea[4]	82,000 (7)	900 (3)
Australia	77,600 (8)	10 (14)
Burma	76,500 (9)	530 (5)
Thailand	46,000 (10)	60 (12)
Canada	44,400 (11)	—
Brazil	39,900 (12)	115 (11)
Peru	28,900 (13)	260 (7)
Spain	27,300 (14)	—
Japan	26,600 (15)	—
Austria	25,600 (16)	190 (9)
Argentina	18,600 (17)	—
France	18,500 (18)	—
Mongolia	13,300 (19)	200 (8)
Zaire	11,000 (20)	—
Mexico	10,800 (21)	145 (10)
Sweden	9,300 (22)	—
Rwanda	8,300 (23)	—
Vietnam	4,400 (24)	—
United Kingdom	4,300 (25)	—
South Africa	3,100 (26)	—
Namibia	2,900 (27)	—
Uganda	2,800 (28)	60 (13)
Turkey	2,000 (29)	—
India	800 (30)	2 (15)
Total	2,095,900	30,652

[1] Includes all countries with deposits and districts in the International Strategic Mineral Issues tungsten inventory, except for Algeria, Chile, Czech Republic, Guatemala, Saudi Arabia, Sudan, and Zimbabwe.

[2] Cumulative and annual production based on reported production (U.S. Geological Survey, 1905–22, and U.S. Bureau of Mines, 1923–95). Data for all countries from all years are not always available.

[3] Dissolved in December 1991; production from deposits now in Kazakstan, Russia, Tajikistan, and Uzbekistan.

[4] Production prior to division of Korea into North and South allocated between the two countries on an equal basis.

Table 6. Tungsten resources in the world's deposits and districts in the R1 and R2 categories (fig. 1, table 3), listed by mining method and economic class of country.

[Resource figures are in thousands of metric tons of contained tungsten; figures may not add to totals shown due to rounding. The mining method was estimated in some cases]

Economic class[1]	Mining method				
	Surface	Underground	Surface and underground	Not mined	Indeterminable
Low-income	559	804	124	—	316
Lower middle-income	63	139	141	—	—
Upper middle-income	14	262	16	1	12
Industrial market	201	338	207	972	—
High-income oil exporter	—	—	—	9	—
Eastern European nonmarket	59	117	292	27	55
Total	896	1,660	780	1,009	383

[1] Economic classes are based principally on gross national product per capita and, in some instances, on other distinguishing economic characteristics (World Bank, 1996). Countries in each class which contain tungsten resources are listed in tables 3 and 4.

CONCLUSIONS

At the 1995 world production level of about 31,000 metric tons of tungsten annually, estimated R1E resources (379,000 metric tons of tungsten) appear to be sufficient to last only until the year 2007. However, this figure for economically exploitable tungsten resources does not include or adequately reflect the economically exploitable parts of tungsten resources in major deposits in China, the former Soviet Union, and other nonmarket-economy countries, because resources in these countries could not be reliably categorized. If economic conditions are suitable, then total tungsten resources in the inventory (4,728,000 metric tons of tungsten) would likely suffice to satisfy levels of world demand that existed in 1995 for tungsten well into the 21st century.

China currently produces about two-thirds of the world's annual production of tungsten. Given its vast resources and potential for the discovery of new deposits, China will likely retain its prominent role in world tungsten

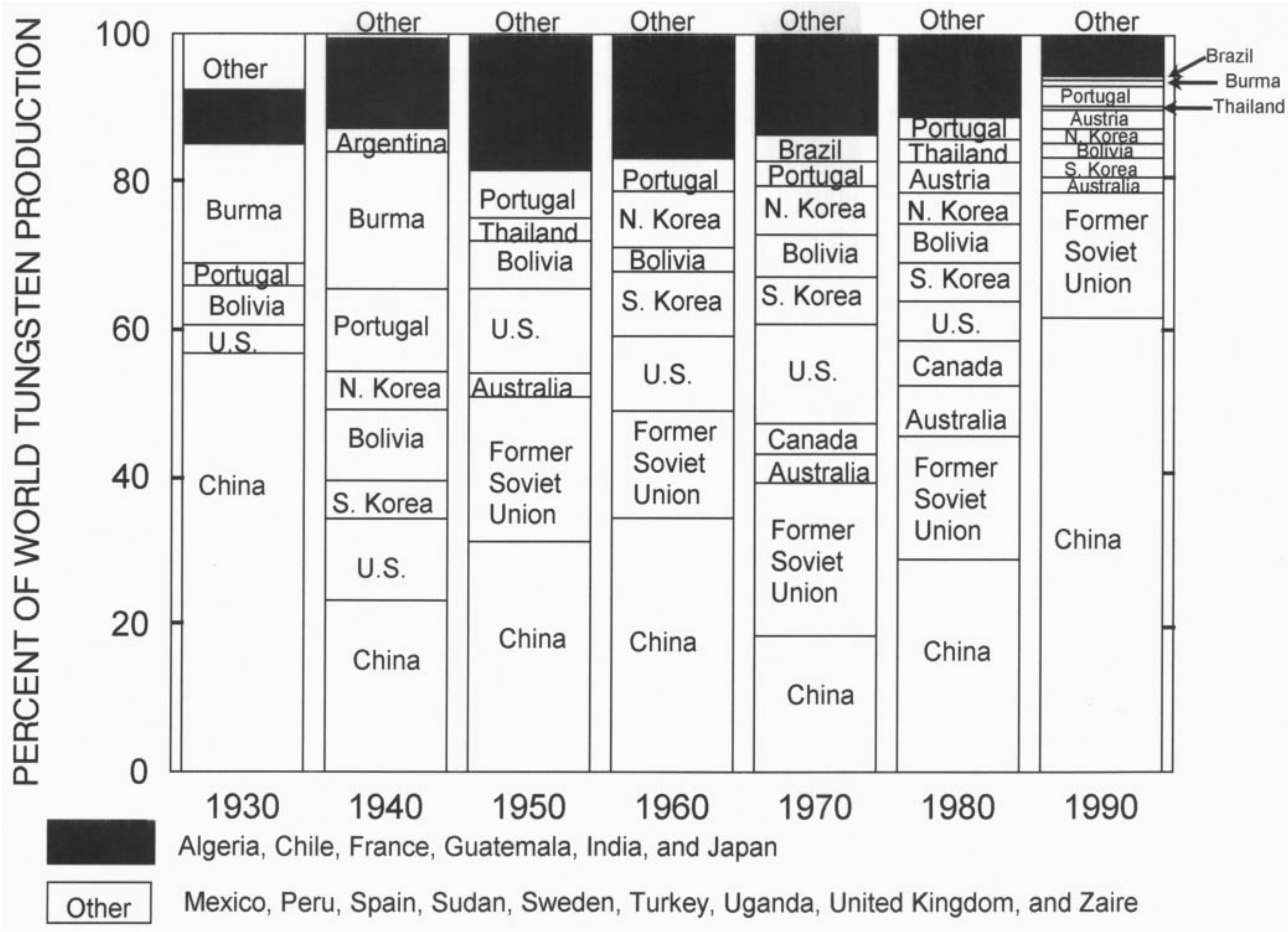


Figure 8. Proportions of total world mine production of tungsten accounted for by countries having deposits and districts in the ISMI tungsten inventory; selected years 1930–90.

supply. In addition to producing and exporting tungsten mineral concentrates, China is likely to increase its output of processed intermediate tungsten products such as ammonium paratungstate and ferrotungsten.

During the next 30 years, tungsten supply patterns will be influenced by discoveries, if any, of significant new deposits; by political events in supplier countries; by world metal price rather than the military requirements of the Cold War; and by shifts in demand for tungsten products. Barring any major changes resulting from such factors, significant mine production will continue to come from the southern Jiangxi region, China; the Tyrnyauz and Vostok-2 deposits in the former Soviet Union; and possibly the Climax mine in the United States, where the amount of tungsten recovered as a byproduct depends upon the quantity of molybdenum produced. Changes in tungsten supply patterns are likely to result from declining output from individual deposits in Australia, Austria, and Portugal. These may be offset by new production from other deposits in Canada, China, and the United Kingdom.

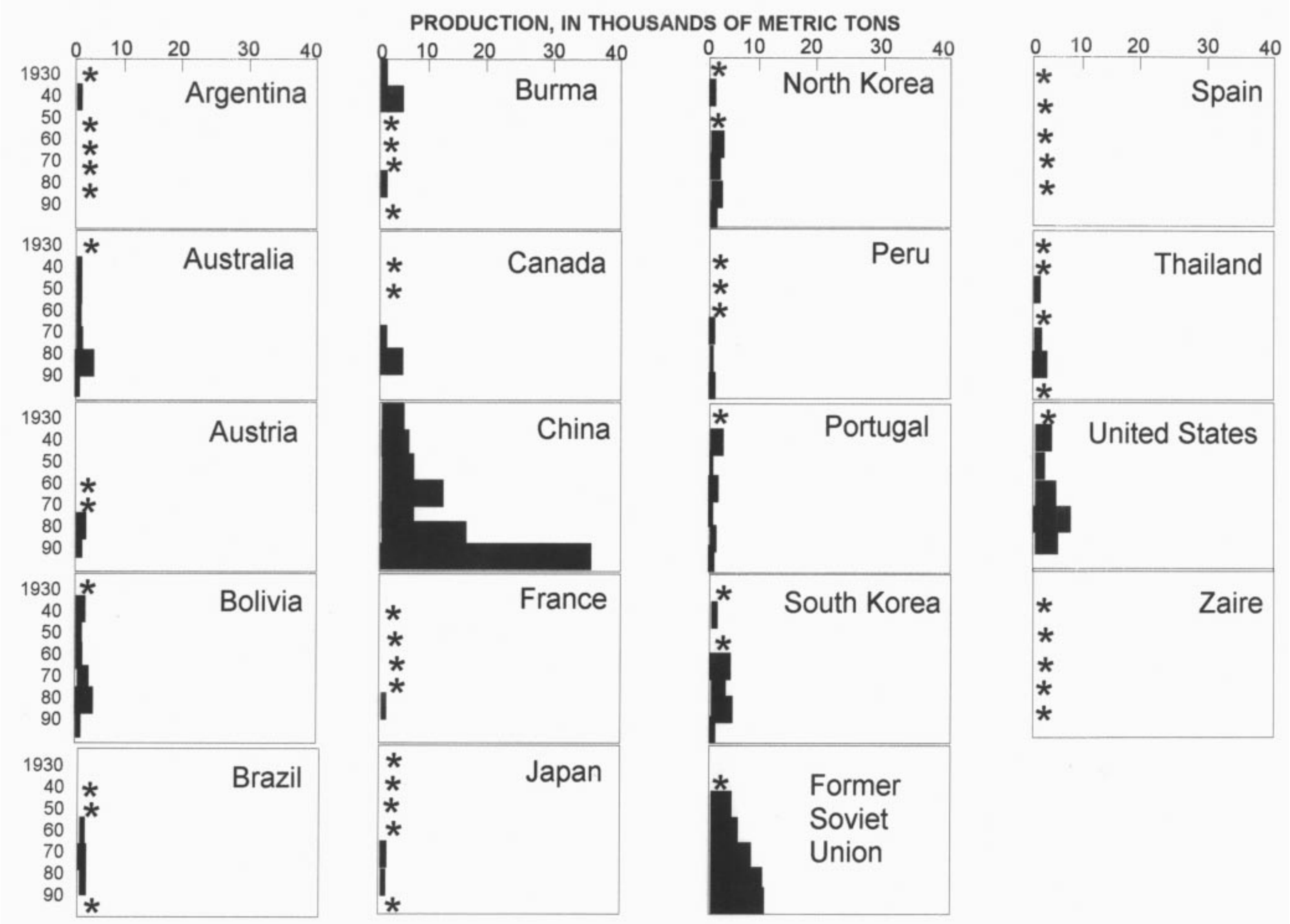


Figure 9. Tungsten mine production in countries having deposits and districts in the ISMI tungsten inventory and a cumulative output of more than 10,000 metric tons (U.S. Bureau of Mines, 1951–90); selected years 1930–90. *, reported mine production of less than 500 metric tons.

PART II—SELECTED INVENTORY INFORMATION ON TUNGSTEN DEPOSITS AND DISTRICTS

Tables 8, 9, and 10 contain information from the ISMI record forms for tungsten deposits and districts. Only selected items of information about the location and geology (table 9) and mineral production and resources (table 10) for the deposits are listed here; some of this information has been abbreviated (table 8).

Summary descriptions and data are presented in the tables essentially as they were reported in the inventory records. For instance, amounts of production or resources have been maintained as reported; no attempt has been made to round to the appropriate number of significant digits. Data that were reported in units other than metric tons have been converted to metric tons for comparability. Some of the data in the tables, such as cumulative production totals, are more condensed than in the inventory records.

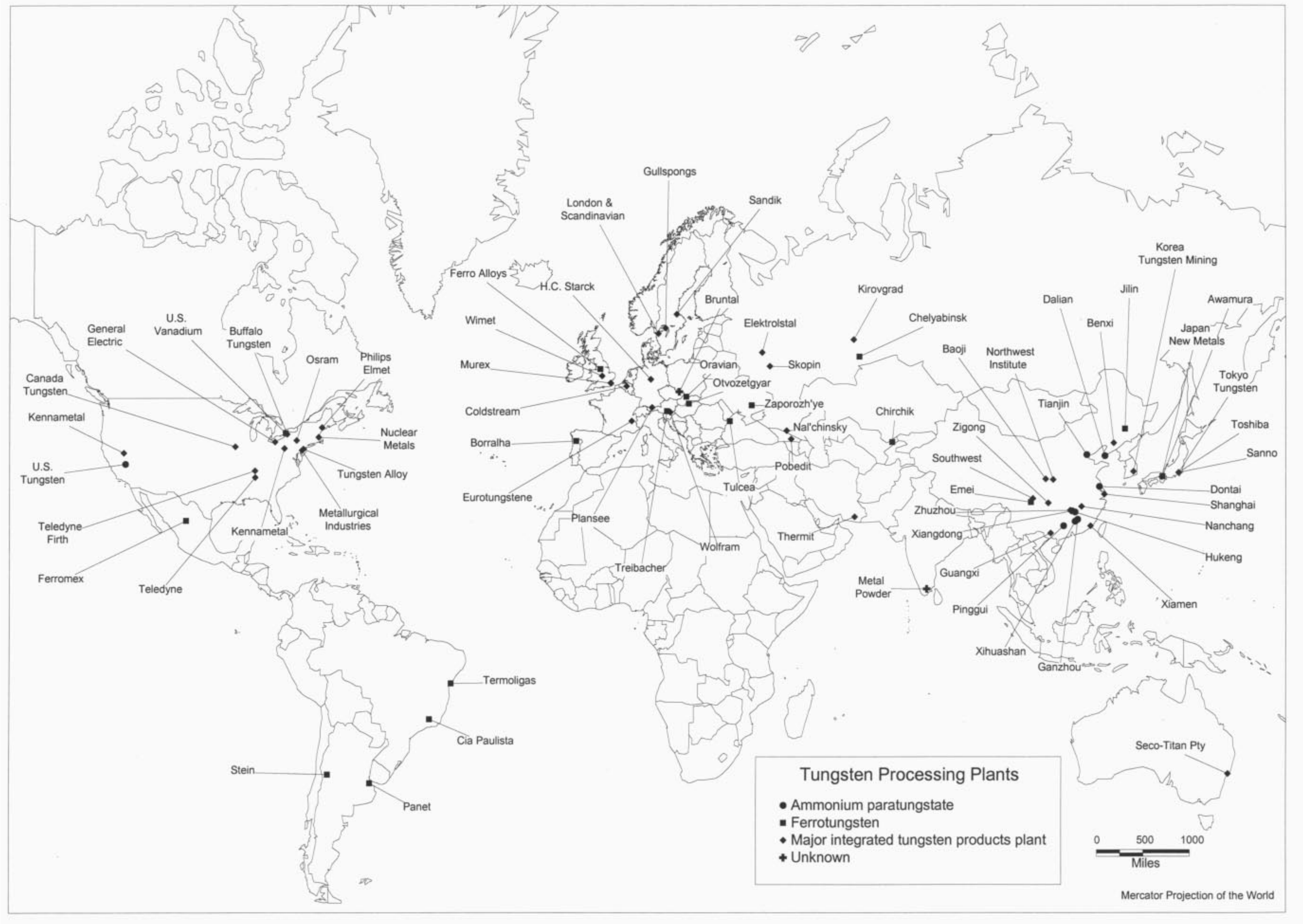


Figure 10. Major world tungsten processing plants, 1919–89. Data on plants are from table 7.

Table 7. Major world tungsten processing plants.

[Plants are plotted in figure 10. —, not reported; t, metric tons; tpy, metric tons per year; capacity refers to annual production capacity in metric tons. Sources: Australia, Bureau of Mineral Resources, Geology, and Geophysics, written commun., 1988; Austria, Bundesministerium für Handel, Gewerbe und Industrie, written commun., 1985; Jones, 1996; Rabchevsky, 1988; Serjeantson, 1997; and L. Speiss, written commun. seen by first author (Werner) in 1988]

Company's headquarters		Plant location		Product	Capacity (metric tons)	Comments
Country	Site	Latitude	Longitude			
Argentina	Panet S.A. Argentina Cifi (Llavallol, Buenos Aires)	34 47 S	58 26 W	Ferrotungsten	—	—
Argentina	Stein Ferroaleaciones Sacifa (Lujan de Cuyo, Provincia de Mendoza)	33 03 S	68 52 W	Ferrotungsten	—	—
Australia	Seco-Titan Pty, Ltd. (Newcastle, New South Wales)	32 55 S	151 46 E	Ammonium paratungstate Sintered tungsten carbide	—	No longer exists.
Austria	Plansee AG (Reutte, Tirol)	47 29 N	10 45 E	Tungsten metal	—	Plant is in Germany—Metallwerk Plansee GmbH, Lechbruck.
Austria	Treibacher Industrie AG (Treibach, Kärnten)	46 53 N	14 28 E	Ferrotungsten Tungsten powder	—	—
Austria	Wolfram Bergbau- und Hütten-gesellschaft mbH (Eibiswald, Steiermark)	46 42 N	15 15 E	Tungsten metal Tungsten powder Tungsten carbide powder Blue Oxide	1,300	—
Belgium	Coldstream, S.A. (Brussels)	50 51 N	04 29 E	Tungsten powder Pre-alloyed tungsten carbide/cobalt grit and powder	—	—
Brazil	Cia Paulista de Ferro Ligas (Barbacena, Minas Gerais)	21 14 S	43 46 W	Ferrotungsten	1,200	—
Brazil	Termoligas Mineracao e Metalurgia S.A. (Simoes Filho, Salvador, Bahia)	12 58 S	38 29 W	Ferrotungsten	—	—
Burma	Kamyawkin Upgrading Plant, Tavoy (Tanintharyi)	—	—	—	—	Magnetic separation of wolframite from tin-tungsten concentrate (1980).
China	Baoji Non-Ferrous Metals Works (Baoji, Shaanxi)	34 24 N	107 07 E	Tungsten metal Tungsten powder Tungsten wire	—	1994 production 11 t tungsten metal.
China	Benxi Alloy (Liaoning)	41 15 N	123 45 E	Tungsten metal	—	1994 production 6 t.
China	Dalian (Liaoning)	38 55 N	121 39 E	Ammonium paratungstate	150	—
China	Dontai (Dontai, Jiangsu)	32 51 N	120 18 E	Ammonium paratungstate	1,000	—
China	Emei, Ferro-Alloy Plant (Emei County, Sichuan)	29 35 N	103 31 E	Ferrotungsten	5,000	—

TABLE 7. MAJOR WORLD TUNGSTEN PROCESSING PLANTS

Company's headquarters		Plant location		Product	Capacity (metric tons)	Comments
Country	Site	Latitude	Longitude			
China	Ganzhou (Smelter) (Ganzhou, Jiangxi)	25 51 N	114 56 E	Ammonium paratungstate	>3,500	Total capacity of three plants. The major plants are Ganzhou Cobalt Smelter (2,000–2,500 tpy); and the Ganzhou Tungsten and Molybdenum Materials Plant (1,000 tpy). 1994 production 609 t ammonium paratungstate, 57 t tungsten metal, and 7 t fabricated products.
China	Guangxi Nanning Aluminium Plant (Nanning, Guangxi)	22 50 N	108 21 E	Tungsten metal	—	—
China	Haizhou Cemented Carbide Co. (Hainan)	—	—	Cast tungsten carbide	—	—
China	Hongxing Works (Guangdong)	—	—	Tungsten acid	—	—
China	Hukeng (Jiangxi)	27 29 N	114 19 E	Ammonium paratungstate	1,000	Production since mid-1955. Target for 1996, 500 t.
China	Jilin (Smelter) (Jilin)	43 51 N	126 33 E	Ferrotungsten	8,000	1995 production 1,767 t ferrotungsten. 1994 production 283 t ammonium paratungstate.
China	Jindong Chemical Works (Sichuan)	—	—	Tungsten acid	—	—
China	Lanshun Refractory Alloy Factory (Liaoning)	—	—	Tungsten carbide?	—	—
China	Nanchang (Hard Alloy) (Nanchang, Jiangxi)	28 41 N	115 53 E	Tungsten carbide Ammonium paratungstate	1,000	A major producer of tungsten products. 1994 production 87 t ammonium paratungstate.
China	Northwest Institute for Non-Ferrous Metal Research (Shaanxi)	34 15 N	108 57 E	Tungsten metal	—	—
China	Pinggui (Guangxi)	24 26 N	111 32 E	Ammonium paratungstate	—	1994 production 307 t.
China	Shanghai (Shanghai)	31 14 N	121 28 E	Ammonium paratungstate Ferrotungsten	100	1994 production 18 t ammonium paratungstate.
China	Southwest Special Materials Plant (Chengdu, Sichuan)	30 21 N	104 02 E	Tungsten metal	—	—
China	Tianjin (Tianjin)	39 08 N	117 12 E	Ammonium paratungstate	100	—
China	Xiamen Tungsten Products Plant (Haichang, Xiamen Suburbs, Fujian)	24 27 N	118 04 E	Ammonium paratungstate Tungsten powder Tungsten oxide	3,300	—
China	Xiangdong (Jiangxi)	27 42 N	113 36 E	Ammonium paratungstate	—	1994 production 601 t.

Table 7. Major world tungsten processing plants—Continued.

[Plants are plotted in figure 10. —, not reported; t, metric tons; tpy, metric tons per year; capacity refers to annual production capacity in metric tons. Sources: Australia, Bureau of Mineral Resources, Geology, and Geophysics, written commun., 1988; Austria, Bundesministerium für Handel, Gewerbe und Industrie, written commun., 1985; Jones, 1996; Rabchevsky, 1988; Serjeantson, 1997; and L. Speiss, written commun. seen by first author (Werner) in 1988]

Company's headquarters		Plant location		Product	Capacity (metric tons)	Comments
Country	Site	Latitude	Longitude			
China	Xihuashan (Jiangxi)	25 28 N	114 19 E	Ammonium paratungstate	—	1994 production 83 t.
China	Zhuzhou Cemented Carbide Industry Co. (Zhuzhou, Hunan)	27 50 N	113 09 E	Ammonium paratungstate Tungsten powder Tungsten carbide	2,500	Largest integrated facility in China. Ammonium paratungstate is produced at two plants. 1994 production 1,808 t ammonium paratungstate and 351 t tungsten metal.
China	Zigong (Hard Alloy) (Zigong, Sichuan)	29 24 N	107 47 E	Ammonium paratungstate Tungsten metal	1,500	Plant uses scheelite as raw material. 1994 production 694 t ammonium paratungstate, 378 t tungsten metal, 35 t fabricated products.
Czech Republic	Bruntal Hydrometallurgical Plants (Bruntal)	50 00 N	17 27 E	—	—	—
France	Eurotungstene—Poudre S.A. (Eaux-Claires, Grenoble, Isere)	45 11 N	05 43 E	Ammonium paratungstate Tungsten metal Tungsten powder	—	—
Germany	Louis Renner GmbH	—	—	Tungsten metal	—	Plant 1: Munich-Dachau, Bavaria. Plant 2: Altmünster/Oberbayern, Bavaria.
Germany	Hermann C. Starck Berlin GmbH & Co. KG (Goslar, Harz)	51 54 N	10 26 E	Tungsten metal Carbides and compounds	—	—
Hungary	Otvozetgyar Salgotarjan (Salgotarjan, Nograo)	48 07 N	19 49 E	Ferrotungsten	—	—
India	India Thermit Corporation, Ltd. (Falzalgarij, Kanpur district, Uttar Pradesh)	26 27 N	60 14 E	Tungsten carbide	—	—
India	The Metal Powder Co., Ltd. (Thirumangalam, Madurai District, Tamil Nadu)	09 50 N	77 59 E	—	—	—
Japan	Awamura Metal Industry Co., Ltd. (Uji City, Kyoto Prefecture)	34 54 N	135 48 E	Ferrotungsten	1,003	—
Japan	Japan New Metals Co., Ltd. (Toyonaka City, Osaka Prefecture)	34 48 N	135 35 E	Ammonium paratungstate Tungsten powder	1,600 1,200	—
Japan	Nippon Tungsten Co., Ltd. (Fukuoka, Fukuoka Prefecture)	—	—	Tungsten metal	—	—
Japan	Sanno Seiko Kaisha, Ltd. (Tokyo)	35 40 N	139 45 E	Tungsten metal	—	—
Japan	Toho Kinzoku (Metal) Co., Ltd. (Mogi, Fukuoka Prefecture)	—	—	Tungsten metal	—	—
Japan	Tokyo Tungsten Co., Ltd. (Tokyo)	35 40 N	139 45 E	Tungsten powder Tungsten metal	630 120	—

TABLE 7. MAJOR WORLD TUNGSTEN PROCESSING PLANTS

Company’s headquarters		Plant location		Product	Capacity (metric tons)	Comments
Country	Site	Latitude	Longitude			
Japan	Toshiba Corp., Metal Sintering Division (Yokohama, Kanagawa Prefecture)	35 40 N	139 45 E	Ammonium paratungstate Tungsten metal	—	—
Mexico	Ferroaleaciones de Mexico S.A.—Ferromex (Gomez Palacio, Durango)	25 39 N	103 30 E	Ferrotungsten	—	—
Mongolia	Tsagaan-davaa (Tov Province)	—	—	—	—	Tungsten concentrating plant using ore from Tsagaan-davaa mine (1988).
Mongolia	Ulaan Uul (Bayan-Olgiy Province)	—	—	—	—	Tungsten concentrating plant using ore from the Ulaan Uul and Khovd Gol mines (1991).
Portugal	Minas de Borralha, S.A.R.L. (Borralha, Vila Real, and Braga)	41 41 N	07 49 W	Ferrotungsten	—	Produces ferrotungsten from own tungsten concentrates.
Romania	Tulcea Metallurgical Complex (Tulcea, Dobrogea)	45 10 N	29 48 E	Ferrotungsten	—	—
Russia	Chelyabinsk Electrometallurgical Work JSC (Chelyabinsk, R.S.F.S.R.)	55 12 N	61 25 E	Ferrotungsten	—	—
Russia	Elektrolstal-Electric Steel Works Elektrolstal, Moscovskaya Oblast (Moscow region, R.S.F.S.R.)	55 45 N	37 42 E	Ammonium paratungstate Tungsten carbide	—	—
Russia	Kirovgrad Mill for Hard Alloys Yekatarinburgskaja Oblast (Kirovgrad, Ukrainian S.S.R.)	57 28 N	60 00 E	Tungsten carbide Tungsten powder	—	—
Russia	Nal'chinsky Hydrometallurgical Plant Nal'chik, Kabadino-Balkarian Republic (Kabardino, Kabardin-Balkar A.S.S.R.)	43 31 N	43 38 E	Ammonium paratungstate Tungsten metal Tungsten carbide	—	Treats material from Tyrnyauz.
Russia	Pobedit Works Vladikavkaz (Vladikavkaz, North Ossetian Republic)	43 02 N	44 43 E	Tungsten powder Tungsten metal?	—	—
Russia	Skopin Hydrometallurgical Mill (Ryasanskaya Oblast)	53 50 N	39 34 E	Tungsten anhydride Tungsten concentrate	—	—
Slovakia	Oravian Ferroalloys Works (Istebne)	49 12 N	19 11 E	Ferrotungsten	—	—
South Korea	Korea Tungsten Mining Co., Ltd. (Daegu)	35 52 N	128 36 E	Ammonium paratungstate Tungsten powder Tungsten carbide powder Tungsten oxide Ferrotungsten	—	—
Sweden	Gullspongs Elektrokemiska AB (Gullspongs)	58 58 N	14 05 E	Ammonium paratungstate Ferrotungsten	—	—
Sweden	Sandik AB (Sanoviken)	60 38 N	16 50 E	Tungsten carbide powder	—	—

Table 7. Major world tungsten processing plants—Continued.

[Plants are plotted in figure 10. —, not reported; t, metric tons; tpy, metric tons per year; capacity refers to annual production capacity in metric tons. Sources: Australia, Bureau of Mineral Resources, Geology, and Geophysics, written commun., 1988; Austria, Bundesministerium für Handel, Gewerbe und Industrie, written commun., 1985; Jones, 1996; Rabchevsky, 1988; Serjeantson, 1997; and L. Speiss, written commun. seen by first author (Werner) in 1988]

Company's headquarters		Plant location		Product	Capacity (metric tons)	Comments
Country	Site	Latitude	Longitude			
Ukraine	Zaporozh'ye Steel Combine (Zaparozh'ye)	47 50 N	35 10 E	Ferrotungsten	—	—
United Kingdom	Ferro Alloys & Metal, Ltd. (Glossop, Derbyshire)	53 25 N	01 54 W	Ferrotungsten	—	Not operating.
United Kingdom	London & Scandinavian Metallurgical Co., Ltd. (London, England)	51 33 N	04 16 E	Tungsten powder	—	Not operating. Plant in Rotterdam, Netherlands; company office in London, U.K.
United Kingdom	Murex, Ltd. (Rainham, Essex)	51 21 N	00 36 E	Ammonium paratungstate Tungsten metal Tungsten powder Tungsten carbide Hard metal powders Hard metal nodules	—	Closed down.
United Kingdom	Wimet, Ltd. (Coventry)	52 25 N	01 30 W	Tungsten powder Tungsten carbide	—	—
United States	Buffalo Tungsten (Depew, New York)	42 54 N	78 42 W	Tungsten powder Tungsten carbide	900	—
United States	Canada Tungsten Mining Corp., Ltd. (Fort Madison, Iowa)	40 38 N	91 27 W	Ammonium paratungstate Tungsten powder	—	—
United States	General Electric Co. (Cleveland, Ohio)	41 30 N	81 41 W	Ammonium paratungstate Tungsten metal Tungsten powder Tungsten carbide	—	—
United States	Kennametal, Inc. (Fallon, Nevada)	39 28 N	118 47 W	Tungsten carbide	—	—
United States	Kennametal, Inc. (Latrobe, Pennsylvania)	40 19 N	79 23 W	Tungsten metal Tungsten carbide	—	—
United States	Metallurgical Industries, Inc. (Tinton Falls, New Jersey)	39 57 N	75 07 W	Tungsten powder	—	—
United States	Nuclear Metals, Inc. (Concord, Massachusetts)	42 21 N	71 04 W	Tungsten powder	—	—
United States	Osram Sylvania, Inc. (Towanda, Pennsylvania)	41 46 N	76 26 W	Ammonium paratungstate Tungsten metal Tungsten powder Tungsten carbide	—	—
United States	Philips Elmet Co. (Lewiston, Maine)	44 06 N	70 13 W	Ammonium paratungstate Tungsten metal Tungsten powder Tungsten wire	—	—

TABLE 7. MAJOR WORLD TUNGSTEN PROCESSING PLANTS

Company's headquarters		Plant location		Product	Capacity (metric tons)	Comments
Country	Site	Latitude	Longitude			
United States	Teledyne Advanced Materials, Inc. (Huntsville, Alabama)	34 44 N	86 35 W	Ammonium paratungstate Tungsten metal Tungsten powder Tungsten carbide	—	—
United States	Teledyne Firth Sterling (La Vergne, Tennessee)	36 02 N	86 39 W	Tungsten powder Tungsten carbide	—	—
United States	Tungsten Alloy Manufacturing Co., Inc. (Harrison, New Jersey)	40 13 N	74 45 W	Tungsten carbide	—	—
United States	U.S. Tungsten Corp. (Bishop, California)	37 20 N	118 24 W	Ammonium paratungstate	—	—
United States	U.S. Vanadium Corp. (Niagara Falls, New York)	43 06 N	79 04 W	Ferrotungsten	—	—
Uzbekistan	Uzbek Refractory & Heat-Resistant Metal Works (Chirchik, Tashkentskaya Oblast)	41 28 N	69 31 E	Ferrotungsten Tungsten metal	—	Treats material from the Ingichka deposit.

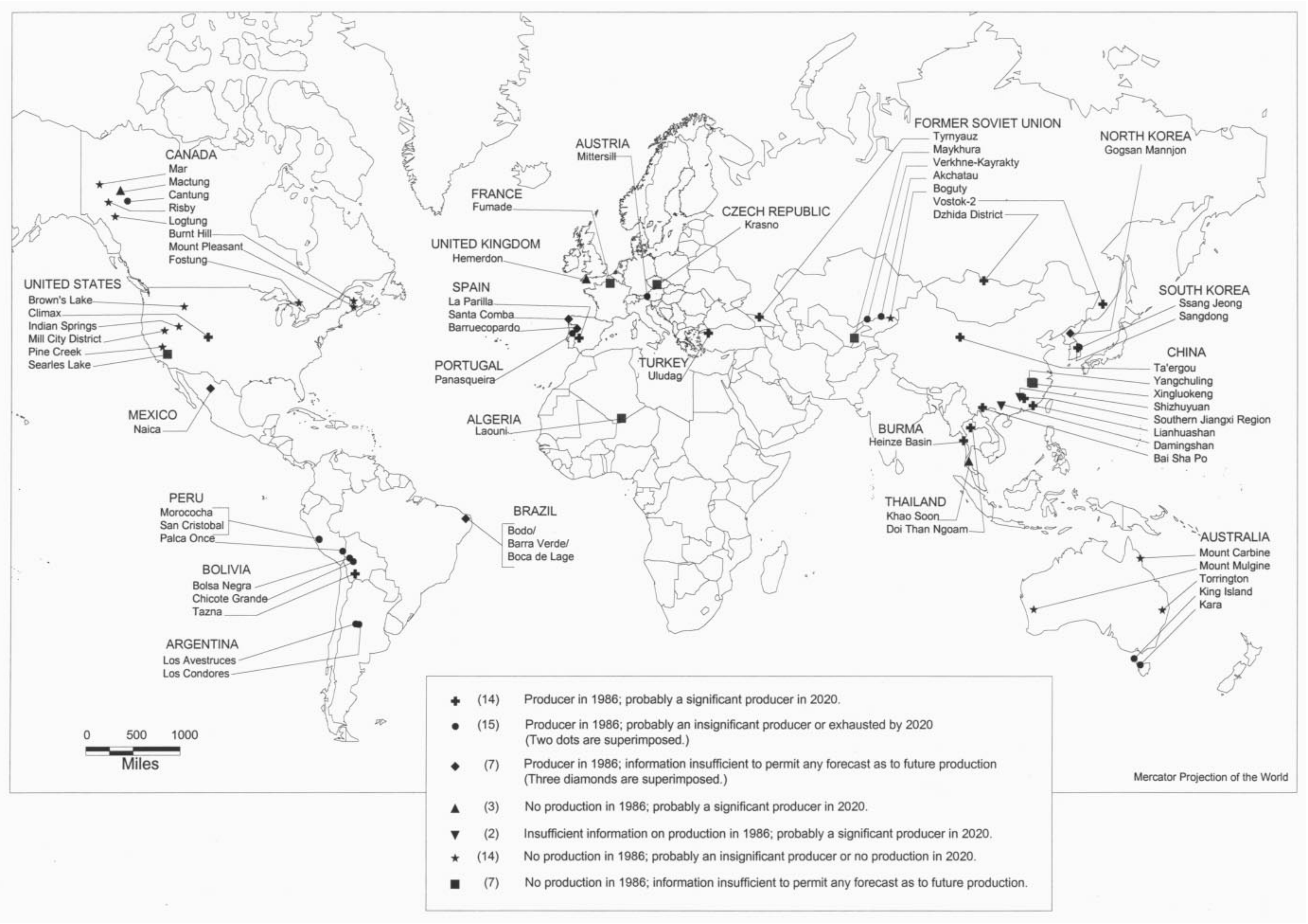


Figure 11. Major tungsten deposits and districts worldwide, their production status at the beginning of 1986, and their probable production status in 2020. Numbers in parentheses indicate the number of records of deposits and districts for each status category.

Table 8. Abbreviations used in tables 9 and 10.

Geologic age abbreviations and prefixes

[Prefixes are combined with abbreviations; for example, EJUR is Early Jurassic. A geologic time chart is shown on the inside front cover]

ARCH	Archean	EO	Eocene	OLIGO	Oligocene	PREC	Precambrian
CAMB	Cambrian	JUR	Jurassic	ORD	Ordovician	PROT	Proterozoic
CARB	Carboniferous	L	Late	PAL	Paleozoic	QUAT	Quaternary
CEN	Cenozoic	M	Middle	PALEO	Paleocene	SIL	Silurian
CRET	Cretaceous	MES	Mesozoic	PENN	Pennsylvanian	TERT	Tertiary
DEV	Devonian	MIO	Miocene	PERM	Permian	TRI	Triassic
E	Early	MISS	Mississippian	PLIO	Pliocene		

Abbreviations for mineral names

[From Longe and others, 1978, p. 63–66]

ACNL	actinolite	CLPX	clinopyroxene	HMTT	hematite	RDNT	rhodonite
ADLR	adularia	CLRT	chlorite	KLNT	kaolinite	SCLT	scheelite
ADLS	andalusite	CLZS	clinozoisite	KOLN	kaolin	SCPL	scapolite
ADRD	andradite	CMNG	cummingtonite	LLNG	loellingite	SDRT	siderite
ALBT	albite	CMST	chamosite	LPDL	lepidolite	SLMN	sillimanite
AMPB	amphibole	CRBN	carbonate	MCCL	microcline	SLPD	sulfides
ANKR	ankerite	CRDR	cordierite	MGNT	magnetite	SLVR	silver
APTT	apatite	CSLT	cosalite	MICA	mica	SPLR	sphalerite
ARGT	argentite	CSTR	cassiterite	MLBD	molybdenite	SRCT	sericite
ARPR	arsenopyrite	DLMT	dolomite	MNZT	monazite	STBN	stibnite
BLND	blende	DPSD	diopside	MRCS	marcasite	STNT	stannite
BMTT	bismutite	EPDT	epidote	MRMT	marmatite	TMLT	tremolite
BOTT	biotite	FLDP	feldspar	MSCV	muscovite	TNNT	tennantite
BRIT	barite	FLRT	fluorite	MTLD	matildite	TNST	tungstite
BRNT	bornite	FRBR	ferberite	ORCL	orthoclase	TNTL	tantalite
BRYL	beryl	GLEN	galena	PLGC	plagioclase	TOPZ	topaz
BSMN	bismuthinite	GOLD	gold	PLGP	phlogopite	TRDR	tetrahedrite
BSMT	bismuth	GRLR	grossularite	PRXN	pyroxene	TRML	tourmaline
CLAY	clay	GRNT	garnet	PWLT	powellite	URNN	uraninite
CLCC	chalcocite	GTHT	goethite	PYRT	pyrite	VSVN	vesuvianite
CLCP	chalcopyrite	HBLD	hornblende	PYTT	pyrrhotite	WLFM	wolframite
CLCT	calcite	HBNR	huebnerite	QRTZ	quartz	WLST	wollastonite
CLMB	columbite	HDBG	hedenbergite	RDCR	rhodochrosite	ZNWD	zinnwaldite

Chemical symbols

Ag	silver	Cu	copper	MoS_2	molybdenum disulfide	SnO_2	tin dioxide
As	arsenic	F	fluorine	Nb	niobium	Ta	tantalum
Au	gold	Fe	iron	Pb	lead	Te	tellurium
Be	beryllium	Hg	mercury	Sb	antimony	W	tungsten
Bi	bismuth	Li	lithium	Se	selenium	WO_3	tungsten trioxide
$CaWO_4$	calcium tungstate	Mo	molybdenum	Sn	tin	Zn	zinc

Units of measure

g	gram	Ma	mega-annum (million years ago)
g/t	gram per metric ton	ppm	parts per million
km	kilometer	t	metric ton
m	meter	tpd	tons per day

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Algeria	Laouni deposit (Adrar Renaissance District)	20 28 N	05 34 E	Vein	Gneiss, migmatite; PROT. Greisenized granite; pre-ORD.	Pre-ORD	Intracratonic	Contact aureole of pre-ORD granite intrusion.	QRTZ, WLFM, SCLT	Three main quartz veins, 1–2 m wide, up to 1 km long. Average grade 1–1.5 percent WO_3.	De Kun (1965).
Argentina	Los Avestruces-Las Asperezas (San Luis)	32 36 S	66 07 W	Vein	Schist; LPREC	PREC–PAL	Intracratonic	Quartz veins cutting LPREC schist.	SCLT, WLFM, QRTZ, BOTT, PYRT, MLBD, BSMT, CLCP, SPLR	Scheelite is more abundant than wolframite.	Willig and Delgado (1985).
Argentina	Los Condores-El Aguila (San Luis)	32 43 S	65 16 W	Vein	Schist, gneiss; PREC	PREC–PAL	Intracratonic	Quartz veins cutting PREC schist and gneiss.	FRBR, QRTZ, SCLT, PYRT, MLBD, BSMN, TRML, WLFM	Two principal vein systems, the Los Condores and the Aguila, intersect at depth.	Willig and Delgado (1985).
Australia	Kara (Tasmania)	41 21 S	145 47 E	Skarn	Carbonaceous limestone, dolomite; Junee group; ORD.	DEV	PAL orogenic belt	Contact aureole of DEV granite intrusion.	SCLT, ACNL, MGNT	—	Wolff (1978).
Australia	King Island (Tasmania)	40 04 S	144 05 E	Skarn	Calc-silicate rock; Grassy group; PROT–ECAMB.	ECARB	PAL orogenic belt	Contact aureole of ECARB granite intrusion?	SCLT, MLBD, PYRT, ARPR, PYTT, CLCP, GRNT, CLCC QRTZ, APTT	—	Kwak and Tan (1981).
Australia	Molyhil (Northern Territory)	22 45 S	135 44 E	Skarn	Skarn, hornfels; PROT. Granite; Jinka granite; EPROT.	EPROT	Intracratonic	Contact aureole of EPROT granite intrusion.	SCLT, MLBD, ADRD, GRLR, PRXN, Ferro-AMPB, EPDT, QRTZ, CLCC, MGNT, SLPD	—	—
Australia	Mount Carbine (Queensland)	16 31 S	145 07 E	Vein/stockwork	Argillaceous sedimentary rocks; Hodgkinson formation; SIL–DEV.	PERM (278 Ma)	PAL orogenic belt	Contact aureole of PERM granite intrusion.	WLFM, SCLT, QRTZ, CLCC, APTT, PYRT, PYTT, MLBD, ARPR, CSTR, MRCS, CLCP	—	Plumridge (1975).
Australia	Mount Mulgine (Western Australia)	29 11 S	116 59 E	Vein/stockwork	Metasedimentary rocks, ultramafic rocks; ARCH.	ARCH	Intracratonic	Contact aureole of ARCH granite intrusion.	SCLT, FLRT, MLBD, CLCP, BRYL, SLVR, GOLD	—	Baxter (1978).
Australia	Sunnymount (Queensland)	17 25 S	144 52 E	Vein/breccia pipe	Siltstone, chert/hornfels; Ringrose formation; DEV?	LCARB–EPERM	PAL orogenic belt	Pipe-shaped breccia body in contact aureole of LCARB–EPERM granite intrusion.	CSTR, WLFM, QRTZ, APTT, CRDR, CMNG, GRNT, BOTT, KLNT, PYRT, CLCP, GLEN	Ore occurs as quartz veins, fracture fillings, and replacement zones.	Pollard (1981).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Australia	Torrington (New SouthWales)	29 19 S	151 41 E	Disseminated/ vein/pipe	Quartz-topaz rock; Mole granite; LPERM. Mudstone, sandstone, siltstone; PERM. Granite; Mole granite; LPERM–TRI.	LPERM–TRI	PAL orogenic belt	Upper part of LPERM–TRI granite and overlying roof pendant.	WLFM, BSMT, GOLD, CSTR, TOPZ, QRTZ	Wolframite is disseminated in magmatic quartz-topaz rock (“silexite”).	Eadington (1983).
Australia	Watershed Grid (Queensland)	16 13 S	144 42 E	Vein/skarn	Carbonaceous conglomerate, arenite; Hodgkinson formation; DEV.	PAL	PAL orogenic belt	Contact aureole of PAL granite?	SCLT, QRTZ FLRT, EPDT, GRNT, PLGC, PLGP, PYRT, ARPR, ALBT, BOTT	—	—
Australia	Wolfram Camp (Queensland)	17 05 S	144 55 E	Breccia pipe	Altered granite; Elizabeth Creek granite; LCARB–EPERM.	LCARB–EPERM	PAL orogenic belt	Roof zone and margin of LCARB–EPERM granite intrusion.	WLFM, MLBD, BSMT, BSMN, PYRT, CLCP, ARPR, PYTT, GLEN, SPLR, FLRT, SCLT	Orebodies consist of upward-branching quartz “pipes” a few centimeters to 6 m across and up to 200 m high.	Plimer (1975).
Austria	Mittersill mine (Salzburg)	47 18 N	12 29 E	Strata-bound	Lava, tuff; lower Schieferhulle; PAL.	—	MES–CEN orogenic belt	Regionally metamorphosed volcanic rocks.	SCLT, QRTZ, MLBD, PYTT, CLCP, BSMT, PYRT	Orebodies are several hundred meters long, 100–150 m wide, and up to 20 m thick.	Vaché (1979).
Bolivia	Bolsa Negra (La Paz)	16 34 S	67 49 W	Vein	Hornfels	EJUR	MES–CEN convergent plate margin	Contact aureole of EJUR granite batholith.	WLFM, SCLT, PYRT, PYTT, QRTZ, CLCP	Orebodies are quartz-rich lenses (“mantos”) in hornfels.	Willig and Delgado (1985).
Bolivia	Chambillaya (La Paz)	17 04 S	67 18 W	Vein/stockwork	Hornfels	MIO?	MES–CEN convergent plate margin	Contact aureole of a MIO? granite intrusion.	FRBR, QRTZ, ARPR, SLPD, SDRT, TRML, TNST	Deposit comprises a circular area 1,400 m in diameter; tonnage potential is considerable.	Willig and Delgado (1985).
Bolivia	Chicote Grande (La Paz)	17 28 S	66 50 W	Vein/stockwork/ alluvial	Quartzite, slate, sandstone; EPAL.	MIO	MES–CEN convergent plate margin	Contact aureole of MIO granite at depth?	WLFM, CSTR, QRTZ, PYRT, ARPR	Narrow veins form large stockwork zone; mineralized vein material also occurs as talus.	Willig and Delgado (1985).
Bolivia	Chojlla (La Paz)	16 23 S	67 45 W	Vein/stockwork	Shale, sandstone; LORD.	EJUR (183 Ma)	MES–CEN convergent plate margin	Contact aureole of EJUR granite batholith.	WLFM, SCLT, QRTZ, BSMN, MLBD, CLCP, HMTT, SDRT, ARPR, CLMB	Deposit consists of more than 30 parallel veins.	Willig and Delgado (1985).
Bolivia	Chorolque (Potosi)	20 58 S	66 05 W	Porphyry	Intrusive breccia; MMIO (12–17 Ma). Shale, sandstone, siltstone; ORD.	MMIO (12–17 Ma)	MES–CEN convergent plate margin	Subvolcanic breccia pipe.	QRTZ, CSTR, WLFM, PYRT, ARPR, PYTT, CLCP, SPLR, STNT, BSMN, TRML	Tungsten occurs in annular zone surrounding a quartz-tourmaline breccia pipe; tungsten potential large but low grade.	Grant and others (1980).
Bolivia	Enramada-Liliana (La Paz)	16 25 S	67 43 W	Vein	Schist; PAL? Granodiorite; Taquesi batholith; EJUR (199 Ma).	EJUR (183 Ma)	MES–CEN convergent plate margin	Contact aureole of EJUR granite batholith.	WLFM, QRTZ, CSTR, SLPD	—	Willig and Delgado (1985).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Bolivia	Kami (Cochabamba)	17 28 S	66 52 W	Vein	Hornfels	MIO?	MES–CEN convergent plate margin	Hornfels zone of MIO? granite at depth.	WLFM, QRTZ, TRML, PYRT, ARPR	Five principal veins.	Willig and Delgado (1985).
Bolivia	Pueblo Viejo (Potosi)	21 42 S	66 11 W	Vein	Dacite; MIO–PLIO?	MIO–PLIO?	MES–CEN convergent plate margin	Subvolcanic dacitic intrusion.	WLFM, QRTZ, BSMN, CLCP, PYRT	Several veins.	Willig and Delgado (1985).
Bolivia	Reconquistada (La Paz)	16 28 S	67 52 W	Vein	Phyllitic schist; PAL?	EJUR	MES–CEN convergent plate margin	Contact aureole of EJUR granite batholith.	WLFM, QRTZ	—	Ahlfeld (1954).
Bolivia	Tazna (Potosi)	20 38 S	66 19 W	Vein	Hornfels	MIO–PLIO?	MES–CEN convergent plate margin	Contact aureole of MIO–PLIO? granite intrusion.	BSMN, WLFM, CSTR, STNT, PYTT, PYRT, GOLD, QRTZ, CLCP, SPLR	Important producer of bismuth.	Willig and Delgado (1985).
Bolivia	Viloco (La Paz)	16 52 S	67 38 W	Vein	Sedimentary rocks; PAL? Granite; Quimsa Cruz (Tres Cruces) batholith; OLIGO–MIO (23.8±1.6 Ma).	OLIGO–MIO	MES–CEN convergent plate margin	Contact aureole of OLIGO–MIO granite batholith.	WLFM, ARPR, PYRT, TRML	Richer areas have been worked out.	Willig and Delgado (1985).
Brazil	Bodo/Barra Verde/Boca de Lage mines (Rio Grande do Norte)	06 12 S	36 30 W	Skarn	Marble, quartz-biotite gneiss, granite gneiss, biotite schist; PREC.	PREC	Intracratonic	Contact aureole of PREC granite stock.	SCLT, EPDT, GRNT, VSVN, HBLD	Minable orebodies are up to 100 m long, 30 m wide, and 10 m thick.	Willig and Delgado (1985).
Brazil	Pedra Preta (Para)	07 11 S	50 34 W	Vein/placer	Metasedimentary, metavolcanic rocks; EPROT.	PROT	Intracratonic	Contact aureole of PROT granite intrusion?	WLFM, SLPD, QRTZ	Small amount of wolframite concentrates produced by “garimpeiros” (prospectors) from weathered quartz veins and colluvial and eluvial material.	Willig and Delgado (1985).
Burma	Heinze Basin (Mon State)	14 45 N	98 00 E	Placer; offshore	Gravel; TERT. Cenozoic sediments.	CRET–TERT–QUAT	—	Offshore drowned tidal valley.	CSTR, WLFM, SCLT	—	Goosens (1978).
Burma	Mawchi mine (Kayah State)	18 50 N	97 10 E	Vein/stockwork; quartz veins, greisen, pegmatite	Argillite, slate, limestone; Mawchi series; CARB. Granite; CRET.	CRET JUR TRIAS?	MES collision zone	Apical part of CRET granite pluton and associated country rocks.	CSTR, WLFM, QRTZ, SCLT, ARPR, PYRT, CLCP, GLEN, TRML	—	Bender (1983).
Burma	Mergui district (Mon State)	11 17 N	99 17 E	Vein/stockwork/placer	Sedimentary rocks Mergui series; CARB. Granite; CRET? Fluvial and alluvial sediments; TERT.	CRET?	MES collision zone	Contact aureole of CRET? granite pluton; modern streams and alluvial terraces.	WLFM, CSTR, QRTZ, MLBD, PYRT, CLCP, TRML, FLRT, LPDL	—	Bender (1983).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Burma	Tavoy district (Tanintharyi Division) Hamyingyi mine Heinda mine Kanbank mine Yadanabon mine	14 20 N	98 20 E	Vein/stockwork/ fossil placer	Granite; LMES. Shale, agglomerate; Mergui series; CARB; CEN sediments.	LMES	MES collision zone	LMES granite intrusion; PAL sedimentary rocks.	WLFM, QRTZ, FLRT, CSTR, PYRT, MLBD, GLEN	—	Zaw (1984).
Canada	Bailey (Yukon Territory)	60 46 N	128 51 W	Skarn	Limestone/skarn; E–MPAL.	CRET	MES collision zone	Contact aureole of CRET granite batholith.	SCLT, CLCP, PYTT, PRXN, GRNT, MGNT	—	Dawson and Dick (1978).
Canada	Burnt Hill (New Brunswick)	46 34 N	66 49 W	Vein	Interbedded quartzite and argillite; LCAMB–EORD.	MDEV	PAL orogenic belt	Hornfels zone of MDEV granite pluton.	WLFM, QRTZ, FLRT, PYTT, TOPZ, ARPR, CMST, CSTR, BRYL, MLBD, SCLT, MSCV, BSMN, SLVR, PYRT, MRCS, CLCP, SPLR, GLEN, BSMT	Wolframite-bearing quartz veins form a zone 150 m wide and 1,000 m long.	Victor (1957).
Canada	Cantung (Northwest Territories)	61 58 N	128 15 W	Skarn	Limestone/skarn; Ore limestone; ECAMB. Limestone/skarn; Swiss Cheese limestone; ECAMB.	MCRET (94.6±2.6 Ma)	MES collision zone	Contact aureole of MCRET granite pluton.	SCLT, PYTT, CLCP, DPSD, HDBG, GRLR, TMLT, ACNL, BOTT, CLRT	Most ore (E-zone orebody) is in Ore limestone.	Mathieson and Clark (1984).
Canada	Fostung (Ontario)	46 14 N	81 39 W	Skarn	Calcareous siltstone; Espanola formation; EPROT.	MPROT	Intracratonic	Contact aureole of MPROT granite pluton.	SCLT, MLBD, GRNT, CLPX, TMLT, ACNL, PYTT, CLCP, SPLR, ARPR, VSVN, WLST, FLRT, GOLD, SLVR	—	Ginn and Beecham (1986).
Canada	Grey River (Newfoundland)	47 36 N	57 06 W	Vein	Amphibolitic gneiss, mica schist, orthoquartzite; MORD. Granite; LSIL–EDEV (408±5 Ma).	LSIL–EDEV	PAL orogenic belt	Contact aureole of LSIL–EDEV granite intrusion.	WLFM, SCLT, QRTZ, PYRT, CLCP, BSMT, GLEN, FLRT, MSCV, FLDP	—	Higgins (1985).
Canada	Lened (Northwest Territories)	62 22 N	128 37 W	Skarn	Limestone/marble, hornfels; Rabbitkettle formation; CAMB–ORD.	CRET	MES collision zone	Contact aureole of CRET granite plutons.	SCLT, PRXN, GRNT, VSVN, BOTT, PYTT, CLCP	—	Forster and others (1979).
Canada	Logtung (Yukon Territory)	60 00 N	131 36 W	Porphyry	Quartz-feldspar porphyry; CRET (Rb-Sr: 118±2 Ma). Calcareous shale, graphitic phyllite; CARB. Diorite; PERM–TRI (Rb-Sr: 245± 32 Ma).	CRET (109±2 Ma)	MES collision zone	CRET quartz-feldspar porphyry dike and associated country rocks.	QRTZ, GRNT, DPSD, SCLT, PYRT, FLRT, FLDP, MLBD, BRYL, BSMT, ARPR, SPLR, GLEN	Stockwork zone is 700 to 800 m across and more than 200 m thick.	Noble and others (1984).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Canada	Mactung (Yukon Territory and Northwest Territories)	63 17 N	130 09 W	Skarn	Limestone/skarn; LCAMB	MCRET	MES collision zone	Contact aureole of MCRET granite intrusion.	SCLT, PYTT, CLCP, GRNT, PRXN, CLCC, QRTZ, AMPB, BOTT, CLRT	—	Dick and Hodgson (1982).
Canada	Mar (Yukon Territory)	64 02 N	135 45 W	Skarn	Marble, quartz-biotite schist; “Grit Unit”; PROT–CAMB.	MCRET	MES collision zone	Contact aureole of MCRET granite intrusion.	SCLT, CLPX, QRTZ, ACNL, CLCC, PLGC, SCPL, GRNT, VSVN, APTT	—	Lennan (1983).
Canada	Mount Pleasant (New Brunswick)	45 25 N	66 49 W	Porphyry	Breccia; Fire Tower breccia; LMISS. Fine-grained granite; LMISS. Quartz-feldspar porphyry; LMISS.	LMISS (340–330 Ma)	PAL orogenic belt	Subvolcanic pluton at margin of LMISS caldera.	WLFM, MLBD, BSMT, BSMN, ARPR, LLNG, QRTZ, TOPZ, FLRT, SRCT, CLRT, BOTT, ORCL	Ore zones are 200–300 m across and up to 200 m high in section.	Kooiman and others (1986).
Canada	Risby (Yukon Territory)	61 51 N	133 23 W	Skarn	Marble/skarn; ECAMB	MCRET	MES collision zone	Contact aureole of MCRET granite intrusion.	SCLT, GRNT, DPSD, CLRT, PYTT, PYRT, CLCP, MLBD	—	Sinclair (1986).
Chile	Copiapo (Atacama)	27 17 S	70 19 W	Breccia pipe	Breccia; CRET–TERT	CRET–TERT	MES–CEN convergent plate margin	Breccia pipe	SCLT, WLFM, QRTZ, TRML, CLCP, BRNT, PYRT, MLBD	—	Segerstrom (1967).
China	Bai Sha Po (Yunnan)	23 15 N	103 09 E	Skarn/vein/alluvial	Limestone; Gejiu formation; TRI.	CRET	MES–CEN collision zone	Contact aureole of CRET granite pluton.	WLFM, CSTR, QRTZ, SCLT, CLCP, SLPD, CRBN	—	Institution of Mining and Metallurgy (1979).
China	Dajishan (Jiangxi)	24 35 N	114 23 E	Vein/disseminated	Phyllite, argillite, quartzite; CAMB. Granite; JUR.	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite intrusion.	WLFM, QRTZ, MICA, TRML	Wolframite occurs in veins in deposit in exploitation and as disseminated grains in granite deposit not in exploitation.	Hsu (1943); Editorial Committee of the Mineral Deposits of China (1992); Shi and Hu (1988).
China	Damingshan, Wuming (Guangxi)	23 42 N	108 11 E	Strata-bound	Sandstone, Lianhuashan formation; DEV. Shale; Nakaoling formation; DEV.	DEV, CRET	PAL–MES–CEN orogenic belt	Transgressive marine—DEV continental margin.	WLFM, MLBD, QRTZ, SRCT, SCLT, PYRT, ARPR, BSMT, SDRT, FLRT	Wolframite occurs as disseminated grains controlled by bedding in sandstone and in crosscutting quartz veins and veinlets.	Ma (1982).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
China	Dayu district (Jiangxi)	[See below]		Vein/stockwork	Granite; JUR (K-Ar: 165 Ma). Granite; JUR (K-Ar: 184–180 Ma). Sandstones, phyllite; CAMB. Limestone, CARB.	JUR	PAL–MES–CEN orogenic belt	Multiphase JUR granite intrusion and associated country rocks.	WLFM, QRTZ, ORCL, MSCV, BOTT, TRML, TOPZ, BRYL, CLRT, FLRT, CLCC, MLBD, CSTR, BSMN, ARPR, SPLR, GLEN, CLCP, PYTT, PYRT, SCLT	Most important tungsten-producing area in China; includes Xihuashan, Dangping, Piaotang, Dalongshan, Muzhiyuan, Baoshan, Zhandongkeng, and Xialong mines.	Tanelli (1982).
	Baoshan	25 33 N	114 16 E	Skarn	—	—	—	—	SCLT, GLEN, CLCP, SPLR	—	Wu (1979).
	Dalongshan	25 30 N	114 22 E	Vein/stockwork	—	—	—	—	—	—	—
	Dangping	25 28 N	114 20 E	Vein/stockwork	—	—	—	—	—	—	—
	Muzhiyuan	25 29 N	114 22 E	Vein/stockwork	—	—	—	—	—	—	Li (1993).
	Piaotang	25 31 N	114 24 E	Vein/stockwork	—	—	—	—	—	—	—
	Xialong	25 36 N	114 31 E	Vein/stockwork	Phyllite, quartzite; PREC–CAMB.	JUR	PAL–MES–CEN orogenic belt	Contact aureole above hidden JUR granite intrusion.	WLFM, QRTZ	—	Hsu (1943).
	Xihuashan	25 28 N	114 19 E	Vein/stockwork	—	—	—	—	—	—	Editorial Committee of the Mineral Deposits of China (1992); Wu and others (1987); Clarke (1983); Li (1993); Giuliani and others (1988).
	Zhandongkeng	25 26 N	114 11 E	Vein/stockwork	—	—	—	—	—	—	—
China	Gueimeishan (Jiangxi)	24 43 N	114 53 E	Vein/stockwork	Quartzite, phyllite; CAMB–ORD. Granite; JUR.	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite intrusion.	WLFM, QRTZ, TRML	Sheeted vein zone is 1,500 m long and 200–500 m wide.	Hsu (1943).
China	Huangsha (Jiangxi)	26 00 N	115 24 E	Vein	Quartzite, slate; CAMB. Granite; Tieshanglong granite; JUR (184–177 Ma).	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite pluton.	WLFM, QRTZ, MSCV, ARPR, BSMN, CSTR, PYRT, SPLR, CLCP, STNT, TRDR, BSMT	—	Chen and Hu (1982); Xia and others (1982).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
China	Hukeng (Jiangxi)	27 29 N	114 19 E	Vein	Granite (approx. 150 Ma)	JUR	PROT orogenic belt	Multiphase JUR granite intrusion.	WLFM, PYRT, BLND, BSMN, GLEN, CLCP, MLBD, QRTZ, FLRT, CLCT, MSCV	Several vein zones; principal vein zone more than 1,000 m long, more than 1,000 m deep, more than 200 single veins.	Chinese Institute of Geology and Mineral Resources Information and others (1992); Editorial Committee of the Mineral Deposits of China (1992).
China	Jubankeng (Guangdong)	24 32 N	114 48 E	Vein	Phyllite, quartzite	JUR	PAL orogenic belt	Folded CAMB–ORD metasediments; magmatic source rocks not encountered so far.	WLFM, CSTR, QRTZ, BLND, GLEN, CLCP, PYRT, TOPZ	Vein zone more than 2,000 m long, 700 m wide, more than 900 m deep. More than 20 veins with “economic ore.”	Editorial Committee of the Mineral Deposits of China (1992).
China	Lianhuashan (Guangdong)	23 44 N	116 44 E	Porphyry	Quartz porphyry; CRET. Sandstone; LJUR.	CRET	PAL–MES–CEN orogenic belt	Subvolcanic quartz porphyry intrusion and associated country rocks.	SCLT, WLFM, CLCP, MLBD, ARPR, PYTT, PYRT, BSMN, SPLR, GLEN, ARGT, ADLS, QRTZ, TOPZ, MSCV, SRCT, GRNT, TRML, BOTT, MCCL, CLCC	—	Lu (1985); Editorial Committee of the Mineral Deposits of China (1992).
China	Pangushan (Jiangxi)	25 38 N	115 25 E	Vein/stockwork	Sandstone; DEV. Granite; JUR.	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite pluton.	WLFM, BSMN, QRTZ, CSTR, Li-MICA, TRML, PYRT, PYTT, MLBD, SCLT	Tungsten-bearing quartz veins occur over an area 1,000 m by 1,000 m and extend 1,000 m downdip.	Hsu (1943); Cai and others (1982).
China	Shangping (Jiangxi)	25 45 N	115 26 E	Vein/stockwork	Phyllite, sandstone; PREC–CAMB.	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite pluton.	WLFM, QRTZ, ORCL, Li-MICA	—	Hsu (1943).
China	Shizhuyuan (Hunan)	25 43 N	113 10 E	Vein/stockwork/ skarn	Limestone; Shetianqiao formation; LDEV. Granite; Qianlishan granite; JUR (K-Ar: 172–139 Ma).	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite pluton.	SCLT, WLFM, GRNT, DPSD, VSVN, FLRT, CSTR, PYTT, PYRT, MGNT, BSMT, BSMN, CLCP, SPLR, QRTZ, BRYL, TOPZ, MSCV	Wolframite occurs in quartz veins and vein stockworks superimposed on scheelite-bearing skarn and underlying greisenized granite; scheelite-bearing skarn makes up less than half of tungsten reserves.	Wang and others (1982); Editorial Committee of the Mineral Deposits of China (1992); Clarke (1983); Li (1993).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
China	Ta'ergou (Gansu)	39 22 N	97 03 E	Vein/skarn	Quartz-sericite schists, marbles, hornblende-quartz schists.	PROT? PAL	PROT–PAL orogenic belt	Magmatic source rocks not encountered.	SCLT, BRYL, CLCP, PYRT, PYTT, GLEN, BLND, QRTZ, DPSD, ADRD, VSVN, CLCT, FLRT, MSCV, WLFM, CSTR, ARPR	Skarn zone more than 2,000 m long, more than 600 m deep, more than 20 scheelite orebodies; wolframite vein zone more than 1,000 m long, more than 800 m deep, more than 200 veins containing "economic ore."	Editorial Committee of the Mineral Deposits of China (1992).
China	Wengyuan (Guangdong)	24 18 N	114 07 E	Vein	Granite; JUR. Sandstone.	JUR	PAL–MES–CEN orogenic belt	JUR granite pluton and associated country rocks.	WLFM, QRTZ	—	Li and Wang (1955).
China	Xiangdong (Hunan)	27 05 N	113 36 E	Vein/stockwork	—	JUR?	PAL–MES–CEN orogenic belt	—	—	—	Anstett and others (1985).
China	Xingluokeng (Fujian)	26 09 N	116 47 E	Porphyry	Granite; JUR (157–133 Ma). Hornfels; DEV.	JUR	PAL–MES–CEN orogenic belt	Multiphase JUR granite intrusion.	WLFM, SCLT, MLBD, CSTR, CLCP, PYRT, BSMN, BSMT, QRTZ, ORCL, SRCT, BOTT, ALBT, CLRT, FLRT, KOLN, CRBN	Ratio of wolframite to scheelite is 51:49.	Liu (1982); Editorial Committee of the Mineral Deposits of China (1992).
China	Yangchuling (Jiangxi)	29 20 N	116 20 E	Porphyry	Granodiorite porphyry; JUR. Breccia pipes; CRET.	CRET	PAL–MES–CEN orogenic belt	Multiphase CRET granite intrusions.	SCLT, MLBD, CLCP, BSMN, PYTT, PYRT, SPLR, QRTZ, ORCL, BOTT, PLGC, SRCT, EPDT	Orebodies are irregular zones tens to hundreds of meters across.	Yan and others (1980); Li (1993).
China	Yangjiatan (Hunan)	27 28 N	111 44 E	Vein	Metasedimentary rocks; DEV–JUR.	CRET?	PAL–MES–CEN orogenic belt	Contact aureole of CRET granite pluton?	SCLT, QRTZ	—	Carter and Kiilsgaard (1983).
China	Yaogangxian (Hunan)	25 39 N	113 18 E	Vein/skarn	Sandstone; DEV. Granite; JUR (175 Ma).	JUR	PAL–MES–CEN orogenic belt	Contact aureole of JUR granite stock.	WLFM, QRTZ, SCLT, FLRT, SLPD, BRYL	—	Li and Wang (1955); Editorial Committee of the Mineral Deposits of China (1992); Li (1993).
China	Yochang district (Guangdong)	25 07 N	113 22 E	Vein	Granite; JUR. Sandstone, shale; PERM.	JUR	PAL–MES–CEN orogenic belt	JUR granite pluton and associated country rocks.	WLFM, QRTZ	—	Li and Wang (1955).
Czech Republic	Cinovec (Severocesky Kraj)	50 44 N	13 43 E	Vein/stockwork/ disseminated	Granite; Cinovec granite cupola; PERM.	PERM	PAL orogenic belt	Apical part of PERM granite cupola.	CSTR, WLFM, QRTZ, ZNWD, TOPZ, ADLR, MSCV, FLRT	—	Stemprok (1986).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

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Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Czech Republic	Krasno (Zapadocesky Kraj)	50 06 N	12 48 E	Disseminated/ vein/stockwork	Granite; Hub stock; PERM	PERM	PAL orogenic belt	Apical part of PERM granite cupola.	CSTR, WLFM, QRTZ, TOPZ, ZNWD, CLCP, SPLR, ARPR	—	Stemprok (1986).
France	Costabonne (Pyrenees-Orientales)	42 31 N	02 31 E	Skarn	Marble/skarn; Canaveille series; CAMB?	PERM	PAL orogenic belt	Contact aureole of PERM granodiorite intrusion.	SCLT, GRNT, PRXN, ACNL, QRTZ, FLRT, PYRT, SPLR, MLBD, BSMN	—	Burnol and Delille (1986).
France	Fumade (Tarn)	43 39 N	02 29 E	Skarn	Limestone, siltstone, dolomite; Serie Noire; CAMB.	PENN–PERM (280 Ma)	PAL collision zone	Contact aureole of PENN–PERM granite intrusion.	SCLT, GRNT, VSVN, PYRT, PYTT, SPLR, ARPR	—	Safa and others (1987).
France	Montbelleux (Ille-et-Vilaine)	48 20 N	01 11 W	Vein/stockwork	Granite; ORD (K-Ar: 475–450 Ma). Schist; PREC?	ORD	PAL collision zone	ORD granite pluton and associated country rocks.	WLFM, CSTR, QRTZ, TOPZ, PYRT, SPLR, CLCP, APTT, SCLT, MLBD	—	Chauris and Guigues (1969).
France	Montredon-Labessonnié (Tarn)	43 44 N	02 21 E	Vein/stockwork	Mica schist; MCAMB. Orthogneiss; MCAMB.	PENN–PERM	PAL collision zone	Contact aureole of PENN–PERM granite intrusion.	WLFM, CSTR, QRTZ, FLDP, FLRT, BRYL, PYRT, ARPR, MRCS, CLCP, SPLR, STNT, BSMT, BSMN	Some possible strata-bound deposits (Auriole and L'Hom-Haut) also present in general area.	Béziat and others (1980).
France	Salau (Ariege)	42 45 N	01 08 E	Skarn	Limestone/skarn; serie de Salau; ORD.	CARB?	PAL collision zone	Contact aureole of CARB? granite intrusion.	SCLT, PYTT, ARPR, APTT, GRNT, HDBG, CLCP, BSMN, SPLR, AMPB, MSCV, EPDT	—	Derré (1979).
Guatemala	Ixtahuacan (Huehuetenango)	15 27 N	91 51 W	Vein	Shale, sandstone; Tactic formation; PENN–PERM.	QUAT?	CEN convergent plate margin	Anticline cut by faults.	STBN, SCLT, PYRT, QRTZ	Deposit related to QUAT volcanic center 4 km to the south?	Collins and Kesler (1969).
India	Agargaon (Maharashtra)	21 06 N	79 29 E	Vein/stockwork	Tourmaline breccia, tourmaline schist, chlorite schist; Sakoli group; MPROT.	M–LPROT	Intracratonic	Aureole of M–LPROT granite?	FRBR, SCLT, QRTZ, MGNT, CLCP, PYRT, PYTT, SPLR, FLRT	Deposit is 1,400 m long, 10–115 m wide, and more than 100 m deep.	Lokras and others (1981).
India	Degana (Rajasthan)	26 56 N	74 20 E	Vein/stockwork	Granite; Malani group; LPROT (Rb-Sr: 735±30 Ma). Phyllite; Delhi supergroup; PREC.	LPROT	Intracratonic	LPROT granite pluton and associated country rocks.	WLFM, QRTZ, FLRT, BOTT, PYRT, CLCP, TOPZ	Eluvial placer deposits occur in gravels below bedrock deposits.	Dekate (1967).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Japan	Akenobe mine (Hyogo Prefecture)	35 13 N	134 41 E	Vein	Sandstone, slate, chert, greenstone; Tamba formation; CARB–PERM. Diorite.	LCRET–ETERT	MES–CEN orogenic belt	Folded CARB–PERM sedimentary rocks above a suspected LCRET–ETERT granite pluton.	CSTR, WLFM, SCLT, QRTZ, FLRT, CLCC, CLRT, EPDT, CLCP, SPLR, GLEN, ARGT	—	Imai and others (1975).
Japan	Kaneuchi mine (Kyoto Prefecture)	35 13 N	135 25 E	Vein	Shale, chert/hornfels; Tamba formation; CARB–PERM.	CRET (91.2±3.7 Ma)	MES–CEN orogenic belt	Contact aureole of CRET granite batholith.	WLFM, SCLT, QRTZ, CSTR, ARPR, CLCC, MLBD, PYRT, PYTT, SPLR, MSCV, TRML, ORCL, APTT, CLCC, SDRT	—	Shibue (1984).
Japan	Kuga (Yamaguchi Prefecture)	34 03 N	132 00 E	Skarn	Limestone; Kuga group; TRI.	CRET	MES–CEN orogenic belt	Axial crest of anticlinorium.	SCLT, CLCP, PYTT, SPLR, CSTR, HDBG, GRNT, AMPB, QRTZ, FLRT	—	Higashimoto (1977).
Japan	Otani mine (Kyoto Prefecture)	35 02 N	135 45 E	Vein	Biotite granodiorite; CRET (93.0±3.7 Ma).	CRET (92–90 Ma)	MES–CEN orogenic belt	Greisenized CRET granodiorite intrusion.	SCLT, CSTR, QRTZ, PYTT, ARPR, PYRT, CLCP, SPLR, STNT, BSMN, BSMT, MSCV, FLRT, CLCC	—	Nakamura and Kim (1982).
Japan	Yaguki mine (Fukushima Prefecture)	37 14 N	140 43 E	Skarn	Limestone; Yaguki limestone; CARB.	CRET	MES–CEN orogenic belt	Contact aureole of CRET granodiorite intrusion.	CLCP, SCLT, GRNT, MGNT, HDBG, PYTT	Tungsten-bearing skarn orebodies occur independently of copper-bearing skarn orebodies within the mine area?	Nishiwaki and others (1960).
Japan	Kiwada mine (Yamagata Prefecture)	—	—	Skarn	Granitic rocks.	CRET	MES–CEN orogenic belt	—	SCLT, SPLR, PYTT, HDBG, GRNT, FLRT	—	Murakoshi and Hashimoto (1956); Ohmachi (1977).
Japan	Takatori mine (Ibaraki Prefecture)	—	—	Vein	Granitic rocks, metamorphosed sediments.	CRET	MES–CEN orogenic belt	—	SCLT, SPLR, MLBD, CLCP, QRTZ, PYRT, FLRT, BSMN	—	Murakoshi and Hashimoto (1956); Ohmachi (1977).
Mexico	Beltran (Baja California)	31 58 N	116 00 W	Skarn	Limestone, shale; LPAL	MES–CEN	MES–CEN orogenic belt	Contact aureole of MES–CEN granite.	SCLT, GRNT, DPSD, VSVN, PYRT, PYTT, CLCP, ARPR	—	Fries and Schmitter (1945).
Mexico	Inguaran (Michoacán)	18 53 N	101 38 W	Breccia pipe	Breccia; OLIGO (35.6±0.8 Ma).	OLIGO (35.6±0.8 Ma)	MES–CEN orogenic belt	Breccia pipe in CRET granodiorite batholith.	SCLT, QRTZ, EPDT, TRML, CLRT, CLCC, CLCP, PYRT	The A-B pipe is principal orebody.	Sawkins (1979).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

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Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Mexico	Naica (Chihuahua)	27 51 N	105 34 W	Skarn	Limestone; Aurora formation; CRET.	OLIGO (26 Ma)	MES–CEN orogenic belt	Contact aureole of felsite dikes.	SCLT, PYRT, GLEN, ARPR, PYTT, CSLT, MTLD, MLBD, WLST, GRNT, HDBG, VSVN	Scheelite occurs in skarn orebodies referred to as silicate-rich “mantos”; tungsten is byproduct.	Ruiz and Barton (1985).
Mexico	San Alberto (Sonora)	27 17 N	108 56 W	Skarn	Limestone; PERM	PALEO (56.4 Ma)	MES–CEN orogenic belt	Contact aureole of PALEO granite pluton.	SCLT, CLCP	—	Anstett and others (1985).
Mexico	San Antonio (Sonora)	29 43 N	110 10 W	Skarn	Carbonate rocks with pelitic interbeds; PERM?	EO (46.6 Ma)	MES–CEN orogenic belt	Contact aureole of LCRET–ETERT granitic intrusion.	SCLT, ADRD, AMPB, EPDT	—	Dunn and Burt (1979).
Mexico	Washington (Sonora)	30 20 N	110 23 W	Breccia pipe	Breccia; EO	EO (46 Ma)	MES–CEN orogenic belt	Subvolcanic breccia pipe related to small granite pluton.	SCLT, PYRT, CLCP, MLBD, TRML, QRTZ	—	Simmons and Sawkins (1983).
Mongolia	Buren-Tsogto mine (Suhbaatar Province)	46 43 N	111 45 E	Vein	Greisenized granite; LJUR. Sedimentary rocks.	LMES	PAL–MES orogenic belt	Greisenized LJUR granite and associated country rocks.	WLFM, QRTZ, MLBD, BRYL	Closed	Wagner and Berthold (1979).
Mongolia	Khovd Gol mine (Bayan-Olgiy Province)	48 50 N	89 56 E	Vein	Granite	—	—	—	WLFM, SCLT	Closed	—
Mongolia	Tsagaan-Dava mine (Tov Province)	48 10 N	106 06 E	Vein quartz	Granite; MES? Sandstone; LJUR.	MES?	PAL–MES orogenic belt	MES? granite and associated country rocks.	QRTZ, WLFM	Closed	Ivanova (1974).
Mongolia	Ulaan Uul mine (Bayan-Olgiy Province)	49 16 N	90 14 E	Vein quartz	Granite	—	—	—	WLFM, QRTZ, MLBD	Closed	—
Mongolia	Yugozyr mine (Suhbaatar Province)	45 54 N	115 24 E	Disseminated(?)	—	—	—	—	WLFM, MLBD	Closed	—
Namibia	Brandberg West (Omaruru District)	21 14 S	14 37 E	Vein/stockwork	Schist, quartzite; Damara system; LPROT.	MES	Intracratonic	Contact aureole of MES granite intrusion?	WLFM, CSTR, QRTZ	Ratio of WO_3 to Sn is approx. 1:2.	Pelletier (1964).
Namibia	Krantzberg (Omaruru District)	21 24 S	16 01 E	Vein/disseminated	Greisenized granite; Salem granite; LPROT. Biotite schist; Khomas series; LPROT.	MES	Intracratonic	Greisen zones related to MES granite.	WLFM, QRTZ, TOPZ, ORCL, MSCV, TRML, FLRT, PYTT, ARPR, CLCP, PYRT, MGNT, MLBD, BSMN	Ore zones are irregular lenses up to 100 m long by 100 m wide.	Haughton and others (1939).
Namibia	Otjima	21 11 S	16 00 E	Unknown	Schist; marble	PROT	—	—	SCLT	Total reserves with 3 percent $CaWO_4$.	—
North Korea	Changseong district (North P’yongan Province)	40 33 N	125 15 E	Vein	Metamorphic rocks	CRET	MES–CEN orogenic belt	CRET granite intrusion?	WLFM, SCLT, QRTZ	—	Kim and Hwang (1983).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
North Korea	Ganggye district (Tschagang Province)	41 05 N	126 40 E	Vein	Schist	JUR	MES–CEN orogenic belt	Contact aureole of JUR granite intrusion?	WLFM, QRTZ, MLBD	—	Kim and Hwang (1983).
North Korea	Gogsan Mannjon district (North Hwanghae Province)	38 56 N	126 57 E	Vein	Granite, granodiorite. Intrusion of granite = Tantschon complex (JUR) in mica schist and granitic gneiss (ARCH).	JUR	MES–CEN orogenic belt	JUR granite intrusion.	WLFM, QRTZ, SCLT, MGNT, FLRT	Veins are 4 km long, dipping to SW, with 30–65 degrees; average thickness of veins is 1 m.	Häusser (1987).
North Korea	Jangdok (South P’yongan Province)	39 15 N	126 40 E	Unknown	—	—	—	—	—	—	Häusser (1987).
North Korea	Kymgang (Kangwon Province)	38 42 N	127 58 E	Vein/stockwork/ skarn (scheelite skarn)	Cambrian marble and schist in contact with ECRET granitoids.	ECRET	MES–CEN orogenic belt	ECRET granite-quartz diorite intrusion.	SCLT, QRTZ, BOTT, FLRT, WLFM, MLBD, BSMN	Orebodies 0.4–7 m thick, 450–700 m long.	Häusser (1987).
North Korea	Sangnong (South Hamgyong Province)	40 38 N	128 43 E	Contact-metasomatic deposit (strata-bound, disseminated)	Tourmaline schist, quartz biotite schist, sillimanite schist (EPROT) in contact with granite (Jwon complex).	JUR	MES–CEN orogenic belt	Contact of granite	CLCP, ARPR, PYRT, MGNT, SCLT, TRML	Cu-Au deposit; TRML is a byproduct; tungsten could be mined as a byproduct; orebody is 3 km long and 400 m wide.	Lesch (1984).
North Korea	Shinheung (South Hamgyong Province)	40 17 N	127 40 E	Vein	Schist	JUR	MES–CEN orogenic belt	Contact aureole of JUR granite intrusion?	WLFM, QRTZ, MLBD, CLCP	—	Kim and Hwang (1983).
North Korea	Tahyng (Kjongsu) (South P’yongan Province)	40 11 N	126 47 E	Vein	Intrusion of granite = Tantschon complex (JUR) in mica schist and granitic gneiss (ARCH).	JUR	MES–CEN orogenic belt	Contact aureole of JUR granite intrusion.	WLFM, QRTZ, SLPD of Cu, Te, Pb, Zn, SCLT, MGMT, FLRT	—	Kim and Hwang (1983); Häusser (1987).
Peru	Morococha (Junin)	11 36 S	76 07 W	Vein/replacement	Limestone, Pucara formation; JUR. Andesite, rhyolite, pyroclastics; Catalina volcanics; PERM.	TERT	MES–CEN convergent plate margin	Contact aureole of TERT granite intrusion.	SCLT, WLFM, QRTZ, PYRT, SPLR, GLEN, CLCP, TNNT, TRDR, FLRT, PYTT, MLBD, RDCR, RDNT, ADRD, BRNT	Tungsten is a byproduct.	Petersen (1965).
Peru	Palca Once (Puno)	14 46 S	69 40 W	Vein	Shale, limestone, sandstone; CRET.	MIO (8 Ma)	MES–CEN convergent plate margin	Contact aureole of MIO rhyolite stocks.	FRBR, SCLT, QRTZ	Scheelite not recovered.	Willig and Delgado (1985).
Peru	Pasto Bueno (Ancash)	08 08 S	77 42 W	Vein	Greisenized granite; Consuzo stock; MIO (9.5±0.2 Ma). Shale, quartzite; MES.	MIO	MES–CEN convergent plate margin	MIO granite intrusion and associated country rocks.	HBNR, SPLR, TRDR, SLPD, BRNT, PYRT, FLRT, QRTZ	Tungsten-bearing quartz veins range from 0.5 to 10 m wide and up to several hundred meters long.	Landis and Rye (1974).
Peru	San Cristobal (Junin)	11 43 S	76 05 W	Vein	Phyllite; Excelsior group; DEV. Andesite, rhyolite, pyroclastics; Catalina volcanics; PERM.	TERT	MES–CEN orogenic belt	Contact aureole of TERT granite pluton.	WLFM, PYRT, QRTZ, CLCP, SPLR, GLEN, BRNT, CRBN	Tungsten is a byproduct.	Campbell and others (1984).
Portugal	Arouca (Aveiro)	40 54 N	08 03 W	Vein/stockwork	Beira schist; PREC–CAMB. Regoufe granite; PENN–PERM.	PENN–PERM	PAL orogenic belt	Contact aureole of PENN–PERM granite intrusion.	WLFM, CSTR, QRTZ, ARPR, BRYL, TRML, MSCV, SPLR	—	Sluijk (1963).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Portugal	Borralha (Vila Real and Braga)	41 41 N	07 49 W	Vein/stockwork	Schist, chert, quartzite; SIL. Granite; PENN–PERM.	PENN–PERM	PAL orogenic belt	PENN–PERM granite intrusion and associated country rocks.	WLFM, SCLT, QRTZ, TRML, MSCV, MLBD, BSMN, ARPR, CLCP, GLEN, ALBT, APTT, CRBN	Ratio of wolframite to scheelite is 80:20.	Conde and others (1971).
Portugal	Covas (Viana do Castelo)	41 54 N	08 37 W	Skarn	Limestone/skarn; ORD	PENN–PERM	PAL orogenic belt	Contact aureole of PENN–PERM granite intrusion.	WLFM, SCLT, VSVN, ACNL, TRML, GRLR, DPSD, EPDT, QRTZ, PYTT, ARPR, PYRT	At least eight orebodies present in Covas area.	Reynaud (1982).
Portugal	Panasqueira (Beira Baixa)	40 09 N	07 45 W	Vein	Schist, quartzite; Beira schist; PREC–CAMB. Granite; Panasqueira granite; PENN–PERM (K-Ar: 290–289 Ma).	PENN–PERM	PAL orogenic belt	Contact aureole of PENN–PERM granite intrusion.	WLFM, ARPR, CLCP, MRCS, PYRT, PYTT, SPLR, STNT, CSTR, GTHT, QRTZ, CLCC, MSCV, TRML	Mineralized quartz veins are horizontal; occur over an area 4 by 2 km.	Kelly and Rye (1979).
Portugal	Santa Leocadia (Viseu)	41 08 N	07 30 W	Skarn	Limestone; Bateiras formation; CAMB.	LPAL	PAL orogenic belt	Contact aureole of LPAL granite.	SCLT	—	Reynaud (1982).
Rwanda	Gifurwe	01 39 S	29 51 E	Vein/stockwork	Graphite schist; Urundi group; PROT.	LPROT	Intracratonic	Folded graphite schist.	QRTZ, FRBR	—	De Kun (1965).
Rwanda	Lutsiro (Kabaya District)	01 55 S	29 26 E	Vein	Schist; granite	MPROT	—	—	WLFM, QRTZ	Numerous pegmatites, quartz veins, and alluvial and eluvial deposits.	—
Rwanda	Nyakabingo	01 52 S	29 28 E	Vein/stockwork	Shale; quartzite	MPROT	—	—	FRBR, TNST, QRTZ	—	—
Saudi Arabia	Baid al Jimalah (Najd)	25 09 N	42 41 E	Vein/stockwork	Porphyritic microgranite; LPROT. Metasiltstone, metasandstone/hornfels; Murdama group; PROT.	LPROT	Intracratonic	Small pluton of LPROT microgranite and associated hornfels.	QRTZ, WLFM, FLDP, FLRT, QRTZ, MSCV, CSTR, STNT, PYRT, ARPR, PYTT, CLCP, BRNT, GLEN, BSMN, STBN, MLBD	Investigated in detail and declared not economically exploitable.	Lofts (1986).
Saudi Arabia	Bi’r Tawilah (Najd)	22 44 N	42 43 E	Vein/stockwork	Porphyritic biotite granite; LPROT. Sericite schist; As Siham formation; PROT.	LPROT	Intracratonic	Small pluton of LPROT granite and associated hornfels.	QRTZ, WLFM, CSTR, ARPR, PYRT, GLEN, SPLR, CLCP, STNT, TRDR, FLRT	Investigated in detail and declared not economically exploitable.	Sabir and Labbé (1986).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Saudi Arabia	Jabal Marya	18 31 N	42 51 E	Strata-bound	—	MPROT	—	—	WLFM, HBLD, SCLT	Investigated in detail and declared not economically exploitable.	Gaukroger (1984).
South Africa	Orange River East (Northern Cape Province)	28 32 S	20 30 E	Vein	Paragneiss; Toeslaan formation; MPROT. Paragneiss; Grunau formation; MPROT. Granite Gneiss; Keimoes suite; MPROT.	MPROT (940±50 Ma)	Intracratonic	Ultrametamorphic; contact aureole of pegmatitic granite.	SCLT, WLFM, CSTR, MLBD, QRTZ, TRML, FLRT, ARPR, SLMN	More than 20 widely scattered deposits and occurrences in district.	Coetzee (1976).
South Africa	Orange River West (Northern Cape Province)	28 56 S	17 53 E	Vein	Metabasalt/meta-andesite; Orange River group; EPROT (1,996±15 Ma). Tonalite; Vioolsdrif suite; EPROT (1,900±30 Ma).	MPROT (960±40 Ma)	Intracratonic	Ultrametamorphic; related to regional development of pegmatites.	SCLT, MLBD, CLCP, QRTZ, TRML, FLDP, EPDT	More than 50 scheelite occurrences in district.	—
South Africa	Riviera	32 42 S	18 43 E	Unknown	Granite	PROT	—	—	SCLT, MLBD, PYTT, PYRT, QRTZ, CLCT, SRCT, KLNT	—	—
South Africa	Shangoni (Northern Cape Province)	23 13 S	30 54 E	Vein/disseminated	Schist; Giyani group; ARCH.	ARCH	Intracratonic	Related to granite pluton?	SCLT, QRTZ, BOTT, TMLT, TRML	Scheelite associated with deposits of emerald.	—
South Africa	Wallekraal (Northern Cape Province)	28 20 S	16 52 E	Vein	Graywacke; Gariep complex; LPROT.	LPROT (585 Ma)	Subducted continental margin	Contact aureole of LPROT granite.	SCLT, QRTZ	Two sites of mineralized veins about 1.5 km apart.	—
South Africa	Wolfram Schist (Northern Cape Province)	29 35 S	17 50 E	Vein	Schist; Khurisberg subgroup; MPROT (1,231±33 Ma).	MPROT (980±22 Ma)	Intracratonic	Ultra-metamorphic/plutonic.	FRBR, SCLT, MLBD, PYRT, QRTZ	Scheelite occurs in accessory amounts only.	Coetzee (1976).
South Africa	Zaaiplaats (Northern Cape Province)	24 03 S	28 45 E	Disseminated/pipes	Granite; Bobbejaankop granite; EPROT (1,920±40 Ma).	EPROT (1,920±40 Ma)	Intracratonic	Upper part of granite pluton.	CSTR, SCLT, FLRT, TRML, SRCT	Scheelite recovered sporadically as a byproduct of tin mining.	Strauss (1954).
South Korea	Bu-Duck (Kyonggi Province)	—	—	Vein?	—	—	MES–CEN orogenic belt	—	SCLT, WLFM	—	—
South Korea	Dae Hwa (North Ch’ungch’ong Province)	37 05 N	127 48 E	Vein	Granite gneiss; PREC.	CRET (88±2 Ma)	MES–CEN orogenic belt	Contact aureole of CRET granite pluton.	WLFM, MLBD, SCLT, CSTR, BRYL, CLCP, BSMN, PYTT, SPLR, GLEN, QRTZ, FLRT, SDRT, DLMT, CLCT	Deposit consists of more than 20 quartz veins.	So, Shelton, and others (1983).
South Korea	Dal Sung mine (North Kyongsang Province)	35 47 N	128 40 E	Vein/breccia pipe	Andesite, rhyolite, agglomerate; LCRET.	LCRET?	MES–CEN orogenic belt	Brecciated volcanic rocks intruded by LCRET? monzonite.	WLFM, SCLT, CLCP, PYRT, SPLR, BSMN, BSMT, GOLD, QRTZ, SDRT	Mineralized veins and veinlets occur in pipe-shaped breccia body.	Chung (1975).
South Korea	Okbang mine (North Kyongsang Province)	36 55 N	129 08 E	Pegmatite	Amphibolite; PREC. Gneiss; Wonnam gneiss; PREC.	JUR?	MES–CEN orogenic belt	Pegmatite occurs near contact of JUR? granite.	SCLT, QRTZ, PLGC, BOTT, HBLD, FLRT, PYRT, PYTT, CLCT	Orebodies consist of scheelite-rich pockets in pegmatite.	Chung (1975).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

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Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
South Korea	Sangdong mine (Kangwon Province)	37 09 N	128 49 E	Skarn	Metasedimentary rocks; Myobong slate; ECAMB.	CRET (84±3 Ma)	MES–CEN orogenic belt	Folded metasedimentary rocks.	SCLT, WLFM, BSMN, QRTZ, DPSD, GRNT, EPDT, HBLD, SRCT, CLCT, FLRT, APTT	"Main vein" is 1,500 m long, 1,500 m downdip, and 3.5–5 m thick.	Chung (1975).
South Korea	Sannae mine (South Kyongsang Province)	35 36 N	128 58 E	Vein	Biotite granite; LCRET?	LCRET (65±2 Ma)	MES–CEN orogenic belt	LCRET granite pluton.	WLFM, SCLT, CLCP, QRTZ	—	Chung (1975).
South Korea	Ssang Jeong mine (North Kyongsang Province)	37 18 N	129 11 E	Vein	Buncheon granitic gneiss; PREC. Hornblende schist; Wonnam formation; PREC.	CRET?	MES–CEN orogenic belt	PREC metamorphic rock.	WLFM, ARPR, SCLT, PYRT, CLCP, BRNT, QRTZ, FLRT	Deposit consists of quartz vein associated with barren pegmatite.	So, Shelton, and Rye (1983).
South Korea	Weolag mine (North Ch'ungch'ong Province)	36 53 N	128 08 E	Vein	Hornfels/calc-silicate rocks; Samtaesan formation; LPROT–MCAMB. Granite; Weolag granite; CRET.	CRET	MES–CEN orogenic belt	Carbonate-rich sedimentary rocks intruded by CRET granite.	WLFM, SCLT, MLBD, BSMN, BSMT, SPLR, GLEN, CLCP, PYRT, PYTT, QRTZ, FLRT, DLMT, SDRT, CLCT	Three ore zones consist of parallel quartz veins.	So, Rye, and Shelton (1983).
Former Soviet Union	Agylky (Sachal Yakutia)	64 30 N	137 00 E	Skarn	Shales, limestone; ETRI	MES	—	—	SCLT, CLCP, SLPD	Mineralized zone at the river "Agylky" is 1,200 m long and 4.5 m thick.	Chernov (1993); Il'in and others (1992); Shishigin and others (1994).
Former Soviet Union	Akchatau (Dzhezkazgan Oblast, Kazakh S.S.R.)	47 55 N	72 15 E	Disseminated(?)	Granite; Akchatau complex; PERM. Sandstone; SIL.	PERM	PAL orogenic belt	PERM granitic intrusion.	WLFM, MLBD, QRTZ, PYRT, SCLT, BSMT, SPLR, CLCP, CSTR, MSCV, TOPZ, FLRT, TRML, BOTT, FLDP	Some vein zones up to 20 m thick; they are traced to a depth of 500 m.	Smirnov (1977); Beskin and others (1996a,b).
Former Soviet Union	Antonovogorsk (Chita Oblast, R.F.S.R.)	50 55 N	115 45 E	Vein	Granite; Kukul'bey intrusions; LJUR. Shale, sandstone; JUR.	LJUR	MES–CEN orogenic belt	LJUR granite intrusion.	WLFM, PYRT, QRTZ, MSCV, FLRT, CRBN, PYTT, CLCP, SPLR, GLEN, MLBD, BSMN, SCLT	Series of parallel quartz veins 800–1,000 m long.	Smirnov (1977).
Former Soviet Union	Balkany (Chelyabinsky Oblast, R.F.S.R.)	53 27 N	59 35 E	Skarn	Sedimentary rocks; MPAL	PENN–PERM	PAL orogenic belt	Contact aureole of PAL granite.	SCLT, MLBD, PYRT, CLCP	One of the Gumbeiskiy group of deposits.	Buros and Wagner (1978).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Former Soviet Union	Bayan (Kokchetau Oblast, Kazakh S.S.R.)	—	— NW. of Kokchetau	Scheelite/skarn vein poligene/ polichrone	Granite/granodiorite; LCARB–PERM. Metasomatic greisen.	CARB–PERM	PAL orogenic belt	CARB–PERM granodiorite-granite intrusion.	SCLT, MLBD, BSMT, CLCP, CSTR, QRTZ, MCSV, EPDT	Large deposit	—
Former Soviet Union	Belukha (Chita Oblast, R.F.S.R.)	51 15 N	116 30 E	Vein/stockwork	Quartz diorite, granite; Kukul'bey intrusions; LJUR.	LJUR	MES–CEN orogenic belt	LJUR granite intrusion.	WLFM, MLBD, BSMT, QRTZ, MCCL, ALBT, SRCT, FLRT, SCLT	More than 100 quartz-wolframite veins; stockwork zones also present.	Barabanov (1961).
Former Soviet Union	Boguty (Almaty Oblast, Kazakh S.S.R.)	43 21 N	78 18 E	Scheelite/ stockwork	Sandstone; MORD. Granite; M–LDEV.	SIL–DEV	PAL orogenic belt	Contact aureole of SIL–DEV granite pluton in ORD sandstone.	SCLT, WLFM, MLBD, QRTZ, MSCV, CLCP, GLEN, PYRT, TRML, FLRT, ORCL	Deposit is a stockwork zone 1,600 m long and up to 200 m wide.	Smirnov (1977); Panova and Gavrilenko (1996).
Former Soviet Union	Bom-Gorkhon (Buryat A.S.S.R., R.F.S.R.)	51 08 N	109 25 E	Vein	Granite; Bom-Gorkhon granite massif; EJUR.	EJUR	MES–CEN orogenic belt	Contact aureole of EJUR granite intrusion.	HBNR, SCLT, QRTZ, PYRT, SPLR, FLRT, CLCP, MLBD, HMTT, CSTR	Veins are up to 3 m wide; average is 1 m.	Smirnov (1977).
Former Soviet Union	Bukuka (Chita Oblast, R.F.S.R.)	51 15 N	116 30 E	Vein/stockwork	Greisenized granite; Kukul'bey intrusion; LJUR. Sandstone, shale; MJUR.	LJUR	MES–CEN orogenic belt	LJUR granite intrusion.	WLFM, MLBD, QRTZ, BSMT, SPLR, GLEN, SRCT, FLRT, SCLT	More than 80 quartz wolframite veins; two stockwork zones.	Smirnov (1977).
Former Soviet Union	Dedosa Gora (Chita Oblast, R.F.S.R.)	50 15 N	114 20 E	Disseminated(?)/ vein	Granite	MES	—	—	WLFM	—	Rabchevsky (1988).
Former Soviet Union	Dzhida district (Buryat A.S.S.R., R.F.S.R.) Inkura mine Kholtoson mine Murr mine	50 10 N	103 28 E	Vein/stockwork/ placer	Metasedimentary and metavolcanic rocks; Khokhyurtovka group; LCAMB. Quartz diorite, granodiorite; SIL–DEV.	LJUR (140 Ma)	PAL–MES orogenic belt	Contact aureole of LJUR granite intrusion.	HBNR, PYRT, QRTZ, GLEN, SPLR, CSTR, CLCP, SCLT, TRDR, FLRT, MCCL, SRCT, ANKR	Includes Pervomaisk, Kholtoson, Inkura, Gudzhir, and Malo-Kholtoson deposits.	Smirnov (1977).
Former Soviet Union	Festivallnoye (Khabarovsk Kray)	50 35 N	136 36 E	Skarn/vein	Granite	LCRET	—	—	CSTR, CLCC, WLFM, SLPD	Many separate orebodies.	Rabchevsky (1988).
Former Soviet Union	Ingichka (Samarkand Region, Uzbekh A.S.S.R.)	39 50 N	65 50 E	Skarn	Limestone/marble; LSIL	M–LCARB	PAL orogenic belt	Contact aureole of M–LCARB granite pluton.	SCLT, GRNT, PRXN, WLST, VSVN	Deposit consists of at least 22 separate orebodies.	Smirnov (1977).
Former Soviet Union	Kalgutin (R. Gorno Altay, Z.F.S.S.R.)	88 40 N	49 42 E	Disseminated(?)	Granite porphyry; DEV	ECARB	—	—	WLFM, MLBD, SLPD	High mountain region	Il'in and others (1992).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

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Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Former Soviet Union	Karaoba (Dzhezkazgan Oblast, Kazakh S.S.R.)	47 16 N	72 15 E	Vein/stockwork/ greisen	Granite; Kulchinsk intrusion; PERM. Quartz porphyry, tuff; DEV?	PERM?	PAL orogenic belt	PERM? granite intrusion.	WLFM, PYRT, MLBD, CSLT, CSTR, BSMT, QRTZ, MSCV, FLRT, SDRT, CLCC, TOPZ, ALBT	—	Buros and Wagner (1978).
Former Soviet Union	Kit-Teberda (Karachay-Cherkess Autonomous Oblast, R.F.S.R.)	43 27 N	41 28 E	Vein	Schist, gneiss; PROT. Granite; Ullumkam granite; PERM (K-Ar: 270–250 Ma).	PERM (270–250 Ma)	PAL–MES–CEN collision zone	Contact aureole of PERM granite intrusion.	SCLT, ARPR, PYRT, GLEN, PYTT, WLFM, SPLR, CLCP, QRTZ, FLDP	—	Buros and Wagner (1978).
Former Soviet Union	Koktenkol (Dzhezkazgan Oblast, Kazakh S.S.R.)	— 120 km SW. of Karaganda City	—	Mo-W stockwork; skarn/ scheelite ore and weathering zone ore	Granite; LCARB. Sedimentary and volcanic rocks; carbonate, terrigenous rocks; LDEV.	CARB/PERM	PAL orogenic belt	CARB/PERM granite intrusion.	MLBD, SCLT, QRTZ, BSMN, CLCP, BRYL, CLAY	—	Mazurov (1996a).
Former Soviet Union	Lermontovsky (Primor'ye Kray, R.F.S.R.)	46 35 N	134 45 E	Skarn(?)	Granite; JUR	—	—	Granite stock	SCLT, diff SLPD	—	Rabchevsky (1988).
Former Soviet Union	Lyangar (Sydar'ya Region, Uzbek S.S.R.)	40 35 N	65 50 E	Skarn	Limestone/skarn; MPAL	LPAL	PAL orogenic belt	Contact aureole of LPAL granite intrusion.	SCLT	—	Buros and Wagner (1978).
Former Soviet Union	Magadan region, Russian S.F.S.R. Iul'tin mine Svetloye mine Tenkergin mine	67 43 N	178 56 E	Vein	Shale, sandstone, conglomerate; Iul'tin group; LPERM. Granite; Iul'tin massif; CRET.	CRET	MES–CEN orogenic belt	Contact aureole above CRET granite intrusion.	WLFM, QRTZ, MSCV, ALBT, FLRT, CSTR, ARPR, CLCP, PYRT, PYTT	More than 100 orebodies have been identified; some placer deposits also?	Smirnov (1977).
Former Soviet Union	Maykhura (Kulyab Oblast, Tajik S.S.R.)	39 10 N	68 30 E	Skarn	Limestone, slate; MPAL	PERM	PAL orogenic belt	Contact aureole of PERM granite intrusion.	SCLT, PYTT, QRTZ, CLCP, MRMT, ADRD, HDBG, CLRT, WLFM, CSTR, ZNWD	—	Buros and Wagner (1978).
Former Soviet Union	Severny Katpar (Dzhezkazgan Oblast, Kazakh S.S.R.)	— 152 km S. of Karaganda City	—	Skarn/greisen	Sandstone, siltstone conglomerate; LDEV. Granite; LCARB.	CARB/PERM	PAL orogenic belt	Contact aureole of granite pluton.	SCLT, MLBD, CLCP, PYRT, QRTZ, CLCT, FLDP	—	Mazurov (1996b).
Former Soviet Union	Shumilovskoye (Chita Oblast, R.F.S.R.)	50 10 N	109 57 E	Disseminated(?)	Granite porphyry; CRET	MES	—	—	WLFM	Synonym: "Chikoy"	Rabchevsky (1988).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Former Soviet Union	Spokoinyi (Chita Oblast, R.F.S.R.)	51 55 N	112 09 E	Disseminated	Greisenized granite; Spokoinyi granite; MES.	MES	PAL–MES orogenic belt	MES granite cupola.	WLFM, PYTT, QRTZ, TOPZ, MSCV, SPLR, CLCP, BMTT, CSTR, SCLT, FLRT, TRML, APTT	Mineralized zones are 1–2 to 30 m thick.	Smirnov (1977).
Former Soviet Union	Tyrnyauz (former Kabardin-Balkar A.S.S.R., R.F.S.R.)	43 25 N	42 45 E	Skarn	Limestone; LDEV. Biotite hornfels; LDEV.	CRET	PAL–MES–CEN collision zone	Contact aureole of CRET granite intrusion.	SCLT, MLBD, PWLT, PLGC, PRXN, GRNT, SLPD, CLCC, QRTZ, FLRT	Approximately 20 orebodies occur over an area 1,600 m by 500 m and to a depth of 900 m.	Smirnov (1977).
Former Soviet Union	Verkhne-Kayrakty (Dzhezkazgan Oblast, Kazakh S.S.R.)	— 140 km S. of Karaganda City	—	Scheelite/ stockwork	Sandstone, siltstone conglomerate; LSIL, MDEV.	CARB/PERM	PAL orogenic belt	Contact scheelite-bearing stockwork of granite pluton.	SCLT, WLFM, BSMT, MLBD, QRTZ, MSCV, FLRT, BOTT, FLDP, PYRT	Largest tungsten deposit in world.	Russkikh and Shatov (1966).
Former Soviet Union	Vostok-2 (Primor'ye Kray, R.F.S.R.)	45 55 N	135 35 E	Skarn(?)	Limestone, hornfels; LPERM.	LCRET	—	Contact along a stock.	SCLT diff SLPD	Ore is in three veins 10 m thick, 475 m long, and 650 m deep.	Rabchevsky (1988).
Former Soviet Union	Yubileinoye (Leninabad Region, Tadzhik S.S.R.)	—	—	Unknown	—	—	—	—	—	—	—
Spain	Barruecopardo (Salamanca Province)	41 08 N	06 31 W	Vein/stockwork	Granite; EPERM	EPERM	PAL orogenic belt	Greisenized EPERM granite.	SCLT, WLFM, QRTZ, MSCV, ARPR, PYRT, CLCP, MLBD, CSTR, TRML, TOPZ, FLRT, ORCL	Scheelite is the predominant tungsten mineral.	Arribas (1979).
Spain	La Parilla (Badajoz/ Caceres Provinces)	39 10 N	05 54 W	Vein/stockwork	Slate, conglomerate; PREC.	EPERM?	PAL orogenic belt	Contact aureole of PERM granite pluton?	SCLT, CSTR, QRTZ, MSCV, ARPR, WLFM, TRML	Scheelite is the predominant tungsten mineral.	Anstett and others (1985).
Spain	Los Santos (Salamanca Province)	40 33 N	05 48 W	Skarn	Limestone; ECAMB	LPAL	PAL orogenic belt	Contact aureole of LPAL granodiorite intrusion.	SCLT, CLPX, PLGC, CLZS, GRNT, PYRT, PYTT, ARPR, CLCP, SPLR, GLEN, LLNG, BSMN	Deposit consists of three orebodies: Las Cortinas, Los Santos, and Los Santos South.	—
Spain	Santa Comba (La Coruna Province)	43 02 N	08 49 W	Vein/dissem-inated	Granite, aplite; LPAL	LPAL	PAL orogenic belt	LPAL granite cupola.	WLFM, CSTR, QRTZ, ARPR, PYRT, TRML	Wolframite occurs in quartz veins and disseminated in aplite.	Gouanvic and Gagny (1983).
Spain	Silleda (Pontevedra Province)	42 52 N	08 33 W	Vein	Granite; LPAL	LPAL	PAL orogenic belt	LPAL granite intrusion.	WLFM, CSTR, QRTZ	—	—

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Sudan	Jebel Eyob (Red Sea Hills)	18 00 N	36 12 E	Vein/stockwork	Granite; PROT	PROT	Intracratonic	PROT granite intrusion.	WLFM, SCLT, QRTZ	Wolframite- and scheelite-bearing quartz vein stockworks in greisenized granite over area of 1 sq km; potential reserves large.	Ahmed (1979).
Sweden	Yxsjoberg (Orebro Province)	60 06 N	15 00 E	Skarn	Limestone; PROT	PROT	Intracratonic	Contact aureole of PROT granite intrusion.	SCLT, FLRT, CLCC, CLCP, PYTT, GRNT, CLPX	Deposit consists of three separate orebodies.	Ohlsson (1979).
Thailand	Doi Mok (Chiang Rai Province)	19 24 N	99 34 E	Skarn/vein	Limestone; SIL–DEV. Biotite granite; TRI–JUR.	TRI–JUR	MES orogenic belt	Contact aureole of TRI–JUR granite pluton.	SCLT, ARPR, PYRT, CLCP, PYTT, GLEN, TRML, FLRT, CLCC, QRTZ, GRNT	Scheelite occurs in skarn and to a lesser extent in quartz veins in granite.	Charoensri (1983).
Thailand	Doi Than Ngoam (Phrae Province)	18 08 N	99 51 E	Vein/stockwork/ breccia	Shale, siltstone, sandstone, minor limestone; Lampang group; TRI. Granite; MES.	CRET	MES orogenic belt	Contact aureole of CRET granite pluton.	FRBR, STBN, CLCP, QRTZ, FLRT	—	Charoensri (1983).
Thailand	Khao Soon mine (Nakhon Si Thammarat Province)	09 21 N	99 23 E	Vein/stockwork/ breccia	Altered metasedimentary rocks; Kanchanaburi series; PAL.	LCRET	MES orogenic belt	Contact aureole of LCRET granite pluton.	FRBR, PYRT, QRTZ, STBN, MRCS	—	Charoensri (1983).
Turkey	Uludag (Bursa Province)	40 12 N	29 04 E	Skarn/stockwork	Brecciated marble; PAL. Brecciated granite; MES–TERT.	MES–TERT	MES–CEN orogenic belt	Contact aureole of MES–CEN granite-granodiorite intrusion.	SCLT, WLFM, QRTZ, FLRT, MGNT, SPLR, GRNT, HMTT, BSMN, MLBD, CLCC, PYRT	Part of ore occurs as wolframite-bearing quartz veins in granite below the skarn deposit.	Karahan and others (1980).
Uganda	Nyamolilo (Kigezi District)	01 47 S	29 52 E	Strata-bound	Shale, phyllite; Karagwe-Ankolean system; PREC.	PREC	Intracratonic	Thin quartz veins in PREC meta-sedimentary rocks.	FRBR, QRTZ, KLNT	Ferberite is pseudomorphous after scheelite.	Reedman (1973).
United Kingdom	Carrock (Cumbia)	54 41 N	03 03 W	Vein	Slate/hornfels; Skiddaw slate; ORD (470 Ma). Granite/greisenized granite; Skiddaw granite; EDEV (399 Ma). Gabbro; Carrock gabbro; EDEV (399 Ma).	DEV (385 Ma)	PAL orogenic belt	EDEV granite pluton and contact aureole.	WLFM, SCLT, QRTZ, ARPR, PYRT, PYTT, CLCC, DLMT	Mineralized veins concentrated in greisen adjacent to Skiddaw granite.	Shepherd and others (1976).
United Kingdom	Hemerdon (Devon)	50 25 N	04 00 W	Stockwork	Hemerdon granite; LCARB (310–300 Ma). Slate; DEV.	PERM (270 Ma)	PAL orogenic belt	LCARB granite intrusion.	WLFM, CSTR, QRTZ, KOLN, MICA	Mineralized granite is strongly kaolinized, causes problems in beneficiation.	Dines (1956).
United Kingdom	Redmoor (Cornwall)	50 31 N	04 19 W	Stockwork	Slate; DEV. Granite; Kit Hill granite; LCARB (310–300 Ma).	PERM (270 Ma)	PAL orogenic belt	Contact aureole of LCARB granite intrusion.	WLFM, CSTR, TRML, QRTZ, MICA, ARPR	Vein/stockwork associated with greisenized country rock.	Dines (1956).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
United States	Andrew mine (California)	34 15 N	117 41 W	Placer	—	PREC	—	—	—	—	—
United States	Brown's Lake (Montana)	45 31 N	112 50 W	Skarn	Carbonate-rich shale, siltstone; Amsden formation; MISS–PENN. Monzogranite; PALEO–OLIGO.	PALEO–OLIGO	MES–CEN orogenic belt	Contact aureole of PALEO–OLIGO monzogranite intrusion.	SCLT, PWLT, CLCP, GRNT, EPDT, QRTZ, MGNT	Local thick glacial moraine cover.	Pattee (1960).
United States	Climax mine (Colorado)	39 22 N	106 11 W	Porphyry	Rhyolite and granite porphyries; Climax stock; OLIGO.	OLIGO	CEN intracratonic rift	Fractured OLIGO rhyolite/granite porphyry stock.	MLBD, HBNR, CSTR, MNZT, QRTZ, PYRT, SRCT, TOPZ, FLRT	Huebnerite, cassiterite, pyrite, and monazite are byproducts.	Wallace and others (1968).
United States	Hamme district (Tungsten Queen mine) (North Carolina)	36 31 N	78 28 W	Vein	Granodiorite, tonalite; CAMB (595–520 Ma). Phyllite; LPROT–CAMB.	CAMB	PAL orogenic belt	Shear zone near phyllite-CAMB granodiorite contact.	HBNR, SCLT, FLRT, QRTZ, PYRT, CLCP, GLEN, SPLR, SRCT, MLBD, RDCR	—	Parker (1963).
United States	Indian Springs (Nevada)	41 37 N	114 15 W	Skarn/stockwork/vein	Sandstone, limestone, Pequop formation; PERM. Monzogranite; Indian Springs stock; ECRET (135 Ma).	ECRET (135 Ma)	MES–CEN orogenic belt	Contact aureole of ECRET granite stock.	SCLT, PWLT, PYRT, MGNT, QRTZ, GRNT, CLCP, MLBD	—	Slack (1972).
United States	Mill City district (Nevada)	40 47 N	118 08 W	Skarn	Limestone, Raspberry formation; LTRI. Granodiorite, Springer stock; CRET (K-Ar: (78.4±2.9 Ma).	CRET (72.0±2.6 Ma)	MES–CEN orogenic belt	Contact aureole of CRET granite stock.	SCLT, MLBD, CLCP, PYRT, DPSD, GRNT, EPDT, QRTZ	—	Kerr (1934).
United States	Nevada Scheelite (Nevada)	39 02 N	118 19 W	Skarn	Limestone, Excelsior formation; MTRI. Granite-granodiorite; LJUR.	LJUR	MES–CEN orogenic belt	Contact aureole of LJUR granite pluton.	SCLT, CLCP, ADRD, CLCC, QRTZ, AMPB, EPDT, PRXN, WLST, PYRT, MGNT	—	Ross (1961).
United States	Pilot Mountain district (Nevada)	38 23 N	117 53 W	Skarn	Limestone, Luning formation; LTRI. Granodiorite; Gunmetal stock; CRET (K-Ar: 83.4±3.1 Ma). Granodiorite; Desert Scheelite stocks; CRET (K-Ar: 80.4±2.9 Ma).	CRET	MES–CEN orogenic belt	Contact aureole of CRET granodiorite stocks.	SCLT, CLCP, SPLR, PYRT, GRNT, PRXN, QRTZ, AMPB	—	Grabher (1984).
United States	Pine Creek mine (California)	37 23 N	118 43 W	Skarn	Marble; Pine Creek marble; PAL. Hornfels, Pine Creek hornfels; PAL. Monzogranite; Morgan Creek quartz monzonite; CRET.	CRET	MES–CEN orogenic belt	Contact aureole of CRET granite intrusion.	SCLT, CLCP, MLBD, GRNT, PRXN, QRTZ, AMPB, PLGC	—	Newberry (1982).
United States	Searles Lake (California)	35 45 N	117 20 W	Brine	Searles Lake brines; QUAT	QUAT	MES–CEN orogenic belt	Salt flat	Precipitated salts of complex mixture	Searles Lake brines contain approximately 70 ppm W.	Altringer and others (1979).

Table 9. Selected geologic and location information from ISMI records for tungsten deposits and districts—Continued.

[Most abbreviations used in this table are defined in table 8. K-Ar, potassium-argon date; Rb-Sr, rubidium-strontium date; —, not reported on the ISMI record form. Host rock includes some or all of the following items (separated by semicolons): main host rock type; formation name; and host rock age]

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
United States	Strawberry mine (California)	37 31 N	119 18 W	Skarn	Hornfels, marble; LJUR. Granodiorite, MCRET.	MCRET	MES-CEN orogenic belt	Contact aureole of MCRET granodiorite pluton.	SCLT, DPSD, WLST, EPDT, GRNT, QRTZ, PYRT, SPLR, CLCP, MLBD	—	Nokleberg (1981).
United States	Tem Piute district (Nevada)	37 38 N	115 38 W	Skarn	Limestone; MISS. Limestone, hornfels; Pilot shale; DEV–MISS.	CRET (90 Ma)	MES-CEN orogenic belt	Contact aureole of CRET granite pluton.	SCLT, FLRT, SPLR, GRNT, QRTZ, CLCC, PYRT, PYTT, DPSD, EPDT	—	Tschanz and Pampeyan (1970).
Vietnam	Da Tria (Lam Dong Province)	12 03 N	108 41 E	Disseminated(?)	Granite; CRET. Andesite, dacite tuff; LJUR, ECRET.	CRET	MES–CEN collision zone	Contact of porphyric granite.	CSTR, QRTZ, SLPD, TRLM	—	United Nations ESCAP (1990).
Vietnam	Pia Oac district (Cao Bang Province, Tonkin)	22 37 N	105 51 E	Vein/stockwork/ placer	Shale; PAL. Rhyolite, TRI. Granite, Pia Oac complex; CRET.	CRET	MES–CEN collision zone	Contact aureole of CRET granite intrusion.	WLFM, QRTZ, CSTR, SPLR, GLEN, MLBD, ARPR, FLRT, TRML	—	Fontaine and Workman (1978).
Vietnam	Tam Dao district (Bac Thai Province) with Da Liem	21 38 N	105 43 E	Scheelite-skarn (placer: Sn) (vein: Sn)	Effusive and intrusive rocks (TRI, CRET) in sedimentary rocks of ORD and SIL age.	CRET (TRI?)	MES–CEN collision zone	Contact of intrusive rocks.	SCLT, WLFM, CSTR, SLPD, TRML, QRTZ, PYRT, CLCP, CSTR, ARPR, BSMN	—	United Nations ESCAP (1990).
Zaire	Bishasha	01 39 S	28 53 E	Vein	Schist, quartz veins associated with granites; small greisen mineralization.	MPROT	—	—	WLFM, CSTR, MLBD, CLMB, TRML, QRTZ	—	—
Zaire	SOMINKI (Kivu)	02 32 S	26 35 E	Vein/stockwork/ placer	Granite; LPROT. Metasedimentary rocks, Kibara group; PROT. Sediments; CEN.	LPROT	Intracratonic	PROT granite and associated country rocks.	QRTZ, CSTR, WLFM, TNTL, SLPD	—	Anthoine and others (1968).
Zimbabwe	Beardmore (Bikita District)	19 58 S	31 28 E	Vein/skarn	Chlorite schist; Bulawayan system; ARCH.	ARCH	Intracratonic	Contact aureole of ARCH granite intrusion.	SCLT, EPDT, QRTZ, SDRT, ACNL, QRTZ, CLCC, GRNT, VSVN	—	Martin (1964).
Zimbabwe	Chiredzi-Chipinage district	21 00 S	32 10 E	Vein/stockwork	Basalt; Karoo system; TRI	TRI	Intracratonic	Contact aureole of TRI granite intrusion.	SCLT, WLFM, QRTZ, SDRT, CLCC, EPDT, PYRT, CLCP, GLEN, SPLR, FLRT, STBN	—	Swift and others (1953).

Country	Site name	Latitude	Longitude	Deposit type	Host rock	Age of mineralization	Tectonic setting	Local environment	Principal mineral assemblages	Comments	Reference
Zimbabwe	R.H.A.	18 30 S	26 38 E	Stockwork	Schist	PROT–PAL	—	—	WLFM, QRTZ	—	—
Zimbabwe	Scheelite King	17 29 S	30 54 E	Vein	Tonalite	ARCH	—	—	SCLT, PYRT, PYTT, CLCP, MLBD, GRNT, CLCC, QRTZ	—	—

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Algeria	Laouni deposit (Adrar Renaissance District)	1959	U	1960’s	W (WLFM, SCLT), Sn	None	—	15; R1E + R1M; WO_3; 1963?	Climate extreme and distance from infrastructure prohibitive.
Argentina	Los Avestruces-Las Asperezas (San Luis)	—	U	1910’s?	W (SCLT, WLFM), Bi	—	297; 67.5 percent WO_3; 1936–39, 1940–49, 1952–54	50; R1E; 0.5 percent WO_3; 1985. 2,000; R2E; 0.6 percent WO_3; 1985	—
Argentina	Los Condores-El Aguila (San Luis)	1897	U	1897?	W (FRBR, WLFM), Bi	—	10,097.8; 68.3 percent WO_3; 1897–1918, 1939–49, 1951–60, 1961–63, 1965–79?	1,500; R1M + R1S + R2S; 0.50 percent WO_3; 1984	—
Australia	Kara (Tasmania)	—	S	1977	W (SCLT), Fe	281; 57.2 percent WO_3; 1980–84	1,754; 58.5 percent WO_3; 1977–84	1,610; R1E; 0.82 percent WO_3; 1982. 259; R1E; 0.51 percent WO_3; 339; R2S; 0.92 percent WO_3; 438; R1S; 0.8 percent WO_3; 254; R1S; 0.83 percent WO_3	Only operating mine in Australia where scheelite is produced as a byproduct of iron ore mining.
Australia	King Island (Tasmania)	1911	U	1911	W (SCLT), Mo	1,770; WO_3; 1980–84	41,808; W; 1911–84	7,140; R1E; 1.0 percent WO_3; 1984. 2,181; R1S; 1.0 percent WO_3; 893; R1S; 0.9 percent WO_3; 616; R1S; 0.9 percent WO_3; 500; R1S; 0.89 percent WO_3	Showings found 1904. Operated as an open-pit mine 1917–74.
Australia	Molyhil (Northern Territory)	1971	S	1974	W (SCLT), Mo	146; 37 percent WO_3; 1979–81	438; 45 percent WO_3; 1974–81	1,800; R1S; 0.6 percent WO_3, 0.3 percent MoS_2; 1983. 600; R2S; 0.2 percent WO_3, 0.3 percent MoS_2; 1979	Last production in 1981.
Australia	Mount Carbine (Queensland)	1895	S	1896	W (SCLT, WLFM)	1,646; 68.2 percent WO_3; 1980–84	16,694; 68.8 percent WO_3; 1895–1984	13,000; R1E; 0.1 percent WO_3; 1983. 8,400; R2S; 0.12 percent WO_3	Mine closed 1958–68, 1968–71, and 1986.
Australia	Mount Mulgine (Western Australia)	1914	U	1914	W (SCLT), Mo, Ag, Au	—	—	37,000; R1S; 0.19 percent WO_3; 1980. 37,000; R2S; 0.19 percent WO_3; 24,000; R2S; 0.079 percent WO_3; 1,573; R2S; 0.54 percent WO_3	Last production in 1922 (for Mo).
Australia	Sunnymount (Queensland)	—	U	1979 (W)	Sn, W (WLFM)	54; W; 1980–84	298; W; 1979–84	6.1; R1M; 1 percent Sn, 0.35 percent W; 1984. 45.2; R2S; 0.3 percent W; 1984. 66; R1S; 0.37 percent WO_3	Mine closed in 1984.
Australia	Torrington (New South Wales)	1883	U, S	1883	W (WLFM), Sn, Bi, F (TOPZ)	50; 65 percent WO_3; 1977–80	2,555; 65 percent WO_3; 1890–1980	6,000; R1S; 0.215 percent WO_3, 0.07 percent Bi, 17 percent topaz; 1982. 10,000; R2S; 0.2 percent WO_3, 0.07 percent Bi, 17 percent topaz; 1982	Mine closed in 1980.
Australia	Watershed Grid (Queensland)	1978	N	None	W (SCLT)	None	None	—	Mine closed.
Australia	Wolfram Camp (Queensland)	1894	U, S	1894	W (WLFM)	47; W; 1979–84	11,000; 65 percent WO_3; 1894–1971. 475; W; 1974–84	—	Mine closed in 1984.

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Austria	Mittersill mine (Salzburg)	1967	S, U	1976	W (SCLT), Mo, Bi	1,450; W; 1980–83	12,692; W; 1975–84	4,500; R1E; 0.5 percent WO$_3$; 1981	—
Bolivia	Bolsa Negra (La Paz)	1900–09?	U, S	1910’s	W (FRBR, SCLT)	121; W; 1980–84	22,339; WO$_3$; 1908–84	1,512; R1E; 0.78 percent WO$_3$; 1984. 1,000; R2E; 0.8 percent WO$_3$; 1978	Known producer in World War I (1914–18).
Bolivia	Chambillaya (La Paz)	—	U	1912	W (FRBR)	181; W; 1980–84	26,864; WO$_3$?; 1912–84	120; R1E; 0.6 percent WO$_3$; 1985	Considerable tonnage potential.
Bolivia	Chicote Grande (La Paz)	1910’s	S, U	1910’s	W (WLFM), As	—	29,000; WO$_3$?; 1908–77	21,200; R1M; 0.43 percent WO$_3$; 1985	—
Bolivia	Chojlla (La Paz)	—	U	1918	W (WLFM), Bi, Mo	446; W; 1980–84	31,384; WO$_3$?; 1908–84	1,495; R1E; 0.54 percent WO$_3$; 1985	—
Bolivia	Chorolque (Potosi)	1875	U	—	W (WLFM), Sn, Bi	—	—	—	Tonnage potential large but low grade (byproduct only).
Bolivia	Enramada-Liliana (La Paz)	—	U	1910’s	W (WLFM), Sn	373; W; 1980–84	29,858; WO$_3$?; 1908–84	472; R1E; 0.80 percent WO$_3$; 1985	—
Bolivia	Kami (Cochabamba)	—	U	1908	W (WLFM)	539; W; 1980–84	24,864, WO$_3$?; 1908–84	288; R1E; 0.65 percent WO$_3$; 1985. 600; R1; 0.97 percent WO$_3$; 1983.	—
Bolivia	Pueblo Viejo (Potosi)	—	U	1914	W (WLFM)	188; W; 1980–84	1,334; W; 1975–84	110; R1E; 1.09 percent WO$_3$; 1985	—
Bolivia	Reconquistada (La Paz)	—	U	1910’s	W (WLFM)	—	600; WO$_3$?; 1908–77	335; R1E; 1.27 percent WO$_3$; 1979. 300; R2E; 1.0 percent WO$_3$; 1979	—
Bolivia	Tazna (Potosi)	—	U	1910’s	W (WLFM), Sn, Bi, Cu, Au, Zn	377; W; 1980–84	2,141; W; 1975–84	1,038; R1E; 1.41 percent WO$_3$; 1984	—
Bolivia	Viloco (La Paz)	1902	U	—	W (WLFM), Sn	12; W; 1980–84	14,132; WO$_3$?; 1908–77	51; R1M; 1.23 percent WO$_3$; 1985	—
Brazil	Bodo/Barra Verde/ Boca de Lage mines (Rio Grande do Norte)	1942	U	1942	W (SCLT)	264; 72.5 percent WO$_3$; 1977–94	43,500; 72.5 percent WO$_3$; 1942–94	8,750; R1E + R2E; 0.36 percent WO$_3$; 1994	—
Brazil	Pedra Prata (Para)	1980	S	—	W (WLFM)	—	—	325; R1; 1.1 percent WO$_3$; 1985	Depleted.
Burma	Heinze Basin (Mon State)	—	S (placer)	1929	Sn, W (WLFM, SCLT)	—	—	32; R1 + R2; W; 1970’s	—
Burma	Mawchi mine (Kayah State)	1900–09	U	1910	W (WLFM, SCLT), Sn	—	11,731; W; 1930–41; 1948–49	600; R1; 0.5 percent WO$_3$, 0.9 percent SnO$_2$; 1983	—
Burma	Mergui district (Mon State)	1905	U, S	1908	W (WLFM), Sn	—	—	—	Estimated to contain 7,000 metric tons of tin-wolframite concentrate and to have had an annual output of 100 t of W concentrate in 1970–75.

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Burma	Tavoy district (Tanintharyi Division)	—	U, S (placer)	1909	W (WLFM, S), Sn	—	—	—	An important producer of tin-tungsten concentrate.
	Hamyingyi mine	—	U	1980	W, Sn	—	—	90: R1;1.04 percent WO_3	Operating.
	Heinda mine	—	—	—	—	—	—	—	—
	Kanbank mine	—	—	—	—	—	—	—	—
	Yadanabon mine	—	S	1980	W, Sn	—	—	7; R1; WO_3	Operating.
Canada	Bailey (Yukon Territory)	1974	N	None	W (SCLT), Cu	None	None	405; R1S; 1.00 percent WO_3; 1981	—
Canada	Burnt Hill (New Brunswick)	1910 (W)	U	1916	W (WLFM), Sn, Mo	—	63; W conc; 1916–18, 1955–57	1,500; R1S; 0.875 percent WO_3; 1965	Year of last production 1957.
Canada	Cantung (Northwest Territories)	1959 (S); 1972 (U)	S, U	1962	W (SCLT), Cu, Bi, Zn	2,865; W; 1983	3,830,000; 1.53 percent WO_3; 1962–85	1,400; R1E; 1.24 percent WO_3; 1986	Mine closed in 1986.
Canada	Fostung (Ontario)	1981	N	None	W (SCLT), Mo	None	None	16,200; R1S; 0.23 percent WO_3, 0.016 percent MoS_2; 1986	—
Canada	Grey River (Newfoundland)	1965	N	None	W (WLFM)	None	None	360; R1S; 1.09 percent WO_3; 1985. 160; R2S; 1.09 percent WO_3; 1985	—
Canada	Lened (Northwest Territories)	1977	N	None	W (SCLT), Cu	None	None	750; R1M; 1.17 percent WO_3, 0.15 percent Cu; 1986	—
Canada	Logtung (Yukon Territory)	1977	N	None	W (SCLT), Mo	None	None	162,000; R1S; 0.13 percent WO_3, 0.052 percent MoS_2; 1984	—
Canada	Mactung (Yukon and Northwest Territories)	1971	N	None	W (SCLT), Mo	None	None	25,401; R1M; 0.88 percent WO_3; 1986. 57,000; R1M + R1S + R2S; 0.96 percent WO_3; 1981	—
Canada	Mar (Yukon Territory)	1979	N	None	W (SCLT)	None	None	5,400; R1M + R1S; 0.82 percent WO_3; 1986	—
Canada	Mount Pleasant (New Brunswick)	1969 (W)	U	1984	W (WLFM), Mo	—	—	9,350; R1M; 0.393 percent WO_3, 0.204 percent MoS_2; 1979. 28,600; R2S; 0.22 percent WO_3, 0.12 percent MoS_2; 1979. 2,400; R2S; 0.07 percent WO_3, 0.42 percent Sn, 0.05 percent MoS_2; 1979.	Year of last production 1985.
Canada	Risby (Yukon Territory)	1978	N	None	W (SCLT), Cu, Mo	—	—	2,700; R1S; 0.81 percent WO_3; 1982	—

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Chile	Copiapo (Atacama)	1950's	—	—	W (SCLT, WLFM)	None	None	—	Reserves of 8 million metric tons, grading 2 percent WO_3 inferred for 3 deposits (1982): Japonesa, Los Plomos, and Inca de Oro; data are of questionable reliability.
China	Bai Sha Po (Yunnan)	—	S	1980's?	W (WLFM), Sn, Cu, Bi	—	—	47,042; R1; 0.15 percent WO_3; 1983	May now (1986) be in production.
China	Dajishan (Jiangxi)	1918	U	1918	W (WLFM, SCLT), Bi, Mo	3,700; 65 percent WO_3	—	38,700; R1; 0.25 percent WO_3; 1983	—
China	Damingshan, Wuming (Guangxi)	1960's	—	1980's?	W (WLFM), Mo	None	None	13,962; R1; 1.04 percent WO_3; 1983	May now (1986) be in production. Percentages of WO_3 exceeding 0.3 percent may not represent Chinese sources of information.
China	Dayu district (Jiangxi)	1908	S, U	1914	W (WLFM), Mo, Sn, Cu, Bi	6,000; 65 percent WO_3; 1981	100,000; 65 percent WO_3; 1960–84	30,000; R1; 0.3 percent WO_3; 1983	Principal producing area in China.
	Baoshan	—	—	—	—	—	—	—	—
	Dalongshan	—	—	—	—	—	—	—	—
	Dangping	—	—	—	—	—	—	—	—
	Muzhiyuan	—	—	—	—	—	—	—	—
	Piaotang	—	—	—	—	—	—	—	—
	Xialong	—	—	—	—	—	—	—	—
	Xihuashan	—	—	—	—	—	—	—	—
	Zhandongkeng	—	—	—	—	—	—	—	—
China	Gueimeishan (Jiangxi)	1918	S, U	1918	W (WLFM)	—	—	2,175; R1; 2.20 percent WO_3; 1983	Percentages of WO_3 exceeding 0.3 percent may not represent Chinese sources of information.
China	Huangsha (Jiangxi)	1930's?	—	—	W (WLFM)	None	None	3,294; R1; 1.75 percent WO_3; 1983	Percentages of WO_3 exceeding 0.3 percent may not represent Chinese sources of information.
China	Hukeng (Jiangxi)	1950	U	1955	W (Zn, Bi)	1,000–2,000; 65 percent WO_3	30,000; 65 percent WO_3	10; R1; 0.3 percent WO_3; 1995	—
China	Jubankeng (Guangdong)	1955	—	—	W	—	—	100; R1M; 65 percent WO_3; 1980	Small-scale artisanal exploitation only.

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
China	Lianhuashan (Guangdong)	1950's	S	—	W (SCLT, WLFM)	—	—	40,000; R1; 1 percent WO_3; 1986	Tonnage estimated from deposit dimensions; grade reported by Chinese geologists.
China	Pangushan (Jiangxi)	—	U?	1922	W (WLFM, SCLT), Bi	—	—	1,528; R1; 1.90 percent WO_3; 1983	Percentages of WO_3 exceeding 0.3 percent may not represent Chinese sources of information.
China	Shangping (Jiangxi)	—	—	—	—	—	—	—	—
China	Shizhuyuan (Hunan)	1950's	U	1980's	W (WLFM, SCLT), Mo, Bi, Sn	Minor (some small-scale production)	—	190,000; R1M; 0.33 percent WO_3, 0.115 percent Sn, 0.06 percent Mo, and 0.122 percent Bi; 1980	The third largest known tungsten deposit in the world; 1996 production is small, from high-grade zones.
China	Ta'ergou (Gansu)	1965	—	—	W	—	—	3,500; R1M; 0.24 percent WO_3; (scheelite) 1985. 9,000; R1M; 1.3 percent WO_3; (wolframite) 1985	Small-scale artisanal exploitation only.
China	Wengyuan (Guangdong)	1910's	S, U	—	W (WLFM), Bi	—	—	359; R1; 1.90 percent WO_3; 1983	—
China	Xiangdong (Hunan)	—	U	—	W?	—	—	2,290; R1; 0.72 percent WO_3; 1983	—
China	Xingluokeng (Fujian)	—	S	—	W (WLFM, SCLT), Mo	—	—	78,000; R1; 0.23 percent WO_3; 1983	Possibly small amounts of production in the 1970's.
China	Yangchuling (Jiangxi)	1960's	U	—	W (SCLT), Mo	—	—	100,000; R1S; 0.2 percent WO_3; 1985	Possibly small amounts of production in the 1970's.
China	Yangjiatan (Hunan)	—	—	—	W (SCLT)	—	—	—	—
China	Yaogangxian (Hunan)	1911	U	1914	W (WLFM, SCLT), Cu	1,250; 65 percent WO_3; 1981	20,000; 65? percent WO_3; 1955–82	25; R1E; 65 percent WO_3; 1982	Indicated resources are for wolframite-bearing quartz veins; a large(?) scheelite-bearing skarn deposit has been outlined by diamond drilling (1982).
China	Yochang district (Guangdong)	1910's	S, U	—	W (WLFM)	—	—	488; R1; 1.90 percent WO_3; 1983	—
Czech Republic	Cinovec (Severocesky Kraj)	Pre-1900	U	Pre-1918	Sn, W (WLFM)	—	—	?; R1E; 0.3 percent WO_3; 0.3 percent Sn; 1965	Tungsten recovered as coproduct; grade reported by Moussu (1965); tonnage unknown.
Czech Republic	Krasno (Zapadocesky Kraj)	Pre-1900	S	—	Sn,W (W)	—	—	35,000; R1; 0.2 percent WO_3; 0.3 percent Sn; 1974	Tonnage and grade based on visual estimate by Taylor (1979). 1991 last production.

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
France	Costabonne (Pyrenees-Orientales)	1951	N	None	W (SCLT)	—	—	1,500; R1S; 0.35 percent WO_3; 1986	—
France	Fumade (Tarn)	1981	N	None	W (SCLT)	—	—	1,300; R1M; 1.1 percent WO_3; 1987	Resources present in two deposits, Fumade sensu stricto and La Fedial.
France	Montbelleux (Ille-et-Vilaine)	—	U	1902	W (WLFM), Sn	—	—	3,000; R1M; 0.25 percent WO_3, 0.12 percent Sn; 1983?	Mine closed in 1983.
France	Montredon-Labessonnié (Tarn)	1942	S	1955	W (WLFM)	—	80,000; 1.08 percent WO_3; 1955–60	1,420; R1M; 0.70 percent WO_3; 1980	Mine closed in 1960.
France	Salau (Ariege)	1960	U	1969	W (SCLT)	757; WO_3; 1982–84	12,000; WO_3; 1971–86	3; R1M; WO_3; 1986	Mine closed in 1986.
Guatemala	Ixtahuacan (Huehuetenango)	1968?	U	1968	W (SCLT), Sb	—	193; W; 1968–85	—	Tonnage and grade of reserves unknown; 22 metric tons of W concentrate produced in 1985.
India	Agargaon (Maharashtra)	1907	—	—	W (FRBR, SCLT)	—	—	2,200; R1S; 0.06 percent WO_3; 1981	Indian mining companies are reported to recover tungsten from relatively low grade materials.
India	Degana (Rajasthan)	1910's	S, U	1966	W (WLFM)	37; 65 percent WO_3; 1977–81	795; 65 percent WO_3; 1939–45; 1951–56; 1965–81	31; R1E; 0.54 percent WO_3; 1984. 4,015; R2S; 0.03 percent WO_3; 1984	Contained in “gravel deposits.”
Japan	Akenobe mine (Hyogo Prefecture)	1909 (W)	U	1936	Sn, W (WLFM, SCLT), Cu, Zn, Pb, Ag	—	—	—	Mine closed in 1987.
Japan	Kaneuchi mine (Kyoto Prefecture)	—	U	—	W (WLFM, SCLT)	76; W; 1977–79. 77; W; 1981. 43; W; 1982	1,390; W; 1974–79	—	Mine closed in 1982.
Japan	Kuga (Yamaguchi Prefecture)	—	U	1911? (W)	W (SCLT), Cu, Zn, Sn	158.9; 57.9 percent W; 1976–79. 148; WO_3; 1986. 56; WO_3; 1989. 57; WO_3; 1991. 125; WO_3; 1992	976; 58? percent W; 1974–79	—	Mine closed in 1993. In 1981, the plant treated 90 tpd of ore (55 percent WO_3); 15 tpd of scheelite concentrate (51 to 68 percent WO_3).
Japan	Otani mine (Kyoto Prefecture)	—	U	1912?	W (SCLT), Sn, Cu, Zn	297; 57.46 percent W; 1974–77. 212; W; 1978	1,915; 57.5 percent W; 1974–79, 1981	—	Mine closed in 1983.

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Japan	Yaguki mine (Fukushima Prefecture)	Pre-1900	U	1971	W (SCLT), Cu	269; 58.2 percent W; 1976–79. 200; WO_3; 1981–85	1,699; 58.2 percent W; 1974–79	8,000; R1; 1.15 percent Cu, ? percent WO_3; 1960	Mine closed in 1988. In 1981, the plant treated 21,000 metric tons of crude ore (0.76 percent WO_3) and produced 150 metric tons of marketable concentrate (74.3 percent WO_3) and 110 metric tons of low-grade concentrate (15–45 percent WO_3).
Japan	Kiwada mine (Yamagata Prefecture)	—	—	—	—	—	—	—	—
Japan	Takatori mine (Ibaraki Prefecture)	—	U	?	W(SCLT)	100; WO_3; 1978–85	—	—	Mine closed in 1985.
Mexico	Beltran (Baja California)	—	U	1917	W (SCLT)	—	98,000; 0.7 percent WO_3 (580.6; WO_3); 1917–19, 1937–43	—	—
Mexico	Inguaran (Michoacán)	—	U	1971	Cu, W (SCLT)	64.7; 64.2 percent WO_3; 1979	—	6,000; R1E; 0.04 percent WO_3, 1.2–1.5 percent Cu; 1976	Tungsten is byproduct.
Mexico	Naica (Chihuahua)	1970's?	U	1890's (W: 1980)	Ag, Au, Zn, Pb, Cu, W (SCLT)	“High-grade“ conc: 120; 1980–85. “Low-grade” conc: 360; 1980–85	—	7,500; R1E; 0.1 percent (tailings) WO_3; 1980. 4,600; R2E; 0.12 percent WO_3, 4.6 percent Pb, 3.9 percent Zn, 153 g/t Ag, 0.42 g/t Au; 1985	Tungsten is byproduct. Deposit discovered in 1794, but first worked for silver and base metals.
Mexico	San Alberto (Sonora)	1950's	S	1980's	W (SCLT)	30,000; 0.5 percent WO_3; 1980’s	—	1,500; R1E; 0.55 percent WO_3; 1985.	—
Mexico	San Antonio (Sonora)	1953	S, U	1953	W (SCLT)	—	—	—	—
Mexico	Washington (Sonora)	—	U	—	W (SCLT)	—	—	1,200; R1E; 0.14 percent WO_3, 1.71 percent Cu, 0.058 percent Mo, 0.172 g/t Au, 15.85 g/t Ag; 1983	—
Mongolia	Buren-Tsogto mine (Suhbaatar Province)	1944	U	1948	W (WLFM)	—	400,000; ore	—	Mine closed in 1979.
Mongolia	Khovd Gol mine (Bayan-Olgiy Province)	—	S	—	W	—	—	6; R1; WO_3	—

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Mongolia	Tsagaan-Dava mine (Tov Province)	1969	U	1988	W (WLFM)	195; 60 percent WO_3; 1989. 60; 65 percent WO_3; 1995	Ca 6,000; 60 percent WO_3; 1948–79	—	Mill operated for 6 months and was closed in 1989. Since 1996, production by Mongolian Co.
Mongolia	Ulaan Uul mine (Bayan-Olgiy Province)	—	U	—	W	—	—	3,200; R1; 2 percent WO_3	—
Mongolia	Yugozyr mine (Suhbaatar Province)	—	—	—	—	—	—	—	—
Namibia	Brandberg West (Omaruru District)	—	S	1933?	W (WLFM), Sn	150 est.; W; 1979	5,509.6; W; 1933?–80	2,400; R1; 0.2 percent WO_3, plus Sn; 1985	Production intermittent 1933?–80.
Namibia	Krantzberg (Omaruru District)	Pre-1938	U	1938?	W (WLFM), Sn	600; 70 percent WO_3; 1978	907; wolframite; 65? percent WO_3; 1938?–56	900; R1; 0.40 percent WO_3; 1982	Production 1938?–56; 1973–80.
Namibia	Otjima	—	—	—	W (SCLT)	—	—	5.4; R	Never exploited.
North Korea	Changseong district (North P'yongan Province)	—	—	—	W (WLFM, SCLT)	—	—	—	—
North Korea	Ganggye district (Tschagang Province)	—	—	Pre-1940	W (WLFM)	—	—	—	
North Korea	Gogsan Mannjon district (North Hwanghae Province)	—	—	1935	W (WLFM, SCLT), Mo	—	—	4,000; ore; 0.7–1.0 percent WO_3	—
North Korea	Jangdok (South P'yongan Province)	—	—	—	—	—	—	—	—
North Korea	Kymgang (Kangwon Province)	—	—	—	W (SCLT, WLFM, MLBD, BSMT)	—	—	—	—
North Korea	Sangnong (South Hamgyong Province)	—	—	—	W (WLFM)	—	—	—	—
North Korea	Shinheung (South Hamgyong Province)	—	—	—	W (WLFM)	—	—	—	—
North Korea	Tahyng (Kjongsu) (South P'yongan Province)	—	—	—	W (WLFM)	—	—	—	—
Peru	Morococha (Junin)	—	U	1964 (W)	Ag, Zn, Cu, W (SCLT, WLFM)	88; WO_3; 1984–85	800; WO_3; 1968–72, 1974–75	3,690; 0.20 percent WO_3; 1980	Deposit known pre-1634. Post-1976 production included in San Cristobal output.
Peru	Palca Once (Puno)	—	U	1979	W (FRBR)	161; WO_3; 1979–83	1,093; WO_3; 1979–83	1,000; R1E; 1.56 percent WO_3; 1985. 270; R2E; 1.29 percent WO_3; 1985	—

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Peru	Pasto Bueno (Ancash)	1900–09	U	1910	W (HBNR), Pb, Cu, Zn, Ag	375; WO_3; 1979–84	8,713; 65 percent WO_3; 1910–19, 1934–54. 7,862 est; W; 1955–84	1,100; R1; 0.44 percent WO_3; 1985	—
Peru	San Cristobal (Junin)	—	U	1964 (W)	Cu, Zn, Ag, W (WLFM)	15; WO_3; 1985	6,121; WO_3; 1968–72, 1974–85	5,800; R1E; 0.22 percent Cu, 1.1 percent Pb, 3.3 g/t Ag, 0.18 percent WO_3; 1983	1974–85 cumulative production also includes output from Morococha.
Portugal	Arouca (Aveiro)	1900–09	S	1910's?	W (WLFM)	—	240; 60 percent WO_3; 1917	—	—
Portugal	Borralha (Vila Real and Braga)	1900–09	U	1914	W (WLFM, SCLT), Cu, Ag	284; 70.2 WO_3; 1977–80	1,460; W; 1914, 1917, 1977–82	700; R1; 0.47 percent WO_3; 1983	Average annual production for wolframite and scheelite.
Portugal	Covas (Viana do Castelo)	—	S, U	—	W (SCLT)	34; 71.40 percent WO_3; 1977–80	135; 71.40 percent WO_3; 1977–80	689; R1E; 0.86 percent WO_3; 1982. 233, R2E; 0.56 percent WO_3; 1982	—
Portugal	Panasqueira (Beira Baixa)	1894	U	1898	W (WLFM), Sn, Cu, Ag, Zn	2,631; 75 percent WO_3; 1979–85	69,685; 72.55 percent WO_3; 1934–78. 14,427; 75 percent WO_3; 1979–86	6,100; R1; 0.36 percent WO_3; 1985	—
Portugal	Santa Leocadia (Viseu)	1970's	N	None	W (SCLT)	None	None	500; R1; 0.30 percent WO_3; 1982	—
Rwanda	Gifurwe	1926	S, U	1940	W (FRBR)	564; 69 percent WO_3; 1979–84	10,601; WO_3 1957–84	6; WO_3; 1984	—
Rwanda	Lutsiro (Kabaya District)	—	—	—	W (WLFM)	—	—	10; W	Intermittently producing.
Rwanda	Nyakabingo	—	—	—	—	—	—	—	—
Saudi Arabia	Baid al Jimalah (Najd)	1980	N	None	W (WLFM), Sn	None	None	10,000; R1S + R2S; 0.10 percent WO_3; 1986	Not commercial.
Saudi Arabia	B'ir Tawilah (Najd)	1982	N	None	W (WLFM), Sn, Ag	None	None	265; R1S; 0.69 percent WO_3; 1986	Not commercial.
Saudi Arabia	Jabal Marya	1982	N	None	W (WLFM)	None	None	—	Not commercial.
South Africa	Orange River East (Northern Cape Province)	Pre-1938	S, U	Pre-1938	W (SCLT, WLFM), Sn	12; 65 percent WO_3; 1966–70	312; 65 percent WO_3; 1939–70?	2,500; R1E; 0.38 percent WO_3, 0.21 percent Sn; 1984. 1; R2S; WO_3; 1984	Last production in 1970.
South Africa	Orange River West (Northern Cape Province)	Pre-1934	S, U	Pre-1934	W (SCLT)	22; W conc; 65 percent WO_3	—	1.9; R2S; WO_3; 1984	Last production in 1976.

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
South Africa	Riviera	—	—	—	W, MLBD	—	—	46; R; 0.22 percent WO_3; 0.02 percent Mo	Never exploited.
South Africa	Shongoni (Northern Cape Province)	1971	—	—	W (SCLT)	—	—	287; R1S; 0.51 percent WO_3; 1978	—
South Africa	Wallekraal (Northern Cape Province)	1968	S, U	1968	W (SCLT)	5; 65 percent WO_3; 1968–71	15; 65? percent WO_3; 1968–71	1; R2S; WO_3; 1984	Last production in 1971.
South Africa	Wolfram Schist (Northern Cape Province)	1938	S, U	1941	W (FRBR, SCLT)	108.1; 66 percent WO_3; 1941–56?	1,714; 65.47 percent WO_3; 1941–56?	—	Last production in 1956.
South Africa	Zaaiplaats (Northern Cape Province)	1906	S, U	1906	Sn, W (SCLT)	—	—	—	A tin producer, with occasional output of tungsten.
South Korea	Bu-Duck (Kyonggi Province)	—	U	1978	W (SCLT, WLFM), Ag, Cu, Au	—	—	—	Not in full production in 1983.
South Korea	Dae Hwa (North Ch'ungch'ong Province)	1902	U	1902	W (WLFM, SCLT), Mo	100; 70 percent WO_3; 1975	—	—	—
South Korea	Dal Sung mine (North Kyongsang Province)	1930's	U	1939 (W)	W (WLFM, SCLT), Cu	110; W conc; 55? percent WO_3; 1977	4,398; W conc; 55? percent WO_3; to 1973	—	A major Korean copper producer.
South Korea	Okbang mine (North Kyongsang Province)	1941 (W)	U	—	W (SCLT), F (fluorspar)	100; W conc; 70? percent WO_3	4,250; W conc; 70? percent WO_3; 1939–78	1,400; R1E; 0.8 percent WO_3; 1975	Registered as a gold mine in 1939.
South Korea	Sangdong mine (Kangwon Province)	1916	U	1927	W (SCLT, WLFM), Mo, Bi	Natural scheelite: 546; 79 percent WO_3; 1980–84. Synthetic scheelite: 415; 74 percent WO_3; 1980–84	15,000; W conc; 60 percent WO_3; 1916–54; 63,000 est., W; 1955–84	8,500; R1; 0.86 percent WO_3, 0.13 percent Bi; 1985	—
South Korea	Sannae mine (South Kyongsang Province)	—	U?	1966	W (WLFM, SCLT)	100; W conc; 70? percent WO_3; 1966–75	230; W conc; 70 percent WO_3; 1975, 1977–78	—	—
South Korea	Ssang Jeong mine (North Kyongsang Province)	—	—	—	W (WLFM, SCLT), Cu, Mo, Bi, Ni, Sn	Less than 100; 70 percent WO_3; 1975	109; W; conc; 70? percent WO_3; 1972, 1977–78	3,200; R1E; 0.41 percent WO_3, 0.025 percent MoS_2, 0.016 percent Bi; 1979	—
South Korea	Weolag mine (North Ch'ungch'ong Province)	—	U	—	W (WLFM, SCLT), Mo, Bi	—	1,128; W conc; 70? percent WO_3; to 1975, 1977–78	—	—

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Former Soviet Union	Agylky (Sachal Yakutia)	—	N	—	W (SCLT), Cu, Au	—	—	30.8; WO_3; 1.27 percent WO_3; 2,7 percent Cu	Reserve deposit.
Former Soviet Union	Akchatau (Dzhezkazgan Oblast, Kazakh S.S.R.)	1936	U	1941	W (WLFM), Mo, Be	NA	NA	2,741; R1; 0.50 percent WO_3; 1983. 65,500; 0.1–0.3 percent WO_3; 17,500; 0.04–0.07 percent Mo; 16,000; 0.03–0.07 percent Be	—
Former Soviet Union	Antonovogorsk (Chita Oblast, R.F.S.R.)	1910's	—	—	W (WLFM)	—	—	1,179; R1; 0.80 percent WO_3; 1983	—
Former Soviet Union	Balkany (Chelyabinsky Oblast, R.F.S.R.)	1920's	N	—	W (SCLT)	—	—	386; R1; 0.60 percent WO_3; 1983	—
Former Soviet Union	Bayan (Kokchetau Oblast, Kazakh S.S.R.)	—	—	—	W (SCLT), Mo (MLBD), Cu (CLCP)	—	—	—	In exploration; surface mining planned.
Former Soviet Union	Belukha (Chita Oblast, R.F.S.R.)	1916	U?	1916	W (WLFM)	—	—	1,181; R1; 0.60 percent WO_3; 1983	—
Former Soviet Union	Boguty (Almaty Oblast, Kazakh S.S.R.)	1941	—	—	W (SCLT), Mo (MLBD)	—	—	4,320; R1; 0.60 percent WO_3; 1983	Explored/reserve deposit; surface mining planned.
Former Soviet Union	Bom-Gorkhon (Buryat A.S.S.R., R.F.S.R.)	—	S	1971	W (HBNR, SCLT), Ta	9 percent of 1992 Russian conc prod when combined with Spokoinyi	—	400; R1; 1.00 percent WO_3; 1983	Orlovsky mining complex.
Former Soviet Union	Bukuka (Chita Oblast, R.F.S.R.)	1911	—	1915	W (WLFM)	—	—	958; R1; 0.60 percent WO_3; 1983	—

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Former Soviet Union	Dedosa Gora (Chita Oblast, R.F.S.R.)	—	—	—	—	—	—	—	—
Former Soviet Union	Dzhida district (Buryat A.S.S.R., R.F.S.R.)	—	—	—	—	—	—	10,910; R1; 0.43 percent WO_3; 1983	Dzhida tungsten and molybdenum complex.
	Inkura mine	—	S	—	W, Mo	11 percent of 1992 Russian conc prod when combined with Kholtoson	—	—	—
	Kholtoson mine	—	U	1941	W, Mo	11 percent of 1992 Russian conc when combined with Inkura	—	—	—
	Murr mine	1933	S, U?	1935	W (HBNR, SCLT)	—	—	—	—
Former Soviet Union	Festivallnoye (Khabarovsk Kray)	—	S	—	Sn, W, Cu, Pb	1 percent of 1992 Russian conc prod	—	—	Solnechny mining complex.
Former Soviet Union	Ingichka (Samarkand Region, Uzbekh A.S.S.R.)	?	U	1960	W (SCLT), Mo	NA	NA	2,866; R1; 0.43 percent WO_3; 1983	1941–47—exploration and development.
Former Soviet Union	Kalgutin (R. Gorno Altay, Z.F.S.S.R.)	—	—	—	W, Hg	1 percent of 1992 Russian conc prod	—	—	Aktash mining complex.
Former Soviet Union	Karaoba (Dzhezkazgan Oblast, Kazakh S.S.R.)	1938?	U	1951	W (WLFM), Mo (MLBD), Be, Nb, Ta, Se	NA	NA	204; R1; 0.80 percent WO_3; 1983	—
Former Soviet Union	Kit-Teberda (Karachay-Cherkess Autonomous Oblast, R.F.S.R.)	—	N	—	W(SCLT)	None	None	71.6; WO_3; R1; 0.35 percent WO_3	Reserve deposit (Chernov, 1993).
Former Soviet Union	Koktenkol (Dzhezkazgan Oblast, Kazakh S.S.R.)	1956	—	—	W (SCLT), Mo (MLBD), Cu (CLCP)	—	—	61,553; WO_3, 0.042 percent WO_3; 430,025; Mo, 0.071 percent Mo; 253,000; Cu, 0.042 percent Cu	Development, surface mining planned (Mazurov, 1996a).
Former Soviet Union	Lermontovsky (Primor'ye Kray, R.F.S.R.)	—	S	1974	W	37 percent of 1992 Russian conc prod when combined with Vostok-2	—	—	Lermontovsky mining complex.

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Former Soviet Union	Lyangar (Sydar'ya Region, Uzbek S.S.R.)	1928	—	1940's	W (SCLT), Mo	—	—	540; R1; 0.50 percent WO_3; 1983	1932–36—exploration and development; 1952—milling.
Former Soviet Union	Magadan region, Russian S.F.S.R.	—	—	—	—	—	—	1,505; R1; 0.8 percent WO_3; 1983	Iultinsky mining complex. Production ceased in 1994.
	Iul'tin mine	1937	U	1954	Sn, W	8 percent of 1992 Russian conc prod when combined with Svetloye & Tenkergin	—	—	—
	Svetloye mine	1983	U	—	Sn, W	8 percent of 1992 Russian conc prod when combined with Iul'tin & Tenkergin	—	—	—
	Tenkergin mine	1983	U	—	Sn, W	8 percent of 1992 Russian conc prod when combined with Iul'tin & Svetloye	—	—	—
Former Soviet Union	Maykhura (Kulyab Oblast, Tajik S.S.R.)	—	—	1978	W (SCLT, WLFM) Sn (CSTR)	—	—	5,000; R1; 0.40 percent WO_3; 1983	—
Former Soviet Union	Severny Katpar (Dzhezkazgan Oblast, Kazakh S.S.R.)	1973	—	—	W (SCLT), Mo (MLBD), Cu (CLCP)	—	—	73,000; WO_3, 0.239 percent WO_3; 13,000; Mo, 0.038 percent Mo; 55,700; Cu, 0.16 percent Cu	Explored/reserve deposit; surface mining planned (Mazurov, 1996b).
Former Soviet Union	Shumilovskoye (Chita Oblast, R.F.S.R.)	—	—	—	—	—	—	—	—

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Former Soviet Union	Spokoinyi (Chita Oblast, R.F.S.R.)	1939	S	—	W (WLFM), Ta	9 percent of 1992 Russian conc prod when combined with Bom-Gorkhon	—	1,000; R1; 0.50 percent WO_3; 1983	Orlovsky mining complex.
Former Soviet Union	Tyrnyauz (former Kabardin-Balkar A.S.S.R., R.F.S.R.)	1934	U, S	1938	W (SCLT), Mo, Cu, Bi	40 percent of 1992 Russian conc prod		50,800; R1; 0.60 percent WO_3; 1983	Tyrnyauz tungsten and molybdenum complex.
Former Soviet Union	Verkhne-Kayrakty (Dzhezkazgan Oblast, Kazakh S.S.R.)	1945	—	—	W (SCLT, WLFM), Mo (MLBD), Cu (CLCP)	—	—	1,100; R1; 0.128 percent WO_3, 0.004 percent Mo; 0.02 percent Cu	Largest tungsten deposit of the former Soviet Union, with 70 percent of total tungsten reserves (Russkikh and Shatov, 1996). Explored reserved deposit; surface mining planned.
Former Soviet Union	Vostok-2 (Primor'ye Kray, R.F.S.R.)	—	U	1968	W (SCLT), Cu, Mo	37 percent of 1992 Russian conc prod when combined with Lermontovsky	—	22,025; R1; 0.58 percent WO_3; 1983	Primorsky mining complex; “Wolfram.”
Former Soviet Union	Yubileinoye (Leninabad Region, Tadzhik S.S.R.)	—	U	1977	W (SCLT)	—	—	1,432; R1; 0.60 percent WO_3; 1983	—
Spain	Barruecopardo (Salamanca Province)	1910's	S	1910's	W (SCLT, WLFM), As	275; WO_3	—	40,000; R1E; 0.1 percent WO_3; 1982. 3,000; R1E; 0.102 percent WO_3 (tailings); 1982	—
Spain	La Parilla (Badajoz/Caceres Provinces)	—	U, S	1951	W (SCLT), Sn, As	450; 78 percent WO_3; 1984	3,000; 78 percent WO_3; 1961–84	6,200; R1E; 0.19 percent WO_3, 0.03 percent Sn, 65,000; R2E + R2S; 0.10 percent WO_3; 1985	—
Spain	Los Santos (Salamanca Province)	1980's	N	None	W (SCLT)	None	None	1,500; R1; 0.8 percent WO_3; 1983	Feasibility study underway (1986).
Spain	Santa Comba (La Coruna Province)	—	U	1943	W (WLFM), Sn	380; W conc; 65? percent WO_3; 1984	—	3,600; R1; 0.5 percent WO_3; 1983	—
Spain	Silleda (Pontevedra Province)	—	U?	Pre-1917	Sn, W (WLFM)	—	—	1,060; R1S; 0.37 percent WO_3; 1971. 800; R2S; 0.37 percent WO_3; 1971	—
Sudan	Jebel Eyob (Red Sea Hills)	1981?	N	None	W (WLFM, SCLT)	None	None	—	—

Table 10. Selected production and mineral-resource information from ISMI records for tungsten deposits and districts—Continued.

[Mining methods: U, underground; S, surface; N, not mined. All production data are in metric tons; years indicate periods for which data are given. All resource data are in thousands of metric tons; year indicates date of resource assessment. Resource types are defined in figure 1. Most abbreviations used in this table are defined in table 8. NA, not available; conc, concentrate; prod, production; —, not reported on the ISMI record form]

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
Sweden	Yxsjoberg (Orebro Province)	—	U	1917 (W)	W (SCLT), Cu	358; W; 1980–84	7,917; W; 1918–20, 1932–63, 1973–84	1,500; R1; 0.43 percent WO_3; 1983	Cumulative production includes total Swedish output in 1918–20 and 1935–63.
Thailand	Doi Mok (Chiang Rai Province)	1969	U	1971	W (SCLT)	—	—	1,000; R1; 0.75 percent WO_3; 1983	—
Thailand	Doi Than Ngoam (Phrae Province)	1977	S	—	W (FRBR)	623; ferberite conc; 1981–82	1,246; ferberite conc; 1981–82	400; R1E; 1.75 percent WO_3; 1983. 2,100; R2S; 1.5–2.0 percent WO_3; 1983	—
Thailand	Khao Soon mine (Nakhon Si Thammarat Province)	1970	S	—	W (FRBR)	—	—	2,500; R1; 1.0 percent WO_3; 1983	Last production in 1979.
Turkey	Uludag (Bursa Province)	1950	U, S	1975	W (SCLT, WLFM)	160; W; 1978–88. 10; W; 1977	1,767; W; 1977–88	14,500; R1E; 0.5 percent WO_3; 1980	—
Uganda	Nyamolilo (Kigezi District)	1946	S	1947	W (FRBR)	—	1,120; W conc; 65.0 percent WO_3?; 1953–73	900; R1; 0.24 percent WO_3; 1983	Last production in mid-1970's.
United Kingdom	Carrock (Cumbria)	About 1854	U	1870	W (WLFM, SCLT)	50; 70 percent WO_3; 1980	550; 70 percent WO_3; 1915–17, 1976–80	120; R1S; 0.75 percent WO_3; 1984. 150; R2S; 0.75 percent WO_3; 1984	Last production in 1980.
United Kingdom	Hemerdon (Devon)	1916	S	1917	W (WLFM), Sn	—	205,000; 1.0 percent W, 0.25 percent Sn; 1917–19, 1943–44	42,000; R1M; 0.18 percent WO_3, 0.025 percent Sn; 1981	—
United Kingdom	Redmoor (Cornwall)	Pre-1861	U	—	W (WLFM), Sn, Cu, Zn, Ag	—	2; 72 percent WO_3; 1861–1908	4,000; R1M; 0.3 percent WO_3, 0.4 percent Sn, 0.5 percent Cu, 0.15 percent Zn; 1987	—
United States	Andrew mine (California)	1952	S	1974	W (SCLT)	—	—	—	—
United States	Brown's Lake (Montana)	1941 (W)	S	1953	W (SCLT)	—	567,477; 0.35 percent WO_3; 1953–58. 19,200; 0.18 percent WO_3; 1952–56	3,175; R1M; 0.57 percent WO_3; 1986. 2,268; R2S; 0.57 percent WO_3; 1986	—
United States	Climax mine (Colorado)	1879	S, U	1948	Mo, W (HBNR), Sn, rare earth elements (monzonite)	224; W; 1984–85	24,500; WO_3; 1948–84	340,000; R1M; 0.03 percent WO_3; 1982. Plus 35,000; R1M; 0.03 percent WO_3 (tailings)	Byproduct of mining and milling molybdenum ore. Mine closed in 1986.
United States	Hamme district (Tungsten Queen mine) (North Carolina)	1942	U	1942	W (HBNR, SCLT)	—	9,100; WO_3; 1943–71	—	Last production in 1971.
United States	Indian Springs (Nevada)	1969	S	1974	W (SCLT), Mo, F	—	0.1; W; 1974–75	15,800; R1S; 0.15 percent W; 1969	Last production in 1975.

Country	Site name	Year of discovery	Mining method	Year of first production	Elements of economic interest	Annual production	Cumulative production	Resources	Comments
United States	Mill City district (Nevada)	1914	U, S	1917	W (SCLT), Cu, Mo	—	13,214; W; 1917–19, 1925–44, 1944–58	4,000; R1M; 0.32 percent W; 1984?	Last production in 1982.
United States	Nevada Scheelite (Nevada)	1930	U, S	1936	W (SCLT)	—	371,300; 0.73 percent WO_3; 1935–60, 1972–76, 1980–82.	—	—
United States	Pilot Mountain district (Nevada)	1916	U, S	1943	W (SCLT)	—	112.4; W; 1943, 1952–56	—	Last production in 1956.
United States	Pine Creek mine (California)	1916	U	1918	W (SCLT), Mo, Cu	2,000; WO_3; 1979	7,613; W; 1918–53	10; R1; W; 1986	Mine closed in 1986.
United States	Searles Lake (California)	1937 (W)	N	None	W	None	None	77; R1S; WO_3; 1985	Cannot be recovered profitably at present.
United States	Strawberry mine (California)	1941	S, U	1943	W (SCLT), Cu, Mo	655; WO_3; 1981–84	5,459; WO_3; 1943–84	100; R1E; 1.0 percent WO_3; 1985	Mine closed in 1986.
United States	Tem Piute district (Nevada)	1916	U	1937	W (SCLT), Zn, F, Mo, Bi	—	2,065; W; 1937, 1940–57	—	—
Vietnam	Da Tria (Lam Dong Province)	—	—	—	W (WLFM), Sn	—	—	Poss: 40,000 Sn and 20,000 WO_3, hard rock; and 2,000 SnO_2, in placers	Explored; no production.
Vietnam	Pia Oac district (Cao Bang Province, Tonkin)	1906	S, U	—	W (WLFM), Sn	—	9,164; 60 percent WO_3; 1910–45	Proven and probable: 1,512, WO_3, and 22,914, SnO_2, in placers; poss: 1,000, WO_3, hard rock; and 3,000: SnO_2, in placers	—
Vietnam	Tam Dao district (Bac Thai Province) with Da Liem	—	—	—	W (SCLT), Sn, Zn, BRIT Bi, Be, Au	—	—	Proven and probable: 12,900, Sn in hard rock; and 13,532, SnO_2, in placers; poss: 30,000, WO_3, hard rock; 20,000 Bi hard rock; 3,000 SnO_2 in placers	Exploration started around 1980; tin mining started 1965; no tungsten mining.
Zaire	Bishasha	—	—	—	W (WLFM), Sn	—	—	—	—
Zaire	SOMINKI (Kivu)	1930	S, U	1932	Sn, W (WLFM)	45; W; 1980–84	4,587; W; 1958–84	611; R1E; WO_3; 1983. 1277; R1; WO_3; 1983. 1476 R1S; WO_3; 1983	—
Zimbabwe	Beardmore (Bikita District)	Early 1900's?	U	1929	W (SCLT)	—	—	—	Important past producer, current reserves unknown.
Zimbabwe	Chiredzi-Chipinage district	1912	U	1938	W (SCLT, WLFM)	—	—	—	Potential for “large” reserves (Anderson, 1978).
Zimbabwe	R.H.A.	—	—	—	—	—	—	—	Was producing in 1931–79.
Zimbabwe	Scheelite King	—	—	—	W (SCLT), Au	—	—	—	Deposit exploited.

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International Strategic Mineral Issues Summary Report

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U.S. DEPARTMENT OF THE INTERIOR
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BRUCE BABBITT, Secretary

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Ian Lambert, Director
Mineral Resources Branch
Bureau of Resource Sciences
John Curtin House
22 Brisbane Avenue
Barton, ACT 2600
AUSTRALIA

Minerals and Metals Sector
Canadian Department of Natural Resources
580 O'Connor Street—Room 729
Ottawa, Ontario K1A 0E4
CANADA

Distribution Branch
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Postfach 51 01 53
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FEDERAL REPUBLIC OF GERMANY

Chief Director, Minerals Bureau
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REPUBLIC OF SOUTH AFRICA

Gregory R. Chapman
British Geological Survey
Keyworth
Nottingham NG12 5GG
UNITED KINGDOM