

# 19th Annual General Meeting, 27-28 September, Boston



▼ ITIA President, Burghard Zeiler, entertains the Vice-Mayor of Ganzhou City, Liu Cong, to lunch. The co-author of the series of articles on Tungsten in these Newsletters, Wolf-Dieter Schubert, is on the left.

▼ Newly-elected Executive Committee member, Zhang Shoulian (right), with the President of Xiamen Tungsten Co, Mr Zhuang Zhigang.



▼ Georg Thurner (Plansee) and Zan Persichetti (Kemmetal). As key members of the HSE Committee, it is surprising they could muster smiles on the last evening after three gruelling days of discussions.



## Election of Officers and Executive Committee

Burghard Zeiler, Managing Director of Wolfram Bergbau-und Hütten GmbH Nfg KG, was elected as President for 2007 and 2008. The following were elected as members of the Executive Committee:

- ▼ Jesper Gullberg, Lead Buyer (Raw Materials) of Sandvik Tooling
- ▼ Claude Lanners, General Manager (Purchasing) of Ceratizit
- ▼ Zhang Shoulian, President of China Minmetals Non-Ferrous Metals Co Ltd

The attendance of 230 delegates was diminished by the absence of 30 others, mostly from China, to whom the US Government declined to grant visas.

The main event opened with a reception and buffet dinner generously co-hosted by Tiberon Minerals whose President, Mario Caron, gave a report at the AGM itself on progress towards production at the Nui Phao mine in Vietnam.

As presaged in the last issue, much time and energy was devoted to HSE issues, notably the formation of a Consortium to administer the necessary procedures, including the collection of scientific data, to assist compliance by the tungsten industry with impending REACH legislation (see page 10). At this time, the final touches are being put to the document, particularly to the sections covering tungsten products and financing, but all companies will be welcome to join (non-members on equal terms with ITIA members) if manufacturing in or importing into the EU.

ITIA was honoured by the presence of Mr Liu Cong, Vice-Mayor of Ganzhou City, who spoke

about the rapid development of Ganzhou's tungsten industry, so important to the economy of the city and the province of Jiangxi. The city will be celebrating the 100th anniversary of the discovery of tungsten in China towards the end of 2007 and Mr Liu Cong has kindly invited ITIA to send a delegation to take part.

Other presentations were:

- ▼ "Geostatistics in the Mid and Long-term Planning for the Panasqueira Deposit" Mr Nuno Alves, Beralt Tin and Wolfram
- ▼ "Current Status of China's Tungsten Industry" Mr Zhou Juqiu, President, China Tungsten Industry Association
- ▼ "Update on the US Tungsten Market" Mr Dean Schiller, Global Commodity Business Manager, Osram Sylvania Products
- ▼ "The Japanese Tungsten Market" Mr Shigeo Nakamura, President, Advanced Material Japan Corp
- ▼ "Review of Trends in 2006" Mr Nigel Tunna, Managing Director, Metal-Pages Ltd

## 20th Annual General Meeting, 24-27 September 2007, Intercontinental Hotel, Madrid

In the same year that the 100th anniversary of the discovery of tungsten in China is celebrated, ITIA holds its 20th Annual General Meeting - a smaller milestone but worth a party. So watch the website for more details next year.

## Membership Welcome to 3 new companies:

- ▼ **Jiangxi Tungsten Industry Co Ltd** (China), a producer of tungsten concentrate (mainly wolframite) at 8 tungsten mines in Jiangxi, together with APT, AMT, tungsten oxides, W/WC powder and Ferro tungsten.
- ▼ **Weiliang Enterprises Group** (China), producing high performance powder metallurgy products and developing granule and non-micron powder products.
- ▼ **Specialty Chemical Group LLC** (USA), supplying W ore, APT, YTO, BTO, W Powder, FeW etc, as well as W scrap recycling, full cycle metal management programmes and toll conversion. bringing the total at the beginning of 2007 to 51 members.

# GEOLOGY OF TUNGSTEN

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## TUNGSTEN IN THE COURSE OF TERRESTRIAL EVOLUTION

### HOW TUNGSTEN ATOMS CAME ON EARTH

About 4.6 billion years ago the solar system was formed by condensation, contraction and subsequent collapse of an interstellar cloud. More than 99% of the matter of the solar system was concentrated in the sun; the rest is contained in planets, meteorites and comets. This event stopped the continuous evolutionary change in element concentrations of the system. Besides hydrogen and helium, as well as the other lighter elements formed by fusion processes within stars, the cloud contained also the heavier elements generated during the short times of extremely high proton and neutron fluxes prevailing in supernova explosions (as a result of absorption reactions). One of the heavier elements in this "star ash" is tungsten. It ranks number 56 of the elements in terms of earth crust abundance and number 18 among the metallic elements.

### ACCRETION, SEGREGATION AND CORE-MANTLE DIFFERENTIATION

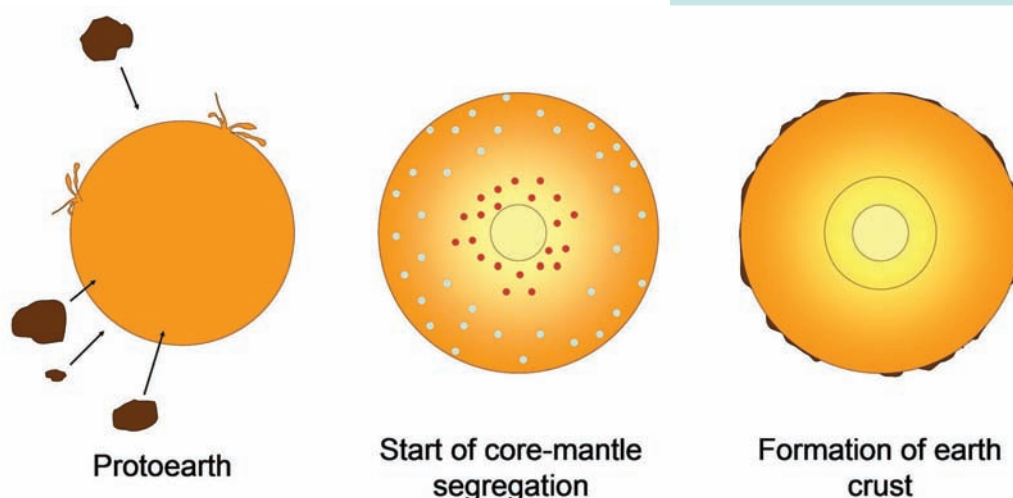
The material remaining outside the sun has undergone one or more of the following processes: oxidation, accretion, melting, segregation, and fractional crystallization. Planetesimals were formed out of dust and ice particles; consequently, planets were built up by collisions of planetesimals.

Very little fractionation of elements is presumed for the early condensate formation and subsequent growth of the *Protoearth* by accretion from planetary components regarding refractory elements like tungsten [1].

It is assumed today that already at a stage of 85% of accretion [within the period of 50 to 200 million years (after 4.55 Ga)] the formation of an iron-nickel core took place by segregation (core-mantle differentiation; **Fig.1**).

During this period of differentiation into core and mantle tungsten was distributed within the respective zones with regard to its chemical environment and chemical affinities. One part was drawn to the iron-nickel core due to its siderophile behaviour in the metallic state as tungsten atoms; the other part, however, "carried along" with the silicates into the mantle because of its highly lithophile behaviour in the oxidized form as positively charged ions. The more oxidizing conditions prevailed, the more tungsten was assimilated into the silica-based mantle.

The partly oxidizing conditions during core segregation in the earth evolution are crucial for the fact that we can find tungsten deposits in the earth crust.



**Fig.1:**

**Core-mantle differentiation**  
Due to repeated impacts of planetesimals, increasing gravitational pressure and radioactive decay the protoearth heated up and the material inside started to partially melt. Materials with higher density (red) segregated to the core, whereas less dense material (blue) migrated towards the surface. Finally, a thin crust formed on cooling with a thickness comparable to the skin of an apple.

Differentiation of elements, like tungsten, occurred during this period according to their chemical environment and chemical affinities (siderophile – lithophile).

## GROWTH AND EVOLUTION OF THE CONTINENTAL CRUST

Growth of the continental crust from the mantle occurred over a period of geological spanning  $>3$  Ga, much longer in comparison to the possibly short, several hundred million year interaction between the core and mantle [1]. During this growth, tungsten, like most of the ore metals, was enriched in the continental crust from about 30 ppb (parts per billion) in the upper mantle to 1 ppm (parts per million) in the upper crust as a result of intracrustal partial melting of more primitive lower continental crust or re-melting of still older oceanic or continental crust and igneous differentiation [1].

These multi-stage changes during the evolution of the earth's crust are the reason why tungsten was fractionated out of the mantle into repositories of ores near the surface of the earth

## ORE DEPOSITION IN SUPRACRUSTAL ENVIRONMENTS

During the recent 200 million years-old period of seafloor spreading and plate tectonics, a varied array of deposits have fixed metals in the continental and oceanic crust (**Fig.2**). Tungsten is transported within the continental crust mainly by *mafic* magma (i.e. magma enriched in magnesium and iron but also in calcium and sodium) apparently originating directly from the mantle [1].

**Table 1:**  
Tungsten Concentrations during Terrestrial Evolution [1]

Bulk Earth	300 ng/g
Earth Core	470 ng/g
Primitive Mantle	10 - 30 ng/g
Ultrabasic magmatites	100 - 800 ng/g
Continental Crust	900 - 1300 ng/g
Granite and Sediments	1500 ng/g
Ore Deposit	4000 – 20000 $\mu$ g/g

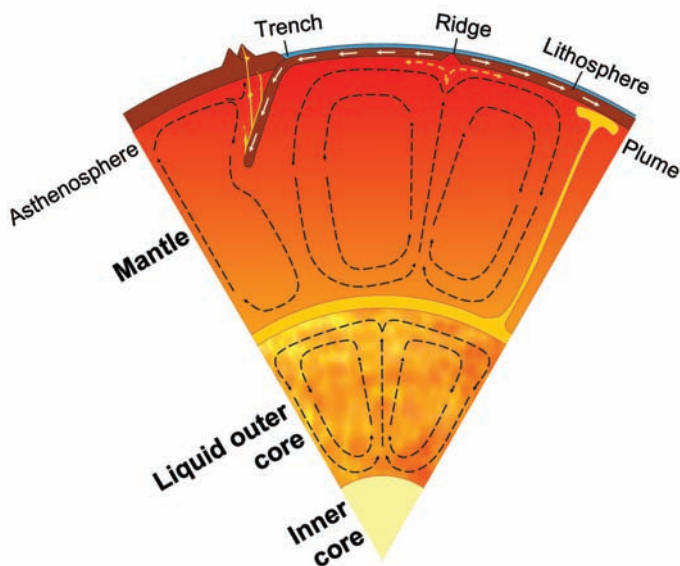
Throughout the fractionation processes the importance of the continental crust formation stands out as the major factor in the progressive enrichment of tungsten. Consequently, supracrustal tectonic and surficial environments provide varied opportunities for further multistage enrichment by magmatic and hydrochemical activities necessary to attain finally ore grade concentrations.

**Table 1** informs about changes in tungsten concentrations during the processes described above.

The increase in concentration by 3 magnitudes, locally even by 4 magnitudes via igneous processes, is the most important fact in understanding tungsten's geology. In sharp contrast to the low abundance of tungsten in the earth mantle (30 ppb) and earth crust (about 1 ppm) one finds concentrations of one-tenth of a percent and sometimes 1-2% as average contents of tungsten ore deposits. All of them are formed by igneous activities which are best discussed in terms of the magmatic hydrothermal model.

## MAGMATIC HYDROTHERMAL MODEL

This model starts with magma of changing composition and of different sources. Moving of the magma to higher levels of the earth's crust leads to differential crystallization as both temperature and pressure gradually drop. The first crystallization step involves the formation of basic rocks and removes Fe, Mg, Ca and Al from the melt. By that, the remaining magma is enriched in silica, alkalis and other chemical compounds which cannot co-crystallize with the minerals of the basic rocks. On further cooling more silica-rich rocks are formed and a fluid remains, consisting of any material which could not be built in during the foregoing crystallization steps. This remaining "hydrothermal liquid" is enriched in excessive silica, volatiles and metals. Metals and volatiles, present in the original magma only in very low concentrations, have now been concentrated as a result of the removal of the main constituents by prior

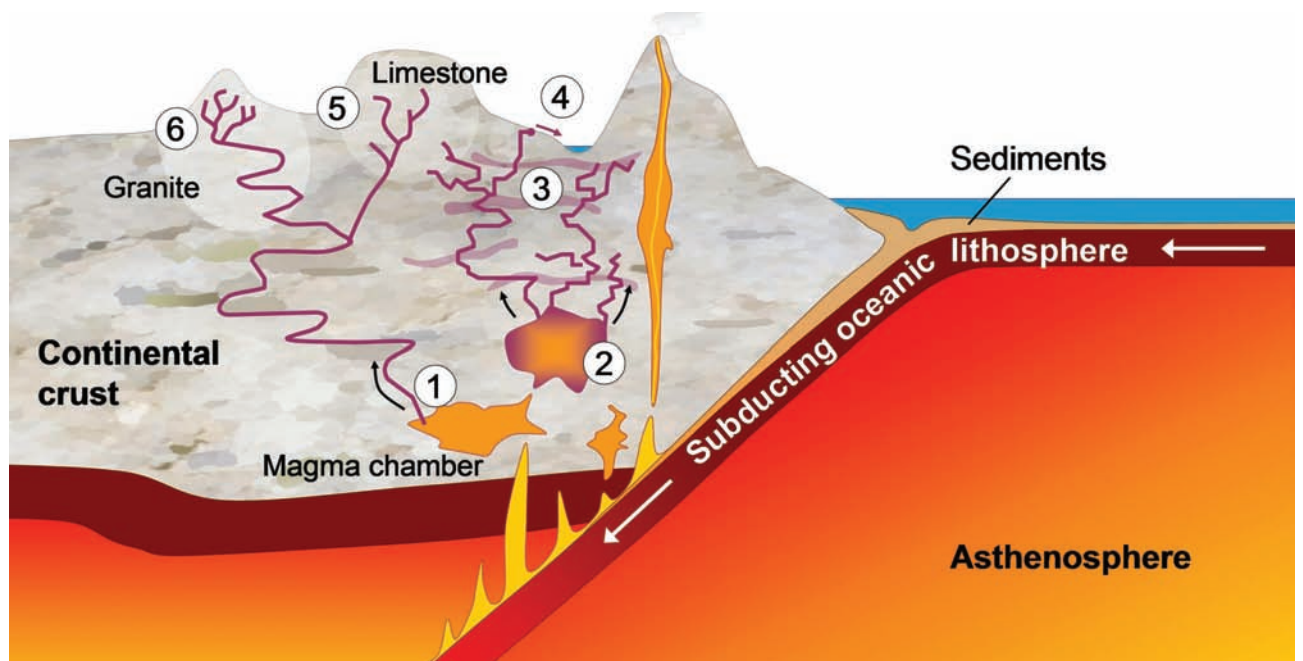


**Fig.2:**

*Schematic presentation of seafloor spreading and plate tectonics as a result of heat transfer from the hot core to the surface*

*At divergent plate borders, plates are drifting apart, whereas at convergent plate borders the plates collide and subduction occurs. Such phenomena are caused by convection currents in the plastic asthenosphere.*

*Divergent plate borders ("seafloor spreading") and subduction zones are important areas for metal enrichment out of magmatic intrusion and formation of ore deposits.*



- ① Zone of liquid-magmatic ore deposits (traces of tungsten);  $T=1100-700^{\circ}\text{C}$ .
- ② Zone of pegmatitic ore deposits; rare and small deposits;  $T=700$  to  $550^{\circ}\text{C}$ .
- ③ Zone of pneumatolytic/hydrothermal ore deposits; important deposits (dykes; veins; stockworks);  $T < 550^{\circ}\text{C}$ .
- ④ Placer deposit; formed through weathering of ore body, subsequent transport and "trapping".
- ⑤ Skarn deposit; important deposits; formed at the contact zone to limestone or dolostone.
- ⑥ Porphyry deposit; important deposits; large volume but low concentration.

**Fig.3:** Schematic, simplified illustration of the formation of tungsten ore deposits as a result of magmatic intrusions

Formation of tungsten ore deposits as a result of hydrothermal fluids forced into crevices, cracks and porous areas close to the dykes; intrusions along layers of neighbouring (tectonically deformed; layered) host rocks and alterations due to the interaction with the fluids under changing formation conditions (temperature, pressure).

crystallization phases. Their concentration in the hydrothermal liquid is high enough to form ore minerals in the successive crystallization.

It is generally believed that tungsten is born in mineralizing fluids chiefly as tungstate ion, tungstic acid, sodium tungstate, or as heteropoly acid. Volatilization is also possible by formation of halide species or  $\text{WO}_3 \cdot n\text{H}_2\text{O}$ . The relative amount of these compounds depends on temperature, pH and silica concentration of solution. Tungsten will be deposited as **wolframite (ferberite, hübnerite)** if the calcium concentration of the environment is low or as **scheelite** if it is high (for example, in contact with limestone).

Hydrothermal deposits are by far the most important type accounting for over 60 % of the known W reserves.

## THE "SUBDUCTION FACTORY" [2]

Subduction zones, as indicated in Fig.2, are an important source of metal enrichment, as in such zones oceanic crust, sedimentary layers and trapped water ("formational brines") are "recycled" into the mantle and continental crust, causing mantle melting and fractionating elements between surface and mantle reservoirs.

Water-rich fluids are important media to further liberate the metals from the magma and/or crystallized rocks.

A simplified illustration is given in Fig.3 of the most important types of tungsten ore deposit, based on the magmatic – hydrothermal model. Please note that in reality such processes are much more complex, as multistage re-melting processes, magma mixing and metamorphic processes (i.e. transformation of the mineralogical composition of a rock through altered temperature- and/or pressure conditions) cannot be considered in such a simple schematic model. Furthermore, each individual tungsten ore deposit on earth is unique in terms of its local formation history.

## MODES OF ENRICHMENT

More generally, three different modes of ore enrichment in the earth's history can be considered [3]:

- ▼ Archean (3800 to 2500 million years ago) magmatic differentiation of a protocrust from primitive mantle
- ▼ Metamorphic and magmatic crustal reworking in the Proterozoic (2500 to 542 million years ago) mobile belts
- ▼ Renewed mantle to crust transfer during subduction-related magmatism in the Phanerozoic (542 million years ago to present day).

Tungsten mineralization from the Archaen to the early Paleozoic is dominated by the metamorphic stratabound type (see below), whereas intrusion-related mineralization formed mainly during the Phanerozoic. The accumulation of tungsten in Phanerozoic deposits is so much larger than in Precambrian (i.e. significantly earlier formed) ores as to suggest that W concentrating processes in the crust have probably changed through Earth's history.

Subeconomic to economic W concentrations occur either in association with *felsic* intrusions (i.e. intrusions which are enriched in the lighter elements, such as silica, oxygen, aluminium and potassium) or with medium to high-grade metamorphic rocks ranging from the Archaen to Cenozoic (66 million years ago to present day), with the majority of economic W deposits being Phanerozoic.

## PALEOZOIC VOLCANISM

Tungsten formations of the mediterranean region and the eastern Alps can be related to early Paleozoic volcanism (542 to 252 million years ago). Many stratiform W deposits and occurrences are today considered volcanic exhalative in origin.

The association between exhalative W mineralization and *mafic* volcanism is evident. But there is no proof that *mafic* volcanism is the source of tungsten, because basaltic rocks have extremely low solubility for W. Therefore, it is proposed that *mafic* volcanism provides only the energy for a process where fluids circulate through and leach W from large volume of sediments. Precipitation of W phases at the sediment-sea water interphase would be associated with *mafic* volcanism



**Fig. 4:**  
Vein Deposit at Panasqueira/Portugal.  
Quartz vein (white) with rich wolframite  
(black)

**Table 2:**  
Estimated tungsten content of the different deposit types  
(Figures include deposits currently being classified as not economic) [3]

Deposit Type	t-10 <sup>3</sup> W	% of Total
Skarn	1764	49
Vein/Stockwork	1475	34
Porphyry	679	15
Stratabound	118	3
Pegmatite	-	-
Breccia	1	-
Brine/evaporite	64	2
Placer	32	1
Disseminated	217	5
<b>Total</b>	<b>4349</b>	<b>100</b>

## DEPOSITS

Seven types of tungsten ore deposits are of major importance [3]: Vein/Stockwork, Skarn, Porphyry, Strata-bound, Disseminated, Placer, and Brine/Evaporite deposits.

Of minor importance are: Pegmatite, Breccia, Pipe, and Spring deposits. **Table 2** informs about the tungsten content and the percentage of total for the different types.

## STRUCTURE OF DEPOSITS

### *Vein/Stockwork deposits*

The deposits consist of tungsten-bearing veins or vein stockworks in or near granitic intrusions. *Wolframite* is commonly the principal mineral, but some deposits contain *scheelite*. Most vein deposits are relatively small, but larger may contain hundreds of viable veins. Stockwork deposits consist of swarms of parallel veins commonly with interconnected veins and veinlets. Stockworks are common in many types of ore deposition, especially notable in greisens. Important accompanying elements are Sn, Cu, Mo and Bi. Larger deposits of this type are in China, Bolivia, Peru, Portugal, and CIS. Well known mines exploiting this type of deposits are *Panasqueira/Portugal* (**Fig. 4**) and *Minera Malaga/Peru*.



**Fig. 5:** Skarn deposit at Tyrnyaus/Kabardino-Balkaria

### Skarn deposits

The term skarn refers generally to an assembly of Ca-Fe-Mg-Al-silicate minerals developed in carbonate-bearing rocks (such as limestone or dolostone) at or near contacts with granitic intrusions. *Scheelite* is the principal W-mineral and occurs both as disseminated grains and veinlets and fractures. Other valuable, accompanying elements can be Cu, Mo, Sn, Zn and Bi. Larger Skarn deposits are in China, South Korea, CIS, Brazil, Canada, USA, Australia and Turkey. *Vostok-2* in Eastern Siberia, *Tyrnyauz* in former Kabardin-Balkar (**Fig. 5**) and *Uludag* in Turkey represent this skarn type.

### Porphyry deposits

They consist of large, equi-dimensional to irregular stockwork zones of W-bearing veins, veinlets, and fractures occurring in or near epizonal to subvolcanic felsic, granitic intrusions. Also mineralized breccia (i.e. sedimentary rock) zones, irregular or pipe shaped can be found. Tungsten is contained either as *wolframite* or *scheelite* and sometimes both minerals may be present. Accompanying, valuable elements are Mo and Sn. Important related deposits are in USA, Bolivia, Canada, and China.

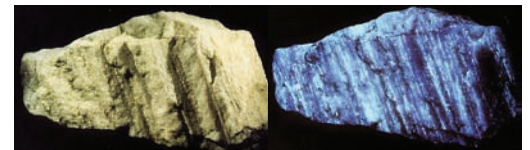
The low tungsten content in enormous deposits like *Logtung* in Canada and the deposits of *Shizuyuan*/Hunan, *Yangchuling*/Jiangxi and *Xingluokeng*/Fujian in China has yet made mining not economic, but these deposits might be exploited some decades from now.

### Strata-bound deposits

The term strata-bound refers to deposits in which the distribution of the tungsten mineral is controlled by bedding in the host rocks and a syngenetic origin of the both may be assumed. But many strata-bound deposits appear to have been affected by later mobilization and re-concentration and therefore a syngenetic origin for them seems questionable, at least for some of them. Stratiform W deposits occur in volcanic-sedimentary sequences and are formed by submarine volcanic activity. The *scheelite* mine at *Mittersill*/Austria is an example for many geologists as of strata-bound origin (**Fig. 6**).

### Disseminated deposits

They are also called **Greisen** deposits and consist of W minerals disseminated in altered (greisenized) Granite. Greisen fluids are forced into the interstitial spaces of the granite and pool at the upper margins, where boiling and alteration occur. They contain mainly *wolframite*, but also, more seldom, *scheelite*. *Zinnwald* in Germany and the tin/tungsten deposits of *Cornwall*/UK are well-known examples for this kind of mineralization.



**Fig 6:**

Strata-bound deposit at *Mittersill*/Austria

Quartzite with rich *scheelite* at *Ostfeld* (open pit mining); daylight illumination (left) and UV illumination (right); note the stratiform grain sequence.

**Fig. 7:**

Placer deposit at *Gifurwe*/Rwanda

Black wolframite pieces embedded in red sediments behind the man with the iron pole.



### Placer deposits

They consist of sedimentary concentrations of *scheelite* or *wolframite* in alluvial, eluvial or marine sediments and are typically associated with, or only slightly removed from, bedrock W-bearing deposits. They were derived by weathering processes and erosion. Most of them are relatively small. The *Heinze Basin* in former Burma is one of the larger mines with heavy mining equipment; quite a lot of this type is run by hand mining (**Fig. 7**).

### Brine/evaporite deposits

They occur in arid regions in lakes of bigger sizes and contain, as an example, in the *Searles Lake* in California about 70 ppm W with a total of 61,000 metric tons of tungsten in highly concentrated brines. This deposit represents an important source of supply for the future.

### Pegmatite deposits

Tungsten is not a common constituent of pegmatite and therefore this type of deposit is rare. The *Okbang* deposit in South Korea is the only example of a deposit of this type of any significance.

### Breccia deposits

They consist of rock fragments of varied shapes and sizes and form integral parts of vein/stockworks and porphyry deposits. But others appear to have formed independently of other deposit types. An example is the *Washington breccia* pipe in Sonora/Mexico, where *scheelite* is associated with copper and molybdenum minerals.

### Pipe deposits

They range from cylindrical to irregular, elongated, bulbous masses of quartz occurring in the margins of granitic intrusions. *Wolframite* is erratically distributed in high-grade shoots or pockets (up to 20% *wolframite*). Their size is small.



**Fig. 8:** Recent *scheelite* formed at the *Champagner Pool* of *Waiotapu* near *Rotorua* in *New Zealand*.

Historically important were these deposits particularly in Australia with the well known *Wolfram Camp* in Queensland.

### Hot spring deposits

Tungsten occurs in hot spring deposits, calcareous tuffs or travertine. They are commonly associated with bedrock W deposits, by circulating hot ground water and are always small. Near Rotorua in New Zealand at the famous *Champagne Pool* of *Waiotapu* the recent formation of such a deposit can be seen (**Fig. 8**).

## SIZE AND AVERAGE GRADE OF DEPOSIT TYPES

**Table 3:** Size and average grade of deposit types (Source: US Geological Survey) [3]

Deposit Type	t of Ore	% WO <sub>3</sub>
Vein small	some 10 <sup>3</sup>	variable
big	tens-hundreds 10 <sup>6</sup>	from 0.1 upwards
Stockwork	tens-hundreds 10 <sup>6</sup>	variable
Skarn	hundreds-thousands 10 <sup>6</sup>	0.3 – 1.5
Porphyry	tens-hundreds 10 <sup>6</sup>	0.1 - 0.4
Strata-bound	one-tens 10 <sup>6</sup>	0.2 – 1.0
Disseminated	tens 10 <sup>6</sup>	a few tenths

Ore content and ore concentration of the deposit types are listed in **Table 3**. The minor important types are not included because they are small or very small and moreover some of them of very low grade.

## GEOLOGIC AGES

**Table 4** gives an overview in which geologic era tungsten deposits have been formed. Only vein/stockwork deposits are represented in every time period. Skarn deposits are proterozoic or younger, porphyry deposits are paleozoic (542 to 252 million years ago) or younger and strata-bound deposits are either proterozoic or paleozoic in age. By far the largest proportion (70%) of W deposits was formed during the mesozoic period (252 to 66 million years ago).

## GEOGRAPHIC DISTRIBUTION

A main factor determining the location of W deposits is the proximity to orogenic belts because of a marked association between W deposits and those mountain belts as for example the Alpine-Himalayan and the Circumpacific Belts.

In particular major W deposits occur in the fold belts of the Far East, in southern China, Thailand, Burma, South Korea and Japan. Rich ore deposits are situated in the Chinese provinces of Jiangxi, Guangdong and Hunan, where all important types of ore deposits can be found (amongst others also the largest *scheelite* mine in the world: *Shizhuoyuan*). In these areas even basaltic rocks contain higher concentrations in tungsten, which has been interpreted by Chinese researchers as an anomaly of the underlying mantle. Similar belts extend throughout the Asiatic part of the former Soviet Union.

Tungsten is also present in the eastern coastal fold belt in Australia and the Alpine belt from France to Turkey. The Rockies and Andes as part of the Circumpacific belt contain a number of important deposits in Canada, USA, Bolivia, and Peru. Ore deposits in Africa (Rwanda, Uganda and the Republic of Congo) and Brasil (Rio Grande del Norte, Rhodonia) indicate a common ore formation history of Sn/W deposits before the opening of the Atlantic Ocean (i.e. separation of Africa and South America) about 100 million years ago [4].

**Fig. 9** shows the location of deposits in a world map [3]. The largest, so far known, individual deposits are located in China, Canada and the CIS, as demonstrated in **Table 5**. These ten listed deposits represent more than 75 % of the total global reserves.

## THE ECONOMY OF A DEPOSIT IN REGARD TO MINING

The economy of tungsten is generally ruled by the current supply/demand situation which is the determining factor for the tungsten price. This situation is influenced by a variety of factors like peace or war situations, policy of producing and consuming countries, general world economy etc.

The question whether a deposit can be mined economically also depends on a number of facts:

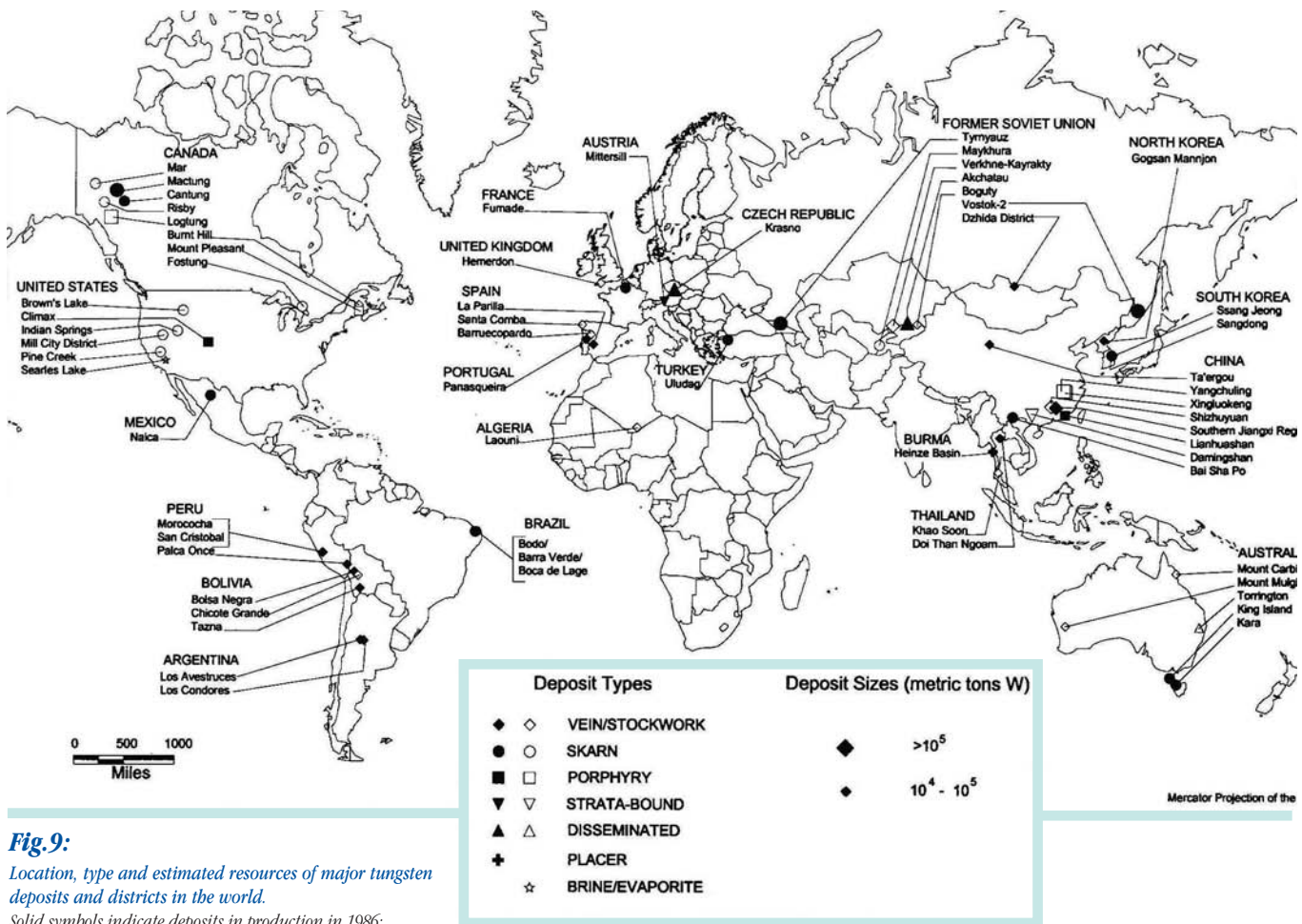
**Properties of the ore:** grade, reserves, structure and type of the ore determines the beneficiation method

**Table 4: Formation era of deposit types and W content (in 10<sup>6</sup> t W) [3]**

Ma = million years ago; Source: US Geological Survey

Deposit Type	Cenozoic 66 Ma to date	Mesozoic 252-66 Ma	Paleozoic 542-252 Ma	Proterozoic 2500-542 Ma	Archean >2800 Ma
Vein/Stockwork	0.23	0.99	0.37	0.06	0.09
Skarn	0.05	1.36	0.19	0.1	-
Porphyry	0.11	0.78	0.1	-	-
Strata-bound	-	-	0.16	0.01	-
Disseminated	-	0.01	0.09	-	-
Placer	0.032	-	-	-	-
Brine	0.061	-	-	-	-
Pegmatite	-	0.011	-	-	-
Breccia	0.003	-	-	-	-
Pipe	-	-	0.007	-	-





**Fig.9:** Location, type and estimated resources of major tungsten deposits and districts in the world. Solid symbols indicate deposits in production in 1986; unfilled symbols indicate deposits not in production in 1986; by courtesy of US Geological Survey [3].

**Mining costs:** underground or open pit, labour availability and cost, location of the deposit, equipment, transportation facilities, climatic conditions, political status of the country.

**Environmental considerations:** environmental regulations of the relevant country, dumping of gangue material, use of chemicals for beneficiation.

**Table 5: World's largest tungsten deposits** (Source: US Geological Survey) [3]

Deposit name (province)	Location	Type of deposit	Contained W (x10 <sup>3</sup> t)
Verkhne-Kayraky (Dzhezkazgan Oblast)	CIS	Vein/stockwork	872
Mactung (Yukon & Northwest Territories)	Canada	Skarn	617
Shizhuyuan (Hunan)	China	Porphyry	502
Tyrnyauz (Kabardino-Balkaria)	CIS	Skarn	244
Logtung (Yukon Territory)	Canada	Porphyry	168
Yangchuling (Jiangxi)	China	Porphyry	160
Xingluokeng (Fujian)	China	Porphyry	144
Damingshan (Guangxi)	China	Stratabound	116
Vostok-2 (Primorskye)	CIS	Skarn	102
Ta'ergou (Gansu)	China	Vein/stockwork	100
<b>TOTAL</b>			<b>3,025</b>

All these factors influence the above question more or less strongly. Interesting examples in this regard are the MacTung and the LogTung deposits of Canada. Their location in the Yukon and North West Territories due to the extreme climatic conditions is the reason for higher costs and a respective high *break even* point. Although these two deposits count to the biggest deposits on earth they cannot be mined under current tungsten price conditions. In the case of LogTung, the low grade of 0.13 % WO<sub>3</sub> is a further reason, which is also responsible for the fact that three of the largest Chinese deposits - Lianhuashan, Yangchuling and Xingluokeng - can not be mined today.

## THE SITUATION TODAY

In the last two decades, with low tungsten prices, many mines were closed and worldwide prospecting and exploration for tungsten deposits came to a stop. Therefore the world resources of tungsten were in 2002 similar to those of 1980 and, in comparison to the annual mine production, very low. With the increase of the tungsten price in 2005, the search for well known but closed mines and new deposits all over the world started and the resources increased immediately. Today many deposits are waiting for the last decision - mainly by the financing experts - to be exploited and closed mines to be reopened. Due to these circumstances we expect in this decade a significant increase of tungsten production worldwide as the demand grows with the enormous development of Chinese industry.

## Literature:

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### Further Reading:

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### Acknowledgements:

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# REACH legislation adopted

.... *prepare for 1 June*

By a substantial majority, the European Parliament approved REACH legislation on 13 December after several years of lobbying and compromise. The new laws will come into force on 1 June 2007 and apply to all chemicals – some 30,000 substances reportedly – which are produced in, or imported into, the EU in quantities of 1 tonne per year or more. Essentially, the burden of proving that substances are safe will now fall on industry, rather than the regulatory authorities having to prove that they are dangerous. Estimates of costs to industry vary between Euros 3 and 5 billion.

There remain some grey areas, as Eurométaux has pointed out, such as the treatment of alloys and the definition of waste. Areas of compromise include substitution of high-risk substances, which was initially proposed as mandatory. Producers may now have the chance to demonstrate that they effectively and safely control the substance and prove an economic case for its authorisation.

There has also been common ground negotiated between the Council and Parliament on:

- ▼ *Information-sharing about substance testing so that use of animals tests is minimised;*
- ▼ *Inclusion of a duty-of-care for manufacturers, importers, and downstream users to prevent and remedy adverse effects from chemicals;*
- ▼ *Arrangements to protect commercially sensitive information; and*
- ▼ *Details relating to the setting up of a European Chemicals Agency, to be located in Helsinki.*

As indicated on Page (1), ITIA has practically completed its proposals for a Consortium which will enable companies in the tungsten industry to fulfil their obligations under REACH legislation to obtain the necessary licences to continue to produce or trade their products within the EU.

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