MONGOLIA

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Covering some 1.6 million km^2 Mongolia is roughly the size of Alaska, straddles three time zones and is sandwiched in Central Asia between the Russian Federation to the north and the People's Republic of China to the south. There are mountainous regions in the north and west, and the rivers that drain the Altai, Khangai and Khentti ranges provide the main sources of water for the country. The central region comprises steppe or grassland and the semi-arid Gobi Desert lies to the south. The average altitude in Mongolia is almost 1,600 m above sea level. The climate is continental, rainfall is sparse and the average temperature is about 25° C in the summer and minus 25° C during the winter.

There are only 2.6 million inhabitants and, with just 1.5 inhabitants per km^2, Mongolia has one of the lowest population densities in the world. About 30% live in the capital city Ulaan Baatar, and a further 30% are nomadic. It is a youthful country, with about 70% of the population under the age of 30.

The country is divided administratively into 21 provinces or *aimags* and, away from the capital, communications and transport infrastructure are elementary. Freight transport is mostly by rail and the network extends to the borders with Russia and China. Much of the national road system is unpaved, necessitating the use of four-wheel-drive vehicles. Highways connect Ulaan Baatar to regional centres in Russia such as Irkutsk and Ulan-Ude, and there is also a road link south across the Gobi desert to the Chinese border.

Last year, Mongolia's GDP amounted to US$1.05 billion (US$433 *per capita*), agriculture (mainly wheat, potatoes, sheep, goats and camels) contributing about 33% and mineral resources about 19%. Minerals accounted for 10% of GNP, 56% of industrial production and provided 66% of the country's export revenues.

Mongolia's mining sector has grown steadily, by 8-12% per annum over the past few years, and when some of the major mineral projects now under development come to fruition, there is every reason to believe that Mongolia's total GDP could double. And the market is there: although Mongolia is land-locked, the current pace of economic development by its neighbour, China, means that Mongolia has a secure and reliable destination for its mineral products. Indeed, Mongolia could become to China what Canada is to the US.

Mongolia's favourable legal, fiscal and investment regimes, the overall economic and political stability, and high exploration potential, are the key factors in attracting investment into Mongolia's minerals sector. Whereas public investment in the mining sector was 1.6 times higher in 2003 compared with 1999, private investment was 4.5 times higher.

And in addition to investment in mining, there are opportunities further downstream eg, for a copper smelter and refinery, plants for processing molybdenum, fluorspar and iron ore concentrates, and a plant for phosphatic fertilizers. Improvements to existing infrastructure are also vital, with a need for power plants, power transmission lines, railways etc.

Geological overview

Mongolia lies within a major intracontinental mobile belt that separates the Siberian and Chinese cratons. This belt hosts the Kazakhstan-Mongolian metallogenic belt, within which there are a number of individual metallogenic provinces associated with fold belts ranging from Palaeozoic to Mesozoic age, and with Caledonian intrusives. The metallogenic zones include the Khangai-Khentii gold zone (containing the Boroo gold district), a major copper-molybdenum zone trending northwest-southeast across northern Mongolia (containing the Erdenet copper deposit) and tin-tungsten zones in eastern Mongolia. The Mongol-Okhotsk metallogenic zone, part of which lies across eastern Mongolia, represents a huge Mesozoic orogenic belt extending from east Asia into the Gobi Desert. Related magmatism makes this area especially prospective for base and precious metals.

Older rocks, ranging from Precambrian to Carboniferous occur in northern Mongolia, and in southern Mongolia there are Permo-Triassic terranes covering much of the Chinese craton.

The principal ore deposit types include: porphyry copper-molybdenum; epithermal gold; tin, tungsten, molybdenum, zinc and copper skarns; granitic greisens and stockworks containing tin, tungsten, molybdenum, fluorine and beryllium; tin placers; structurally-controlled veins and stockworks; intrusion-related gold; metamorphogenic gold (and related placers); and alkaline intrusions carrying niobium, tantalum and rare earths.

Exploration potential

In terms of exploration potential, the Altaids, a collage of Palaeozoic magmatic arcs extending from Kazakhstan into northern and western Mongolia, are believed to have excellent potential for the discovery of porphyry copper-gold deposits. There is also potential for sedimentary-hosted copper, and polymetallic volcanic massive sulphide deposits in back-arc belts parallel to frontal volcanic arcs. Northeast Mongolia is deemed to have potential for carbonate rock-hosted, Carlin-style gold deposits, similar to the extensive deposits in China on the northwestern and southwestern margins of the Yangtze Craton.

State-funded geological exploration and surveying conducted up until the 1990s established about 6,000 deposits and the occurrence of over 80 different minerals of economic significance. Today, the government's aim is to increase significantly the national budget allocation for basic geological investigation, to provide 1:200,000 scale geological map coverage for the entire territory and to complete 50,000 km^2 of mapping in selected areas at a scale of 1:50,000 by the end of 2004.

Efforts to enhance the sector's international competitiveness has resulted in a massive inflow of foreign private capital into Mongolia's economy. International majors such as Anglogold Ashanti, Barrick Gold Corp, Cameco, CVRD, Outokumpu and Placer Dome now have offices in Mongolia, and the exploration and planned development by Ivanhoe Mines of the world-class Oyu Tolgoi copper-gold deposit has served to encouraged dozens of junior companies to enter Mongolia's mineral exploration sector.

The number of exploration licences issued each year is rising steeply. In 2003 the Office of Geology and Mining Cadastre granted 1,289 licences covering an area of some 17.4 million hectares, and 156 mining licences. The total number of exploration licences valid as of May this year was 3,271 covering some 43.5 Mha. There were 754 valid mining licences. Total exploration expenditure in Mongolia last year is estimated at some US$37 million. Despite the growing exploration activity, however, more than 70% of Mongolia is unexplored.

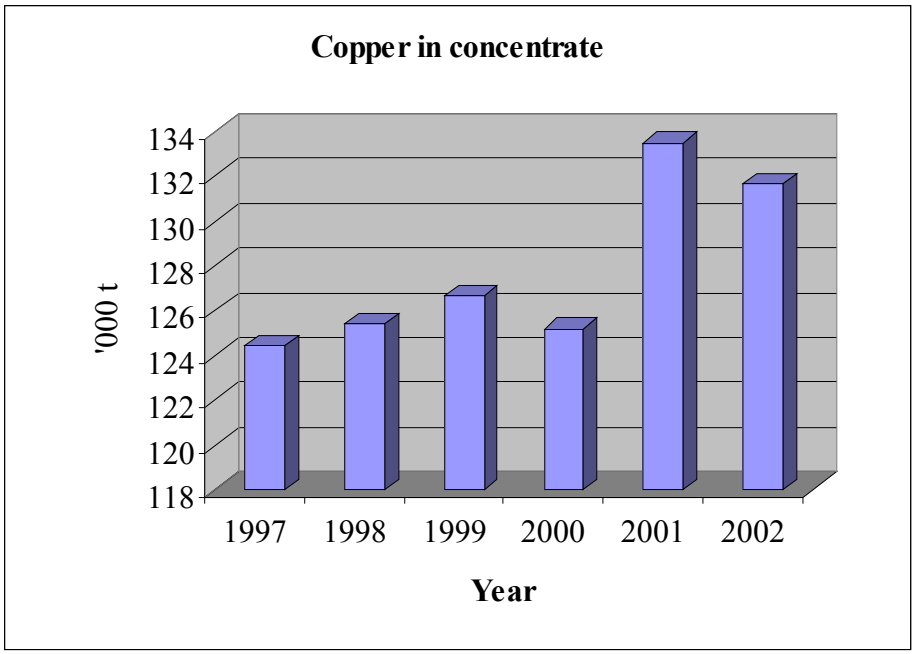
Mining activity

Base metals

Copper: the Erdenet copper deposit, 365 km northeast of Ulaan Baatar is Mongolia's best known and single largest mine. It has been in operation since 1978 and is a joint venture between the governments of Mongolian (51%) and Russian (49%). Erdenet is a typical stockwork copper-molybdenum porphyry and, since operations began, the mine has produced 2.5 Mt of copper and 36,000 t of molybdenum concentrate. It is an open-pit operation and the pit now extends to a depth of 270 m and measures some 2.5 km by 1.2 km in surface area. A conventional flotation circuit is used to process the ore. Copper and molybdenum concentrates were originally delivered to Kazakhstan but are now sent to China.

The 26 Mt/y capacity plant treats around 20 Mt/y of ore to produce about 354,000 t of copper concentrate and 3,500 t of molybdenum concentrate (about 1.2% of world production) containing about 124,000 t of copper metal and 1,672 t of molybdenum. In addition, a modest amount of cathode copper is produced by the Mongol-US Erdmin JV, which uses leaching and SX-EW technology to process stockpiled oxidised ore.

Estimated reserves in the main stockwork total 2,295 Mt averaging 0.5% Cu, 0.014 % Mo, 1.81 g/t Ag and 0.05 g/t Au. In the deeper stockwork zones there are estimated to be some 1.4 Mt of contained copper and 37,000 t of molybdenum. The calcium-tungsten mineral scheelite is irregularly distributed throughout the orebody.



In 2003, 130,270 t of copper in concentrate was produced.

Without doubt, the most important mineral project in Mongolia at present is the exploration and development by Ivanhoe Mines Ltd of the Oyu Tolgoi (Turquoise Hill) copper-gold porphyry deposit in the Gobi Desert in southern Mongolia (and within 80 km of the Chinese border). The deposit is considered to be one of the largest in the world and estimated to contain at least 21,400 Mlb of copper and 7.3 Moz of gold in some 1,200 Mt of ore. Ivanhoe expects to have an interim engineering report ready by mid-year and, by year-end, a bankable feasibility study for an open-pit mine, and a prefeasibility study for an underground operation.

In southeastern Mongolia, the Surven Sukhait copper-molybdenum deposit in the Dornogov region, one of several such deposits in the district has reserves of some 230 Mt including a mineable reserve of 77 Mt averaging 0.5% Cu and 0.02% Mo. A Mongolian company holds the exploration licence but exploration is incomplete and mining has yet to commence.

Lead and zinc: the main deposits are located in eastern and central Mongolia and in the Altai mountains. In eastern Mongolia, the Tumurtin Ovoo zinc deposit located 180 km southwest of a railway and the city of Choibalsan is a skarn-type deposit estimated to contain 7.7 Mt averaging 12.43% Zn. A Chinese-Mongolian JV holds the mining licence and production of lead, zinc and silver will start in 2006.

In the northeast of the country, in the Dornod region and close to the Mardai uranium mine, the Ulaan lead-zinc deposit is awaiting development by a Mongolian company that holds the mining licence but is seeking investor interest. The deposit comprises four breccia pipes extending to depths of up to 500 m and ranging in widths from 20-120 m. There are an estimated 68 Mt,

including oxide and semi-oxidised ore averaging 2% Zn, 1.2% Pb, 53 g/t Ag and 0.21 g/t Au.

Tungsten: There has been a modest production of tungsten since the 1940s, with annual production as much as 350 t. One of the most promising undeveloped deposits is Ondor Tsagaan in the Khenti region of northeastern Mongolia, 70 km northwest of Ondorkhaan. Reserves have been estimated at 186 Mt averaging 0.17% WO_3, 0.02% Mo,0.07% Li, 0.13% Rb and 0.001% Cs. An exploration licence has been taken out on the area. In the extreme southeast of the country, the Yugodzer tungsten deposit contains an estimated 42,500 t of wolframite and 12,000 t of molybdenum in 21.6 Mt of ore but, to date, neither exploration nor mining licences have been issued.

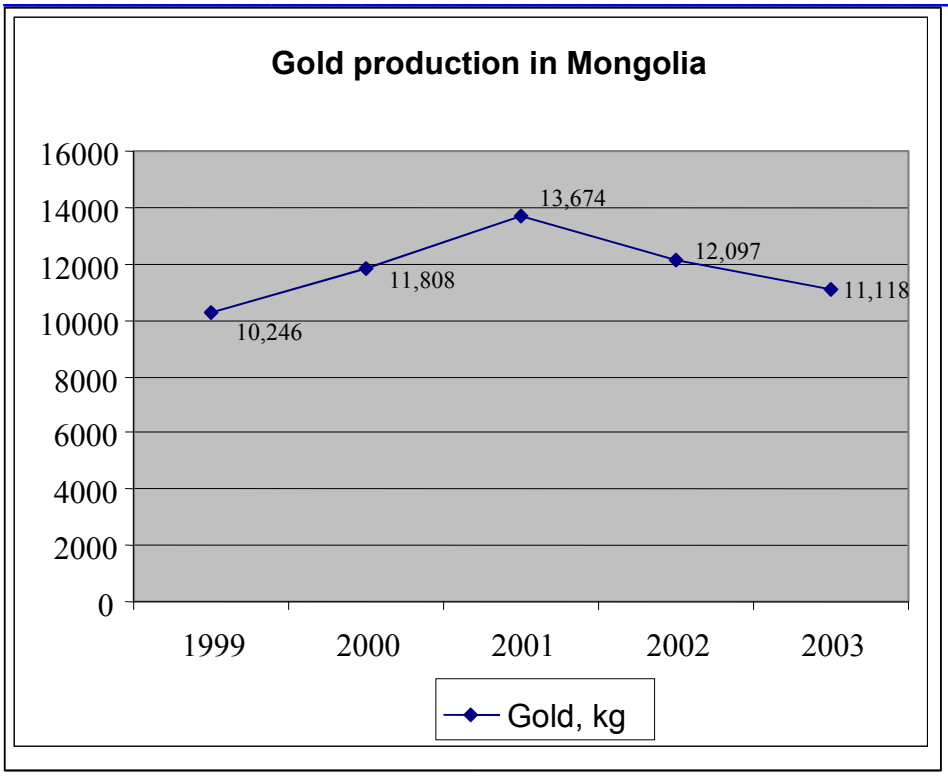
Precious metals

Gold : Annual gold production in recent years has averaged over 10 t and totalled 11.1 t in 2003. The bulk of current production is from placer deposits and the main producers are: Altan Dornod Mongol (100% Russian owned) and Shijir Alt (a Mongol-Russian JV), and wholly-owned Mongolian companies such as Gachuurt, Mongol Alt Corp and Erdes Holding.

At present there are only two hard-rock gold mines: Boumbat, an auriferous quartz vein deposit that has been mined since 2002 by Mongolyn Alt Corp and producing about 1.0 t/y; and the Boroo mine, scheduled to commence production this year and now owned by Centerra Gold Inc (formed from the Central Asian gold assets of Cameco Corp of Canada). Reserves and resources at Boroo are estimated at 10.1 Mt averaging 3.5 g/t, 40% in oxide form, which should yield a 95% recovery, 45% in transition ore (90% recovery) and 15% in sulphides (77% recovery). Production is expected to average 180,000 oz (5.5 t) annually over six years from four shallow pits. Operating costs for the US$74 million project are estimated at US$160/oz. It is Mongolia's first large gold mine involving Western investment.

Other hard-rock gold discoveries warranting development are at Oloon Ovoot, Gatsuurt and Tavt, and it is clear that hard-rock mining will become more and more important in terms of output, employment and revenue. The currently dominant placer producers will face increasing pressure to invest in exploration for new deposits to replace their depleting reserves.

Western-based junior companies (such as ErdeneGold, QGX, UGL Enterprises, Fortress, Planet Exploration and others), hold many potentially good licence areas. A very liberal legal environment, reasonably transparent procedures, high gold and copper prices, and an increasing awareness of Mongolia as a mineral investment destination have allowed juniors to raise significant funds to finance exploration work. Major international gold producers, such as AngloGold Ashanti, CVRD (Tethys Mining) and Placer Dome, are now also on the scene.



Silver: Mongolia's principal silver deposit is in the far northwest at Asgat near the Russian border. It was discovered nearly 30 years ago and there are 11 separate areas of silver and base-metals mineralisation in veins, breccias and stockworks, and the grades are very variable. There is an estimated silver resource of 10,000 t, plus by-product copper, antimony, bismuth and minor mercury. A domestic company, Asgat Mongo Co, in joint venture with Metal-Altai of Russia, has established a new company, MC Asgat, to develop the deposit.

Industrial minerals

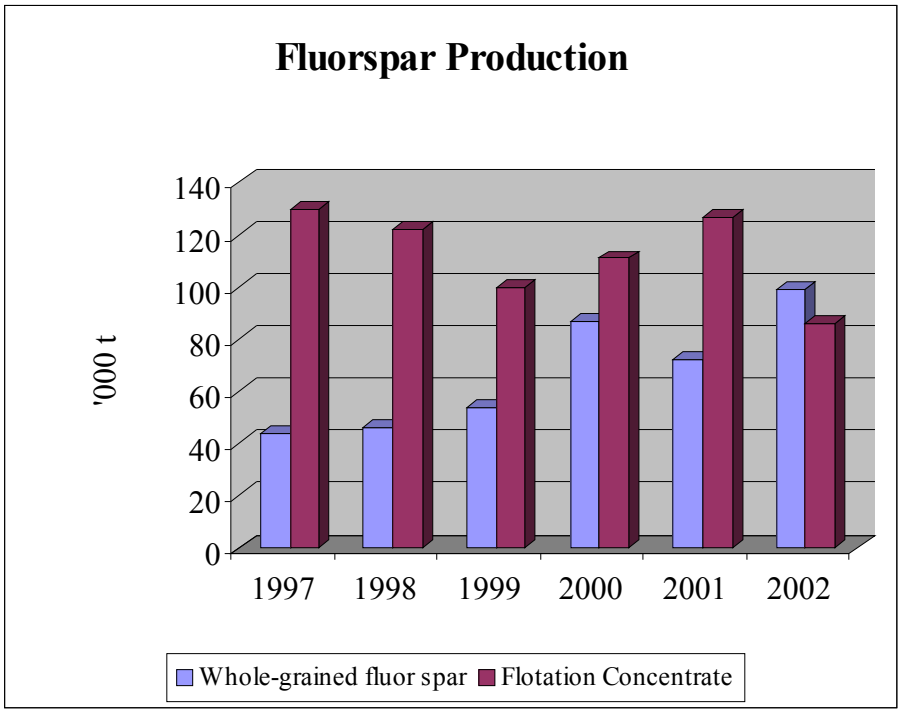
Fluorspar: There are numerous fluorite deposits in Mongolia, ranging in age from late Palaeozoic to late Mesozoic. The mineralisation typically occurs in epithermal veins or in metasomatic deposits and there are three main provinces – Northern Mongolia, Southern Mongolia and Trans-Mongolia. The latter province possesses the largest reserves and is most actively mined.

In 2003, Mongolia produced 275,200 t of fluorspar, ranking it as the world's fourth-largest fluorspar producer. Mongolrostsvetmet, a joint venture between Mongolia and Russia, is the dominant producer and owns Mongolia's largest fluorspar operation, Bor Undur, in east-central Mongolia. This has produced fluorspar continuously since 1970. The mineralisation occurs in breccia bodies in a large fault-bounded block within Triassic granites. More than 20 orebodies have been recognised, zoned in four distinct groups: Bondor Undur, Adag, Bayan Ulaan and Ondor Ovoo within an area of 70 km^2. The Urgen field, some 60 km southeast of Sainshand, has been worked since 1981. Mongolrostsvetmet exports its production mainly to Russia and Ukraine.

A number of small fluorspar producers has emerged in Mongolia and this has contributed to an increase in the production of metallurgical-grade fluorspar, for export to countries such as China and South Korea. Last year, fluorspar production comprised 80,500 t of metallurgical-grade fluorspar and 116,200 t of flotation concentrate. The increasing number of smaller metspar producers in Mongolia, plus a growing number of Russian traders, has intensified competition, with the result that production costs have been forced down and export prices for fluorspar exported to Russia and Ukraine have reduced.

Fluorspar production

Year	Number of economic entities	Volume ('000 t)			Value (million US$)	Unit price (US$/ t)
		Total	Mongolrosts-vetmet	Others		
2001	11	215.6	209.4	6.2	19.8	92.0
2002	25	192.5	160.8	31.7	17.0	88.1
2003	45	275.2	198.1	77.1	21.8	79.3



Phosphorite

In the Khovsgol Lake region of north-central Mongolia, more than 30 phosphorite occurrences have been discovered since the 1960s by teams of Mongolian, Russian and Czech geologists, and reserves of more than 2.4 Mt have been estimated.

Energy minerals

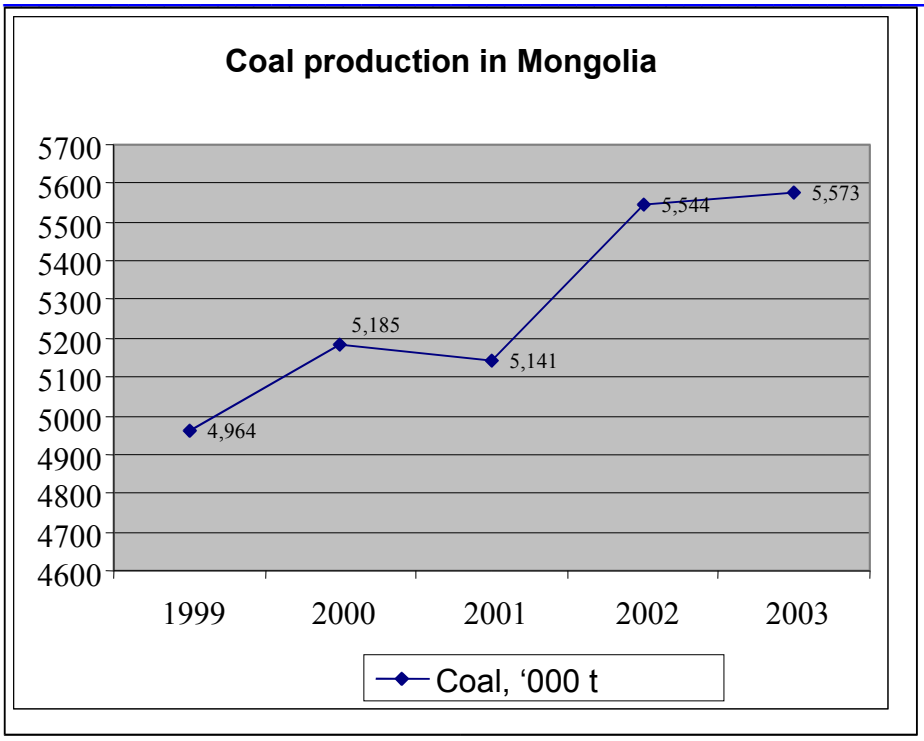
Coal: Mongolia, has yet to develop its oil and gas resources significantly and although there is potential for new discoveries in the eastern and western parts of the country, there is only one operating field, in the Gobi region. Hence, the country is reliant on coal for its prime source of power generation, and there are over 200 coal deposits and occurrences. Around 80% of the

coal that feeds Ulaan Baatar's power plants comes from the Baga Nuur deposit in the Tabunsubatuin basin. This deposit has been mined since 1978 and there are two coal-bearing horizons containing 24 seams. Remaining reserves amenable to open-pit mining are estimated to be approximately 600 Mt

Economic exigencies during the early 1990s impacted on coal production and by 1994 output had reduced to 4.9 Mt, from 8.6 Mt in 1988. Nevertheless, there have been a number of mine rehabilitation projects at larger operations such as Baga Nuur and Shivee-Ovoo, assisted by aid from Japan and the World Bank through concessional loan funds. Some smaller, local mines, have also received some government assistance, with the result that output has improved significantly. During the past five years, Mongolia's output has risen steadily, from 5.1 Mt in 2000, to 5.9 Mt in 2003. Moreover, output has risen sufficiently to enable Mongolia not only to meet its domestic needs, but also to export some of its production. In 2004, for example, a number of mines, including Baga Nuur, Alag Togoo and Nariin Sukhait, entered into agreements to export over 2 Mt of coal to China.

A series of significant steps and measures have been undertaken over the past few years to commercialise the goal sector and establish a favourable legal environment for its sustainable development. A privatisation programme has been successfully implemented, and has resulted in the full privatisation of all but the Baga Nuur and Shivee Ovoo mines, and a decision to privatise these two giant goal producers has now been made.

For the future, the Tavan Tolgoi coking-coal deposit in the south Gobi region is regarded as having great potential. It is located in the Ulannuur coal basin where there are 16 seams, ranging in thickness from 2 m to 72 m, within a late Permian coal-bearing sequence some 965 m thick. The area covers some 90 km^2 and only the central 9 km^2 has been studied in detail, and to a depth of 340 m. Reserves are estimated at some 5,000 Mt, including 2,800 Mt amenable to open-pit extraction. However substantial infrastructure investment will be necessary. For example, Tavan Tolgoi is located 400 km from the nearest railway. There is currently only a small operation but when the deposit is eventually developed as a large-scale mine, Tavan Tolgoi could provide a major new source of export earnings for Mongolia. The recent discovery of Oyu Tolgoi by Ivanhoe Mines gives opportunities for synergies and potential for development cost-sharing. The licence-holders are currently in active negotiations with potential investors.



Uranium: Exploration for uranium began in the 1940s and, by the mid-1960s, Soviet and Mongolian geologists had outlined numerous deposits, mainly associated with coal. Exploration continued through the next two decades and important discoveries were made in eastern Mongolia at Dornod, Gurvanbulag and Mardai, and in southern Mongolia in the Kharaat area. Reserves in these deposits have been estimated at 62,000 t U and Mongolia's total resource base has been estimated to be some 1.3 Mt U. Open-pit mining commenced at Marda in 1989 as a Russian-Mongolian joint venture, with the ore sent for processing at Russia's Priargunsky plant. Operations ceased in 1993 and efforts to restart the operation by a Mongolian-Russian-US JV in 1998 failed a result of low uranium prices.

Rare earths

At least six widely-distributed rare-earth provinces have been identified in Mongolia. Mineralisation is variously associated with alkaline granites, tungsten veins and stockworks in granitoids and tin skarns associated with granites and carbonates. The Lugeengol deposit in the Dornogov district, on the eastern flank of the South Gobi alkaline belt is associated with nepheline syenite and a dyke sequence intruded into siltstone and limestone. Some 17 carbonate veins have been identified up to 1.0 m wide and extending from a few metres to 430 m. The rare earth oxide content of the veins averages 3.23%. A mining licence has been issued but, thus far, no activity has been reported.