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## The Dornod Uranium Project in Mongolia

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**T**he Republic of Mongolia, located on the northern plateau of Central Asia, is a landlocked country, bounded on the north by Russia and on the east, south and west by China. The country is slightly larger than the State of Alaska, or approximately the size of Western Europe, which makes it the seventh largest country in Asia and 18th largest in the world. The climate is harsh, with extremes of both heat and cold. The country is sparsely populated, with a little over 2.4 million inhabitants.

The topography consists principally of a high-altitude plateau, with fully 40% of the country classified as mountainous. The largest mountain range, the Altai, rises to over 4200 meters (14 000 feet). The Gobi Desert dominates the central and south-eastern areas of the country.

Economic development in Mongolia has been limited by the harsh climate, scattered population and sizeable expanses of unproductive land. Mongolia has been characterised principally as a pastoral country with extensive animal husbandry (sheep, goats, yaks, camels and horses). Arable land represents only one percent of the total country. The infrastructure is not well developed, telecommunications are limited but improving, few roads outside the cities are paved, and with the vast distances, vehicular transport is slow. There is one major railway line – the Trans-Mongolian Railway – linking Mongolia with Russia and China.

Economic growth in the post-Soviet era has been sporadic. The rapid transition to a market economy has been made more difficult of late.

The country is currently facing a budget crisis, brought on to a degree by external factors, with severe shortfalls in revenues, exacerbated by the decline in prices of Mongolia's major export commodities, specifically copper, and coupled with rising import prices, specifically oil prices.

However, despite the slow economic recovery, there are several reasons why Mongolia is still considered an attractive region for continued exploration and development:

- It is rich in mineral resources. Minerals exports account for an estimated 50% of Mongolia's total export earnings.
- It has an aggressive, competitive, young government and an encouraging foreign investment climate.
- It has a well-educated, young population, substantial natural resources, and is close to the large Asian markets.
- A new Constitution has introduced radical economic, legal and social reforms, based on democratic principles, and created an economy based on public and private ownership of property.
- There are new foreign investment and tax laws providing a liberalised, clear and transparent legal and regulatory framework conducive to private sector development, with minimum interference and maximum support, equal treatment of foreign and domestic investors, stable and long-term land leases.
- A new, competitive mining law provides security of tenure, transferability of title, clear and transparent procedures, complete access to

mineral resources, a stable and equitable tax regime, zero import duties, and a first come, first served principle.

- The government is committed to promoting the expansion of the private sector, providing a supportive, fair and competitive environment for investment.
- A comprehensive privatisation programme is in place.
- There is a relatively stable exchange rate.

Mongolia is rich in mineral resources that are being increasingly exploited by a variety of joint venture and Western companies, including the exploration and ongoing development of new and existing uranium deposits.

As reported by the IAEA, uranium exploration within Mongolia commenced immediately after the end of World War II. Preliminary geological investigations were carried out by joint Mongolian–Russian geological organisations. Uranium occurrences associated with lignite deposits comprised the results of pre-1966 investigations. Subsequent exploration activities were more systematic resulting in the identification of four uranium-bearing provinces, which included the Mongol-Priargun, Gobi-Tamsag, Hentei-Daur, and Northern Mongolia districts. The known uranium resources in the Dornod area occur in six deposits belonging to two deposit types, the vein–stockwork deposits (represented by Dornod) and sandstone.

Uranium production in Mongolia commenced in 1989 following the start-up the previous year of the Dornod open pit mine, located 120 km north of the city of Choibalsan in Dornod Province (north-eastern Mongolia). The uranium deposits in this project were discovered and defined by Geologorazvedka, a division of the Ministry of Geology of Russia (formerly of the Soviet Union). Uranium exploration in the region during the

1945–60 period proved unsuccessful. However, the uranium ore deposit was discovered in 1977 following a Mongolian–Russian intergovernmental exploration agreement, signed in 1970, covering the Mongol-Priargun district. Exploration activities continued in the district through 1990. Development of the requisite infrastructure, a town site, railway, power lines, support facilities, underground shafts and drifts for exploration drilling and coring of the discovered deposits, and leach processing studies, were completed.

Commercial uranium mineralisation was discovered in a 20 km<sup>2</sup> area containing 13 potential orebodies. Under a secret agreement executed in 1981 between Mongolia and the USSR, Russian interests were permitted to operate the Dornod mine and export uranium ore to Russia for final processing. The Dornod mines and associated support infrastructure were developed as a “sub-Combine” (called ERDES) to the Priargunsky Mining and Chemical Enterprise, a division of the (then Soviet) Ministry of Atomic Energy (Minatom). Priargunsky is located at Krasnokamensk, Russia, approximately 400 km north of Dornod.

The No. 2 Orebody (open pit) was partially stripped of overburden and was placed into production in 1988. The initial mine plan was designed to recover approximately 1.2 million pounds U<sub>3</sub>O<sub>8</sub>/year (460 tU/y). Between 1988 and 1995, uranium ore was shipped via a dedicated rail line to the hydrometallurgical plant at Krasnokamensk for processing, packaging and shipment. In March 1995 shipping of ore was stopped, although mining activities continued into late 1996. Production of uranium during this time totalled 2 238 000 pounds U<sub>3</sub>O<sub>8</sub> (860 tU). Ore production and grades are shown in Table 1.

In addition to the open pit mine, extensive development work was completed on the No. 7

Table 1. Historical production statistics for the Dornod open pit mine.

| Year         | Waste produced (tonnes) | Ore produced (tonnes) | Ore grade (%U) | Ore grade (%U <sub>3</sub> O <sub>8</sub> ) | Uranium recovered (pounds U <sub>3</sub> O <sub>8</sub> ) | Uranium recovered (tU) |
|--------------|-------------------------|-----------------------|----------------|---|---|------------------------|
| 1988         | 6 128 000               | 117 400               | 0.090          | 0.106                                       | 253 000   | 97                     |
| 1989         | 7 515 750               | 122 400               | 0.091          | 0.108                                       | 267 000   | 103                    |
| 1990         | 3 864 250               | 75 000                | 0.100          | 0.118                                       | 163 000   | 63                     |
| 1991         | 160 500                 | 66 000                | 0.100          | 0.118                                       | 158 000   | 61                     |
| 1992         | 222 500                 | 100 000               | 0.104          | 0.123                                       | 248 000   | 95                     |
| 1993         | 609 000                 | 76 600                | 0.091          | 0.108                                       | 167 000   | 64                     |
| 1994         | 824 750                 | 150 500               | 0.104          | 0.123                                       | 374 000   | 144                    |
| 1995–96      | Unknown                 | 238 000               | 0.071          | 0.084                                       | Ore stockpiled  | –                      |
| <b>Total</b> |                         | <b>945 900</b>        | <b>0.091</b>   | <b>0.108</b>                                | <b>1 630 000</b>  | <b>627</b>             |

Table 2. Production plan for the Dornod uranium project.

| Production   | 1998    | 1999      | 2000      | 2001      | 2002      | 2003      | 2004      | 2005      | 2006      | 2007      | 2008    | Total      |
|--|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|---------|------------|
| Tonnes mined   | 538 000 | 700 000   | 1 050 000 | 1 050 000 | 1 050 000 | 750 000   | 350 000   | 350 000   | 350 000   | 350 000   | 95 328  | 6 633 328  |
| Contained tU @<br>0.192% grade                           | 613     | 940       | 1 729     | 1 729     | 1 729     | 1 446     | 1 068     | 1 068     | 1 068     | 1 068     | 261     | 12 722     |
| Years of production                                      | 0.5     | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 1.0       | 0.4     | 9.9        |
| <b>Mine #2 stockpile</b>                                 |         |           |           |           |           |           |           |           |           |           |         |            |
| Tonnes to pad  | 238 000 | 0         |           |           |           |           |           |           |           |           |         | 238 000    |
| – Head grade (%U)  | 0.071%  | 0.071%    |           |           |           |           |           |           |           |           |         | 0.071%     |
| – Recovery (%U)  | 77.0%   | 77.0%     |           |           |           |           |           |           |           |           |         | 77.0%      |
| – Recoverable tU   | 39.0    | 91.1      |           |           |           |           |           |           |           |           |         | 130        |
| – Recoverable<br>lbs U <sub>3</sub> O <sub>8</sub>       | 101 489 | 236 809   |           |           |           |           |           |           |           |           |         | 338 298    |
| <b>Mine #2 open pit</b>                                  |         |           |           |           |           |           |           |           |           |           |         |            |
| tonnes to pad  | 300 000 | 700 000   | 700 000   | 700 000   | 700 000   | 400 000   | 0         |           |           |           |         | 3 500 000  |
| – Head grade (%U)  | 0.148%  | 0.134%    | 0.094%    | 0.094%    | 0.094%    | 0.094%    | 0.094%    |           |           |           |         | 0.107%     |
| – Recovery (%U)  | 77.0%   | 77.0%     | 77.0%     | 77.0%     | 77.0%     | 77.0%     | 77.0%     |           |           |           |         | 77.0%      |
| – Recoverable tU   | 102.7   | 601.7     | 616.5     | 508.8     | 508.8     | 399.8     | 145.4     |           |           |           |         | 2 884      |
| – Recoverable<br>lbs U <sub>3</sub> O <sub>8</sub>       | 266 976 | 1 564 369 | 1 602 885 | 1 322 922 | 1 322 922 | 1 039 438 | 377 978   |           |           |           |         | 7 497 490  |
| <b>Mine #7 UG</b>  |         |           |           |           |           |           |           |           |           |           |         |            |
| Tonnes to pad<br>(69%)                                   |         |           | 241 500   | 241 500   | 241 500   | 241 500   | 241 500   | 241 500   | 241 500   | 241 500   | 72 058  | 2 004 058  |
| – Head grade (%U)  |         |           | 0.159%    | 0.159%    | 0.159%    | 0.159%    | 0.159%    | 0.159%    | 0.159%    | 0.159%    | 0.159%  | 0.159%     |
| – Recovery (%U)  |         |           | 70.0%     | 70.0%     | 70.0%     | 70.0%     | 70.0%     | 70.0%     | 70.0%     | 70.0%     | 70.0%   | 70.0%      |
| – Recoverable tU<br>(30%)                                |         |           | 134.7     | 269.4     | 269.4     | 269.4     | 269.4     | 269.4     | 269.4     | 269.4     | 215.1   | 2 235      |
| – Recoverable<br>lbs U <sub>3</sub> O <sub>8</sub> (30%) |         |           | 350 185   | 700 369   | 700 369   | 700 369   | 700 369   | 700 369   | 700 369   | 700 369   | 559 158 | 5 811 927  |
| <b>Mine #7 UG</b>  |         |           |           |           |           |           |           |           |           |           |         |            |
| Tonnes to mill<br>(31%)                                  |         |           | 108 500   | 108 500   | 108 500   | 108 500   | 108 500   | 108 500   | 108 500   | 108 500   | 23 270  | 891 270    |
| – Head grade (%U)  |         |           | 0.630%    | 0.630%    | 0.630%    | 0.630%    | 0.630%    | 0.630%    | 0.630%    | 0.630%    | 0.630%  | 0.630%     |
| – Recovery (%U)  |         |           | 92.0%     | 92.0%     | 92.0%     | 92.0%     | 92.0%     | 92.0%     | 92.0%     | 92.0%     | 92.0%   | 92.0%      |
| – Recoverable tU<br>(70%)                                |         |           | 628.9     | 628.9     | 628.9     | 628.9     | 628.9     | 628.9     | 628.9     | 628.9     | 134.9   | 5 166      |
| – Recoverable<br>lbs U <sub>3</sub> O <sub>8</sub> (70%) |         |           | 1 635 052 | 1 635 052 | 1 635 052 | 1 635 052 | 1 635 052 | 1 635 052 | 1 635 052 | 1 635 052 | 350 670 | 13 431 082 |
| <b>Mine #7 UG</b>  |         |           |           |           |           |           |           |           |           |           |         |            |
| Total tonnes mined                                       |         |           | 350 000   | 350 000   | 350 000   | 350 000   | 350 000   | 350 000   | 350 000   | 350 000   | 95 328  | 2 895 328  |
| – Average head<br>grade (%U)                             |         |           | 0.305%    | 0.305%    | 0.305%    | 0.305%    | 0.305%    | 0.305%    | 0.305%    | 0.304%    | 0.274%  | 0.304%     |
| – Average recovery<br>(%U)                               |         |           | 71.5%     | 84.1%     | 84.1%     | 84.1%     | 84.1%     | 84.1%     | 84.1%     | 84.4%     | 133.9%  | 84.1%      |
| – Total recoverable<br>tU                                |         |           | 764       | 898       | 898       | 898       | 898       | 898       | 898       | 898       | 350     | 7 401      |
| – Total recoverable<br>lbs U <sub>3</sub> O <sub>8</sub> |         |           | 1 985 236 | 2 335 421 | 2 335 421 | 2 335 421 | 2 335 421 | 2 335 421 | 2 335 421 | 2 335 421 | 909 828 | 19 243 009 |
| Total recovered (tU)                                     | 142     | 693       | 1 380     | 1 407     | 1 407     | 1 298     | 1 044     | 898       | 898       | 898       | 350     | 10 415     |
| Total recovered<br>(lbs U <sub>3</sub> O <sub>8</sub> )  | 368 466 | 1 801 178 | 3 588 121 | 3 658 342 | 3 658 342 | 3 374 859 | 2 713 398 | 2 335 421 | 2 335 421 | 2 335 421 | 909 828 | 27 078 797 |

**Orebody (underground).** The main orebody resides in a single block approximately 30 metres thick which is amenable to bulk mining technology. Three shafts have been sunk (400–450 metres deep) with extensive underground exploration drifts (22 km).

In June 1995, WM Mining Company entered into a tripartite agreement with the Priargunsky

Mining and Chemical Company and Mongol Erdene, a mining company owned by the Mongolian government. Initially each party had one-third ownership, but WM Mining eventually negotiated 58% ownership, with the other parties owning 21% each.

WM Mining was obligated to place US\$2 million into a Charter Fund to register the company, which

is a Mongolian limited liability corporation (stock company) named Central Asian Uranium Company (CAUC). WM Mining was further obligated to provide US\$6 million in financing and had responsibility for marketing 100% of the production, as well as providing Western-style market economy management assistance. WM Mining also undertook to provide a project feasibility study for the open pit mine and an environmental assessment; both were completed in 1995.

In November 1996, the mine was placed in care and maintenance status by Priargunsky, the then project operator. In July 1997, WM Mining sold its rights and obligations to World Wide Minerals Ltd, a public company listed on the Toronto Stock Exchange. Under World Wide's ownership, the Charter Fund was set up, the company registered and, in November 1997, mining operations at the open pit were recommenced.

Since late 1997, the No. 1 Heap Leach Pad has been constructed and 230 000 tonnes of stockpiled ore have been placed on the pad. Over 200 000 m<sup>3</sup> of overburden have been stripped utilising three EKG five cubic metre electric shovels and a fleet of seven 35-tonne Belaz trucks. The project-related workforce totalled 363 employees – including those associated with the infrastructure (store, schools, hospital) – of which half are Russian and half are Mongolian.

The current plan is to purchase five additional Belaz trucks, two 988 F Caterpillar front-end loaders and six 769 Caterpillar 40-tonne trucks, with EXIM Bank financing. This additional equipment will provide an open pit mine capacity of over 1 million pounds U<sub>3</sub>O<sub>8</sub> (380 tU) with six million tonnes of ore mining and stripping capacity per year. The open pit mine is planned to produce over 1 million

pounds U<sub>3</sub>O<sub>8</sub> per year for seven years at an average grade of 0.15% U<sub>3</sub>O<sub>8</sub> for the first two years and 0.1% U<sub>3</sub>O<sub>8</sub> for the final five years. A heap leach process plant has been designed and will be constructed to recover ammonium uranyl carbonate (yellowcake), which will be purified at Priargunsky.

As the company acquires long term contracts sufficient to support and to finance underground production we will place the underground mine into production with a capital investment of US\$17 million. This mine is planned to produce over 2 million pounds U<sub>3</sub>O<sub>8</sub> (770 tU) per year for 10 years. The average ore grade of ore mined (with dilution) will be 0.359% U<sub>3</sub>O<sub>8</sub>.

CAUC plans to radiometrically sort the ore from the underground mine. The low grade fraction should be 69% of the ore (30% of the recovered uranium) and average 0.187% U<sub>3</sub>O<sub>8</sub>. This ore will be heap leached. The higher grade fraction should be 31% of the ore (70% of the recovered uranium) and average 0.74% U<sub>3</sub>O<sub>8</sub>. The high grade ore will be shipped to Priargunsky for milling.

The annual production according to the planned schedule is shown in Table 2. However, market conditions are likely to delay the start of the underground mine. As of 7 August 1998, the Dornod project has been placed on standby pending an improvement in the fundamentals of the uranium industry and the resolution of the long outstanding debt of the Kazakhstan government to World Wide Minerals Ltd.

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