with weak disseminated copper mineralization are intruded also into this Dushlin ovoe volcanites. Generally this area is poorly studied but it might be one promising area if carried out more detailed study.

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PETROLEUM POTENTIAL OF MONGOLIA

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Historical review on oil production in Mongolia

Petroleum exploration in Mongolia began with the classification of Mesozoic and Tertiary sediments and the discovery of outcrop of oil-shale related to petroleum genesis during the geological research by American geologist H. Berkley and C. Morris in 1922-1923 in the Gobi region of the country. The existence of oil in Mongolia was presumed by American geologist D. Tenner in 1931, and the Zuunbayan oilfield in East Gobi was discovered by Mongolian geologist J. Dugersuren and Soviet geologist Yu. S. Jelubovsky in 1940.

Between 1947 and 1963 two small oilfields and 80 buried structures with possible oil potential, were discovered during the petroleum exploration by former Soviet geologists in the southern, southeastern and eastern parts of the country.

In 1947 "Mongolneft" trust was established and an oil refinery with a processing capacity of about 0.4 million barrels for year was built in Zuunbayan in 1950. Between 1950 and 1969 some 4 million barrels of oil were produced from the Zuunbayan oilfield and a total of 7 million barrels of oil (including lighter oil imported from Russia to be mixed with Zuunbayan oil) were processed at the refinery, which supplied more than 20% of the country's fuel and lubricants demand at that period. However, due to several factors such as well pressure decrease, the fire accident that destroyed the refinery, and discoveries of giant oil fields in western Siberia, Russia, petroleum operations in Mongolia ceased in 1969.

Following the breakup of the Soviet Union in 1989, a wave of democratic reforms swept through Mongolia. In 1990 Mongolia chose democracy and an open-market economy. Resumption of the petroleum industry of Mongolia followed these transactions.
In 1991 the Petroleum Law of Mongolia was ratified by the Parliament. The Law established a legal foundation for new development of petroleum exploration in Mongolia.

Mongolia's sedimentary basins, prospects for petroleum, were divided into 22 exploration blocks (with a total area of 528.400 square kilometers) for which Mongolia carried out two international exploration promotion biddings.

During 1990-1993 a number of exploration studies were carried out, including sedimentary basins fieldwork by "British Petroleum" and "Phillips Petroleum" reprocessing of reports and information prepared by previous researchers in cooperation with "Exploration Associates International", USA, and seismic surveys performed by "Western Geophysical", USA and "Sibneftgeophysica", Russia.

Current exploration and production activities

Tamtsag basin

Since 1993 on Blocks XIX, XX, XXI and XXII in the Tamtsag basin the SOCO International plc, UK, has acquired, processed and interpreted a total of 6282 km. of 2D and 232 sq.km. of 3D seismic, drilled 20 exploration and appraisal wells, with overall investing exceeding US$ 70 min. SOCO were operated in Blocks XIX, XXI and XXII, retaining 85% interest in the Tamtsag Basin, with Huabei Oilfield Services, the Chinese drilling sub-contractor holding 10% interest and Petrovietnam, holding the remaining 5%.

SOCO's 2000 and 2001 successful drilling program (6 out of 8 wells in Blocks XIX and XXI encountered very good oil shows) confirmed the value of 3D seismic surveys and repeated their 75% wildcat success rate. Currently there are 6 wells on regular production, which is estimated to be, 1.000 barrels per day during 2002.

Sales of crude oil to the China National United Oil Corporation were disrupted by a fire accident at SOCO's storage facility in October 2002. Sales were resumed in August, 2001 after completion of the installation of production and storage facilities at four producing wells. Since February, 1998, more than 180.000 bblls of oil were exported by trucks to the Aershan pipeline terminal in Inner Mongolia, China. At the August, 2005, Daqing of China. Petrochina Daqing Tamtsag Co. acquired all the rights from SOCO and started of the operating on oil Exploration and Production test. As of today Daqing is operating in Blocks XIX, XXI and XXII, currently there are 19-26 wells on regular production, which is estimated to be, 1.300 barrels per day.

East Gobi Basin

In 1994-1997 Nescor Energy (USA) conducted exploration and appraisal operations in Blocks XIII and XIV, drilling two exploration wells, re-entering some old Russian wells and establishing a field base in Zuunbayan city.

In 1998 the Joint Venture of Gulf Canada and ROC Oil (Australia) acquired all the rights and assets under two PSCs on Blocks XIII, XIV from Nescor Energy and concluded two new PSCs on Blocks XV and X-North.

In 1998-2000 the Joint Venture drilled 5 exploration and appraisal wells, acquired, processed and interpreted a total of 2745 km. of 2D seismic surveys and carried out satellite imagery analysis, regional technical studies, pilot surface geochemistry (iodine detection) and basin modeling programs, investing in excess of US$55 mln. Also, under the sales contract with Sinochem, a total of 151.000 bbls of oil were exported to China by railway in 1998-2001.

In January 1999 Gulf Canada decided to withdraw from the Mongolian project because of the oil prices downturn. The other acreage, which is Block XV, X-North and a PSC on the remaining area of Blocks XIII and XIV was relinquished in February 2001 according to agreement between PAM and ROC.Subsequently, effective June 21, 2001 ROC farmed out 49% of its interest of the PSCs, which covers parts of Blocks XIII, XIV to the Dongsheng Jinggong Petroleum Development

Group, a Chinese oil company under SINOPEC. Unter the terms of the farmout agreement, Dongsheng will pay 100% of two exploration wells to be drilled in 2002 and later of this year Dongsheng Jinggong Petroleum Group of China acquired all the rights from the ROC Oil . As of today Dongsheng is operating in area of Oil fields Zuunbayan and Tsagaan Els, currently there are 30-37 wells on regular production, which is estimated to be, 800 barrels per day.

Petroleum potential of Mongolia

Despite the scarcity of exploration data on Mongolia's petroleum potential, caused by the interruption of exploration activities for 20 years between 1970 to 1990, positive geological and geophysical data reported oil seeps throughout the sedimentary basins. Recent discoveries of oil, as well as geologic similarities of hydrocarbon basins in Mongolia to adjacent Chinese producing basins, such as the existence of stratigraphic traps, fault traps, faulted anticlines and over-thrust folds, indicate the high probability of finding substantial petroleum reserves in Mongolia.

Mongolia's hydrocarbon potential remains almost unknown. Lack of exploration data prohibits us from coming up with a precise estimation of recoverable petroleum reserves in Mongolia. Some American experts estimate it to be from 4 to 6 billion barrels of recoverable oil. However, given the presence of source rocks and good quality acquisition and geological analyses are necessary to better delineate and evaluate the petroleum prospects of the country.

The greater part of China's crude oil production is concentrated in the north-western and northeastern basins adjacent to Mongolia, such as Daqing, Erlian, Shendenkou and Karamay, where intensive exploration activities have been carried out science the early 80s. Geologic fieldwork conducted in Mongolia revealed many similarities between the Chinese Ershan and Hailar basins and the eastern Mongolian basins such as Tamtsag and East Gobi basins.

These similarities indicate that Mongolia has the necessary geologic conditions critical to the formation of oil.

The recent exploration activities in the Tamtsag and East Gobi basins have substantially reduced the exploration risk in these prospects. Current results of upstream activities in Mongolia clearly indicate that there are exciting opportunities for foreign oil companies willing to explore this frontier area.

An independent analysis of the Tamtsag Basin, which was conducted in 2001 by the Research Institute of Chinese National Petroleum Corporation (CNPC) based on SOCO's 1993-2000 exploration operations data, attributed original oil-in-place in the Tamtsag Basin to be approximately 1.5 billion barrels. The Chinese recovery factor in analogous basins range around 30%.

All, proven reserves of the 3D covered area of Block XIX are estimated to be 49.8 million barrels according to the resource assessment by the Fekete Associates Inc, a reservoir engineering and geological company from Calgary, Alberta, Canada.

Geological Setting

The Soviet and Mongolian geoscientists have previously established and defined thirteen (13) major sedimentary basin systems within Mongolia, and they further subdivided the basinal systems into fifty-nine (59) sub-basins, see fig. 1 and table 1. These basins are Cenozoic and Mesozoic rift basins that were developed as successive tectonostratigraphic terrine accreted to the southern margin of the Siberian Craton. Rift and graben deformation developed during the opening and closing of Paleo-Tethys and Neo-Tethys. The rift basins were filled with continental sediments beginning in the Jurassic. These sediments include volcanic, breccias and conglomerates. During the Upper Jurassic-Lower Cretaceous lacustrine shale-sandstone sequence contains the known hydrocarbon source and reservoir rocks in southeastern Mongolia.

Geology of oil field in Mongolia

In the East Gobi, Tamtsag and Nyalga basins are distributed Paleozoic, Sharlyn Formation of Upper Jurassic, Tsagaantsav Formation of Upper Jurassic and Lower Cretaceous and Lower and Upper Zuunbayan Formations of Lower Cretaceous and Upper Cretaceous were predominantly deposited in fluvial environments.

The stratigraphic column for the basins is shown in figure /3, 1992, and 6, mogoi/.

Sharlyn Formation is composed interbedded of medium to large sized conglomerate with sandstone. TD has been set to fully penetrate the Tsagaantsav Formation and will be called once the Sharlyn formation has been recognized.

Tsagaantsav Formation is composed of mudstone, sandstone, conglomerates, igneous rock and bentonites. Rock types change rapidly. Five sections can be divided from top to bottom.

1. mid-fine conglomerates with lenticular sandstone and mudstone.
2. muddy sandstone, sandstone, siltstone and mudstone, with dark grey or green shale at the top.
3. igneous sandstone with mudstone and siltstone interbeds.
4. dark, green grey mudstone; and
5. sandy mudstone with sandstone, mudstone and siltstone.

Total thickness is about 560 m.

Lower Zuunbayan Formation is composed predominantly of dark gray shale. The upper part is composed of dark gray shale (usually paper shale) with sandstone or siltstone layers in the middle, while the lower part is composed of mudstone and sandstone interbedded with oil shale /to 90 ms /. Total thickness is 1075 m.

Upper Zuunbayan Formation is composed of sandy mudstone mostly colored green gray. Two parts can be divided. The lower part is dominated by sandy mudstone with conglomerate interbeds. The upper part is interbedded with coal seams. Total thickness is about 875 m.

Late Cretaceous is composed predominantly of red sandstone in the lower part and red mudstone in the upper deposited in alluvial- fluvial facies, about 470-500 m thick.

Palynological study on oil field

Palynological analyses were done for the Lower and Upper Zuunbayan Formations of Zuunbayan area.

In assemblage dominant gymnosperm pollen and represented by *Variavesiculites delicates, Podocarpidites luteus, Pinuspollenites divulgatus, Cedripidites admirabilis, Sciadopityspollenites sp., Cycadopites sp., Classopollis sp., Abiespollenites sp., Protocedrus cenomanicus* and *Protoconiferus lunarius.* Among the spores are presents *Cicatricosisporites australis, Leptolepidites verrucatus, Distaltriangulisporites sp., Lygodiumsporites subsimplex and Laevigatisporites ovatus.* Angeosperm pollen is rare in this assemblage.

These are well correlated to spores and pollen assemblages of Zuunbayan (Davies, 1999).

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