

Potash Development in Lao PDR

Manomay Vilayhong

Vice General Manager, Sino-Lao Potash Mining Co., Ltd

1 Introduction

The northern Thai potash basin, the Sakon Nakhon basin extends across the Mekong into the Lao PDR in two locations, north of Nongkhai in the Vientiane Basin and east of Nakon Phanom in the Thakhek Basin (Fig.1).

The existence of potash salts in Lao PDR was proven during the potash exploration campaign of 1970s by one single drill hole in the Vientiane Basin. This hole was drilled in 1974 in the area of Ban Don Noun (15 km north of the Vientiane center by USAID and intersected a considerable length of high grade sylvinite (Hite R.J. and Jakapasetr T. Economic Geology, vol. 74, 1979).

Exploration and development of the potash resources in Lao PDR have progressed well over the years.

2 Exploration and Development of Potash in the Vientiane Basin

In 1986 Intergeo of Vietnam evaluated the potash resources in the Vientiane Basin. A drill program of 32 holes was completed and the total resources of the basin were calculated at 9 billion tonnes of KCl in 50 billion tonnes of ore.

In a bi-lateral arrangement, a Chinese Government company, Yunnan Geological and Mineral Exploration Engineering Corporation (Group), China, was given an exploration concession area over a large part (1998 km²) of the Vientiane Basin in 2001.

The exploration works started from March 2001 and ended in June, 2003. A drill program of 19 boreholes with total drilling depth 9,582 m was completed and the total resources/reserves

of the explored area (Basin) were calculated at 14.20536 billion tonnes of potassium chloride (KCl). The resource estimation map of the Potash- magnesium Salt in Vientiane Plain is shown in Fig. 2.

The report preparation has completed in November, 2003 and its assessment was completed in April 2004.

3 Current Status of Potash Development in the Vientiane Basin

3.1 Mining Licenses

In Vientiane Basin the Lao Government has granted 2 mining licenses. First mining license was issued to Sino-Lao Potash Mining Co., Ltd and the second mining license was issued to SinoHydro Mining (Lao) Co., Ltd. The mining concession area is shown in Fig. 3.

Sino-Lao Potash Mining Co., Ltd

The Agreement on the Exploration and Feasibility Study for the Development of Potash Deposits in the Vientiane Basin, Lao PDR, between the Yunnan Geological and Mining Survey Engineering Corporation Group of China and the Lao Government has been signed on July 2001 in Vientiane Capital, Lao PDR.

After nearly 3 years of the exploration works, it has been made clearly that in the area of nearly 2000 km² on the Vientiane plain, there are rich in potassium salt reserves.

The Agreement on the Mining and Production of Potassium Salt in Vientiane basin, Lao PDR has eventually been signed in November 2004.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต

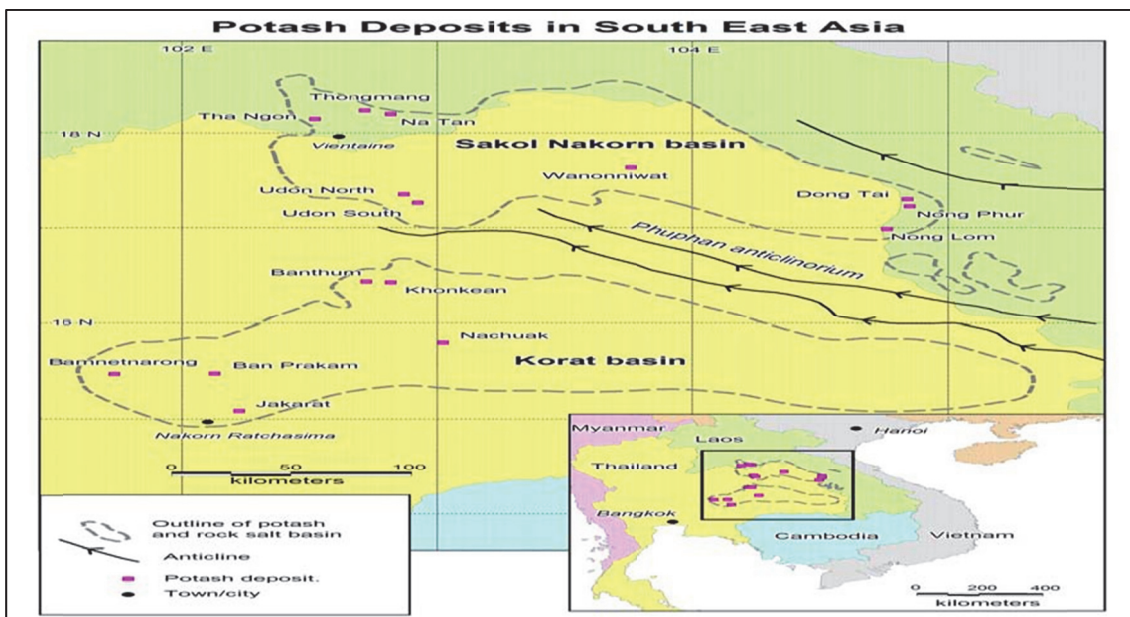
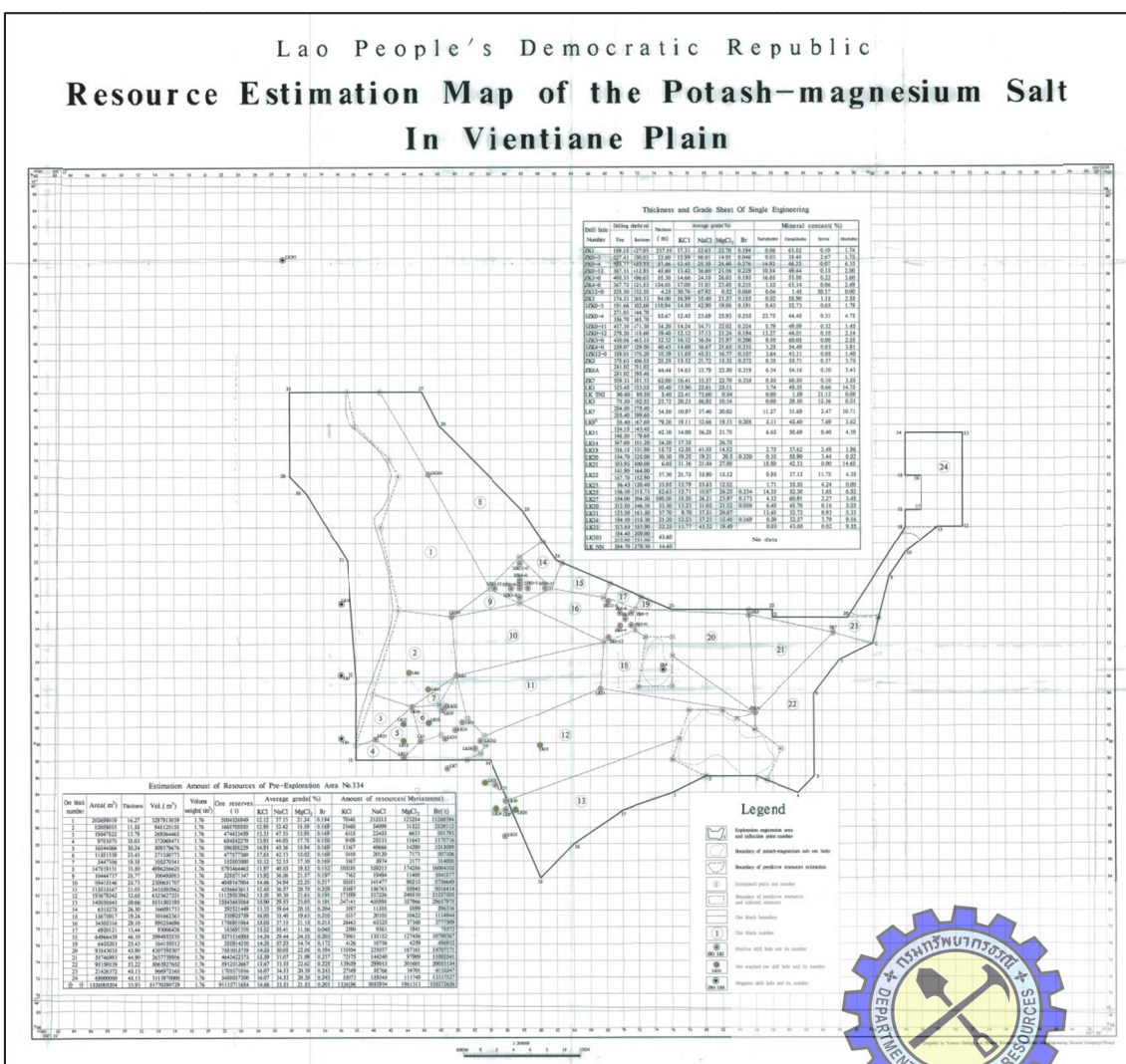


Fig. 1 Potash deposits in Thailand and Lao PDR.



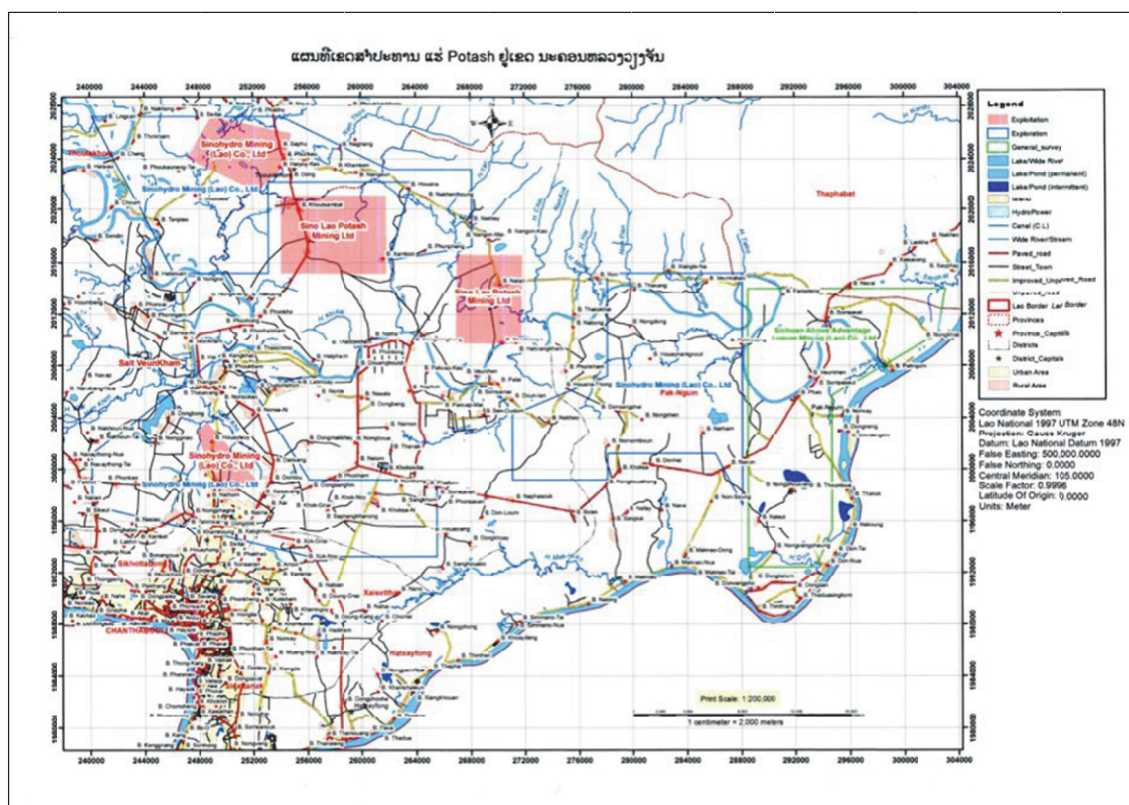


Fig. 3 Map of the Potash Mining Concession Area in Vientiane Basin

By this agreement, the company engages investment in mining potash mineral by constructing of potash factory with the production capacity of one million tonnes per year.

To obtain the optimum mining and processing technical parameters and to accumulate experience and make conditions for the subsequent large scale development and construction, the government of Lao PDR will approve Yunnan Sino-Lao Mining Development Investment Co., Ltd. to start commercial experimental mining and production of KCl at a scale 50,000 t/a, for a final objective to build a potassium salt base sized at 1 million t/a of KCl.

The initial mining area selected for the commercial experimental mining and production of KCl at a scale 50,000 t/a lies in the section of Thong Mang Mine (Fig. 4),

which covers an area of about 11.0 square kilometers and has ore reserve of 9,664.94 million tonnes with ore grade of (KCl%) 14.24% and KCl 1,376.07 million tonnes.

Mining Project Location (2)

The objective of the project's product follows standards of potassium chloride in the National Standard of the People's Republic of China GB6549-1996. Total investment in this project's construction is estimated at about 387 million RMB.

The construction of the potash mining and production at Thong Mang site has started in December 19th, 2008, and in the year 2010 the opening ceremony for the first mining and production of Potassium chloride (carnallite type) on the scale 50,000 t/a has been commissioned officially.

เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต



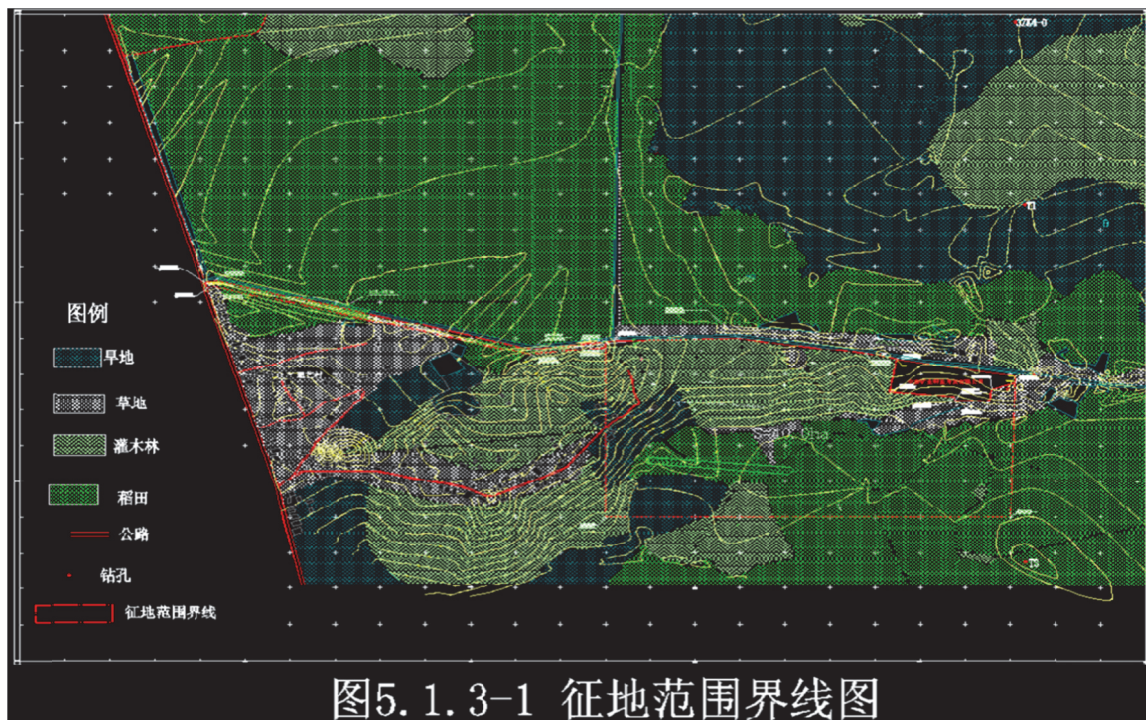


Fig. 4 Thong Mang first initial mining site of Sino-Lao Potah Mining Co., Ltd.

By the year 2012, 1500t of KC has been produced (Fig. 5 and 6). Some technical problems met during the operation of the underground exploitation of the ore have been observed and studied in order to resolve the problems. Based on the researches on the existed problem the company can find the method to improve that of exploitation and processing. The company expected that from July 2013 the full system of exploitation and processing can be operated regularly and the production of 50,000 t/KCl can be reached in the year 2014.

4 Current Status of Potash Development in the Thakhek / Khammouane Basin.

Currently, in the Khammouane Basin the Lao government has granted 2 mining licenses. The first mining license was issued to Jiayi Lao Co., Ltd (Sino-Agri) and the second license was issued to Lao Kaiyuan Co. Ltd. Both are Chinese companies. VINACHEM, Vietnamese company, has also signed a mining agreement

with the Lao government but VINACHEM still not yet received the Certification of Compliance for ESIA. After the approval of the revised ESIA, VINACHEM will also obtain a Mining License. The location of the Potash mining concession area is shown in Fig. 7.

4.1 Lao Kaiyuan Mining Co., Ltd.

Project Name: Khammouane 500,000 t/a Potassium Chloride Project of Lao Kaiyuan Mining Co., Ltd.

The Owner: Lao Kaiyuan Mining Co., Ltd

Nature of Enterprise: Shareholding Company

Project Location: Thakhek City of Khammouane Province, Lao PDR.

Concession Area: 194.8 km² Mining Area, Nongkhou Area (41.69 km²) is determined to be the initial mining area based on the ore bed characteristics through boring in the mining area.

เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต



Fig 5-6 First product of KCl.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต

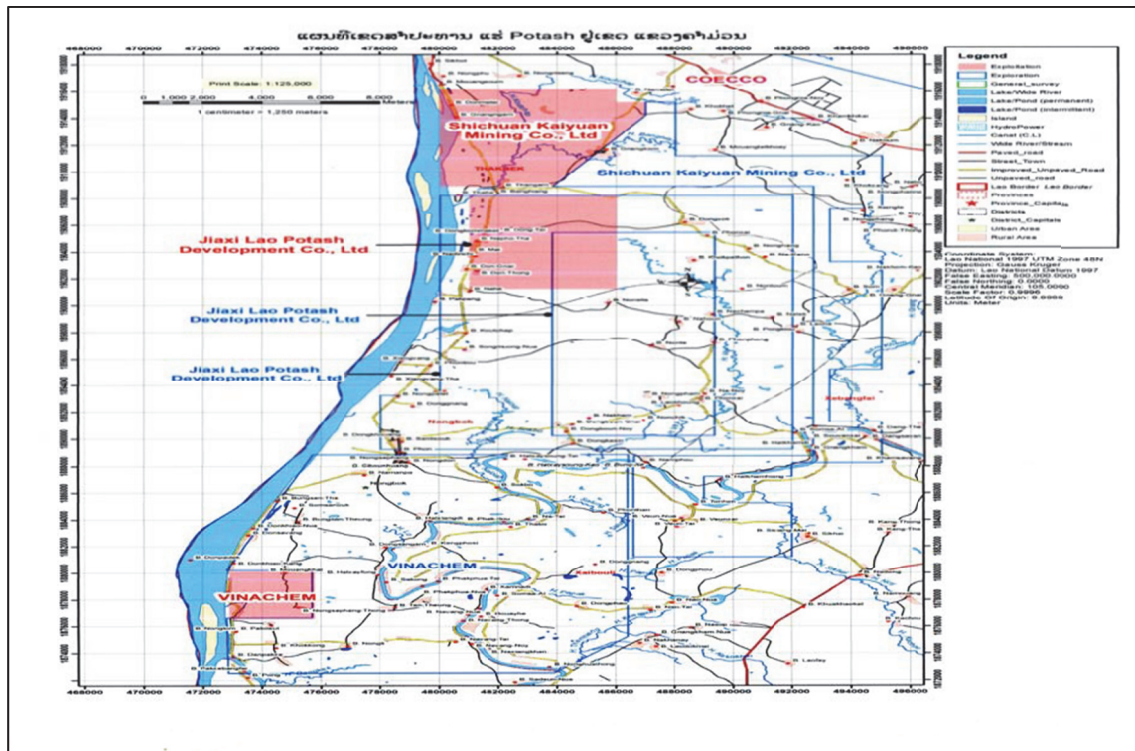


Fig. 7 Map of the potash mining concession area in the Khammouane Basin.

According to the geological exploration report reviewed and approved, potash-magnesium salt resources in the proposed exploration area are about 1,346 million tonnes, and resources potassium chloride are about 231.8 million tonnes.

The construction scale of phase I will reach annual yield of 500,000 tonnes potassium chloride and sylvinites will be exploited.

Geology

According to the feasibility study and design, potash deposit in Thakhek- Xebangfay-Khammouane & Saybouri-Savannakhet will be mined, where the potash-magnesium salt deposit is about 7.0 km long, 2.8-4.7 km wide and has an area of around 22.38 km².

Potash-magnesium salt ore bed in the Nongphu Mining Area can be divided into three ore beds from top to bottom: secondary sylvinites ore bed, carnallite ore bed,

and primary sylvinites ore bed. Of these, secondary sylvinites ore bed in the upper part is the major mining object of this feasibility study.

Potash-magnesium salt ore bed in the Nongphu Mining Area is a super huge potash-magnesium salt ore bed, which is with overburden layer (thickness of the overburden layer is 70.85-366.96m, averaging at 186.43m), slightly tilting (with inclination of 3-25°, mostly around 10°), thick bed (average thickness of the sylvinites deposit is 5.23m and that of carnallite deposit is 20.91 m), of medium-low grade (average content of KCl in potash-magnesium salt deposit is 17.29%, in which average content of KCl in potash deposit is 27.52% while that in carnallite is 16.91%), and consists mainly of carnallite deposit.

Structure of the mining area

Geological structure of the Nongphu Mining Area is mainly salt anticline. Distribution of the potash-magnesium salt deposit is totally

เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต

controlled by the salt anticline. Therefore, structure of the Nongphu Mining Area is featured by characteristics of the anticline.

Ore and Mineral characteristics

Ore mineral in potash-magnesium salt deposit of the Nongphu Mining Area is mainly carnallite and sylvinite, and gangue mineral is mainly halite and anhydrite. Classification standard is sylvinite ore: $MgCl < 2.50\%$, $KCl \geq 5.00\%$, carnallite ore: $MgCl_2 > 2.50\%$, $KCl \geq 5.00\%$.

Construction conditions

Resource conditions

Exploration object is designed to be the sylvinite ore bed in the first mining area. Sylvinite lies in the upper and lower ore beds, which incline slightly from northeast to southwest with the gradient of $3^\circ - 23^\circ$. The upper K3 ore bed consists of secondary sylvinite ore, whose roof level is 18.16-204.06m, floor level 12.97-173.73m, and average thickness 4.68m; the lower k1 ore bed consists of primary sylvinite ore, whose roof level is 68-201.77m, floor level 55-202.46m, and average thickness 1.40m. KCl average grade in K3 ore bed is 27.46% and KCl average grade in K1 ore bed 14.32%. The sylvinite ore has an average mass of 2.03t/m³ and average humidity of 1.39%.

According to the technical conditions if exploration of the ore bed and content of useful component in the ore, it is designed to explore (exploit) the upper K3 ore bed. The lower K1 ore bed will be explored (exploited) in combination with carnallite in the future.

According to the exploration report submitted, the ore resources are 105,100.41Kt and KCl resources 28,862.84 Kt.

Construction scale and product scheme

Construction scale is 500,000 tonnes of potassium chloride every year, for which 1,853,300 tonnes of sylvinite ore is required. As for the product scheme, only potassium chloride will be produced, with KCl content $\geq 95\%$ and recovery rate of 90% (Fig. 8)

4.2 Jiaxi Lao Potash Development Co., Ltd. (Sino-Agri Potash Mining)

Project Name: Dong-Tai Potash Project, Khammouane 100,000 t/a Potassium Chloride Project of Jiaxi Lao Potash Development Co., Ltd. (Sino-Agri Potash Mining)

The Owner: Jiaxi Lao Potash Development Co., Ltd. (Sino-Agri Potash Mining)

Project Location: Nong Bok District of Khammouane Province, Lao PDR.

The designed throughput of Dong-Tai Potash Deposit Demonstration Project of Lao PDR is 500,000t sylvinite ore per year, and output of sylvinite concentrate is 108,600 t/a. The ore contains rich sylvinite. After the Demonstration Project is put into production, practical experiences from sylvinite mining and mineral processing will be accumulated in production, and pilot test will be carried out in order to provide the essential production data for future large-scale development and construction

Main design indexes include:

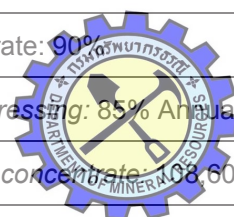
Mining capacity: 500,000 t/a Grade of run-of-mine

ore: KCl 23%

Grade of concentrate: 90%

Recovery of ore dressing: 85% Annual

output of sylvinite concentrate: 108,600 t/a



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต



Fig. 8 Construction of Mining and processing facility of Kaiyuan.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต

Dong-Tai Potash Project

The mine site is located at the northeast edge of the Sakon Nahone Basin, and the basin is located north of the Khorat Plateau with an area of 170,000km². The Khorat Plateau is located in the Indo-China middle block and situated in the south section of Indo-China folding system.

According to the comprehensive geophysical exploration results, three prospective potash deposits are outlined within 240km²: Deposit No.1 is named Dong Tai Potash Deposit with an area of 35 km², Deposit No.2 is Nachampa Prospective Potash Deposit with an area of about 24 km², and the deposit No.3 is Nongbok Prospective Potash Deposit with an area of about 24km². The general (preliminary) exploration and current engineering design are focused at deposit No.1.

Orebody characteristics

The deposit can be roughly classified into 5 ore beds according to the different types and grades of ores. However, the number and thickness of ore bed discovered by individual boreholes differ greatly; the thickness ore bed is 76.64m (JX-5), and the thinnest 2.02m (JX-4).

Ore property

The principal minerals include carnallite, sylvinite, halite, anhydride and gypsum, etc.

First Mining Area

The mining area near drill holes 4 (JX-4) is selected as the first mining section. The principal and the basis are as follows:

(1) Exploration degree of this area is high, and the amount of resource is reliable;

(2) Potash ore bed of this section is vast and thick (9.20m), the grade is high (KCl's content is 29.34%). The depth of the ore body is shallow (buried depth of 131.30m).

(3) There are a few of constructions and buildings on the ground; the section is far away from the Mekong River (more than 4 km). These are the advantages for the arrangement of shafts and auxiliary utilities on the surface.

Mining Method

Mining Conditions of the orebody

According to the latest material at present, the potassium and magnesium salt deposit layer of the first mining area has the thickness of 131.30-243.79m at the upper covering land, wherein, Mekong F. (Qmk), 1.30~5.80m; the upper alt unit of NongBok F.: mudstone, 41.20~42.11m; halite, 14.25-21.50m; middle salt unit: mudstone, 50.73~60.40; halite, 7.62~55.37m; lower salt unit: mudstone, 4.45~139.87m.

Mining method selection

Based on the above considerations, room and pillar stoping with post filling method is selected.

Dong-Tai potash Demonstration Project has been designed based on throughput of 500,000t/a of rich sylvite, 108,600t/a of potash concentrate output.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต



Fig. 9 Overview of Jiaxi processing plant.



Fig. 10 Inclination shaft.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต



Fig.11 First KCl product of Jiaxi

5 Exploration Licenses:

In Vientiane Basin (Vientiane Capital and Vientiane Province)

An Exploration License was also granted to Sinohydro Mining Co., (Lao) Ltd in order to continue to undertake more detailed exploration including feasibility in the remaining area from the mining area.

Three Prospecting Licenses for potash have been issued on Vientiane Province:

Beijing Phuyer Investment Co (Laos) Ltd, has licenses for 29,202 ha in Xaithani and Hatxayfong Districts. Beijing Phuyer –also known as Wyatt in some press reports—from the English translation of the Chinese name (北京普悅投資 (老撾)有限公司), is understood to be majority owned by Lingbao Gold Company, a Chinese Gold Mining company.

Shandong Haiwang Chemical Co Ltd. (山东海王化工股份有限公司) has prospecting

rights for 173 Km² in Thoulakhom District. Shandong Haiwang is Chinese company specialising in bromide salt production and from its website it has a current production of over 100 million tonnes raw salt in China.

Sichuan Above Advantage Lomon Mining (Lao) Co. Ltd has prospecting rights for

180 Km² in Pak-Ngum District. It is understood that this company is a subsidiary of the Lomon Mining Group in Sichuan, a significant phosphate chemical and Titanium Dioxide producer in China.

Bolikhamxai Province

Qinghai Xingdi Co. Ltd., has prospecting rights 16,099 ha in Thaphabath (Thaphabat) District north and east of Vientiane Capital and adjacent to and due north of an area being prospected in Pak-Ngum District, Vientiane Capital.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต

Yunnan Fortune Seecome Investment Industrial Co. Ltd., has 17,685 ha in Pakxan District. This is a Chinese investment company with unknown involvement in potash.

In Khammouane Province:

The exploration licenses were granted to JiaXi Lao Potash Development Co., Ltd, Lao Kaiyuan Mining Co., Ltd and Vinachem in order to continue to undertake more detailed exploration including feasibility in the remaining area from their mining area.

VI. Conclusion

Exploration and development of the potash resources in Lao PDR have progressed well over the years and at present there are 5 approved Mining Licenses. A total production level of between 3.8-7.8 million tonnes per year of KCl from the combined operations could be reached over the next few years, a level that will put the country firmly on the map as a significant potash producer.



เอกสารฉบับนี้เป็นลิขสิทธิ์ของกรมทรัพยากรธรณี
ห้ามทำซ้ำหรือดัดแปลงและแก้ไขโดยไม่ได้รับอนุญาต