Mongolia
Ministry of Mining

DATA COLLECTION SURVEY ON COPPER INDUSTRY SECTOR IN MONGOLIA

FINAL REPORT

October 2014

Japan International Cooperation Agency（JICA）

Mitsubishi Materials Techno Corporation
Mitsubishi Research Institute, Inc.
Sumiko Resources Exploration & Development Co., Ltd

I L
JR
14-111

Table of Contents

List of Figures, Tables and Photos

List of Abbreviations

Abbrebiation	Full name
BOT	Build Operate Transfer
CAPEX	Capital Expenditure
CGE	Computable General Equilibrium
DEIA	Detail Environmental Impact Assessment
DOR	Department of Road
EIA	Environmental Impact Assessment
EMC	Erdenet Mining Corporation
FS	Flash Smelting
GDP	Gross Domestic Product
GEIA	General Environmental Impact Assessment
HGP	Herlen Gobi Pipeline Project
ICSG	International Copper Study Group
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
JOGMEC	Japan Oil, Gas and Metals National Corporation
JORC	Joint Ore Reserves Committee
LME	London Metal Exchange
MAK	Mongolian Alt Corporation
MI	The Mitsubishi Process
MKPC	Mongolian-Korean Polytechnic College
MMAJ	Metal Mining Agency of Japan
MNMA	Mongokian National Mining Association
MRAM	Mineral Resources Authority of Mongolia
MTZ	Mongolian Railway State Owned Shareholding
MUST	Mongolian University of Science and Technology
NEDO	New Energy and Industrial Technology Development Organization
NSR	Net Smelter Return
NUM	National University of Mongolia
OGP	Orhon-Gobi Pipeline Project
OJT	On the Job Training
PP	Price Participation
RAM	Railway Authority of Mongolia
RF	Reverberatory Furnace
SEA	Strategic Environmental Assessment
SEPC	Specialist Education and Production Center
SX-EW	Solvent Extraction and Electrowinning
TC/RC	Treatment Charge / Refining Charge
UB	Ulaanbaatar
WB	World Bank

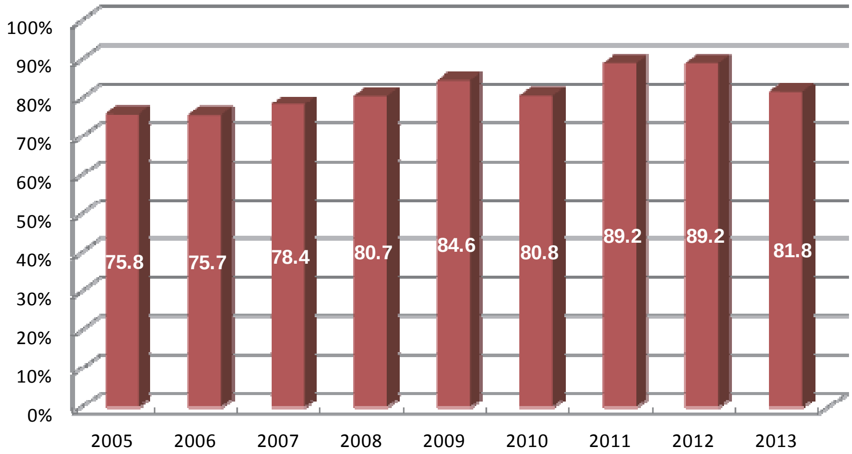
Note: Alphabet in order

Chapter 1. Introduction

1.1 Background of the Survey

1.1.1 Outlined State of Mining Industries in Mongolia

The mining in Mongolia is the industry accounting for 18.5% of GDP and 81.8% of total amount in exportation (both in 2013), and especially among whole mining industries, the mining of copper ores and production of copper concentrates, as mainly represented by Erdenet Mine which has been developed since 1970's, have played a large role in Mongolian economy (Figure 1.1.1). Although the development of coal mines has rapidly progressed in recent years, it is certain that the development of copper mines will continuingly occupy an important situation in the Mongolian economy since the development of new large scale copper mines such as Oyu Tolgoi Copper Mine, etc. are being progressed.



(Source: Statistical Bureau)

Figure 1.1.1 Percentage of Mineral Products in Total Amount of Exportation

On the other hand, from the reason that Mongolia is a landlocked country hemmed in by China and Russia, Mongolia is in the state subject to the deviation in prices of mineral resources since the exportation of ores, the method of transportation and the destination are limited. And, the majority of present industries relating to copper are mining of ores and production of concentrates, and however, the large scale pyrometallurgical smelting has not been carried out so far with the exception of small scale hydro-metallurgical smelting from low grade ores. From these states, the Government of Mongolia considers that the extension and improvement of market, increase in added value of products and diversification of industries related are the tasks for steady growth in the field of mineral industries, and accordingly the government is being in discussions on the preparation of policy for promoting and locating the most suitable industries related.

Although the action to these tasks has to be discussed upon grasping the industrial structure from mining, ore dressing to smelting in the field of mineral industries, international supply and demand, trend and future forecasting of foreign owned enterprises and geopolitical circumstances, etc., Mongolia is in the state that the cooperation from Japan will hopefully be expected since there is insufficiency in human resources and knowledge therein.

In 1990s of Mongolia, although agricultural and stock farming such as production of cashmere, wool, etc. were the major industries, mining industries have functioned as a leading force and as an importance acquisition source of foreign currency since 2005 because Mongolia is the country of mineral resources such as copper, gold, etc. Especially, it is being expected that the development of Oyu Tolgoi Mine (copper and gold) and the development of Tavan Tolgoi Coal Mine (coking coal and thermal coal) will largely contribute to the economical growth and the acquisition of foreign currency in Mongolia. Oyu Tolgoi Mine has commenced its production in 2013 and it is planned to perform its full operation in 2016, and the real growth rate on GDP of Mongolia in 2013 was 11.7% in accordance with the development of Oyu Tolgoi Mine as well as influence as the ripple effect to other industries from the same.

1.2.2 Policy for Mineral Industries in Mongolia

The government of Mongolia established in January of 2008 "General Development Policy of Mongolia based on the Millennium Development Target (The MDG-based Comprehensive National Development Strategy, 2008-2021: NDS)", which is comprehensively showing the policies for fourteen (14) years from the present for the purpose of development of nations in the democratic society, as well as the great development of economy, science, technology and culture in own country.

The policy in relation to mineral resources of the government on the basis of the above policy is as follows.

- Discovery of new mineral deposit(s)
- Renewal of facilities required
- Increase in production of final products
- Construction of copper smelter and commencement of producing cathode type copper (electrolytic copper) by 2015
- Construction of processing plant for molybdenum concentrates
- Production of phosphoric fertilizer
- Development of uranium deposit and refinery of uranium ores
- Investigation on the utilization conditions of nuclear power and environment
- Development of rare earth deposit and production of final products
- Construction of noble metal processing plant
- Investigation on the appropriate assistance by taxation system and financing so that the

products can sell under the conditions of both domestic and international markets as well as by increasing purity of respective metals

- Supply of domestically made construction materials (cement, iron, glass, etc.)
- Supply of domestically made petroleum products by refinery of crude oil and processing of coal
- Commencement of geological survey for coal-bed methane gas (CBM) and natural gas as well as promotion of gas utilization
- Decrease of exportation in the form of raw materials and promotion of exportation in the form of value added products
- Increase of gold reserves by the discovery of new gold mine(s) by means of utilizing advanced technologies as well as assistance(s) to the domestic gold smelter

In addition to the governmental policy as above stated, the National Policy on the Field of Mineral Resources (2014 ~ 2025) has newly been determined at the Great Parliament in January 2014. In the general provisions of the said policy, it is described that the national policy in the field of mineral resources is to improve the quality of exploration, mining and processing, to produce higher value added products and to increase competitiveness in the international market as its purpose by means of forming a safety and steady climate for investment, introducing the latest technology and machinery for minimizing the influence to natural environment as well as carrying out the innovation. According to the decision as above stated, the legal reformation of the Mineral Law is being deliberated in the Spring National Diet in 2014.

1.1.2 Copper Resources in Mongolia

Mongolia is one of major copper producing countries being next to Indonesia and China, and produced the quantity of copper concentrates corresponding to 130,000 t of copper metal in 2007. Although the annual production of copper ores from the country in the past several years is in the state of crawling sideways of a crab, a wide increase of production in future can be expected according to the development of large scale copper deposit.

The Parliament of Mongolia designated fifteen (15) deposits as the strategically important mineral deposits under stipulations in the Article of 8-14 in the Law of Mineral Resources. Copper deposits being included in the designated ones are shown in Table 1.1.1 and the locations of such deposits are as shown in Figure 1.1.2.

Table 1.1.1 Major Copper Mines and Deposits in Mongolia

Name of Mine	Erdenet Copper Mine	Oyu Tolgoi Copper Mine	Tsagaan Suvraga Copper Deposit
Location	Orkhon Province, Bayan -undur	Omnogobi Province, Khanbogd	Dornogobi Province, Mandakh
Type	Porphyry Copper Type	Porphyry Copper Type	Porphyry Copper Type
Mineral	Copper & Molybdenum	Copper & Gold	Copper & Molybdenum
Mine development	1978	2013	Under construction
Ore reserves	1,200,000,000 t	2,300,000,000 t	Oxide ore: 10,640,000 t Sulfide ore: 240,100,000 t
Ore grade	0.51%Cu (0.012g/t Au)	1.16%Cu (0.35g/t Au)	Oxide ore: 0.42%Cu (0.011g/t Au) Sulfide ore: 0.53%Cu (0.018g/t Au)
Method of mining	Open pit	Open pit (0.3% Cu) Underground mining (Planed ore grade: 0.6% Cu)	Open pit
Operator	Erdenet Mining (Joint Venture with shearing interests of 51：49 by the Mongolian Government and the Russian Government)	Oyu Tolgoi Corporation (Joint Venture by Turquoise Hill Resources and Mongolian Government)	MAK (Mongolian ALT Corporation)

（Source：Prepared by Survey Team）

In Mongolia, Erdenet Mining, a joint venture company of the Government of Mongolia and the Russian Government having rights and interests of 51:49 respectively, has exclusively produced copper concentrates so far. Total annual production of copper concentrates is approximately 530,000 t, and the copper contents of concentrates are approximately 25%. Erdenet Mining Company has produced copper concentrate at Erdenet Mine since 1978, and the copper concentrates produced by the said company are being exported to Russia and China as well as respective countries in the world such as U.S.A., Europe, etc.

However, Oyu Tolgoi Mine, the world largest class copper mine (Reserves in the quantity of metal are Copper: 25,400,000 t, Gold: 1,028 t and Silver: 5,144 t), has been developed by Ivanhoe Mines Company in Canada and Rio Tinto Group as the major enterprise handling mineral resources, and commenced its production in 2013 and produced copper concentrates of 290,000 t by the end of the same year.

Moreover, development of a Tsagaan Suvarga copper deposit is furthered by MAK Corporation of Mongolian capital aiming at the operation start in 2016. The Tsagaan Suvarga copper deposit is located to the 110km northeast of Oyu Tolgoi mine, and it is reported that reserves are 10,640,000 t (0.42% of copper content) of oxide ore and 240,100,000 t (0.53% of copper content) of sulfide ore.

N.B.) **Mine**: Baganuur (Coal), Boroo (Gold), Erdenet (Copper), Oyu Tolgoi (Copper), Tumurtein Ovoo (Zinc)
Tavan Tolgoi (Coal), Nariin Sukhait (Coal), Shivee Ovoo (Coal)

Deposit: Tsagaan Suvarga (Copper), Asgat (Silver), Burenkhaan (Phosphorus),
Gurvan Bulag (Uranium), Mardai (Uranium), Dornod (Uranium), Tunurtei (Iron)

(Source: MRAM, 2011)

Figure 1.1.2 Location Map of Mines and Major Deposits in Mongolia

1.2 Purpose of Survey

The purposed of this work is to investigate and to analyze the fundamental information on present states, requirements, issues, etc. of industries relating to copper, and the result of the same is to be provided to the Ministry of Mining in the Mongolia and to carry out discussions on the way and suitability of possible cooperation from Japan.

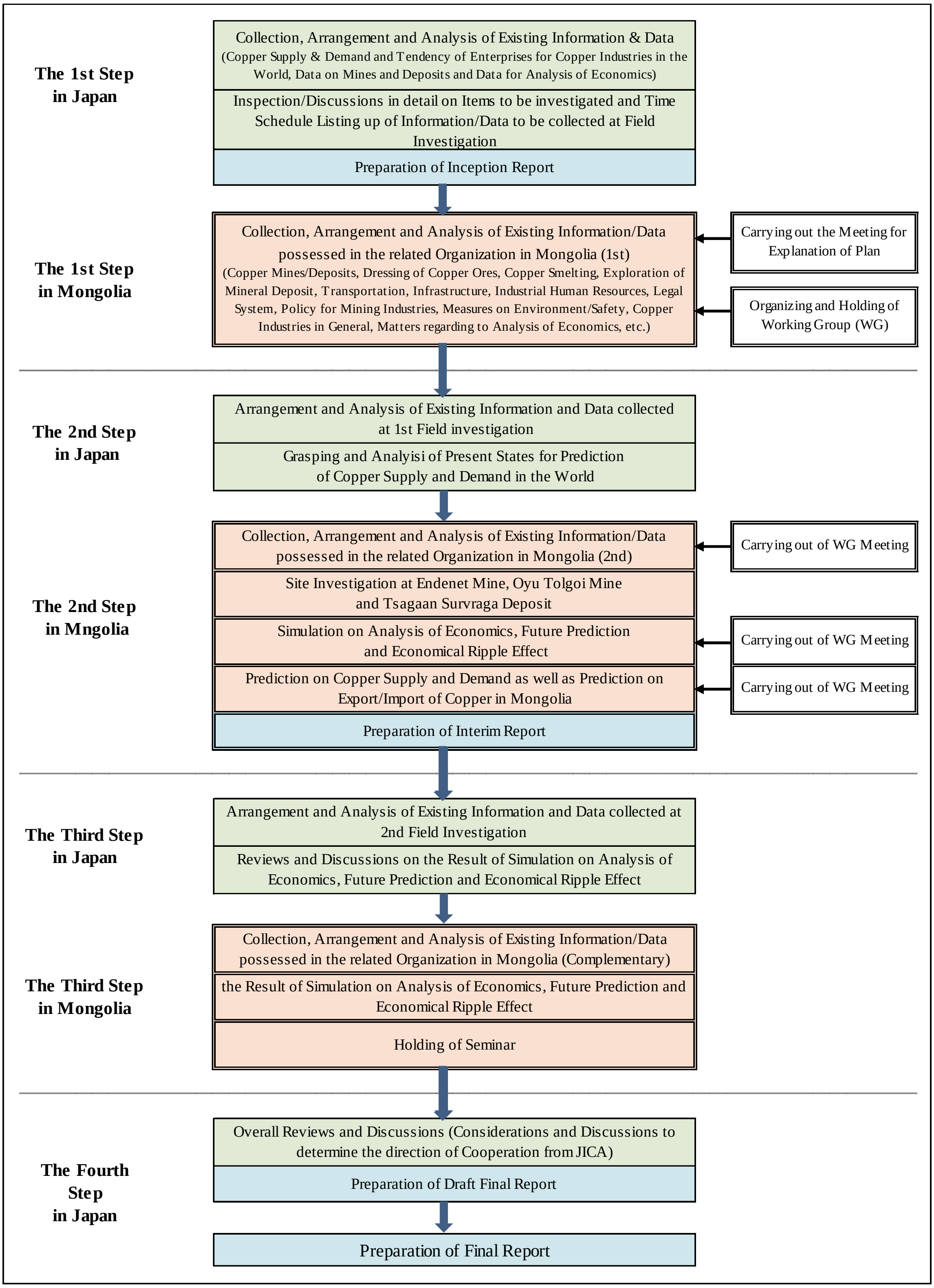
1.3 Principle for the Execution of the Survey

As the exportation of mineral products occupies about 80% of the total amount of exportation in the economy of Mongolia, the development of copper mines is in an important economical situation as well as the coal resources from the view point of importance. The Parliament of Mongolia designated three (3) copper deposits as the strategically important mineral deposits, and it is one of the policies for mineral industries to establish the copper smelter in Mongolia by 2015 as the direction. On the other hand, mineral resources are likely to affect from the deviation in prices of the same as their characteristics. The Government of Mongolia announced as the issue in mineral mining industries (1) Extension and improvement of market in the field of mineral industries, (2) Realization of high added value in products, (3) Diversification of operations related for steady growth of the industry. For this purpose, the preparation of policies and measures is being investigated in order to promote and to locate the most suitable industries relating to the above, and however, it is considered that human resources and knowledge for achieving are insufficient in the country itself as the present state.

From these backgrounds, this survey is to carry out the prediction on the future development and direction of whole copper industries including from mine development to copper smelter as an important part. At the execution of this investigation work, it is important to proceed the work with sufficient exchange of opinions and discussions between Mongolian side and us at the respective steps of collecting and analyzing the information from the background of concrete issues.

1.4 Flow of Survey

Figure 1.5.1 shows the working process on the survey.



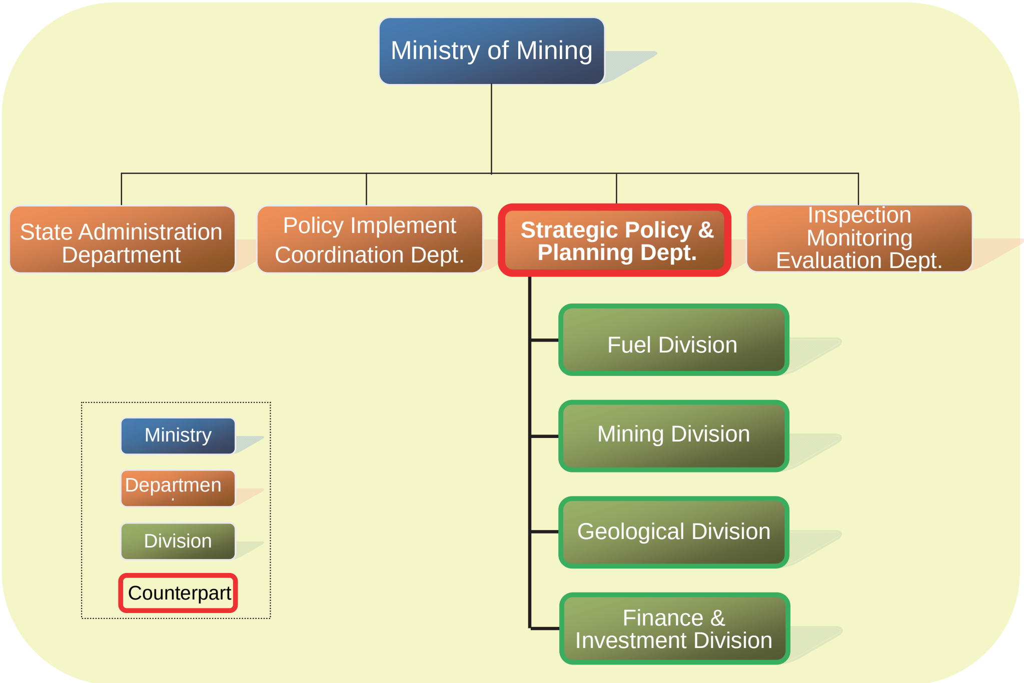
(Source: Prepared by Survey Team)

Figure 1.4.1 Outlines of Working Process

1.5 Survey Organization

1.5.1 Counterpart

The counterpart organization in relation to this survey is Strategic Policy and Planning Department in the Ministry of Mining of Mongolia. Organization chart of the Ministry of Mining is as shown in Figure 1.6.1.



Remarks: It was decided in the National Diet in October, 2014 that the Ministry of Mining is unified with the Ministry of Energy.

(Source: Prepared by Survey Team)

Figure 1.5.1 Organization Chart of the Ministry of Mining

1.5.2 Survey Team Member

Members in the survey team are shown in Table 1.6.1 and Table 1.6.2.

Table 1.5.1 Survey Team (Mongolian Member)

Name	Organization
Mr. OTGOCHULUU Chuluuntseren	Ministry of Mining, Head of Dept. of Strategic Policy and Planning
Mr. NERGUI Byambadavaa	Ministry of Mining, Head of Division of Mining Policy
Mr. ZUUNNAST Tegshee	Ministry of Mining, Division of Mining Policy
Mr. ALTANZUL Erdenepurev	Ministry of Finance, Fiscal Policy and Planning Dept.
Mr. BOLD Dambiisuren	Mineral Resources Authority of Mongolia
Mr. MENDBAYAR Melschoo	Mineral Resources Authority of Mongolia
Dr. BAT-OCHIR Bayantur	Mining Designer's Association of Mongolia
Dr. DAVAATSEREN Gendeekhuu	Mongolian ALT Corporation, Vice President
Ms. UURTSAIKH Dagvatseren	Mongolian Association of Chemists and Chemical Engineers, Executive director

Table 1.5.2 Survey Team (Japanese Member)

Name	In charge
Mr. Yoshiaki SHIBATA	Team leader, Policy for mining
Mr. Tadashi YAMAKAWA	Sub-leader, Policy for mining, Transportation and infrastructure
Dr. Shigefumi OKUMURA	Economical analysis, Policy of industrial location
Mr. Yoichi MIZUOCHI	Mine development
Mr. Yoshio AKIYAMA	Mine development
Mr. Hirohisa KOBAYASHI	Supply-demand and market analysis
Mr. Ken NAKAYAMA	Supply-demand and market analysis
Mr. Hideaki SHINDO	Smelting and processing
Dr. LIM Poh Soon	Industrial human resources
Dr. Dinh Minh HUNG	Investment promotion
Mr. Shusaku MIYAIKE	Consideration for environment and Society

1.6 Survey Schedule

Figure 1.7.1 shows the overall schedule of the survey.

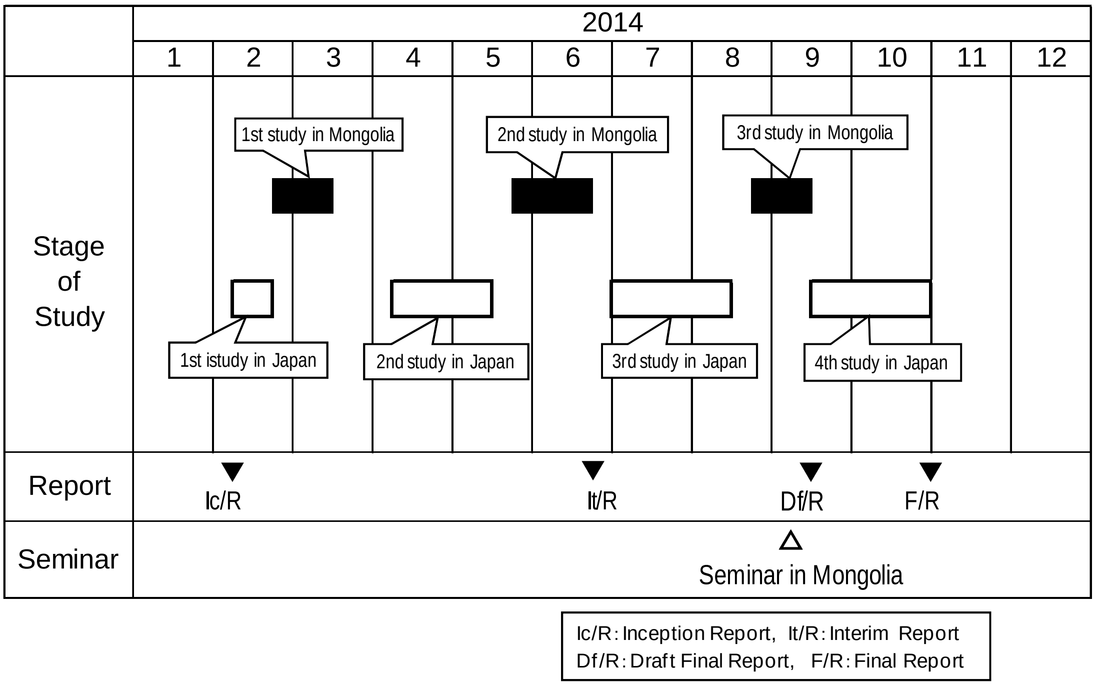


Figure 1.6.1 Survey Schedule

Chapter 2. Potential of Copper Industry and Copper Resources in Mongolia

2.1 Copper Industry Overview in Mongolia

The majority of products from copper industries in Mongolia are copper concentrates being produced from Erdenet Mine and Oyu Tolgoi Mine at present. There are only productions of cathode copper by hydrometallurgic process at the area around Erdenet Mine and manufactures of copper wires and electric cables by processing the said cathode copper as the copper industry being operated other than these two (2) mines.

Erdenet Mine had been opened in 1975 by the joint investment of governments of Mongolia and (former) Soviet Union and was the first large scale copper mine in Mongolia. Crude ore production output of this mine in recent years is 25,000,000 t/year ~ 29,000,000 t/year, and this mine, as only one domestic copper mine, had contributed to the development of economy in Mongolia for a long period until the development of Oyu Tolgoi Mine. The production output of copper concentrates at present is 530,000 t/year and that of molybdenum concentrates is 4,500 t/year, and whole amount of them is being exported to China.

Oyu Tolgoi Mine is one of the world largest scale copper mine which has been developed mainly by Rio Tinto Limited. This mine commenced its production from 2013 and produced 290,000 t of copper concentrates in the same year and started to export them to China. Presently, the production is being carried-out by open pit mining method as Phase-I, and however, it is planned to commence the underground mining as well from September, 2014 as Phase-II. From the present development plan, it is scheduled to supply 100,000 t of ores both by open pit mining and underground mining, and this mine is the largest copper mine in Mongolia which largely exceeds production scale of Erdenet Mine.

In the field of copper industries, Erdmin Co. Ltd. (hereinafter expressed as “Erdmin”) which is located at the area close to the mine is producing refined copper in small scale (2,000 ~ 2,600 t/year) by means of hydrometallurgic process from 1997 and the majority of its products is exporting to outside of Mongolia. Also, the plant to produce cathode copper by hydrometallurgic process has been constructed at the area around the mine by Achit Ikht Co. Ltd (hereinafter abbreviated as Achit Ikht) and commenced its operation and production of 10,000 t/year scale from 2014.

And, there is only one copper processing plant in Mongolia which is constructed by Erdmin and is producing copper wires and sheathed electrical cables from the cathode copper produced in its own refinery as raw materials, and its production output is approximately 150 t/year.

Thus, the copper industry in Mongolia other than the production of copper concentrates as above stated is only a small scale hydrometallurgic smelter at the area around Erdenet Mine and processing plants, and however, present state is in a situation that the pyrometallurgic smelting and processing industry have not been developed yet.

2.2 Outlines of Existing Copper Mines

As existing copper mines, there are Erdenet Copper Mine and Oyu Tolgoi Mine which commenced its production from 2013. Descriptions on these two mines are made in the following.

2.2.1 Erdenet Mine

(1) Location

Erdenet mine is located at the area NE365km from Ulaanbaatar, and SW165km from Darkhan where connected to Trans-Mongolian Railway.

(2) Outlines of Mine

The development of Erdenet Copper Mine which is the first large scale copper mine in Mongolia and discovered in the latter half of 1960s and commenced its development from Erdenetiin Ovoo Deposit. The ore dressing plant which is capable for dressing ores of 4,000 Kt/year had been constructed and the first copper concentrates had been produced in 1978. At this stage, ores of 26,000 Kt/year are being dressed, and producing copper concentrates of 530,000 t/year and molybdenum concentrates of 4,500 t/year. This mine had been the largest copper deposit in Mongolia and had been only one producing copper concentrates in Mongolia until the discovery of Oyu Tolgoi Mine.

The management style of this mine is established by Erdenet Mining Corporation (hereinafter expressed “EMC”). EMC is a joint venture company of the government of Mongolia and that of Russia, and the rate of investment is as follows:

The Government of Mongolia 51% : ERDENES MGL LLC
The Government of Russia 49% : “Mongolrostsvetmet” LLC

At the time of start-up, the composition ratio of employees was 28% of Mongolian persons and 72% of Russian persons among 2,000 employees in total. According to country ownership promoted since then, the composition ratio of employees has become 95% of Mongolian employees.
Scenery on present state of pits in Erdenet Mine is as shown in Photo. 2.2.1.

(Source: Photo taken by Survey Team)

Photo 2.2.1 Scenery on Pits of Erdenet Mine

(Photo taken on 26th, May, 2014)

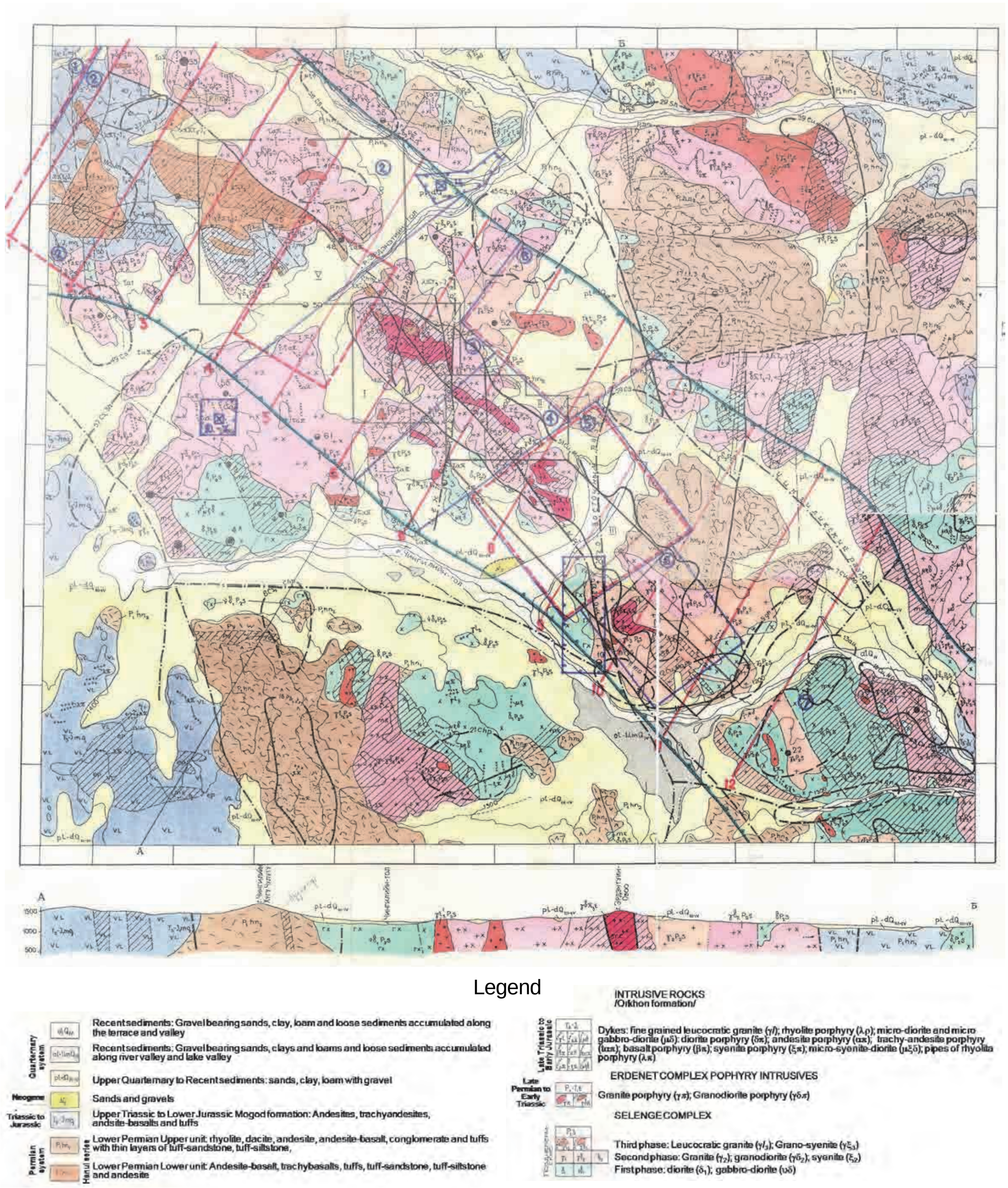
Although it was pointed out that the copper ore reserved in Erdenet Mine will become insufficient in future, new ore deposits have been discovered by the satellite exploration and it was found that the production may be sustainable for not less than approximate 40 years.

(3) Geology and Geological Structure

Erdene deposit is composed of Erdenet complex second phase granodiorite, intruded by third phase plagiogranite body. The ore body is stockwork in shape and located at the top of intrusive rock (Figure 2.2.1).

Ore body is controlled by SW and NW trending faults and its length is 2,400 m with width ranging from 300 m to 1,300 m (at the central part), continues up to 700-100 m in depth. Host rock is gray colored tonalite and granodiorite, intruded by medium grained whitish gray colored plagiogranite and biotite granite. Plagioclase is affected by alteration and formed sericite, albite, kaolinite and chlorite.

Dikes and plagiogranite is subdivided into several stages: Pre-mineralization, syn-mineralization, post mineralization and Mesozoic mafic dikes. There are several reports and papers studied age of intrusive rocks of Erdenet deposit area. Age of rocks are given on the Table2.2.1 below.



(Source: Geological Information Center, 1978)

Figure 2.2.1 Geology of Erdenet deposit

Table 2.2.1 Age of rocks in Erdenet Deposit Area

№	Rock type	Age	Detected mineral	Method	Age, Ma	Reference
1	Selenge complex granodiorite	P_3	Biotite	K-Ar	250-210	Geology., 1973 /Russian/
2	Selenge complex granodiorite	$P_{2\text{-}3}$	Biotite	K-Ar	290-260	Sotnikov 1985
3	Erdenet complex granodiorite	T_2	Biotite	K-Ar	245-226	Arakelyants 1983
4	Quartz-sericite ore	$T_{2\text{-}3}$	Sericite	$^{40}Ar/^{39}Ar$	207	Lambe Cox, 1998
5	Molybdenite ore	$T_{2\text{-}3}$	Molybdenite	Re-Os	240.7	Watanabe and Stein,2000
6	Selenge complex	$P_{2\text{-}3}$	Bulk rocks, granitoids	Rb-Sr	290-260; 280±10	Sothikov et al 1995
7	Porphyry-I,	P_2- T_1	Plagioclase	Rb-Sr K-Ar	253, 262-242	Sotnikov et al, 1995
8	Porphyry-II, Oyut part	T_3	Potassium feldspar	K-Ar	224	
9	Porphyry-II, NW part	T_3	Biotite, plagioclase	K-Ar K-Ar	229-239; 212-214	
10	Porphyry-II, NW part	T_2	Plagioclase	Rb-Sr	220-230	
11	Porphyry-III, mineralized granodiorite	T_3	Plagioclase	K-Ar	203±8	
12	Central part,	T_3	Plagioclase	K-Ar	207±6	
13	Post mineralization andesite porphyry	J_1	Andesine	K-Ar	178-182 179	

(Source: Sotnikov et al, 1995)

(4) Copper-Molybdenum mineralization

Ore body of Erdenet copper-molydenum deposit show NW trending stockwork shape with length up to 2,400 m at the central part, and width ranging from 1,300 m at the surface to 600 m in the depth. Host rock shows wide range of alteration.

Alteration

- Epidote alteration in granodiorite: Thin veinlets and stringers of green colored epidote widely distributed in deposit are and described as pre mineralization prophylitic alteration. Amphibole and biotite of granodiorite is chloritized.
- Argillic and chlorite-sericite alteration: developed in wide range and plagioclase is sericitized.
- Phyllic alteration: Silica-sericite with pyrite alteration. Silica is intensively developed and form silicified zone. Quartz-sericite alteration is formed at the top of plagiogranite and it contains small amount of potassium feldspar, pyrite, chalcopyrite and molybdenite.

The ore of Erdenet deposit is divided into three different types: leaching zone of 1,090 m thickness, secondary enrichment zone of 60-300 m thickness and primary ore zone.

1. The leaching (oxidized) zone is brownish and yellowish brown in color contains veinlets and stringers of carbonate and gypsum, enriched by limonite, goethite and malachite. Copper content is low.
2. Secondary enrichment zone is controlled by lower level of groundwater circulation and at central part of deposit is reaches up to 300 m depth. Copper and molybdenum content is high.
3. Primary ore zone contains primary ore minerals as pyrite, chalcopyrite and molybdenite. Copper and molybdenite content is lower than secondary enrichment zone.

These characteristics were summarized in Table 2.2.2.

There are many stringers and veinlets of quartz and quartz sulfide, with thickness ranging from 1-2 mm to 1-2 cm and forms stockwork shaped ore body. Quartz veinlets and surrounding space contain pyrite, chalcopyrite, bornite, molybdenite, rarely sphalerite, galena and chalcosite. Quartz-sulfide veinlets show assemblages as following:

- Quartz-pyrite
- Quartz-molybdenite-pyrite
- Quartz-chalcopyrite-molybdenite
- Quartz-pyrite-galena-sphalerite
- Quartz-chalcopyrite-bornite-chalcosite-covellite in secondary enrichment zone
- Post ore veinlets of calcite-gypsum-pyrite

Table 2.2.2 Characteristics of Erdenet ore type

№	Ore zone	Thickness	Main mineral	Associated mineral	Metal content, %
1	Oxidation and leaching /gossan/	10-30 m	Limonite, malachite, azurite and goethite	Jarosite, chrysocolla, tenorite, cuprite, native copper and covellite	Cu-0.001-0.01% Sometimes 0.1-1% Mo 0.005%
2	Secondary enrichment zone	60 m in marginal part and 300 m in central part	Chalcopyrite, covellite, bornite, pyrite and molybdenite	Molybdenite, malachite, chalcosite, tennatite and sphalerite.	Cu 0.8-7.6% Mo 0.01-0.76%
3	Primary ore	300-1000 m	Pyrite, chalcopyrite and molybdenite	Sphalerite and tetrahedrite	Marginal part: Cu=0.2-0.3%, Mo=0.01-0.025%, In depth 500-1000 m: Cu=0.2-0.25%

(Source: Prepared by survey team)

(5) Exploration

At Erdenet deposit, oxide ore, such as turquoise or natural copper have been outcropped for a long time, the Chinese had the mining activities according to the legend. There was a trace that they were producing the copper product about 200 years ago.

Modern exploration of Erdenet deposit was started by survey geologist of Russia in 1940. Agomalyan and F. Ushakov conducted the field survey and made simple evaluation in 1963. Joint geological survey team of the Czech Republic and Mongolia launched an investigation, and made ore resources evaluation in 1964-1968. Investigation team of the Soviet Union studied in more detail then further ore reserves evaluation. As a result, EMC was founded in 1975, mine construction and mining and ore treatment began, and export of concentrate was started by railway in 1977. Geological information of deposits increased thereafter.

In the exploration sector, they have been establishing a detailed investigation of ore reserves every five years. According to the development plan called "Conception 2010-2012", they are doing new investigation of deposit, the completion of the study of exploration results, Reserves estimation can't be fully finished, not yet submitted to the State Reserve Committee.

(6) Ore reserves, ore grade

The geology and exploration results of the 1981-1989, 1,885 Mt @ 6,730 Kt Cu Ore Reserves, 0.357% Cu), 200 Kt Mo and (0.0106% Mo) is reported to ore reserves committee of the state.
According to this Presentation, the latest Resources of Erdenetiin Ovoo deposit of 2012 is shown in Table 2.2.3 (Copper grade is calculated by the author). Inferred resources also can be a reserve-production ratio unlike. Reserve (Mongolian ore reserves criteria, not from NI43-101) is 714,201 Kt, containing Cu Metal 5,220 Kt, quality is 0.731%.
According to EMC, after expansion to 35,000 Kt/year ore treatment from current 26,000 Kt/year, they can produce in 42 years.

(7) Ore Dressing

The ore dressing in concentrator is similar to a series of ore dressing circuit design for general porphyry copper type deposit, i.e. crushing, grinding of ore, floatation, filtering and drying. There are two (2) lines in crushing and grinding process, and one line has 20,500 Kt/year capacity and another has 5,000 Kt/year capacity, and the additional equipment to increase its capacity upto 35,000 Kt/year in total is under construction. The type of ore dressing being employed is to concentrate Cu and Mo components by floatation at a time and then to classify into respective concentrates. Tailings are charged into the sedimentation pond and the top clear water is to be recycled for re-use.
General views of ore dressing concentrator and floatation system in Erdenet Mine are shown in Photo 2.2.2 and Photo 2.2.3 respectively.

(Source: Photo taken by survey team from the model of mine facilities)

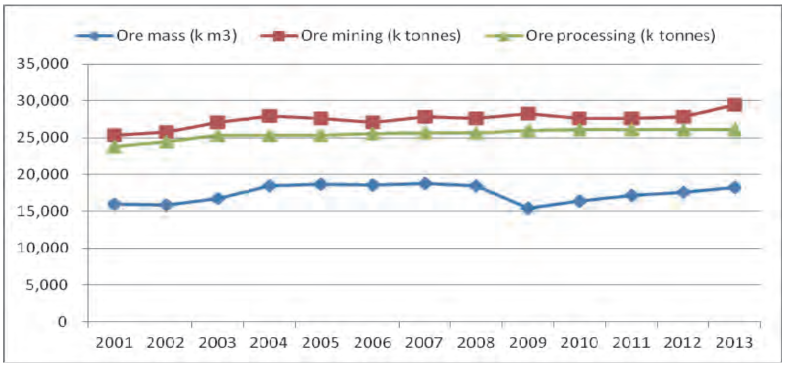
Photo 2.2.2 General View of Concentrator in Erdenet Mine

(Source: Photo taken by survey team)

Photo 2.2.3 Floatation System in Concentrator of Erdenet Mine

(8) Actual Record of Production

The transitive graph of actual production in EMC is shown in Figure 2.2.2. From this graph, the production of copper concentrates is 530,000 t/year and that of molybdenum concentrates is 4,500 t/year (the amount of ore dressing is 26,000 Kt/year).



(Source: Prepared by Survey Team)

Figure 2.2.2 Transitive Graph of Actual Production in EMC

(9) Matters to be specifically noted

Matters to be specifically noted are mentioned as follows:

- Whole amount of copper concentrates produced is transported to China through Trans-Mongolian Railway.
- The level of open pit has been lowered by 706 m in altitude due to mining work for 36 years since opening of mine.

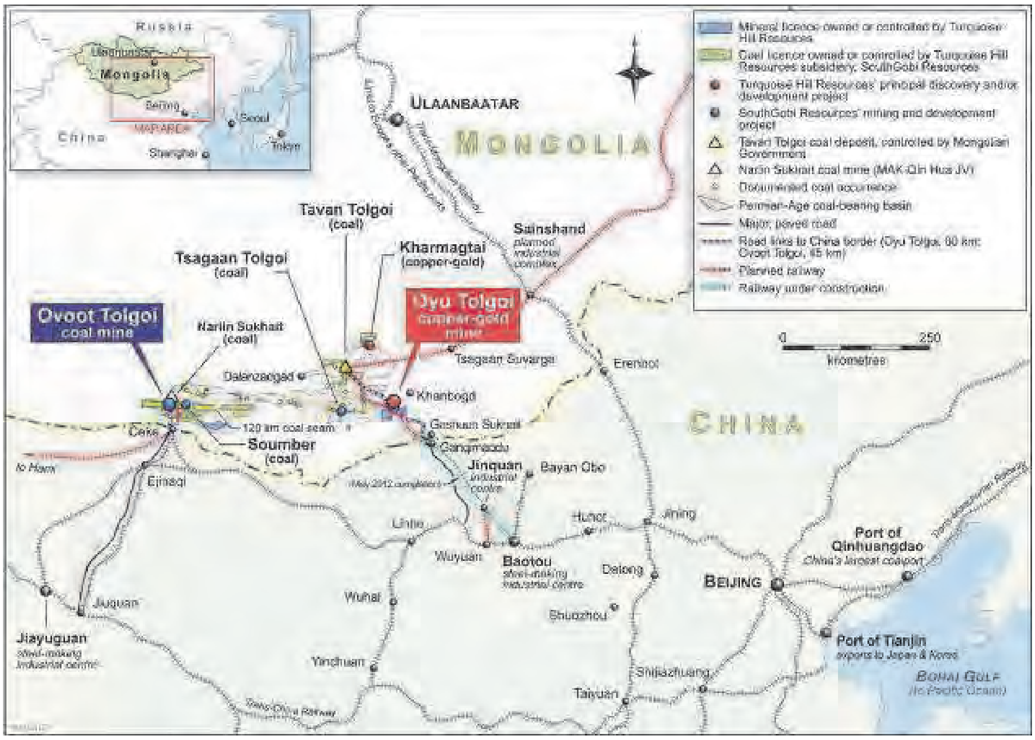
2.2.2 Oyu Tolgoi Mine

(1) Location

Oyu Tolgoi Mine is located at t he point of 500 km south (distance in a straight line) from the City of Ulaanbaatar of Omnogovi Aimag in South Govi. There is Tavan Tolgoi Coal Mine existing at the area of about 100 km north-west there from. The location of Oyu Tolgoi Mine is shown in Figure 2.2.3 below.

(2) Outlines of Oyu Tolgoi Mine

Oyu Tolgoi Mine which commenced its production of copper and gold concentrates from the beginning of 2013 is being managed by Oyu Tolgoi LLC of which 66% stocks are possessed by a listed company in the Canadian stock exchange Turquoise Hill Resources (about 51% of stocks are owned by Rio Tinto Group) and 34% stocks are possessed by the government of Mongolia. The scale of deposit is larger than that of Erdenet Mine and represents a distinguished scale in the world. Although the production of concentrates is carried out by open pit mining at present, the preparation work of underground mining is being carried out for mining of higher grade ores. The scenery of present pit is shown in Photo 2.2.4.



(Source: Oyu Tolgoi, Technical Report 2013)

Figure 2.2.3 Location of Oyu Tolgoi Mine

(Source: Photo taken by Survey Team)

Photo 2.2.4 Scenery of Pit (Photo taken on 9th June, 2014)

(3) Geology and Geological structure

The Oyu Tolgoi area lies within an east-west-trending belt of Devonian-Carboniferous volcanic and sedimentary rocks of continental margin and island arc affinities, constituting the South Mongolia Volcanic Belt. Two major stratigraphic sequences are recognized in the project area 1) tuffs, basaltic

rocks, and sedimentary strata of probable island arc affinity, assigned to the Upper Devonian Alagbayan Formation; and 2) an overlying succession containing conglomerates, fossiliferous marine siltstones, sandstones, waterlain tuffs, and basaltic to andesitic flows and volcano-clastic rocks, assigned to the carboniferous Sainshandhudag Formation. The two sequences are separated by a regional unconformity.
The Devonian Alagbayan formation rocks sub-crop in the area around and to the west of the South and Southwest Oyu deposits and consist of 4 major lithologic divisions. The two lower units (DA1 and DA2) are commonly strongly altered and form important ore hosts, while the upper two units (DA3 and DA4), although pre- to syn-mineral in age, lack significant alteration and mineralization.

Intrusive rocks are widely distributed through the Oyu Tolgoi area and range from large batholithic intrusions to narrow discontinuous dykes and sills. At least seven classes of intrusive rocks can be defined on the basis of compositional and textural characteristics. Copper-gold porphyry mineralization is related to the oldest recognized intrusive suite, comprising large Devonian quartz monzodiorite intrusions that occur in all of the deposit areas.

These intrusions are texturally and compositionally varied, and several distinct phases can be distinguished within the deposits. Preliminary U/Pb zircon ages of 370.6 Ma and 378 Ma have been obtained from unaltered and altered phases of the quartz monzodiorite in the Southwest Oyu deposit. The Oyu Tolgoi deposit area is bounded on the northwest by a large, poly-phase granitic complex. Intrusive phases recognized in this complex include syenite, granite, quartz monzonite, quartz diorite, and quartz syenite. The temporal relationships between these different compositional phases have not been documented, and the only radiometric date obtained to date is a U/Pb zircon age of 348 Ma (Wainwright et al., 2005), implying that the complex post-dates mineralization at Oyu Tolgoi. The Early Permian Hanbogd alkaline granite complex is a large, circular intrusion exposed just east of the Oyu Tolgoi property.

The Oyu Tolgoi project area is underlain by complex networks of faults, folds, and shear zones. Most of these structures are poorly exposed on surface and can only be defined through integration of detailed exploration data (primarily drill hole data), property-scale geological mapping, and geophysical data. Ivanhoe has made extensive use of oriented core drilling at Oyu Tolgoi, and the structural data collected has been invaluable in helping determine the subsurface morphology and structural history of the project area. Major structures in the project area strongly influence the distribution of mineralization by both controlling the original position and form of mineralized bodies, and modifying them during post-mineral deformation events.

The Solongo Fault is an east- to east-northeast-striking, sub-vertical structure that cuts across the Oyu Tolgoi deposit just south of the Southwest Oyu and South Oyu deposits. The Solongo Fault forms a major structural break, and there is a minimum of approximately 1,600 m of south-side-down stratigraphic offset where it juxtaposes mineralized basalt in the South Oyu deposit against sediments correlated with the upper Alagbayan Formation to the south.

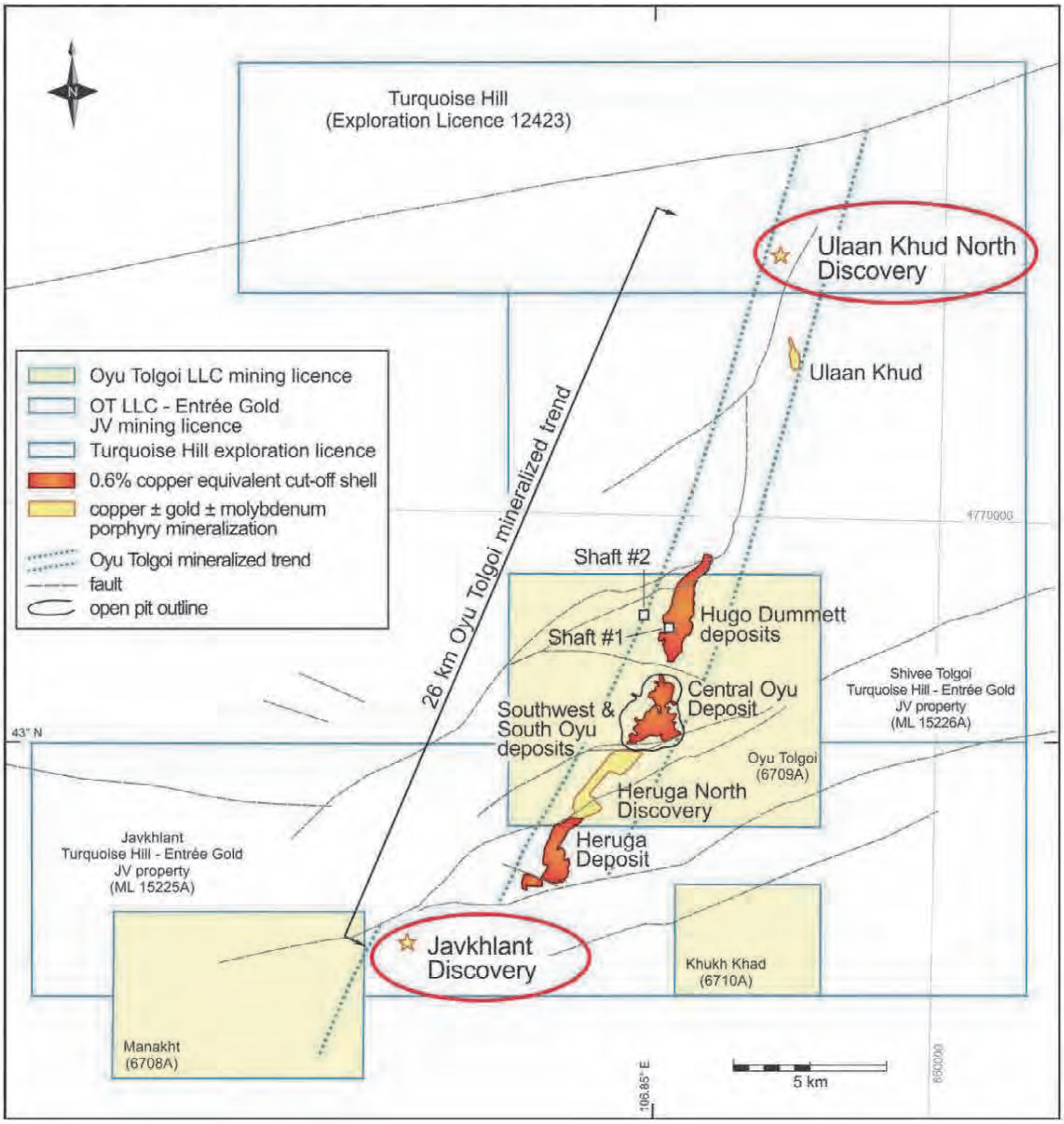
The Northwest Shear Zone is a wide, ductile shear zone that cuts across the far northwest corner of the Oyu Tolgoi project area. This shear zone consists of mylonitic to ultra-mylonitic rocks in the centre, grading outward over about 200 m to rocks lacking visible ductile strain. The magnitude of displacement is not closely constrained, but the geometry of deformed dykes in the shear zone indicates that at least several kilometers of displacement have occurred.

The Central Fault is a west-northwest-striking, moderately north-dipping structure that lies between the Hugo South and Central Oyu deposits. The fault consists of several splays and may have experienced multiple periods of displacement. The simplest interpretation of geological relationships is that early fault displacement resulted in north-side-down apparent offset, followed by a later apparent reverse displacement of lesser magnitude.

The alignment of the Southwest Oyu, Central Oyu, and Hugo Dummett deposits strongly implies that an underlying north-northeast-striking fault or fault zone controlled emplacement of porphyry intrusions and related hydrothermal activity. The Hugo Dummett deposit lies within a north-northeast-trending structural high bounded by the West Bat and East Bat faults. Although the latest movement on these bounding faults displaces post-mineral strata, they may represent the shallow expression of a longer-lived, deposit-controlling fault zone. Offsets of post-mineral stratigraphic contacts measure at least a kilometer (east-side up) for the West Bat Fault, and 200 m to 300 m (west-side-up) for the East Bat Fault.

(4) Mineralization

The Oyu Tolgoi deposits display copper-gold porphyry and related high-sulfidation copper-gold deposit styles. The Oyu Tolgoi deposits consist of a north northeast-trending 6 km long mineralized zone, containing six porphyry Cu ± Au deposits; Southwest Oyu Tolgoi, South Oyu Tolgoi, Wedge, Central Oyu Tolgoi, Hugo South and Hugo North (Figure 2.2.4).
Relationship of deposits, ore bodies and development phase are listed in Table 2.2.4. Long section of Oyu Tolgoi Porphyry Cu-Au system and Plan view of Oyu Tolgoi Porphyry Cu-Au system are shown in Figure 2.2.5 and Figure 2.2.6, respectively.



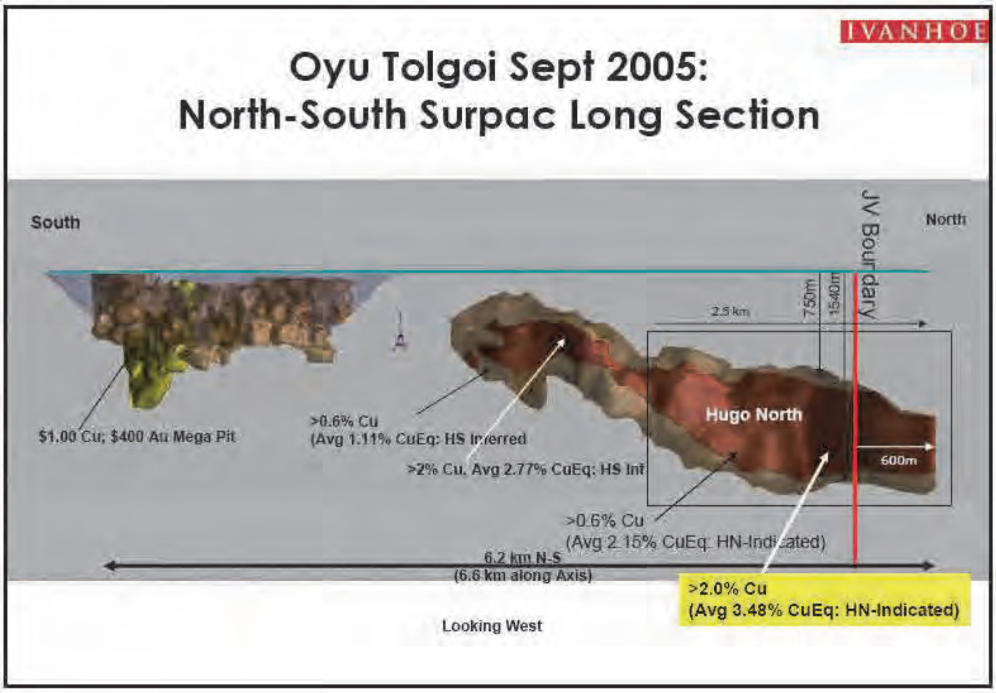
(Source: Oyu Tolgoi, Technical Report 2013)

Figure 2.2.4 Locating Map of Ore Deposit in Oyu Tolgoi

Table 2.2.3 Relationship of Ore Deposit and Orebody

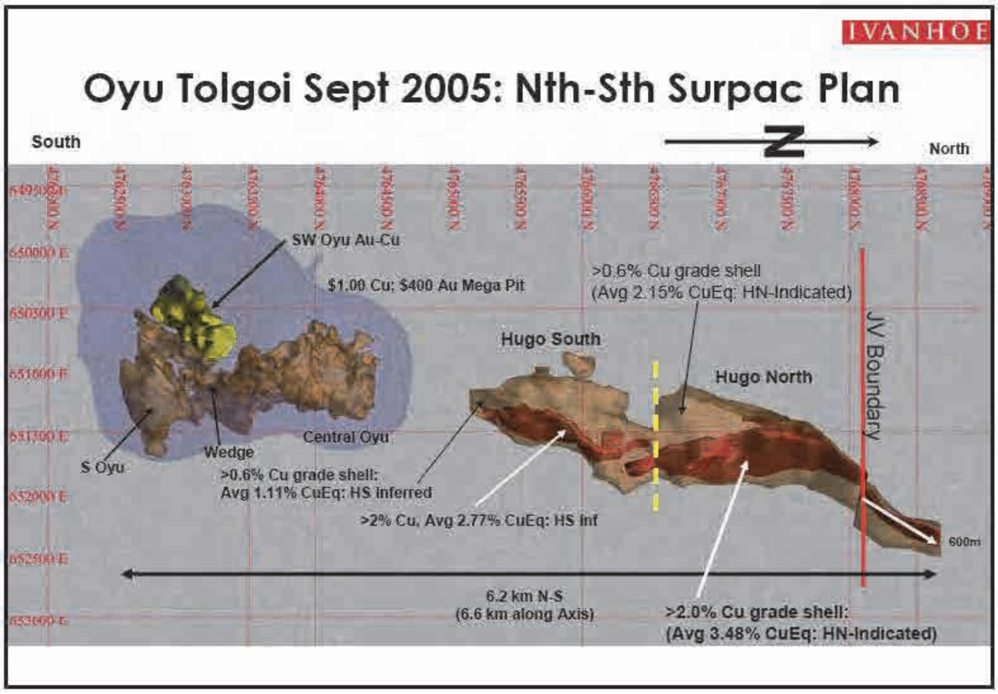
Deposit	Ore body	Phase	Mining Method
Southern Oyu Deposits	Southwest Oyu Tolgoi South Oyu Tolgoi Wedge Central Oyu Tolgoi	Phase I	Open pit Block-caving partially
Hugo Dummett Deposits	Hugo South Hugo North	Phase II	Block-caving
Heruga Deposits		Planned	Block-caving

(Source: Prepared by Survey Team)



(Source: Khashgerel B, Rye R, Hedenquist JW, Kavalieris I, 2006)

Figure 2.2.5 Cross Section of Oyu Tolgoi Deposit



(Source: Khashgerel B, Rye R, Hedenquist JW, Kavalieris I, 2006)

Figure 2.2.6 Plan View of Oyu Tolgoi Deposit

The Oyu Tolgoi porphyry copper deposits display a range in mineralization styles, alteration characteristics, and deposit morphologies despite having formed in close spatial and temporal association. These distinctions likely reflect differences in structural controls, host rock lithology, and depth of formation. In general, high-sulfidation mineralization and associated advanced argillic alteration are most common within the dacite tuff and the upper parts of the quartz monzodiorite, where it intrudes to levels high in the stratigraphic succession, and in narrow structurally controlled zones. In contrast the more typical copper-gold porphyry style alteration and mineralization tend to occur at deeper levels, predominantly within basalt and quartz monzodiorite.

Southwest Oyu Tolgoi deposit is Cu-Au porphyry style mineralization and consists of a cylindrical high-grade core roughly 250 m in diameter enclosed within a broad zone of lower-grade mineralization. The high-grade core is characterized by 1 cm to 50 cm wide contorted milky white quartz veins. Chalcopyrite with subordinate pyrite, bornite, and molybdenite occur as late veinlets filling fractures in quartz veins and disseminated through wall rocks. Low-grade copper mineralization peripheral to the high-grade core is characterized by lower vein densities, hosted in chlorite + epidote altered basalt and lesser sericite + albite altered quartz monzodiorite. Chalcopyrite, bornite, and pyrite are mainly disseminated, with fracture or vein controlled sulfides being less prominent. Gold in the Southwest deposit is closely associated with chalcopyrite, and occurs intergrown with chalcopyrite, as inclusions and fracture infills within pyrite, or on grain boundaries of pyrite. The gold to copper ratios range from 2:1 to 3:1 within the high-grade core, decreasing to 1:1 in the low-grade margins of the deposit. The Southwest deposit is capped by an oxidized zone that varies from 50 m to 60 m thick, and consists of black copper oxide (neotocite or tenorite) as fractures coatings and speckled throughout the oxidized limonite stained basalt.

South Oyu Tolgoi deposit is hosted dominantly in quartz monzodiorite in the southwestern portion of the deposit. Contorted quartz veins are present, consequently, fracture-controlled sulfide veins are minor, and sulfides occur dominantly as disseminated chalcopyrite, bornite, and molybdenite. Chalcopyrite is the principal copper sulfide, but in higher-grade areas bornite locally exceeds chalcopyrite in abundance. A small zone of high sulfidation mineralization occurs within a quartz monzodiorite breccia in the western part of the deposit, adjacent to the South Fault. Mineralization here consists of pyrite, chalcopyrite, bornite, covellite, and primary chalcocite in quartz sericite kaolinite alteration, with late dickite veins. An oxide zone approximately 60 m thick overlies the South deposit and consists of malachite, azurite, cuprite, chrysocolla, neotocite, or tenorite hosted within basalt and quartz monzodiorite.

Wedge deposit contains a zone of high-sulfidation mineralization hosted principally in dacite tuff, grading downward and southward into chalcopyrite mineralization in basalt and quartz monzodiorite host rocks. High-sulfidation mineralization consists of pyrite, chalcopyrite, bornite, enargite, covellite, and primary chalcocite in advanced argillically altered host rocks. Higher grades of copper (>0.8% Cu) occur in a shallowly east-dipping zone in the upper hundred meters of dacite tuff. Gold is absent, except locally in drill holes adjacent to the South Fault. Mineralization is open down dip and to the north. The advanced argillic alteration grades downward into biotite + chlorite alteration with hematite overprinting magnetite, mainly within basalt host rocks underlying the dacite tuff. In the southern part of the Wedge deposit, sericite + pyrite alteration occurs within the quartz monzodiorite.

Central Oyu Tolgoi deposit is characterized by an upward-flaring, high-sulfidation zone that overprints and overlies porphyry-style chalcopyrite-gold mineralization. A secondary-enriched supergene chalcocite blanket tens of metres in thickness overlies the high-sulfidation covellite-pyrite zone. Chalcopyrite-gold mineralization is dominant on the south and western margins of Central within either basalt or quartz monzodiorite adjacent to intrusive contacts with basalt. Higher grades are associated with zones of intensely contorted quartz stockwork veins, where the gold (ppm) to copper (%) ratios reaches 2:1. Peripheral, lower-grade mineralization has gold:copper ratios of less than 1:1. Hematite, pyrite, chalcopyrite, bornite, magnetite, and gold occur disseminated in the zone and as fracture fillings. Hematite is pervasive and overprints magnetite. A supergene enrichment zone overlies the high sulfidation assemblage and underlies a 20 m to 60 m thick, hematitic limonite, goethite-rich leached cap. The supergene zone consists of pyrite, hematite, and chalcocite/digenite, with lesser amounts of colusite, enargite, tenorite, covellite, bornite, chalcopyrite, cuprite, and molybdenite. Pyrite is the dominant sulfide and occurs as disseminated crystals. Sooty chalcocite occurs as rims or microveinlets in pyrite and covellite, and as independent disseminations.

Hugo South deposit is centered on a high-grade (typically > 2% Cu) zone of intense quartz stockwork veining, which is localized within narrow quartz monzodiorite intrusions and extends into the enclosing basalt and dacite tuff. The intense stockwork zone has an elongate tabular form, with a long axis plunging shallowly to the north-northwest, and an intermediate axis plunging moderately to the east. Dominant sulfide minerals at Hugo South are chalcopyrite, bornite, chalcocite, and pyrite, with minor molybdenite, enargite, tennantite, and covellite. Rarely, sphalerite and galena occur. Sulfides are zoned with bornite +/- chalcopyrite, chalcocite, and tennantite comprising highest grades (>2.5% Cu), grading outwards to chalcopyrite (1% to 2% Cu). Pyrite-chalcopyrite +/- enargite, tennantite, bornite, chalcocite, and rarely covellite occur with low-grades (<1% Cu), mainly in advanced argillically altered dacite tuff.

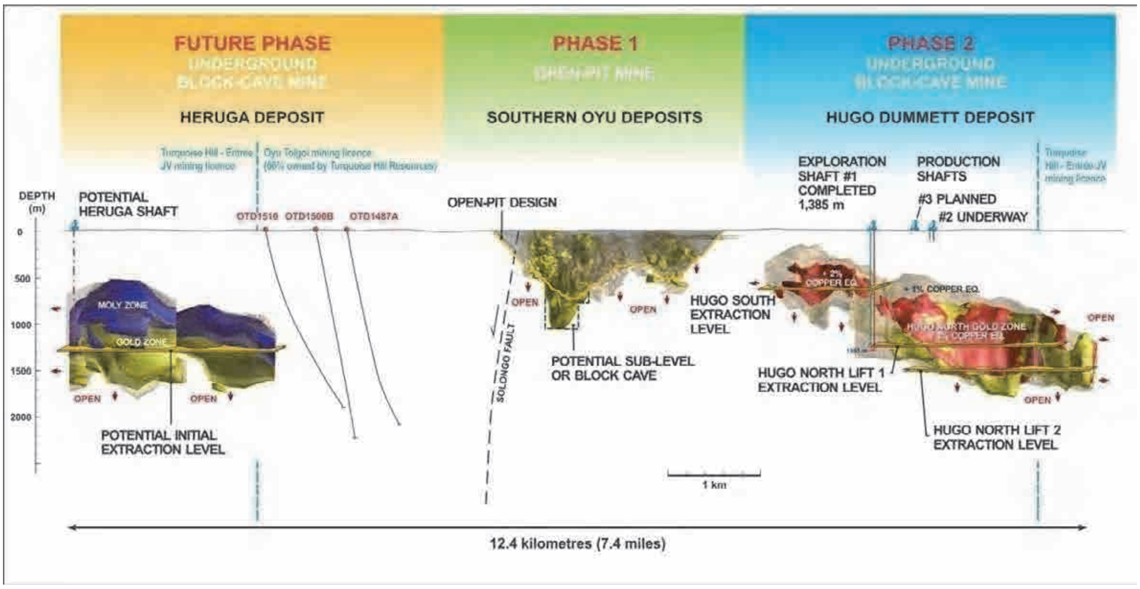
Hugo North deposit is related to a zone of intense stockwork to sheeted quartz veins. The high-grade zone is centered on thin, east-dipping quartz monzodiorite intrusions or within the upper part of the large quartz monzodiorite body, and extends into the adjacent basalt. In addition, moderate to high-grade copper and gold values occur within quartz monzodiorite below and to the west of the intense vein zone, in the Hugo North gold zone. This zone is distinct in its high Au (ppm) to Cu (%) ratios (0.5:1). Bornite is dominant in highest-grade parts of the deposit (3% to 5% Cu) and is zoned outward to chalcopyrite (2%). At grades of <1% Cu, pyrite-chalcopyrite +/- enargite, tennantite, bornite, chalcocite, and rarely covellite occur, hosted mainly by advanced argillically altered dacite tuff. Similar to Hugo South, copper in the Hugo North deposit correlates with elevated abundances of Ag, Se, and Te. Arsenic occurs at low levels in the high-grade zone and is related to tennantite. Zn (about 300 ppm) occurs mainly as sphalerite. Se and Te are attributed to hessite and clausthalite inclusions in bornite. Pb occurs at levels of up to several hundred ppm peripheral to the high-grade zone in dacite tuff. Low levels of Hg (0.2 ppm) occur in the upper part of the ore body.

(5) Exploration

There was a trace that made the small-scale mining in 4000 years ago Oyu Tolgoi deposit. Copper mineralization indication is found at Oyu Tolgoi by the team of the preliminary investigation of mineral symptom areas of Mongolia by Magma Copper Company in 1996. By BHP's acquisition of Magma Copper Company in 1996, exploration license move to BHP. BHP was drilling exploration to 1998 afterwards, but it does not continue the exploration activities in the business review in 1999, and exploration was carried out Earn-in agreement with Ivanhoe. By the continuation of Ivanhoe drilling from 2000, Hugo Dummett Deposit was discovered.

(6) Reserves and ore grade

The deposits that have been discovered now, (is being developed in Caving) are Hugo Dummett Deposits present in the northeast (part with the plan of Caving and a portion mining is progressing in Open pit in some cases), the Southern Oyu Deposit, and Heruga Deposit in the J/V mining area with Entrée gold company. More than one deposit has been found in the same fault zone in addition to this. Oyu Tolgoi deposit and cross-sectional view of the development concept is shown in Figure 2.2.7.



(Right is northeastern side of the deposit, left is Southwest side of the deposit)

(Source: Oyu Tolgoi, Technical Report 2013)

Figure 2.2.7 Oyu Tolgoi Deposit and Cross-sectional View of the Development Concept

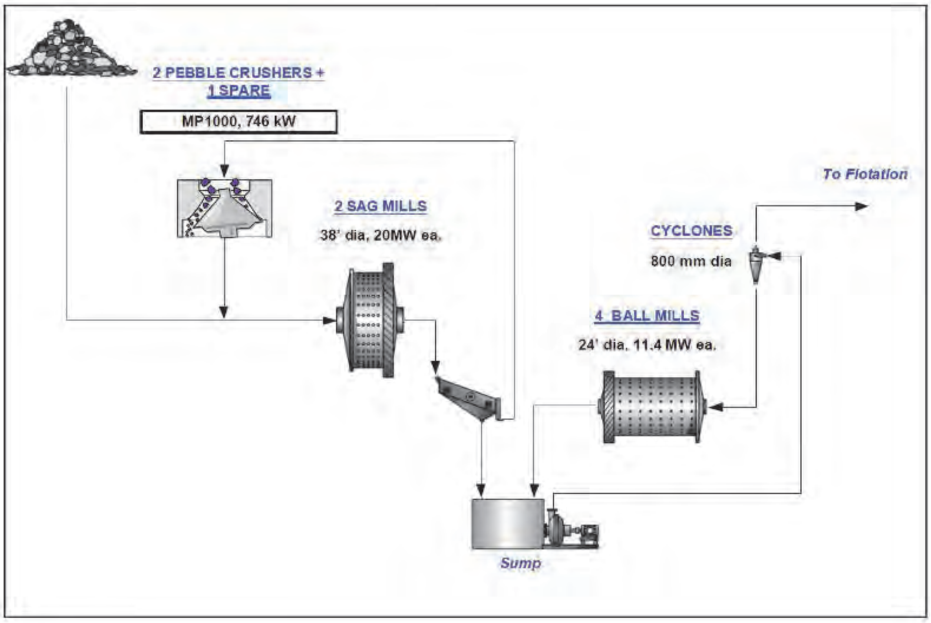
Mineral resources have been reported in accordance with NI43-101.
Reliable, Measured + Indicated Resources are at 0.22% Cu-Eq. cut off, at Southern Oyu where Open Pit mining is progressing, 1096 Mt@0.45% Cu, 0.30g/t Au, of 0.93g/t Ag. Plus some 218Mt@0.27% Cu 0.15g/t Au, 0.77g/t Ag are classified as unreliable Inferred.

At the bottom of Southern Oyu, reliable of Measured + Indicated at 0.37% Cu-Eq. cut off, resources is 172Mt@0.37% Cu, 0.52gpt Au, and 0.93g/t Ag where cave mining is planned at the bottom of the same mining area,. Some 237Mt@0.37% Cu-Eq. cutoff, classified as Inferred, grade are 0.38% Cu, 0.29gpt Au, 0.87gpt Ag.

The Hugo Dummett mining area, mining is planned by Caving, Indicated Resources at 0.37% Cu-Eq. cutoff is 907Mt@1.69% Cu, 0.39gpt Au, 3.77g/t Ag, in inferred category 1969Mt@0.80% Cu, 0.18gpt Au, is 2.12g/t Ag.
Heruga deposit is all Inferred, at 0.37% Cu cutoff, 1944Mt@0.38% Cu, 0.36g/t Au, 1.37gpt Ag is estimated.

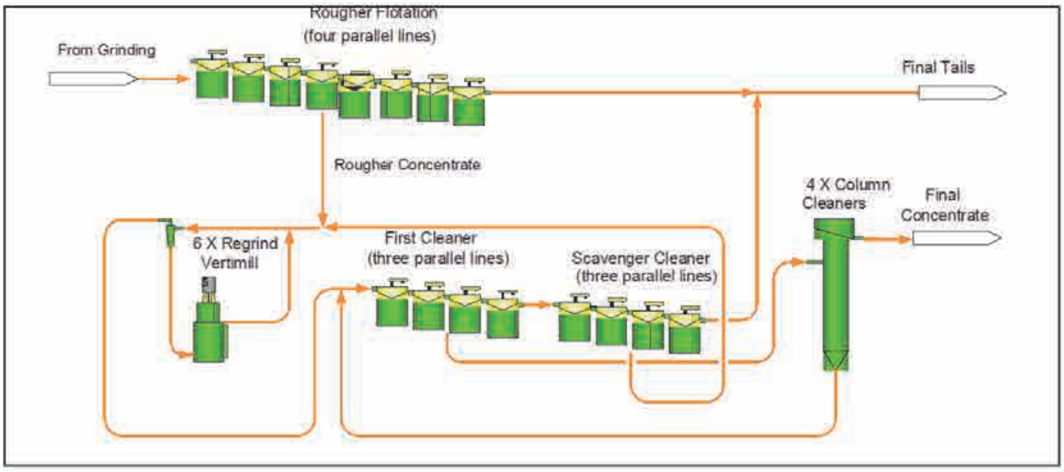
(7) Ore Dressing

Dressing of ores in concentrator is similar to a series of ore dressing circuit design for general porphyry copper type deposit. The operational flow of ore grinding process and that of floatation process are shown in Figure 2.2.8 and Figure 2.2.9 respectively.



(Source: Oyu Tolgoi, Technical Report 2013)

Figure 2.2.8 Oyu Tolgoi Mine Grinding Circuit Flow Sheet



(Source: Oyu Tolgoi, Technical Report 2013)

Figure 2.2.9 Flotation Circuit in Oyu Tolgoi Mine

Mineral processing facilities are located and designed two lines for future expansion. They completed 1 line and started to feed ore from the Open pit in 2013. Nominal design capacity is 100,000 t/day ore and it exceeds the design capacity at the end of 2013.

Open pit operation is as scheduled, in mine section, the ore of 72.032 Mt@0.47%Cu, 0.36 g/t Au, 1.39 g/t Ag were mined and fed to plant in 2013.

And, the production of copper concentrates (quality grade; Cu; 26.4%) in the same year was 290,000 tons/year and the recovery rate was 81.6% for Cu, 66.1% for Au and 54.2% for Ag respectively.

The ore grinding system in concentrator of Oyu Tolgoi Mine is as shown in Photo 2.2.5.

(Source: Photo taken by Survey Team)

Photo 2.2.5 Ore Grinding System in Concentrator of Oyu Tolgoi Mine

(8) Production (Plan)

According to the report of Oyu Tolgoi LLC (2013), the long term production plan for forty-three (43) years is as shown in Table 2.2.4.

Table 2.2.4 Yearly Production Plan

(Upper Table;1st~13th Year, Middle Table;14th~29th Year, Lower Table;30 th~43 Year)

			Year													
Description	Unit	Total	–1	1	2	3	4	5	6	7	8	9	10	11	12	13
Open Pit Ore	Mt	1,048	2	52	51	46	42	47	37	30	20	14	16	24	5	32
Open Pit Waste	Mt	1,905	55	58	59	64	64	63	72	41	21	26	24	16	35	8
Total Open Pit	Mt	2,953	57	110	110	110	106	110	110	71	41	40	40	40	40	40
U/G Ore	Mt	491	–	–	0.1	1	2	3	6	13	21	27	30	32	33	3
Total Ore Mined	Mt	1,539	2	52	51	47	44	50	44	42	41	40	46	56	38	66
Re-handle	Mt	189	–	–	–	–	4	–	–	–	–	–	–	–	–	–
Total Material including Stockpiles	Mt	3,142	57	110	110	110	110	110	110	71	41	40	40	40	40	40
Total Process Feed	Mt	1,539	1	30	35	36	35	33	33	36	37	37	36	37	38	38
Parameter Values	NSR $/t	47.17	33.15	48.33	37.46	44.18	20.49	41.62	40.41	56.05	98.23	112.81	95.25	92.37	91.17	96.60
	Cu %	0.89	0.54	0.60	0.55	0.67	0.42	0.62	0.69	1.07	1.83	2.09	1.78	1.78	1.77	1.82
	Au g/t	0.34	0.43	0.96	0.59	0.65	0.18	0.73	0.54	0.35	0.57	0.61	0.47	0.41	0.36	0.45
	Ag g/t	2.03	1.10	1.45	1.43	1.76	1.24	1.57	1.85	2.55	3.95	4.29	3.61	3.60	3.67	3.77
	Conc kt	40,655	9	615	669	842	492	694	713	1,020	1,567	1,809	1,694	1,783	1,878	1,879
	Con Cu %	29.6	26.8	25.5	25.5	25.7	24.9	25.8	27.8	33.8	39.6	39.5	35.2	33.6	32.9	33.3
	Con Au g/t	9.4	18.4	35.8	23.9	22.0	9.3	27.1	17.3	9.6	10.8	10.0	7.9	6.7	5.8	7.1
	Con Ag g/t	65.0	51.3	57.6	61.6	63.3	69.3	62.0	72.7	77.2	81.5	77.1	67.7	64.5	64.7	65.6
	Con As ppm	1,712	272	243	478	1,016	678	392	658	1,068	1,153	854	728	828	1,405	1,277
	Con F ppm	301	251	317	301	298	217	261	215	235	266	283	298	324	345	344
	Copper m lb	26,486	5	346	376	476	271	395	437	761	1,369	1,575	1,314	1,320	1,360	1,380
	Gold koz	12,889	5	708	515	596	148	605	445	322	563	602	448	403	361	443
	Silver koz	83,001	15	1,140	1,324	1,714	1,096	1,383	1,626	2,480	4,053	4,436	3,652	3,658	3,861	3,924

(Continued)

		Year															
Description	Unit	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Open Pit Ore	Mt	8	7	6	10	8	10	24	18	27	10	7	24	12	4	6	18
Open Pit Waste	Mt	35	33	37	31	32	31	14	19	31	70	76	74	74	74	77	79
Total Open Pit	Mt	43	40	43	41	40	41	38	37	58	80	83	98	86	79	83	97
U/G Ore	Mt	33	33	33	32	32	32	33	28	20	14	–	–	–	–	–	–
Total Ore Mined	Mt	41	40	39	42	40	42	57	46	47	24	7	24	12	4	6	18
Re-handle	Mt	–	–	–	–	–	–	–	–	–	9	27	12	24	29	25	13
Total Material including Stockpiles	Mt	43	40	43	41	40	41	38	37	58	90	110	110	110	108	109	110
Total Process Feed	Mt	38	39	39	41	40	42	42	43	42	33	34	36	36	33	32	31
Parameter Values	NSR $/t	94.67	89.81	83.28	63.27	54.60	55.38	63.46	61.87	47.69	44.54	23.46	22.55	23.88	21.65	20.01	20.08
	Cu %	1.71	1.55	1.42	1.22	1.09	1.12	1.29	1.27	1.00	0.99	0.50	0.51	0.50	0.43	0.35	0.36
	Au g/t	0.51	0.45	0.46	0.26	0.24	0.18	0.17	0.15	0.13	0.15	0.19	0.15	0.19	0.22	0.26	0.27
	Ag g/t	3.62	3.31	3.14	2.69	2.54	2.44	2.56	2.42	1.93	1.98	1.30	1.20	1.29	1.28	1.25	1.16
	Conc kt	1,849	1,770	1,704	1,540	1,378	1,444	1,676	1,659	1,330	1,086	603	617	603	492	377	372
	Con Cu %	32.3	31.4	29.8	29.1	28.3	29.0	29.1	29.2	27.7	26.8	23.8	24.2	24.3	24.0	24.1	24.3
	Con Au g/t	8.3	8.0	8.3	5.4	5.3	4.1	3.4	3.0	3.1	3.5	8.0	6.4	8.3	10.9	15.6	16.4
	Con Ag g/t	64.9	64.1	62.8	61.2	63.2	60.0	55.3	53.2	51.7	51.8	60.9	57.3	60.6	69.7	82.7	80.0
	Con As ppm	1,357	1,425	1,305	1,747	1,500	2,012	2,339	2,582	2,366	2,362	4,306	4,630	3,791	2,880	662	930
	Con F ppm	349	356	374	367	332	298	321	352	361	407	268	269	260	240	196	185
	Copper m lb	1,316	1,226	1,121	987	859	922	1,075	1,067	811	641	317	329	323	260	201	199
	Gold koz	509	470	470	275	245	195	188	166	139	120	154	122	160	175	193	196
	Silver koz	3,819	3,602	3,393	2,995	2,762	2,754	2,949	2,794	2,158	1,760	1,136	1,078	1,155	1,083	987	904

(Continued)

		Year													
Description	Unit	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Open Pit Ore	Mt	18	35	31	35	16	36	36	36	34	35	34	33	31	20
Open Pit Waste	Mt	75	75	49	53	27	30	34	32	26	28	29	26	20	7
Total Open Pit	Mt	94	110	80	88	42	66	70	68	60	63	63	59	51	27
U/G Ore	Mt	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total Ore Mined	Mt	18	35	31	35	16	36	36	36	34	35	34	33	31	20
Re-handle	Mt	16	–	3	–	18	–	–	–	–	–	–	–	–	9
Total Material including Stockpiles	Mt	110	110	83	88	61	66	70	68	60	63	63	59	51	36
Total Process Feed	Mt	35	35	34	35	34	36	36	36	34	35	34	33	31	29
Parameter Values	NSR $/t	16.95	22.03	20.83	22.86	14.65	23.70	23.75	23.33	21.37	20.56	19.27	20.95	32.92	42.73
	Cu %	0.34	0.44	0.41	0.47	0.31	0.49	0.49	0.48	0.43	0.41	0.37	0.35	0.42	0.28
	Au g/t	0.17	0.19	0.20	0.19	0.11	0.18	0.18	0.18	0.20	0.20	0.23	0.34	0.70	0.69
	Ag g/t	1.15	1.28	1.20	1.18	1.01	1.17	1.14	1.11	1.05	1.02	0.99	1.13	1.46	1.30
	Conc kt	389	509	461	542	363	586	592	592	500	494	440	389	445	189
	Con Cu %	24.1	24.5	24.4	24.3	23.4	24.2	24.1	23.9	23.7	23.3	23.1	23.6	24.8	27.8
	Con Au g/t	10.1	9.4	11.0	8.6	8.2	7.8	7.8	7.8	10.8	10.2	12.6	19.9	34.4	43.8
	Con Ag g/t	81.3	72.7	72.1	62.5	75.2	59.1	58.6	58.2	62.8	62.4	64.4	77.9	88.8	98.8
	Con As ppm	2,180	3,337	2,852	3,242	1,568	3,421	3,368	3,167	2,569	2,685	2,363	1,234	351	329
	Con F ppm	183	213	207	231	170	239	242	250	237	241	230	198	222	125
	Copper m lb	207	274	248	291	187	313	315	312	261	254	224	202	244	116
	Gold koz	131	159	161	154	83	150	151	150	159	161	178	259	519	480
	Silver koz	965	1,114	1,017	1,033	822	1,033	1,014	994	891	876	836	913	1,157	646

(Source: Oyu Tolgoi, Technical Report 2013)

(9) Matters to be specifically noted

Matters to be specifically noted other than those previously described are mentioned as follows:

- Copper concentrates has firstly been shipped for exportation to China in the year end of 2013.
- The present open pits is planned to be expanded with the step-by-step from Phase-1 to Phase-10, and finally it will become to the scale of about 2 km x 1.5 km.
- The underground mining of Hugo Dummett Deposit (Method of Underground Block Caving) is planned to be commenced from 2014, and it is planned to commence the ore production from mining area of Hugo South Extraction (Shaft #1) and that of J/V with Entrée (Shaft #2 and Shaft #3) before around 2019.
- As to the transportation, paved roads of 106 km in length to the border line between Mongolia and China (Gashuunsuhayt Gate) are completed.
- As for the supply of electric power, whole electric power required, i.e. 220KVx310MW is being supplied through two (2) lines from the Inner Mongolian Autonomous Region of China (Bayainhanggai) by means of buying electricity. The length of power transmission cable network reaches to170 km.
- Whole of water required (for operation and for living) are supplied from groundwater (fossil water) and it is indicated that a higher recycling rate of water is maintained accordingly.

2.3 Development Plan of New Mine

2.3.1 Outlined State on Development of Tsagaan Suvarga Deposit

(1) Location

This deposit is located at the area of 110 km east of Oyu Yolgoi Mine in Dornado Aimag of South

Govi. And, the distance from the deposit to Sainshand City is 250 km in a straight line.

(2) Outlines of Mine

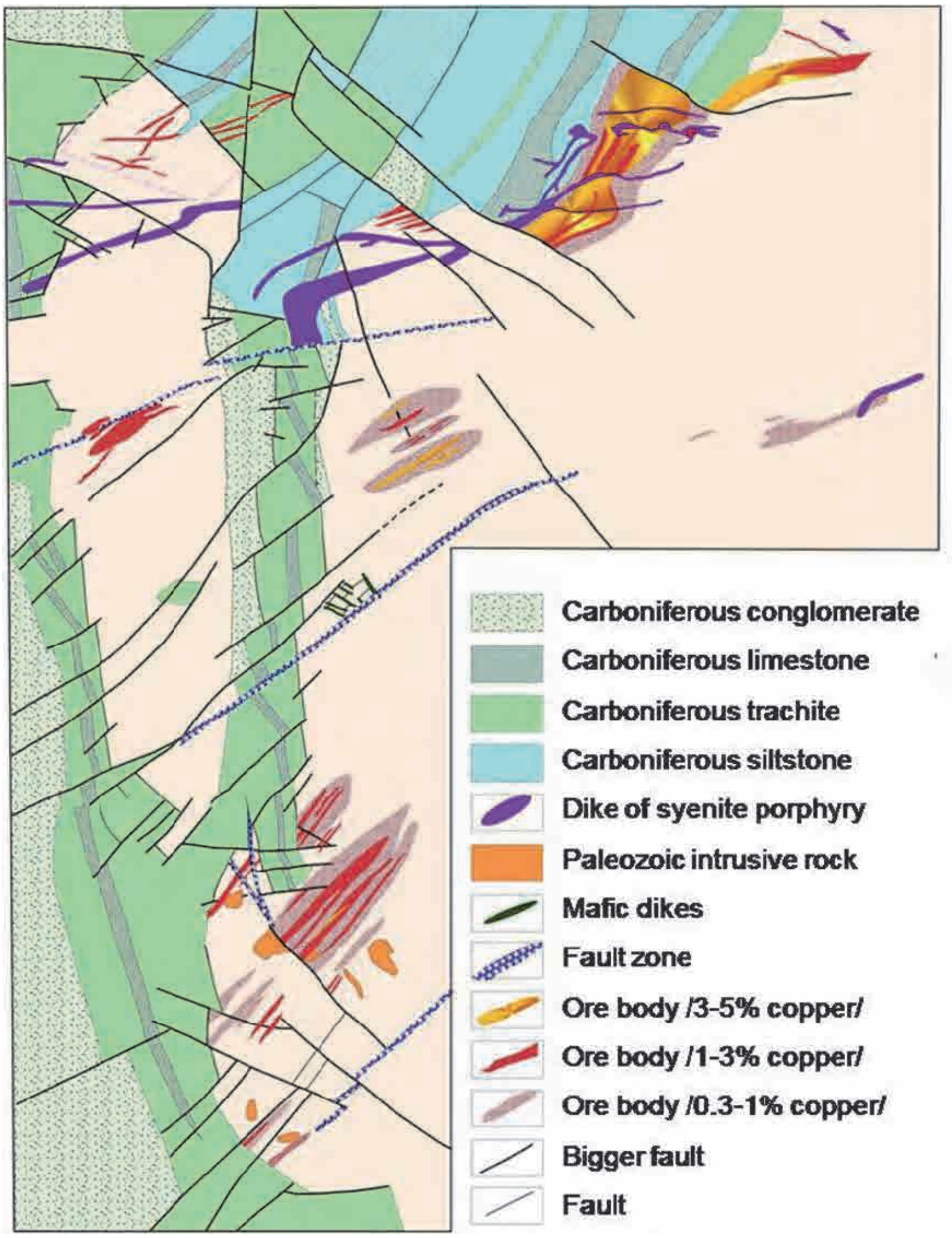
The mining area of this mine is owned by Mongolian Alt Corporation (hereinafter expressed "MAK") which is an enterprise in Mongolia and the development work is proceeding. MAK was established by purely Mongolian capital and is the largest mining company in Mongolia. This deposit is being under development for opening until 2017.

According to the report from press on 30th, May, 2014, the government of Mongolia decided in the Diet that the government will make investment of 34% in capital (the fourth quarter in 2014). And the fund for the same is to be provided by the governmental bond. However, the permanent committee on economy held on 10th, July of the same year has decided that the committee does not admit the necessity of governmental participation to this mining area, and appeared a confused aspect.

(3) Geology and Geological Structure

Serven Sukhait deposit in Tsagaan Suvarga is composed of Middle Paleozoic syenite-diorite, granodiorite, granosyenite and syenite, intruded by dikes of gabbro porphyrite and andesite porphyrite.

Serven Sukhait deposit is located at the north-west and north side of Tsagaan Suvarga copper mineralized area and ore body is situated along the boundary between syenite diorite and Triassic age volcanogenic sedimentary rocks. Central part of deposit is intensively affected by fractures and form massive copper mineralized ore body with copper content ranging from 0.4% to 4.56%. Host rock is altered and developed silicification, with stringers of quartz, quartz-sulfide and quartz-sericite-sulfide, containing copper ore higher than 0.4%. There is post stage carbonate, chlorite alteration without copper mineralization.
Geological map of Tsagaan Suvarga area is shown in Figure 2.3.1.



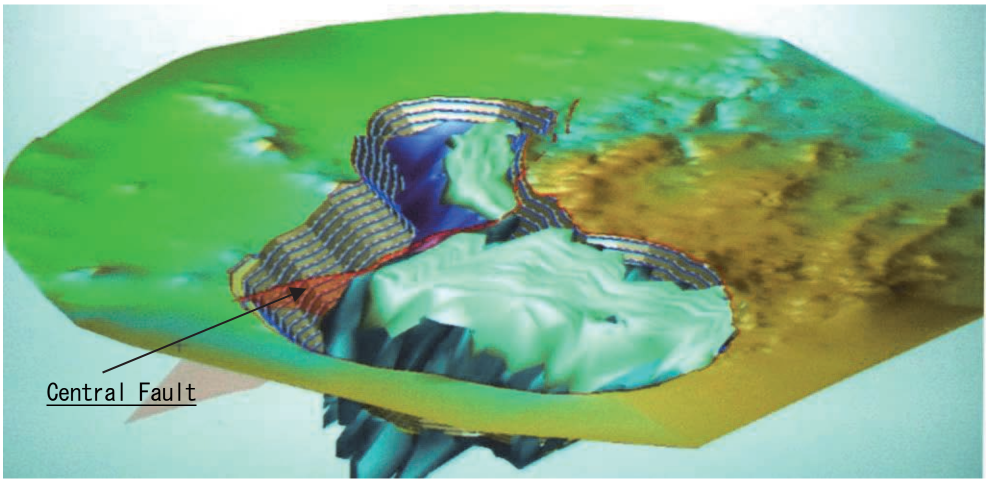
(Source: Geological Information Center, 1985)

Figure 2.3.1 Geological Map of Tsagaan Suvarga Area

(4) Ore mineralization

Main ore mineral is chalcopyrite which formed with quartz muscovite stringers and impregnations in rock. Thickness of stringers ranges from 1 mm to several cm. Chalcopyrite show association with bornite, pyrite, molybdenite, chalcosite and rarely sphalerite and galena. Molybdenite forms flaky grains with size up to 4 mm, usually associates with chalcopyrite and pyrite. Sometimes found in quartz vein.

Content of trace metal is analyzed by Chemical Institute of Mongolian Science Academy and detected as following: Au=0.083ppm, Ag=2.64ppm, Re=0.39 ppm, Se=8.30 ppm, Te= 12.8 ppm. Ore body is NE trending 1,980 m long and 180-500 m wide. It is divided into south and north bodies by Central fault. Ore body was estimated using copper grade 0.3%. Oxidation zone is very small its thickness is 20-30 m. Main minerals in oxidation zone is malachite, azurite, iron and manganese oxides. 3D model of Serven Sukhait ore body is shown in Photo 2.3.1.



(Source: Photo taken by Survey Team)

Photo 2.3.1 3D Model of Serven Sukhait Deposit 3D

(5) Exploration

The rough survey had been carried out in 1965 ~ 1967 by the national budget and followingly the preliminary survey had been carried out in 1974 ~ 1977, also the detailed survey had been executed in 1980 ~ 1982. The boring survey was carried out for the extent that the total extended length of boring reached to 22,742 m and in addition the grid boring of 280 bore holes and total extended length of 41,272 m (space between adjacent two holes 45 ~ 50m x depth 70 ~ 100 m) had additionally been executed by MAK during the period of 2001 ~ 2008. MAK refunded the cost for exploration expended by the government of Mongolia to the government in 2006.

(6) Quantity and Quality Grade of Ore

MAK carried out the calculation on the reserve quantity of ores based upon JORC in 2006 ~ 2007. The result of this calculation was submitted to the national committee of ore reserve, and obtained its approval. The minable reserve of Tsagaan Suvarga Deposit is shown in Table 2.3.1.

Table 2.3.1 Mineral Resources (JORC) in Tsagaan Suvarga

		Mineral Resources					
Cutoff(Cu%)	Ore type	Class	Tonnage Mt	Cu%	Mo%	Au g/t	Ag g/t
0.18	Oxide(Cap)	Measured	16.3	0.402	0.011	0.05	1.06
		Indicated	4.6	0.388	0.011	0.03	0.72
		Inferred	0.2	0.326	0.018	0.04	0.57
		Total	**21.2**	**0.398**	**0.011**	**0.04**	**0.98**
0.2	Primary	Measured	199.8	0.598	0.022	0.05	1.31
		Indicated	91.6	0.457	0.015	0.04	1.17
		Inferred	15.2	0.333	0.01	0.02	0.95
		Total	**306.6**	**0.543**	**0.019**	**0.05**	**1.25**

(Source: Micromine, 2009)

And the abundance of Tsagaan Suvarga Deposit according to the standard on reserve of ore in Mongolia is as shown in Table 2.3.2.

Table 2.3.2 Reserves by Mongolian Reserve Estimate Standard in Tsagaan Suvarga

Category Grid size (m)	Ore WEIGHTS tonnes	CONTENTS		
		CU, % Tonnes	Mo, % Tonnes	Au, g/t, t onnes
SURE(A) 45 x 60m	141,499,963	0.688	0.029	0.046
		973,059	41722	6.503
realistic (B) 70 x 100m	94,753,644	0.6	0.023	0.044
		568,556	21617	4.2
POTENTIAL (C) 80 x 129m	14,142,633	0.492	0.02	0.03
		69,582	2829	0.424
Total	250,396,240	0.643	0.026	0.044
		1,611,197	66,167	11.127

(Proven Primary =A+B+C: 250Mt)

(7) Ore Dressing

The flow of ore dressing process is a kind of normal dressing process, i.e. primary crusher, ore grinding system (SAG mill, i.e. semi-autogenous grinding mill, of 17 mm in dia.) having one (1) line, ore grinding system (ball mill), cyclone, floatation (300 m^3 x 8 sets) and concentration facility by sedimentation (thickener). The production capacity of this system is 14,600,000 t/year (=40,000 t/day, and produces 316,000 t/year of copper concentrates (quality grade; 25.69%) and 4,400 t/year of molybdenum concentrates (quality grade; 51.89%). The durability of facilities is planned for 18 years. The recovery rate of copper is 92% and that of molybdenum is 65%. The construction plan for Tsagaan Suvarga Mine is shown in Table 2.3.3 herein.

Table 2.3.3 Construction Plan of Tsagaan Suvarga Mine

Schedule	From	To
Detailed engineering, design	2011.11	2014.07
Equipment supply	2011.11	2015.07
Earth work/ore loading/unloading, tails dam	2012.08	2015.06
Construction	2013.04	2016.09
Completion (Latest info Mid 2015)	2016.09	2016.12

(Source: Prepared by Survey Team)

And, the state of construction of this mine is as shown in Photo 2.3.2.

(Source：Photo taken by Survey Team)

Photo 2.3.2 State of Construction of Tsagaan Suvarga Mine

(8) Production Plan

Tsagaan Suvarga Mine is scheduled to be opened in 2017 and to develop for eighteen years. The production plan has not officially been announced yet.

(9) Matters to be specifically noted

Matters to be specifically noted other than those previously described are mentioned as follows:

- The first shipment of copper concentrates is scheduled in 2017.
- It is planned to receive all electric power required from Oyu Tolgoi Mine, and the electric

power transmission cable network (220KV x 150 km) is under construction at present.

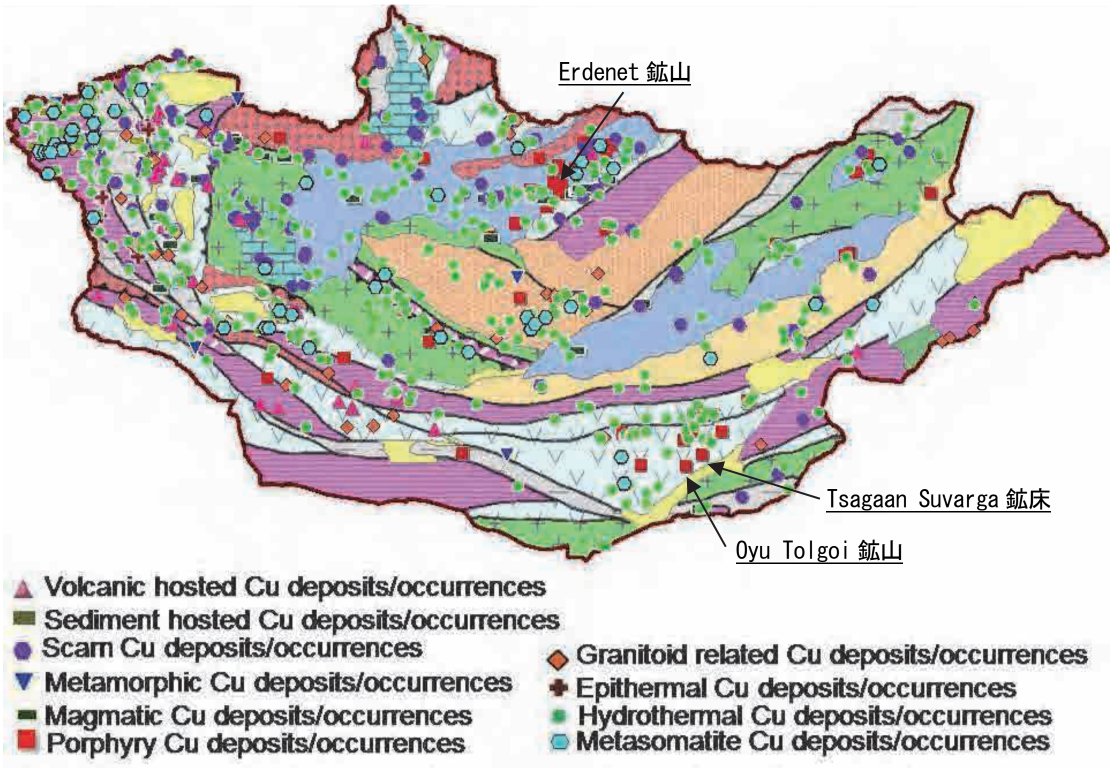
- It is planned that copper concentrates are to be transported to the railway station close to the mine by means of truck vehicles and transported to Sainshand City through a new railway therefore. Although it is planned to complete the construction of railway between Tavan Tolgoi and Sainshand in 2015, the construction is considerably being delayed at this stage. In case that the railway construction could not be completed before the first shipment, concentrates will have to be transported to Sainshand City by means of truck vehicles through gravel paved road to be newly constructed alternatively.
- Whole of water required (for operation and for living) are to be supplied from groundwater (fossil water) and it is planned that a higher recycling rate of water is to be maintained accordingly.

2.4 Potential of Copper Resources

In Mongolia, there are three (3) copper deposit belts existing, i.e. Northern Mongolian, Central Mongolian and Southern Mongolian, and the locations of these belts coincide with those of volcanic zones having same names respectively. The copper mineralization can be seen at the areas relating to volcanic rocks ~ plutonic rocks. The copper mineralization as listed below can be recognized:

- Marine volcanic rocks and related copper mineralization (VHMS)
- Copper mineralization relating to sedimentary rock (relating to sandstones)
- Copper mineralization relating to skarn
- Copper mineralization relating to regional metamorphism
- Copper mineralization relating to mafic and ultramafic rocks (Magma)
- Copper mineralization relating to intrusion of porphyry
- Copper mineralization relating to granite
- Epi-hydrothermal copper mineralization
- Hydrothermal copper mineralization
- Copper mineralization relating to metasomatic metamorphism

Outlined distribution of copper deposits in Mongolia is shown in Figure 2.4.1.



(Source: Mineral Resources Map of Mongolia, 2002 including Partial Revision)

Figure 2.4.1 Outlined Distribution of Copper Deposits in Mongolia

And summarized list of copper deposits in Mongolia is shown in Table 2.4.1. According to this list, it is understood that ore reserves in three (3) deposits and/or mineralized zones, i.e. Oyu Tolgoi Mine, Erdenet Mine and Tsagaan Suvarga Deposit, are extremely large among deposits and/or mineralized zones where copper is a major mineral, and especially reserves in Oyu Tolgoi Mine are prominently larger than others. Next to them, Shand mineralized zone is in existence, and other mineralized zones have their reserves so small that numbers of digits may differ by on digit from those of other mineralized zones. From the view point of metallic copper quantity, Tavt-2 Mineralized Zone has larger reserves than those of Erdenet Mine and Tsagaan Suvarga Deposit though copper ore is byproducts of the deposit, and Tavt-1 Mineralized Zone is larger scale mineralized zone in its reserves than those of Tsagaan Suvarga Deposit though its reserves do not reach to those of Erdenet Mine.

Total reserves (Ore A+B+C) of deposits and mineralized zones having copper as their main minerals is 7,965,534,000 t, and the quantity of metric copper (Metal A+B+C) becomes 54,545,000 t (Ore A: Proven reserve, Ore B: Probable reserve, Ore C: Possible reserve, provided that these figures determined on the basis of standards for reserve in Mongolia)

Table 2.4.1 List of Copper Deposit in Mongolia

№	Name of deposit	Type	Province	Location						Ore A+B+C	Metal A+B+C
				X			У			thous.tn	thous.tn
1	Oyu Tolgoi	Main	OmnoGobi	106	51	30	43	0	10	6,451,511	45,031
2	Erdenet	Main	Orkhon	104	7	0	49	1	0	714,201	5,219
3	Tsagaan Suvarga	Main	DornoGobi	108	19	0	43	52	0	250,396	1,611
4	Shand	Main	Bulgan	104	16	10	48	46	35	194,584	625
5	Saran Uul	Main	Bayankhongor	100	36	0	45	45	30	36,196	337
7	Bayan Airag	Main	Zavkhan	94	58	30	47	48	30	15,443	250
8	Khadat Gun	Main	Gobi-Altai	97	50	15	44	9	15	84,690	164
9	Ulaan Khud	Main	OmnoGobi	106	50	30	43	10	3	45,999	162
10	Tsakhir Tolgoi	Main	Bayankhongor	100	9	0	44	45	30	15,501	162
11	Nomint	Main	Dornot	114	50	25	49	40	45	13,640	158
12	Budag Tolgoi	Main	DundGobi	104	16	0	45	56	0	45,35	150
13	Nariin Khudag	Main	DornoGobi	108	0	0	44	14	15	41,035	135
14	Nogtsot Tolgoi	Main	DornoGobi	109	59	53	43	7	17	12,934	133
15	Oyut Ulaan	Main	DornoGobi	109	23	30	44	35	30	19,071	56
16	Ulaan Tolgoi	Main	Bayankhongor	98	23	7	43	59	1	20,764	46
17	Khokh Adar	Main	Bayan-Olgii	90	22	28	48	17	37	4,817	45
18	Mankhan Uul	Main	Gobi-Altai	95	47	30	46	26	55	8,442	43
19	Tamgat	Main	OmnoGobi	100	37	15	43	39	10	896	38
20	Khadat Uul	Main	Tov	105	36	45	48	3	10	8,350	34
21	Zuun Ikh salaa	Main	Selenge	105	22	2	46	32	35	1,111	28
22	Khul Morit	Main	Bayankhongor	98	21	3	44	0	2	7,393	25
23	Khul Morit-1	Main	Bayankhongor	98	20	15	43	59	20	4,761	21
24	Khalzan Uul	Main	OmnoGobi	107	42	15	43	24	45	1,987	15
25	Bayantsagaan	Main	Bayankhongor	98	58	30	44	56	25	1,908	14
26	Kharaat	Main	Увс	92	28	20	49	12	0	1,906	14
27	Sangiin dalai	Main	Bayankhongor	98	25	0	44	25	1	1,433	8
28	Avdar Tolgoi	Main	Dornot	114	50	20	49	40	45	1,617	7
29	Artsat Tsunkheg	Main	Bayan-Olgii	90	4	35	48	18	45	403	1
30	Tavt-2	By-prod	Bulgan	102	26	10	50	7	30		6,309
31	Tavt-1	By-prod	Bulgan	102	26	0	50	7	0		2,366
32	Kharmagtai	By-prod	OmnoGobi	106	7	30	44	2	30		347
33	Zuun Mod	By-prod	Bayankhongor	99	9	30	44	4	0		241
34	Lam chuluut	By-prod	Dornot	115	34	32	49	6	2		100
35	Ulaan Khajuu	By-prod	Bayan-Olgii	90	7	30	48	17	0		97
36	Asgat	By-prod	Bayan-Olgii	89	38	30	49	52	20		72

(Source: Summarized by Survey Team)

On the one hand, reserves of Oyu Tolgoi Mine, Erdenet Mine and Tsagaan Suvarga Deposit approved by the national committee on mineral reserves in Mongolia are as shown in Table 2.4.2 and the total amount of them is 7,416,108,000 t in copper ores and 51,862,000 t in metal copper. The sum of reserves in these three mines and deposit is 51,862,000 t which becomes 93% of total reserves in whole country of Mongolia. The breakdown of reserves in Mongolia is shown in Table 2.4.3.

Table 2.4.2 Ore Reserve Approved by the Committee on Ore Reserves

Name of Mine/Deposit	Name of Province	Organization obtained and Date of Approval		Ore Reserve (x 1,000 t)	Metal Reserve (x 1,000 t)	Cu grade (%)
Oyu Tolgoi Mine	Omnogobi	MRAM ebmz	2009/09	6,451511	45,031	0.698
Erdenet Mine	Orkhon	uamnk	1972/12	714,201	5,220	0.731
Tsagaan Suvarga Deposit	Domogobi	MRAM ebmz	2009/09	250,396	1,611	0.643

(Source: Report from the Committee of Mineral Reserves in Mongolia)

Table 2.4.3 Breakdown of Copper ore Reserves in 3 Mines/Deposit

Cut off (%)	Ore type	Class	Tonnage (x 1,000 t)	Cu %	Mo %	Au g/t	Ag g/t
Oyu Tolgoi Mine							
0.22	Open Pit	Measured	1,096,000	0.45	-	0.30	0.93
		Indicated					
		Inferred	218,000	0.27	-	0.17	0.77
0.37	Underground Mining	Measured	172,000	0.37	-	0.52	0.93
		Indicated					
		Inferred	237,000	0.38	-	0.29	0.87
0.37	Hugo Dummett Deposit	Measured	-	-	-	-	-
		Indicated	907,000	1.69	-	0.39	3.77
		Inferred	1,969,000	0.80	-	0.18	2.12
0.37	Heruga Deposit	Measured	-	-	-	-	-
		Indicated	-	-	-	-	-
		Inferred	1,944,000	0.38	-	0.36	1.37
Erdenet Mine							
-	Open Pit	Measured	714,201	0.731	-	-	-
		Indicated					
		Inferred					
Tsagaan Suvarga Deposit							
0.18	Oxide Ore	Measured	16,300	0.402	0.011	0.05	1.06
		Indicated	4,600	0.388	0.011	0.03	0.72
		Inferred	200	0.326	0.018	0.04	0.57
0.20	Primary Mineral	Measured	199,800	0.598	0.022	0.05	1.31
		Indicated	91,600	0.457	0.015	0.04	1.17
		Inferred	15,200	0.333	0.010	0.02	0.95

Note)Reserves of Erdenet have not officially been announced yet.Mine

(Source: Prepared by Survey Team)

2.5 Present State on Dressing and Processing of Copper Ore

Copper industries in Mongolia other than dressing and processing of copper ores for the production of copper concentrates in Erdenet Mine and Oyu Tolgoi Mine are the production of cathode copper by hydrometallurgic smelting being in operation at the area around Erdenet Mine and the production of copper wires and electrical cables by using the said cathode copper as raw materials. Descriptions on the same are made in the following.

2.5.1 Hydrometallurgic Smelting

Two (2) companies, i.e. Erdmin and Achit, are carrying out dressing and processing of copper ores and production of cathode copper by hydrometallurgic smelting (SX-EW process).

(1) Erdmin Co. Ltd.

Erdmin Co. Ltd. is a small enterprise which established in 1994 by the joint investment with Erdenet Mine, RMC of U.S.A. and private persons and has a hydrometallurgic smelter as the first smelter in Mongolia, and the number of employees is 110 persons. This company is producing cathode copper by SX-EW process from low grade copper oxide ore in debris stockyard and the cumulative total of 33,000 t of cathode copper has been produced since commencement of operation in 1997.

This hydrometallurgic smelting plant designed by BSK Engineering Co. in U.S.A. was constructed as a test plant and the capacity of cathode copper production is 2,880 t/year. However, the test plant as it is continues its production without installation of additional equipment, etc. In recent years, the production of cathode copper has become 2,000 ~ 2,800 t/year due to lowering of ore quality grade.

All of sulfuric acid required for dissolution of copper in the solvent extraction process is being exported from Russia and annual usage of sulfuric acid is approximately 2,500 t/year. Generally, the company is carrying out the production throughout the year by its own know-how such as freeze prevention method in the severe climate conditions of Mongolia, etc. though the damp leaching has less cases using in cold countries. Cathode copper to be produced in the electrolytic refining process is specified in LME Specification “A” and copper contents in cathode copper is to be 99.99%. Chemical analysis result of cathode copper produced by Erdmin Co. Ltd. is shown in Table 2.5.1.

Table 2.5.1 Example of Chemical Analysis for Cathode Copper of Erdmin

Element	Content	Unit	Element	Content	Unit
Cu	99.9877	%	O	0.0656	%
Ag	0.0002	%	P	0.0002	%
As	<0.0001	%	Pb	<0.0001	%
Bi	<0.0001	%	S	0.0117	%
Cd	<0.0001	%	Sb	<0.0001	%
Co	0.0001	%	Se	<0.0001	%
Cr	<0.0001	%	Si	<0.0001	%
Fe	<0.0001	%	Sn	<0.0001	%
Mn	<0.0001	%	Te	<0.0001	%
Ni	0.0001	%	Zn	<0.0002	%

(Source: Provided by Erdmin)

The most of cathode copper produced in this company is exported to Taiwan through Tianjin port in China. And, some are to be processed for production of copper bar and electric cable in its processing plant and such products are to be shipped to the domestic market in Mongolia.

(Source: Photo taken by Survey Team)

Photo 2.5.1 Damp Leaching Field of Erdmin

(Source: Photo taken by Survey Team)

Photo 2.5.2 Electro-extraction Plant of Erdmin

(Source: Photo taken by Survey Team)

Photo 2.5.3 Cathode Products of Erdmin

(2) Achit Ikht Co., Ltd.

The enterprise called Achit Ikht is located at the area around Erdenet Mine and producing cathode copper by the hydrometallurgic smelting as same as that of Erdmin. As the shareholder composition of this firm, 51% of stocks are held by relative(s) of the chief of presidential mansion and 34% of stocks are possessed by EMC respectively.

Procedures of production in this company is producing cathode copper by SX-EW process from low grade copper oxide ore in debris stockyard as same as those in Erdmin and the operation of its cathode copper production plant has been commenced from July, 2014.

The production capacity of this company is 10,000 t/year and this is 3.5 times of that in Erdmin accordingly. It will be possible to produce cathode copper of approximately 13,000 t/year in future in case that this production plant is operated satisfactorily.

(Source: Photo taken by Survey Team)

Photo 2.5.4 Hydrometallurgic Smelter of Achit Ikht being under Construction

2.5.2 Other Copper Industries

The processing industry in the field of copper industries of Mongolia is very limited and only an enterprise of Erdmin is in existence. This company had commenced the production of copper bar and copper wire (IEC60558) from cathode copper produced by SX-EW process in 2005 and the production of poly vinyl chloride (PVC) insulated cable (IEC60227-3 and IEC60227-5) from 2007 (Table 2.5.2). Forty seven (47) kinds of PVC insulated cables, depend on difference of size, sheath, etc., are being produced in this company and total production of these products is approximately 150 t/year. All products are shipped to domestic markets in Mongolia, and the exportation to China has not been achieved due to a lower competitiveness in price. And, the production of these products is presently in a state that the production adjustment is being done due to the recent decrease of demands in Mongolia.

Table 2.5.2 Copper Products of Erdmin

Pproducts	Capacity	Standard
Cathode copper	2,880 ton/year	MNS 4501:97
Rolled copper	2,000 ton/year	MNS 4738:2005
Copper wire	3,800 m/year	MNS 5932:2009
Electric copper wires	3,800 m/year	MNS 5933:2009

(Source: Prepared by Survey Team)

(Source: Photo taken by Survey Team)

Photo 2.5.5 Copper Wire produced in Processing Plant of Erdmin

(Source: Photo taken by Survey Team)

Photo 2.5.6 Electric Cable produced in Processing Plant of Erdmin

Chapter 3. Outlook of the World Copper Demand and Supply

3.1 Current Copper Supply and Demand Analysis

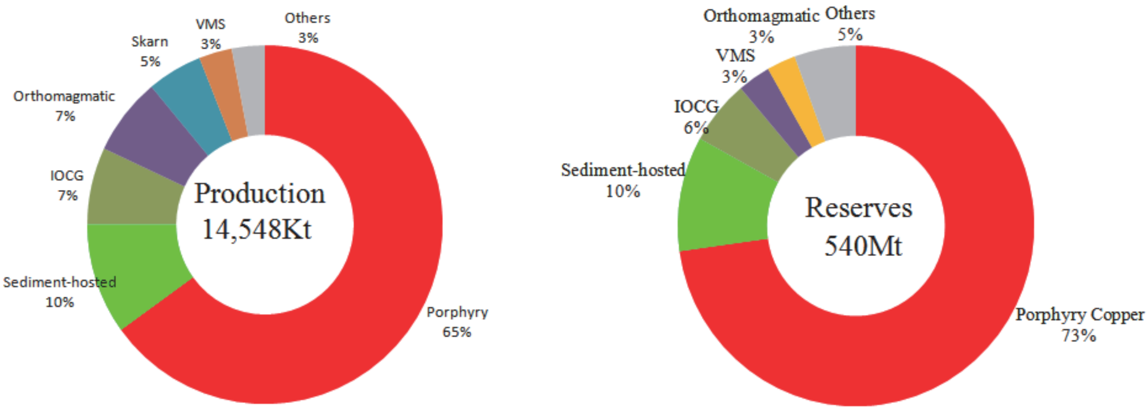
3.1.1 Supply Side

(1) Copper sources

Copper is one of the basic metallic materials and is originated from copper ores (primary sources) and recycled copper (secondary source). Main copper ores are produced from porphyry copper deposit, sediment-hosted copper deposit, iron oxide copper and gold deposit, volcanogenic massive sulfide deposit, orthomagmatic deposit and skarn deposit.

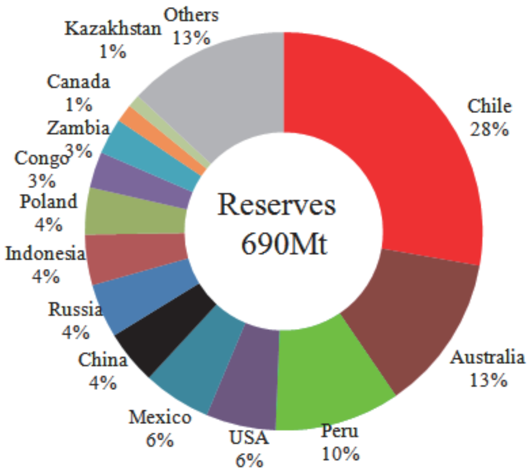
Among them porphyry copper deposit is the most important sources and compose of about 70% of world copper resources and 63% of copper production in 2010 respectively (Figure 3.1.1). While copper grade of the porphyry copper deposit is lower than that of other deposit types, generally it forms large mass containing large quantity of copper. Consequently mining companies are targeting this type of deposit because they can excavate them for a long term with relatively low cost operation.

As shown in Figure 3.1.2, three countries such as Chile, Australia and Peru have over 50% of the world copper reserves that is Chile 28%, Australia 13%, and Peru 10% respectively. The durable length of time of copper is estimated to be 38.5 years, divided by annual consumption in 2013.



(Source: Prepared by Survey Team from the Various Statistical Data)

Figure 3.1.1 Copper Production and Reserves by Deposit Types (2010)



(Source: Prepared by the Survey Team from Mineral Commodity Summaries (2014))

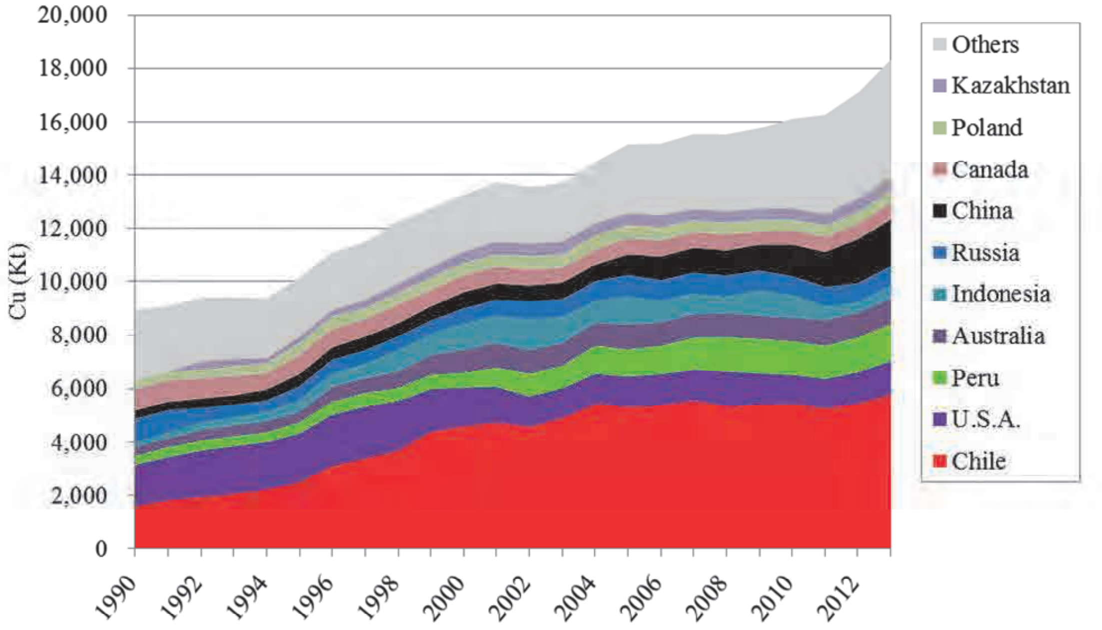
Figure 3.1.2 Copper Reserves by Countries

More than 30% of copper consumption came from recycled copper (ICSG, 2013). Recycled copper is consisted of post consumer scraps (old scraps from used electric goods and etc.) and industrial scraps (new scraps from the copper semis and final products such as electric machines) and 6,616 Kt of copper from scraps is recovered (WBMS, 2014). Recovered scraps are converted to refined copper by direct melting or secondary refining.

(2) Copper ore production

From 1990 to 2013 world copper production increased by annual growth rate 3.2% and recorded 18,322 Kt/year as shown in Figure 3.1.3. Especially Chile is keeping the top producing countries since 1990, when surpass USA because geological potential is higher and keeping excellent mining investment climate. On the other hand USA recorded 1,900 Kt in 1997 and drifting around 1,200 Kt/year because of few new discoveries. China and Peru are gradually increasing production. In case of China, domestic strong copper demand encourage domestic copper mine production. In case of Peru, mining investment climate has been improved and large mining project go on line.

Copper ore production capacity of the top 20 mines as shown in Table 3.1.1 occupies 40% of the world copper production capacity and, 9 mines are in Chile and 14 mines are porphyry copper deposit. According ICSG (2013), the actual production is around 82-85% of world copper production capacity.



(Source: Prepared by the Survey Team from World Bureau Metal Statistics)

Figure 3.1.3 Copper Mine Production (1990-2013)

Table 3.1.1 Biggest 20 World Copper Mines Currently in Operation (basis 2011 capacity)

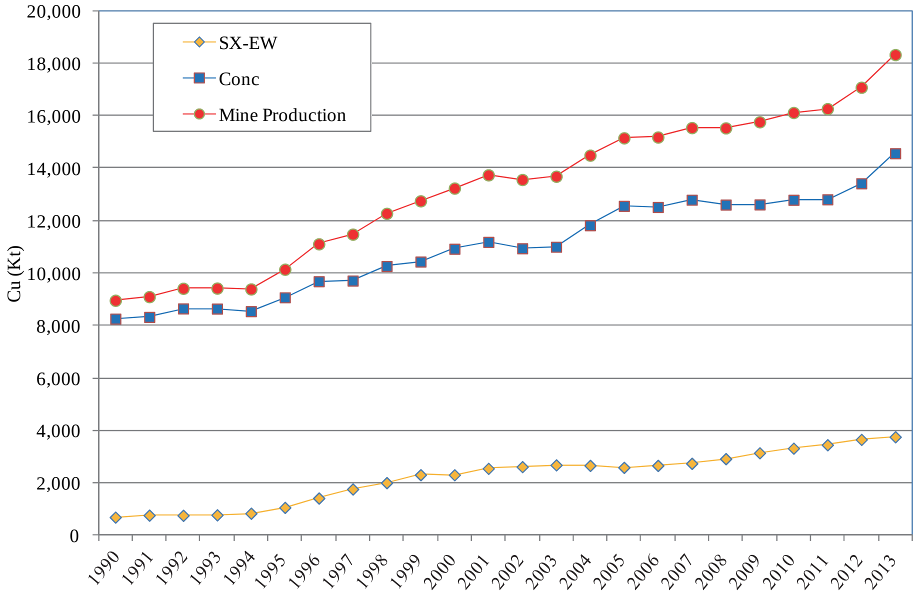
Country	Mine	Owner(s)	Process	2011
Chile	Escondida	BHP Billiton (57.5%), Rio Tinto Corp. (30%), Japan Escondida (12.5%)	Concs & SX-EW	1,250
Chile	Codelco Norte	Codelco (Includes Chuquicamata, Radomiro Tomic, Mina Ministro Hales project)	Concs & SX-EW	920
Indonesia	Grasberg	P.T. Freeport Indonesia Co. (PT-FI), Rio Tinto	Concentrates	750
Chile	Collahuasi	Anglo American (44%), Xstrata plc (44%), Mitsui + Nippon (12%)	Concs & SX-EW	540
Chile	Los Pelambres	Antofagasta Plc (60%), Nippon Mining (25%), Mitsubishi Materials (15%)	Concs & SX-EW	470
Chile	El Teniente	Codelco Chile	Concs & SX-EW	454
Russia	Taimyr Peninsula (Norilsk/ Talnakh Mills)	Norilsk Nickel	Concentrates	430
United States	Morenci	Freeport-McMoRan Copper & Gold Inc./Sumitomo	Concs & SX-EW	420
Peru	Antamina	BHP Billiton (33.75%), Teck (22.5%), Xstrata plc (33.75%), Mitsubishi (10%)	Concentrates	370
Chile	Andina	Codelco Chile	Concentrates	300
United States	Bingham Canyon	Kennecott	Concentrates	280
Zambia	Kansanshi	First Quantum Minerals Ltd (80%), ZCCM (20%)	Concs & SX-EW	260
Indonesia	Batu Hijau	PT Pukuafu 20%, Newmont 41.5%, Sumitomo Corp., Sumitomo Metal Mining & Mitsubishi Materials 31.5%, PT Multi Daerah Bersaing 7%	Concentrates	250
Chile	Los Bronces	Anglo American (100%)	Concs & SX-EW	246
Kazakhstan	Zhezkazgan Complex	Kazakhmys (Samsung)	Concentrates	230
Australia	Olympic Dam	BHP Billiton	Concs & SX-EW	225
Poland	Rudna	KGHM Polska Miedz S.A.	Concentrates	220
Iran	Sarcheshmeh	National Iranian Copper Industry Co.	Concs & SX-EW	204
Chile	Spence	BHP Billiton	SX-EW	200
Mexico	La Caridad	Mexicana de Cobre S. A. (Grupo Mexico)	Concs & SX-EW	195
Peru	Cerro Verde II (Sulphide)	Freeport-McMoRan Copper & Gold Inc.53.5%, Compañia de Minas Buenaventura 18.5%, Sumitomo 21%	Concentrates	194
Total Mine Production Capacity of the 20 biggest world copper mines				8,398
Share in world total copper mine production capacity				41%

(Source: ICSG (2011)) Unit: Kt

(3) SX-EW cathode

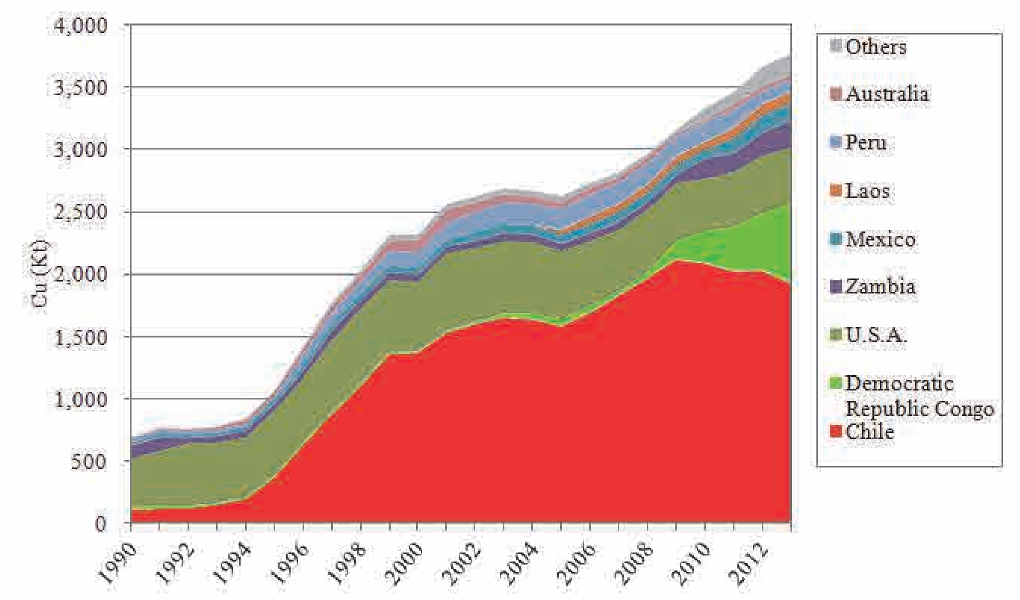
Among copper mine production, ratio of copper concentrate and SX-EW cathode is shown in Figure 3.1.2. A suitable copper ore for hydrometallurgy (SX-EW) is oxide copper minerals such as malachite, chrysocolla, tenorite etc. and secondary sulfide ore such as bornite, chalcocite originated from primary sulfide as chalcopyrite by supergene oxidation. As the formation of oxide copper and secondary copper is associated with climate(arid to semi arid), the development of such copper ore is restricted to low latitude area such as North and South America, and Africa. Furthermore oxide copper and secondary copper precipitates near the surface, accordingly this zone will be extinguished when excavation advanced to deeper level. As making SX-EW cathode large volumes of sulfuric acid is consumed, production of SX-EW cathode is restricted the region where sulfuric acid is supplied.

As shown in Figure 3.1.4, since 1990 mine production is increasing gradually at around annual growth rate 20 %/year. The largest SX-EW cathode producing country is Chile where large new mines started production and increased production such as Escondida, Collahuasi etc. and recorded 2,111 Kt in 2009 (Figure 3.1.5), however after that it dropped. In USA, it is fluctuating between 400 Kt and 600 Kt/year. On the other hand in Congo and Zambia, production has been increasing due to new development of sediment-hosted copper mines such as Kansanshi.



(Source: Prepared by the Survey Team from World Bureau Metal Statistics)

Figure 3.1.4 SX-EW Cathode Production (1990-2013)

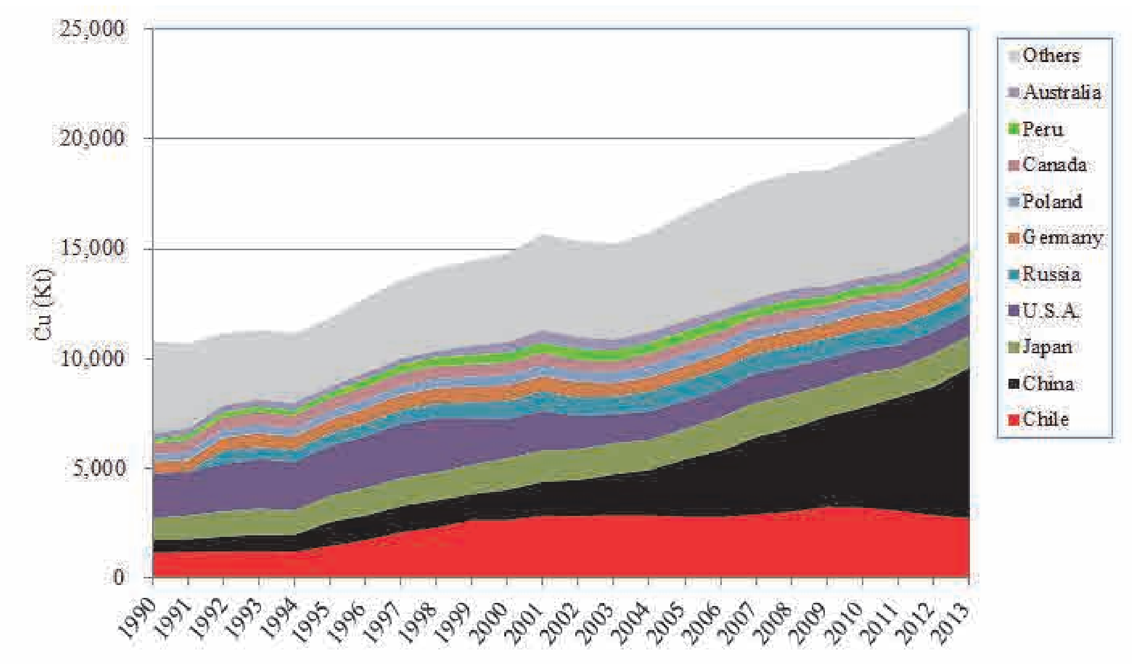


(Source: Prepared by the Survey Team from World Bureau Metal Statistics)

Figure 3.1.5 SX-EW Cathode Production by Countries (1990-2013)

(4) Refined copper production

Refined copper is composed of primary refined copper (from concentrates), secondary copper (from scraps) and SX-EW cathode (electrowinning).



(Source: Prepared by the Survey Team from World Bureau Metal Statistics)

Figure 3.1.6 Refined Copper Production (1990-2013)

As shown in Figure 3.1.6, world refined copper production have been increasing at the rate of 3 %/year since 1990. USA decreased from 2,017 Kt in 1990 to 1,001 Kt in 2013 due to decreasing of domestic mine production. Japan is stay at around 1,500 Kt. On the other hand China has increased production at the rate of 11.5%/year. While SX-EW cathode produced in Chile is 1,933 Kt, which is 70% of total refined copper production in Chile, refined copper produced in China is mainly by pyrometallurgy of concentrates and scraps. China constructed new smelter and refinery to meet increasing domestic copper demands. Table 3.1.2 shows biggest 20 world copper refinery currently in operation. Five refineries of them are Chinese, of which capacity is estimated to 2,100 Kt. Actual production stays at around 80% of capacity (ICSG, 2013).

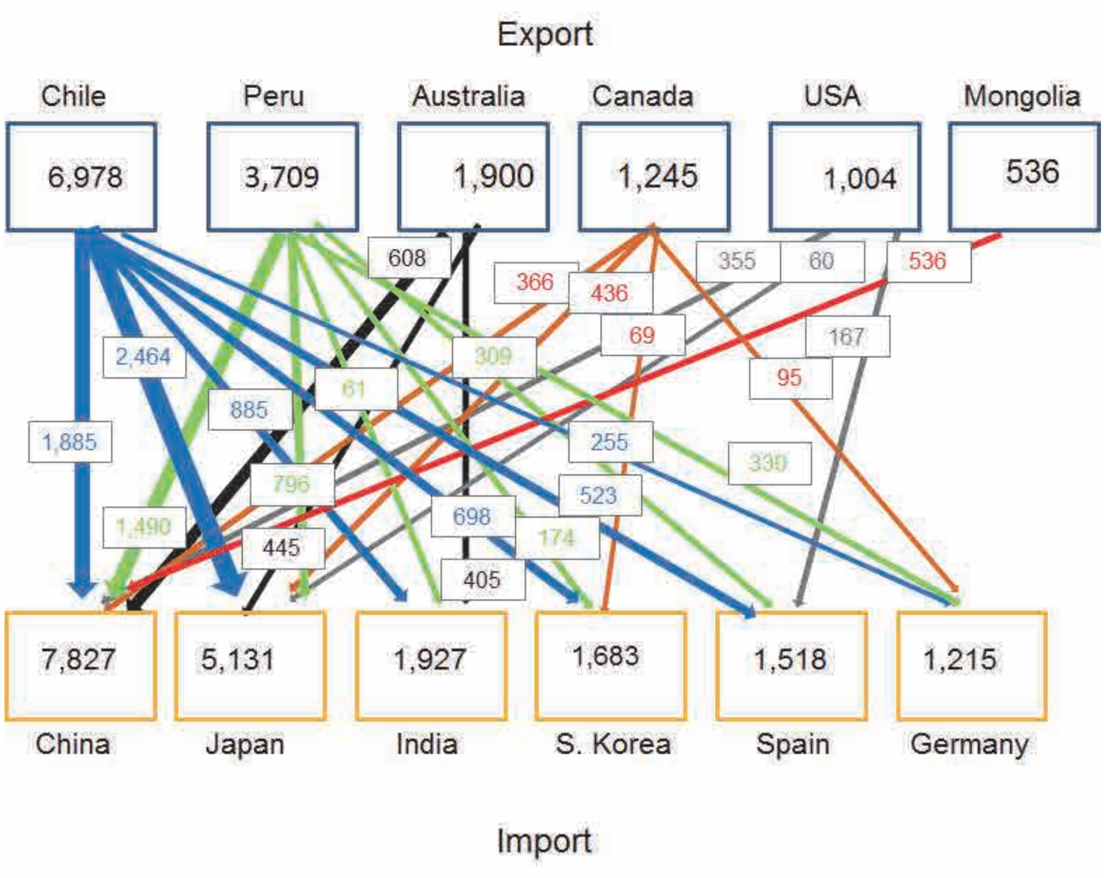
Table 3.1.2 Top 20 World Copper Refineries Currently in Operation (basis 2011 capacity)

Country	Refinery	Owner(s)	Process	2011
China	Guixi	Jiangxi Copper Corporation	Electrolytic	900
Chile	Chuquicamata Refinery	Codelco	Electrolytic	600
China	Yunnan Copper	Yunnan Copper Industry Group (64.8%)	Electrolytic	500
China	Jinchuan	Jinchuan Non Ferrous Co.	Electrolytic	500
India	Sterlite Refinery	Vedanta	Electrolytic	500
India	Birla	Birla Group Hidalco	Electrolytic	500
Chile	Codelco Norte (SX-EW)	Codelco	Electrowinning	470
Japan	Toyo/Niihama (Besshi)	Sumitomo Metal Mining Co. Ltd.	Electrolytic	450
United States	Amarillo	Grupo Mexico	Electrolytic	450
United States	El Paso (refinery)	Freeport-McMoRan Copper & Gold Inc.	Electrolytic	415
Chile	Las Ventanas	Codelco	Electrolytic	400
Germany	Hamburg (refinery)	Aurubis	Electrolytic	395
Russia	Pyshma Refinery	Uralelectromed (Urals Mining & Metallurgical Co.)	Electrolytic	380
Canada	CCR Refinery (Montreal)	Xstrata plc	Electrolytic	370
Peru	Ilo Copper Refinery	Southern Copper Corp.	Electrolytic	360
Chile	Escondida (SX-EW)	BHP Billiton (57.5%), Rio Tinto Corp. (30%), Japan Escondida (12.5%)	Electrowinning	350
China	Zhangjiagang	Tongling Non Ferrous Co.	Electrolytic	350
China	Jinlong (Tongdu) (refinery)	Tongling NonFerrous Metal Corp. 52 %, Sharpline International 13%, Sumitomo Corp. 7.5%, Itochu Corp. 7.5%	Electrolytic	350
United States	Morenci (SX-EW)	Freeport-McMoRan Copper & Gold Inc./Sumitomo	Electrowinning	350
Belgium	Olen	Aurubis	Electrolytic	345
Korean Republic	Onsan Refinery I	LS-Nikko Co. (LS, Nippon Mining)	Electrolytic	330
Total Refinery Production Capacity of the 20 biggest world copper refineries				9,265
Share in world total copper refinery production capacity				38%

(Source: ICSG (2011)) Unit:Kt

(5) World trade of concentrate and refined copper

The largest copper concentrate exporting country in 2012 is Chile, which exports 6,978 K t (gross weight) to China, Japan, India, Germany and etc. Among them, 2,464 Kt is to Japan and 1,885 Kt is to China respectively. Peru exported 1,490 Kt to China and 796 Kt to Japan as shown in Figure 3.1.7.



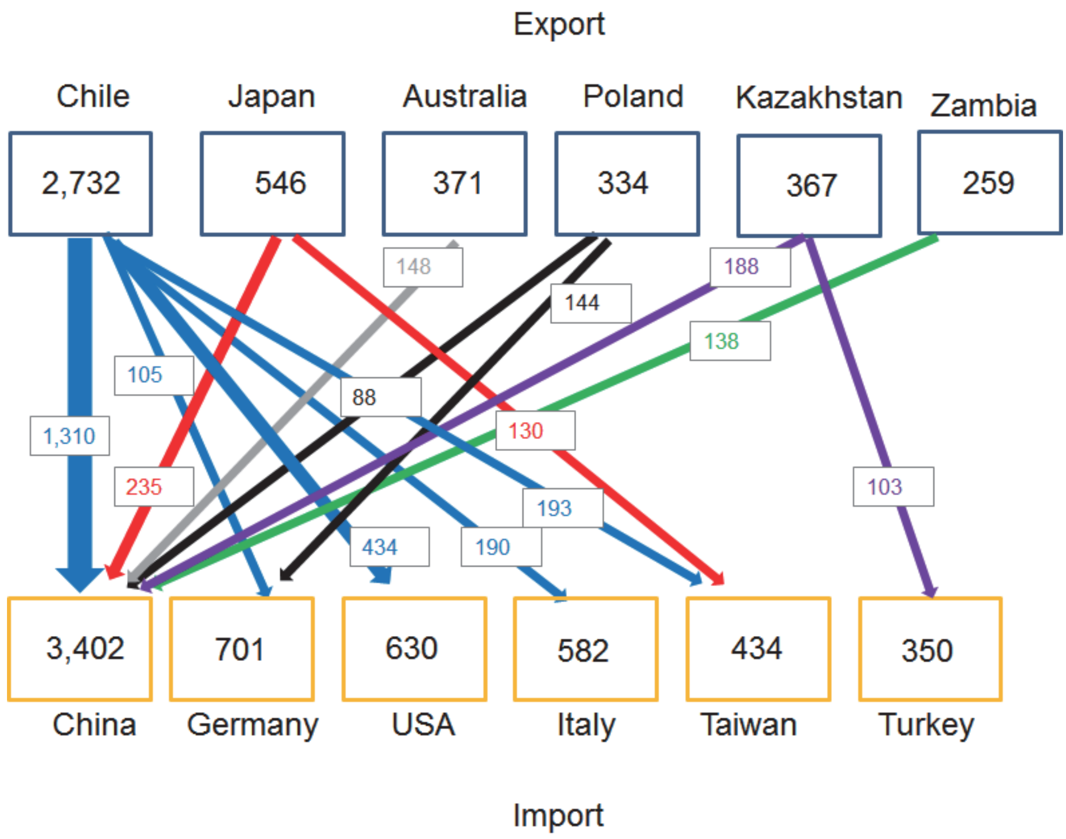
Unit: gross metric tons

(Source: Prepared by the Survey Team from ICSG (2013))

Figure 3.1.7 Trade of Copper Concentrates

In 2012 China imported 7,828 Kt (gross weight) of ores from Chile, Peru, Mongolia, Mexico, Canada, USA, Turkey and Indonesia. The following country is Japan, which imports 5,131 Kt from Chile, Peru, Australia, Canada and etc. While total import of Asian countries accumulated to 16,904 Kt, European countries imported 3,058 Kt. This phenomenon means tremendous demand of Asian region.

As for the refined copper export Chile is the largest country, exported 2,732Kt, followed by Japan exported 546 Kt and Australia, Kazakhstan, Poland and Zambia as shown in Figure 3.1.8. While all refined copper exporting countries except Japan produced refined copper by ore producers, Japanese smelters import concentrate from overseas and produced refined copper as a custom smelter. The largest refined copper importer is no need to say "China", which import 3,406 Kt, putting away from 630 Kt of USA and 701 Kt of Germany.



Unit: metric tons

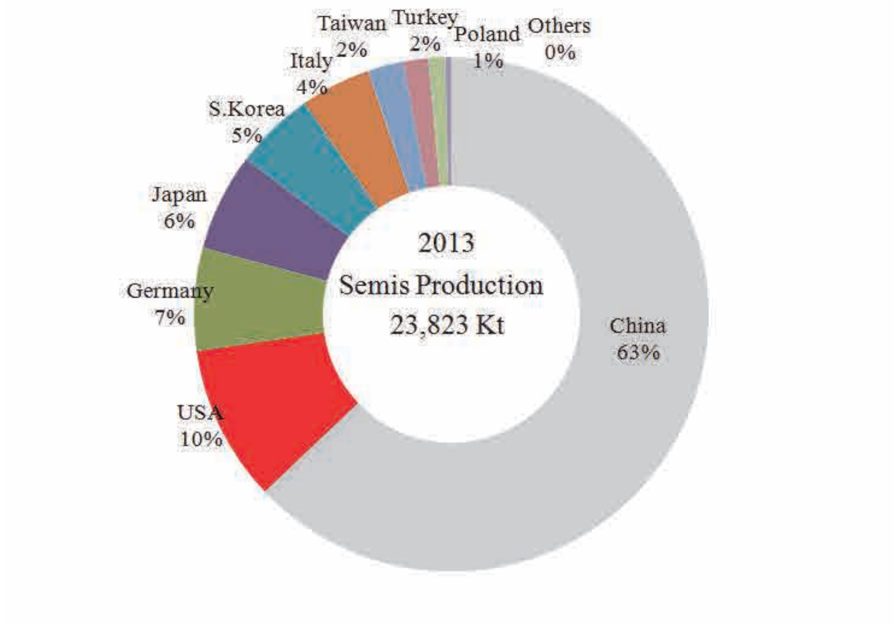
(Source: Prepared by Survey Team from ICSG (2013))

Figure 3.1.8 Trade of Refined Copper

Looking at number by region, Europe imported 1,901 Kit and Asia imported 5,264 Kt. Excluding China, Asian import was almost same as Europe.

(6) Semis production

China produced 63% of the world semi-manufactured goods such as copper, copper alloy, bars & profiles, wire, plate, sheet, foils, tubes as shown in Figure 3.1.9. Trade of semis by China in 2010 was small, that is, export: 256.2 Kt (gross weight) and export: 708.91 Kt compared with total production 9,483 Kt.



(Source: Prepared by Survey Team from World Bureau Metal Statistics)

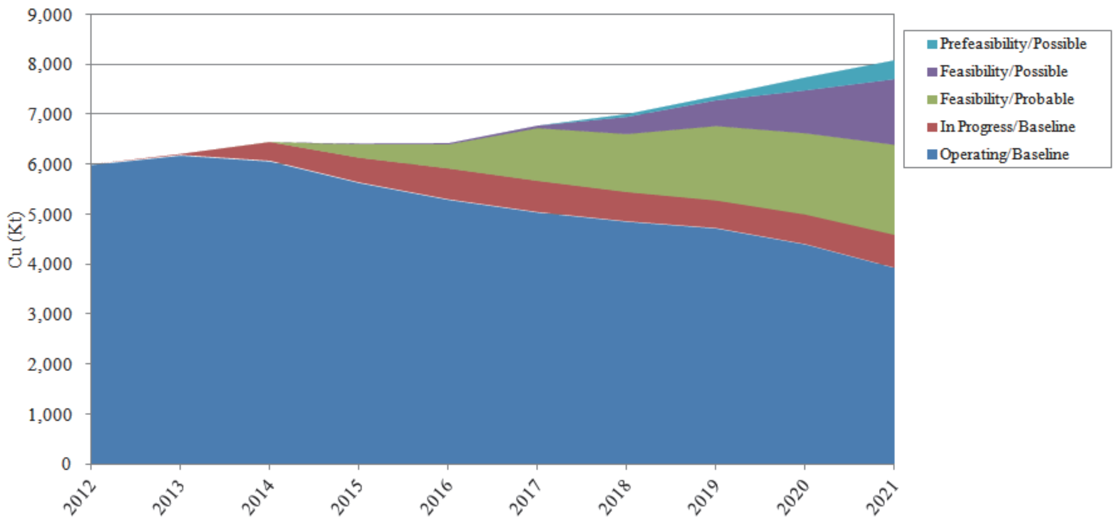
Figure 3.1.9 Production of Semis by Countries

(7) Overview of copper ore producing countries

(a) Chile

Chile is not only keeping excellent mining investment climate from views of the various kinds of criteria but also geological high potentiality of porphyry copper and IOCG deposits, consequently Chile became one of the most attractive mining investment countries (MEG, 2011). Chile is currently producing over 30% of world copper mine production. Although from 2004 to 2012 copper production stays flat, in 2013 expansion of the Escondida and Los Pelambres mines, and started production of Esperanza mine lifted production to 5,776 Kt, 6.3% higher than that of the previous year.

When the new projects such as Chile's state copper producer CODELCO's Ministro Hales, Anglo American's Los Bronces, Japan's Pan Pacific Copper's Caserones, Antofagasta Minerals' Antucoya, and the Poland-based KGHM Polska Miedz's Sierra Gorda come on line in 2014 production is expected to jump up. Cochilco (2013) forecasted if copper price stay in high level production in 2020 will reach 7,734 Kt as shown in Figure 3.1.10.



(Source: Prepared by Survey Team from Cochilco (2013))

Figure 3.1.10 Copper Production Forecast in Chile

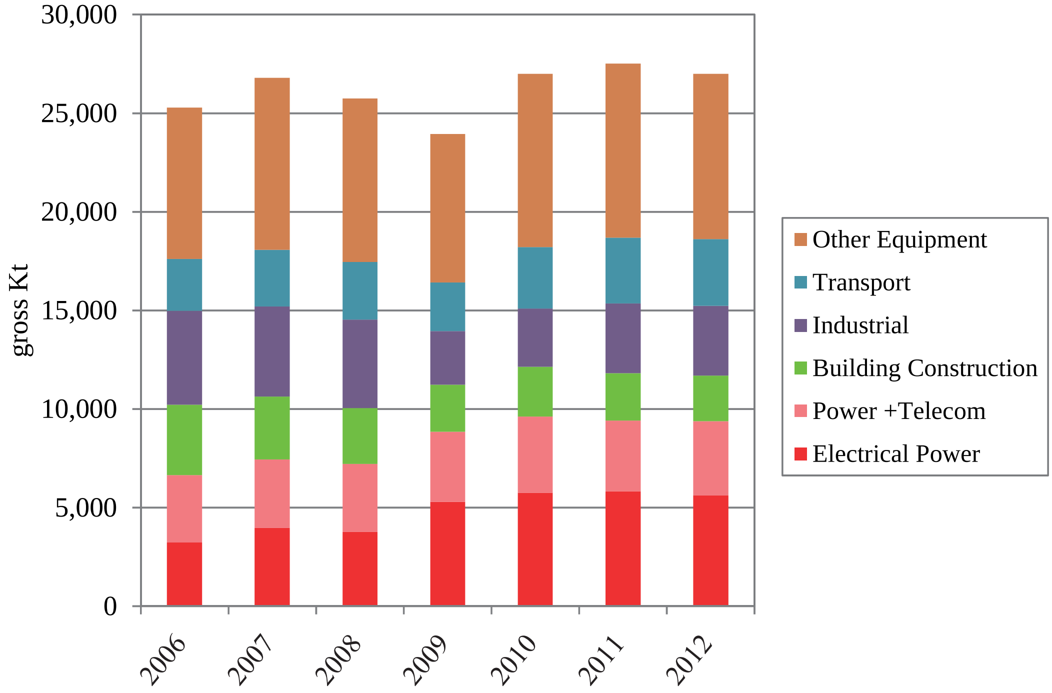
(b) Peru

During the 1990s Peruvian mining industries have been developed by execution of the policy of foreign capital inflow promotion and privatization of national mining companies through the Fujimori regime. In ranking of Mineral potential assuming current regulations/land use restrictions by the Frazer Institute, Peru is ranked to 50th among 93 regions and countries due to mainly conflict with the local peoples. Production of copper, one of the main mineral commodities of Peru, jumped up 1.5-fold (from 843 Kt in 2003 to 1,299 Kt in 2012) during this decade. Although annual copper production is staying at around 1,200 Kt since 2008, production in 2012 reached best yearly performance. This is mainly subjected to completion of expansion program at the Antamina mine, which increased from 347 Kt in 2011 to 463Kt in 2012. There are some brown field projects such as Toromocho, Las Bambas, La Granjas, Antapaccay, Quellaveco and etc. When these projects start operation, production of copper will step up.

3.1.2 Demand Side

(1) Usage of copper

As shown in Figure 3.1.11, the fine copper has a wide variety of usage such as construction, infrastructure materials, electric apparatus and etc. Among them, electric wire and distribution cables in building are major usages.

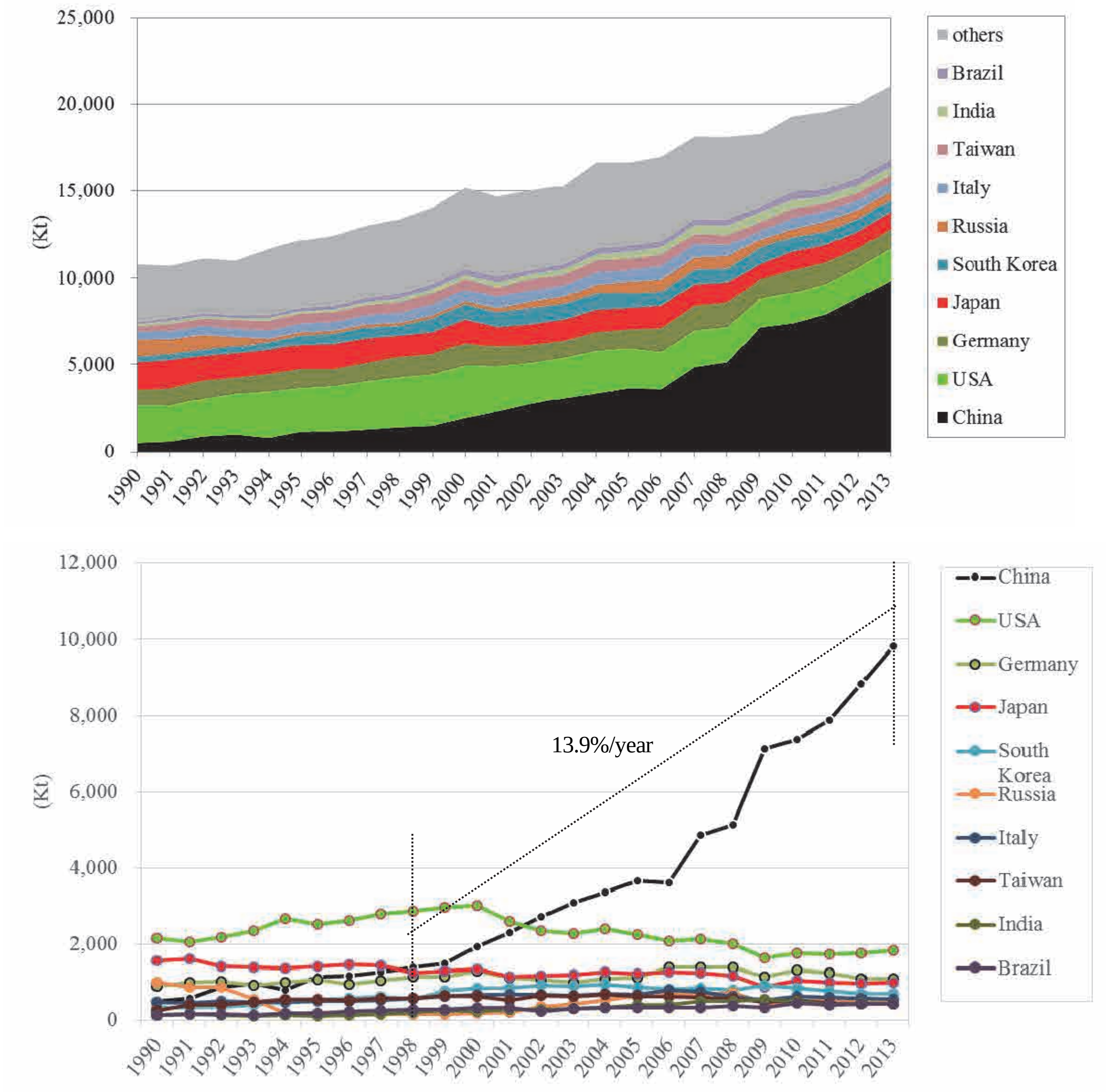


(Source: Prepared by Survey Team from IWCC HP.)

Figure 3.1.11 Usage of Copper

(2) Refined copper consumption

Refined copper consumption increased at annual increasing rate 2.9% from 1990 to 2013 as shown in Figure 3.1.12. Consumption in USA decreased from 2,150 Kt in 1990 to 1,843 Kt in 2013 due to industrial structure change from heavy industry to IT and telecommunication industries. Change of refined copper consumption in G7 countries such as Germany, Japan and Italy is small. On the other hand consumption of China in 2013 is remarkably grown at an annual rate of 13.7% since 1990 and 1recorded 9-fold compare with data of 1990. Especially after 2006 consumption in China increased at an annual rate of 15.4% due to acceleration of domestic economic growth.



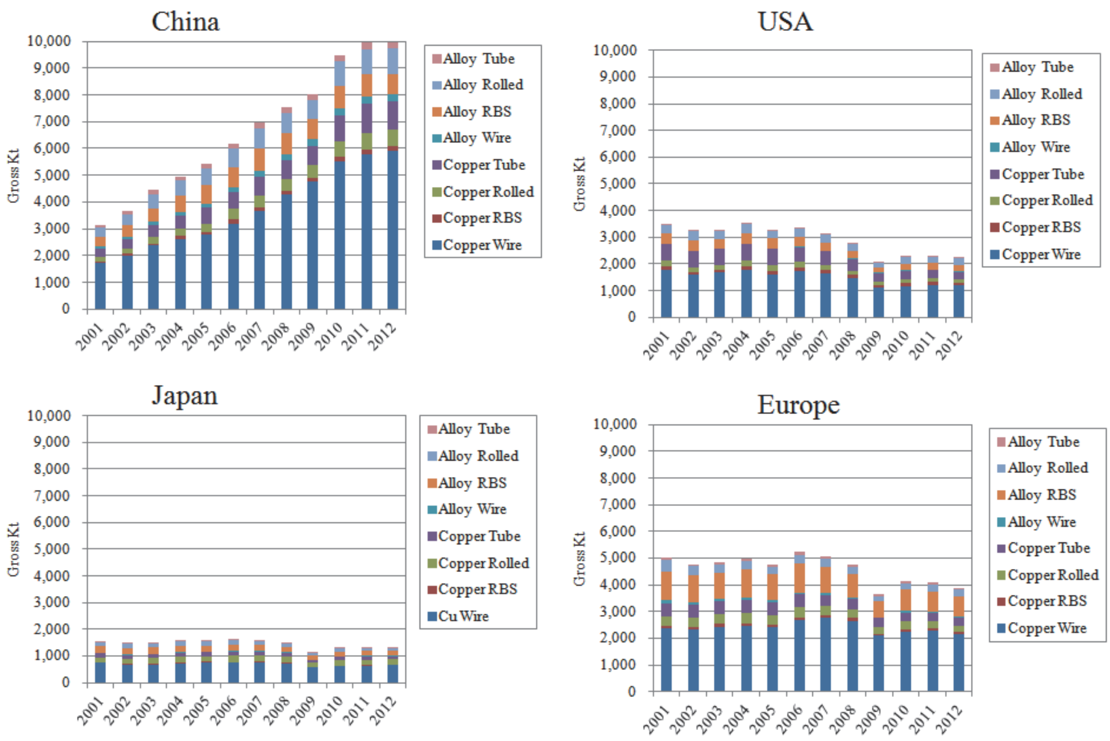
(Source: Prepared by Survey Team from World Bureau Metal Statistics)

Figure 3.1.12 World Consumption of Refined Copper (1990-2013)

upper: cumulate graph, lower: individual graph

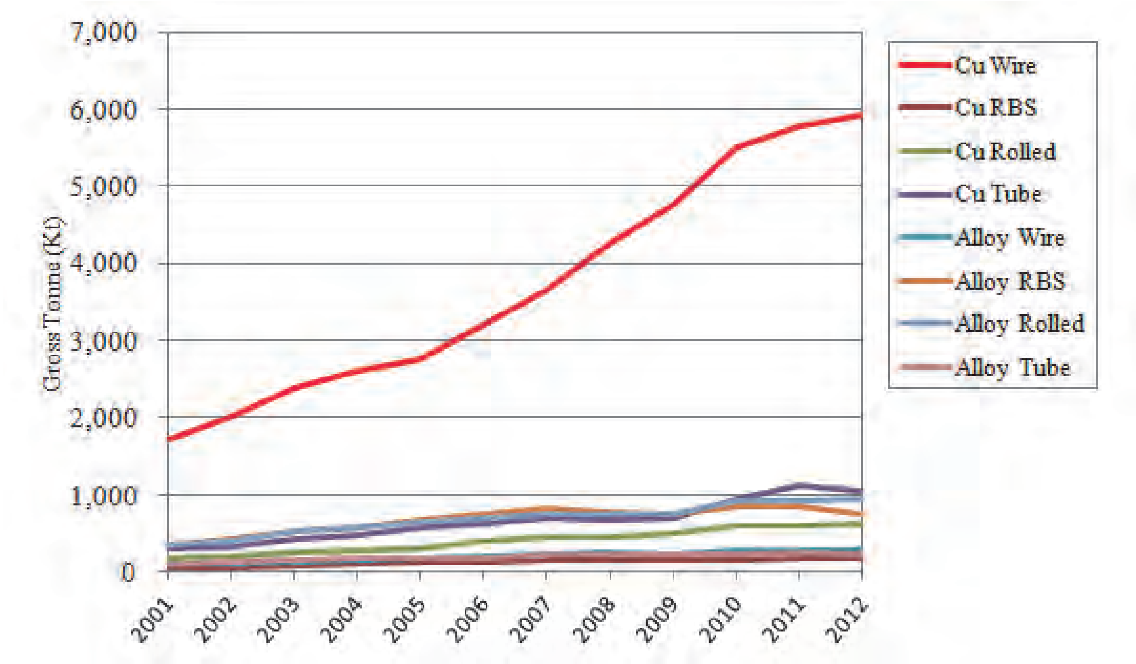
(3) Consumption of Semis

According to IWCC (2013) ,while consumption of semis in Japan, USA and EU is decreasing, in China consumption reached 9,970 Kt in 2012 and increased at an annual rate of 11% from 2001 due to not only increase in domestic demand but also shifting semis production to China from developed countries (Figure 3.1.13). Consumption of wire in China is an average of 55.1% for 12 years and higher than that of other countries and region. As shown in Figure 3.1.14 growth rate of consumption of wire is higher than that of others and account for 60% since 2008. It is inferred wire is used for infrastructure building such as transportation system and distribution of electricity in provincial cities.



(Source: Prepared by Survey Team from IWCC HP.)

Figure 3.1.13 Consumption of Semis in China, USA, Japan and EU (2001-2012)

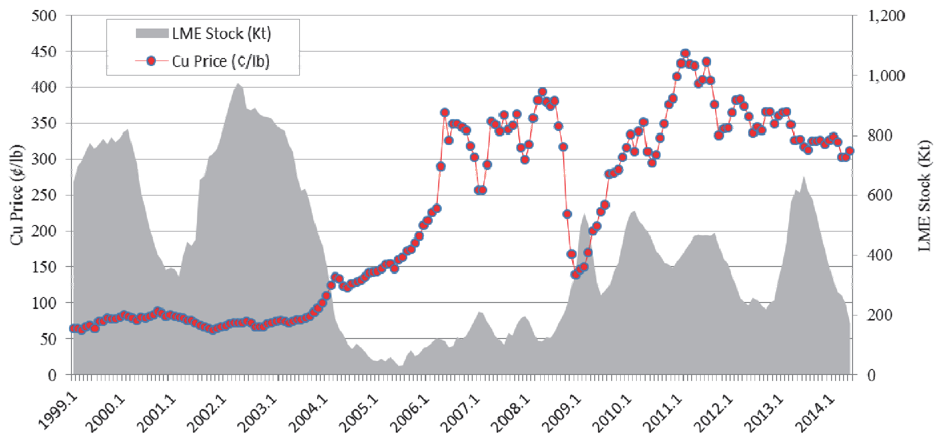


(Source: Prepared by Survey Team from IWCC HP.)

Figure 3.1.14 Changes in Semis Consumption in China (2001-2012)

3.1.3 Change of Copper Price

Copper price (LME settlement price) stayed below US$3,000/t from 1980s to 2004 and is stable at US$1,500/t to US$1,800/t between 1998 and 2003 (Figure 3.1.15). Since Q3, 2003 it shifted upward trend and from 2006 to 2008 and stayed in high between US$6,000/t and US$7,000/t. Although by the economic downturn precipitated by the Lehman Brothers bankruptcy in 2008 LME price declined to US$5,000/t level in 2009, in February 2011 it recorded US$9,000/t due to economic recovery. LME stock decreased to below 200 Kt since 2003 and continued low level until by the Lehman Brothers bankruptcy. After that it has been fluctuating between 200 Kt to 600 Kt.



(Source: Prepared by Survey Team from LME data)

Figure 3.1.15 LME Copper Price (spot) and LME Stock

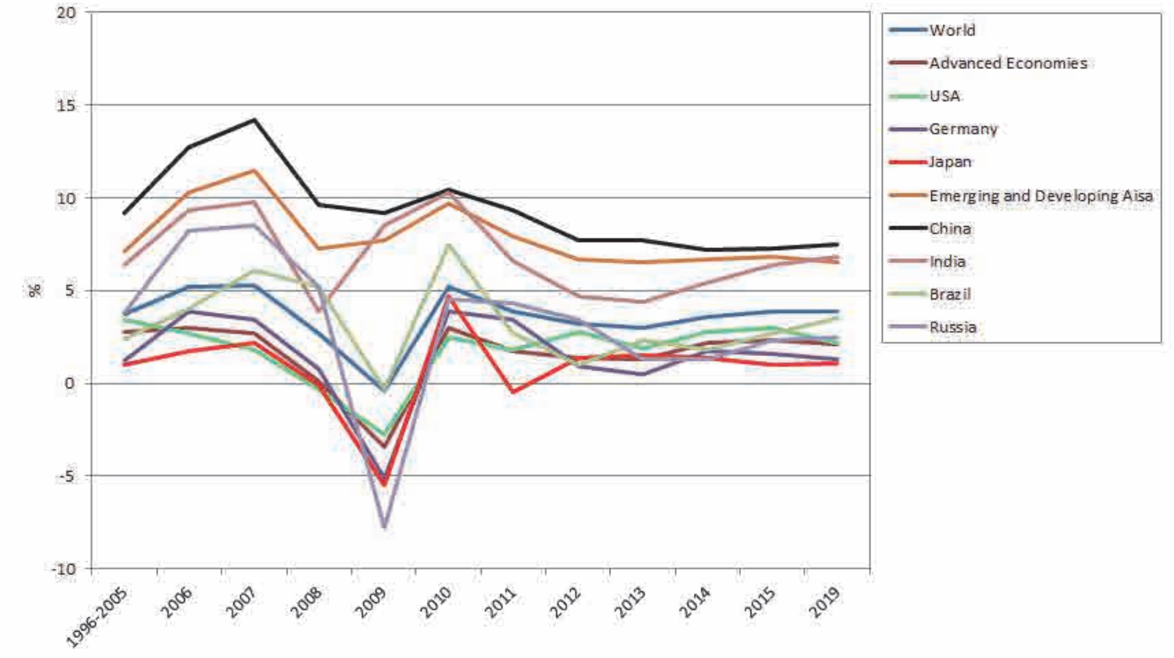
3.2 Outlook of World Copper Demand and Supply and Copper Price

3.2.1 World Economic Outlook

As shown in Figure 3.2.1, after the breakaway from a world simultaneous economic depression in 2009 called Lehman Shock, the tendency of the growth rate is slightly decreasing but maintains the approximately stable economic growth. It is 3.9% and IMF (2014) predicted 3% in 2013, 3.7% in 2014, and 3.9% in 2015. The growth rate of 2014 in the United States accelerates from 1.9% in 2013, and it is expected to be with 3% in 2015.

In Japan, fiscal stimulus package by Abenomics is offset under the influence of the minus number of the consumption tax rate increase in 2014 partly, but it is with 1.7% without almost changing and is predicted it slows down to 1% in 2015.

The Economic growth rate of the emerging countries and regions is anticipated to reach 5.1% in 2014 and 5.4% in 2015. Besides other countries China still maintains a high growth rate and is anticipated 7.3% in 2015 and 7.5% in 2019. In 2011 and 2012 economic growth rate of India largely decreased with 36% and 29% compared with the previous year, however it is predicts economy will enlarge at a faster pace for coming several years by birth of Modi new government. Morgan Stanley revised up the GDP growth rate of India between April of 2015 and March of 2016 from 6.2% to 6.5%.



Advanced economics: G7 and other 29 countries, Emerging and Developing Asia: China, India and other 27 countries.

(Source: Prepared by Survey Team from IMF (2014))

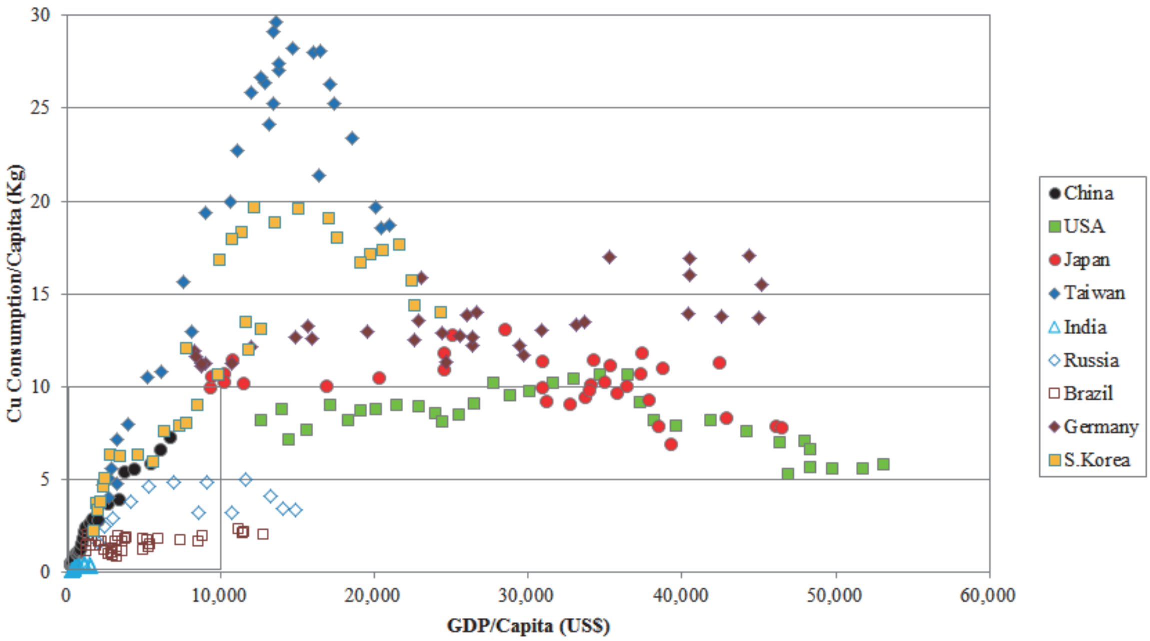
Figure 3.2.1 World Economic Outlook

3.2.2 Copper Demand Outlook

The copper consumption had a strong co-relation with world economy, and as described in 3.1.2 (2) for 1990 through 2013 copper consumption increased at annual rate of 2.9%. Whereas consumption in China is increased at annual rate of 13%, it is minus in the industrial country or approximately remains at the same level, and this increase depends on China. Consumption in Brazil and India show a little less than 5% of growth rates, but do not greatly influence a ratio among the whole because there are few consumptions. Therefore, a consumption trend of China will have a big influence on the world copper consumption.

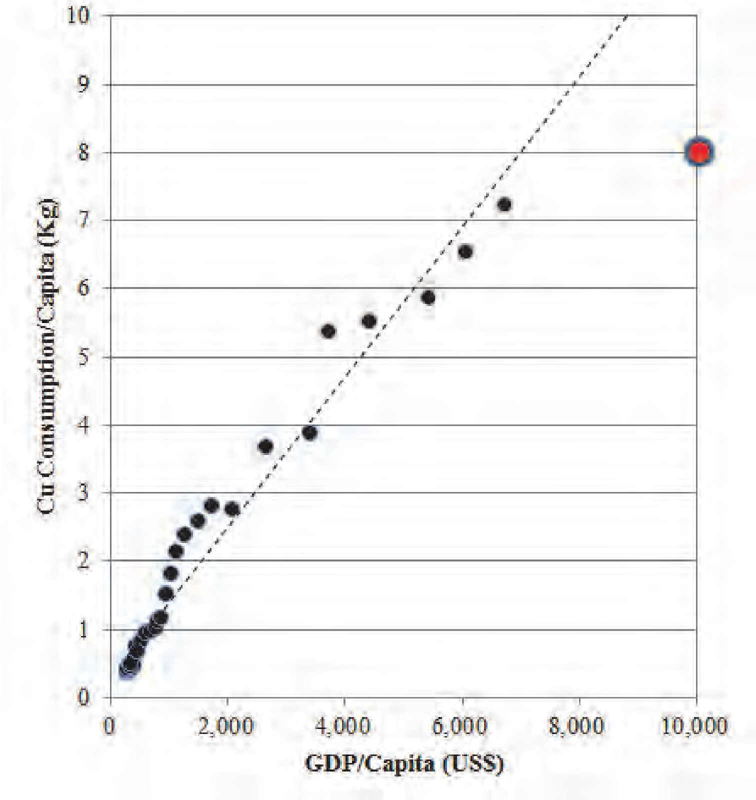
This is also shown in Figure 3.2.2. As for the co-relation GDP/capita vs. copper consumption, even if GDP/capita increase in industrialized country such as Japan, Germany and USA, copper consumption/capita remains at the same level. On the contrary copper consumption/capita in newly industrializing countries such as South Korea and Taiwan increase sharply with the increase in GDP/capita. While GDP/capita in Brazil and Russia surpasses China, copper consumption/capita is lower than that of China. A pattern of co-relation GDP/capita vs. copper consumption/capita in China is similar to South Korea and Taiwan, and copper consumption/capita in China outperforms USA in 2013. IMF (2014) forecasted GDP/capita in China would reach US$10,000 in 2018. As shown in Figure.3.2.3, if copper consumption is supposed to be 8 kg/capita and multiply inferred population by IMF (2014) in 2018, whole copper consumption in China is estimated to be 11,144 Kt. Then annual increasing rate of copper consumption since 2012 is estimated to be 3.9%.

Cochilco (2013) predicted an annual increasing rate of the world copper consumption from 2013 to 2025 to be 3.3 %, and EU 0.9%, USA -0.8%, Japan and South Korea -0.5% that of India is to be 9.0% that means total consumption is 1,700 Kt. China will consume 16,000 Kt in 2025, which is 51% of the world consumption. These numbers is thought to be reasonable.



(Source: Prepared by Survey Team from IMF (2014) and World Bureau Metal Statistics)

Figure 3.2.2 GDP/Capita vs. Copper Consumption/Capita in Japan, USA, Germany, Taiwan, South Korea and BRICs (1980～2013)



(Source: Prepared by Survey Team from IMF (2014) and World Bureau Metal Statistics)

Figure 3.2.3 GDP/Capita vs. Copper Consumption/Capita in China

(Enlarged from left lower corner of Figure 3.2.2)

3.2.3 Copper Mine Production Outlook

The copper ore production from now 2014 on is from the currently operating mines (including the expansion) and from the new mines under preparation. Productions from new mines consist of the total of future production from project of currently under construction, feasibility and pre-feasibility study, and exploration.

Ignoring copper price, over 30,000 Kt of copper is mineable within 10 years. As shown in Figure 3.2.4, in 2019 around 4.9 Mt of copper will be short without production from new greenfield projects. In order to operate new mines profitable to supply of 4.9 Mt of copper, PIP (project incentive price) is estimated to be 6,600 US$/t at minimum.

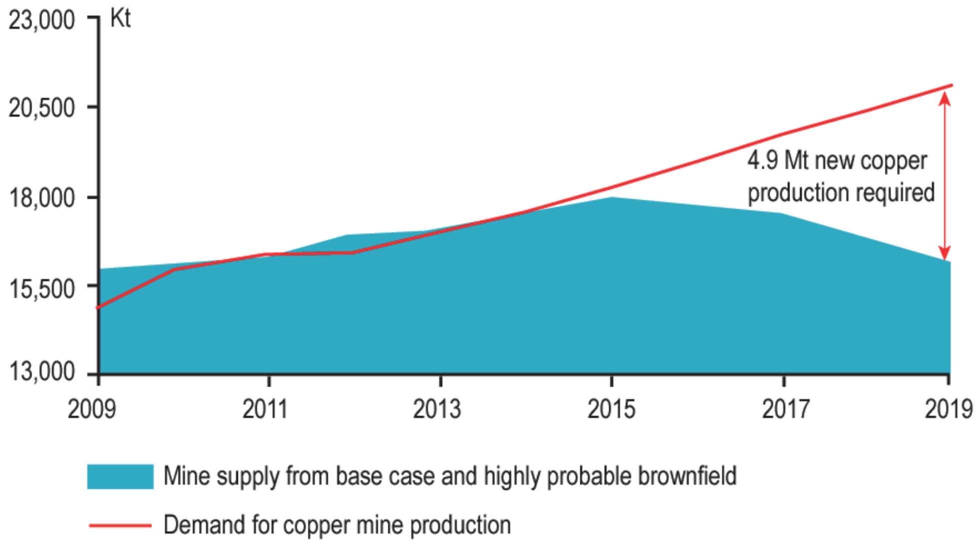
ICSG is forecasting global refined copper production to increase by around 3.9% at 20.9 Mt in 2014 and 5.5% to 22.1 Mt in 2015, resulting in a market surplus of 387,000 t and 632,000 t, respectively. In Table 3.2.1 advanced stage exploration projects and feasibility stage projects are shown.

Table 3.2.1 The Main Advanced Stage Exploration and Feasibility Projects (as of 2011)

Rank	Mine	Country	Reserves+ Resources (Mt)	Cu%	Contained Cu (Kt)	Type	Source	Start	Production (Kt/a)	Owner
1	Oyu Tolgoi	Mongolia	1,511	1.04	15,714	PO	Conc.	2013.7	450	Turquoise Hill(66), Mongolian Gov.(34)
2	Ministro Mina Hales	Chile	1,339	0.94	12,587	PO	Conc., SX-EW	2013.Q3	170	Codelco(100)
3	Cobre Panama	Panama	1,457	0.77	11,219	PO	Conc.	2017	320	Inmet(100)
4	Pebble	USA	3,029	0.28	8,481	PO	Conc.	2019	350	Northern Dynasty(100)
5	Sierra Gorda	Chile	2,079	0.40	8,316	PO	Conc.	2014.Q1	220	KGHM(55), Sumitomo(45)
6	Toromocho	Peru	1,706	0.47	8,018	PO	Conc.	2014.7	275	Chinalco* (100)
7	La Granja	Peru	1,200	0.65	7,800	PO	SX-EW	2018	150	Rio Tinto(100)
8	Konkola North	Zambia	297	2.57	7,645	SED	Conc., SX-EW	2013	170	Vale(50), African Rainbow(50)
9	Rio Blanco	Peru	1,257	0.57	7,165	PO	Conc.	2015	190	Monterrico Metals* (100)
10	Salobo	Brazil	929	0.77	7,153	IOCG	Conc.	2012	200	Vale(100)
11	Quellaveco	Peru	938	0.64	6,003	PO	Conc.	2019	215	Anglo American (80), IFC(20)
12	Caserones	Chile	1,350	0.43	5,805	PO	Conc., SX-EW	2013.Q1	170	PPC(75), Mitsui Corp,(25)
13	Aktogay	Kazakhstan	1,614	0.35	5,649	PO	Conc., SX-EW	2015	80	Kazakhmys(100)
14	El Arco	Mexico	1,016	0.52	5,283	PO	Conc.	2019	190	Grupo Mexico(100)
15	Antapaccay	Peru	1,000	0.49	4,900	PO	Conc.	2012	160	Southern Copper(100)
16	Esperanza	Chile	988	0.46	4,565	PO	Conc.	2011	200	Antofagasta(70), Marubeni(30)
17	Panantza	Equador	678	0.62	4,204	PO	Conc.		190	Corriente(100)
18	Michiquillay	Peru	544	0.69	3,754	PO	Conc.	2018	300	Anglo American(100)
19	Agua Rica	Argentina	731	0.50	3,655	PO	Conc.	2016	150	Yamana Gold(100)
20	El Galeno	Peru	661	0.5	3305	PO	Conc.	2014	200	Northern Peru Copper* (100)

*Chinese Company

(Source: Prepared by Survey Team from various kind of data)



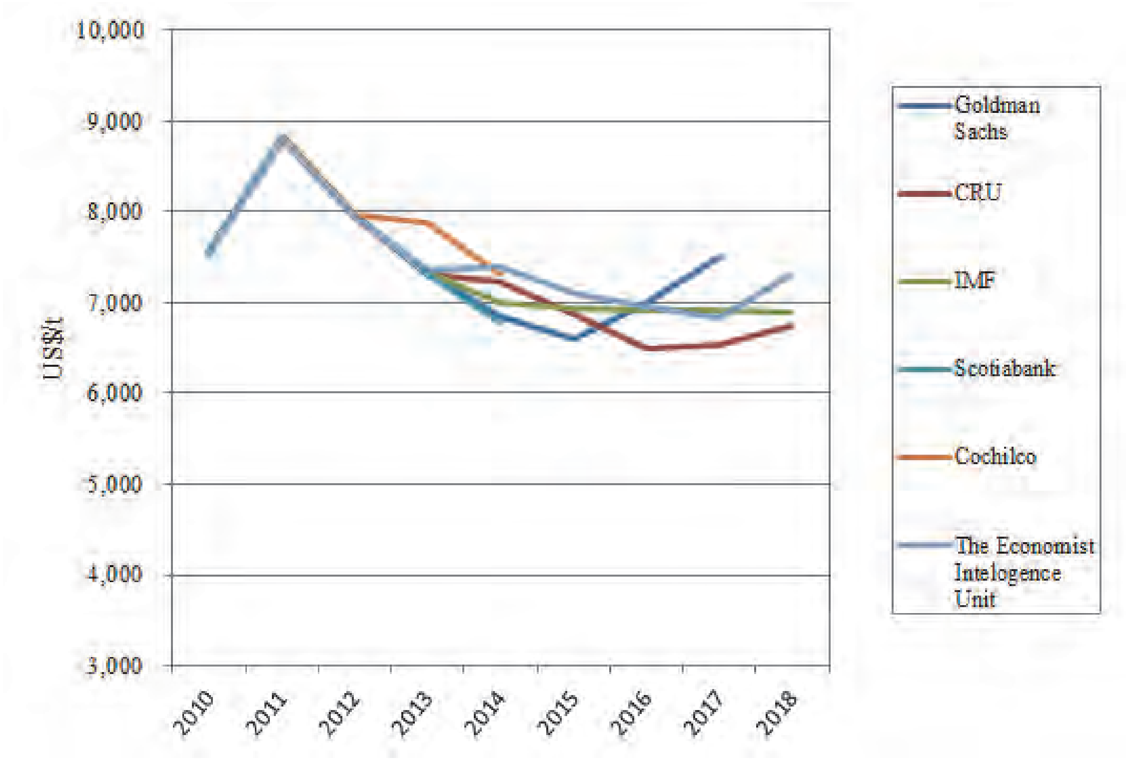
(Source:Berry (2013))

Figure 3.2.4 Copper Demand and Available Supplies

3.2.4 Copper Price Forecast

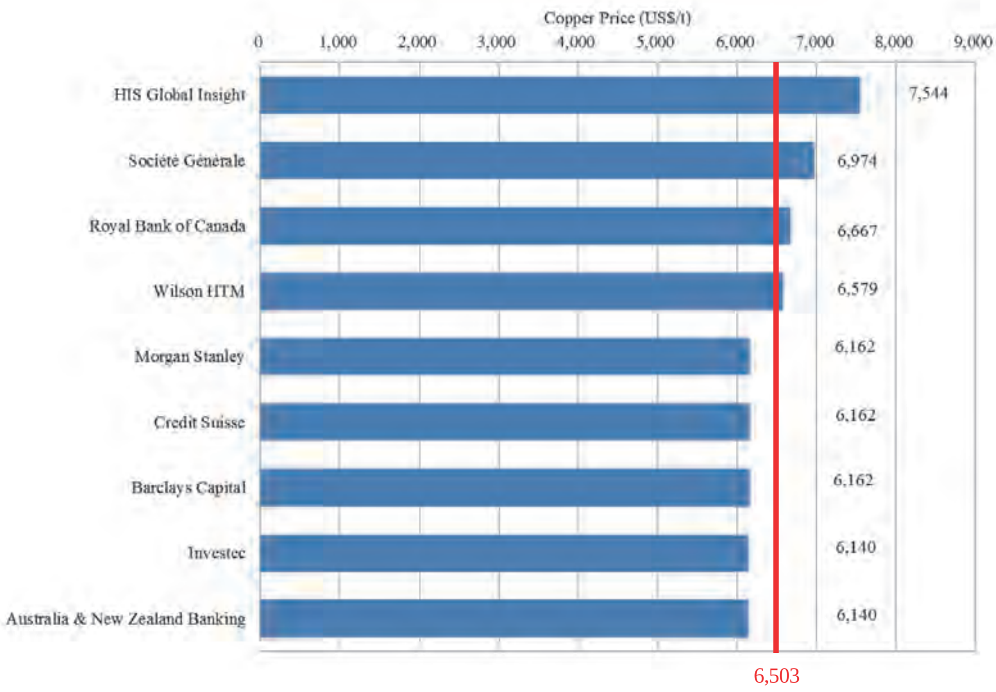
After hit the peak in February, 2011 9,868 US$/t copper price is decreasing in 2012 7,950 US$/t and

2013 7,326 US$/t. Copper price forecast from six research institutes is shown in Figure 3.2.5. 5 research institutes except for Barclays forecasted copper price will decrease until 2015, 2016 or 2017 due to surplus from newly opened mines and then hitting the bottom it will recover (Figure 3.2.5). CRU forecasted 7,228 US$/t in 2014 and 6,749 US$/t in 2018. It is plausible to forecast that copper price will drift around 6,000 US$/t. Cochilco (2013) arranged data from research institute and forecast copper price at 6,500 US$/t from 2018 to 2022.



(Source: Prepared by Survey Team from Research Institutes)

Figure 3.2.5 Copper Price Forecast (~ 2018)



(Source: Prepared by Survey Team from Cochilco (2013))

Figure 3.2.6 Copper Price Forecast (2018～2022)

3.3 Current Conditions of the Securing of Chinese Copper Raw Materials

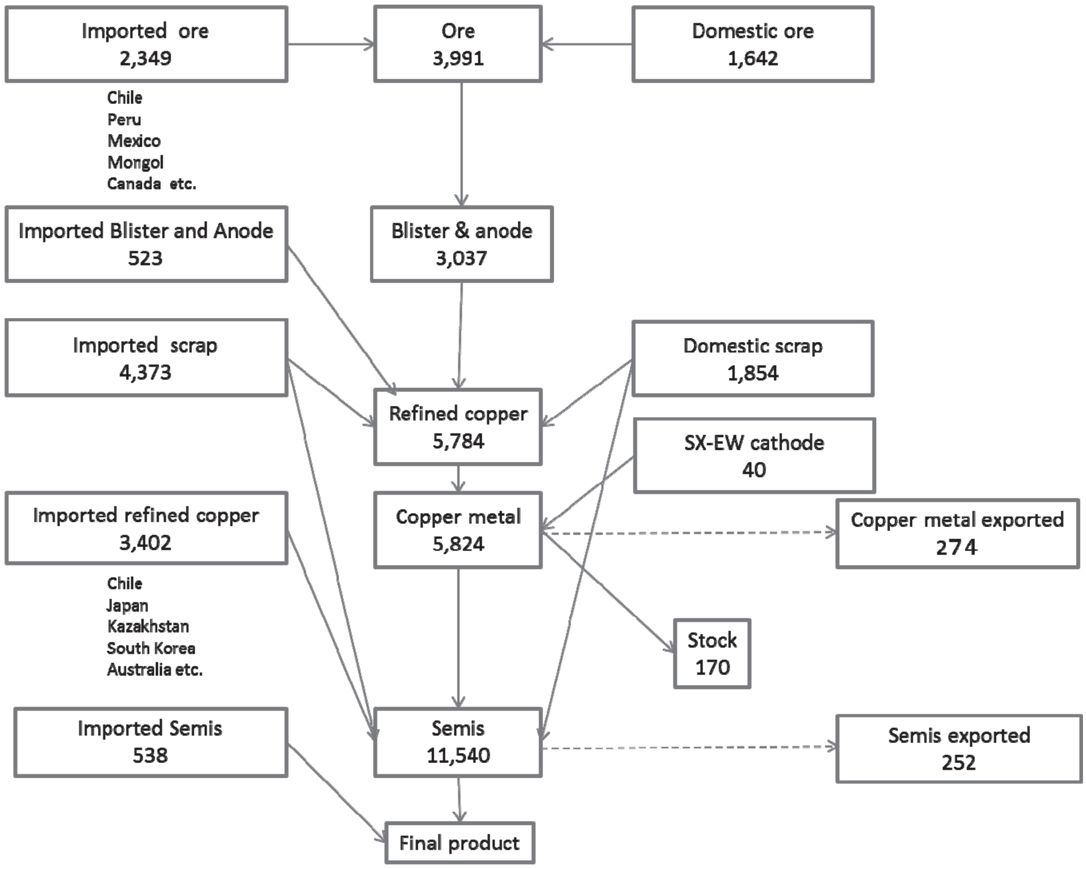
From early 2000s, China becomes the world's largest mineral resources consumer. Copper consumption in G7 has become matures as shown in Figure 3.2.2, and sudden increase in copper consumption with economic growth would not be anticipated. On the other hands in NIES countries such as South Korea and Taiwan metal copper consumption have soared in short terms with economic growth. The tendency of copper consumption in China is following the pattern of South Korea and Taiwan. Copper consumption in China in 2018 is forecasted to be 11,144 Kt as described previously if current economic condition continues.

As shown in Figure 3.1.12, copper metal consumption increased at an annual rate of 13.3% in China from 1998 and recorded 9,830 Kt in 2013. In contrast, the ore supply from the domestic mine increased at 8.7% of growth rates in these 13 years and remains in 17.8% for the self-sufficiency ratio in 2013. In order to compensate for deficit in domestic copper ore supply, China depends on import of not only copper ore, refined copper and copper scrap from foreign countries.

Chinese government set a national goal on the twelves five years national plan from 2011 to 2015 to achieve the capacity of copper concentrate to be 1,300 Kt/year and refined copper in 2015 to be 6,500 Kt (in 2013 they produced 5,823 Kt of refined copper). In this chapter we discuss on supply of copper raw material to meet future copper demand, which is forecasted to increase.

Copper material flow as of 2013 in China is shown in Figure 3.3.1. As for the copper concentrates imported concentrates 3,024 Kt exceeded domestic concentrates. They produced 3,037 Kt of anode and blister from domestic and imported concentrates and produced 6,338Kt of refined copper form anode and blister and 3,301 Kt of secondary copper refined from copper scrap and SX-EW cathode.

Ratio of secondary copper is higher than that of Japan and Korea owing to lower treatment cost of scrap. As a result, total 9,226 Kt of copper metal was supplied from domestic and imported refined copper, domestic SX-EW cathode. Copper consumption in 2013 is 8,840 Kt and difference between supply and demand might be assumed to be stocked.



Unit: Kt, Scrap and semi products: gross tones, imported concentrates are recalculated as copper content is assumed to be 30%

(Source: Prepared by Survey Team from World Bureau of Metal Statistics)

Figure 3.3.1 Copper Material Flow in China (2013)

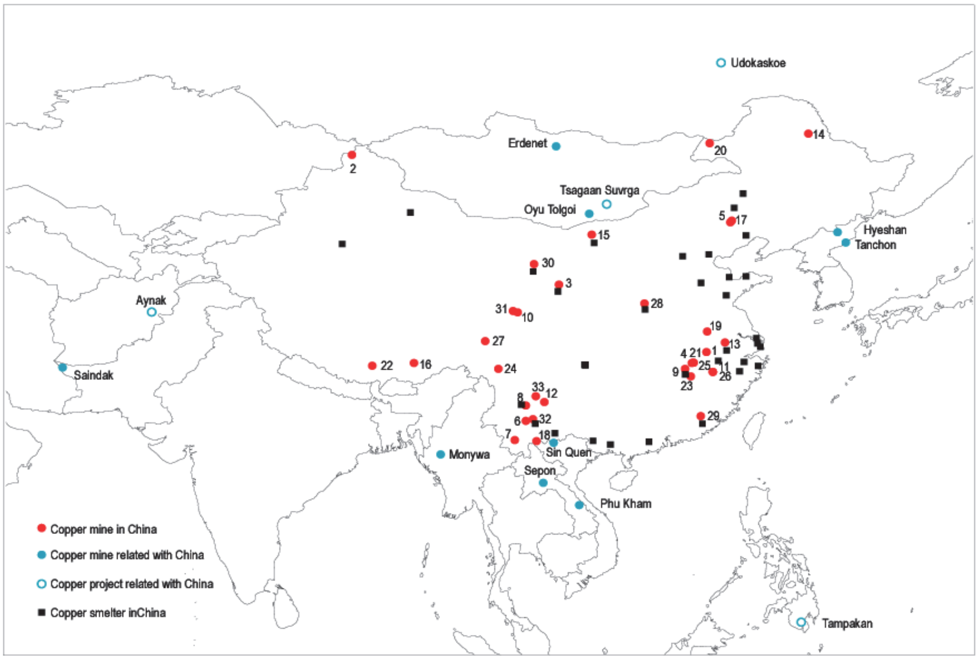
3.3.1 Domestic Copper Supply

Various kinds of copper deposits occur in China such as porphyry copper deposit, skarn type copper deposit, volcanogenic massive sulfide deposit, ortho-magmatic copper deposit and sediment-hosted copper deposit. Porphyry copper and skarn type copper deposit make metallogenic provinces in mid to downstream region of Yangzi River (Jiangxi and Anhui provinces) and the western region such as Yunnan, Sichuan province and Tibet autonomous region. As the latter region is located at the rural area, the Chinese government has been promoting mineral exploration. The location of the major mines is shown in Figure 3.3.2. The copper deposits in China are relatively small compared with porphyry copper deposits in South America such as Collahuasi and Los Pelambles which are producing over 300 Kt of copper annually, even the largest copper mine in China is the Dexing mine, which has annual production capacity of 160 Kt/year. According to MERI/J (2010), which cited data from the Ministry of Land and Resources of the People's of Republic of China, copper reserves (contained copper) is estimated 7.2 million t. As described above, copper reserves concentrate in the mid to downstream region of Yangzi River region such as Jiangxi province: 18% and the western region such as Yunnan province: 15% and Tibet autonomous region: 16%. There is a huge discrepancy between estimation by the Ministry of Land and Resources of the People's of Republic of China and U.S. Geological Survey, which estimated to be 2.7million t (Figure 3.1.2).

It was said copper mines in China are too small to modernize, and then the Chinese government has been directing intensification. Recently seven companies such as Yunnan Copper Industry, Jiangxi Copper Industry Group, Tongling Non-ferrous Metal Group, Jichuan Group, Baiyin Non-ferrous Metal Group, Daye Non-ferrous Metal and Zhongtiaoshan Non-ferrous Group have been developed to be leading copper companies in China. Copper production by these seven companies recorded 453Kt of copper, which was 49% of domestic mine production in 2008 (JOGMEC, 2009).

Domestic copper ore production in 2013 recorded 1,751.8 Kt, which is the second largest in the world and 2.96 times larger compared with 2000, and surpassed USA in 2010 and Peru in 2011.

However self-sufficient rate (domestic mine production/domestic consumption of refined copper) in 2013 is 17.8%, which is not changed from 18.1% in 2004. That means domestic mine supply cannot catch up with increasing refined copper consumption. Although discovery of new deposits and start operation of new mines in the western region such as Yunnan, Sichuan province and Tibet autonomous region are anticipated, it might be difficult to improve self-sufficient rate to compensate increasing copper demand.



Note: Name of the mines are listed on Table 3.3.1.

(Source: Prepared by Survey Team)

Figure 3.3.2 Copper Mine and Smelter in China, and Copper Mine and Project related with China

Table 3.3.1 Major Copper Mine in China

No	Project Name	Type	Province	No	Project Name	Type	Province
1	Anqing	Skarn	Anhui	18	Luchun Da Ma Jian Mountain	PO	Yunnan
2	Ashele	VMS	Xinjiang	19	Qianchang	Other	Anhui
3	Baiyin Changtong	VMS	Gansu	20	Wunugetushan	PO	Inner Mongolia
4	Chengmenshan	PO	Jiangxi	21	Wushan	Skarn	Jiangxi
5	Chifeng Copper	Other	Inner Mongolia	22	Xietongmen	PO	Tibet
6	Dahongshan	VMS	Yunnan	23	Xinzhuang	Other	Jiangxi
7	Dapingzhang	Other	Yunnan	24	Yangla	VMS	Yunnan
8	Dayao	SED	Yunnan	25	Yinshan	Other	Jiangxi
9	Daye Nonferrous Metals Complex	Skarn	Hubei	26	Yongping	Skarn	Jiangxi
10	Derny	VMS	Qinghai	27	Yulong	PO	Tibet
11	Dexing Complex	PO	Jiangxi	28	Zhongtiaoshan	PO	Shaanxi
12	Dongchuan	Vein	Yunnan	29	Zijinshan Copper	PO	Fujian
13	Dongguashan	VMS	Anhui	30	Jinchuan	OM	Anhui
14	Duobaoshan	PO	Heilongjiang	31	Deerni	OM	Qinghai
15	Huogeqi	SED	Inner Mongolia	32	Yimen	SED	Yunnan
16	Jiama	Skarn	Tibet	33	Lala Copper	VMS	Sichuan
17	Jiguanshan	PO	Inner Mongolia				

PO: Porphyry copper deposit, Skarn: Skarn type copper deposit, OM: Ortho-magmatic copper (nickel) deposit, SED: Sediment-hosted copper deposit, VMS: Volcanogenic massive sulfide

(Source: Prepared by Survey Team)

3.3.2 Overseas Mine Investment and Import of Foreign Copper Ore

As for the import of ore from foreign countries, spot purchase is the main constituent. Currently import from the mine, of which Chinese mining companies hold equity, is limited to only Saindak (Pakistan), Chambishi (Zambia), etc., and quantity is estimated to be few tenths of kilo tones.

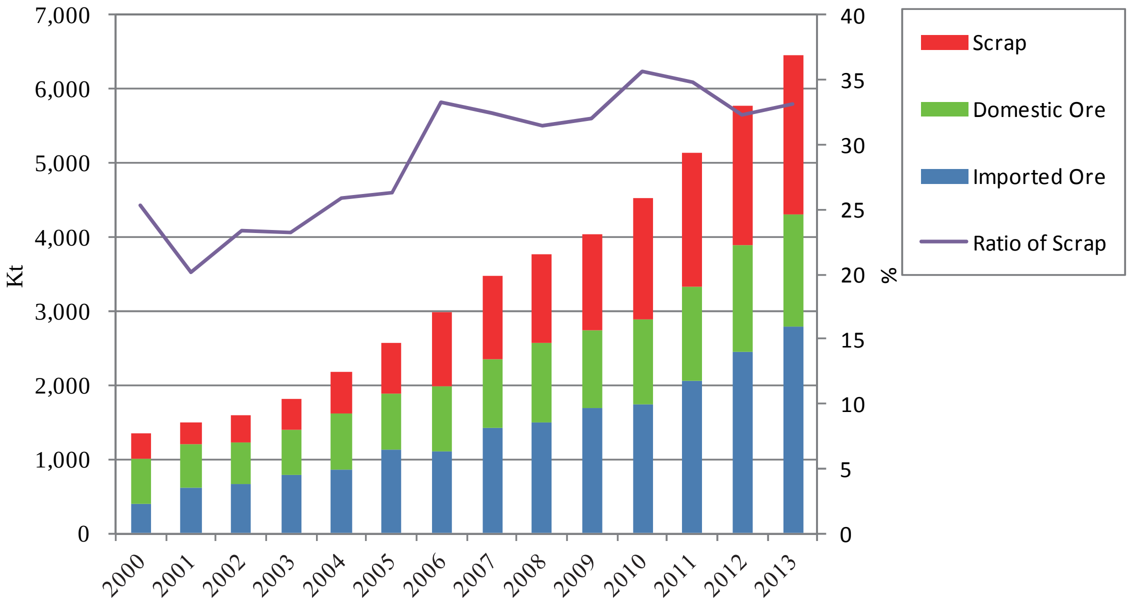
Under the national policy of Zouchuqu (go global), Chinese mining companies have been aggressively investing foreign projects and mines as shown in Table 5.2.3. When large projects such as Toromocho (Peru), Las Bambas (Peru), El Galeno (Peru), etc. start production another around 1 million t of copper ore (contained copper) will be shipped to China. Investment of US$550 million to Gabriela Ministral (Gaby) by Minmetals is a kind of financing to get refined copper 57,000 t/year for 15 years.

3.3.3 Refined Copper Production and Constituent of Raw Materials

Domestic refined copper production in 2013 recorded 6,839Kt and keeping world largest producing country after they overtook Chile in 2006 (Figure 3.1.6).

Copper metals are made of refined copper from domestic ore and scrap, imported ore and scrap and SX-EW cathode. In 2013 supplied domestic ore was 1,752 Kt, which is only 25.6% of refined copper produced in China and remained are relay on imported ore and scrap (Figure 3.3.3). Imported ore was 3,024 Kt (calculated from 10,080 Kt of concentrate ×30% (copper grade)) and covered 44% of refined copper. Secondary copper originated from scraps was 2,153 Kt, which was 33% of refined copper. Comparing with Japan and Korea which were 20% and 21% respectively, ratio of secondary copper is higher than that of other countries. They import scrap not only from G7 countries, Spain and Netherland but also neighboring newly industrializing countries such as Malaysia, Hong Kong, Korea, etc. It seems to perform scrap sorting at low cost in China.

Production of SX-EW cathode is 50 Kt/year at most because development of oxide and secondary copper suitable for leaching is scarce in the Chinese copper deposit. Consequently SX-EW cathode will not be important sources in China.

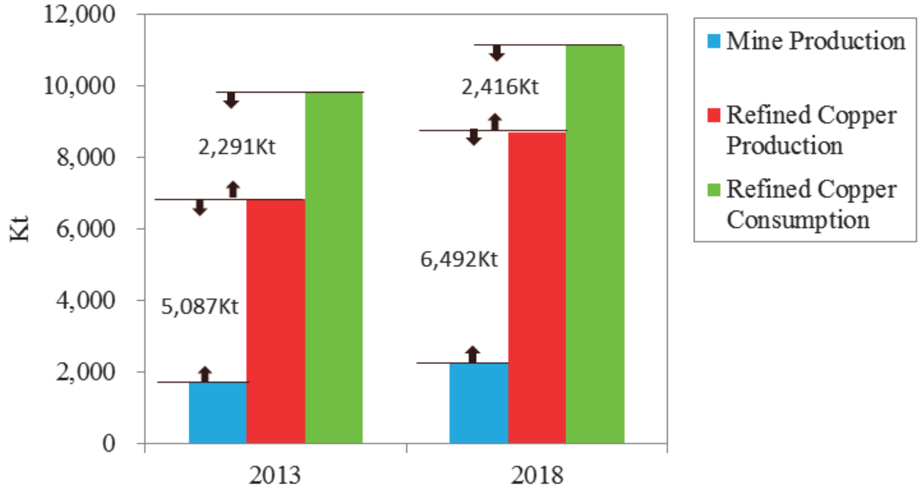


(Source: Prepared by Survey Team from ICSG data)

Figure 3.3.3 Refined Copper Production and Constituent of Raw Materials

3.3.4 Outlook of Securing Copper Raw Materials in China

As described previously, given that demand of refined copper is 11,144 Kt in 2018 and supply of domestic refined copper and domestic copper ore will increase rate of 5 %/year, China have to import 2,416 Kt of refined copper and 6,492 Kt of copper ore and scrap in order to meet domestic demand (Figure 3.3.4). China needs to import more copper ore and refined copper than 2013 as well. As shown in Table 5.2.4, import from overseas projects such as Toromocho (Peru) will be stable sources. Moreover, copper ore from Mongolia such as Erdenet, Oyu Tolgoi and Tsagaan Suvarga are the nearest and important foreign copper sources.



(Source: Prepared by Survey Team from World Bureau of Metal Statistics)

Figure 3.3.4 Copper Supply and Demand in China (2018 is forecasted)

Chapter 4. Copper Supply-Demand, Import-Export in Mongolia

4.1 Copper Supply and Export of Mongolia

4.1.1 Trace of Refined Copper

The refined copper is produced by only Erdmin Co., LTD in Mongolia. Erdmin located at the place adjacent to Erdenet mine, the company had bought 18,000 Kt of low grade oxide copper ore (Cu 0.5%) from the debris deposit yard in Erdenet mine and refined copper has been produced since 1997 by the SX-EW process. Details of the same are described in Chapter 2.5.
According to database of the Agency of Customs Services in Mongolia, the exportation of refined copper from Mongolia is steadily being charged in the range of 2,100 - 2,800 t/year.

The unit price of refined copper calculated in respective years as the result that the export price shown in the database of the Agency of Customs Services in Mongolia (Table4.1.2) is divided by the exported quantity, and compared with LME copper price (annual average price; Table4.1.3). The unit price and LME copper price are mostly linked with each other, and it can be understood that the refined copper exports from Mongolia is performed in the international copper market price.

Table 4.1.1 Copper Production in Mongolia

DataSource	Indicators	Mesuring Unit	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ICSG2013YearBook Mongolia MineProduction	Concentrates	1000t	130.3	130.0	126.5	129.7	130.2	126.8	126.5	123.5	121.6	118.1
	SX-EW	1000t	1.6	2.3	2.4	2.4	2.4	2.6	2.5	2.6	2.4	2.2
	Total	1000t	131.9	132.3	128.9	132.1	132.6	129.4	129.0	126.1	124.0	120.3
ISGS Copper Bulletin 2014 Mongolia Production	Concentrates	1000t						126.8	126.5	123.5	121.6	118.4
	SX-EW	1000t						2.6	2.5	2.6	2.4	2.2
	Total	1000t						129.4	129.0	126.1	124.0	120.6

(Source: Prepared by Survey Team from ICSG, 20013, 2014)

Table 4.1.2 Export of Refined Copper from Mongolia

HS Code	Commodity	Year	Amount kg	Price 1000USD
7403	Refined copper	2008	2,603,651.2	18,526.2
		2009	2,320,908.0	11,850.0
		2010	2,800,439.0	20,357.2
		2011	2,360,819.0	21,027.9
		2012	2,120,256.0	16,647.2
		2013	2,201,432.0	16,136.1

(Source: Customs Service database, http://www. customs.gov.mn/statistics/)

Table 4.1.3 Price of Export Refined Copper from Mongolia and LME Copper Price

HS Code	Commodity	Year	Export			LME Copper Price
			Amount kg	Price 1000USD	Unit Price USD/t	USD/t
7403	Refined copper	2008	2,603,651.2	18,526.2	7,115	6,963
		2009	2,320,908.0	11,850.0	5,106	5,165
		2010	2,800,439.0	20,357.2	7,269	7,538
		2011	2,360,819.0	21,027.9	8,907	8,823
		2012	2,120,256.0	16,647.2	7,852	7,959
		2013	2,201,432.0	16,136.1	7,330	7,331

(Source: Copper price (LME) is calculate the year average using the data from Web page of IMF, http://www.imf.org/external/np/res/commod/index.aspx)

4.1.2 Estimation of Refined Copper Production

The refined copper has been produced by Erdmin for approximately 15 years in Mongolia, the production capacity of Erdmin is 2,880 t/year. A Mongolian private company, Achit Ikht LLC, has newly been established at the place adjacent to Erdmin Plant and the company constructed a hydrometallurgy plant having the capacity of 10,000 t/year in electrolytic copper, and commenced its operation in July of 2014. Under these circumstances, the maximum refined copper supply in Mongolia will become 12,880 tons per/year if the operation of Achit Ikh plant is commenced and continued satisfactorily.

4.1.3 Production of Copper Concentrates

There are 2 operating copper mine sites in Mongolia 2013, i.e. Erdenet mine and Oyu Tolgoi mine. Since Oyu Tolgoi mine commenced its production of copper concentrates in 2013, thus Erdenet mine (started in 1978) was only a unique copper mine site in Mongolia until 2012.
The production of copper concentrates from Erdenet mine has been kept around 570 Kt/year, i.e. copper metal amount is from 120 to 130 Kt/year, and almost whole quantities of them have been exported.

Oyu Tolgoi mine commenced the shipping of concentrates from 2013. The production of Oyu Tolgoi mine in 2013 is 290 Kt of concentrates, i.e. equivalent to 70 Kt of copper metal, according to their quarterly reports. The exportation of copper concentrates from Mongolia have increased to 650 Kt/year in 2013 from about 570 Kt/year until 2012, i.e..equivalent to copper metals contained in concentrates increased to 190 Kt/year from 120 Kt/year (Table4.1.4).

The amount of copper ores and copper concentrates in respective years are summarized by using data from the database of the Agency of Customs Services in Mongolia (Table4.1.5). The destination of exported goods from Mongolia until 1998 was wide enough, i.e. to Russia, China, Uzbekistan, Kazakhstan as well as Japan. The amount of export to Russia had decreased since 1998 when economical crisis had been occurred in Russia, and the exportation to Japan, Uzbekistan, Kazakhstan has become none, and the amount of export to Russia had become almost none in 2003, the destination for whole exportation had tended to limit only to China since then. Finally whole amount has been exported to China in 2012.

The prices of copper ores and concentrates exported from Mongolia are summarized similarly in the case of exported concentrate quantity (Table4.1.6). Since 1998, the amount in price for exportation from Mongolia to Russia had been decreased, and the amount of exportation to Japan, Uzbekistan, and Kazakhstan became none. All amounts in price for the exportation of copper concentrates has become equal to that to China in 2012.

The unit prices obtained from the simple calculation that the amount in price of exportation is divided by the quantity exported, and compared with LME copper prices (yearly average; Table 4.1.7). The unit price calculated has a trend to deviate from LME copper price in case of small quantity exports equal or less than 100 t/year (gray colored portion in the table). With the exception of these small amount exportation, any big difference in the unit prices in respective years of copper concentrate exportation depend on destination (delivered countries) could not generally be found out. Additionally, the unit prices of copper concentrate exportation are linked with the deviation in price of copper metal (LME).

Transition on the ratio of LME pure copper price and the unit price in exportation of concentrates to China which is the destination of exportation having continuous data over the years is summarized (Fig. 4.1.1). The price of pure copper has been ascended from the year of 2004 and the unit price for the exportation of concentrates has gone up according to the rise of pure copper price as mentioned. The ratio simply calculated in the way that the unit price for exportation divided by the price of pure copper has a steady transition within the range from fifteen percent (15%) to twenty percent (20%) .

The copper content contained in concentrates is estimated around 24%. The difference between this 24% and the ratio 15 - 20% can be estimated as the sum of smelting costs, transportation costs and profit from smelting. On the assumption that the copper content in concentrates is twenty four percent (24%), the value of copper in the concentrates can be calculated.

The difference between this value of copper and the unit price of exportation is deemed to be the sum of smelting cost, profit and transportation cost, and can be deemed to be the margin for the smelting. For the purpose of calculating the cost for smelting, the treatment charge (hereinafter abbreviated as TC), the refining charge (hereinafter abbreviated as RC) and the price participation (hereinafter abbreviated as PP) were estimated. The basic data used for the estimation are those of TC/RC (USc/lb) shown in the “Presentation of Metal Resources Achievement Report” of JOGMEC, TC and RC were estimated on the assumption that the copper grade of concentrates is thirty percent (30%). Also, as to the estimation from 2012 to 2013, the estimated value of information material that is handed over the news media is used.

If the sum of TC, RC and PP is deemed to be smelting cost, the difference between the profit and the cost for smelting is esteemed to be the sum of profit and transportation cost, and the difference on amount is shown in the Table 4.1.8.

This difference in amount had increased from around 2005 when the copper price raised up, and it has reached more than approximately 200 US$/t after 2009. If the difference of transportation costs between from Mongolia to China and that to Japan is cheaper than these prices, it can be said that the exportation of copper concentrates to Japan will be possible.

Table 4.1.4 Amount of Production and Export in Mongolia from Each Source

Data Source	Indicators	Mesuring Unit	2008	2009	2010	2011	2012	2013
Erdenet Brochure	Ore mass	1000m^3	18,430	15,400	16,370	17,150	17,600	
	Ore mining	1000t	27,570	28,200	27,575	27,550	27,780	
	Ore processing	1000t	25,640	25,920	26,060	26,100	26,030	
ICSG2013YearBook Mongolia Export	Gross Wt	1000t	523.4	530.3	517.6	519.4	535.0	
	Cu Cont	1000t	126.3	125.8	122.4	122.4	126.0	
ICSG2013YearBook Mongolia Mine Production	Concentrates	1000t	126.8	126.5	123.5	121.6	118.1	
	SX-EW	1000t	2.6	2.5	2.6	2.4	2.2	
	Total	1000t	129.4	129.0	126.1	124.0	120.3	
ISGS Copper Bulletin 2014 Mongolia Production	Concentrates	1000t	126.8	126.5	123.5	121.6	118.4	
	SX-EW	1000t	2.6	2.5	2.6	2.4	2.2	
	Total	1000t	129.4	129.0	126.1	124.0	120.6	
World Bureau Metal Production	Ore,Conc.	CuContent t				123,978	123,942	189,001
	Refined Cu	t				2,383	2,282	2,346
World Bureau Metal Export	Ore,Conc.	GrossWt Total				572,800	574,500	649,800
	to China	GrossWt Total				572,800	574,500	649,765
	to Other Countries	GrossWt Total						35
2012 Copper Production in the World, JOGMEC	Erdenet Production	1000t	126.8	129.8	125.0			
Quauternary Report OyuTolgoi	Concentrates produced	1000t						290
	Copper in concentrates	1000t						76.7
	Ave. concentrate grade	Cu%						26.4

(Source: Prepared by Survey Team)

Table 4.1.5 Amount of Copper Ores and Concentrates from Mongolia

Year	Copper ores and concentrates from Mongolia (t)							
	China	Russia	Uzbekistan	SouthKorea	Japan	Kazakhstan	Others	Total
1995	92,900	106,779	57,063	65	39,825	168,367	15,561	480,560
1996	160,346	211,474	25,930	129	37,623	25,955	10,185	471,641
1997	289,530	99,213	65,465		25,284		255	479,747
1998	371,079	55,250	5,036	30,147	8,079	16,007	65	485,662
1999	439,828	52,743		125				492,697
2000	467,564	28,388		38				495,990
2001	514,764	26,122						540,886
2002	501,517	47,074			0		1	548,591
2003	562,890	5,934		0	62		26	568,912
2004	556,256	1	6,120				259	562,636
2005	559,002	62	27,993				1	587,057
2006	599,469	66					4	599,539
2007	607,776	0			0		14	607,790
2008	582,882	0		0			7	582,889
2009	586,787	195					1	586,983
2010	568,664	0					1	568,665
2011	575,901	2					1	575,904
2012	574,343							574,343
2013	649,781			35				649,816

(Source: Customs Service Database, http://www. customs.gov.mn/statistics/)

Table 4.1.6 Price of Copper Ores and Concentrates from Mongolia

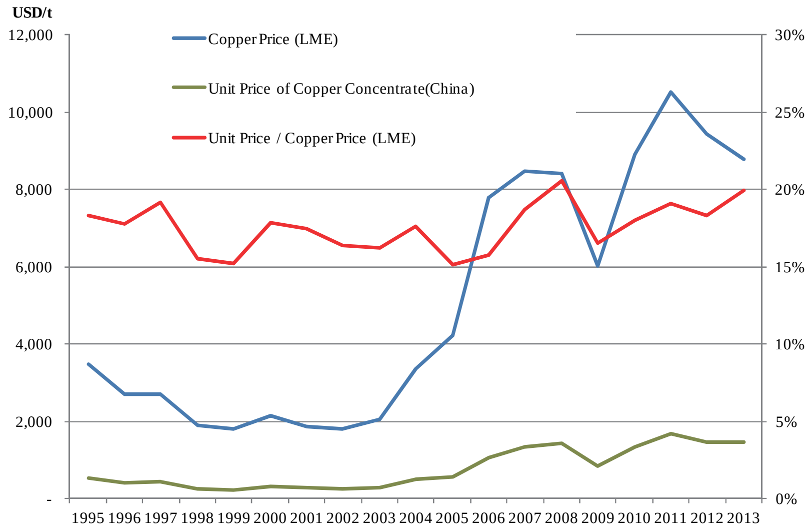
Year	Copper ores and concentrates from Mongolia (1000USD)							
	China	Russia	Uzbekistan	SouthKorea	Japan	Kazakhstan	Others	Total
1995	49,944	54,011	32,973	43	24,935	88,604	9,486	259,997
1996	65,405	93,020	12,495	42	17,034	14,529	4,154	206,680
1997	126,404	43,566	29,957		11,347		116	211,389
1998	95,197	14,306	1,413	7,592	2,122	4,125	15	124,770
1999	105,349	13,841		25				119,215
2000	151,335	8,925		15			0	160,276
2001	141,853	6,049						147,902
2002	128,230	12,006			0		1	140,238
2003	162,064	1,612		0	18		12	163,707
2004	280,628	0	3,553				142	284,323
2005	311,698	38	14,480				1	326,217
2006	635,345	75					6	635,426
2007	811,502	0			0		11	811,513
2008	835,657	0		0			10	835,667
2009	501,748	174					2	501,924
2010	770,593	0					2	770,595
2011	968,551	0					1	968,552
2012	838,579							838,579
2013	948,901			50				948,951

(Source: Customs Service Database, http://www. customs.gov.mn/statistics/)

Table 4.1.7 Unit Price of Copper Ores and Concentrates from Mongolia

Year	Unit Price of Copper ores and concentrates from Mongolia (USD/t)							Copper Price LME (USD/t) (B)
	China (A)	Russia	Uzbekistan	SouthKorea	Japan	Kazakhstan	Others	
1995	538	506	578	660	626	526	610	2,932
1996	408	440	482	329	453	560	408	2,293
1997	437	439	458	-	449	-	454	2,275
1998	257	259	281	252	263	258	226	1,654
1999	240	262	-	201	-	-	-	1,573
2000	324	314	-	400	-	-	-	1,815
2001	276	232	-	-	-	-	-	1,580
2002	256	255	-	-	360	-	1,919	1,560
2003	288	272	-	10,000	288	-	473	1,779
2004	504	719	580	-	-	-	549	2,863
2005	558	604	517	-	-	-	1,655	3,676
2006	1,060	1,139	-	-	-	-	1,709	6,731
2007	1,335	1,277	-	-	146	-	778	7,132
2008	1,434	1,047	-	1,321	-	-	1,460	6,963
2009	855	893	-	-	-	-	1,908	5,165
2010	1,355	1,480	-	-	-	-	2,354	7,538
2011	1,682	167	-	-	-	-	806	8,823
2012	1,460	-	-	-	-	-	-	7,959
2013	1,460	-	-	1,434	-	-	-	7,331

(Source: Copper price (LME) is calculate the year average using the data from Web page of IMF http://www.imf.org/external/np/res/commod/index.aspx)



(Source: Copper price (LME) is calculate the year average using the data from Web page of IMF http://www.imf.org/external/np/res/commod/index.aspx)

Figure 4.1.1 Copper Price, Unit price of Concentrates and their Ratio

Table 4.1.8 Marginal profits at Smelters and Difference

Year	Copper Value(USD/t) in 1t Concentrate (24%) (C)=(B)x0.24	Marginal profits at Smelters USD/t (D)=(C)-(A)	TC USD/t	RC cent/lb	TC/RC(24%) USD/t (E)		Difference USD/t (D)-(E)
1995	704	166	70.5	7.05	108		58
1996	550	143	95.0	9.50	145		-3
1997	546	109	105.0	10.50	161		-51
1998	397	140	102.5	10.25	157		-16
1999	377	138	67.9	6.79	104		34
2000	435	112	69.0	6.90	106		6
2001	379	104	75.0	7.50	115		-11
2002	374	119	70.0	7.00	107		12
2003	427	139	58.1	5.81	89		50
2004	687	183	43.0	4.30	66		117
2005	882	325	100.0	10.00	153		172
2006	1,616	556	60.0	6.00	92		464
2007	1,712	376	60.0	6.00	92		285
2008	1,671	238	47.2	4.72	72		165
2009	1,240	385	75.0	7.50	115		270
2010	1,809	454	46.5	4.65	71		383
2011	2,118	436	70.0	7.00	107		329
2012	1,910	450	63.5	6.35	97		353
2013	1,760	299	70.0	7.00	107		192

(Source: Study Team Estimate TC/RC, PP using the data from "presentation of metal resources achievement report" of JOGMEC)

4.1.4 Forecast on Production of Copper Concentrate

The copper grade in copper ore had been approximately one percent (1%) at the commencement of operation in Erdenet mine, and however, it has been reduced to about 0.5% now, and it will further be decreased to 0.4% in the future. In order to keep the shipment of 500 Kt/year concentrates and 114 Kt/year of copper metal, it is scheduled that the ore mining is to be increased and the ore processing capacity is to be improved to the level of 25,000 - 26,000 Kt/year (verbally heard from the Vice President of Erdenet mine). Under these circumstances, it is esteemed that the production of concentrates in Erdenet mine will be 500 Kt/year, and 114 Kt/year of copper metal.

As Oyu Tolgoi mine had commenced its operation in 2013, it can be estimated that the possible production in future will be more than 290 Kt/year of concentrates and 70 Kt/year of the copper metal. The production schedule of Oyu Tolgoi mine is indicated in the table of "2013 Oyu Tolgoi Technical Report (2013 OTTR)", the table shows the quantity of ore mined, concentrates produced and the contents of copper, gold and silver in respective years from the 1st to the 43rd year (please refer to Chapter 2). In this table, the plan for excavation of drifts and shafts for mining during the period of the 3rd year to the 23rd year is indicated. The production rate of Oyu Tolgoi mine in future is estimated on the basis of these data (Table 4.1.2, Table 4.1.3).

The representing value of production rate in Oyu Tolgoi mine in future is estimated as follows:

・Estimated Value at Excavation of Open Pit: the value of the 2nd year.

Concentrates: 669 Kt/year, Copper metal: 171 Kt/year

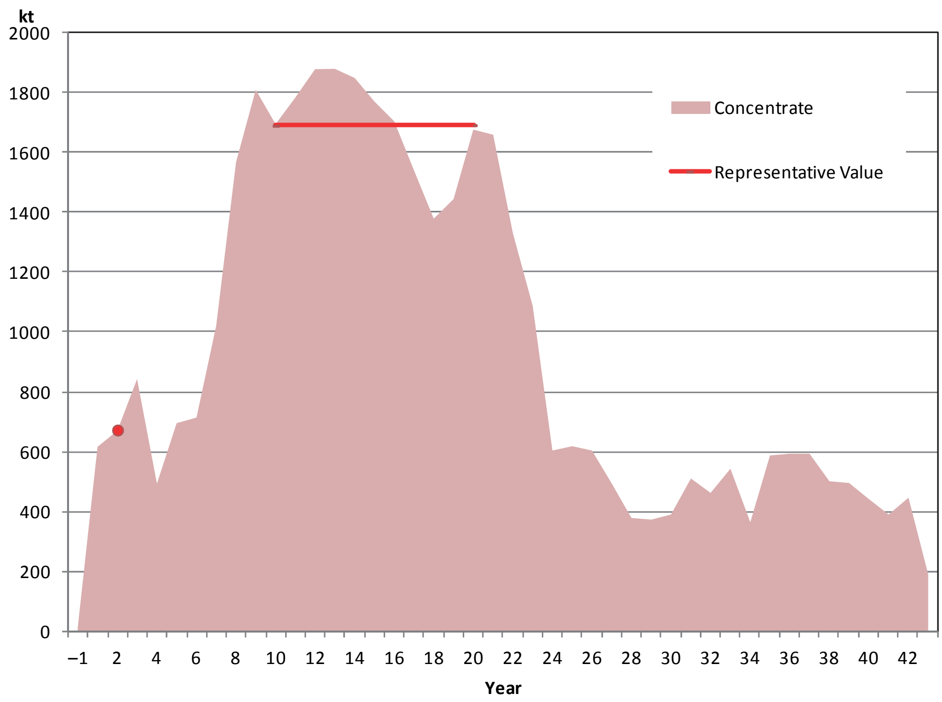
・Estimated Value at Under Ground mining: the average value from 10th - 20th year

Concentrates: 1,690 Kt/year, Copper metal: 531 Kt/year

Tsagaan Suvarga mine is under construction at this stage, and aims to commence the operation in 2016. It is their plan that the production target, i.e. concentrates of 320 Kt/year with their copper grade of 25.6% from the 3rd year, even though the production target value cannot be achieved at the 1st - the 2nd year (according to the verbal explanation from the staff of mine at the visit for inspection of mine). From this, it can be considered that the estimated production of copper concentrates will be 320 Kt/year equivalents to 81,920 t/year of metallic copper.

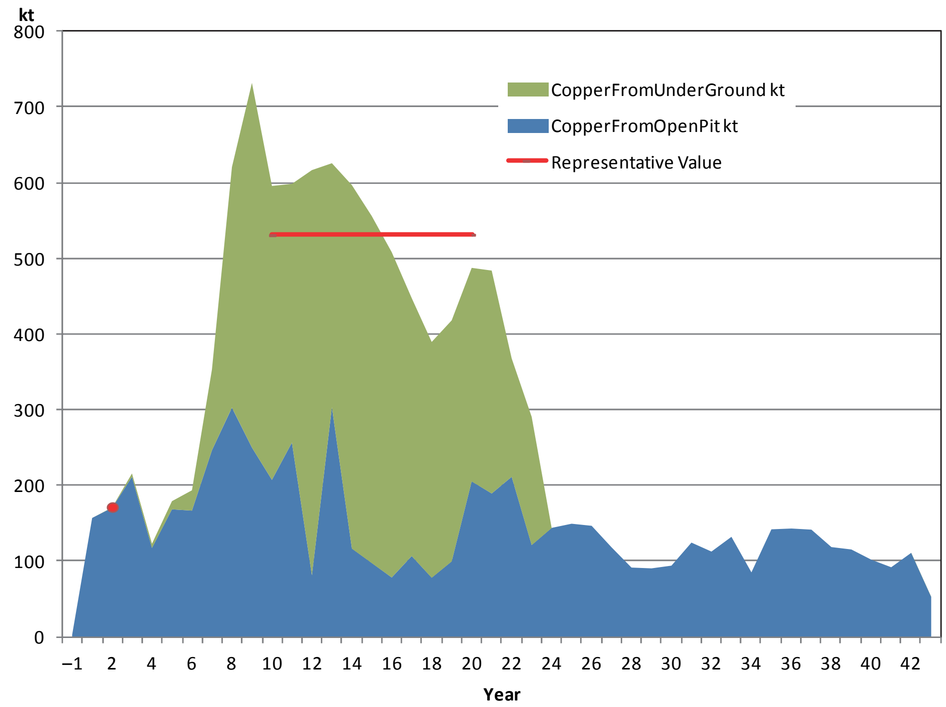
As for the production plan of these 3 mines, the production of copper concentrates in Mongolia is estimated assuming 3 stages of production, i.e. the point of time that the operation of Open Pit mining in Oyu Tolgoi mine goes successfully, the time when the Open Pit mining and Under Ground mining of Oyu Tolgoi mine are both operated, and that when the operation in Tsagaan Suvarga mine is commenced in addition to the second step. The production of copper concentrates will increase to 1.4 times of current production when Open Pit mining in Oyu Tolgoi is operated steadily in addition to the operation in Erdenet mine, and the production will reach to 2.6 times of current production when the Under Ground mining is carried out additionally. The production rate in Mongolia will reach to 3 times of current production when 3 mines are being in operation simultaneously, and the production rate will be expected 2,510 Kt/year of concentrate, 727 Kt/year of copper metal (Table 4.1.9, Figure 4.1.4, Figure 4.1.5).

The copper concentrates produced in Mongolia have mostly been exported to China. On the other hand, Chile and Peru have taken the first and second place in the importation of concentrates to China, and Mongolia and Australia have taken the 3rd and 4th place. If all 2,510 Kt of copper concentrates which will expectedly be produced in Mongolia were exported to China, Mongolian Concentrates would obtain a large part of market shear in importation of concentrates to China (Figure4.1.6). In the presentation of Mr. Wan Ling, he estimated by quoting the said figure that Mongolia would take the 2nd place next to Chili in the importation of concentrates to China when Oyu Tolgoi mine commenced its operation.



(Source： 2013 Oyu Tolgoi Technical Report)

Figure 4.1.2 Production Schedule of Oyu Tolgoi Mine (Concentrates)



(Source： 2013 Oyu Tolgoi Technical Report)

Figure 4.1.3 Production Schedule of Oyu Tolgoi Mine (Copper metal)

Table 4.1.9 Expected Production Rate of 3 Mines

		Current	ErdeNet +OyuTolgoiOpenPit	ErdeNet +OyuTolgoiOpenPit +OyuTolgoiUnderGround	ErdeNet +OyuTolgoiOpenPit +OyuTolgoiUnderGround +TsagannSuvarga
Copper Concentrates (kt)	Erdenet	535	500	500	500
	OyuTolgoi	290	669	1690	1690
	TsagaanSuvarga			0	320
	Total	825	1169	2190	2510
Copper in concentrates (kt)	Erdenet	126	114	114	114
	OyuTolgoi	76	171	531	531
	TsagaanSuvarga			0	82
	Total	202	285	645	727

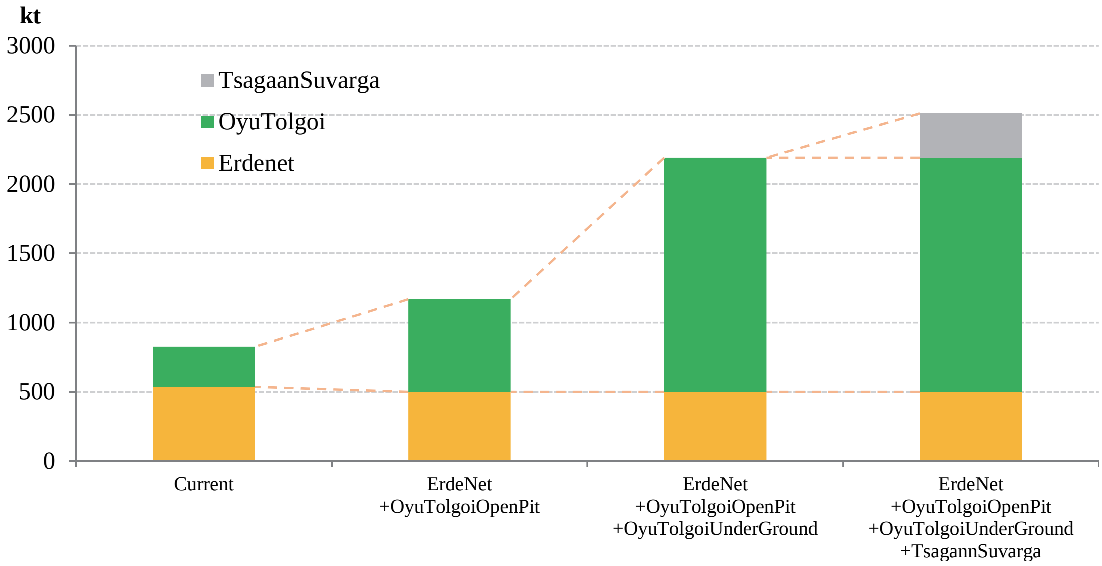


Figure 4.1.4 Expected Production Rate (Concentrates)

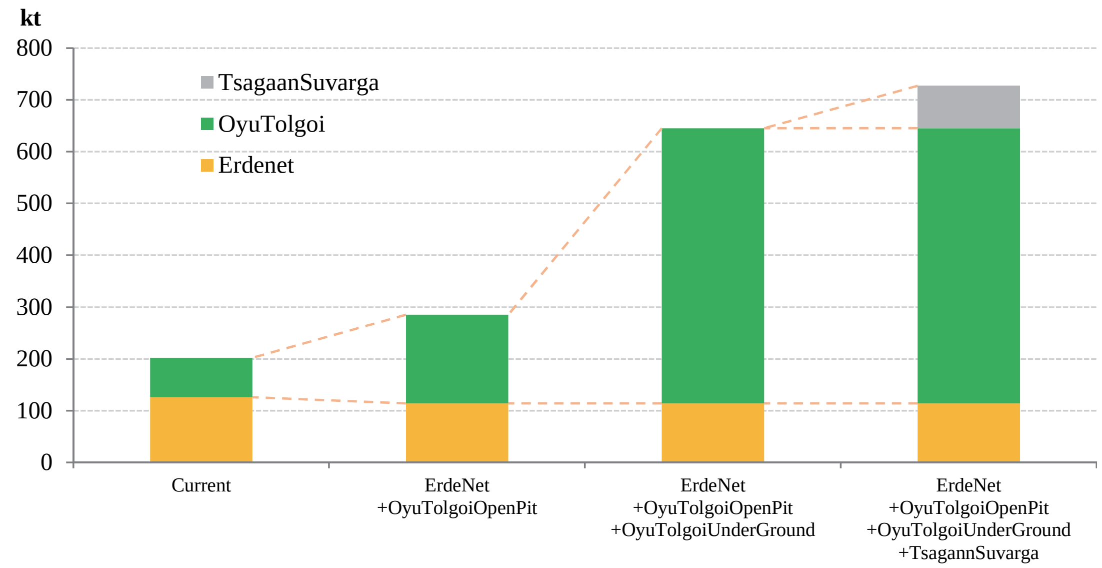
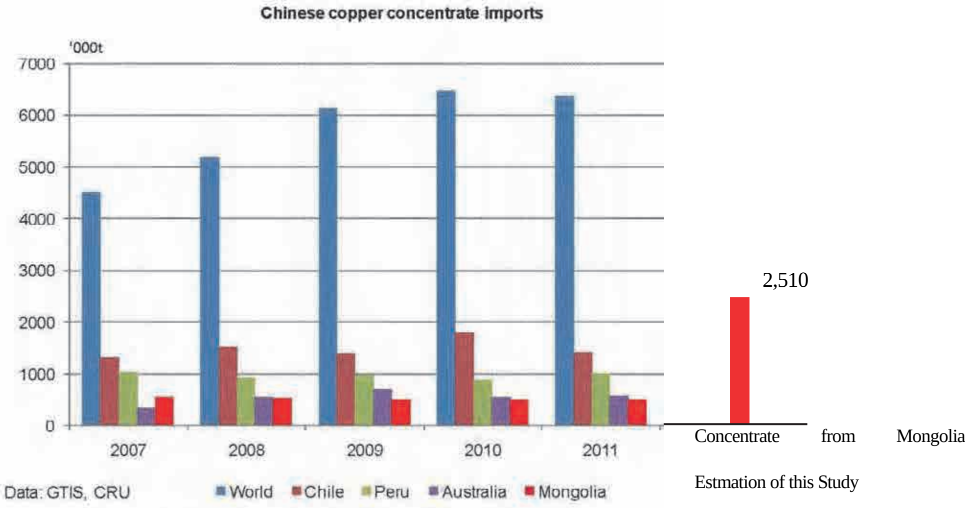


Figure 4.1.5 Expected Production Rate (Copper metal)



(Source: Wan Ling, 2012. Presentation "Chinese Copper Market and Mongolia" retouched)

Figure 4.1.6 Expected Mongolian Copper Concentrates and Import Concentrates of China

4.2 Copper Demand and Import in Mongolia

4.2.1 Importation

The amount of copper and copper products imported in Mongolia is summed up and summarized from database of the Agency of Customs Services (Table4.2.1). However, "Table, kitchen or other household articles and parts thereof, of copper; pot scourers and scouring or polishing pads, gloves and the like, of copper; sanitary ware and parts thereof, of copper" (HS code 7418) are excluded since there is no description on measuring unit in the database.

The maximum amount of importation on copper and copper products was approximately 400 t in 2011 and decreased since then and reached to around 250 t in 2013. The exportation of 2,000 t refined copper is extremely small in comparison with the exportation of copper concentrates containing 120 t of metals.

There are "Copper wire" (HS code 7408) and "Copper wire, fibers and ribbons of copper" (HS code 7413) as the items having a large deviation in importation. Total of these items was 160 - 210 t in 2010 - 2011 respectively. However, it has remarkably been decreased to 15 t/year in 2013. This fact is consistent with "Erdmin company is selling various kinds of copper cables of approximately 150 t/year to domestic clients from the wire demands in Mongolia" (please refer to Item 4.1.1 Actual Production of Refined Copper).

The item of which importation tends to decrease is "Refined Copper or Blocks of Copper Alloys"

(HS code7403). On the other hand, the items having a tendency of increasing though they have deviations are “Copper bars, rods and profiles”(HS code 7407), “Copper plates, sheets & strip”(HS code 7409), “Copper foil”(HS code 7410), “Nails & similar articles, of copper or of iron or steel with heads of copper; screws & similar articles, of copper”(HS code 7415) and “Other articles of copper chain, containers” (HS code 7419).

4.2.2 Demand

It can be considered that the copper demand in Mongolia is the sum of Erdmin’s cable sales and the amount of copper imported as well as the surplus amount of copper imported to Mongolia, since there is no copper processing industry in Mongolia with the exception of Erdmin company (the information obtained by hearing from Ministry of mining and other organizations).

The demand of copper products in Mongolia can be calculated by using database of the Agency of Custom Services as the result that subtracting the amount of copper products exported from the amount of copper products of the same imported (Table 4.2.2). The amount of copper products exported from Mongolia with the exception of refined copper and copper concentrates, it is very few. Most of copper products exported from Monglia are less than 1 ton/year, except “Copper pipe fittings & couplings” (HS code 7412) which had a record for exportation of 5.4 tons in 2010. Therefore, the amount of import is almost equal to the amount of excess importation.

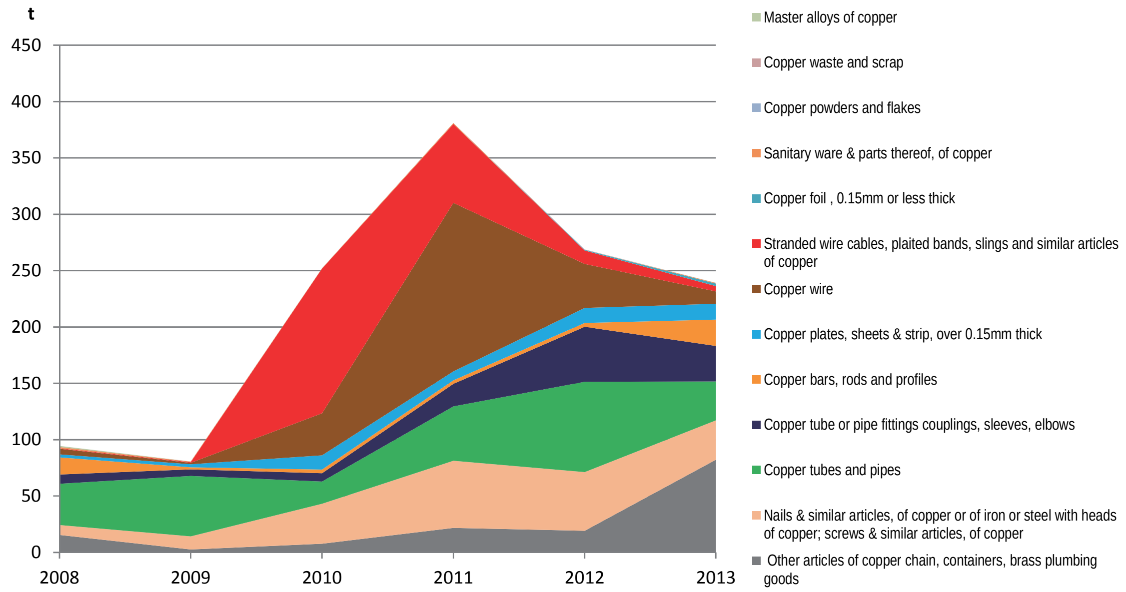
As described in Item 4.2.1 of “Importation”, “Copper wire” (HS code 7408) and “Copper wire cables, fibers, ribbons of copper” (HS code 7413) have been imported from totally 160 t to 210 t in 2010 and 2011, and decreased to 15 t in 2013. It can be understood that this decrease in importation was caused due to the substitution of electrical cable products from Erdenet company for imported goods among the domestic demand of 160-210 t/year .

The amount of copper products imported is approximately 150 - 250 t/year with the exception of “Copper wire” (HS code 7408) and “Copper wire cables, fibers, ribbons of copper” (HS code 7413) and is in a state having a tendency to increase in importation. Approximately 400 t/year as the sum of the imported amount 150-250 t as above mentioned and the importation of 160-210 t for “Copper wire” and “Copper wire cables, fibers, ribbons of copper” can be deemed to be domestic demands in Mongolia..

Table 4.2.1 Import Amount of Copper to Mongolia

Code	Code Description		2008	2009	2010	2011	2012	2013
26030020	Copper concentrates	kg	0	0	7	60	36	1
7403	Refined copper & copper alloys	kg	67,116	40,250	36,194	24,639	14,500	19,458
7404	Copper waste and scrap	kg					0	5
7405	Master alloys of copper	kg	1,013	0				
7406	Copper powders and flakes	kg			0	21	250	42
7407	Copper bars, rods and profiles	kg	15,154	1,870	3,236	3,144	3,302	23,305
7408	Copper wire	kg	4,975	1,233	37,322	149,592	38,964	10,889
7409	Copper plates, sheets & strip, over 0.15mm thick	kg	2,791	2,787	12,615	7,881	13,411	14,154
7410	Copper foil , 0.15mm or less thick	kg			0	4	447	2,273
7411	Copper tubes and pipes	kg	36,543	53,680	19,648	48,209	80,114	34,512
7412	Copper tube or pipe fittings couplings, sleeves, elbows	kg	8,216	5,688	12,835	20,020	48,925	31,508
7413	Stranded wire cables, plaited bands, slings and similar articles of copper	kg	364	557	128,384	69,947	12,006	4,659
7415	Nails & similar articles, of copper or of iron or steel with heads of copper; screws & similar articles, of copper	kg	8,893	11,584	35,500	59,592	52,009	34,941
74182000	Sanitary ware & parts thereof, of copper	kg	1,119	588	243	823	58	578
7419	Other articles of copper chain, containers, brass plumbing goods	kg	15,410	3,224	7,702	21,843	19,189	82,241
	Total	kg	161,592	121,460	293,686	405,774	283,213	258,566

(Source: Customs Service Database, http://www. customs.gov.mn/statistics/)



(Source: Customs Service Database, http://www. customs.gov.mn/statistics/)

Figure 4.2.1 Changes of Each Copper Import

Table 4.2.2 Import Surplus Amount of Mongolia

Code	Code Description		2008	2009	2010	2011	2012	2013	Average
26030020	Copper concentrates	t	-582,888	-586,982	-568,664	-575,900	-574,343	-649,816	-589,766
7403	Refined copper & copper alloys	kg	-2,536,535	-2,280,658	-2,764,245	-2,336,180	-2,105,756	-2,181,974	-2,367,558
7404	Copper waste and scrap	kg	0	0	0	0	0	5	1
7405	Master alloys of copper	kg	1,013	0	0	0	0	0	169
7406	Copper powders and flakes	kg	0	0	0	21	250	42	52
7407	Copper bars, rods and profiles	kg	15,154	1,870	3,236	3,144	3,302	23,305	8,335
7408	Copper wire	kg	4,975	1,233	37,322	149,592	38,964	10,889	40,496
7409	Copper plates, sheets & strip, over 0.15mm thick	kg	2,791	2,787	12,615	7,881	13,411	14,154	8,940
7410	Copper foil , 0.15mm or less thick	kg	0	0	0	4	447	2,272	454
7411	Copper tubes and pipes	kg	36,543	53,680	19,648	48,209	80,114	34,512	45,451
7412	Copper tube or pipe fittings couplings, sleeves, elbows	kg	8,216	5,688	7,435	20,018	48,925	31,503	20,298
7413	Stranded wire cables, plaited bands, slings and similar articles of copper	kg	364	557	128,384	69,947	12,006	4,659	35,986
7415	Nails & similar articles, of copper or of iron or steel with heads of copper; screws & similar articles, of copper	kg	8,893	11,584	35,500	59,592	52,009	34,935	33,752
74182000	Sanitary ware & parts thereof, of copper	kg	1,119	588	243	823	58	578	568
7419	Other articles of copper chain, containers, brass plumbing goods	kg	15,391	2,604	7,637	21,725	19,166	82,241	24,794
	Total	kg	94,456	80,590	252,021	380,956	268,654	239,095	219,295

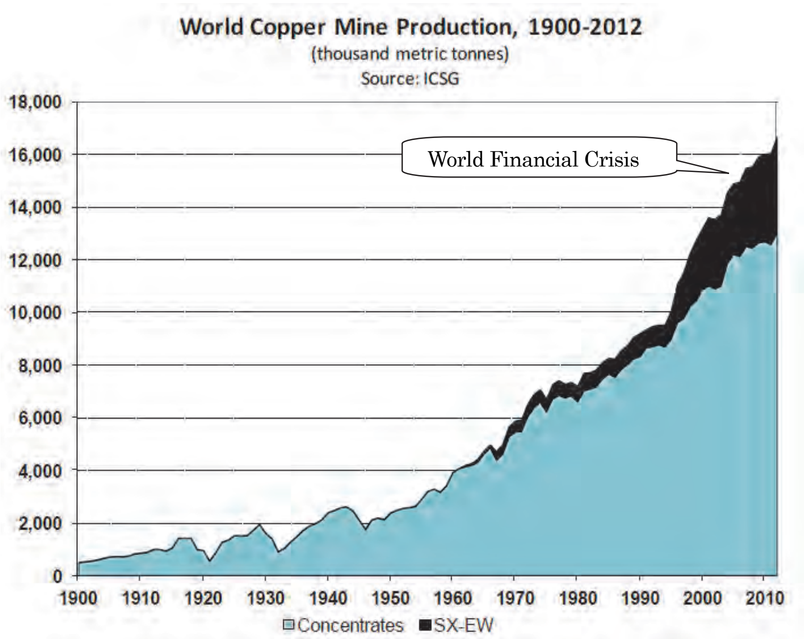
(Source: Customs Service Database, http://www. customs.gov.mn/statistics/)

Chapter 5. World Major Copper Mines and Overview of Copper Producing Organizations

5.1 Major Copper Mines in the World

(1) Copper Production

The transitive graph of copper mine production in the world during the period from 1990 to 2011 is shown in Figure 5.1.1. According to this graph, it can be seen that the copper mine production in the world has a tendency of growing, i.e. the graph rising to the right, and particularly the increase rate of copper mine production including that of SX-EW is evident since 1990. Recently, the copper mine production in 2011 was 16,240 Kt/year of metal which is 20% increase in comparison with that in 2002 and 0.7% increase in comparison with the previous year (i.e. production of concentrates; Approx. 12,240 Kt/year of metal, and that of SX-EW; Approx. 40,000 Kt/year of metals).



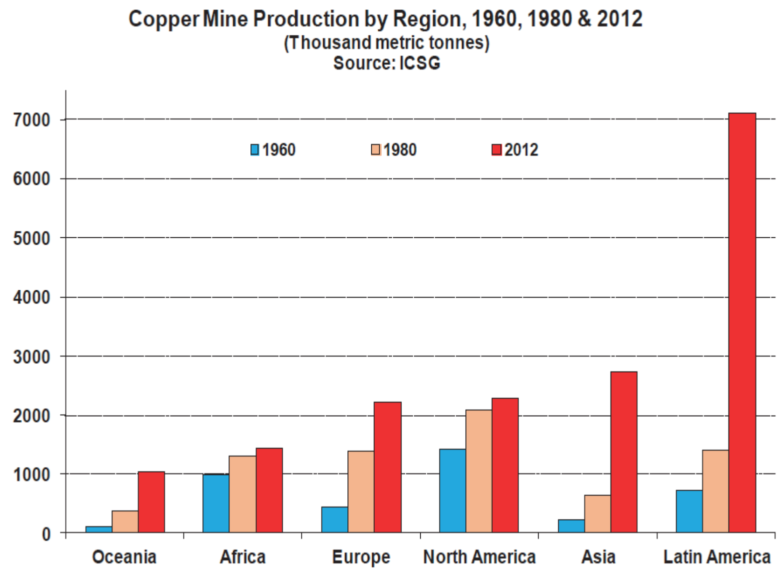
(Source： ICSG, 2013)

Figure 5.1.1 Copper Mine Production in the World (1990 ~ 2010)

The copper mine production in respective regions of the world (1960, 1980 and 2012) is as shown in Figure 5.1.2. In comparison with the production in respective years, the characteristics in change of production can be summarized as follows:

- In 1960, North American countries were the largest in their copper mine production and African countries were the second, and the third was that in South American countries.

- In 1980, North American countries were the largest in their copper mine production and European countries were the second, and the third was that in South American countries.
- In 2012, South American countries were the largest in their copper mine production and Asian countries were the second, and the third was that in North American countries.
- The growing rate on copper mine production of South American countries in 2012 was extremely high, and the copper mine production of Chile reached to thirty two percent (32%) of total production in the world.
- The growing rate on copper mine production of Asian countries in 2012 became next to that of South American countries, and that of other countries firmly increased as well.

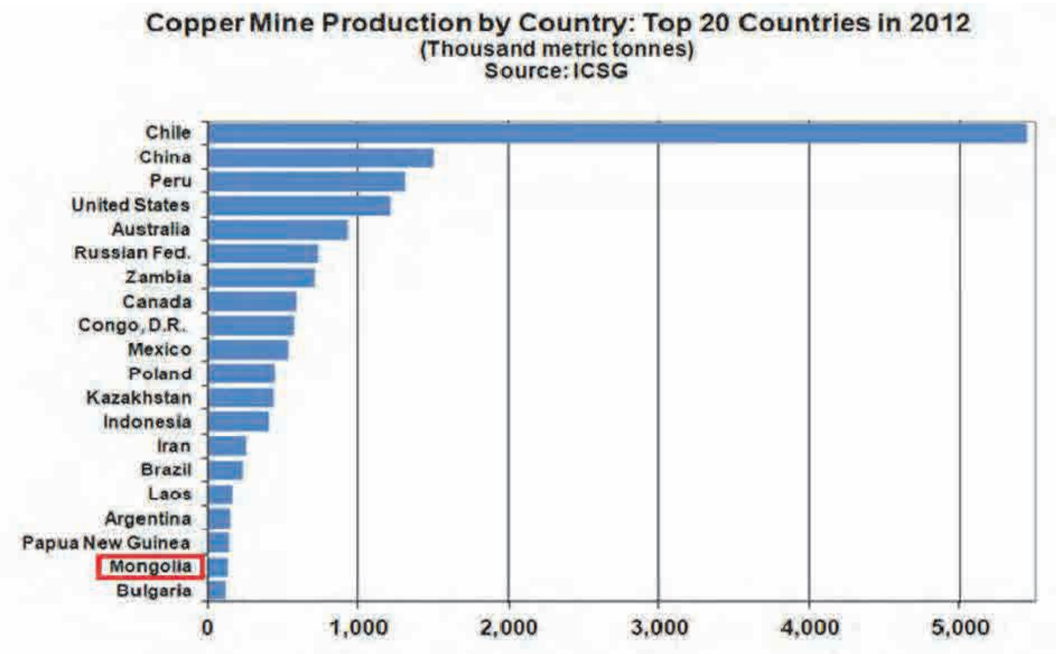


(Source: ICSG, 2013)

Figure 5.1.2 Copper Mine Production of Respective Regions in the World (1960, 1980 and 2012)

The copper mine production of top twenty countries in the world (in 2012) is shown in Figure 5.1.3. The characteristics of copper mine production in respective countries can be summarized as follows:

- The copper mine production in Chile is the projectively highest, and the second is that in China though there is a large difference those of these two countries.
- Among countries in South American region, the copper mine production in Chile and Peru is higher than others and shows the difference in locality.
- The top twenty countries are also sporadically existing in the world as a trend.
- The copper mine production in Mongolia is placing in the nineteenth order of the world, and further growing may be expected in future.



(Source: ICSG, 2013)

Figure 5.1.3 Copper Mine Production of Top Twenty Countries (in 2012)

Also, the production capacity of mines in top twenty countries in the world is as shown in Table 5.1.1.

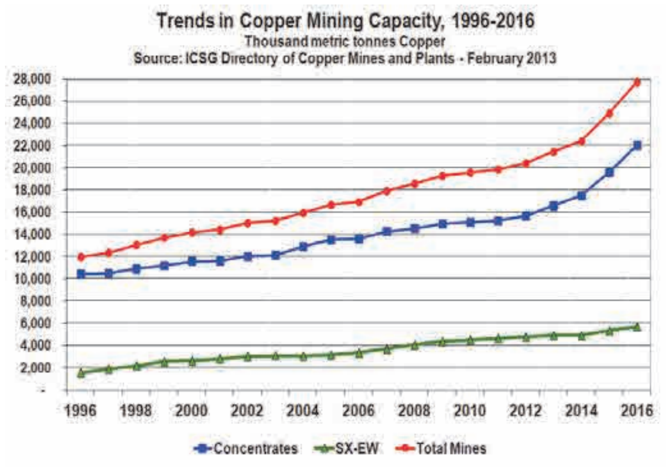
Table 5.1.1 Production Capacity of Mines in Top Twenty Countries in the World (during the period of 1996～2016)

No.	Mine	Deposit type	Country	Ownwer(s)	Source	Capacity (TMT)	Production, 2010 (TMT)	Production, 2011 (TMT)	Increase /Decrease ratio	First production year
1	Escondida	porphyry	Chile	BHP Billiton(57.5%)、Rio Tinto (30%)、Japan Escondida(12.	Concs & SX-EW	1,120	1,087	818	−25	1990
2	Grasberg	porphyry	Indonesia	Freeport McMoRan(90.64%)、Indonesia Government(9.36%)	Concentrates	600	603	400	−34	1972
3	Collahuasi	porphyry	Chile	Anglo American(44%)、Xstrata (44%)、Mitsui+Nippon(12%)	Concs & SX-EW	520	504	453	−10	1999
4	Chuquicamata	porphyry	Chile	CODELCO(100%)	Concs & SX-EW	450	528	443	−16	1910
5	Rudna	sediment-hosted	Poland	KGHM(100%)	Concentrates	450	425	427	0	1966
6	El Teniente	porphyry	Chile	CODELCO(100%)	Concs & SX-EW	434	404	400	−1	1904
7	Taimyr Peninsula	orthomagmatic	Russia	Norilsk Nickel (100%)	Concentrates	430	382	304	−20	1939
8	Los Pelambres	porphyry	Chile	Antofagasta(60%)、five Japanese companies(40%)	Concentrates	420	398	426	7	1999
9	Morenci	porphyry	USA	Freeport McMoRan(85%)、Sumitomo(15%)	Concs & SX-EW	420	233	279	19	1987
10	Radomiro Tomic	porphyry	Chile	CODELCO(100%)	Concs & SX-EW	375	375	470	25	1998
11	Antamina	porphyry+skarn	Peru	BHP Billiton(33.75 %)、Xstrata (33.75%)、Teck(22. 5 %)、Mitsubishi Corp.(10%)	Concentrates	370	325	347	7	2001
12	Cerro Verde	porphyry	Peru	FreeportMcMoRan(53.6 %)、Buenaventura(18.2%)、Sumitomo(15%)	Concs & SX-EW	300	229	303	32	1977
13	Andina	porphyry	Chile	CODELCO(100%)	Concentrates	300	189	234	24	1970
14	Bingham Canyon	porphyry	USA	Rio Tinto(100%)	Concentrates	280	250	195	−22	1904
15	Kansanshi	vein-hosted	Zambia	First Quantam(80%)、ZCCM (20%)	Concs & SX-EW	250	235	230	−2	2005
16	Batu Hijau	porphyry	Indonesia	Newmont Mining(31.5%)、Indonesia comany(44%)、four	Concentrates	250	246	128	−48	1999
17	Los Bronces	porphyry	Chile	Anglo American(50.1%)、CODELCO(24.5%)、	Concs & SX-EW	246	221	222	0	1925
18	Zhezlazgam Complex	sediment-hosted	Kazakhstan	Kazgeology	Concentrates	230	170	170	0	−
19	Olympic Dam	oxide copper gold (IC	Australia	BHP Billiton(100%)	Concs & SX-EW	225	133	197	49	1988
20	Sarcheshmeh	porphyry	Iran	National Iranian Copper Industries(100%)	Concs & SX-EW	204	190	250	32	1974

(Source: JOGMEC, 2013)

Meanwhile, the trend of change in copper mining capacity (during the period of 1996 ~2016) is as shown in Figure 5.1.4. The characteristics of copper mining capacity can be summarized as follows:

- It shows as a trend that the copper mining capacity is gradually growing (in other words, graph rising to the right hand side).
- The further increase in the mining capacity is expected from the year of 2014, and the capacity would reach to 28,000 Kt of metal in 2016.
- The capacity increase of SX-EW can be observed since 2014, and the remarkable increase in capacity of ore concentration treatment can also be anticipated.

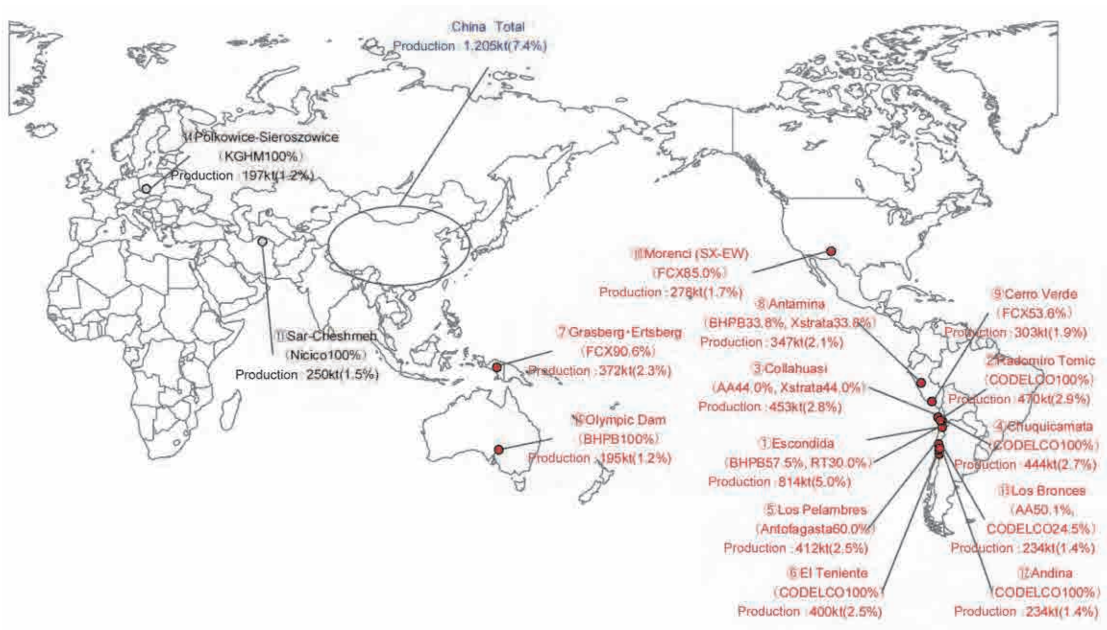


(Source: ICSG, 2013)

Figure 5.1.4 Trend in Change of Copper Mining Capacity (1996 ~ 2016)

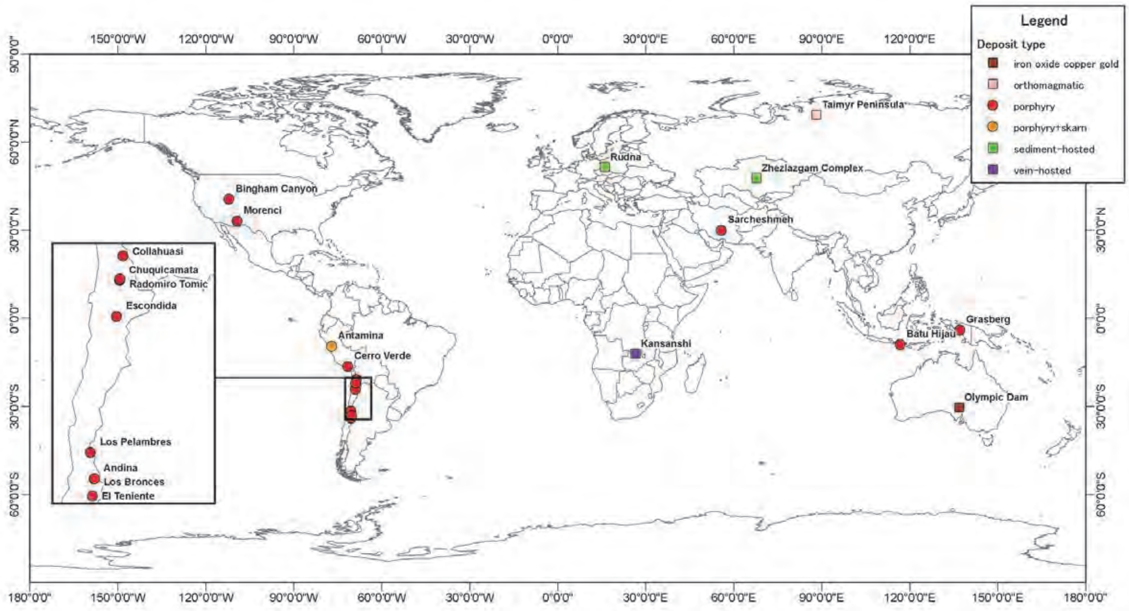
(2) Distribution of Major Mines and Type of Deposit

The distribution of major copper mines in the world is shown in Figure 5.1.5. Distribution of top twenty copper mines and types of their deposits are as shown in Figure 5.1.6 .



(Source： JOGMEC, 2012)

Figure 5.1.5 Distribution of Major Copper Mines in the World



(Source: JOGMEC, 2013)

Figure 5.1.6 Distribution and Deposit Types of Top Twenty Copper Mines in the World

From these data as above stated, the major copper mines are concentrically existed in Chile and Peru among South American countries, and other major copper mines are sporadically existed in the world as a tendency. As for the type of deposits, the porphyry copper type ones are majority as the mainstream, and other types of deposits, such as the iron oxide copper gold type, orthmagmatric type, skarn type, sediment-hosted type, vein type, etc. are respectively existed as well.

(3) World Copper Resources Already Discovered and Undiscovered by Respective Regions

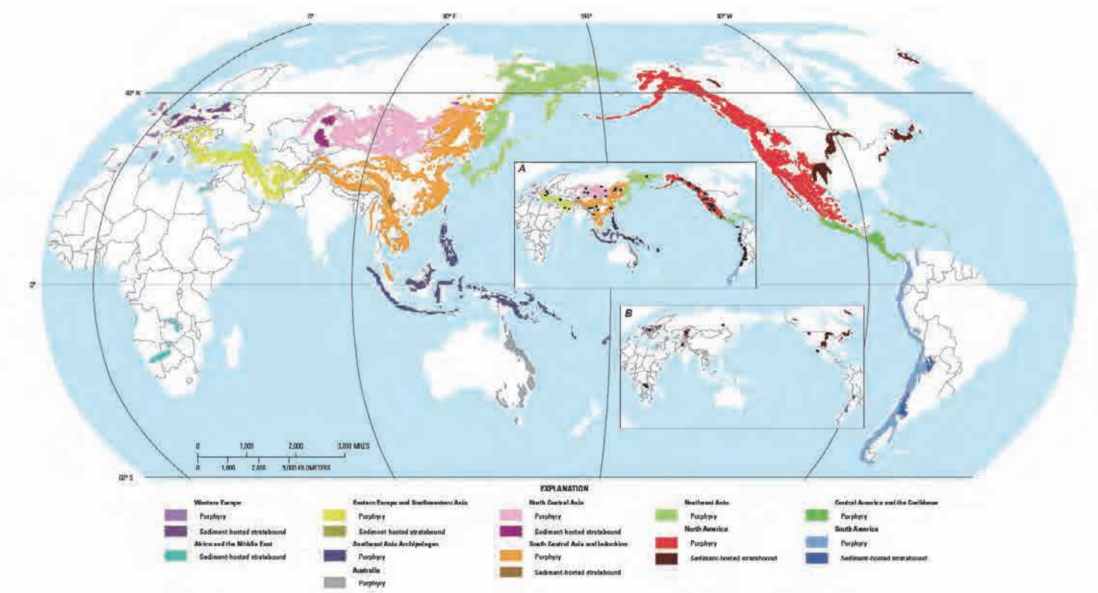
World copper resources which had already been discovered and those which have not been discovered yet are as shown in Table 5.1.2 by respective regions. From this table, the South American countries have the maximum potential since they are possessing 810 Mt of identified resources. The second is the North American countries since they have 470 Mt of identified resources, and the third is Africa and Middle East countries of 160 Mt. And next to these regions as aforementioned, 130 Mt (Porphyry Type) in Northern Central Asian countries including Mongolia would hopefully be anticipated as well as South East Asian countries. These areas are as shown in Figure 5.1.7.

Table 5.1.2 World Copper Resources Discovered and Undiscovered

Region	Deposit type	Tract extent (km²)	Undiscovered resources (Mt)				Identified resources (Mt)
			90	50	10	Mean	
South America	Porphyry	1,200,000	500	730	1,000	750	810
	Sediment-hosted	99,000					0.51
Central America and the Caribbean	Porphyry	540,000	78	150	280	170	42
North America	Porphyry	3,200,000	250	370	540	400	470
	Sediment-hosted	450,000	15	48	110	57	18
Northeast Asia	Porphyry	2,300,000	76	220	500	260	8.8
North Central Asia	Porphyry	3,200,000	210	360	590	440	130
	Sediment-hosted	180,000	22	49	90	53	48
South Central Asia and Indochina	Porphyry	3,800,000	280	490	770	510	63
	Sediment-hosted	29,000					4.5
Southeast Asia Archipelagos	Porphyry	850,000	180	290	430	300	130
Australia	Porphyry	580,000	1.9	14	54	21	15
Eastern Europe and Southwestern Asia	Porphyry	1,200,000	130	220	370	240	110
	Sediment-hosted	4,800	0.052	4.8	36	13	6.4
Western Europe	Porphyry	73,000					1.6
	Sediment-hosted	190,000	38	110	230	120	77
Africa and the Middle East	Sediment-hosted	200,000	81	150	260	160	160
Total copper						**3,500**	**2,100**

Note)The figure in the column "Undiscovered resources (Mt) shows the possibility of discovery in percentage (for example,90%), and "Mean" shows the average value (Mt) of these amount. The figure inside the red colored rectangular enclosing line of the above table shows that of Northern Central Asian countries (Porphyry Type) including Mongolian Peoples' Republic.

(Source: USGS, 2013)



(Source: USGS, 2013)

Figure 5.1.7 Area where Discovery of New Copper Deposit(s) will be expected and their Type of Deposit

(4) State of Economy in the World (in 2012)

The state of economy in the world in 2012 can be summarizes as follows (quoted from Anglo American Annual Report in the year of 2012).

- Activities of world economy are evidently being slowed down.
- The world economy is being in a situation of recession period and however the economic growth in U.S.A. is slightly in the state of recovery trend.
- The economy in Europe is being inactive even in 2012 in contrast to that of U.S.A.
- The economy in China has largely been slowed down from 2012.
- Other large developing countries have also experienced the remarkable economic recession.
- As the uncertainty in environment of macro-economy has been increased, the price of goods was in lower tendency and the estimated rate of fluctuation was also higher in 2012.
- The price of platinum was raised up by eight percent (8%) in 2012.
- It was evident that the price of bulk materials, especially raw materials relating to iron making industry was in lower tendency.
- Due to the mitigation of macroeconomic policy in the world wide scale and the restart of investment for infrastructures in China as well as the production increase of industrial goods, the demand for resources would be increased in 2013.

5.2 Overview of World Copper Producing Organizations

The supply chain of the copper spreads from upstream as mine and smelting to downstream such as consumer goods through semis fabrication as shown in Figure 7.2.2. As copper is one of the base metals and is indispensable for the life infrastructure including the electric wire and etc., the market size of copper standed at 123 billion US$ in 2010 following to that of iron ore. For this reason copper mining is one of the attractive investment targets and is core commodity for the world major mining companies[1]. The stable mine operation is one of the possible attractive investments targets for mine companies for a long term. The copper assets of the major companies are shown in Table 5.2.1. Recently with large increase in copper demand led by mainly China the oligopoly by the major company measure advances. As shown in Figure 5.2.1 and Figure 5.2.2, the top ten major companies possess around 65% of copper resources and own about 50% of the world production in 2011. Figure 5.2.3 shows change of copper production by major companies. CODELCO (Corporación Nacional del Cobre de Chile) has been the top copper producing company. Financial

[1] Definition of resources major companies is not clear. JOGMEC (2013) defined a major company as the following criteria; deployment his business in worldwide, mine operation rather than downstream, major producer of multiple commodities, large scale mine operation, possessing strong management resources and etc. In this report we introduce the following ten companies; Anglo American, Antofagasta, BHP Billiton, CODELCO, Freeport-McMoRan Copper and Gold (FCX), Grupo Mexico, Norilsk, Rio Tinto, Vale and Xstrata.

condition in 2011 among 10 major companies, BHP Billiton recorded 72,226 million US$ in sales and Vale was recorded highest profit and profit rate with 22,885 million US$ and 37.9% respectively (Table 5.2.2) The ratio of sale of copper segment in Xstrata is the largest, which has acquired other mining companies which having quality copper mines and projects (Figure 5.2.4). The mining strategy of major companies and investment to overseas copper mine by Japan and China who are depend on foreign sources are also introduced as follows.

Table 5.2.1 Copper Mines and Projects Owned by Major Companies (1)

Company	Mine Smelter	Mine/Project	Country	Source	Type	Equity (%)	Production (Kt)	Mineable Cu (Mt)	Status
Anglo American	Mine	Collahuasi	Chile	Conc. SXEW	PO	44	199.5	24.3	Operating
		El Soldado	Chile	Conc. SXEW	IOCG	50.1	46.9	1.8	Operating
		Los Bronces	Chile	Conc. SXEW	PO	50.1	221.8	28.0	Operating
		Mantoverde	Chile	SXEW	IOCG	100	58.7	1.0	Operating
		Mantos Blancos	Chile	Conc. SXEW	IOCG	100	72.1	1.5	Operating
		Michiquillay	Peru	SXEW	PO	100		3.8	Project
		Quellaveco	Peru		PO	80		6.6	Project
	Smelter	Chagres	Chile	Anode		50.1		-	Operating
Antofagasta	Mine	El Tesoro	Chile		PO	70		1.5	Operating
		Esperanza	Chile		PO	70		7.3	Operating
		Los Pelambres	Chile	Conc.	PO	60		30.6	Operating
		Michilla	Chile	SXEW	IOCG	74		1.0	Operating
		Telegrafo	Chile	Conc. SXEW	PO			10.1	Project
		Antucoya	Chile	SXEW	IOCG	80		3.4	Project
BHP Billiton	Mine	Antamina	Peru	Conc.	SK	33.75		14.0	Operating
		Cerro Colorad	Chile	SXEW	PO	100		2.3	Operating
		Escondida	Chile	Conc. SXEW	PO	57.5		57.8	Operating
		Olympic Dam	Australia		IOCG	100		14.7	Operating
		Spenc	Chile	SXEW	PO	100		3.3	Operating
Codelco	Mine	Andina	Chile		PO	100		106.3	Operating
		Chuquicamata	Chile		PO	100		73.9	Operating
		El Abra	Chile		PO	49		6.2	Operating
		El Teniente	Chile		PO	100		92.6	Operating
		Gaby	Chile		PO	100		2.7	Operating
		Ministro Mina Hales	Chile		PO	100	170		Project
		Radomiro Tomic	Chile		PO	100		4.0	Operating
		Salvador	Chile		PO	100		2.8	Operating
	Smelter	Chuquicamata	Chile	SM, RF		100			Operating
		Pterorillos	Chile	SM		100			Operating
		Ventana	Chile	SM, RF		100			Operating
		El Teniente	Chile	SM, RF		100			Operating
FCX	Mine	Bagdad	USA	Conc. SXEW	PO	100	88	4.9	Operating
		Candelaria/Ojos del Salad	Chile	Conc.	IOCG	80	139.7	2.0	Operating
		Cerro Verde	Peru	Conc.	PO	53.56	157.2	15.5	Operating
		Chino	USA	Conc. SXEW	PO	100	31.3	1.8	Operating
		Miami	USA	SXEW	PO	100	34.5	0.3	Operating
		El Abra	Chile	SXEW	PO	51	63.4	3.7	Operating
		Morenci	USA	Conc. SXEW	PO	85	236.8	11.5	Operating
		Grasberg/Erzberg	Indonesia	Conc.	PO	90.64	383.7	24.5	Operating
		Safford	USA	SXEW	PO	100	68.5	0.9	Operating
		Sierrita	USA	Conc. SXEW	PO	100	80.3	6.4	Operating
		Tenke-Fungurume	Congo D.R.		SED	57.75	73.6	4.2	Operating
		Tyrone	USA	SXEW	PO	100	34.5	0.4	Operating
	Smelter	El Paso	USA			100	230		Operating
		Miami	USA			100			Operating
		Huelva	Spain			100	255		Operating
		Gresik	Indonesia			25	55		Operating

Table 5.2.1 Copper Mines and Projects Owned by Major Companies (2)

Company	Mine Smelter	Mine/Project	Country	Source	Type	Equity (%)	Production (Kt)	Mineable Cu (Mt)	Status
Grupo Mexico	Mine	Cananea	Mexico		PO	99		18.9	Operating
		Charcas	Mexico		PO	99		0.03	Operating
		Cuajone	Peru		PO	99		12.6	Operating
		La Caridad	Mexico		PO	99		7.2	Operating
		San Martin	Mexico		PO	99		0.1	Operating
		Santa Barbara	Mexico		PO	99		0.1	Operating
		Tia Maria	Peru	SXEW	PO	100		2.5	Operating
		Toquepala	Peru		PO	100		17.4	Operating
		Mission	USA		PO	100		3.9	Operating
		Ray	USA		PO	100		3.4	Operating
		Silver Bell	USA	SXEW	PO	75		0.6	Operating
	Smelter	Hayden	USA						Operating
		Amarillo	USA						Operating
		La Caridad	Mexico						Operating
		Ilo	Peru						Operating
Norilsk	Mine	Norilsk	Russian		OM	100		34.4	Operating
		Selebi-Phikwe	Botswana		OM	28.75		0.3	Operating
		Tati Nickel	Botswana		OM	85		0.4	Operating
	Smelter	Nadezhda	Russian						Operating
Rio Tinto	Mine	Bingham Canyon	USA		PO	100		6.0	Operating
		Eagle	USA		PO	100		0.1	Operating
		Escondida	Chile		PO	30		57.8	Operating
		Oyu Tolgoi	Mongolia		PO	32	450	80.4	Operating
		Palabora	South Africa		Other	57.7		0.6	Operating
		Resolution	USA		PO	50		23.8	Project
		La Granja	Peru		PO	100	250		Project
		Grasberg/Erzberg	Indonesia		PO	0.43			Operating
	Smelter	Kennecott Utha Copper	USA	SM, RF					Operating
Vale	Mine	Konkola North	Zambia		SED	40		7.9	Project
		Salobo	Brazil		IOCG	100		7.1	Project
		Sossego	Brazil		IOCG	100		1.6	Operating
		Sudbury	Canada		OM	100			Operating
		Voisey's Bay	Canada		OM	100		0.4	Operating
Xstrata	Mine	Alumbrera	Argentina	Conc.	PO	50	58.3	1.4	Operating
		Antamina	Peru	Conc.	SK	33.75	112.6	14.0	Operating
		Bracemac McLeod	Canada		VMS	50			Project
		Brunswick	Canada	Conc.	VMS	100	8.8	0.01	
		Collahuasi	Chile	Conc. SXEW	PO	44	199.4	24.3	Operating
		El Pachon	Argentina		PO	100		7.6	Project
		Ernest Henry	Australia	Conc.	IOCG	100	100.3	0.8	Operating
		Falconbridge Nickel Ops	Canada	Conc.	OM	100	49.9	1.1	Operating
		Frieda River	PNG		PO	72.8		7.5	Project
		Kidd Kreek	Canada	Conc.	VMS	100	42.3	0.6	Operating
		Lomas Bayas	Chile	SXEW		100	73.6	2.2	
		Mount Isa	Australia	Conc.	IOCG	100	148.8	1.5	Operating
		Perseverance	Canada	Conc.		100	9.8	0.01	Operating
		Raglan	Canada	Conc.		100	7.2	0.2	Operating
		Tampakan	Philippines	Conc.		62.5		13.2	Project
		Antapaccay	Peru		PO	100	160		Project
		Tintaya	Peru	Conc. SXEW	PO	99.4	95.2	6.7	Operating
	Smelter	Townsville	Australia			100	276.5		Operating
		Altonorte	Chile			100	311		Operating
		Horne	Canada			100	187.4		Operating
		Sudbury	Camada			100	20		Operating
		CCR	Camada			100	264		Operating
		Nikkelverk	Norway			100	36.3		Operating

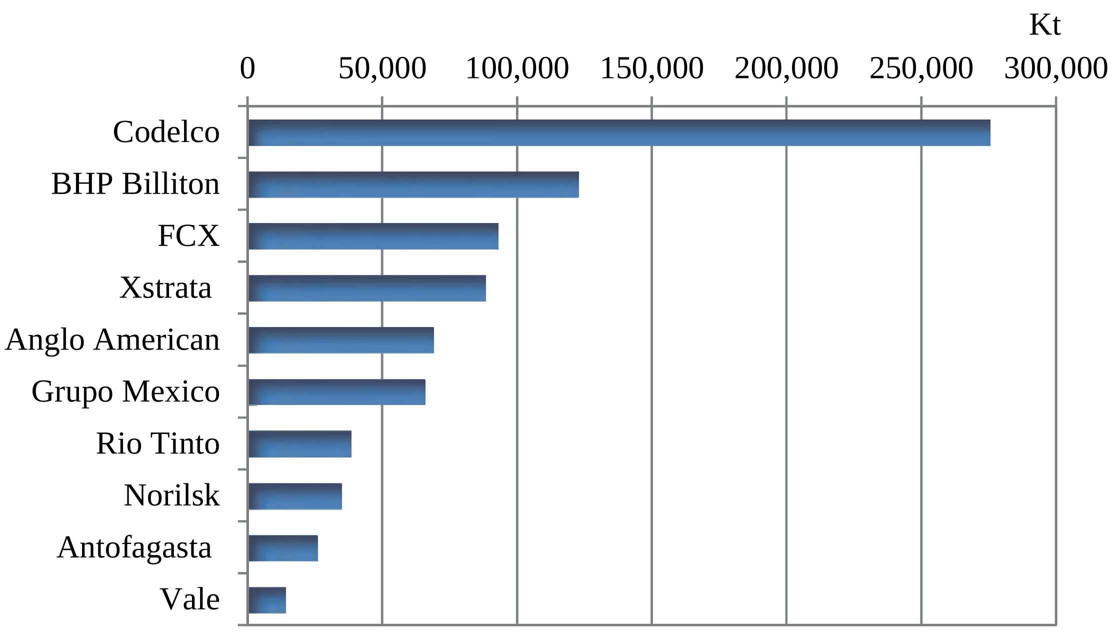
(Source: Prepared by Survey Team)

Table 5.2.2 Financial Condition of Major Companies

Company	Sales (a)	Current Income (b)	Profit Rate (b/year)	Gross Asset	Net Asset
BHP Billiton	72,226	15,417	21.3%	129,273	67,085
Rio Tinto	60,537	5,826	9.6%	119,545	59,208
Anglo American	30,580	6,169	20.2%	72,442	43,189
Vale	60,389	22,885	37.9%	128,728	79,609
Xstrata	33,877	5,713	16.9%	74,832	45,701
FCX	20,880	4,560	21.8%	32,070	18,553
CODELCO	17,515	2,056	11.7%	20,835	6,065
Norilsk Nickel	14,122	3,604	25.5%	18,912	11,222
Grupo Mexico	10,443	2,472	23.7%	15,201	8,737
Antofagasta	6,076	1,237	20.4%	11,705	7,807

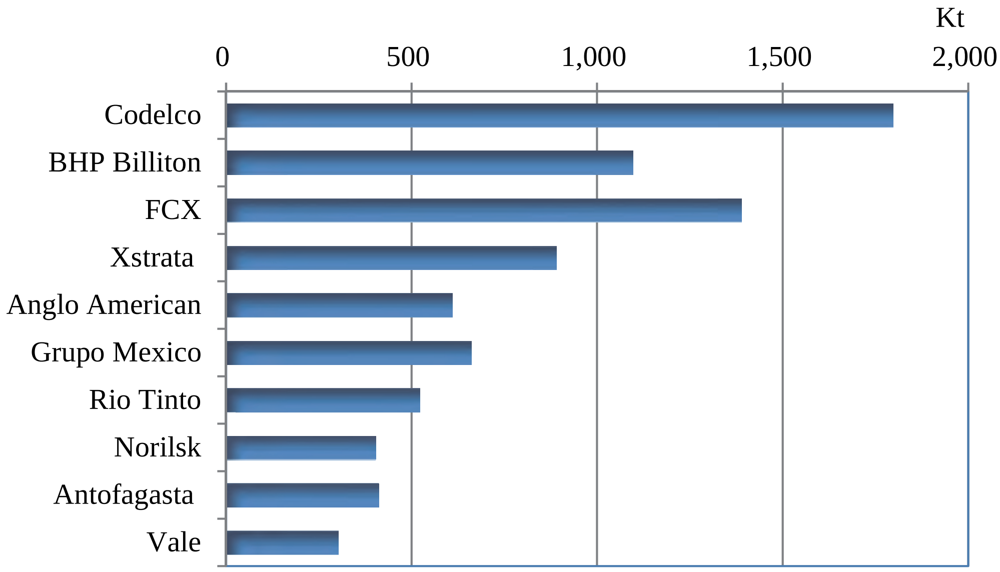
Unit：US$ million

(Source: JOGMEC (2013))



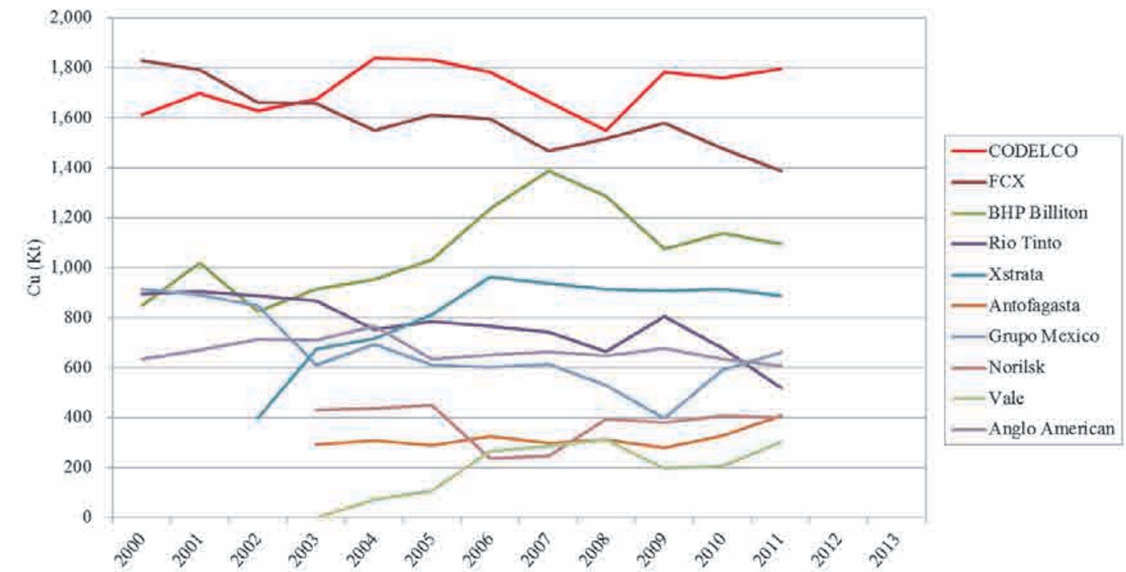
(Source: Prepared by Survey Team from Annual Reports of Mining Companies)

Figure 5.2.1 Copper Resources and Reserves Owned by the Top 10 major Companies



(Source: Prepared by Survey Team from Annual Reports of Mining Companies)

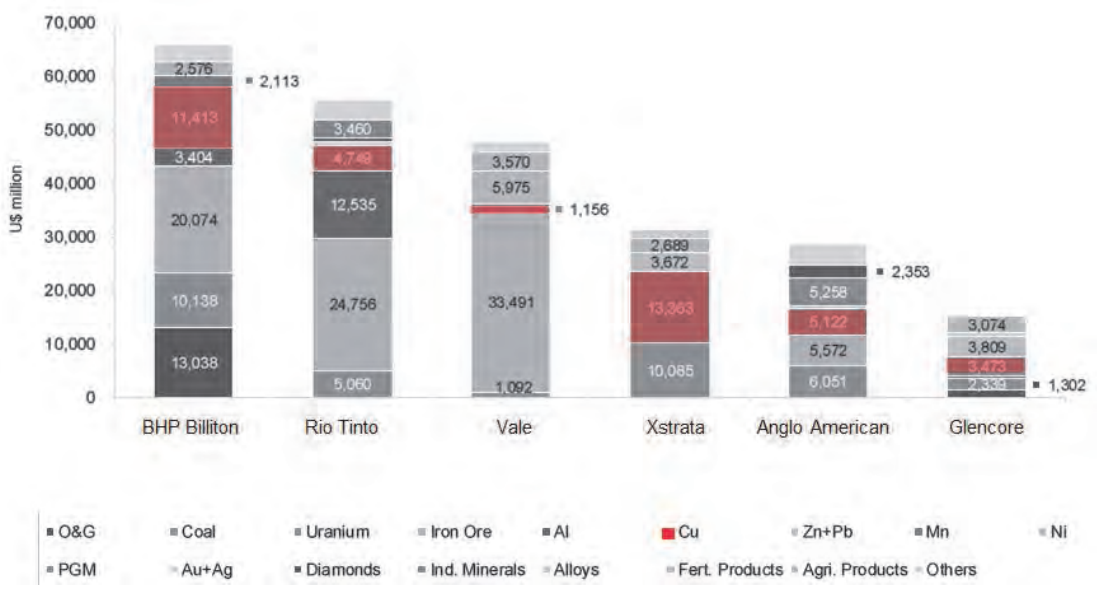
Figure 5.2.2 Copper Production by the Top 10 Major Companies (2011)



Data of FCX from 2000 to 2007 are contained that of Phelps Dodge. Data of Xstrata from 2002 to 2005 are also contained that of Falcon Bridge.

(Source: Prepared by Survey Team from JOGMEC (2013))

Figure 5.2.3 Trend of Copper Production by the Top 10 Major Companies



(Source: JOGMEC (2013))

Figure 5.2.4 Sales by Segments of 6 Major Companies in 2012

5.2.1 Major Companies

(1) CODELCO

CODELOCO is the largest copper mining company and owned by the government of Chile. While they have exploration projects in foreign countries such Brazil, they own whole copper mines in Chile such as Chuquicamata, Ministro Hales, Radomiro Tomic, Gaby, El Salvador, Adnina, Los Bronces, El Teniente and El Abra mine as shown in Table 5.2.1 and Figure 5.2.5. Except for El Abra, Los Bronces and El Sodado they own 100% of interest in. They also have been operating Chuquicamata、Petrorillos and El Teniene smelters, which treat copper ores from mines close to the smelter. Only Ventanas smelter is located at the seaside and treats ores from other mines. Chiquicamata, one of the largest open pit mines, and El Teniente mines, one of the largest underground mines have a history over 100 years since start operation and, Andina and El Salvador were nationalized in 1972. Other mines such as Radomiro Tomic, Gaby, and Ministero Hales were discovered after nationalization. In 2013 CODELOCO exercised option right of Anglo American Sur and acquired 24.5% of right.

In 2013 CODELCO produced 1,792Kt of copper from 8 mines accounting for 11% of world mine production and owns 2,750 Mt of copper resources and reserves excluding ex-Anglo American Sur, which is the largest volume in the world. In the Chuquicamata open pit transition from the open pit mining to the underground mining to excavate deeper deposit is proceeding and they are planning to start production from 2018 extending mine life to around 2060 as shown in Figure 5.2.6. In the Radomiro Tomic open pit, they are developing deeper level sulfide deposit and planning to start operation from 2017. In the El Teniente underground developing of deeper level is proceeding and is planning to start production 2017. Around the Chuquicamata mine, the Toki deposit has already discovered and the potentiality of large deposits is thought to be high.

Excluded asset of Anglo American Sur

(Source: Prepared by Survey Team)

Figure 5.2.5 Location of Mines and Projects of CODELCO and Vale

(Source: CODELCO (2014))

Figure 5.2.6 Expansion Project in the Pipeline in CODELCO

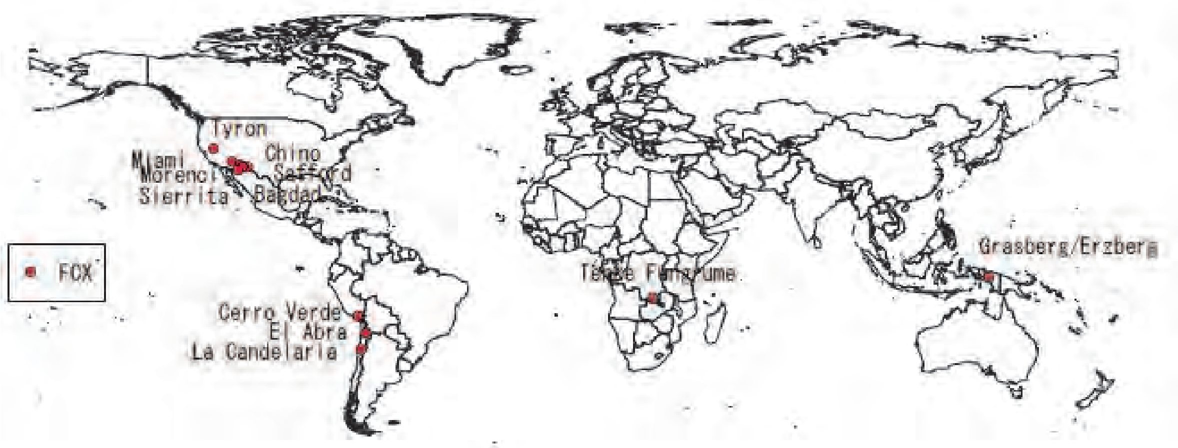
(2) Vale

Vale is the Brazil based world largest iron ore and manganese producer and consisted of steel material department, base and precious metal department (copper, gold, precious metals and aluminum). After acquisition of Ionco in 2006, which was a leading nickel producer operating Sudbury, Thompson and Vosys Bay mines, Vale newly started production at Onca Puma near

Carajas and entered into the Nickel mining industry. Vale also started operation Salobo copper mine following to the Sossego mine in the Carajas region (Figure 5.2.5) and then became one of the major companies. In Carajas region they have already identified other copper deposits such as Cristalino, Alvo 118, Igarape Bahia and Alemao. In 2010 Vale purchased Tres Valles mine (oxide copper) in Chile, however soon after Vale sold it because they changed their strategy, concentrate to world class assets. Currently Konkola North copper project in Zambia with African Rainbow Minerals is proceeding.

(3) FCX (Freeport McMoran Copper & Gold Inc.)

Assets of copper mines of FCX were only Grasberg/Erzberg Indonesia. In 2007 FCX merged Phelps dodge and acquired asset of copper mine in South and North America and Africa as shown in Table 5.2.1. and Figure 5.2.7. In 2011 FCX produced 1,388 Kt of copper in concentrate that is the second largest after CODELCO and produce 540.4 Kt of refined copper at El Paso (USA), Gresik (Indonesia) and Huelva (Spain) smelter. Tenke Fungrume mine owned by Phelps Dodge started operation in 2009 and produced SX-EW cathode since 2009. After completion of the second phase construction, it has ability of 181 Kt of refined copper. At Morenci (USA) and Cerro Verde (Peru) mines, they have abilities to produce 102 Kt and 272 Kt copper in concentrate due to mill plants enhancement. After completion of development of Deep Mill Zone Grasberg below the current open pit, they are planning to produce 240 Kt/day of crude ore (FCX Annual Report, 2013).

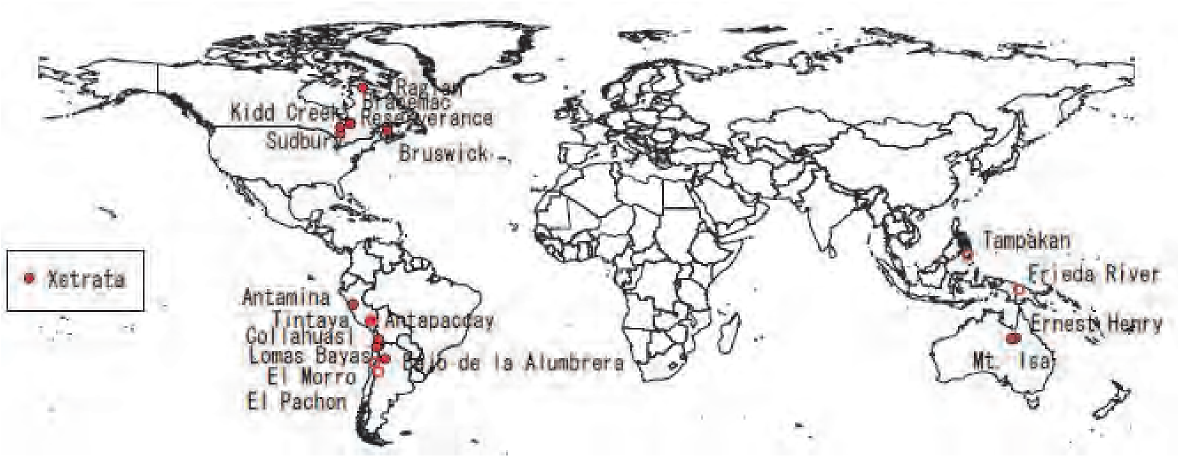


(Source: Prepared by Survey Team)

Figure 5.2.7 Location of Mines and Projects of FCX

(4) Xstrata

Xstrata merged with Glencore in May, 2013, and new Glencore-Xstrata was started. The total assets as of the first half of 2013 was approximately 155,900 million US$ and then jumped to the largest company among the major companies surpassing so-called other major companies such as BHP Billiton (138,100 million US$), Vale (126,500 million US$) and Rio Tinto (111.5 million US$). As for commodities, copper was ranked at 4th (1.2 Mt), zinc was the top (1.6 Mt), lead (0.32 Mt) and nickel is 4th (0.11 Mt). The copper assets in North America are restricted to the eastern Canada, which are orthomagmatic nickel and copper mines such as Raglan and Sudbury, and VMS such as Kidd Creek and Brunswick. Those of South America are located in Peru, Chile and Argentina. In Asia and Oceania Ernest Henry and Mt Isa are under operation (Figure 5.2.8).

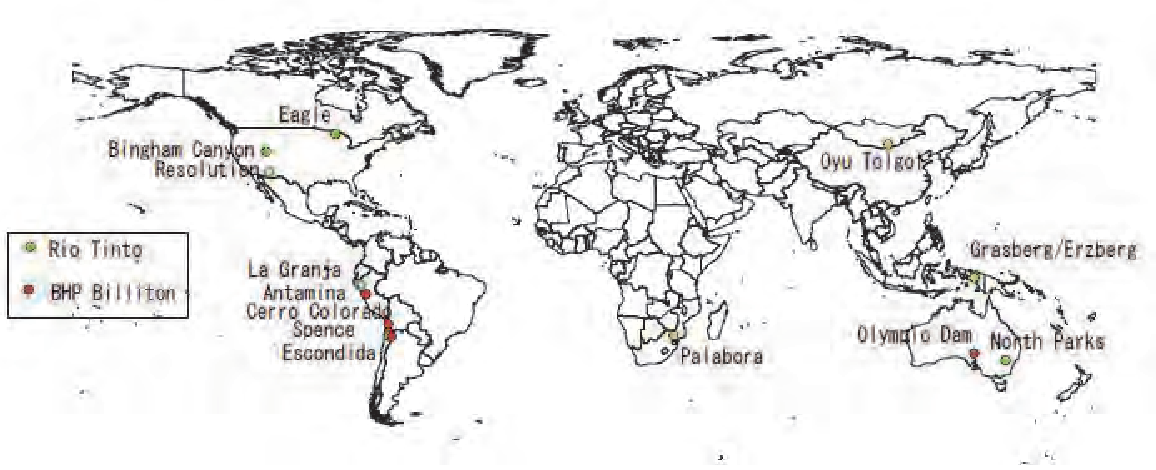


(Source: Prepared by Survey Team)

Figure 5.2.8 Location of Copper Mines and Projects of Xstrata

(5) RionTinto

Rio Tinto has 6 mineral segments such as iron ore, copper and gold, aluminum, fuel resources, diamond, industry minerals. In 2011, sales of iron ore was 29,909 million US$ (44%) among total amount 68,495 million US$, copper and gold was 7,634 million US$ (11%). In addition as for profit, iron ore business dependence is high 78% in 12,853 million US$ among 16,433 million US$, whereas copper and gold is with 12% in 1,932 million US$. Copper mines owned by Rio Tinto are Bingham Canyon (USA), Escondida (Chile), Grasgerg (Indonesia), Palabora (South Africa) and Oyu Tolgoi (Mongolia) as shown in Figure 5.2.9. They also have La Granja (Peru), Resolution (USA) projects as an advanced stage. They withdrew from the Pebble copper /gold project in Alaska in 2014 due to environmental issues.



(Source: Prepared by Survey Team)

Figure 5.2.9 Location of Mines and Projects of Rio Tinto and BHP Billiton

(6) BHP Billiton

BHP Billiton has 7 segments such as aluminum, base metal, carbon steel raw materials (iron ore, cooking fuel coal, manganese), stainless steel raw materials, general coal, oil and diamond ·special materials. In 2012 sales and margin from iron ore were top and recorded 22,601 million US$ and 14,201 million US$ respectively. Sales and margin of the base metal segment was US$11,596m and 3,965 million US$, and ranked 3 after oil segment. BHP Billiton owns copper assets such as Escondida, Cerro Colorado and Spence mines in Chile, Antamina in Peru, Olympic Dam in Australia and Pinto Valley in USA as shown in Figure 5.2.9. Exploration budget for copper deposits in 2011 was the largest with 256 million US$ in the world (JOGME, 2013). Reserves of the Escondida mine has increased to 11,900 Mt with copper grade 0.59% from 8,500 Mt with 0.61%. New giant deposits were discovered around the Escondida mine such as Pampa Escondida deposit (7,400 Mt, 0.47%Cu) and Pinta Verde (180 Mt, 0.56%Cu).

(7) Anglo American

Business of Anglo American is consisted of iron ore and steel materials, coaking coal, fuel coal, base metal (copper and nickel), PGE, diamond and other industrial minerals. Main copper assets owned by Anglo America are in Chile such as Los Bronces, Collahiasi, Mantos Blancos, El Soldado and Mantoverde as shown in Figure 5.2.10. In 2011 expansion of the Los Bronces mine was completed and has capacity of production, 200 Kt/year. To the South of Los Bronces mine, they discovered giant porphyry copper deposits; one is Los Sulfatos (1,200 million tons, 1.46%Cu) and San Enrique Monolito (900 Mt, 0.81% Cu). In 2013 they withdrew from the Pebble project in Alaska due to environmental issues. Anglo Mining rights of American Sur (Los Bronces and El Soldad mine, and Chagres smelter), a subsidiary of Anglo American were divided into Anglo American (50.1%), CODELCO (24.5%), Mitsubishi Corporation (20.4%) and Mitsui Corporation (5%) by exercise of option by CODELCO. In Peru they have advanced stage exploration projects such as Michiquillai and Qullaveco. Although the latter project had been possessed mine water issue with local peoples, people agreed with construction of new a reservoir dam. Consequently it is desired that mine operation will start middle of 2019.

(Source: Prepared by Survey Team)

Figure 5.2.10 Location of Copper Mines and Projects of Anglo America and Norilsk

(8) Norilsk

Norilsk has been operating Taimarskyn copper, nickel and PGE mine and etc. at the Polar Division and Sevemy copper Nickel mine and etc. at the Kola Division as shown in Figure 5.2.10. Since acquisition of mining right of Stillwater Mining in USA in 2003, Norilsk acquired nickel department of OM Group in 2006 , and acquired Lion Ore Mining International which owned Nkomati copper nickel mine in South Africa and Tati copper nickel mine in Botswana. In the same year Norilsk purchased Harjavaltas nickel smelter in Finland under the strategy of foreign deployment concentrated in orthomagmatic copper, nickel and PGE main and smelter.

(9) Grupo Mexico

In 1999 Grupo Mexico acquired ASARCO that was holding company of Grupo Mexico. In 2005 Mineral Mexico, a subsidiary of Grupo Mexico merged SCC (Southern Copper Corporation). Grupo Mexico is consisted of mining department, which is controlled by 100% subsidiary American Mining Corporation, and rail transportation and infrastructure department. Main copper assets are La Caridad and Buenavitsa del Cobre mine in Mexico, Cajone and Toquepala mine in Peru, and Mission, Ray and Silver Bell in USA as shown in Figure 5.2.11. Sales of the mine department in 2011 were 6,888 million US$, 66% of total sales.

(Source: Prepared by Survey Team)

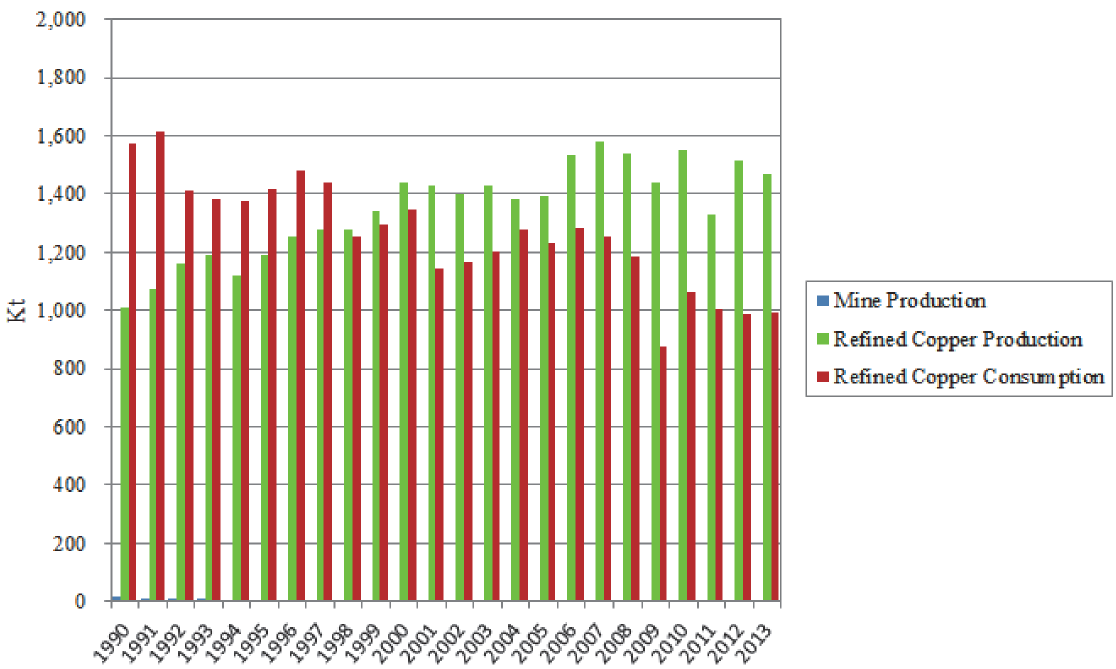
Figure 5.2.11 Location of Copper Mines and Projects of Grupo Mexico and Antofagasta

(10) Antofagasta

Antofagasta is the UK capital in origin and own mining right of copper mine in Chile such as Los Pelambres, El Tesoro, Espearnza and Michilla mines and brown field project such as Antucoya and Telegrafo through Chilean subsidiary, Antofagasta Minerals as shown in Figure 5.2.11. In 2011 Antofagasta Minerals started operation of the Esperanza mine and produced 400 Kt of copper in concentrate at Los Pelambres mine, which is equity equivalent to Antofagasta due to completion of expansion project. An exploration license of Reko Diq copper and gold project (Barrick Gold: 37.5%, Antofagasta: 37.5%, Balochistan local government: 30%) in Pakistan, which is the first outside of project of Chile, was frozen by the government of Pakistan.

5.2.2 Foreign Investments by the Japanese Companies

As Japan does not have any mineable copper resources, they must depend on oversea supply. In Japan there are modern and large scale copper smelters and refineries to supply enough amount of refined copper to the domestic users. The capacity of smelter and refinery is around 1,600 Kt of fine copper from imported ores. Quantity of copper which the Japanese mining and trading companies keep equities is estimated around 500 Kt of copper. This figure is about 30% of smelters capacity and 50% of domestic demand. Rest of copper is imported from independent mines as concentrate and refined copper. Consequently imported refined copper is about 100 Kt/year. As securing of stable supply is the serious issue and Japanese mining companies and trading companies have been invested foreign mines and projects, and acquired interest to receive ores as shown in Table 5.2.3. The countries where the Japanese organization invested are North and South America (Chile, Peru, Canada, and USA) , Australia, Indonesia, Pacific Rim of Fiji. In particular in Chile 4 Japanese mine companies and 4 trading companies invest in 12 mines and/or projects because of benign investment climate. After 1998, the supply of refined copper exceeds quantity of domestic demand as shown in Figure 5.2.12, and then excessed copper is exporting to the Asian newly industrializing countries such as China, Taiwan, Malaysia, Thailand, Indonesia and South Korea.



(Source: Prepared by Survey Team from World Bureau Metal Statistics)

Figure 5.2.12 Current Production in Japan

Table 5.2.3 Japanese Companies participated in Mines and Projects

Country	Mine	Equity of Japanese company	Partner	Production (Kt/year)	Status
Canada	Gibraltar	Sojitsu:12.5, Furukawa:.6.25 , Dowa:6.25	Taseko Mines:75		Mine
	Huckleberry	Mitsubishi Material:31.25, Furukawa:6.25, Dowa:6.25, Marubeni:6.25	Imperas:50		Mine
	Similco	Mitsubishi Material:25	Copper Mountain:75		Mine
USA	Morecnci	Sumitomo Metal Mining:15	FCX:85		Mine
	Silver Bell	Sojits.:25	ASARCO:75		Mine
Peru	Antamina	Mitsubishi Corp:10	BHP Billiton:33.75, Xstrata: 33.75, Tec:22.5,		Mine
	Cerro Verde	Sumitomo Metal Mining:16.8, Sumitomo Corp	FCX:53.6, Other:25.4		Mine
	Quechua	Pan Pacifi Copper:100	-		Project
	Quellaveco	Mitsubishi Corp:18.1	Anglo American:81.9		Project
	Zafranal	Mitsubishi Material:40	AQM Copper:60		Project
Chile	Escondida	Mitsubishi Corp.:8.75, JX Nippon Mining & Metals:2.5, Mitsubishi Material:1.25	BHP Billiton:57.5, Rio Tinto 30		Mine
	La Canderalia/Ojos del Salados	Sumitomo Metal Mining:16, Sumitomo Corp:4	FCX:80		Mine
	Collahuasi	JXNippon Mining & Metals: 3.6, Mitsui & Co.:7.43, Mitsui Metal Mining:0.97	Anglo American:44, Xstrata:44		Mine
	Los Pelambres	JXNippon Mining & Metals:15, Mitsubishi Material:10, Marubeni:8.75, Mitsubishi Corp.: 5.0 , Mitsui & Co.:1.25	Antofagasta:60		Mine
	El Tesoro	Marubeni:30	Antofagasta:70		Mine
	Esperanza	Marubeni:30	Antofagasta:70		Mine
	Antocoya	Marubeni:30	Antofagasta:70		Project
	Telegrafo	Marubeni:70	Antofagasta:30		Project
	Atakamakozan	Nittetsu Mining:60	Imperas:40		Mine
	Los Bronces	Mitsubishi Corp.:24.5, Mitsui & Co.5.0	Anglo American:50.1, Codelco: 24.5		Mine
	El Soldad	Mitsubishi Corp.:24.5, Mitsui & Co.5.0	Anglo American:50.1, Codelco: 24.5		Mine
	Sierra Gorda	Sumitomo Metal Mining:31.5, Sumitomo Corp.:13.5	KGHM: 55		Project
	Caserones	Pan Pacifi Copper: 70, Mitsui Corp.: 30	-		Mine
Indonesia	Batu Hijau	Sumitomo Corp.:18.2, Sumitomo Metal Mining: 3.5, Mitsubishi Material:1.75, Furukawa: 1.05	Newmont: 31.5, Othes:46.8		Mine
Fiji	Namosi	Mitsubishi Material:28.06 , Nittetsu Mining:	Newcrest: 69.94		Project
Australia	North Parks	Sumitomo Metal Mining:13.3, Sumitomo Corp.:6.7	China Moly.:80		Mine

(Source: Prepared by Survey Team)

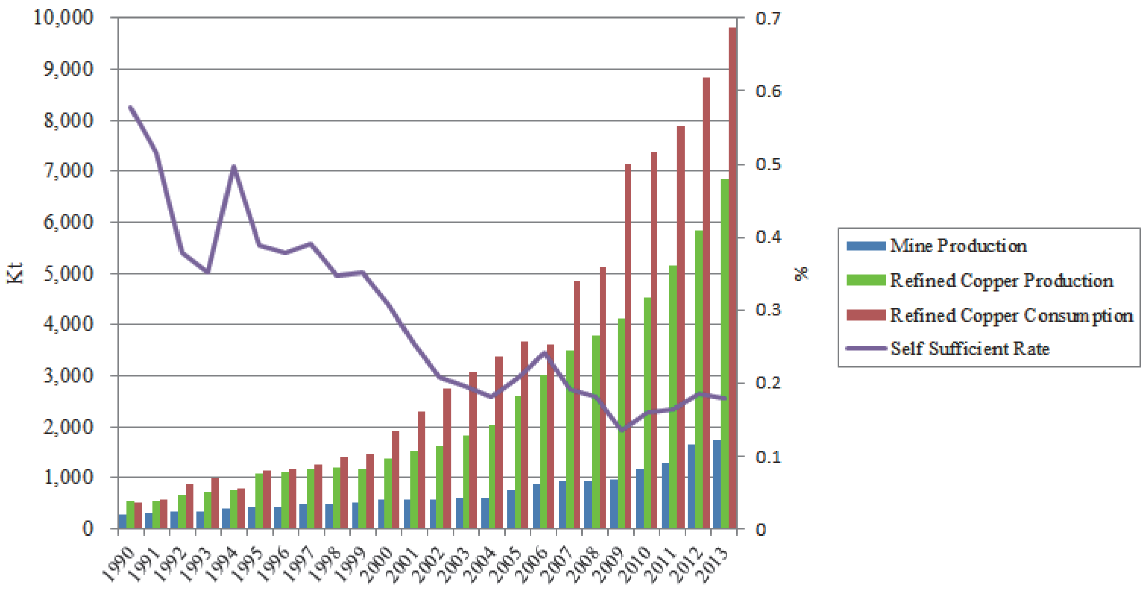
5.2.3 Foreign Investments by the Chinese Companies

In China to meet rapidly increasing domestic demand, they secure from not only domestic concentrate and scrap but also imported concentrate and refined copper. Even though copper mine production is the second largest in the world, the operating cost is high because mines are relatively small and old, and deteriorated. The self-sufficiency ratio is around 18% and domestic mine production cannot cover increasing domestic demand (Figure 5.2.13). By the national policy “advance overseas”, the government promotes resources diplomacy in Africa, Asia and South

America. The Chinese mining companies have been investing mining projects owned not only junior company but also major companies such as Xstrata's Las Bmanbas in Peru and Rio Tints's North Parks in Australia under the support of finance and information by .the Chinese Governments (Table 5.2.4).

Minmetals, leading nonferrous metal company in China, promoting foreign investment based on long-term demand of copper, nickel and aluminum that are lack in China. For example they participated in copper partnership with CODELCO to purchase refined copper Gaby mine and acquired Northern Peru Copper Corporation with Jiangxi Copper Industry Group (JOGMEC, 2012)

Chinalco is the second largest alumina producing company in the world, but advancing into copper business. They acquired the Tromocho project from Peru Copper, which started operation in 2013. They also farmed in the giant Simadou iron ore development in Guinea.



(Source: Prepared by Survey Team from World Bureau Metal Statistics)

Figure 5.2.13 Copper Production in China

Table 5.2.4 Chinese Companies Participated in Mines and Projects

Country	Mine	Equity of Chinese company	Partner	Aquired from	Start of Production	Capacity (Kt/year)	Status
Zambia	Chambishi	CNMC:85	ZCCM:15		2003	24	Mine
	Cahmbishi West	CNMC:85	ZCCM:15				Mine
	Munal	Jinchuan Group: 50.42					Mine
	Luanshya	CNMC:80	Zambian Gov.:20				Mine
	Hebei Jidong	Hebei Jindong Construction					Project
	Mufulira Tailing	CNMC:85	ZCCM:15				F/S
	Ichimpe	Zhonghui Mining: 100	-				F/S
	Muliashi North	CNMC:85	Zambian Gov.:15				Project
	Mushiba	CNMC:85	Zambian Gov.:15				Project
Peru	Toromocho	Chinalco:100	-	Peru Copper	2013	375	Mine
	EL Galeno	Minmetals:60, Jiangxi:40		Northern Peru Copper		200	Project
	Rio Blanco	Zijin Mining Group (including Tongling Non-ferrous Metal Group):79.9	LS-Nikko:10	Monterrico Metals		200	Project
	Marcona	China Sci-Tec Holding: 70	LS-Nikko: 30			110	Project
	Las Bambas	Minmetals:100,	-	Xstrata	2015	400	Project
Chile	Gaby	Minmetals	Codelco	Codeclo	2008	150	Mine
	Cadelabro	Chinalco Yunnan Copper Resources (option)	Rio Tinto	Rio Tinto	2011		Project
	Caramasa	Chinalco Yunnan Copper Resources (option)	Rio Tinto	Rio Tinto	2011		Project
	Palmani	Chinalco Yunnan Copper Resources (option)	Rio Tinto	Rio Tinto	2011		Project
	Humitos	Chinalco Yunnan Copper Resources (option)	Xstrata				Project
Equador	Mirador	Tongling Non-ferrous Metal Group: 100	-			60	Project
Mexico	Bahuerachi	Jinchuan Group: 100	-			83	Project
Canada	Wolverine	Xise International Investment, Jinduicheng Molybdenum Group		Yukon Zinc		5	Project
	Izok Lake	Minmetals:100				20	Project
	High Lake	Minmetals: 100				38	Project
Russia	Kyzil Tashitygskoe	Zijin Mining Group:70					Project
Afganistan	Aynak	Jiangxi Copper Industry Group: 100					Project
Pakistan	Saindak	MCC			2003	45	Mine
Laos	Sepon	Minmetals			2005	65	Mine
	Sanmu	Chinalco Yunnan Copper Resources (option)					Project
Philippines	Tampakan	Zijin Mining Group:					Project
Australia	Northparks	China Molybudenum:80	Sumitomo Metal Mining:13.3, Sumitomo Corp:6.7	Rio Tinto		34	Mine
	Mount Frosty		Rio Tinto				Project
	Elaine	Chinalco Yunnan Copper Resources					Project
	Mary Kathleen	Chinalco Yunnan Copper Resources	Goldsearch Limited				Project

(Source: Prepared by Survey Team)

5.3 Major Issues for Smelters

Smelting industry generally has various issues; they include smelting technology, production efficiency, profitability, and environmental and social conditions, and their locations in terms of concentrate supply from mines. The extent of these impacts on smelters is different by country to country. The major common issues for smelters in the world are discussed here, with particular comments on those in Japan as a typical case in the economically matured country, in China as a typical case with the fastest growth rate for copper production and consumption, in Chile as the second largest copper production country including SX-EW cathodes, and in Europe. Furthermore, a brief comment is given with regard to some issues in case the copper smelter will be constructed and operated in Mongolia.

5.3.1 Revenues and Costs

Characteristics and issues of the profitability of a copper smelting business is discussed in terms of revenues and costs other than smelting technology.

(1) Copper Concentrate Market and Instability of TC/RC

The pre-tax profit from smelters is calculated as a balance gained from total revenues based on TC/RC minus on-site operating costs including salaries and wages, depreciation, amortization and financial expenses. It is a conventional rule for a long term TC/RC contract other than spot buying to be determined twice a year through negotiations between mines as the sellers and smelters as the buyers of copper concentrates. The amount of TC/RC is generally agreed upon supply-demand relations of concentrates as in the case with other commodities. However, poisonous substances in the concentrates such as arsenic and mercury are penalized to be deducted from the TC/RC when they are included more than acceptable levels, as they have adverse effects for smelting.

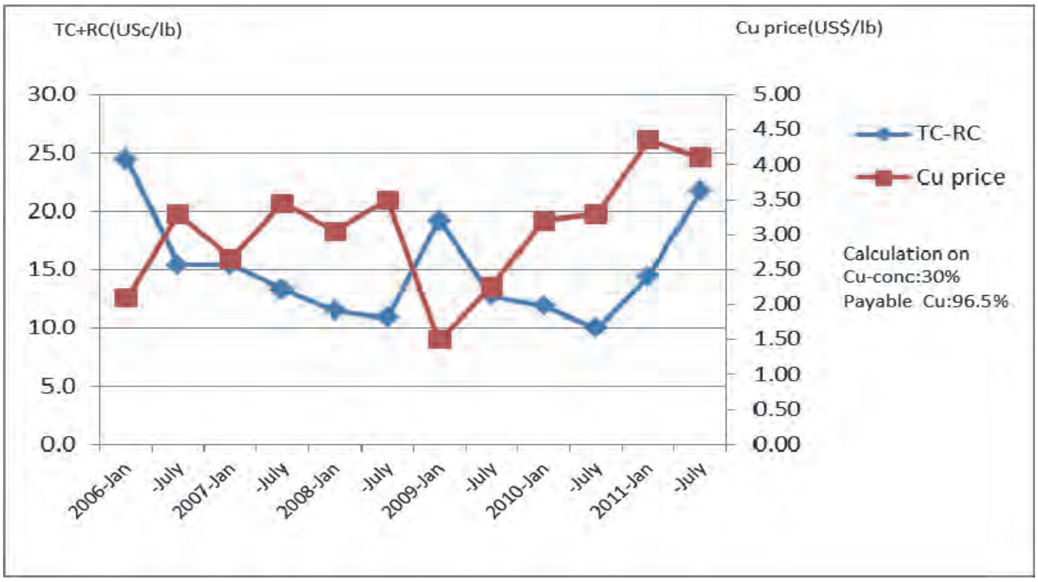
Japanese smelting companies were seizing the initiative in the copper concentrate market until the end of 1990s when the copper demand in China was still less than Japan and the United Sates. Since then China was quickly getting a position of the most influential player in the market supported by the robust demand for copper metal. As the suppliers of copper concentrate, mining companies began to primarily offer TC/RCs to Chinese smelters, the largest copper concentrate market, almost on equal terms with the Japanese smelters after the mid-2000s (Table 5.3.1).

A sum of TC/RC per lb copper clearly demonstrates fluctuations, in particular since mid-2006 when the PP (Price Participation) was abolished in the concentrate purchase contracts between mining companies and smelters (Figure 5.3.1). It is noteworthy in the figure that a sum of TC/RC per lb copper is not linked to variations of copper prices. The PP mechanism involved the smelters in rises and falls in the metal prices by adjusting TC, and to share both a benefit and burden when copper prices hiked and slumped as well. This enables the smelters to mitigate the effect of sharp variations of revenues due to copper price fluctuations. However, the disuse of PP resulted in spurs to fluctuations in TC/RC settlements, which became an insecure factor to managements of smelting business due to up and down revenues in accordance with copper prices.

Table 5.3.1 Recent TC/RC Fluctuations between Mining companies and Chinese Smelters

Period	Copper Price Range (US$/lb)	TC-RC (US$/conc-t-Usc/lb)	Remarks
2007	3.2-3.6	60-6	BHP vs Tongling/Jinlong
		45-4.5	Highland Valley vs Sumitomo
2008	3.1-3.7	47.2-4.72	BHP vs Tongling/Jinlong
2009	1.3-3.2	75-7.5	Freeport-McMoran vs Mitsubishi
2010	2.8-4.4	46.5-4.65	BHP/Freeport vs Chinese smelters
2011(Q1-2)	3.9-4.5	72/7.2	BHP vs Chinese smeleters
2011(Q3-4)	3.2-3.9	90-9	BHP vs Chinese smeleters
2012	3.3-3.9	60-6	BHP vs Chinese smeleters
		63.5-6.35	Freeport-McMoran vs Jiangxi/Pan Pacific
2013	3.1-3.7	70-7	Freeport-McMoran vs Jiangxi Copper
2014	3.0-3.3	92-9.2	Freeport-McMoran vs Jiangxi Copper

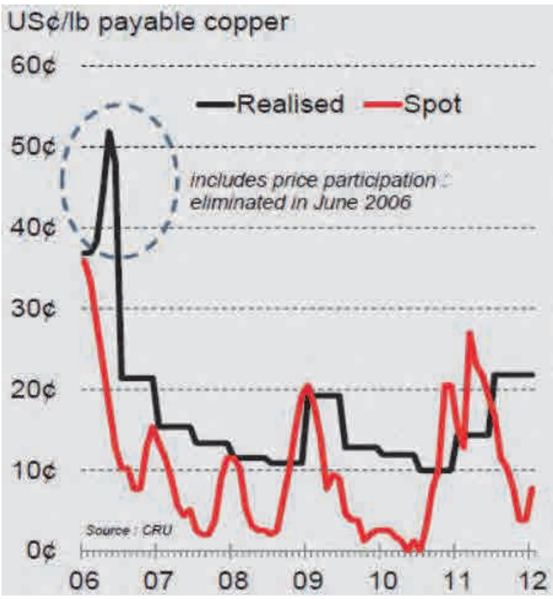
(Source: Reuters, USGS Mineral Yearbook 2010 and et al)



(Source: Teck Modelling Workshop (March 13, 2012), LME-HP and et al)

Figure 5.3.1 TC/RC and Copper Price before and after Rehman Brothers Bankruptcy in 2008

Instability of TC/RC generally makes the concentrate spot market more unfavorable to the smelters than long-term purchasing contracts, which is more desirable for the smelters (Figure 5.3.2).

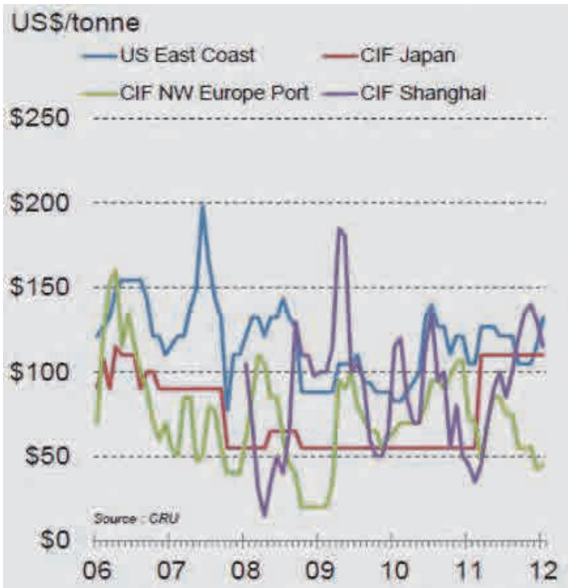


(Source: Teck Modelling Workshop (March 13, 2012))

Figure 5.3.2 Historical TC/RC Trend for Long-term Contracts and Spot Markets

(2) Premium

Copper is traded based on the LME price plus a premium that varied historically between 50 and 150 US$ /t of copper cathode as shown in Figure 5.3.3.



(Source: Teck Modelling Workshop (March 13, 2012))

Figure 5.3.3 Historical Copper Premium Fluctuations

The premium is conventionally determined each year by CODELCO, the largest copper producer in the world, and noticed to its major customers such as wire cable manufacturers and copper fabricators. Most smelting companies use this amount as an indicator when determining the premium charged to the buyers, taking into account various factors including the supply-demand relation, product quality, and delivery/payment terms. The premium, ranging around 100 US$/ton of cathode, accounts for a significant revenue source for the smelters, as it is equivalent to 4.5 USc/lb copper. Premium amounts are mostly split in the area due to local supply-demand relations. It is another factor beyond the control of the smelters in addition to the LME pricing system, which could affect the profitability of the smelters.

(3) Exchange Rate

It is the exchange rate to dollars that has long tortured the Japanese smelters in the past decades. This is because TC/RC is settled by US$ and the revenue of Japanese smelters is reduced when yen is appreciated against US dollar. The exchange rate was 360 yen to 1 US$ before 1971 when the economic policy taken by US President Richard Nixon to cancel the direct convertibility of the US dollar to gold. However, since then yen has been gradually been appreciated up to a level of 240 yen against US dollar, and quickly up to around 120 yen in 1985 with the Plaza Accord among the G-5 nations as a turning point. One US dollar has long stayed at a level below 100 yen, occasionally slumping down to the lowest level around 70 yen before settled in 2013 at the most recent level around 100 yen. This demonstrates that revenues of the Japanese smelters have been slashed down to one third and half in last 40 and 30 years respectively.

Revenues of the US copper smelters are free from the exchange rate due to revenues from US dollar based TC/RCs. The Chinese smelters are also least affected by fluctuations of the exchange rate because the Chinese government keeps the policy to maintain the exchange rate of Yuan to US dollar within a certain range through exchange intervention in a managed floating system. The exchange rate is also a minor issue for the Chilean smelters because the value of peso to US dollar has been stable in the past few decades, although it was rather in a persistent inflation trend.

It is said that an average current direct cash cost of smelters ranges around 21 to 22 US cents per lb copper (Nikkan Sangyo Newspaper, Sept 11, 2013). This is a level equivalent to slightly over 80/8 in TC/RC. Operating costs of Japanese Smelters are obviously higher than the global average, in particular with regard to salaries/wages and electricity prices. It is likely that they were below the break-even point or ran small profits with the past levels of TC/RCs. Probably there are some reasons why the Japanese smelters survived without being shut down. Firstly most smelting companies did not have such an appropriate corporate culture that easily allows a drastic merger and acquisition. Secondly they made diligent efforts to maintain a supply chain within the same group and affiliated companies to vertically deploy copper business into downstream manufacturing and fabrication. Thirdly they could acquire income gains from overseas copper mine projects invested and lastly they progressively began to treat industrial wastes, scrap metals, waste electronic substrates/parts, and electrolytic slime containing precious metals.

(4) Utility Costs

The cost of electricity is the largest among the utility including power, fuel, industrial water, and sewage for the operation. It is essential to save and reduce power usage among the utility costs in Japan where the electricity price is the highest in the countries under discussion on smelters, while it is critical to secure industrial water required for the operation irrespective of its cost in Chile and Mongolia where the climate is arid with little precipitation.

(a) Power

Electricity used for smelting covers various stages and areas, including an acid plant, oxygen production, matte and slag granulation, blowers, secondary gas handling and auxiliary equipment. Total energy for process requirements is summarized in Figure 5.3.2 by converting electric energy to thermal energy in the energy balance. Steam credits are also taken into account when excess steam is produced in the estimation.

The electricity energy required to produce one ton of anode ranges 7,000 to 10,000 MJ, depending on the smelting methods. This is approximately equivalent to 1.9 to 2.8 MWh/year, using a converting factor 1 kWh to 3.6 MJ. This electricity consumption requires the power generation of 63 to 91 MW for a smelter with production capacity of 200 Kt of anode per year, using power factor of 70%. The electricity consumption to produce one ton of cathode from anode is about 250 KWh, including auxiliary equipment. The total power generation of 72 to 100 MW is required to produce 200 Kt of cathode from copper concentrates, and the annual electricity consumption amounts to 442,000 to 610,000 MWh.

Table 5.3.2 Comparison of Energy Consumption in Major Smelting Methods as MJ/ t of Anode Cu

Processing Route	Eletric Energy (MJ/t-anode)	Fossil Fuel (MJ/t-anode)	Total (MJ/t-anode)
Flash-Flash	9,266	1,518	10,784
Isasmelt	6,903	4,175	11,078
Mitsubishi	8,508	2,498	11,006
Noranda-Teniente	10,088	2,657	12,746

(Source: Pascal Coursol et al (June 7th 2010) Energy Consumption in Copper Sulfide Smelting, Copper 2010 Conference in Hamburg, Germany)

(b) Fuel

Energy consumption from fossil fuel used for the smelting stage ranges 1,500 to 4,200 MJ/t of anode (Figure 5.3.2). This is equivalent to 12,000 to 34,000 t of thermal coal for a smelter with an annual production capacity of 200,000 t of cathode, using a standard calorific value of 25 MJ/kg of standard thermal coal. The amount of thermal coal equired for the smelting process is not so large. There is no concern about the supply of the thermal coal, in particular for Mongolia.

(c) Industrial Water

The seaside-located copper smelters in Japan are allowed to use huge amount of seawater for cooling and granulation process of molten slag. The seaside-located smelter in Japan normally uses water as shown below, excluding potable use.

- Seawater : 300 Kt/ day
- Fresh industrial water : 28 Kt/day

It would be a significantly increased cost burden for most of the seaside-located Japanese smelters except for Kosaka and Hitachi if they are unable to use seawater for some reason and have to switch to municipal industrial water. Industrial water prices from the local prefectural administration range 65 yen per cubic meter down to 20 yen, averaging about 25 yen per cubic meter. The smelters will have to bear 28 million US$/year when 100% relying on the municipal industrial water.

One of the most concerned issues for new mine development projects in Chile is water supply for concentrators, which require large amount the process water like copper smelters. Water pumped up from the aquifer system is strictly controlled by the Chilean government in order to maintain a certain level of underground water for environmental reasons. Escondida copper mine spent more than 3.4 billion US$ to construct the sea-water desalination facility with a capacity of 2.5 t/sec. Security of industrial water will be a much severer issue in Mongolia when the copper smelter will be planned in the southern Gobi region close to the existing Oyu Tolgoi and Tsagaan Suvarga copper mines, unlike in Chile where groundwater in the region's aquifer system is constantly recharged from precipitations and glaciers in the Andes not away from the mining area.

(d) Proportion of Utility Costs to the Entire Revenue

Power cost, which is the largest proportion in the utility, for the smelter with an annual production capacity of 200 Kt of cathode is summarized on major smelting countries as shown in Table 5.3.3. Electricity prices are basically derived from the home pages of the tabled electric company and electric-related associations, and partly estimated by the various sources of information as shown below.

- Japan : 11.1 USc/kWh (industrial use combined with 20,000 V extra high tension power of Shikoku Electric Power Company as of June 1, 2014)
- USA : 7.0 USc/kWh (average industrial use in the US as of March 2014)
- China : 10 USc/kWh (industrial use as of May 2013)
- Chile : 15 USc/kWh (estimated from 10.7 USc/kWh as of 2006 and current 25 USc/kWh for spot price)
- Mongolia : 7.4 USc/kWh (actual 130 MNT/kWh as of August 2013, 1US$ = 1,750 MNT)

Smelters' revenue based on the actual TC/RC contract term in 2013 is estimated using the following preconditions. The proportions of power cost to the revenue estimated in each country are also shown in the Figure 5.3.3.

- Smelting copper recovery : 98%
- TC/RC : 92 US$/conc-DMT and 9.2 USc/lb-Cu
- Concentrate grade : Cu 25% (no byproducts such as Au and Ag)
- Payable copper : 96% (=(25-1)/25)
- Copper price : 3.2 US$/lb
- Annual revenue : 9.2 × (200,000 ÷ 98%) ÷ 25%+0.092 × 200,000 × 96% × 2204.62= 114MU$

Table 5.3.3 Power Costs by Country for the Smelter with Annual Production Capacity 200,000 t of Cathode

		Japan	USA	Chile	China	Mongolia
Electricity consumption (MWh/y)	442,000-610,000					
Electricity unit price(US$/KWh)		0.111	0.07	0.15	0.10	0.074
Electricity cost (MUS$/y)		49-68	31-43	66-92	44-61	33-45
Ratio of electricity cost(%)		56-78	36-50	76-106	51-70	38-52

(Source: home page of the association of electric companies, individual electric company and other internet information as described above)

The revenue is estimated 114 million US$/year, excluding sulfuric acid, gold and silver as byproducts. The power cost accounts for a maximum of 50% of the total revenue in the US where the electricity price is the cheapest among the listed countries. It is 78% maximum in Japan where the electricity price was escalating gradually since the earthquake in 2012. The power cost is more than the revenue in Chile, although the source of information on the electricity price may not be reliable enough to warrant the calculation result. It is an undeniable fact that the power cost is the largest item in the operating costs of copper smelters in most countries.

5.3.2 Technical Aspects

Smelting industry needs a huge amount of power and process water, and discharges both waste water and flue dust in a large quantity as well. Contaminated rivers and polluted air easily flow into adjacent countries across the borders in landlocked regions. Consequently environmental conservation should be given a top priority to control the effluents as severe as possible. As in the case with new mine developments, strict application of the environmental regulations, that are compliant with the global standard used in developed countries, will be inevitable to the smelters in developing countries including Mongolia.

Smelters in Japan and Europe are paid a lot of attention in the past several years for the function of scrap metal recycling and industrial waste disposal in the recycle-based or zero waste society. These materials including electronic waste and parts rich in precious metal became important sources for profits to the smelters, especially in Japan.

(1) Environmental Aspects

(a) Waste Water Treatment

The major sources of copper smelting effluents, that need proper treatment, are as follows.

- Effluents from off-gas wet scrubbers for sulfuric acid plant to remove dust
- Waste water from slag granulation circuit
- Effluents from electrolytic circuit
- Cooling water from equipment and facilities
- Rain water flowing over the smelting plant area

Sulfuric acid is produced from sulfur dioxide which is generated mostly in the gas cleaning stage for dust removal. Sulfur dioxide gas which had been released into the air in Japan, US, and Europe until 1960s' was recognized as an air pollutant and plants began to be constructed to produce sulfuric acid from captured sulfur dioxide. Clearing water used for the process needs to be strictly treated on the designated elements including arsenic, mercury and other hazardous elements below the control standard levels before draining into rivers. Waste water used for slag granulation is often recycled. However, regular addition of fresh water is necessary to replace used water which needs appropriate handling at the waste water treatment facility, as pH gradually gets low if repeatedly recycled. Major effluents that are different in the chemical natures and components depending on emission sources need to pass through respective preliminary treatment circuits subsequently followed by final treatment plant to remove heavy metals and other toxic substances before draining into rivers.

(b) Slag

Crude mixture of molten sulfides formed during the initial smelting circuit is gradually separated into matte rich in copper and slag rich in silica and iron also contained in the copper concentrate. Molten slag is rapidly cooled down by water in the granulation circuit to be recovered as granulated grits. Iron and other minor amounts of metals including copper losses contained in slag are basically insoluble in the water as they are physically confined in vitrified granulated grits due to rapid water cooling. Slag can be used for a number of applications including road construction in place of coarse sand, blasting medium to remove rust and paint from the surface of metal or stone and fill material in the building industry. The volume of slag produced in copper smelting is almost three times as large as cathode.

(c) Flue Dust

Flue dusts, which are most generated in the converting circuit to higher grade of blister copper, are recovered into the dust collectors. Converter flue dusts recovered are generally recycled to the furnace in order to further recover remaining valuable elements with significant concentrations including copper, lead, zinc and bismuth. As a result of the further processing of these metals, concentrations of some elements such as lead and zinc are gradually enhanced within the same circuits to such a level that may potentially affect the quality of the smelter products. Recently, hydrometallurgical treatments of the flue dusts have been employed to cope with this issue outside the smelter processing circuits.

(2) Energy-Saving and Reduction Control of CO_2 Emission

Cost effective energy-saving, that needs daily persistent efforts by all of the employees, is an indispensable requirement for the smelters which use massive amount of electricity. This is also an ignorable issue due to direct linkage to the reduction of CO2 emission.

The smelters in Japan have struggled with the issues to attain the CO2 reduction by average 6% for the five years from 2008 to 2012 against the 1996 emission level that is the government’s commitment in the Kyoto Protocol. As a result of the persistent endeavors, the energy reduction by average 3.9% was implemented despite of the production increase by 10.6% for the four years from 2008 to 2011(Table 5.3.4). Consequently the CO2 emission rate as per ton of metal produced decreased by 13.7% on the average for the same period although the reduction to the 1996 emission level averaged 4.7% slightly below 6% of commitment. The statistics were reported by the Japan Mining Industry Association with the data collected from all the non-ferrous Japanese smelters of copper, zinc, lead, nickel, and ferro-nickel.

Table 5.3.4 Rates of Energy Consumption and CO_2 Emission in the Smelters in Japan

	1990	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total producion(1,000t)	2,325	2,699	2,667	2,707	2,660	2,671	2,766	2,773	2,589	2,577	2,658	2,459
Copper production ratio (%)	44.0	52.8	52.5	52.8	51.9	51.7	55.3	56.8	59.5	56.1	58.3	53.9
Energy consumption (1,000 Kl)	2,053	2,167	2,150	2,155	2,157	2,076	2,062	2,045	1,961	1,975	2,049	1,912
Reduction rate to 1990		5.6%	4.7%	5.0%	5.1%	1.1%	0.4%	−0.4%	−4.5%	−3.8%	−0.2%	−6.9%
CO2 Emission (1,000t)	4,865	5,024	5,020	5,159	5,096	4,968	4,825	4,915	4,632	4,517	4,657	4,741
Reduction rate to 1990		3.3%	3.2%	6.0%	4.7%	2.1%	−0.8%	1.0%	−4.8%	−7.2%	−4.3%	−2.5%
Energy consumption rate (Kl/t)	0.883	0.803	0.806	0.796	0.811	0.777	0.745	0.738	0.757	0.767	0.771	0.778
Reduction rate to 1990		−9.1%	−8.7%	−9.9%	−8.2%	−12.0%	−15.6%	−16.4%	−14.3%	−13.1%	−12.7%	−11.9%
CO2 emission rate (t-CO2/t)	2.092	1.861	1.882	1.906	1.916	1.860	1.745	1.772	1.789	1.753	1.752	1.929
Reduction rate to 1990		−11.0%	−10.0%	−8.9%	−8.4%	−11.1%	−16.6%	−15.3%	−14.5%	−16.2%	−16.3%	−7.8%

(Source: added and revised to "Action Plan for Low-Carbon Emission Society", the Japan Mining Industry Association (Aug, 2012))

(3) Metal Recycle and Industrial Waste Disposal

Metal recycling has the potential to minimize energy use, some emissions, and waste disposal if appropriately managed. Metal recycle using scrap metals also helped the smelters in Japan find one of the ways out of a difficulty resulted from TC/RC revenues slashed by yen appreciation against US dollar for the past decades. Metal recycling is inevitable in the resource and energy intensive economies, and stays in the most advanced stage in Japan and European countries. For instance, an average proportion of metals produced from recycled materials reached 18.8% in 2010 in Japan, and 14.3% for copper (Table 5.3.5).

It is substrates and parts of electronic instruments including waste electric appliances, personal computers and cellular phones that have increasingly been treated in the copper smelters in the decade. They are valuable to the smelters because of relative abundance of gold and silver other than copper despite of a small quantity compared to copper scraps (Table 5.3.6).

Table 5.3.5 Ratio of Metal Production from Recycled Source

	Production (1,000t)	Recycle metal(1,000t)	Recycle ratio
Cu	1,499	215	14.3%
Zn	561	114	20.3%
Pb	216	106	49.1%
Ni	42	0.16	0.4%
Total	2,318	435.16	18.8%

(Source: Action Plan for Low-Carbon Emission Society, the Japan Mining Industry Association (Aug, 2012))

Table 5.3.6 Metal Grade in the Electronic Substrates/Parts

	Cu (%)	Au(g/t)	Ag(g/t)
Waste electronic substrate	20–30	200	1,000
Waste electronic parts	30–50	400	5,000
Waste cellular phone	25–30	400	3,000
Coated copper wire waste	40–75	–	–

(Source: Nikko-Tsuruga Recycle Co., recycling case study, Journal of the Mining and Materials Processing Institute of Japan (1997), vol 113, p1177-1178)

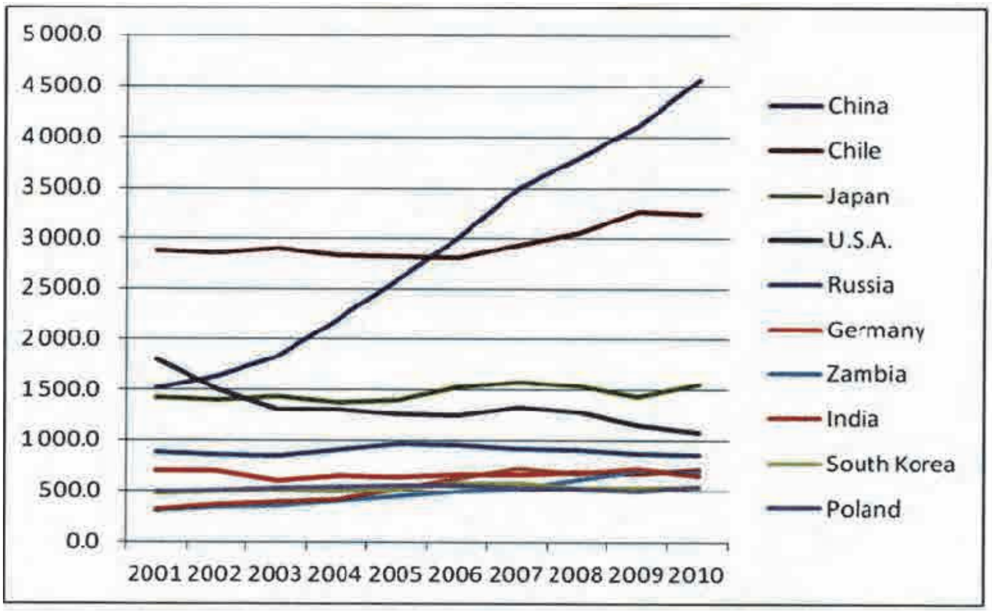
5.3.3 Chinese Smelters

In early 2000s Chinese smelters became prominent in the copper market due to their cheaper TC/RCs in an attempt to purchase as much copper concentrate as possible when it was ranked 3rd, surpassing US in copper production behind Chile and Japan. Since then copper production in China has kept on increasing supported by the rapidly growing domestic consumption for the industry use, surpassing Japan in 2002 and at last gained the summit as No.1 in 2005 to 2006 (Figure 5.3.4).

Negotiations with major copper mining companies eventually came to turn in favor of Chinese smelters as the largest buyers. This can be implied from TC/RC trends from a comparison between the period 2007 to 2008 when the copper price was a little higher than now and the first half of 2013. The TC/RCs ranged around 50/5 to 60/6 in 2007, while it was hiked up to 70/7 to 90/9 despite the lower copper price (Table 5.3.1).

It was a symbolic incident that the management company of LME in London that was founded in 1877 was sold to the operator of the Hong Kong stock exchange in 2012. Despite the Honk Kong government's expectation to promote metal trading in Hong Kong through the deal, the function as an actual metal business center still remains in London, but the situation starts to change eventually.

Thus, copper business including metal and concentrate has virtually come under the control of China and the Chinese smelters, through acquisition of both LME and nearly 50% share of world copper consumption as well as production. China has been playing in the market orientated economy domestically and internationally; however there is an intangible awareness of risk to smelting companies in the rest of the world in the future copper business as in the case of arbitrary government control for exporting rare earth elements.



(Source: World Metal Statistic Yearbook 2011)

Figure 5.3.4 Historical Copper Production by Country

Chapter 6. Mineral Resources Policy and Related Statute of Mongolia

6.1 Policies of Mining Development

Policies concerning the mineral resources development field in Mongolia include the Comprehensive National Development Policy in 2008, which covers the goal and the basic policy of the mineral field development, and the Mongolia's Policy for National Security in 2010, which covers national security.

The new State Policy on Mineral Sector Development (2014-2025) was resolved at the Diet in January 2014, to implement the above policies, which specify the priority of development according to the guidelines of the policies and the amendment of laws and regulations, based on the mineral field and the medium- to long-term program.

The outline of the new mineral field development policies are as follows.

<Background of the policies>

(1) State policy on the minerals sector will be private sector-oriented, will develop open and responsible mining, establish economically balanced multi-pillared structure in short- and mid-term terms, and protect fundamental rights of the nation.

(2) The goal of State policy on the minerals sector is to ensure stable investment climate, to support environmentally friendly equipment and technological innovations, with less damage on environment, for advancement of quality of prospecting, mining and processing, to produce value-added products, to strengthen the competitive capacity on international markets.

(3) State policy on the minerals sector will be implemented in coordination with policies of other sectors.

<Outline of basic principle of the policies>

Based on the long-term strategy of the minerals sector, the Comprehensive National Development Strategy for implementation of Mongolian Millennium Development goals, and with a goal to extend economic and social benefits to citizens, the main principles for the minerals sectors shall be as followed:

(1) To base any decisions on legal and tax regulations on results of studies and analysis to secure long-term sustainability of Policy on minerals sector and to protect legal rights of participating stakeholders;

(2) To support the use in the mining and mineral processing industry of advanced equipment, technology, innovations with little impact on human health and environment;

(3) State organizations and private enterprises of the minerals sector to adhere to the principles of transparency and accountability;
(4) Investors in minerals sector shall obey the rule of law, adhere to mutual profitability and support good corporate governance;
(5) In its implementation of the policy in the minerals sector, State shall provide equal conditions to investors and shall not discriminate on ownership type;
(6) All state- and private-funded geological prospecting, mining, processing information shall be open and transparent to public, if not prohibited by law;
(7) Standards and laws on labor safety and health shall be improved to reach international standards and their implementation ensured;
(8) To preserve some categories of mineral deposits to conform to needs of national security, environment, eco-balance and interests of future generations;

<Outcomes expected to be achieved as a result of implementation of the policies>

(1) Geological survey and exploration will be conducted in accordance with the state policy, increasing the country's mineral reserves, foundation for long-term sustainable development of the mining sector will be formed;
(2) Mineral reserves will be extracted in a complex and environment-friendly way, technology with low impact on environment will be utilized, amount and types of value-added products will be increased through upgrading of processing level;
(3) Unified standards will be followed in mineral extraction and processing activities, work safety and health will be ensured at all levels and stages of production, occupational accidents will be reduced;
(4) Opportunities for infrastructure development (road networks, power plants, city, and settlements) will be expanded, allowing long-term development planning;
(5) As a result of the development of large-scale industrial centers, population migration will be stabilized;
(6) An adequate number of professional personnel of the minerals sector will be prepared; number of national professionals will be increased, new jobs will be created and unemployment decreased;
(7) Environmental protection, closure of mines, land rehabilitation and long-term monitoring will be implemented in a responsible and planned way following the legislation and international standards;
(8) Mineral extraction and processing will be restricted in water catchment areas, river basins, forest zones, agricultural lands, nutritious pastures, Gobi oases, and areas near lakes and ponds to ensure ecological balance and production of healthy, organic food, allowing citizens to live in safe environment and consume healthy food;

(9) All activities in the minerals sector will be transparent to public and implemented in accordance with laws and regulations, a legal framework for ensuring public consultation in developing laws, regulations and large-scale projects will be developed;

(10) Favorable environment will be provided in the minerals sector, an environment for transparent trading of mineral products, complaint with international standards, will be ensured at Mongolian Minerals Exchange;

6.2 Minerals Law

According to the Minerals Law of Mongolia (1997), mining area is open to both national and foreign applicants, along with tax advantages. Therefore, the problem has arisen in Mongolia that in some areas, there would be no benefit to the government due to the removal of precious resources out of the country, which would then harm national interests. Thus, the law was amended in July, 2006 in the Mongolian Parliament with the expectation that it would lead to resource development and environmental protection without affecting the national interests.

The main points of the 2006 Amended Minerals Law is as follows.

(a) Ownership of mining rights (Article 5) (newly introduced regulation)

The State may participate up to 50% jointly with a private legal person in the exploitation of strategically important mineral deposits where State funded exploration was used to determine proven reserves.

The State may own up to 34% of the shares of the investment made by a license holder in a mineral deposit of strategic importance where proven reserves were determined through funding sources other than the State budget.

Strategically important deposits are defined as "deposits that may have a potential impact on national security, economic and social development of the country at the national and regional levels (Article 4.1.10).

(b) Licensee qualification (Article 7)

"The right of exploration" is applicable to any exploration license holder, while anybody without license can be explored on the surface in case of non-mining activities.

(c) Validity period of the license (Article 21 & 22 (exploration rights) and Article 27 & 28 (mining rights))

The validity period of the license was amended as follows,

- Right of Exploration: Maximum 9 years (3 years at the beginning + 3 years of extension x 2 times)
- Right of Mining: Maximum 70 years (30 years at the beginning + 20 years of extension x 2 times)

(d) Investment Agreement (Article 29)

This refers to an agreement between the government and the investing company on the investment terms and conditions. Since resource development requires an immense investment, the agreement, which is valid irrespective of changes in tax rates, concludes on investments beyond a fixed scale in the first five years of its development, with the purpose of attracting foreign investments by stabilizing the investment climate.

(e) Mining Tax (Article 34)

New regulations were established outlining the requirement to apply a certain amount of funds towards exploration annually (Article 34). This provision was not outlined in the original Minerals Law drafted in 1997. An overview of mining taxes and minimum exploration expenditures are shown in Table 6.2.1. Prior to the revisions, rights of mining area could be retained simply by paying mining taxes but following the revisions, annual exploration reports are now mandatory and failure to conduct mining exploration equating to minimum expenditure levels will result in the suspension of mining rights. This enables the government to prevent the acquisition of mining rights for resell purposes.

Table 6.2.1 Mining Tax and the Minimum Exploration Costs

Mining Tax	Minimum Exploration Costs
Right of Exploration: per 1 hectare (ha) 1st Year → 0.1 US\$ 2nd Year → 0.2 US\$ 3rd Year → 0.3 US\$ 4th to 6th Year → 1.0 US\$ 7th to 9th Year → 1.5 US\$ (If explores for 9 years, 8.1 US\$/ha)	per 1 hectare 1st to 3rd Year → 0.5 US\$ 4th to 6th Year → 1.0 US\$ 7th to 9th Year → 1.5 US\$ (If explores for 9 years, 9.0 US\$/ha)
Right of Mining: 15.0 US\$/year/ha (Coal is 5.0 US\$/year/ha)	

(Source: JICA, 2013)

(f) The Upper Limit of Foreign Employment (Article 43) (Provisions newly introduced)

Earlier, the law stated that "a license owner employs only Mongolian for exploration and mining". However, the new revisions state that "foreign workers must not exceed 10%" of the total number of employees under the license holder.

(g) Environmental protection obligations (Article 35 - 40, Article 66 (Penalties))

According to the newly introduced obligations, the license holder must draw up an environmental protection plan, submit it to the government, and observe it. However, when laws with respect to environmental protection are violated, the exploration and mining activities of the license holder is suspended for two months and a complaint is registered. Moreover, if the mining license holder causes serious damage to the environment, the license would be revoked and no license shall be issued for the next 20 years.

(h) Information Supply (Article 48) (Newly introduced provisions)

The license holder must release information related to the production and sales of mineral resources, i.e., results of the exploration work, for the general citizens of the country (According to the Penalty Provisions (Article 66), the highest penalty for breach of this law is 1 million Tg)

(i) Royalty (Article 47)

The loyalty was amended by 5% of the sales value of mineral resources (it was 2.5% before amendment and only gold was 7.5%). However, about the mineral resources widely distributed and thermal coal for domestic use, it kept unchanged to 2.5%.

6.2.1 Amendment of the Minerals Law in 2011

The following is a summary of the royalty laws that were newly revised in 2011.

- Those with special development rights pay mineral resource use royalties to national and regional budgets calculated based on the sales value of all types of products used, products sold/extracted from mining areas, or products transported for the purpose of being sold.
- Usage royalties for coal and mineral resources sold in Mongolia shall be equivalent to 2.5% of the sales price of either the product used, sold/extracted from the relevant mining area, or transported for the purpose of being sold.
- In the legal revision of December 23, 2011, in the rule of mineral resources royalties, “widely available mineral resources” was changed to “coal,” and this is to be observed starting on January 1st, 2013.
- The minimum usage royalties for other mineral resources excluding those stipulated in Article 47 Paragraph 3 of this law are equivalent to 5.0% of the sales price of either the product used, sold/extracted from the relevant mining area, or transported for the purpose of being sold.
- In addition to the above, those that reflect the ratio that corresponds to the market value standard of the product in question (Article 47, Paragraph 2) are charged as mineral resource use royalties.

6.2.2 Amendment of the Minerals Law in 2014

The amendment draft for the Minerals Law of Mongolia prepared in accordance with the National Policy (2014 ~ 2025) for the field of mineral resources which was decided in January of 2014 by the Great National Congress of Mongolia (Ulsyn Ikh Khural) has been approved on July 8th of 2014 by the Parliament. This amendment is based on the basic policy to protect the right of investors and to maintain fundamental concepts of the Minerals Law of Mongolia amended in 2006.

The purpose of this amendment is as enumerated below:

1) The provisions of Minerals Law of Mongolia are to be conformed to the National Policy for the field of mineral resources decided at the Parliament in January of 2014.
2) To support enterprises in order to improve their competitiveness in the international market.
3) In order to promote the investment to the field of exploration for mineral resources, attractive conditions are to be provided and the areas corresponding to 15 ~ 20% of the country are to be opened to the private enterprises for mineral exploration.

The major points in this amendment, etc. are as follows:

- To maintain the system that the Mineral Resource Agency of Mongolia (MRAM) has the responsibility for the issuance of license and is in charge of monitoring the license holders as its main duties.
- To establish the National Geological Bureau having its functions as mentioned below:
- To carry out the geological survey, the geological mapping and other investigations relating to geological matter(s).
- To carry out the evaluation on mineral deposit(s) and mining area(s) for the exploration of resources.
- To provide information services regarding to the data base on minerals.
- To maintain and to renew the mineral data base in whole country.
- To establish the special advisory committee by the Ministry of Mining for the purpose of ensuring the system for steady control and improving the competitive power as well as for promoting the development of mining industries.
- To extend the effective period of exploration right by three (3) years, consequently the period became to twelve (12) years.
- To maintain the concept on strategic mineral deposit as designated by provisions of the Minerals Law of Mongolia amended in 2006.

6.3 Issues on Designation of Strategic Deposit

The Government of Mongolia designated the large scale mines such as Erdenet Mine, Oyu Tolgoi Mine, etc. as the strategic deposit and made capital participation by the government. And its significance and effect as well as issues are briefly discussed in the followings.

6.3.1 Significance of Designation of Strategic Deposit

It is defined in the fourth clause of Minerals Law of Mongolia that the strategic mineral deposit is the deposit having the potential to provide impact(s) on national security also on social and economic development or that having the production corresponding to equal or more than five percent (5%) of gross domestic product in Mongolia or that having a production capacity of the same as aforementioned. And in the fifth clause of the same law, it is defined that the capital participation by the government is possible to be made up to fifty percent (50%) as the upper limit for the deposit explored and surveyed by utilizing the national budget and is up to thirty four percent (34%) as the upper limit for the deposit other than the aforementioned. Also, fifteen (15) strategic deposits and thirty nine (39) deposits possibly to be strategic ones are being registered.

6.3.2 National Management and Control of Mines by Capital Participation

The country will become possible to participate deeply for management of the company and for the operation of mine by the capital participation. In accordance with this, the actual state of accounting, industrial safety and health, management and control of mineral resources, environmental protection, etc. can be grasped by the government, and the appropriate judgment as well as the required action can be performed.

On the other hand, although the country largely obtains right and interest from the above capital participation, the contradiction hardly avoidable would exist in the relation between the standpoint of the government to control the mine operation and that of the government as the mine operator to be controlled. For the purpose of avoiding this contradiction as far as possible, it is considered, as an example, to establish the organization managing mine operation independent from the government. From this, the organization to control and that for mine operating can evidently be classified and the responsibility of respective sides can also become evident. As the example of this type of solution, the case of CODELCO in Chile, that of ANTAM in Indonesia, etc. can be enumerated.

6.3.3 Capital Participation to Mine having a Large Risk by the Government

Although the mining industry has a large profit if it successfully operated, the mining industry may have large risks. Major risk factors are as enumerated in the following:

- The ore reserve has to be calculated by estimating geological features on the basis of partial information on underground geology at limited areas.
- Enormous construction costs and long construction periods are required.
- The market conditions will largely be fluctuated.

It may have a large financial risk to the national finance that the country having no sufficient financial potential makes capital participation of a large percentage to the mining industry having such large risks. In order to decrease such risks, the percentage of capital participation shall carefully be determined.

6.3.4 Management and Control of Mine without Capital Participation

Even though the ratio of capital participation is decreased, it is considered that the economic security and the influence to national economy may possibly be managed and controlled by means of the followings.

- The management and control of mines are to be enforced by sufficiently utilizing the ministerial authority to grant permit and approvals of the government, the investigatory powers, the duty to report from enterprises for mine operation, etc.
- The large amount of investment to Mongolia is to be limited for corporation(s) listed on the stock market of Mongolia.
- The disclosure system of management and operation of enterprises listed on the stock market is to be established as in the case of SEDAR (Canada) and EDGAR (U.S.A.).
- The information on the result of exploration and the mineral reserve which are assets of the company are to be released to the public in accordance with the international standards as the legal obligation of enterprises listed on the stock market.
- EITI (Extractive Industry Transparency Initiative) is to be utilized. EITI is requesting the transparency of accounting for the international mining company, etc., and requesting the transparency of tax and royalty to the resource-rich country. Mongolia is being participated to EITI as well.

6.4 Outline of Copper Program

This program is to utilize copper ore resources for long period, to develop non ferrous industries and to ensure the carrying out the Resolution No. 57 adopted at the National Diet in 2010 according to the Copper Program in Mongolia, and to determine the method and the type which the national government will participate refinery plant(s) for copper concentrates, gold and silver as its purpose. This program is paying a higher attention for the processing of copper concentrates rather than for the development of mines.

Although copper concentrates are being exported at present stage by the efficient utilization of copper ore resources as well as advancement of industries under the leadership of the Government of Mongolia, this program is to export the products of which value added is increased by adding treatment(s), and as the result it is to increase the income of Mongolia and to provide more places of work to the nation.

The program decided followings as concrete policies;

- Tax environment modification from copper sales to increase the economic efficiency
- To cultivate the expert
- To expand the knowledge, survey, study, established experience.

- The technical activity that process the oxide ore and low grade ore by acid leaching and extract pure copper.
- To establish the action group to lead the program and make them proceed the program.
- Construct the first smelter fed concentrate from Erdenet and Tsagaan Suvarga.
- Establishment of technology of solvent mixing with sulfuric acid and of the basic chemical industry
- As one part of Oyu Tolgoi copper-gold mine development, construct the second smelter at Sainshand.
- Establish the business progressively of gold and silver recovery from residue of copper anode.

The schedule of this program is divided into three stages as follows;

- 1st stage (2014 - 2016): To construct the first smelter by TSL method of 200,000t/year capacity near Erdenet to process the concentrate from Erdenet and Tsagaan Suvarga mines
- 2nd stage (2016 - 2020) : To construct the second smelter fed by Oyu Tolgoi concentrate at Sainshand Industry Park
- 3rd stage (2020 - 2025): To construct the precious metal recovery plant

6.5 Investment Policy

6.5.1 Foreign Investment Policy

The Government of Mongolia is promoting the economic openness to the international community and is promoting the direct foreign investment for the purpose of employment creation and the transfer of technology since the reorganization of political and economical system in the period of 1990’s. The organization in charge of foreign investment is the Foreign Investment Regulation and Registration Department (FIRRD) in the Ministry of Economical Development.

The Government of Mongolia enacted “the Investment Law” and “the Investment Fund Law” as well as the amendment of related acts, regulations, etc., and to be enforced them from 1st of November in the Autumn National Diet in October of 2013 as counter-measures against the decrease of foreign currency reserves and the low exchange rate of the Tugrik (Tg) due to the decrease in inward investment by foreign capital enterprises. As the result of the above, “the Foreign Investment Law” and “the Law of Management and Control of Foreign Investment to Strategic Types of Industries”, which became a factor for the decrease of investment, were abrogated.

6.5.2 Investment Law

The government suddenly enforced “the Strategic Entities Foreign Investment Law” in May, 2012 in order to stop the indirect purchase (or merger and acquisition) of mine(s) by Chinese state owned enterprise(s). Although the purchase (or merger and acquisition) could be avoided by the enforcement of the said law, it was true that foreign investors distrusted for the safety and security of investment from the reasons that the law was not widely and sufficiently known and that the effectuation of acts and regulations relating to the same was delayed, etc. Even before the above, the government enforced “the Prohibition Law of Resources Exploration and Mining at Protection Zone of Water Source in River” in July of 2009 and “the Law on Moratorium of newly Issuing Resource Exploration License” in July of 2010. Due to the enforcement as above stated, the investment to rights and interests of to mineral mines by foreign capital enterprises and the operation of alluvial gold mines were stopped since the Resource Exploration License will not newly be reissued after expiration of its effective period for three (3) years, and as the result the tax revenue by gold mining as well as the inward transfer of foreign currency into the amount of foreign currency reserves were decreased.

As such factors were overlapped, the investment from foreign countries was decreased since the third quarter of the year 2012. Furthermore, as the first phase of investment to Oyu Tolgoi Mine was terminated, the inward investment in the first half of the year 2013 was decreased by 42% in comparison with the corresponding period of a year earlier. As the amount of foreign currency reserves was decreased due to the trade deficits in addition to the decrease of investment as aforementioned as well as the price increase of imported goods due to lowering exchange rate of the Tugrik (Tg), the economy in Mongolia is having a great influence accordingly.

The government of Mongolia newly enacted “the Investment Law” by carrying out the legal reform for the purpose of improving the investment climate in order to escape from such adverse circumstances by the increase of inward investment and discontinued previous “the Foreign Investment Law” and “the Strategic Entities Foreign Investment Law” at the same time.

6.5.3 Investment Fund Law

Law(s), act(s) and regulation(s) in relation to the investment fund have not been established in Mongolian Peoples’ Republic until recently, and some parts of issues relating to the same are prescribed in “the Stock Exchange Market Law”. However, as the personal pension fund and the membership system investment fund are being increased, preparation and establishment of law(s), act(s) and regulation(s) became necessary. From this reason, “the Investment Fund Law” was enforced so that the foreign investment organization may cope with (or solve) the issue(s) during the execution of business by clarifying the legal status of joint investment organization, requirements and fundamental rules in order to form the appropriate market and to prepare the conditions for promoting and supporting the development of capital market. As the result of above, small and medium-sized enterprises can obtain their finance from other financing sources as well than the bank financing, and the nations become possible to utilize the company of investment trust and can receive the professional investment management services as the new method of managing assets.

The Investment Fund Law is composed of eleven (11) chapters and includes the fundamental issue such as general regulations, types/kinds, management of fund, procedures of establishment and payment, utilization of investment fund, coordination by the government, investment management companies, capital registration and storage of fund, etc. Main items of the Investment Fund Law are as listed below:

(1) Investment Fund can be divided into two categories, such as joint investment and personal investment
(2) Business approval, sanction or license provided to enterprisers for investment fund and service providers relating to investment by the government should not be deemed for ensuring the profit, and accordingly the government does not guarantee to bear any loss incurred by these activities.
(3) The period of activities for investment fund shall be ten (10) years or less regardless of the type of investment fund.
(4) Taxation to the profit for the management of investment fund will be assessed to investors as the income tax in lieu of assessing to the investment fund.