

## IV. Geology, reserves, and mining method/processing

### A. Geology

The mountain ranges of Northern Luzon, of which the site of Philex mining operation is part, belongs to a volcanic arc terrain. Gold and copper mineralization is often associated with volcanic rocks as well as fault lines in the earth's crust. In fact, the location of the ore body that is the main subject of mining operations by Philex is actually crissed-crossed by fault lines. The most notable of the fault lines are the Albion and Sta. Fe faults.

Thus, it is not be surprising for Philex gold and/or copper production to be associated with geo-hazard risks vis-à-vis volcanic or earthquake activity.

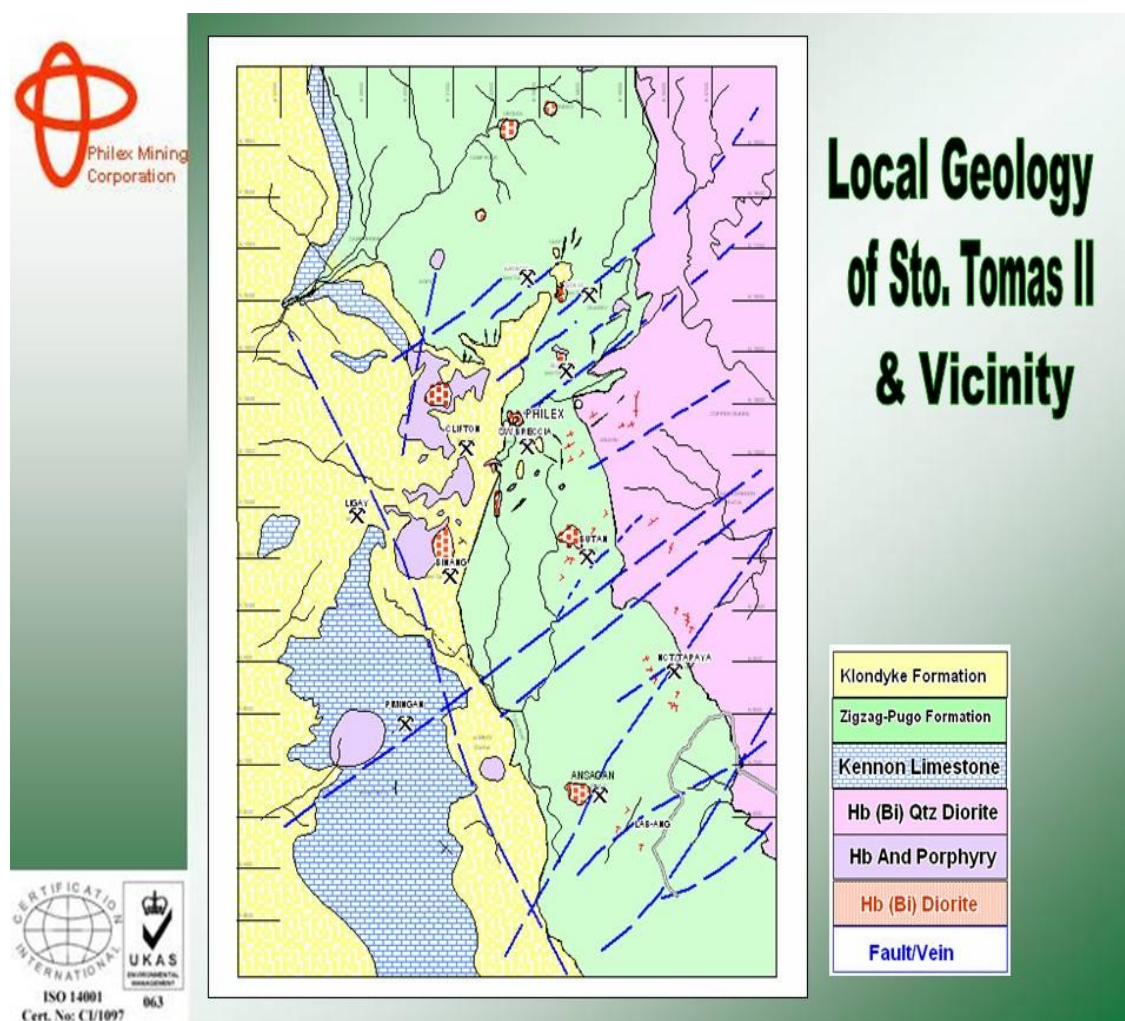
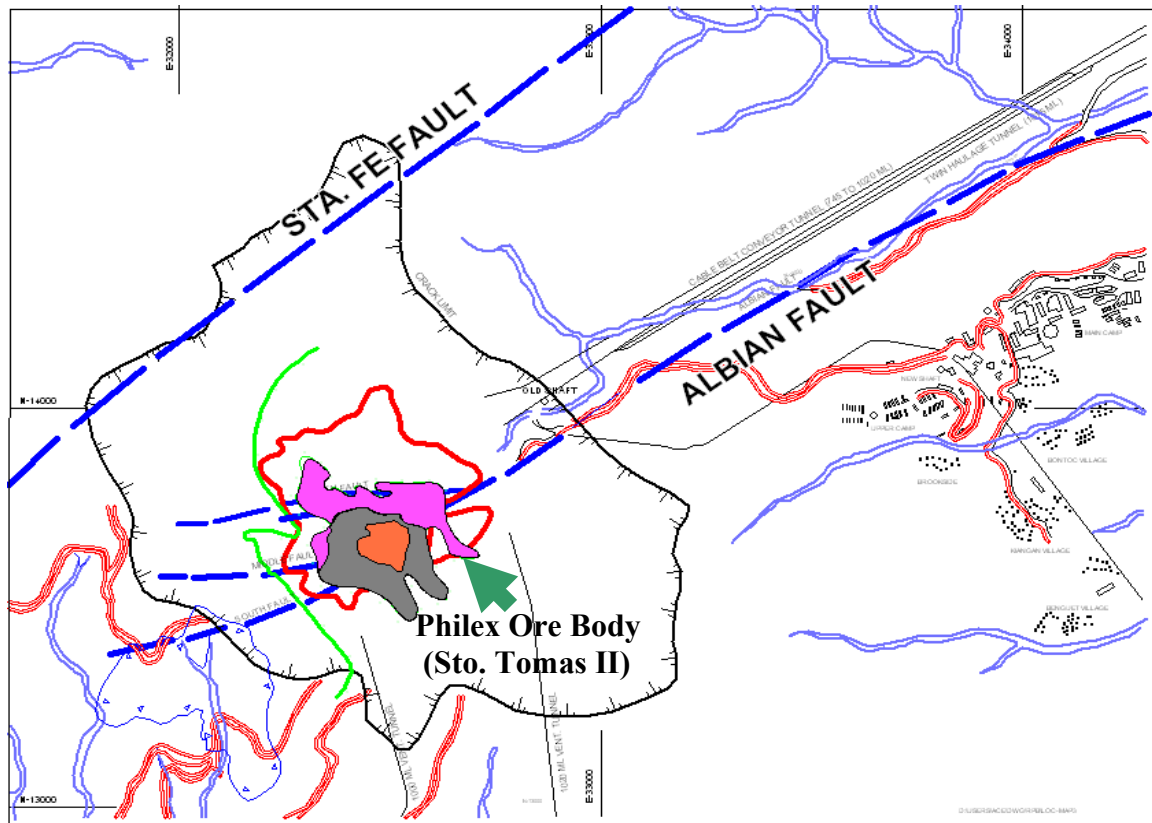


Figure 14 below gives us a close-up of the Sto. Tomas Ore body that is the main site of Philex mining operation.



**Figure 17. Philex Mining company illustration of Philex ore body (Sto. Tomas ore body is directly along the Albian and Sta. Fe faults)**

As indicated by the figure above, the Sto. Tomas Ore Body of Philex Mines directly along the path of the Albian and Sta. Fe fault lines. A movement along the fault line can result to a geological disaster.

In the future, we will analyze Figure 14 further as we associate the map with ground data. Further, we will also analyze deeper all the figures in this work as they are probably very indicative of the risks to the environment posed by Philex mining operations. The figures in this work probably contain information more than what are obvious.

Figure 18 on the next page indicate the proximity of the Philex milling plant to the Sto. Tomas II ore body. The ore body is actually the site of the old open pit mining of Philex. Underneath the site of the old open pit mine, Philex underground mining continues.

This geological map illustrates the tectonic environment of the Luzon Strait. The Philippine Sea Plate is shown to the north, and the Sulu Sea Plate is to the south. The map highlights the Subduction Zone, the Manila Trench, and the Palawan Trench. Key faults depicted include the Tubbataha Fault, the Palawan Fault, and the San Juan Fault. The map also shows the locations of various islands and reefs, such as Cebu, Agut, and San Juan. The map is bounded by coordinates 10°N to 15°N latitude and 120°E to 125°E longitude.

(Philex Mines' powerpoint picture above suggest s that the Sto. Tomas ore body is approximately at N16°16' E120°32'. However, as discussed in Chapter 5, the ore body is most likely at 16°15'45.62" North 120°37'18.87" East)

## B. Reserves

<b>PHILEX MINING CORPORATION</b> <b>STO. TOMAS II OREBODY</b> Padcal, Camp 3, Tuba, Benguet Year Discovered : 1955 Year Production : 1958 <b>Initial Ore Reserve</b> 18.0MT @0.90%Cu; 0.98gAu/t  <b>Initial Production</b> 800TPD @0.80%Cu; 1.0gAu/t  <b>Total Geologic Resource since start:</b>  <b>368 Million DMT @0.30%Cu; 0.60 gAu/t</b>
<b>Geologic Resource</b> <b>Remaining as of January 1, 2006</b> 95.8 Million DMT @ 0.28%Cu; 0.68gAu/t  <b>Production History (from start to December 31, 2005)</b> Tons Milled : 302.2 M DMT %Cu : 0.33 gAu/t : 0.56 Copper Conc. Produced : 3.324 M DMT Copper Kgs. Produced : 840.6 M Gold Gms. Produced : 149.5 M Silver Gms. Produced : 165.9 M



### ORE RESERVE

(CY 2006-2011)

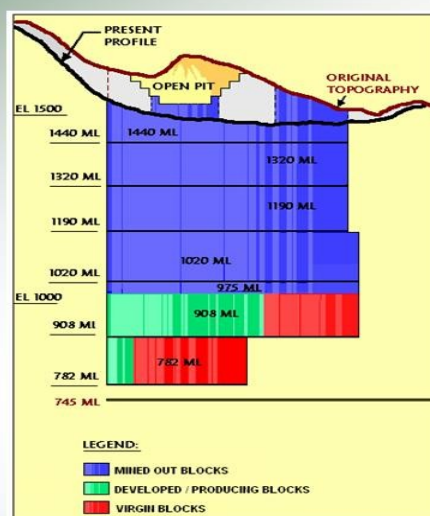
Meter Level	tonnes	% Cu	g/MT Au
+908 ML	24 million	0.23	0.36
+782 ML	30 million	0.29	0.75
Combined	54 million	0.26	0.57

\* As of December 31, 2005.



## MINEABLE RESERVE AS OF Dec. 31 2006

### 54 MILLION METRIC TONS



**The remaining life of the mine is 6 years assuming no new ore discovery**



Figure 20. Reserves according to a public declaration of Philex Mines

Figure 20 above comes from the public PowerPoint presentations of Philex Mines. The figure claims that Philex will be operating only up to 2012 when no new ore discoveries are made. This schedule coincide with the maximum mine tailing pond life of 20 (not 18) years of Philex tailings pond 3. Thus, if the company shuts down by 2012, it is important to find out how the 3 tailings ponds (1, 2, and 3) will be managed, especially tailings pond 2 and 3. Tailings pond 1 must also be inspected for any instability.

### C. Mining method/processing

Figure 21 on the next page that comes from a set of Philex PowerPoint Slides indicates the bias of the company for open pit mining. An educational and research site on precious metals, [www.aboutpreciousmetals.com](http://www.aboutpreciousmetals.com), defines open pit mining as a method of extraction done by digging a large hole in the ground and removing the ore. According to the educational site, the walls of the mine are dug out in steps called benches to provide a stable structure to the pit walls to allow earth moving machinery as the size of the pit is expanded. The educational site also says that before ores can be removed, they need to be broken up into manageable pieces by drilling strategic holes into the rock which are then filled with explosives.

On the other hand, according to <http://technology.infomine.com> (April 2009), block-caving extends open pit mining underground by the caving and extraction of a massive volume of rock which potentially translates into the formation of a surface depression.

In block caving, underground tunnels are constructed to underground haul points where the rocks above are broken down and made to flow down via gravity to the haul points. From the haul points, the ore are then transported to the milling plant. Figure 24 and 25 (pages 22-23) illustrate block caving methods. Fundamentally, block caving makes intensive use of gravity to mine ores. The LHD in the figure refers to Load-Haul-Dump and is one variation of the block-caving mining method. LHD refers to loading of the ore, hauling, and transport via dump trucks or transport vehicles.

As admitted by Philex Mining Company through its PowerPoint Slides, open pit mining was the method of mining used by Philex Mining Corporation in 1958 to 1963 when ore was extracted at the rate of 800 million metric ton per day (MTPD).

In 1963-1996, Philex mining used slusher-scraper machines in their block-caving operations and so the mining method is called **blocking caving-slusher method** today. This is illustrated by Figure 24 (page 22),

Finally, beginning 1996, the block caving system of mine operation used load-haul-dump units and the mining methodology is called block **caving-load haul dump** or LHD. This is illustrated in Figure 25 on page 23.

According to the World Gold Council ([www.trustingold.com](http://www.trustingold.com), 2009) that is composed of gold miners around world, block-caving is the one with the lowest cost of all mining methods except when compared to open pit mining. Charles Kubach ([www.mine-engineer.com](http://www.mine-engineer.com), 2009), world renowned mining engineer, considers open pit mining as the mining method with the lowest possible cost.

Thus, Figure 22 (page 21) basically summarizes that the main products of Philex operations are gold, copper, and silver. The mining method used is block caving-load/haul/dump while the milling used to turn ore into copper concentrates is flotation.



Data are yet unavailable on how Philex Mines dispose of its gold and silver as well as its other by-products: magnesium, iron, bismuth, manganese, nickel, cobalt, cadmium, chromium, mercury, platinum, and palladium.

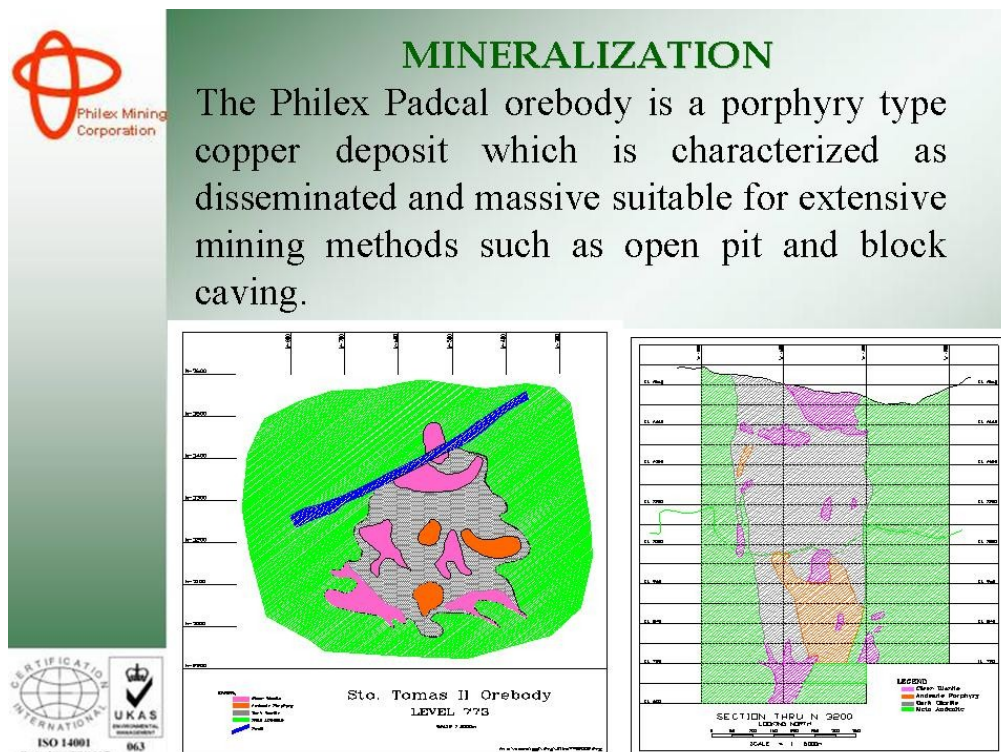


Figure 21. Characteristics of Philex ore body: massive

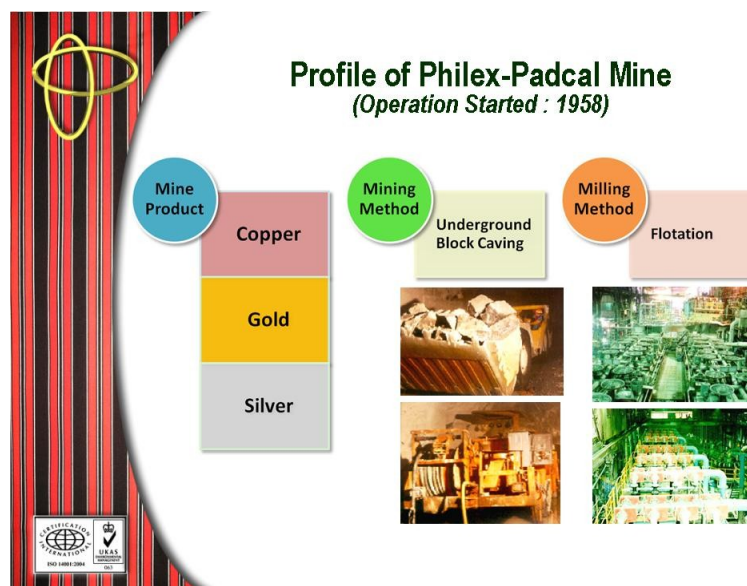


Figure 22. Overview on mining and milling method at Philex-Padcal



## MINING METHODS

### OPEN PIT METHOD (1958-1963)



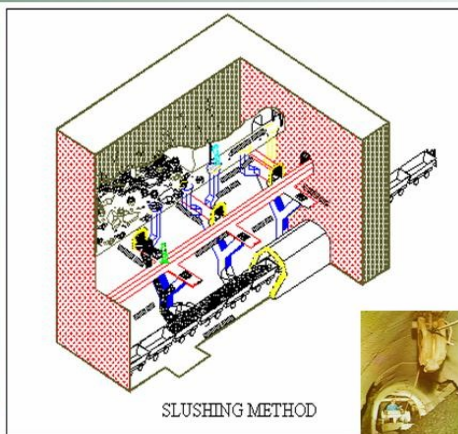
- Ore is extracted at an average of 800 MTPD.



Figure 23. Philex mining method 1958-1963: open pit mining



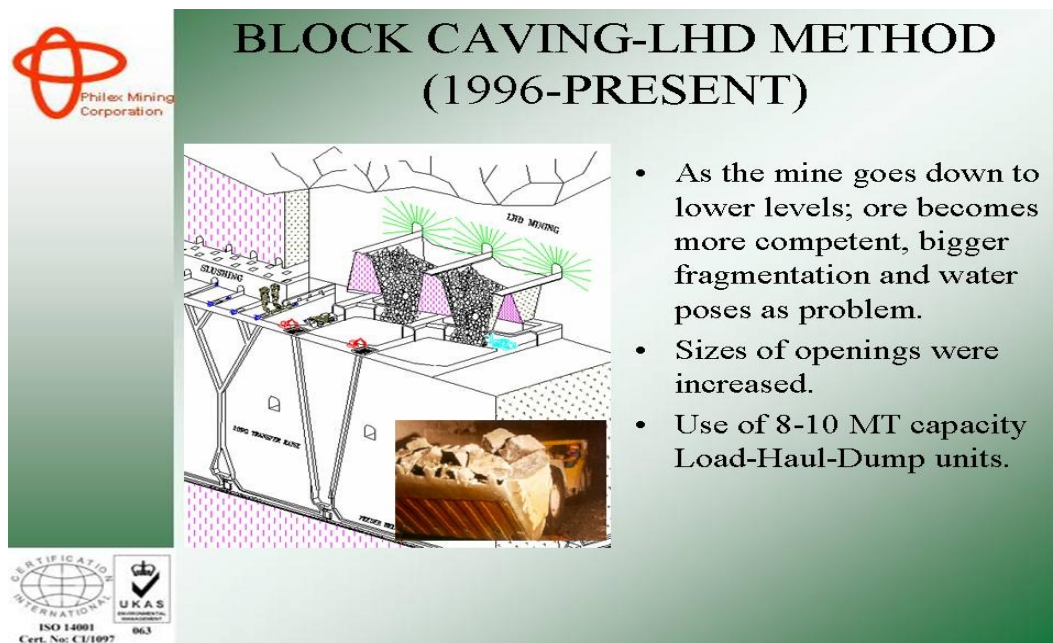
### BLOCK CAVING-SLUSHER METHOD (1963-1996)



- Ore is extracted at the slusher lines through the finger raises.
- Ore are scraped/slushed to raises and reports to a 75MT capacity locomotive.
- Ore is transported to the dump bin via the locomotive.



Figure 24. Philex mining method 1963-1996: block caving-slusher method



**Figure 25. Philex mining method 1996-present: block caving with load-haul-dump**

SunStar (2 February 2005) describes the LHD or load, haul, and dump of the Philex mining method this way: ore is drawn by the load-haul-dump or LHD units then transported to the mill through cable belt conveyor system, 2.7 kilometers away from the ore body. In particular, SunStar reports that the milling process of Banguet Concentrator utilizes three stages of crushing having a final product of 73% minus 10 mm. The final product is a copper concentrate.

Developing mines from which ores can be gathered involves the following processes: horizontal and vertical driving, installation of rock support, drilling of fanholes, excavation of trenches, and undercutting. Figures 26-31 on pages 23-26 are illustrative.



**Figure 26. Overview on Philex mine development**





## HORIZONTAL DRIVING



Particular Drives	Sizes of Openings (Finished Dimensions)	
	Height (m)	Width (m)
Production Lines	4.0	4.0
Undercut Lines	3.5	3.5
Draw Crosscuts	3.5	3.5
Access Ramps	4.0	4.0
Ventilation Drifts	3.5	3.5
Drainage Drifts	3.5	3.5

Equipment	Model/Maker	Total Fleet	Productivity
Jumbo Drill	Tamrock-AXERA 05	2	3.0 m per blast
	MTI-Dritrunner	1	
	SECOMA-MERCURY	1	
	Tamrock-MINIMATIC	1	
<b>Total Jumbo Drill</b>		<b>6</b>	
Development LHD	Tamrock-TORO 300	7	6.0 MT per trip
	Atlas Copco-ST3.5	1	
	Atlas Copco-ST6C	2	
<b>Total LHD</b>		<b>10</b>	

Figure 27. Horizontal driving in Philex mine development



## VERTICAL DRIVING



Particular Drives	Sizes of Openings (Finished Dimensions)	
	Length (m)	Width (m)
Pilot Raise	2.0	2.0
Shot Raise	2.0	2.0
Long Transfer Raise	2.5	2.5
Access Manway	2.0	2.0

Equipment	Model/Maker	Total Fleet	Productivity
Raise Climber	ALIMAK-5L	5	1.2 m per blast
	ARKBRO-AB 5A	2	
<b>Total Raise Climber</b>		<b>7</b>	
Rock Drill Machine	TOYO	17	
	FURUKAWA	19	
<b>Total Rock Drill Machine</b>		<b>36</b>	

Figure 28. Vertical driving in Philex mine development

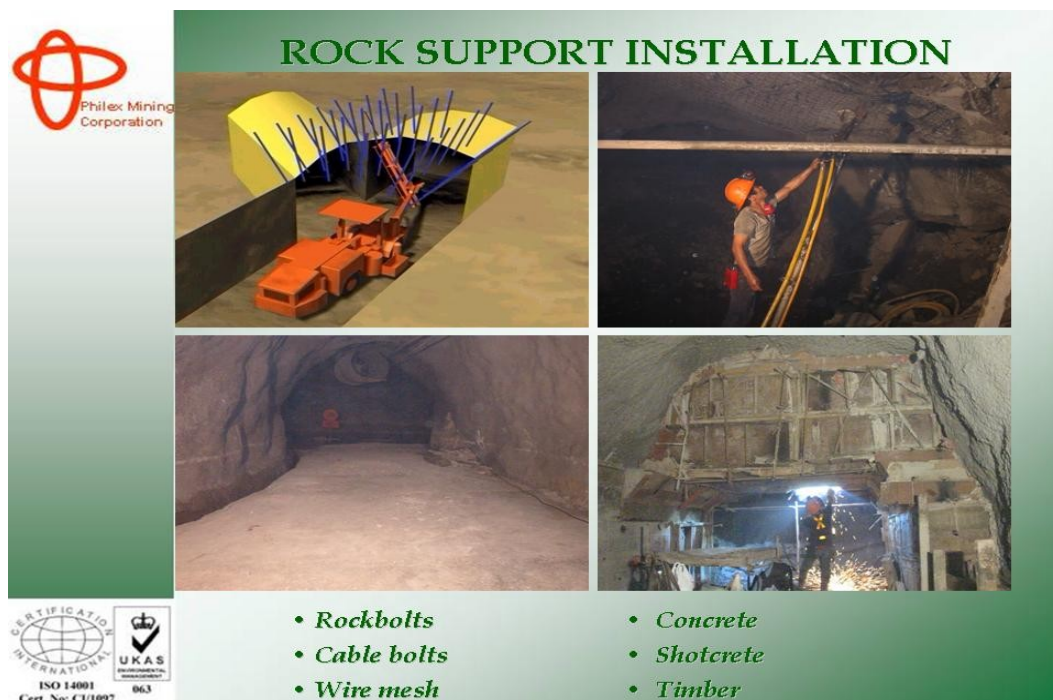


Figure 29. Installation of rock support in Philex mine development

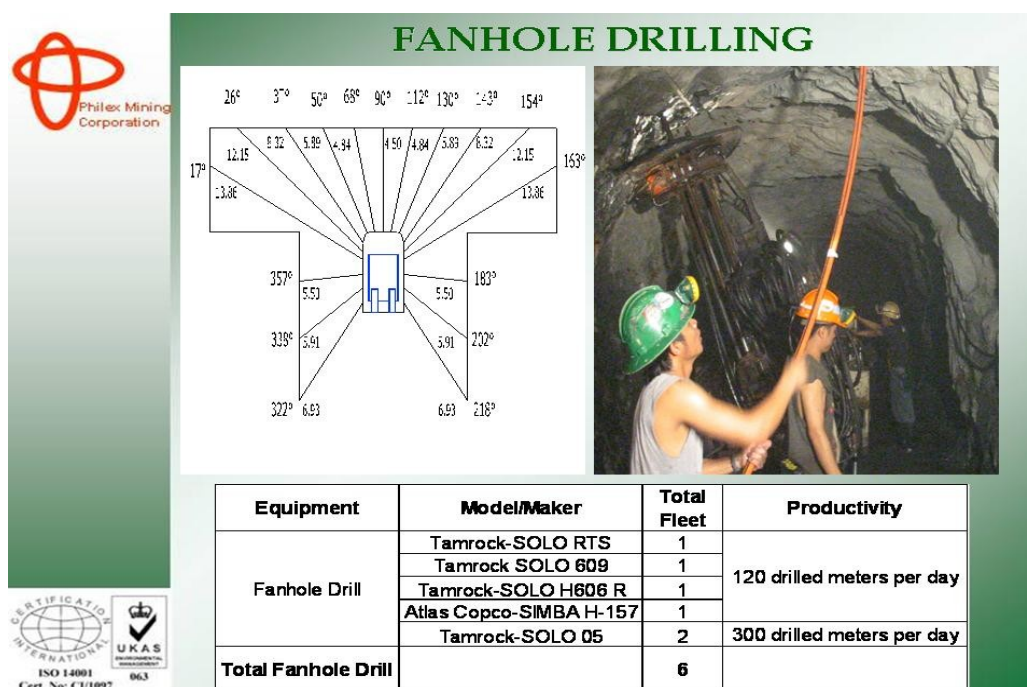


Figure 30. Drilling of fan holes in Philex mine development





## TYPICAL DRAWPOINT, FULLY SUPPORTED AND COMMISSIONED FOR PRODUCTION



• The miner is posed to perform pop hole drilling on a boulder sized ore.

Figure 31. Drawpoints from which ore are drawn as a result of mine development

After a mine has been developed, mine production commences. Production involves scooping, breaking rocks for the ore, handling the ore, crushing the ore, and conveying the ore. Figures 32-34 of pages 23-27 are illustrative.



## MINE PRODUCTION USING BLOCK CAVE MINING METHOD

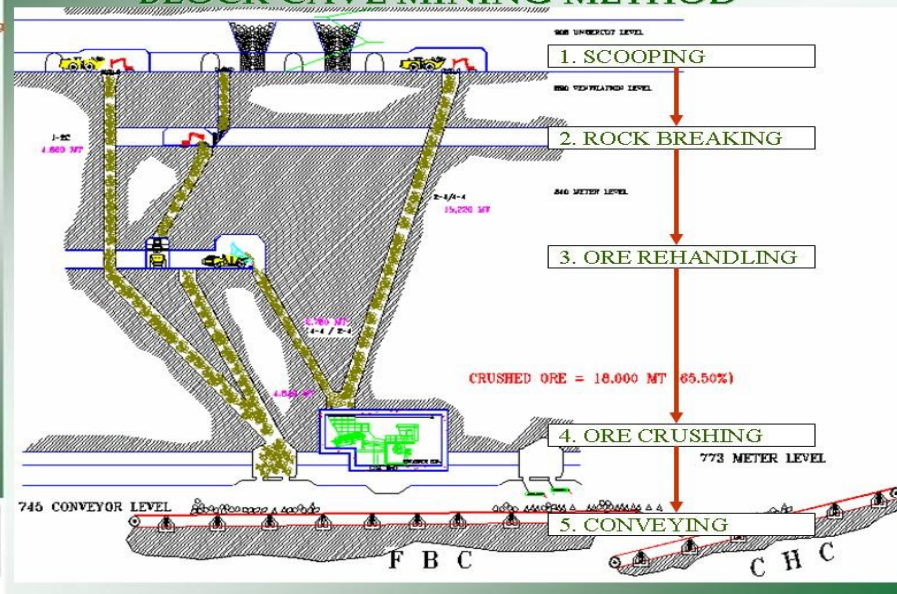
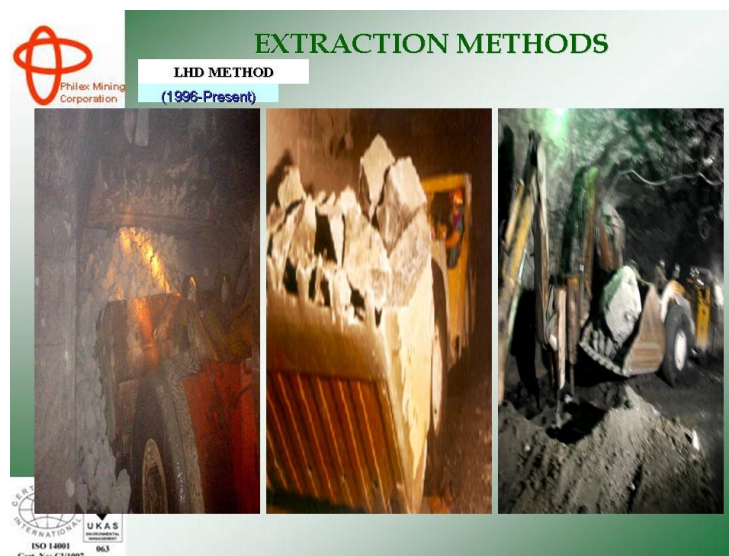


Figure 32. Overview on block-caving in mine operations



**Figure 33. Ore extraction method**



**Figure 34. Scooping, loading, and dumping of ore**



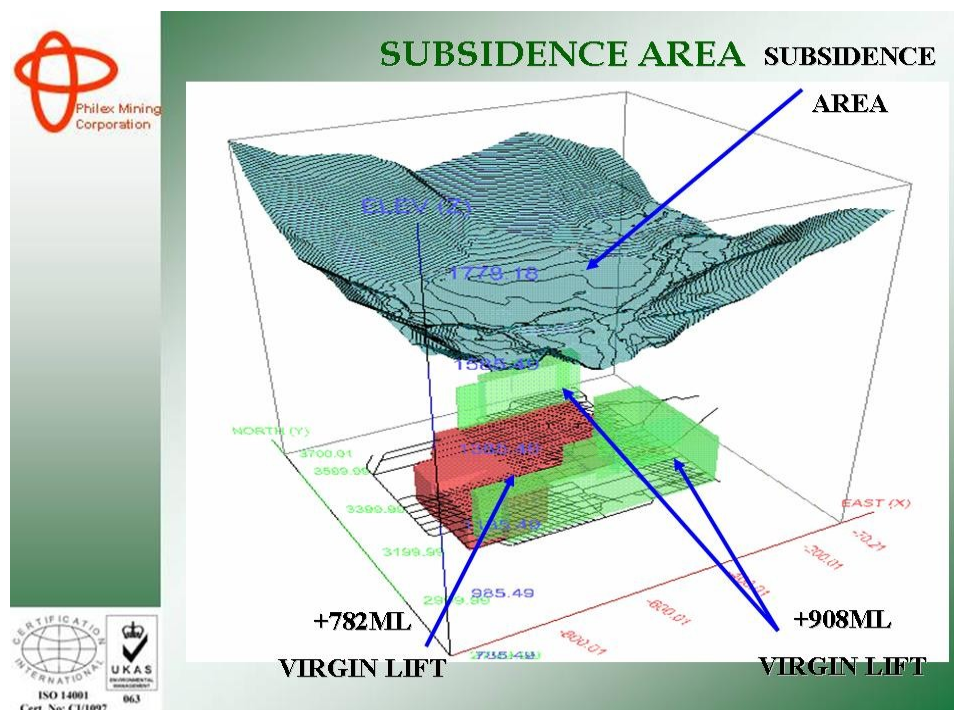


Figure 35. Subsidence at the ore body as a result of the mine operation



Figure 36. Backfilling operations on subsidence

As discussed earlier, Figure 17 of page 17 indicate that the Sto. Tomas II ore body is along the Albian and Sta. Fe faults. Based on Figures 35 and 36 above and Figure 37 of page 29, it is clear that the **block caving-LHD** mining method currently used by Philex mines involve the backfilling of subsidence

areas. A very important question to ask is: what are the risks and how can we quantify the risk and monetary value of the risks involved in Philex mining given that the Philippines lie along the Pacific ring of fire that is vulnerable to frequent earthquakes and given that the Philex ore body itself are crisscrossed not by one but by two faultlines?



Figure 37. Backfilling above active mining area

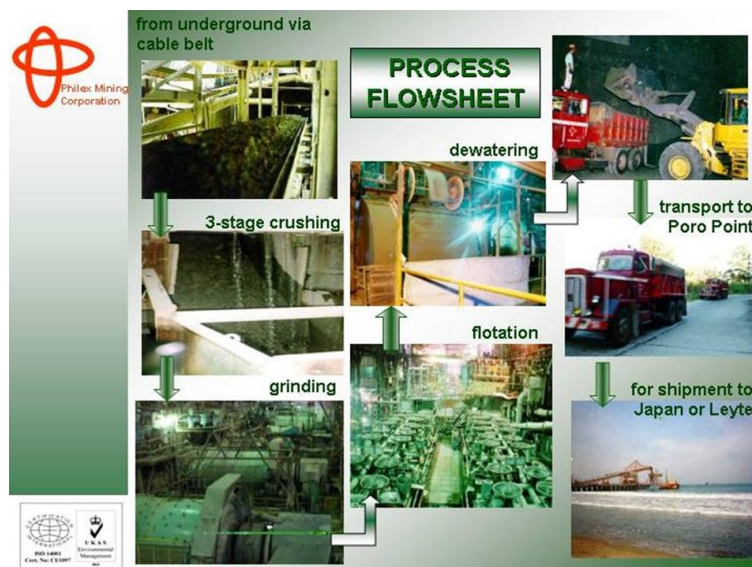


Figure 38. Milling flow sheet and transport to Poro Point for Japan or Leyte