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CHUQUICAMATA MINING COMPLEX DAMAGE ANALYSIS

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SUMMARY

OVERVIEW

The mining complex at Chuquicamata, Chile, is the world's largest open-pit copper mine and the second deepest open pit. The mine is owned and operated by Codelco (Corporación Nacional del Cobre de Chile) and is one of the seven mine sites (known as Divisions), that Codelco operates: Chuquicamata, Ministro Hales, Radomiro Tomic, Gabriela Mistral, Salvador, Andina, El Teniente.

On August 3rd, 2022, an incident occurred at the Chuquicamata concentrator plant, and Skytek was requested to investigate the asset's condition using very high-resolution satellite imagery.

CHUQUICAMATA MINE OVERVIEW

In this section, we provide pre and post-event images of the larger area in which the asset of interest is located, as well as conditions of interest which may affect the asset.

Chuquicamata is located near Antofagasta in the north of Chile, in an area known for above-average seismic activity. With potential relation to the collapse of the Chuquicamata concentrator dome, Skytek lists in Table 1 below the magnitude and frequencies of historical earthquakes in the region:

Earthquake Magnitude	Year				
	2022	2021	2020	2019	2018
Over 6	2	0	4	0	0
5 to 6	8	5	7	11	10
4 to 5	151	100	119	124	108
3 to 4	895	734	830	699	677
2 to 3	1531	1181	1163	929	799

Table 1 - Overview of past earthquakes in the Chuquicamata region

Copper and Molybdenum ore are extracted from the Chuquicamata open pit, the world's largest open pit and in operation since 1910.

In operation since May 2019, Codelco Chuquicamata Underground started transitioning the open pit mining operations to underground exploitation of the resources below the open pit, estimated to have more than 1,700 tons of copper reserves.

About 20 km to the north of the mine, Codelco operates the Radomiro Tomić mine, which is linked by a conveyor belt to the Chuquicamata concentrator.

Ore mineral from the Chuquicamata open pit, the Chuquicamata underground and the Radomiro Tomić mine is transported by conveyor belts to the conventional mills (Ball Mill) and Semi-Autogenous Grinding (SAG) mills and, via internal belts, to the concentrator plant at Chuquicamata.

The concentrate that results from this process, feeds the Pile Mineral Treatment Plant (PTMP), for processing electro-refined and electro-won copper cathodes.

Skytek obtained a very high-resolution image dated February 21st, 2022, represented in Figure 1 (overview), depicting the main conveyor belts converging in the Chuquicamata concentrator and the Pile Mineral Treatment Plant (PTMP):

Figure 1: Mineral Treatment Plant (PTMP) and Chuquicamata concentrator, on February 21st, 2022 – Overview Credits @AirbusSpace

Figure 2: Mineral Treatment Plant (PTMP) and Chuquicamata concentrator on February 21st, 2022 – Detail Credits @AirbusSpace

The very high-resolution image acquired on February 21st, 2022, in Figure 2 (detail), shows in detail the Chuquicamata concentrator and treatment plant. Analysing this image at 50cm resolution, Skytek makes the following observations:

- The dome of the Chuquicamata concentrator appears in good structural condition
- The dome of the Radomiro Tomic concentrator appears in good structural condition
- The main conveyor belts appear in good structural order and fully functional:
    - 22CV3 from the Chuquicamata open mine to the main concentrator via the complementary conveyor
    - the DGH u/g and Pila Mina conveyors from the Chuquicamata underground mine to the main concentrator
    - the Radomiro Tomic conveyor to the main concentrator via the complementary conveyor
    - Internal conveyor belts from the Chuquicamata open mine to the Radomiro concentrator to the Chuquicamata concentrator via complementary belt appear in good structural condition

- The Treatment Plant (PTMP), Ball and SAG mills appear in good structural condition

Following the Chuquicamata concentrator incident on August 3rd, Skytek obtained a very high-resolution image for the post-event assessment. This image, represented in Figure 3 below, is dated August 22nd, 2022, and it is at 40cm resolution.

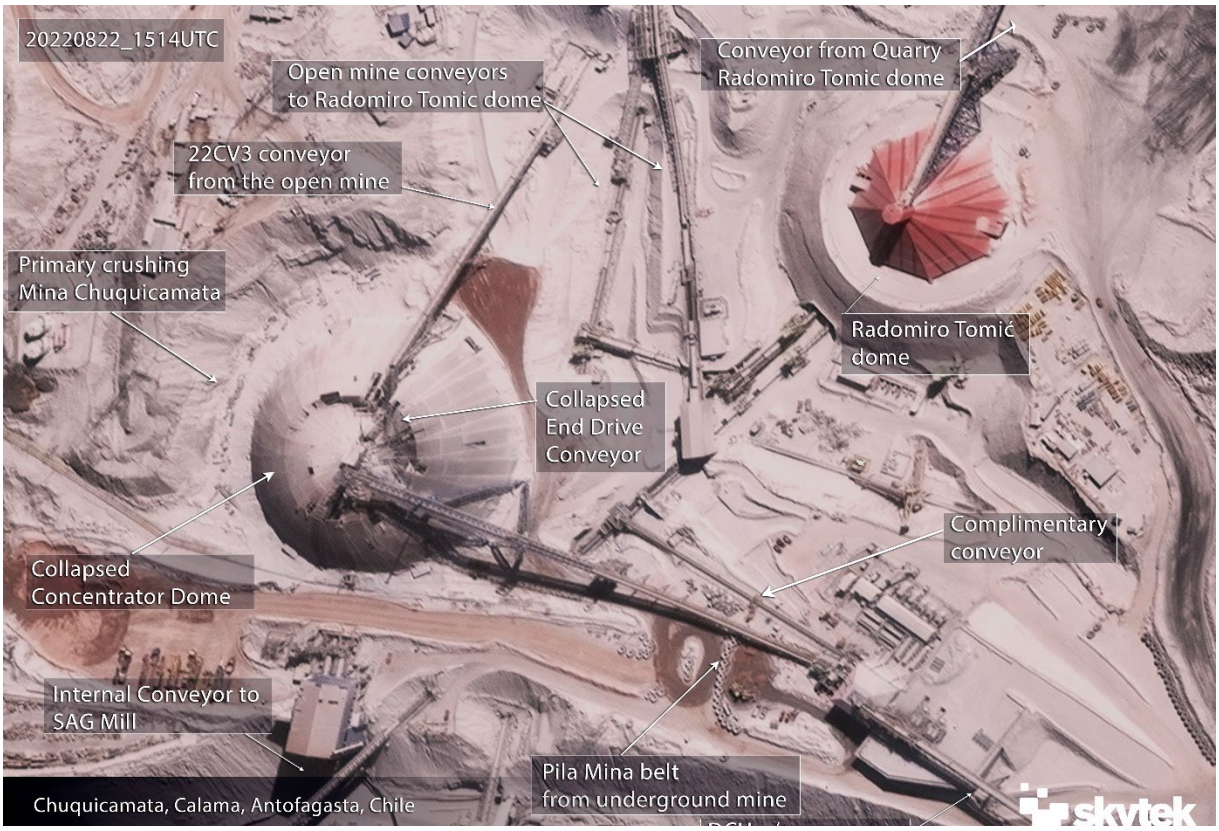

Figure 3: Chuquicamata copper mine, detail of the Concentrator Dome on August 22nd , 2022 @Digital Globe WorldView satellite

Analysing the satellite image dated August 22nd, 2022, Skytek makes the following observations:

- The top of the Chuquicamata concentrator dome appears to have collapsed over the copper concentrate. There are several holes punctured in the walls of the dome, whose structural condition appears compromised
- 22CV3 conveyor from the Chuquicamata open mine to the main concentrator appears to have the end drive collapsed together with the top of the dome he was resting upon

- The dome of the Radomiro Tomic concentrator appears to be in good structural condition
- the DGH u/g and Pila Mina conveyors from the Chuquicamata underground mine to the main concentrator appear in good order. The end drive of the Pila Mina conveyor was not resting on the Chuquicamata concentrator dome and appeared to have sustained minor damage to the head chute at its apex.
- The Radomiro Tomic conveyor to the main concentrator via the complementary conveyor appears in good condition
- The Treatment Plant (PTMP), Ball and SAG mills appear in good condition.

Remedial works were expected to begin shortly after the incident. To assess the progress of these works, Skytek obtained a very high-resolution image dated October 12th, 2022, at 50cm resolution, as depicted in Figure 4 below.

Figure 4: Chuquicamata copper mine, detail of the Concentrator Dome on October 12th, 2022 Credits @AirbusSpace

Analysing this very recent imagery, Skytek makes the following observations:

- The East wall of the Chuquicamata concentrator dome appears to have deteriorated significantly further in comparison to the condition reflected on August 22nd (see Figure 3 above)
- Near the 22CV3 conveyor, a crane has been stationed potentially to assist with the removal of the dome structure
- 22CV3 conveyor from the Chuquicamata open mine to the main concentrator appears in the same condition as on August 22nd, with the drive end broken
- The dome of the Radomiro Tomic concentrator appears to be in good structural condition
- the DGH u/g and Pila Mina conveyors from the Chuquicamata underground mine to the main concentrator appear in good order with no significant changes since August 22nd
- The Radomiro Tomic conveyor to the main concentrator via the complementary conveyor appears in good condition
- The Treatment Plant (PTMP), Ball and SAG mills appear in good condition.

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