





# Reflexion de Seguridad



# Reflexion de Seguridad





# Geotecnia Cadia East PC1

**TABLE 1**

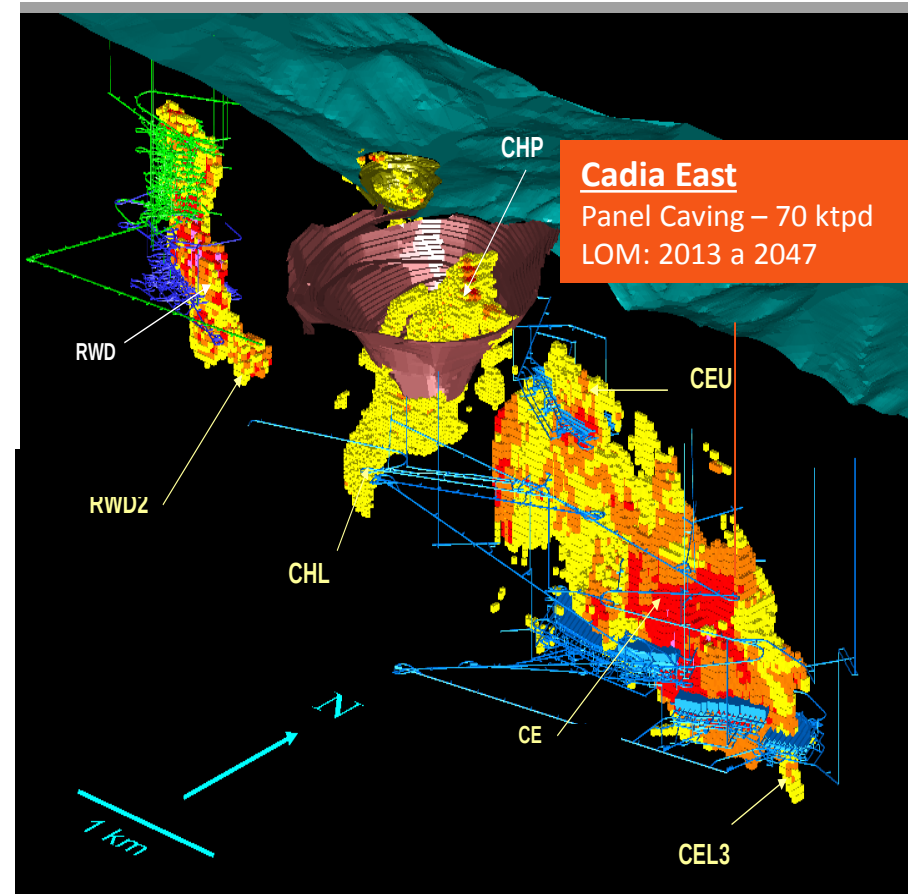
Principal stress field magnitudes and orientations at Cadia East at a depth of 1200 m (after Lee, 2012).

| Principal stress | Magnitude (MPa) | Orientation (dip/dip direction) |
|------------------|-----------------|---------------------------------|
| Sigma 1          | 62.5            | 02°/243°                        |
| Sigma 2          | 41.3            | 03°/333°                        |
| Sigma 3          | 35.6            | 86°/119°                        |

**TABLE 2**

Geomechanical properties of major rock types at Cadia East Panel Cave 1.

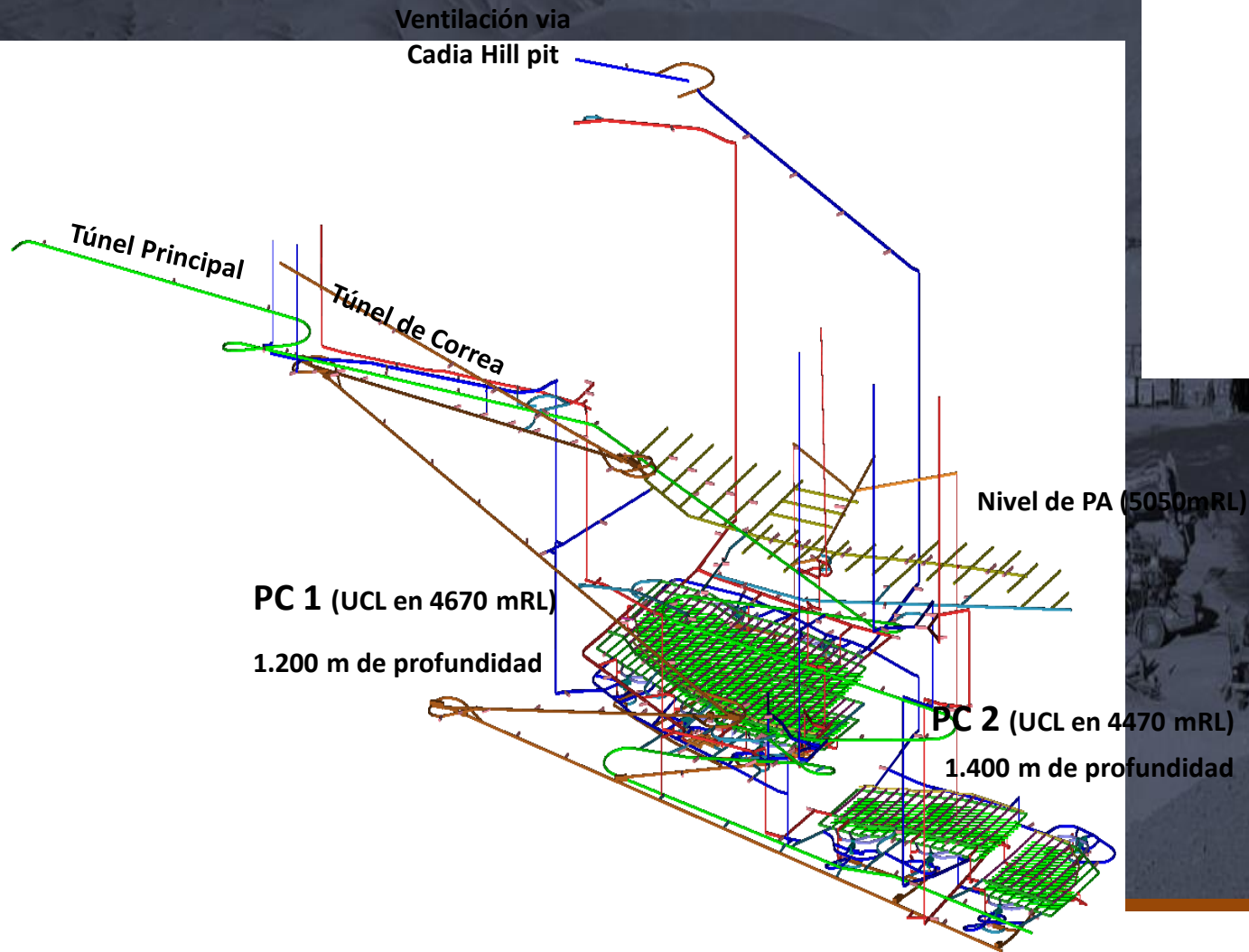
| Rock type              | Uniaxial compressive strength (MPa) | Fracture frequency (ff/m) | Rock mass rating (L90) |
|------------------------|-------------------------------------|---------------------------|------------------------|
| Volcanoclastics        | 169                                 | 3.9                       | 60.8                   |
| Lower capping porphyry | 145                                 | 3.8                       | 58.2                   |
| Upper capping porphyry | 145                                 | 5.7                       | 54.1                   |



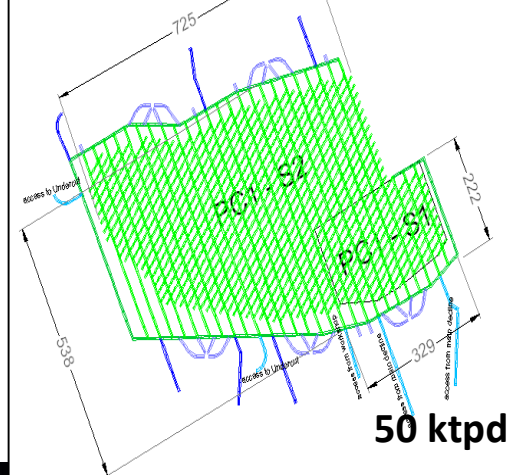


# Cadia East

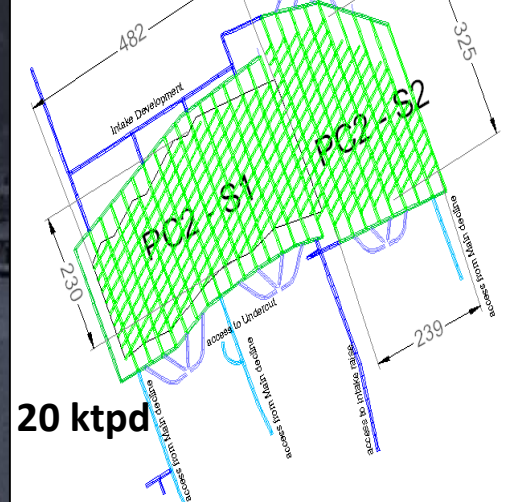
## Configuración General Cadia East



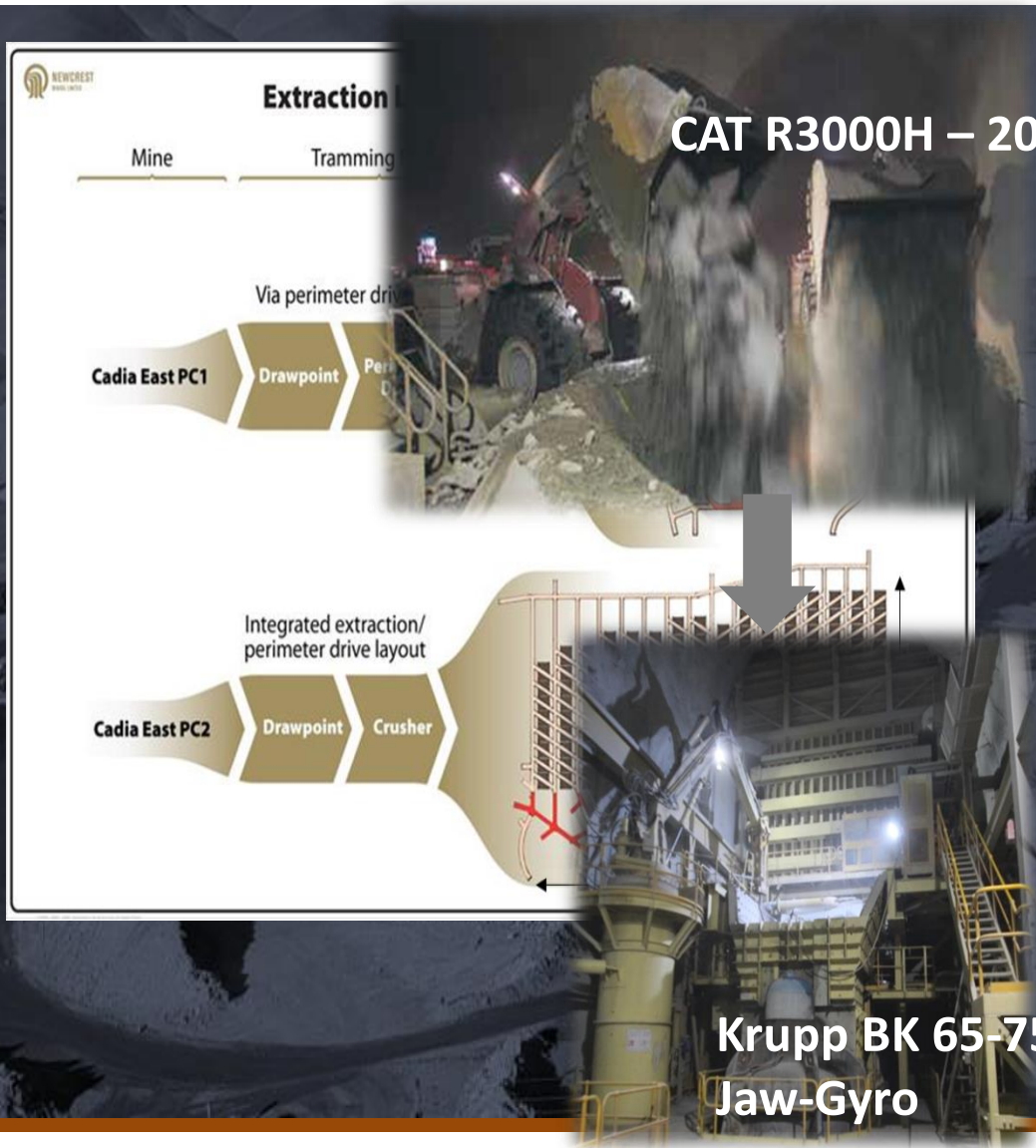
PC 1 (UCL en 4670 mRL)



PC 2 (UCL en 4470 mRL)

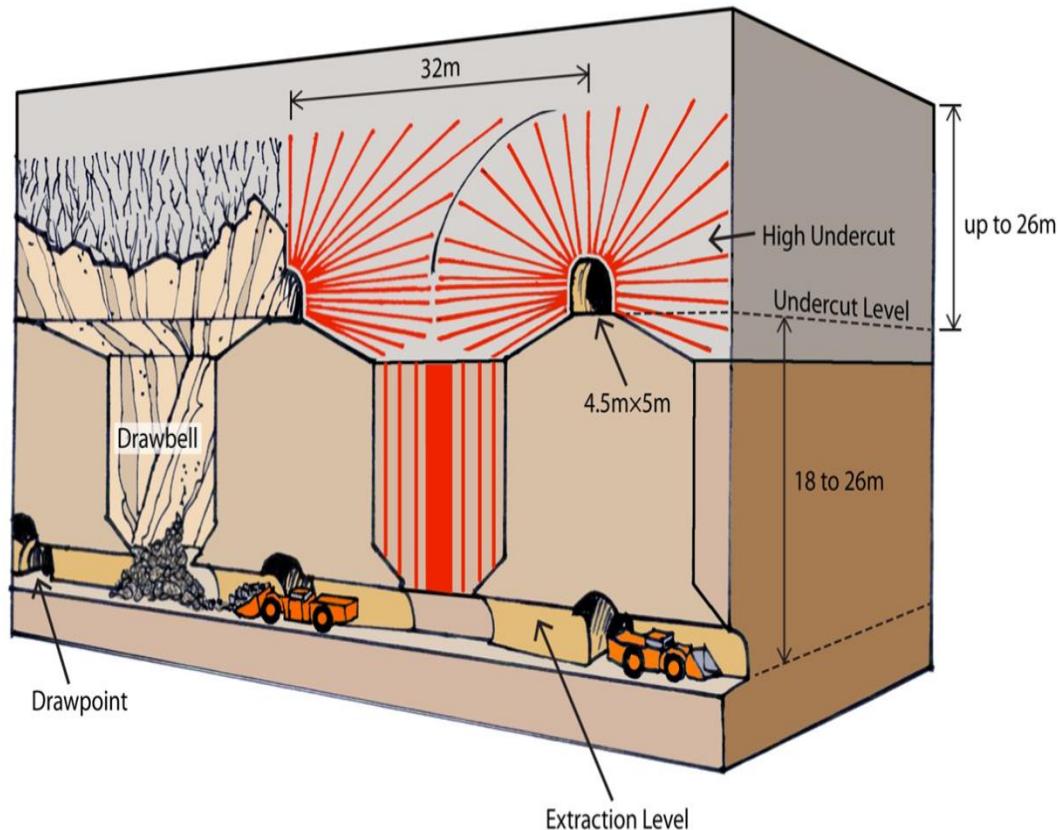


# Cadia East Diseño Minero y Manejo de Materiales





# Diseño Minero



## PC 1 – S1

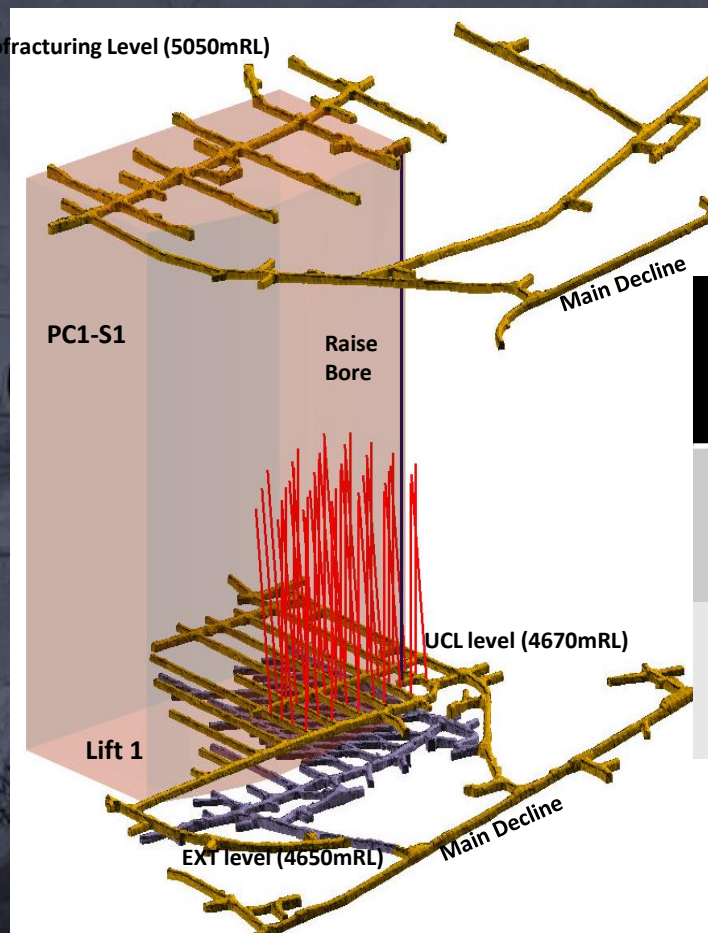
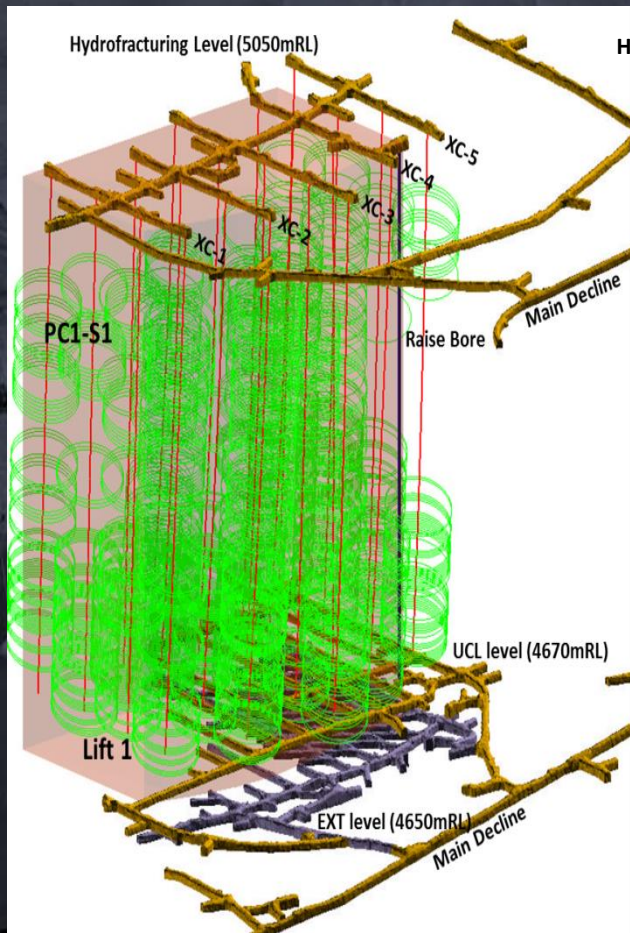
- Malla Teniente 16 x 20
- Hundimiento Convencional
- Corte Alto > 20m
- PA (FH+DDE)

## PC 2 – S1

- Malla Teniente 16 x 20
- Hundimiento Convencional → Avanzado
- Corte Bajo
- PA (sólo FH)

# Diseño Minero

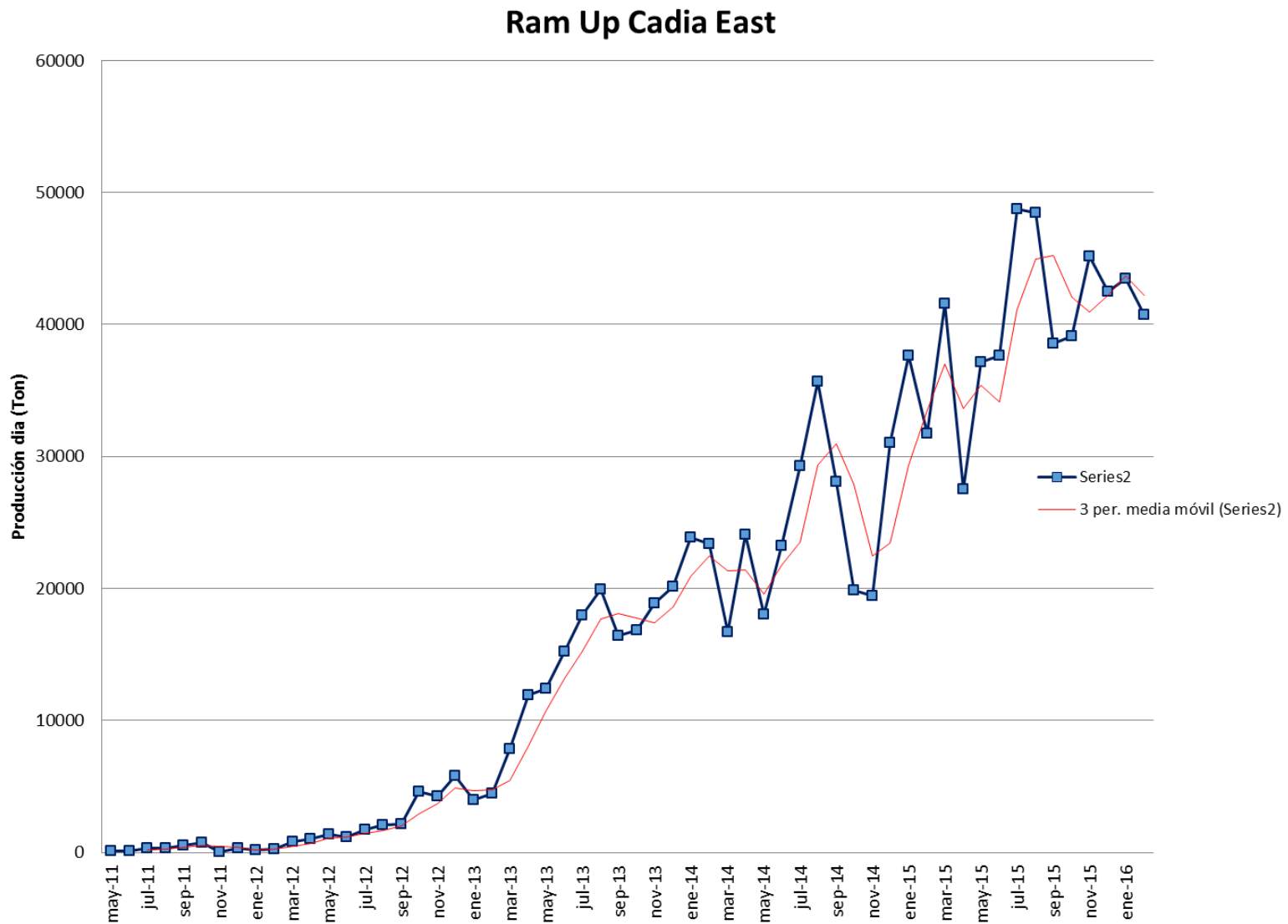
## Preacondicionamiento Intensivo en PC1-S1



| Técnica de PA | Nº Pozos | Total               |
|---------------|----------|---------------------|
| FH            | 21       | 1,182 Fracturas     |
| DDE           | 43       | 141,255 Kg Emulsion |



# Producción Histórica Cadia East



# Desarrollos



Los desarrollos se efectúan por el método de Rapid Development.

Se cuenta con un total de 38 personas para realizar los desarrollos en toda la mina.

Se cuenta para los desarrollos con 2 Jumbos de perforación y 8 de Fortificación, con una disponibilidad de equipos de 85% a 90%.

Se queman 11 frentes al día, con un avance promedio de 4.5 m por quemada.

La sobreexcavación típica es de 12 a 15%.

El desarrollo de labores va en línea con el avance del hundimiento.

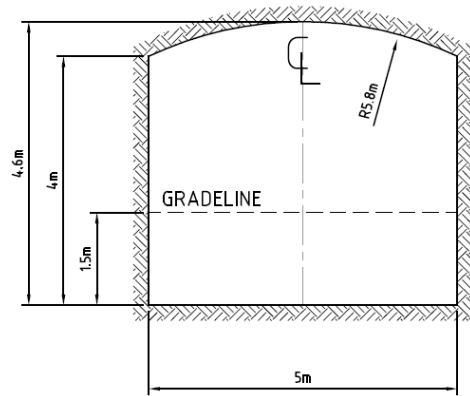


# Fortificación Puntos de Extracción

## Fortificación Liviana en Puntos de Extracción

### Definición de fortificación estándar

- Perno, malla, shotcrete y cables en cajas y techo
- Viga empotrada en techo con refuerzos en cajas



**PROFILE T**  
5.0m wide x 4.6m high  
Dimensions refer to excavated profile size

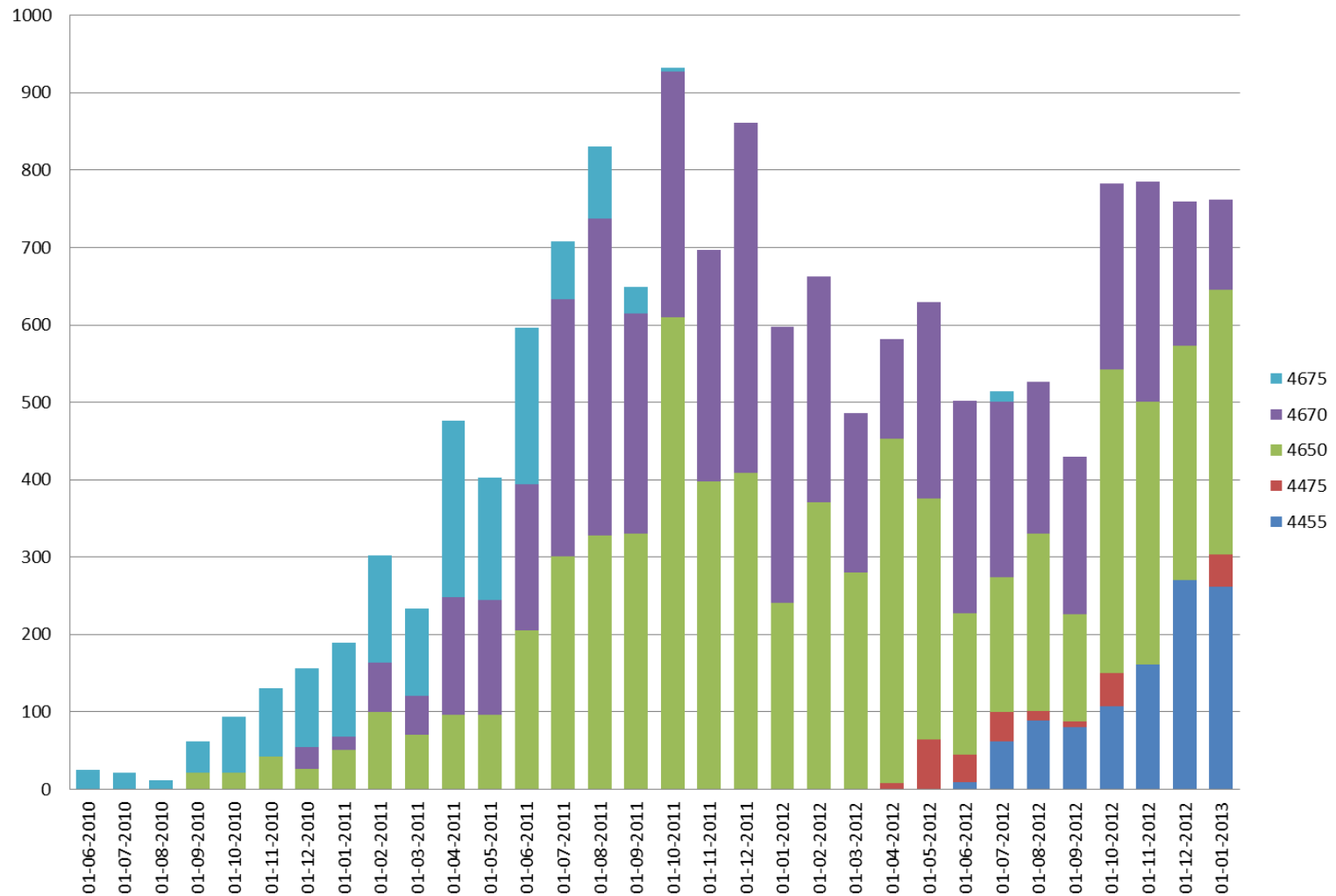
|                          |                      |
|--------------------------|----------------------|
| Profile Area (excavated) | 22.05 m <sup>2</sup> |
|--------------------------|----------------------|

TYPICAL USES: EXTRACTION DRIVES,  
DRAWPOINTS, UNDERCUT DRILL DRIVES.



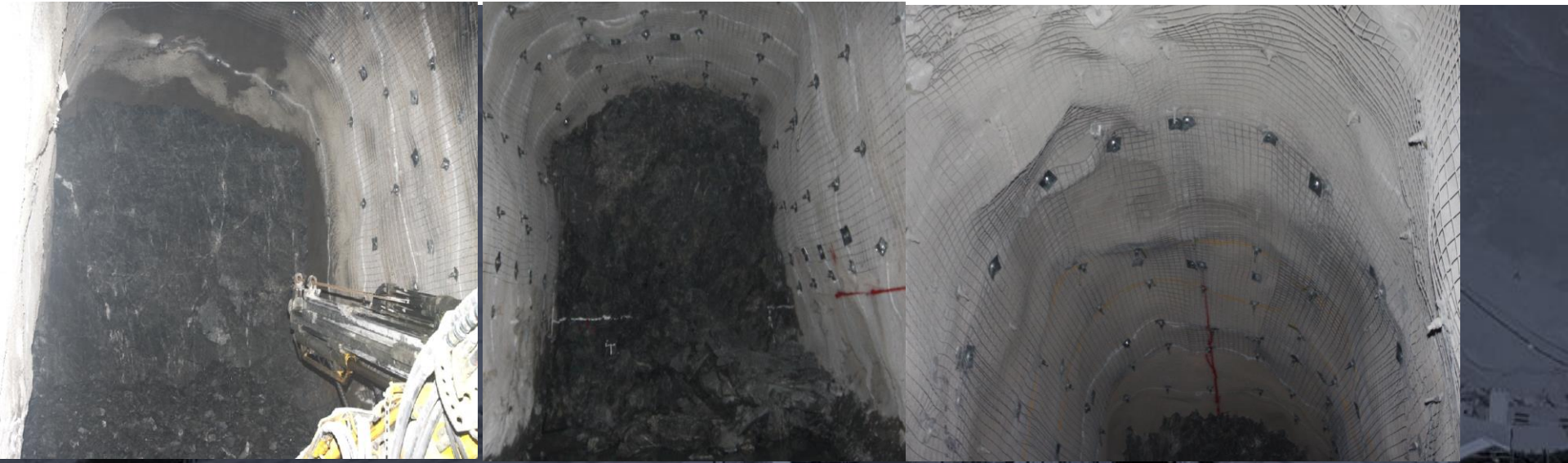
# Desarrollos Cadia East

## Desarrollos Mensuales Cadia East





# Fortificación de Labores



La fortificación de labores se realiza a la frente con pre shotcrete (con fibra) de 7.5 cm y pernos lechados de 2.4 m de largo en pattern de 1.2 m. Sobre lo anterior se instala una malla ACMA soportada con pernos split set.

En toda luz de mas de 7 m de diámetro, se instalan además cables dobles de 16 mm de diámetro.

# Nivel de Hundimiento



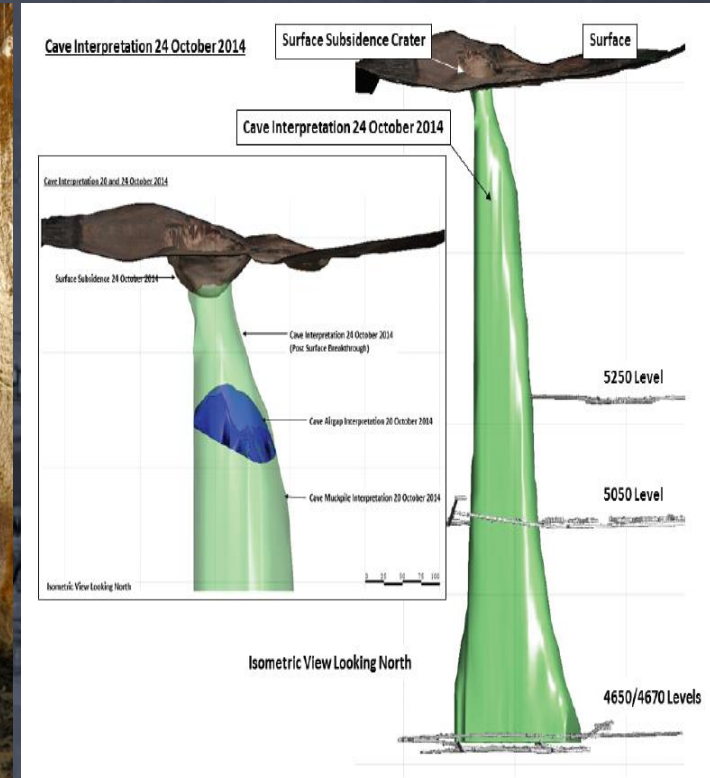


# Preacondicionamiento

## Preacondicionamiento Intensivo (FH + DDE) y Corte Alto en PC1-S1 - Resultados

### PC 1 – S1

- Buena fragmentación
- Baja tasa de colgadas
- Alta disponibilidad de PE
- 0,5 t/m<sup>2</sup>/día en quiebre
- 1,75 t/m<sup>2</sup>/día en régimen
- Propagación a superficie 1200m
- 1,2 m/día propagación
- Se alcanza el régimen 6 meses antes que FS



# Preacondicionamiento

## Eliminación de DDE y Corte Bajo en PC2-S1 - Resultados

### PC 2 – S1

- Aumento en tasa de incorporación de área (de 5000 m<sup>2</sup>/mes en PC1 a 7000 m<sup>2</sup>/mes)
- Fragmentación gruesa al inicio de caving (80% PE con fragmentación gruesa)
- Estallido de rocas (implicó cambio a Hundimiento Avanzado)





# Monitoreo del Caving

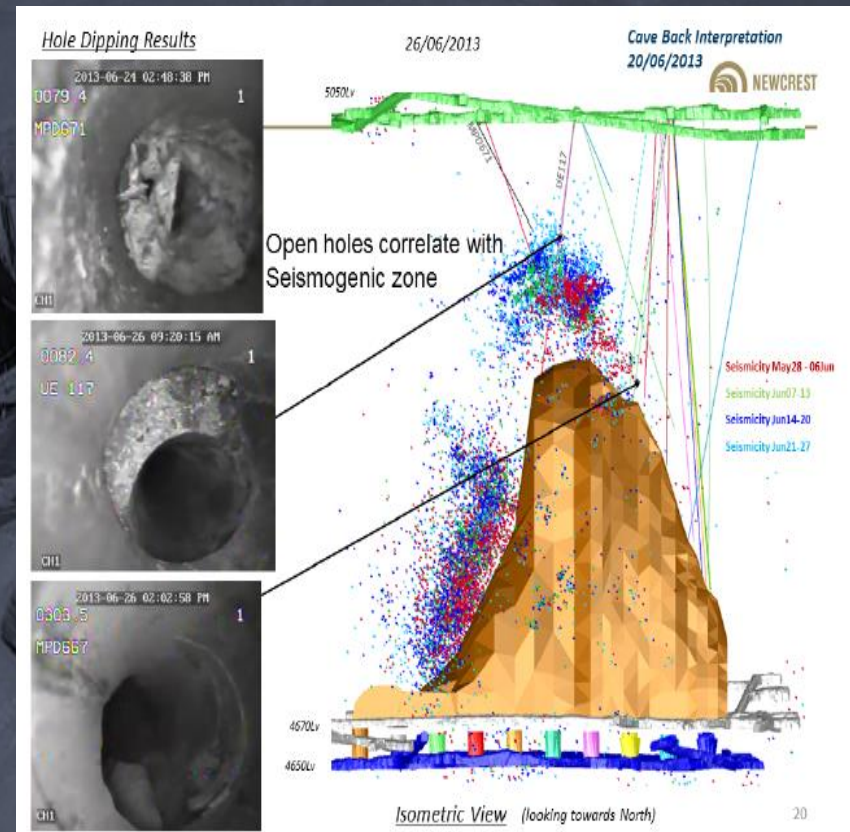
## Sistema de Monitoreo y Estrategia de Extracción

### Sistema de Monitoreo

- BoreHole Cameras (23 tiros en PC2, 50% reutilizados de HF)
- Sistema Sísmico consolidado en software mXRap
- Leapfrog para integrar información de Cámaras y Sísmica

### Definición de Estrategia de Extracción

- Se actualiza interpretación de cave back y pila de quebrado diariamente
- Se estima potencial de air blast a través de método de presiones y se evalúa máximo air gap permisible. Esta es la única limitante para la velocidad de extracción durante el quiebre



# Parque de Equipos PC1



Flota 10 LHD

Disponibilidad 80%

Producción 50000 tpd

Rendimiento LHD 6250 tpd





# LHD Híbrido

## Prueba de LHD Híbrido de 22t Joy Global

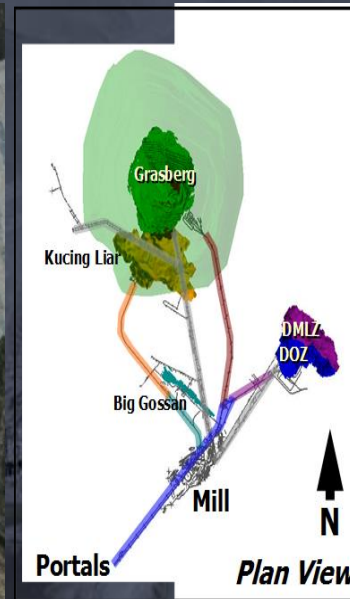
### Datos Relevantes

- Capacidad 22t
- Motor de 300 kw para 500 kw de potencia
- 50% de consumo de diesel comparado con CAT R3000H
- Costo de Capital: 2 veces el de CAT R3000H



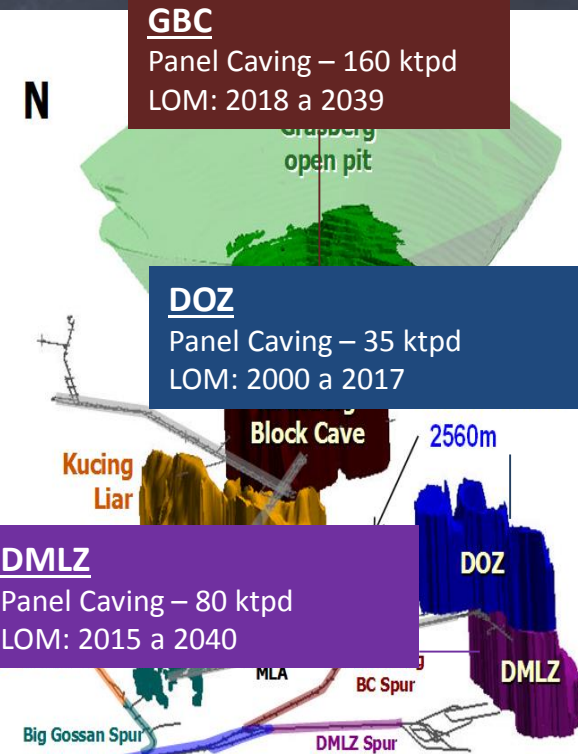
# Complejo Minero Erstsberg, Papua Indonesia

## Complejo minero Erstsberg, Papua, Indonesia



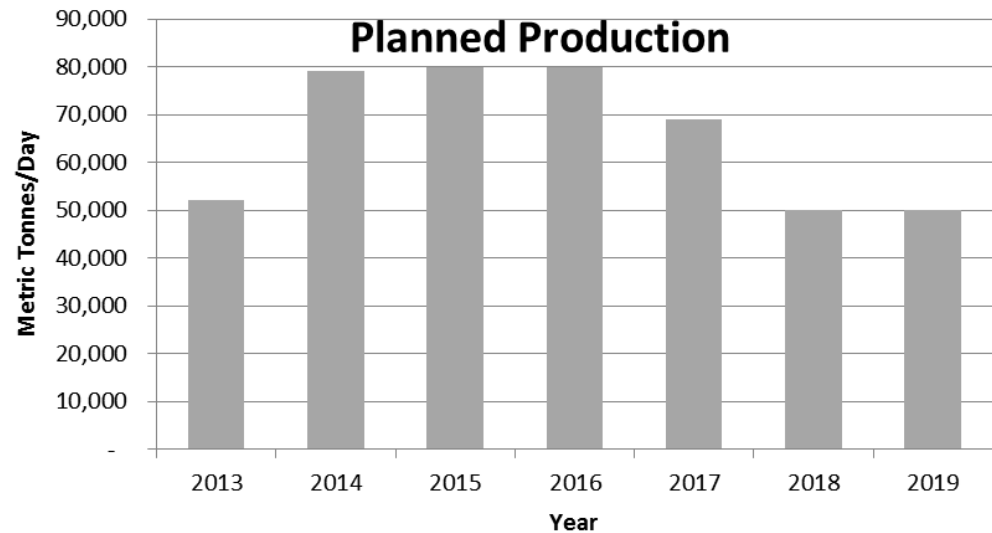
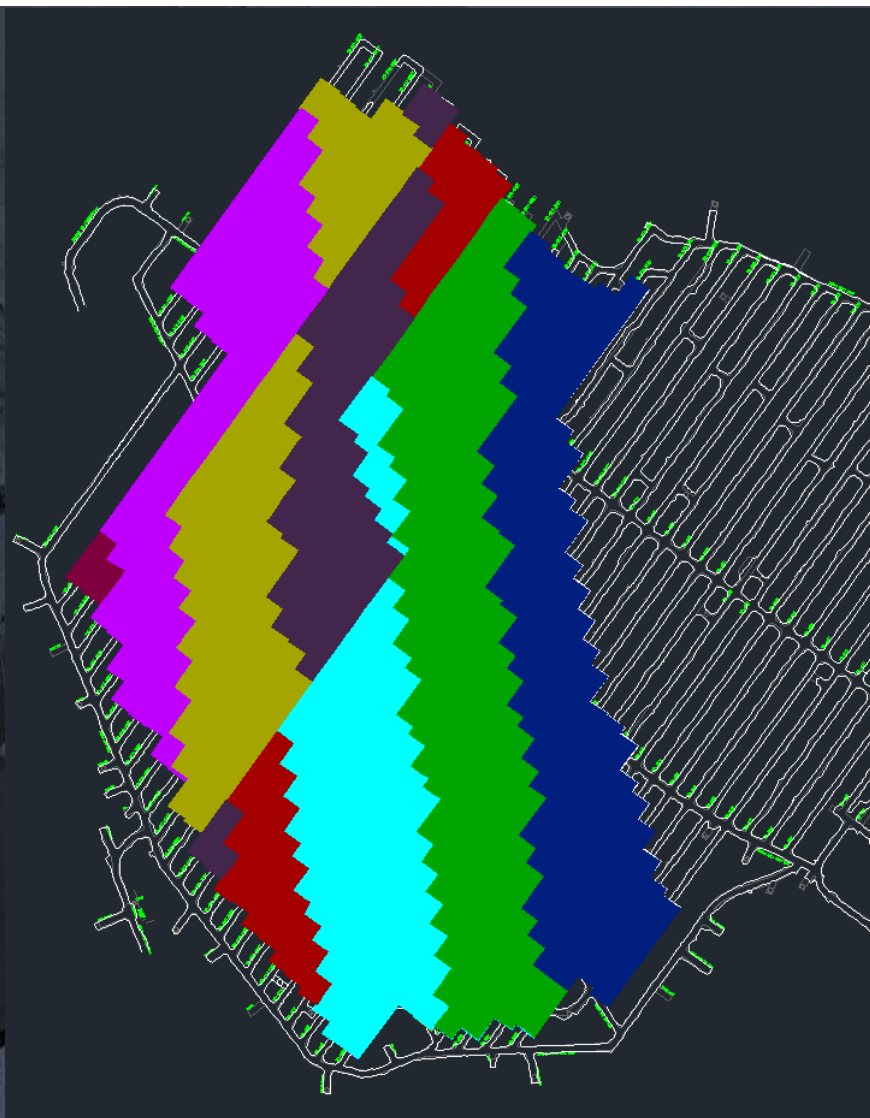
AB Portals  
(at Ridge Camp)

Common Infrastructure System:  
2,500m elevation





# DOZ Secuencia de Hundimiento



- 111 Mt @ 0,5% Cu, 0,78 g/t Au
- Malla Herringbone 18m x 30m
- 370,000 m<sup>2</sup> footprint
- Producción: 35 ktpd
- Acceso Principal por túneles mellizos de 6mx7m

#### LEGEND :

- : ACTUAL CAVE LINE
- : 2009
- : 2010
- : 2011
- : 2012
- : 2013
- : 2014
- : 2015
- : 2016

# Nivel de Producción





# Nivel de Producción



# Fortificacion Calle y Punto de Extraccion





# Rehabilitación Calles DOZ



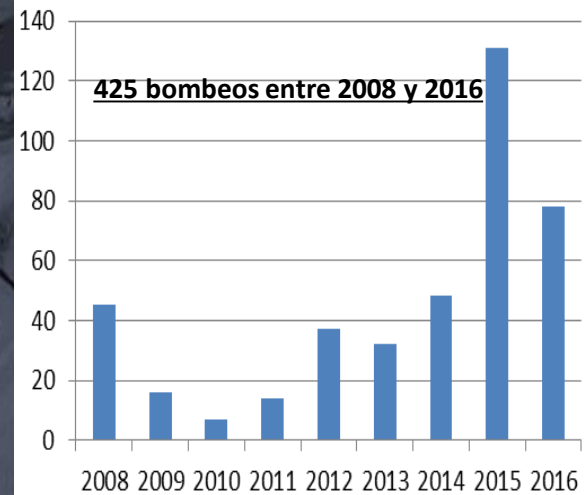
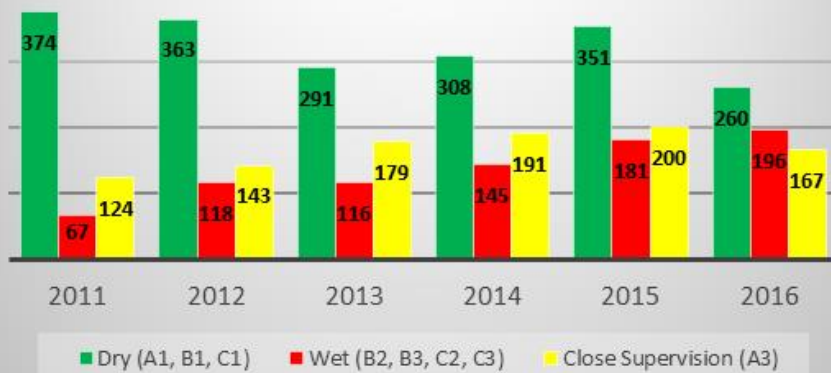


# Barro



Bombes de Barro

$\Sigma(DP \text{ Dry, Wet and Close Supervision})$





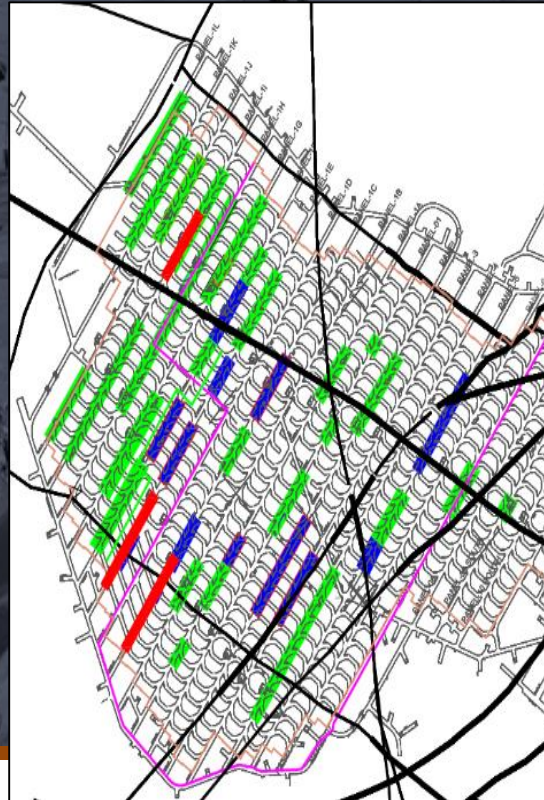
# Disponibilidad de Area DOZ

Reservas perdidas por colapsos

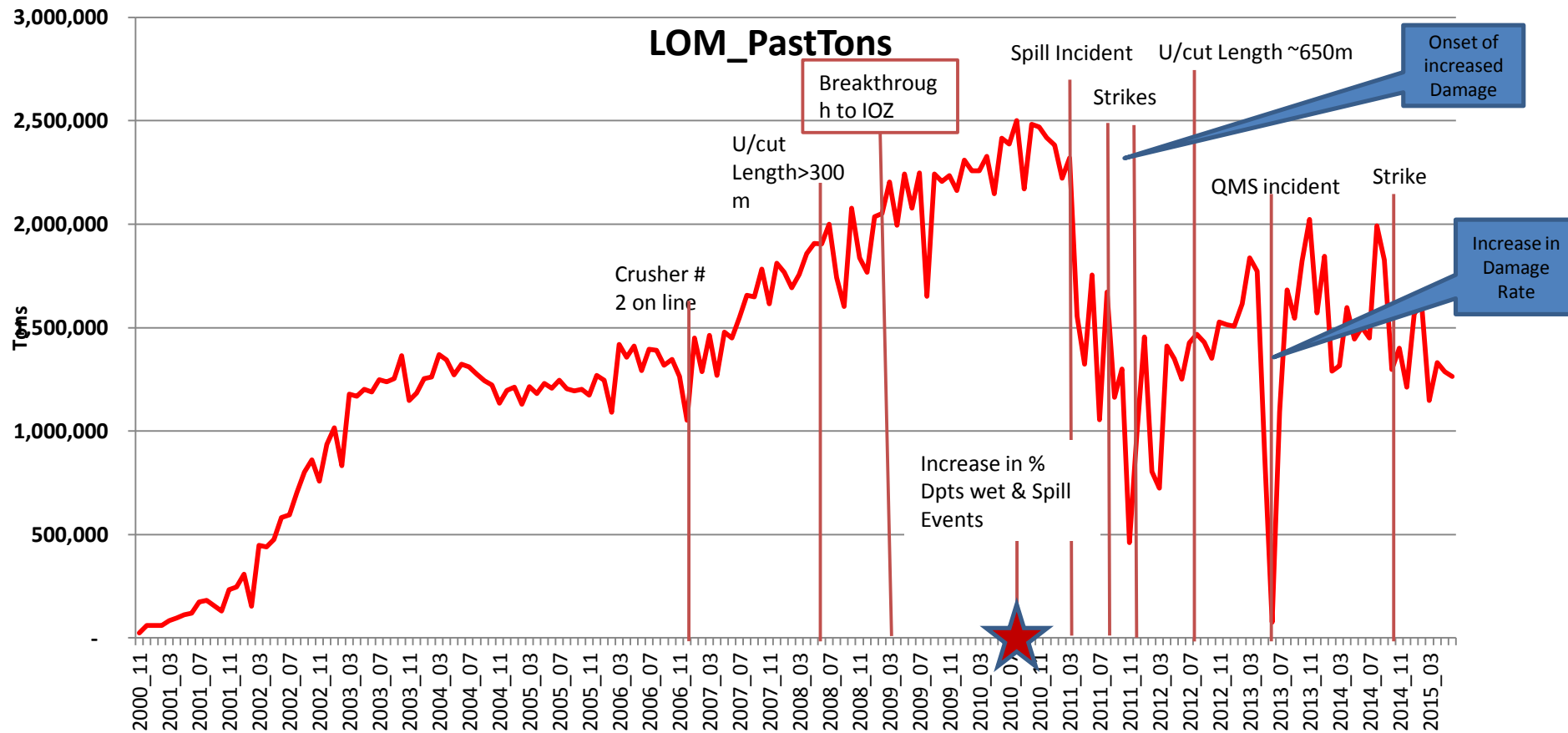
17,7 Mt @ 0,79% Cu, 0,57 g/t Au



-  Rehabilitación planificada
-  En rehabilitación
-  Calles rehabilitadas



# Producción Histórica DOZ





# DOZ Producción Areas

| Panel | PIL | PIK | PIJ | PII | PIH | PIG | PIF | PIE | PID | PIC | PIB | PIA | P01 | P02 | P03 | P04 | P05 | P06 | Panel |     |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|-----|
| D/P   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E     | D/P |
| 0     |     |     |     |     | A1  | A3T | A2T | A2T | AVT |     |     |     |     |     |     |     |     |     |       | 00  |
| 1     |     |     |     |     | A2T | AVH | AVT | A3T | A3T | A3T |     |     |     |     |     |     |     |     |       | 01  |
| 2     |     |     |     |     | A3T | AVH | AVT | A3T | A3T | A3T |     |     |     |     |     |     |     |     |       | 02  |
| 3     |     |     |     |     | A3H | AVT | A1  | AVH | A1  | AVT | B3T | B3T | B3T | C3T | C3T | C3T |     |     |       | 03  |
| 4     |     |     |     |     | A3H | A1  | A1  | A1  | A1  | AVT | C3T | C3T | B3T | B3T |     |     |     |     |       | 04  |
| 5     |     |     |     |     | A3  | A1  | A1  | AVH | A3T | B3T | B3T | C3T | C3T |     |     |     |     |     |       | 05  |
| 6     |     |     |     |     |     | A1  | A1  | AVH | A1  | B3T | B3T |     |     |     |     |     |     |     |       | 06  |
| 7     |     |     |     |     |     | A1  | A1  | AVH | A1  | A3T | C3T |     |     |     |     |     |     |     |       | 07  |
| 8     |     |     |     |     |     | A1  | A1  | A1  | A1  | AVT | AVT |     |     |     |     |     |     |     |       | 08  |
| 9     |     |     |     |     |     | A3H | AVH | AVH | AVH | AVT | AVT | A2T | A2  | AVH |     |     |     |     |       | 09  |
| 10    |     |     |     |     |     | A3H |     |     |     |     |     |     |     |     |     |     |     |     |       | 10  |
| 11    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 11  |
| 12    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 12  |
| 13    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 13  |
| 14    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 14  |
| 15    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 15  |
| 16    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 16  |
| 17    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 17  |
| 18    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 18  |
| 19    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 19  |
| 20    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 20  |
| 21    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 21  |
| 22    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 22  |
| 23    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 23  |
| 24    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 24  |
| 25    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 25  |
| 26    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 26  |
| 27    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 27  |
| 28    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 28  |
| 29    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 29  |
| 30    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 30  |
| 31    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |       | 31  |
| D/P   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E   | V   | E     | D/P |
| Panel | PIL | PIK | PIJ | PII | PIH | PIG | PIF | PIE | PID | PIC | PIB | PIA | P01 | P02 | P03 | P04 | P05 | P06 | Panel |     |

■ Cerrados (por barro/colapsos)

■ Con barro

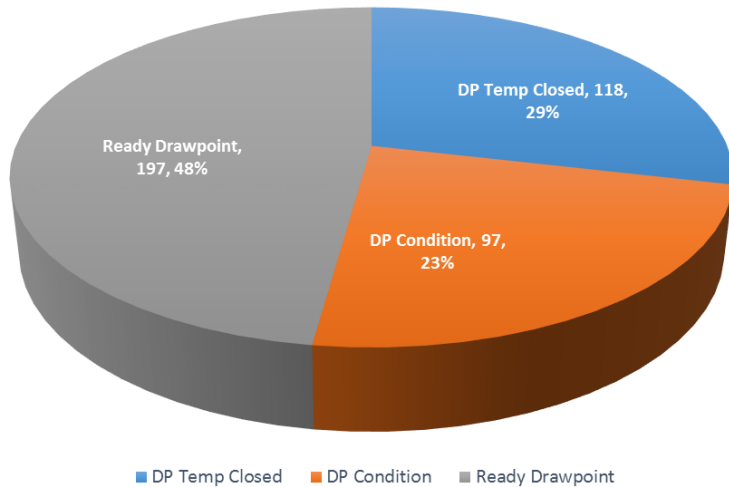
■ Supervisión exhaustiva

■ Sin barro

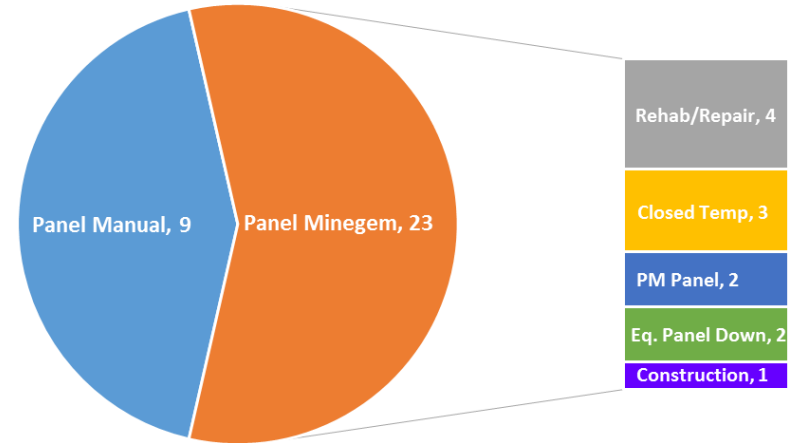
30% Colapsado, 28% Barro, 12 % Super., 30% Seco

# Disponibilidad de Area DOZ

Actual Drawpoint Availability



Actual Panel Availability



Puntos de Extracción Abiertos 694

- 155 Puntos de Extracción Secos
- 539 Puntos de extracción con Humedad

Puntos de Extracción Cerrados o Colapso 282

Puntos de Extracción Disponible 412

- 197 OK para extraer 48%

Calles de Producción Activas

- 9 Calles secas
- 23 Calles Humedad
- 12 Calles No disponible
- Disponibilidad de Calles 62%

Puntos Efectivos para Extraer 30% ( 124 ) 25000 tpd



# Extracción de Barro

## Extracción de Barro

### ➤ LHD SA:

- Parque de 19 LHD SA 10t para extracción de Barro: 6 – 7 operativos (130 tph, 12 hrs/día)
- 2 – 3 enterrados en barro
- 2 – 3 en Overhaul luego de ser recuperados
- 7 – 8 Fuera de servicio por mantención o baja de servicio MineGem
- Otros en labores de servicio (recuperando LHD o limpiando)



# Clasificación de Puntos de Extracción con Barro

**Table 2 Wet Muck Classifications (Previous Version)**

| DRAW POINT CLASSIFICATION                              | TYPE OF LOADER USED        |
|--------------------------------------------------------|----------------------------|
| A. COARSE DRY<br>+70% > 50 mm (2in)<br>MC < 8.5%       | AL = ANY LOADER            |
| B. FINE DRY<br>+30% < 50 mm (2in)<br>MC < 8.5%         | AL = ANY LOADER            |
| C. COARSE WET<br>+70% > 50 mm (2in)<br>MC : 8.5% - 11% | RL = REMOTE CONTROL LOADER |
| D. COARSE VERY WET<br>+70% > 50 mm (2in)<br>MC > 11%   | RL = REMOTE CONTROL LOADER |
| E. FINE WET<br>+30% < 50 mm (2in)<br>MC : 8.5% - 11%   | RL = REMOTE CONTROL LOADER |
| F. FINE VERY WET<br>+30% < 50 mm (2in)<br>MC > 11%     | RL = REMOTE CONTROL LOADER |



# Clasificación de Puntos de Extracción con Barro

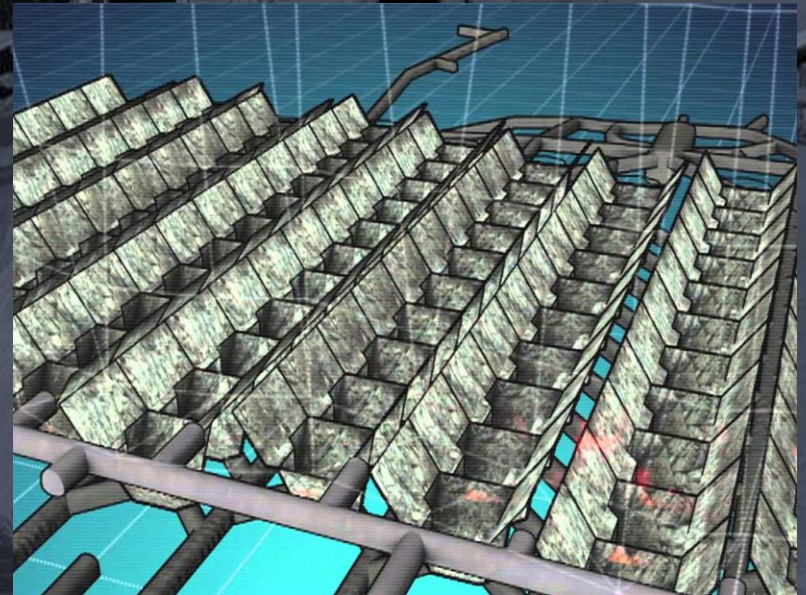
**Table 3 Wet Muck Classifications (New Version)**

| Wetness/Water content                                                                                                                                                                             | Material size $\geq 5$ cm (M)          |                      |                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------------|-----------------------------------------|
|                                                                                                                                                                                                   | M > 70%<br>(dominated by coarse grain) | $30\% < M \leq 70\%$ | M $\leq 30\%$ (dominated by fine grain) |
| < 8.5% (dry)                                                                                                                                                                                      | <b>A1</b>                              | <b>B1</b>            | <b>C1</b>                               |
| 8.5 -11% (moist)                                                                                                                                                                                  | <b>A2</b>                              | <b>B2</b>            | <b>C2</b>                               |
| $\geq 11\%$ (wet)                                                                                                                                                                                 | <b>A3</b>                              | <b>B3</b>            | <b>C3</b>                               |
| Note:<br>Green box : any loader<br>Yellow box : any loader with close supervision<br>Red box : remote loader<br>For Class B2 and A3, HOD/Fragmentation information is critical to consider surely |                                        |                      |                                         |

## Tema de discusión

When a wet drawbell is not being pulled or its drawpoints closed / concreted and muck has been saturated, water will be transferred to adjacent drawbells

- Drawbell ~ Ice cube tray

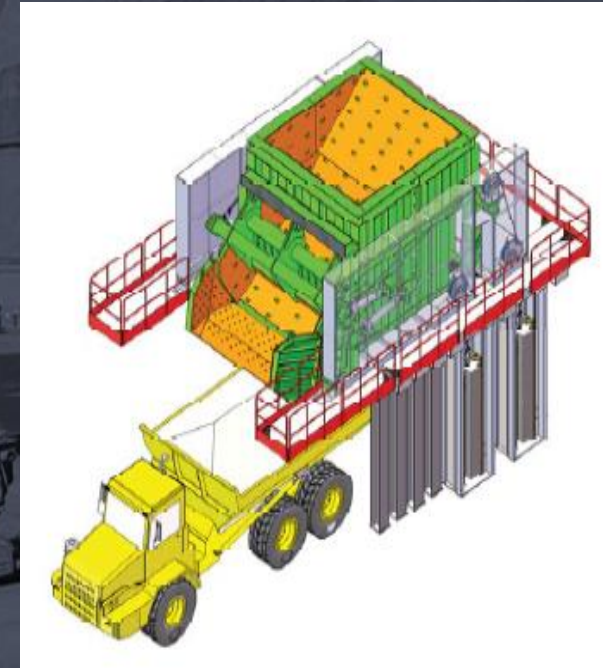




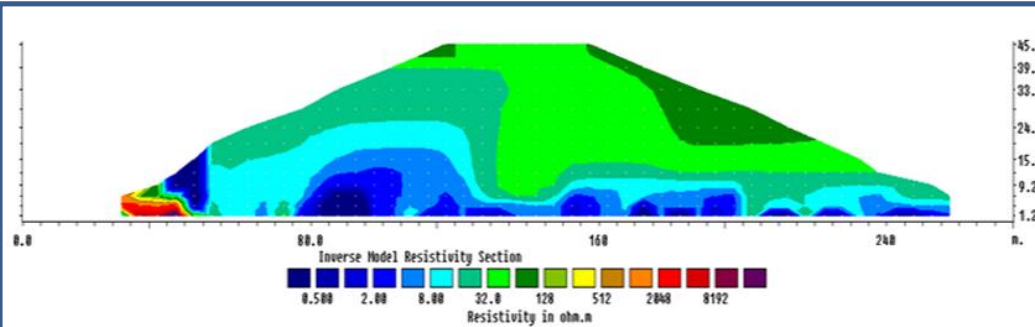
# Tecnología DOZ - DMLZ

## Extracción de Barro

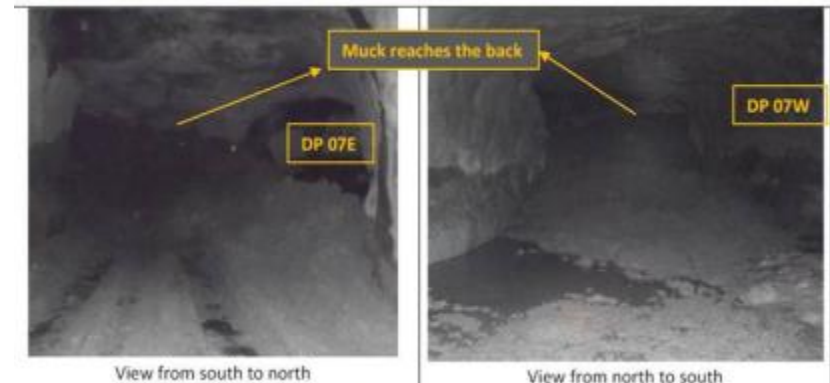
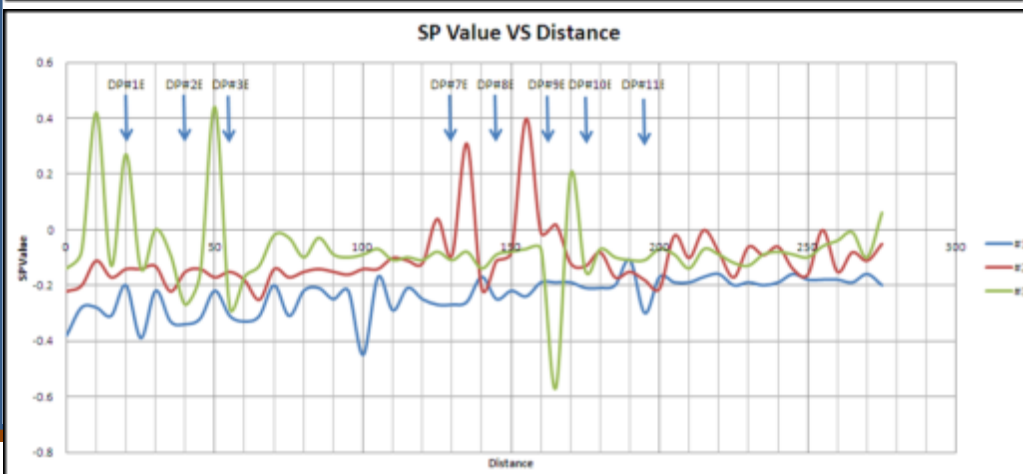
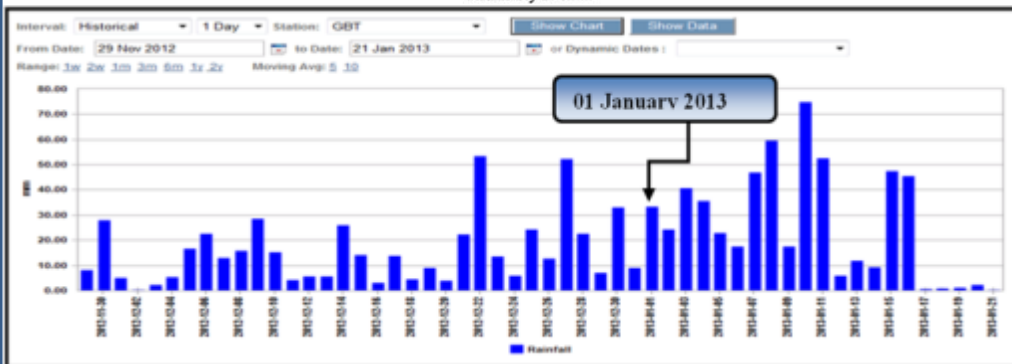
- Buzones Teleoperados y Carga en Reversa de Camión CAT AD55



# Tecnología Instrumentación Resistividad



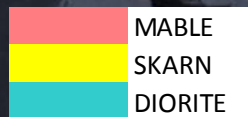
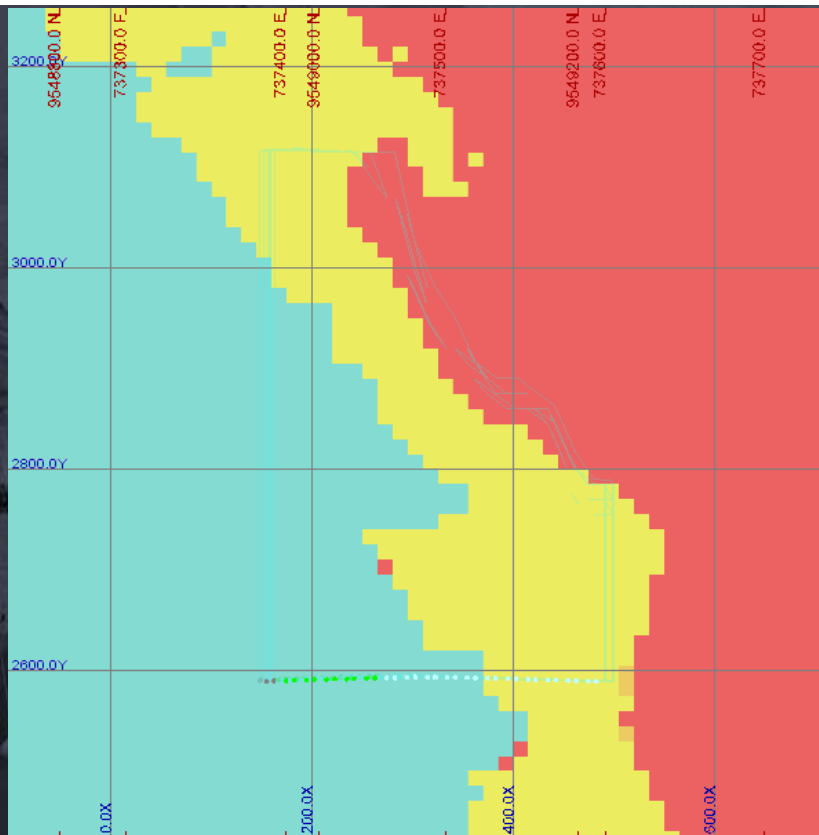
- The result from resistivity & SP show significant correlation with rain fall rate, spill and mucking activity.
- Conclusion from this trial, Spill will be occurred when the rain fall rate is above 20mm per day, water flowing above wet draw point and mucking activity.



| 1   | Draw Point Name | dump loc. | 25-Dec | 26-Dec | 27-Dec | 28-Dec | 29-Dec | 30-Dec | 31-Dec | 1-Jan | 2-Jan | 3-Jan | 4-Jan |
|-----|-----------------|-----------|--------|--------|--------|--------|--------|--------|--------|-------|-------|-------|-------|
| 634 | P03-01W         | P03       | -      | -      | 19     | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 635 | P03-02W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 636 | P03-03W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 637 | P03-04W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 638 | P03-05W         | P03       | -      | -      | 57     | -      | 150    | -      | -      | 0     | 0     | 0     | 0     |
| 639 | P03-06W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 700 | P03-07W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 701 | P03-08W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 119   | 0     | 0     |
| 702 | P03-09W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 20    | 0     | 0     |
| 703 | P03-10W         | P03       | -      | -      | 30     | -      | 135    | -      | -      | 0     | 0     | 0     | 0     |
| 704 | P03-11W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 705 | P03-12W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 0     | 0     | 0     |
| 706 | P03-13W         | P03       | -      | -      | -      | -      | -      | -      | -      | 0     | 169   | 532   | 0     |



# DMLZ Geotecnia



- Preparación y Hundimiento se esta desarrollando
- Sector de Altos Esfuerzo con una alta Actividad sísmica
- Sistema de Soporte ha trabajado bien. Principal riesgo es la eyección de la “piel” del macizo rocoso “ Strainburst” la cual esta siendo administrada, en las cajas del nivel de hundimiento estan colocando capas de shotcrete, malla y pernos
- Sistema sísmico instalado, combinado con la evaluación geomecánica
- Primera etapas del caving con un a radio Hidráulico de 28 . Area Inicial Hundibilidad RH 30 y 56 caving sustentable

# DMLZ

Reserve (Based on Forecast Q1-2016):

- 460,3 Million tons
- 0,89 % Cu & 0.74 g/t Au

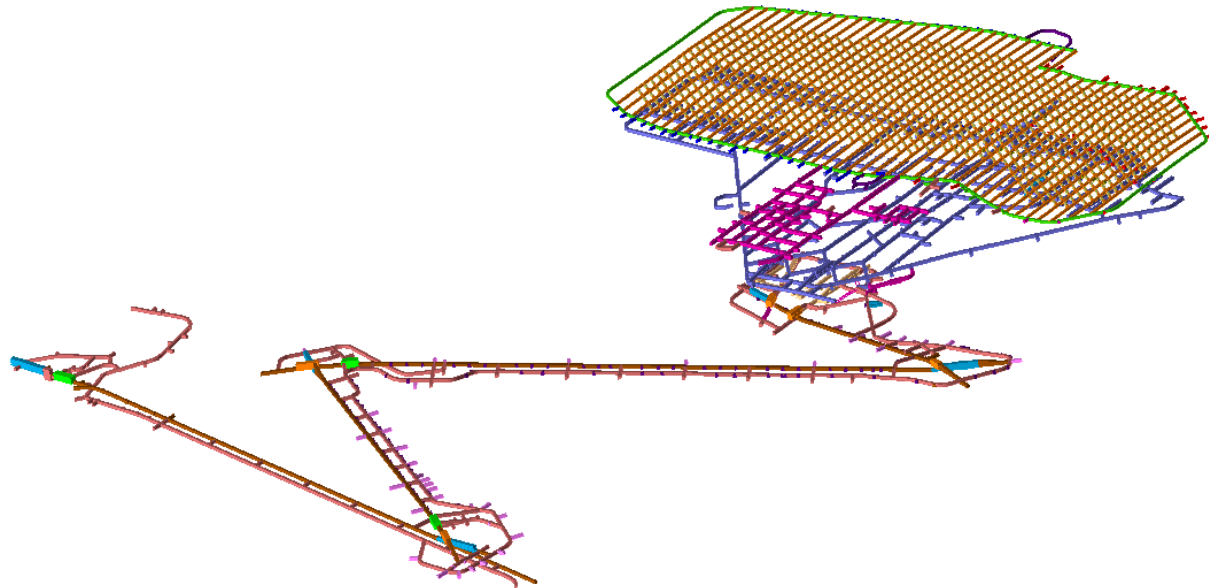
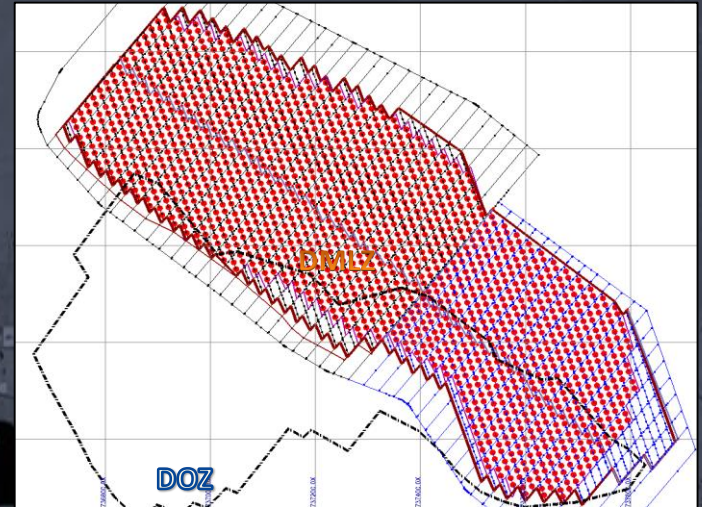
*Advance Undercut system*

Project commence 2008

Production startup September 2015

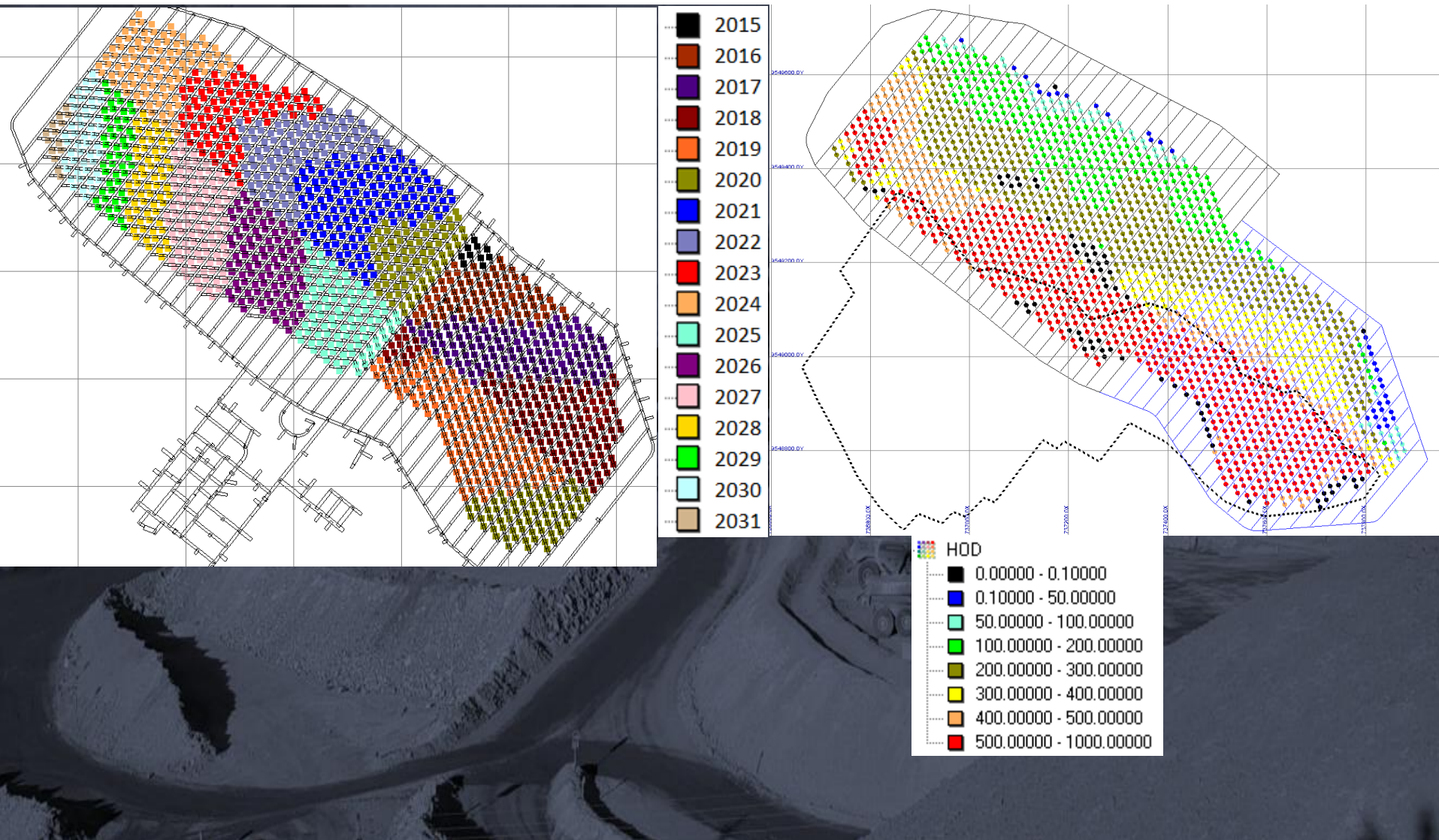
Capex until 2015: \$1.4 Bn

Total developed (2008-2015): 110 km

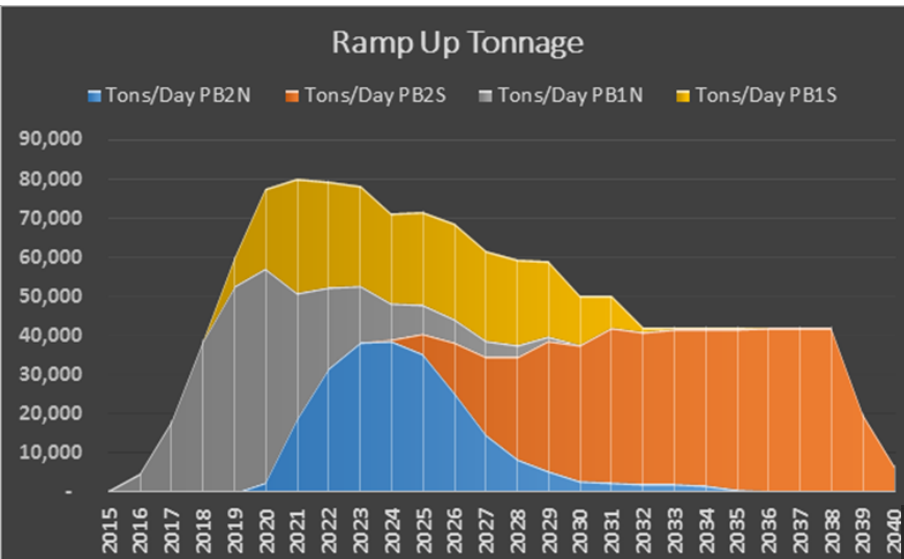




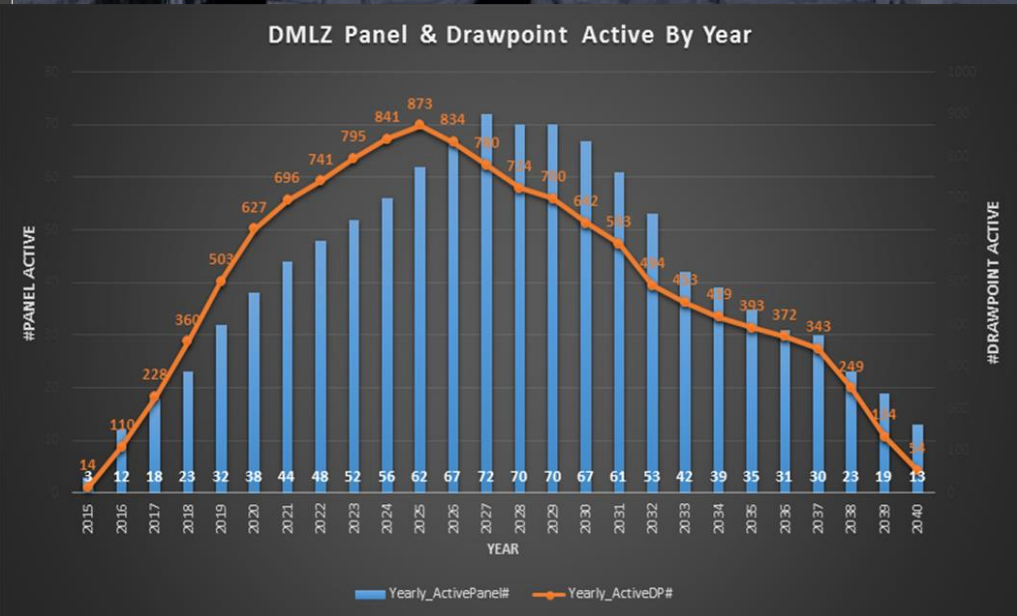
# Macrosecuencia y Alturas Extraíbles DMLZ



# Plan de Producción



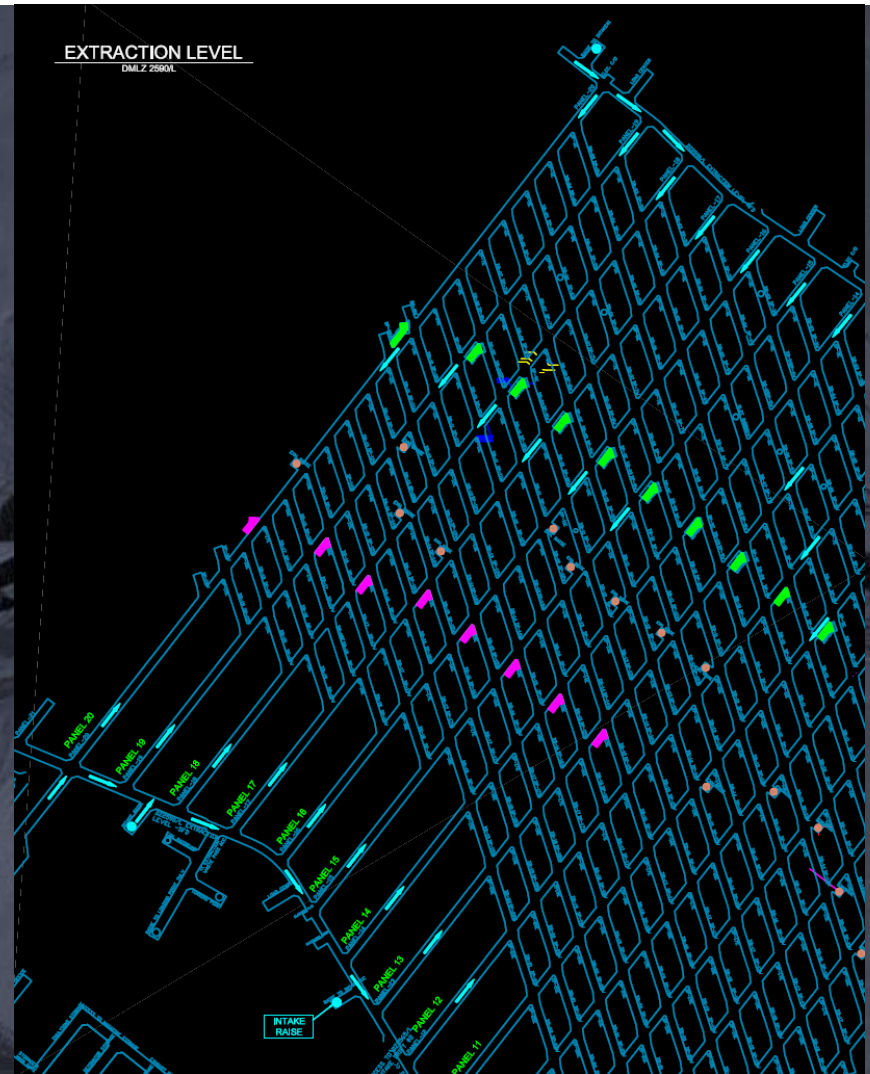
Ram up 6 años  
80.000 tpd





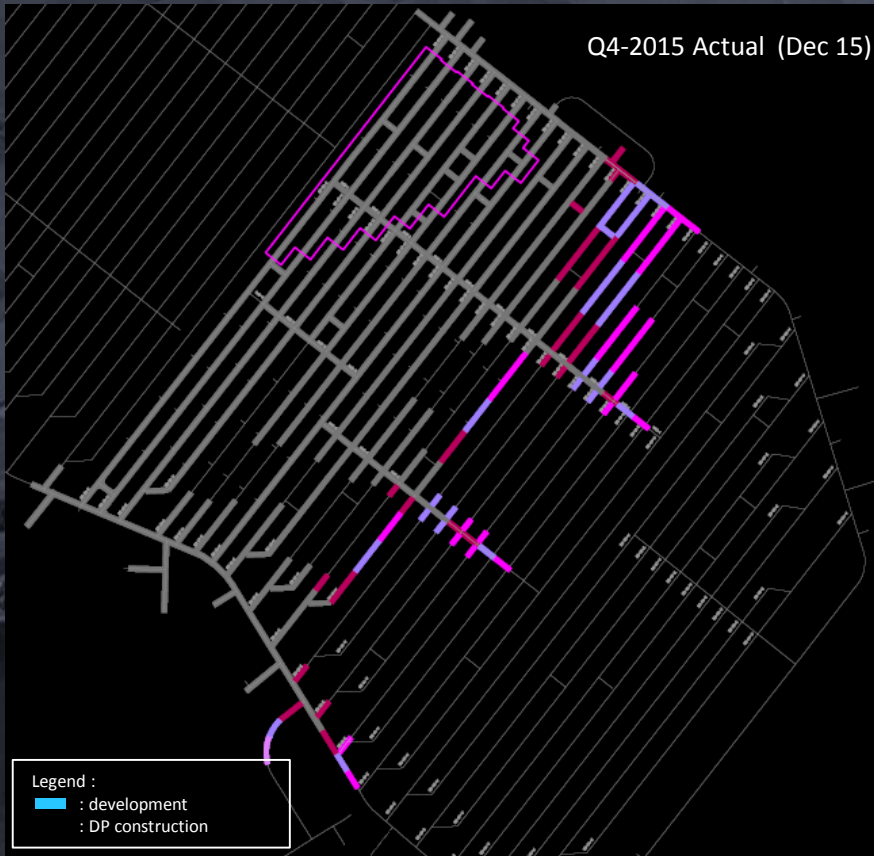
# DMLZ Diseño Minero

- El-tiente layout with 20m x 30m
- Drift dimension
  - EXT : 4.4m x 4m
  - UC : 4.0m x 3.8m
  - Haulage : 5.5m x 5m
- Draw points= 1.803
- 2 segments ventilations
- Each panels has 2 grizzlies with fixed rock breaker
- Truck Haulage system using AD 55

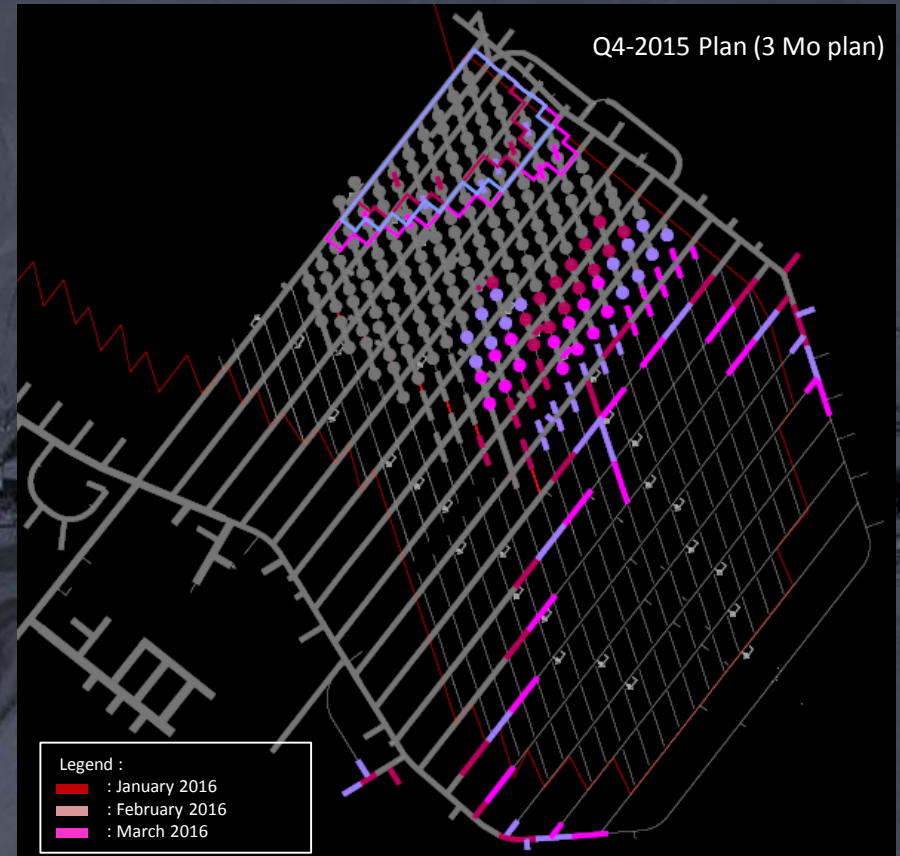


# Preparación UCL & Producción Marzo 2016

Q4-2015 Actual (Dec 15)



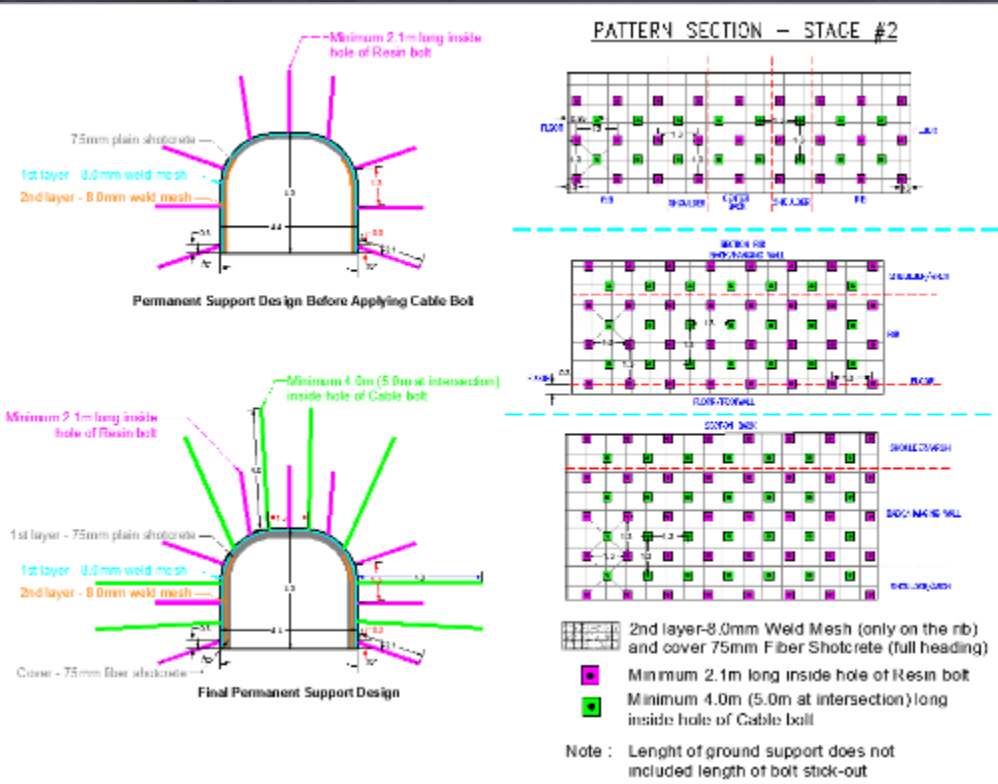
Q4-2015 Plan (3 Mo plan)



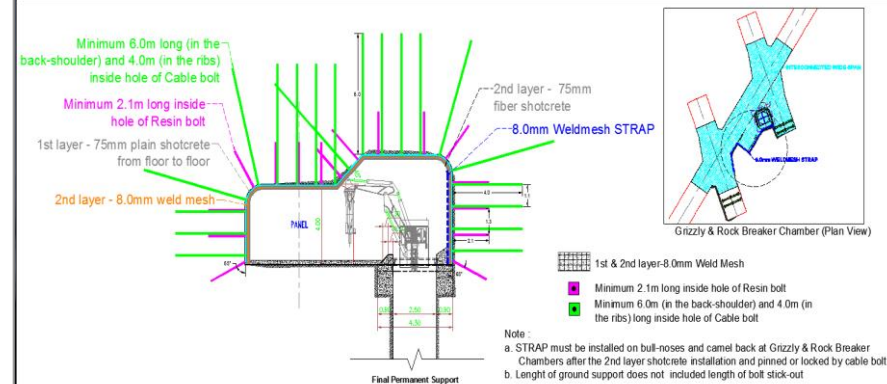


# Fortificación Nivel de Producción

## MAIN DRIFT / PANEL - Dimension 4.4mH × 4.0mW



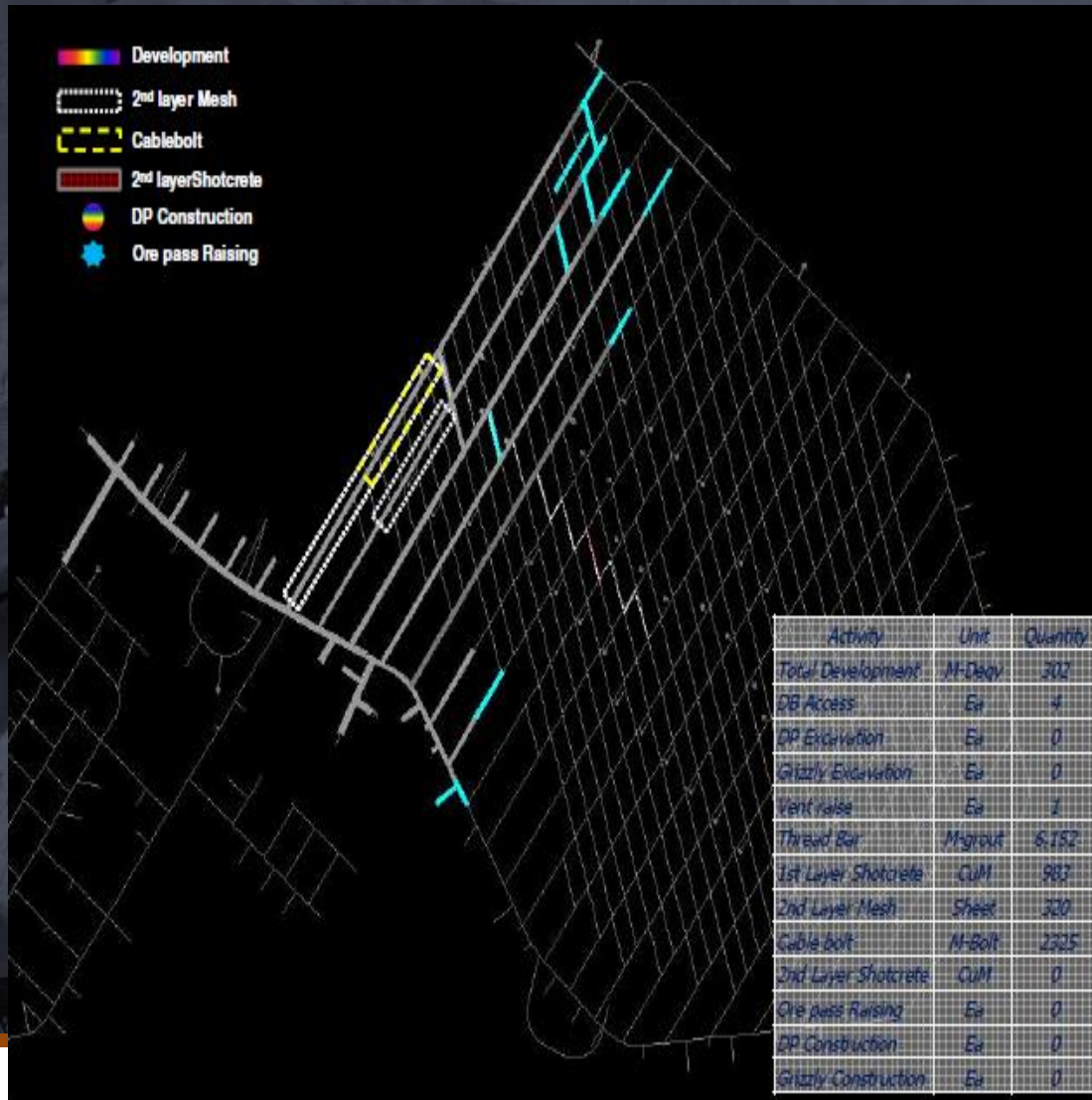
## GRIZZLY & ROCK BREAKER CHAMBER – Dimension 10.3-16.0mW × 4.0-5.5mH



- 8mm weldmesh + shotcrete , resin bolt and cable bolt are the standard ground support at extraction level
- The undercut level only use splitset and shotcrete for the Drill drift and for the the intersection added with cable bolt
- On January 2016, UG Geotechnical reviewed the recommendation for using in-situ shotcrete followed with resin bar and cable bolt

# Estrategia de Desarrollos

## Secuencia de Desarrollos Típica

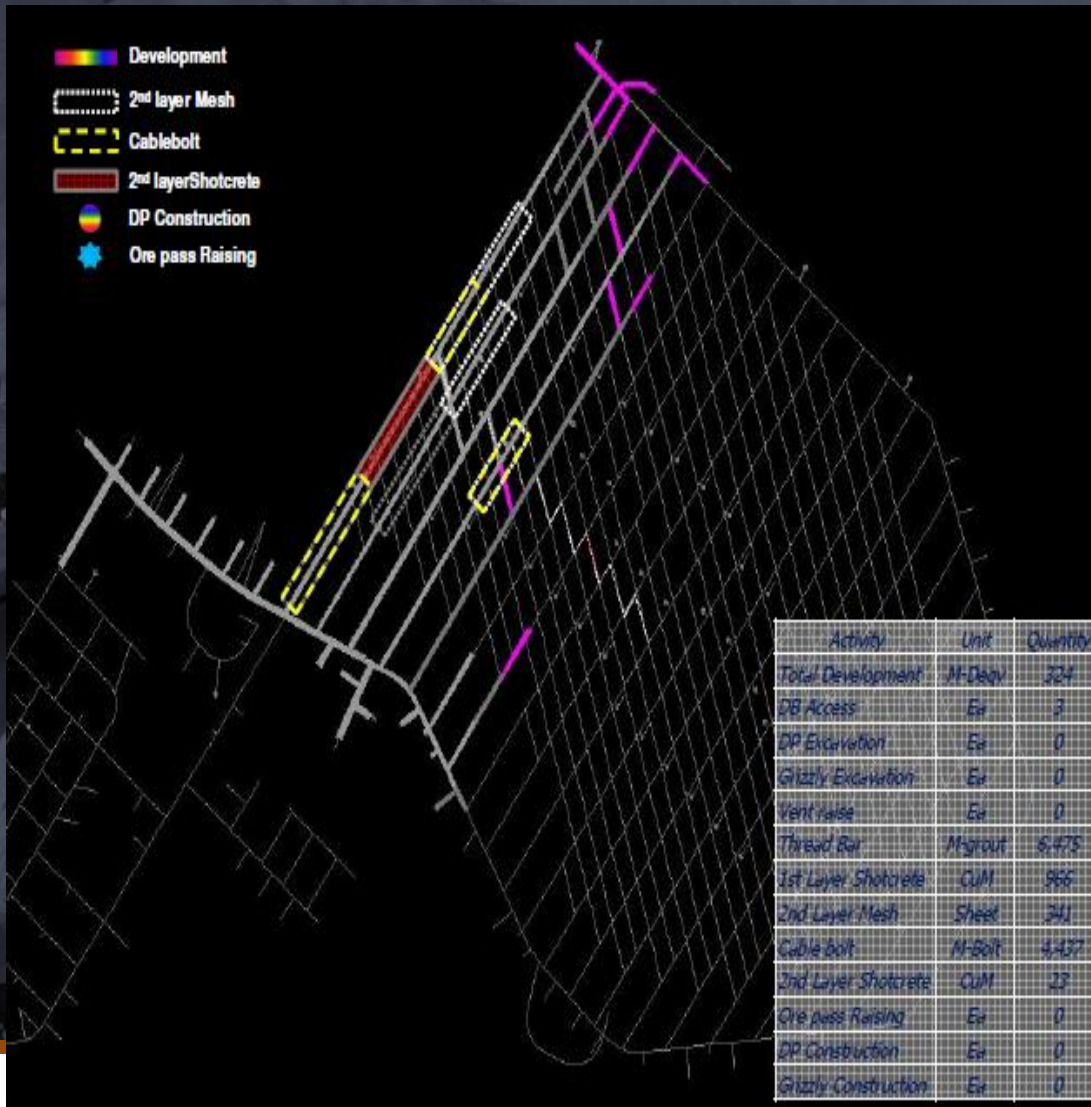


- Desarrollo con fortificación de avance 100 m delante de fortificación definitiva
- Secuencia prioriza accesos independientes para cuadrillas de avance y fortificación



# Estrategia de Desarrollos

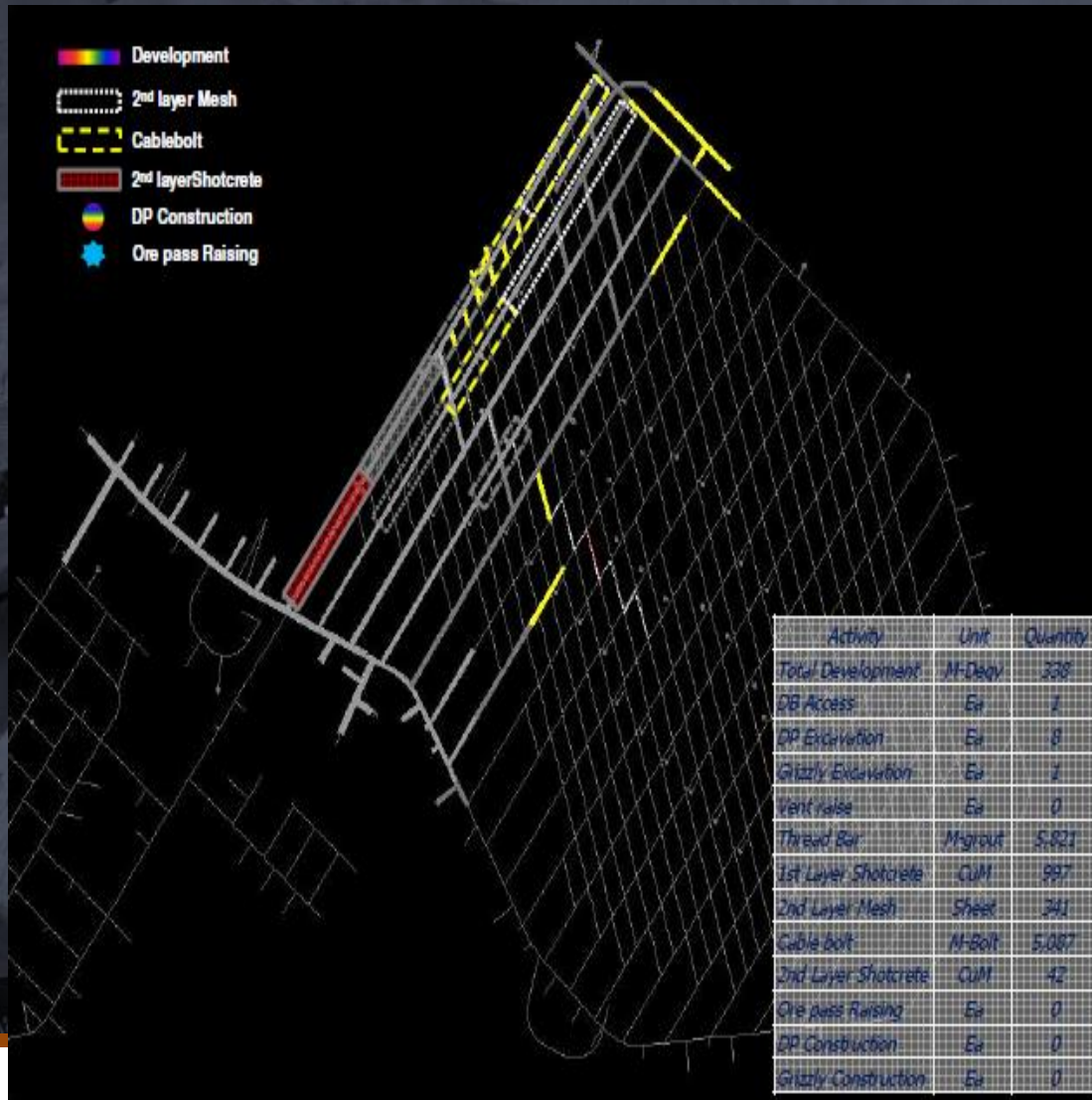
## Secuencia de Desarrollos Típica



- Desarrollo con fortificación de avance 100 m delante de fortificación definitiva
- Secuencia prioriza accesos independientes para cuadrillas de avance y fortificación

# Estrategia de Desarrollos

## Secuencia de Desarrollos Típica

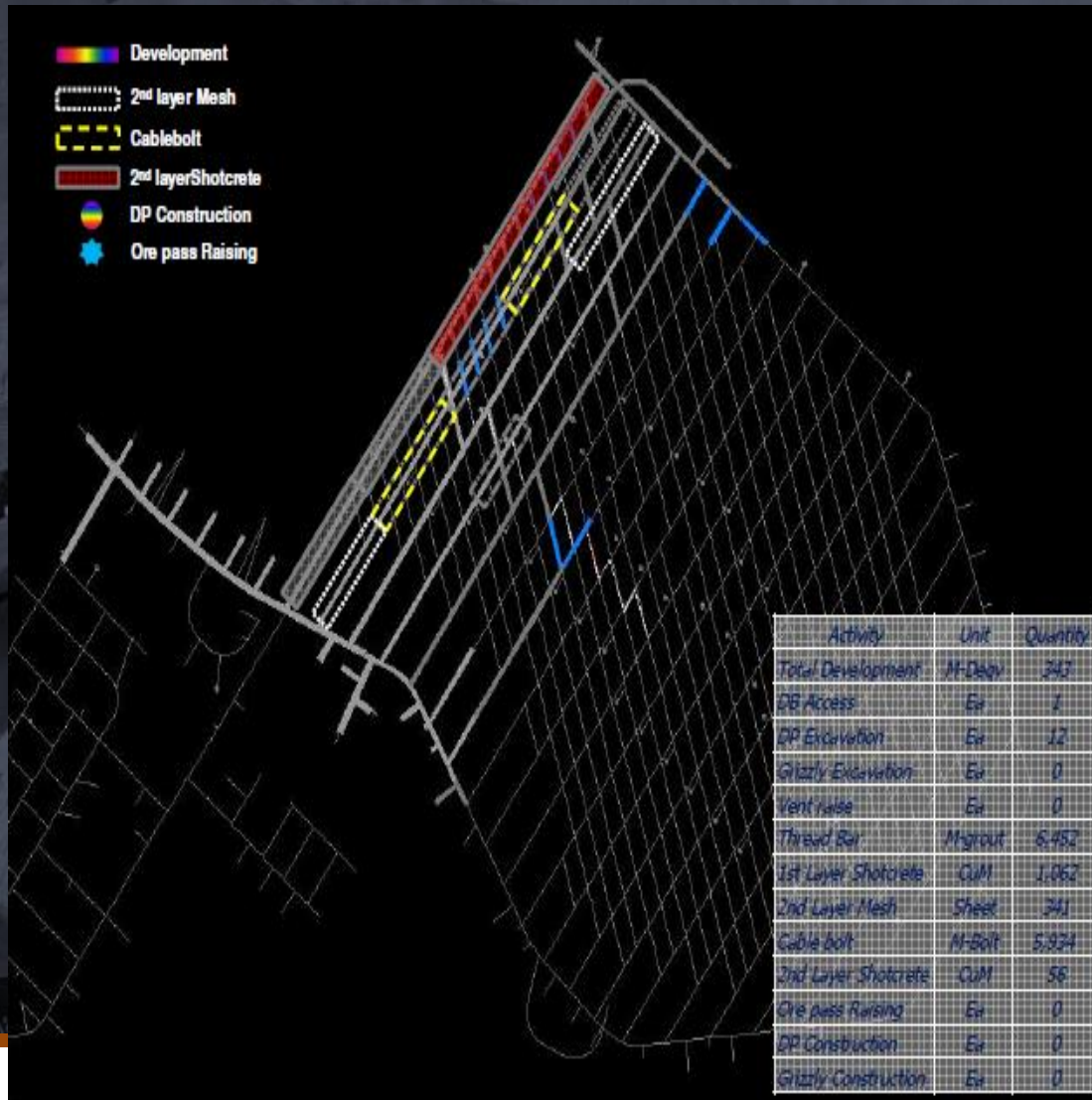


- Desarrollo con fortificación de avance 100 m delante de fortificación definitiva
- Secuencia prioriza accesos independientes para cuadrillas de avance y fortificación



# Estrategia de Desarrollos

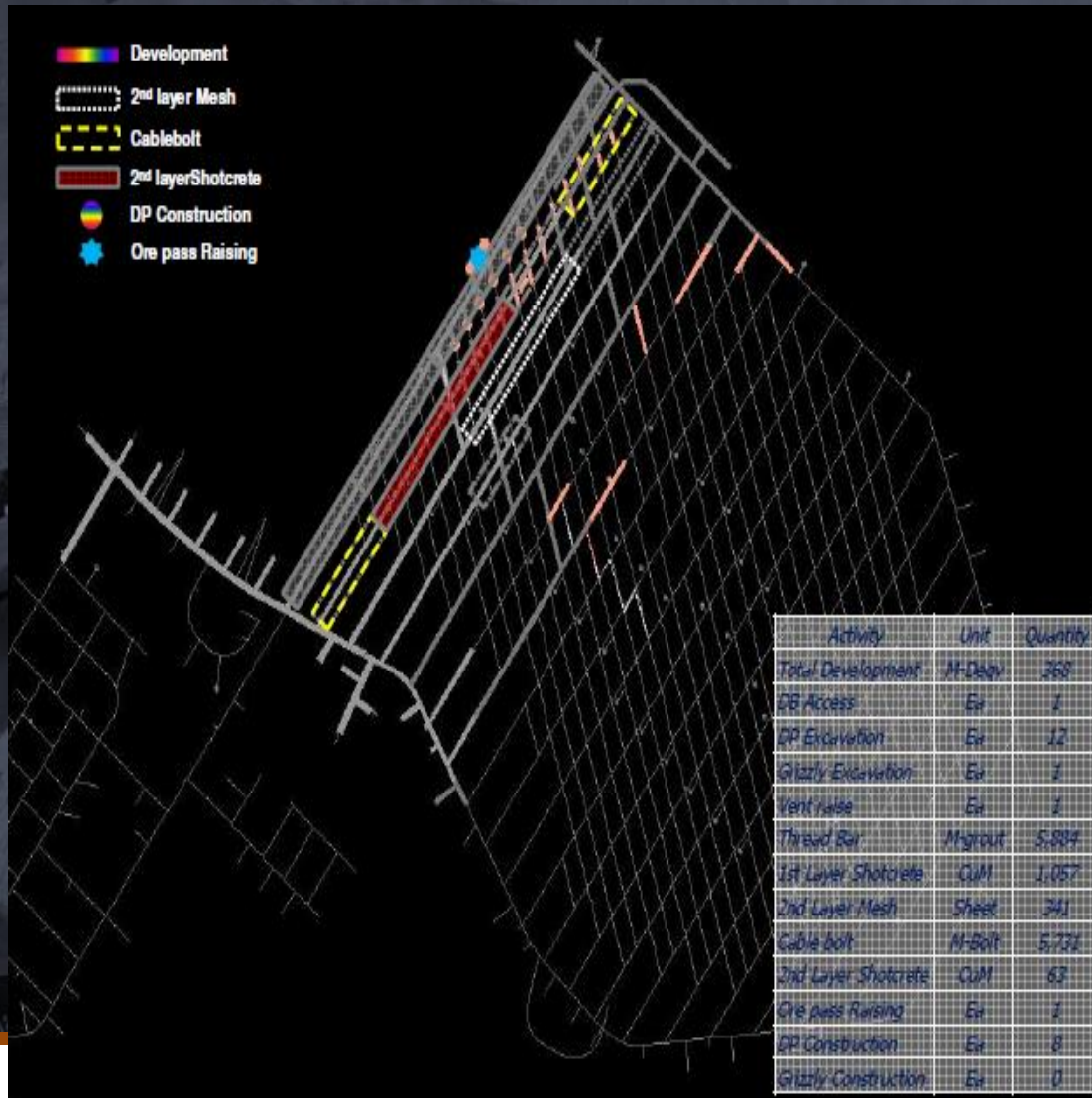
## Secuencia de Desarrollos Típica



- Desarrollo con fortificación de avance 100 m delante de fortificación definitiva
- Secuencia prioriza accesos independientes para cuadrillas de avance y fortificación

# Estrategia de Desarrollos

## Secuencia de Desarrollos Típica



- Desarrollo con fortificación de avance 100 m delante de fortificación definitiva
- Secuencia prioriza accesos independientes para cuadrillas de avance y fortificación



# DMLZ Calle Producción



# DMLZ Construcción Punto de Extracción





# DMLZ Construcción Punto de Extracción



# DMLZ Calle Zanja





# DMLZ Calle Producción

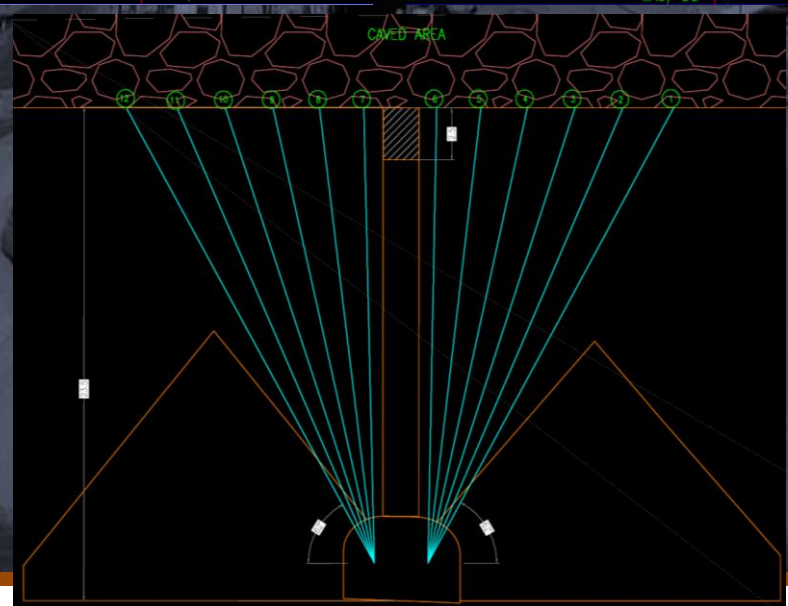
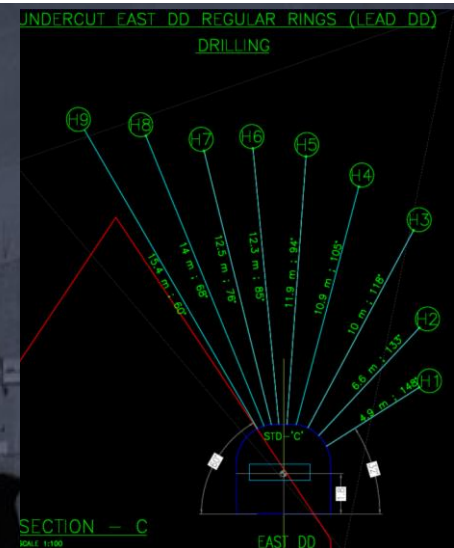
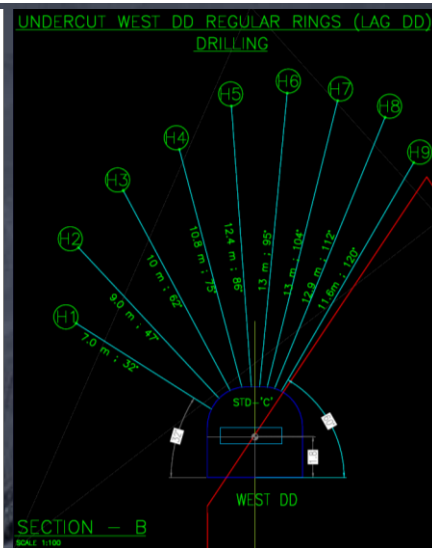
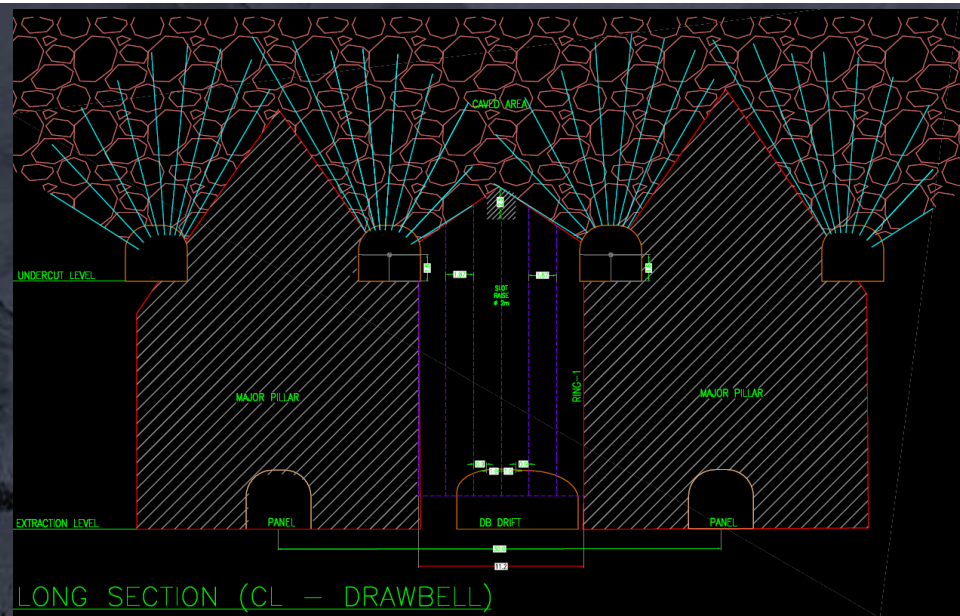


# DMLZ Calle Producción





# Perforación % Tronadura



## UC Drilling:

- 9 Holes each rings staggerred
- With 89 mm bit diameter
- Ring Interval (burden) is 2.2 m
- Hole's toe spacing is 2.4 m

## DB Drilling:

- Seven ring each drawbell
- Ring Interval (burden) is 2.25 m
- Hole Spacing is 2.1 m
- Drill holes no breakthrough 0.5 from undercut level

# DMLZ Tronadura de Zanja 1 Fase





# DMLZ Tronadura de Zanja 1 Fase



# DMLZ Frentes de Hundimiento





# DMLZ Calle Nivel de Hundimiento



# DMLZ Calle Nivel de Hundimiento

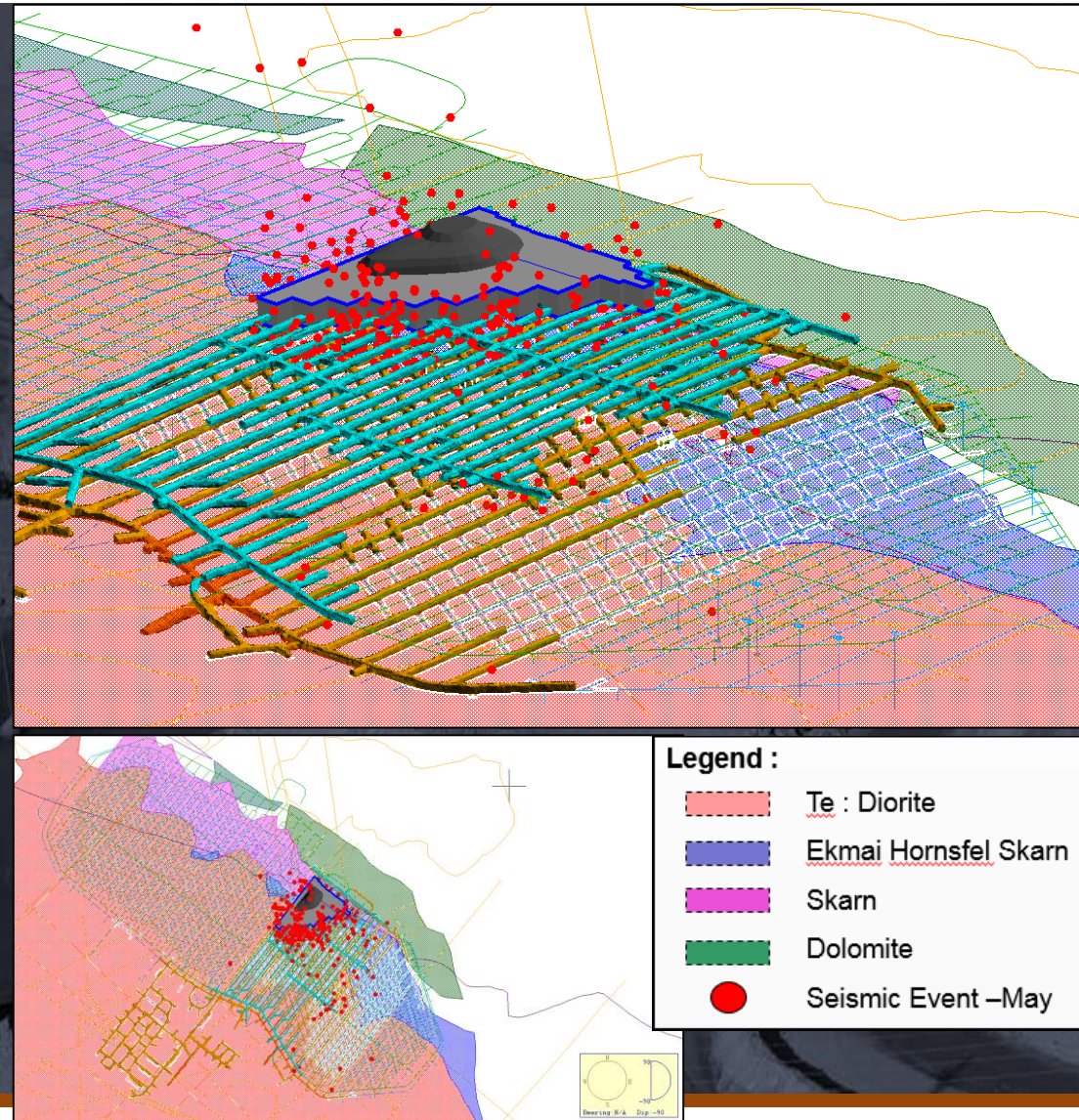




# DMLZ Cruzados Nivel de Hundimiento



# Desafíos DMLZ

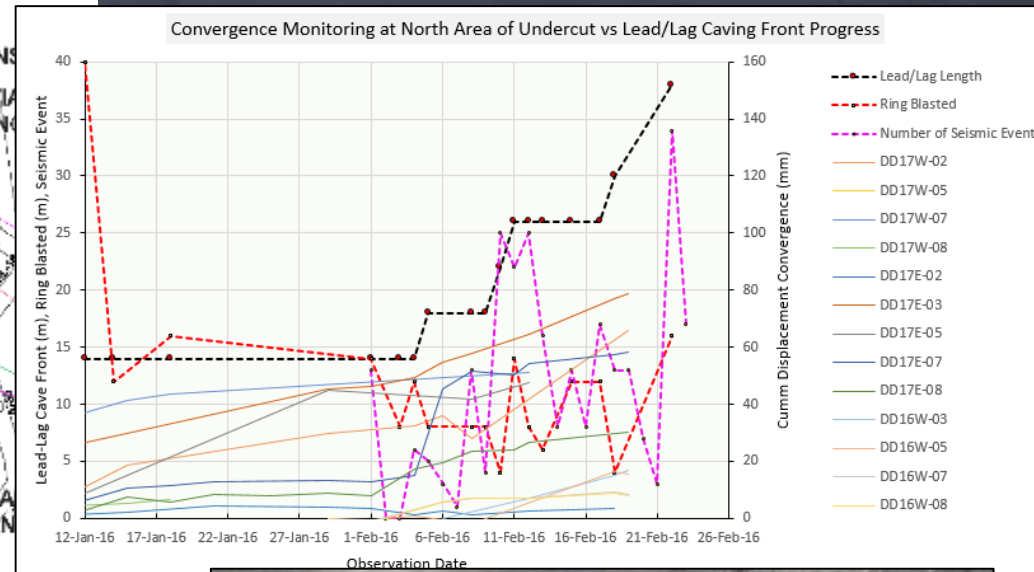
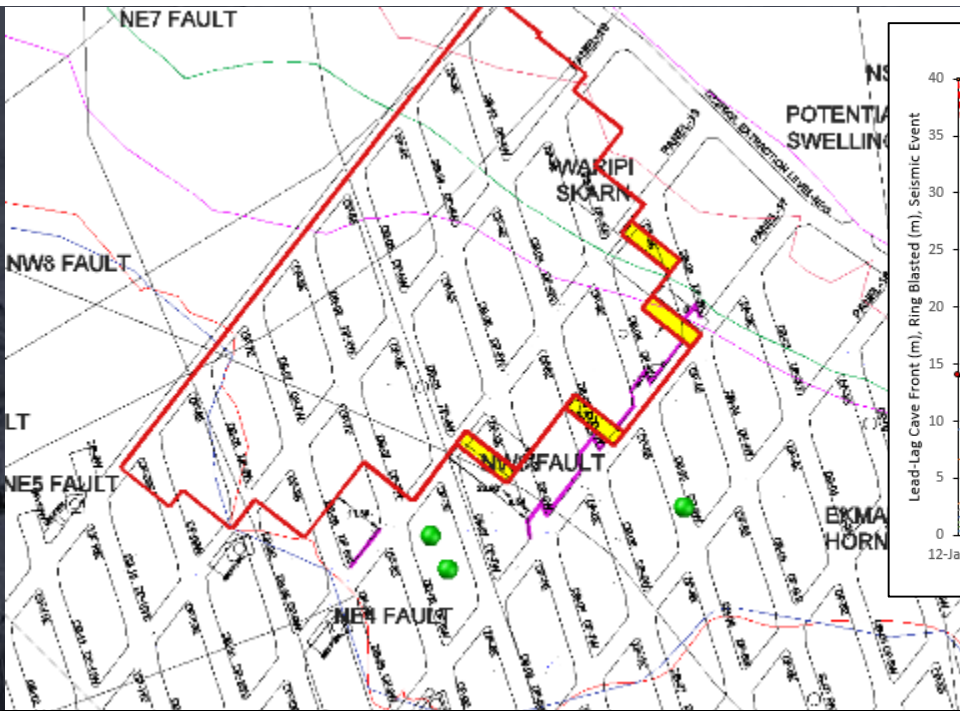


- DMLZ extraction level located on 2590/L approximately 1400m from the surface
- The high stress environment and brittle rock
- Rock Bursting and Wet Muck

Junio de 2016,  
15000 m2 socavados,  
con un Radio  
Hidráulico de 25



# Administracion Caving (Cantidad de Paradas a Tronar, Sísmica, Geometría (lead/lag))



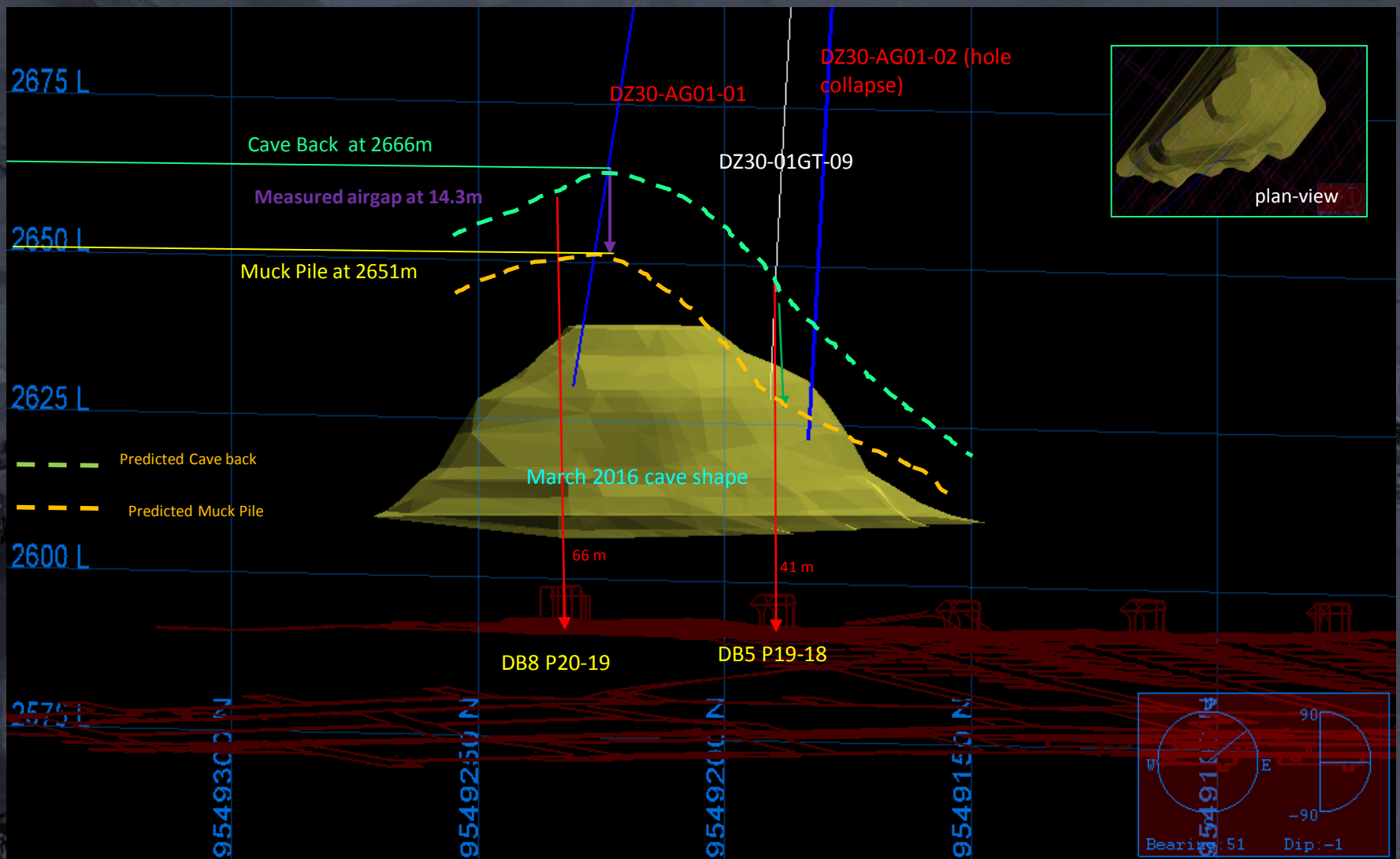
| No. | Date       | Time     | Level | Magnitude | Remarks                                  |
|-----|------------|----------|-------|-----------|------------------------------------------|
| 1   | 1/2/2016   | 17:30:35 | 2713  | 1.1       | Damage Panel 17 DP3W-7W and DD18E        |
| 2   | 20/02/2016 | 11:33:18 | 2602  | 0.8       | Damage Panel 18 DP6W-7W                  |
| 3   | 23/02/2016 | 2:04:50  | 2600  | 0.9       | Damage Panel 17 DP7W and MAD#1 DD18W-17W |



Panel 17 DP07W – view to south (February 23<sup>rd</sup>, 2016)

- Monitor caving advance to observed ground response, stress level and seismic activities related to undercutting
- Regular updates the geomechanic analyses

# Monitoreo Caving Airgap





# Monitoreo Caving Airgap

- Three open holes were drilled to monitor the air gap
- Measurements indicate movement of the cave back with a relatively constant gap between cave back and muck pile; ~ 13-14m
- Monitor closely both during early stage to sustain caving and caving times

| DZ30-01AG-02 |        |                                                      |                 |             |
|--------------|--------|------------------------------------------------------|-----------------|-------------|
| Measurement  | Date   | Cave Back Level                                      | Muck Pile Level | Air Gap (m) |
| 1            | 23-Feb | 2622                                                 | 2617            | 5           |
| 2            | 14-Mar | 2624                                                 | 2618            | 6           |
| 3            | 13-Apr | 2626                                                 | 2620            | 6           |
| 4            | 27-Apr | Unable to be measured, collapse at 280 m from collar |                 |             |

| DZ30-01AG-01 |        |                                                 |                 |             |
|--------------|--------|-------------------------------------------------|-----------------|-------------|
| Measurement  | Date   | Cave Back Level                                 | Muck Pile Level | Air Gap (m) |
| 1            | 14-Mar | 2631                                            | 2617.5          | 13.5        |
| 2            | 13-Apr | 2634                                            | 2620.5          | 13.5        |
| 3            | 27-Apr | Unable to be measured, need to recondition hole |                 |             |
| 4            | 3-May  | 2645.7                                          | 2632.7          | 13          |
| 5            | 11-May | 2665.7                                          | 2651.4          | 14.3        |

| DZ30-01GT-09 |        |                 |                                         |             |
|--------------|--------|-----------------|-----------------------------------------|-------------|
| Measurement  | Date   | Cave Back Level | Muck Pile Level                         | Air Gap (m) |
| 1            | 27-Apr | 2628            | material railing, unable to be measured |             |
| 2            | 3-May  | 2633            | material railing, unable to be measured |             |
| 3            | 11-May | 2640.3          | 2626                                    | 14.3        |

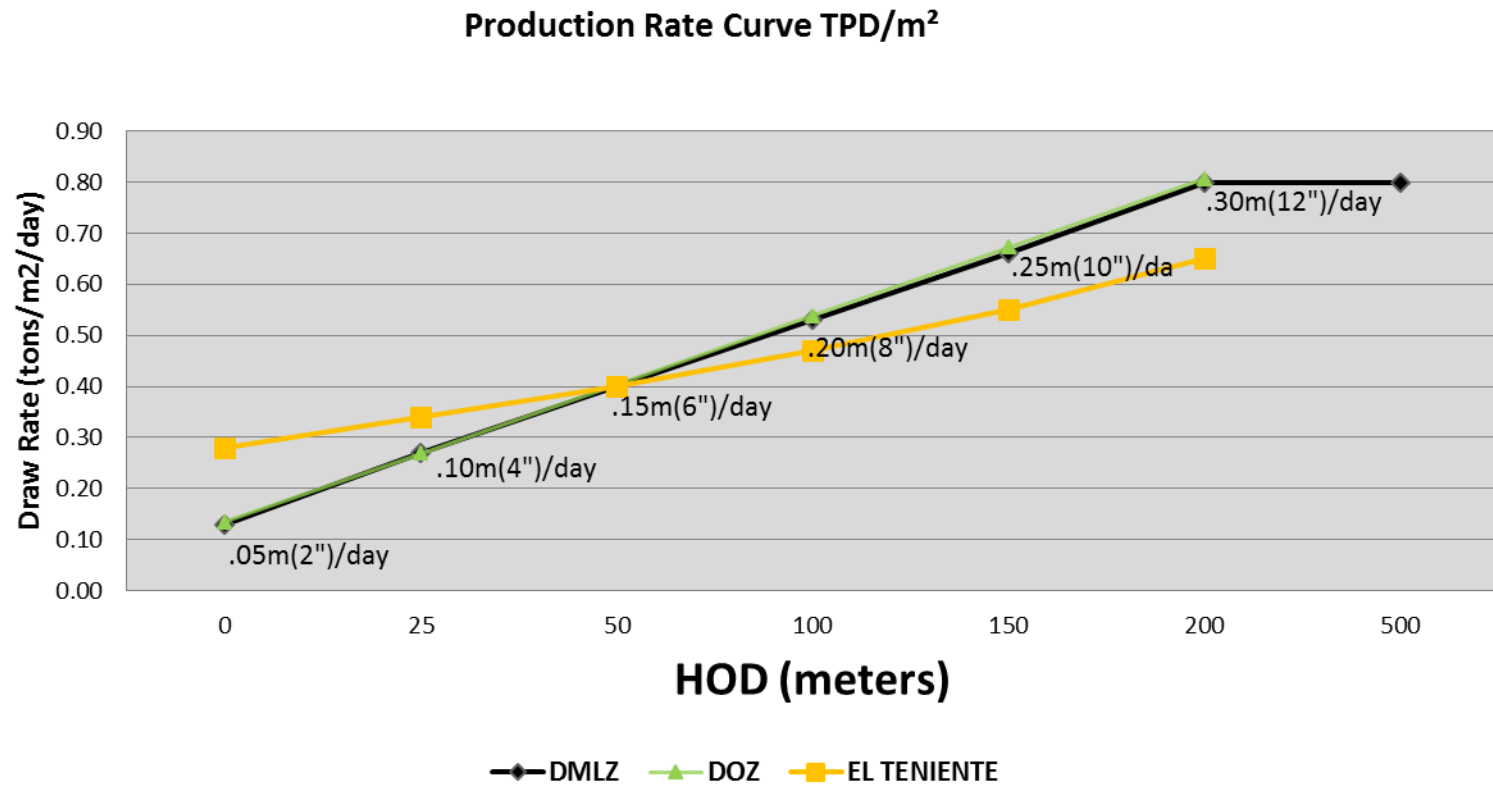
# Monitoreo Caving Airgap

## Air Gap: TARP

|                  | Level 1: Acceptable Conditions                                                                                                                                                                 | Level 2: Non-Urgent Action                                                                                                                                                        | Level 3: Urgent Action Required                                                                                                                                                                                    |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | Gap 5-10m                                                                                                                                                                                      | Gap 10-20m                                                                                                                                                                        | Gap >20m or Open Drawpoint                                                                                                                                                                                         |
| DMLZ Engineering | <p>Continue draw orders. New drawbells are pulled until cave muck reports to drawpoint.</p> <p>After that, draw only enough to prevent packed muck until cave reaches self-propagating HR.</p> | <p>Stop draw orders until air gap is reduced to 10m or below.</p> <p>If air gap &lt; 5m then potential for stall. Review draw order to determine if additional call required.</p> | <p>Immediately alert DMLZ Operations and UGSC</p> <p>Develop remedial action plan, in cooperation with UGSC.</p>                                                                                                   |
| GeoEngineering   | <p>Continue with routine monitoring</p>                                                                                                                                                        | <p>Immediately alert DMLZ Operations/Engineering</p> <p>Increase monitoring frequency to 2X/week.</p>                                                                             | <p>Immediately alert DMLZ Operations/Engineering</p> <p>Increase monitoring frequency to 4X/ week</p>                                                                                                              |
| DMLZ Operations  | <p>Follow draw orders, as issued by DMLZ Engineering</p>                                                                                                                                       | <p>Barricade drawpoints with no draw orders.</p>                                                                                                                                  | <p>Barricade drawpoints with no draw orders.</p> <p>Barricade other areas, as instructed by DMLZ Engineering, UG Senior Management, and/or UGSC</p> <p>Develop remedial action plan, in cooperation with UGSC.</p> |
| UGSC             | <p>No action required</p>                                                                                                                                                                      | <p>No action required</p>                                                                                                                                                         | <p>Lead the development of a remedial action plan within 48 hours.</p>                                                                                                                                             |



# Velocidad de extracción DMLZ

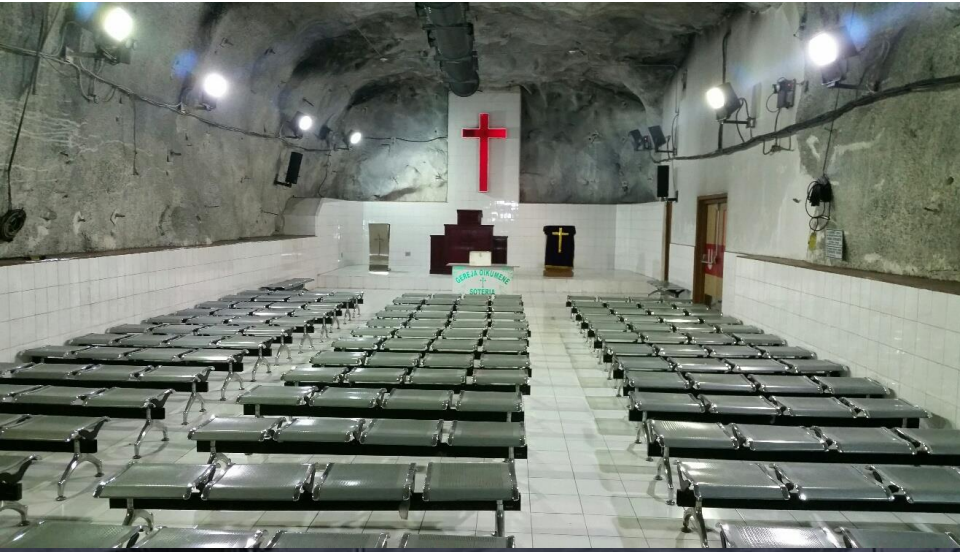


# Incorporación de Bateas DMLZ

|                     |      |    | 2015 |     |     |     |     |      |      |     |      |     |     |     | 2016 |     |      |      |      |
|---------------------|------|----|------|-----|-----|-----|-----|------|------|-----|------|-----|-----|-----|------|-----|------|------|------|
| DRAWBELL BLASTING   |      |    | JAN  | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC | JAN  | FEB | MAR  | APR  | MAY  |
| 2590L/P#20-19 DB 05 | PTFI | ea |      |     |     |     |     |      |      |     | 1,0  |     |     |     |      |     |      |      |      |
| 2590L/P#20-19 DB 04 | PTFI | ea |      |     |     |     |     |      |      |     |      |     | 1,0 |     |      |     |      |      |      |
| 2590L/P#19-18 DB 05 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     | 1,0 |      |     |      |      |      |
| 2590L/P#20-19 DB 06 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     | 1,0 |      |     |      |      |      |
| 2590L/P#20-19 DB 03 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     | 1    |     |      |      |      |
| 2590L/P#19-18 DB 04 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     | 1    | 1   |      |      |      |
| 2590L/P#18-17 DB 04 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     | 1    |      |      |
| 2590L/P#19-18 DB 06 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     | 1    |      |      |
| 2590L/P#18-17 DB 03 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     | 1    |      |      |
| 2590L/P#20-19 DB 08 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      | 1    |      |
| 2590L/P#18-17 DB 05 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      | 1    |      |
| 2590L/P#17-16 DB 03 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      | 1    |      |
| 2590L/P#19-18 DB 07 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      |      | 1    |
| 2590L/P#18-17 DB 06 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      |      | 1    |
| 2590L/P#17-16 DB 04 | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      |      | 1    |
|                     | PTFI | ea |      |     |     |     |     |      |      |     |      |     |     |     |      |     |      |      |      |
| TOTAL               |      |    | 0    | 0   | 0   | 0   | 0   | 0    | 0    | 0,0 | 1,0  | 0,0 | 1,0 | 2,0 | 2    | 1   | 3    | 3    | 3    |
| YTD                 |      |    | 0    | 0,0 | 0,0 | 0,0 | 0,0 | 0,0  | 0,0  | 0,0 | 1,0  | 1,0 | 2,0 | 4,0 | 2    | 3,0 | 6,0  | 9,0  | 12,0 |
| ITD                 |      |    | 0    | 0,0 | 0,0 | 0,0 | 0,0 | 0,0  | 0,0  | 0,0 | 1,0  | 1,0 | 2,0 | 4,0 | 6,0  | 7,0 | 10,0 | 13,0 | 16,0 |

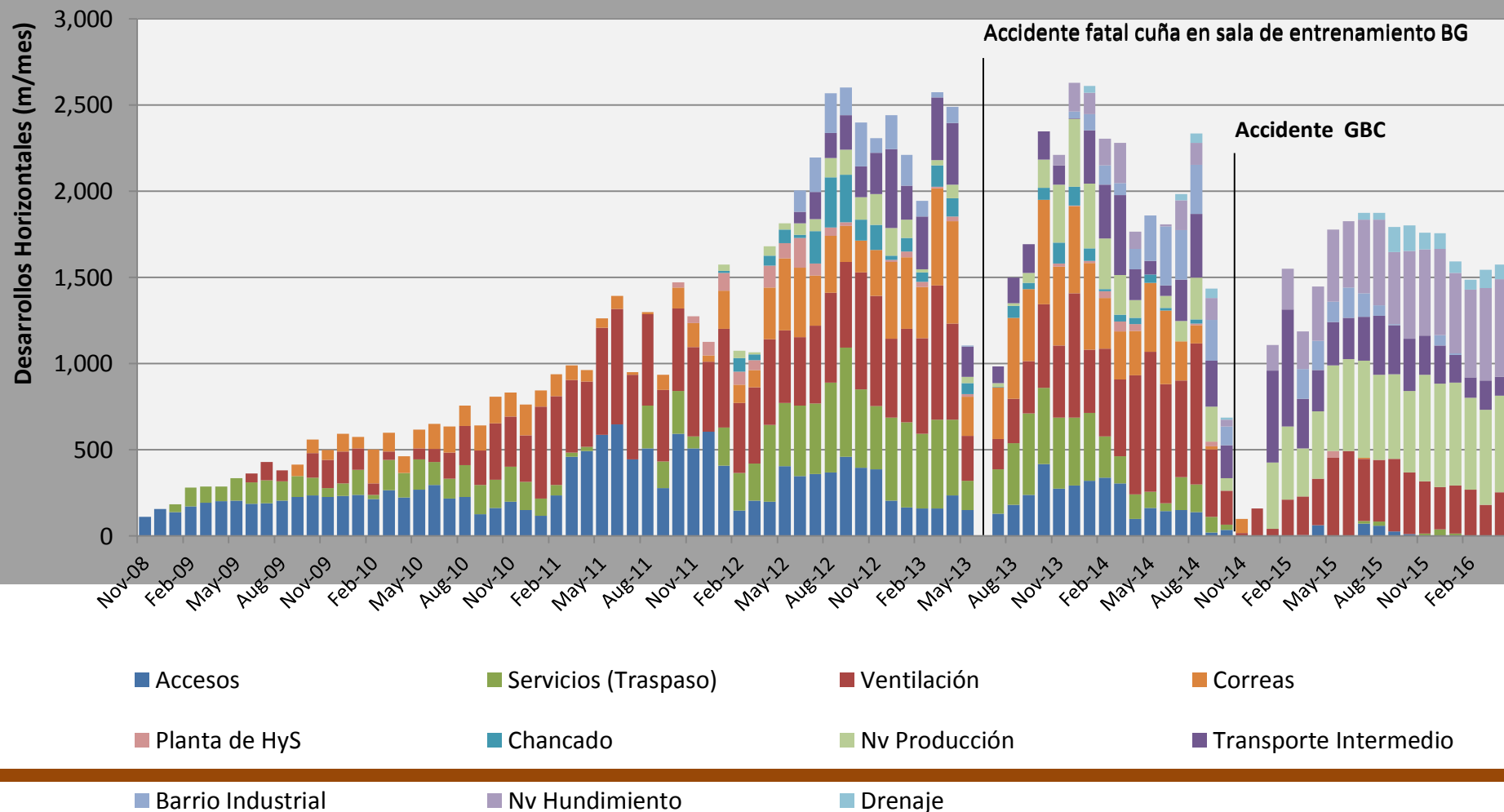


# Geomecánicos DMLZ Rezan



# Desarrollos DMLZ

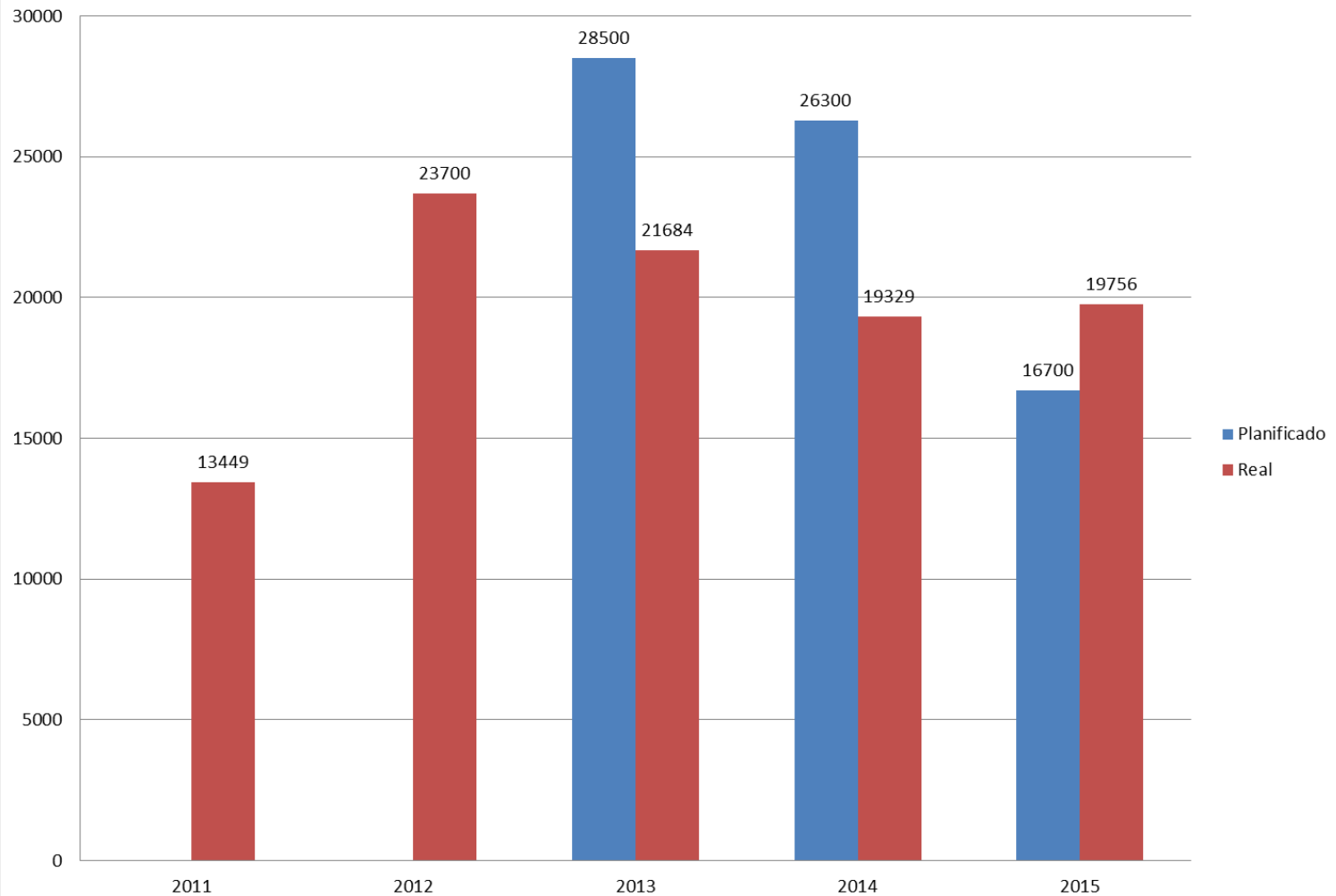
- Promedio en régimen: 1.917m/mes
- Máximo: 2.628 m/mes
- Área incorporada a 2016: 19 bateas (3 bateas/mes, 2.500 m2/mes hundidos)



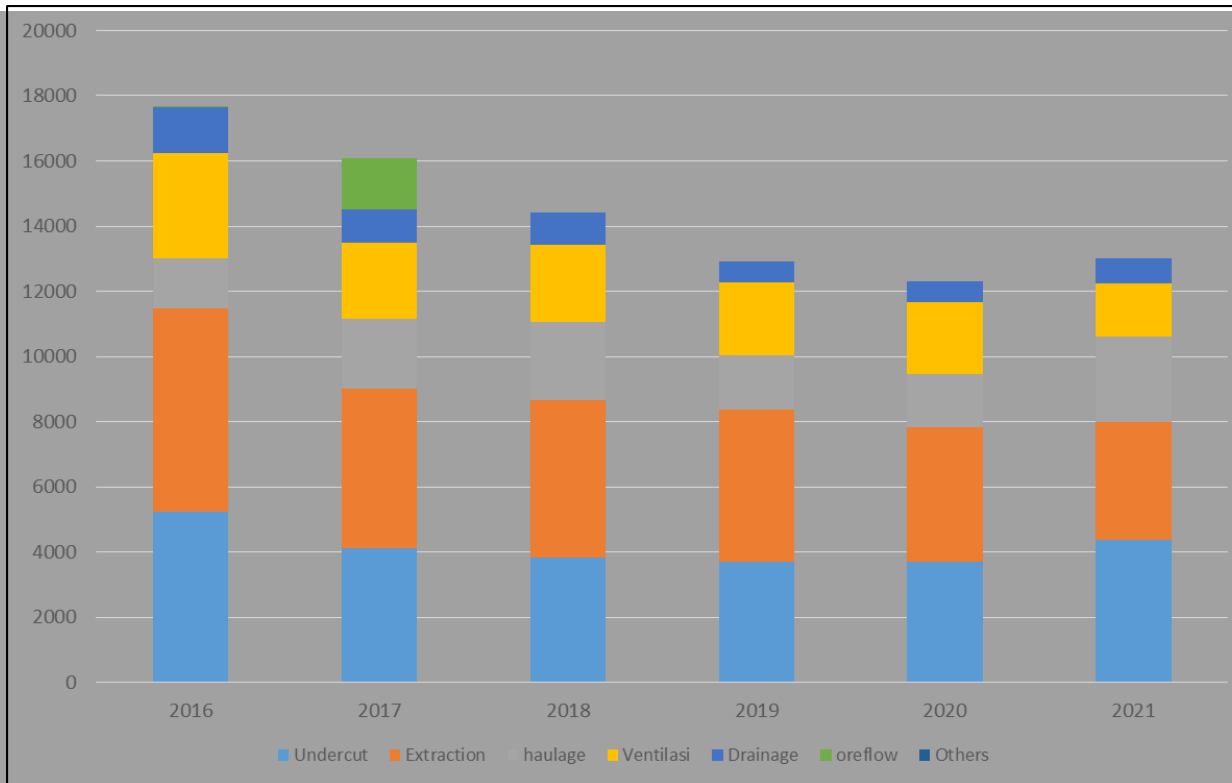


# Desarrollos DMLZ

Desarrollos Anuales Proyecto DMLZ PT Freeport Indonesia



# Programa de Desarrollo DMLZ





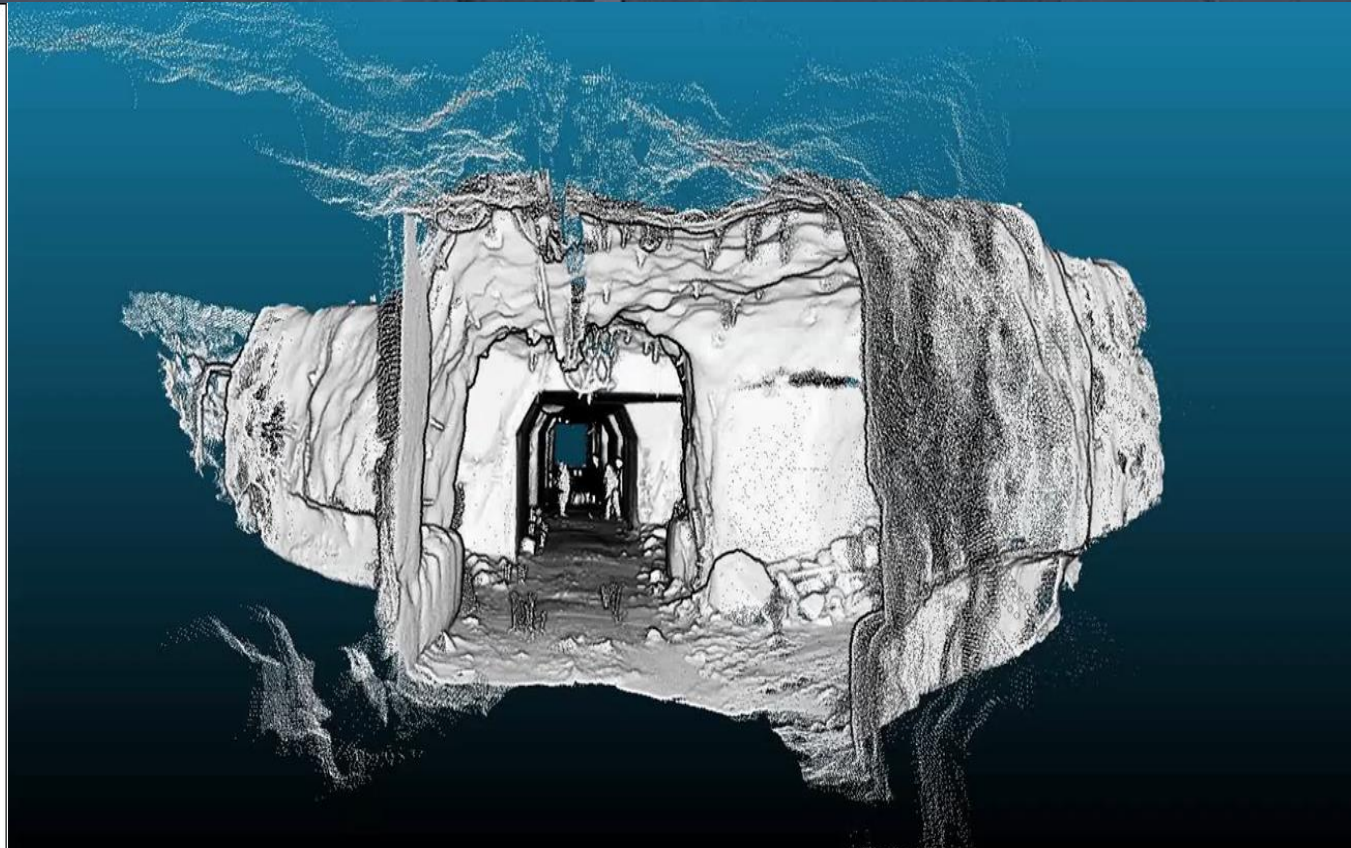
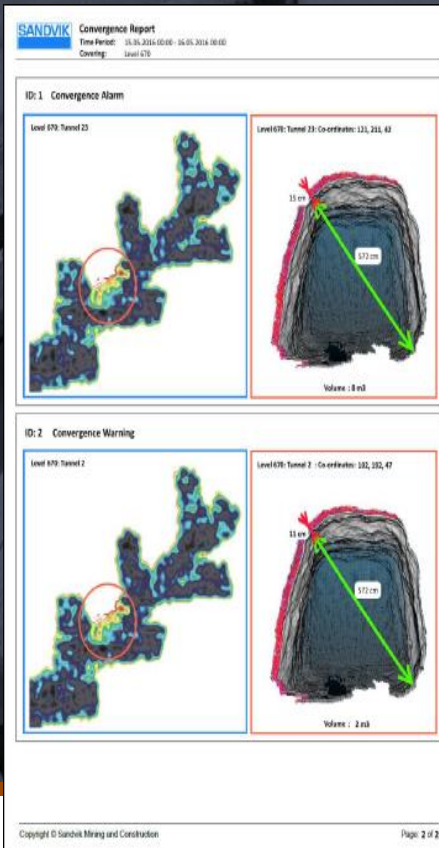
# Tecnología DOZ - DMLZ

- **MineStar** Para Control de Extracción y Sistema Semi-Autónomo **MineGem** LHDs
  - 19 LHDs operando en DOZ (CAT R1600 y R1700)



# Tecnología DOZ - DMLZ

- **INSAR:**
  - Escaneo de superficie sobre vehículo móvil
    - Detección automática de convergencia

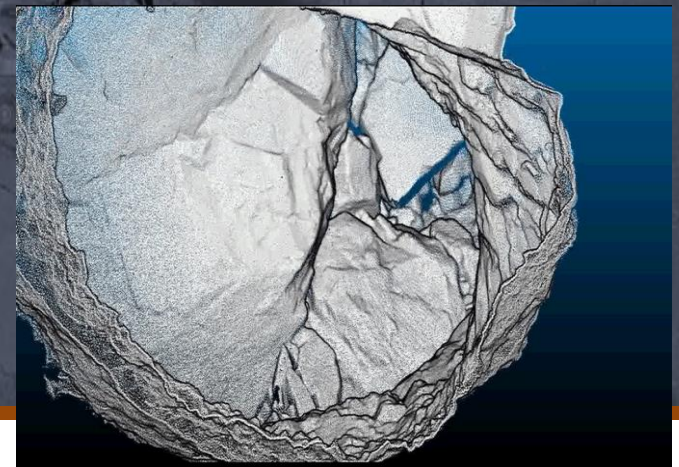
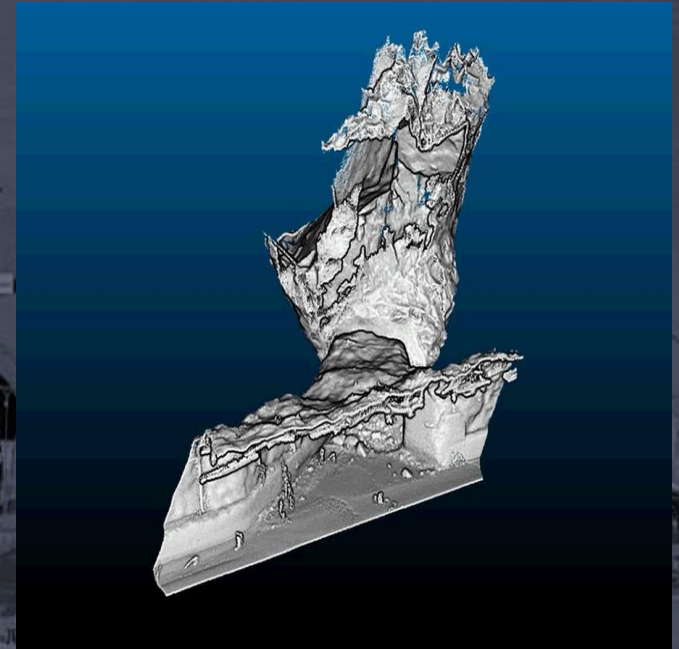




# Tecnología DOZ - DMLZ

## ➤ INSAR:

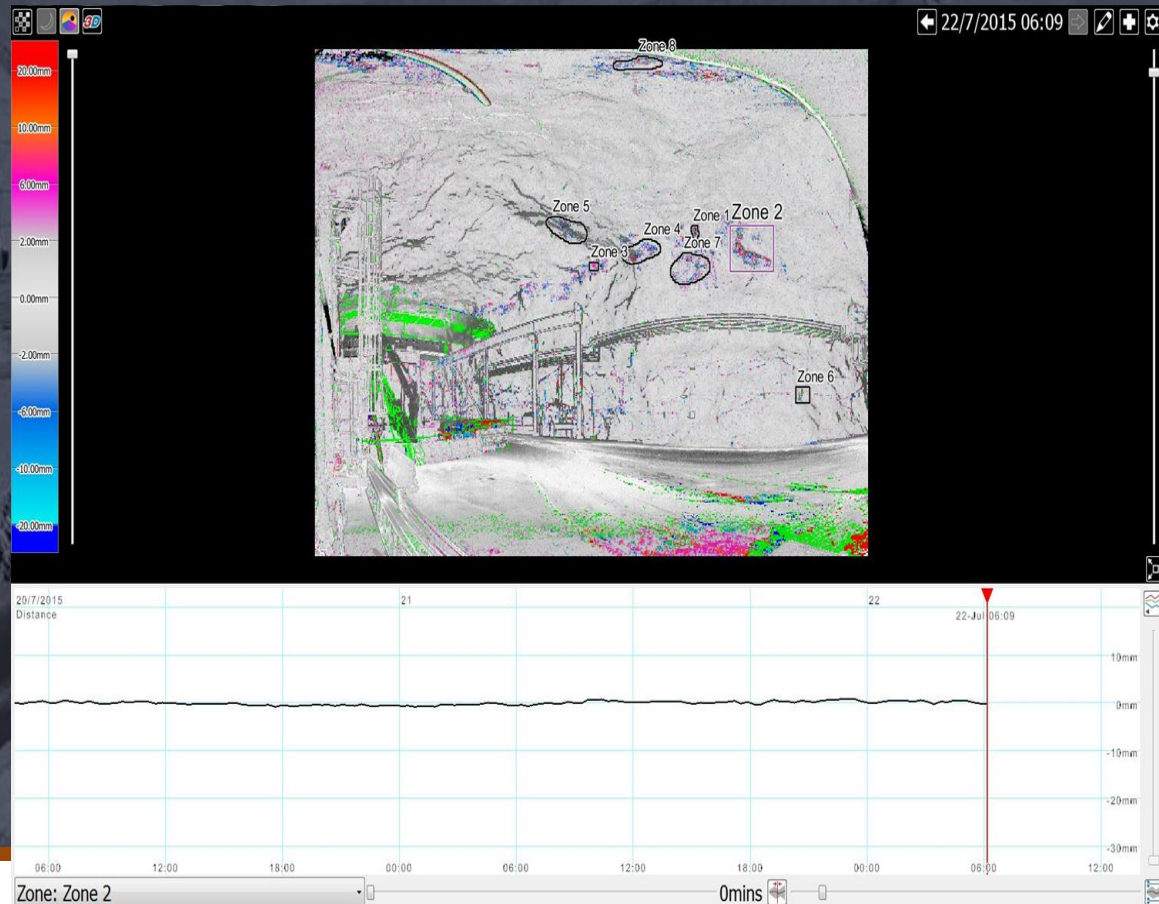
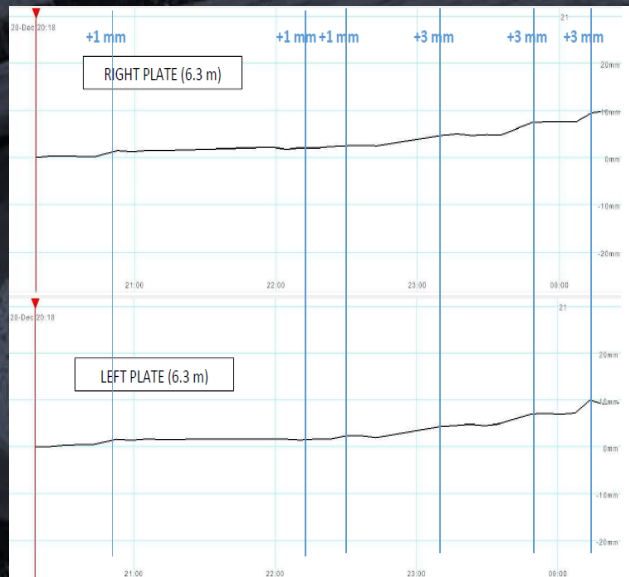
- Escaneo de superficie sobre vehículo móvil
  - Inspección de colgaduras para mejorar aplicación de método de descuelgue



# Tecnología DOZ - DMLZ

## ➤ INSAR:

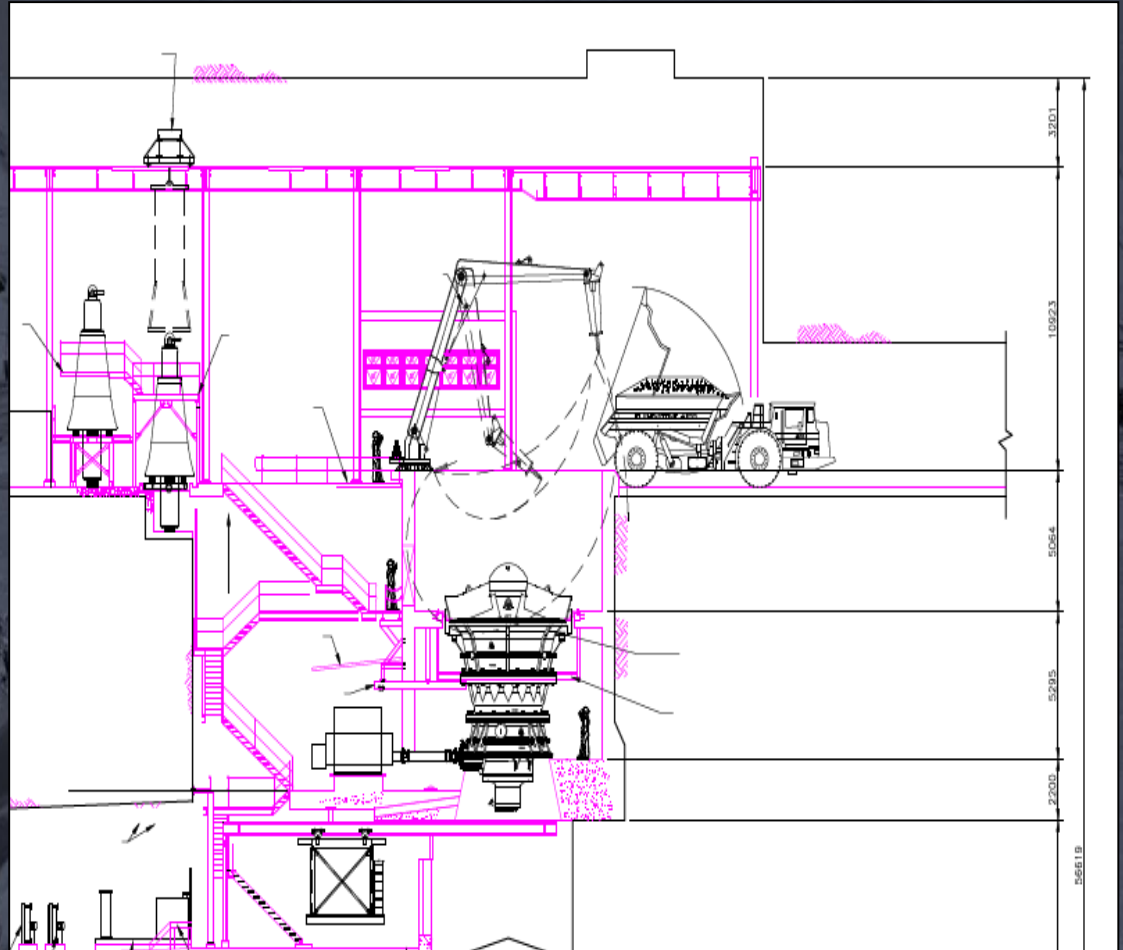
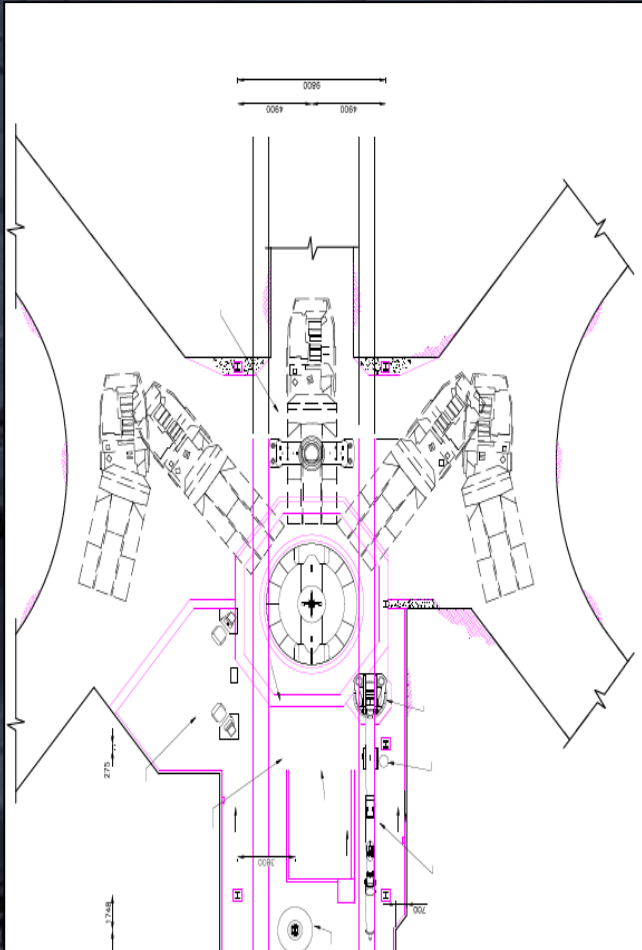
- Monitoreo de Convergencia en Línea
  - Para Infraestructura Crítica
  - Monitoreo Remoto 24/7
  - Precisión de mm en superficie de 10cmx10cm





# Diseño Vaciado Camion - Chancador

3 Camiones en descarga simultánea directo a Chancador Giratorio



# Nave de Chancado DMLZ





# Vaciado de Camiones DMLZ



## Vaciado de Camiones DMLZ





# Nave de Mantenimiento Camiones DMLZ



# Correas DMLZ





# Estación de Transferencia DMLZ





# Estación de Transferencia DMLZ - DOZ





# DMLZ Correa Techo sin Encapsular

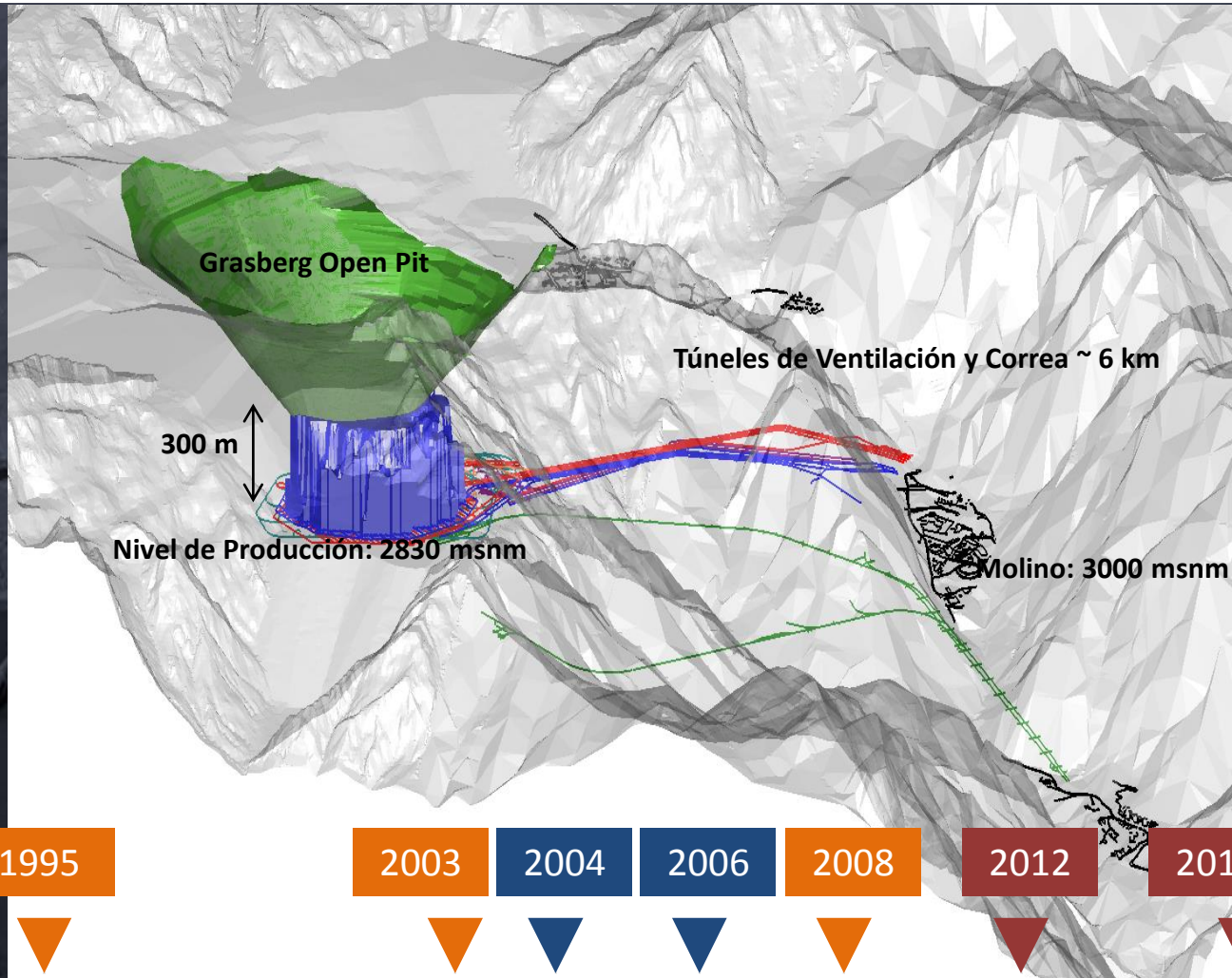


# DMLZ Detector de Inendio

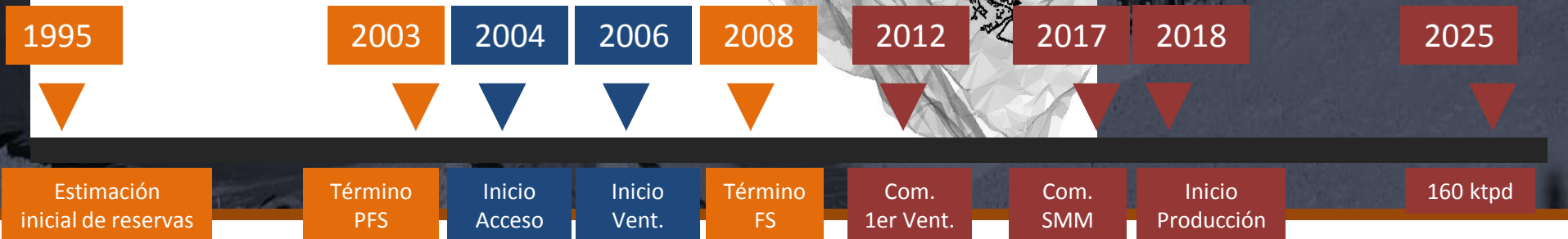




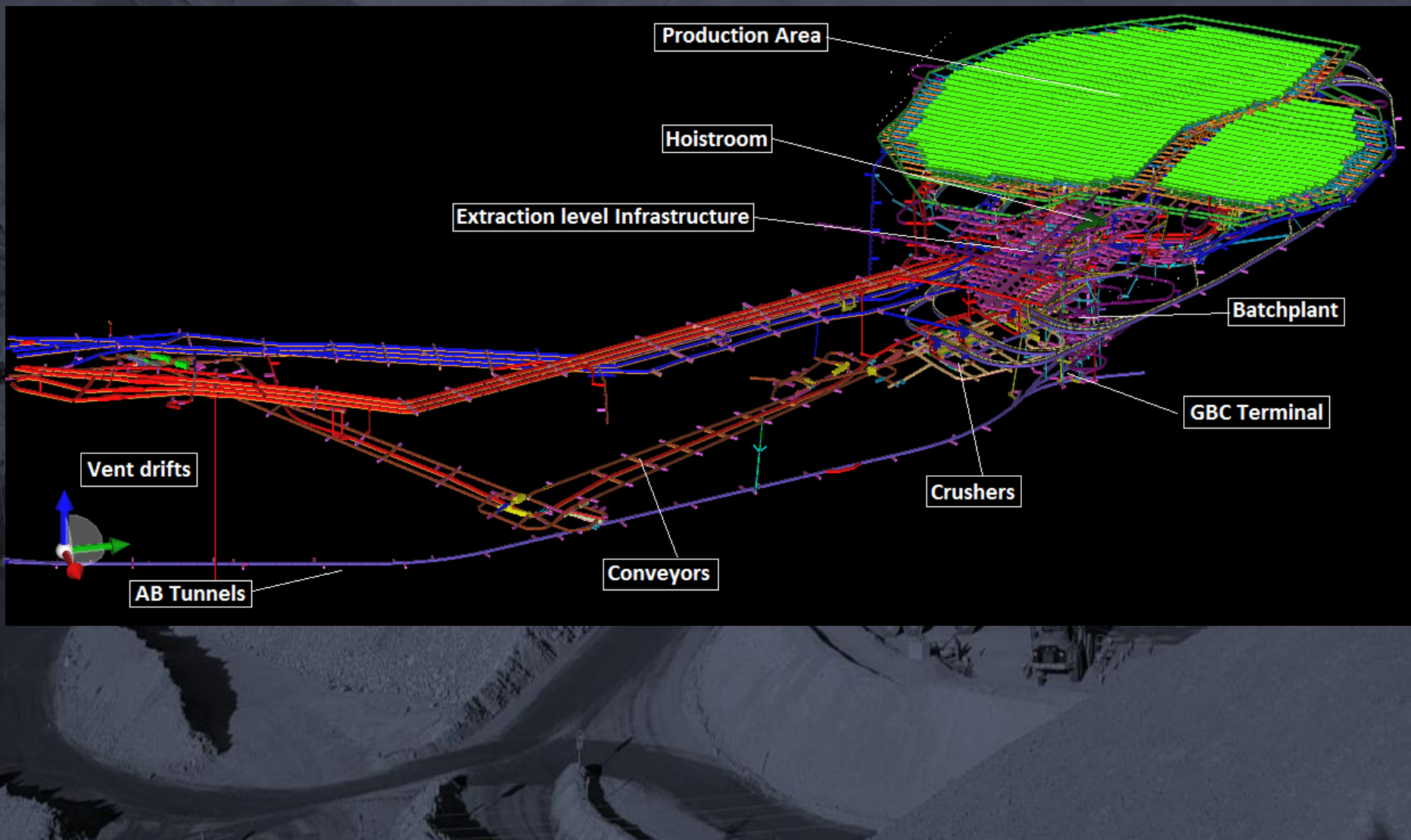
# Proyecto GBC



- 962 Mt @ 1,03% Cu, 0,78 g/t Au
- Malla Teniente 15m x 20m
- 700,000 m<sup>2</sup> footprint
- Altura columna promedio 267m
- Producción Peak: 160 ktpd
- Acceso Principal por túneles mellizos de 6mx7m

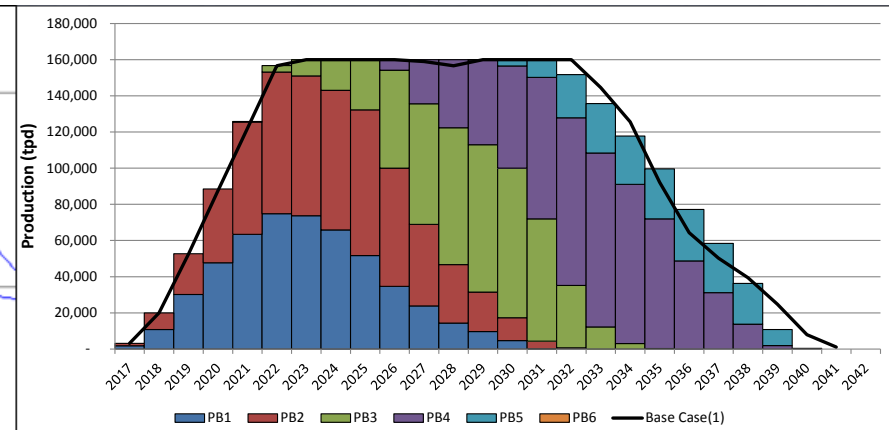
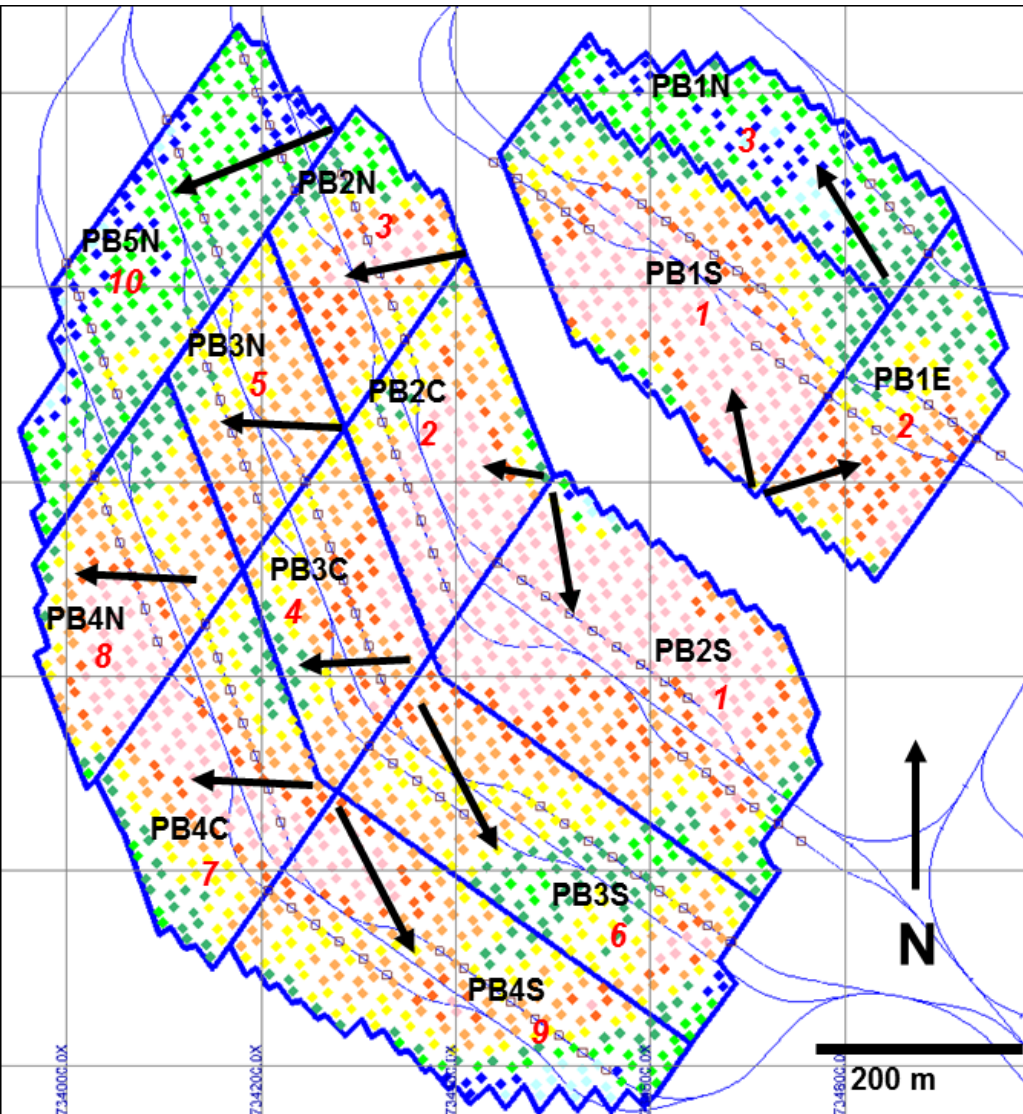


# Proyecto GBC





# Ram up GBC



# Estado Tensional GBC

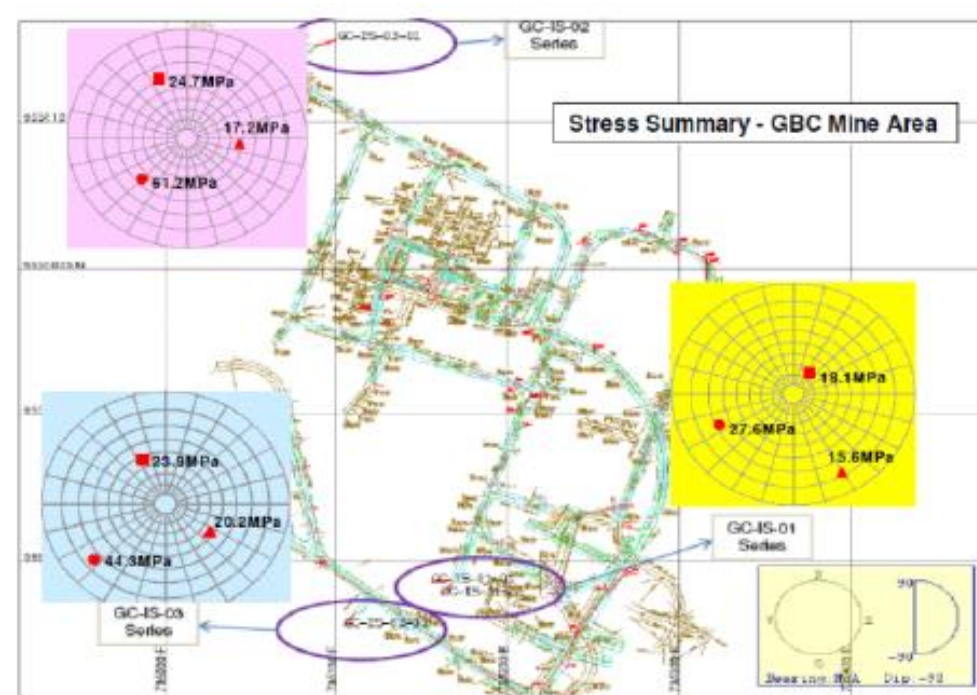
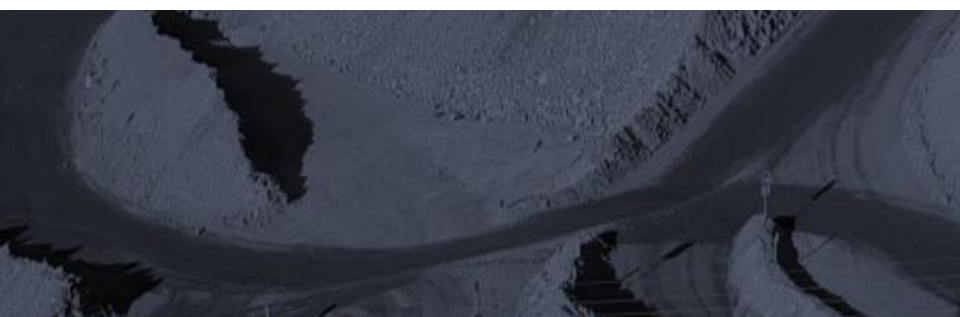


Figure 13. Measured In situ Stress Locations



Table 5. Results of Measured In situ Stress

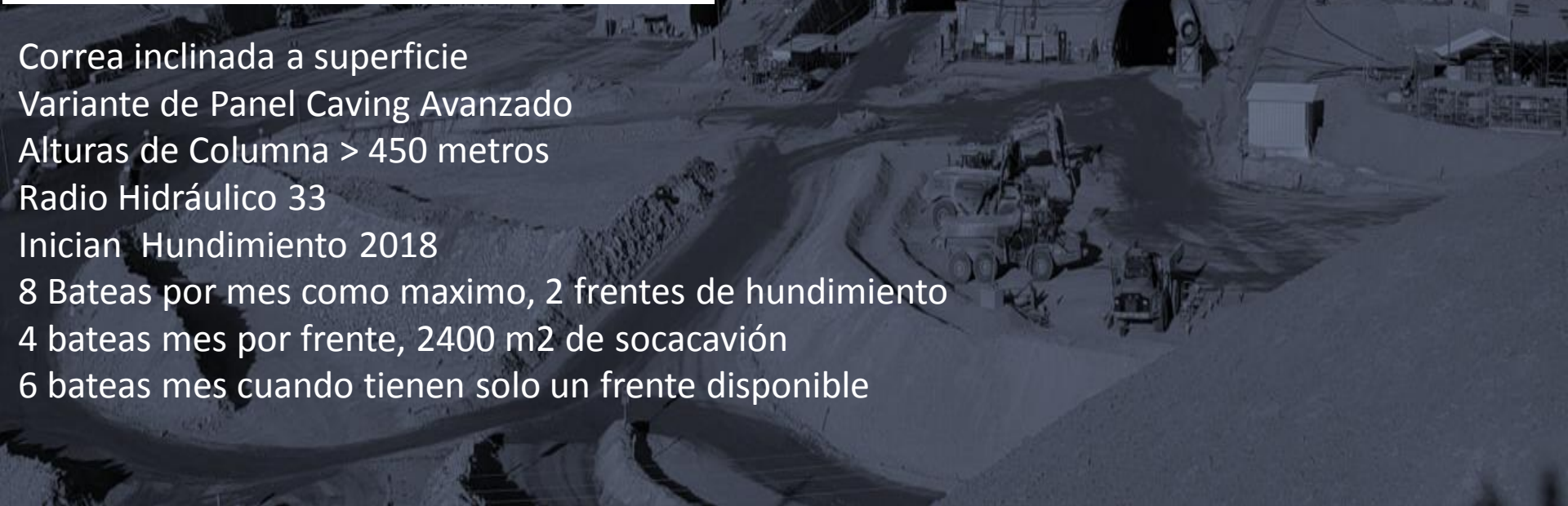
| Principal Stresses | 2820 - Ramp     |         |             | Undercut Level Ramp |         |             | Access to Hoist Room |         |             |
|--------------------|-----------------|---------|-------------|---------------------|---------|-------------|----------------------|---------|-------------|
|                    | Magnitude (MPa) | Dip (°) | Bearing (°) | Magnitude (MPa)     | Dip (°) | Bearing (°) | Magnitude (MPa)      | Dip (°) | Bearing (°) |
| $\sigma_1$         | 27.6            | 23      | 246         | 61.2                | 34      | 225         | 44.3                 | 16      | 230         |
| $\sigma_2$         | 18.1            | 64      | 035         | 24.7                | 28      | 337         | 23.9                 | 43      | 335         |
| $\sigma_3$         | 15.6            | 12      | 151         | 17.2                | 42      | 096         | 20.2                 | 43      | 124         |



| SITE                | MEASURED |      |      | MODEL |      |      | DIFF |      |     |
|---------------------|----------|------|------|-------|------|------|------|------|-----|
|                     | S1       | S2   | S3   | S1    | S2   | S3   | S1   | S2   | S3  |
| 2820 - RAMP         | 27.6     | 18.1 | 15.6 | 37.8  | 23.1 | 13.9 | -27% | -22% | 12% |
| UNDERCUT LEVEL RAMP | 61.2     | 24.7 | 17.2 | 43.9  | 20.1 | 13.7 | 39%  | 22%  | 25% |
| ACC TO HOIST ROOM   | 44.3     | 23.9 | 20.2 | 37.4  | 21.2 | 11.8 | 18%  | 12%  | 71% |



100



# Tres Chancadores de Cono

6 bateas mes cuando tienen solo un frente disponible

# Sala de Huinche





# Techo Sala de Huinche



# Cajas Salas de Huinche





## Desarrollo Nivel de Hundimiento



# Fortificacion Desarrollo





# Fortificación Definitiva





# Desarrollos UCL





# Desarrollos UCL

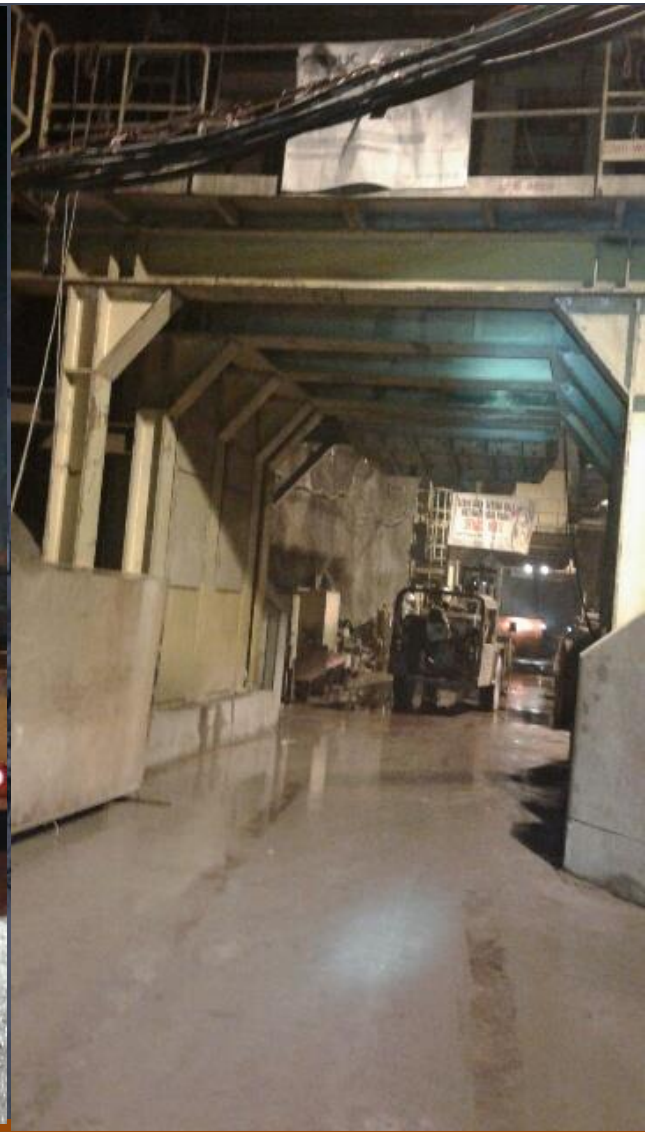


## Desarrollos Nivel de Producción



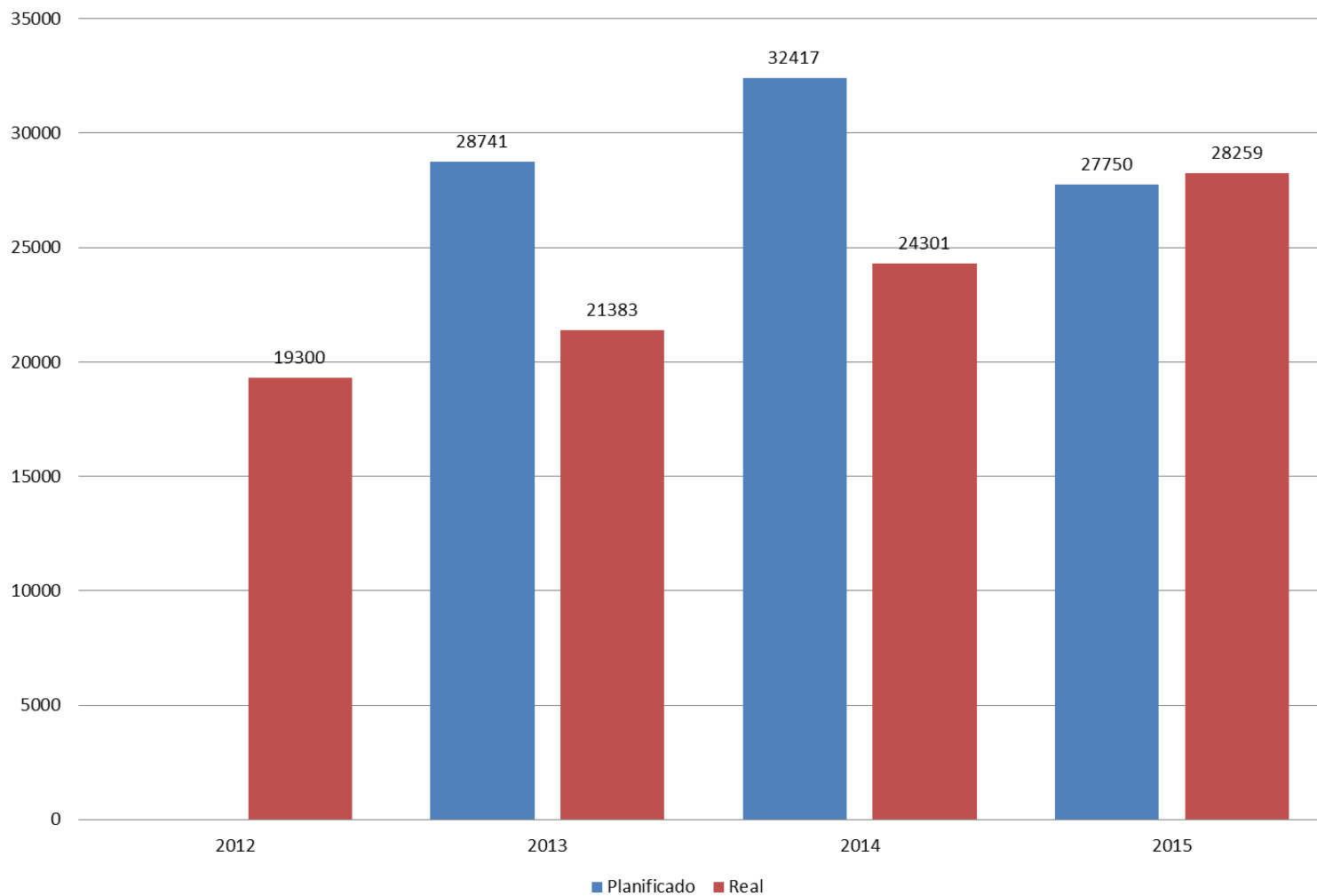


# Nivel de Transporte



# Desarrollos GBC

Desarrollos Anuales Proyecto GBC PT Freeport Indonesia





# Reflexion de Seguridad





# PMCHS

## Visita Técnica Cadia East - Grasberg Papua Guinea

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17 Junio 2016

Hugo Constanzo Beitia

