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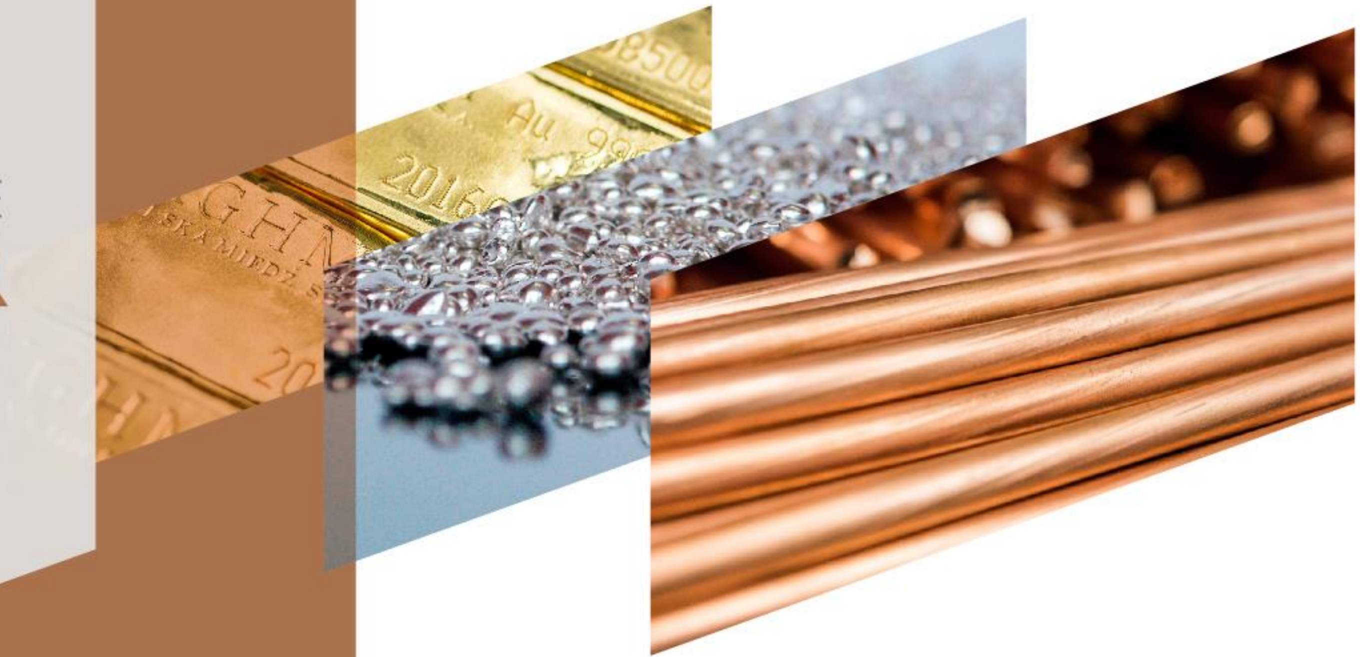

Ground Monitoring in Underground Mine Design - A Case Study

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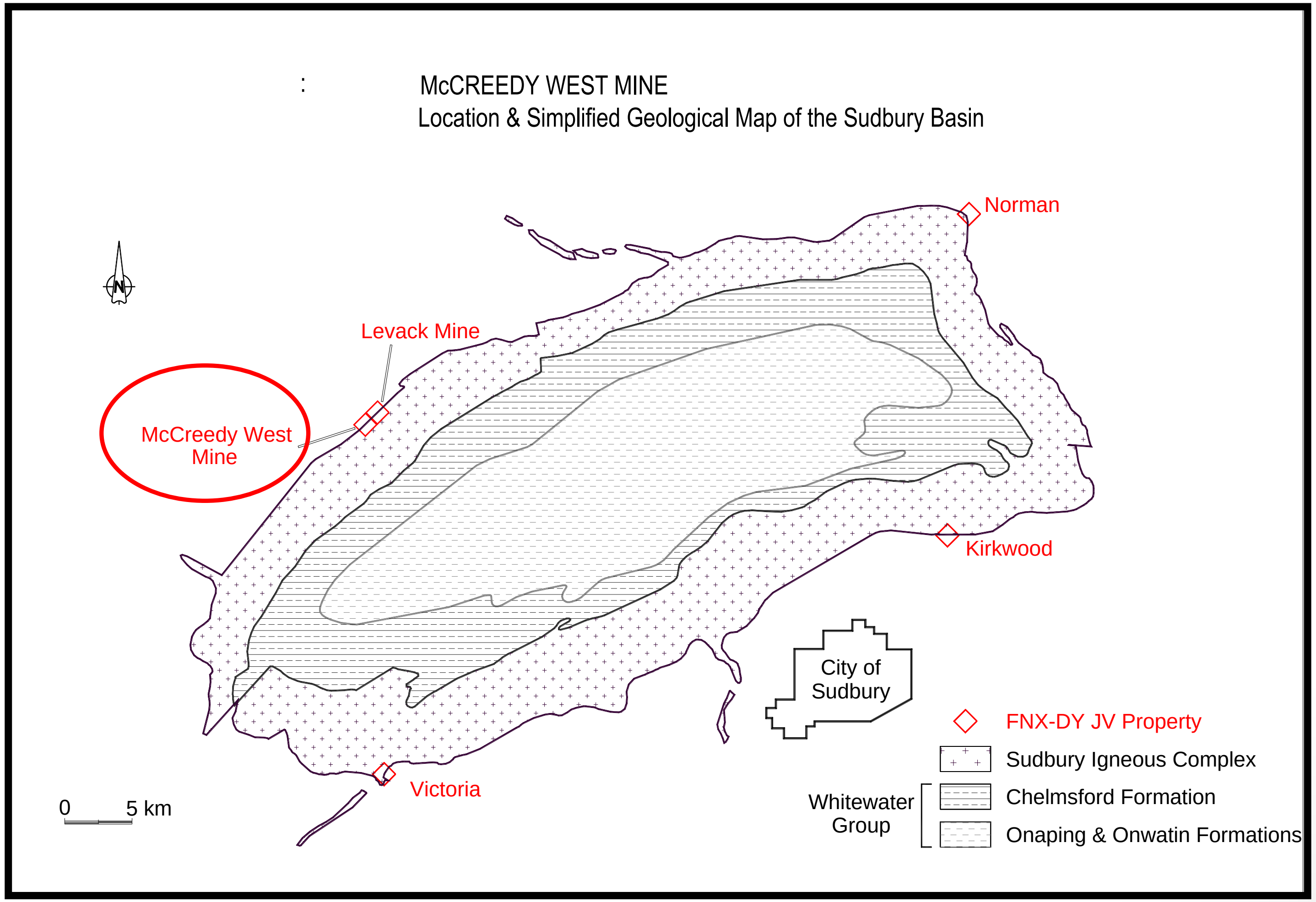
OUTLINE

- Introduction
- Geology of the mine environment
- Stoping plan
- Rock properties
- Instrumentation of the stope
- Monitoring results
- Summary

Introduction

- The McCreedy West Mine is located in Levack Township within the City of Greater Sudbury, approximately 40 km northwest of downtown Sudbury area
- McCreedy West Mine was first developed by Inco in 1970 and operated until 1998, when it was closed.
- KGHM International begin work on this property in 2002 and brought the mine to production in 2003.
- McCreedy West Mine went on care and maintenance in 2015 and was reactivated in 2017.



Geology

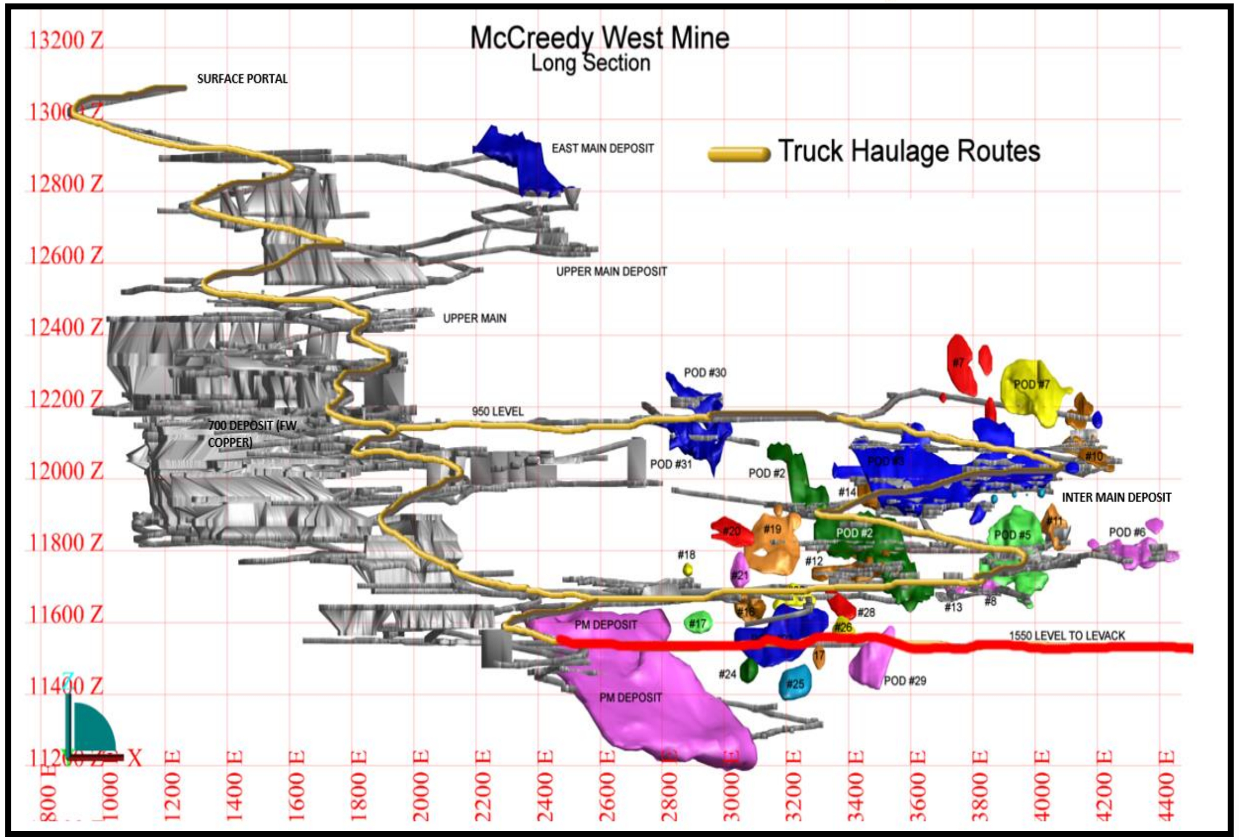
MCW is situated within a geological structure included in the Sudbury Nickel Irruptive, a rock unit associated with nickel-copper, PGM deposits.

MCW is the most westerly actively producing mine in a group of nickel-copper, PGM deposits along a discontinuously mineralized, eight-kilometer long section of the North Range of the Sudbury Nickel Irruptive.

Nickel-copper sulphide mineralization is typically associated with discontinuous zones of sublayer Norite and Granite Breccia, at the base of the south-dipping Sudbury Nickel Irruptive structure.

Mineralization is also associated with metamorphosed, recrystallized and brecciated Gneiss and Granite Breccia.

There are two styles of sulphide deposits at McCreedy West Mine; contact-style, and footwall vein-style.



Isometric view of McCreedy West Mine

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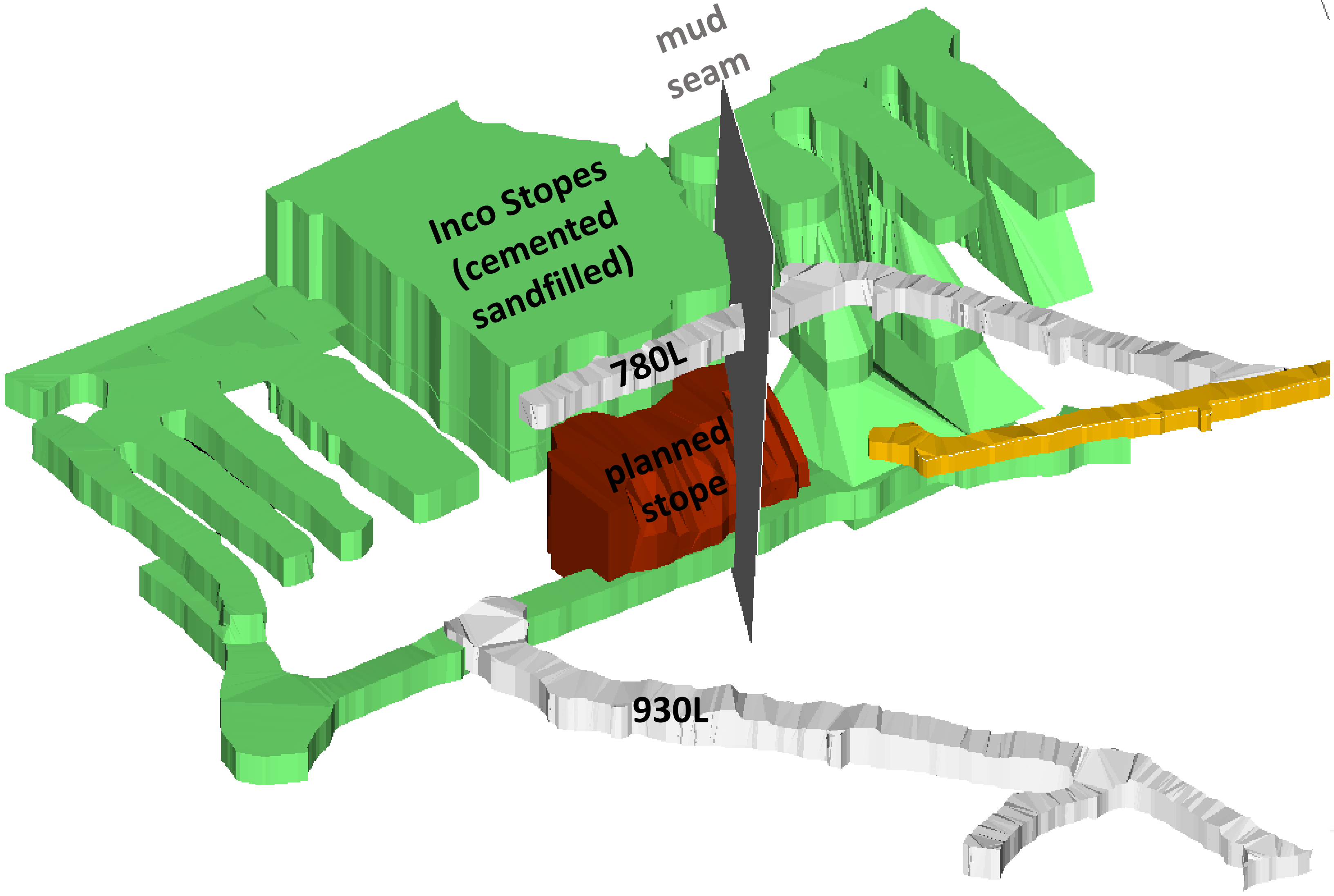
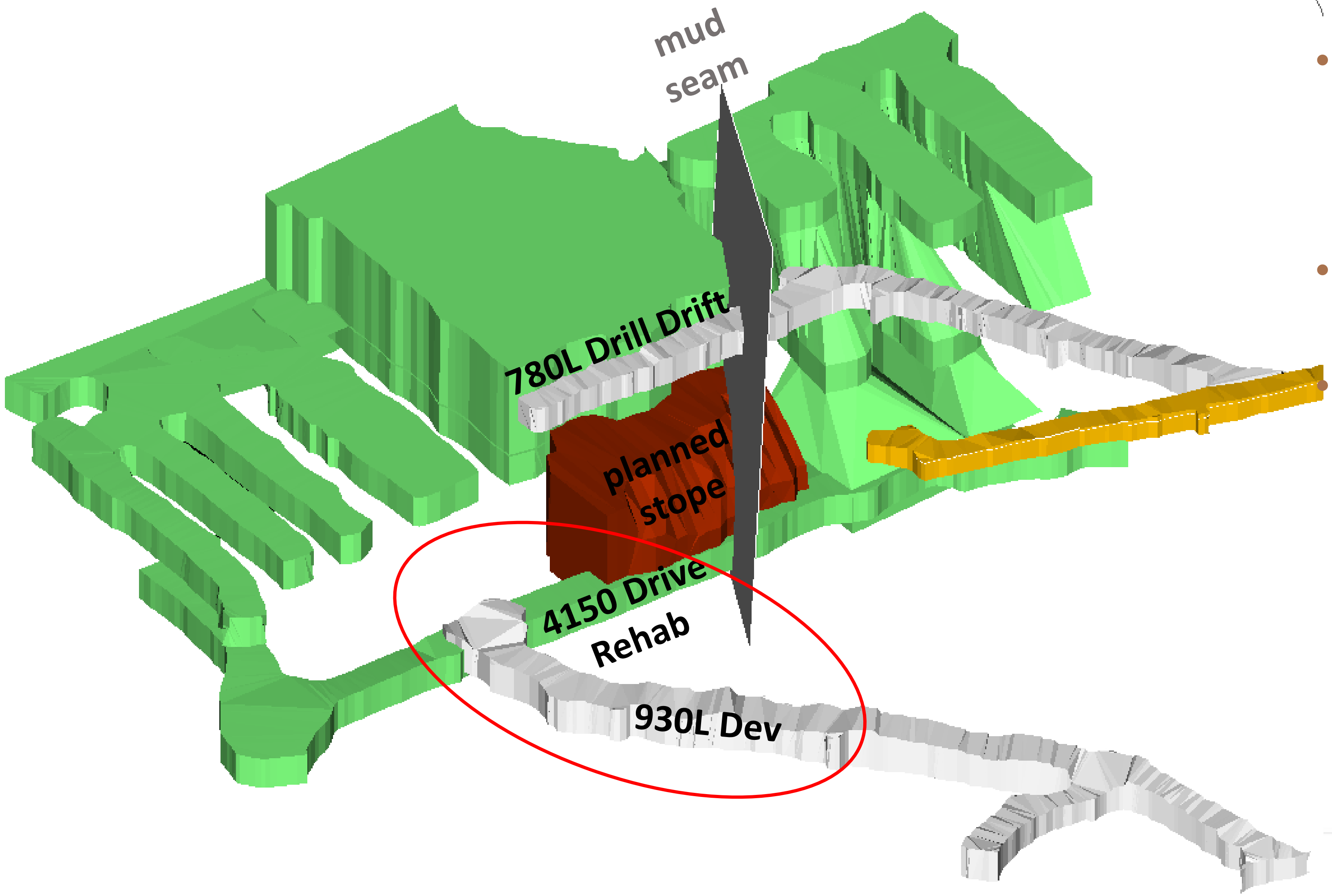
The 930 Stope, NV



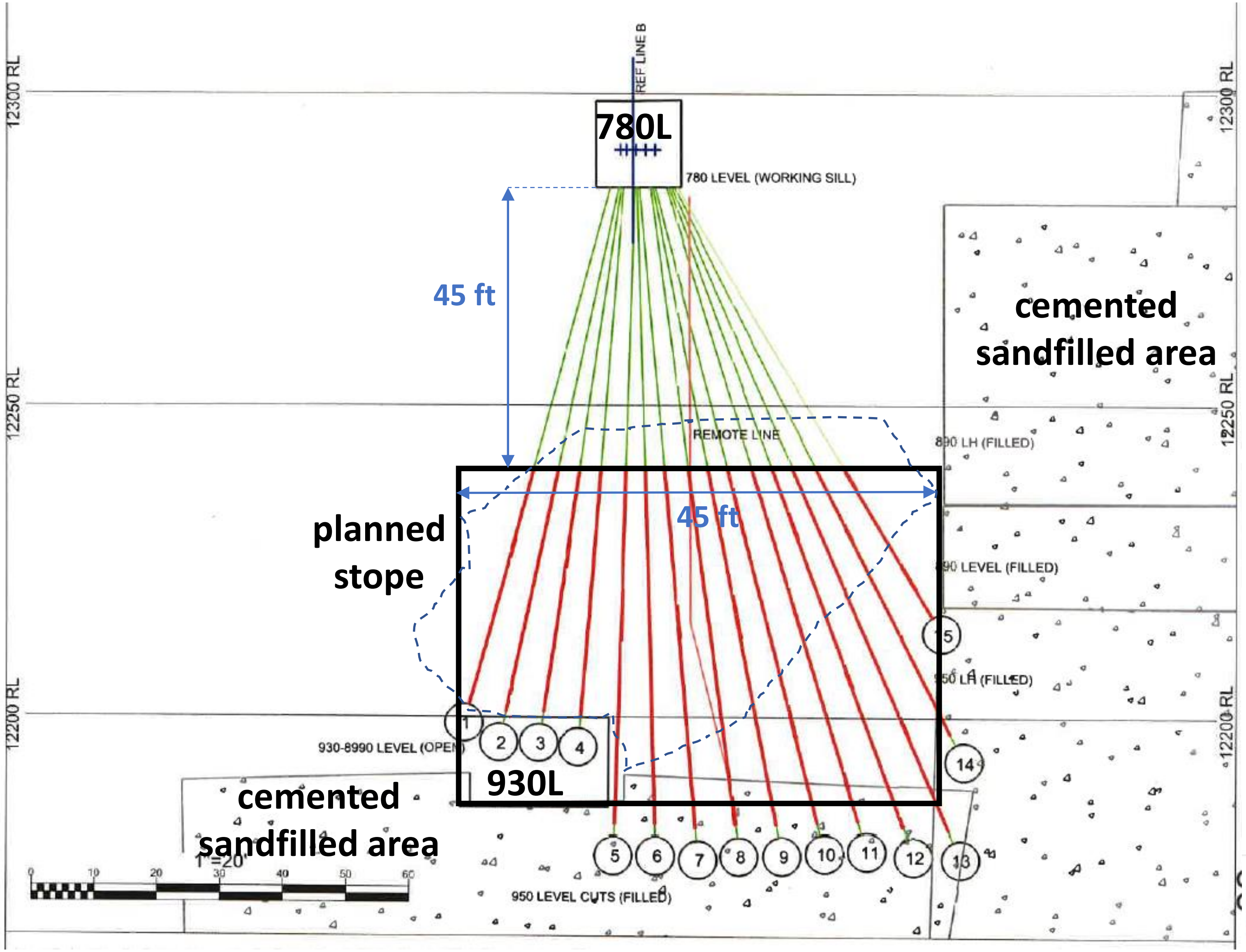
- The zone is hosted by Sudbury Breccia
- Longhole stopes exploit the mineralization primarily via Uppers Longitudinal retreat
- However, the 930L was planned to be mined by downhole drilling from 780L.
- Rock type SUBX, GDGN and MFGN

Geomechanical Characteristics



- Challenging ground conditions were encountered when developing the 930L to access the old Inco 4150 drive.
- Rehab was very slow on the 4150 drive
- Also encountered a 2-in-thick mud seam and chlorite-filled joints when developing the 780L drill drift.

A Ring Design



- Cross section of a blast ring
- Dashed line shows the cavity after final CMS
- Cemented sandfill area on one side

Rock Mass Classification

Q and RMR Systems

RMR Parameter	Parameter Value-Descriptor	Rating
UCS	100-170 MPa	12
RQD	50-60	7
Joint Spacing	20cm-60cm	10
Condition of Disc.	3m-10m, <0.1mm, smooth, no infill, weathered	15
Water	wet	7
Adjustment for Discont.	Fair to unfavorable	-5 to -10
RMR	Class III Fair Rock	41-46

Q Parameter	Parameter Value-Descriptor	Rating
RQD	50-60	50-60
Jn	3 to 4 sets	9-16
Jr	smooth, planar	1
Ja	Slightly altered/chlorite coating	2-3
Jw	Wet to Occasional outwash	0.66-1
SRF	Single weak zone (mud seam), low stress	2.5
Q’	----	1.04
Q	Very Poor to poor	0.275

MPBX Location, Plan View

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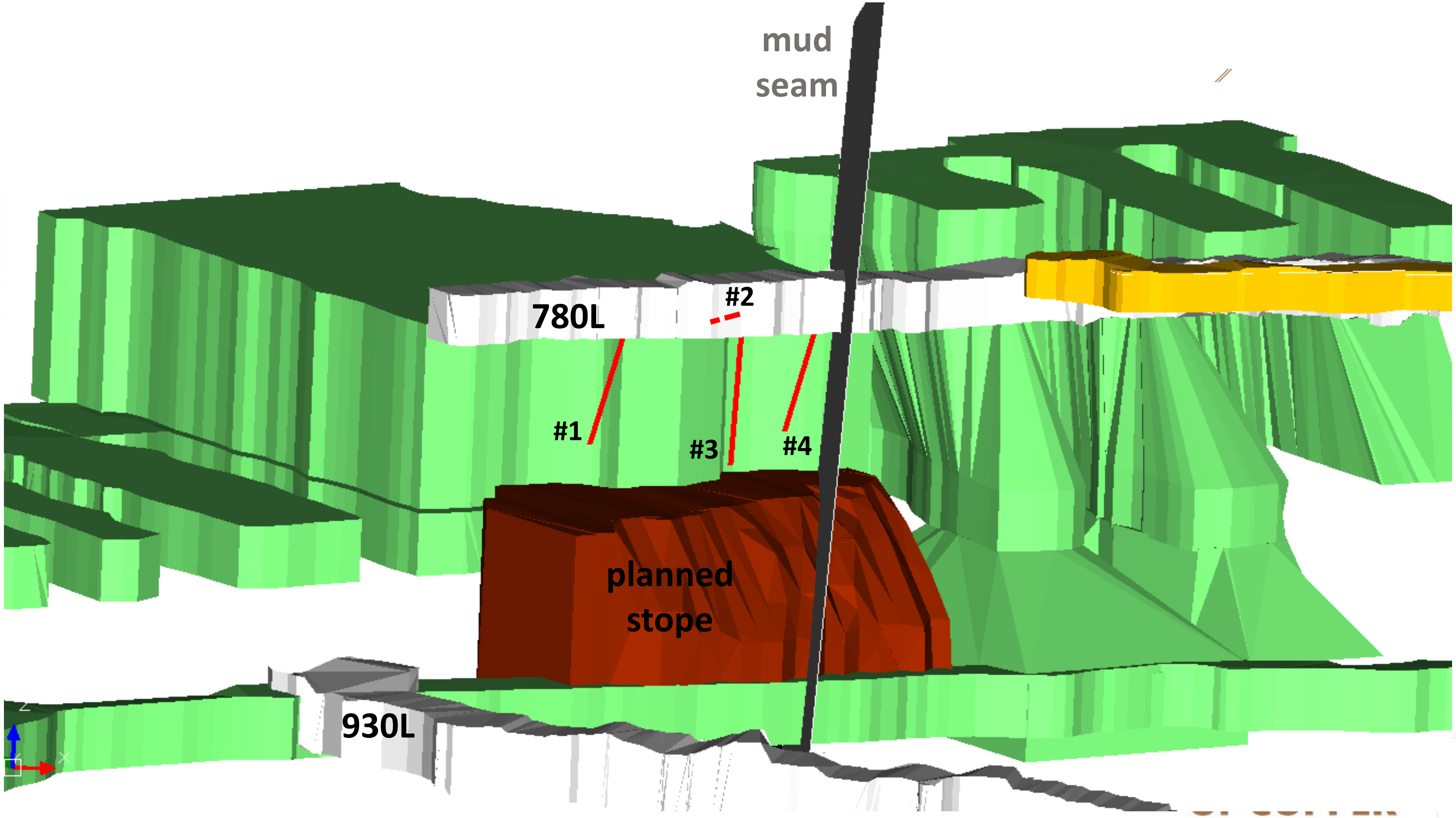
MPBX Locations, Isometric View



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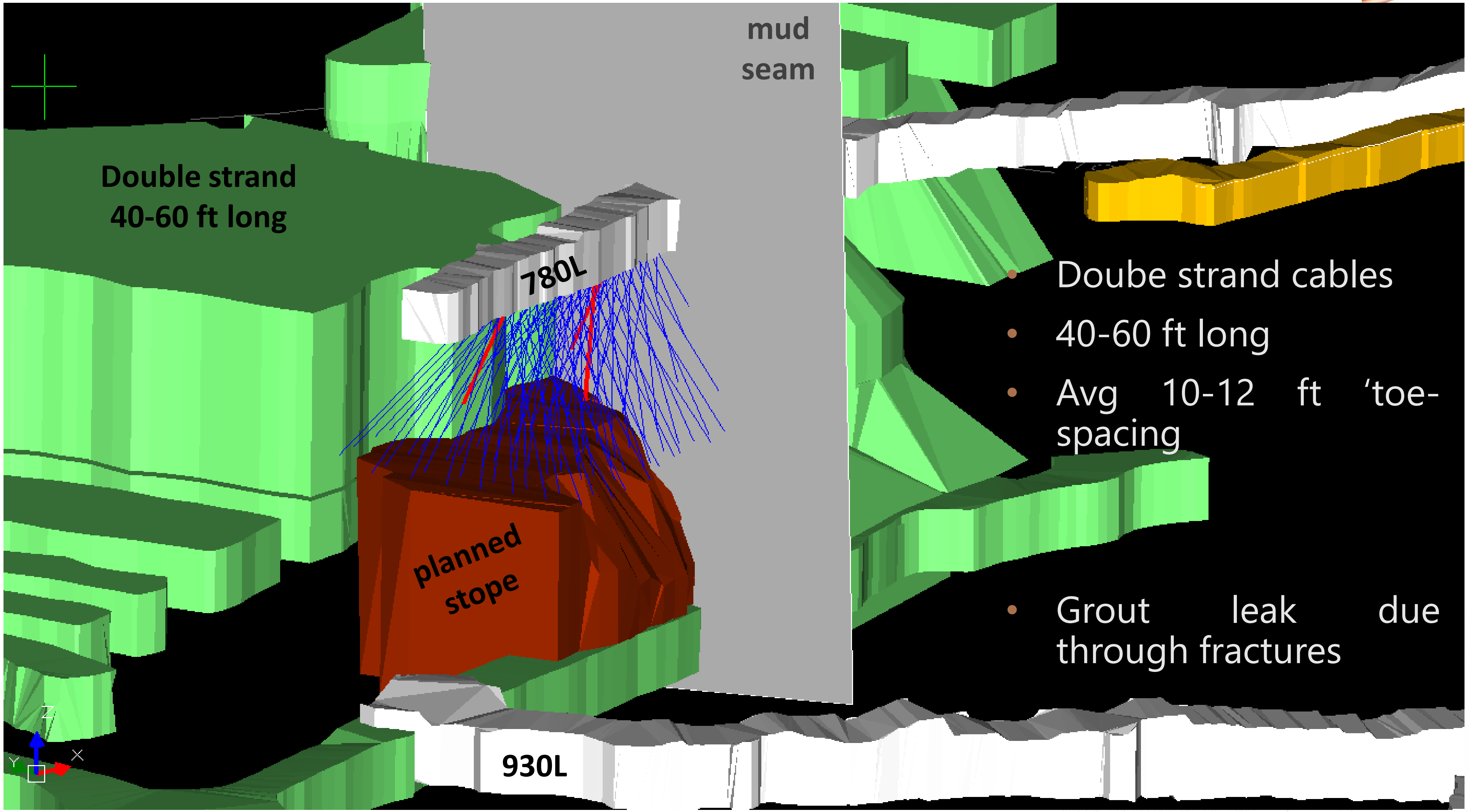
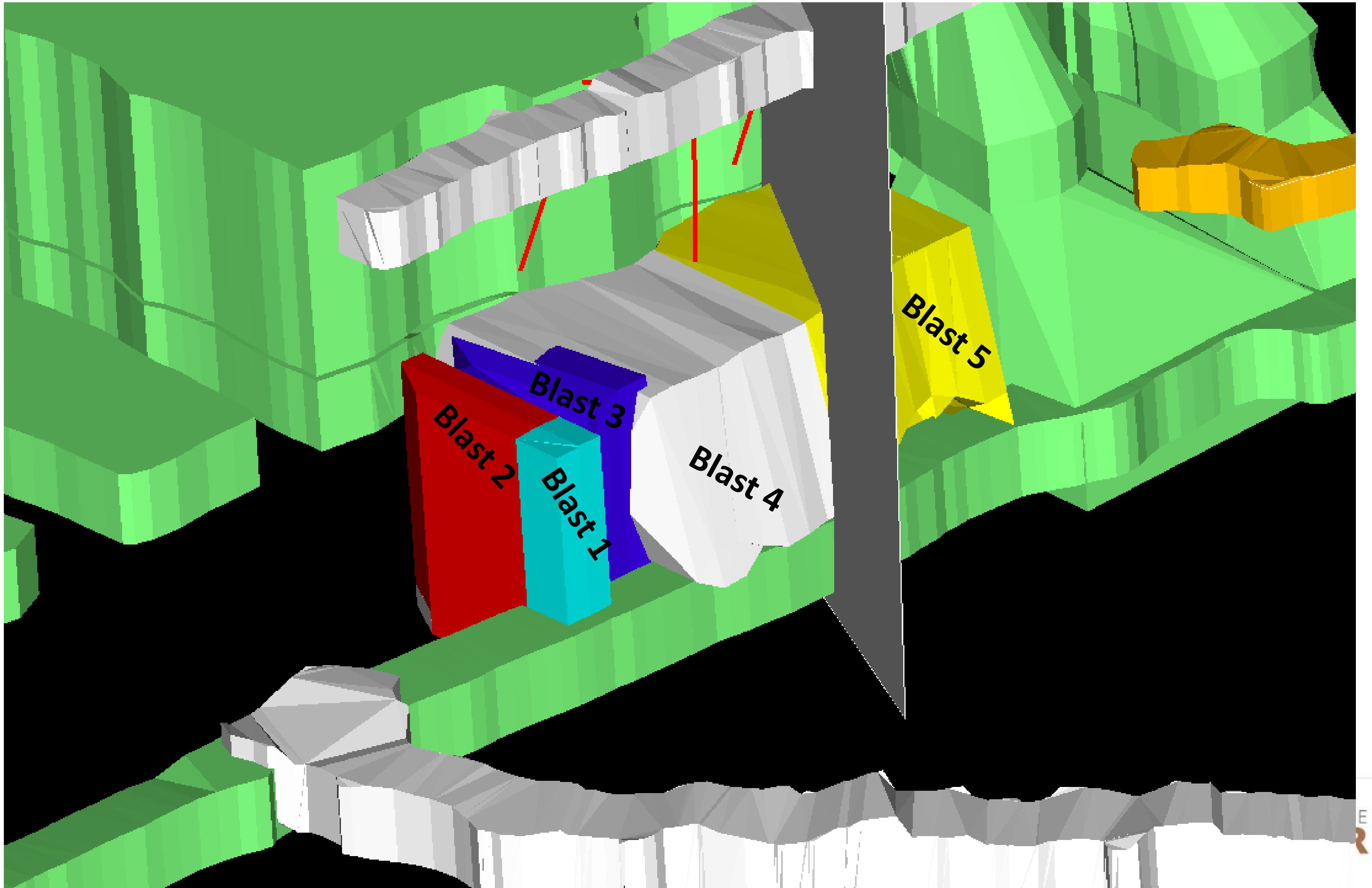
Cable Bolts



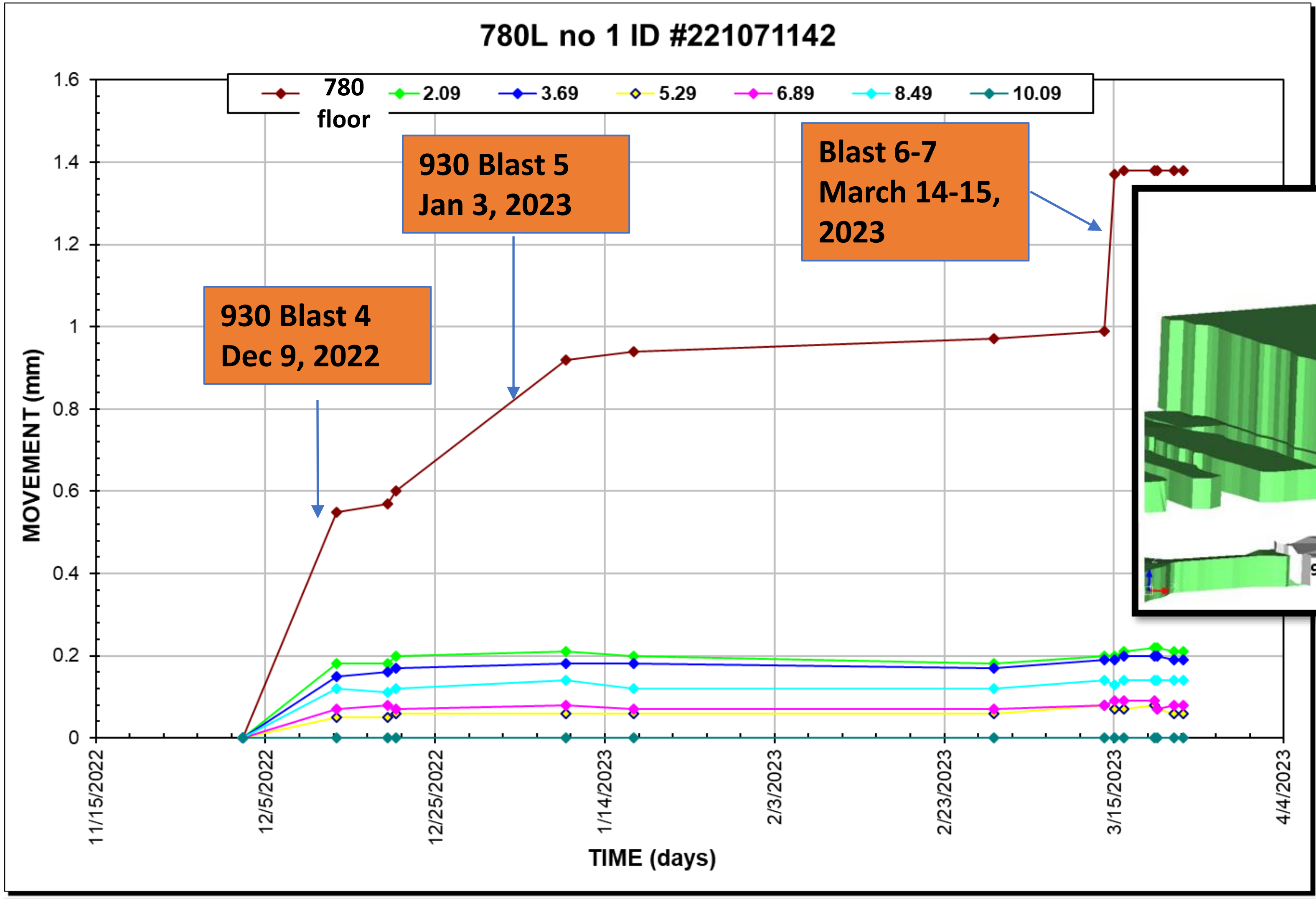
- Doube strand cables
- 40-60 ft long
- Avg 10-12 ft 'toe-spacing
- Grout leak due through fractures

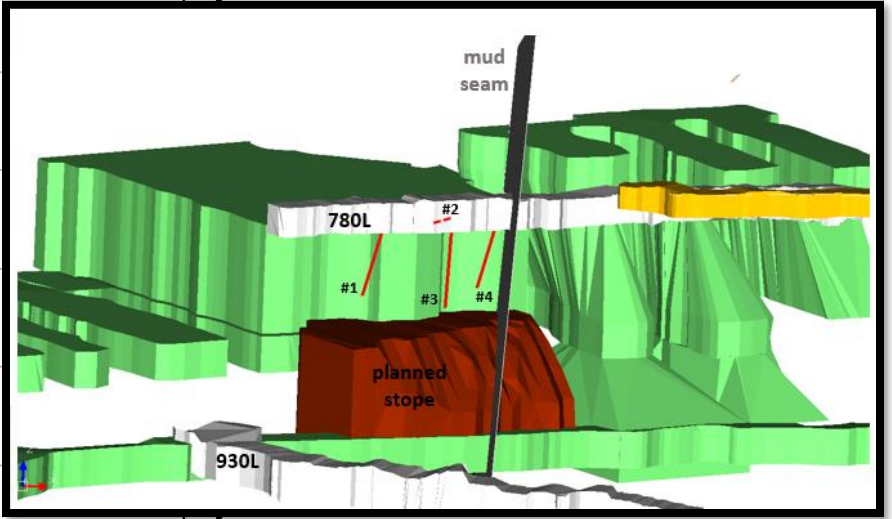
Stope Blast Plan



- The stope was designed to be mined through 5 blasts
- Blast 6 and 7 were designed to slightly increase the size of the void around blast 1-3
- Blast 8 was to mine the sill pillar above

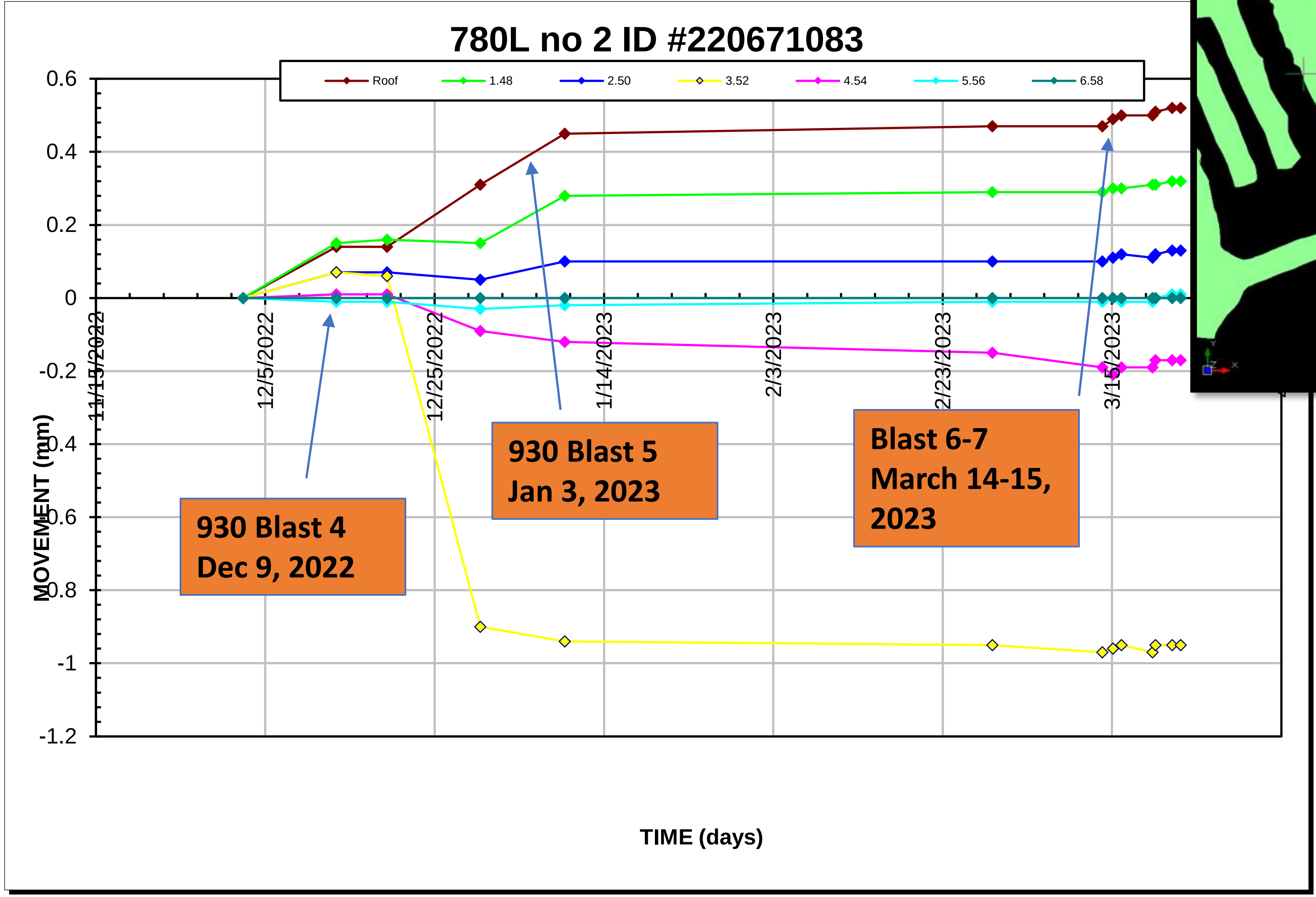
MPBX No 1

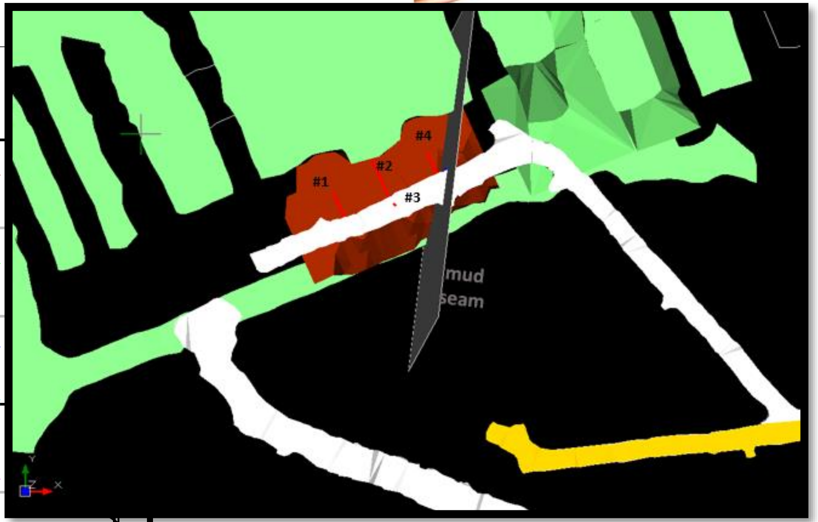




Movement and extension on all the nodes showing floor shake up and bulking on 780 due to the last two raise blasts

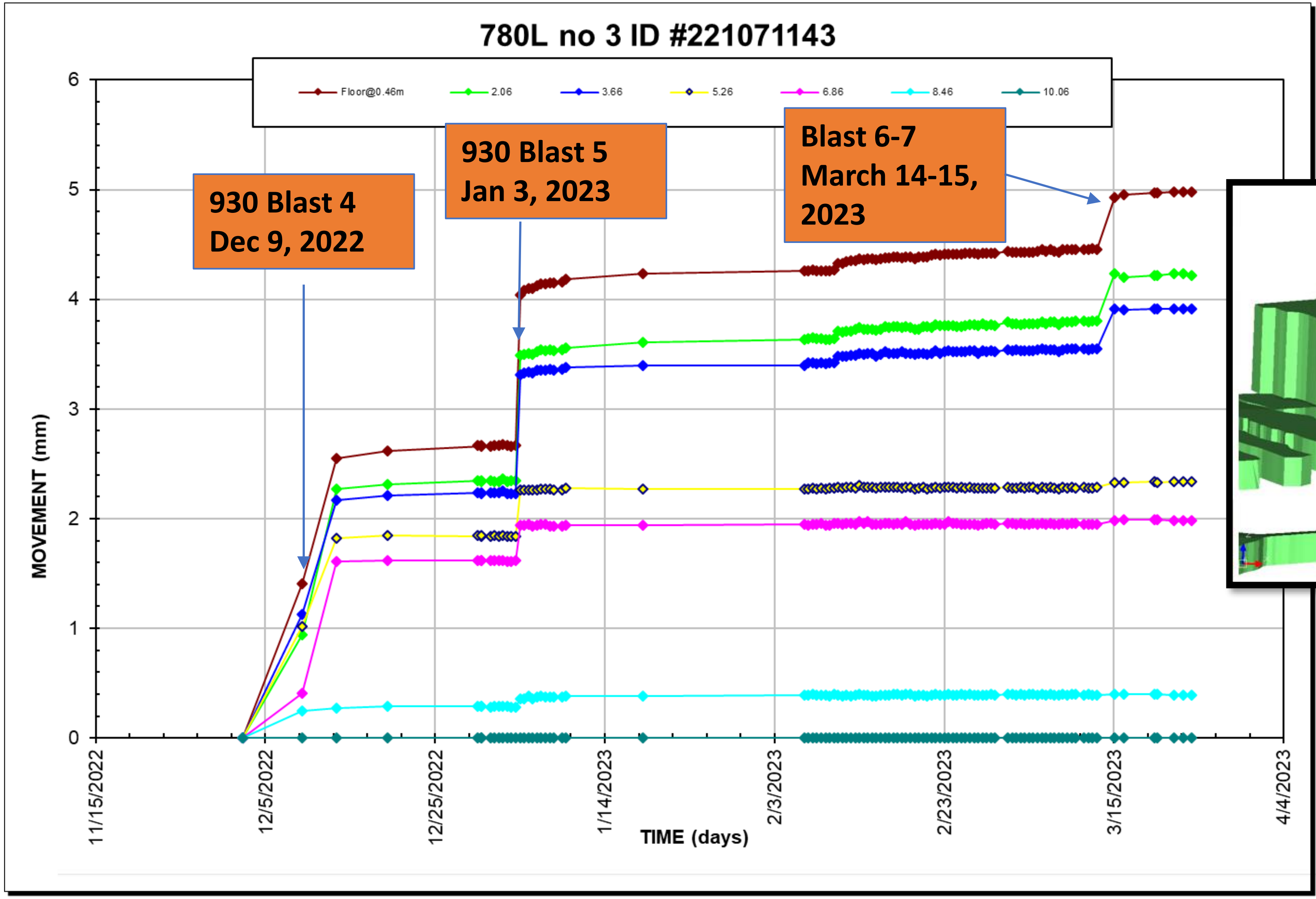
MPBX No 2

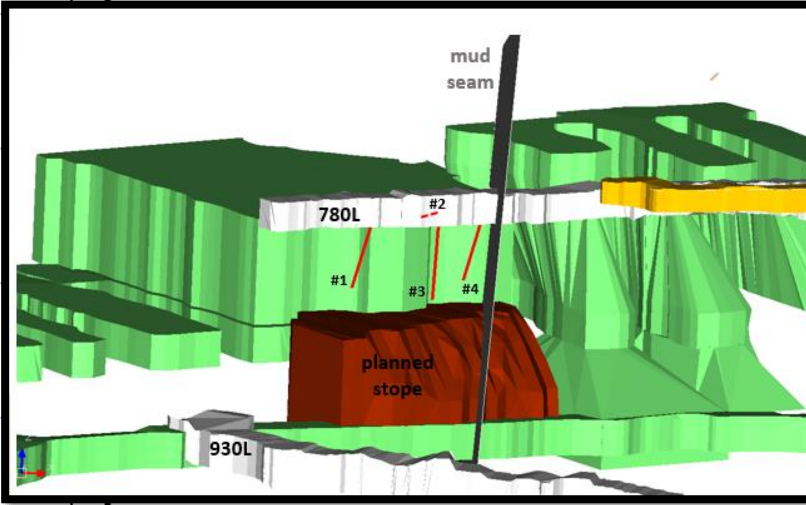




- Movement and extension on all the nodes except the middle node
- Explanation for anchor no 4 (yellow line)?

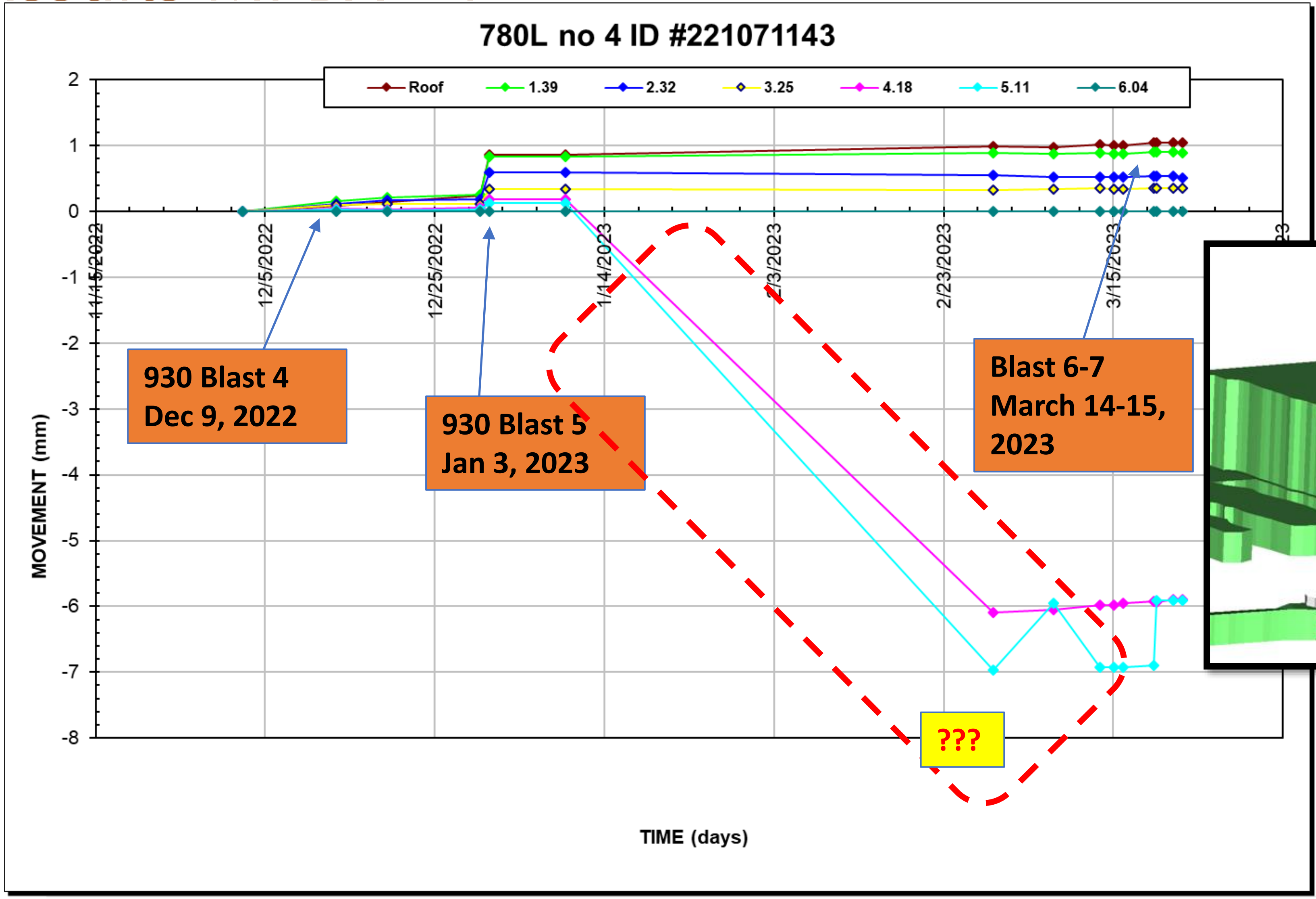
Results MPBX #3



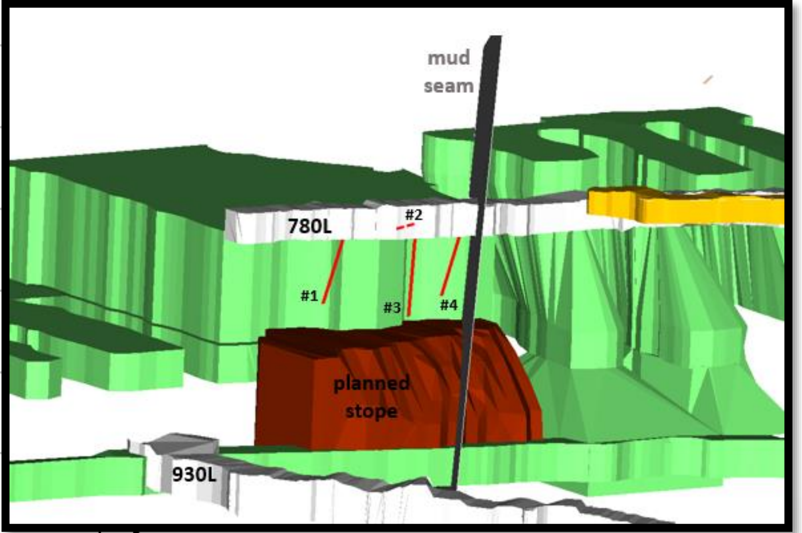


Movement and extension on all the nodes

Results MPBX #4



- Compression on two nodes??? (cyan and purple lines)



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Summary

- There are many uncertainties involved in the geotechnical design of any underground opening, especially an underground mine.
- These uncertainties impose major risks and limitation to mine and stoping design and the economy of the operation.
- Geotechnical instrumentation and monitoring are vital tools to ensure effective design and safe operation.
- Implementation of these tools helps mitigate risk, reduce cost or save lives.
- Although such tools are very useful, there are concerns regarding their applicability and reliability, e.g. shift in movement for no reason, negative values, oscillation, etc.
- 2 out of 4 extensometers used in this case study did not function as expected.
- More reliable monitoring devices would provide engineers the base for reducing risk and enhancing performance of the project in hand.

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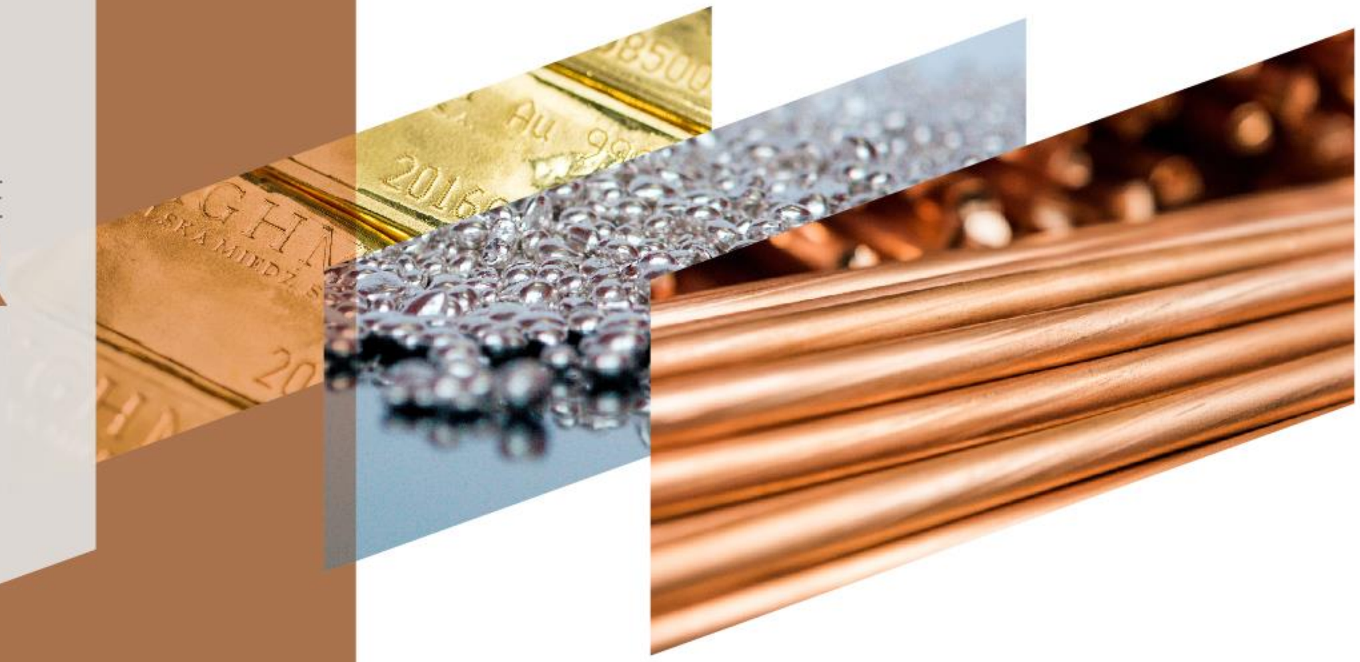

THANK YOU!