

Excavation of the HK Cavern

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Cavity and Tank Session

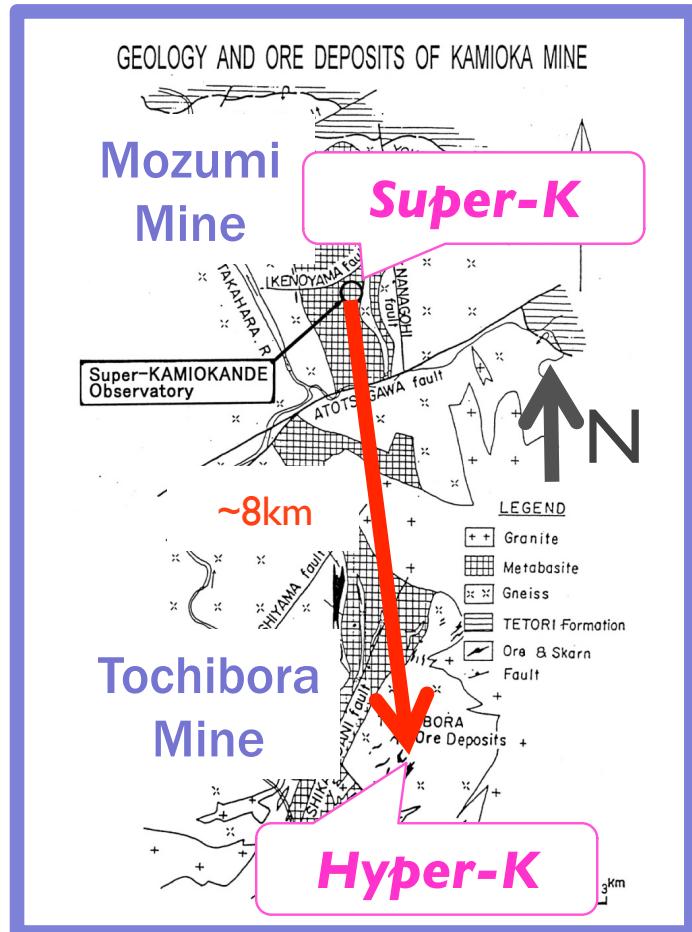
- 30 min. Excavation of the Hyper-K cavern SHIOZAWA
- 30 Hyper-K liner and PMT support TANAKA
- 20 Geomagnetic field compensation NAKAYAMA

Contents of this talk

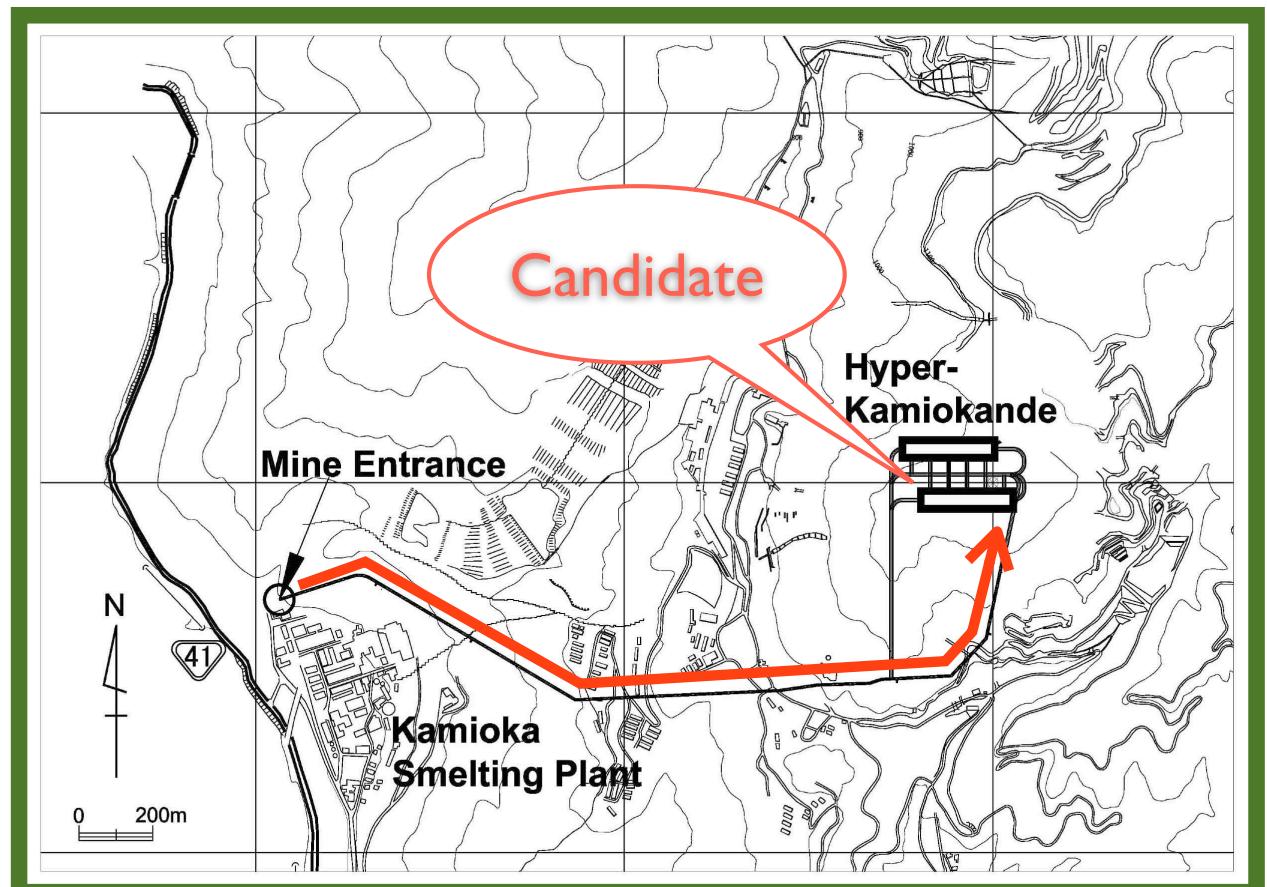
- Baseline design of the cavern
 - Revised cavern analysis results
 - Revised PS anchor design
 - Feasibility study of rock disposal
- Cost estimation will be revised **by the end of January**
- Summary of other cavern shapes, other site (**Mozumi**)

Baseline Design

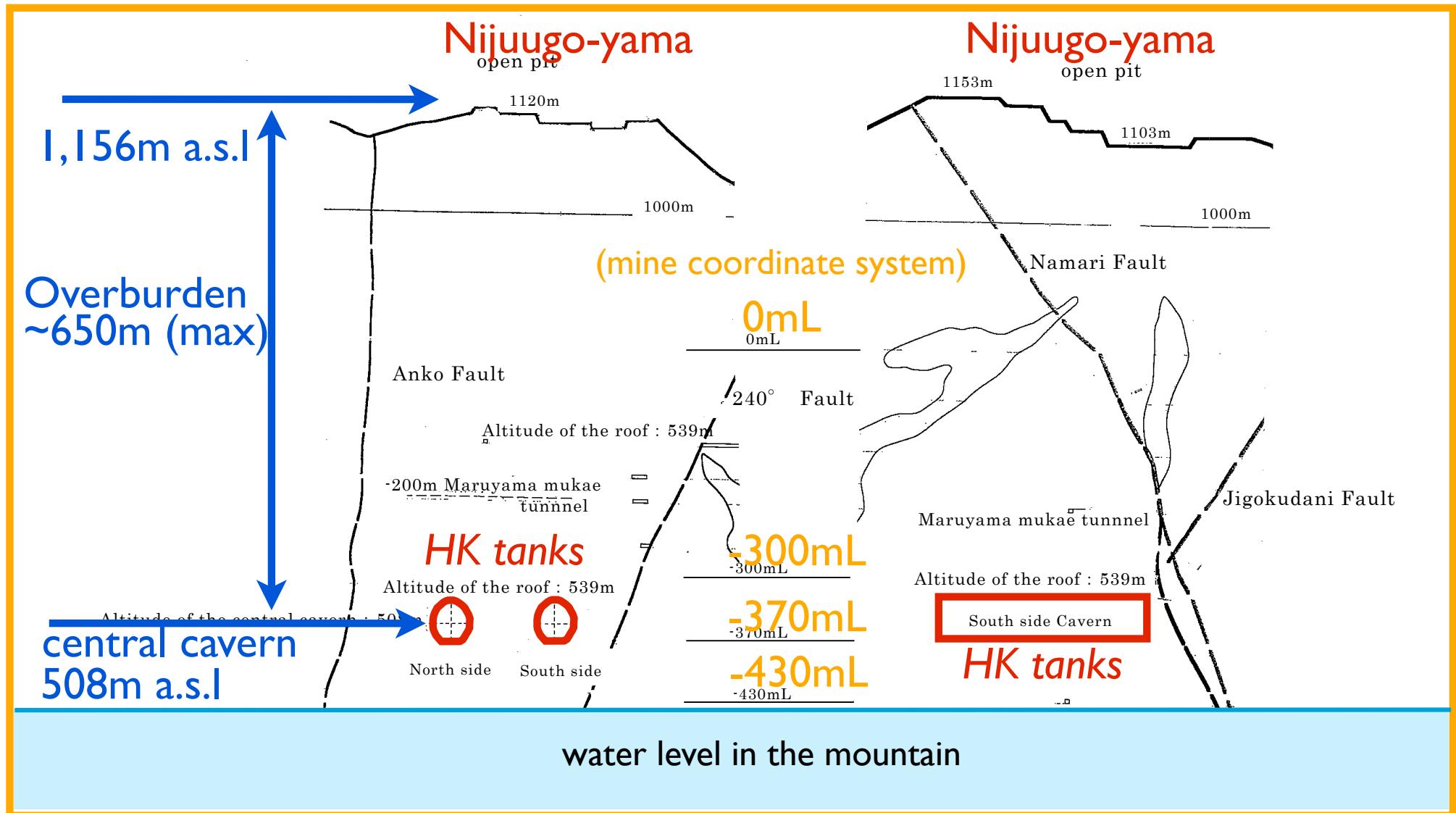
Hyper-K candidate site



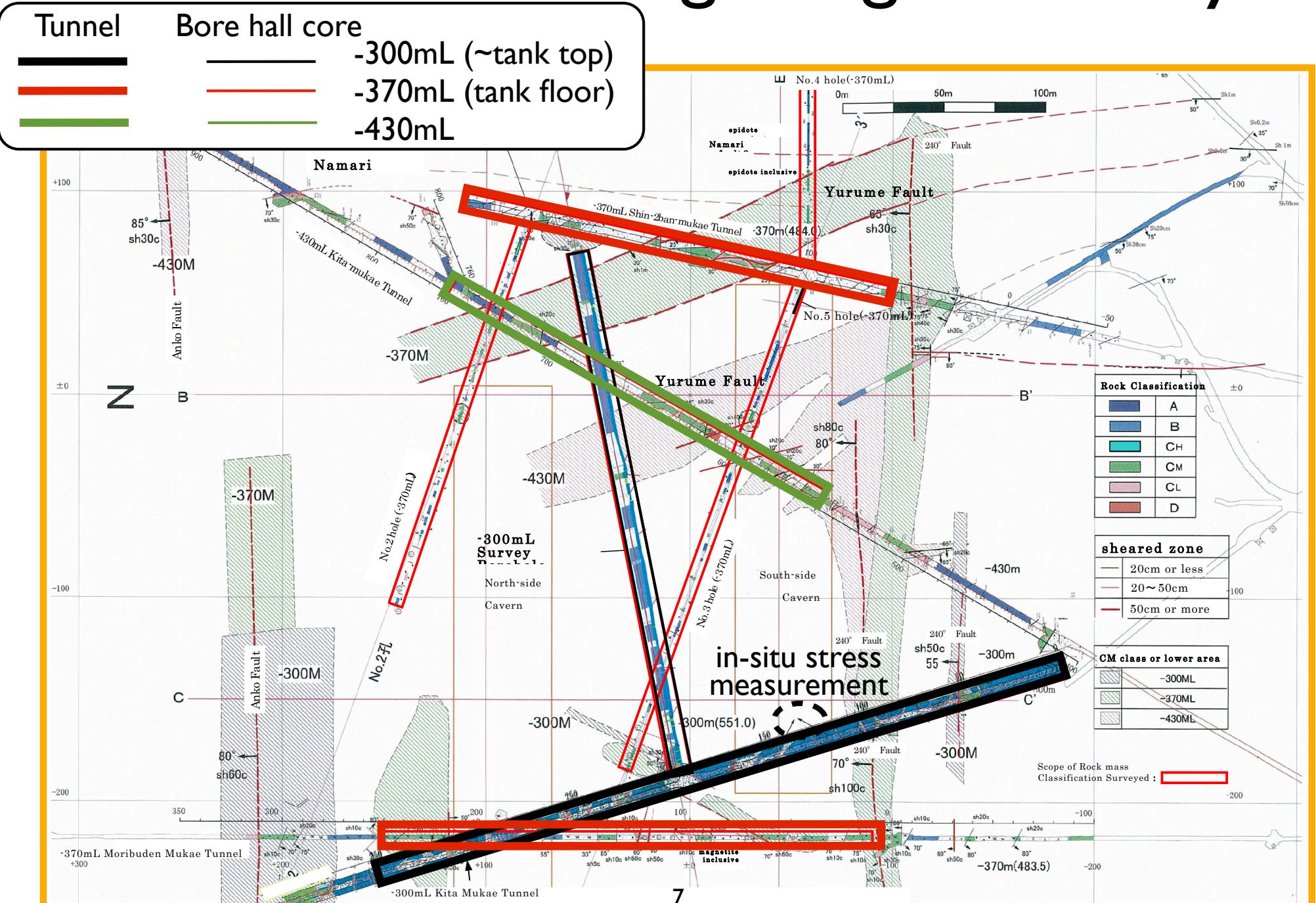
- ◆ 8km south from Super-K
 - ◆ same T2K beam off-axis angle (2.5 degree)
 - ◆ same baseline length (295km)
- ◆ 2.6km horizontal drive from entrance



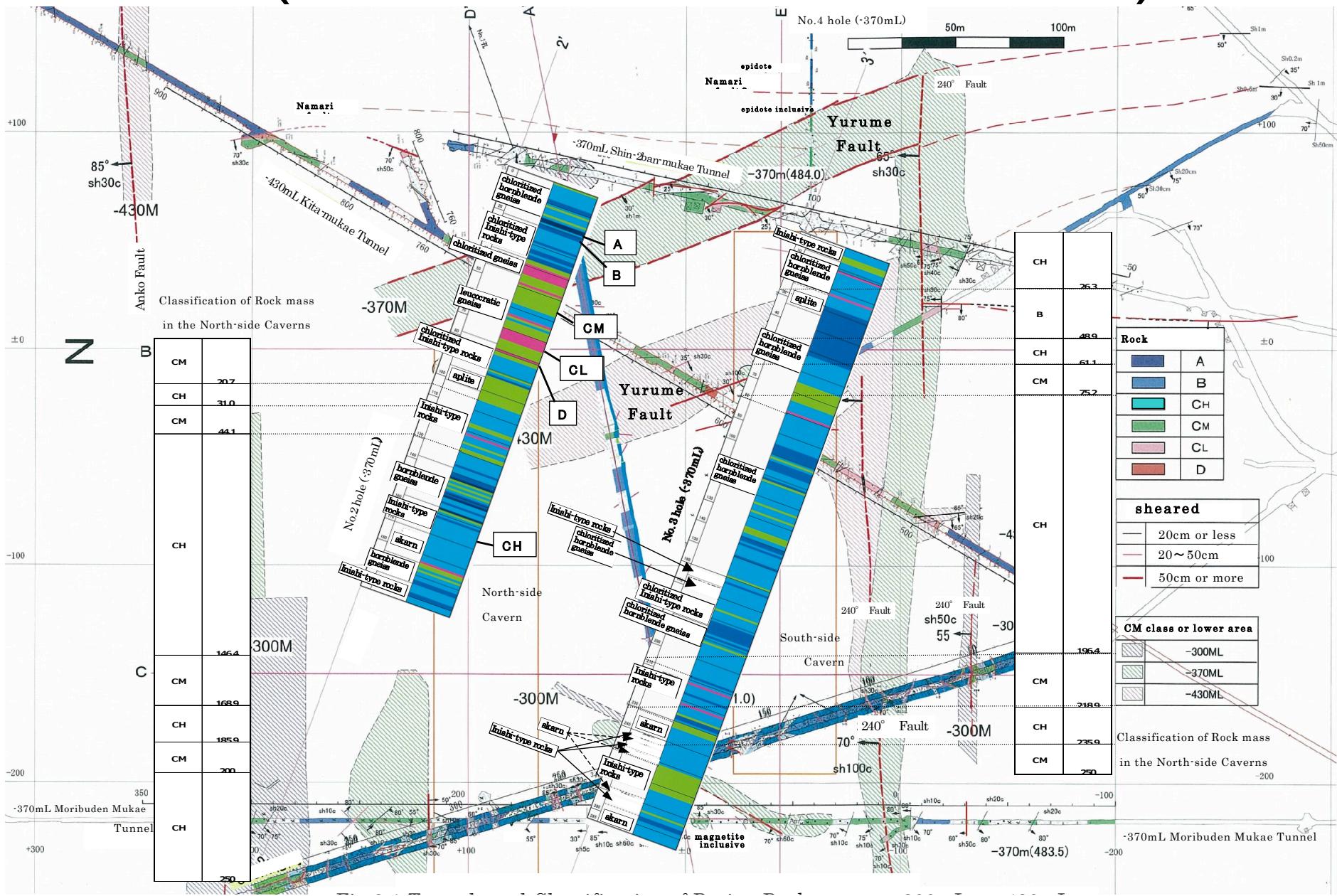
Side view of the site



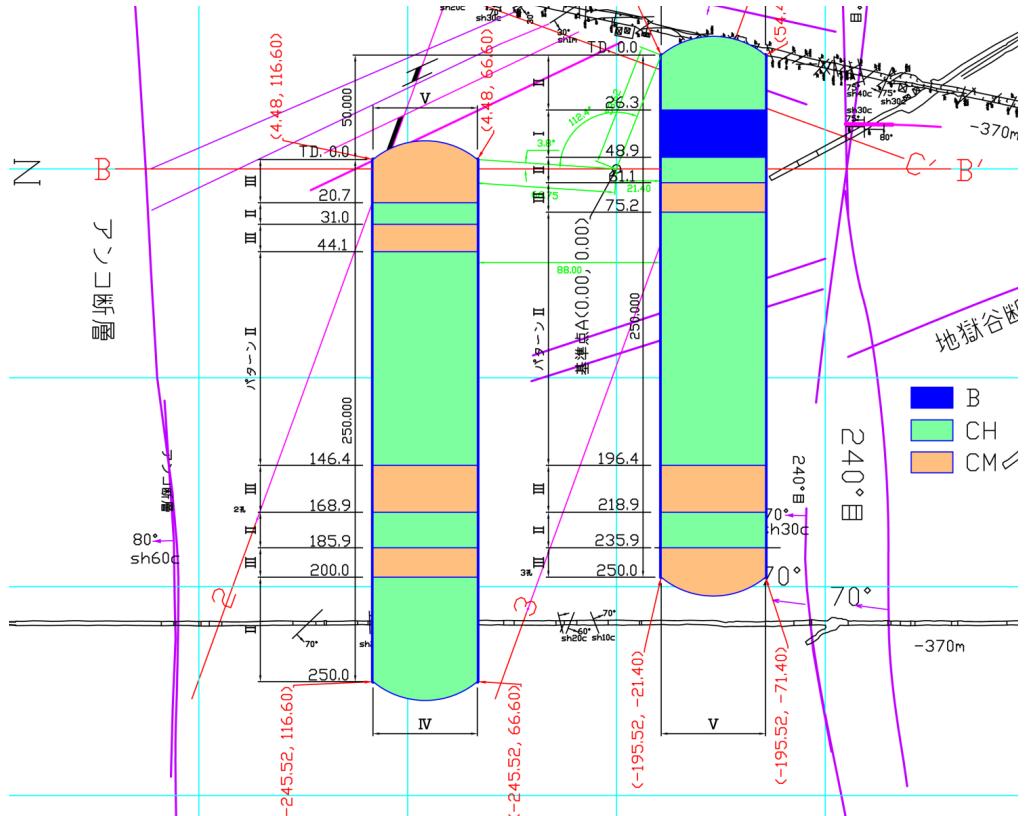
Overview of the geological survey



Rock class model (-370mL, tank floor level)



Model of rock class distribution



-B class (4.5%)

-The rock mass is solid. There are no opening joint and crack

-CH class (71.3%)

-The rock mass is relatively solid. The cohesion of joints and cracks are slightly decreased.

-CM class (24.2%)

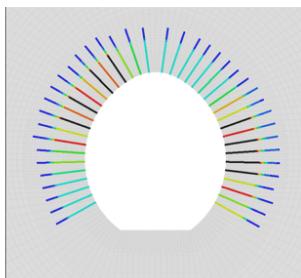
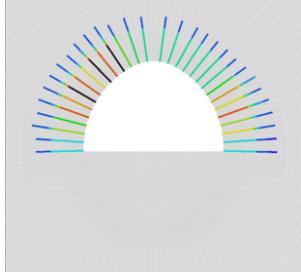
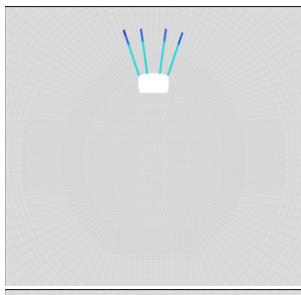
-The rock mass is somewhat soft. The cohesion of joints and cracks is somewhat decreased and rock blocks are separated by ordinary hammer blow along the joints.

1st version document

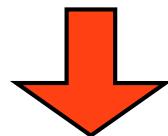
- 1st version excavation document is ready and available to the working group
 - Summary of geological survey, results of elastic cavern analysis
 - English and Japanese
 - Posted on the Hyper-K WG page
 - [Home >>Hyper-K Working Group >> Documents >> Engineering Document >> Excavation](#)

Cavern Analysis Overview

- **Elastic**, static analysis was conducted and reported at the last meeting
 - one calculation for the whole cavern.
 - evaluate the plasticity region based on elastic analysis
 - Mohr-Coulomb's criterion as failure criteria, general (mean) values for Young's modulus
 - design PS anchors, rockbolts, and shotcrete to support the loosened area.
 - elastic limit of the supports themselves not taken into account

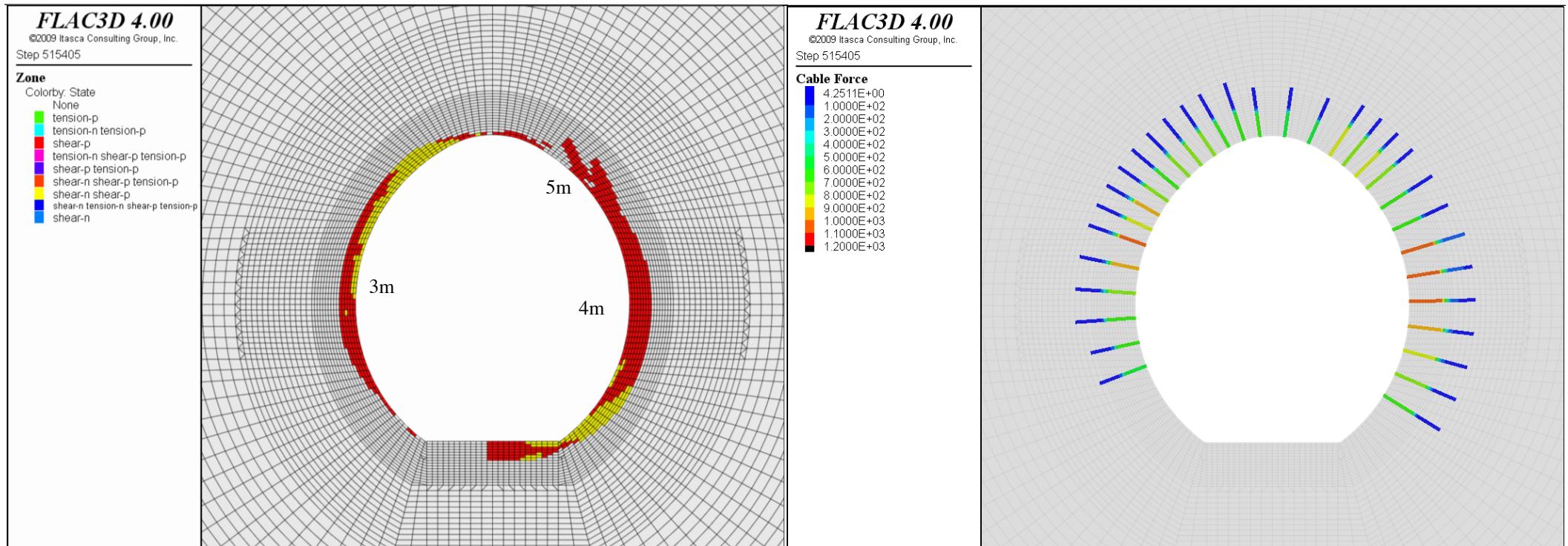


NEW



- **Elasto-plastic, static analysis**
 - **step-by-step calculations** for each excavation benches.
 - perform calculation even after the stress exceeds the elastic limit.
 - Hoek-Brown's criterion as failure criteria, revised Young's modulus
 - strain softening calculation
 - Designed supports are considered in the calculation
 - **elastic limit of the supports** also taken into account.

CH class (relatively solid rock mass)

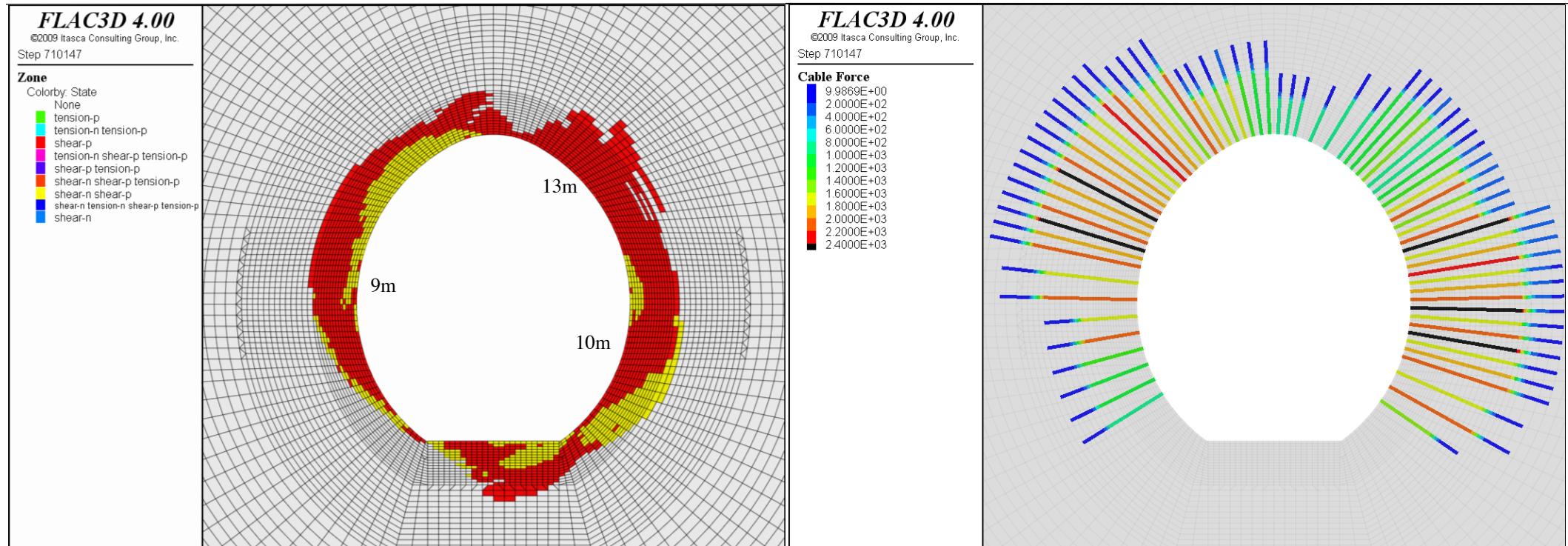


Plasticity region depth~5m

PS anchor tension
(black is over tension)

Affordable cable tension and plasticity region depth
for B and CH class.

CM class (somewhat soft rock mass)



Plasticity region depth~10m

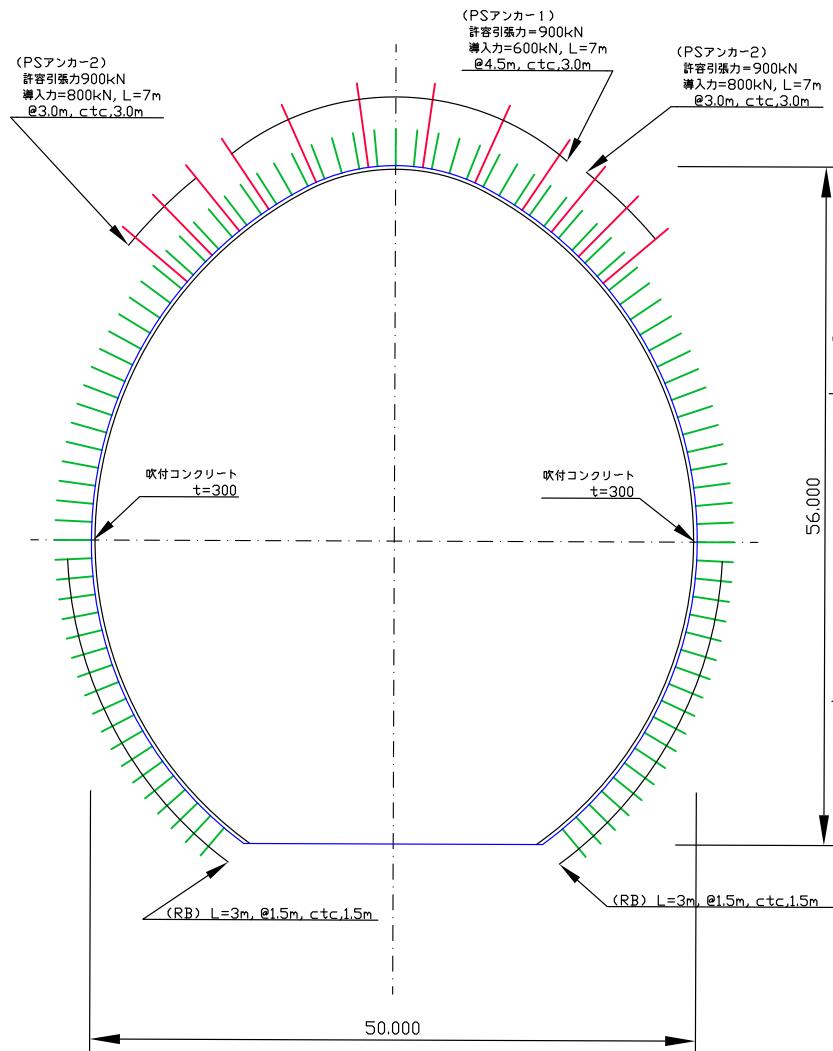
PS anchor tension
(black is over tension)

- Affordable cable tension and plasticity region depth even for CM class.
- Need more long anchors than the past elastic analysis.
 - Cost and schedule are to be revised in January.

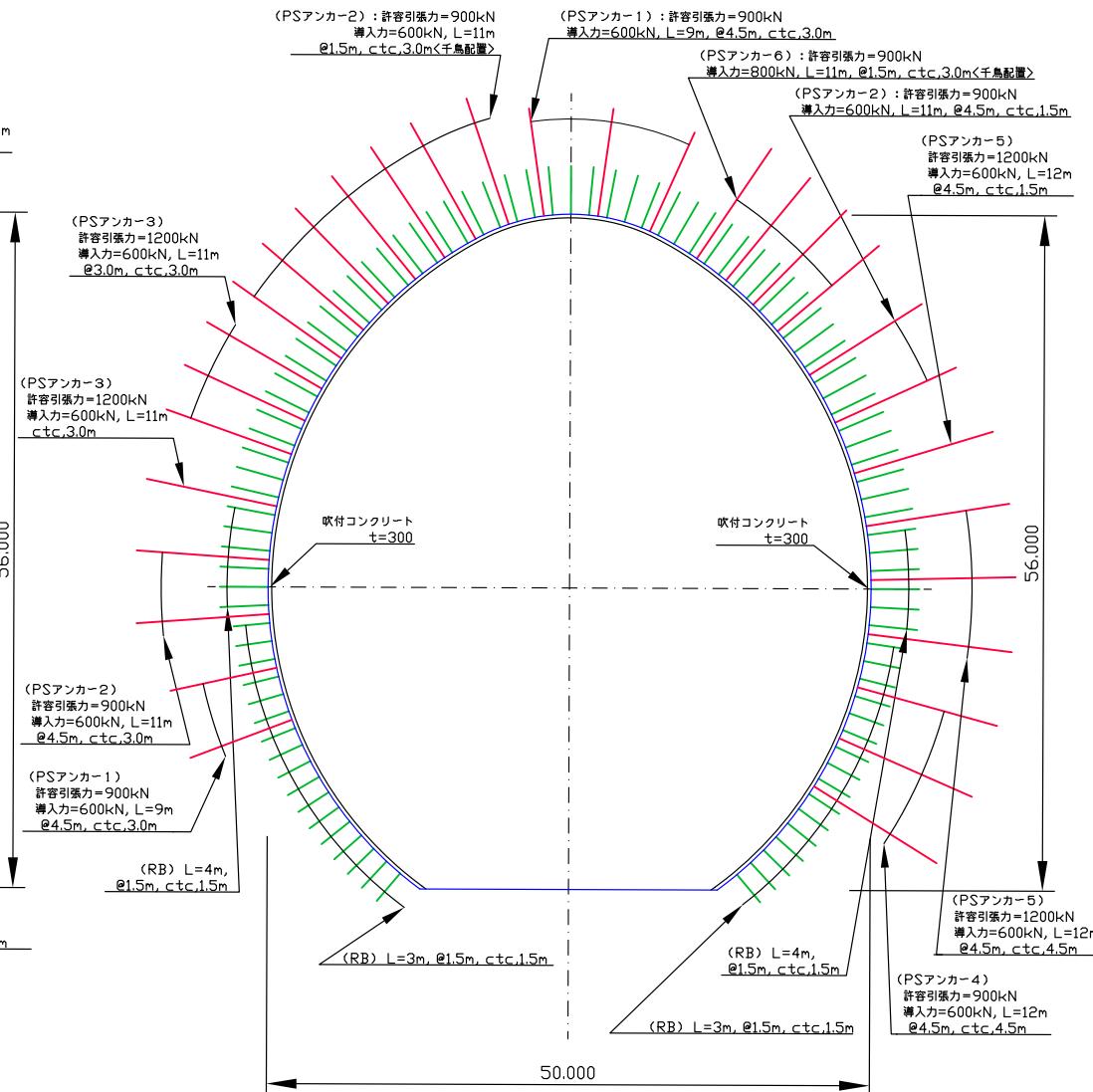
PS anchor design (B and CH)

水槽空洞断面支保パターン区分

パターン I (B級岩盤)

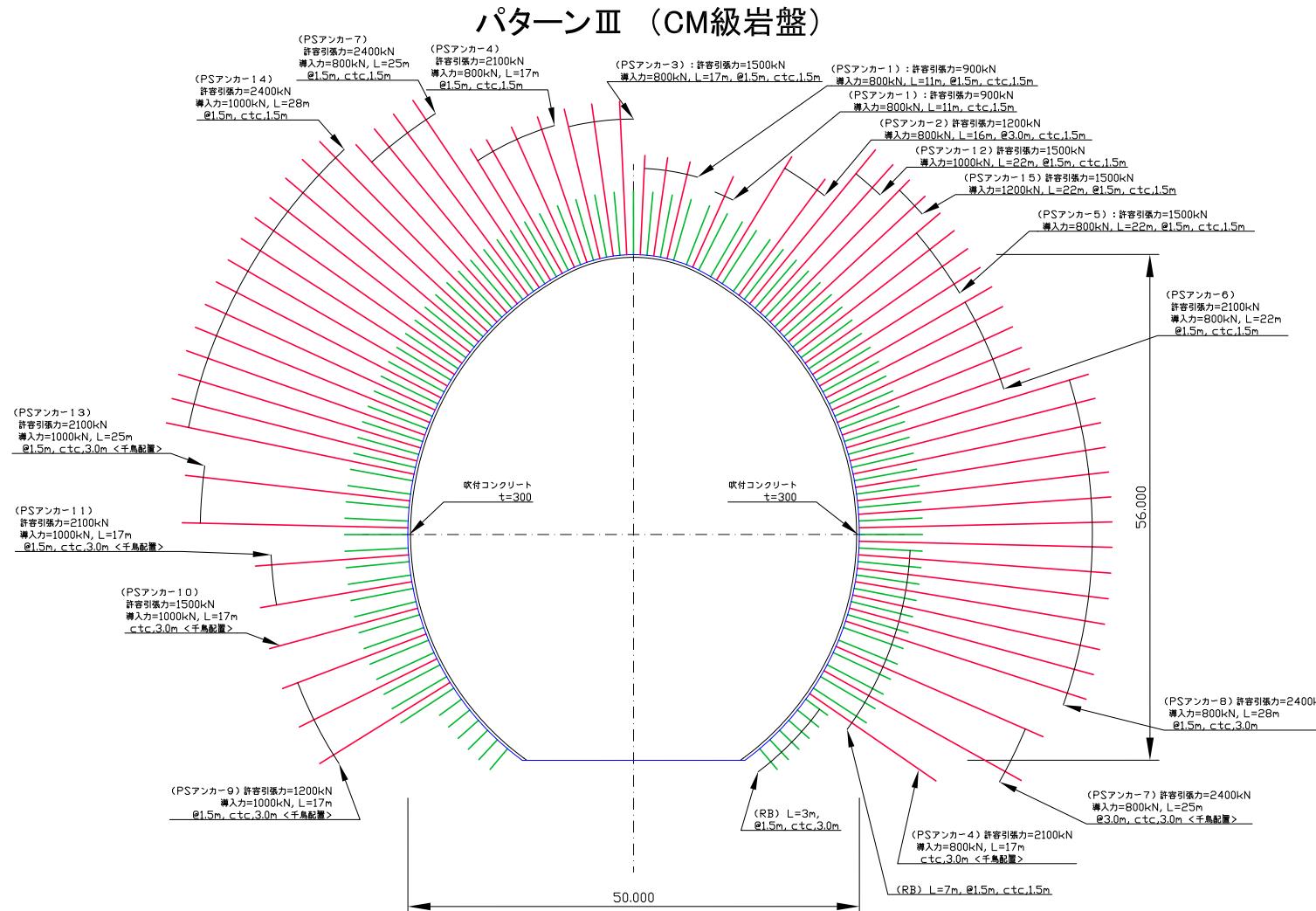


パターン II (CH級岩盤)

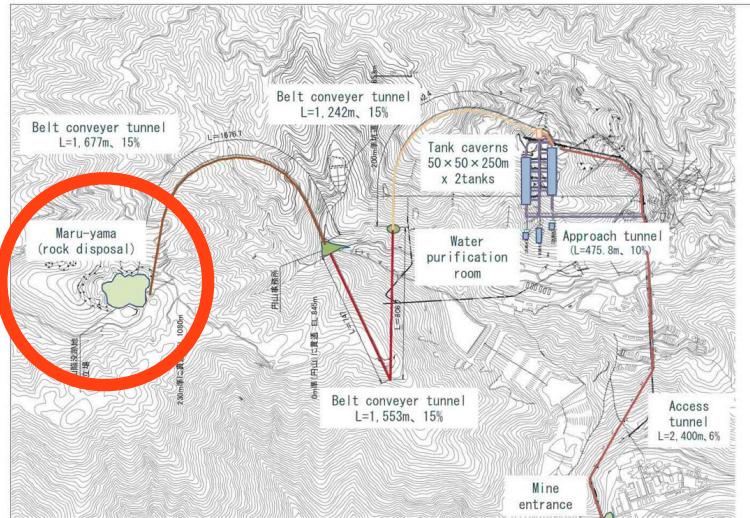


PS anchor design (CM)

水槽空洞断面支保パターン区分

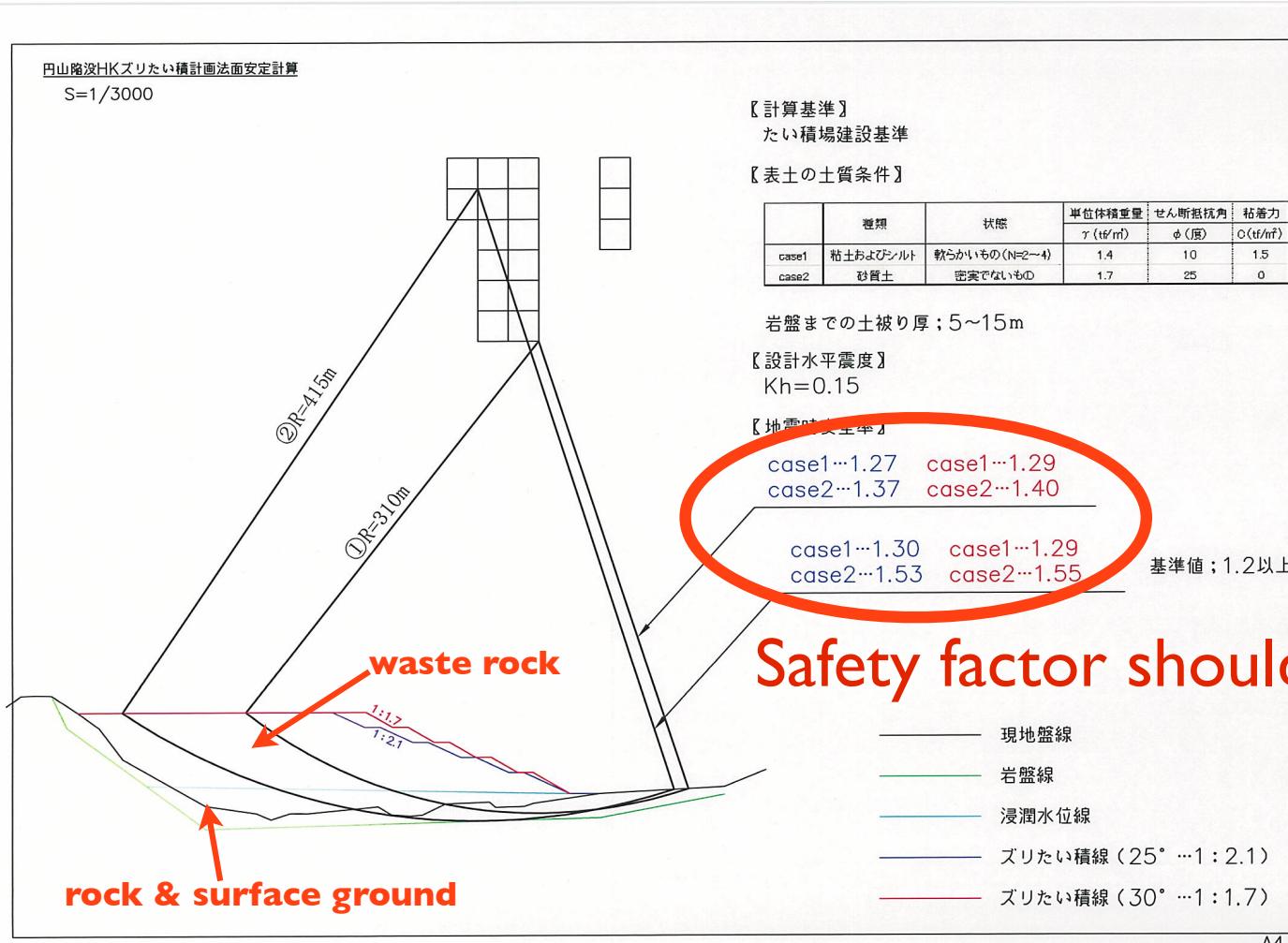


Study for rock disposal place



- We are planning to stack waste rock at the top of Maru-yama.
- Concern about rock sliding.
- Feasibility study was done.

Study for rock disposal place



- case1&2: two assumptions on surface ground property
- Blue and red: two cases on slope angle

- Analysis results is encouraging
- Need geological survey data in future

Other cavern shapes, site

Comparison of the Hyper-K Cavern from Various View Points

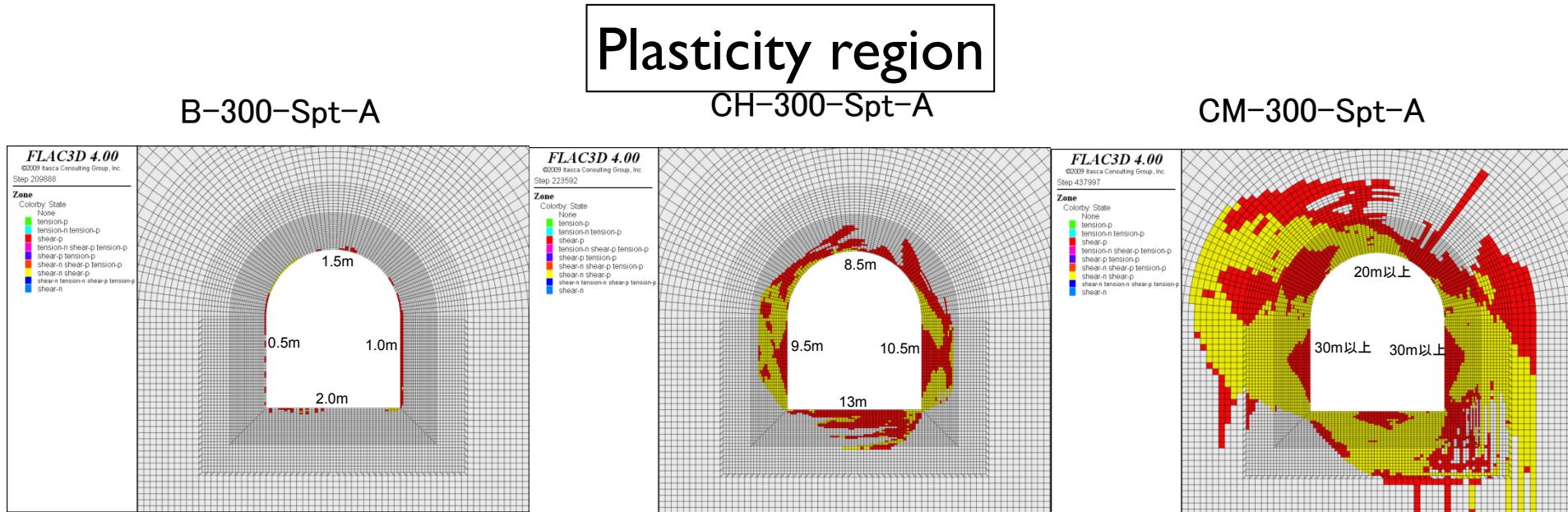
Cavern Type	Multiple Domes	Single Tunnel	Two Parallel Tunnels
Construction Period & Cost	×	○	○
Early Observation Startup	△	△	○
Observation during Maintenance	○	×	○
Cost Performance of Detector Tank	×	○	△
Cavern Stability	◎	○	○
Total Evaluation	×	△	○

Size of one Cavern (m)	Height	60.0	54.0	54.0
	Width	Φ 60	48.0	48.0
	Length	---	500	250
Vertical Cross Section Area (m ²)	3,368	2,076	2,076	
Volume of one Cavern (m ³)	152,600	1,038,000	519,000	
Required No. of Caverns	7	1	2	
Total Volume of Caverns (m ³)	1,068,200	1,038,000	1,038,000	



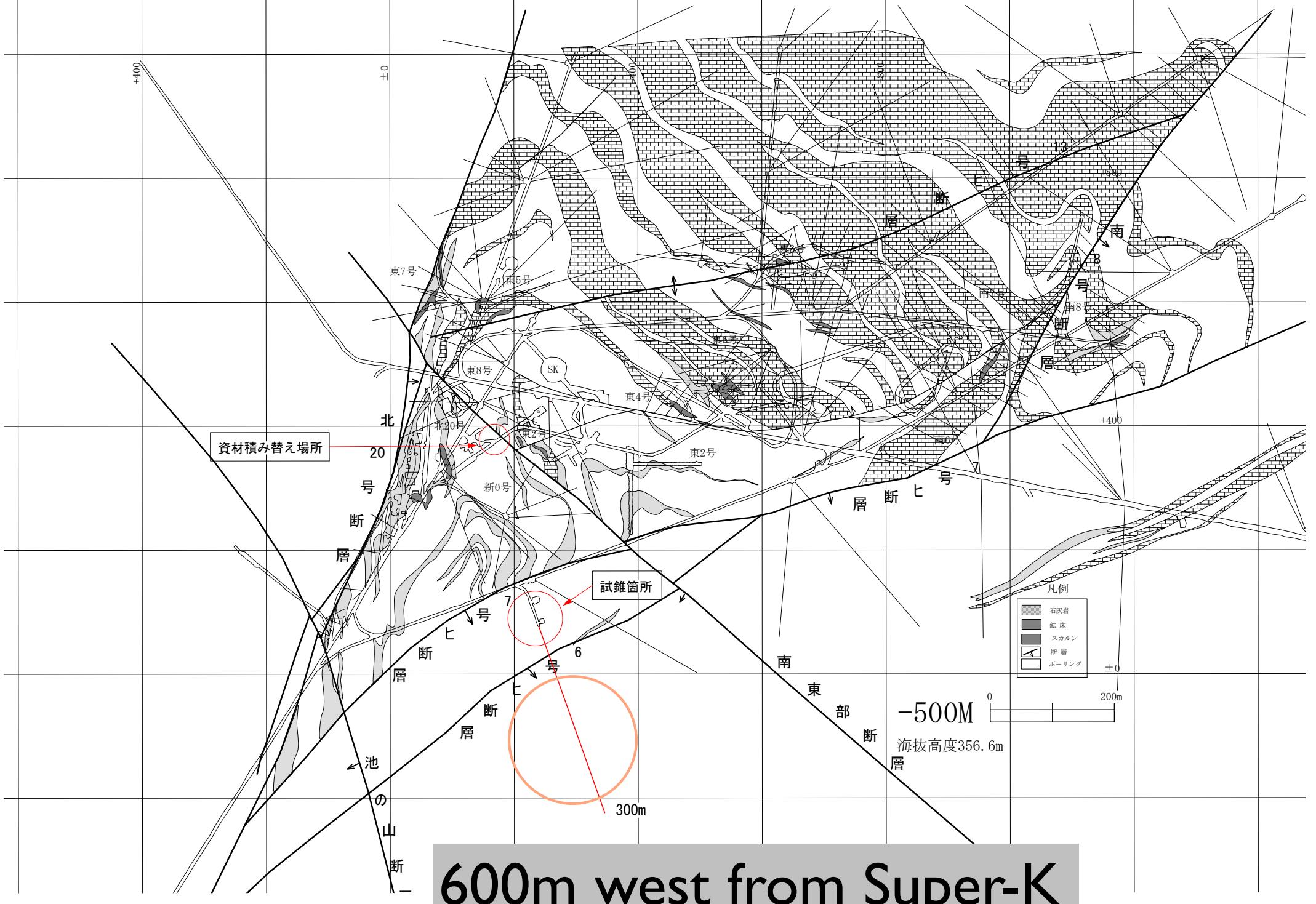
Different tunnel shape

We are interested in the tunnel w/ vertical straight wall for various reasons, but the analysis shows negative...



- Displacement: B-2cm, CH-17cm, CM-100cm
 - PS anchor tension in CM exceeds the limit.
 - Plasticity region depth is too deep to treat in CM.

→ Looks impossible to excavate the straight wall cavern in the candidate site. → Egg-shaped tunnel as a baseline design



West Mozumi

- Overburden >700m
 - CR muon rate is about twice of SK. $\leftrightarrow 10 \times SK$ at Tochibora site
- Geological information not available
 - No info. on rock mass class, in-situ rock stress
 - No show stopper but need survey (money)
- Water source to be identified.
- Nationally-owned land (need confirmation)
- Tunnels for access and waste rock transportation
 - Can we use the existing Atotsu tunnel? or need new tunnels to avoid interference w/ other projects?
- Rock disposal place to be identified.
- Need to check impact of HK construction on SK, KamLAND, GW...



Summary

- Detailed cavern analysis has been completed.
 - The cavern construction is feasible.
 - Egg-shape cross section, Design of supports was made.
 - The study shows that the the rock quality is essential for construction cost and period. Final tuning of the shape and size might be necessary when more data become available.
 - Estimation of cost and construction period to be revised in a month.
 - V2 document is to be prepared.