A Proposal of the System using Exploratory Boring for Tunnelling by TBM in Deep Ground with High Water-Pressure

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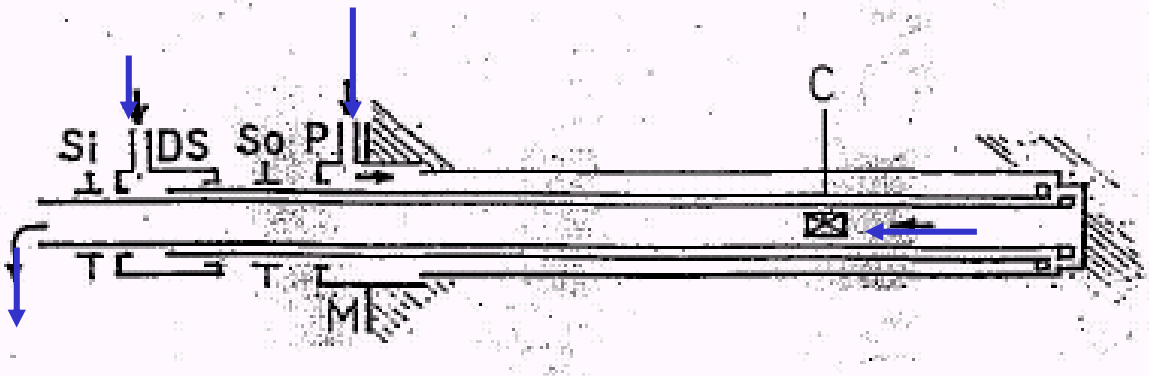
Contents

(1) Conventional system with wire-line (normal water- circulation).

(2) Reverse water- circulation system with single tube.

(3) Reverse water- circulation system with double tube.



Legend

M: Mouth pipe

C: Boring core

S: Spindle

WS: Water- swivel

WL: Wire- line

CB: Core- barrel

So: Spindle for outer tube

DS: Double swivel

Si: Spindle for inner tube

→ : Water- flow

(circulating direction)

Phenomena of collapse or failure in vicinity of the face tunnelling commonly.

(1) Collapse in fore-upward portion about the face, often with much water-inflow.

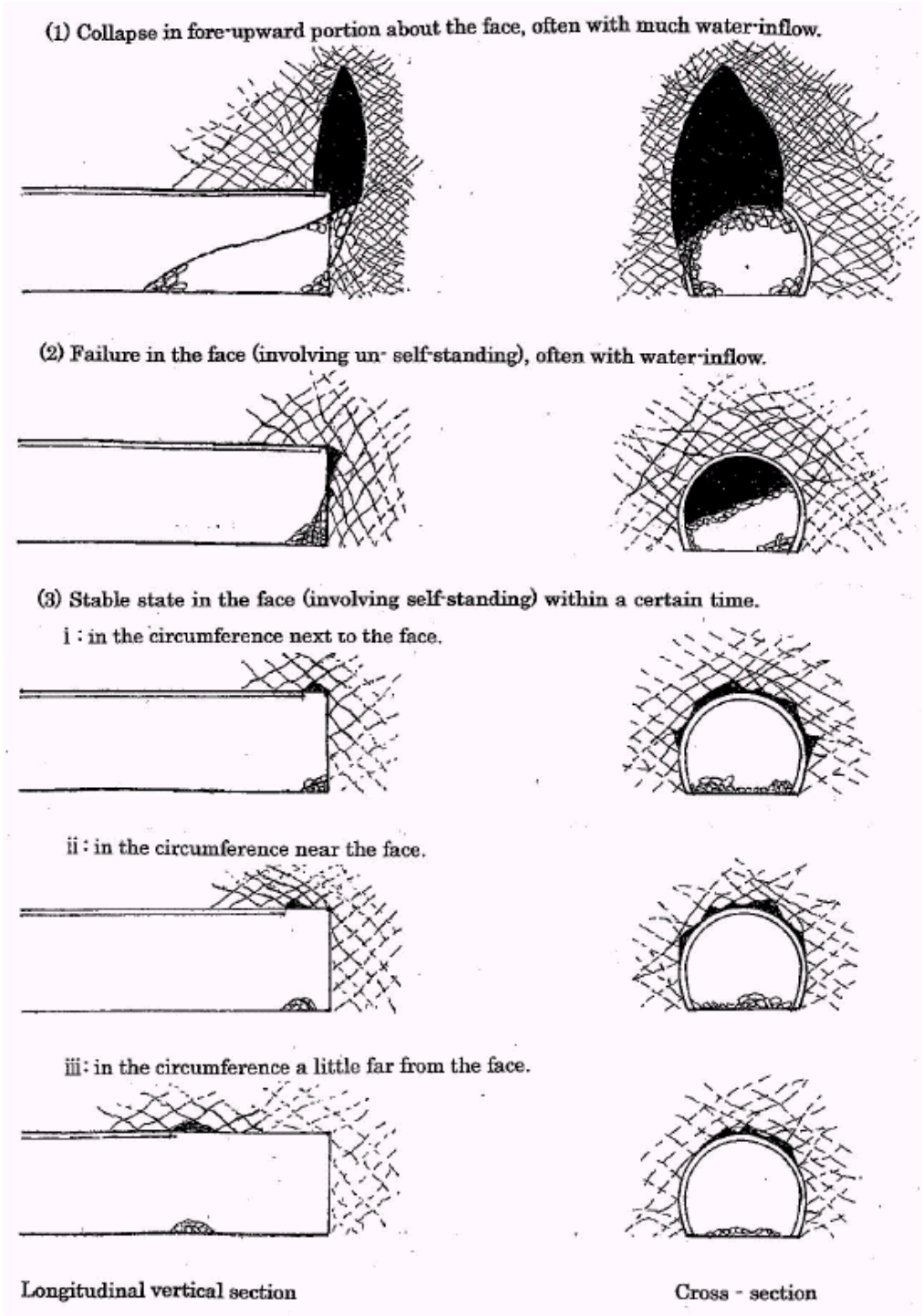
(2) Failure in the face (involving un- self-standing), often with water-inflow.

(3) Scaling or slaking in soft ground, dropping or slipping off seam in cracky ground.

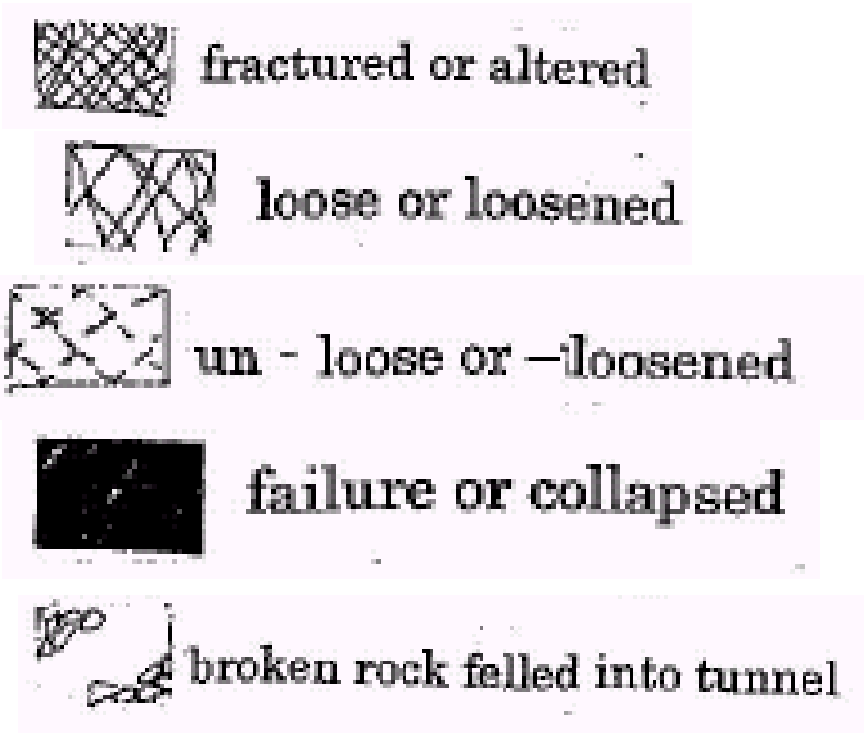
i : in the circumference next to the face.

ii : in the circumference near the face.

iii : in the circumference a little far from the face.


(1) Collapse in fore-upward portion about the face, often with much water-inflow.
(2) Failure in the face (involving un- self-standing), often with water-inflow.
(3) Stable state in the face (involving self-standing) within a certain time.
i : in the circumference next to the face.
ii : in the circumference near the face.
iii : in the circumference a little far from the face.
Longitudinal vertical section
Cross - section

Legend


fractured or altered
loose or loosened
un - loose or –loosened
failure or collapsed
broken rock felled into tunnel

Phenomena in vicinity of the face tunnelling at great depth, added usuals.

(1) Much water-inflow with high pressure.

(2) Large deformation or displacement in circumference , for example swelling or squeezing.

States cooperating with characters of rocks at great depth.

(1) Ground- water (borne, permeable).

(2) Pressure of earth.

Troubles in tunnelling by TBM at deep ground with high water- pressure

Common troubles

(0-1) Water to inflow with high energy near the face.

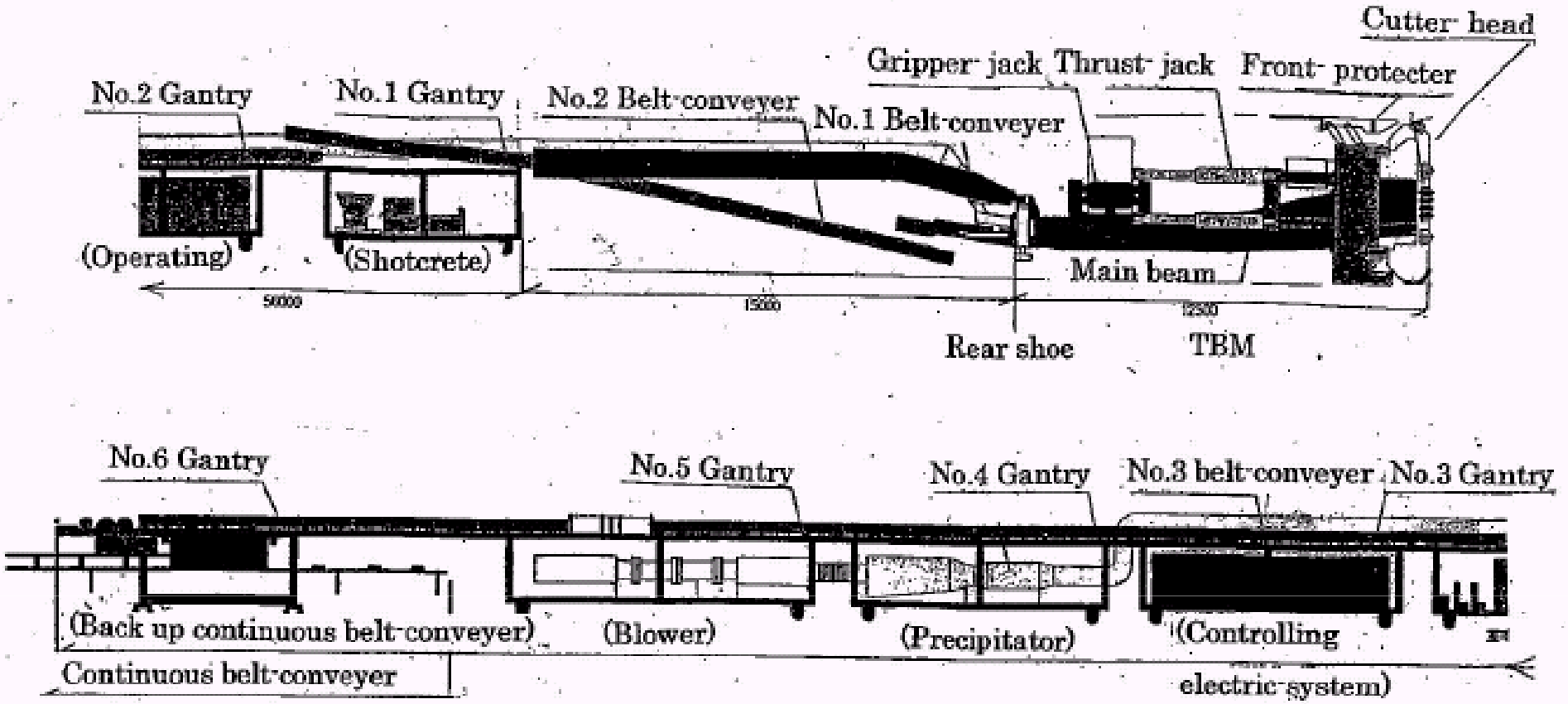
(0-2) Ground near the face to fracture with collapse, often with much water inflowing.

(0-3) TBM advancing with excavation at the face not self- standing to loose ground and to introduce possibly the phenomenon (0-2).

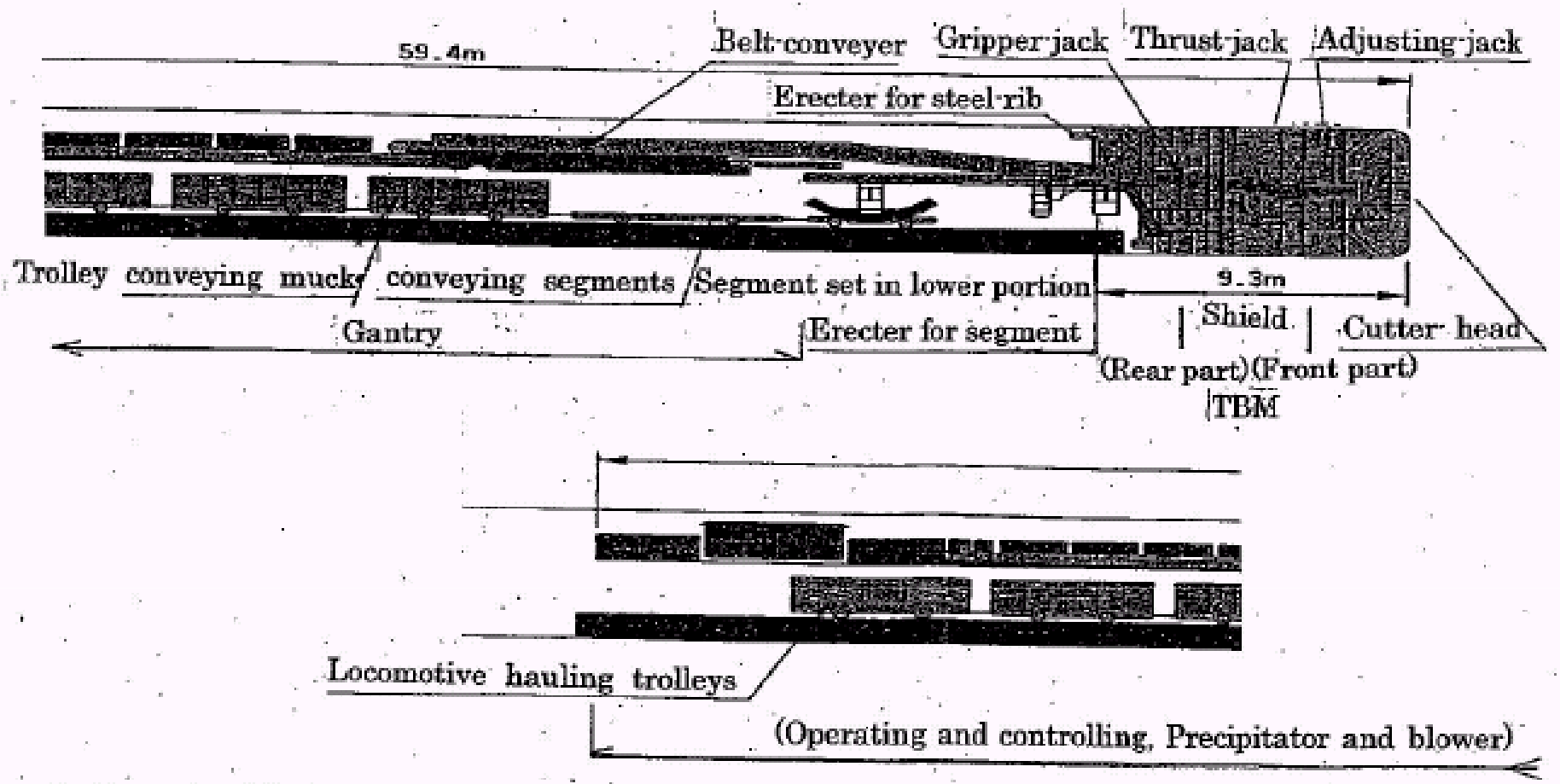
Troubles on disk- cutter to chip rock.

(1-1) Disk- bit to chip less due to rock hard (uni- axial strength more than 80 MPa) or much of abrasive component (quartz more than 40 %).

(1-2) Disk- bit to bite less due to rock soft (elastic modulus less than 3 GPa) or much of un- consolidated constitution (clay and sand more than 40 %).



An Example of the Equipments arranged in TBM System without Shield



An Example of the Equipments arranged in TBM System with Shield

Troubles on TBM without shield.

(2-1) Rocks in circumference to fracture with slaking or slipping down between cutter- head and rear shoe.

(2-2) Gripper not to be propped due to circumference weak or soft.

Troubles on TBM with shield.

(3-1) The shield not to advance due to hard breccia detained in sliding joint (between front- and rear shield).

(3-2) The shield not to advance due to large deformation of circumference slaking, swelling or squeezing.

(3-3) Rocks in circumference slaking or slipping down in variety after shield
(problem of choice or alternation of supporting system or segment).

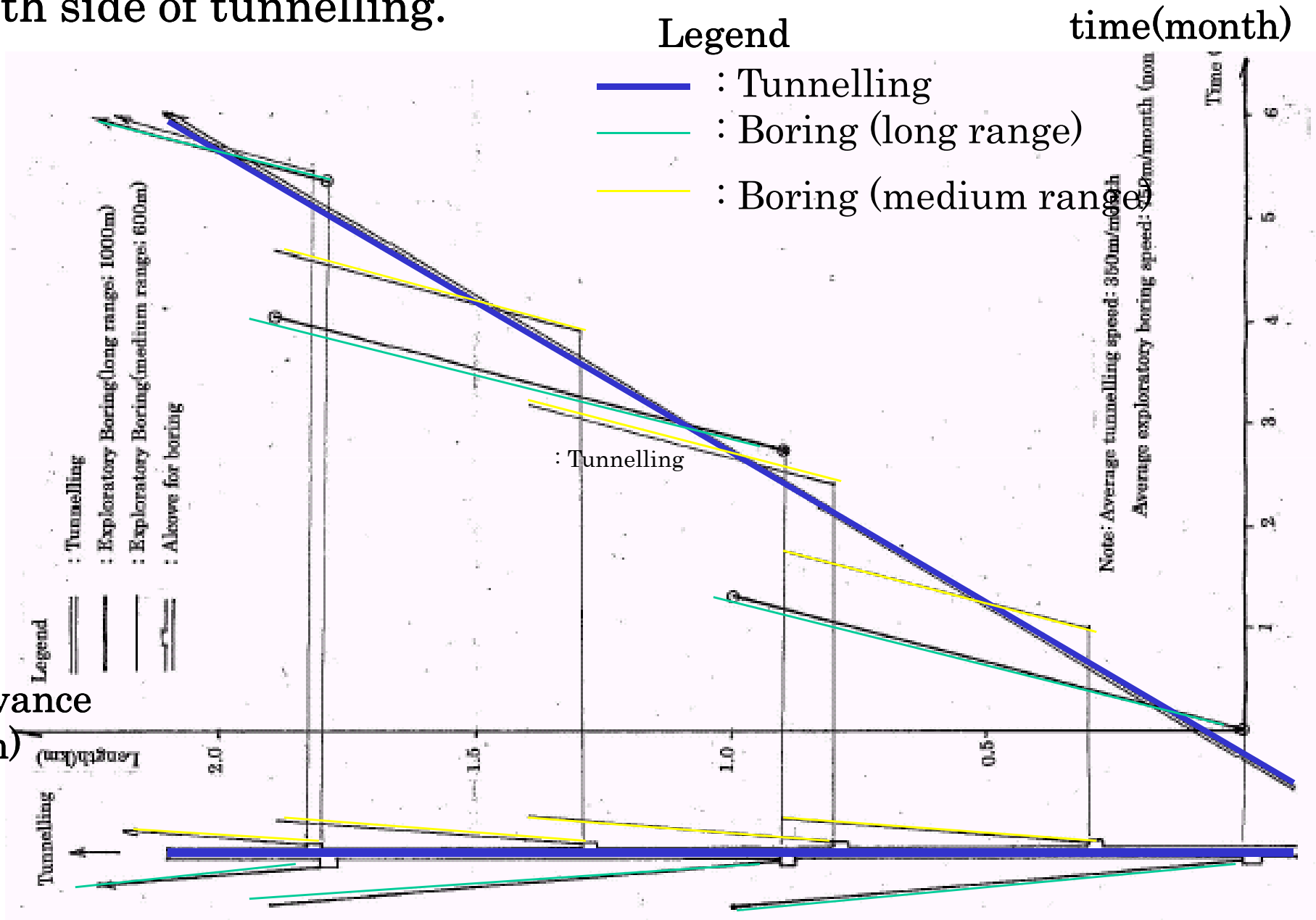
Ranges to forecast geological state before tunnelling

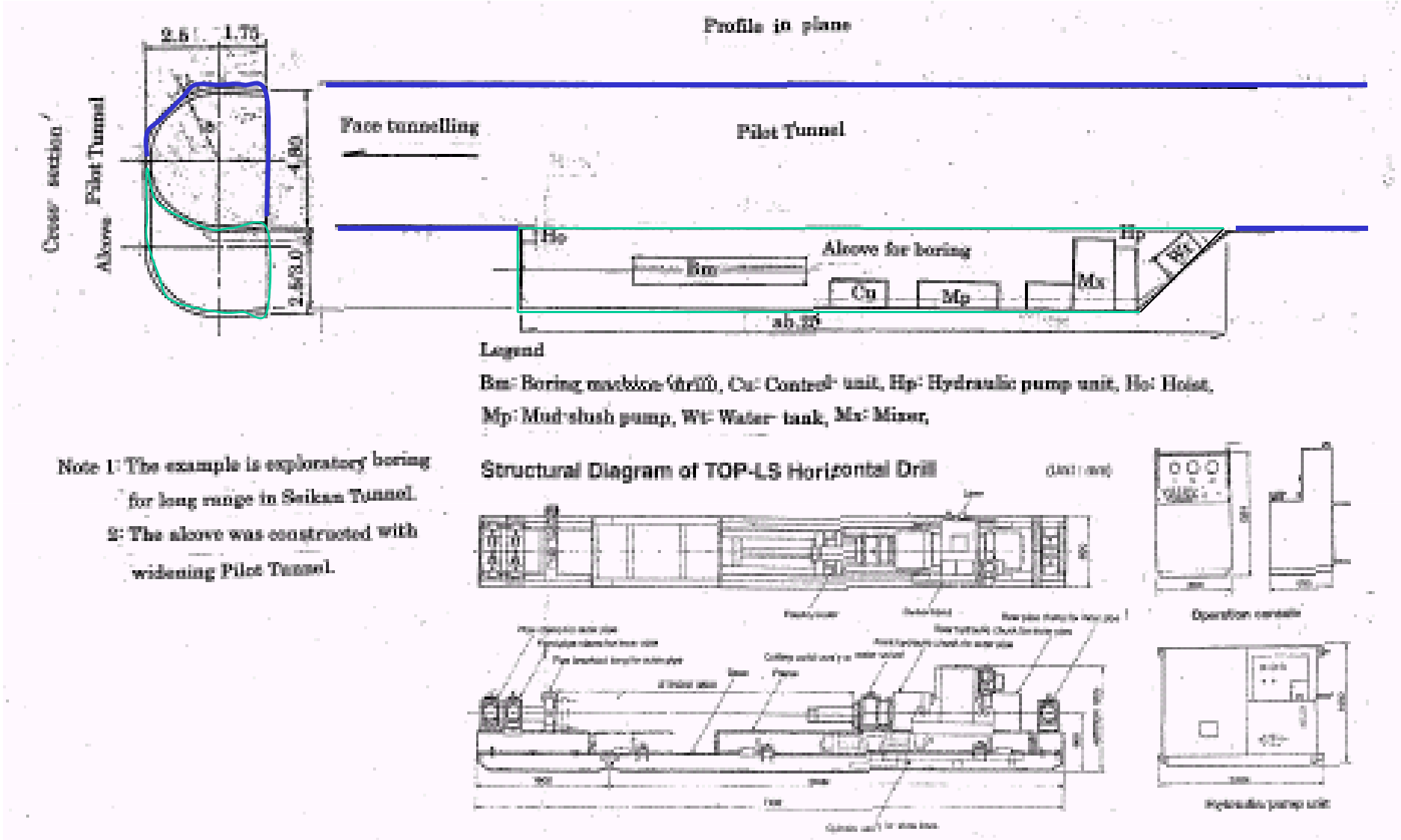
Long **:** geological state in the main,
to plan the system tunnelling in long section.

Medium: geological state in certification,
to consider the method preventing troubles
in tunnelling.

Short **:** geological state in detail,
to execute the countermeasure treating
ground before tunnelling.
(complex state with serious problem)

An example of exploratory borings arranged both side of tunnelling.





Example of arrangement in alcove for exploratory boring.

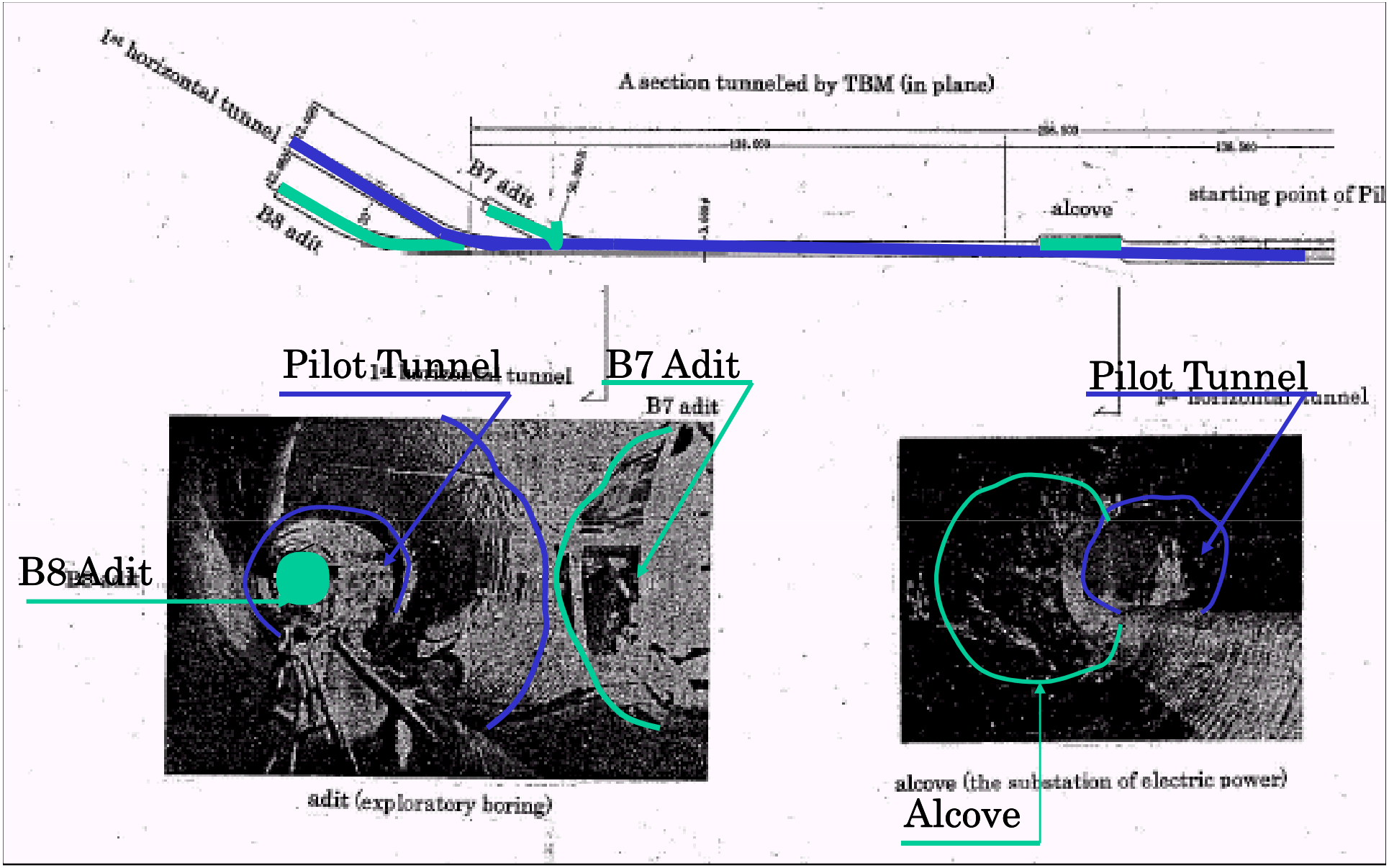
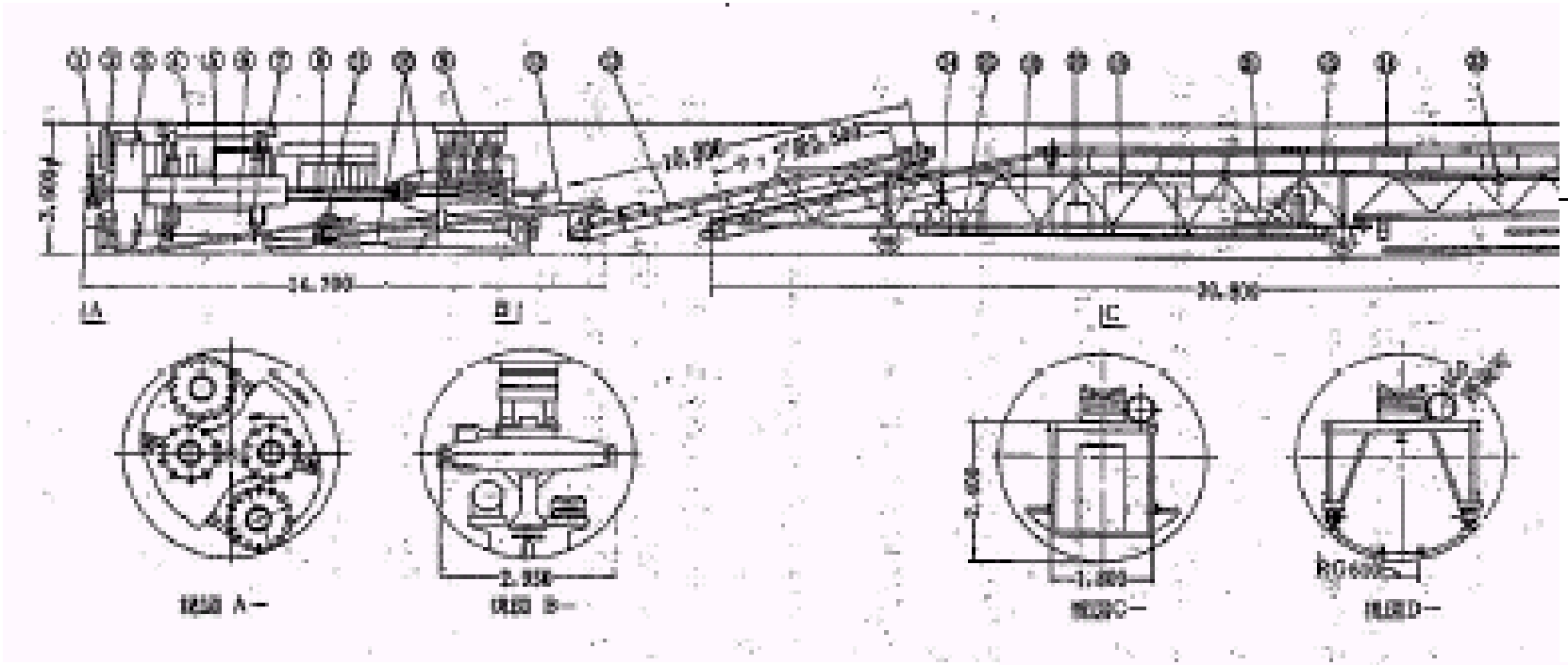
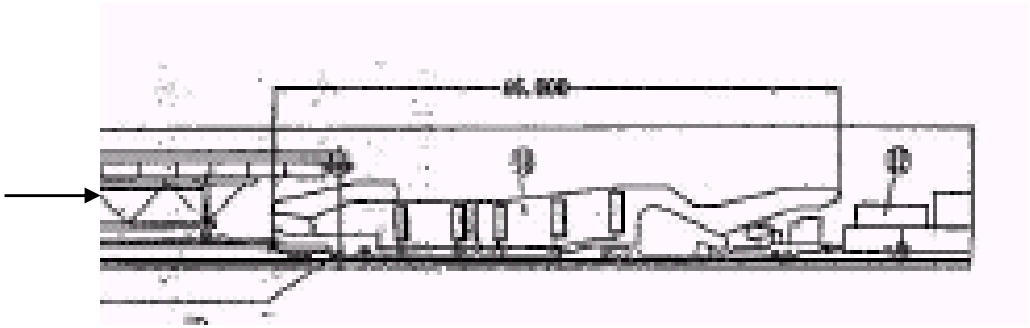


Fig. A4. Example of alcove and adit set by TBM.





Legend

TBM

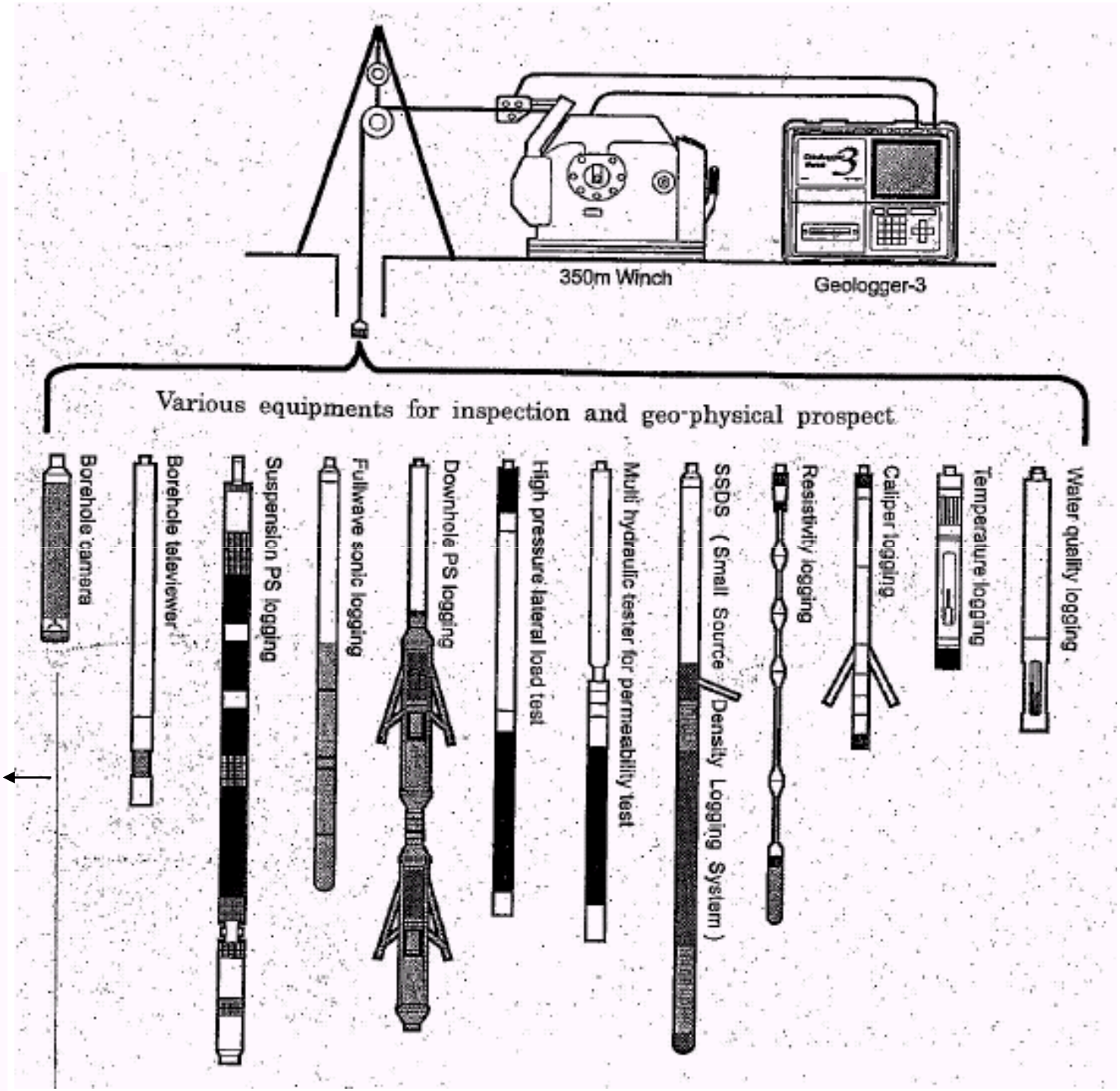
①: inner cutter
②: outer cutter
③: drum (cutter)
④: upper shoe
⑤: side shoe
⑥: lower shoe
⑦: jack- support
⑧: electric distributor
⑨: jack- press
⑩: jack- thrust
⑪: scraper
⑫: conveyer- belt

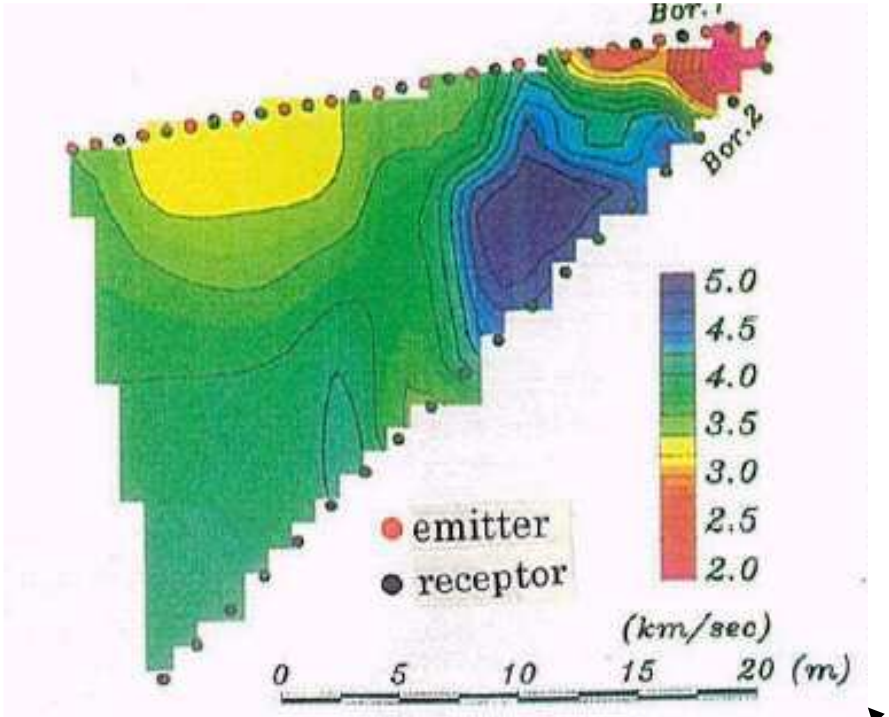
Back- up facilities

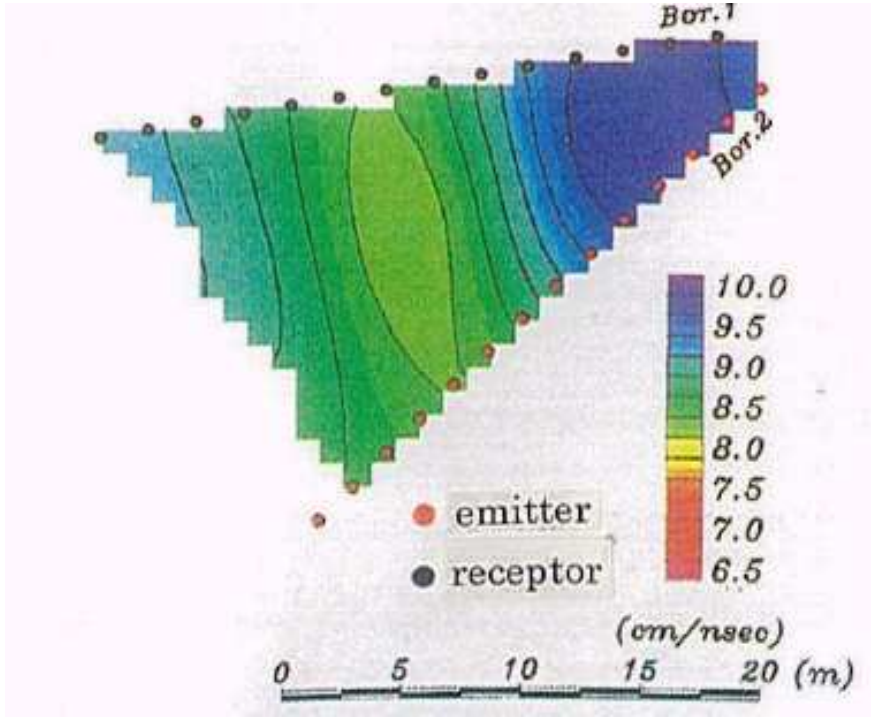
⑬: 2nd conveyer
⑭: 3rd conveyer
⑮: gantry
⑯: banker- train
⑰: locomotive
⑱: electric trans (TBM)
⑲: electric trans (banker- train)
⑳: electric trans (general)
㉑: drum (cable high voltage)
㉒: hoist (setting rail)
㉓: pump (sprinkler)
㉔: winch (hauling gantry)

Wohlmeyer 736
Type

Digital photo
of circumference
of Bore-hole

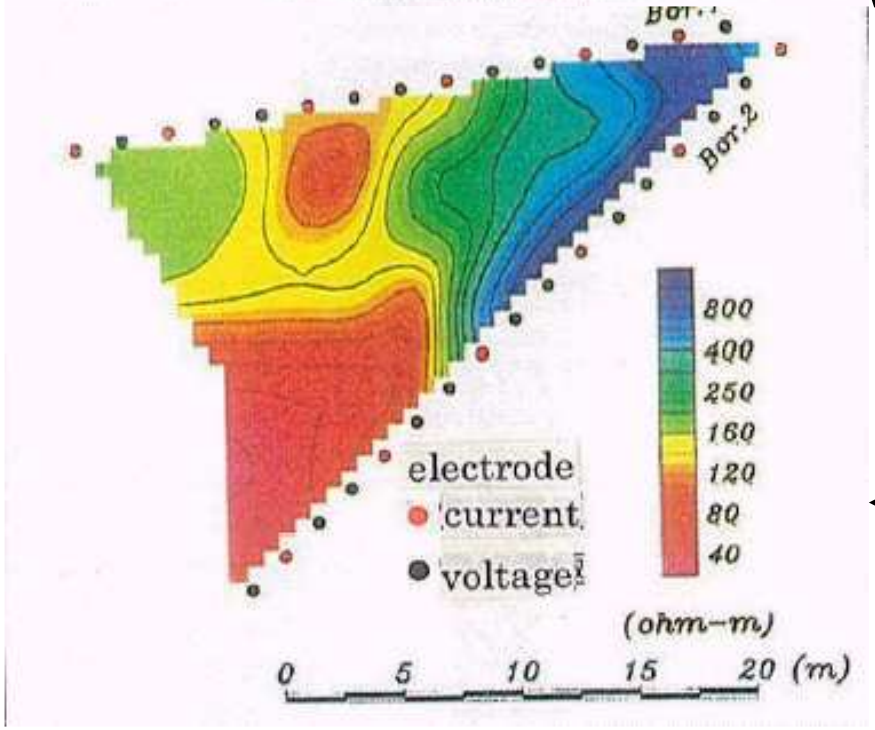






Radar Tomography

Seismic Tomography



Electric Tomography

Examples of geo- tomography used bore- holes.

Improvements of Geo-tomography using bore-hole

- (1) Special apparatus and equipment to insert, convey and set the probe in the long bore- hole in horizontal direction.
- (2) Number or length of probe (emitters and receptors) on one measurement.
- (3) Strong emitter or sensitive receptor.
- (4) Probe bearing much water in flowing with high pressure.