



**THE FIRST
MONITORING
CHANNEL**



MINING
MONITORING
INSTRUMENTATION

— INDEX

- *Some monitoring philosophy*
- *Open-pit mine*
- *Underground mine*
- *Tailings (waste repository)*



— THE MISSION OF MONITORING

The “Mission” of Monitoring is:

*“Provide as much **information** as possible
in the **simplest** and most **complete**
form **to be used** by those
who have to make decisions”*

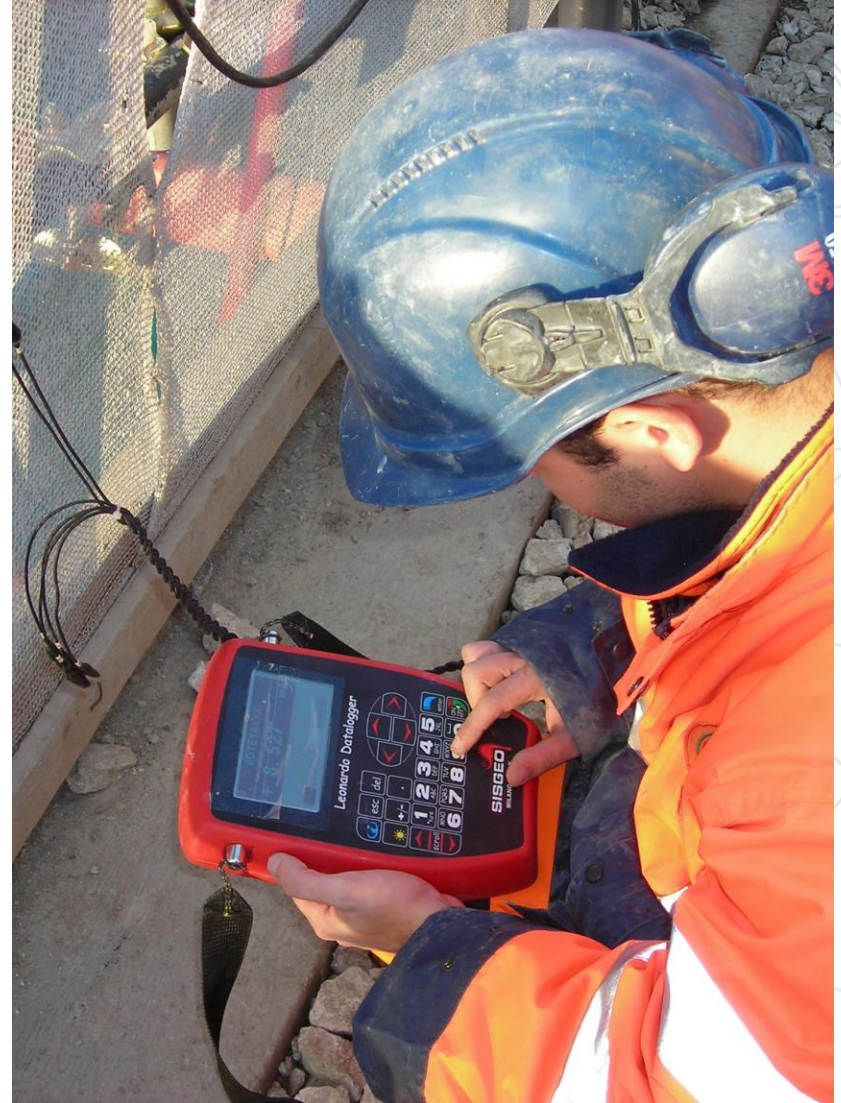
— WHY MINES NEED A MONITORING SYSTEM?

- *To Improve design,*
- *To Reduce costs,*
- *To Increase safety,*
- *To Increase knowledge*
- *To Enable control of the works / operations*

— WHAT IS MONITORING?

*Collected Data +
Information =*

MONITORING



— WHAT ARE THE INFORMATION?

*“Information”
is the result of processing, gathering, manipulating
and organizing data in a way
that adds to the knowledge
of the receiver.*

*In other words,
it is the context in which data is taken.*

— WHAT IS THE “CONTROL”?

Monitoring +

Protection works =

CONTROL



— OPEN-PIT MINE



__ OPEN-PIT MINE



Piezometer



Multipoint piezometer



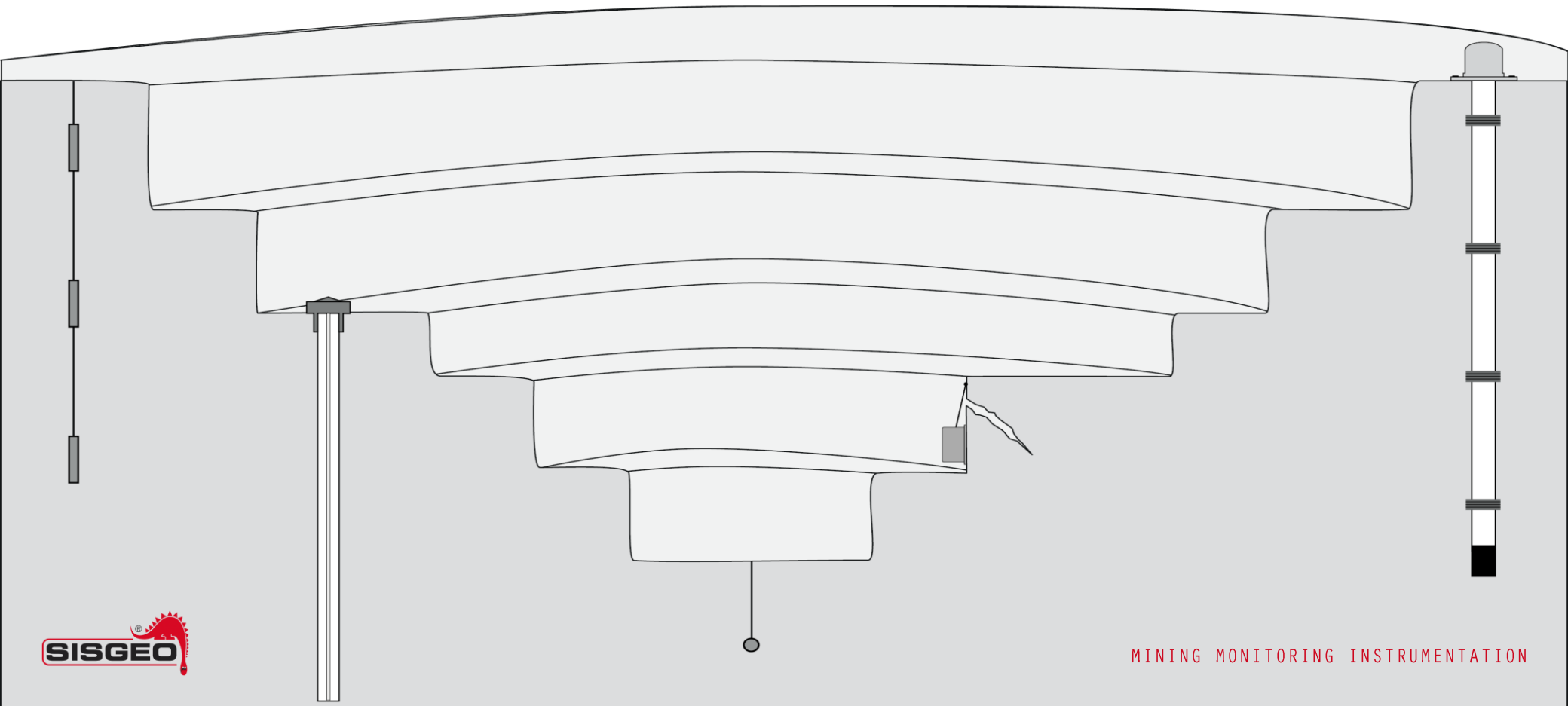
Inclinometer casing



Extenso-inclinometer casing



Wire extensometer



__ PIEZOMETERS



Piezometer



Multipoint piezometer



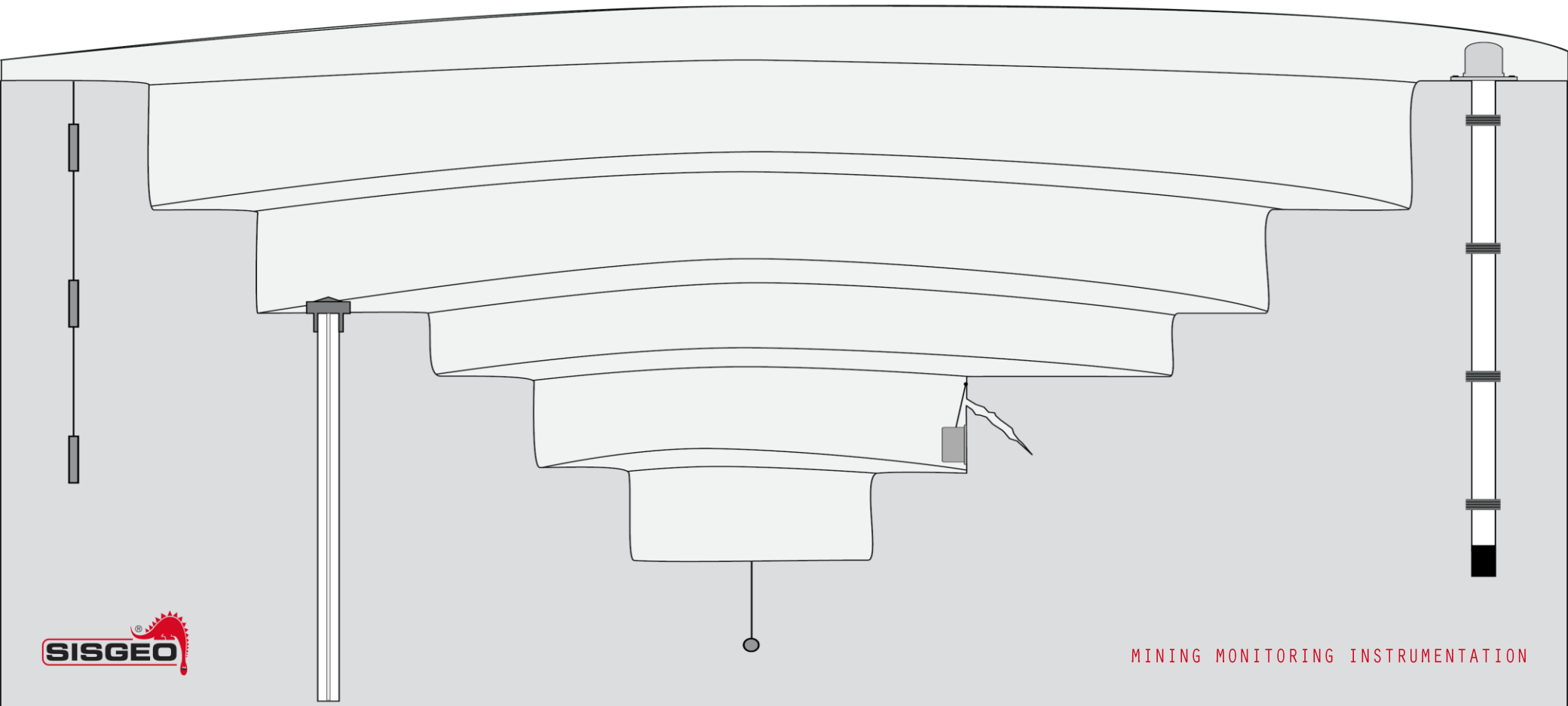
Inclinometer casing



Extenso-inclinometer casing



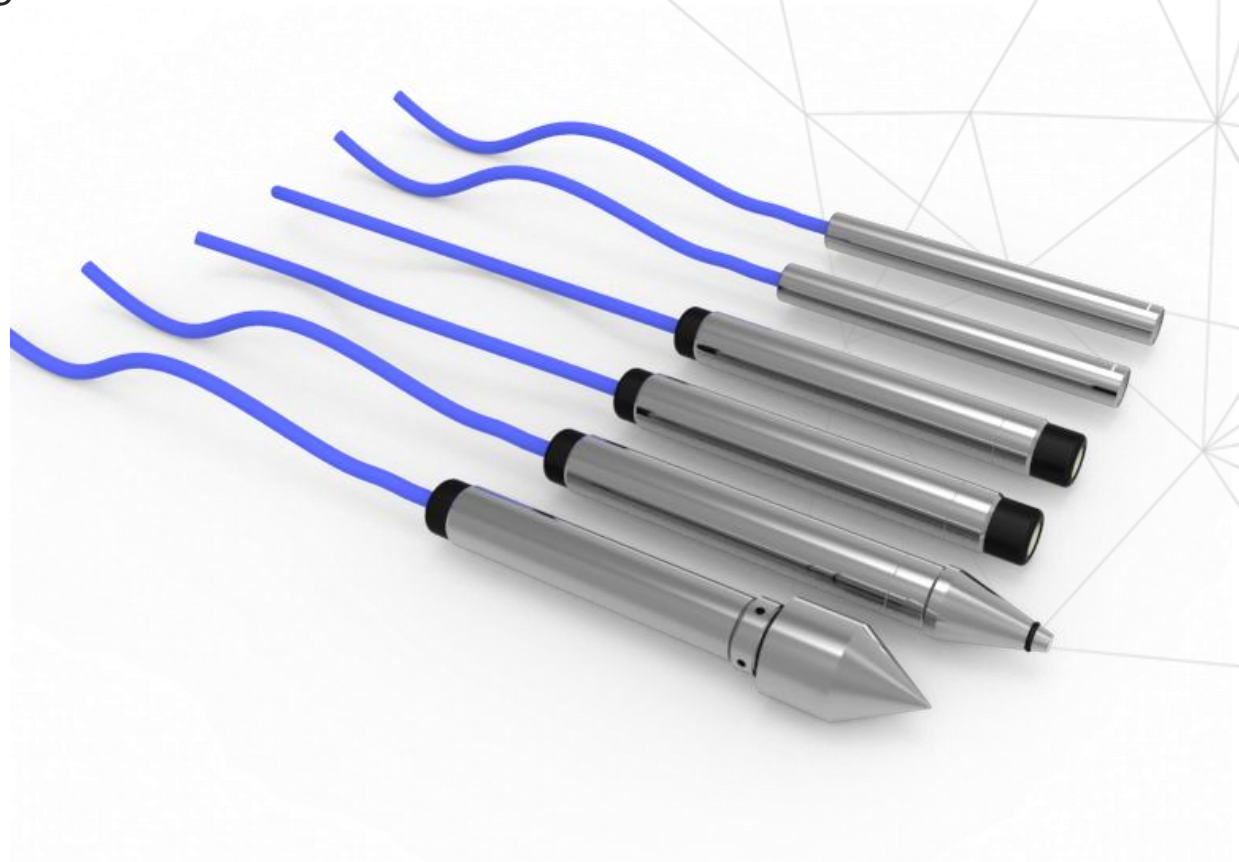
Wire extensometer



— PIEZOMETERS FOR PORE PRESSURE

Purpose:

- *Pore pressure monitoring*



__ PORE PRESSURE: INSTALLATION PHASES



Insert the transducer in the borehole



Filling with bentonite pellets (sealing)



Take zero reading

__ MULTIPOINT PIEZOMETER



Piezometer



Multipoint piezometer



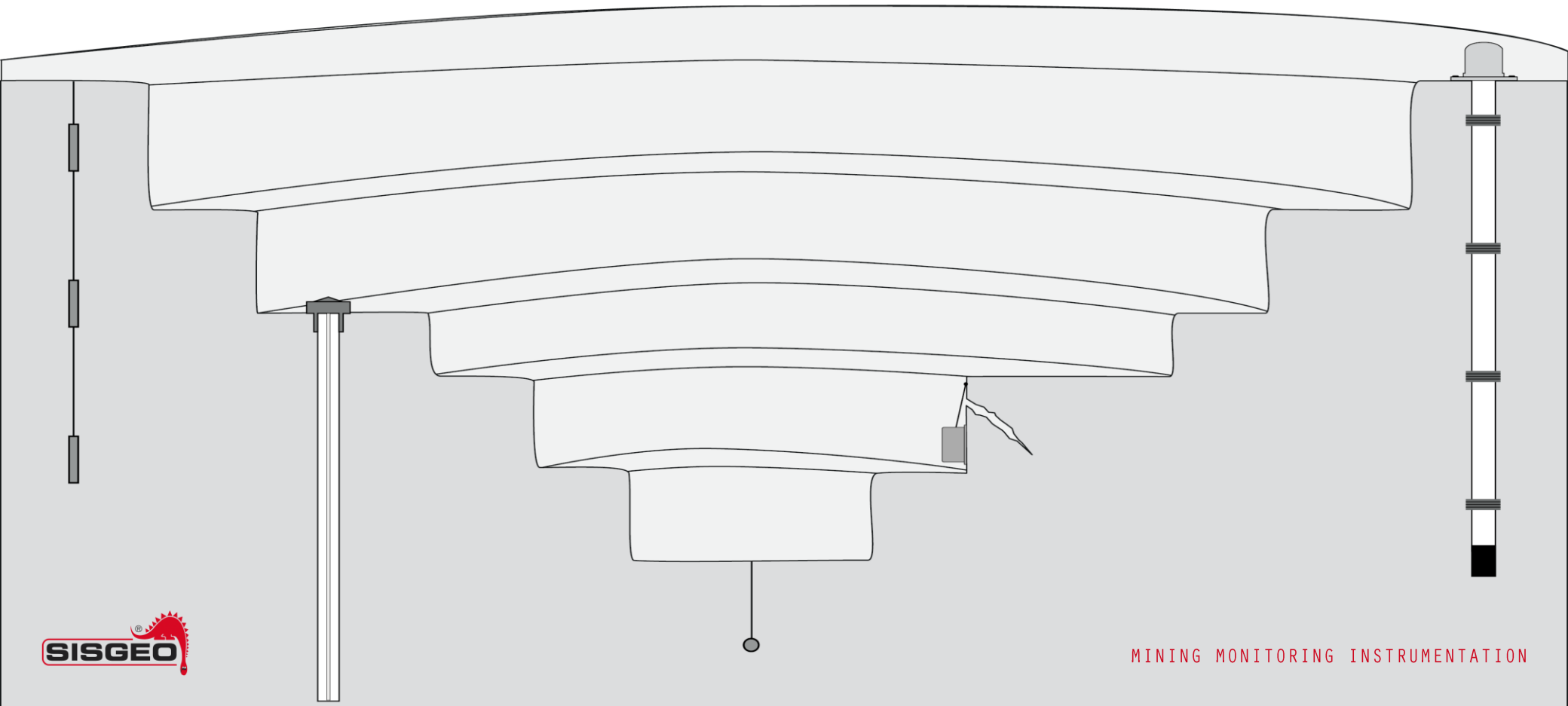
Inclinometer casing



Extenso-inclinometer casing



Wire extensometer



— PIEZOMETERS FOR PORE PRESSURE

Purpose:

- *Pore pressure monitoring in the same borehole at different depths / levels*






Installation method:
FULLY GROUTED

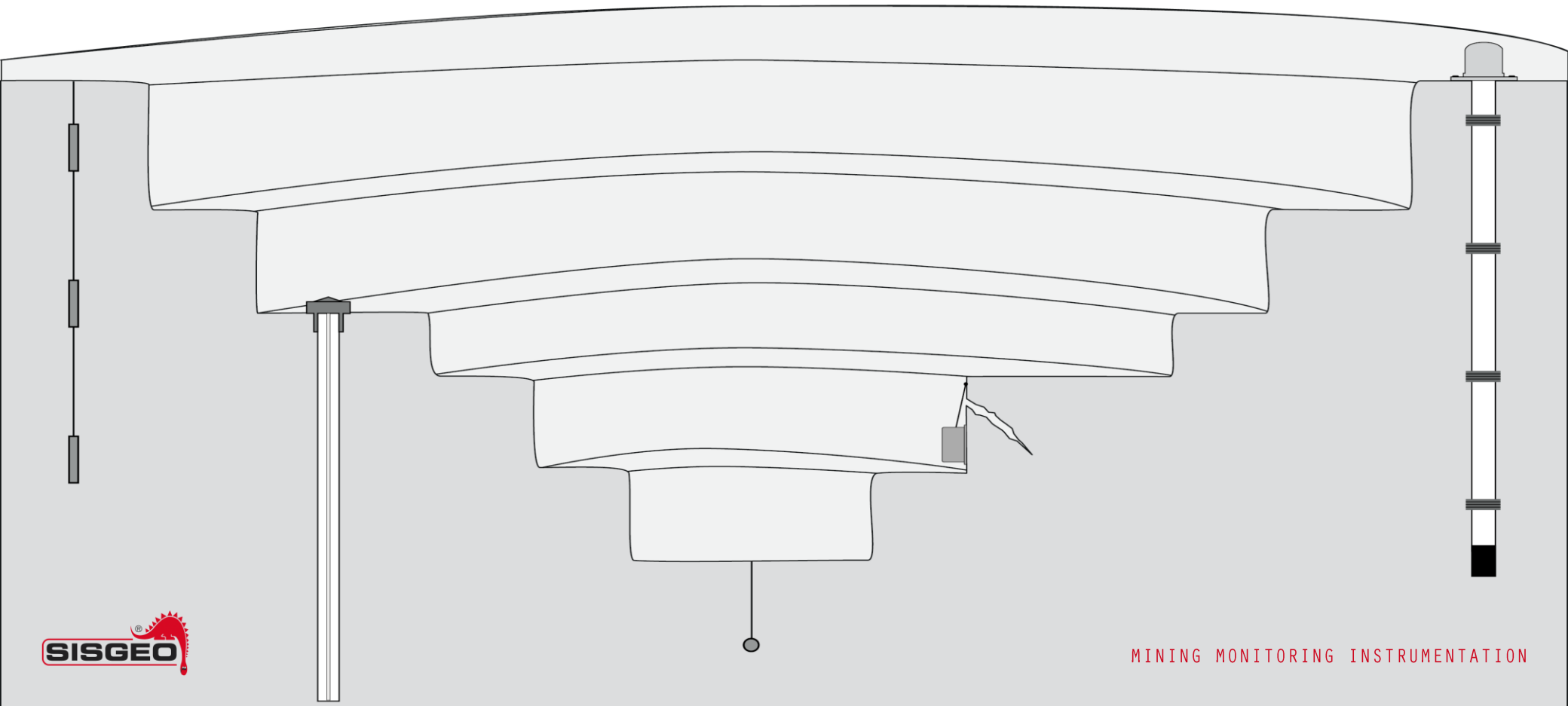


— MULTIPOINT (MULTILEVEL) PIEZOMETERS

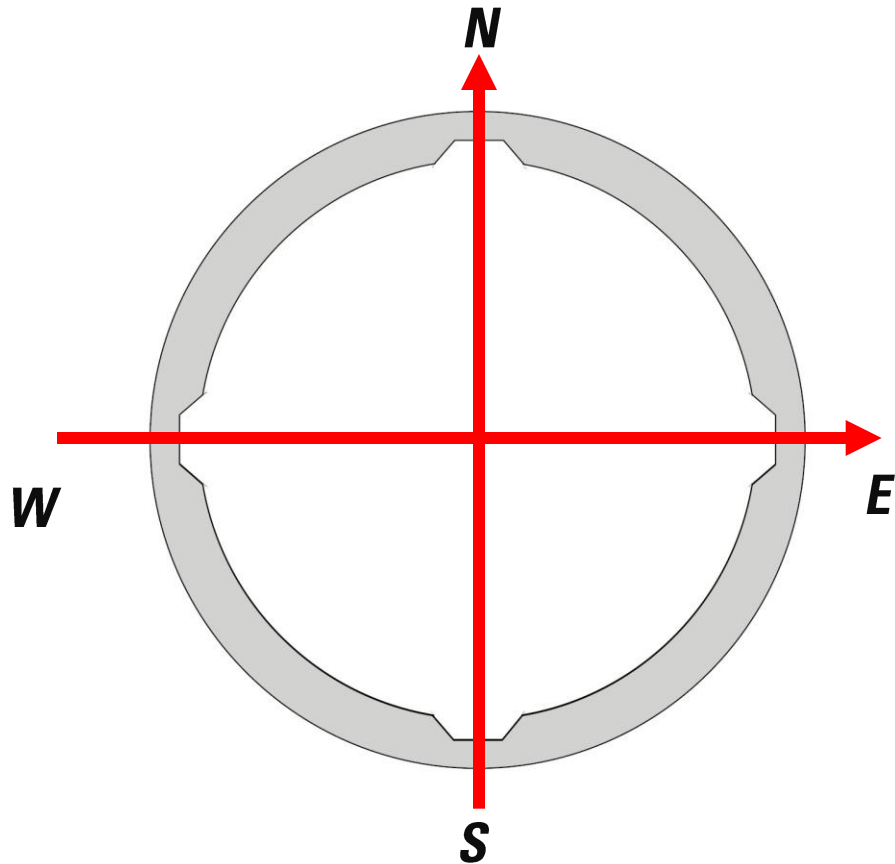


— INCLINOMETER CASING FOR HORIZONTAL DISPLACEMENTS

-  Piezometer
-  Multipoint piezometer
-  **Inclinometer casing**
-  Extensometer casing
-  Wire extensometer

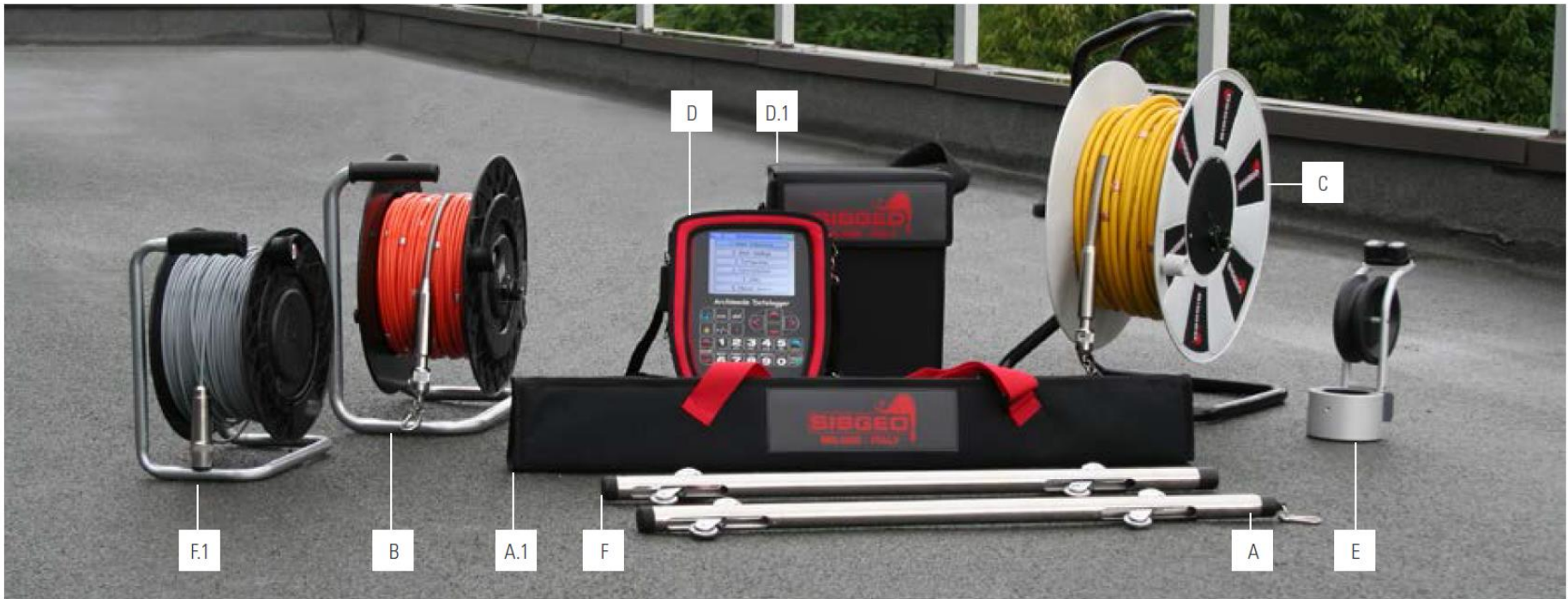


__ INCLINOMETER CASING FOR HORIZONTAL DISPLACEMENTS



***Inclinometer casing section:
4 grooves to guide the probe
in the tube without twisting***

REMOVABLE INCLINOMETER SYSTEM FOR INCLINOMETER CASING SURVEYING



A Digital inclinometer probe

A.1 Travel bag for both inclinometer and dummy probes

B Light inclinometer cable reel

C Heavy-Duty cable

D Archimede readout

D.1 Archimede carrying case

E Pulley assembly

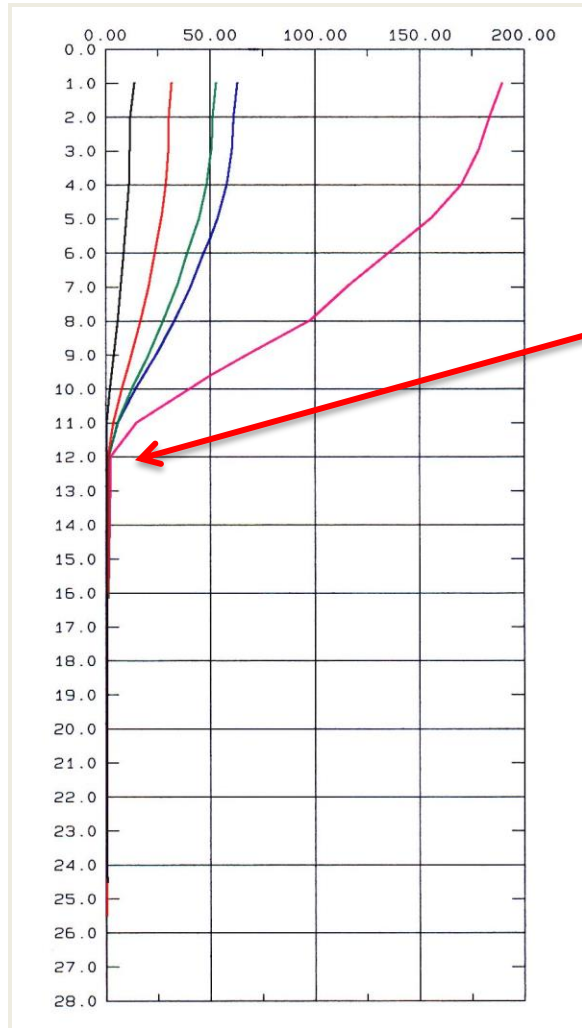
F Dummy probe

F.1 Cable for dummy probe

REMOVABLE INCLINOMETER SYSTEM FOR INCLINOMETER CASING SURVEYING



REMOVABLE INCLINOMETER SYSTEM FOR INCLINOMETER CASING SURVEYING

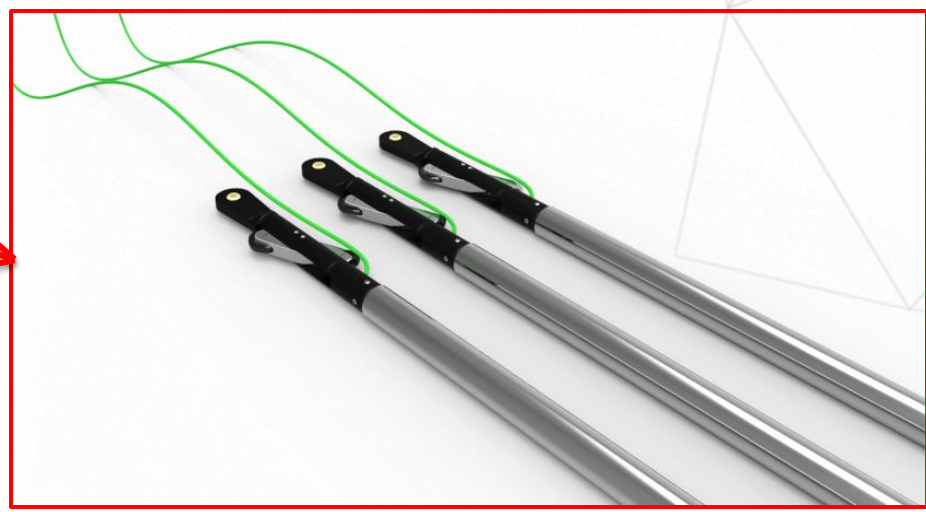
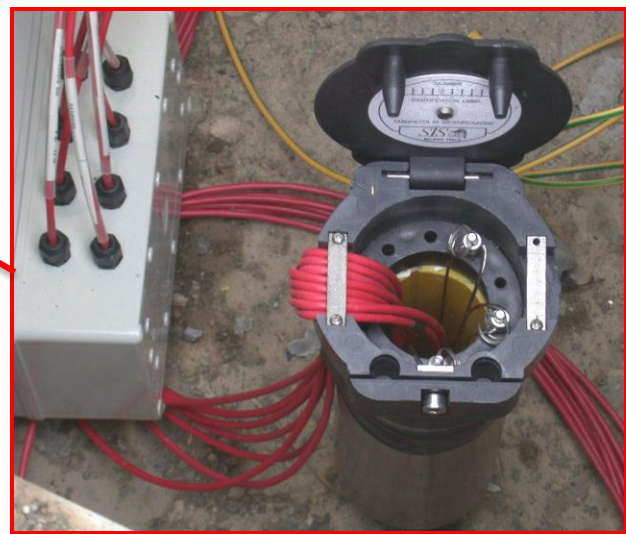
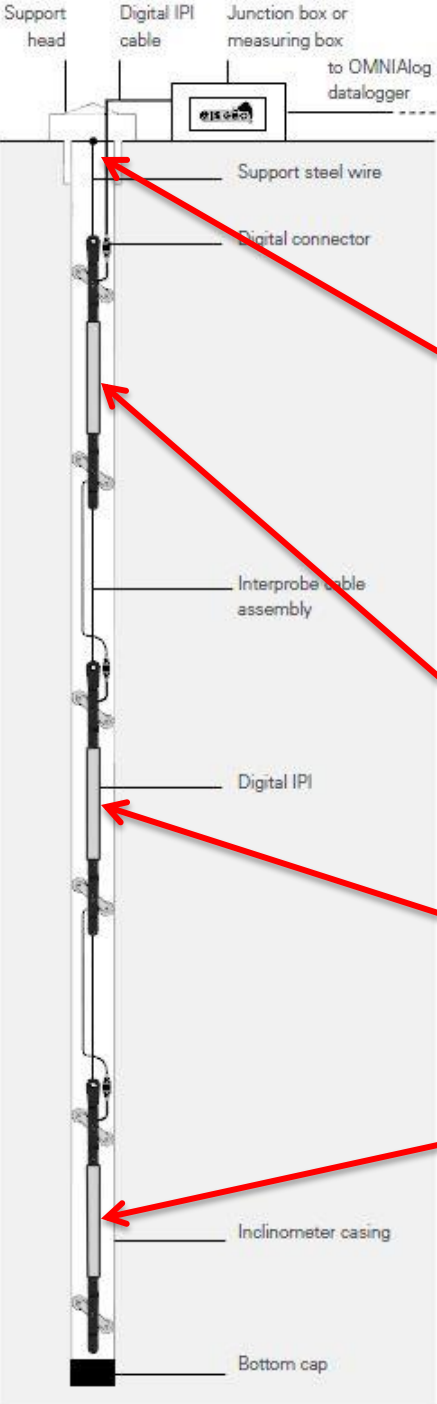


In this landslide example is clear that at depth -12.0m there is a slipping surface

IN-PLACE INCLINOMETERS (IPI) FOR AUTOMATIC INCLINOMETER MONITORING

Support top cap after installation

IPI probes

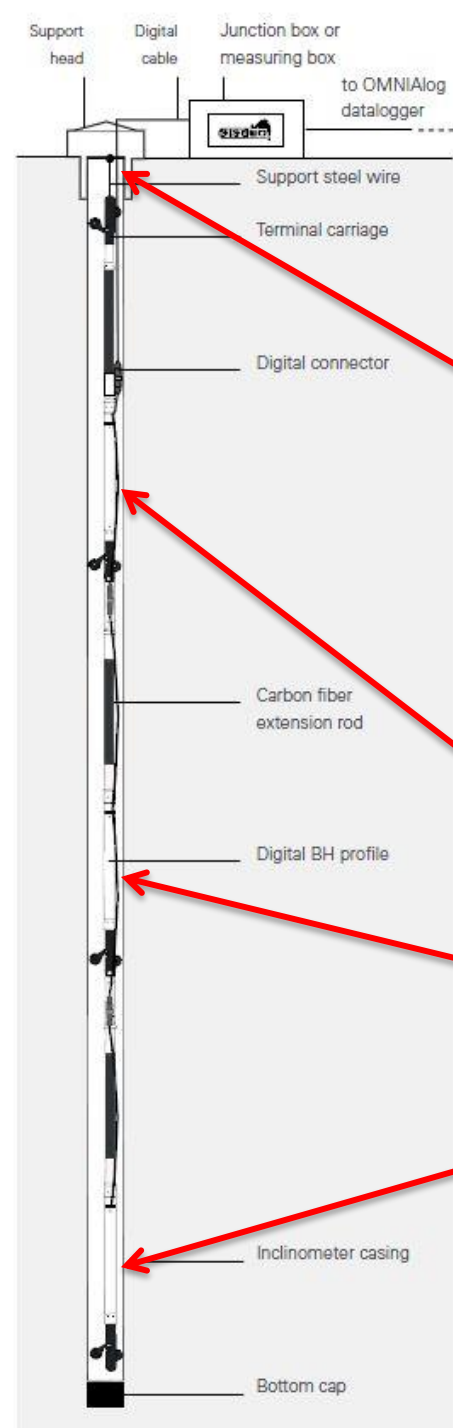


BH PROFILE INCLINOMETERS FOR CONTINUOUS BOREHOLE PROFILING






Support top cap after installation

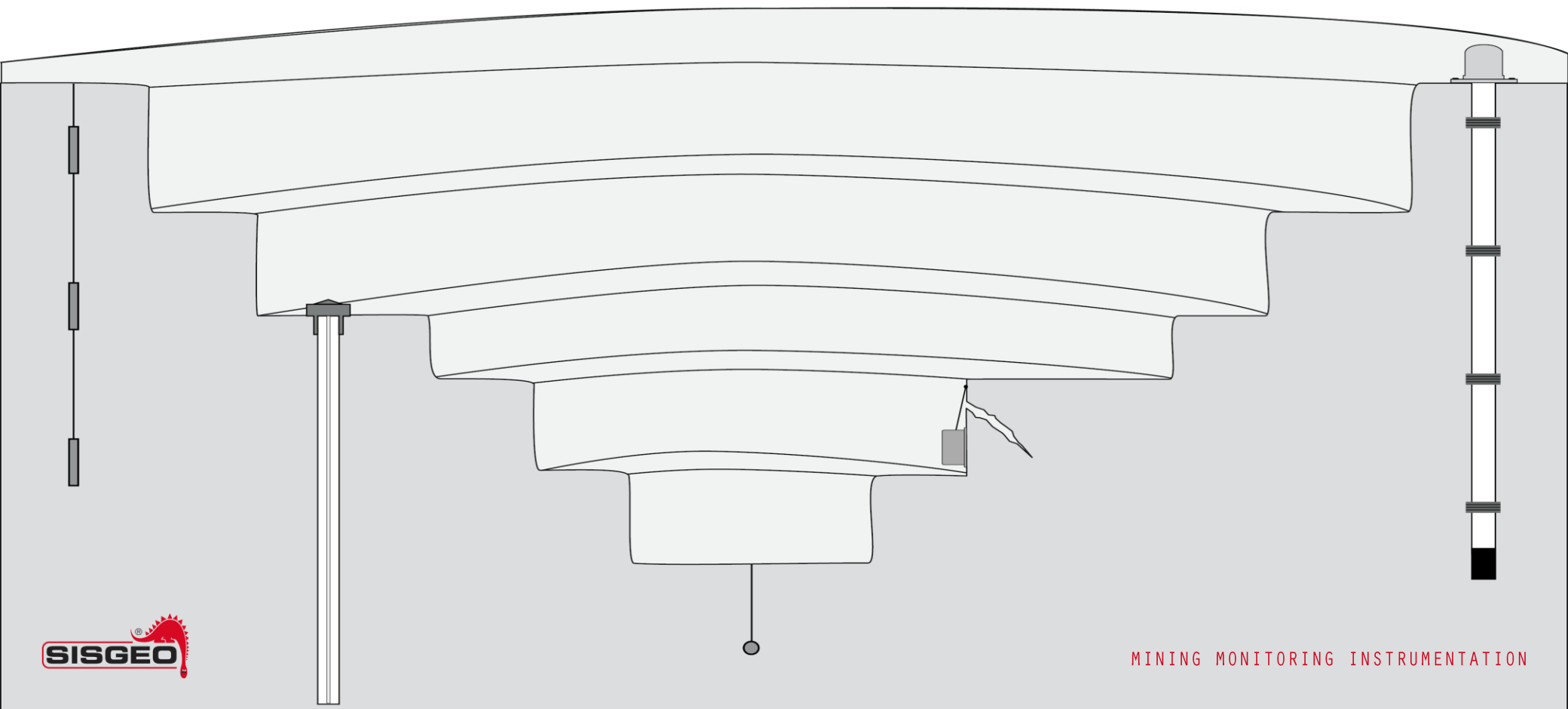


Digital BH profile inclinometers with carbon fiber extension rod



EXTENSO-INCLINOMETER FOR 3D BOREHOLE MONITORING

-  Piezometer
-  Multipoint piezometer
-  Inclinometer casing
-  **Extenso-inclinometer casing**
-  Wire extensometer



— EXTENSO-INCLINOMETER COLUMN

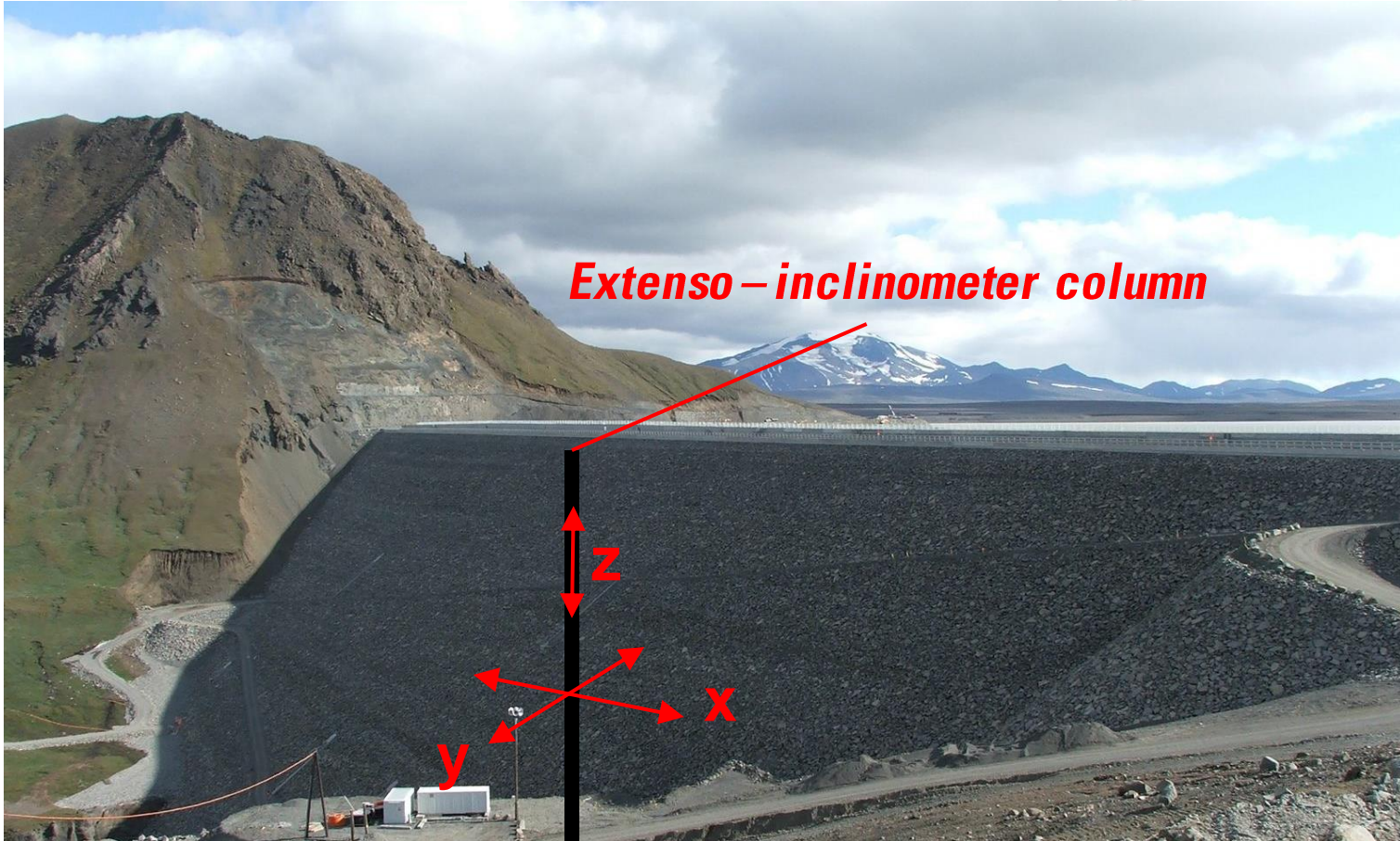
Purpose:

*monitor both horizontal
and vertical displacement*

→ 3-D borehole monitoring



— EXTENSO-INCLINOMETER COLUMN



— EXTENSO-INCLINOMETER - CASINGS

Casing for extenso-inclinometer column:

- *ABS inclinometer casings (Flush type)*
- *Magnet reference rings*



__ EXTENSO-INCLINOMETER – MANUAL READINGS



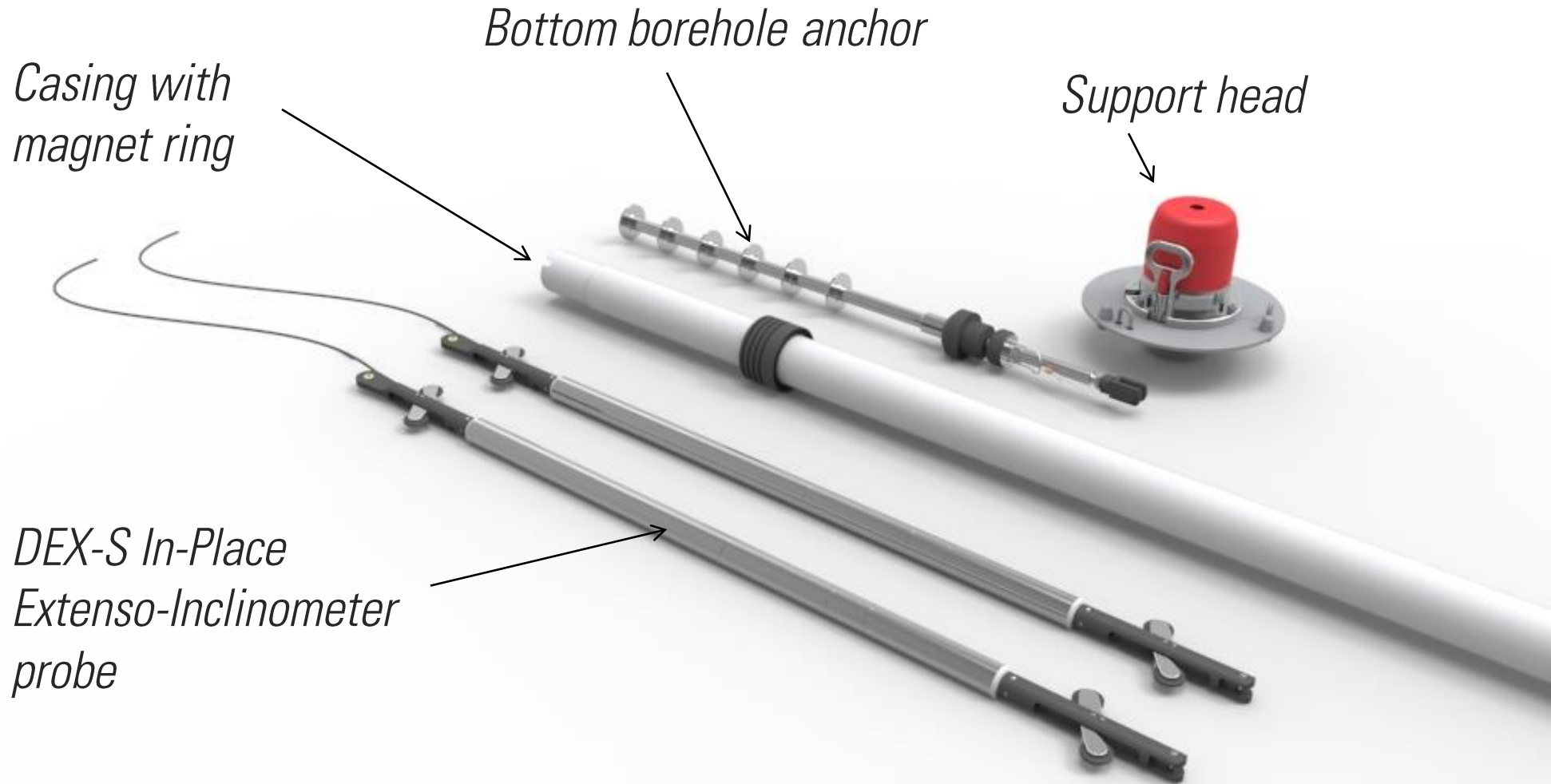
*Removable
MEMS
inclinometer*



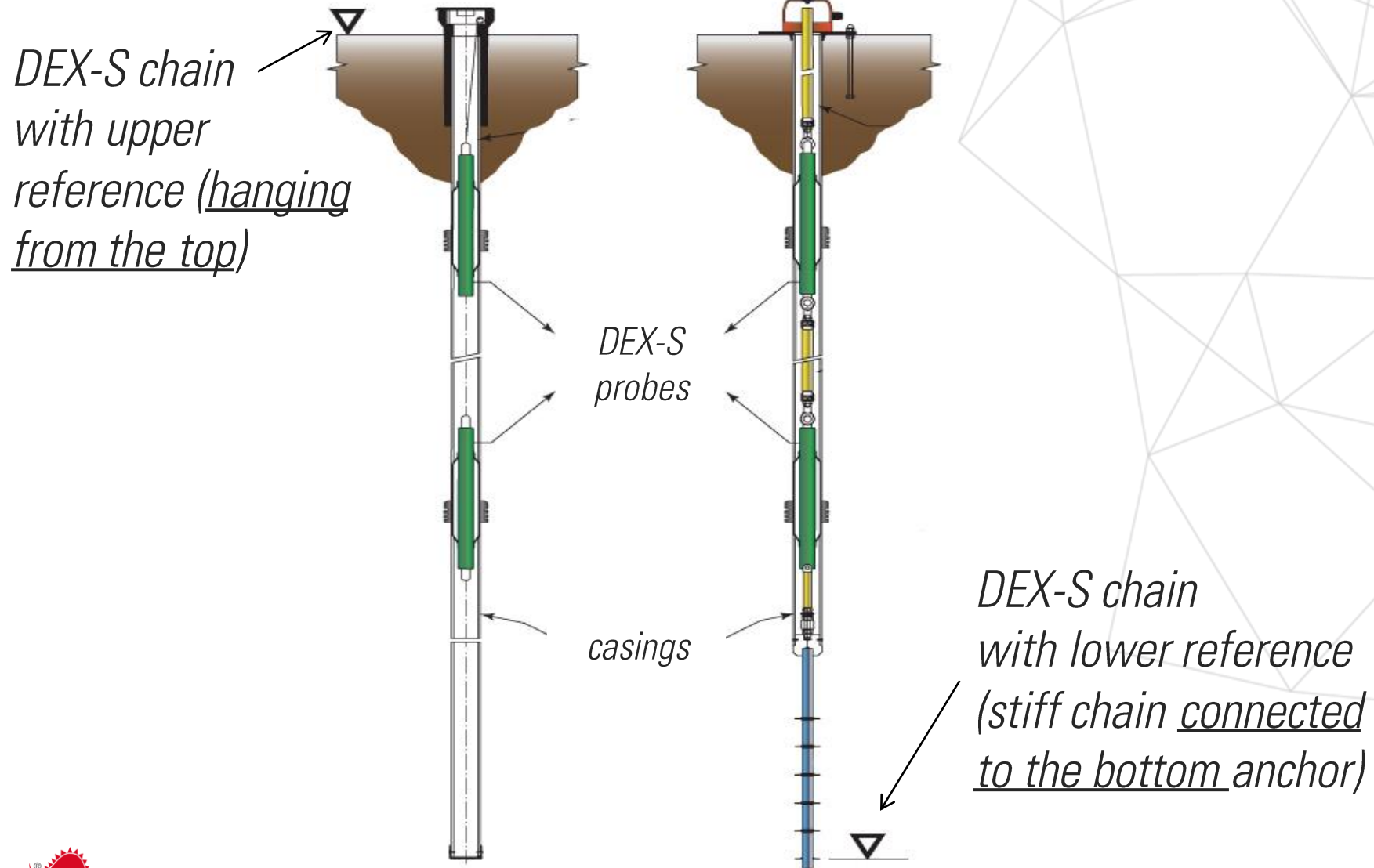
*T-REX
incremental
extensometer*



**EXTENSO-INCLINOMETER – AUTOMATIC MONITORING:
DEX-S IN-PLACE EXTENSO INCLINOMETER**



DEX-S IN-PLACE EXTENSO-INCLINOMETERS



— EXTENSO - INCLINOMETER COLUMN

DEX-S probes allow:

- *3D monitoring*
- *High accuracy*
- *Removable probes for re-installation at different locations and maintenance (if needed)*
- *Real-time monitoring in unattended location*

__ WIRE EXTENSOMETER



Piezometer



Multipoint piezometer



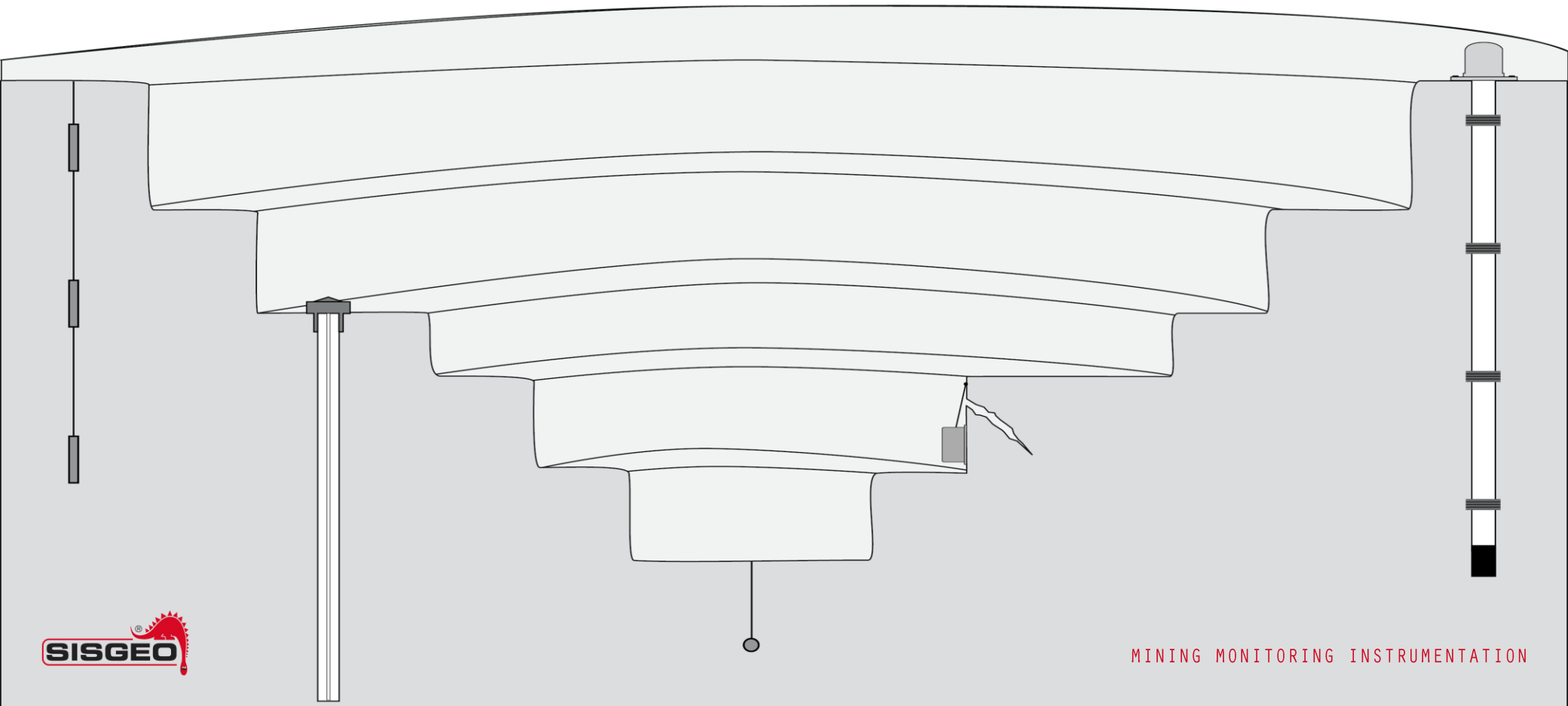
Inclinometer casing



Extenso-inclinometer casing



Wire extensometer








__ WIRE CRACKMETER ON TOPPLE LANDSLIDE

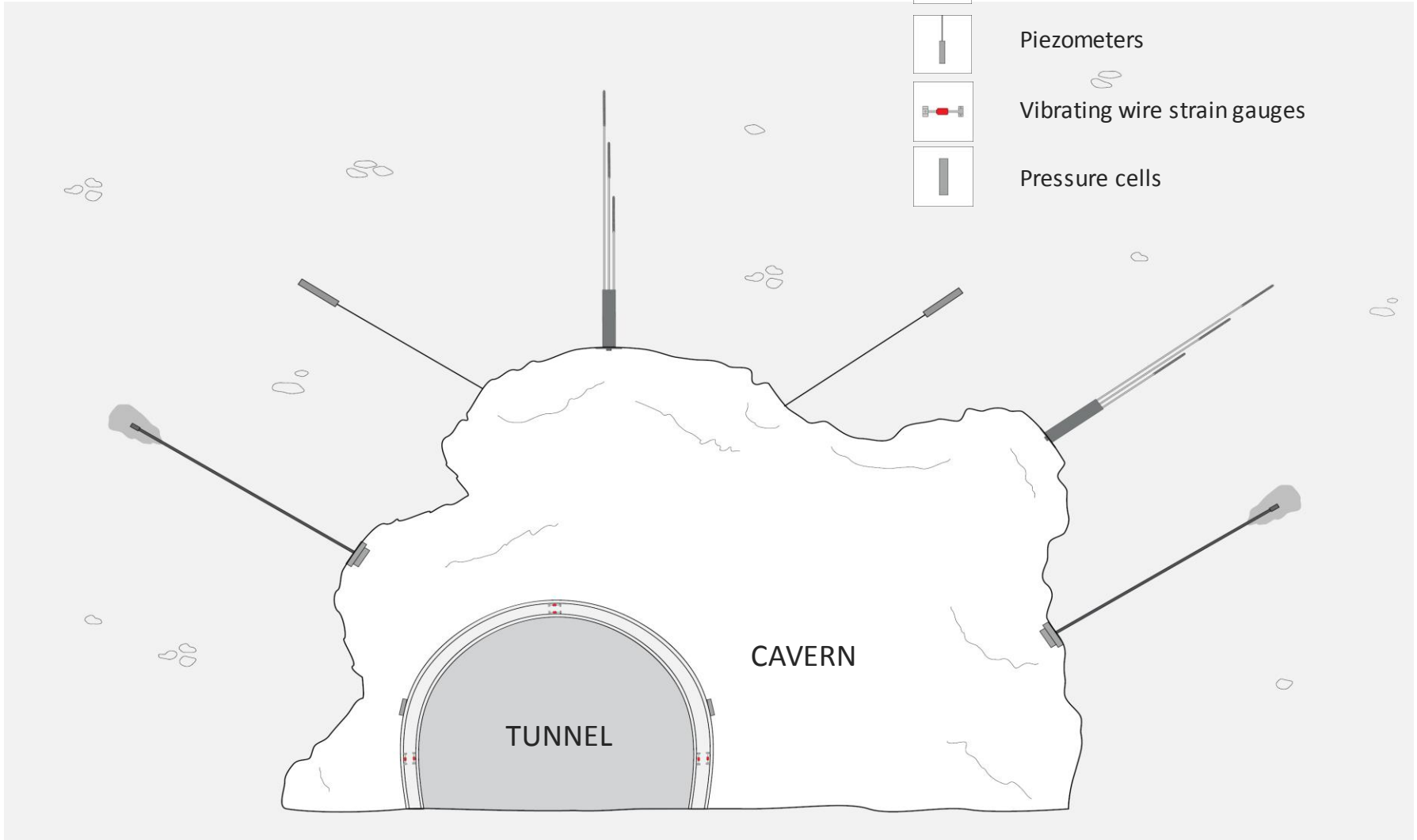


— UNDERGROUND MINE



— UNDERGROUND MINE

-  MEXID miniaturized MPBXs
-  Anchor load cells
-  Piezometers
-  Vibrating wire strain gauges
-  Pressure cells



— MEXID MINIATURIZED MPBX



MEXID miniaturized MPBXs



Anchor load cells



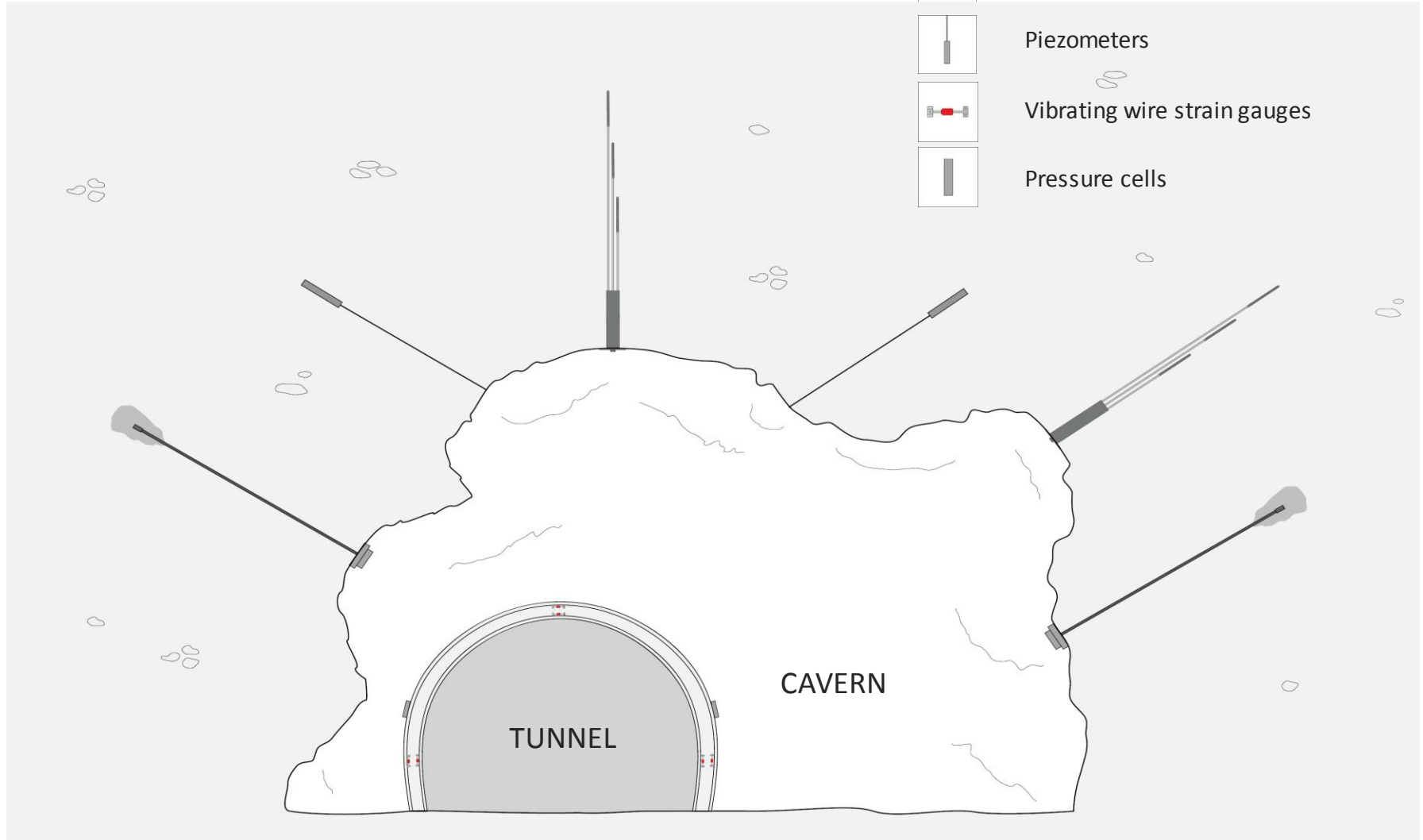
Piezometers



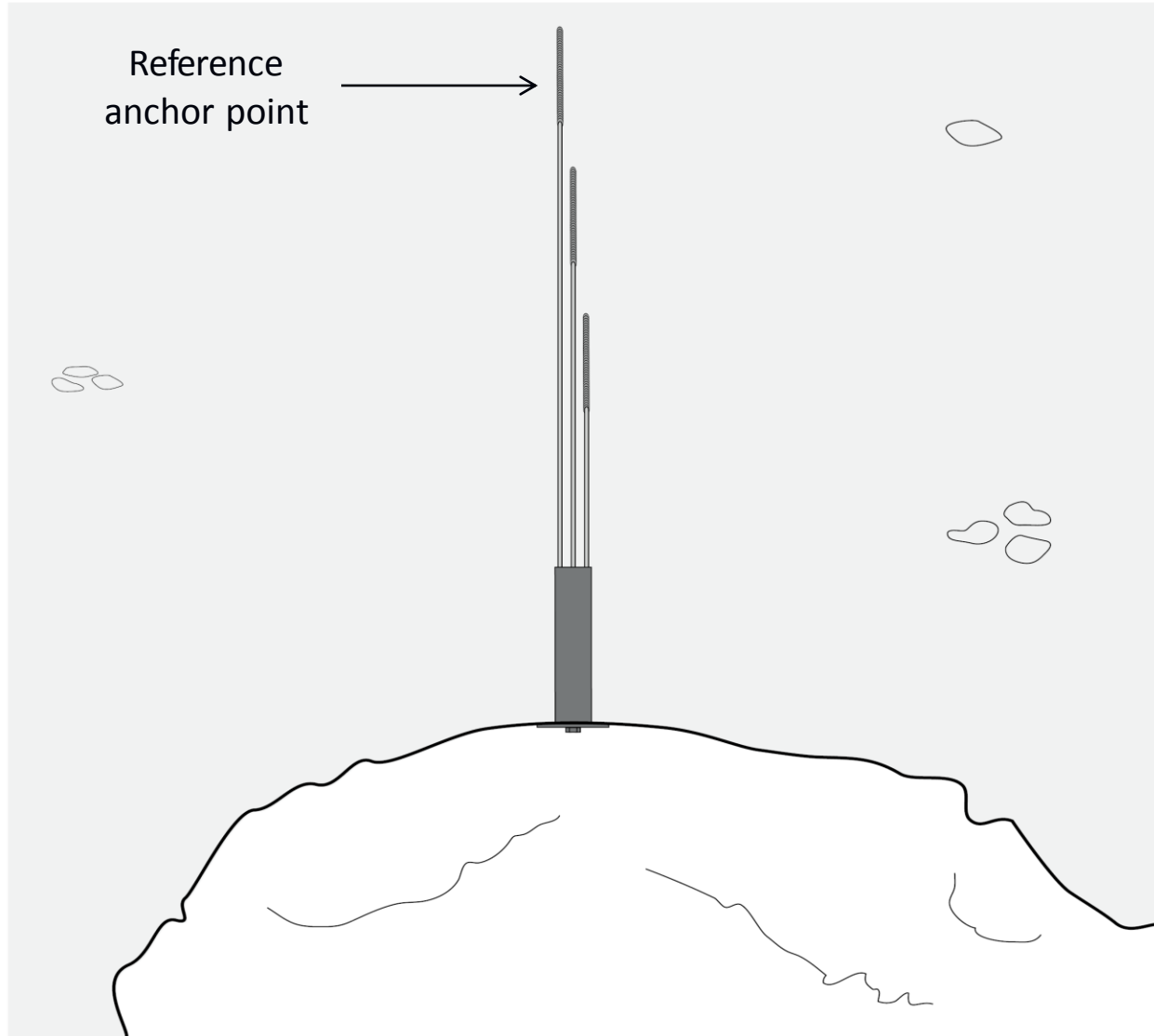
Vibrating wire strain gauges



Pressure cells

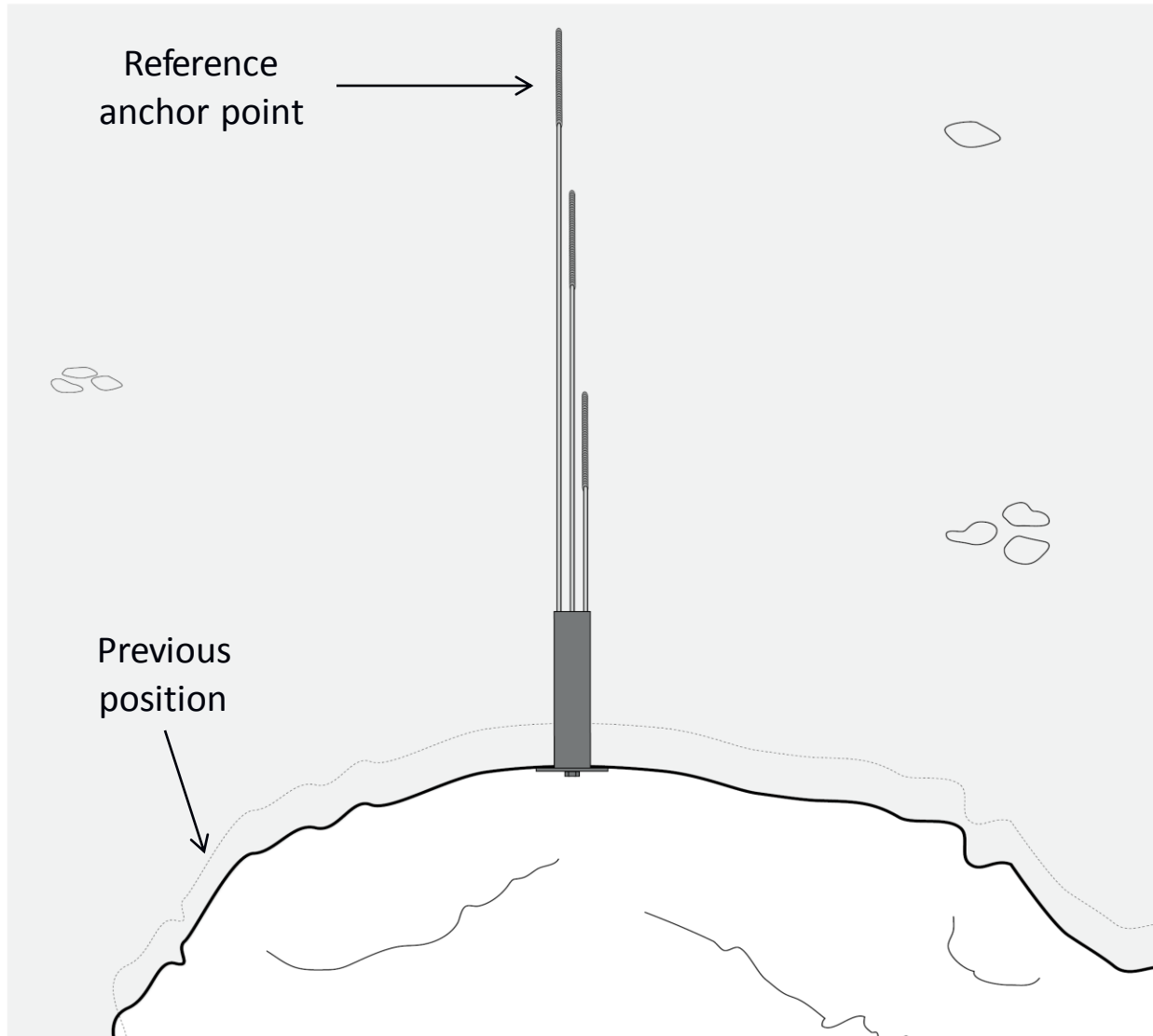


__ MEXID MINIATURIZED MPBX – HOW IT WORKS



The groutable anchor installation points can give information of internal rock displacement at different depths

__ MEXID MINIATURIZED MPBX – HOW IT WORKS



The groutable anchor installation points can give information of internal rock displacement at different depths

— MEXID MINIATURIZED MPBX

*Installation of MEXID
extensometer
into the cavern's ceiling*

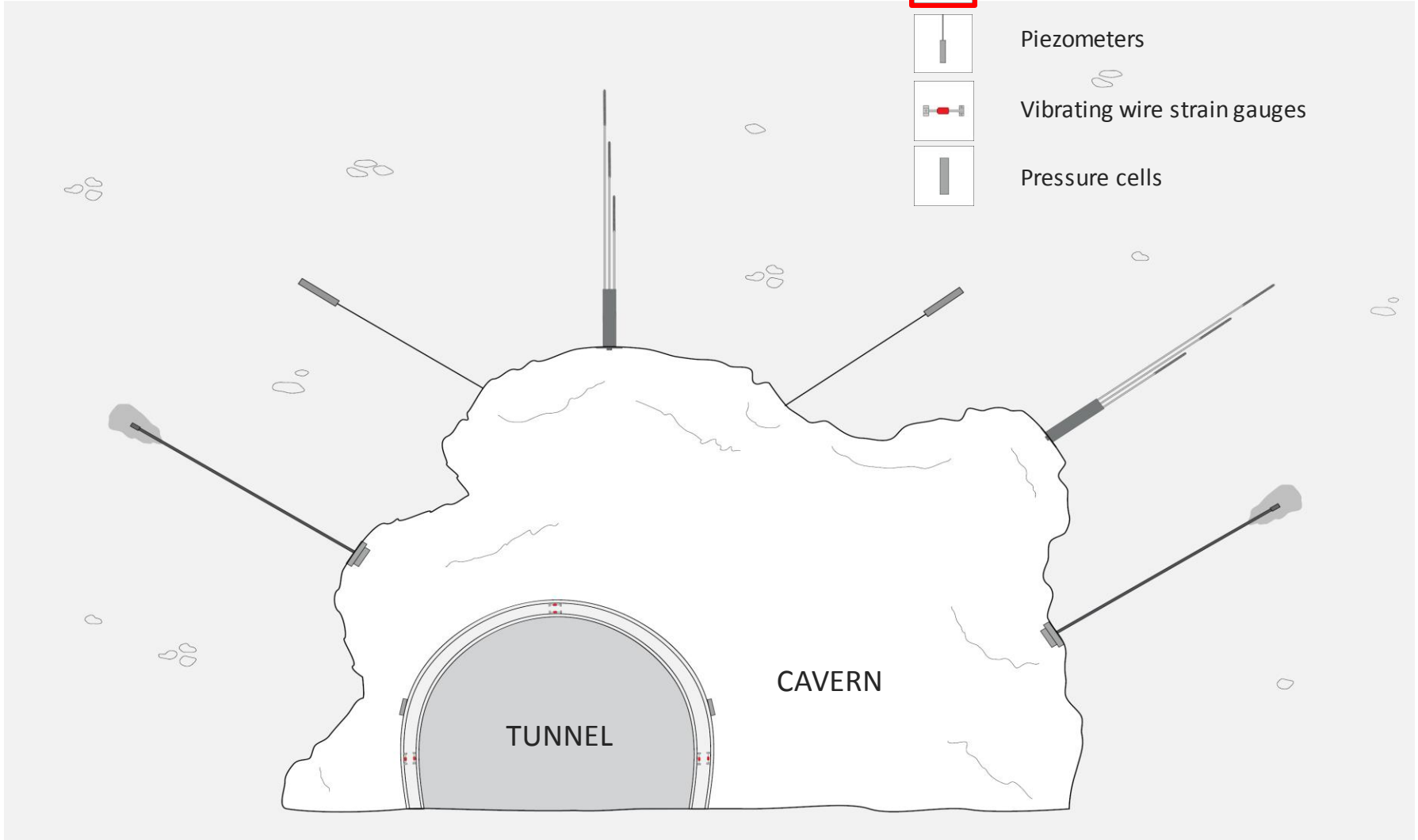
— MEXID MINIATURIZED MPBX



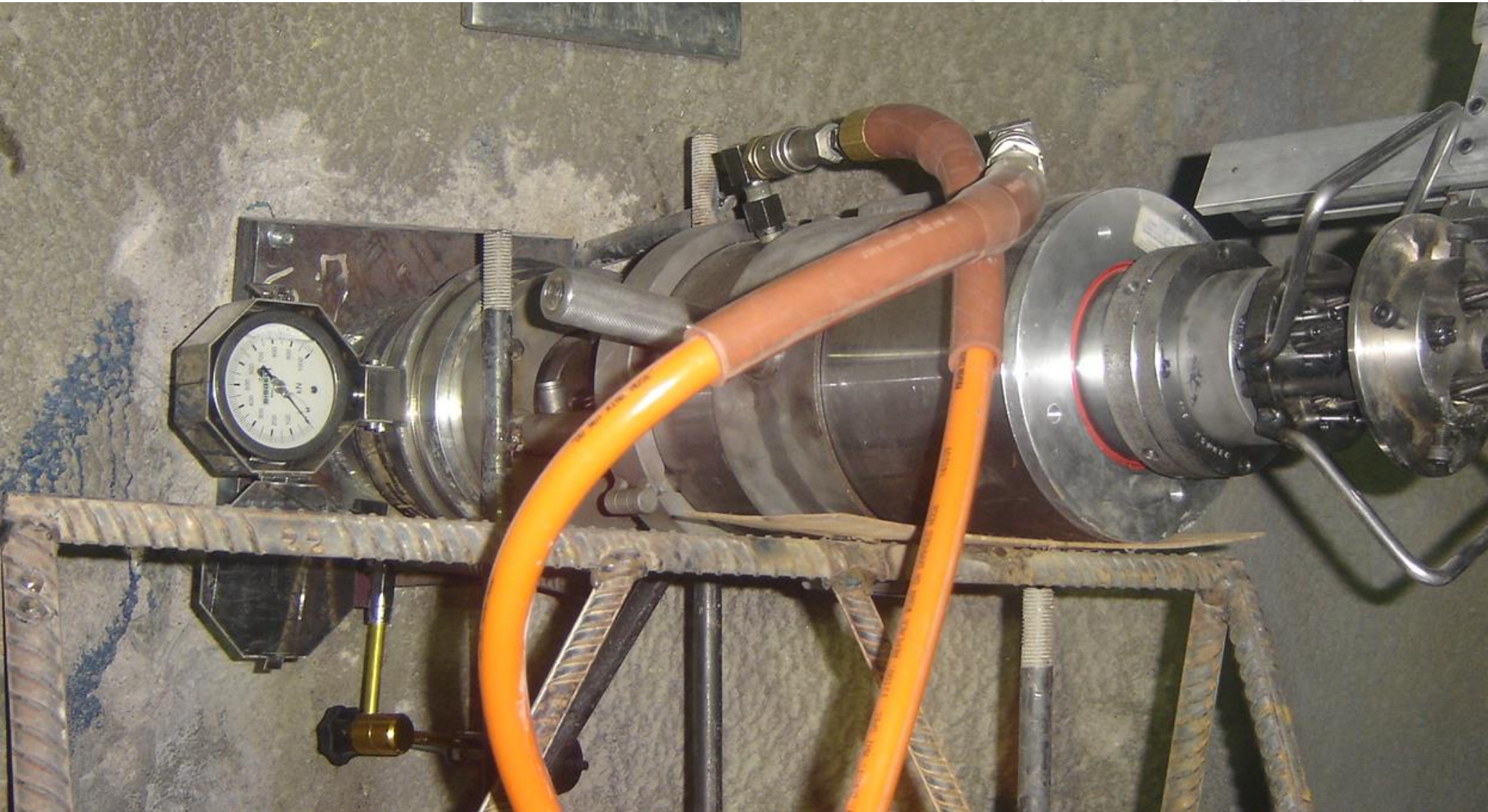
***MEXID extensometer
after installation:
flush-mount
→ maximum clearance***

— ANCHOR LOAD CELL

- MEXID miniaturized MPBXs
- Anchor load cells**
- Piezometers
- Vibrating wire strain gauges
- Pressure cells

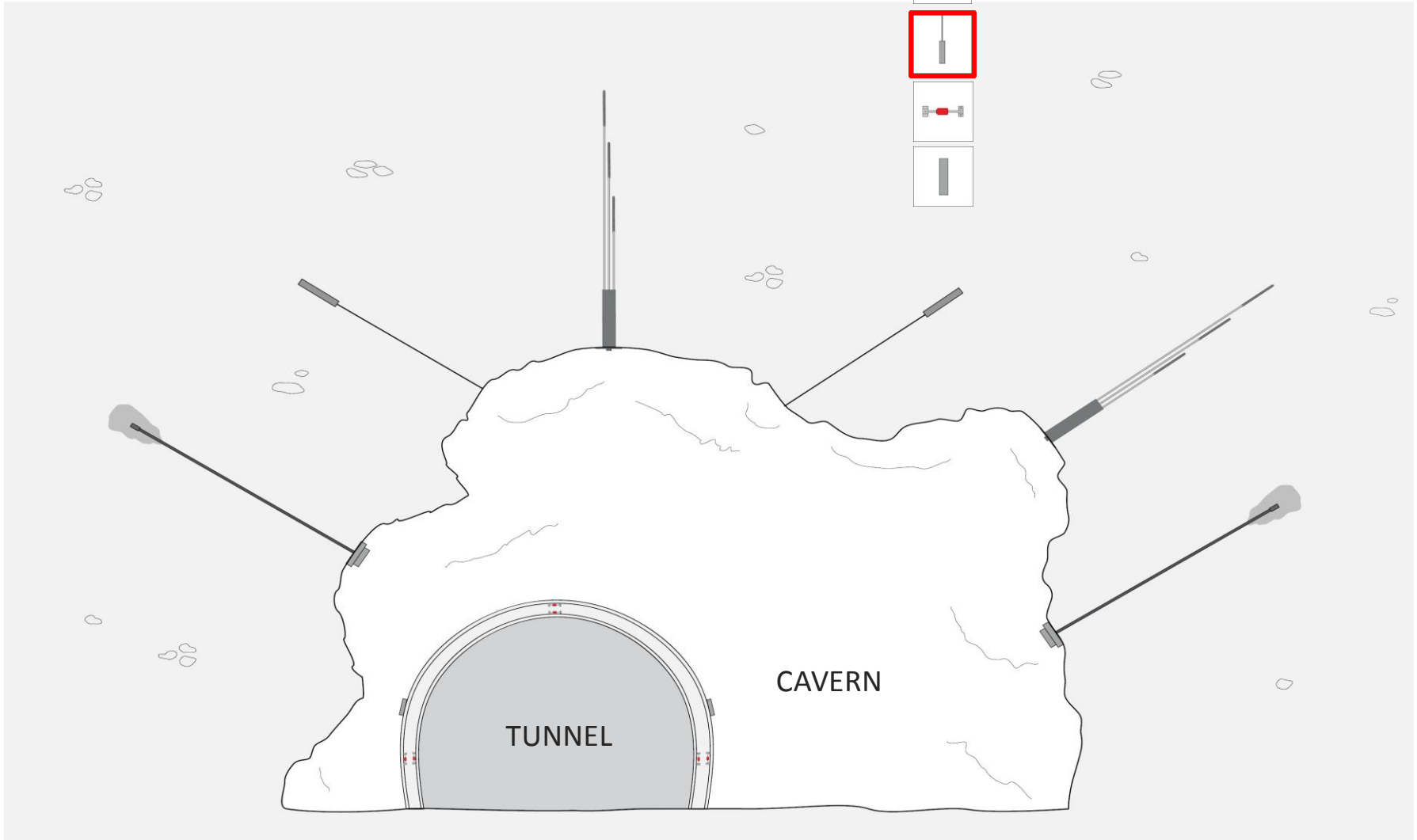


__ ANCHOR LOAD CELLS IN CHUQUICAMATA MINE (CHILE)



PIEZOMETERS

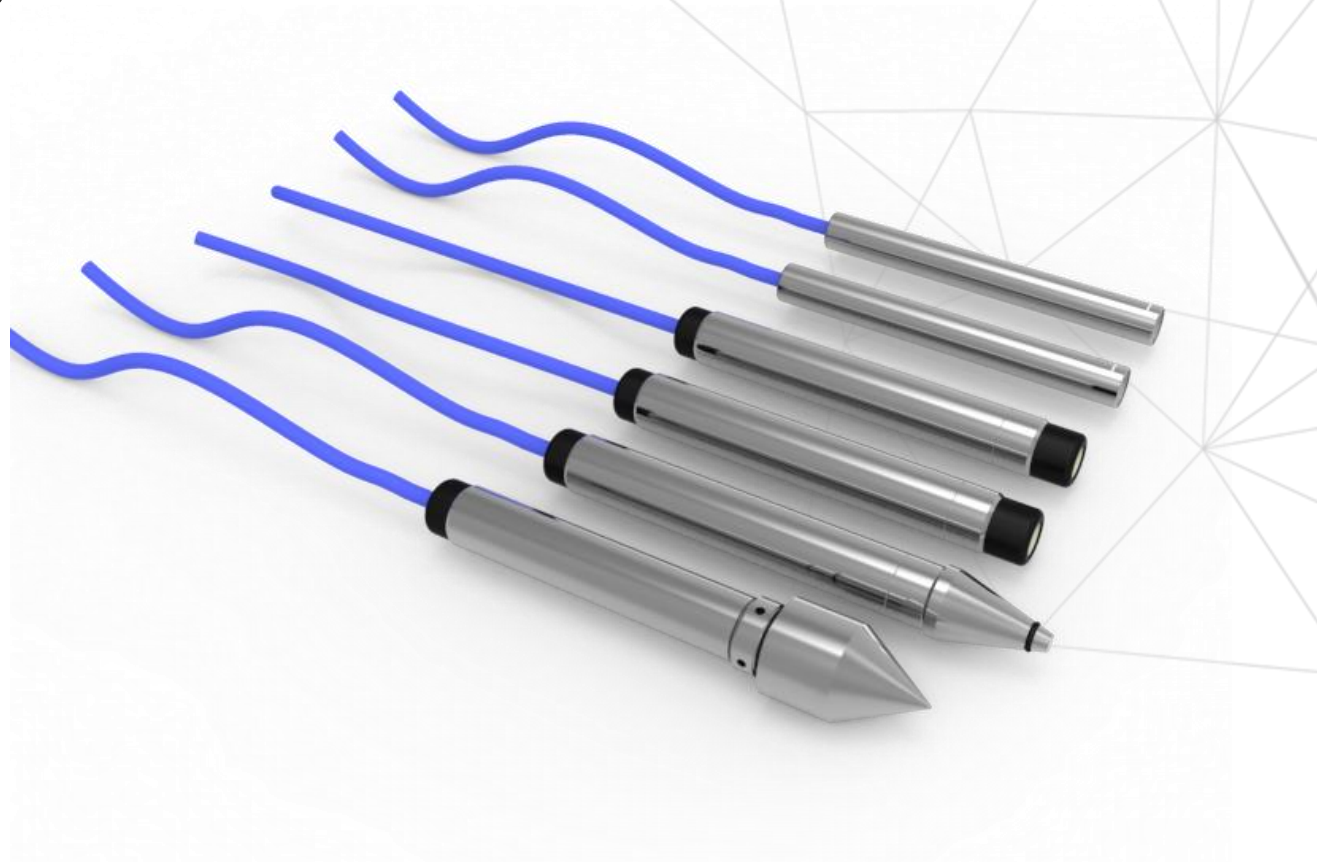
- MEXID miniaturized MPBXs
- Anchor load cells
- MEXID miniaturized MPBXs**
- Anchor load cells
- Anchor load cells



— PIEZOMETERS FOR PORE PRESSURE

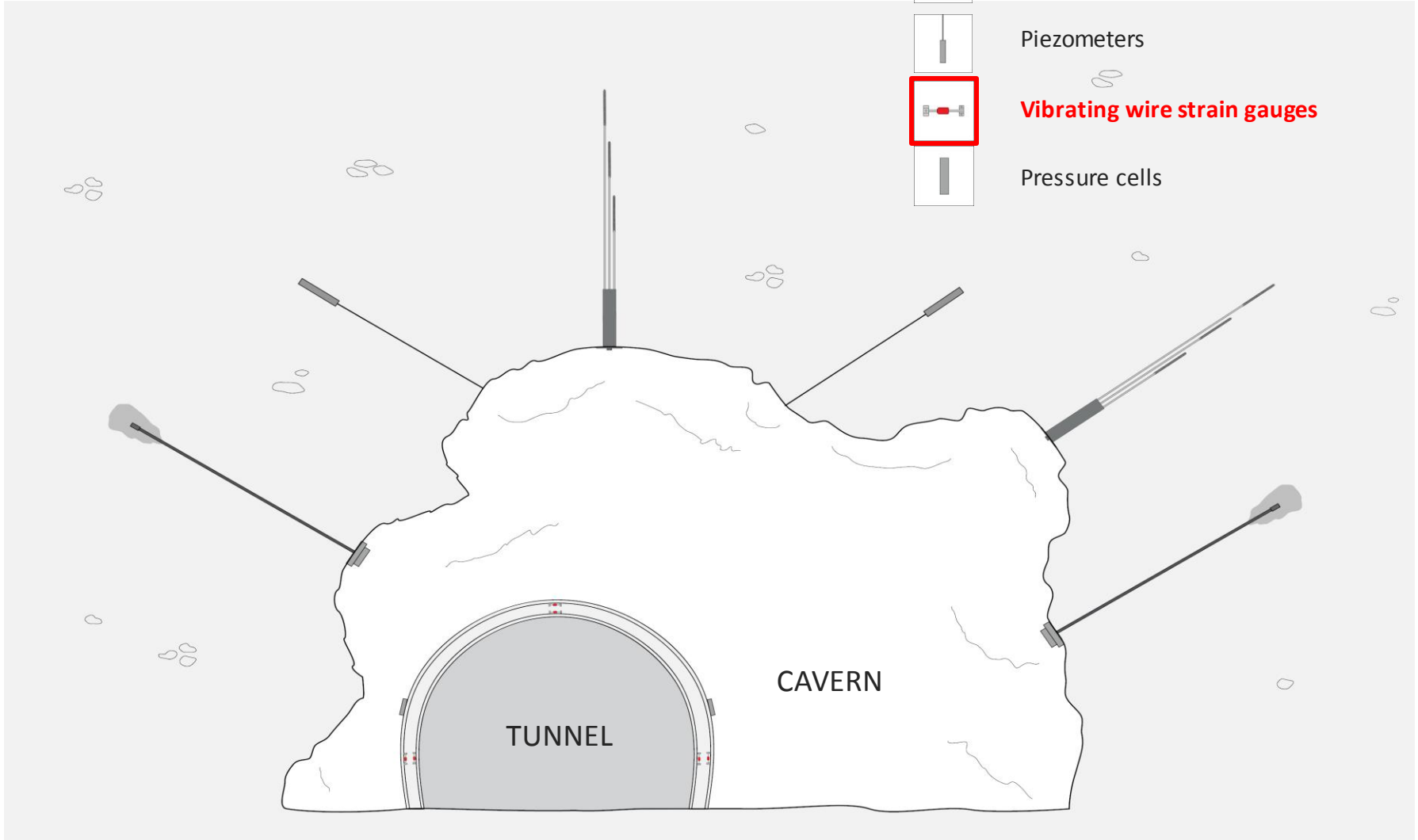
Purpose:

- *Pore pressure monitoring*








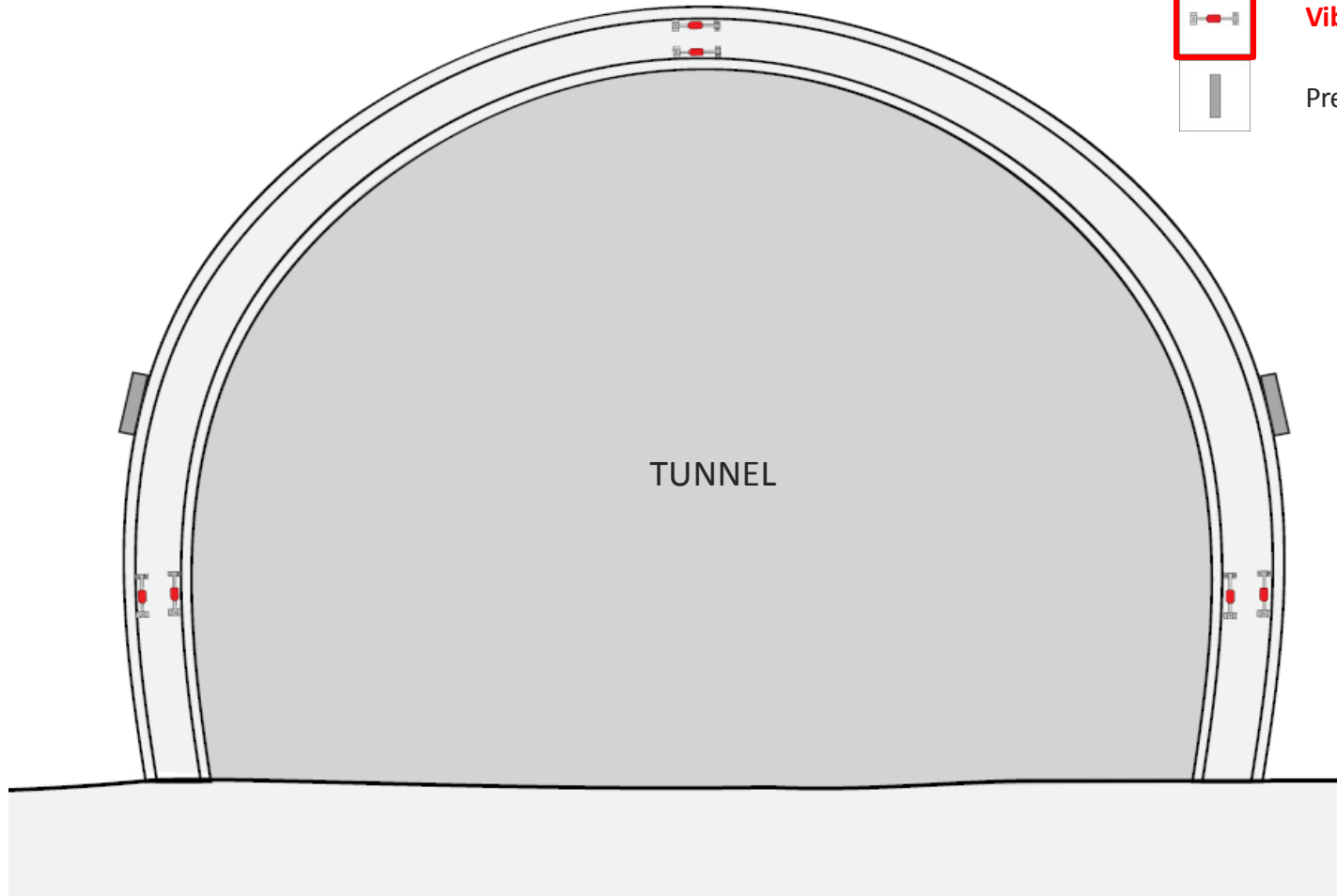
— VW STRAIN GAUGES

- MEXID miniaturized MPBXs
- Anchor load cells
- Piezometers
- Vibrating wire strain gauges**
- Pressure cells



— VW STRAIN GAUGES

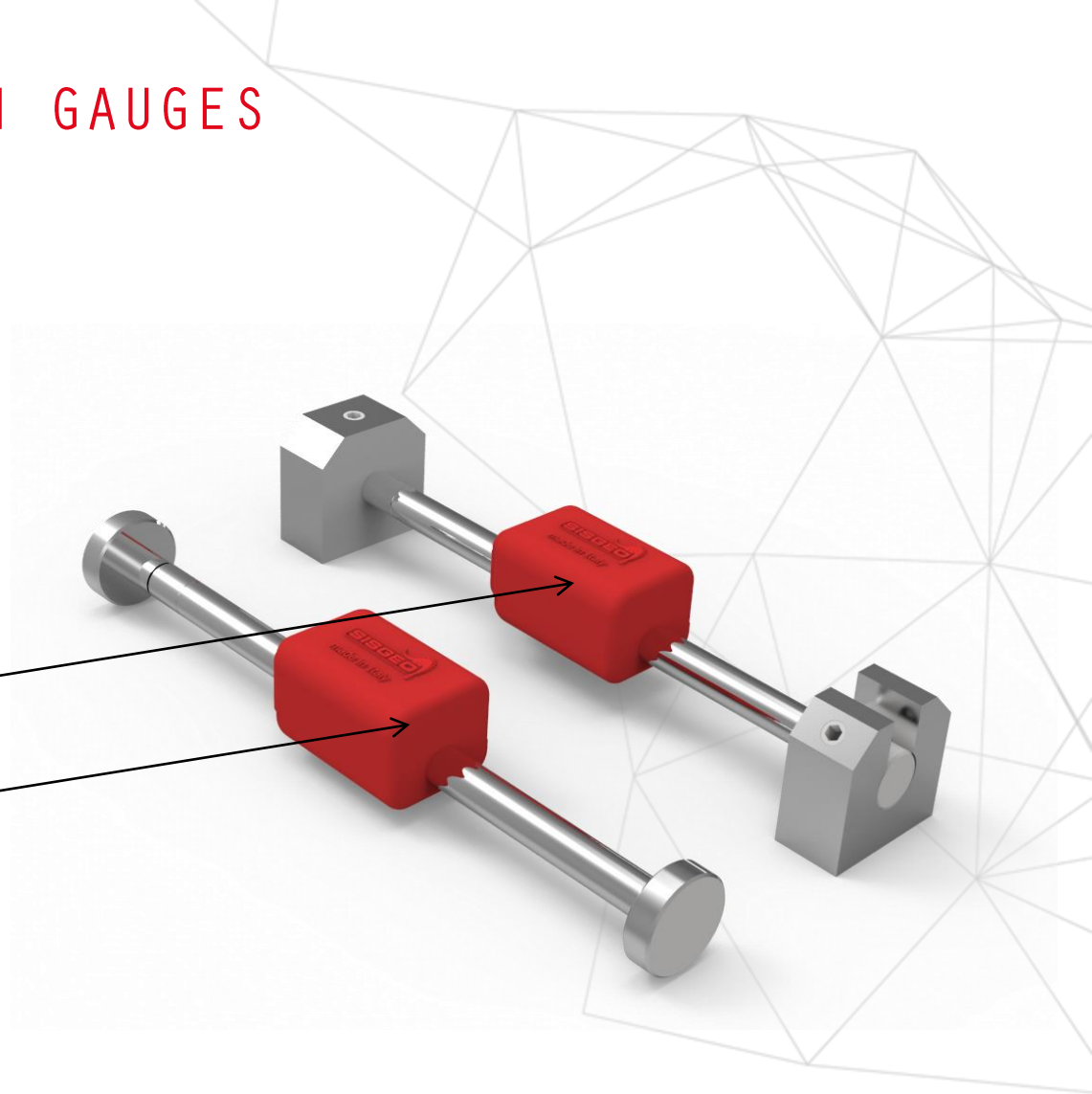
-  MEXID miniaturized MPBXs
-  Anchor load cells
-  Piezometers
-  **Vibrating wire strain gauges**
-  Pressure cells



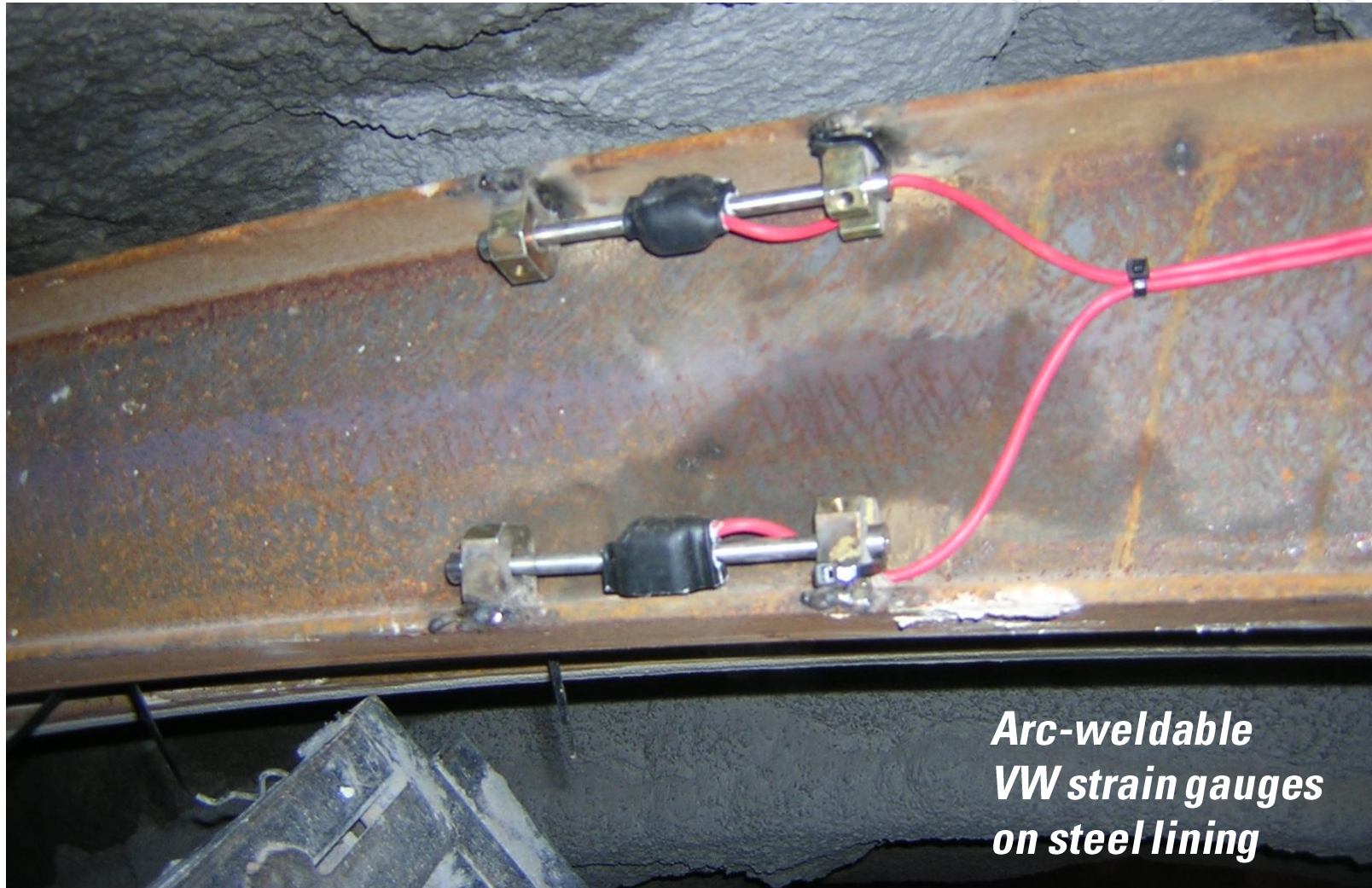
VIBRATING WIRE STRAIN GAUGES

Stress monitoring into concrete structures or on metal supports.

- *Arc-weldable model*
- *Embedment model*



__ ARC-WELDABLE VIBRATING WIRE STRAIN GAUGES








*Arc-weldable
VW strain gauges
on steel lining*

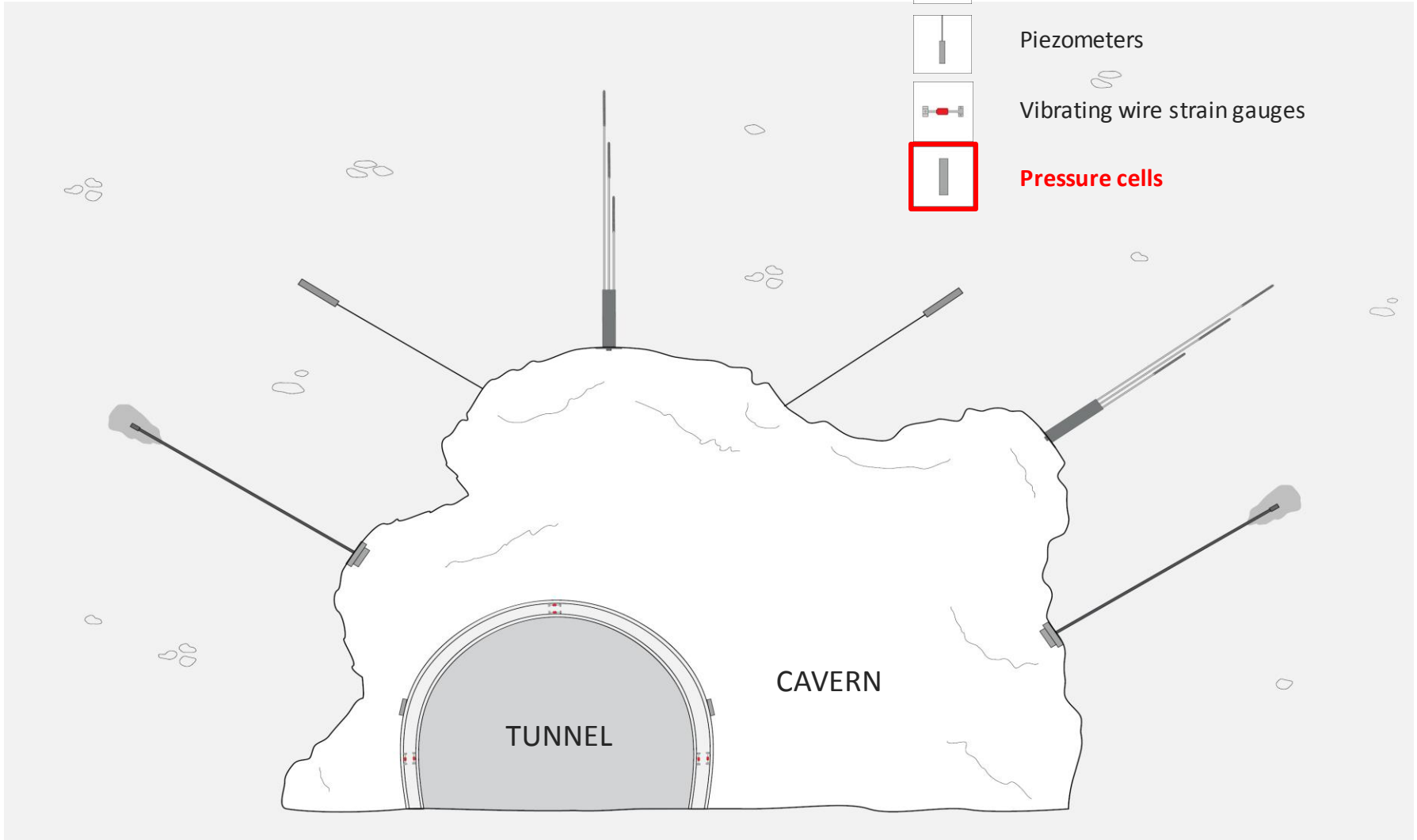
__ EMBEDMENT VIBRATING WIRE STRAIN GAUGE



*Embedment
VW strain gauge
before grouting*

— PRESSURE CELLS

-  MEXID miniaturized MPBXs
-  Anchor load cells
-  Piezometers
-  Vibrating wire strain gauges
-  **Pressure cells**



— PRESSURE CELLS



MEXID miniaturized MPBXs



Anchor load cells



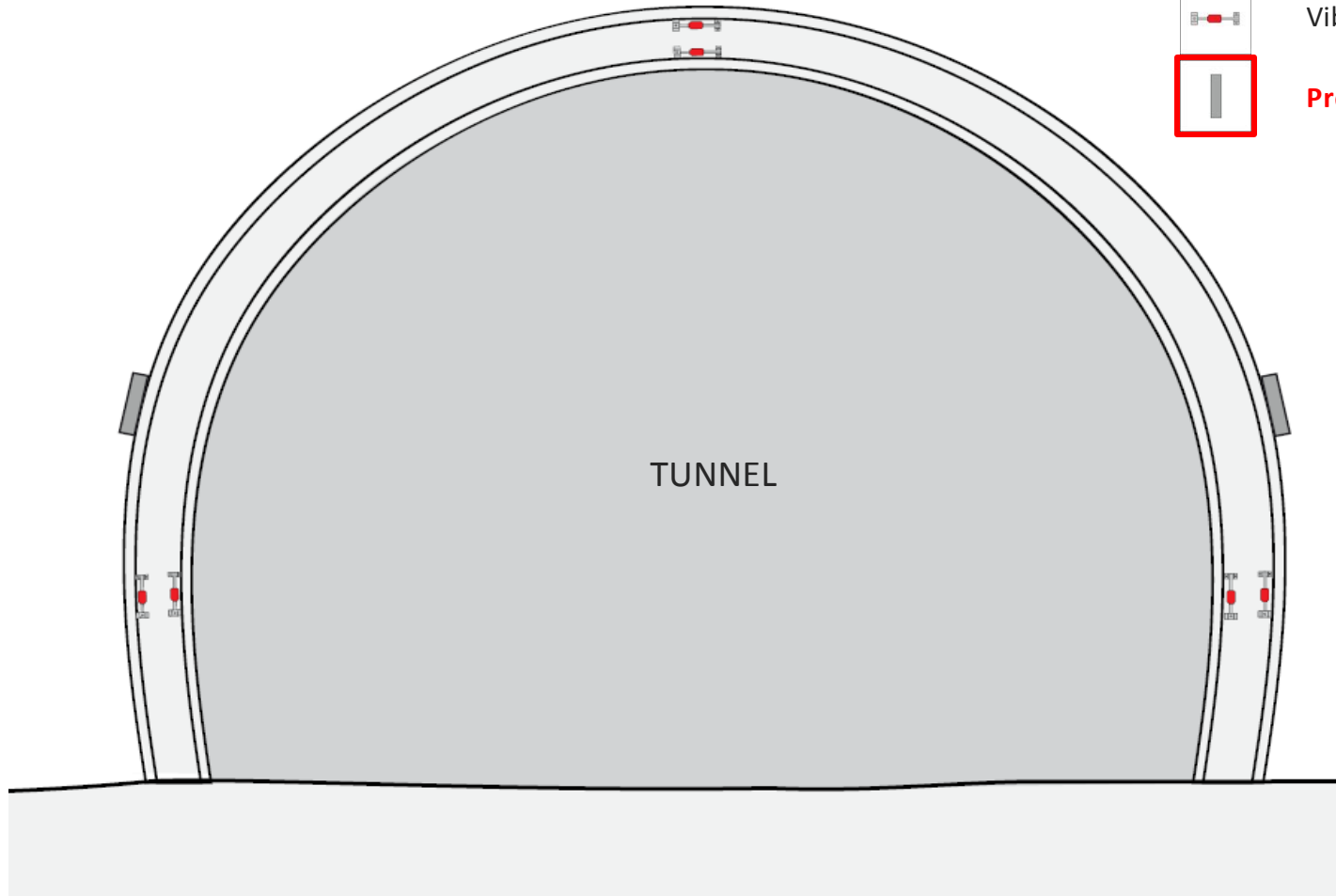
Piezometers



Vibrating wire strain gauges

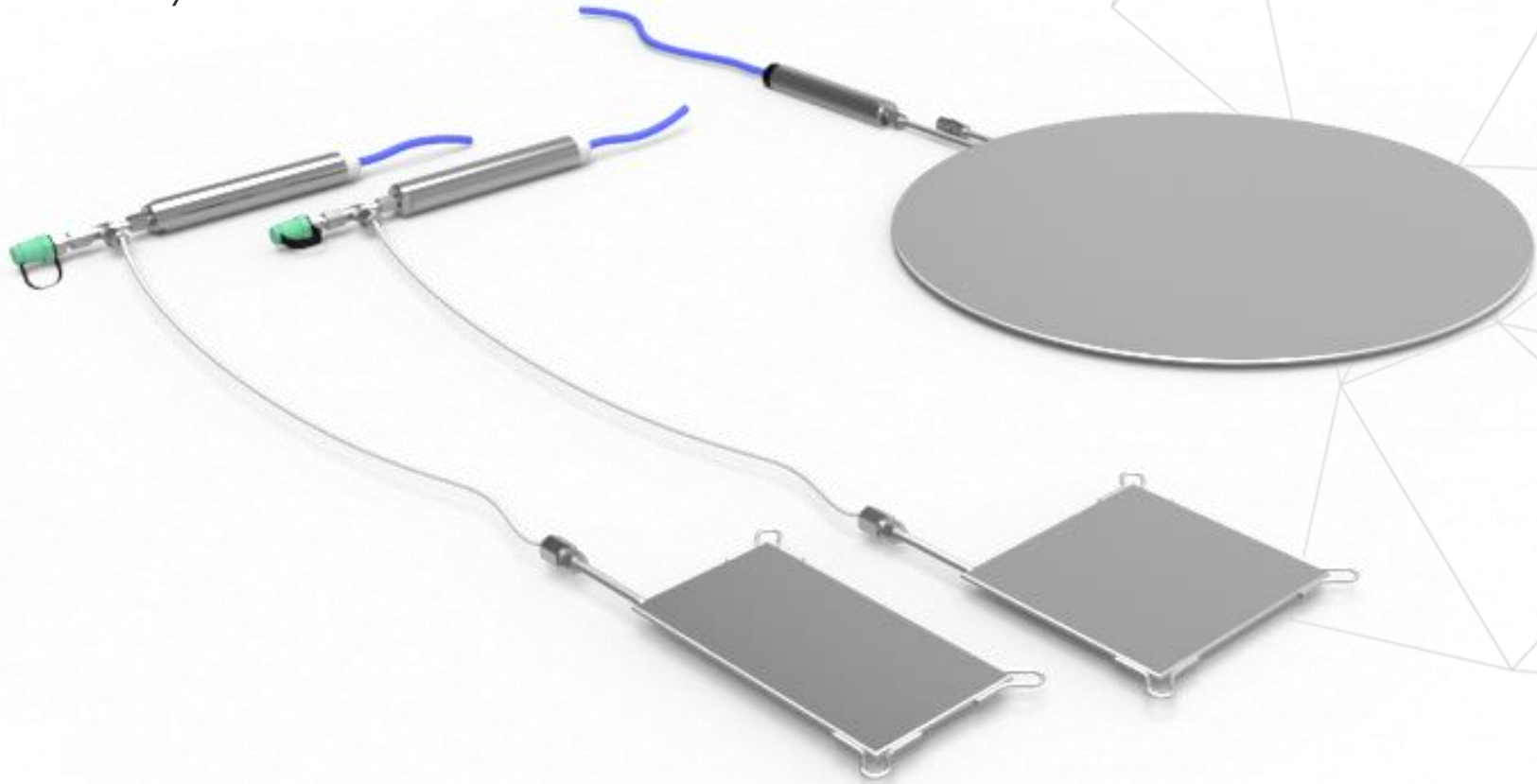


Pressure cells



— PRESSURE CELLS

*Stress monitoring
into rock / concrete mass*



— PRESSURE CELLS



__ TAILINGS (MINE WASTE REPOSITORY)



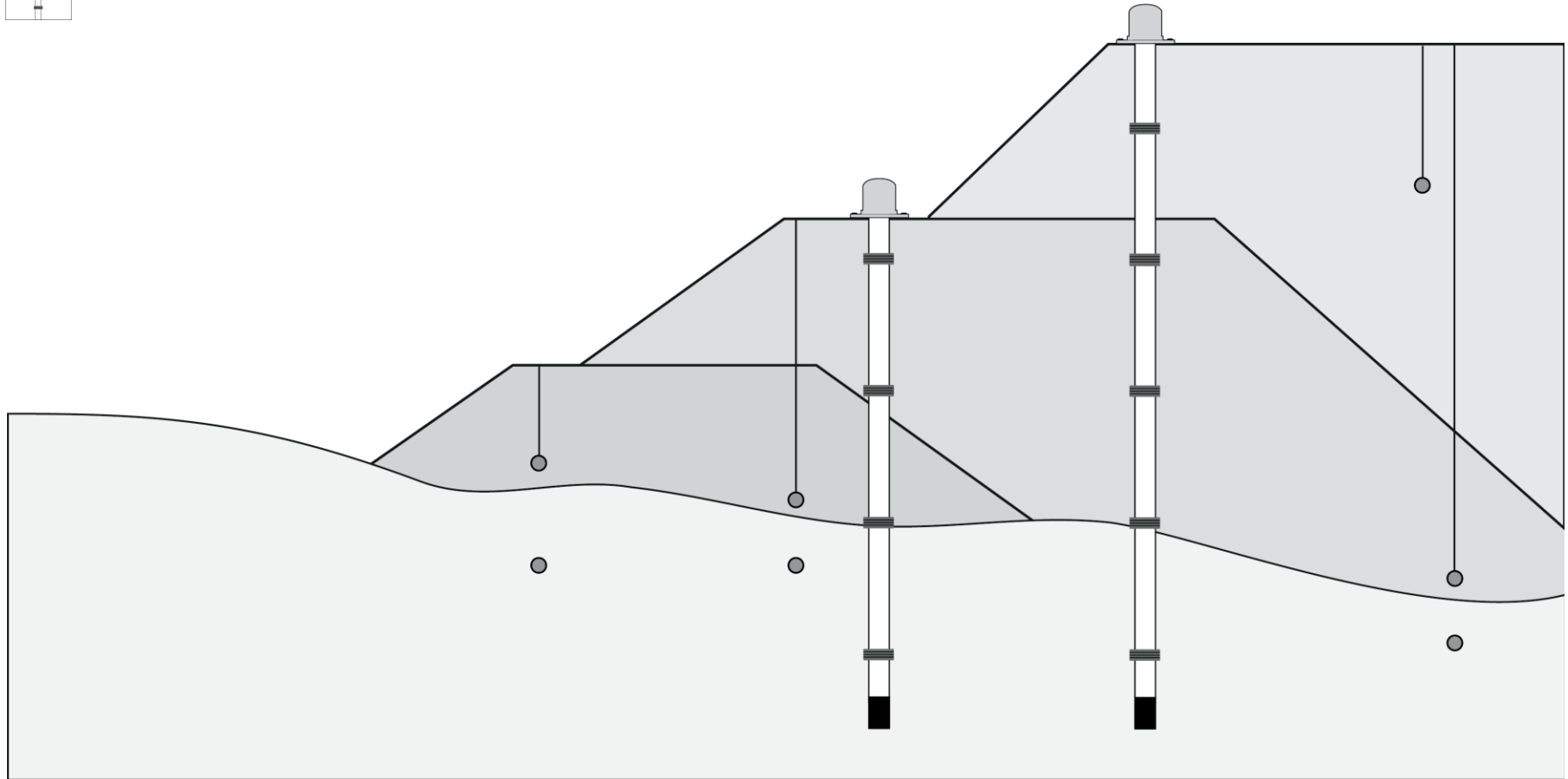
TAILING (MINE WASTE REPOSITORY)



Titanium Piezometers (pore pressure)



Extenso-Inclinometers



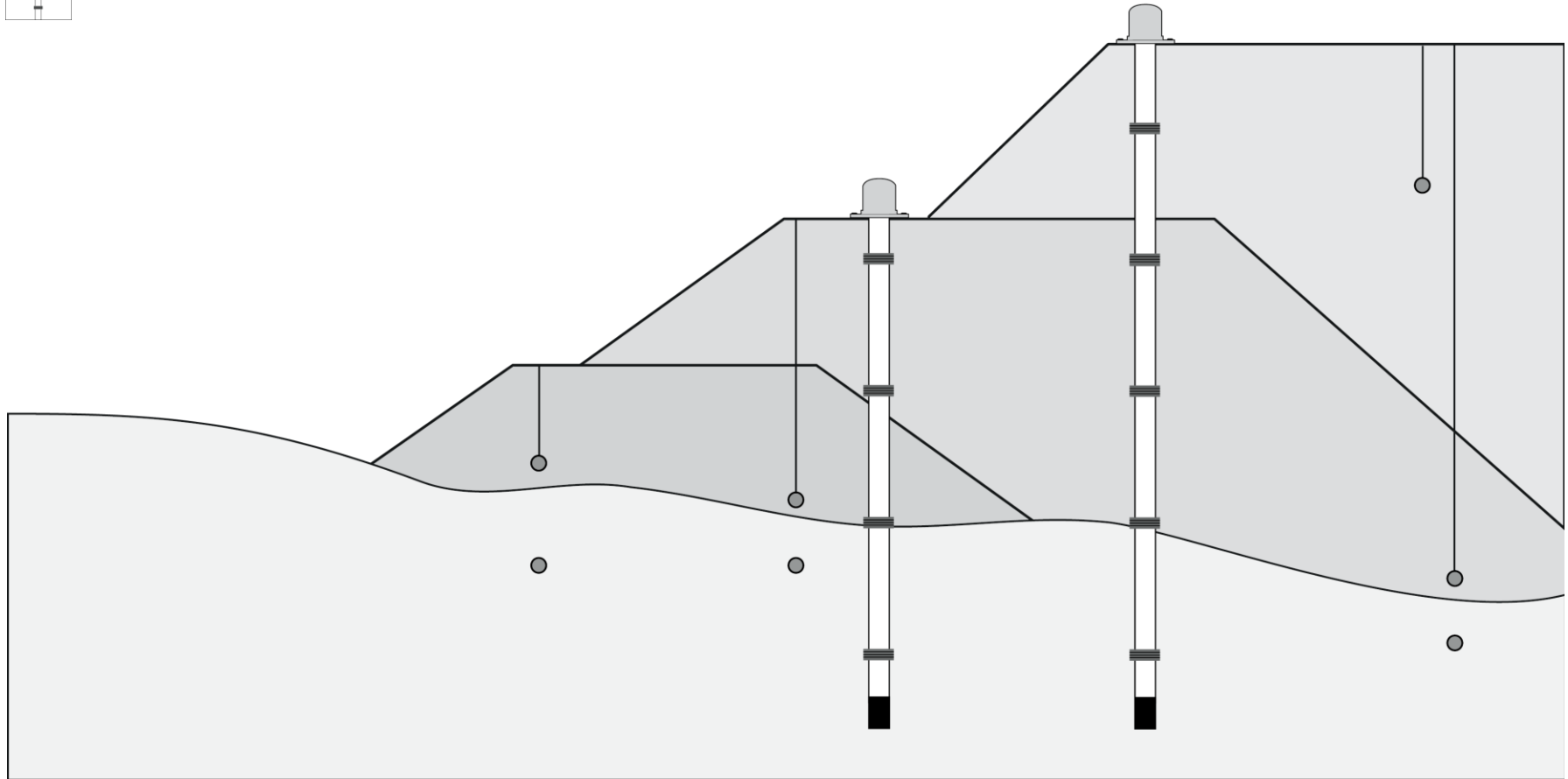
TITANIUM PIEZOMETERS



Titanium Piezometers (pore pressure)



Extenso-Inclinometers



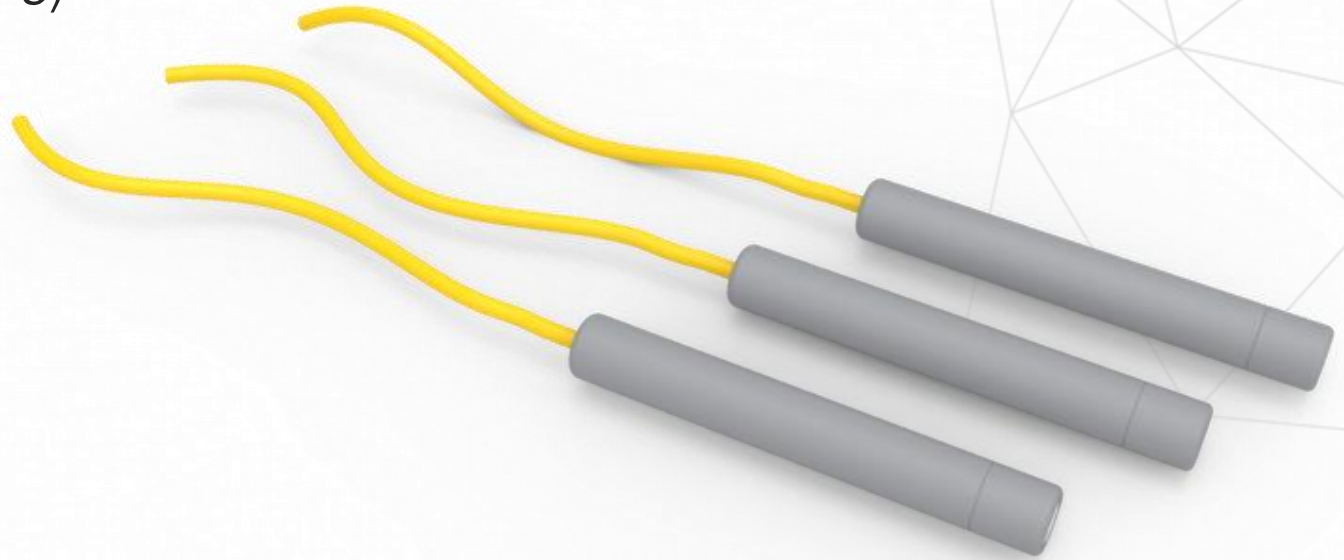
— TITANIUM PIEZOMETERS FOR PORE PRESSURE

Purpose:

- *Pore pressure monitoring.*

They are designed for installation in highly corrosive environments and aggressive soils

(up to pH = 1 @ 20°C)



— TITANIUM PIEZOMETERS FOR PORE PRESSURE



Installation of titanium piezometer under waste repository (before construction)

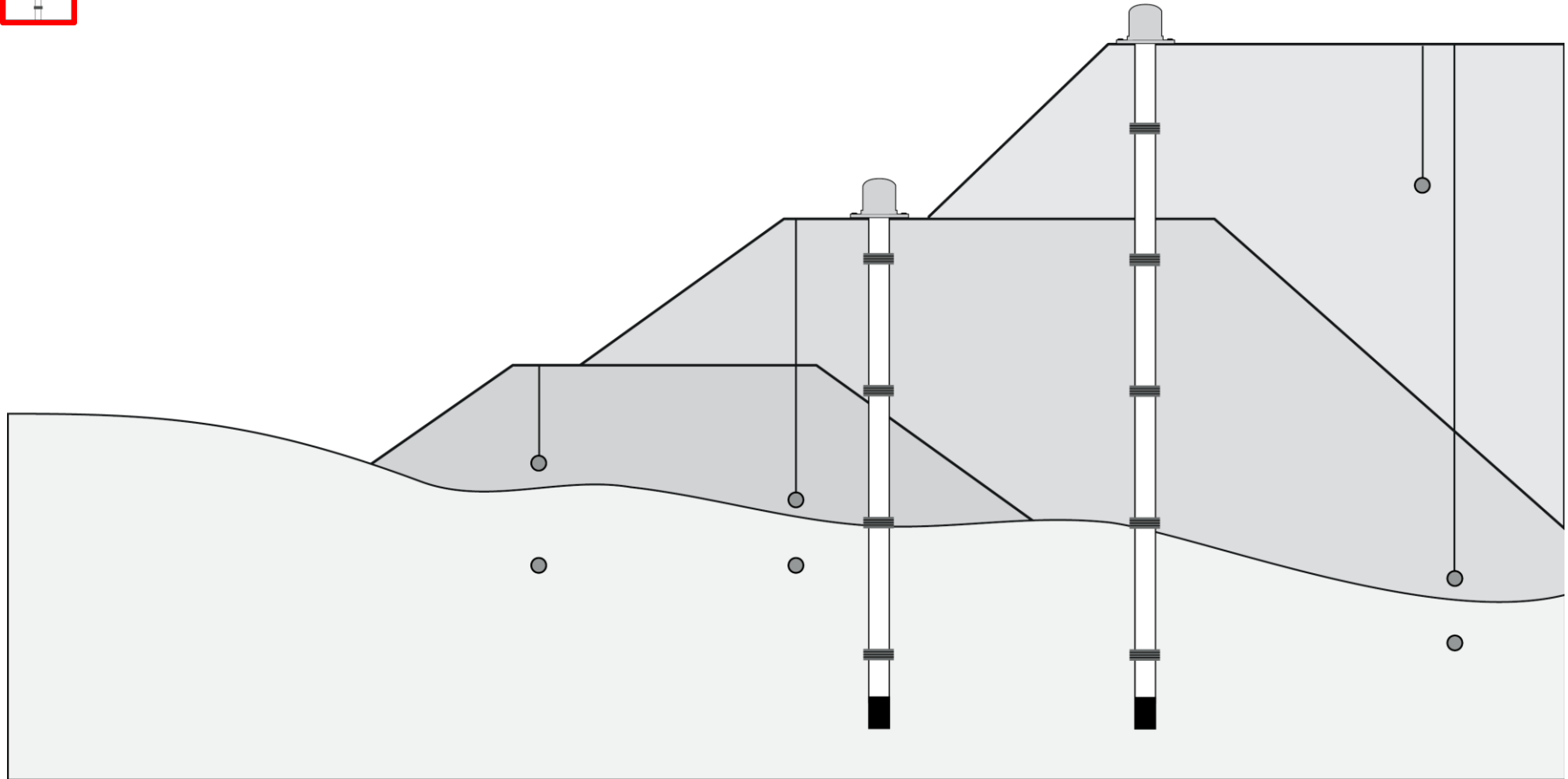
EXTENSO-INCLINOMETERS



Titanium Piezometers (pore pressure)



Extenso-Inclinometers



__ EXTENSO-INCLINOMETER – MANUAL READINGS



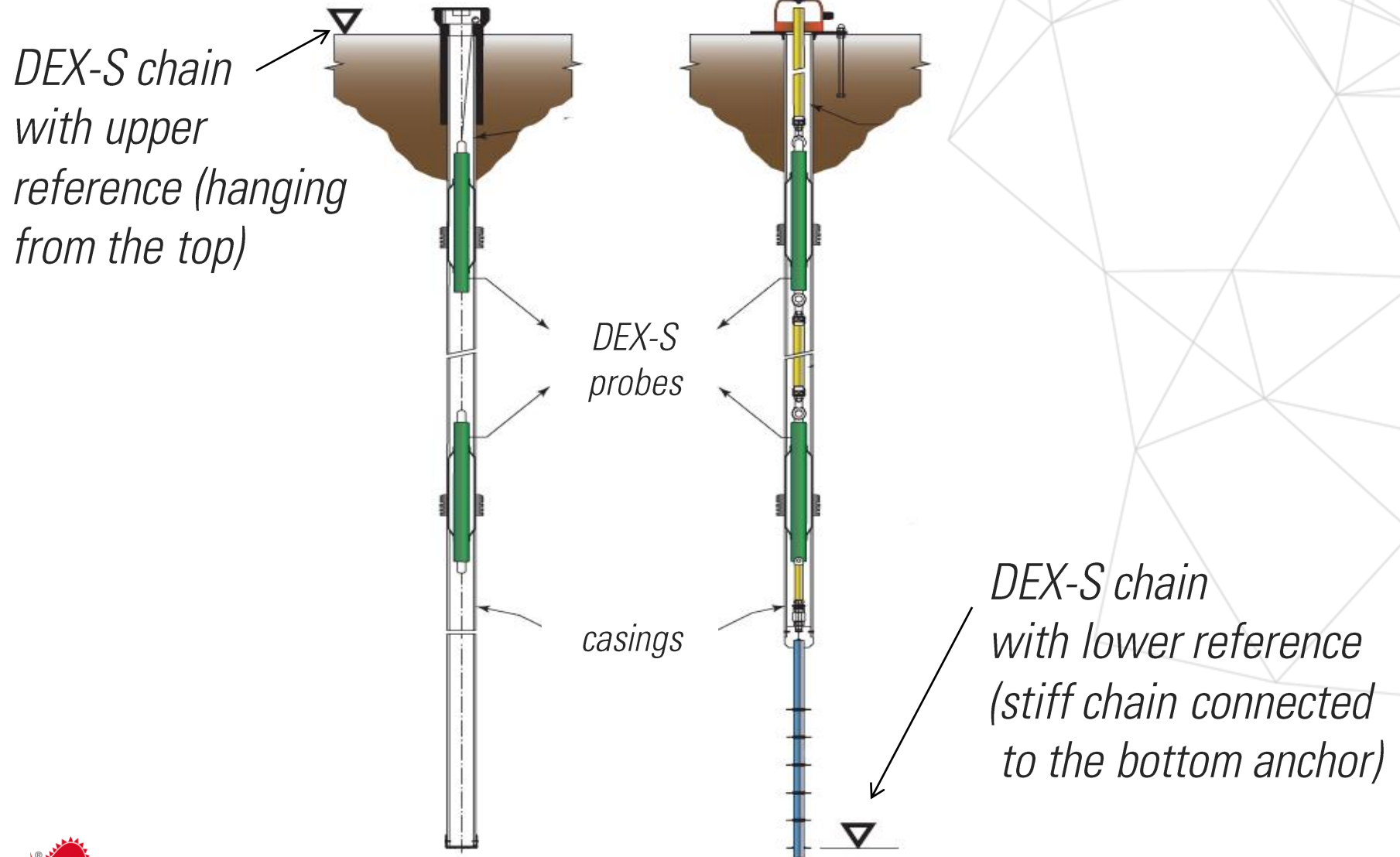
*Removable
MEMS
inclinometer*



*T-REX
incremental
extensometer*



DEX-S IN-PLACE EXTENSO-INCLINOMETERS



__ MINE MONITORING: DATA ACQUISITION SYSTEM

Instruments installed for mine monitoring provide automatic real-time monitoring by means of OMNIAlog datalogger.

OMNIAlog have a standard LAN port that can be connected i.e. to an industrial fiber optic interface or a GPRS modem allowing remote system management, data pushing on a server and allarms.



OMNIALOG DATALOGGER: EXTERNAL MULTIPLEXER

OMNIALOG CABINET



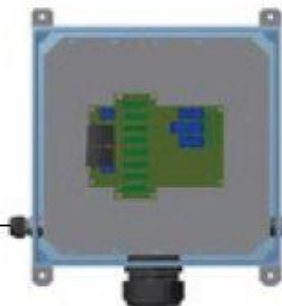
INTERNAL MUX
O0MN24MUX00

MUX WIRING BOARD
O0MX4MUXEXT

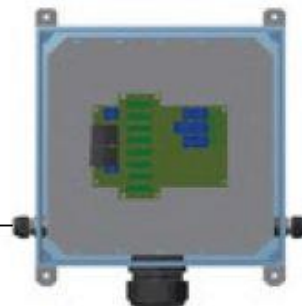
EXTERNAL MUX BOX
O0MN48MUXBO



EXTERNAL MUX BOX
O0MN24MUXBO



EXTERNAL MUX BOX
O0MN24MUXBO



MUX CABLE
O0WE610MUXZH

MUX CABLE
O0WE610MUXZH

Max 1200m

__ OMNIALOG IN PASCUA LAMA MINE - ARGENTINA





THANKS FOR WATCHING

*For any further clarification
visit www.sisgeo.com
or email us: info@sisgeo.com*