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LATINOAMERICA

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LANDSLIDE MONITORING INSTRUMENTATION

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Defining Risk

Risk = Probability of Failure * Consequences

A good monitoring System

dramatically reduces the probability of failure

A good monitoring System can reduce consequences

by giving early notice to remediate:

- Loss of life
- Damage to other properties
- Loss of facility
- Costs to mitigate and repair
- Delays
- Damage to reputation

Monitoring = Less Risk

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Advantages from Monitoring

Safety: Enhance the safety of structures and thus *workers/population*. The respect of international standards of safety, is also a way to increase the *prestige of the project*.

Quality: Promptly identify problems that may be caused by mistakes/inaccuracies in the design of the project, enabling the construction company to make adjustments and therefore *improve the quality of the structures*

Costs: The geotechnical monitoring usually accounts for a very small portion of the entire project (avg. 0.5-2%). In the long run, such small investment allows significant *costs reduction*

Timing: Sisgeo's acquisition systems make possible both "real time" data retrieving and remote data management, which is of critical importance to support constructions' operations and *avoid costly delays*

Reputation: Monitoring is a powerful tool to show that everything is made properly, according to legal standards, and thus *prevent* inconvenient *damages to reputation*

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ROTATIONAL LANDSLIDE

Piezometer (pore pressure)

Piezometer (water table level)

Inclinometer casing

Wire extensometer

Meteorological station

PIEZOMETERS FOR PORE PRESSURE

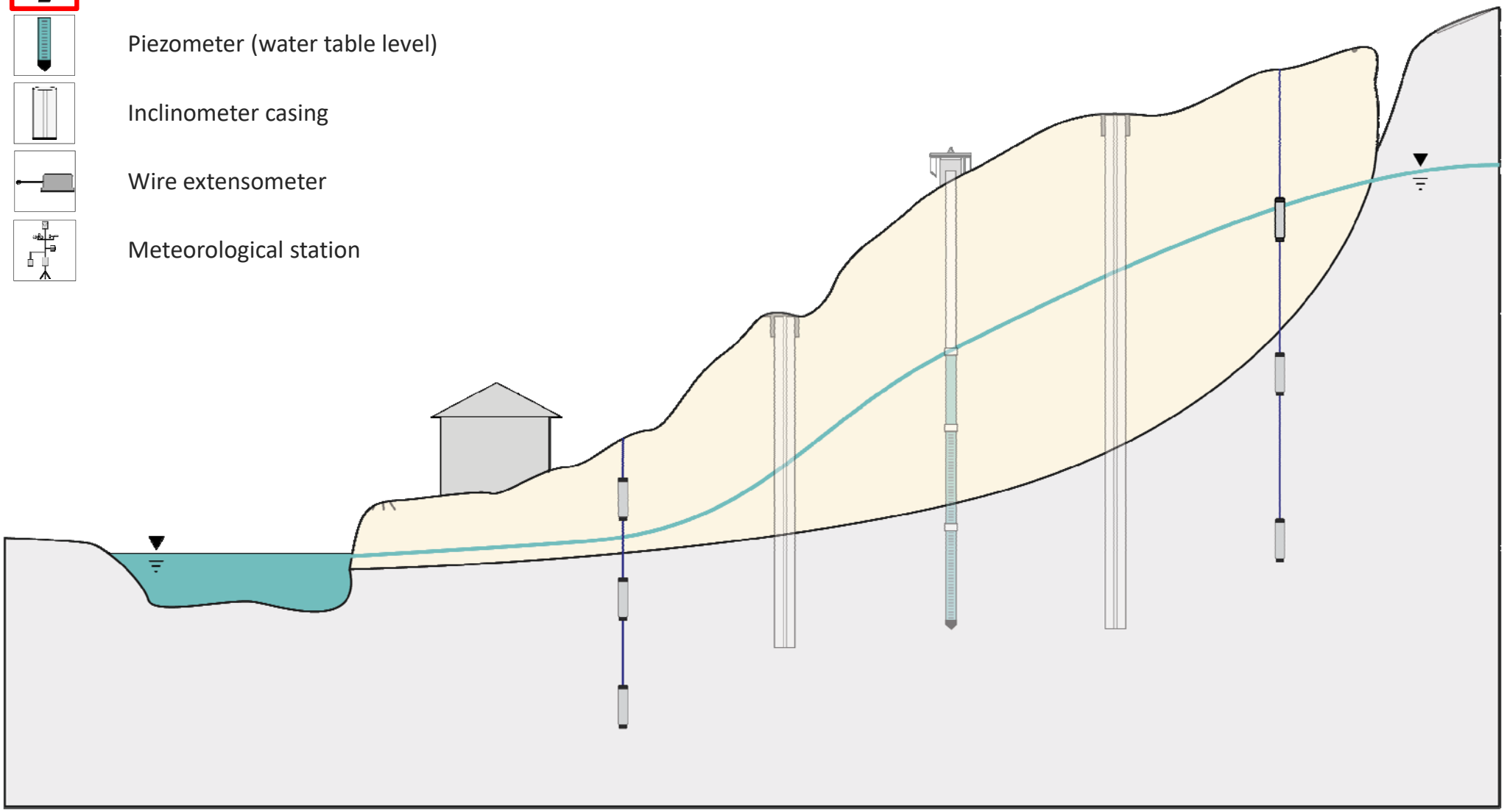
Piezometer (pore pressure)

Piezometer (water table level)

Inclinometer casing

Wire extensometer

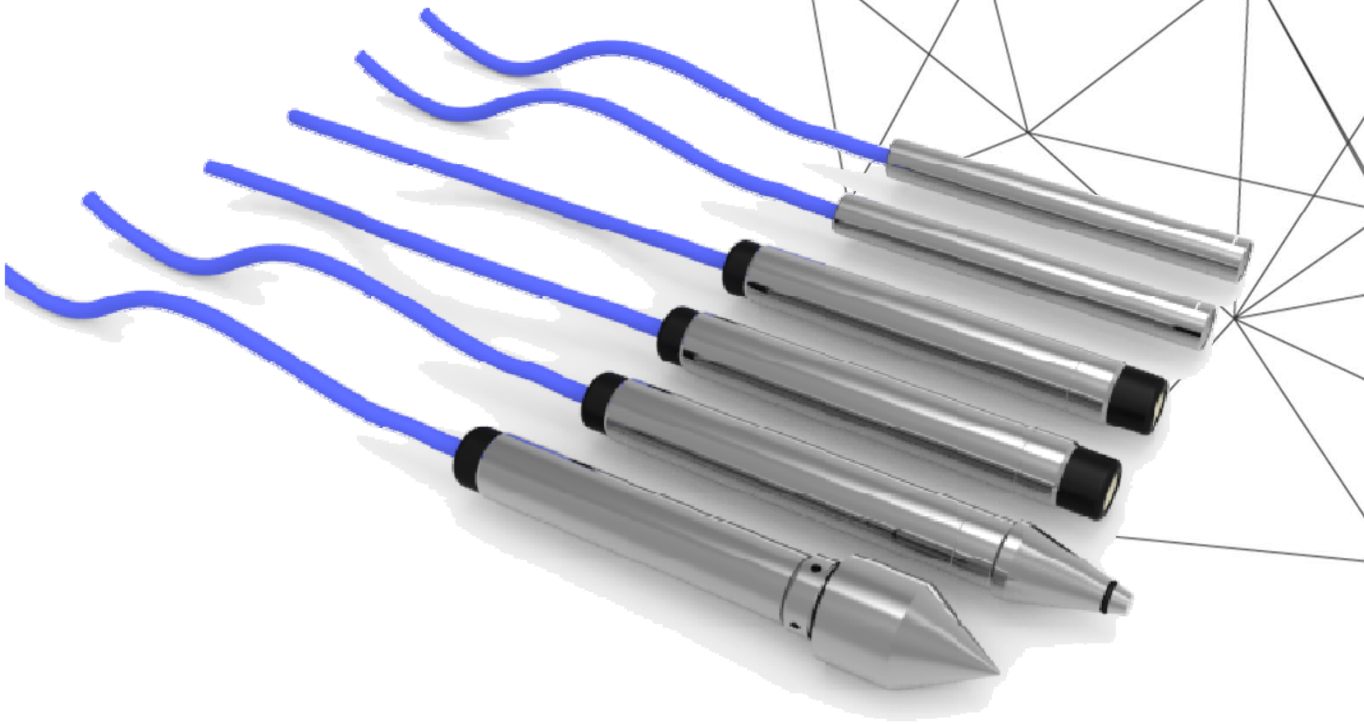
Meteorological station



PIEZOMETERS FOR PORE PRESSURE

Aims:

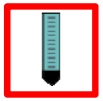
- *Pore pressure monitoring in landslide body*
- *Pore pressure under landslide body*



PIEZOMETERS FOR PORE PRESSURE

PIEZOMETERS FOR WATER TABLE LEVEL (STAND PIPES)

Piezometer (pore pressure)



Piezometer (water table level)

Inclinometer casing

Wire extensometer

Meteorological station

STAND PIPE PIEZOMETERS FOR WATER TABLE LEVEL

Sakhalin Island II project

STAND PIPE PIEZOMETERS FOR WATER TABLE LEVEL

Stand pipe piezometer head: detail of slotted tube with geotextile filter

INCLINOMETER CASING FOR HORIZONTAL DISPLACEMENTS

Piezometer (pore pressure)

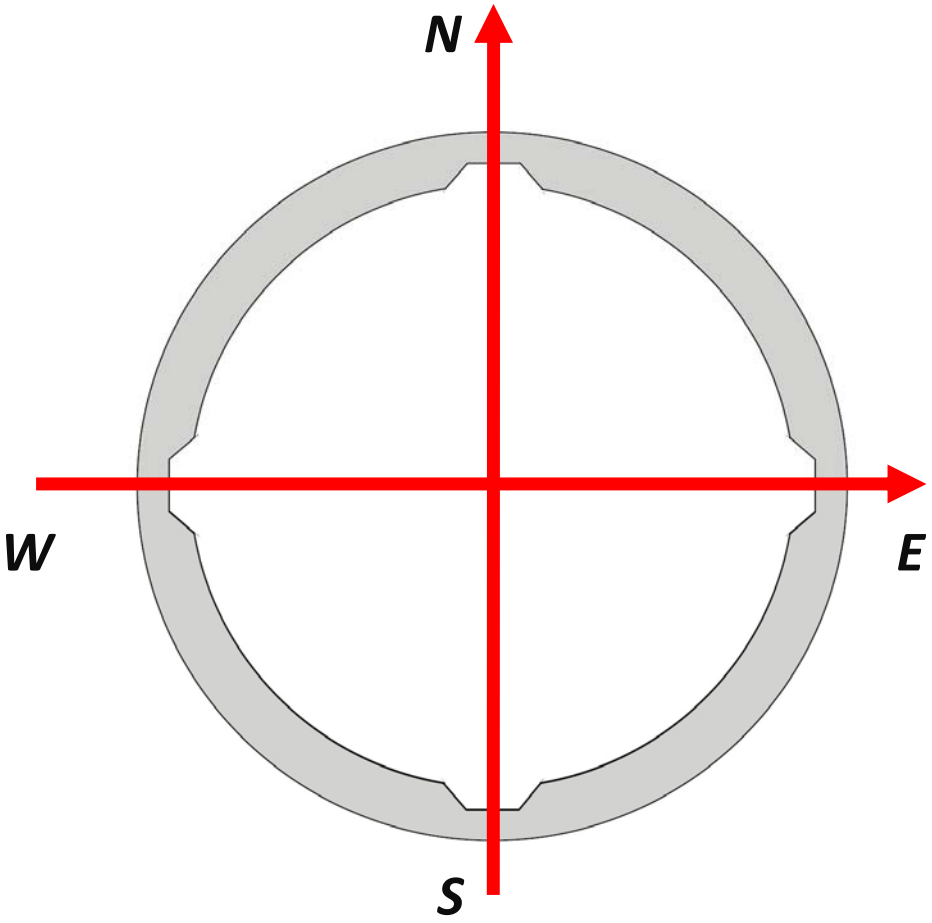
Piezometer (water table level)

Inclinometer casing

Wire extensometer

Meteorological station

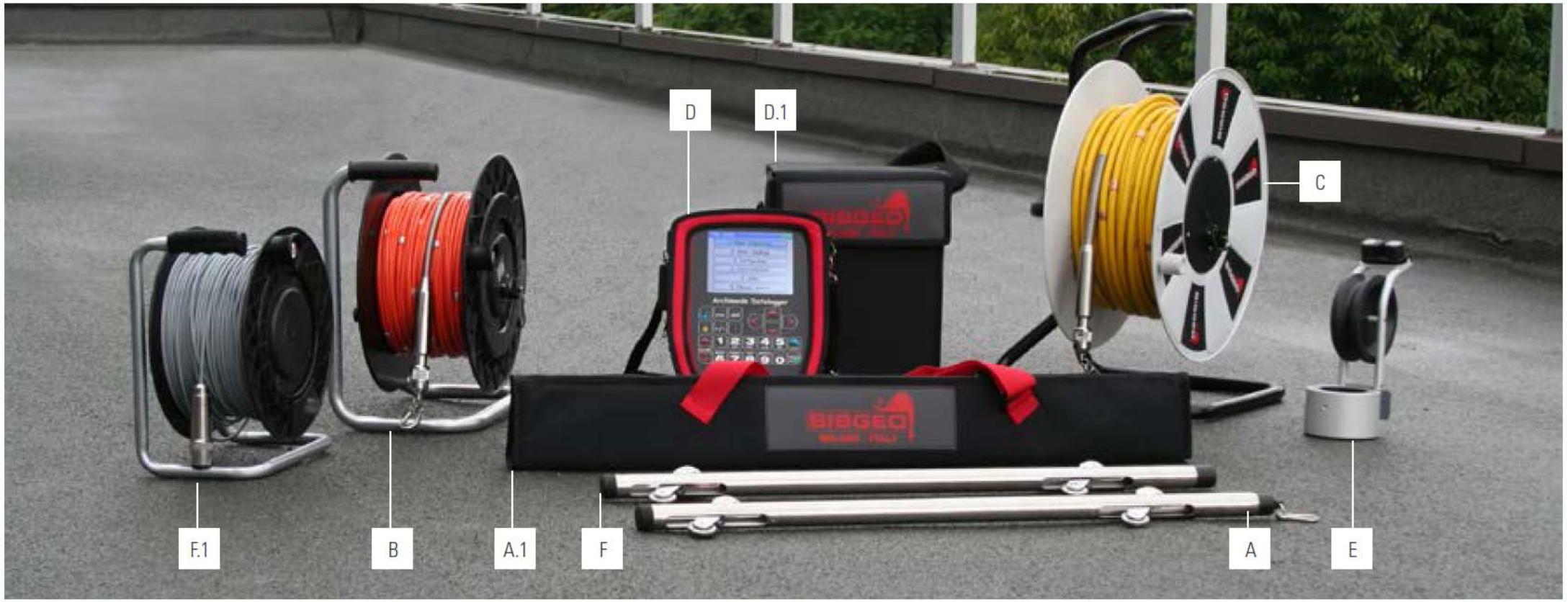
INCLINOMETER CASING FOR HORIZONTAL DISPLACEMENTS



Inclinometer casing section:

4 grooves to guide the probe in the tube without twisting

REMOVABLE INCLINOMETER SYSTEM FOR INCLINOMETER CASING SURVEYING



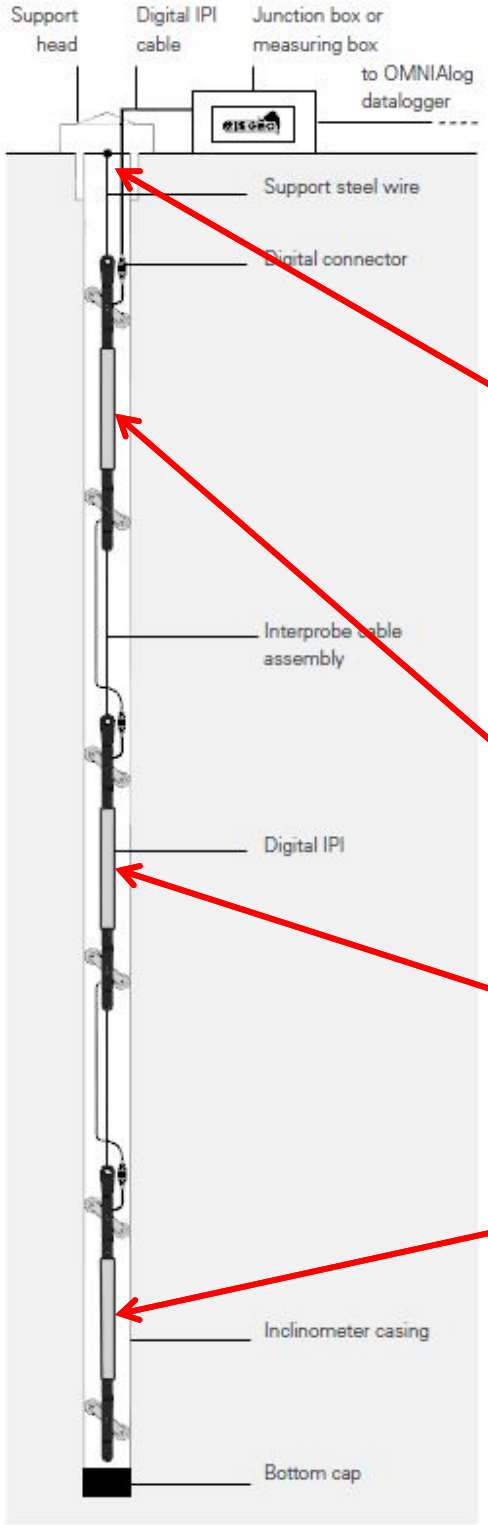
A Digital inclinometer probe
A.1 Travel bag for both inclinometer and dummy probes
B Light inclinometer cable reel
C Heavy-Duty cable
D Archimede readout
D.1 Archimede carrying case
E. Pulley assembly
F. Dummy probe
F.1 Cable for dummy probe

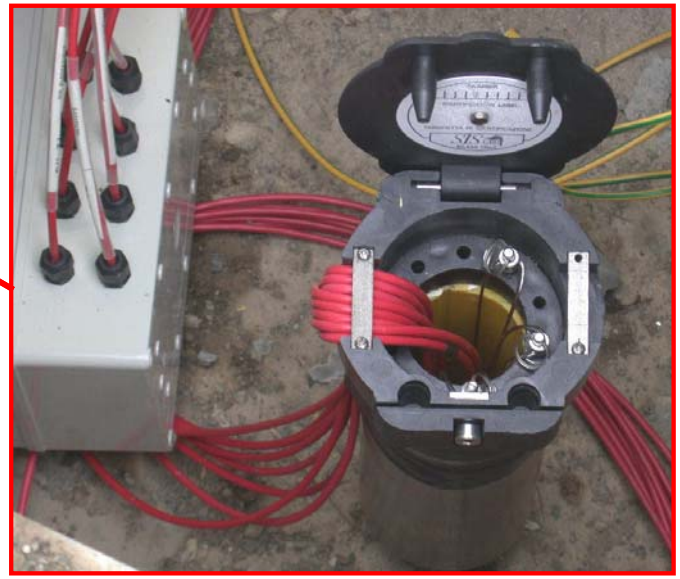
REMOVABLE INCLINOMETER SYSTEM FOR INCLINOMETER CASING SURVEYING

REMOVABLE INCLINOMETER SYSTEM FOR INCLINOMETER CASING SURVEYING

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

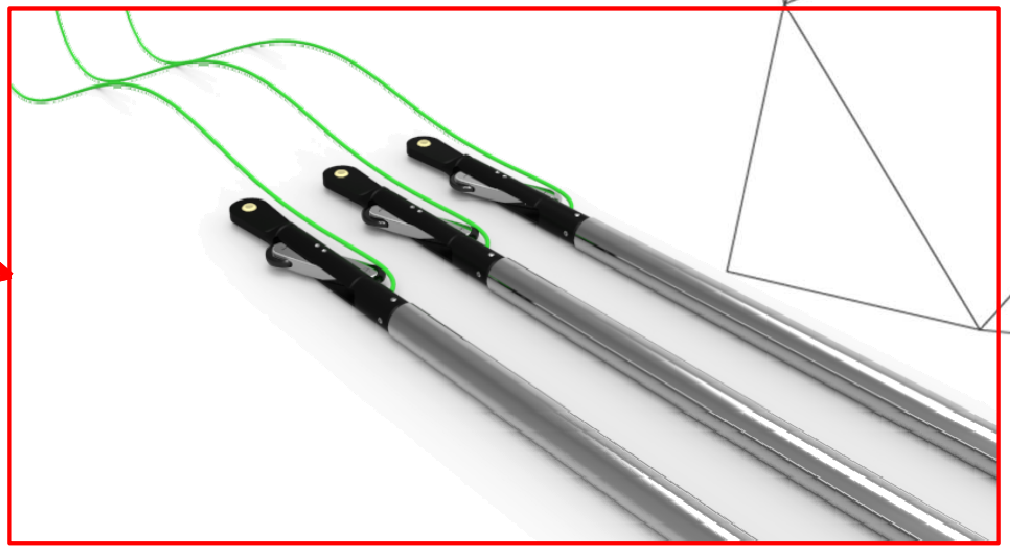
IN-PLACE INCLINOMETERS (IPI) FOR AUTOMATIC INCLINOMETER MONITORING



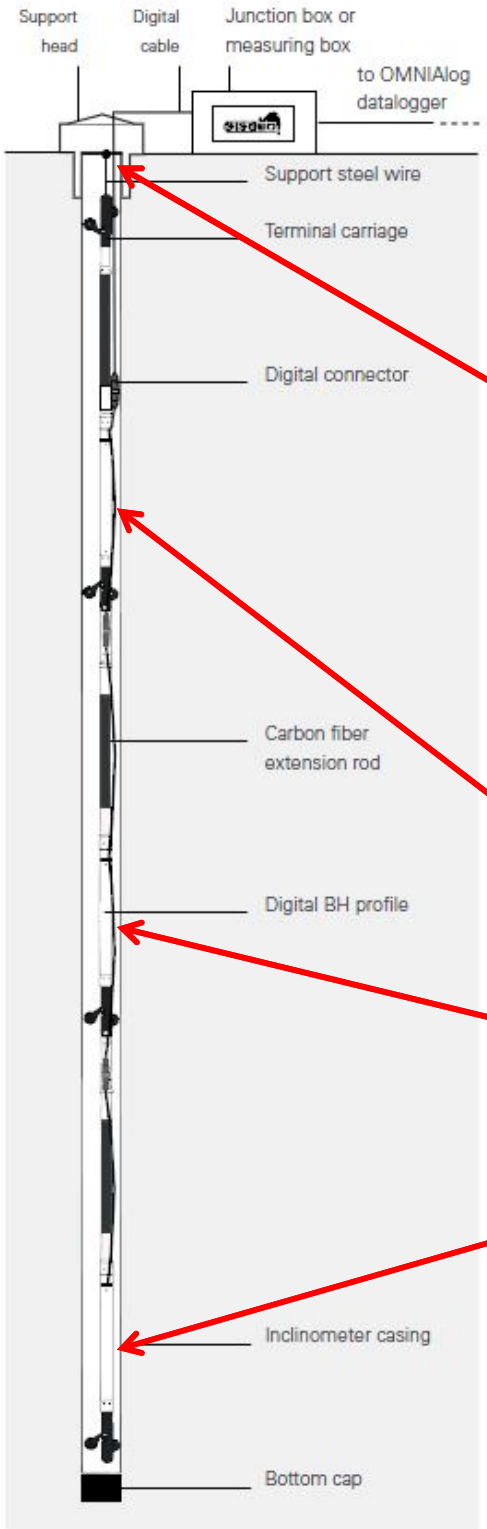


Support top cap after installation

IPI probes



BH PROFILE INCLINOMETERS FOR CONTINUOUS BOREHOLE PROFILING

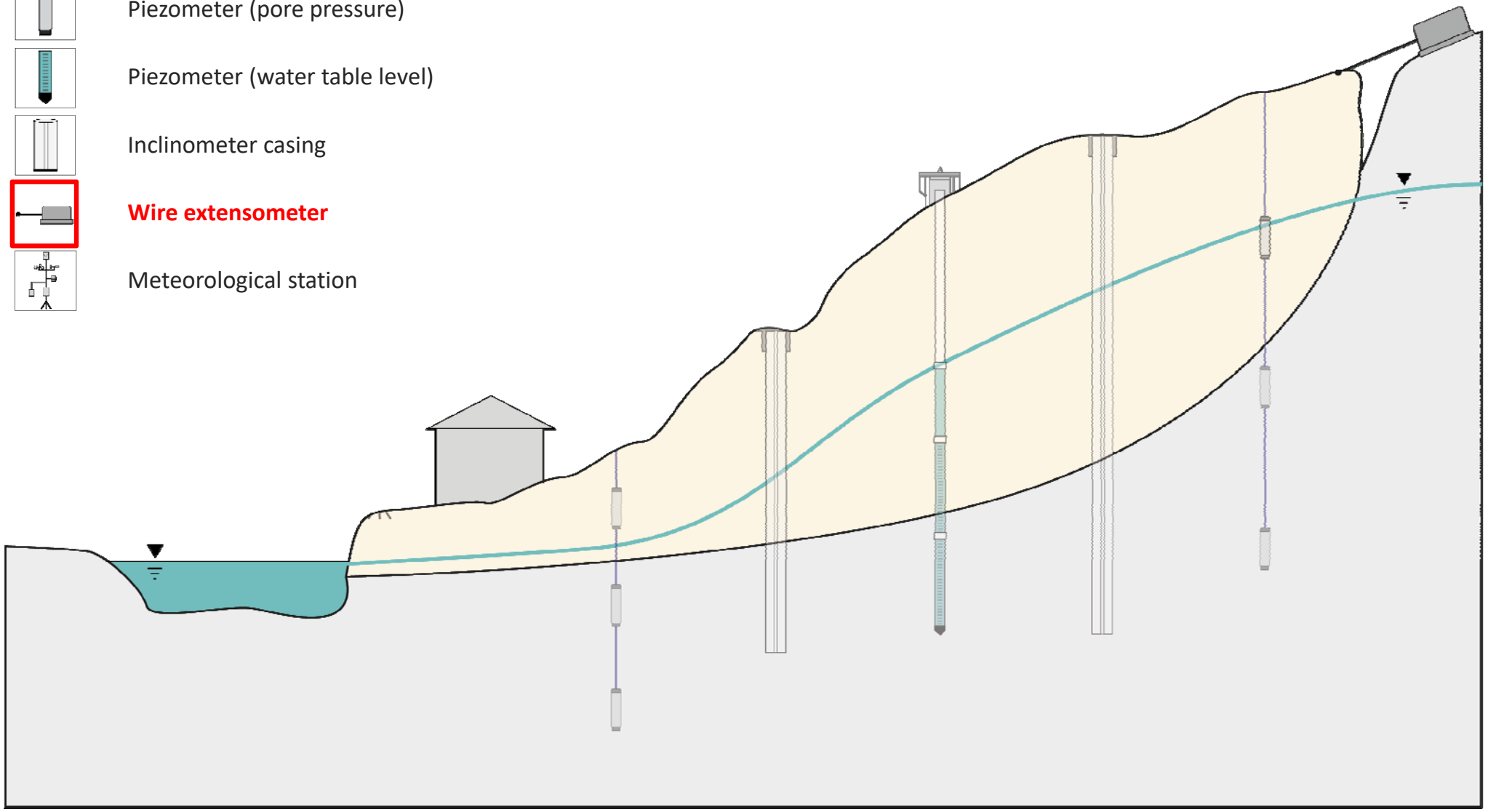


Support top cap after installation

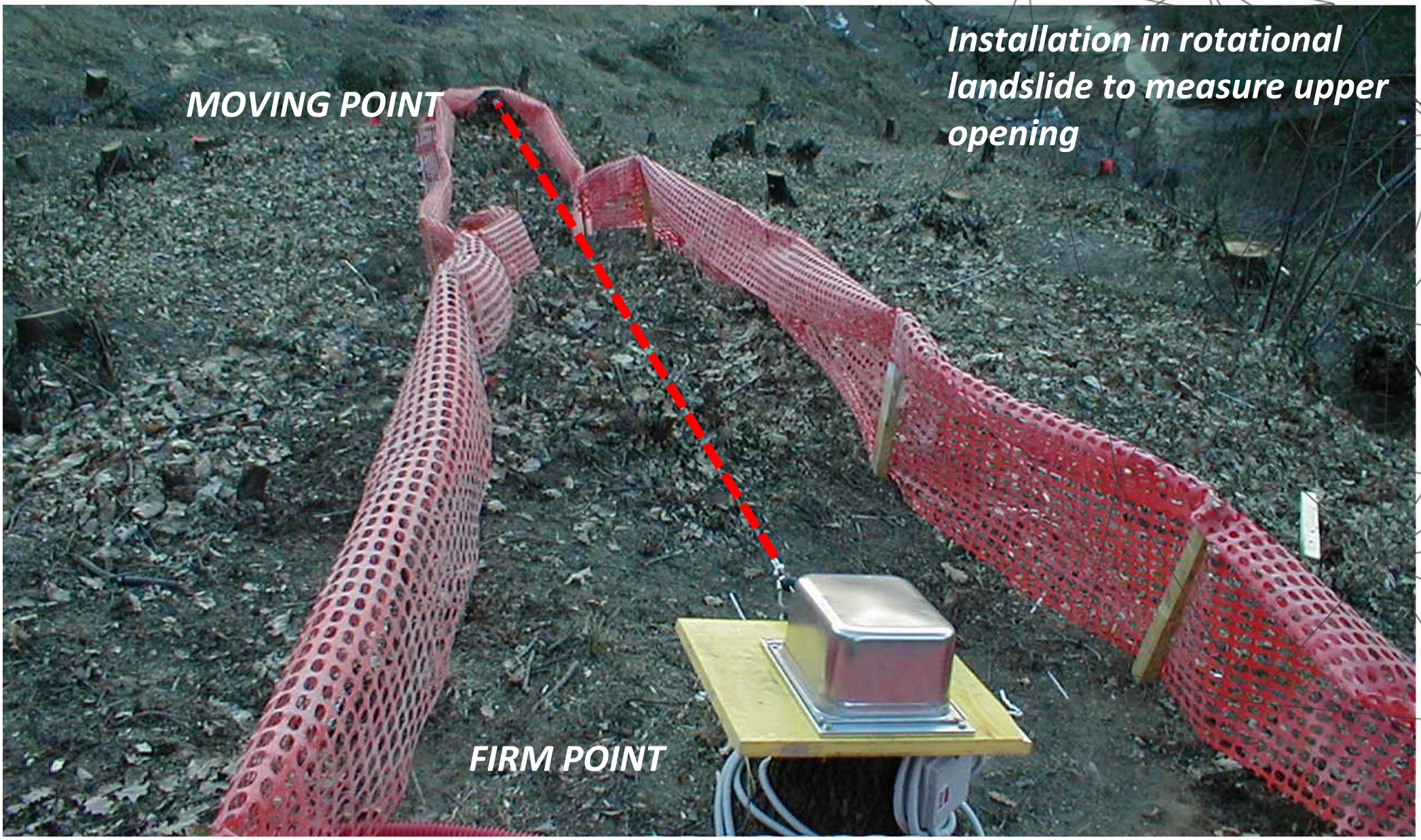
Digital BH profile inclinometers with carbon fiber extension rod

WIRE EXTENSOMETER

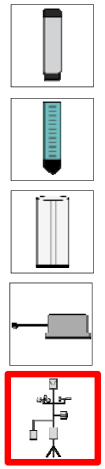
- Piezometer (pore pressure)
- Piezometer (water table level)
- Inclinometer casing
- **Wire extensometer**
- Meteorological station



WIRE EXTENSOMETER



METEOROLOGICAL STATION



Piezometer (pore pressure)

Piezometer (water table level)

Inclinometer casing

Wire extensometer

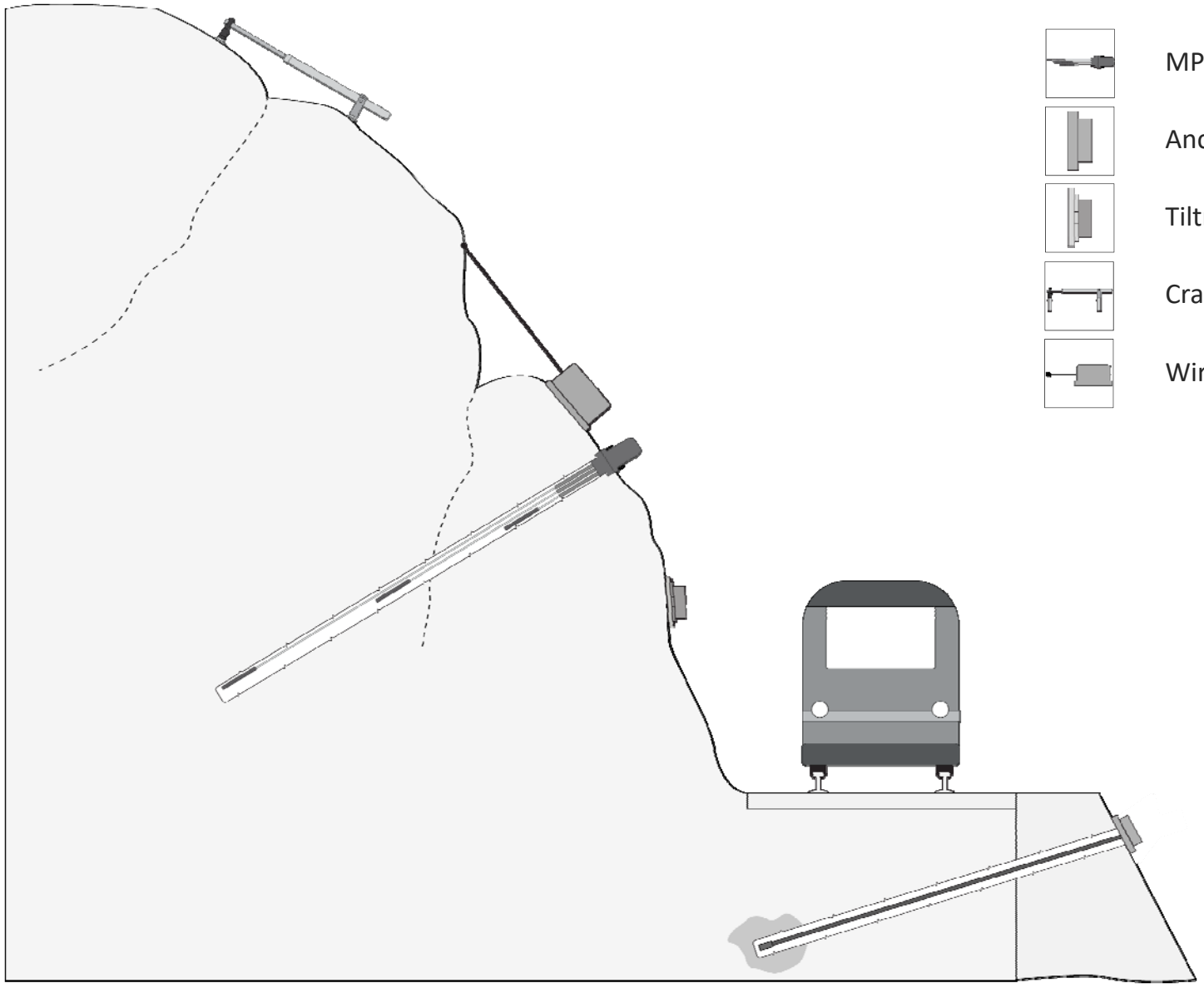
Meteorological station

METEOROLOGICAL STATION

Usually composed by:

- *Rain gauge*
- *Wind speed gauge*
- *Wind direction gauge*
- *Air temperature gauge*
- *Air humidity gauge*
- *Barometer*
- *Datalogger powered by solar panel*

ROCKFALL OR TOPPLE LANDSLIDES



MPBX Multi Point Borehole eXtensometer

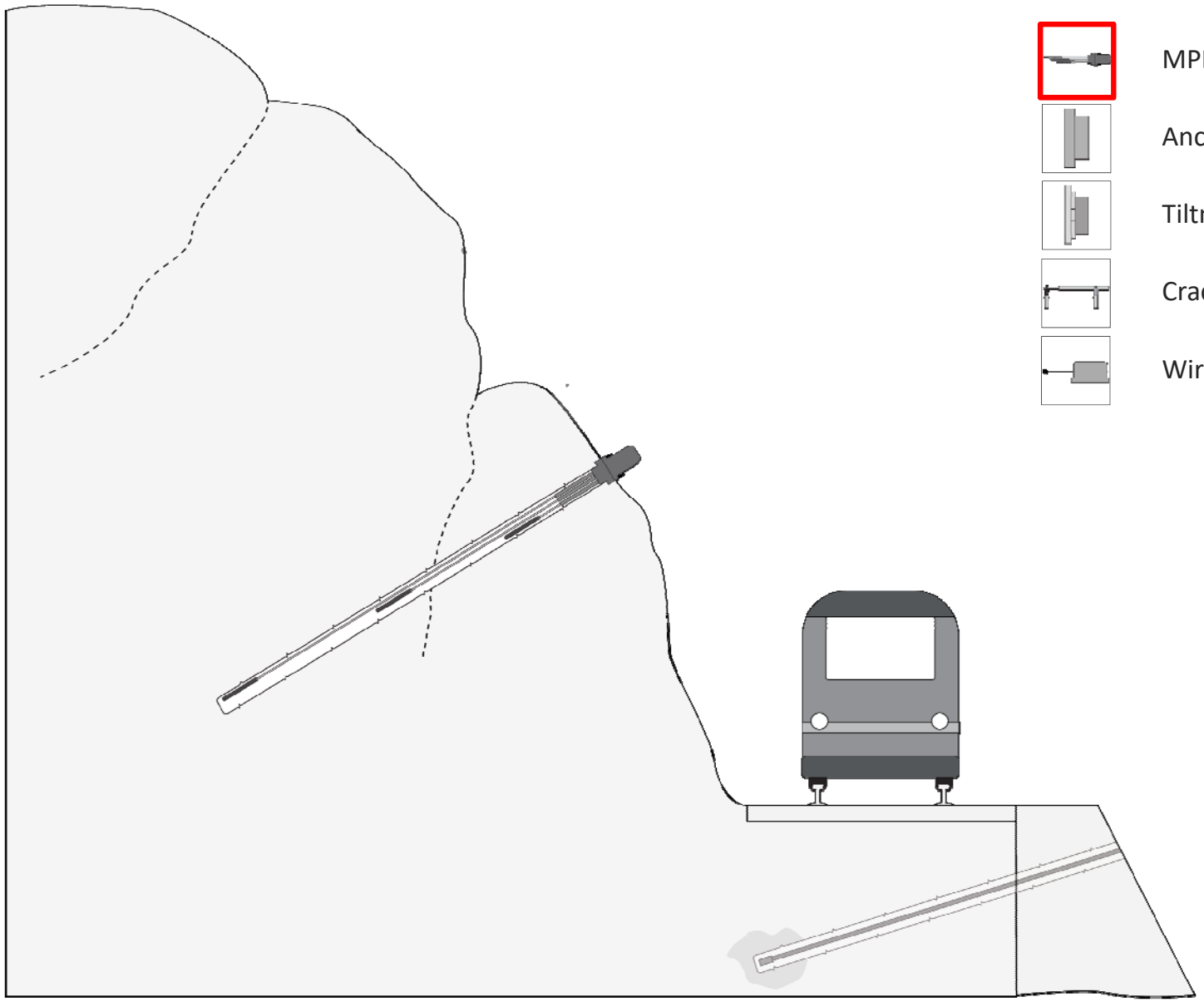
Anchor load cell

Tiltmeter

Crack meter

Wire extensometer

MPBX MULTIPOINT BOREHOLE EXTENSOMETER



MPBX Multi Point Borehole eXtensometer

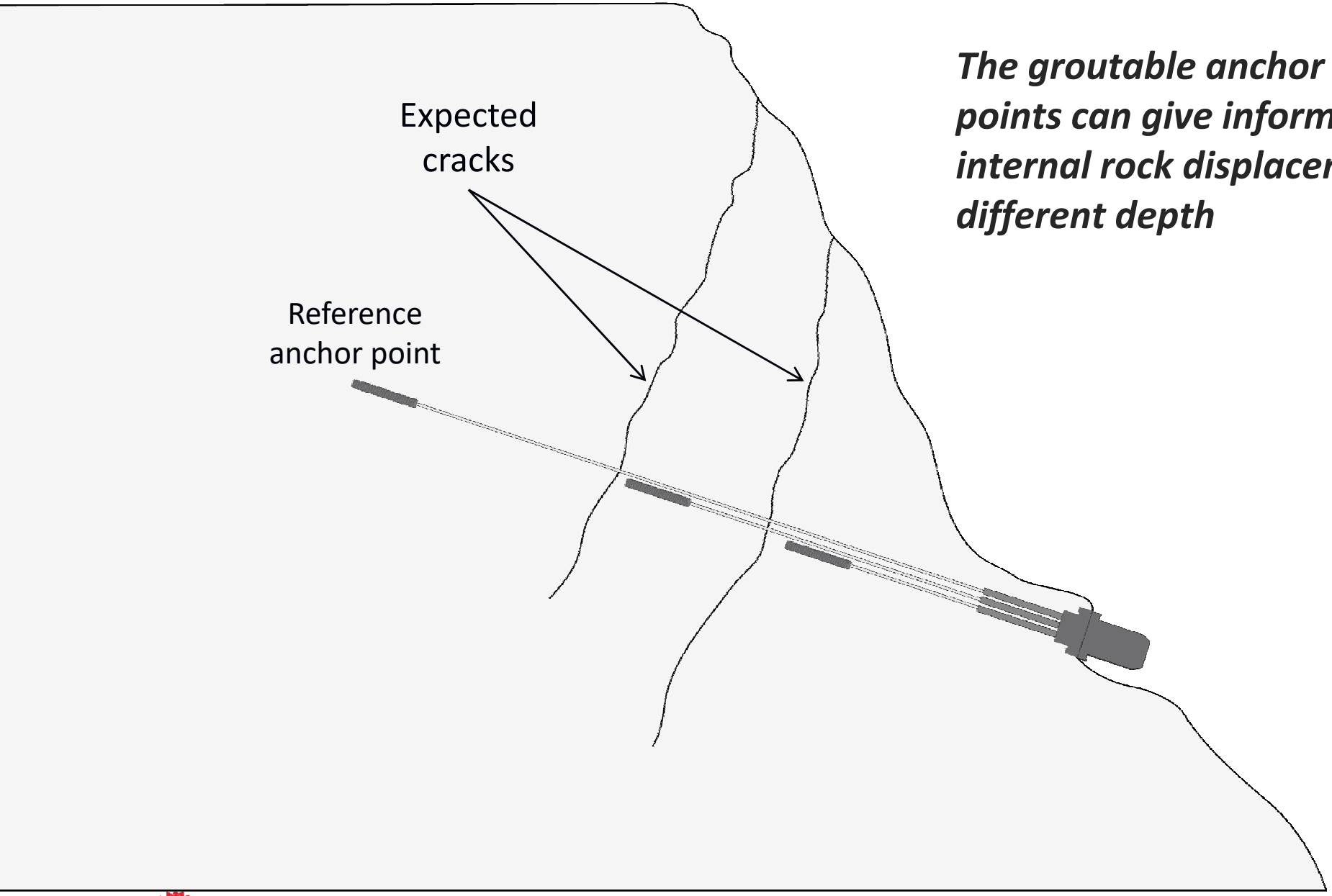
Anchor load cell

Tiltmeter

Crack meter

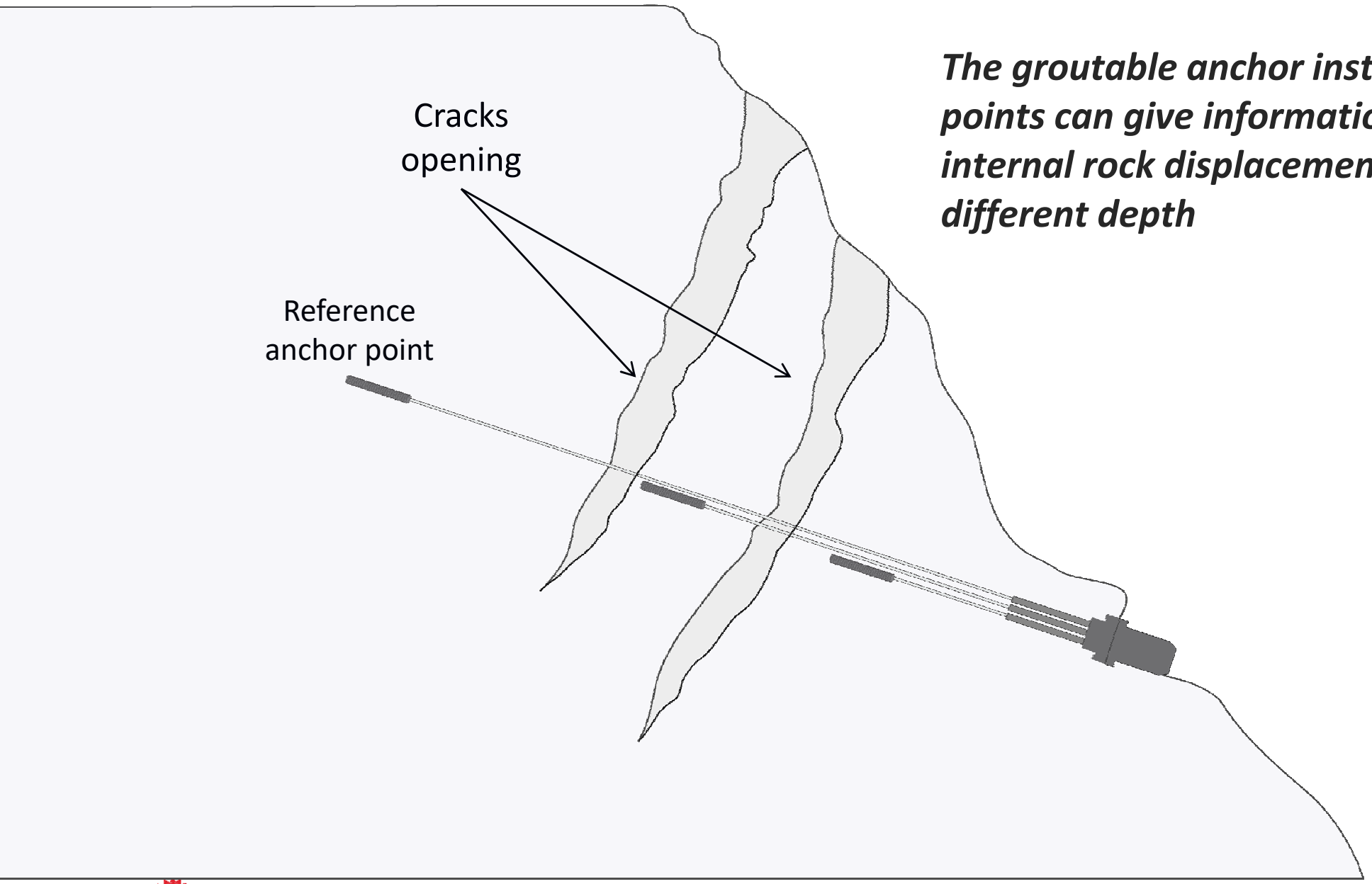
Wire extensometer

MPBX MULTIPOINT BOREHOLE EXTENSOMETER



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

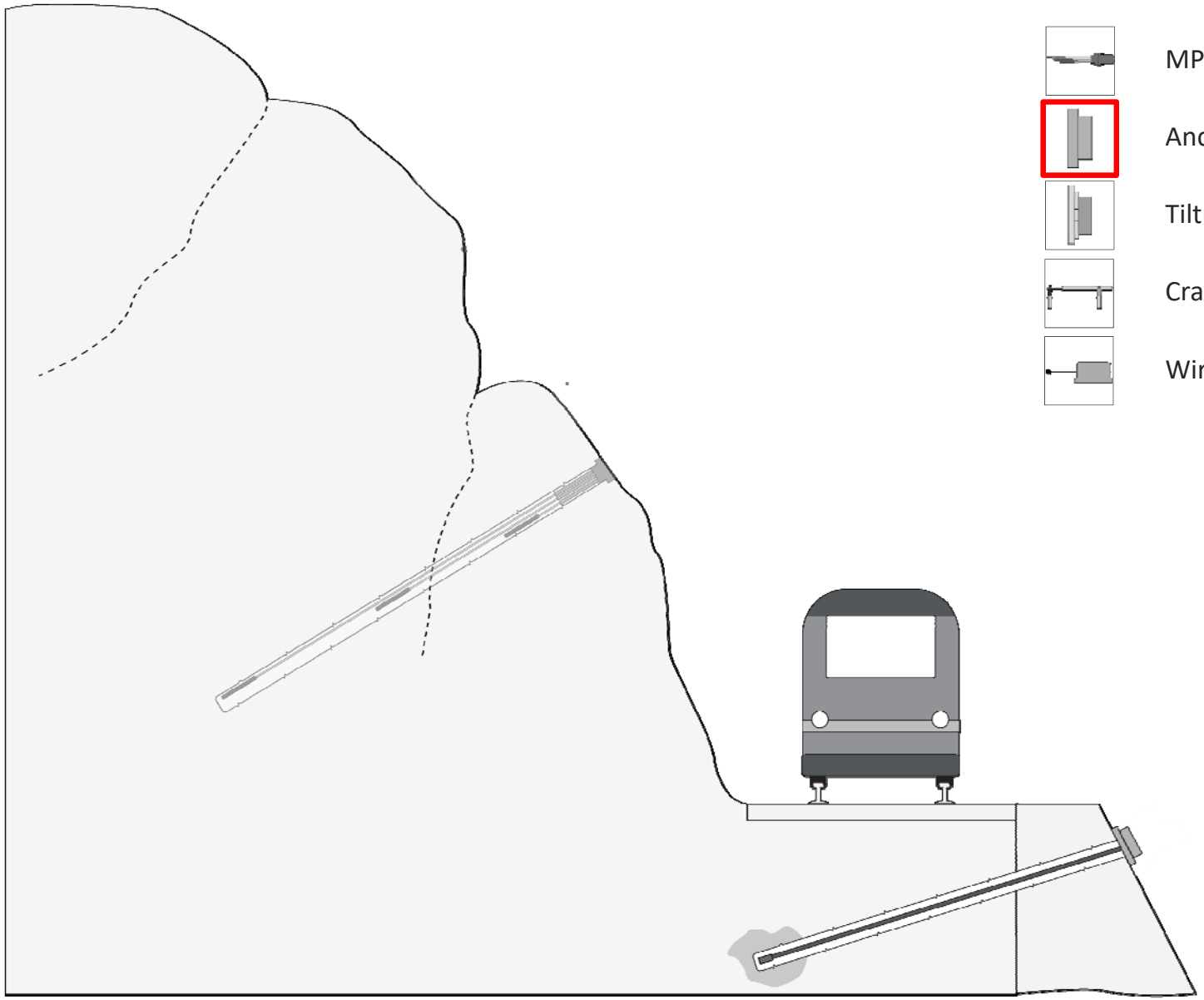
MPBX MULTIPOINT BOREHOLE EXTENSOMETER



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

MPBX MULTIPOINT BOREHOLE EXTENSOMETER

ANCHOR LOAD CELL



MPBX Multi Point Borehole eXtensometer

Anchor load cell

Tiltmeter

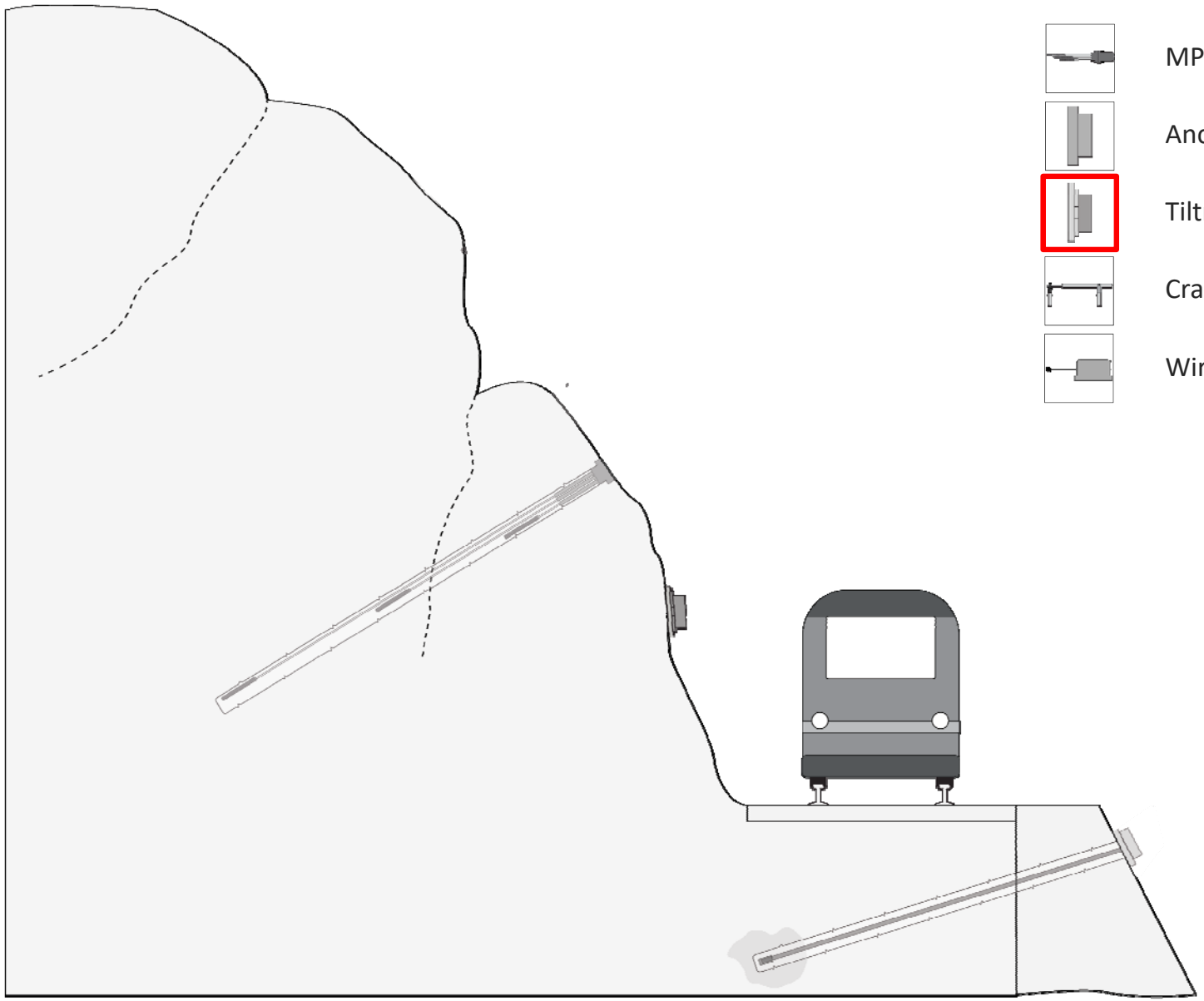
Crack meter

Wire extensometer

ANCHOR LOAD CELLS ON RETAINING WALL

ANCHOR LOAD CELLS ON RETAINING WALL

TILTMETER



MPBX Multi Point Borehole eXtensometer

Anchor load cell

Tiltmeter

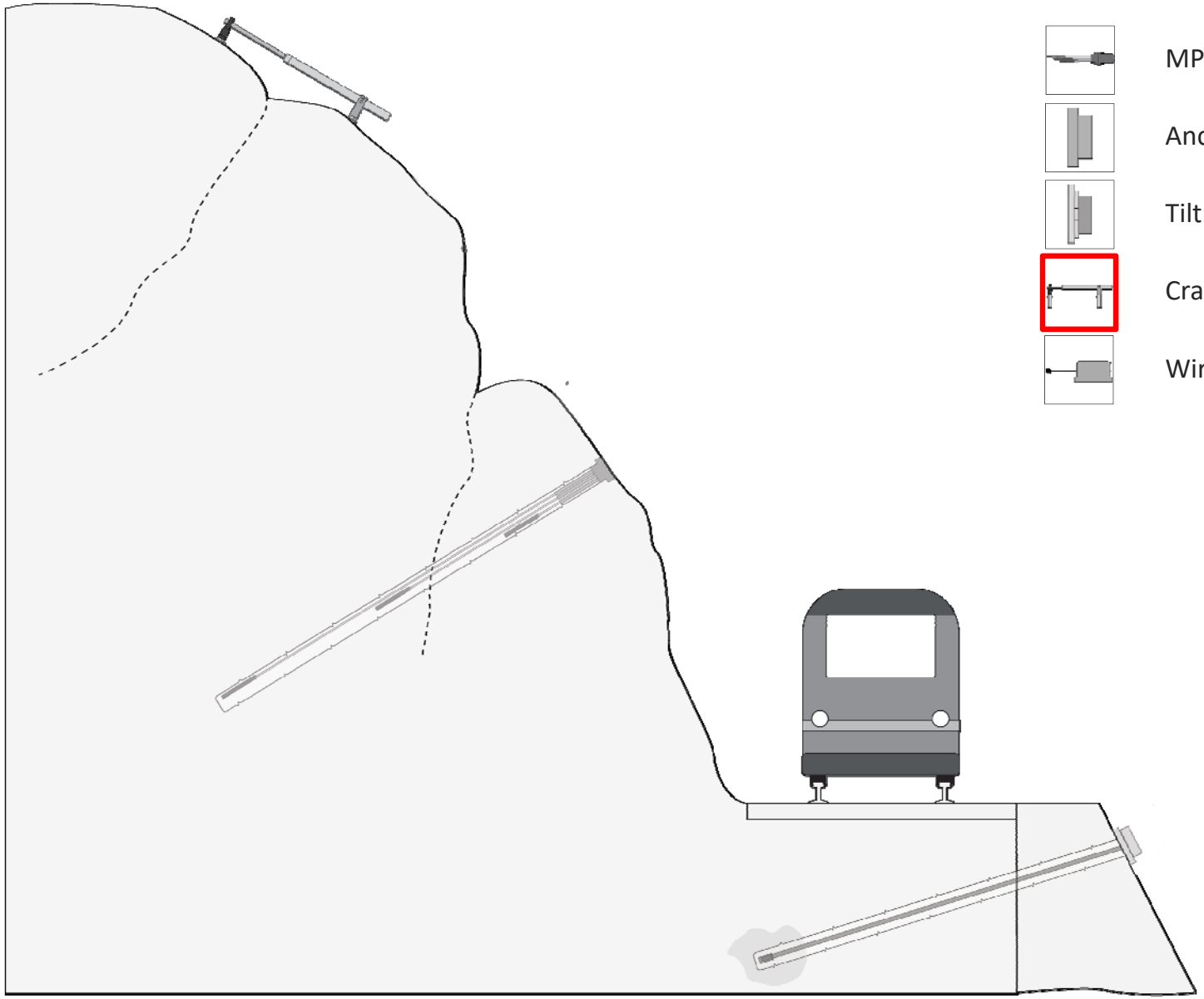
Crack meter

Wire extensometer

TILTMETER

IP68 waterproof tiltmeter installation on rockfall landslide

CRACKMETER



MPBX Multi Point Borehole eXtensometer

Anchor load cell

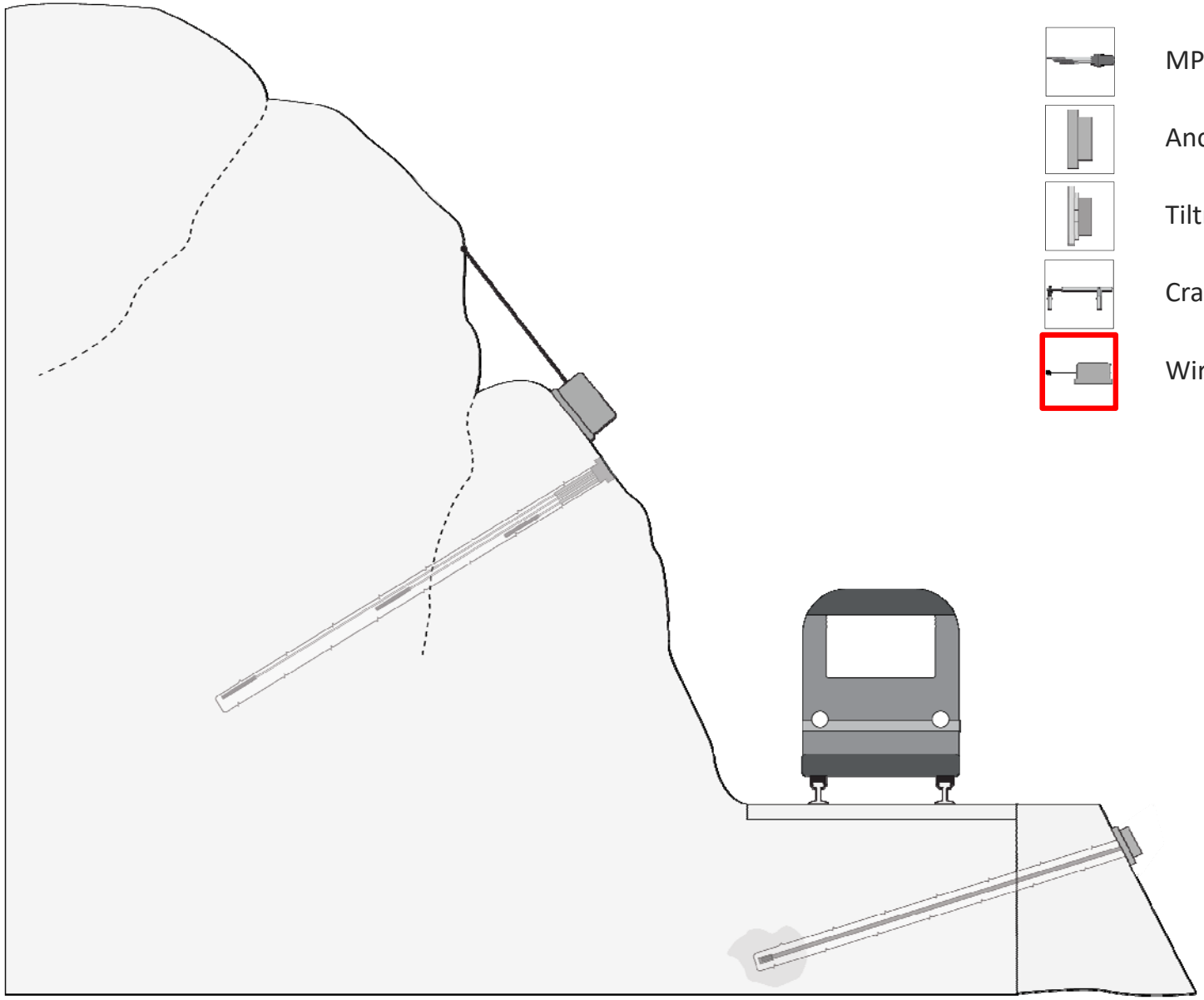
Tiltmeter

Crack meter

Wire extensometer

CRACKMETER INSTALLED ON ROCK WALL / MASS

WIRE CRACKMETER



MPBX Multi Point Borehole eXtensometer

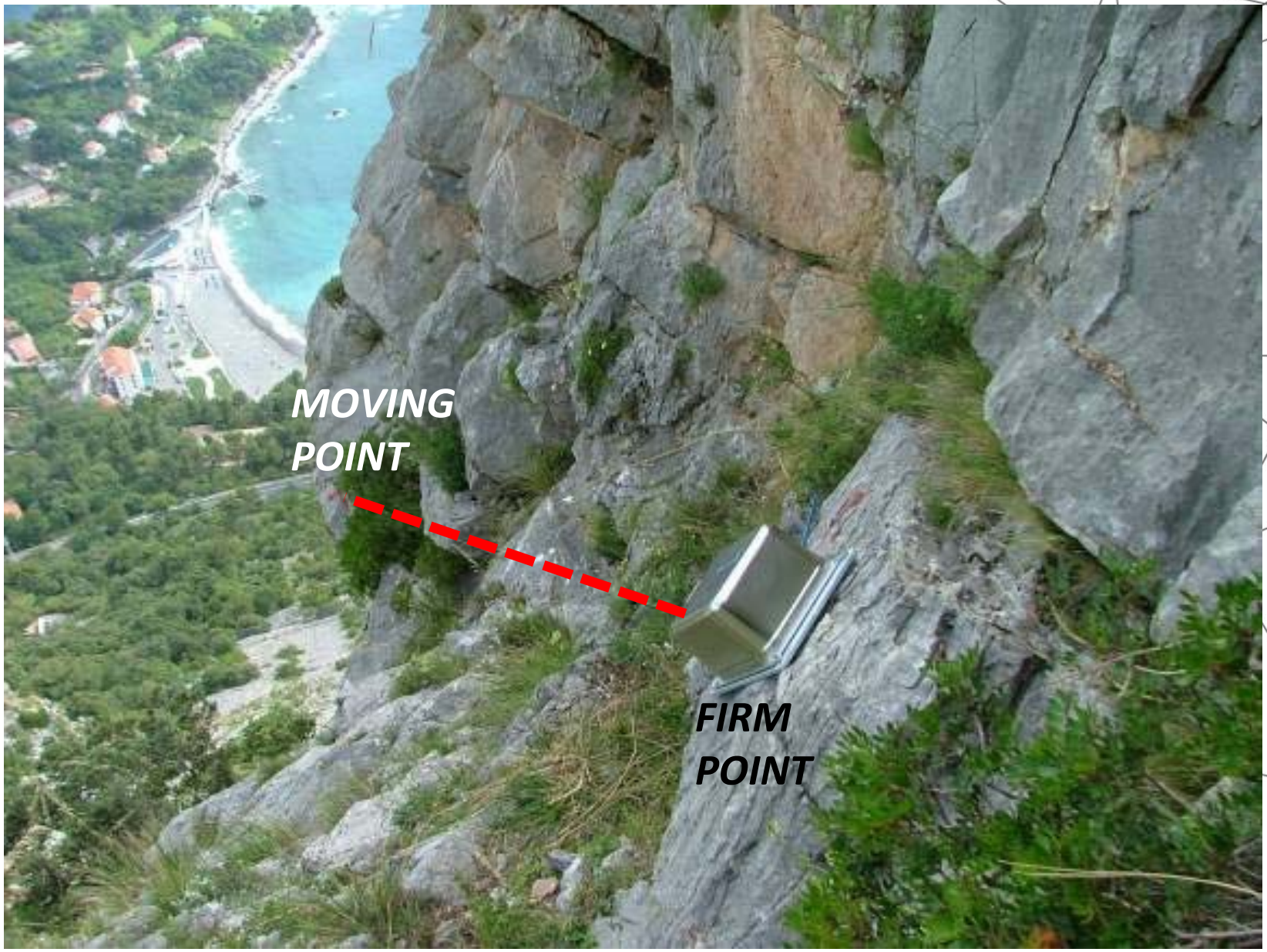
Anchor load cell

Tiltmeter

Crack meter

Wire extensometer

WIRE CRACKMETER ON TOPPLE LANDSLIDE



LANDSLIDE MONITORING: DATA ACQUISITION SYSTEM

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

Usually in landslide DAS are powered by solar panel package.

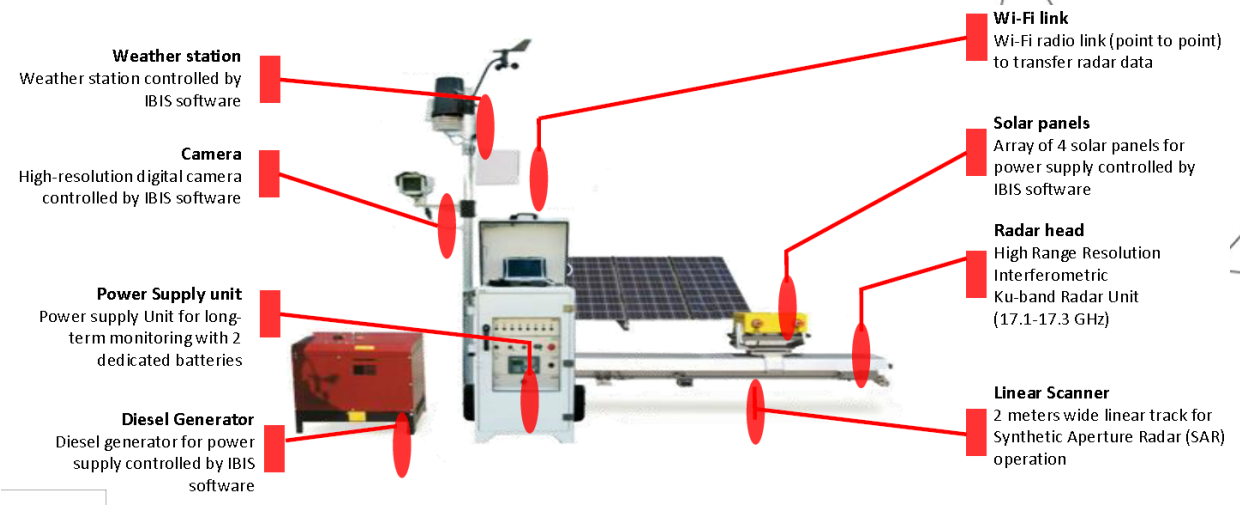
With an internet 3G router, OMNIAlog can provide remote system management, data pushing on a server and alarms.

SAR INTERFEROMETRICO

Control remoto estático y dinámico para deslizamientos con Radar Interferométrico (SAR)

SISGEO LA suministra sistemas y realiza las siguientes actividades con Radar Interferométrico (SAR) para:

- Pruebas de carga de estructuras en puentes, edificios, monumentos históricos y torres
- Desplazamiento de la estructura y riesgos de colapso.
- Preservation del patrimonio cultural.
- Medición de frecuencia de resonancia en estructuras.
- Análisis estructural modal de la forma.
- Análisis de estabilidad 24/7 en tiempo real y sistema de alarma en taludes.
- Desplazamiento simultáneo de miles de puntos en grandes áreas.
- Identificación de áreas de riesgo para la prevención de deslizamientos y proyectos de mitigación de deslizamientos
- Riesgos en Estabilidad y Sistema de alarma para Taludes en Minas a Cielo Abierto

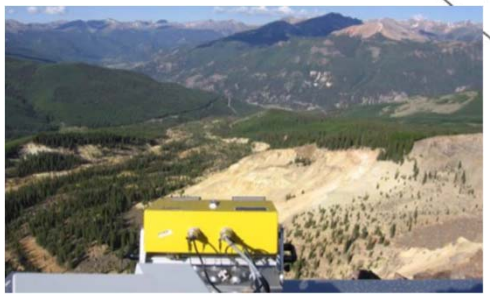


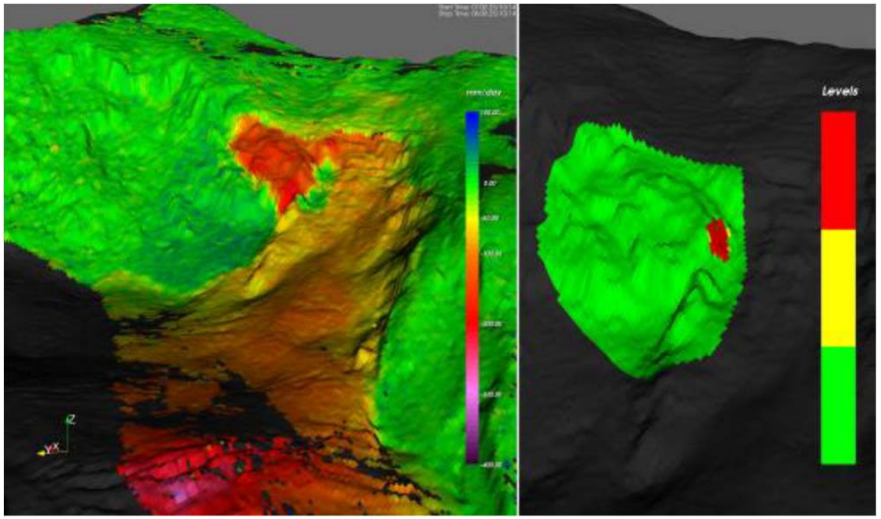
SAR INTERFEROMETRICO

Control remoto estático y dinámico para deslizamientos con Radar Interferométrico (SAR)

BENEFICIOS:

- No access requested to the structure
- Easy and rapid installation of the measurement set (~20 min)
- No interference with the structure before, during and after the measurement
- Simultaneous multi-point measurement with only one instrument
- Increased safety for the technicians
- Automatic Early Warning
- Operative day & night, also with fog and rain
- Measure the cumulative displacement over a long period
- Compare displacement in different time
- Automatic system: 24H operative





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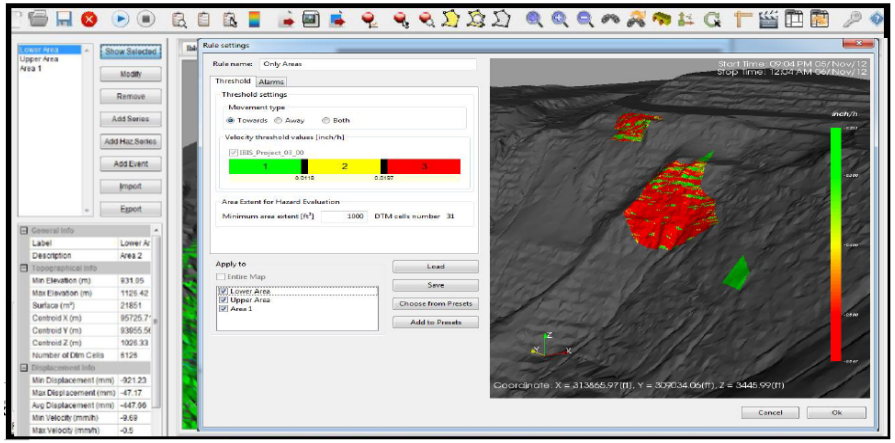

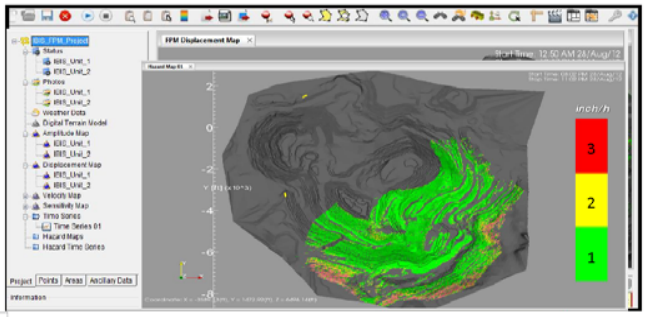

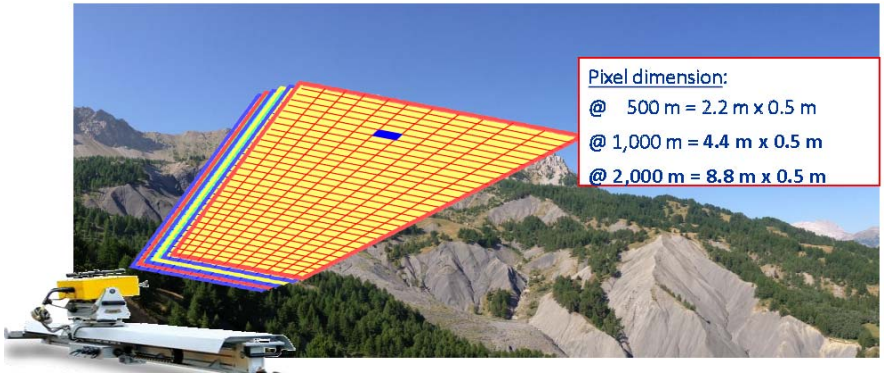

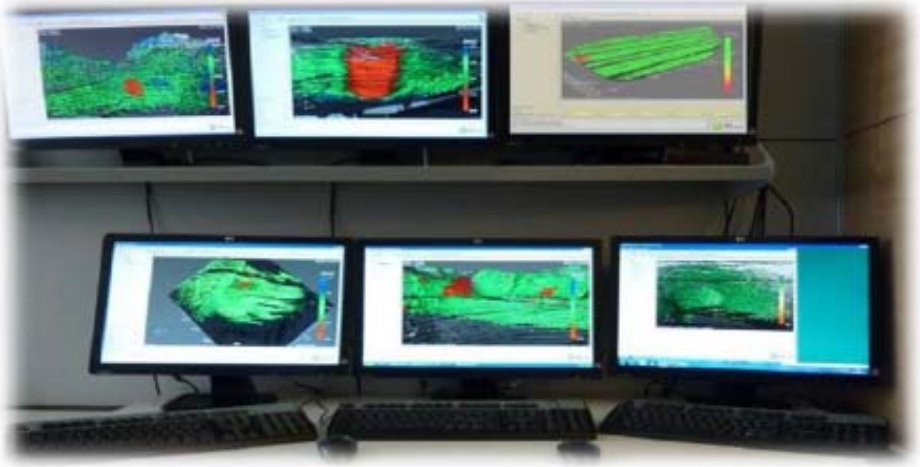

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