NATO/CCMS PILOT STUDY

Prevention and Remediation In Selected Industrial Sectors: Rehabilitation of Old Landfills

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UMS
Underground Monitoring System

ESPOSITOGROUP

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UMS

A Tool for Dry Directional Monitoring System

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WHAT IS UMS

UMS IS A NEW MACHINE FOR SITE CHARACTERISATION IN HOSTILE ENVIRONMENTS.

UMS REPRESENTS AN EXTENSION OF INTRUSIVE TECHNOLOGIES FOR SITE CHARACTERISATION.

IS BASED ON HORIZONTAL DRY DIRECTIONAL DRILLING TECHNOLOGIES

WHAT IS UMS

SURGERY METAPHORE

In medical practice *a Biopsy needle* is used for tissues characterisation

UMS uses a new tool called *geopsy needle* since it achieves site diagnosis by aspiration through a needle as in tissue biopsy.

WHAT IS UMS

UMS IS A NEW TOOL FOR BOREHOLE DRILLING INTRUSIVE INVESTIGATION

WHAT IS UMS

UMS IS BASED ON ESPOSITOGROUP PROPRIETARY TECHNOLOGY FOR HORIZONTAL DIRECTIONAL DRILLING

HORIZONTAL DIRECTIONAL DRILLING

HORIZONTAL DIRECTIONAL DRILLING MACHINE

Horizontal Directional Drilling is a trenchless construction technique, using guided drilling for creating an arc profile.

This technique is used for long-distance drilling such as in lagoons, under rivers, or highly-urbanized areas.

HORIZONTAL DIRECTIONAL DRILLING

The process involves three main stages:

1. **drilling a pilot hole**
2. **enlargement of the pilot hole**
3. **pullback installation of the carrier pipe**

Horizontal Directional Drilling is becoming a preferred practice for installing pipelines, cables, water and sewer lines, horizontal wells for contaminated site remediation and for drinking water supply, and other infrastructural elements.

HORIZONTAL DIRECTIONAL DRILLING

Main advantage is the combination of speed and reliability with minimal environmental impact in installation.

HORIZONTAL DRY DIRECTIONAL DRILLING (HDDD™)

HDDD™ IS A TRADE MARK OF SE INDUSTRIES AN ESPOSITOGROUP ENTERPRISE

HORIZONTAL DRY DIRECTIONAL DRILLING

The operation of the SE Technology boring system is based on a directional boring head with a percussion system.

The unit operates by using compressed air to drive both thrust and pullback actions as well as rotation and percussion at the drill head.

Spoil is removed by the compressed air flow through the bore hole.

HORIZONTAL DRY DIRECTIONAL DRILLING

Tracking is achieved by similar techniques to systems using liquid drilling fluids, but the electronic sonde in the head has to be fitted with a shock absorber to dampen the effects of the percussion system.

The system can be used to drill all soil types. Further advantages include no requirement for a mud mixing plant, no bentonite requirement and therefore no fluid losses to the ground.

HORIZONTAL DRY DIRECTIONAL DRILLING

HOW DOES IT WORK

BASED ON HORIZONAL DRY DIRECTIONAL DRILLING TECHNOLOGY

A NEW TOOL

UNDERGROUND MONITORING SYSTEM

UNDERGROUND MONITORING SYSTEM

UMS is a technology derived from the *CADRIANN research project.*

CADRIANN is a research project funded by the Italian Ministry for Higher Education, Training and Research (Anagrafe nazionale della Ricerca 51018XTU).

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UNDERGROUND MONITORING SYSTEM

This project has improved HDDD™ technology with:

- **a *learning system* called *Ground Recognition System* capable to recognize underground properties while drilling, storing and enhancing its experience with time.**

- ***an on-line path correction based on a dynamic programming method*.**

- **a proprietary *Wireline Inertial Measurement Unit (WIMU)* by which the driller can track the orientation and position of the bore hole assembly, in real-time**

UNDERGROUND MONITORING SYSTEM

These tools are used for developing a new machine specifically applied to monitoring underground pollution.

These results extend the no dig technology to a new class of machine called

No Dig Underground Monitoring System (UMS).

UNDERGROUND MONITORING SYSTEM

HOW DOES IT WORK

UNDERGROUND MONITORING SYSTEM

This system works according to two phases:

- **First phase: UMS recognizes underground properties and then localizes the candidate area in order to define the site characterisation plan.**

- **Second phase: the system localizes the selected area more precisely and accomplishes a directional core boring.**

UNDERGROUND MONITORING SYSTEM

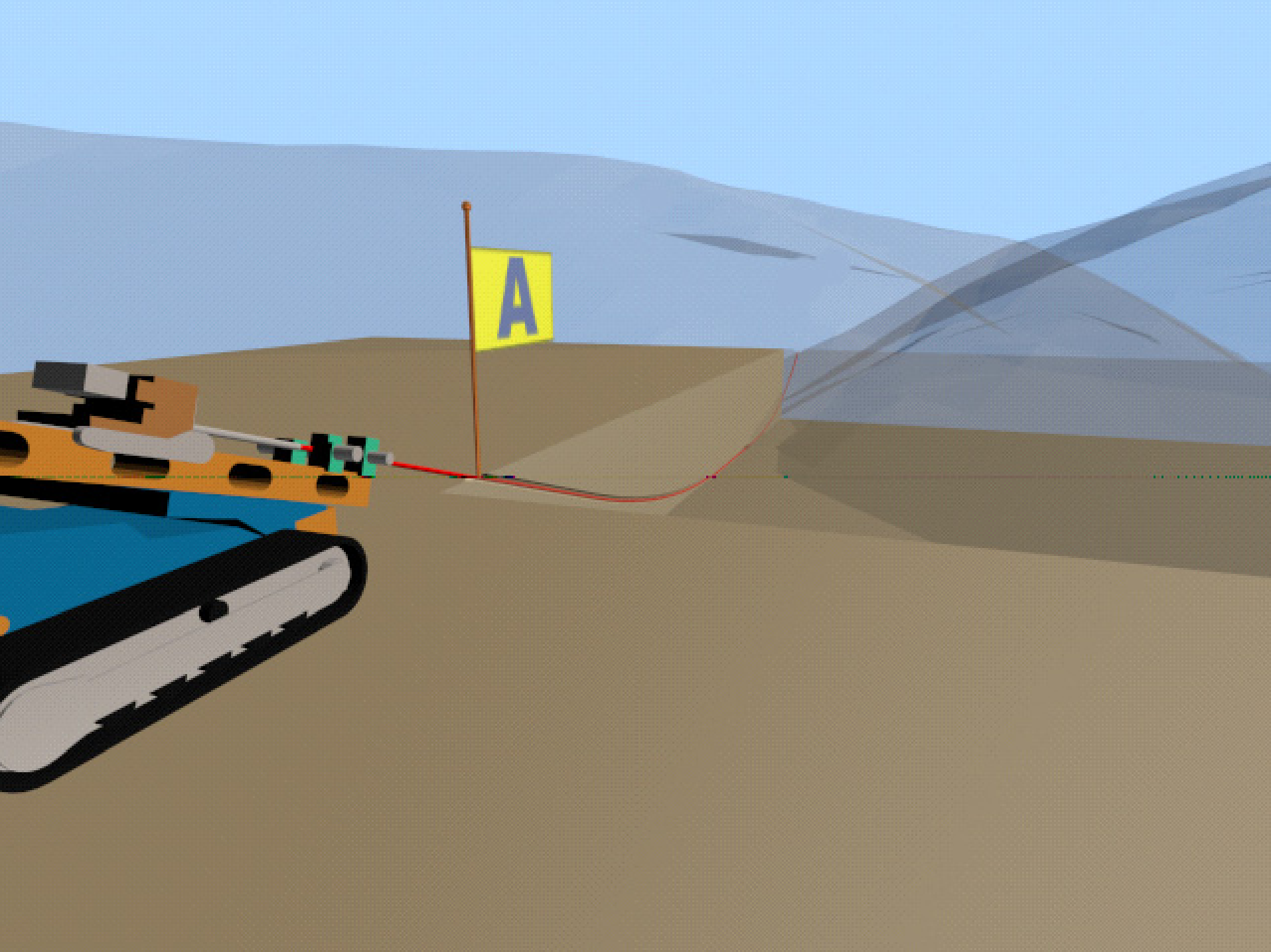
PHASE I

DIAGRAPHY AND SETTING RODS FOR DIRECTIONAL CORE BORING

THE RIG IS EQUIPPED WITH *GROUND RECOGNITION SYSTEM* (GRS).

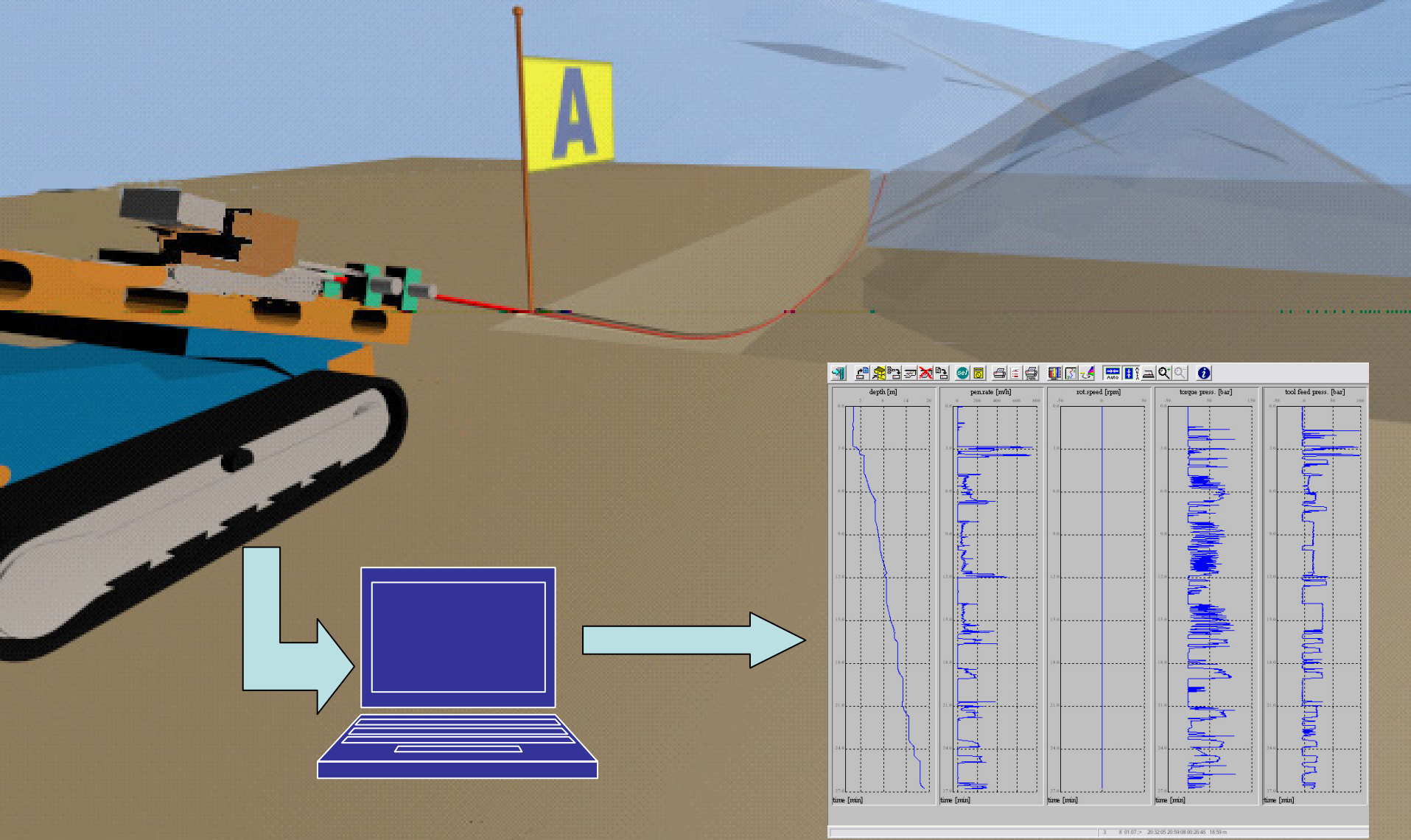
THE RIG EQUIPPED WITH *GROUND RECOGNITION SYSTEM* DRILLES A PILOT BORE AND AT THE SAME TIME IT RECOGNIZES CANDIDATE AREA TO DEFINE A PLANNING FOR SITE CHARACTERISATION

GRS IS A *LEARNING SYSTEM* THAT UTILIZES THE RIG AS SENSOR IN ORDER TO RECOGNIZE THE GROUND LITHOLOGY. GRS GAINS KNOWLEDGE BY EXPERIENCE AND STORES IT IN A KNOWLEDGE BASE.


A

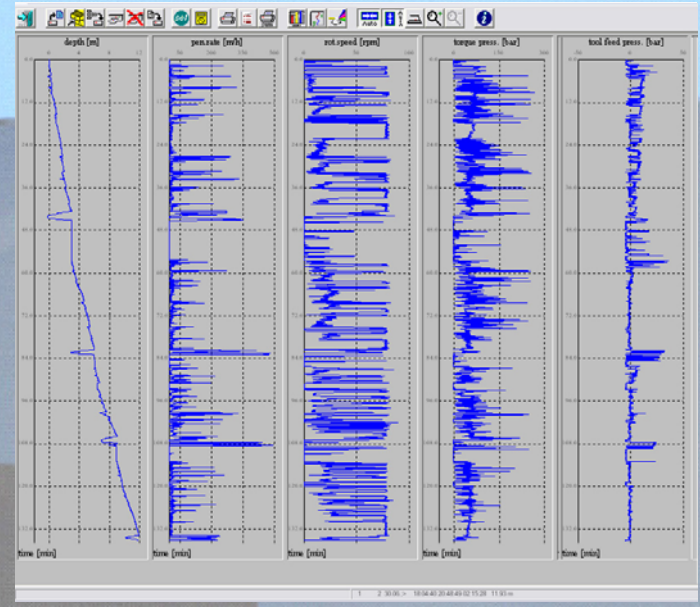
WHILE DRILLING SOME MECHANICAL PARAMETERS ARE ACQUIRED FROM A NETWORK SENSOR INSTALLED ON THE DRILL.

THESE DATA AND THE KNOWLEDGE BASE ARE USED FROM AN ON-LINE ALGORITHM IN ORDER TO RECOGNIZE UNDERGROUND FEATURES.



WHILE DRILLING THE ROCK IS CHARACTERIZED BY A SERIES OF PARAMETERS

THESE DATA ARE RECORDED FOR ANALISYS



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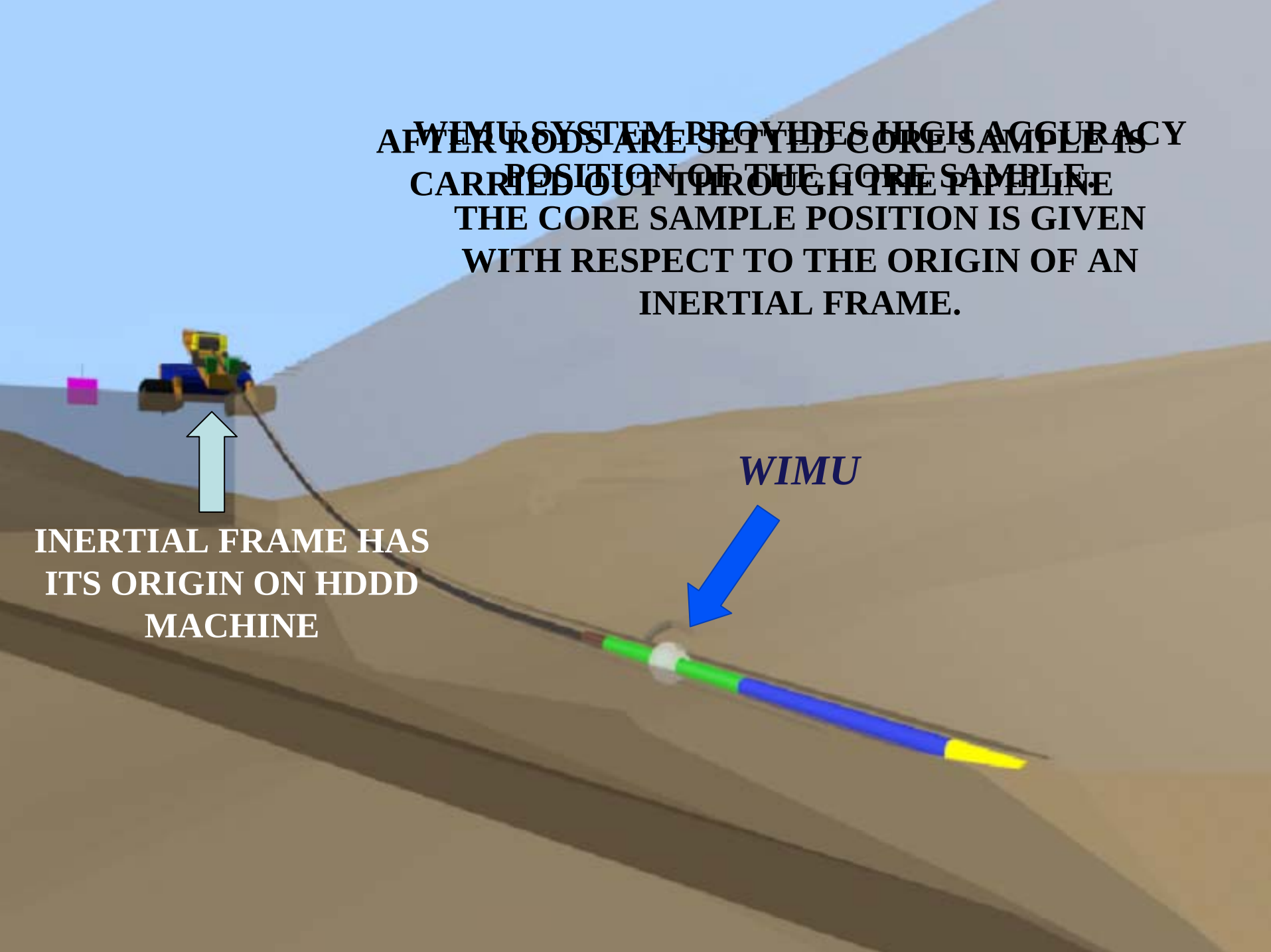
DURING THIS PHASE, USING A RADIO SONDE, THE POSITION OF THE INVESTIGATED AREA IS DETERMINED.

Investigated Area

UNDERGROUND MONITORING SYSTEM

PHASE II

ACCURATE LOCALIZATION OF CHARACTERISATION AREA AND DIRECTIONAL CORE BORING

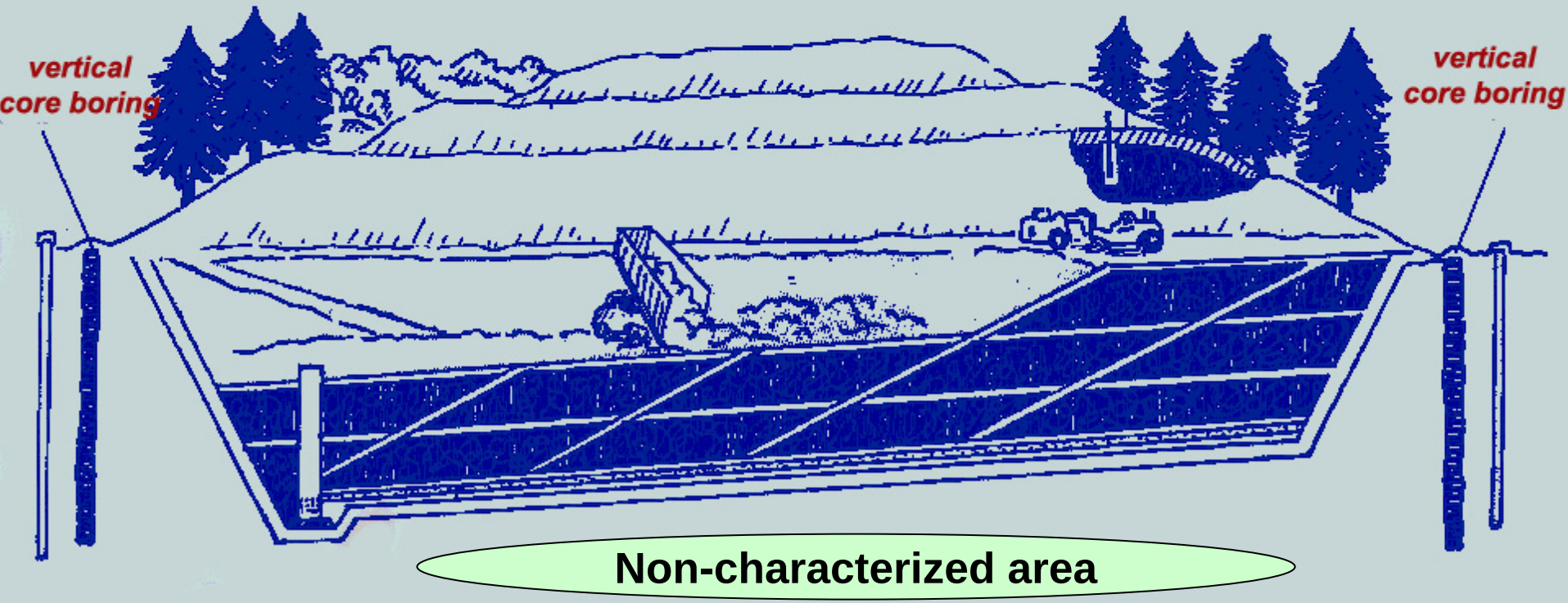

WIMU SYSTEM PROVIDES HIGH ACCURACY POSITION OF THE CORE SAMPLE.
AFTER RODS ARE SETTED CORE SAMPLE IS CARRIED OUT THROUGH THE PIPELINE.
THE CORE SAMPLE POSITION IS GIVEN WITH RESPECT TO THE ORIGIN OF AN INERTIAL FRAME.
WIMU
INERTIAL FRAME HAS ITS ORIGIN ON HDDD MACHINE

THE PROTOTYPE

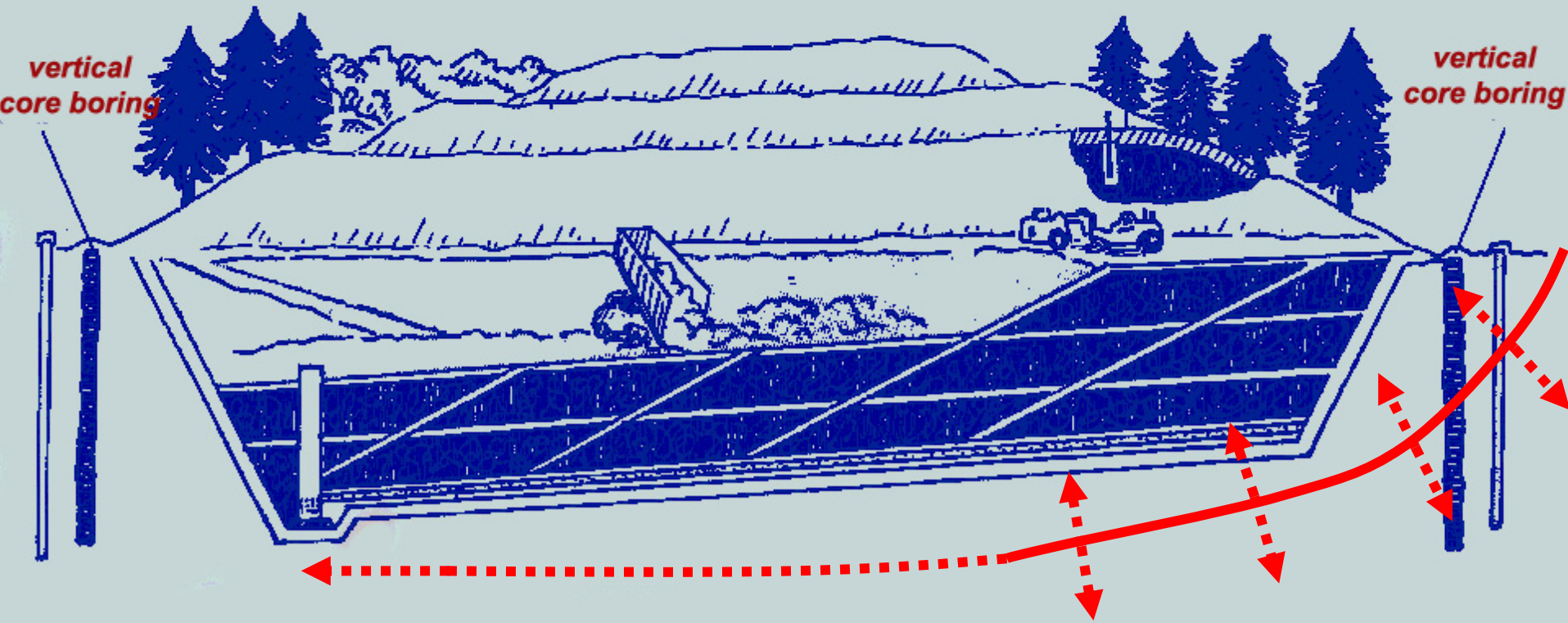
EXAMPLE

LANDFILL MONITORING

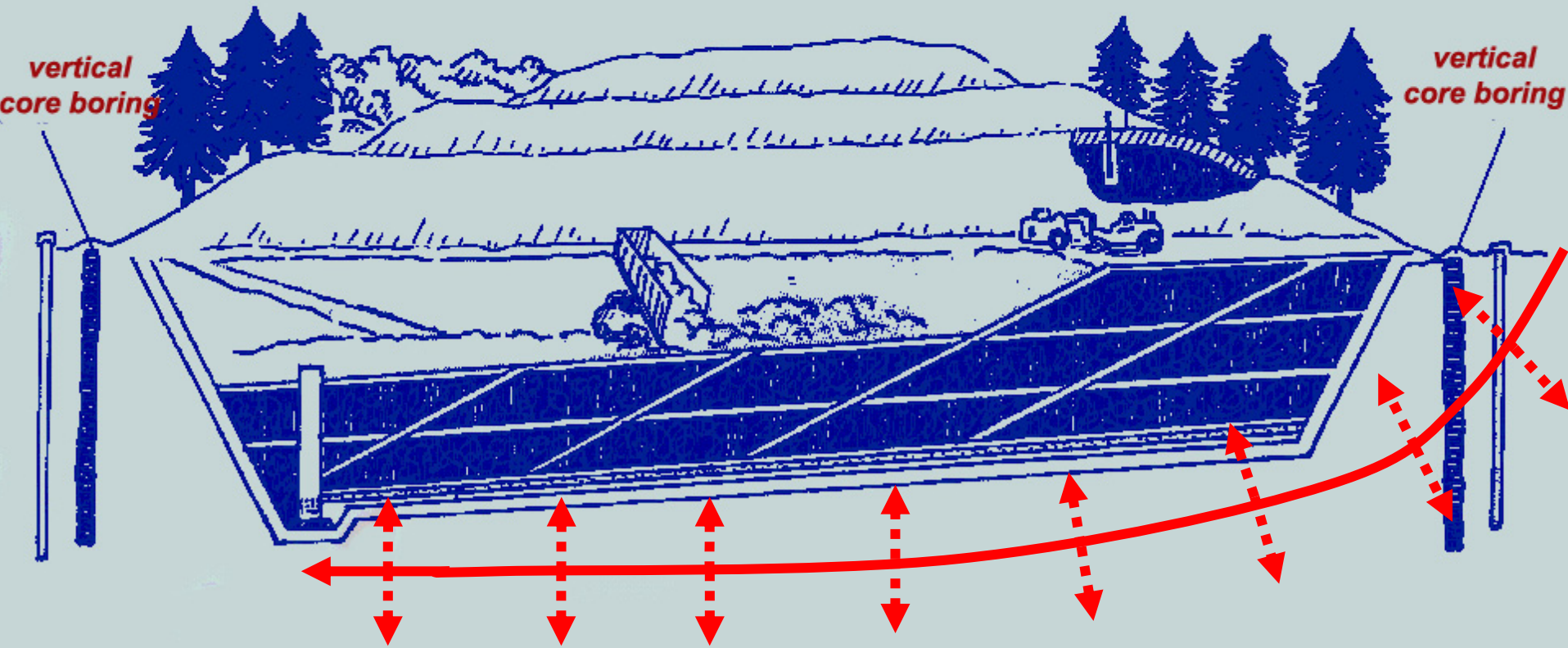
Generally landfill characterisation relies on vertical core borings at the landfill border, without monitoring the underneath zone. This is not sufficient for a correct analysis.



UMS can also recognize the underneath zone of the landfill achieving a more complete localization of the pollution leakage.



Core bored area with UMS



APPLICATIONS WITH UMS

landfill pollution
industrial pollution
sewer leakage
oil leakage
toxic substances disposal
nuclear contaminated land
other applications

PLANNED WORKS

AT PRESENT ESPOSITOGROUP IS INVOLVED IN TWO SITE CHARACTERISATION PROJECT WITH UMS IN POLLUTED AREAS:

- **AN INDUSTRIAL POLLUTED AREA IN NORTH-EAST ITALY**

- **A LANDFILL SITE IN SOUTHERN ITALY**

FUTURE WORKS

Generally a full site characterization requires both intrusive and non-intrusive methods.

FUTURE WORKS

AT STATE OF ART NON-INTRUSIVE METHODS PROVIDE CHARACTERISATION OF THE NEAR SURFACE ENVIROMENT NO MORE THAN FEW METERS FROM GROUND SURFACE

FUTURE WORKS

Generally non-intrusive investigations fail at few meters depth because there is a lack of definition of complex media physics.

A complex media is a media with *continually varying material properties.*

Subsoil is a COMPLEX MEDIA

FUTURE WORKS

COMPLEX MEDIA PHYSICS

The complex media physics is the study of the behavior of electrical, acoustic, electromagnetic fields in a complex media.

FUTURE WORKS

The underground is a complex *geotonic* (i.e. with spatially-dependent properties) media.

The problem is:

learning in real-time the behaviour of physical fields in geotonics complex media by inverse methods in a minimum range of 0-100 meters below surface.

Presently this is the open problem for the Espositogroup research center

The End

Thank You for your attention