

## **RACOS<sup>®</sup>:**

specialized core analyses to quantify in 3D:

- **In situ stresses and pore pressure effectiveness**
- **Loading-dependent complete and elastic deformations**
- **Rock strength<sup>1</sup>**

and to describe spatial aspects of:

- **Rock mass structure**
- **Fracturing (micro and macro)**
- **Fluid flow (permeability) development**

## ***Current applications:***

Determination of in situ and material parameters to characterize rock mass conditions and as input to analytical and numerical calculations for:

- Evaluation of the stability of boreholes, caverns, tunnels and mine openings
- Optimization of the configuration of wellbores for production or injection of fluids
- Planning perforations and hydraulic fracturing
- Assessment of sand inflow during extraction of oil, gas and water
- Evaluation of geological barriers for underground storage, waste deposits, repositories etc.
- Assessment of possible pore pressure induced changes in reservoir parameters and of vertical compaction (subsidence)
- Evaluation of induced seismic events

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<sup>1</sup> These measurements are made on plugs selected on the basis of the RACOS<sup>®</sup> data.



## ***Advantages of RACOS<sup>®</sup>:***

- No work is needed at the drill site.
- All the 3D stress and deformation parameters are determined on the basis of the same set of measurements.
- Measurements and analyses can be made at any time after coring.
- A relatively small amount of core is required (< 1.7 dm<sup>3</sup>).

## ***RACOS<sup>®</sup> principle:***

- Analyses are based on the propagation characteristics of shear and compression waves and on rock deformation as measured on core samples in prescribed directions und under a range of loadings.

## ***Measurement procedures:***

- Rectangular prismatic samples with the optimal distribution of the orientations of the end-faces are prepared from a piece of core. Geographical reorientation of the core can be made independently or as part of the RACOS<sup>®</sup> analyses.
- Under a range of loading conditions shear and compression waves are transmitted between the opposing end-faces of each sample.
- To calibrate the deformation parameters the sample porosity and rock density under unloaded conditions are used together with measured the axial deformation behaviour of a plug (taken in a defined direction) under isotropic loading.
- To determine the 3D values of rock strength and permeability plugs are taken in the principle directions determined in RACOS<sup>®</sup> and tested in compression/extension tests.

## ***Data evaluation:***

- All the test results are collated to derive the magnitudes and directions of the 3 principal components (major, intermediate and minor) of the parameters and also their values in any selected directions.



- A statistical process is used to eliminate parameter deviations resulting from any locally anomalous parts of the core.

## ***Products 1 - rock and rock mass properties:***

- Information on rock and rock mass anisotropy
- 3D loading-dependent complete and elastic deformations
- Vertical deformations corresponding to changes of the effective in situ stresses
- 3D permeability and porosity for selected pore pressure conditions
- Principal flow directions
- 3D strength and fracture (micro and macro) data

## ***Products 2 - in situ stresses:***

- Magnitudes and orientations of the 3D effective and total in situ stresses and the 3D pore pressure effectivenesses at the time of coring and under paleo conditions
- Changes in the effective and total in situ stresses and the pore pressure effectiveness resulting from altered pore pressure conditions or from fracturing
- Deformation and tectonic contributions to the in situ stresses

## ***Previous RACOS<sup>®</sup> analyses:***

- Cores tested to date using RACOS<sup>®</sup> came from a wide range of lithologies (claystone, sandstone, limestone, anhydrite, clay shale, marble, dolomite, conglomerate, gneiss, amphibolite, granite, basalt and rock salt) from depths between 150 and 7000 m.
- Analyses were made for oil and gas concerns and energy companies working onshore and offshore in Europe, Asia and North Africa, for coal-mines in Germany, for tunnel construction in the Austrian Alps and for a geothermal project in Switzerland.

