RACOS®
3D in situ stress analysis

Method - brief description

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RACOS® (Rock Anisotropy Characterization On Samples) is a set of procedures for determining 3D in situ stresses using cores[1]. This information is essential for evaluating the stability of openings (boreholes, tunnels etc.), for planning hydraulic fracs and for determining directly pore-pressure related reservoir deformations. It is also provide crucial input parameters for a variety of other rock mechanics analyses.

RACOS® - analyses are based on linked special laboratory measurements and evaluations. The first step consists in measuring the propagation velocity of elastic waves (compressional and shear waves) in diverse directions under hydrostatic stresses.
In a second step the data are combined in symmetrical 2nd order tensors to define the 3D magnitudes and orientations of principal parameters. These data already enable some conclusions to be drawn about in situ structures, rock fabric and main flow directions. In a third step special RACOS® procedures are used to determine directly the 3D anisotropic in situ stresses from the results of the tests.

For the in situ stress analysis the influences of the measured compressional and shear wave velocities are considered. One of these is the lithology (seismic anisotropy of the rock fabric). The measured seismic data are also influenced by load-dependent changes of the wave velocity resulting from deformations and displacements during rock mass formation and by the effects of closure/opening of natural and technically induced pores/fractures. For the effective stress analysis in RACOS® only these latter two effects are of interest. Therefore the wave velocity influences of the rock fabric are removed from the measured data. For this purpose special procedures are used to select a calibration load which defines the transition between the rock fabric and the other two types of influence.

In RACOS® the effective in situ stress analysis is based initially on isotropic reloading of the core samples to compensate for the hydrostatic unloading during core recovery[2]. The sum of these data and the remaining triaxial load differences (to reproduce the calibrated wave velocity anisotropies) corresponds to the effective in situ stress state at the time of coring. In this way in RACOS® a reconstruction of the anisotropic 3D rock stress conditions is based only on isotropic laboratory loadings.

The total stress tensor results from the direct determined effective stress, the in situ pore pressure and the pore pressure effectiveness (Biot coefficient in 3D calculated using the elastic rock data determined in RACOS®). On the basis of these test data and the analyses some conclusions can also be drawn about recent tectonic loading, the stress changes caused by pore pressure modification (*future conditions*) and about palaeo effective stresses (*past conditions*).

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[1] *The RACOS® analyses can be carried out at any time after coring and do not require any on-site measurements or any assumptions and/or additional investigations concerning the rock properties.*

[2] *This is generally referred to the velocity for a known loading component (usually the overburden load) and/or to an observed sudden change in the propagation characteristics of the elastic waves.*