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Residual stress/strain in rocks determined by Neutrons diffusion

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A residual stress is a tension/compression which exists in the bulk of a material without application of an external load (applied force, thermal gradient. . .). Residual stress is produced by heterogeneous plastic deformations, thermal contractions and phase transformations induced by any “natural” and/or artificial processing.

Depending on the scale at which the matter is analysed, three kinds of residual stresses are therefore classically defined: the macro stresses (or stresses of first kind) over a few grains, the stresses of second kind over one particular grain or phase and the stresses of third kind across sub-microscopic areas (several atomic distances within a grain).

The effects of residual stresses on the different properties of a material (fracture, corrosion, friction, aging) are important in metals and geomaterials as well.

The neutron and X-ray (Synchrotron) stress evaluation methods are based on the use of the lattice spacing as a strain gauge. Meanwhile, the neutron diffraction is suitable for coarse grain material (rocks) and 3D analyses (full strain tensor). Indeed both residual elastic and plastic strains can be determined but, for the latter, the synchrotron diffraction has a far better resolution.

The neutrons diffraction method has been used (LLB, CEA-CNRS, Saclay, France) in the case of well studied Quartz rich rocks (quartzite and sandstone). Various aspects will be considered: the homogeneity/order of the residual stresses; the effect of textures components; the form and

magnitude of the calculated full strain tensor; comparisons between plastically deformed rocks at medium/high temperature and rocks only just compacted and cemented. Furthermore the residual elastic strain tensor obtained have been used for some numerical simulations of deformation textures already published.