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Rock-fluid interaction in the preparatory stage of earthquakes.

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Effects of faulting on fluids permeating the crust have been documented in several cases. The reverse effect of pressurized fluids in triggering seismicity was also observed in connection with fluid re-injection experiments in deep wells. Since fluids (e.g. H_20, CO_2 and Sulfur anhydrites) are continuously released by ascending magma, we expect that they may influence significantly the seismic activity in volcanic and geothermal regions. A model is devised for the upward migration of these fluids from below the brittle-ductile transition within brittle crustal layers, subject to high deviatoric stress imposed by tectonic motions. Fluids are thought to open their way through small hydraulic fractures, within a medium endowed with low intrinsic permeability: the appearance of fractures has no practical effect on fluid flow if the intrinsic permeability K_0 is relatively high ($K_0 > 10^{16}\,\mathrm{m}^2$), but it alters the effective permeability considerably if the intrinsic permeability is low ($K_0 < 10^{-17}\,\mathrm{m}^2$). The effective permeability K_{eff} is found to be strongly pressure-dependent according to a non-linear relationship: K_{eff} may be order of magnitude higher than K_0. As a result, near lithostatic pore pressures are found to propagate from the brittle-ductile transition through most of a low permeability layer, decreasing considerably the threshold for failure, according to the modified Coulomb criterion. When the distribution of hydrofractures crosses a discontinuity of elastic parameters, large stress changes are induced along the stronger side of the discontinuity; these induced stresses enhance fluid migration. Moreover, following the appearance of hydraulic fractures, the effective elastic parameters of the rock change; this change might be observed from seismic tomography studies (which are sensitive to the undrained elastic parameters) but should be particularly important in long-term deformation processes (which are sensitive to the drained elastic parameters). Several evidences are discussed which

support the indications of the model.