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Permanent pressure monitoring of a karstic system from a deep borehole

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The 1000-meter deep AIG10 borehole intersects the Aigio fault, on the southern shore of the Gulf of Corinth, in western Greece. Since September 2003, a permanent set of pressure gauges is monitoring pressure data at a frequency of 1/8Hz. This borehole is part of the Corinth Rift Laboratory (CRL) project, aiming at characterizing the fault hydraulic behavior. However, correct interpretation of the data requires the prior assessment of the surrounding aquifer characteristics.

Below its upper 700m deep cased section, the well is left open and intersects two artesian aquifers. The upper aquifer is fully hydraulically decoupled from surface aquifers by clay layers thicker than 100m and is developed in tectonized platy limestone, with a 0.5 MPa original pressure. Below the fault, the limestone is heavily karstified and the artesian overpressure reaches about 0.85MPa. Hence the fault supports a 0.35 MPa differential pressure through the 5m thick radiolarite clay layer that has been smeared along the 150 m fault offset.

In September 2003, the borehole was let produce water and then was plugged with a packer set at the top of the casing resulting in a direct connection between both aquifers. The pressure is monitored by sensors set just below the packer and mainly corresponds to the karstic pressure.

Tidal variations are recorded, with a resolution better than 1/100. We interpret them using both theoretical tides and records from marine tidal gauge. Using also atmospheric pressure data, we derive some poroelastic coefficients : the sensitivity of the karst to deformation $BK_u = 17 \pm 1\,\mathrm{GPa}$ and a barometric efficiency $\gamma = 0.2 \pm 1$. These values are confirmed by the study of the response of the aquifer to other external solicitations, such as shorter-period seiches and seismic records. Moreover, these coefficients enable to compute a specific storativity of $S_s = 8.7\,10^{-7}\,\mathrm{s}^{-1}$. Combined

with the previously estimated hydraulic conductivity $k = (1.5 \pm 0.5)\,10^{-5}$m/s, the hydraulic diffusivity is thus $D \sim 20\,\mathrm{m}^2/\mathrm{s}$, only 10 times higher than the typical range obtained for classical aquifers.

The whole interpretation was done under the assumption of linear homogeneous isotropic porosity. However, it produced coherent results on a karstic system, a highly heterogeneous media. This success might be due to (1) The scale length of the excitations compared to the caves dimensions (2) The fact that this deep aquifer is exempt from the desaturation processes which impedes hydrological study on karstic systems.