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Vertical ground deformation monitored during a large-scale pumping test in a crystalline aquifer: comparison of several geodetic measurements.

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In this study, we used several geodetic methods to monitor and quantify the vertical deformation induced by the variations of the pumping rate of the crystalline aquifer of Ploemeur (French Brittany). During this two-weeks hydrologic experiment, all the water pumping was stopped for 39 hours. It lead to a variation of the piezometric level of about 10 meters, the major part of this variation occurring in the first 2 hours. The study was conducted simultaneously with the measurement of the absolute and relative gravity which, related with the variations of piezometric levels, can give an evaluation of the porosity of the upper unconfined part of the aquifer.

For the monitoring of the deformation, we compared the results obtained by a mea-

surement network of 2 long-based tiltmeters, 2 Blum tiltmeters, 7 GPS receivers (5 bi-frequency and 2 monofrequency) and the differential levelling of a zone of about 1 km^2. These three different measurements of the hydrological deformation during this experiment are in good agreement : they all show an amplitude of the vertical deformation of about 0.8-1 cm, with a region of maximum convex deformation located around the three pumping wells where the piezometric level most increases. The accuracy of the results are greatly dependant of the method : the tiltmeter method show clearly its ability to detect rapid variations of the elastic deformation induced by the water level variations. The levelling gives a complementary information on the spatial distribution of the deformation, confirmed by the local GPS measurements.

The measurements of the vertical deformation have been firstly used to evaluate the free air gravity needed for the absolute gravity data corrections. In complement, these results were compared to previous continuous GPS measurements of the vertical deformation of the aquifer due to the annual recharge. During this 8 months survey, for a smaller water level variations of 6 m, the continuous GPS measurement shows a vertical deformation of 2 cm. Thus the response of the aquifer to water level variations depends on the amplitude but also on the time constant of the water level variations implying a non-elastic deformation.