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GPS monitoring of the vertical deformation of a confined granitic aquifer (Ploemeur, French Brittany)

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We are interested in the detection, measurement and interpretation of vertical ground movements associated with the charge and the discharge of a fractured aquifer located in French Brittany. Indeed, the variations of the water table level - due to natural seasonal effects and to human exploitation - can produced volume variations of the aquifer and consequently movement of ground surface if the aquifer is confined. The Ploemeur aquifer is used for water supply, with a very large pumping rate (3000 m3/d) compared to the usual pumping rates obtained in crystalline rocks. Two semi-permanent GPS receivers with differential configuration have been used to measure the hydrological subsidence. The differential GPS experiment consists of a receiver located directly on the pumping station which record the ground deformation and a second receiver acting as the reference, located on the steady-state granitic bedrock. The two GPS receivers are separated by 4.6 kilometres. The continuous time series of the horizontal and vertical deformation are obtained by the day average of positions acquired each minute. This setup allows a precision of 5 mm. A preliminary study conducted during height months in 2003 displays a N-S component of the deformation of the order of 8 mm, an E-W component of the order of 4 mm and a vertical component of the order of 25 mm. This 25 mm ground subsidence from March to August is linearly correlated to the piezometric level, with a 6 m decrease of the water level during this period principally induced by seasonal variation. This correlation allows us to derive a good estimation of the storage coefficient of the aquifer. We also present a new data set representing 15 months of continuous GPS measurements in 2004-2005. These data confirms the first results and allows to precise the influence of the pumping of the aquifer on the vertical deformation. This study shows that this kind of GPS survey allows a time continuous monitoring of the deformation of a confined aquifer and can be used to estimate some hydrological properties of the aquifer.