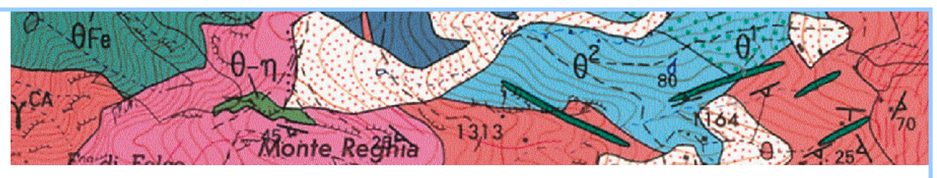

Vertical evolution of hydrodynamic parameters in weathered and fractured south Indian crystalline-rock aquifers

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Introduction & objectives

Crystalline rock aquifers represent a large area of India. Resources in such aquifers is known to be limited but for almost 1/3 of India it remains the only perenial water source. With increasing water exploitation, water level decreased drastically in some areas implying modification of the cropping patterns. Effects of decreasing water levels are large and include decrease of borehole yield, aquifer compartmentalization, change in water quality. All increase farmers vulnerability. However in the area no detailed quantification of the vertical evolution of aquifer hydrodynamic properties with depth has been conducted. In this project we perform such quantification to increase our understanding and predictive capacities.

Site characteristics

> Investigations were carried out on the Experimental Hydrogeological Park (EHP) of Choutuppal setup by BRGM. This experimental site, site of the H+ observatory is located within the archean granite typical of south India. Weathering profile follows the typical profile with top to bottom the saprolite, the fractured zone and a fresh granite.

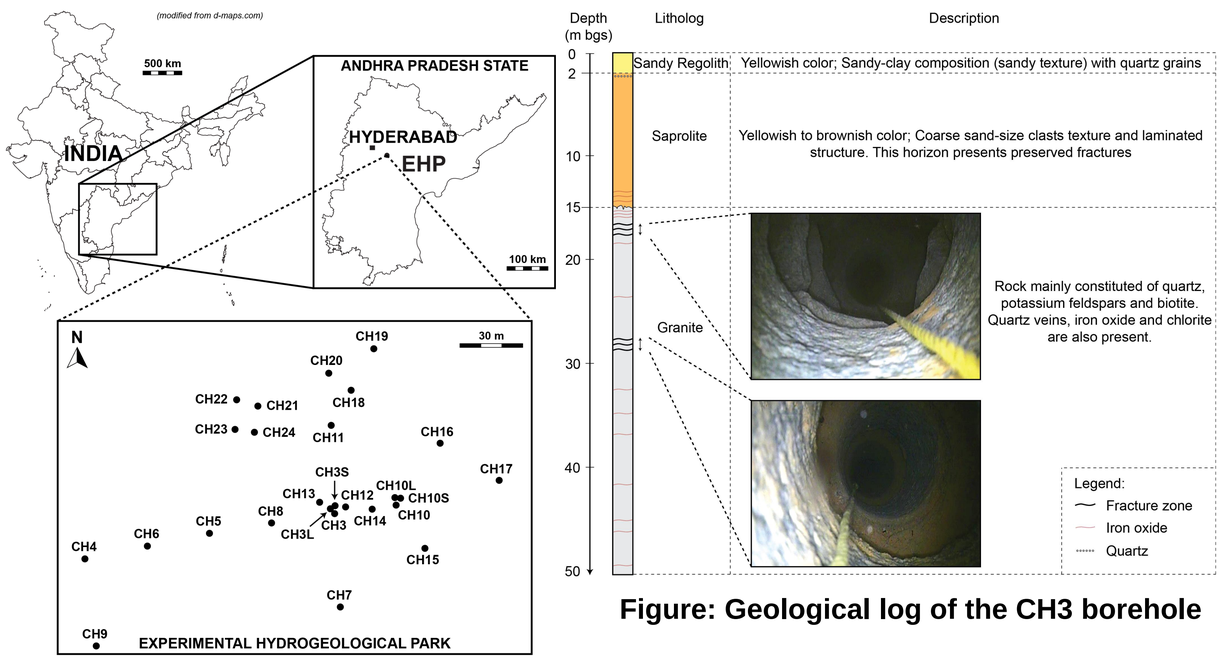

Figure: Geological log of the CH3 borehole

Figure: Localisation of the EHP

Unsaturated zone characterisation

> With the increase of ground water exploitation and the decrease of water levels the role of the unsaturated saprolite becomes more and more important. However only few studies provide information on the hydrodynamic characteristics of the saprolite. Investigation through falling-head permeameter method interpreted with Reynolds 2011 solution allow such determination.

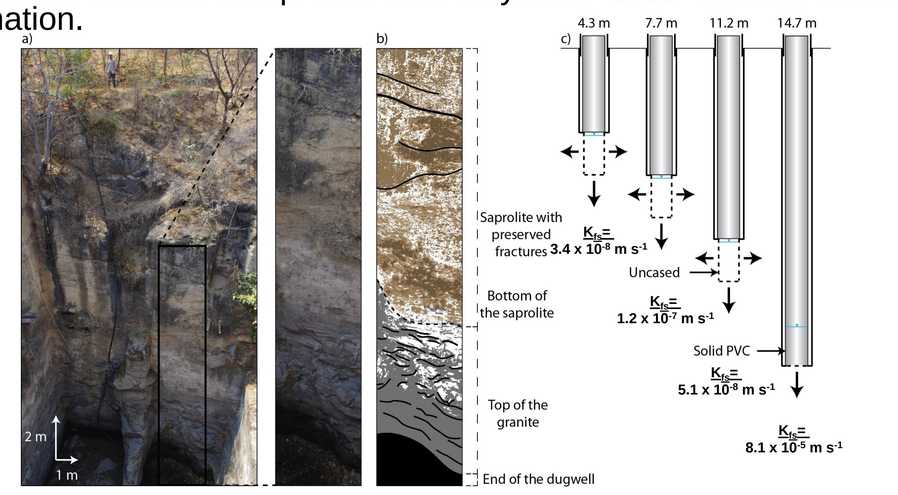

Figure: a) Picture of a dugwell, b) interpretation of the weathering profile and c) experimental protocol for falling-head borehole permeameters in saprolite

Saturated zone connectivity

> In such fractured media, altrough a general decrease of the hydraulic conductivity with depth is known, only very limited information is available on the vertical connectivity of the dominant horizontal fracture network. This connectivity has been investigated through packer tests.

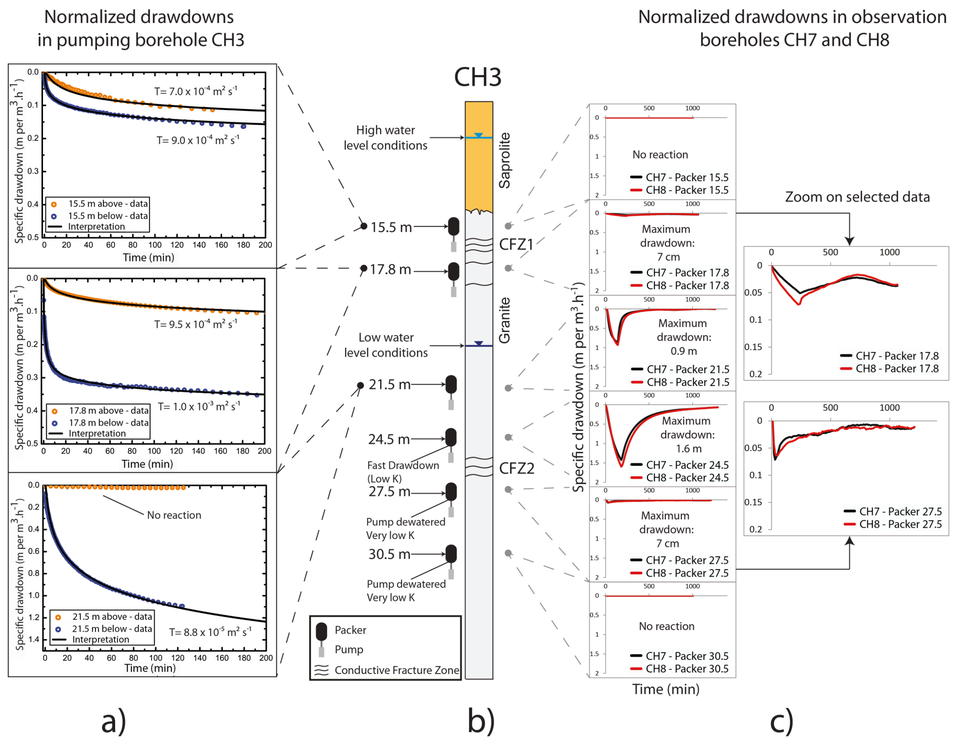

Figure: a) normalized drawdown in pumping borehole CH3, b) log of CH3 borehole, c) normalized drawdown in observation borehole during packer tests

Water level evolution as indicator of fracture location

> Continuous monitoring of water level evolution in borehole CH3, highlights by the change of slope the localisation of the saprolite (1) and the major fractures. This simple monitoring provides relevant information for the first characterisation.

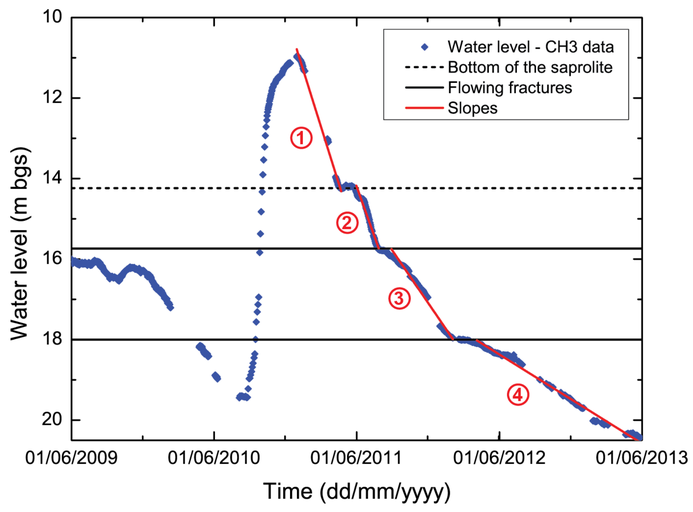

Figure: Water level evolution in borehole CH3. Change of slope are in accordance with the geological observations and fractures locations

Synthetic hydrodynamic profile

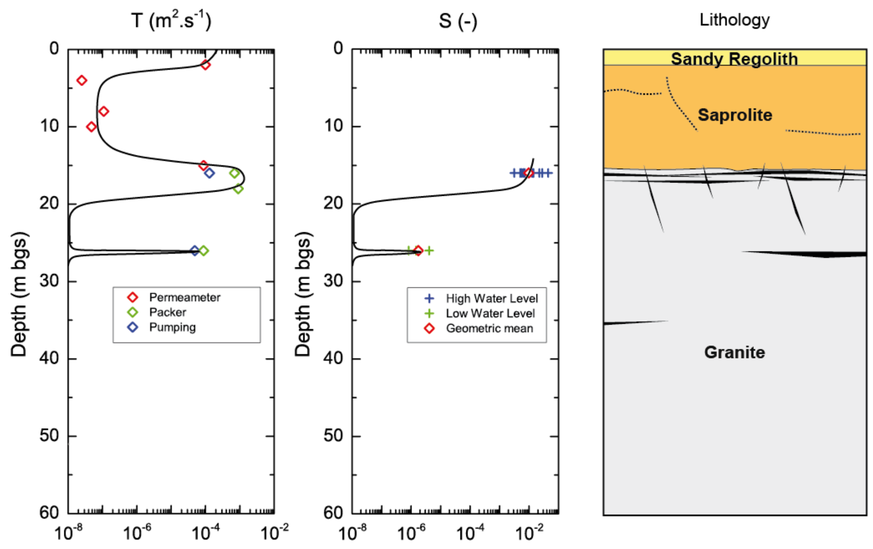

Figure: a) Normalized drawdown in pumping borehole CH3, b) log of CH3 borehole, c) normalized drawdown in observation boreholes during packer tests

Conclusions

> The Saprolite has good storage coefficient but low transmissivity, while the fractured zone has a higher transmissivity. The first meters of the fractured granite, just below the saprolite, appear to be the most productive zone despite limited vertical extension. Deeper, there are fewer horizontal fractures, with a significant transmissivity and low storage coefficient, which seem disconnected due to an low permeability matrix, but which may provide water. These deep fractures would be difficult to find through drilling, and attempts to do so would likely fail to yield much water. The discontinuous nature of permeability variations with depth is highlighted by this study. The upper part of the fractured zone appears to be of prime importance as it controls the aquifer behavior because of an enhanced horizontal productivity and because of its good connection across the watershed.

Reference: Boisson, A., Guihéneuf N., Perrin J., Bour O., Dewandel B., Dausse A., Viossanges, M, Ahmed, S., Maréchal JC. 2015 *Determining the vertical evolution of hydrodynamic parameters in weatheredand fractured south Indian crystalline Rock aquifers: Insights from a study on an instrumented site. Hydrogeology journal, 23:757-773 DOI 10,1007/s10040-014-1226-x*