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Hydrogeophysical characterization and data integration for the Sardon catchment hard rock aquifer (Spain)

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Unaltered hard rocks are hydrogeologically characterized by low primary porosity and permeability. Productive aquifers can however be supported by fractured and/or weathered hard rocks. In this type of composite aquifers, the upper weathered layers have typically a storage function while the underlying fissured layers have a transmissive function. Such aquifer sequence is usually highly heterogeneous because the weathered and fractured zones are controlled by various factors such as mineralogy and texture of lithologies, regional and local tectonics, paleoclimate and interaction between these factors.

In the proposed study we attempt to develop an efficient and accurate method to provide the hydrological characterization of a small hard rock (granite) aquifer within Sardon catchment (∼80km2), located in the Iberian Meseta (west of Salamanca, Spain). The proposed method is based on the integration of five techniques : i) field mapping; ii) remote sensing imagery analysis (RS); iii) geographical information system (GIS); iv) hydrogeophysics; v) numerical flow modeling. The geological mapping including characterization of fractures was processed in GIS through the combination of conventional field survey and analysis of aerial photographs and space borne imagery. The hydrogeophysics complemented the previous work by: i) sub-surface characterization of weathered layers using vertical electrical soundings (VES) at 61 locations, an electromagnetic (EM) transect perpendicular to the main valley (∼3 km length) and electrical resistivity tomography (ERT) at 13 locations; ii) ground penetrating radar (GPR) to derive the depth of the groundwater table to complement the information of the piezometric monitoring network (35 transects with a total length of ∼23 km) in order to provide additional constrain of the numerical flow model; iii) magnetic resonance sounding (MRS) to derive the depth-wise subsurface water content and aquifer transmissivity at 15 locations. The collected information was used to develop a 3-D hydrogeological conceptual model of the Sardon catchment and further to convert it into 3-D numerical flow model.

The combination of the several techniques allowed: i) to identify the hydrodynamics of the Sardon aquifer; ii) to confirm the presence of the main prospective zone in the center of the area where a regional shear zone drains the groundwater of the catchment; iii) to evidence through MRS a high-yield at the intersection of two major fault zones; iii) to provide the spatio-temporal variability of fluxes and estimate the water balance in the study area; iv) to define an efficient protocol of hydrogeological assessment in data scarce areas. Ongoing work will concentrate on adding additional constrains to the groundwater model by a better definition of spatio-temporal fluxes and validation of the model by extending the piezometric network.