Geophysical Research Abstracts
Vol. 14, EGU2012-11643-2, 2012
EGU General Assembly 2012

Fault control on the hydrogeological setting of the Sibillini Mountains aquifers (Central Apennines, Italy): an example of hydrogeological structures in thrust-belt contexts

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This work is aimed at highlighting the importance of fault control on the hydrogeological setting in orogenic areas. In Sibillini Montains, Umbrian-Marchean pelagic succession outcrops. This succession, characterized by calcareous, calcareous-marly and silicate could presents condensed succession and is involved in fold and overthrust deformation, followed by a development of normal faults.
The lithostratigraphical and structural study allowed defining the aquifer settings. Several cross-sections have been drawn to identify the three-dimensional geological setting and aquifer's boundaries that consist on: lithological limit between permeable and very low permeable complexes and structural features (groundwater divide and faults).
The analyses of principals structural features (e.g. overthrust) have allowed to identify the prominent groundwater flow direction: the Sibillini Montains, Monte Val di Fibbia-P.ta Bambucerta and Visso overthrusts represent three important inverse faults oriented NNW-SSE having aquiclude role due to the high displacement. The altitude gradual decrease forward N of aquiclude handing aquifers combined to Apennine orientation of overthrusts induce a SSE-NNW groundwater flow.
A detailed analysis of base flow has allowed to: 1) define the river's base flow; 2) recognize the punctual, diffused and linear springs; 3) quantify the water resource on average drained; and 4) determine the discharge regime of springs and rivers.
The geologic-structural analyses with the quantitative hydrogeological studies have allowed to prepare the Conceptual Hydrogeological Model (CHM) and to calculate the hydrogeological balance for each aquifer. This double approach let to carry out a detailed study and make out hypotheses about groundwater circulation for each aquifer. These hypotheses represent the bases for the groundwater modelling that could give an important contribute to confirm or not them.
The CHM of main aquifer has been adopted to carry out the groundwater numerical simulation. Modelling validation has been performed through the matching between the experimental and calculated discharge values, between the piezometric field and topography (the calculated piezometric field always resulting above the spring altitude and below the hydrographical network without base flow) and between the piezometric field and altitude of aquiclude that limits the aquifer. If one of these three conditions is not verified the model is not realistic and the hypotheses must be rejected.
In two cases the modelling results suggested a revision of the assumptions and only through a depth structural analysis has been possible to estimate the real role of Vettore Mont normal fault and recognize a secondary fault that divide an aquifer.
In conclusion this study represents an example of necessary combination between structural and hydrogeological analyses and underlines the importance of information exchange and/or cooperation to allow the 3-D reconstruction of hydrogeological setting.