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Co-seismic and post-seismic hydrogeological response of the Gran Sasso carbonate aquifer to the 2009 L'Aquila earthquake (central Italy)

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The Mw=6.3 April 6 2009 L'Aquila earthquake mainshock produced self-evident co-seismic and post-seismic changes in the hydrogeological setting of the Gran Sasso carbonate fractured aquifer (Adinolfi Falcone et alii, 2008; Barbieri et alii, 2005) in which the seismogenic Paganica Fault, which is responsible for the mainshock, is located (Anzidei et alii, 2009; Atzori et alii, 2009; Chiarabba et alii, 2009; Walters et alii, 2009): i) the sudden co-seismic disappearance of some springs localized exactly along the surface trace of the Paganica Fault; ii) co-seismic and post-seismic increases in the discharge of the Gran Sasso highway tunnel drainages (+20%) and of other springs (+10%) and iii) a progressive increase of the water table (+1m) at the boundary of the aquifer.
Taking into account previous data collected since the '90s, and spot and aftershock monitoring data on spring discharge, spring turbidity, water table levels and rainfall events, a preliminary conceptual
model of the earthquake's consequences on the Gran Sasso aquifer is proposed, excluding the contribution of seasonal recharge. Co-seismic effects registered immediately after the shock (i.e. disappearance of local springs and discharge peaks), are caused by pore pressure increase related to
deformation. Post-seismic effects, observed in the months following the mainshock (i.e. discharges remaining higher than in the inter-seismic period and a progressive increase of the groundwater level), suggest a permanent change in groundwater hydrodynamics. Additional groundwater flowing towards aquifer boundaries and springs reflects a possible increase in hydraulic conductivity, which can be related to fracture clearing and/or dilatancy (Montgomery and Manga, 2003).
To validate the proposed conceptual model we analyse pore pressure changes and the Darcy flow pattern immediately after L'Aquila earthquake for a layered poroelastic medium, using a Green's functions approach (Wang and Kumpel, 2003), and compare results with observations of co-seismic spring discharge changes.
As regards the post-seismic phase, several springs in the Gran Sasso region exhibit long-lasting flow increase, but pore pressure changes can sustain flow changes for few days only. We treat the Gran Sasso acquifer as a homogenous/heterogeneous one-dimensional/annular-sectored aquifer and compare the observed changes and model predictions computed for a permanent or transient increase in permeability.

References

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