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Quantifying the hydraulic properties variations related to fault propagation into thick alluvial materials overlying an active deformation zone: The Chihshang fault at Chinyuan (Taiwan)

Chung-Hsiang Mu (1,2), Yves Guglielmi (3), Frederic Cappa (1), Jia-Jyun Dong (2), Jian-Cheng Lee (4), and Jacques Angelier (1)

(1) Geoazur (UMR6526), University of Nice Sophia-Antipolis and Côte d'Azur Observatory, B.P. 48, La Darse, 06235, Villefranche-sur-Mer, France , (2) Institute of Applied Geology, National Central University, No.300, Jungda Rd., Jungli City, Taoyuan, 32001, Taiwan, (3) Geology of Carbonate System and Reservoirs, University of Aix-Marseille 1, 3 V.Hugo square, 13331 Marseille cedex 3, (4) Institute of Earth Sciences, Academia Sinica, P.O. Box 1-55 Nankang, Taipei, Taiwan

Since April 2007, water-pulse injection experiments were carried out monthly to monitor the hydraulic properties variations related to active faulting in a thick alluvial aquifer overlying the Chihshang fault (Taiwan). Pulses were performed in observation wells drilled in the undeformed zone (H1) and in the zone of the aquifer affected by the active fault deformation (H3 and H2). Pulses consist in a constant volume of water of 5x10-3 m3 suddenly injected into sealed sections of the wells located at 10m (H1), 45m (H2) and 44m depths (H3). The hydraulic permeability is estimated from the analysis of the pressure-versus-time pulse curve with the Cooper-Brederhoeft-Neuzil method. The permeability ranges from 2x10-6 to 50x10-6 m.s-1 with a 10% accuracy. In the undeformed zone, permeability displays oscillations around a 25x10-6 m.s-1 value that are correlated to seasonal groundwater level fluctuations influencing the test. In the deformed zone, permeability displays a non-linear increase over the monitoring period not correlated to seasonal effects. Variations are characterized by a factor-of-2-to-10 step increase from April to September 2008 followed by low magnitude oscillations. The increase of permeability seemingly corresponds to a sudden increase of shallow seismicity along the Chihshang fault in the same period. We tend to interpret this permeability increase as a result from a dilation effect induced by co-seismic slip propagation in the alluviums. The step-increase follows a peak in the 0-5 km depth seismic activity of the fault meaning that permeability variations are controlled by dynamic slip of the fault. This paper also contributes to the validation of a new active monitoring protocol of faulted rock hydro mechanical properties.