Evidences of high diffusivity near a waste water injection well in the Val d’Agri oil field (Italy) from noise-based monitoring

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We monitor the relative variations of crustal velocity during a shut of water injection at the Val d’Agri oilfield (Italy) in January-February 2015 from the analysis of the ambient seismic noise cross-correlations. This technique allows the continuous estimations of the relative velocity variations occurred in the superficial layers of the Earth crust independently from the earthquake occurrence. Our results show a relative decrease in seismic velocity of about 0.08%, detected seven days after the injection restart of fluids injection and can be compatible with an increase of fluids in the medium. We estimate the medium diffusivity from this delay time obtaining a value of about 2.0 m²/s. Independently, we compute diffusivity from the observed delay time of small-magnitude (M_L ≤ 1.8) seismicity induced by the first injection tests in June 2006, finding a similar value. The high diffusivity values found from the two independent analysis are compatible with the hydraulic properties of the hydrocarbon reservoir. Finally, we estimate the spatial distribution of the observed variations finding that the largest changes are located in the North-West direction, where the oilfield is elongated. Our results show that fluids propagate efficiently from the wellbore in the reservoir direction through a strongly fractured medium following efficient hydraulic pathways, and that the noise-based monitoring technique adequately map in time and space this perturbation.