Geophysical Research Abstracts
Vol. 19, EGU2017-6879-1, 2017
EGU General Assembly 2017

High-resolution seismic reflection and refraction imaging across the epicentral area of the 2009, Mw 6.1 Aquila (Italy) earthquake.

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We present for the first time the results of high-resolution seismic reflection profiling aimed at imaging the shallow structure of Paganica and Bazzano Quaternary sub-basins across the shallow segments of the Paganica-S. Demetrio Fault, which has been indicated as the causative fault of the 6th April 2009 (Mw 6.1) L'Aquila earthquake (central Italy). The seismic data were collected along five dense and partly overlapping wide-aperture profiles, which run SW-NE for a total length of ∼6 km, mostly in the hanging wall of the Paganica-S. Demetrio Fault.

To evaluate the optimal seismic reflection imaging strategy, we applied three different processing techniques to the dense, wide-aperture acquired data: a conventional CMP reflection processing; pre-stack depth migration (PSDM); and finally the Common-Reflection-Surface (CRS) stack technique. PSDM has proven capable of overcoming many of the typical drawbacks of CMP processing in the presence of complex subsurface velocity distributions. However, PSDM is highly sensitive to the accuracy of the background velocity model. Despite the use of an acquisition geometry effective for refraction tomography (e.g. dense wide-aperture), we were able to estimate a high-resolution background tomographic model suitable for migration purpose for Bazzano profile, whereas this was not the case for Paganica profile, due to greater structural complexity and a higher level of ambient noise. In these settings, the data-driven and velocity-independent CRS method provided a feasible alternative for seismic imaging in Paganica sub-basin.

Integration of reflection seismology with refraction tomography and with new surface, paleoseismological and borehole data during interpretation provides new insights on the shallow architecture of the 2009 Mw 6.1 L'Aquila earthquake fault-system and related basins. Bazzano sub-basin is about 50-100 m deeper than Paganica sub-basin. The latter is offset by a large number of NE and SW-dipping faults affecting the Meso-Cenozoic carbonate basement and the continental infill, to form a series of small, buried horst and grabens. Some splays are directly linked to coseismic surface ruptures observed after the 6 April 2009 earthquake. The reflectivity images moreover depict some clear unconformities within the continental infill of the sub-basins, and we relate them to abrupt changes in the sedimentation pattern, due to a combination of climatic and faulting processes over the whole Quaternary.