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Seismic reflection imaging of seismogenic faults: observations from the Apennines of Italy

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Identifying and characterizing the seismogenic sources is an important task for the elaboration of new maps of seismic hazard, not exclusively based on a traditional, probabilistic approach. Both geological and geophysical data have to be used, in order to identify the location, dimensions (length, dip and depth) and the kinematics of active geological structures, which can be reasonably associated to one or more major, historical or instrumental earthquakes. Good quality seismic reflection profiles give reliable images of the faults, whose location, depth and trajectory can be compared with the space distribution of the earthquakes (mainshocks, aftershocks, background microseismicity) and with the fault plane geometry and kinematics obtained by their focal mechanisms. In this study, we analyze seismic reflection profiles crossing different structures of the Apennines of Italy, a seismically active area, characterized by both extensional and compressional seismicity, distributed along two sub-parallel alignments. In particular, we make detailed analysis of the region where the 1997-98 (Mw = 6.0) Umbria-Marche earthquake occurred, where precisely located instrumental seismicity effectively constrains the geometry of the activated faults. In most cases, we find a good correspondence between the long-term faults, imaged by seismic profiles, and seismic ruptures, imaged by earthquakes' foci and focal mechanisms. Moreover, we obtain further information about the actual geometry of the active faults and their long-term deformation history. Where the interpretation of the seismic reflectors can be calibrated by well data, we can also know which rocks are involved in the ruptures at seismogenic depth, and infer their mechanical behavior.