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Microseismic activity on a low angle normal fault (northern Apennines, Italy)

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The possibility that normal faults may be seismically active at low dips in the upper continental crust is much debated due to the lack of clear examples of low angle ruptures in seismological records. Here we present seismological evidence for the microseismic activity of a low angle normal fault. During a time span of 8 months, more than 2,200 earthquakes with M_L <3.2 have been recorded by a dense temporary seismic network. The seismicity, relocated with the double-difference algorithm and waveform cross correlation analysis, allows the resolution of structural details in the order of hundreds of meters. The microseismicity highlights a major low angle normal fault dipping $\sim 15^{\circ}$ east. The fault, about 60 km long and 40 km width, plays a major role in the tectonic style of the area cross-cutting almost the entire upper crust from 4 km to 16 km depth showing a nearly planar geometry. In the hanging-wall block the microseismicity distribution defines synthetic and antithetic high-angle normal fault (4-5 km long) soling into the detachment and suggesting a contemporaneous activity. The focal mechanisms are consistent with the geometry of the structures highlighted by earthquake distribution and confirm the extensional kinematics. The comparison of the recorded seismicity, with the geometry of the fault obtained by converting at depth a set of seismic profiles crossing the area, demonstrate that the two data set image the same low-angle structure. The seismic release on the low angle normal fault shows a nearly constant seismicity-rate of 3.5 events/day with $M_L \leq 2.0$. Based on the lack of strong historical and instrumental earthquakes in the investigated volume and the

observed constant seismic release, we speculate that this active low-angle normal fault my predominantly accommodate deformation by aseismic slip.