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Limits on nucleation and some pre-seismic phenomena from continuous strain in the near field of the 2009 L'Aquila earthquake.

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Several phenomena have been proposed as diagnostic precursors of earthquakes, including strain-rate changes, changes in seismic wave velocities, electromagnetic signals, changes in groundwater levels and flow, radon anomalies, and acoustic emissions. Moreover, laboratory studies and models suggest that fault failure is preceded by subsonic pre-seismic slip. Most, if not all, those phenomena should produce an associated strain field detectable by close strain meters. Till now, most observations of crustal strain have not detected any pre-seismic deformation, thus constraining the size and strength of the pre-seismic phenomenon source. The constraint strictness depends on the time interval considered and on the distance of the strain meter from the source.

Two crossed 90-m long laser extensometers are operating in the Gran Sasso underground observatory (Central Italy) since several years. The instruments are characterized by very high sensitivity, wide frequency band (from DC up to hundreds of Hz), large dynamic range, and long-term stability (years).

Here we show the results from the analysis of strain recorded in the two years preceding the 2009/04/06 L'Aquila earthquake. No anomalous signal is clearly visible and thus we can limit the maximum strength of some possible pre-seismic phenomena. In particular, our analysis indicates that

1. the seismic moment of the pre-rupture nucleation slip in the hypocentral region was less than 5×10^{-4} M_0 (5×10^{-7} M_0) in the two days (two seconds) preceding the main shock, M_0 being the seismic moment of the main shock itself;

2. the volume of the dilatant zone was smaller than few km^3 in the month preceding the main shock, for a 10% change of the elastic moduli (5% change of seismic velocities);

3. change in tidal response was not greater than about 1% in amplitude and 1^0 in phase.

Our results confirm what previously obtained by others, e. g. for the 2004 Parkfield earthquake, and put lower limits on the size of pre-seismic phenomena capable to generate a strain field, at least in the case of the 2009 L'Aquila earthquake.