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High precision Seismic velocity variations at Mt. Vesuvius measured using the Coda Wave Interferometry technique

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The Coda Wave Interferometry (CWI) technique is able to detect and discriminate between velocity variations in the medium, source location displacements and 'average scatterer displacement' when applied to Coda of repeating multiplet or doublet data, recorded at a single receiver.

CWI is based on path summation, wherein the signal is decomposed into a sum over all scattering path changes and all possible mode conversions. Cross correlation reaches its maximum at a time that is given by the mean travel time change over all paths. This mean is weighted by the energy of each arrival in the path summation.

We applied Coda Wave Interferometry method to detect long and short term changes in seismic velocity at Mt. Vesuvius, using doublets. The high sensitivity of multiply scattered coda waves to temporal changes in the medium allows us to detect velocity variations smaller than 0.4%.

Data analysed, spanning January 1996 to December 2005, show a systematic increase in velocity from 1996 to end-September 1999, followed by a rapid drop in velocity. This abrupt variation immediately precedes a sustained swarm of VT-type earthquakes, including the 9th October 1999 M=3.6 event, the largest in the region since at least 1972.

We suggest that these variations might be stress related: long term velocity increase is possibly due to a continuous stress loading whereas the sudden velocity decrease could be related to cracking and/or fluid influx. Seismicity would be triggered by

stress changes as a consequence of pressure variation, associated with degassing of the Vesuvius hydrothermal system. This is also supported by the observed spatio-temporal evolution of seismicity associated with a diffusive process.

We propose a long term fluid pressurization followed by influx as a possible causative mechanism.