MONITORING TEMPORAL CHANGES IN CRUSTAL CONDITIONS THROUGH MULTIPLE SCATTERING IN THE SOUTH ICELAND SEISMIC ZONE

Understanding how crustal conditions change with time is important when studying a range of geophysical problems.

Changes associated with stress redistribution, fluid movement or temperature changes can be subtle. In such cases using classical tomographic techniques to investigate them may not be appropriate as the resolution might not be sufficient.

It is well known that the coda of a seismogram contains important information about the degree of heterogeneity encountered by a passing wave (Aki and Chouet, 1975). The Coda Wave Interferometry Technique (Snieder et al., 2002) further exploits this information by using doublets (i.e. two events recorded at the same station at different times, with high coherency waveforms). Later coda arrivals are thought to be dominated by multiply scattered waves, which are very sensitive to subtle changes in the scattering properties of the medium. Comparing the coda of doublets enables the detection and discrimination of velocity variations in the medium, source location displacements and ‘average scatterer displacement’ from correlation of waveforms recorded by a single receiver.

Coda Wave Interferometry 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.

The obtained Correlation Coefficient and the Correlation Lag-Time are mathematically related with the variance and the mean travel time perturbation. The mean variation is computed only by cross correlation using the scattering medium as an interferometer.

First we demonstrate the reliability and range of applicability of the technique by applying it to synthetic seismograms with different source-receiver distance, in a heterogeneous fractal medium for changes in the medium velocity and for different source displacement distance. Then we apply the Coda Wave Interferometry method to recorded data from the South Iceland Seismic Zone (SISZ) over a temporal window from 1993 to 2004.

In real data, for a correct application of the technique it is compulsory to employ doublets, so we used cross correlation analysis to identify the doublets and we visually check each pair. In order to avoid artefacts associated with instrument response, we choose stations that use the same seismometer over the time window of interest. All data are filtered between 1.0 and 15 Hz. We used only the stations named SOL (Lat: 63.92, Long: –20.94) and SAU (Lat: 63.98, Long: –20.41) of the Icelandic Meteorological Office (IMO) network.

In June 2000, the SISZ experienced two significant earthquakes M = 6.6, on the June 17 and M = 6.6 on June 21. These events occurred on two parallel N-S striking, right-lateral strike slip faults, separated by about 17 km. The earthquakes caused
significant pressure changes in geothermal reservoirs and triggered four events (M > 4.8) within 5 minutes. In this work we used a cluster of events in a region close to the fault of the second earthquake, the 21st June 2000 (Lat: 63.977, Long: -20.713) and we examine possible variations in a decade time window before and after the two June 2000 events. Although the work is still ongoing, initial results point to variations in source location, whereas velocity variations are observed in a 7 year time window associated with the two 2000 June 17 and 21 M > 6.0 earthquakes.

REFERENCES