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Real-time processing of earthquake information in Iceland.

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Tools for real-time analysis have been implemented at seismic stations in the SIL system in Iceland, as a part of the Icelandic Meteorological Office participation in the SAFER and TRANSFER projects. These tools include processes to support alert maps and Shake Maps, first steps towards fast magnitude determination based on dominant frequency, and the development of procedures to map faults in near-real-time.

Data for alert maps and Shake Maps is obtained using a real-time process that monitors both ground velocity and acceleration in 4 separate frequency bands at each station: 4-50 Hz, 1-10 Hz, 0.25-2.5 Hz and 0.05-0.5 Hz. A reference level is maintained for horizontal and vertical components in each frequency band, such that it is exceeded a few times per hour. When signals exceed this level by more than 50%, a report is sent to the processing center. When 5 or more stations send reports within a time interval of 20 seconds, alert maps are generated. The alert maps show observed values for each station, including peak ground velocity and arrival times for peaks in ground motion and first break.

An attempt is also made to solve for the location of the event. The location solution is based on the assumption that time when the vertical component first exceeds the reference level by a certain amount indicate the arrival of the P wave from an earthquake. Before searching for a location solution, the arrival times for different stations are compared and stations are dropped so that no time differences are greater than the time that it takes a P wave to travel from one station to another. The location calculation uses a fixed depth (4 km) and uses a parametric travel time curve that is based on observations from South Iceland. All possible combinations of 3 stations are used to compute potential solutions; the location that yields the lowest sum of absolute residuals is then found.

Once the location has been determined, conventional magnitude can be calculated, using recently refined magnitude-distance relations for Icelandic earthquakes. When a good fit is obtained for at least 5 stations, for both arrival times and amplitudes, and the magnitude indicated is greater than 2.0, a Shake Map is generated and placed online automatically. The Shake Maps are usually ready within 2 minutes of the earthquake. The maps can be accessed at http://hraun.vedur.is/ja/alert.

This real-time analysis has been operational on over 40 stations in the SIL system since early September 2008. These tools have yielded accurate magnitude estimations for nearly all earthquakes that have been felt in Iceland during this period.

In order to extend coverage to surrounding ocean areas, we are working on having access to real-time data from a few seismic stations around the North-Atlantic. This should enable early warning for large offshore earthquakes.

Mapping of faults in near-real-time fault is performed by using double-difference relocation of automatically located microearthquakes, relative to a library of events already located with high precision. Thus, taking advantage of the tens of thousands of earthquakes in South Iceland that have been relatively located. Automation of the relocation process is under development. When completed, the process will enable near-real-time delineation of activated faults by the distribution of microearthquakes.