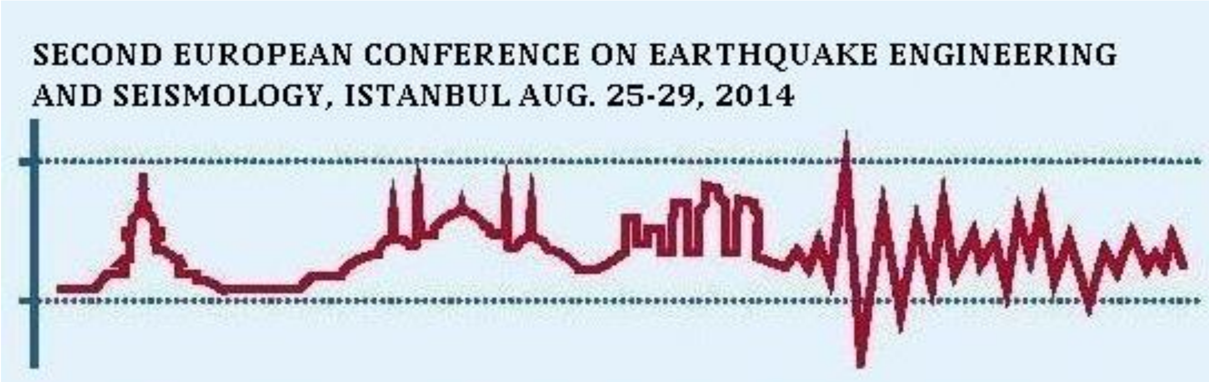


# EARTHQUAKE EARLY WARNING IN ICELAND

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Iceland is located on the mid-Atlantic Ridge where the Eurasian and North American plate are separating at a rate of 2 cm yr-1. The plate boundary zone is mostly defined by volcanic zones that accommodate the spreading motion by several parallel and overlapping volcanic systems. It stretches from the south west to the north and is offset 100 km towards east, resulting in two transform zones capable of producing M7 earthquakes. The Southern Iceland Seismic Zone (SISZ) consists of a series of parallel N-S trending strike-slip faults, sometimes referred to as bookshelf faulting. The Northern transform zone or the Tjörnes Fracture Zone (TFZ) is primarly offshore and has a different geometry consisting of a 100 km long fault and a second parallell lineament.

The history of moderate earthquakes is quite well known in the SISZ with two Ml 6,5 on average per century. However, records for the TFZ are not as well preserved but recent deformation study of the area suggests there is potential for a strike slip event with magnitude M6,8 on the major fault.

The regional seismic network (SIL) in Iceland is operated by the Icelandic Meteorologial Office, which is by law responsible for monitoring all natural hazard in the country. The network started as a collaborative project between the Nordic countries on earthquake prediction research in1988. The project included the installation of seismic stations in the SISZ and the design of an earthquake data acquisitionand analysis system. Today the network has grown to monitor not only the active transform zones but also the rift zones. The SIL network currently consists of 70 stations short and broad band, concentrated mainly in the SISZ and around the most active volcanoes, north of Vatnajökull, in the vicinity of the manmade reservoir Hálslón and in the TFZ. In addition 4 accelerometers are streaming data in real time from the SISZ and TFZ.

The highly automatic SIL system, which has been in operation since 1991, was designed to enable accurate locations, source parameter determination and fault plane solutions for earthquakes. In particular the design was focused on very small earthquakes (micro earthquakes) since they can provide a detailed view of the distribution of stresses within the crust, an essential factor for understanding earthquake processes and for earthquake prediction.

Allthough the system has undergone many changes, today it is quite homogeneous with minimum equipment running on site in the field where they are difficult and expensive to maintain. All stations are online and send modulated data packets in real time to the center in Reykjavík were detectors are run to find local p- and s-phases. A phase associator selects the phase-logs which are likely to represent real events. In order to catch even the smallest events, the requirements for the selector are not very strong. The system even allows for single station locations making use of p- and s-phase detections and a stable azimuth solution. With the help of assigning event quality to the automatic system, we can quickly filter the most probable events. On a routine basis, all events, above a quality threshold, are manually checked and re-picked if necessary.

Automatic locations and magnitudes of earthquakes are usually available within few minutes from origintime. For a period of time an automated warning system for single station amplitude warnings was tested as an early warning process for large ground movements, but was taken out of operation since it gave to many false alarms.  A part from that,  an earthquake early warning system (EEW) has not been in operation in Iceland before Virtual Seismologist (VS) was installed in 2013 in test mode as a part of the REAKT European project. It is based on SeisComp3 which has been run along side the home designed SIL system.

The VS aims at estimating earthquake magnitude, location and distribution of peak ground shaking as early as possible, or with the ultimate goal of having a valid estimate only 3 seconds after p-wave detection. The primary focus in tuning VS at IMO is to minimize data latency and delay and at the same time optimizing the SeisComp3 system to get as sound and quick solutions as possible. An earthquake early warning system, such as the VS, has the potential of significantly decreasing the response time for the civil protection in the highly plausible event of a moderate size earthquake in Iceland.