

Iceland GeoSurvey's seismic monitoring of exploited geothermal fields in Iceland

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Abstract

Geothermal areas in Iceland, specifically the high-temperature ones, are located in tectonically active areas that naturally experience seismicity. Iceland has successfully exploited the bountiful energy of some of the geothermal areas, both for electrical power production and space heating. Iceland GeoSurvey (ÍSOR) currently monitors six exploited geothermal areas with permanent seismic stations for three Icelandic energy companies: Landsvirkjun Power (LV), Reykjavík Energy (ON) and Norðurorka (NO). Previously, ÍSOR also operated a seismic network for HS Orka, and has in the past run various temporary networks for the Icelandic energy companies. The geothermal areas currently monitored are Krafla (LV), Peistareykir (LV), Námafjall (LV), Hellisheiði (ON), Nesjavellir (ON) and Eyjafjörður (NO). Additionally, ÍSOR takes part in multiple European collaboration projects in geothermal areas with the respective energy companies, as well as independent research institutions. The seismic stations of the different networks are all online, streaming data in real-time to ÍSOR, and subsequently, automatic locations of earthquakes are available to the respective energy company. The online seismic stations are a combination of stations owned by the energy companies, ÍSOR stations operated for the energy companies, stations from the national seismic network of the Icelandic Meteorological Office and research stations. The seismic networks comprise 1s, 5s and 120s instruments. In addition, ÍSOR's collaborators run research networks of seismic stations on the Reykjanes Peninsula, comprising 30s and 120s instruments.

At ÍSOR, the SeisComP software by Gempa is used for automatic detection and location of earthquakes, and day to day monitoring of the geothermal areas where the majority of events are manually refined. In general, increased but variable seismic rate is observed in production and injection areas. However, it can be challenging to distinguish between natural and induced seismicity. The mapping of seismic activity can give valuable information about the fracture permeability of the geothermal fields. For a more detailed analysis, earthquakes are relatively relocated, earthquake source mechanisms calculated, and new 1D velocity models constructed. The development of ÍSOR's seismic data analysis mostly takes place within the European collaboration projects, where for example new SeisComP modules are tested and implemented, new data processing techniques explored, and beneficial relationships between scientists are established. ÍSOR strives towards interdisciplinary interpretation of the seismic data with existing geophysical and geological data sets.