Optimal configuration of the local Ostrobothnian seismic network OBF

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Abstract

This study simulates automatic event detection and location performance of a micro-earthquake network centred around a site selected for a future power plant in Finland, Fennoscandian Shield. Simulation of the event location capability is based on a relationship derived between event magnitude and maximum detection distance. Azimuthal coverage and threshold magnitude are computed for different station configurations and the results are presented as contour maps. An optimal configuration of ten seismograph stations is proposed for further on-site survey.

1. INTRODUCTION

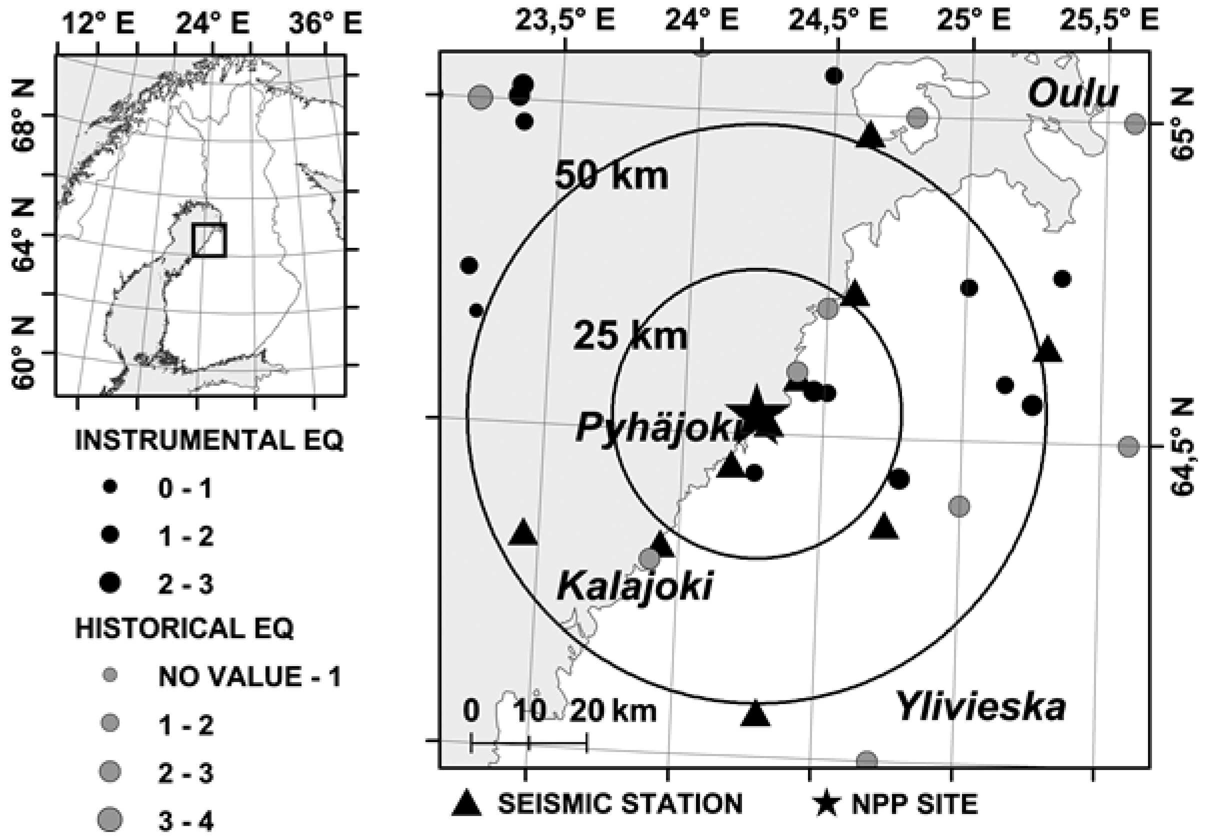
Sites of vulnerable constructions, such as nuclear power plants, are required to be evaluated for seismic risk and monitored for seismicity (IAEA, 3.30, 2010). When a dense, local seismic network is set up around the site, numerous microearthquakes are expected to be recorded. Local networks can provide accurate estimates of seismic source parameters and thus seismotectonic interpretation and seismic hazard evaluation of the area can be improved.

This study searches for an optimal configuration for a microearthquake network to be deployed around a site selected for a power plant in northern Ostrobothnia, Finland. Ostrobothnia is situated in the seismically quiet central part of the Fennoscandian Shield (Figure 1). Due to the low seismic activity rate of the area the network should have an ability to detect and locate extremely weak seismic events. We suggest that the OstroBothnia Finland (OBF) network should have an automatic event location capability down to ML 0.0 or lower.

2. SIMULATIONS OF AUTOMATIC LOCATION CAPABILITY

The event location performance of a local network is governed by azimuthal gap (AG, i.e. the largest gap in azimuth between stations seen from the epicentre). For good location precision, AG less than 180° is adequate. Small AG could be gained by simply surrounding the study area consistently with stations.

P- and S-wave detections from at least three stations are a pre-requirement in an automatic location procedure applied (Tiira et al. 2011). To simulate the automatic event location capability of the OBF network, a relation between event magnitude and maximum detection distance is



Kuva 1: A seismicity map of the study site (Ahjos and Uski, 1992). Macroseismic (–1970) and instrumental (1971–) epicentres are denoted by gray and black dots. The triangles denote the optimal station configuration and the star denotes the nuclear power plant site.

derived. The detection distances define the magnitude of the smallest earthquake that can be located.

Contour maps presenting maximum AG and magnitude threshold M_{th} are computed by forming a 0.1×0.1 degree grid over the area. Mth is determined as the magnitude of the weakest locatable event on a given grid point and the maximum AG is computed directly from the nework geometry.

3. RESULTS

The results of the study (Tiira et al. 2011; Valtonen et al. 2013) suggest that a minimum of ten seismic stations is required (Figure 1), if the network is to have the event location threshold of approximately ML 0.0 and the AG smaller than 180° within 25 km distance from the study site.

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