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Predicting the frequency of seismic events for subsurface engineering projects usingbackground microseismicity data

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The general public is concerned about subsurface energy projects and their link to seismic activity. However, in order to meet the Net Zero requirements, low carbon technologies involving fluid injection into the subsurface, such as geothermal, Carbon Capture and Storage (CCS) and gas storage, must be developed and implemented. In an effort to enhance their confidence, it is important to comprehend the seismogenic effects and the triggering mechanism that such technologies could have in a region.
The frequency of occurrence of microearthquakes (earthquakes with magnitude < ML0 in the Gutenberg – Richter scale) in natural faults can provide crucial details about the evolution of seismicity of a region and the geological structures that support this. The permanent seismic monitoring networks, due to their detection threshold on small magnitude earthquakes (< ML1), do
not enable for the long – distance recording of all microearthquakes. These events have higher frequencies that attenuate fast, making detection at stations 10s or more kilometres away difficult, if not impossible.
In order to determine whether microearthquakes share the same characteristics as larger earthquakes and whether they can be used as a precursor to the occurrence of larger earthquakes,
this research focuses on the study of the characteristics of natural microseismicity (frequency of occurrence, magnitude distribution, depth of hypocentres etc.). In July 2022, we deployed a temporary microseismic monitoring network in the southern Heraklion prefecture (Crete, Greece) in
collaboration with the Hellenic Seismological Network of Crete with the aim of recording very small in magnitude earthquakes (within the range of -0.5 < M < 3, i.e. two orders of magnitude below the
current completeness magnitude of M c 2.0). The network consisted of seven short period seismometers, one of which was placed in the centre of a nearly circular geometry with the remaining six distributed around it at a radius of approximately 6.1km. This geometry provided a good azimuthal coverage for determining the hypocentres.

In this work, we present analysis and results of the microseismic data collected from our local monitoring network. We find a significantly larger number of microseismic events than that reported
for the same time period within 50 km distance from the central station of our local network in the published seismic catalogue by the National Observatory of Athens. The number of detected events
we report here refers to only those events that can be visually observed in the recordings. The real number of smaller in magnitude events is larger but obscured by noise. We use the detected microseismic events to populate the Gutenberg Richter magnitude distribution for lower magnitude

events and discuss the implications on the existing Gutenberg Richter magnitude distribution for the
region as derived from events recorded by the permanent seismic network in Crete.