Seismicity of the Mt. Kinabalu fault system in Sabah, Borneo, revealed using waveform backprojection

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The aim of the Northern Borneo Orogeny Seismic Survey (nBOSS) is to better understand the mechanisms driving the processes that occur in a post-subduction setting. A network of 46 seismometers was deployed across Sabah, Borneo, between March 2018 and January 2020 (22 months) in order to investigate these mechanisms using a suite of seismic imaging techniques.

Mt. Kinabalu (~4100 m) is a large granitic pluton that was emplaced between ~7.9 and 7.2 Ma. The region around the mountain experiences infrequent earthquakes, with the M6.0 Sabah earthquake in 2015 being the second largest earthquake to strike the region in the past century. This earthquake caused the loss of 18 lives and an estimated 100 million Ringgit (~€22 million) of damage to buildings, roads and infrastructure. The 2015 earthquake has highlighted the importance of improving our understanding of seismic hazards in northern Borneo. Although both a network of faults striking along the spine of the Crocker range, and a complex network of faults around the Kinabalu massif have been mapped, which of these are currently active remains poorly understood. Using data from the nBOSS seismic network, together with additional data from the Malaysian Meteorological Service, we aim to quantify and categorise the seismicity associated with this fault system.

We have used QuakeMigrate, a new, modular, open-source Python package for waveform backprojection to efficiently, automatically and robustly detect and locate microseismicity in the region around Mt. Kinabalu. We provided QuakeMigrate with continuous raw seismic data, a velocity model derived using nBOSS seismic data, and a list of station locations. A realistic estimate of the event location uncertainty, phase picks with uncertainties, and a suite of visual outputs allows for rigorous selection of real events at a sub-SNR detection threshold.
Using data from March 7 2018 to 28 August 2018, we have detected and located over 1500 events with hypocentres highly concentrated beneath the Kinabalu massif. Given existing catalogues for the area around Mt. Kinabalu only record on the order of tens of events between 1990 and the present day, our results demonstrate that these catalogues are highly incomplete at low magnitudes and thus existing tectonic and hazard models for the area need to be revised.