Developing a catalog of automated focal mechanisms for microearthquakes at Axial Seamount based on waveform-correlation

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Axial Seamount is a submarine volcano at the intersection of the Cobb hotspot and the Juan de Fuca Ridge. The last eruption in 2015 was recorded by 7 ocean bottom seismometers (OBSs) on the Ocean Observatories Initiative Regional Cabled Array. Levy et al. (2018) obtained 100 composite focal mechanisms from manual first motion picks and S/P amplitude ratios for 501 earthquakes that spanned the 2015 eruption and demonstrated that the inflation and deflation of the caldera are accommodated by a change in the sense of motion on a buried outward dipping ring fault. The Axial Seamount earthquake catalog now comprises ~150,000 locatable earthquakes and it will grow with installation of a 2-year 15-station autonomous OBS network in September 2022. A large data set of focal mechanisms would provide new constraints on the geometry and deformation of the caldera ring faults, the impacts of magma movement and hydrothermal process on faulting, and the evolution of crustal stresses through the eruptive cycle. To generate focal mechanisms automatically, we are adapting the method of Shelly et al (2016) which determines polarities that optimize the fit to signed waveform correlation coefficients. Using test data sets of 5,000 earthquakes from each of the east and west walls, we have obtained 30,000 polarities that have a reliability of 90% based on comparison with manually picked events. This reliability is insufficient to support robust single event focal mechanisms, so we are employing hierarchical clustering to group earthquakes based on the similarity of waveforms, polarities, S/P amplitude ratios, and locations. The groups are used to obtain composite focal mechanisms from both polarities and S/P amplitude ratios with the HASH program. Our results demonstrate the potential of this method but further work is required to improve clustering, particularly for earthquakes lacking several polarities and S/P amplitude ratios.