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Microseismicity along Major Ross Ice Shelf Rift Resulting from Thermal Contraction of the Near-Surface Firm Layer

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Seismicity within ice shelves arises from a variety of sources, including calving and rifting. In this study, we identify and locate cryoseisms in the Ross Ice Shelf (RIS) to better understand ice shelf internal stress and deformation. We use data from a two-year 34-station deployment of broadband seismographs operational from December 2014 – November 2016. Two lines of seismographs intersect near 79S°, 180° close to a large rift, and cryoseisms were recorded by up to 10 seismographs within 40 km of the rift tip. We identified around 5,000 events from 2015 and 2016 and grouped them based on number of stations recording and signal-to-noise ratio. The events show a long-period character compared to similar magnitude tectonic earthquakes, with peak amplitudes at 1-4 Hz and P, S, longitudinal, and surface wave arrivals. Cross correlation analysis shows that the events cannot be divided into a small number of repeating event clusters with identical waveforms. High quality events were located with a least-squares algorithm using Rayleigh arrivals, and the resulting locations show strong spatial correlation with the rift, with events distributed along the rift rather than concentrated at the tip. The events do not show teleseismic triggering, and did not occur with increased frequency following the Illapel earthquake (8.3 Mw) or subsequent tsunami. Instead, we note a concentration of activity during the winter months, with several days exhibiting particularly high seismicity rates. We compare the full catalog of events with temperature data from the Antarctic Weather Stations and find that the largest swarms occur during the most rapid periods of seasonal temperature decline. Internal stress in ice floes and shelves is known to vary with air temperature; as temperature drops, the upper layer of ice thermally contracts, causing near-surface extensional stress to accumulate. We propose that this seasonal stress enhances the inherent N-S extensional stress prevalent in this area of the RIS to produce rift-associated microseismicity.