

Detection of Seismic Sources Associated with Ice Movement in Antarctica using the AGAP and POLENET Seismic Deployments

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Antarctica has a very low level of seismicity in global seismic catalogs. In addition, although many long period “glacial earthquakes” have been found in Greenland, only a few have been detected around Antarctica [Nettles and Ekstrom, 2010]. The sparse seismicity of Antarctica must be due at least in part to poor seismic station coverage in the global network. Recent seismic deployments offer the opportunity to characterize the seismic sources of Antarctica at a much lower magnitude level, as well as investigate the occurrence of long period seismic sources such as those from Whillans Ice stream (WIS) basal slip events [Wiens et al., 2008] and other types of seismicity related to ice movement. We use data from permanent GSN stations and two regional broadband seismic arrays, the AGAP (GAMSEIS) array in East Antarctica, and POLENET array in West Antarctica, to identify and locate local and regional seismic events. Data for approximately 20 seismic stations are available for 2007-2008 and 40 seismic stations for 2008-2009. We detect and locate events using the traditional method of identifying the first arriving high frequency P phases with an STA/LTA algorithm and association programs provided by the ANTELOPE seismic database. In addition to locating these fast slipping events, we implement a modified time reversal method to locate and identify ‘slow’ events that would otherwise go undetected. These slow events generally show emergent arrivals and lack the high frequency phases used in traditional methods. For our modified time reversal, the long period envelopes of all the stations are first shifted by their Rayleigh wave propagation time and then stacked at each of a grid of equidistantly spaced potential source locations. The source time and location of actual seismic events can then be identified by large amplitude stacked signals at one of the potential source locations. The method has been tested using several trial cases; the first using known small earthquakes (M_S 4.6-5.3) at coastal locations and the second using a well recorded example of the daily slip of the WIS. The analysis method was able to correctly detect all of the test cases. We are now applying the method to catalog slip events of the WIS and to search for unknown long period sources in Antarctica and the southern oceans surrounding it. Our integrated catalog of events detected using long period methods and traditional high frequency methods will give insight into current seismic activity and its association with ice movement in Antarctica.