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Micro-seismic activity within a serac zone in an alpine glacier (glacier d’Argentière, France)

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Previous seismic experiments on seismic activity in alpine glaciers have shown the opening of crevasses as the main source of the seismic signals recorded. Yet *Deichmann et al.*, 2000 have pointed up evidence for deep icequakes. In order to characterize these deep seismic sources involved in glacierquakes, micro-seismic activity of a serac fall was monitored during two periods (one month in April 2002 and four months during winter 2003-2004) underneath a 500m wide serac zone of an alpine glacier (glacier d’Argentière, France). A network of 1 Hz Mark Products L4-C seismometers was installed in a gallery lying 5 m underneath the glacial base, in the bedrock. Monitoring from the base allows to capture the deep-seated signals, that can be masked from surface measurements because of the emissive crevasse processes (*Neave and Savage*, 1970) . The data show a very high emissivity from the glacier. Most of recorded events show short, impulsive signals, but some, like serac falls, are longer with more large-band signals. Regional tectonic earthquakes are also recorded as low frequency events. Almost all of the seismic events recorded have quasi-harmonic codas, peaked at 21 Hz. These are neither due to site effect, nor to instrumental response, and are likely to result from stationary waves developping across the glacier, giving a way to compute glacier thickness.

We apply seismic array methods for locating the sources of these signals, using a two-step grid search in the parameter space. The first step consists in tracing rays from every point in the ice area of the DEM to the nine seismometers of the antenna deployed in the gallery, in order to compute the travel-times. To this effect an enhanced Podvin-

Lecomte algorithm is run (*Podvin and Lecomte,* 1991 ; *Monteiller et al.*, 2005). We then perform a grid search in the three position parameters plus two velocity parameters (for ice and rock), to find the velocity model and the source position that best match the delays between each seismometers. We discuss the results of this analysis, with regards to glacier mechanics, in particular involving basal processes.