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Bubble cloud oscillations as a potential source of volcanic tremor at Mt Erebus volcano, Antarctica

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Erebus is an intraplate stratovolcano of phonolitic composition located at the southern end of Terror Rift within the West Antarctica Rift system. The volcanic edifice of Erebus exhibits a summit plateau that hosts the main crater and a smaller inner crater that contains a persistent lava lake. Volcano-seismic signals are recorded at Erebus by a permanent network of short-period and broadband seismometers installed around the volcano edifice. We analyze tremor data recorded by the closest (∼0.6-2 km) broadband stations to the inner crater during May 2002-April 2004 in order to elucidate the physical processes that take place at its source. After screening the data for signals related to non-volcanic sources such as iceberg calving, we obtained 72 tremor events. Spectral analysis reveals that these events were either harmonic exhibiting several overtones or broadband, but there were also mixed events that contained both of these two states. All tremor episodes considered in this study follow an exponential duration-amplitude distribution that implies a scale-bound source process. This precludes the possibility that any of these signals is related to iceberg calving near Ross island, or that rock fracturing processes play any role in tremor generation. The large viscosity of phonolitic magma (∼10$^{5.3}$ Pa s) suggests that source mechanisms that require high flow speeds in order to excite tremor are unlikely to operate at Erebus. On the other hand, oscillations of CO_2 bubble clouds formed at localized asperities within the magma chamber represents a scale-bound source that is also consistent with the observed oxidation state of ascending gas and with the deep (∼5-7 km) location of the tremor source. These results are important for understanding tremor processes at volcanoes which, similar to Erebus, exhibit vigorous convection in their shallow plumbing system.