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**Seismic waveform modeling of the reflection response from a mid-ocean ridge axial melt sill: understanding the message behind the polarity of waves reflected off the melt lens**

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Seismic reflections from axial magma chambers (AMCs) are commonly observed along many mid-ocean ridges, and are thought to arise from the negative impedance contrast between a solid, high-velocity lid and the underlying low-velocity, partially molten sill. The polarity of the AMC reflection (PAMCP) at vertical incidence is often used as a diagnostic tool for the presence of melt because the negative impedance contrast should result in waves with polarity reversed with respect to the polarity of reflections from the positive-impedance seafloor interface. Here we present results from time-domain finite difference calculations to study the waveforms of AMC reflections and investigate the effect of several features in controlling waveform polarity: (1) interference with free-surface reflections, (2) thickness of the AMC, and (3) velocity gradient above the AMC. The seismic propagation is modeled with pulses centered at 10 Hz with a bandwidth of 6.8-13.6 Hz, and the geometry of the source-receiver pattern for the synthetic calculations is the same as a single-streamer multi-channel seismic (MCS) survey. Our results indicate that the free surface interference does not affect the polarity of PAMCP reflections. Reversed polarity of reflections from the top of the AMC is observed when the AMC is thicker than ~150 m (half-wavelength of the P-wave within the AMC). For a thinner AMC, reflections from the top and bottom of the AMC interfere with each other, making them indistinguishable. In this scenario, polarity of the PAMCP reflection may be a poor indicator for the presence of melt. The PAMCP reflection decreases in amplitude, and eventually disappears, if the sharp interface forming the roof of the melt sill is replaced with a layer of negative velocity gradient whose thickness is less than ~50 m. In this case, reflections from the bottom of the AMC could be misinterpreted as reflections from the top of the AMC, again making the polarity an unreliable indicator for the presence of melt. In addition to the above-mentioned effects, the synthetic seismograms are allowing us to identify peg-leg multiples and S-wave converted phases that we will use to place constraints on the origin and nature of the sub-AMC reflections observed in the 3D MCS dataset acquired over the RIDGE-2000 Integrated Study Site at East Pacific Rise (cruise MGL0812).