Seismic Structure of the Axial Magma Chamber Along the Southern Juan de Fuca Ridge From Full-Waveform Inversion and Partial S-Wave Stacking

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Multichannel seismic data collected along the Cleft segment on the southern Juan de Fuca Ridge shows that this intermediate-spreading center is underlain by a mid-crustal reflector interpreted as the top of an axial magma chamber (AMC). The AMC reflection is present along most of the segment, and deepens gently from 2.1 km near the southern end of the segment beneath the RIDGE Cleft Observatory Site, to 2.4 km at the northern end beneath the site of the mid-1980's submarine eruption. f-k filtering of super-CDP gathers allows the identification of a weak, coherent seismic phase interpreted as the P- to S-wave conversion at the AMC (P_{AMC}). Stacking of this event shows that the P_{AMC} is only detectable along the northern part of the segment. In this area, one-dimensional waveform modeling in the time intercept-slowness (tau-p) domain indicates that the AMC is ~100 m thick, and it is characterized by a decrease in P-wave velocity from 6 km/s to 3.7 km/s. In contrast, the P-wave velocity within the southern, shallower AMC is larger (4.5 km/s). Our results suggest along-axis variations in the crystallinity of the AMC. Assuming that the AMC represents spherical crystals suspended in a melt matrix (mush), the AMC along Cleft varies from a high crystal content (~10% melt) magma chamber at the southern end of Cleft, to a mush zone with ~60% melt in the source of the 1980's eruption at the northern end.