Crustal structure of the Cleft segment (southern Juan de Fuca Ridge) from multichannel seismic profiling

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We use multichannel seismic data collected in 2002 to constrain processes of magmatic accretion, and the structure of young oceanic crust formed along the intermediate-spreading Cleft segment, in the southern Juan de Fuca Ridge. The Cleft segment is characterized by a 10-15-km-wide area elevated ~450 m above the surrounding seafloor. Within this relatively inflated morphology, the axial region is characterized by 1-3-km-wide smooth terrain bounded to the east and west by linear ridges 100-m-high. The study area was densely surveyed with 5 axis-parallel profiles running along zero-age crust and up to 430-kyr-old crust along both flanks of the ridge axis, and with 13 cross-axis profiles extending up to 600-kyr-old crust. Migrated seismic images show that at least 65% of the Cleft axial region is underlain by a bright reflector continuous along distances of 10-15 km, interpreted as the top of an axial magma chamber (AMC). The depth of the AMC appears to decrease from 950 ms two-way travel time (~2.4 km, assuming an average velocity of 5 km/s above the AMC) below the seafloor beneath the Monolith hydrothermal vent near the northern end of the segment, to 810 ms (~2.0 km) beneath the hydrothermal vents in the RIDGE Seafloor Observatory near the southern end of the Cleft segment. The AMC is narrower (~600 m) near the northern end of the segment, and wider (~1100-1650 m) in the other areas. The extrusive volcanic layer (2A) shows contrasting patterns within and outside the axial region. Layer 2A thickness within the axial region is 200-300 ms (~300-450 m, assuming an average velocity of 3 km/s). This layer thickens off-axis symmetrically by ~55%, to 335-435 ms (~500-650 m) immediately outside of the axial region. This thickening is rapid, with no clear correlation with topographic slopes, suggesting that the linear ridges that flank the axial region play an important role on the emplacement process of the extrusive layer.