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# Magmatic accretion versus serpentinized mantle exhumation at ultraslow spreading rates: constraints from seismic data and Vp/Vs ratios, Mid-Cayman Spreading Centre, Caribbean Sea

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About 57% of the Earth's surface is covered by oceanic crust and new ocean floor is continuously created along the ∼60.000 km long mid-ocean ridge (MOR) system. About 25% of the MOR spread at an ultra-slow spreading rate of <20 mm/yr. At ultra-slow spreading rates the melt supply to the ridge is thought to dramatically decrease and crustal thickness decreases to a thickness of <6 km. Further, geological evidence suggests wide-spread un-roofing of mantle. Yet, seismic data provide little evidence for amagmatic lithospheric emplacement away from oceanic core complexes. Formation of crust from a magma chamber would suggest the creation of a well stratified crust, with an extrusive upper crust (layer 2) and a lower gabbroic crust (lower 3) and a well-defined crust-mantle boundary and hence a seismic Moho. In contrast, un-roofing of mantle would support a crustal structure where seismic velocities change gradually from about 4.5 km/s at the seabed to velocities of mantle rocks at depth. In addition, exposure of mantle to seawater would cause serpentinization. Serpentine, in turn, would support high Vp/Vs ratios of >1.9.

Here, we report results from a seismic refraction survey from the ultra-slow spreading Cayman Spreading Centre in the Caribbean Sea, sampling mature crust along a flowline from both conjugated ridge flanks. The ocean-bottom-seismometer and hydrophones provide both P-wave and S-wave refracted arrivals. Travel time data were inverted using seismic tomography. Resulting Vp/Vs ratios suggest that up to 25% of the lithosphere have high ratios of >1.9, supporting serpentinization and exposure of hydrated mantle at the seafloor. Further, the mode of accretion has changed over time, supporting both areas of mantle exposure and magmatic crust. Magmatic crust has a typical layer 2 and layer 3 velocity structure and a thin crust of 3 to 5 km thickness. However, a well-defined Moho boundary was not observed. Thus, crustal rocks are characterized by typical crustal-velocities (<7.2 km/s) and mantle has velocities of >7.6 km/s. Domains of un-roofed mantle have high Vp/Vs ratios and velocities gradually increasing from ∼4.5 km/s at the top basement to 7.4-7.6 km/s at 3-5 km depth.