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Seismic structure of the St. Paul Fracture Zone near 18°W in the Atlantic Ocean– evidence for a magmatic origin of crust

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The structure of large-offset transform faults and fracture zones associated with the Mid-Atlantic Ridge studied before the 1990s exhibits anomalous crustal structures that fall well outside the range typically observed for normal oceanic crust, both in thickness and internal structure. The geological nature of the seismically anomalous crust and how this crust forms, are still a matter of debate. One interpretation is that the crust within North Atlantic fracture zones consists of a thin, intensely fractured, and hydrothermally altered basaltic section overlying ultramafics that are extensively serpentinized in places. (Detrick et al., Rev. Geophys., 1993). For nearly three decades, transform faults and fracture zones garnered little attention. However, in late 2017 we surveyed the St. Paul fracture zone near 18°W during Maria S. Merian cruise MSM69. Fourteen ocean-bottom-seismometers and hydrophones sampled seismic shots fired along a 140 km long seismic profile, running within the ~10 km wide valley of the fracture zone, that separates 40 Ma crust in the south with 70 Ma crust in the north. Seismic refraction and wide-angle data provided both first arrival refracted P-waves and wide-angle reflections. Furthermore, a clear Pn refraction branch with the apparent velocity of ~8 km/s has been observed. Joint refraction and reflection tomographic inversion of P-wave travel times supports a seismic structure, which is heterogeneous, but shares common features with 4-5 km thick normal oceanic crust, supporting a magmatic origin of the crust. Both the observed reflections from the crust-mantle boundary and upper mantle P-wave speed of ~8 km/s provide little evidence for large quantities of serpentinites being distributed through the crust and upper mantle.