An intrusive complex imaged within the roots of an oceanic core complex using 3D full-waveform inversion

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3D full waveform inversion (FWI) has been applied to the seismic refraction data of the MARINER (Mid-Atlantic Ridge INtegrated Experiment at Rainbow) experiment to create a robust high-resolution model of the seismic velocity structure of the Rainbow massif. The Rainbow massif is an oceanic core complex located on a non-transform discontinuity (NTD) in a magma-starved region of the mid-Atlantic Ridge. Despite the low magmatic input, the core complex hosts a high-temperature hydrothermal vent field (>340°C) that requires a long-lived magmatic heat source. The FWI results show that deep within the massif, ∼3-8 km below the seafloor, is a low-velocity body that represents a partially molten sill complex with >20% gabbro intrusions. The complex extends out north to the AMAR Minor N segment suggesting an increased magmatic input into this segment, forcing the NTD to migrate southwards. Extensive magmatic intrusion into the core complex was likely responsible for the termination of slip on the detachment fault. Above the sill complex, we image a channel of lower velocity material that cuts through the main hydration front to the deep sill region. Velocity values and micro-seismicity correlation suggests that this channel consists of 10-30% serpentinized peridotite and fracturing from serpentinization reactions create fluid pathways for fluids to exchange between the deeper partially molten heat source and the fluid network of the hydrothermal vents. A high-velocity chimney below the extinct vent sites of the massif may represent the abandoned stockwork of these extinct hydrothermal systems.