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The continent-ocean transition zone in the Iberia Abyssal Plain re-visited: seismic constraints from FRAME profile P3

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When continents break apart, continental crust and lithosphere is stretched until break-up occurs and seafloor spreading forms new oceanic basins. However, at settings with low magma supply the area between the oceanic and continental domain is a wide transition zone (COT) rather than a sharp boundary. This end-member type of margin has been defined as non-volcanic or magma-poor margin and type-examples are the Iberia Abyssal Plain and the conjugated Newfoundland margin. Yet, at both margins, the structure of the COT and the onset of seafloor spreading are poorly defined with available data and a matter of long debate. For instance, some authors suggested that a prominent magnetic anomaly – called the J-anomaly – is not marking an age-isochron, but is mimicking the onset of oceanic crust and hence seafloor spreading. Others have proposed that the COT is actually ultra-slow seafloor spreading before the J-anomaly. Here, we present results from a new seismic refraction and wide-angle profile shot in September of 2018 aboard the Spanish research vessel Sarmiento de Gamboa in the Iberia Abyssal Plain about 20 km to the south of seismic line IAM9. Thirty ocean-bottom-seismometers and hydrophones spaced at 10-12 km intervals recorded seismic shots fired along the 360 km long profile P3. The line is roughly centred at the J-anomaly, revealing the nature of crust and lithosphere on either side. Seismic travel time data were inverted to yield the P-wave seismic velocity (Vp) structure using a least-square damped tomographic inversion procedure. To assess the nature of basement, we used two features derived from the seismic velocity structure: (i) average Vp within 4 km below basement and (ii) maximum P-wave speed in the same depth range. Results show that the J-anomaly marks indeed a major change in lithology. Thus, to the west, sedimentary cover is in the order of 2 km and average crustal velocity ranges from >6 km/s to 6.7 km/s, with a maximum velocity of <7.2 to 6.5 km/s. To the east, the basement is rugged and occurs at 5-9 km below seafloor. Average Vp is >6.6 to 7.5 km/s and maximum velocity ranges from 7.0 to 8.1 km/s. Therefore, the domain to the east of the J-anomaly seems to be dominated by serpentinized mantle as previously proposed, but the structure is more complex than the image obtained in previous sparser data sets. The domain of serpentinized mantle may include some bodies of magmatic crust and thus could either be interpreted as domain of un-roofed mantle, which had been affected by some magmatic activity as observed in the Tyrrhenian Sea or it may represent ultra-slow spreading lithosphere as observed in the Cayman Trough. The domain west of J may indicate magmatic crust, though it shows notable differences when compared to normal oceanic crust. The new higher resolution data set challenges the concepts built in numerous publications based on lower resolution geophysical images.