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Three-dimensional P-wave velocity structure of the Deep Galicia rifted margin

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In 2013, we carried out the Galicia-3D controlled-source reflection-refraction seismic experiment at the Deep Galicia rifted margin in the northeast Atlantic Ocean, west of Spain. We acquired more than 3200 km of seismic profiles within a three-dimensional (3D) box measuring 64 by 20 km (1280 km^2). The main features within this box are: the peridotite ridge (PR), composed of serpentinized peridotite; a series of fault bounded, rotated basement blocks; and the S reflector, which has been interpreted across most of the box as a low angle detachment fault forming the crust-mantle boundary. Shots from two 3300 cu.in airgun arrays fired alternately in a flip-flop configuration, with a shot spacing of 37.5 m, were recorded by four six-kilometer streamers of R/V Marcus Langseth, as well as by 72 Ocean Bottom Seismometers (OBS) of the Galicia-3D network.

We present tomographic results obtained using three well known controlled-source seismic tomography codes: the three-dimensional (3D) first-arrival time seismic tomography code FAST, and the 3D joint refraction-reflection travel-time tomography codes TOMO$_3$D and JIVE3D. Results obtained with three different codes were compared with the seismic reflection images of the area, and this comparison confirms that the main features of the area are accurately represented in all three results. The 3.5, 5 and 6.5 km/s contours match well the top of the acoustic and crystalline basements and the S-reflector, respectively. Largest differences between results of different codes occur, as expected, in poorly resolved areas. In addition, due to differences in parameterisations and inversion schemes, the same structure is expressed in three different ways in the results. Below the S-reflector, P-wave velocities indicate a degree of serpentinisation of 45 to 30 %. The distribution of the serpentinisation allows us to estimate the amount of water reaching the mantle, and suggests that the water reaches the mantle when faults are active. Our models allow us to explore the relationship between extension inferred from fault heaves and crustal thickness variations in 3D.