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Kinematic implications of last stages of rifting across the Galicia margin observed from 3D seismic data

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The west Galicia margin has been at the forefront of 2D models of breakup subsequently applied to other margins. A new 3D multi-channel seismic dataset was acquired in 2013 over the Galicia margin to understand processes of continental extension and break-up through seismic imaging using a 3D perspective. The volume has been processed through to prestack time migration, followed by depth conversion using velocities extracted from new velocity models based on wide-angle data.

We show that the most recent block-bounding faults detach downward on a bright reflection, the S reflector, corresponding to a succession of detachment faults and locally the crust-mantle boundary. Beneath the block bounding faults, the 3D topographic and amplitude maps of the S reveal a series of slip surface "corrugations", typically known to parallel the displacement direction on major exposed slip surfaces such as oceanic detachment faults. The orientation of these corrugations changes oceanward, from E-W to ESE-WNW, and remains approximately perpendicular to the strikes of the faults. We relate both the change of the orientations of the corrugations and of the strikes of the faults to a change in the slip direction during the rifting. Mapping the main block-bounding faults and measuring their heaves in the flow direction (parallel to the corrugations) reveals that the sum of the heaves slightly decreases from south to north, showing a higher displacement in the south, which is associated with a thicker basement in the north than in the south.

Rigid body rotation about an Euler pole is one of the defining kinematic features of plate tectonics. We propose that during the last stages of hyperextension, the spreading axis of the Newfoundland-Iberia conjugate margins in the region of Galicia was linked to a rotation about a pole located 80 km to the north of the 3D volume, near the apex of an inverted-V-shaped basin between the Galicia escarpment and the Galicia Bank, defined by the intersecting point of the perpendiculars to the corrugations observed on the S surface. This rotation is compatible with the northward propagation of the Northern Atlantic rift and with the variable strikes of the faults. It also explains why the faulted blocks appear much more intensely deformed and the basement thinner in the south and is consistent with the northward decreasing extension observed on summing the heaves of the faults systems.

Our results show that rifting was a complex and time-variant process that requires considering the three dimensions features of the system to better constrain the processes of thinning of the continental lithosphere at rifted margins.