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The submarine geology of the Azores Plateau – insights from marine reflection seismic and multi-beam imaging

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We investigated the marine geology of the Azores by means of high-resolution reflections seismic and multi-beam measurements during two surveys with the research vessel METEOR in 2009 and 2015. The data reveal the relationship between tectonics, magmatism and volcanism, mass wasting, sedimentation and bottom currents.

Tectonics: Several profiles across the Terceira Rift unravel its tectonic evolution. A volcanic ridge divides the South Hirondelle Basin along strike into two sub-basins. The fact that the East Graciosa Basin is rather undisturbed is consistent with the low earthquake activity of this rift segment. Assuming that no seafloor spreading occurred, the analysis of the fault geometry implies that rifting started 1-1.5 Ma. An abandoned paleo-rift south of the Terceira Rift and the present day diffuse plate boundary clearly show evidence for recent faulting.

Volcanism/magmatism: Several hundred volcanic cones are present at the flanks, on the plateau and in the Terceira Rift down to water depths of >3000m. Their imaged architecture allows establishing an evolutional history of individual cones. Those volcanic cones on the plateau that are surrounded by moat channels (so called "fried eggs") have previously been interpreted as impact features. The evolution of volcanic cones on the central plateau predated the deposition of a large magmatic sill complex. The seismic data further elucidate how volcanic islands develop.

Mass wasting: A seismic profile offshore Povoação (S. Miguel Island) shows the stratigraphy of mass-wasting deposits sourced in Nordeste. A mass flow deposit south of Pico Island has a volume of at least 100 cubic-km. Its deposition predated the proposed collapse of the late Pleistocene Topo shield volcano on Pico. Seismic and parametric echo-sounder data from the northern flank of S. Jorge Island document the mass disaggregation which increased with the transport distance. Mounded sediment bodies on the slope represent slump, which converted downslope to debris and turbidity currents, which in turn formed sediment waves off the lower slope. On the shelf of S. Jorge vertically stacked prograding clinoforms are interpreted as forced regression systems tract, implying that relative sea-level changes control accommodation space on the shelf and, consequently, sediment transport from the terrestrial hinterland into the deep sea.

Sedimentation: On the central plateau and outside the rift basins, the crystalline basement is covered by mainly conformable sediments of some 100 ms (TWT) thickness. The lower ca. 2/3 of the sequence reveals weak reflection amplitudes, the upper part strong amplitudes. We believe that the vertical transition marks the onset of subaerial volcanism.

Contour currents: Within the basins, bottom currents are deflected by volcanic ridges or controlled by fault scarps and cause the formation of drift bodies. Parallel to the contour, the currents prevent sedimentation or even remobilize (erode) sediments. The distribution of drift deposits and moats reflects a complex pattern of bottom and contour currents, which are part of the Atlantic meridional overturning circulation.