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Evidences of intraplate deformation in the West Madeira Abyssal Plain (eastern North Atlantic) from seismic reflection and multibeam swath bathymetry data

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The West Madeira Abyssal Plain is located in the eastern North Atlantic off Madeira Islands, forming part of the Canary Basin and reaching a mean water depth of 5300 m. This region is also located within Africa plate at about 500 km southwards from the Açores-Gibraltar plate boundary, and for that reason lacks seismic activity. Although this region being located in an intraplate setting, the presence of faulted sediments was reported in several works published during the eighties of last century following a study conducted in late 1970s to evaluate the feasibility of disposal of high-level radioactive wastes in the ocean. According these works, the Madeira Abyssal Plain sediments are cut by many normal growth faults and this deformation is a result of compaction and dewatering of the sediments. Evidences of tectonic deformation of oceanic sediments in intraplate settings are uncommon, but folded sediments and reverse faults extending into the basement, were recognized in the equatorial Indian Ocean and in the West African continental margin.

Recently, during 2006 multi-channel seismic reflection and multibeam swath bathymetry surveys were carried out in the West Madeira Abyssal Plain by EMEPC in order to prepare the Portuguese proposal for the extension of the continental shelf. The seismic lines were acquired onboard R/V Akademik Shatskiy using a source of 5720 cu in bolt gun array, cable length of 7950 m and shot interval of 50.00 m. The multibeam swath bathymetry was acquired onboard NRP Gago Coutinho, and allowed a high resolution mapping of the main geomorphological features. The multichannel seismic lines, oriented WNW-ESE, image the Madeira island lower slope located at about 4000 m water depth and the almost flat abyssal plain at about 5300 m water depth. These seismic lines show a thick sedimentary succession that reaches a maximum thickness of about 1.5 sec twt in the deepest parts of the West Madeira Abyssal Plain, overlying an irregular diffractive Late Cretaceous oceanic basement. This basement is outcropping in some places originating small highs, which top is placed at 4700-4800 m water depth, about 500 m above the surrounding flat abyssal plain. The acoustic facies shown by the sedimentary record suggests the presence of a great thickness of turbidites within the sedimentary succession. The sismostratigraphy interpretation allowed the identification of four distinctive seismic units named from bottom to top U1 to U4. A theoretical stratigraphic correlation model between these seismic units and the ODP 157 data (Sites 950, 951 and 952) is proposed in the present work. The oldest seismic units U1 and U2 rest above the oceanic basement and could be correlated with the Late Cretaceous to Early Miocene sediments drilled during ODP 157. The youngest seismic units U3 and U4 show a succession of very continuous and parallel reflections alternating between low and high amplitude. Such type of seismic facies could be correlated with alternating turbidites and pelagic sediments possibly of Middle-Upper Miocene to Pleistocene age considering the ODP 157 data.

The Cenozoic sedimentary succession is cut by several normal faults, close spaced, possibly related to compaction and dewatering processes. The acoustic record suggests the occurrence of fluid circulation along these faults, which are rooted in the oceanic basement. In some places these faults cut though the entire sedimentary sequence, almost reaching the seafloor. Evidences of recent compressional deformation are shown by reverse faults that affected the sedimentary sequence and also deform the seafloor by buckling and high amplitude folding. A large pop-up structure is recognized, generating a seafloor high, suggesting the occurrence of recent compressional events in the West Madeira Abyssal Plain region.