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Tectonic control and mass-wasting processes along S. Vicente Canyon (SW Iberia): evidences from multibeam bathymetry and seismic reflection data

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The S. Vicente Canyon is located in the Gulf of Cadiz (GoC), in the Northwest Atlantic Ocean, offshore SW Iberia. The GoC is located between the Straits of Gibraltar (5ºW) and the Gorringe Bank (12ºW) and 34ºN and 38ºN. It is situated in a complex geodynamic setting at the Eastern tip of the Azores-Gibraltar fracture zone, part of the convergent plate boundary between Northwest Africa and Southwest Eurasia. There are several evidences for active tectonics, moderate seismic activity and some events of high magnitude for earthquakes and tsunamis (like the 1755 and 1969 events). The canyon lies between two of the most prominent faults in the GoC: the Marquês de Pombal and the Horseshoe thrust faults.

Since the 1990's nineteen multibeam swath bathymetry surveys were carried out in the Gulf of Cadiz and a compilation of the data was produced adding up to more than 180.000km2. This 100m cellsize compilation allowed a detailed analysis of the seafloor of the GoC including the South and Western Portuguese margins and is in the junction point between these two margins that the S. Vicente Canyon (SVC) is located. The bathymetry data here presented is derived from the MATESPRO survey from 2004, the first large multibeam swath bathymetry survey in the area.

The canyon has a general staircase-like shape with the upper and lower parts trending NE-SW and the middle sector with an NNE-SSW direction. The SVC head lies very close to the shore, at depths shallower than 70m and runs towards the Horseshoe Abyssal Plain (HAP) at around 4900m depth. It extends for more than 120km (larger than any other submarine canyon on the GoC) and can reach up to 20 km in width. The walls are steep and frequently affected by mass wasting scars and also strongly incised by minor contributories valleys. A major kink is present where the canyon diverts about 60º from its upper course, as well as several minor ones and some knickpoints are also identifiable across its entire track. Across its length the morphology changes: the SE side is the steepest for the upper and deepest parts, whilst for the intermediate sector the NW wall is steeper. Its head has an amphitheater shape due to the pattern defined by its minor contributories as a result of slumps and slides and therefore appears to be retreating upslope in the direction of the shore.

Reflectivity imagery derived from the multibeam probe shows high reflectance throughout the whole of the S. Vicente Canyon thalweg indicating that the canyon and its sedimentary transport are active in present times. The HAP also shows a relatively high backscatter response, probably related to the abundant turbidite deposits whose coarse sedimentary load was partially carried by the SVC.

Inspection of several multichannel seismic profiles revealed that the two major structures that are more closely located to the canyon present a polyphase and complex history. The Marquês de Pombal Thrust (MPT), located to the NW of the SVC, reveals an extensional activity during continental break-up in the Mesozoic. The compressive episodes started in the Eocene/Oligocene (and extended until present times) and were followed by other compressive events, the more relevant ones in the Late Miocene. The Horseshoe Thrust Fault, located SE of the deepest section of the canyon, revealed no major extensional events and shows a compressional history somewhat similar to the previously described MPT. These events and the compressive history is related with the relative movement between Africa and Iberia and the tectonic plate boundary convergence.

The compressive episodes and fault activity during the Miocene have led to the uplift of this sector of the margin, causing major erosion onshore, redistributing sediments and leading to the submarine incision and canyon formation after the Miocene, more precisely in Lower Pliocene times.