



Marine terrace staircases of western Iberia: uplift rate patterns from rocky limestone coasts of central Portugal (Cape Espichel and Raso)

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The Western Iberian passive margin is under compressive tectonic reactivation resulting in spatial and temporal variations in surface uplift. This uplift can be quantified in coastal settings using staircases of wave-cut platforms developed onto rocky headlands. This study focuses on two marine terrace staircases of central Portugal: Cape Raso (west of Lisbon) and Cape Espichel (western Arrábida mountain chain). Geomorphic and stratigraphic analyses identified four marine terraces above sea level at Cape Raso area and twelve at Cape Espichel. ESR and pIRIR dating were used to develop a chronological framework for the staircases, from which uplift rates were calculated.

Using the interaction between the global mean sea-level elevations in the Quaternary and the local uplift rate (Roberts et al., 2013) the marine terraces were correlated with Marine Isotope Stages (MIS). At Cape Raso, Tm1 (+38 m) corresponds to MIS 17 (712-676 ka), Tm2 (+34 m) corresponds to the MIS 15 (621-563 ka) and was reworked during the MIS 11 (399-408 ka), Tm3 (+ 22 m) correlates with MIS 13 (533-478 ka) and was reworked during the highstand of MIS 9 (330-316 ka) and Tm4 (+9 m) correlates with MIS 7 (243 -191 ka). At Cape Espichel, a correlation was found between the relative sea-level elevations of the eight lowest terraces with several MISs (MIS 5 until MIS 17). The correlation becomes unclear for terraces older than MIS 17, translating into an apparent decrease in uplift rate towards older times. Either in Cape Raso or Espichel, the terrace staircases do not correlate in all cases with sea level high stands sequentially. For instance, the palaeoshoreline elevation of MIS 11 is higher than the palaeoshoreline of MIS 13. This suggests that marine terraces have been formed by superposition of multiple sea-level fluctuations in a long-term uplift context, but with an uplift rate low enough to allow the reworking of older shorelines during subsequent MISs.

At Cape Raso, the dating of Tm2 correlated with MIS 15 allows for an estimation of an uplift rate of ~0.07 m/ka for this coast, seemingly decreasing over the last ~125 ka. At Cape Espichel, the chronological framework of Tm5 and Tm6 allows associations with MIS 15 and MIS 11, respectively.

The estimated mean uplift rate from MIS 5e to MIS 17 was ~ 0.14 m/ka. For times older than MIS 17 (up to ca. 3.7 Ma) the uplift rate was lower than during the last ~ 125 ka (~ 0.04 m/ka). The present elevations of the late Zanclean wave-cut platform, represented by the Raso Cape Platform (~ 100 m) and the Cape Espichel (up to ~ 220 m) platforms, further express the differential uplift between the study areas for the last ~ 3.7 Ma.

References:

Roberts, G.P., Meschis, M., Houghton, S., Underwood, C., Briant R.M., 2013. The implications of revised Quaternary paleo-shoreline chronologies for the rates of active extension and uplift in the upper plate of subduction zones. *Quaternary Science Reviews* 78, 169-187.