Geophysical Research Abstracts, Vol. 8, 07794, 2006
SRef-ID: 1607-7962/gra/EGU06-A-07794

On the origin of the strait of Gibraltar

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Most interpretations of the Early Pliocene opening of the Strait of Gibraltar, which ended the Messinian Salinity Crisis, involve a tectonic process. All previous studies did not provide really convincing proof for the crucial role of tectonics in the opening of the Strait of Gibraltar during the Early Pliocene. Whereas the Gibraltar area is a topographic low, that this one corresponds to some structural feature (i. e., graben, pull-apart basin or syncline) was never proved. Indeed, numerous, contradictory fault mappings have been proposed that rely on regional tectonic interpretations but apparently not on field observations in the Gibraltar area itself. Deformation on a lithospheric scale such as roll-back subduction, producing surface uplift and subsequent gravity-induced slumping, has been also put forward as a possible cause of the opening of the strait (e.g. Duggen et al., 2003), but whatever the reality of such a process, it requires the occurrence of a topographic low in the Gibraltar area that this process does not explain. Considering that the reflooding of the desiccated Mediterranean basin cannot be ascribed to the Atlantic sea-level rise alone, especially not during the Early Pliocene (e.g. Hodell et al., 2001), this suggests an alternative process. On the other hand, it has been recognized long before that the desiccation of the Mediterranean during the Messinian has produced a vigorous incision of the drainage networks that were flowing into the Mediterranean. Messinian incision rates (up to 10 mmy-1), as the rates of inland migration of associated knickpoints (up to 10 my-1), are among the fastest of geological archives. It would be very unlikely that such rejuvenation power did not also develop, and influence the morphology of the future strait. This is all the more so as, in the surrounding areas, even small catchments display a significant incision. We present a numerical modelling of erosion dynamics showing that a drainage network may develop in the Gibraltar area. Using pertinent parameters, it shows that fluvial regressive erosion is able to penetrate within a proto Gibraltar area (as we considered

as a flat bottom of a saddle) to eventually capture the Atlantics waters (Blanc, 20002). We therefore propose that the deep cut into the threshold of Gibraltar was due to the regressive erosion of a stream that was flowing toward the desiccated Mediterranean basin, resulting in the opening of the “Strait of Gibraltar”.