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OSL surface exposure dating of wave-emplaced coastal boulders – Research concept and first results from the Rabat coast, Morocco

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Fields of wave-emplaced blocks and boulders represent impressive evidence of cyclone and tsunami flooding over Holocene time scales. Unfortunately, their use for coastal hazard assessment is in many cases impeded by the absence of appropriate dating approaches, which are needed to generate robust chronologies. The commonly applied AMS-14C, U/Th or ESR dating of coral-reef rocks and marine organisms attached to the clasts depends on a – mostly hypothetical – coincidence between the organisms' death and boulder displacement, and inferred event chronologies may be biased by the marine 14C-reservoir effect and reworked organisms. Here we discuss the potential of the recently developed optically stimulated luminescence (OSL) surface exposure dating technique to directly date the relocation process of wave-emplaced boulders. By measuring the depth-dependent resetting of luminescence signals in exposed rock surfaces and comparing it to the signal-depth profiles of known-age samples, OSL surface exposure dating may be capable to model direct depositional ages for boulder transport. Thereby, it promises to overcome the limitations of existing dating techniques, and to decipher complex transport histories of clasts that underwent multiple phases of exposure and burial.

The concept and some first results of OSL surface exposure dating shall be presented for coastal boulders from the Rabat coast, Morocco, where the preconditions for successful dating are promising: (i) Several coastal boulders show clear indication of overturning during wave transport in the form of downward-facing bio-eroded surfaces; (ii) the boulders are composed of different types of sandstone that contain quartz and feldspar, the required dosimeters for OSL dating; (iii) all boulders are of Holocene age and, therefore, in the dating range of OSL surface exposure dating. The main challenges for a successful application are the intensive bio-erosion and weathering of some surfaces exposed after transport, and the need for method calibration using surfaces with similar lithology and known exposure ages. However, in the best case, OSL surface exposure dating will provide quantitative information about the frequency-magnitude relationship of extreme wave events at the Rabat coast, in particular determining whether severe tsunami-induced flooding can be expected (e.g. during the 1755 Lisbon tsunami and similar events), or if boulders were only moved during flooding by exceptional winter storms.