Proceedings of the 2nd Croatian Conference on Earthquake Engineering - 2CroCEE
Zagreb, Croatia - March 22 to 24, 2023

DOI: https://doi.org/10.5592/CO/2CroCEE.2023.38

LATE HOLOCENE RELATIVE SEA-LEVEL CHANGE AND PALAEOEARTHQUAKES AT THE ELAFITI ISLANDS (SOUTHERN ADRIATIC, CROATIA)

Sanja Faivre [(1)], Tatjana Bakran-Petricioli [(2)], Marijan Herak [(3)], Jadranka Barešić [(4)], Davor Horvatić [(5)]

[(1)] *University of Zagreb, Faculty of Science, Department of Geography, Marulićev trg 19/II, 10 000 Zagreb, Croatia, sfaivre@geog.pmf.hr*
[(2)] *University of Zagreb, Faculty of Science, Department of Biology, Rooseveltov trg 6, 10 000 Zagreb, Croatia, tbakran@biol.pmf.hr*
[(3)] *University of Zagreb, Faculty of Science, Department of Geophysics, Horvatovac 95, 10 000, Zagreb, Croatia, marijan.herak@gfz.hr*
[(4)] *Ruđer Bošković Institute, Radiocarbon Laboratory, Bijenička 54, 10 000 Zagreb, Croatia, Jadranka.Baresic@irb.hr*
[(5)] *University of Zagreb, Faculty of Science, Department of Physics, Bijenička 32, 10 000 Zagreb, Croatia, davorh@phy.hr*

Keywords: Algal rim, Tidal notch, Lithophaga lithophaga boreholes, Coastal geomorphology, 1667 CE Dubrovnik earthquake, Palaeoearthquakes, Palaeoshoreline, Coseismic movements

In micro tidal settings, processes of bioerosion and bioconstruction can lead to the development of distinct morphological features that define the modern shoreline. When such features are discovered above or below the present-day mean sea level, they reveal relative sea-level (RSL) change. Among the best sea-level indicators on rocky coasts are fixed biological and geomorphological markers – algal rims, *Lithophaga lithophaga* borehole upper limits, and tidal notches [1, 2]. For instance, the coralline alga *Lithophyllum byssoides* can build algal rims that are considered one of the most precise RSL markers along rocky coasts [3, 4]. Consequently, studying RSL markers on Lopud, Koločep and Grebeni two elevated palaeoshorelines have been distinguished.

Their detailed survey allowed the distinction of seismotectonically uplifted sectors of the coast. The established high-resolution geochronology enables separation of coseismic uplift events from the periods of interseismic subsidence. Studying the local tectonic contribution to RSL change, we approach aspects of neotectonics and palaeoearthquakes offering new insights in a timetable (500 BC up to 1800 AD) where earthquake related data are either missing or incorporate high uncertainties, both regarding their epicentral localities and estimated magnitudes.

Our reconstruction provides evidence on two successive major earthquakes which affected approximately 5 km of coasts in the Pelješac-Dubrovnik fault zone, with an uplift amplitude between 40 and 80 ± 15 cm per event (Fig. 1). The earlier, older events, caused larger displacements (60-80 cm), while the later, younger events, revealed on average lower displacements (40-55 cm) corresponding to the 1520 AD quake and the 1667 Dubrovnik earthquake [5, 6].

Here we demonstrate the importance of *Lithophyllum* rims in the studies of RSL change as they make creation of high-resolution geochronology possible. This new approach refers to algal rims as a possible tool for constraining palaeoseismic events, allowing to supplement the database of instrumental records and historical observations through field-based evidence.

Furthermore, the study of algal rims, tidal notches and upper limits of *L. lithophaga* boreholes allow us to reconstruct the 2.6 ka evolution of Koločep and Grebeni islands and islets coasts, detect seismic events and demonstrate their effects, reconstruct the RSL changes at high resolution and finally distinguish the drivers of RSL change.

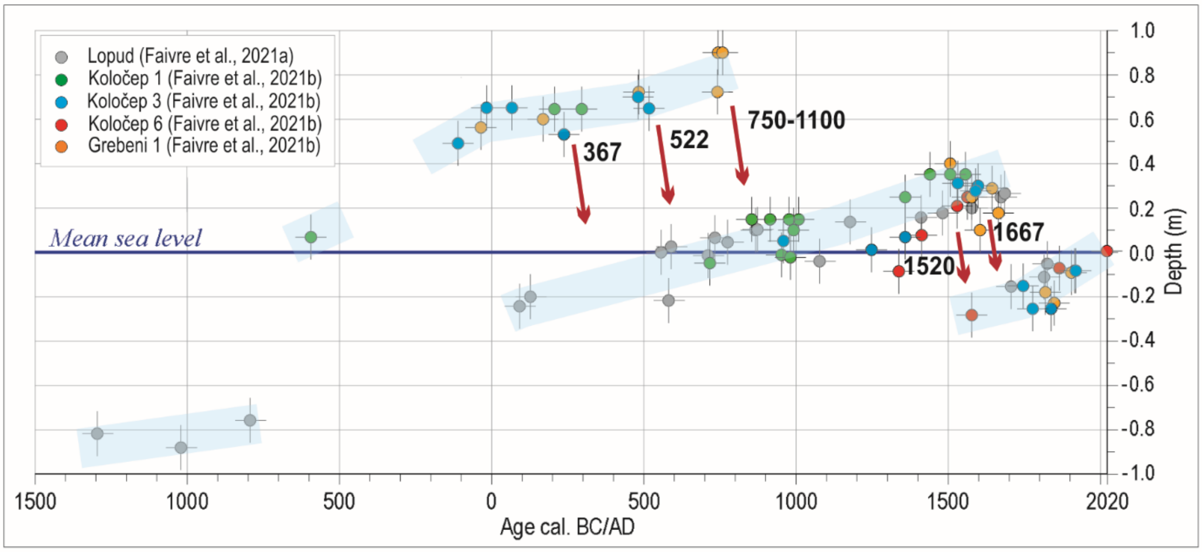

Figure 1. Relative sea-level changes at Lopud, Koločep and Grebeni island and islets based on the geochronology of algal rims. Error bars correspond to two standard deviations (2s). Blue band represents segmented linear trendlines. Red arrows mark periods of abrupt RSL fall i.e. potential seismic events [5, 6].

As the southern part of the eastern Adriatic coast is the area of highest seismic risk in Croatia, the new obtained data will thus be essential for assessment of recurrence rates of the largest earthquakes that the main faults in the area can produce, as well as for understanding of the Late Holocene geodynamics.

Acknowledgements

This research was supported by Croatian Science Foundation project HRZZ-IP-2019-04-9445 – Relative sea-level change and climate change along the eastern Adriatic coast – SEALeveL.

References

[1] Stewart, I.S., Morhange, C. (2009): Coastal geomorphology and sea-level change. In: Woodward, J. (Ed.), *The Physical Geography of the Mediterranean.* Oxford University Press, Oxford, pp. 385–414.

[2] Marriner, N., Morhange, C., Faivre, S., Flaux, C., Vacchi, M., Miko, S., Boetto, G., Radić Rossi, I. (2014): Post-Roman Sea-level changes on Pag Island (Adriatic Sea): dating Croatia's "enigmatic" coastal notch? *Geomorphology,* **221**, 83–94.

[3] Laborel J., Delibrias G., Boudouresque C.F. (1983). Variations récentes du niveau marin à Port-Cros (Var, France), mises en évidence par l'étude de la corniche littorale à *Lithophyllum tortuosum*. *C.R. Acad. Sci., Fr.*, 297 Sér. II: 157-160.

[4] Faivre, S., Bakran-Petricioli, T., Barešić, J., Horvatić, D., Macario, K. (2019): Relative sea-level change and climate change in the Northeastern Adriatic during last 1.5 ka (Istria, Croatia), *Quaternary Science Reviews*, **222**, https://doi.org/10.1016/j.quascirev.2021.107284

[5] Faivre, S., Bakran-Petricioli, T., Barešić, J., Horvatić, D. (2021a): Lithophyllum rims as biological markers for constraining palaeoseismic events and relative sea-level variations during the last 3.3 ka on Lopud Island, southern Adriatic, Croatia, *Global and Planetary Change* **202**, 103517. https://doi.org/10.1016/j.gloplacha.2021.103517

[6] Faivre, S., Bakran-Petricioli, T., Herak, M., Barešić, J., Borković, D. (2021b): Late Holocene interplay between coseismic uplift events and interseismic subsidence at Koločep island and Grebeni islets in the Dubrovnik archipelago (southern Adriatic, Croatia) *Quaternary Science Reviews*, **274**, 107284, https://doi.org/10.1016/j.quascirev.2021.107284