Investigation on coastal sand as a fortuitous dosimeter by Optically Stimulated Luminescence

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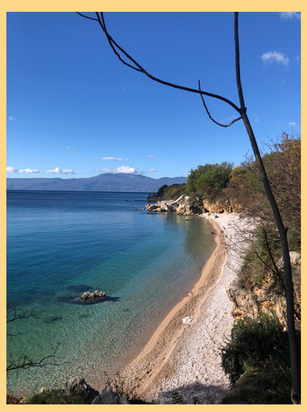
INTRODUCTION

In a mass-casualty radiological or nuclear (R/N) event, the fast triage of individuals into those who are unaffected and those requiring medical help is a high priority. Oftentimes, people who were present during such accident do not own a professional dosimeter and therefore the assessment of their exposure to ionizing radiation depends on fortuitous dosimeters[1,2].

This study focuses on the dose response of coastal sand for doses up to 5 Gy and its possible application as a fortuitous dosimeter in a R/N emergency. Although a noteworthy number of articles regarding the dating of sediments with optically stimulated luminescence (OSL) has been published[3], none investigate the possibility of using them as fortuitous dosimeters.

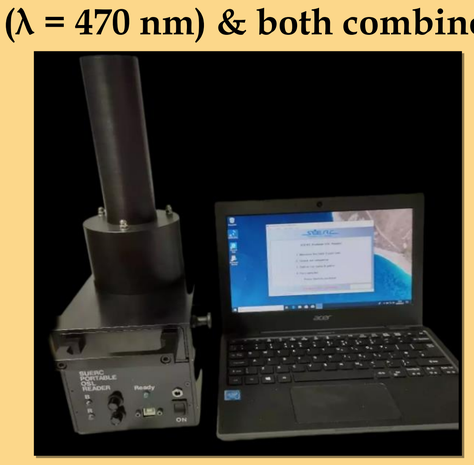
MATERIALS & METHODS

- Coastal sand from the beach Vela Plaža in Kostrena (Croatia) was collected and dried at room temperature for about a week.



- Irradiation of sand was carried out with ^{60}Co in a calibration teletherapy unit ^{60}Co Alcyon, CIS Bio International (SSDL – Secondary Standards Dosimetry Laboratory), available at RBI (dose rate = 3.26 Gy min^{-1}).

- SUERC Portable OSL Reader V.2.4 with 3 different stimulations: Infrared (λ = 890 nm) & Blue light (λ = 470 nm) & both combined



- Limit of detection (LOD) calculation from slope $\bar{S} = k \cdot D + l$ ($\bar{S}$ - average signal in a.u. , k – slope in Gy^{-1} , D – dose in Gy, l in a.u.)

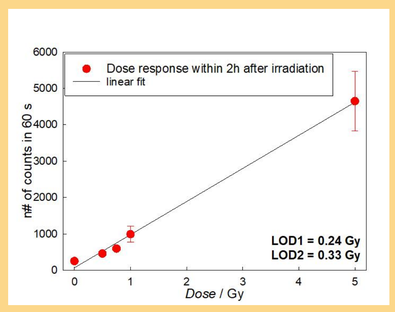
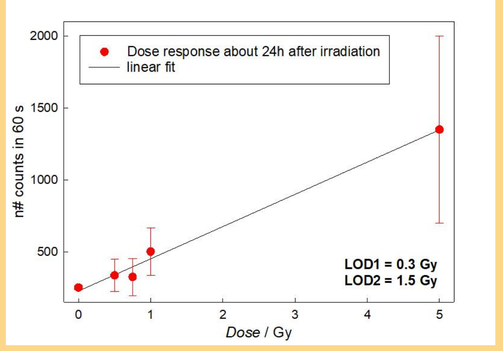
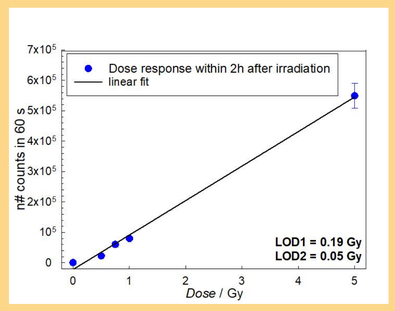
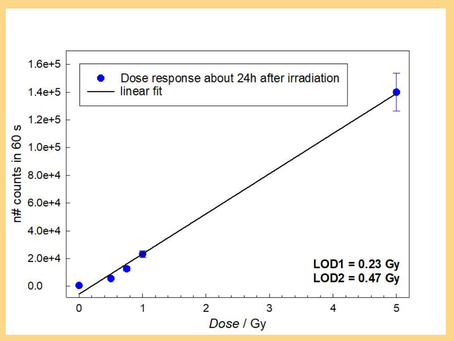
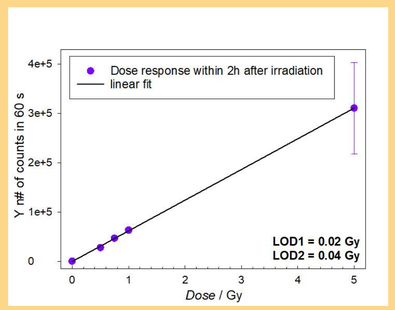
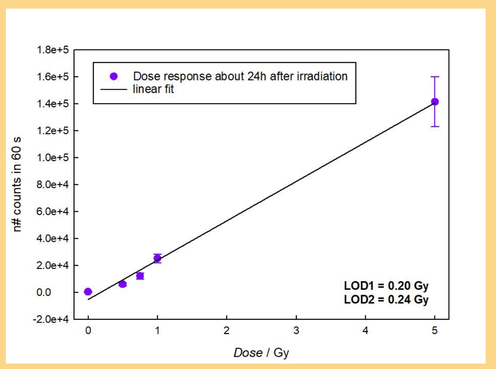
  1st method[4]: invert fit equation for $\overline{S_0}$ + 3SD (zero-dose average + 3 SD)

  2nd method[5]: $\mathrm{LOD} = \frac{\langle S_0 \rangle}{k} + 3 \cdot \frac{\langle S_0 \rangle}{k} \sqrt{\left(\frac{\sigma_S}{\langle S_0 \rangle}\right)^2 + \left(\frac{\sigma_k}{k}\right)^2}$

  ($\bar{S}_0$ - zero average signal, σ_S - SD of $\bar{S}_0$, k- slope, σ_k - SD of k)

RESULTS

The dose response curves for each stimulation (IR, B and IR+B) right after irradiation and 24 hours after irradiation are presented below with the corresponding LODs.

	within 2 h after irradiation	about 24 h after irradiation
IR		
B		
IR+B		

CONCLUSION

- Coastal sand was found to be a potential fortuitous dosimeter, considering the dose response & calculated limits of detection (LODs) within 2 h and 24 h after irradiation, although the signal faded more than 50 %
- Blue stimulation and combined stimulation give stronger response and lower LODs compared to infrared stimulation
- The data can be acquired fairly fast with the portable OSL Reader, which is crucial for the application in the case of a R/N event.

FUTURE PLANS

- Characterization of sand & comparison of different types of sand
- Harmonization with other laboratories and instruments
- Further investigation of signal stability

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