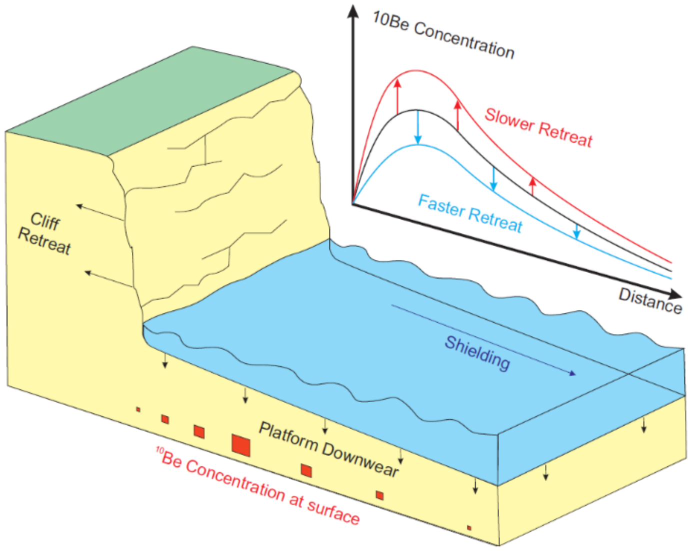
Will climate change make coastal erosion rates faster?: Comparing historic and Holocene cliff retreat rates using cosmogenic isotopes with numerical models

Supervisors: Dr Dylan Rood (d.rood@imperial.ac.uk), Dr Martin Hurst (University of Glasgow) & Dr Michael Ellis (Climate and Landscape Change, BGS)

Background: Coastal zones and associated populations and industry infrastructure are particularly vulnerable to future climate change. Current NERC-funded research (iCoast) endeavours to predict the evolution of coastal environments under scenarios of future climate change. Such models need to be both informed and trained by antecedent conditions. Historical records of cliff retreat rates are typically limited to a few decades. This period may often be shorter than the return frequency of coastal landslides and therefore such observations have limited use in establishing baseline conditions against which to assess the impact of environmental change. Additionally it is unclear the extent to which human intervention at the coast may have influenced rates of coastal change, with large-scale coastal engineering and the onset of historic record collection coinciding. Uncertainty of the extent to which recent observations of cliff retreat may reflect long term average rates in the face of stochastic coastal processes, sea level rise, climate change and human modification of the coastline, motivate alternative approaches to quantifying long-term (centennial to millennial) rates of coastal erosion. This project will combine numerical modelling and the use of cosmogenic radionuclides (CRNs) to achieve this goal.

Methods: Cosmogenic radionculides (CRNs; Granger et al, 2013) are a versatile tool for dating rock surfaces and measuring the rates at which erosion processes operate over geomorphically significant timescales (100s-1000s years). Recent pioneering studies of coastal change using CRNs have been successful in estimating cliff retreat rates averaged over several thousand years (Regard et al., 2012). Recently, the PIs have successfully measured CRN concentrations in diagenetic flint from chalk platforms in East Sussex from which they were able to interpret cliff retreat rates using a numerical model (Hurst et al., 2016). These preliminary data are the first high-precision analyses of their kind, and suggest that long-term averaged cliff retreat rates may be slower than those derived from historical surveys of cliff positions, implying that the magnitude of coastal change may be increasing.



Outcomes: This studentship would apply CRN analysis to quantify Holocene-averaged rates of sea cliff retreat for the world famous white chalk cliffs of the south eastern UK. The student will perform quantitative analysis of coastal topographic and bathymetric data, map cliff line positions and look at event scale changes in response to recent severe storms. Observed differences between long- and short-term trends in coastal change will be explored though analysis of the magnitude-frequency relationship of coastal landslides. Numerical modelling of coastal evolution will seek to quantify coastal sensitivity to varying boundary conditions such as scenarios of sea level rise, increased storminess and wave climates, informed by both historic and geomorphic (i.e. CRNs) records of coastal change. Results will be published in high-profile journals and the PhD student will have the opportunity to present major findings in at least one international conference.

Training: The ideal candidate will be interested in coastal processes, geomorphology, isotope geochemistry, and numerical modelling. **A passion for science that matters to society is critical**. This is a multidisciplinary project, with significant training in field, laboratory, analytical, and numerical methods. Fieldwork (including mapping and sample collection) will be conducted in field areas around the world; the candidate should be prepared to camp for significant periods of time and must be able to drive a vehicle. Laboratory work will involve mineral separation and chemistry preparation of cosmogenic isotope samples in Imperial's newly developed CosmIC labs; the candidate should thus be meticulous and attentive to detail. Analytical work will involve travel to the San Francisco Bay Area (USA) for Accelerator Mass Spectrometry (AMS) measurements. The student will collaborate with international project partners in academia, government, and industry, and establish skills and networking connections important for further career opportunities in any of these scientific realms.

Abbreviated References: Regard, V. *et al. Quat. Geochronol.* 11, 87-97, (2012).; Granger, D. E. *et al. Geol. Soc. Am. Bull.*, (2013).; Hurst, M., Rood, D.H. *et al. Earth Surface Dynamics*, doi:10.5194/esurf-2016-41, (2016).