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Movement of boulders and megagravel by storm waves

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Coastal boulder deposits along Ireland's west coast—which include megagravel with masses in the 100s of tonnes near sea level, and boulders > 1 t at locations up to 50 m above high water (AHW)—record extreme wave events. As their scale and elevation seem inconsistent with our current understanding of storm wave hydrodynamics, and because the deposits have been largely inactive in the last decade or so (the time span over which they have been studied), there has been controversy over whether they are moved by storms or whether they are relict tsunami deposits.

Recent data acquisition shows definitively that these rocks are moved during storms. Using repeat photography of sites on the Aran Islands and on the mainland (images taken before and after the severe storms of winter 2013-2014) we documented movement of >1100 clasts, 84 of which were $\geq$ 20 t, and 16 of which were $\geq$ 50 t. The highest elevation at which we recorded movement was 25 m AHW, and the largest clast moved at this elevation was $\sim$5.5 t. Larger clasts (up to $\sim$400 t) moved at lower elevations. Horizontal transport distances exceeded 100 m in some instances, including large dislocations of some very large clasts (e.g. a $\sim$210 t block that moved 23 m inland).

The large dataset allows us to investigate relationships between clast movements and topography. For each site, the largest clast moved represents an upper limit on the transport capacity at that site (for that set of storms). We find an inverse correlation between mass transported and height above high water, as well as a (counter-intuitive) positive correlation between boulder mass and distance inland. The strongest correlation, however, is an exponential relationship between mass and average coastal slope: the largest clasts moved over the most gently sloping terrain.

We use the term "waves" quite loosely. The clasts were transported by overland flow of ocean waters activated by storm systems, but we cannot determine whether the flow was due to breaking wind waves, infragravity waves, cliff-top bores generated by collapsed vertical jets, or some other mechanism. Given the variability in relief, different dynamics may have operated at different sites.