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Effects of high-energy events on rocky shorelines: history of megaclast emplacement and transport on a shore platform, Oahu, Hawaii

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Hawaiian Islands are subject to large swell waves, as well as very large waves associated with hurricanes and tsunami. Megaclasts of well cemented coralgal limestone have been emplaced onto a coastal rock platform by large waves near Sunset Beach, on the North Shore of Oahu, Hawaii (Noormets et al., 2002). They occur in seaward-dipping, imbricate clusters and as solitary clasts.

A series of photographs, covering the period from c. 1905 to 2000, show episodic rearrangement of megaclasts on the platform, and the appearance of new megaclasts near the platform edge. Emplacement and movements of the largest, c. 96 ton megaclast have been dated using aerial photographs. It was emplaced on the platform between 1940 and 1950, most likely by the 1946 Aleutian tsunami, and has moved twice since then in c. 30 m jumps along two different trajectories.

Wave forces at the low submerged shoreline cliff have been computed using design wave characteristics based on linear wave theory and experimental results, considering the local wave climate and near-shore bottom topography (Noormets et al., 2004). Force exerted by a tsunami has been estimated based on the 1946 Aleutian tsunami. The computed forces have been evaluated in terms of the initial fracturing along a given failure plane that is required in order for the detachment to occur. The analysis

shows that tsunami, as well as large swell waves, are capable of quarrying the megaclast, provided that sufficient initial fracturing is present. Swell waves, however, are seldom capable of emplacing large blocks onto the platform due to their rapid disintegration after breaking, so that most blocks quarried from the cliff edge fall back onto the submarine terrace. Subsequently, considerably higher wave is required to lift the megaclasts from the base of the cliff to the shore platform. Hence, dislodgement and emplacement most likely occur in an immediate succession during impact of a single wave on the shoreline cliff. Emplacement of large boulders seems to require extreme sea waves with periods longer than storms or North Pacific swells usually produce. The quarrying and movement of smaller tabular, clasts (c. 30-40 t), however, appear to be continuously ongoing processes on the surface of the rock platform. Partial detachment of clasts by marine erosion processes along joints and cracks in the limestone bedrock facilitates their complete detachment from both the platform edge and the platform surface.

Transport mechanisms on the shore platform vary, depending on megaclast shape. Sliding is a common mechanism of transport for larger and irregular megaclasts whereas somewhat smaller and platy megaclasts are occasionally found in overturned positions.

References:

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