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Towards a theory for the formation of sea stacks

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Sea stacks are isolated cliff-bound columnar islands, which are formed as shore-line cliffs are eroded by ocean wave action. We have developed a theory which aims to explain how they can be formed, and in this talk we will provide a description of the mathematical model in its present form, some analytic insights into its behaviour, and some numerical computations of the solutions.

The key idea in the model is that eroded cliffs provide shore-line debris which enhance erosive power during storms, thus providing a positive feedback which enables spatial instability of a uniformly receding cliff face. Important ingredients in the model are along-shore boulder transport, and a newly-introduced 'cliff energy length', both of which provide regularising effects on what would otherwise be an ill-posed (and thus physically meaningless) model.

We provide analytical and numerical results which may provide insight into the formation of headlands and inlets, and we also discuss the potential application of the model to the formation of sea stacks.