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Geomorphology and the Law of Unintended Consequences (Locke, 1691): Lessons from coastal weathering and erosion at Prawle (UK) and Kaikoura (NZ)

Derek N. Mottershead [a,*], Wayne J. Stephenson [b], Maree A. Hemmingsen [c]

[a] Department of Geography, University of Portsmouth, Buckingham Building, Lion Terrace, Portsmouth PO1 3HE, Hampshire, UK
[b] Department of Geography, University of Otago, PO Box 56, Dunedin, New Zealand
[c] Department of Geology, University of Canterbury, Private Bag 4800, Christchurch, New Zealand

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ABSTRACT

The sites of two field experiments based on micro-erosion metering, one in UK the other in New Zealand, were independently revisited respectively 33 and 17 years after installation. At both sites natural weathering and erosion processes had been inadvertently interrupted by the experimental works, leading to the development of new microscale landforms. These are interpreted in the context of modifications of the controls on weathering processes, leading to enhanced understanding of the processes themselves. This has lessons for the geomorphologist in maintaining a long-term watching brief over former experimental sites, lest some unintended and potentially beneficial outcome has ensued. This theme is embraced by the Law of Unintended Consequences.

1. Introduction

The concept unpinning the Law of Unintended Consequences, though not initially termed as such, has a long and distinguished history. It was apparently first articulated in the field of economic policy by John Locke (1691), who expounded the notion in the context of proposed legislation to restrict interest rates. The concept was subsequently discussed by Smith (1759), and further developed in the twentieth century in particular by R.K. Merton in the context of social science (Merton, 1936). The concept states that deliberate (purposive) action may have unanticipated outcomes that may include benefits, drawbacks, or perverse outcomes in which the outcome is the opposite of that intended. Merton explores the 'unanticipated consequences of purposive action', and identifies the causes of unanticipated consequence as ignorance, error, 'imperious immediacy of interest', basic values, and self defeating prediction, the first four of which are potentially relevant in a scientific context. He also observes that they can be found in a wide range of contexts 'from theology to technology', noting that 'no systematic or scientific analysis of it has as yet been effected'. The underlying concept thus has a venerable tradition, and is popularly described by the term Law.

In this paper we report the application and relevance of the Law to field observations in coastal geomorphology. At two contrasting locations, Prawle, South Devon, UK and Kaikoura, South Island, New Zealand, micro-erosion meter (MEM) installations and associated fieldwork disturbed geomorphic processes in the immediate vicinity. During the years and decades subsequent to the initial or intended experimental period, these intrusions have inadvertently created unexpected long-term consequences including the development of new landforms at the millimetre/centimetre scale. These unanticipated and unintended effects have, serendipitously, had beneficial consequences in permitting further insights into weathering and erosion processes at the two instrumented sites. We are pleased here to report the beneficial outcomes from two sites, each of which has independently led to increased understanding of the subject of study.

2. Prawle

2.1. Site details

At the coast near East Prawle, South Devon, UK (Fig. 1), the sites of interest are located at Horseley Cove and Langerstone Point (50.21° N; 3.70° W). Here a supratidal platform is formed in greenschist bedrock. At 1–2 m above mean high water, it lies in the spray zone of the rocky shore and is occasionally washed by storm surges. Two lithological variants are present (Floyd et al., 1993). One variant is an initial assemblage of actinolite-epidote-albite schist, the second a retrograde assemblage of chlorite-epidote-albite schist in which the chlorite replaces the actinolite to varying degrees. The former is finely laminated in character, whilst the latter includes larger prismatic subhedral crystals of up to 500–1500 μm

* Corresponding author.
E-mail address: derek.mottershead@port.ac.uk (D.N. Mottershead).

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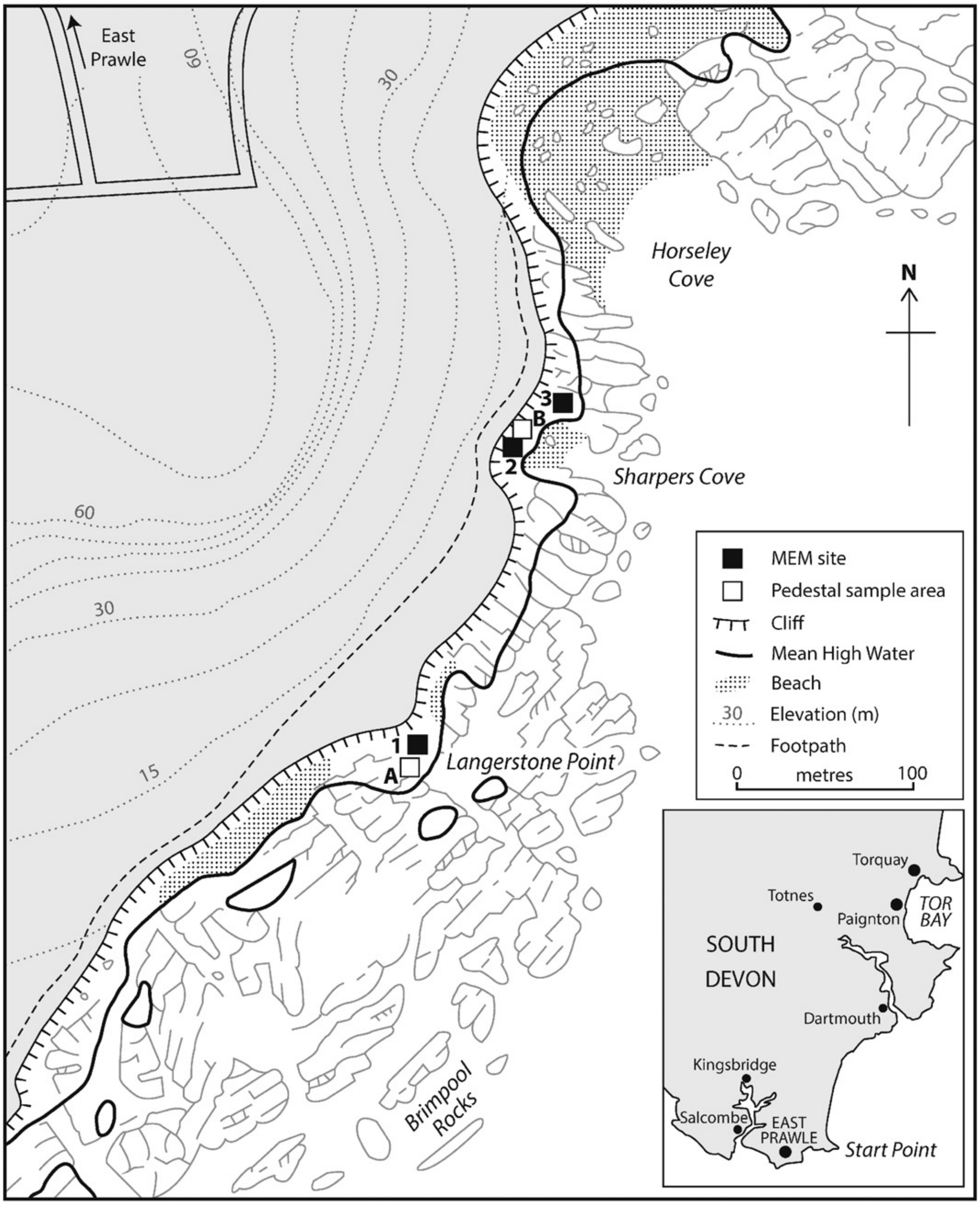

Fig. 1. Location map of the Prawle site showing the MEM stations and oil-capped rock pedestal sites in 1980.

which create a more granular texture. Initial field inspection in late 1979 revealed that rock pedestals up to 11 mm high present on the supratidal platform had formed as a consequence of protective caps of stranded oil spills (Fig. 2). The pedestals were congruent in planform with the overlying oil, which ranged from sticky tar-like blobs to runny oil which had evidently flowed across the rock surface. These features ranged in planform from ~10 mm to ~450 mm across. They had clearly developed as a consequence of protection by the oil cover of the subjacent rock from weathering and erosion. In the shore platform context small particles detached as a consequence of weathering are readily removed by wind, onshore spray and occasional overwashing by storm waves. They may be described as weathering-limited erosional landforms, at the micromorphological (Viles, 2001) or picomorphological (Brunsden, 1993) scale.

It is not known when the oil became stranded, but close examination showed that by 1979 it was breached in places on the top surfaces and had begun to recede from the shoulders of the pedestals.

The general freshness of the pedestal forms suggested that they had grown by emergence from a rapidly lowering rock surface. Accordingly MEM (Fig. 3) sites were established in 1980 (designated t_0) on the rock platform to investigate the weathering and erosion involved in their development (see Mottershead, 1982a, 1989 for details). At three sites arrays of six studs were installed (Fig. 4), such that they formed four triangles. With an off-centre probe and three possible orientations for each triangle of studs, the MEM yielded a potential twelve discrete point values per visit. A key feature of the installation was that the countersunk holes which housed the MEM studs were sealed with grease in order to protect them from exposure to weathering agents. The initial hope was that they would be sufficiently durable to permit a full year of observation; in the event, they facilitated effective continuous monitoring over a period of seven years.

2.2. Unintended consequences

In the period of regular monitoring it was observed that, during the above-average summer temperatures of the mid 1980s (Mottershead, 1989), the grease had seeped into the bedrock surrounding the