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Badlands in marl lithologies: a field guide to soil dispersion, sub-surface erosion and piping-origin gullies

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Whilst assuming surface loss dominates gully erosion invariably works well in northern Europe in the context of non-dispersive erodible materials, marl landscapes in Mediterranmean and Semi-arid contexts are more often dispersive than not. When soils are dispersive, piping is very frequently a significant geomorphological agent. To fully interpret badland form and function in rapidly erosion Mediterranean and semi-arid climatic contexts, therefore, field scientists embarking upon any investigation into the gully processes involved require assurances that the material in which the gullies are presented is not dispersive. A dispersive context means that (i) infiltration rates may be radically changing in very short periods due to swelling and deflocculation of clays; (ii) surface crusts could be the result of translocation of sodium into subsurface positions; (iii) rills may be formed or at least exacerbated by shallow subsurface erosion; (iv) large gullies with substantial up-channel headcuts, including so-called 'bank gullies', may have formed because subsurface pipes have collapsed; and that (v) network connectivity and evolution may be principally internal, being effected by subsurface pipe capture network integration; and most importantly (vi) the bulk of the sediment moving around in the landscape is not being lost from the surface. The author develops a robust argument to illustrate how because of the lack of visibility of piping in some settings, it is too easy for geomorphologists to assume the Hortonian model applies, and then set up field investigations which are not measuring what is actually happening.

This paper presents a decision-support tool to assist the effective diagnosis of a landscape's principal genetic process suite. The soil's behaviour in response to its geochemistry in marls with high exchangeable sodium percentages (ESPs) is outlined in simple terms with mimimumuse of laboratory or field chemical investigations. Using examples the paper then presents a simple set of form indicators that can be used in the field to diagnose the possibility that subsurface process are dominating landscape erosion. Surface crust character, ephemeral rills, and large subsurface tunnel settings are explained and classified. In a final section, the geomorphological implications of piping in gullied landscapes are finally explored by reference to literature on connectivity.