Granite geomorphology and its geological controls, Serra da Estrela, Portugal

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1. Introduction

Geological factors are amongst the fundamental controls in the evolution of landscapes and are therefore central to geomorphological interpretation. One of the approaches used to assess rock control at a regional scale could be to compare geomorphometric characteristics and landform assemblages of adjacent terrains underlain by different rock types and, if they are different, to use this evidence to argue for an influence of rock properties on the rates and directions of geomorphic change through time (e.g. Kühni and Pfiffner, 2001; Grebby et al., 2010; Zhang et al., 2013). Within this framework differences in altitude are interpreted as either the result of differential rock-controlled erosion or the consequence of spatially varied uplift and subsidence. Among common rock types, granite is often cited as one that supports very distinctive assemblages of landforms (e.g. Thomas, 1974; Godard, 1977; Twidale, 1982; Gerrard, 1988; Godard et al., 2001; Twidale and Vidal Romani, 2005; Migoń, 2006). Boulders, tors and inselbergs, although not restricted to granite, are characteristic for most granite terrains, whatever the climatic conditions.

Less emphasis has been given to geomorphic variation within granite terrains. In many studies it has been demonstrated that jointing patterns guide exogenic processes and hence, exert considerable control on the shape of individual landforms, whether convex (domes, tors, boulder fields) or concave (basins, valleys, channels). Recent reviews are provided by Godard et al. (2001), Twidale and Vidal Romani (2005), and Migoń (2006), each summarizing a wide range of site-specific publications from different settings and published in different languages. By contrast, the influence of lithological variation has been seldom addressed, although a significant contribution to the understanding of the role of lithology has been made by the French school of structural geomorphology, as summarized by Lagasquie et al. (2001). The granite family in fact includes rocks of varied compositions (Streckeisen, 1976), hence with different proportions of minerals of varied susceptibility to weathering, and an equally wide range of textures. Fracture density also varies considerably. Since both rock composition and fracture patterns influence the intensity of exogenous processes acting upon rock surfaces and rock masses underground via deep weathering, there are good reasons to assume that different lithological variants of granite may be associated with different types of terrain. In a number of studies such relationships have been indicated. For example, Flageolet (1977, cited in Godard et al., 2001) showed that in Limousin, France, higher altitudes correlate with decreasing plagioclase and, especially, biotite content, while Lagasquie (1984) presented evidence that granodiorite ranks as less resistant than monzogranite in the French Pyrenees and preferentially occupies topographic hollows. Pye et al. (1988) have demonstrated that inselbergs in the Kora area of Kenya tend to occur in potassium-rich granites, a finding confirmed in several