



Factors controlling granitic cavernous weathering forms in a Mediterranean island: the case of Naxos island, Aegean Sea, Greece

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With 12 figures, 3 tables and 1 appendix

Abstract: The aim of this paper is to determine the controlling factors and processes of granitic cavernous weathering development in a Mediterranean island focusing to the case of Naxos Island, Aegean Sea, Greece. At the western part of the island, a granodioritic rock has been weathered to a variety of well-developed cavernous forms. Almost 200 of those forms were randomly examined through a detailed geomorphological, mineralogical and geochemical investigation. Visual, morphometric and analytical data have revealed their evolution. Boulders of the wider area constitute the incipient formation, where honeycombs and tafoni genesis and growth take place. Their development in Naxos Island is controlled by a combination of factors, which recapitulate to the mineralogy, mineral chemistry, microbial activity, microclimatic regime and the seawater-spray presence from the adjacent shores. The increased presence of exfoliated micas and gypsum along with the presence of halite at littered rock fragments suggests that weathering, due to sea moisture and seawater spray, plays an important role in the development of these cavernous weathering features. The softening of the rock is intensive, especially inside cavities, whereas fractures facilitate the draining and loose material is removed due to salt crystallization, which subsequently provokes mainly biotite and eventually plagioclase weathering. Furthermore, biotite alteration may be a key factor not only for their formation but for the yield of iron bearing bacteria in the cavities. The growth of iron rich bacteria in between biotite flakes may contribute to mineral break down producing more cracks and cavities on the rock surface.

Keywords: cavernous weathering; honeycombs; tafoni; micas; exfoliation; cavities; granite weathering; iron bearing bacteria

1 Introduction

Cavernous weathering is related to the ‘hollowing-out of rock outcrops and boulders’ (Turkington & Phillips 2004). It is most commonly noted in sandstones, limestones, granites, tuffs (Paradise 2013, Mottershead 2013). It results into two main forms: alveoli (honeycombs) and tafoni (Turkington 2004). Alveoli are closely spaced cavities of several centimeters in size, separated by narrow walls, and their overall structure is reminiscent of honeycomb (Turkington 2004, Bruthans et al. 2018, Klimchouk 2018). Tafoni are cavernous weathering features, that have arch-shaped entrances, concave inner walls, overhanging margins (visors) and rather smooth, gently sloping, floors covered in debris (Cooke et al. 1993, Mellor

et al. 1997, Turkington & Phillips 2004). Their size is variable from centimeters to several meters in diameter and depth (Turkington 2004), while larger dimensions have recently been reported by Migoñ & Maia (2020) in northeastern Brazil, with tafoni 30–50 m long and up to 20 m high. The origin of both forms remains under discussion (e.g., Turkington 2004, Bruthans et al. 2018) and their distinction is mainly based on shape and size; honeycombs have commonly a diameter of few centimeters and a width less than 1 m, while tafoni can reach several meters in size (e.g., Roqué et al. 2013, Migoñ & Maia 2020). Due to these discrepancies and the different characterization among researchers, Groom et al. (2015) proposed for all of these forms the use of the single term ‘tafoni’. In this work, we adopt the distinction of these