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The power of moisture: ‘under and over ‘weathering’ and the ‘umbrella effect’

El poder de la humedad: la "meteorización" por debajo y por encima y el "efecto paraguas"

Charles Rowland TWIDALE

Department of Geology and Geophysics, School of Physical and Earth Sciences, University of Adelaide. Australia.

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Abstract

Water is the supreme agent of weathering and even small amounts even moisture, can have far-reaching impacts.

Key words: granitic geomorphology, weathering, humidity, umbrella effect

Resumen

El agua es el agente supremo de la meteorización e incluso pequeñas cantidades, incluso de humedad, pueden tener impactos de gran alcance.

Palabras clave: geomorfología granítica, meteorización, humedad, efecto paraguas

WATER AS A WEATHERING AGENT

Water in its various states is a significant agent of weathering and erosion, but especially as a cause of chemical weathering or etching, both at the surface and underground. Because of its molecular structure and size water is the supreme solvent, as well as an important reactant that disrupts crystal lattices, causing alteration (MASON 1966; YATSU 1988). Hydration or water pressure wedging and hydrolysis (reaction with silicate minerals are significant weathering processes and biotic contributions add to the aggressiveness of soil moisture (e.g. HIEBERT and BENNETT 1992). But 'Solution is essential to chemical weathering' (LOUGHNAN 1969, p. 61). As demonstrated for instance by ALEXANDER (1959) even quartz, the most stable of the common rock-forming minerals eventually is dissolved in moist soils and regoliths. Moreover, and as noted by LOGAN (1851, p. 326), small amounts of water, of moisture, have noticeable impacts.

MOISTURE AND 'UNDER AND OVER' WEATHERING

This last is exemplified by a consideration of the granite boulder shown in Figure 1a, that stood in isolation on an etch platform at the northern end of Tcharkulda Rock, a low block- and boulder-strewn granite residual located some 4 km east of Minnipa, on North Western Eyre Peninsula (Figure 2). The granite comprises 60-65% K-feldspar, 30-35% quartz, and minor plagioclase and mica (FERRIS *et al.* 1998).

The boulder was levered aside to reveal a tafone shaped in its base or underside and two concentric circular rims, the innermost with a cover of mixed mineral and organic detritus on the platform (Figure 1b). It is surmised that moisture was retained in the sheltered fracture -initiated interface between platform and boulder. It attracted biota, and also reacted with the mica and feldspars in the granite to produce hydrophilic clays that expand on contact with water and rupture the rock (hence physicochemical weathering) forming the thin slivers that constitute laminated granite. Haloclasty and carbonic acid may have contributed – the ocean is located to the west and there are *salinas* to the north in the Corrobinnie Depression (BOURNE *et al.* 1974; BINKS and HOOPER 1984; TIMMS and RADFORD 2015), and calcarenitic coastal dunes have sourced carbonaceous dust and a widespread calcrete carapace (BOURNE and TWIDALE 2016) but most of the weathering can be attributed to physicochemical processes.

The inner walls of the hollow or tafone are flaky, suggesting that the hollow expanded as attenuated lenses or layer upon layer of rock was loosened and fell away (e.g. DRAGOVICH 1969; BRADLEY *et al.* 1978). The veneer of mixed mineral and organic detritus within the inner circle preserved on the platform beneath the boulder, when moist rendered even more aggressive the sedimentary veneer that is responsible for the shallow bedrock basin scored in the platform. Thus, the upper hollow was matched by a shallow basin, as a consequence of what might be called “under and over weathering”

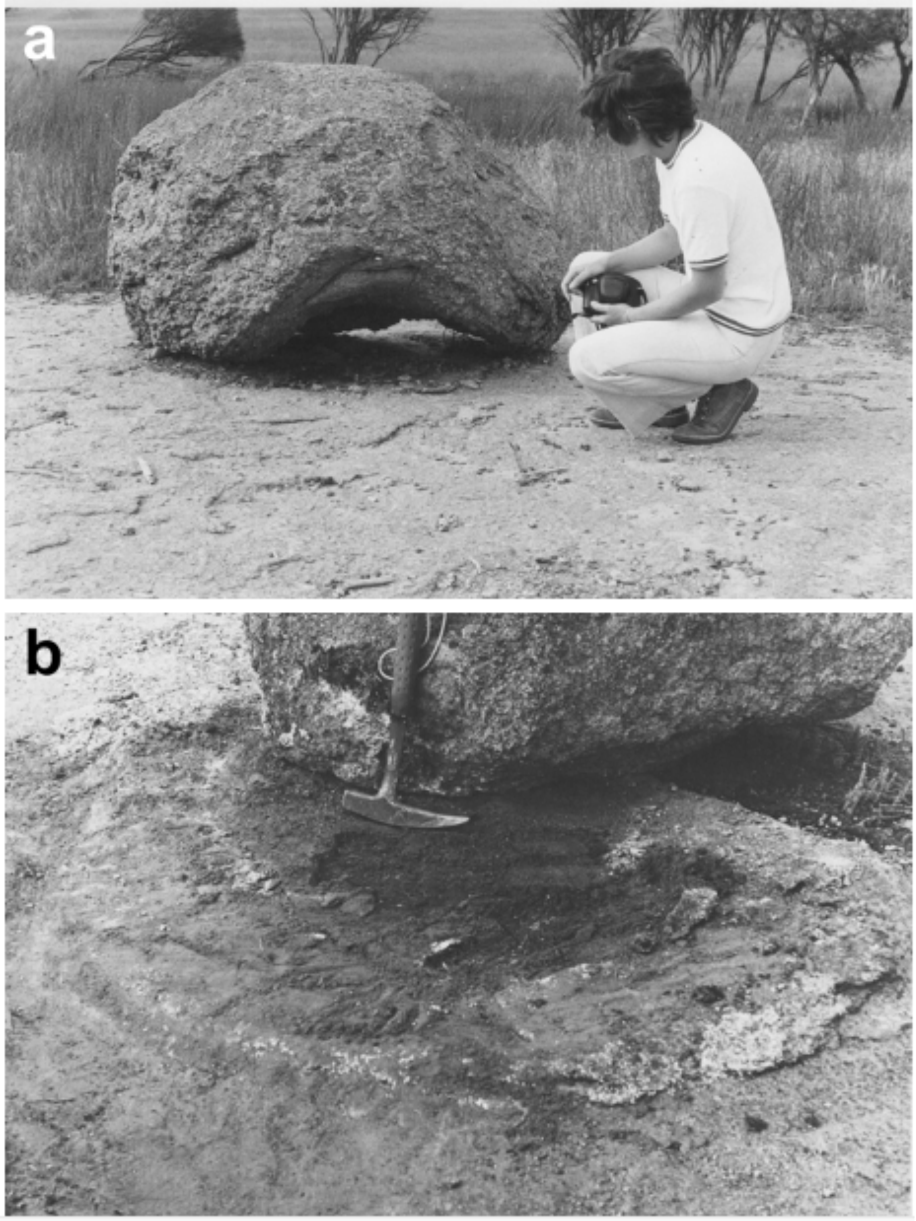

Figure 1. (a) Granite boulder with hollowed base on a platform at the northern end of Tcharkuldu Rock, near Minnipa, North Western Eyre Peninsula, South Australia. It was levered aside to reveal (b) its natural resting place, with boulder separated from platform by fracture in which was retained moisture that attracted biota and which caused weathering in the base of the boulder above (tafoni) and in the platform below (basin).

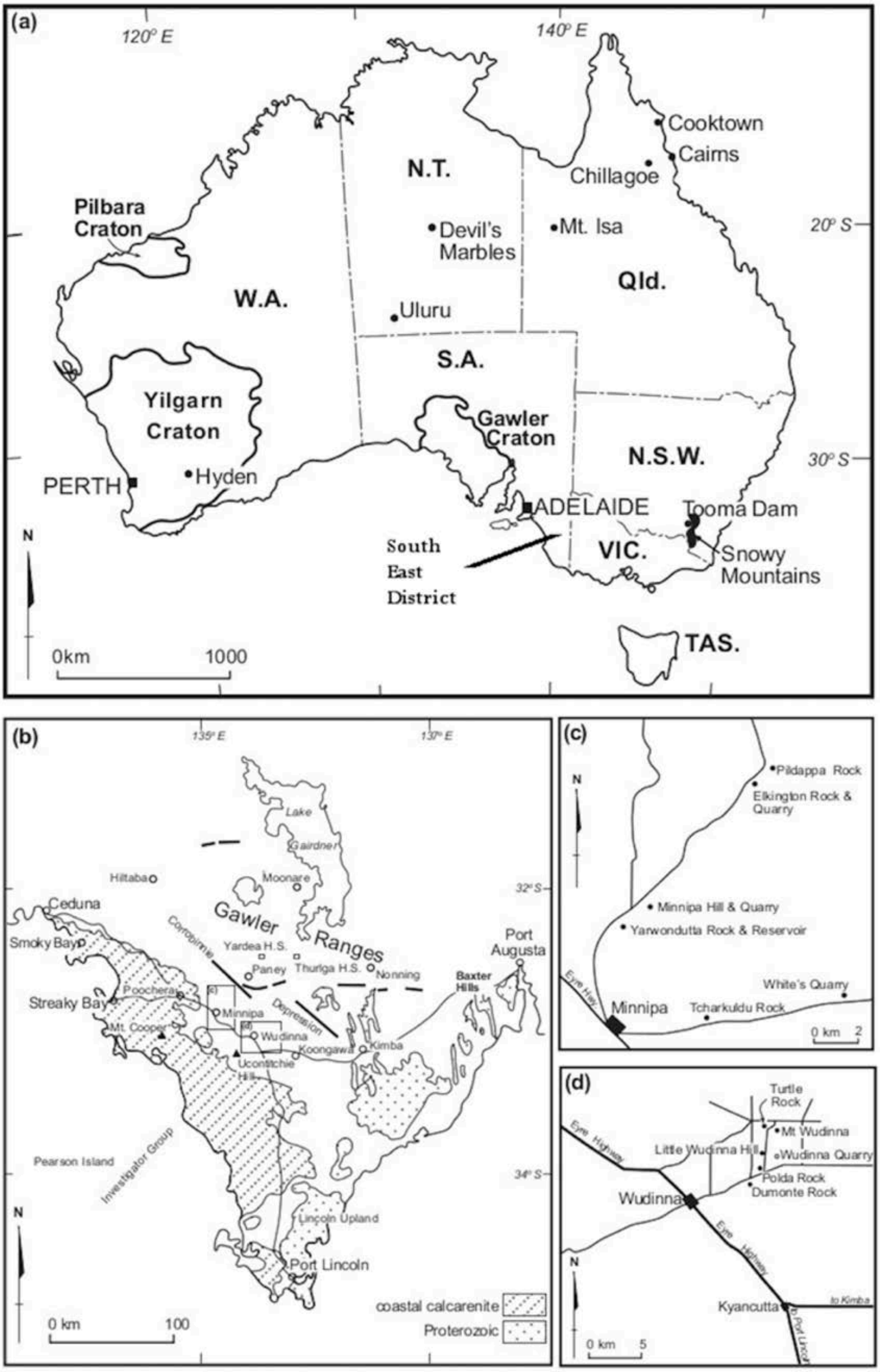

Figure 2. Location maps.

THE 'UMBRELLA' EFFECT

The outer circle outlines the narrow zone impacted by water dripping from the outer or lateral limit the boulder, the plan shape of which it mimics. The underside of the boulder is sheltered by the mass of boulder - an umbrella effect - but the splash zone is weathered and creating a circular depression or 'moat' that attracts run off from the adjacent areas (Figure 3).

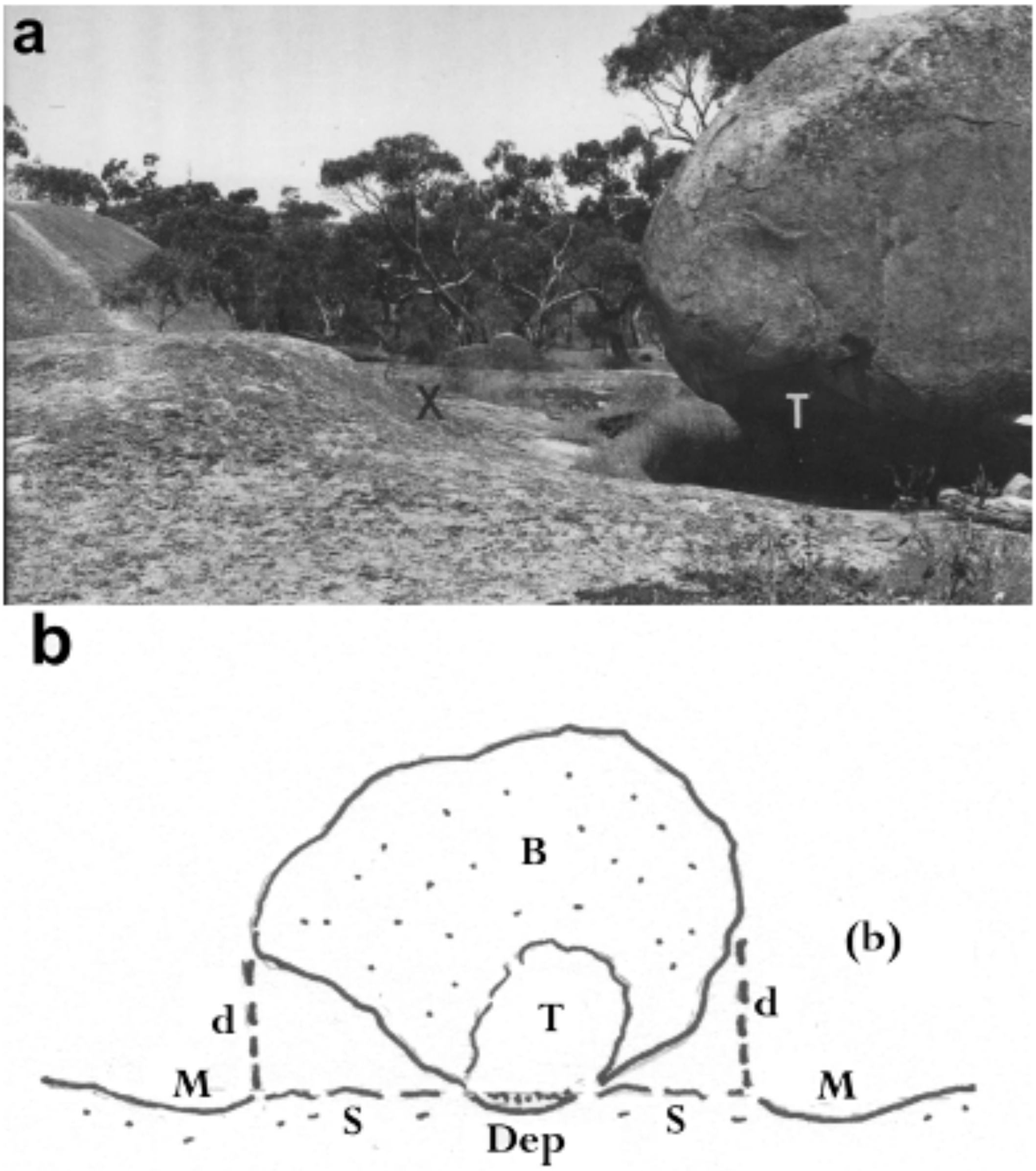

Figure 3. (a) Boulder and moat at Tolmer Rock, in the South East District of South Australia X – moat, T-tafone. (b) Diagram illustrating the umbrella effect: B -boulder, T -tafone, Dep -depression/basin with detritus, M – moat, s- sheltered surface, d – drip.

WIDER IMPLICATION

This small assemblage on Tcharkuldu Rock illustrates the impact of even small amounts of water, for though the features discussed are minor, the same processes acting in a similar situation, but over longer periods, have generated similar basin and hollow assemblage at an altogether larger scale (e.g. Figure 4).

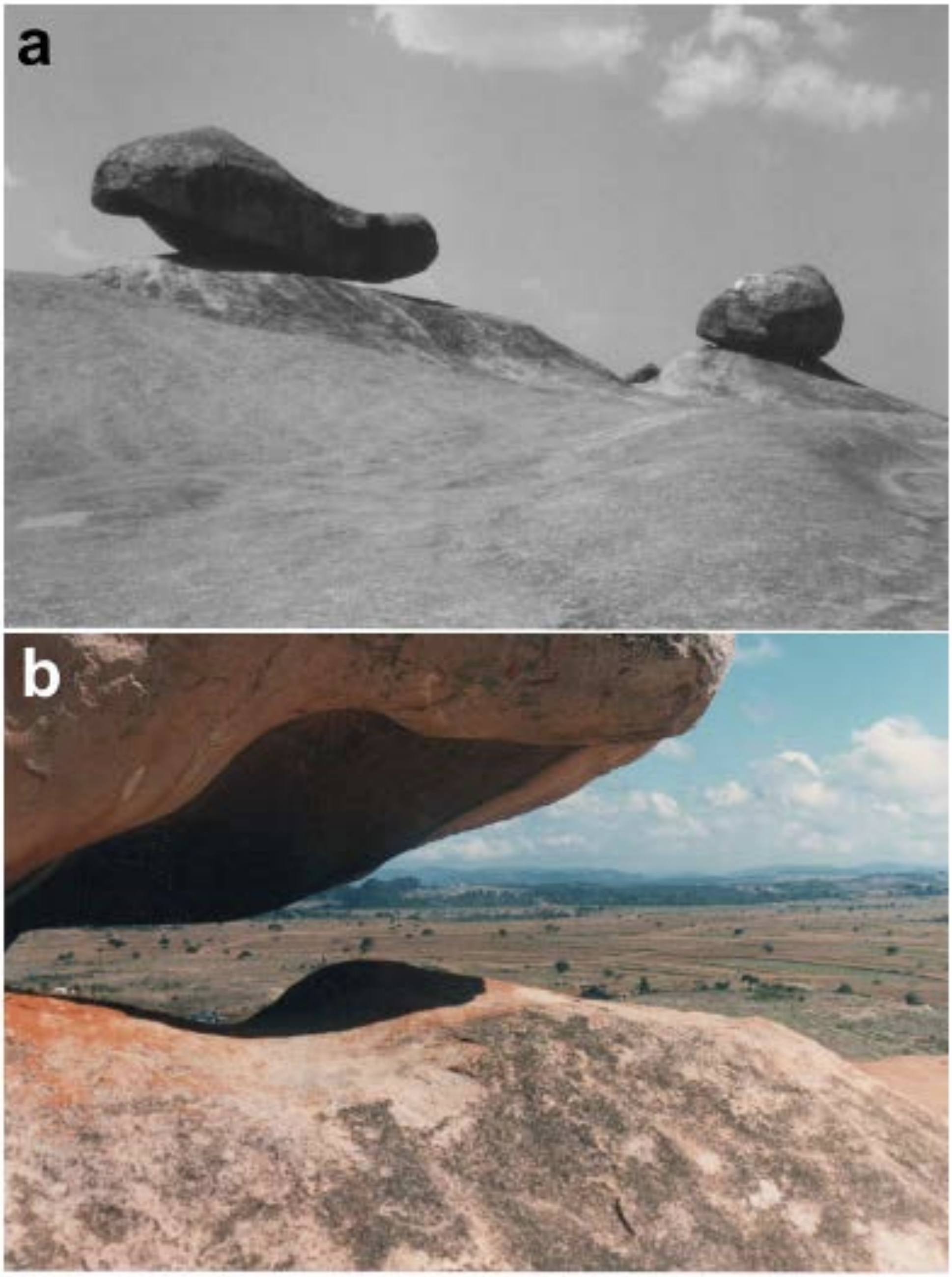

Figure 4. (a) Pedestal and perched rocks on the crest of Domboshawa, a large granite inselberg near Harare, Zimbabwe. (b) Detail – a larger scale example of 'under and over' weathering by moisture in the nearer of the two residuals.

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