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"OBSCURE" REFERENCES: A CAUTIONARY TALE

[Referencias bibliográficas oscuras: una historia con moraleja]

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RESUMEN: Algunos conceptos que han llegado a ser importantes para la interpretación de las formas del relieve y del paisaje fueron publicados por primera vez en medios locales y de forma poco clara, mencionados de pasada, o aparecen recogidos en algún volumen o en alguna nota al pie o apéndice, antes de ser redescubiertos de nuevo e incorporados como parte de los cánones geomorfológicos. En algunos casos, las observaciones que han llevado al establecimiento de nuevos conceptos fueron expuestas hace decenas o incluso cientos de años. Pero una nueva idea es siempre una nueva idea, independientemente de la época en que se descubra. Aunque no se niega la importancia de la experimentación y de la confirmación de los hechos, la justicia natural nos llama a reconocer a aquellos que, por primera vez, vislumbraron los diversos conceptos que han sido establecidos.

Palabras clave: Orígenes oscuros, viejas fuentes de información, ideas olvidadas, procesos científicos.

ABSTRACT: Several concepts that have come to be significant in the interpretation of landforms and landscapes were first published in obscure local outlets, mentioned in passing, or tucked away in a large tome or in a footnote or appendix, before being revived or discovered anew and developed as part of the geomorphological canon. In some instances, the observations that led to new concepts were first aired decades or even centuries ago. But a new idea is a new idea, whenever it was discovered. Although the importance of testing and corroboration is not denied, natural justice surely calls for the recognition of those with whom the first glimmer of the various concepts originated.

Key words: Obscure sources, old sources, neglected ideas, scientific process.

What is now proved was once only imagined (Blake, 1792-1793: 36).

In science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs (Darwin, 1914: 9).

INTRODUCTION: REMOTE AND SELF-SUSTAINING SCIENTIFIC COMMUNITIES

Modern communications are immediate. Complicated papers can be transferred electronically half way across the world at the touch of a key or button.

It was not always so. Communities were not necessarily isolated but were in many instances remote from major centres of learning, so that scientific correspondence, address and reply, was conducted over a period of weeks or months. The writer recalls meeting the distinguished geomorphologist C. A. Cotton in Wellington, New Zealand in 1955, and his stating that the greatest boon in his professional lifetime was the introduction of airmail, which had reduced the exchange of letters between his homeland and Europe or North America from several weeks or even a few months, to 10-14 days.

This remoteness factor also encouraged, or even compelled, a measure of self-sufficiency. One result was the establishment of local or regional societies that acted as forums for people of similar interests. For example, the Dutch established the Verhandlungen Genootschap van Kunsten en Wetenschappen based in Batavia, the chief city of Java (now Jakarta, Indonesia) and the *Journal of the Asiatic Society* was founded in Calcutta by the British colonists, in order to publish scientific papers concerned with various aspects of the natural history, viewed eclectically, of southern and southeastern Asia. In Australia, Royal Societies were established in each of the States. The societies were concerned with the natural sciences sensu lato. (Indeed, the Royal Society of South Australia began life as the Philosophical Society at a time when the term "philosophy" covered all scientific endeavours.) They also held regular meetings at which papers were presented and discussed, and each published a journal –Papers, Transactions, Proceedings– comprising original articles, most of them concerned with local features.

However, the Australian state societies and journals have experienced difficulties in recent years and continue to do so. There are two reasons. First, communications have improved out of all recognition and it has become as easy and economical of time for an Australian author, for example, to send a paper to a journal in London, Chicago, New York or Salamanca, as it was to contact an editor in Melbourne or Sydney. Second, the sciences became more specialised, and this was reflected in the character of groups, meetings, and publications. The generalist societies and journals were left in "no man's land" together with diminishing memberships and readerships.

This is not to suggest that only minor papers were offered for publication in the broad-interest local outlets. On the contrary, some authors wished to support the societies and their publications, and in an effort to maintain and support them, offered earth science papers, for example, with new ideas as well as data, papers that in many instances could have been placed in better-known journals. What is disconcerting, and concerning, is that such local and regional general publications have come to be regarded with disfavour, and in particular as "obscure" and "old". Pejorative comments have been made because papers have been published in what are evidently considered to be "obscure" journals.

WHAT IS MEANT BY "OLD" AND BY "OBSCURE"?

Papers published long ago and in out-of-the-way contexts are now habitually overlooked by many modern workers. As a result, not only is "reinventing the wheel" not uncommon (e. g. Twidale, 2004) but several conclusions and ideas now recognised as useful and in some instances significant or even basic, were first aired in such unfashionably local or ancient outlets. But what qualifies as "old" or as "obscure" and how is obscurity attained?

Antiquity appears to date from 1990 or thereabouts and appears to refer to pre-electronic times before which, apparently, nothing worthwhile was thought or published. Obscurity, on the other hand, implies an unexpected or not readily available source. The journal may have been discontinued, the book out of print. The journal may be regional rather than national or global. Ideas may have been launched in a Festschrift, thematic journal issue, or other irregular publication, or it may have been mentioned incidentally, or in a letter to the Editor (as with Lamplugh's introduction of the term "calcrete" in 1902), or in an appendix, or in a review. Thus Matthews (1831) anticipated Darwin's *Origin of Species* (1859) but his brief, incidental reference to natural selection appeared in an Appendix to a book on arboriculture (Dempster, 1983). Similarly, the feature under discussion may be referred to by a synonym, as for instance A-tent or pop-up (Twidale & Bourne, 2009); or singing, booming, whistling, sounding or "sonorous" (Lowe, 1902) sand for quartz sand that emits a noise when in motion. It may have been named according to an interpretation which at the time seemed sound but which later was queried or revised. For example, the appropriateness of "offloading joint" to indicate the arcuate fractures that define thick slabs cutting across sundry other structures and textures has been called to question (e. g. Gilbert, 1904; Dale, 1923; Twidale *et al.*, 1996). The article under review may have appeared some years ago in a journal, the original ambit of which bears no relation to the type of papers now sought or published, or because language has changed its meaning (as with "philosophical"). Data and interpretations may be lodged in a thesis that is not readily available.

It can be argued, and cogently, that authors who do not qualify as what Sherman (1996) called geomorphological dudes, that is, currently influential personages, or are not associated with one, more frequently attain obscurity. On the other hand, some may prefer that condition, just as Degas is said to have wished to be "illustrious but unknown". Certainly, obscurity can be self-imposed. Not all authors spell out and develop their ideas in print, much less trumpet a new concept. The ages of reticent achievement have all but disappeared. Indeed, when A. A. Öpik (Professor of Geology at Tartu, Estonia, prior to World War II but later serving with what is now known as Geoscience Australia) was asked why he had not pointed out certain implications of one of his palaeontological papers (Öpik, 1967), he replied that he liked to leave his readers to draw their own conclusions!

But whatever the reason, obscurity, a lack of headlines, is no excuse, much less a justification, for neglect. Examples of important ideas that have been overlooked, in part at least because of the place and time of their publication are cited, mainly from the geomorphological literature.

EXAMPLES AND VARIETIES OF OBSCURITY

SEAFLOOR SPREADING

A notable example of casual and obscure citation pertains to the plate theory (Vine & Matthew, 1963; Morley & Larochelle, 1964) a vital part of which is the evidence pointing to seafloor spreading. This concept also provides an example of the germ of an idea being overlooked, in part because of its place of publication. In addition, the idea was ahead of its time and minds possibly were not prepared to contemplate so revolutionary an idea: chance only favours those who are prepared (Pasteur, according to Roscoe, 1910-1911). Seafloor spreading is a vital component of the continental migration concept and is driven by injections of lava into the upper crust or lithosphere from the mantle and asthenosphere. The idea is usually attributed to Hess (1962) and it appeared in a Festschrift in honour of A. F. Buddington, published by the Geological Society of America. In 1931, however, Holmes had published a paper concerned with radioactivity in which he included a diagram (figure 1) which, had it appeared 30 years later, would have been accepted

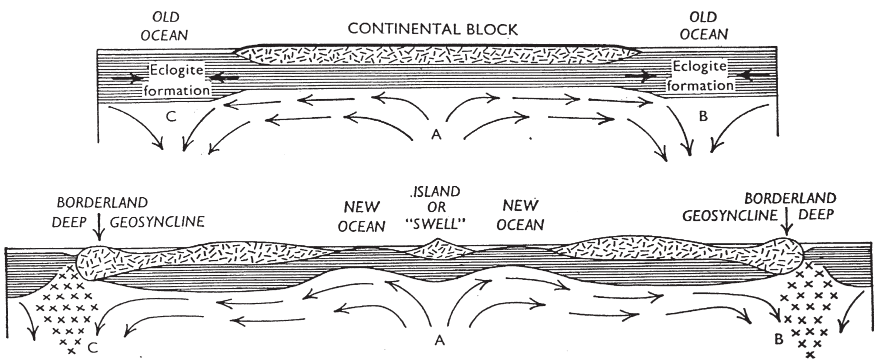

Figure 1. Holmes' 1931 diagram showing what is now called seafloor spreading (after Holmes, 1931: 579).

as demonstrating seafloor spreading (see Meyerhoff, 1968). But Holmes did not give the idea an evocative name or title and his paper appeared in the Transactions of the Glasgow Geological Society and escaped wide notice.

TECTONIC TERRAINS: THE GULFS REGION OF SOUTH AUSTRALIA

The continent of Australia is located distant from plate boundaries and is not subject to major earthquakes. On the other hand, the continent is moving NNE at a measurable rate. In a structurally and rheologically heterogeneous mass of rock such movement has induced stresses and strains sufficient to cause frequent and widely distributed seismic events. However, though the entire continent is constantly joggling (e. g. Hills, 1956, 1961; Twidale & Campbell, 1995: 20; Twidale & Bourne, 2004), the southwest of Western Australia and the Gulfs region of South Australia are the two areas subject to the most frequent and intense earthquakes. This has been known for some time.

That the Mt Lofty Ranges is a horst block was suggested by Benson (1909, 1911) and by Howchin who in a letter to J. T. Jutson, dated 19 May 1911, cited "large scale block faulting" as contributing to the "making" of South Australia (Brock, 1977, II: 103). This was confirmed by Fenner (1930: 15, 1931) who described it as severely block-faulted (figures 2a & 2b), envisaged it as part of the "South Australian Shatter Belt", and cited evidence of geologically recent dislocations (disturbed ?Pleistocene alluvia). His interpretation of the summit surface that is prominently preserved in the Ranges was in error, being unduly influenced by Professor D. W. Johnson, the distinguished geomorphologist then visiting from Columbia University; but Fenner's tectonics were sound. Thus, he realised (Fenner, 1930: 34-35) that in the Murray Basin, uplift of the Marmon Jabuk structure had caused the westward diversion of the River Murray at Mannum.

Later workers detailed and corroborated the suggestion that the Gulfs region is a tectonic landscape and clarified the nature of the faulting (e. g. Sprigg, 1942, 1945, 1946; Miles, 1952a, 1952b; Campana, 1958a, 1958b; Johns, 1961; Crawford, 1965; Williams, 1973; Bourman & Lindsay, 1989; Dunham, 1992; Sandiford, 2003). They also confirmed that the region is still tectonically active (Love *et al.*, 1995; Twidale & Bourne, 2000, 2003; Sandiford, 2003; Quigley *et al.*, 2006). But Fenner it was who, alerted by the identification of fault scarps by Benson and Howchin plotted the topographic expressions of crustal dislocations to make a plan pattern that is still accepted. Despite a proposal to have the period of Late Cenozoic earth movements named after Sprigg (Sandiford, 2003: 118), it was Howchin and Fenner who linked earlier recognised local structures and identified the tectonic character of the Gulfs region landscape. Though anticipated as early as 1911, Howchin's conclusions appeared in print in his locally printed texts (e. g. 1929: 240-255) and Fenner's keynote statements were published in the local Royal Society Transactions and in a general geographical text (Fenner, 1930, 1931). They were published about 80 years ago. Today Howchin's and Fenner's publications are forgotten by all but those students now of mature years whose eyes were opened by their texts.

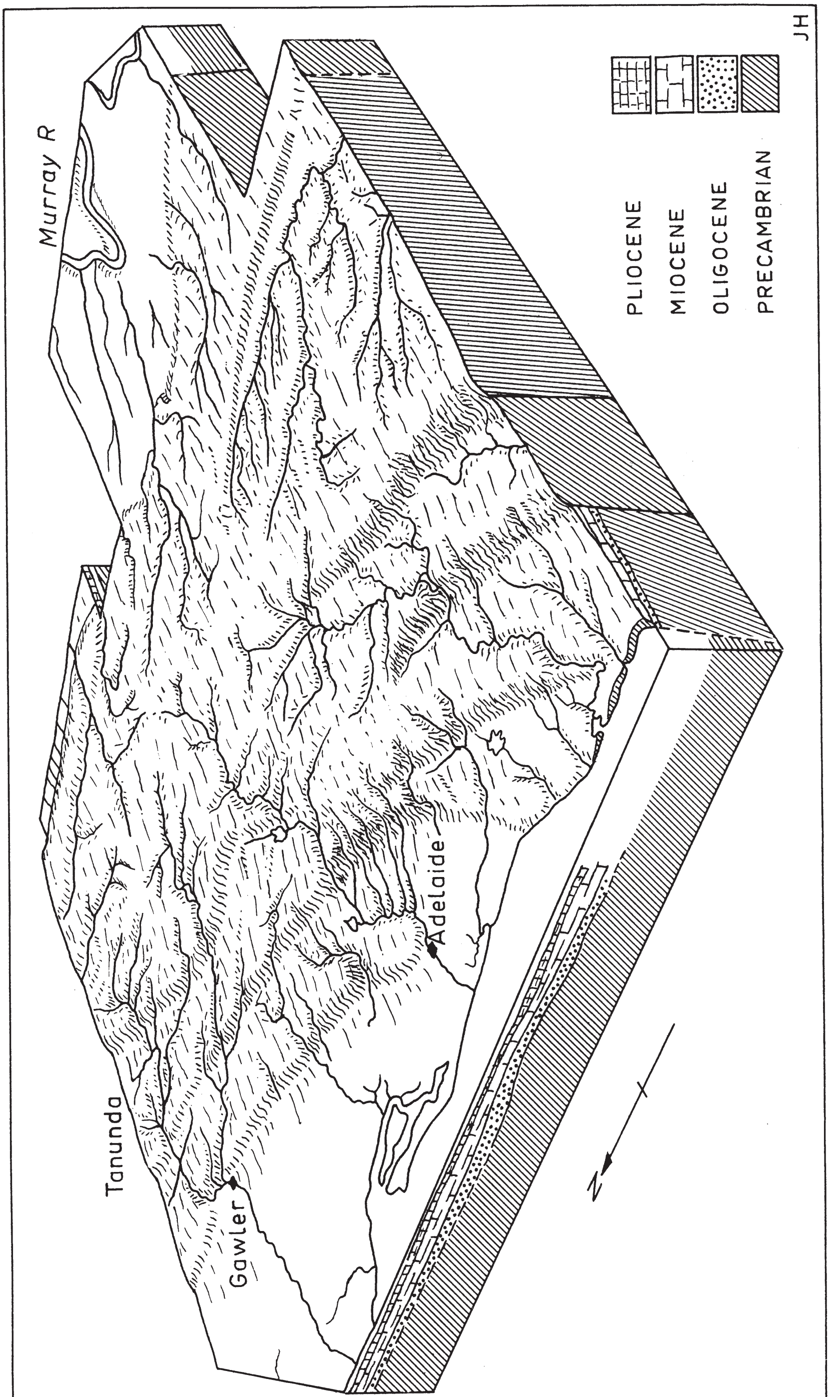

Figure 2a. Block diagram of the Mt Lofty horst with prominent summit surface (after Sprigg, *1945).*

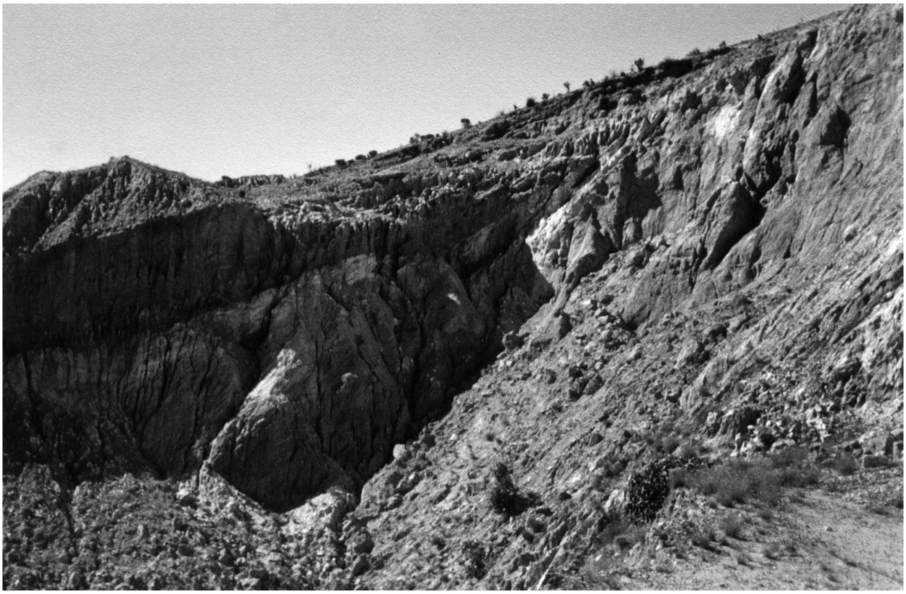

Figure 2b. Drag in Eocene strata exposed in a sand and clay quarry near Adelaide (1959), as result of relative uplift along the Eden Fault of the Proterozoic rocks that comprise the western Mt Lofty horst.

Figure 3. On the horizon, the Gregory Plateau as seen from Mt Matlock, eastern Victoria. The surface predates the Early Tertiary lava flows that occupy some of the valleys incised in the Plateau (Geological Survey of Victoria).

OLD LANDSCAPES

The Mount Lofty Ranges is a horst on which is preserved a prominent summit surface the putative Mesozoic age of which poses problems for conventional theories of landscape evolution (e. g. Twidale, 1994, 2007a). The received wisdom was, and essentially remains, that with the exception of exhumed forms all landscapes are youthful. Estimates of possible maximum age varied between Pleistocene and Eocene (see e. g. Ashley, 1931; Wooldridge, 1951; Thornbury, 1954; Linton, 1957; Schumm, 1963; Brown, 1980), though most favoured youthfulness of surface. This concept was demolished by observations and reasoning from Gondwanan terrains, incidentally by Hossfeld (1926) working in South Australia, but particularly by Hills (1934, 1938; see also Craft, 1932, 1933), who used the relative topographic positions of stratigraphically-dated valley lavas in southeastern Australia (figure 3) to indicate a minimum date for the adjacent summit high plains (see also Twidale, 1976, 1994). The stratigraphic ages of the lavas were later confirmed by physical dating (e. g. Price *et al.*, 1988; Jenkin, 1988; Orth *et al.*, 1995). Hossfeld's evidence and arguments were recorded in a graduate thesis in the University of Adelaide and were never published in a more readily available medium. Hills, however, and appropriately for the time, published his evidence and conclusions in his local (Victorian) Royal Society Proceedings, which though widely circulated was neither specifically geological nor of international standing.

Also, Hills was not then the name he later was, for he became well known for his text on structural geology (Hills, 1940). Yet in his 1934 and 1938 papers (see also Jenkin, 1988) he called to question the very foundations of the conventional models of landscape evolution, which were based in Huttonian constant change (Hutton, 1795) and the Davisian concept of complete planation (Davis, 1899, 1909: 266-267). It can be argued that the outbreak of the Second World War pushed such matters into the background; or perhaps people did not welcome ideas that upset the status quo. Whatever the reasons, the papers and their implications had little or no impact at the time.

The question of how very old landscapes have persisted remains open (e. g. Twidale, 1976, 2007a). Several factors can be considered, including the mode of landscape development (scarp retreat), the nature of the preserved surfaces (etch forms) and the nature of the processes and mechanisms at work in the landscape (concatenation).

SCARP RETREAT

Whether land masses are worn down, as suggested by Davis (1899, 1909), or are reduced by stream incision and the subsequent recession of slopes, as advocated by Lester King (1942, 1953, 1957), was for many years a contentious geomorphological question. Dury (1959: 59-71), for instance, devoted a chapter of his text book to "Wearing down or wearing back?".

In southern Africa, and other regions of capped slopes, King pointed to the similar form and inclination of slopes bounding plateaux, mesas and buttes, as evidence of parallel scarp retreat, an argument sustained by Fair's (1947, 1948) later slope measurements. Structure (lithology) in the form of caprocks certainly exerts a major control but increasingly, the evidence of preferential scarp-foot weathering and erosion, and the regradation of slopes from below, points to the dominance of scarp recession in landscape evolution (e. g. Twidale & Milnes, 1983; figure 4). Thus King's concept was more widely applicable than he realised.

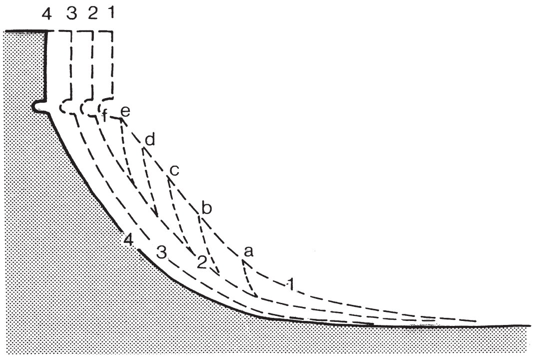

Figure 4. Scarp recession driven by basal slope weathering and erosion followed by regrading of slope from below and collapse of upper slope elements (after Twidale & Milnes, 1983: 348).

Figure 5. Weathering front and kaolinised regolith with corestones of dacite exposed in quarry at Mt Cooper, northwestern Eyre Peninsula, South Australia.

The concept of parallel slope retreat had its origins in local observations, speculations and impressions. Slope recession was deduced by Fisher (1866, 1872) and then by workers such as Penck (1924), Lehmenn (1933), and Wood (1942). It was suggested in explanation of field situations by workers like Jutson (1914: 142 et seq., 156), and Holmes (1918) but then taken up by King and applied to landscapes at the regional scale.

Acceptance of scarp recession as a central principle of landscape development attained a new significance with the emerging evidence of landscape antiquity and the implied persistence of n+1 landscape elements until late in the cycle. In addition, "unequal activity" (see below) came to be recognised as a significant factor in landscape development and survival. The implied concentration of water, weathering and erosion on lower slopes, valley floors and plains not only drives scarp recession but also assists the conservation of higher topographic elements and induces increased rather than decreased relief amplitude.

ETCH OR TWO-STAGE LANDFORMS AND LANDSCAPES

General comments

Davis (1909: 249) stated that landscape is a function of structure process and time. Of this triad "process" refers to the external forces at work shaping the Earth's surface. In recent years, however, it has become clear that many landforms are mainly shaped not at the surface, but below, at the base of the regolith. The change between the weathered mantle above and the intrinsically fresh cohesive country rock below is known as the weathering front (Mabbutt, 1961). Typically it is located a few metres below the land surface (figure 5) but some regoliths are several scores of metres thick. Some fronts are regular but more frequently they are uneven as a result of the exploitation of structural weaknesses in the rock. The water held in the base of the regolith is armed with chemicals and biota and this cocktail eats into, or etches, the bedrock, to produce a weathering front, that commonly takes the form of an abrupt transition from fresh to altered rock.

Many familiar landforms are of etch origin (Twidale, 2002). They include pitted surfaces some rock basins and gutters, flared or concave slopes, boulders and bornhardts, rock pediments and some extensive plains. They form in two stages. The first is achieved by the exploitation of structural weaknesses by etching at the base of the regolith, and the second, by the stripping of the relatively weak regolith, resulting in the exposure of the weathering front as a bedrock topography (figure 6). Thus such forms have two ages. The first refers to the period of subsurface preparation, the second, to the phase of erosion and exposure. Also, as water and regolith are widely distributed and are not restricted to any particular climatic zone, it follows that etch forms are azonal. Though rates of development vary

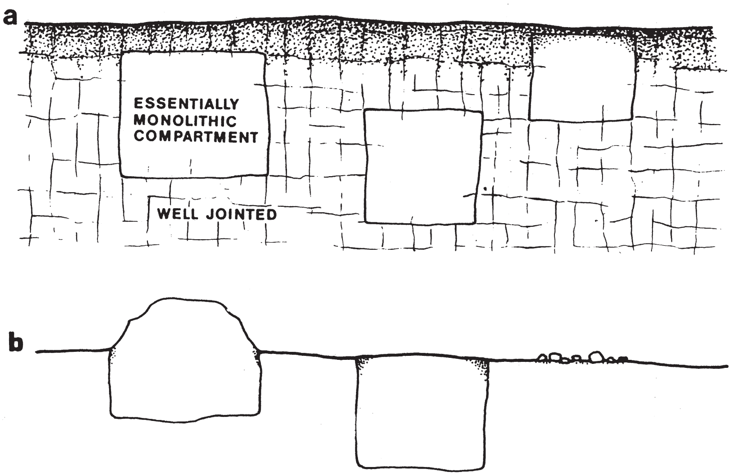

Figure 6. Diagram showing stages in the development of two-stage bornhardts and intervening plains.

according to the biochemistry of the particular shallow groundwaters and the nature of the country rock they are nevertheless widely developed on petrologically contrasted (but physically similar) rock types such as massive and impermeable granite and other plutonic rocks, quartzite, conglomerate, and crystalline limestone.

Corestone boulders

Recognition of etch forms and the two-stage mechanism goes back at least to 1791 when Hassenfratz published a paper recording the observations he made near Aumont, between St Flour and Montpellier in the southern Massif Central of France. He described granite boulders at the surface and, exposed below them, rounded masses (or corestones) set in a matrix of weathered granite or what is now commonly called grus. He imagined that the boulders were genetically related to the spheroidal masses visible in the cutting noting that: "on apperçoit tous les intermédiaires entre un bloc de granit dur contenu et enchassé dans la masse totale du granit friable et un bloc entièrement dégagé" (Hassenfratz, 1791: 101). Such a sequence is initiated by the subsurface weathering of orthogonal fracture systems resulting in the formation of spherical residuals of fresh rock which were later exposed and thus converted to boulders by the washing away of the decayed rock around them (figures 7a & 7b). They were what appropriately later came to be called "corestone-boulders" (Scrivenor, 1931: 364-365).

For some years, however, the argument concerning two-stage development of corestone boulders was complicated by the suggestion that the weathered mantle with rounded boulders had been transported and deposited; that is, was "drift", then the general name for any unconsolidated, surficial, and by implication geologically recent sediment. The assemblage was interpreted as landslides or mudflows, as ill-sorted riverine alluvia, or as glacial till with erratic boulders that constituted evidence of past glaciations, the latter a notion with startling implications for such tropical regions as Brazil, Malaysia and the Antilles (e. g. Agassiz, 1865; "W. T.", 1896; Romanes, 1912). Such explanations were swept aside by a significant observation from southern China recorded by Kingsmill (1862) who in the Journal of the Royal Geological Society of Ireland noted corestones in a matrix of grus but with intrusive veins in situ, proving that the weathered mantle was just that and not an allochthonous deposit (see also figure 7c).

Another astute comment on the two-stage origin of corestone boulders is due to Lewis (1955) who, in the discussion printed with Linton's (1955) presentation, pointed out that the relative rates of subsurface weathering and erosion of the regolith has determined the size and shape of the bedrock residuals. Intense or long-continued weathering has produced complete rotting of the rock mass. However, active erosion of the weathered margins of fracture-controlled blocks has in many places outpaced weathering to

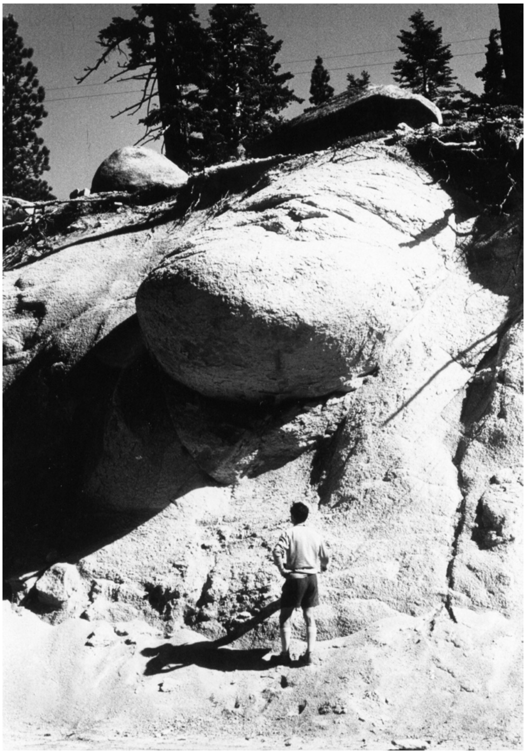

Figure 7a. Road cutting near Lake Tahoe in the Sierra Nevada of California, USA (1965), showing corestone boulders set in a matrix of grus, with exposed corestones standing on the natural surface.

expose corestones as boulders. The latter are of a size and sphericity that reflects relative rates of weathering and erosion. Once exposed they are not continually in contact with moisture and are thus relatively protected.

HASSENFRATZ' authorship of the concept largely has been ignored. He was mentioned by HUTTON (1795: 174), but the article appeared more than two centuries ago. It was written and published in French by an author not well known for his work in geology. It appeared in a journal, the *Annales de Chimie*, that though dedicated in part to minerals and mining, HASSENFRATZ' primary interest (see GRISON, 1996), could not be considered geological. Though the two-stage mechanism was published and "discovered" several times in the next 150 years (see TWIDALE, 1978), HASSENFRATZ' work was, and remains, rarely acknowledged.

Inselberg landscapes

As it applies to major forms and landscapes the etch or two-stage idea can be traced back to FALCONER who in 1911 suggested that some inselbergs, and particularly the domical variety known as bornhardts (BORNHARDT, 1900; WILLIS, 1934) are of this origin. Some are upstanding partly because the

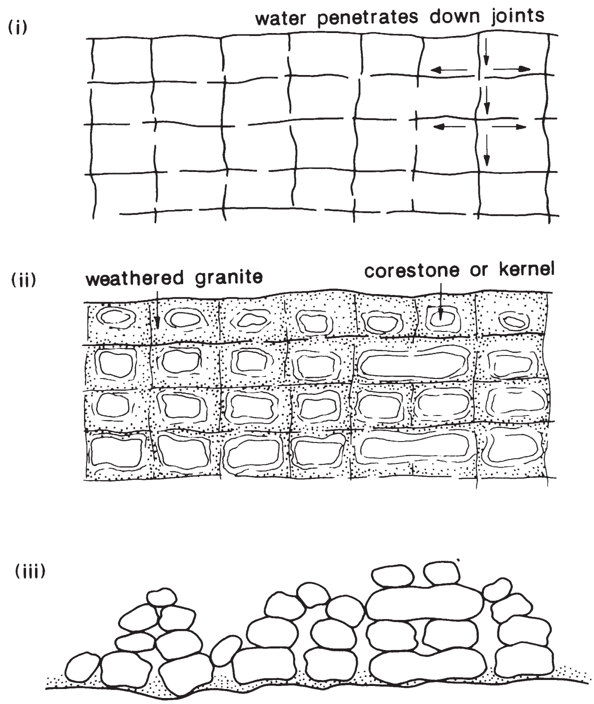

Figure 7b. Diagram to illustrate stages in the etch or two-stage development of corestone boulders.

country rock is buttressed by veins of resistant material. In the Yilgarn and Pilbara cratons, for example, the granite is strengthened by the inclusion of numerous veins, sills, and dikes, mainly of quartz or aplite, but in places of dolerite. Most, however, are initiated by differential weathering beneath a regolithic cover (figure 8a) of fractured rock. Massive compartments are essentially untouched, whereas densely fractured zones suffer significant alteration. Jutson (1914: 142 et seq.) identified the so-called New Plateau of the southwest of Western Australia as a plain associated with the stripping of the mainly lateritic regolith (figure 8b) developed on the (Cretaceous) Old Plateau (see also Büdel, 1957; Thomas, 1989a, 1989b; Bremer, 1995; Twidale & Bourne, 1998; Twidale, 2002). Thus, residual remnants vary in origin, but the basic components of inselberg landscapes are of etch or two-stage origin.

Falconer described the concept clearly and succinctly: "A plane surface of granite and gneiss subjected to long-continued weathering at base level would be decomposed to unequal depths, mainly according to the composition and texture of the various rocks. When elevation and erosion ensued, the weathered crust would be removed, and an irregular surface would be produced from which the more resistant rocks would project. Those rocks which had offered the greatest resistance to chemical weathering beneath the surface would upon exposure naturally assume that configuration of surface which afforded the least scope for the activity of the agents of denudation" (Falconer, 1914: 246).

Figure 7c. Small corestones exposed in road cutting in the Rocky Mountains of Colorado, USA. The intrusive veins show that the partly weathered mantle is in situ.

Figure 8a. The Bushmans Kop near Witrivier, eastern Mpumalanga Province, RSA, showing rounded masses of fresh granite –incipient bornhardts– exposed in the flanks of the spur surmounted by remnants of an old (African) planation surface.

Figure 8b. Etch surface of plain and bouldery outcrops (part of the younger or New Plateau) recently exposed by the stripping of the lateritic regolith that forms the Old Plateau in the background, near Mt Magnet, northern Yilgarn Block, Western Australia.

Neither Falconer nor Jutson offered a name for the mechanism. Moreover, Falconer's key statement appeared late in a book devoted to the general geology of part of Nigeria, and Jutson's seminal review was published as a Bulletin of a State Survey, in what was then remote Australia or "Down Under". Nevertheless, the concept is backed by compelling evidence in the form of the rounded masses of granitic rocks covered by a weathered mantle in situ, plausibly construed as bornhardts at the first stage of development and awaiting exposure as landforms, and recorded from several parts of the world, but particularly Africa and Australia (Boyé & Fritsch, 1973; Twidale, 1982a: 142-146; Vidal Romaní & Twidale, 1998: 151-202; Ho *et al.*, 2000; Twidale & Vidal Romaní, 2005: 131-149).

That variations in fracture density may be responsible for the development of many bornhardt inselbergs is implicit in Falconer's thesis, for it is the massive compartments of rock that survive weathering and become upstanding. Piedmont exposures providing apparent proof of such contrasts in fracture density (figure 9a) have been reported from several parts of the world (e. g. Twidale, 1964, 1982a; Büdel, 1977). For example, at Ucontitchie Hill, northwestern Eyre Peninsula, corestones exposed in a reservoir excavated in the western scarp foot average about one metre diameter, indicating original fracture spacing of that order or a little more. By contrast, joints in the adjacent bornhardt are 20-25 m apart. But the argument is not entirely convincing, for what is significant is not fracture density in the rock masses in the present piedmont but rather that of the compartments of rock that formerly stood adjacent to and at the same level as the residual. The relevant compartments have been eroded so that direct comparison is not possible. But support for the fracture density argument is provided by the work of Blès (1986), who demonstrated that surface fracture patterns and densities are indicative of patterns and densities at depth (figure 9b). If patterns can be extrapolated to depth they can also be extrapolated upwards and into the past, as it were: present piedmont fracture spacing can be taken as representative of patterns at former higher levels. This was pointed out not in a journal article but in a review of the Blès publication (Twidale, 1987). It is rarely cited (except by the author!).

CONCATENATION: STRUCTURE, UNEQUAL ACTIVITY AND REINFORCEMENT

The existence of very old palaeosurfaces –surfaces that predate the Cenozoic and have not been buried and exhumed– is now widely accepted, yet as mentioned earlier, they pose problems. How and why have they survived the ravages wrought by weathering and erosion over the ages? Again, the first inkling of an answer was to be found in incidental observations published in out-of-the-way sources. Most old surfaces are of etch type, are underlain by relatively fresh bedrock, are developed in various country rocks, and demonstrably transect structure. Thus, they cannot be explained either as structural or in terms of planation surfaces, the elevations of which were determined by perched local baselevels.

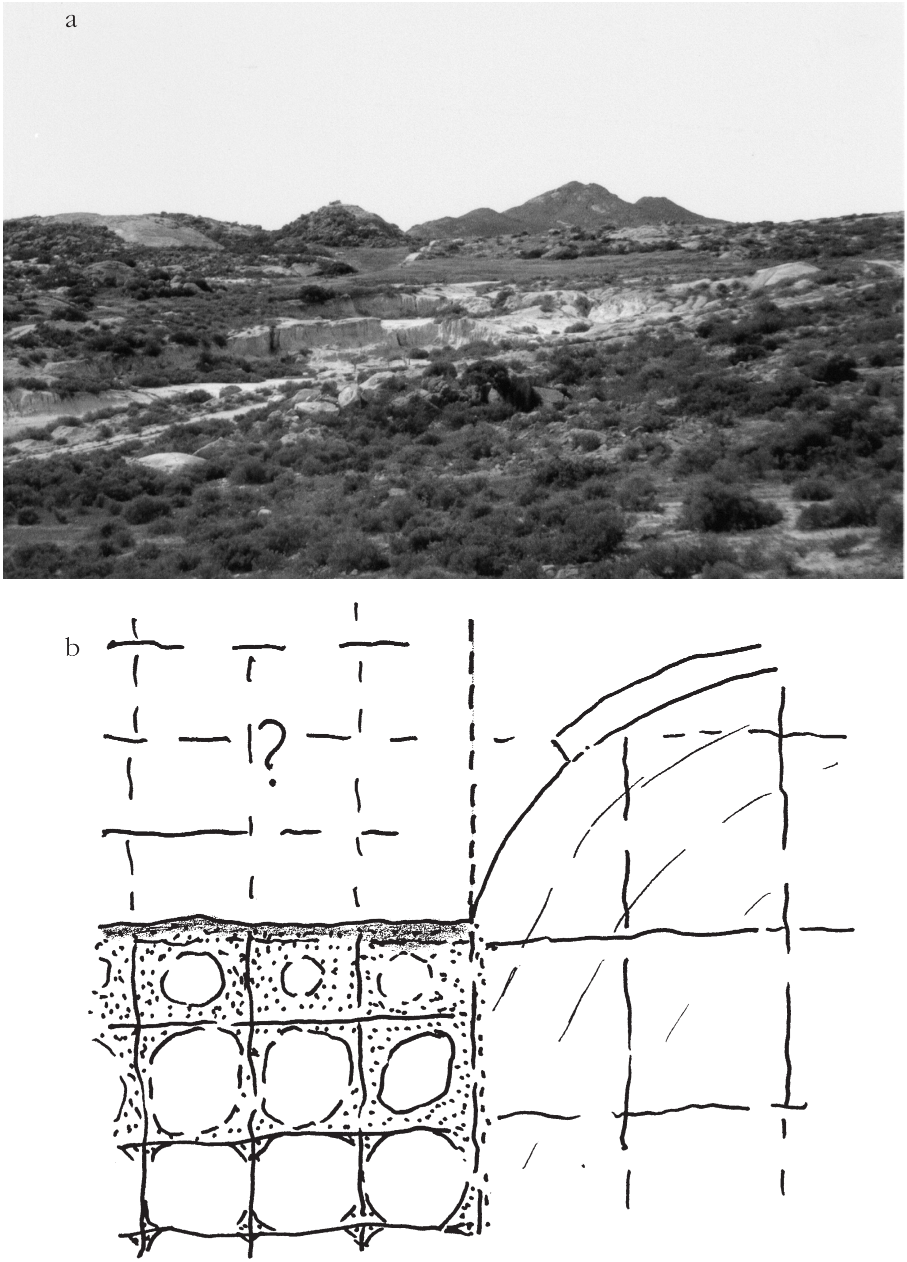

Figure 9a. Contrasted fracture density near Garies, Namaqualand, Northern Cape Province, RSA. Shallow excavations in the valley exposed corestones about a metre diameter set in grussy matrix, by contrast with the massive granite exposed in adjacent bornhardts; 9b. Diagram showing problem created by eroded piedmont mass of densely fractured rock.

Despite Davis' (1909: 266-267) assertions to the contrary, the destructive processes of weathering and erosion are not equally distributed over the land surface. Indeed, the survival or persistence of old land surfaces partly has been attributed to such inequalities. Thus, whereas rivers clearly erode their bed and banks, the lowering of the intervening divides is much slower and on and near divides is minimal, causing them to be well preserved (figures 10a & 10b). Thus watersheds tend to persist as the older landscape elements. This was noted by Bliss Knopf (1924: 637-638), who in comments incidental to her theme, remarked that in the eastern Appalachians of Pennsylvania the headwater reaches of some catchments are "out of reach of erosion" with the result that in such areas "isolated residuals of earlier planate surfaces have been preserved from dissection". Working in southeastern Queensland, Marks (1933) noted what he called the "fixity of divides" or watersheds, but drew no inferences either as to why they survived (see also Young, 1989) or their wider implications.

Similar observations, however, stimulated Crickmay (1932) to develop the concept of unequal activity in explanation of the Cypress Hills landscape of

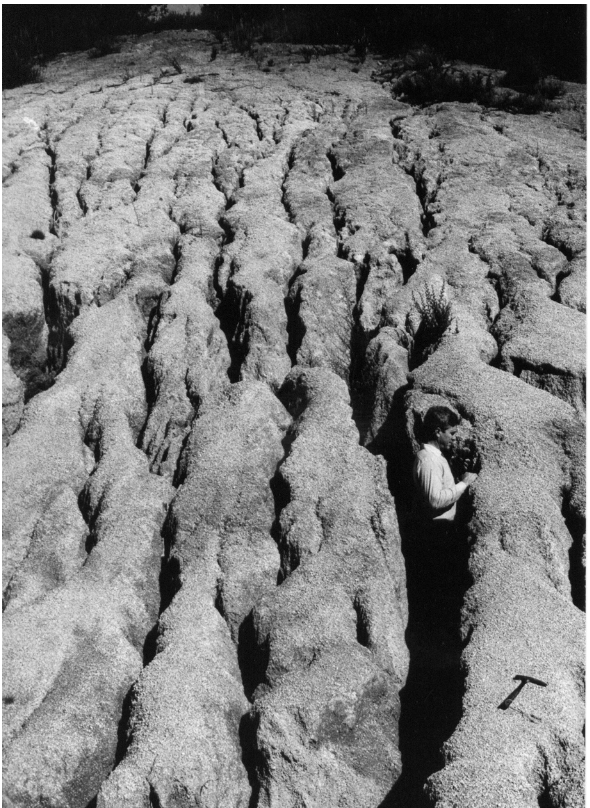

Figure 10a. Deep gullies cut into weathered granite or grus, leaving intervening divides intact, near Paarl, Western Cape Province, RSA.

southwestern Alberta. Ironically, his interpretation of the particular landscape almost certainly was in error (see Alden, 1932), but the concept of unequal erosion was conceived. Crickmay (e. g. 1959, 1974, 1975) went on to assemble corroboratory evidence from many parts of the world, and the idea found subsequent support in the headwater zones of nil or minimal erosion identified by Horton (1945), and Dunne & Aubry (1986).

Though Crickmay applied the question of unequal activity to models of landscape evolution, the question had in principle, though not by name, been identified in earlier literature. Discussing the minor landforms of Pulau Ubin, an island in the Strait of Johor, Logan (1849, 1851: 326), noted features that indicated contrasts in rates of weathering between moist and dry sites, implying unequal activity and reinforcement (Twidale, 2007b). In his 1851 paper Logan appreciated the results of contrasted rates of activity on covered surfaces in constant contact with soil moisture charged with chemicals and

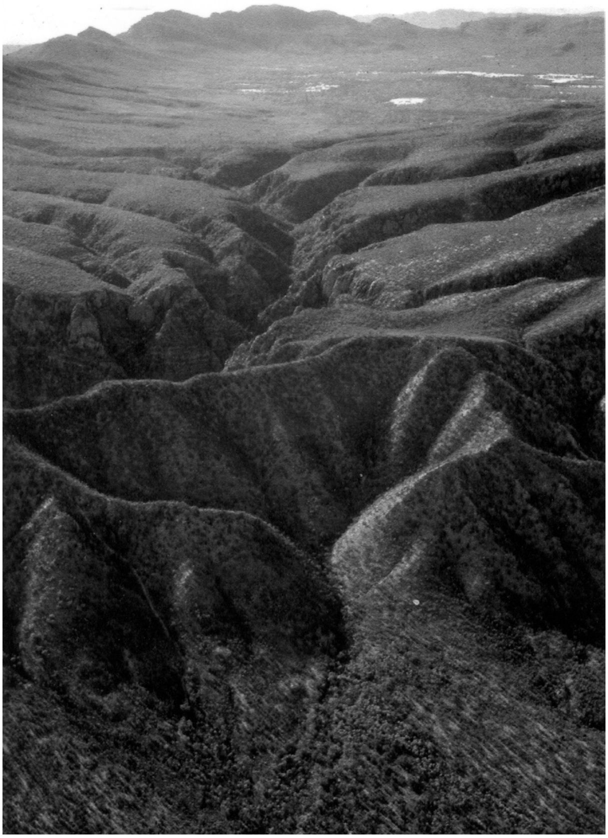

Figure 10b. Edeowie Gorge, at the northwestern rim of Wilpena Pound, Flinders Ranges, South Australia, cut in massive Neoproterozoic quartzite but leaving extensive remnants of planate divides.

biota, and also noted that even in the humid tropics with their frequent falls of rain, exposed surfaces dry in the sun. He noted that the actions of gravity and the sea degraded and washed away "… the decomposed portions, thus leaving the more resistant masses to emerge from the soil and stand out above the influence of decomposition" (Logan, 1851: 326).

Crickmay's ideas did not receive attention and consideration for many years. His first foray concerning unequal activity appeared in a magazine that though of national distribution was broadly based, and not routinely consulted by geologists and geomorphologists. Crickmay's was a penetrating and innovative mind. He was also uncompromising, and evidently he refused to accept editorial advice. For that reason, his most important ideas did not appear in the regular scientific press. Instead, supported by his employer, the Imperial Oil Company, he published his developing ideas on unequal activity, in a series of private publications. Unequal activity was outlined in an accessible form in a later book (Crickmay, 1974) and a brief conference proceedings (Crickmay, 1976), but only in the last few years have the reality and significance of unequal activity been accorded a measure of recognition.

Unequal activity implies the operation of a feedback mechanism and especially positive feedback or reinforcement (Behrmann, 1919; King, 1970; Twidale *et al.*, 1974), and to concatenation, or the inevitable onset of what were initially determined structurally determined inequalities of weathering and erosion that induced reinforcement effects (Twidale, 2007b). For instance, and whatever the reason, once in existence inselbergs, like other uplands, tend to be preserved; they are self-perpetuating and enhancing landforms. Accordingly, a hill sheds rainfall as runoff to the adjacent plains so that the latter are more rapidly weathered, whereas the hill is little changed. If baselevel permits, the plains are eroded and lowered so that the upland comes to stand relatively higher in the landscape. Repeated alternations of phases of weathering and then of erosion have resulted in stepped topography (figure 11) at both local and regional scales (Jessen, 1936; King, 1962; Twidale & Bourne, 1975; Twidale,

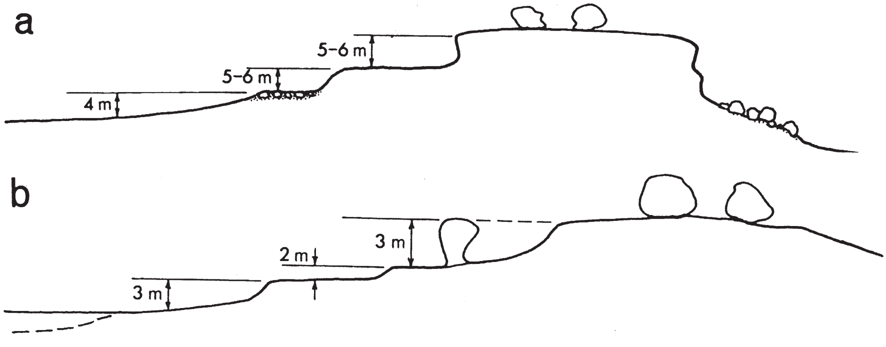

Figure 11. Sections showing stepped topography of two bornhardts: (a) Tcharkuldu Hill, and (b) Cocata Hill, both on northwestern Eyre Peninsula, South Australia (after Twidale & Bourne, 1975).

1982b, 2009), in increasing relief amplitude with time and sundry minor forms (e. g. TWIDALE, 1993; TWIDALE & CAMPBELL, 1998).

LOGAN (1851: 326) was aware of such self-enhancing or self-perpetuating mechanisms, for he realized that once in positive relief a surface was relatively protected against further attack. Thus he anticipated what is today known as the reinforcement or positive feedback mechanism. Seventy years later, BAIN (1923), reporting on granitic hills in Nigeria, noted that rock basins containing water charged with chemicals and biota are deepened faster than any of the surrounding surfaces affected by waters overflowing from the depressions. Slight surface irregularities and joints also are deepened by such waters (BAIN, 1923: 99-100) clearly implying contrasted rates of activity. One of LOGAN's Pulau Ubin papers was published in a respectable but little known regional journal (LOGAN, 1849), and his critical 1851 observation appeared in an international journal, but was carried in a footnote, while BAIN's was an incidental observation, albeit published in an established journal.

Thus, contrary to the eventual overall lowering and diminution of relief amplitude implicit in Davisian modelling (e. g. DAVIS, 1899, 1909), this mechanism leads to an increase in relief amplitude through time, as well as the survival of old landscape elements on divides (TWIDALE, 1991, 2007a). Unequal activity drives a significant landscape-shaping sequence.

DISCUSSION

The examples discussed are but a few among many that could be cited. For instance, J. B. NEWSOM's suggestion that swamp slots at the base of karst

Figure 12. Rhyolite pillars, Giant of the Mimbres, southwestern New Mexico, USA.

towers in Malaysia (also known as cliff-foot caves or notches) are formed by "stagnant swamp water remaining at the same level for periods long enough to eat into the cliffs" is recorded not in a Newson paper but in the pages of Scrivenor's The Geology of Malaya (1931: 123; see also Twidale, 2006). Some 65 years ago R. L. Crocker drew attention to the existence of a field of old desert dunes on Eyre Peninsula and extending east into the Murray Basin (Crocker, 1941, 1946a, 1946b). But he published in the Transactions of the local Royal Society and in a report of a reputable organisation, the name and acronym of which were changed soon afterwards. The palaeodunefield remained unexplored until relatively recently, when investigations were stimulated by the availability of luminescence dating (e. g. Gardner *et al.*, 1987; Lomax *et al.*, 2006; Twidale *et al.*, 2007).

The examples cited show that several of what later came to be recognised as interesting ideas first appeared in print in local journals, some of which are defunct. It still happens. For instance, the Giants of the Mimbres is a group of blocks, boulder and slender columns shaped in Oligocene rhyolite in southwestern New Mexico (figure 12). J. R. Bartlett sketched in the area about 150 years ago while serving on a Commission delineating the boundary between the USA and Mexico (see Mueller, 2006). Comparison of his work with the present landscape indicates that the bedrock forms have changed but little over the intervening years. However, at the time of Bartlett's visit, in mid century, arroyos (gullies) had already been incised in the regoliths mantling slopes and valley floors (Mueller & Twidale, 2002). This is pertinent to the long-standing debate as to whether the epicycle of soil erosion in the American Southwest is related to climatic fluctuations or to the occupation of the region by farmers and ranchers (e. g. Duce, 1918; Leopold, 1942; Schumm & Hadley, 1967). Human interference undoubtedly caused the Dust Bowl catastrophe in Oklahoma and adjacent areas in the late 1920s and early 'thirties (e. g. Egan, 2006), but the evidence from the Giants of the Mimbres published as a record in the local geological journal, suggests, first, that the answer is complex rather than simple, and, second, that evidence of wider import is still available in regional and unanticipated sources.

Another concern is that even if a paper is remembered, if what has been called "scientific amnesia" (Hobbs, 1985) has not set in, some consider that as long as the work was done it does not matter to whom it is credited. And certainly any ideas are there to be used regardless of whether or not their origin is known. Humankind owes a great debt to whoever invented the wheel, although the identity of the inventor is unknown. Yet fairness surely calls for attribution if it is possible for it to be established. Would it not be interesting to know in what circumstances the usefulness of a round tabular mass of wood or rock was recognised? One can draw a musical comparison. Many ancient airs and themes of unknown origin have been saved from oblivion, recorded and arranged. Many have found their way into works by major composers, while others have been arranged for orchestras and voices as "ancient airs and dances" and as such have provided enormous pleasure: "Anonymous" and "Traditional" were gifted scientists as well as prolific composers!

In science, who made the discovery and in what circumstances are not only interesting but potentially significant for those interested in scientific method. Thus, a casual observation in his garden near Grantham, Lincolnshire (whence he had retreated from Cambridge, in 1666, hopefully to escape the plague) where "il voyait des fruits tomber d'un arbre…" (Voltaire, 1734: 121-122) resulted in his fundamental contributions to the understanding of gravitation (e. g. the inverse square law) and of mechanics. Chance or serendipitous occurrences have their place in scientific discovery as well as conclusions eventually drawn from planned systematic observations. If it is customary to acknowledge the achievements of inventors, writers and composers, surely scientific perception and creativity ought to be recognised?

CONCLUSIONS

Clearly, almost regardless of its intrinsic merits or otherwise an idea is more likely seriously to be considered if it appears in a prestigious journal, clearly stated, with an evocative label and in open view, and preferably under a recognisable name. But this presumes that the significance of the idea is appreciated for what it is, and as the examples cited demonstrate many useful concepts were initially aired in passing and without fuss. Translated to the modern electronic era, they would not have been identified by titles, abstracts, or keywords: they were remarks made in passing.

Whether published yesterday or two centuries ago, credit for an idea surely ought to belong to its originator, though as has been pointed out (Osler, 1904; Darwin, 1914) it has frequently instead been bestowed on the one who persuaded the scientific community of its worth. It may be argued that the authors of incidental comments did not realise the significance of what they had reported, but who is to know? It might be argued that it is left only to certain minds to place data in context –only a few are the scientific master builders– but this too is debatable.

These considerations aside, even casual references ought to be noted and acted upon, as ought statements recorded in irregularly published books, collections of essays, and even footnotes and appendices. But new does not necessarily mean better, and publicity does not necessarily involve or imply the best. Some journals considered old or obscure record significant observations and ideas and reward examination. As with contracts, read the fine print!

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