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ROCK INSCRIPTIONS IN WESTERN AUSTRALIA

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Abstract. Rock inscriptions purportedly related to Dutch shipwrecks and other early exotic visitors on the west coast of Western Australia are examined. The question of authenticity is investigated by microscopic analysis of weathering phenomena, such as the retreat rate of carbonate cement in calcareous sandstone. Dated rock inscriptions are of great value in developing quantitative and repeatable methods of estimating the age of petroglyphs. In this context, they can be of considerable importance in scientific studies of rock art. Moreover, the study of rock art should not be arbitrarily divorced from the analysis of rock inscriptions, as similar scientific methods study the two forms of rock markings and can provide mutually complementary information.

Introduction

Rock inscriptions are not rock art, but we should also concern ourselves with inscriptions on rock to study rock art. There are several good reasons for this, one of which is eloquently discussed by Ahmed Achrati. He demonstrates what should have been evident to us all along, that in specific world regions, rock inscriptions can provide some of the most valuable ethnographic evidence about the meaning of rock art we can ever hope to glean (Achrati 2006). Since then, others have used this information source (Alzoubi et al. 2016; Bednarik 2017, 2021). However, as a discipline, we have left much of this potential untapped in the nascent state of this field of research.

There are, however, various other reasons why rock art scientists need to concern themselves with ancient or even more recent scripts on rock surfaces. One of them relates to their frequent use in the calibration of methods of rock art age estimation (e.g. Bednarik 1992, 1993, 2001, 2002; Tang and Gao 2004; Bednarik and Khan 2005, 2017; Tang et al. 2014; Jin et al. 2016; Tang et al. 2017, 2018; Santos et al. 2018; Jin and Chao 2020). Some are fundamental in a methodological sense. For instance, analytical methods developed from the study of inscriptions of known ages can be directly applied to petroglyphs (Bednarik 2009a), as the present paper will attempt to show. Such methods may be concerned with deposition rates of accretions, weathering rates, lichen and other issues.

Moreover, there is no sharp taxonomic separation between rock art and rock inscription; there is a continuum between them. At some point, pictograms grade into pictographs, i.e. iconic written symbols, including hieroglyphs. In several ancient cultures, including some of those of Mesoamerica, China or the Middle East, it would be counterproductive to try separating the study of rock art from that of inscriptions. Then, there is always the possibility of confusing written characters with 'proper rock art' or vice versa (Bednarik 2016: 103–110). Finally, it must be appreciated that the recording, analysis, preservation and site management methods are much the same for both types of phenomena, making it sensible to study them together where possible.

The present paper offers practical applications of the principle that a method serving the authentication of rock inscriptions is likely also helpful to petroglyph analysis. The work reported here forms part of a broader effort involving the study of numerous historical rock inscriptions in various parts of Australia and elsewhere. They include well-known and historically cited inscriptions by early explorers, many of which occur amidst concentrations of petroglyphs. Examples are the '1867 W W' inscription authenticated in Sacred Canyon, South Australia, possibly by William Wright (Bednarik 2010: 107) or Ernest Giles' rock inscription at Mutawintji (Mootwingee). Some have already been used in calibrating rock art dating (Bednarik 2002); others may be recruited for that purpose in the future. Here, we are only concerned with the rock inscriptions found along or near the coast of Western Australia.

The Abydos inscription

The massive petroglyph site complex of Abydos and Woodstock in the Pilbara comprises numerous hills decorated with some of Australia's most outstanding rock art. It generally occurs on rocky hills rising above the surrounding plain. One of these hills has yielded some of the earliest direct dating results so far secured in Australia (Bednarik 2002). Another

Figure 1. *The Abydos rock inscription and petroglyphs composition, Pilbara, Western Australia (images by author unless noted otherwise).*

in the vicinity provided one of the country's oldest rock inscriptions. Near a significant petroglyph site, an isolated panel of four motifs was found on the horizontal upper surface of a prominent elevated block of greyish-green diabase or dolerite (Bednarik 2000). These motifs consist of one anthropomorph, a figure resembling the letter 'H', another apparently depicting a ship's steering wheel that seems clasped by two hands, and the number '1771'. Significantly, they were partly made with a metal tool, whose elongated impact marks resemble those of a knife blade used in indirect percussion (Fig. 1). Almost twenty other, more recent engraved dates in the area have been studied and their patination colour digitally sequenced (Bednarik 2009b). This work has shown remarkable consistency in that the purported ages of engraved dates correspond closely with the degree of patination (darkness of the accretionary deposit). It has also shown that the four motifs on the 1771 rock at Abydos cannot be recent and appear to form a single composition created in a single event. They are of identical 'dark reddish-brown' colour, matching Munsell 2.5YR 3/5.

The patina derives from the magnetite component's oxidisation to full rust-brown and extraneously derived accretionary deposition of aeolian detritus. The latter is caked together by iron oxides/hydroxides and silica, locally arranged in distinctive 'laced' patterns. The accretion within the petroglyphs reaches a thickness of up to 100–150 μm and is morphologically identical to the adjacent rock surface's thicker accumulation. Other dated inscriptions in the area began developing similarly composed accretions within a few decades. Their thicknesses are directly related to their relative ages, reaching 30–50 μm after 80–120 years. On that basis, the four motifs described here are well over two centuries old. Microscopy also determined that two of the four motifs, the 'wheel' and the 'H', were first roughly sketched by indirect percussion with a long and nearly straight metal edge. The tribology of the individual metal marks demonstrates that they were not created by abrasion but by compressive impact. The two motifs were then completed by direct percussion with a hammerstone, but many of the metal marks survive intact, with at least one 'bounce mark' present (caused by rebounding of the tool edge). The numerals and the anthropomorph appear to have been made entirely with stone hammers, as it seems unlikely that previous metal marks were entirely obliterated.

The most logical interpretation of this arrangement of four petroglyphs is that it is a statement by a possibly semi-literate sailor who lived among the Indigenes of the region, conveying his nautical background with one of the motifs. The age indicated in the palimpsest agrees with the degree of patination and weathering. At the implied time, the presence of a European in the region was far from impossible, with Dutch and British ships, and possibly French, Portuguese and even American vessels exploring the coast of north-western Australia in the late 18th century. Most of their journeys were not recorded, and some were deliberately concealed (e.g. American whalers sought to keep their movements secret to thwart competitors). Portuguese words in the Pilbara (and other Australian regions) suggest contact with Portuguese, yet no records seem to exist of any Portuguese landings. Indeed, a great deal of coastal exploration remains unknown, and there are several reasons why a sailor might have been left behind in those times. It is more difficult to explain how such a stranded European would have managed to travel

more than 200 km upriver from the coast and end up so far inland. Without Indigenous support, he would not have been able to travel or even survive in this environment. We cannot fathom the details of his experiences, but the data imply that the 1771 date is authentic, and the use of a metal tool demands exotic contact. Of the two iconographic components of the panel, one is not Aboriginal (the 'wheel'), the other combines local petroglyph style (large 'penis') with non-indigenous aspects ('flat feet'). Any explanation of the palimpsest has to accommodate all testable empirical factors, but a validation of its narrative may still need to be discovered.

The *Beagle* inscriptions

Depuch Island (Warmalana) is located 83 km east of Murujuga, the largest of the Dampier Archipelago's 42 islands (Fig. 2). Measuring just under 5 km from its northern to southernmost tips, Warmalana houses an estimated 5000 petroglyphs (Ride et al. 1964). The first known non-Aborigines to visit the island were Nicolas Baudin's landing party of the *Géographe* on 27 July 1801 (Péron 1809: 129), who failed to report the rock art. Their cartographer, François-Michel Ronsard, charted the island. The second known landing by Europeans was led by Captain J. C. Wickham of the HMS *Beagle* in June 1840, who took considerable interest in the petroglyphs (Wickham 1843; Stokes 1846). The *Beagle* expedition left behind three rock inscriptions: two at Anchor Hill, which forms the island's easternmost point, and one more in Watering Valley. The Western Australian Museum's expedition (Ride et al. 1964) of 26 May to 18 June 1962 recorded much of the island's rock art in some detail and other scientific information but reported no particulars of the inscriptions. Here, we present specifics of those at Anchor Hill, not having seen the third.

Anchor Hill consists of a distinctive dolerite plateau, peaking at 157 m asl, about 150 m long and half as wide. It is connected with a low saddle to the island's boulder piles' main body but delineated by cliffs elsewhere, especially to the north. Several hundred petroglyphs occur on this plateau and some of its periphery's steep panels. Their density is remarkably high, but they are noticeably smaller here than in the nearby Dampier islands, and their size is apparently not a function of block sizes. A large stone cairn once painted white is in the plateau's southern part. There is a distinctive *tharlu* site about 50 m to the north of it. The two *Beagle* inscriptions occur a few metres from the standing stone site and within 6 m of each other. Most other inscriptions at the site occur in their vicinity, generally commemorating the landings of various vessels. These include a visit by the *Penguin* in 1908 and several more recent visits in the 20th century, including in the 1960s. The *Beagle* inscription featured in the 1964 report (Ride 1964), the more northerly of the two, faces roughly northeast and wraps around two sloping upper facets of a boulder, effectively facing two slightly divergent directions. The script reads 'H M Beagle Sloop June the 10th 1840'. Morphologically, it consists of two parts: script made by repeated rubbing or pounding and script with a surround by single applications of a pointed metal tool or tools (Fig. 3). Tribological examination by microscopy focused on the inscription's 'B', which features the largest modified area; the lower loop of the 'g' in the word 'Beagle'; and particularly on the '1' in '1840'. The

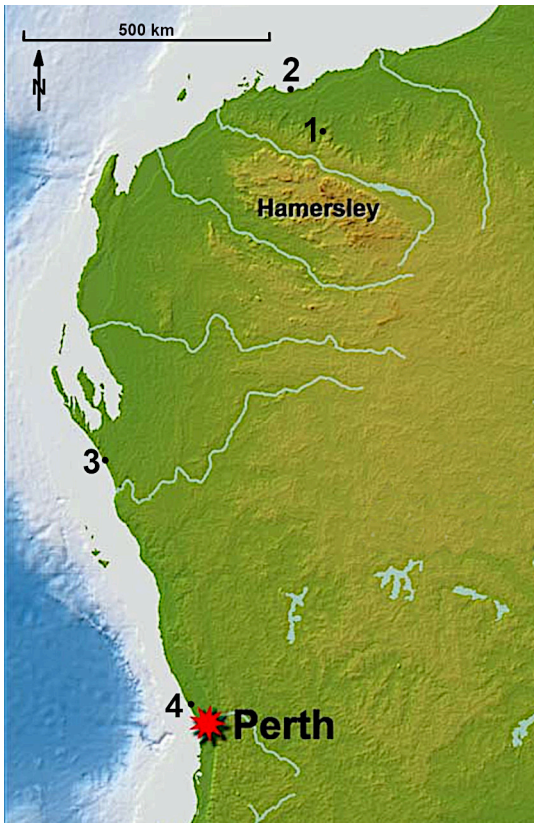

Figure 2. *Rock inscription sites in Western Australia: 1 – Abydos, 2 – Depuch Island, 3 –* Zuitdorp *site, 4 –* Vergulde Draeck *site.*

patination appears slight macroscopically and of reasonably uniform light-brown colour. However, microscopically it is much more complex, demonstrating that accretion deposition issues need to be examined more closely if this process is to be quantified.

Unfortunately, the letter 'B' bears clear if only superficial damage occasioned much more recently in a misguided attempt to renew the inscription. This damage is evident in the published 1962 photograph (Ride 1964: Pl. 5), so it may date from that visit or a previous attempt to improve the visibility of the inscription. Moreover, due to surface undulations, the depth of the initial removal of the accretionary crust by abrasion varies considerably. Therefore, more consistent observations about patination rates might be possible from single-tool application marks. Microscopy of the letter 'g' reveals similar recent damage. Although the modified area's band forming the lower loop of this letter is well delineated, patina coverage is very uneven. Numerous protruding crystals, often bearing evidence of micro-fracture, are entirely free of any accretions. There is no detectable trace of post-production modification of crystals, such as oxidation or hydration, at 80× magnification. The accretion accumulated in 166 years is relatively minor and limited

Figure 3. *Rock inscription by a crew member of the* Beagle, *Depuch Island, Western Australia.*

mainly to depressions and recesses on the surface. It is always thickest in surface recesses, reaching about 15 μm, locally even more. Thickness reduces markedly towards the slopes to prominent surface aspects. All characters in 'H M Beagle' appear to have been renewed in a relatively recent event.

Having been made with a single stroke of a metal point from the top down, the '1' in '1840' yields more definite morphological and microscopic data. The panel slopes at approximately 45° here and is, in this part, coated by very dark, purplish-brown accretion. The groove shows distinctive bifurcation, indicating two equally prominent aspects on the point of the tool used. Due to the panel surface's minor unevenness, there are variations in the groove's width and depth, but in general, it averages widths of 600 to 650 μm, with the depth varying from about 300 to 500 μm. Along the groove's entire course, patination is reasonably even. It is also in a 10.3 mm long subsidiary groove to the lower left of the mark defining the year. The accretion is of a silky surface texture and light-brown colour, apparently cemented by silica. In general, it is of about 10 to 15 μm thickness. Locally, there are distinctive terraced formations related to rainwater flow along the groove floor. They are of the same colour and composition as the accretion elsewhere along the groove and imply that accretionary matter is being recycled by meteoric water. Airborne debris is present in the accretion formed mainly by supersaturated solution flow over the rock surfaces. Very little, if any, of the material derives from in-situ modification of mineral components of the dense rock.

The second *Beagle* inscription, 6 m south of the first, was not examined microscopically. It occurs on the flat panel of a square block 58 cm long and reads 'HMS BEAGLE AD 1840 C. Paseo'. The patina within the grooves is more evenly distributed than on the previous panel, and no recent renewal attempt is evident. Each character is rendered in a scratched outline, and the first two of the three lines are partially filled with hatch marks (Fig. 4).

Figure 4. *Second* Beagle *rock inscription at Depuch Island.*

The *Zuytdorp* inscriptions

The available records suggest that the first contact of Australian indigenes with Europeans was limited to Dutch sailors, soldiers and civilians. Apart from a (supposed) landing on Cape York Peninsula in 1606 and landings on Tasmania in 1642, all this contact appears to have occurred on the continent's west coast, commencing with Dirk Hartog in 1616. From 1602 to 1799, the Dutch East India Company had some 200 ships operating on the route to Batavia (Java), which, after rounding the Cape of Good Hope, would sail east for around three weeks until they sighted the west Australian coast (the 'Brouwer route'). They would then turn north to proceed to Java, with seasonal variations. Seven of

these ships never arrived there, and the wrecks and remains of five ships (and possibly a sixth) have been located along the rugged coast of Western Australia. The (British) *Tryall* was wrecked in 1622 off the Monte Bello Islands and found by E. Christiansen in 1969. The *Batavia* met its infamous fate in 1629 at Morning Reef in the Abrolhos, where M. Cramer discovered the wreck in 1963; the *Vergulde Draeck* foundered on a reef off Ledge Point, just north of Perth in 1656, where G. Henderson found it in 1963; the *Zuytdorp* rammed into the cliffs south of Tamala Station in 1712, and its remains were located by T. Pepper in 1927, following a previous sighting by Ada and Ernest Drage in 1926. The *Zeewijk* met its end at Gun Island in 1727, where H. Edwards found it in 1968. Another, the *Ridderschnappe van Holland*, disappeared in 1695. However, it is thought to have been the victim of pirates from Madagascar (pers. comm. D. J. Varney, 1983, obtained from Cape Archives Department, South Africa). This leaves the *Aagtekerk*, which left Capetown in 1726, and the *Fortuyne*. The last-named ship has yet to be found, but it disappeared in 1724, three years before the *Zeewijk* was wrecked. The latter's survivors reported seeing and even using the remains of a previous nearby wreck, which may have been that of the *Fortuyne*, but it too has not been re-located so far. We have no idea of the fate of the *Aagtekerk*, which quite possibly also foundered in the surf of Western Australia.

It is unknown how many sailors, soldiers and passengers of these ships reached the shore alive, but we know historically that they numbered in the hundreds. For instance, there is no reason to assume that many people on the *Zuytdorp* should not have survived the collision. The ship ran aground immediately on the mainland, and we know from random finds that material was salvaged, including water barrels and trunks. Up to 100 people, including several women and children, could have survived the calamity. They and survivors of other shipwrecks and surviving rescuers lost can be assumed to have made contact with Aboriginal people.

Moreover, the Dutch also made occasional exploratory landings, and Abel Tasman charted parts of Australia's west coast in 1644. Some encounters the Dutch had with the resident Indigenes were not very auspicious. For instance, Jan Carstenz, captain of the *Pera*, had three Aborigines killed and two others kidnapped in 1623. Evidence has been tendered from time to time of Dutch influence among coastal groups of the lower west coast, including the occurrence of Dutch words in Aboriginal languages and dialects (e.g. in Nanda-Watchandie and the two other Nanda dialects) and the incidence of blond hair and blue eyes among Aborigines near Geraldton, Carnarvon and Moore River, north of Perth. However, no historical records exist to tell all others' fate except for those cases where survivors subsequently reached Java. For instance, we have minimal information about the fate of the *Zuytdorp* survivors. The ship had rammed into a small promontory along the generally straight coast of almost continuous 30 m-high cliffs. Although located in highly turbulent water, it was probably so close to the rocks that salvage of essential supplies was possible. The finds of iron hoops from barrels some distance inland suggest that drinking water was salvaged, and it has been mooted that a small dam to retain rainwater was constructed in a gully (Playford 1959).

The *Zuytdorp* survivors found themselves in a rather hostile environment, which offers only limited occupation evidence by Aboriginal people. Though there are aquatic resources along the coast, the hinterland consists of dunes covered by semi-arid vegetation. No permanent freshwater sources are nearby, and finding food for many people would have presented a significant challenge. The area is rich in rockshelters and small caves, many of which have been checked for occupation evidence, mostly without success.

The existence of a three-masted shipwreck in the Shark Bay region has been known to Europeans since early British settlement, when Swan River colonists were told about it by Indigenes in 1834. A mission to find it remained unsuccessful. Kimberly (1897) considered that it was the wreck of the *Zuysdorp* [sic], and Ada and Ernest Drage, local settlers of the early 20th century, sighted the wreckage (Anon. 1968). The first surveyors marking out the leases also saw the debris. In 1954, P. Playford was made aware of the wreck by its re-discoverer, T. Pepper, and commenced its investigation.

In May and June 1975, an expedition of eight men, including four military personnel, searched the Zuytdorp Cliffs and the surrounding area to the north for traces of the *Zuytdorp* survivors. D. J. Varney led the civilian contingent of the expedition; J. Stewart from the Western Australian Museum participated. During a reconnaissance of this operation, on 25 May 1975, Varney discovered a rock inscription within a few dozen metres of the wreck site, reading 'ZUYTDORP 1712'. At the time of discovery, the inscription was almost entirely covered by sand. The military party leader was filmed as he uncovered the lower part of the script by sweeping away the sand with his hand. This film has been examined by us, as have several still photographs of the inscription's initial assessment. Varney states in his report to the Museum:

> [The inscription] is badly worn and eroded and its original depth would have been about 2" (two inches). I believe this carving to be authentic and request that it be examined by a competent authority to determine its possible age. ... The sand had to be removed to uncover the carving completely but before leaving the wreck site the carving was again covered by sand. A complete movie and slide recording has been made and your Mr Stewart has his own records (Varney 1975: 3).

The fake inscription

Instead of securing a specialist's examination of the inscription, Varney's report led to its deliberate

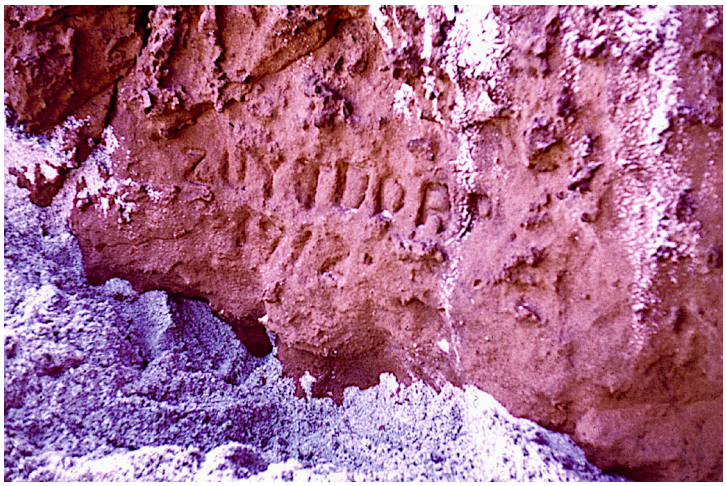

Figure 5. *The 'ZUYTDORP 1712' inscription, as found in 1975 (photograph by D. J. Varney).*

destruction. It was erased between July 1975 and April 1978.

Playford, a geologist, having continued his research of the site, was advised by a Museum contact, D. Hutchison, of the inscription's discovery and asked to see if he could determine its antiquity. He travelled to the site within weeks of Varney's discovery. He claims he did not erase the inscription himself but concedes that he 'can guess who removed it' (pers. comm. to author). Up to July 1979, the site was under the Western Australian Museum's control and its subsidiary, the Western Australian Maritime Museum. Its historical remains were protected by law. The Museum's personnel were frequently on site, if not constantly, engaged in salvaging the treasure of precious metal coinage and other shipwreck residue.

The film and still photographs show no colour or surface texture difference between the inscription grooves and the surrounding rock surface. They also indicate that weathering appears to be uniform, and there is no hint that the inscription, which certainly had been made with well-suited metal tools, had been made recently. Its edges are relatively diffuse and battered by erosion (Fig. 5). It must be borne in mind that the inscription features the name of the shipwreck, which until 1958 was unknown to the public. Although re-discovered in April 1927 (by T. Pepper), the identification of the wreck was attributed to Playford (various articles in *Daily News*, December 1954 and May 1958), after he considered that the tonnes of silver coins (most of which have since been stolen) carried by the ship were of 1711 or earlier. Therefore, if the inscription were a fake, it would have had to date from after 1958, making it less than seventeen years old in 1975 ('... did not prove conclusively [the identity] until 1958', *Daily News*, December 1958; cf. Playford 1996: 67–68; Select Committee 1994: 18).

One of the civilians in 1975 had inserted his left index finger into the deepest of the grooves, the lower end of the letter 'T', then withdrew it to show the depth in a photograph. This indicates a groove depth between 45 mm and 50 mm, which is extraordinarily deep compared to all other known historical rock inscriptions in Australia. Although the inscription had been erased before Varney's next visit in 1979, we considered it possible that, given its great depth, its destruction had not been complete. Removing more than 50 mm of rock requires considerable effort in a remote place, perhaps with improvised tools. Since the objective was only to destroy the defining grooves, not necessarily their floors, we hoped their floor surfaces' remnants survived the destruction.

On the strength of that possibility, we undertook an expedition into the very remote region between Kalbarri and Shark Bay in July 2006 to clarify the status of the inscription and check for others. Access to the Zuytdorp Cliffs is via many hours of rugged sand tracks, and the region is rarely visited. The inscription's precise location was established based on location photographs taken in 1975, and it was immediately apparent to us that remnants of some of the inscription's individual grooves had indeed remained (Fig. 6). The 'ZUYTDORP 1712' script is 12 m north of a prominent round boulder at the cliff's foot. The region's usually buff-coloured calcarenite sandstone is distinctly red in this area. So, the red indicates no patination; it is the rock's actual colour. A 60 cm-diameter blowhole, one of several such features in the vicinity, is located 2.5 m from the inscription. It emits sand from a cavity below, as a result of which there is always a deposit of well-sorted quartz sand next to it. This tends to conceal at least part of the inscription most of the time. The inscribed panel is about 8 m from the high-water mark and about 1.5 m above it. However, the blowhole ensures ample moisture and accelerated weathering of the inherently very fragile aeolianite.

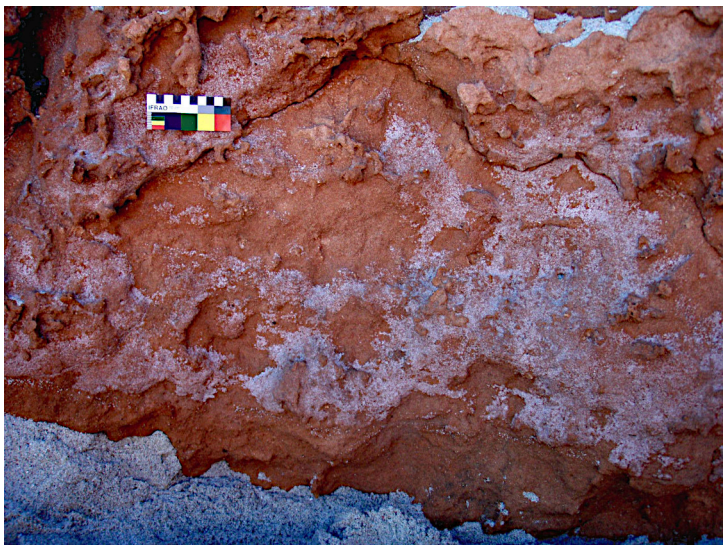

Figure 6. *The largely erased 'ZUYTDORP 1712' inscription in July 2006.*

The extent of the damage occasioned in the 1970s is readily definable, not by colour or macroscopic appearance, but by microscopy of the arenite's cement component. The impacted area was established and found to extend just a few centimetres beyond the former inscription. The deeper parts of several of the grooves that formed the script had remained intact and entirely undamaged. Well preserved are the bottom and middle part of the vertical stroke of the 'T', initially the deepest section of the inscription, and the vertical stroke of the 'D'. The curved portion of the 'D' can be recognised, with traces of the 'R'. The lower part of the vertical stroke of the 'P' is well preserved. However, the remainder of these letters have been lost in the damage. The four numerals, formerly reading '1712', have not survived, and the definable area of damage extends several centimetres beyond them on their right. The total length of the inscription 'ZUYTDORP' was 52 to 53 cm before the damage, and the actual distance between the bottom of the 'T' and the vertical line of the 'P' is 18 cm.

Except for the lower end of the 'T', which is still 15 mm deep, and the lower portion of the vertical stroke of the 'P' (9 mm), the remaining grooves are all under 5 mm deep at the deepest point of the surviving surface areas. Considering that we know the approximate former depth of the lower part of the 'T' from 1975 photographs, we can estimate that approximately 35 mm of rock has been removed at that location. The grain size distribution of the distinctly reddish facies, coloured by the minor presence of haematite, is mainly in the 400 to 800 μm range. Both fully rounded and angular-rounded grains occur, and there is diversity in grain minerals. The cement of this calciferous aeolian sandstone is calcite or aragonite. It relates to higher relative sea levels during the Pleistocene when the deposits were formed, sometimes occurring as massive carbonate formations (including oolitic and travertine deposits) but more often in the form of the cement of mostly quartzose recent sandstones formed from the stabilisation of dunes.

Analysis of the inscription

The term *microerosion* refers exclusively to solution processes whose effects can be seen only at the microscopic level. Microerosion analysis is not one specific method but a cluster of possible methods around a basic concept. Two have so far been applied practically: the measurement of microwanes on fractured crystals (Bednarik 1992, 1993) and the selective, often alveolar retreat in certain rock types of components that weather at vastly different rates (Bednarik 1995). Various alternative indices of microerosion may also prove useful, but so far, their potential remains unexplored (Bednarik 2001: 125).

Here, we are only concerned with the second type of method, where different minerals erode at significantly different rates, thus providing the possibility of calibrating the erosion process against time. This can occur in two circumstances: where a rock fabric includes zones of greater resistance to erosion (e.g. local silicification, spot metamorphism and similar small-scale phenomena) or where components are cemented by a mineral far more or far less resistant to erosion. Typical examples of the latter type are conglomerates, breccias or sandstones. The last-named are often of well-sorted quartz grains cemented by much more soluble material, such as colloid silica or carbonate. Crystalline quartz is thought to recede only 1 mm per 34 million years in some conditions (Rimstidt and Barnes 1980), whereas calcite retreats between 2 mm and 20 mm per millennium (Bednarik 2001: 61). However, there are significant differences according to the crystallisation state of the carbonate mineral, the ambient pH and other factors (relating to climate, moisture and water turbulence), and limestone solution rates can be very much higher in laboratory experiments.

In the case of the inscription, we now have the benefit of exploiting the surfaces left by the damage occasioned in the 1970s: they are readily detectable, and we know that they were about thirty years old at the time of examination. These surfaces bear fractured and crushed grains, although these are not common. There is no evidence that indirect percussion (use of a chisel-like artefact) was used; instead, the rarity of damaged quartz grains suggests that most rock was removed in small scales detached by hammer blows. No broken grains of a fracture angle suitable for measuring micro-wanes were detected. However, the retreat of the carbonate cement was determined in several locations of the 1970s damage. It was found to be uniformly between 10% and 20% (Fig. 7a). This means that the cement between the sandstone grains had receded 10–20% of the amount needed to erode before the grains would become detached.

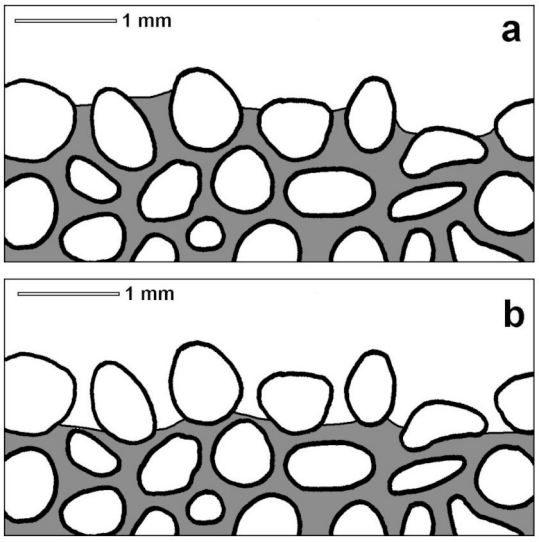

Figure 7. *Pattern of microerosion comparing (a) 10–20% cement retreat at the fake* Zuitdorp *inscription in the area hacked out between 1975 and 1978; and (b) 100% cement retreat, as found in the inscription at Site J.*

We also examined the surviving inscription groove surfaces with a binocular microscope. All showed a more significant cement retreat. While this means that the grooves must predate the damaged surface, a significant age difference is not evident. To be authentic, the inscription would have to be in the order of 300 years old, which is considered impossible on this friable support and in this moist environment. The second inscription at the site, discovered only in 2006, is high up on the cliff, not exposed to marine erosion and on more stable support in a slightly sheltered location, and was already barely decipherable after less than 300 years. We, therefore, conclude that the destroyed *Zuytdorp* inscription was a modern creation intended to mislead. Nevertheless, it should not have been obliterated without specialist analysis because it can still furnish scientific data.

Site J

The described inscription is not the only one near the *Zuytdorp* wreck site. The author discovered the inscription at Site J on 16 July 2006. It is located in a shallow shelter in buff-coloured calciferous Pleistocene sandstone, 11 m wide, forming a broad sweeping curve in plan view. The dripline is 4.5 m from the floor at the highest point, well indented from the vertical flanks. The shelter faces almost due west and is located at an elevation of 18 m above the high-water mark. The calcarenite features a relatively narrow range of grain sizes, mostly from 200 to 400 μm and well-rounded and frosted. There is a considerable diversity of grain minerals, with clear crystalline quartz occurring with various other minerals, but mollusc shell fragments are absent. Within the shelter, the rock recedes through granular mass exfoliation, forming deeply concave aspects of up to 1.6 m depth, and such erosion features as tafoni occur. However, where pre-existing fractures, which can be orientated in any direction, have become exposed, flat surfaces that are significantly more resistant to erosion occur. This is attributable to precipitated silica sheets within these fracture spaces and the immediately contiguous rock fabric. Indeed, the resistance to all the Quaternary sandstones' erosional processes along this coast is primarily a function of silica penetration. At Site J, the older fractures are occupied by colloid silica precipitate, up to several mm thick, and these penetrate slightly into the rock fabric on either side of the fault. Where tectonic (structural) events uncover these fractures, flat vertical panels that the silica has stabilised become exposed, and they erode significantly slower than the unmodified arenite. These panels tend to be much darker than the unconsolidated sandstone and often bear surface remnants of silica. They occur only on the flanks of the shelter, presenting relatively stable, flat vertical panels.

At the northern flank of the shelter occurs such a flat, almost perfectly vertical panel of this erosion-resistant rock, nearly 3 m high. It faces due south and bears fractures that are silica-filled, with silica-free fractures in the lower part that may be more recent. The principal horizontal fracture on this panel, just above the inscription, is entirely occupied by colloid silica. The inscription is located about 1.8 m from the northern end of the shelter scarp, at a height of 1.4 to 1.5 m above the floor. It is unlikely that the shelter's steeply sloping floor level could have been significantly different in the past; there is no significant floor sediment present. Therefore, the inscription, which occurs at the most suitable place within the shelter, was likely inscribed at the most convenient level above the floor. Moreover, the standing room below it is the only part of the shelter floor that is nearly horizontal. The vertical panel on which the inscription occurs is not fully sheltered from rain; only the deeply eroded part of the shelter, where the dripline recedes about 5 m from the flanks, is fully protected.

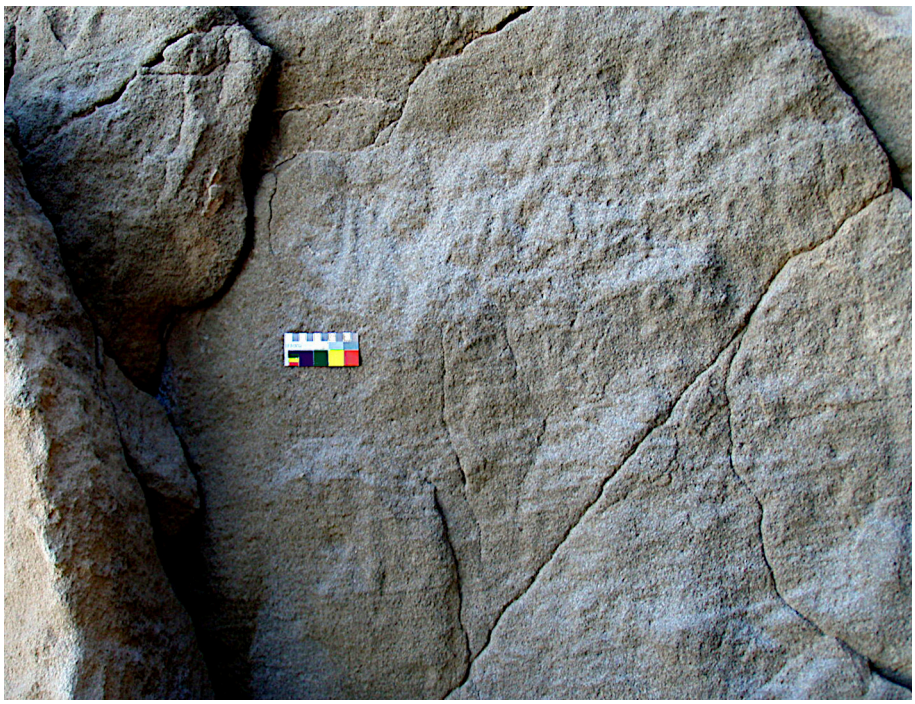

Figure 8. *The inscription at Site J, near the* Zuytdorp *wreck site.*

The inscription (Fig. 8) is relatively faint and heavily weathered but does remain visible. Its left part appears to read 'JIV' or 'JIU' and it becomes increasingly unreadable towards the right. The first letter is 11 cm high and consists of a well-rounded and continuous groove, 15 to 20 mm wide, with a depth averaging 3.4 mm but reaching a maximum of 4.5 mm. The 'I' has a maximum depth of 4.7

mm. The third letter is 6.7 mm deep at just one point but is mostly much shallower, in the order of 2.7 mm deep. There appears to be a dot on the top of the third letter's left branch, separated from the groove forming the letter, and it is unclear whether the letter is intended to constitute a 'U' or a 'V'. However, the widths of the grooves forming all three letters are very constant, generally ranging up to 20 mm and nowhere less than 15 mm. Distinct residues of the former colloid silica sheet that gave rise to the panel occur just to the left of the lower part of the 'J', extending over an area of 40 mm. A similar precipitate appears just above the 'I'. Small patches of the silica membrane can be found all over the panel.

A microscopic search yielded no fractured mineral grains in grooves forming the letters. The cement retreat between grains is generally 100%, i.e. identical to the adjacent unmarked rock surface (Fig. 7b). Although no means of calibrating this measure of antiquity are available for the site, a 20th-century origin can be safely excluded given the vastly greater longevity of the stabilised, silica-permeated panel relative to the general rock retreat near the site, and also considering the extremely weathered general appearance of the inscription. Most of it is beyond discernibility and an antiquity of some centuries seems soundly demonstrated.

The crew and passenger list of the *Zuytdorp* was lost in World War 2, but the list of the 103 soldiers on board has survived. The possibility that the inscription records a soldier's name's initials or first letters was investigated, but no perfect match was found.

The *Vergulde Draeck* inscription

Sailing from Texel in Holland to Batavia in Java, the *Vergulde Draeck* (Guilt Dragon) was wrecked near Ledge Point, just north of Perth, on 28 April 1656. Of the 193 people on board, 75 survived the disaster. Seven of them travelled in a small boat to Batavia (Jakarta) to request the remaining survivors' rescue. Several rescue expeditions sent from Java failed to locate the party, and many rescuers were lost in these endeavours. The fate of all these people remains unknown, but the ship's wreck was eventually found in April 1963. Seven years earlier, Wanneroo dairy farmer Harry Duffy had reported finding a large stone slab with an inscription near Burns Beach, just north of Perth. At that time, the site had remained quite remote and secluded. The inscription, reading 'VERGULDE DRAECK 1656', purported to be by a survivor of the *Vergulde Draeck*, was examined at the request of a newspaper, *The West Australian*, by two geologists. J. E. Glover and B. F. Glenister of the University of Western Australia pronounced the inscription a recent hoax, less than ten years old at the time. They based this verdict on the colour differential between the engraved grooves and the surrounding, darker 'dolomite skin', suggesting that the latter should have been completely replaced within 300 years (Anon. 1956).

In January 2004, we endeavoured to re-locate the engraved slab along the coast between Mullaloo and Burns Beach, a coastal stretch of about 4.7 km, but failed to find it. Eventually, we secured photographs from the newspaper's archive to match any landscape details with the terrain. We managed to find the site quickly then, but the 4 m-long engraved rock had vanished. During a further examination of the site in August 2004, we noticed a groove on a small block largely submerged under the beach sand nearby. Upon excavating it, several inscription letters emerged (Fig. 9), and we could reconstruct what had occurred. The fragment of the slab reported, photographed and published half a century earlier was found a few metres from the slab's original location and bears extensive traces of two massive impact blows, 40–50 cm apart. One point of impact is marked by distinctive compres-

Figure 9. *The* Vergulde Draeck *inscription fragment, as it was uncovered near Burns Beach in 2004.*

sive-tensile rock markings (Bednarik 2019). Comparison with the inscription's 1956 photograph shows that heavy bruising has erased several letters, so only three remain largely undamaged. The bruised areas are of lighter colour and smoother than the weathered pre-1956 surface. All damage appears to have been occasioned by applying a sledgehammer, first to efface the script and finally smash the slab, which was up to 50 cm thick in places. The three surviving characters are the first two of the first line ('V' and 'E', plus part of the 'R') and the first of the second line ('D').

Our examination detected no trace of any 'dark dolomite skin' on the rock fragment or the other rocks at the site. Moreover, the argument that there should have been subsequent deposition of any form of mineral skin is specious because unstable environmental factors would influence the formation and dissolution of such accretions. The aeolianite rock shows distinctive layering parallel to its formerly upper surface, which is remarkably well consolidated. Its average grain size of 1–2 mm has, through granular exfoliation, determined a surface relief of similar magnitude between the top of the remaining grains and the erosion front of the cement. The grains consist primarily of well-rounded, sometimes frosted quartz grains and occasional small gastropod shells or coral fragments. At the edge occurs a conchoidal fracture scar of about 5 cm in length. Within it are at least four distinctly fractured quartz grains, all in close vicinity. At 160× magnification, their edges remain quite sharp, with wane widths of only 1 or 2 μm.

A search for fractured grains in the grooves of the three remaining letters (V, E, D) located two in the 'D', which were measured, and four more in the 'V'. All these fracture edges exhibit distinctive micro-wanes. Measurements were made on the two grains in the letter 'D'. In the straight part of the groove, the first grain is eminently suitable for microerosion analysis. It has been truncated across its top, parallel to the surface, so that the sub-spherical grain bears a dish-shaped, slightly concave and roughly circular scar. Its 580 μm-long edge, which ranges in angle from c. 90° to 110°, forms a continuous wane, from which the following reliable size estimates were secured: 10, 11, 11, 10, 12, 10, 12, 12, 12, 12, 14, 12, 12, 10, 12 μm.

The second micro-wane in the letter 'D', from its bottom part, is of a long edge on a grain in the groove's sidewall that has been truncated at a right angle to the surface. The edge is harder to see (the truncating vertical surface is inaccessible to microscopic examination), but the following estimates were provisionally made of the wane: 12, 11, 10, 10, 10, 12 μm. These closely match the previous readings, but all are unsuitable for microerosion dating. The site is frequently exposed to sea spray and occasionally, during very high tides, is submerged by the alkaline seawater (pH = ~8.1).

What renders these two results particularly compelling is that the several quartz fracture edges in the letter 'V' all exhibit very similar development in their micro-wanes, all essentially in the 10–12 μm range. Even in this site's moist and erosive, relatively high-pH environment, such extensive wane formation cannot possibly be attributed to a period of 50 years or so. Moreover, the wane development in grains presumably fractured in 1956 or soon after is only a fraction of that seen in the inscription. Given the linearity of microerosion (Bednarik 1992), it is in the order of one-tenth to one-sixth of the immediately adjacent inscription's age. The probability that the slab fragment was periodically buried by sand also needs be considered. Therefore, it must be concluded that the inscription could not possibly be of the 20th century, and an age of the 19th century is also unlikely. The most apparent and parsimonious conclusion is that its purported age is indeed its actual age.

Figure 10. *Night-time view of the* Vergulde Draeck *inscription fragment.*

Although the inscription is badly weathered, it is apparent that it was made with a steel tool, and it is apparent that the maker was well-versed in making such letters in stone or took considerable care in this work (Fig. 10).

Several factors contradict the notion that this is a fake. For instance, in 1956, well before the shipwreck was located, the public had given no attention to it. Several features of the script resemble an antiquated style and are unlikely to have been employed by a faker. There is also the need for a proper motivation: the discoverer would not have known about the shipwreck or its survivors. A blackish material evenly covers both the

inscription grooves and the undamaged surrounding surfaces but is entirely lacking on the post-1956 damaged areas and the impact fractures. The accretionary material was not analysed but is most probably of an organic nature, relatively thin and discontinuous, but it separates the pre-1956 from the post-1956 surface aspects. Its absence on the latter several decades later shows that it takes much longer than 50 years to accumulate or that it is formed under conditions not applicable since 1956. Finally, microscopic wane formation on quartz was five or six times greater in the inscription than on the fracture inflicted in 1956 or shortly after that.

In 1956, the site was quite remote and difficult to access. Nevertheless, someone considered it necessary to bring the tools needed to destroy a purported last message of the doomed survivors of a maritime disaster. In recent years, the site has been sacrificed to the establishment of the Ocean Reef Marina. Our suggestion to find the remaining fragments of the inscribed slab and preserve the pieces for future investigation elicited no interest from the parties involved. So, we may never know the status of this inscription, just as we have no idea what happened to the survivors of the *Vergulde Draeck*.

Discussion

Of the six Western Australian rock inscriptions considered here, one is attributable to a hoax (*Zuitdorp* Wreck Site), two are historically validated (Depuch Island), two are considered authentic based on their analysis (Abydos and *Zuitdorp* Site J), and the last remains unresolved and will probably continue to be so (*Vergulde Draeck* Site). The two specimens known to government agencies and related to ancient Dutch shipwrecks were deliberately destroyed by unknown parties or perhaps the same party. Regrettably, we need to withhold information about rock inscriptions, especially their locations and any data that may betray their locations, including photographs of sites. We trust that the reader agrees that, under the circumstances, releasing such details would be irresponsible. Successive state governments of Western Australia have routinely approved the destruction of cultural heritage, ranging from the Dampier Archipelago rock art (reputed to be the world's most extensive rock art corpus) continuously since 1964 to the Juukan Gorge rockshelters in 2020. Destruction is apparently not limited to Aboriginal heritage monuments; other non-British heritage has also fallen victim to such sentiments. For instance, a government agency is responsible for losing many tonnes of silver and gold coins and bullion from the *Zuytdorp* wreck through theft (Playford 1996). The only two Australian rock inscriptions allegedly relating to early shipwrecks so far reported publicly have both been destroyed soon after they were reported to responsible authorities. In these circumstances, we suggest that archaeologists, historians, and others exploring the pre-British historical evidence of this state need to be circumspect in reporting such finds as rock art or rock inscriptions — given the long history of endemic state heritage vandalism in Western Australia.

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