ORIENTATION

Dampier rainwater as acidic as beer: CSIRO

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On 25 July 2002, in direct response to a report about the destruction of Dampier rock art (Bednarik 2002), the State Government of Western Australia announced that it would conduct a four-year study of this issue. On 16 October 2002, the then Premier, Dr G. Gallop, announced a committee of nine members, the Rock Art Monitoring Reference Committee (RAMRC), to oversee this project. Exactly four years later, on 17 October 2006, the government released a report on the results of only the first of these four years of study, conducted by a supposedly independent team from CSIRO (The Australian Commonwealth Scientific and Research Organisation).

This raises some very pertinent questions: why did it take four years to present the outcomes of just the first of four years of research? Is the project team that produced this report free of influence from government agencies? Does this report exonerate the government from the accusation that its policies are destroying the Dampier rock art, or from the responsibility of managing this world-class cultural monument? These are the principal questions examined here.

The first two questions are easily answered. The incredible delay is attributable to government procrastination and dithering. Although the RAMRC was established three months after the initial announcement, it took to 16 July 2003 to invite interested parties to conduct this study, i.e. a full year. It took another year, to 12 August 2004, to commence the project by CSIRO, which the government announced then as a unique and advanced pioneering study, 'the first of its kind in the world'. CSIRO (2006) produced a report for the first year of its work (August 2004 to August 2005) on 10 April 2006, but the government delayed its release for another six months. At the same time it became known that the study had run out of funding. Therefore the history of this project indicates a scandalous inefficiency of the government.

The second question, was there government influence in the project, is just as readily clarified. One of the members of the CSIRO team is not a scientist of that organisation, but is none other than Bill Carr, recently of the Department of Industry and Resources, currently the Director of the Conservation Commission (CC 2006) of Western Australia. At the DIR, he was responsible for defending the government from accusations of rock art vandalism, and appointing him Director of the Conservation Commission is like placing the fox in charge of the chicken coop. It refutes the idea that the government lacks a sense of humour or irony. The fact that Carr has served as a member of the CSIRO team, despite his significant conflict of interest, severely questions the independence of this report.

Which brings us to the third question to be considered. The value of the CSIRO report should be judged solely on how well it meets the original objectives of the project. The principal objective, as stated on its page 4, was to 'investigate and report on impacts of proposed industrial developments on the rock art of the Burrup'. The RAMRC formulated three research questions to be investigated by this project:

- Is the natural weathering of the rock art of the Burrup Peninsula being accelerated by industrial emissions?
- Is there a significant and measurable problem?
- If there is a significant issue, what management approaches are recommended?

The project has not clarified the first issue, and has hardly even attempted to do this. The second issue remains unanswered, hence no attempt was made to address questions of management. Moreover, the initial objective, to report on the 'impacts of proposed developments' (such as the Pluto plant and others) was completely ignored in this report. No modelling of any kind was even attempted, and in that sense alone this report is significantly inferior to previous studies of the impact of Dampier industry, such as those by Sinclair Knight Merz just a few years ago. The project has therefore failed to deliver on any of its objectives, and in that sense it is an unmitigated failure.

It has, however, provided excellent basic data on the quantification of some of the many relevant airborne pollutants, and in that sense offers substantial justification for the concerns first expressed five years ago (Bednarik 2002). Most important of all, it provides unequivocal confirmation that acidic precipitation occurs for most of the year. Although the data are highly fragmentary (two of the samplers are

said to have 'experienced problems'; CSIRO 2006: 1), covering only a few weeks at each of only five of the sampling sites, they suffice to show that acid rain occurred in eighteen out of twenty periods checked (CSIRO 2006: Table 13a). Acid rain is precipitation of a pH of <5.6 caused by anthropic agents, especially industrial emissions. At Site 8, the pH was 7.5 and 5.8 respectively in two periods, but in the eighteen other periods it fell between pH 4.3 and 5.3, with a mean of pH 4.597. This represents a ten-fold increase in acidity (reduction of hydrogen ion concentration) from the upper limit of acid rain. It means in practical terms that the rainwater at Dampier has the acidity of beer, but is slightly less acidic than lemon juice.

The rainwater pH of Dampier was mostly in the vicinity of pH 7.0 and 7.2 in the 1960s (Bednarik 2002: 36), peaking at pH 7.6, and has fallen gradually since then, especially after the commissioning of the NW Shelf facility in 1980. On 29 June 2002, Pilbara MLA Fred Riebeling was quoted by The *West Australian Weekend Extra* as saying '[I]f the government produces acid rain [at Dampier] it will be an absolute tragedy. And the first time I see a reputable agency say that, then I'll take it seriously.' Perhaps Mr Riebeling does not regard the CSIRO as a reputable agency, but the CSIRO report does provide substantial evidence of acid rain at Dampier. The granophyre and dolerite rocks of the Archipelago typically lack acid neutralising capacity, and the ferruginous mineral crust covering all rocks is gradually degraded through the mobilisation of its cations, notably iron and manganese. Ford et al. (1994) have shown that a reduction in pH of 2.2 units in the Napier Range, Kimberley, has increased rock solubility by 230%.

This brings us to the most serious omission in the CSIRO study: it completely disregarded the crucial factor in the rock art deterioration, the erosion of the iron-rich rock patina. The percussion petroglyphs are not 'etchings', as they are naively called in the report, they were made by pounding through the mineral accretionary deposit, exposing the light-coloured weathering separating this dark-brown substrate from the unaltered rock beneath. The result of this technique is called a sgraffito. Thus the petroglyphs depend for their continued existence entirely on the preservation of the surface patina, which has provided the necessary colour contrast since they were created. The whole point of their conservation revolves around the need to prevent the mobilisation of this surface crust's cations, especially iron and manganese, caused by a lowering of the ambient environmental pH. The solubility of iron increases about 100 000-fold through the lowering of the pH from 8.5 to 6.0. Much of this change occurs in the pH range of 7 to 6, which represents a ten-fold increase of acidity (the pH scale is a decadial logarithm). Not only does the CSIRO report reveal a decrease of the precipitation pH from around 7.2 to an average of 4.6, its single measurement of pH 7.5 (16–23 March 2005, at sampling site 8) confirms that, under exceptional climatic conditions the pristine values are still achieved — perhaps once in a year. About fifty weeks in the year, precipitation (dew or rain) is in the form of 'acid rain', containing sulphuric, nitric and other acids.

It needs to be appreciated that the distribution of this dark-brown, ferruginous accretionary crust is a feature of the high-pH arid environments of Australia, and all similar environments of the world (e.g. parts of south-western U.S.A., Mexico, Arabia, Sahara). It is absent in any region of low-pH regimes, such as the Kimberley, and of course in the vicinity of any major city. The argument raised in the CSIRO report, that the air quality at Dampier is better than in many polluted cities, is irrelevant. The purpose of the CSIRO project was not to determine the effects of pollution on the human population, it was to establish the processes effecting the deterioration of the ferromanganeous accretion. It should be self-evident that sgraffito petroglyphs on such deposits would never survive in the air pollution of southeast-Asian cities, or even in Perth (cf. Rye et al. 1996). In referring to the conditions in polluted cities, the CSIRO team indicates that it has misunderstood the brief of its project.

There are also significant shortcomings in its design. For instance, it is well known that gaseous air emissions such as nitrogen dioxide travel enormous distances (Wenig et al. 2003), and the 'control site' CSIRO used in this project, at Mardie Station, is only 81 km from Dampier. It is undeniably within the zone affected by the Dampier fallout, as shown by several observations. A minimum distance of 200 or 300 km would be advisable, although even that would not provide true control data. To place the control station so close to the source of emissions was inappropriate. Similarly, the report's frequent comments about sampling sites 1 and 3 providing good background data are misleading. These sites are only 7 and 14 km respectively from the principal pollution source. Hence the report's assumptions made about background levels are false.

There are three basic methods of measuring air pollution, the passive, active and automatic sampling methods. These offer considerable differences in cost and reliability, the cheapest by far being passive sampling, involving no pumping of air. Automatic sampling methods are about 1000 times as costly. CSIRO has chosen to use the passive sampling method, no doubt for economic reasons, at the expense of precision and reliability. The method is unable to show maximum levels or daily variations, it simply provides a rough guide of average level over exposure period (Steinbacher et al. 2005). It is technically no more sophisticated than the methods used by independent environmental advocacy groups (such as the 'Bucket Brigades' in the U.S.A.), and its results are not legally accepted in the European Union. To claim, as the government has, that this study is

groundbreaking, is severely misleading. Vastly more sophisticated studies of the effects of industrial emissions on rock art have been conducted in other countries (cf. Bednarik 2002 for some references), and CSIRO's pollutant measurements at Dampier are low-budget versions of work done by that agency previously. The Melbourne laboratory of CSIRO certainly has the capability of conducting much more sophisticated research on nitrogen oxides (cf. Galbally and Roy 1978).

The quantified data provided by CSIRO does not support the recent claim made by the former corrupt Minister, John Bowler, that pollution is low at Dampier. (In February 2007, Bowler was sacked after the Crime and Corruption Commission of Western Australia sensationally exposed his corruption while a minister.) It shows that modelling predictions severely understated the level of air pollution (SKM 2003). For instance, the Dampier nitrogen dioxide concentrations are now said to hover around 2000 to 3000 ppt (CSIRO 2006: Fig. 10), whereas predictions had been about 200 ppt three years ago (op. cit.: Fig. 25). Compared to those of 4 ppt at Cape Grim in Tasmania (pers. comm. Rob Gillett, member of the CSIRO team), a site with relatively clean air, the Dampier levels are close to a thousand times as high as at a 'clean' site. This is hardly surprising; Dampier industry emits around 15 000 tonnes of nitrogen oxide per year, Woodside being the greatest polluter in Australia (cf. *National Pollutant Inventory*). In some countries such as Sweden, a nitrogen oxide levy is paid by industries emitting large quantities of this pollutant, but Australia lacks such incentive to reduce emissions.

In short, the CSIRO study has confirmed that the petrochemical industry at Dampier produces acid rain nearly all year round, but it has failed to investigate its effects on the rock art or the rock patina. It has therefore failed to address its terms of reference, which were specifically to study the effects of the emissions on the rock art; to assess the impact of future developments on the Burrup; and to advise on appropriate management measures. The project failed in all its terms of reference.

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