8

Appendix – Principal degradation mechanisms

by Neville McMillan, Rob Allen & Trevor Hellen

1. Seawater Corrosion

Seawater and airborne sea spray present a number of corrosion problems of varying severity to all metallic climbing equipment. *In all cases, the corrosion is electrolytic with the chloride ions in the seawater acting as the electrolyte. In climbing equipment electrolytic corrosion can take one or more of the following forms:*

General corrosion

This occurs in the form of uniform chemical attack, and is the most easily detectable form of damage as it is visually obvious on the outer surfaces of equipment. *This corrosion does not usually cause a problem with PPE, (as items are usually retired when they acquire a thin surface layer of corrosion products), but its presence is a useful indicator that other, more serious forms of corrosion may be active elsewhere on the component. This form of attack is however an issue with in-situ pegs as shown in Fig 8.2 (see also the section on localised corrosion).*

Galvanic corrosion

Galvanic corrosion occurs when two dissimilar metals are in contact in the presence of an electrolyte (ie. in this case seawater). These conditions are met (for example) in the hinges of karabiners and on the axles of camming devices where aluminium alloy and steel are in contact with each other. Such small gaps provide ideal sites for water to collect, and corrosion in these locations can lead to a much stiffer action of the moving parts, or even complete sticking. This could result in the gate of a karabiner not opening or closing properly, or the cams of a camming device failing to operate.

Figure 8.1 Sea-cliff climbing can be outstanding – but what is happening to your gear? ***Photo:*** *BMC Collection*

Figure 8.2 Badly-corroded piton ***Photo:*** *David Hillebrandt*

Localised corrosion
This can occur as pitting corrosion (which is confined to a small point or area, and takes the form of small cavities), or crevice corrosion (associated with sites such as small gaps and crevices). Both forms of attack can locally thin the metal, making it more prone to stress-related failure, and in addition crevice corrosion can lead to exfoliation of the metal ie. cumulative degradation propagating outwards from the crevice site.

The most severe forms of attack are *intergranular corrosion* and *stress corrosion cracking* (SCC). These can occur in several alloys when exposed to aqueous chloride ions and oxygen (in combination with tensile stress in the case of SCC). They manifest themselves as fine, potentially deep cracks, which can be exceedingly difficult to detect and can result in catastrophic failure of metallic climbing equipment. Fortunately, only one instance of this type of failure has been known to occur to climbers' Personal Protective Equipment (15 years ago), and this was attributed to a quality control problem with the alloy, which was rectified. *However, a number of failures attributed to SCC have been reported in stainless steel bolts in Thailand, The Cayman Islands and the Calanques sea-cliffs of Southern France. No such failures of bolts in the UK have yet been reported to the BMC, but this issue is currently under investigation by the UIAA.*

In storage, it is essential to keep metallic equipment dry!

After every use of metallic climbing gear on sea cliffs, and anywhere within the region of sea spray (which may extend well over and around the actual sea cliff in rough weather), it is recommended that the following procedure be carried out:

- After finishing climbing for the day, keep the dry gear separate from the wet, and make sure it is kept away from any damp ropes, slings and clothing etc – even to the point of carrying a drybag to store dry equipment. Any wet metallic equipment should be washed thoroughly in tap water or a freshwater stream to remove all traces of salt, then after removal of surface water it should be hung out to dry. This should be done even if the plan is to climb again the following day.
- If you are travelling home, do not leave any metal equipment that may have been contaminated with salt water in a rucksack or other carry bag where it may come into contact with slings or ropes – especially in a warm environment – as this will induce corrosion. If karabiners or camming devices are left like this for, say, a week, they will at the very least become discoloured and suffer surface corrosion. Within a few weeks, they could be so badly affected as to be unfit for further use – a costly mistake!
- As soon as possible after returning home, all metallic equipment that has been contaminated with salt water should be thoroughly washed in tap water, preferably with a little mild detergent. Then remove all surface water and put in a warm, dry, airy place (such as a rack in an airing cupboard) to dry off the remaining moisture. With chocks and camming devices, take special care that the wire cables have been thoroughly washed and dried.
- When dry, any hinges, movable joints, wires and cables etc. should be treated with a suitable aerosol lubricant, any surplus wiped away, and the movement checked before storage.