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Corrosion products on carbon steel and microbial community structure in marine environments

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Research on interactions between microorganisms and corrosion of metallic materials focuses largly on identification and metabolic activities of single bacterial species implicated in Microbiogically Induced Corrosion (MIC), especially sulphate-reducing bacteria (SRB). Our investigation aimed to elucidate relationship between accelerated marine corrosion of carbon steel and community structure of bacterial biofilms associated with corrosion products. The study was conducted in three different French costal regions (English Channel, Atlantic Ocean and Mediterranean Sea). Techniques of SEM-EDX, ICP-AES, XRD and micro-Raman Spectrometry revealed stratification of corrosion products with the presence of iron sulphide species, green rust, magnetite, goethite and lepidocrocite. In constant immersion zone these corrosion products were organized based on iron oxidation state, regardless of geographical location. Molecular biology techniques and standard cultivation methods demonstrated that bacteria in corrosion products were abundant ($\sim 10^8$ bacteria per gram of humid deposit) and highly diverse. Moreover, corrosion products contained many species of diatoms and pluricellular organisms. Characterisation of cultivable bacteria and culture-independent fingerprinting method (CE-SSCP) showed more than 20 bacterial ribotypes in the deposits. Molecular detection of SRB was carried out using dissimilatory sulfite-reductase gene (dsrAB) and probes specific for six SRB sub-groups. SRB were found in all corrosion layers, especially at the interface between FeS layer and sulphated green rust layer. *Desulfobulbus* and *Desulfovibrio* were detected as dominant SRB genera irrespective of the site studied. The phenomenon of marine bio-

corrosion is reviewed with emphasis on the role of green rust as sulphate reservoir, the localized acidification induced by biogenic sulphur, and the plausible role of extracellular polymeric substances in connecting bacterial cells and mineral corrosion products. The impact of pluricellular organisms on the deposit stability is discussed.