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Bio-corrosion detection by sulphur isotopic fractionation measurements using nanoSIMS

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The presence of Sulphate-Reducing Bacteria (SRB) may influence the corrosion rate of ferrous objects by inducing iron sulphides precipitation. The same phases are formed by biotic or abiotic ways. Yet, biotic iron sulphides are supposed to be depleted in heavy isotopes of sulphur relative to the starting sulphates [1]. So, sulphur isotopic composition analyses enable to determine the (a-)biotic origin of the iron sulfides. Previously, a single study [2] devoted to corrosion issues had used the sulphur isotopic composition to determine the origin of sulphides compounds formed on Cu/Ni steel. However, the sulphur isotopic fractionation was obtained by global mass spectrometry from the precipitation into $BaSO_4$ of the remaining sulphates of the corrosion experiment. This method is not adapted to the iron sulphides formed in field samples, presents as strips of some micrometers size [3].

To fill this analytical gap, in the study presented here, nanoSIMS (nanoscale Secondary Ion Mass Spectrometry) is used to determine the local sulphur isotopic composition of the iron sulphides within the corrosion product layers of two kinds of field samples: a short term system consisting of a steel coupon buried for 24 months in the Andra (French National Radioactive Waste Management Agency) Underground Research Laboratory devoted to research on the geological disposal of radioactive waste at Bure (Grand Est, France); and long term systems composed of iron nails buried in the water-saturated soil of the archeological site of Glinet (Normandie, France) during around 500 years. Thus, thanks to the methodology developed the iron sulphide bio-origin is proved in both corroded samples.

[1] Sim *et al.* (2011) *Science* **333**, 74–77. [2] Little *et al.* (2012) *Biofouling* **6**, 279–288. [3] Grousset *et al.* (2016) *Corros. Sci.* **112**, 264–275.