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Development of a nanoSIMS analytical protocol to determine the sulphur isotopic composition of iron sulphides formed during anoxic corrosion

S. GROUSSET^{1,2,3*}, A. DAUZERES², D. CRUSSET³, V. DEYDIER³, Y. LINARD³, S. MOSTEFAOUI⁴, L. URIOS⁵, P. DILLMANN¹, F. MERCIER¹, D. NEFF¹

¹LAPA-IRAMAT, NIMBE, CEA, CNRS, CEA Saclay, 91191 Gif-sur-Yvette, France (*presenting author, sophie.grousset@alumni.enscp.fr)

²IRSN, PRP-DGE/SRTG/LETIS, B.P.17, 92262 Fontenay-aux-Roses, France (alexandre.dauzeres@irsn.fr)

³Andra, 1-7 rue Jean Monnet, 92298 Châtenay-Malabry, France (didier.crusset@andra.fr)

⁴IMPIC-COSMO, MNHN, 75005 Paris, France (smail@mnhn.fr)

⁵UPPA, IPREM-EEM, UMR 5254, IBEAS, 64013 Pau, France (laurent.urias@univ-pau.fr)

The presence of Sulphate-Reducing Bacteria (SRB) may influence the corrosion rate of ferrous objects by inducing iron sulphides precipitation [1]. 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 sulfates [2]. So, sulphur isotopic composition analyses could enable to distinguish between an abiotic or biotic origin of the iron sulphides. Currently, the sulphur isotopic compositions of sulphates and sulphides are broadly determined by mass spectrometry on previously dissolved phases [3]. Yet, this methodology is not adapted to the iron sulphides located in the corrosion product layers of field samples, presents as strips of some micrometers size [4].

The approach developed in this study is based on the determination of the sulphur isotopic composition of iron sulphides within the corrosion product layers by nanoSIMS (nanoscale Secondary Ion Mass Spectrometry). This new diagnostic tool has been validated on model systems composed of iron coupons corroded in an anoxic solution with or without SRB, and on an iron bar corroded in an anoxic percolation cell in contact with clay and in presence of SRB. Results show that iron sulphides are depleted in ³⁴S when corrosion is active in presence of bacteria.

[1] Videla *et al.* (2009) *Int. Biodeterior. Biodegrad.* **63**, 896–900. [2] Sim *et al.* (2011) *Science* **333**, 74–77. [3] Canfield (2001) *Geochim. Cosmochim. Acta* **65**, 1117–1124. [4] Grousset *et al.* (2016) *Corros. Sci.* **112**, 264–275.