



**HAL**  
open science

## Use of the $^{34}\text{S}/^{32}\text{S}$ isotopic ratio for the study of the biorigin of the sulfur phases located in the corrosion product layer of iron or low alloy-steel samples corroded in anoxic conditions

Sophie Grousset, Alexandre Dauzères, Didier Crusset, Valérie Deydier, Yannick Linard, Laurent Urios, Smail Mostefaoui, Nicolas Nuns, Muriel Bouttemy, Arnaud Etcheberry, et al.

### ► To cite this version:

Sophie Grousset, Alexandre Dauzères, Didier Crusset, Valérie Deydier, Yannick Linard, et al.. Use of the  $^{34}\text{S}/^{32}\text{S}$  isotopic ratio for the study of the biorigin of the sulfur phases located in the corrosion product layer of iron or low alloy-steel samples corroded in anoxic conditions. Eurocorr 2016, Sep 2016, Montpellier, France. cea-02332799

**HAL Id: cea-02332799**

**<https://cea.hal.science/cea-02332799>**

Submitted on 25 Oct 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## Use of the $^{34}\text{S}/^{32}\text{S}$ isotopic ratio for the study of the bioorigin of the sulfur phases located in the corrosion product layer of iron or low alloy-steel samples corroded in anoxic conditions

Sophie GROUSSET<sup>1,2,3</sup>, Alexandre DAUZERES<sup>2</sup>, Didier CRUSSET<sup>3</sup>, Valérie DEYDIER<sup>3</sup>, Yannick LINARD<sup>3</sup>, Laurent URIOS<sup>4</sup>, Smail MOSTEFAOUI<sup>5</sup>, Nicolas NUNS<sup>6</sup>, Muriel BOUTTEMY<sup>7</sup>, Arnaud ETCHEBERRY<sup>7</sup>, Philippe DILLMANN<sup>1</sup>, Florence MERCIER-BION<sup>1</sup>, Delphine NEFF<sup>1</sup>

<sup>1</sup> NIMBE/LAPA, CEA/CNRS, UMR3685, CEA Saclay, 91191 Gif sur Yvette, France

<sup>2</sup> IRSN, PRP-DGE/SRTG/LETIS, B.P.17, 92262 Fontenay-aux-Roses, France

<sup>3</sup> ANDRA, Direction de la recherche et développement, 1-7 rue Jean Monnet, 92298 Châtenay-Malabry, France

<sup>4</sup> IPREM-EEM, UMR 5254, Université de Pau et des Pays de l'Adour, 64013 Pau Cedex, France

<sup>5</sup> IMPMC-COSMO, Museum National d'Histoire Naturelle, 75231 Paris Cedex 05, France

<sup>6</sup> Institut M.E. Chevreul, Université de Lille, CNRS, 59650 Villeneuve d'Ascq Cedex, France

<sup>7</sup> ILV, Institut Lavoisier de Versailles, UMR CNRS-UVSQ 8180, 78000 Versailles, France

The presence of Sulfate-Reducing Bacteria (SRB) may influence the corrosion rate of ferrous objects by inducing iron sulfides precipitation [1]. The same phases are formed by biotic or abiotic ways. An analytic method for detecting bacterial interventions in corrosion processes is required. Yet, biotic iron sulfides are supposed to be depleted in heavy isotopes of sulfur relative to the starting sulfate [2].

The aim of this study is to set-up a methodology based on  $^{34}\text{S}/^{32}\text{S}$  isotopic ratio determination to evidence the origin of sulfides in the corrosion product layers of “long term systems”: ferrous archaeological samples studied as analogues of long-term corrosion of nuclear waste package and steel samples issued from anoxic corrosion experiments in contact with claystone. In parallel “model systems”, iron coupons corroded in anaerobiosis with or without SRB, are studied to compare the sulfur isotopic fractionation resulting from a bacterial or an inorganic sulfide source.

Complementary techniques were used to characterize the sulfur-bearing compounds in the samples: FESEM-EDS for their distribution,  $\mu$ -Raman and nano-Auger spectroscopy for the nature of phases. Then, the  $^{34}\text{S}/^{32}\text{S}$  isotopic ratio was determined by NanoSIMS and compared to the one of the sulfates from the surrounding solution. As a result,  $d^{34}\text{S}_{\text{sulfate-sulfide}}$  reaches values of  $\sim 10$  ‰ to  $\sim 60$  ‰.

[1] H.A. Videla *and al.*, Int. Biodeterior. Biodegrad. 63 (2009) 896–900.

[2] M.S. Sim *and al.*, Science. 333 (2011) 74–77.