New insight in fluorescence Pseudomonas iron acquisition in soil: pyoverdine plays a key role in iron oxydes weathering

Elena Orozco, Claire Ferret, Stéphanie Lawniczak, Isabelle Schalk, Guillaume Echevarria, Thibault Sterckeman, Valérie Geoffroy

To cite this version:

Elena Orozco, Claire Ferret, Stéphanie Lawniczak, Isabelle Schalk, Guillaume Echevarria, et al.. New insight in fluorescence Pseudomonas iron acquisition in soil: pyoverdine plays a key role in iron oxydes weathering. Seminaire de Microbiologie de Strasbourg (SMS), Apr 2013, Ilkirch, France. 2013. hal-02809145

HAL Id: hal-02809145
https://hal.inrae.fr/hal-02809145
Submitted on 6 Jun 2020

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.
New insight in fluorescence Pseudomonas iron acquisition in soil: pyoverdine plays a key role in iron oxides weathering

Orozo Elena¹, Ferret Claire¹, Lawniczak Stéphanie², Schalk Isabelle³, Echevarria Guillaume³, Sterckeman Thibault³ and Geoffroy Valérie¹.

1. Université de Strasbourg, Biotechnologie et signalisation cellulaire, UMR 7242, ESBS, 300 bd Brant BP 10413, 67412 Illkirch Cedex
2. Université de Strasbourg, Laboratoire d’Hydrologie et de Géochimie de Strasbourg, UMR7517, 1 Rue BLESSIG, 67084 STRASBOURG
3. INRA, Université de Lorraine, Laboratoire Soils et Environnement, UMR 1120, BP 172, Vandoeuvre-lès-Nancy Cedex, F-54505, France

Objectifs: Bacteria required iron for essential metabolic processes. However, ferric iron is poorly available in soil due to various parameters (pH, oxygen, crystallinity, specific area, ...). To get access to this crucial element, bacteria produce in their environment siderophore, a high affinity Fe³⁺ chelator. As a reference, pyoverdine was used as the main siderophore produced by fluorescent Pseudomonas. First, this research aims to understand the pyoverdine-mediated dissolution of different iron-oxides. We tested two iron-oxides, a well crystallized goethite and a poorly crystallized ferrhydrite. Secondly, the involvement of metabolizing siderophore-producing bacteria was investigated on iron-bearing minerals dissolution.

**MINERALS**

- Ferrhydrite: Amorphous
- Goethite: Well crystallized

Electron micrographs of synthetic ferrhydrite 2-lines and goethite

Iron oxides were prepared according to the methods of Schwertmann and Cornell 1991. A goethite substituted with aluminum was prepared.

<table>
<thead>
<tr>
<th>Minerals</th>
<th>% substitution</th>
<th>Specific area (m² g⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-substituted goethite</td>
<td>6.1</td>
<td>34.6 x 10²</td>
</tr>
<tr>
<td>Al-substituted goethite</td>
<td>4.9</td>
<td>54 x 10²</td>
</tr>
</tbody>
</table>

**RESULTS**

**Effect of pyoverdine on iron release from iron oxides**

In the presence of pyoverdine, iron concentration increased in solution. The amorphous iron oxide, ferrhydrite, was more easily weathered by pyoverdine than the well-crystallized oxide, goethite.

**Fluorescence spectra of pyoverdine incubated with goethite**

In the presence of goethite, the fluorescence of pyoverdine decreased, meaning that a pyoverdine-Fe complex was formed. At 1 g. L⁻¹, the fluorescence was almost repressed.

**Alteration of iron oxides in the presence of pyoverdine-producing Pseudomonas**

**Conclusions and perspectives**

In conclusion, the iron solubilisation from the iron oxides explained the growth stimulation and siderophore repression observed with Pseudomonas. The weathering of iron oxides by the siderophore itself and to a lesser extend by siderophore-producing bacteria, enhanced the release of substituted metal found in the crystals, that could be potentially toxic for the environment. Further investigations are in process to better understand the interaction between bacteria and minerals and to determine the mechanism involved in iron chelation.