Mineralizing filamentous bacteria from the Prony Bay Hydrothermal Field give new insights into the functioning of serpentinization-based subseafloor ecosystems

Céline Pisapia 1,2,*, Emmanuelle Gérard 1, Martine Gérard 3, Léna Lecourt 1, Susan Q. Lang 4, Bernard Pelletier 5, Claude E. Payri 6, Christophe Monnin 7, Linda Guentas 6,8,9,10, Anne Postec 11, Marianne Quéméneur 11, Gaël Erauso 11, Bénédicte Ménez 1*

1 Institut de Physique du Globe de Paris, Sorbonne Paris Cité, Université Paris Diderot, CNRS, Paris, France
2 Synchrotron SOLEIL, DISCO beamline, Saint Aubin, France
3 Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, Institut de Recherche pour le Développement, Université Pierre et Marie Curie, Paris, France
4 School of the Earth, Ocean and Environment, University of South Carolina, Columbia, USA
5 GIS Grand Observatoire de l'environnement et de la biodiversité terrestre et marine dans le Pacifique Sud, Centre IRD de Nouméa, Nouméa, New Caledonia
6 UR227 COREUS, Centre IRD de Nouméa, Nouméa, New Caledonia
7 Géosciences Environnement Toulouse, Univ Paul Sabatier/CNRS/IRD, Toulouse, France
8 Université de Toulon, Laboratoire Matériaux Polymères Interfaces Environnement Marin EA 4323, La Garde, France
9 MIO, Centre IRD de Nouméa, Nouméa
10 Université de la Nouvelle-Calédonie, LIVE, BPR4, Nouméa, New Caledonia
11 Aix Marseille Université, CNRS/INSU, Université de Toulon, IRD, Mediterranean Institute of Oceanography (MIO), UM 110, 13288 Marseille, France

* Correspondence:

Pisapia Céline, Geomicrobiology group, IPGP, Sorbonne Paris Cité, Université Paris Diderot, CNRS, Paris, France, celine.pisapia@gmail.com

Ménez Bénédicte, Geomicrobiology group, IPGP, Sorbonne Paris Cité, Université Paris Diderot, CNRS, Paris, France, menez@ipgp.fr
1. Supplementary Figures

Figure S1. Simplified geological map and bathymetric curves of the Prony Bay, New Caledonia, South Pacific (modified from Monnin et al., 2014). The Western coast of the bay is constituted by serpentinized peridotites while the Eastern coast corresponds to gabbros and dunites. The geological substrata of the Prony Bay hydrothermal field are then comparable to those of the Lost City hydrothermal field (Kelley et al., 2001). Coastal and lagoonal hydrothermal vents, including sites ST09, ST11 and ST07 specifically studied here, are localized with black dots. They were visited and sampled since 2005, especially in 2011 during the French HYDROPRONY cruise on the R/V Alis (Pelletier et al., 2011). Further description can be found in Monnin et al. (2014), Quéméneur et al. (2014) and Postec et al. (2015).
Figure S2. Photographs of the ST11 hydrothermal edifices from the Prony Bay (New Caledonia) characterized in the present study and sampled by scuba divers in 2011: (a) and (b) are dive photographs of ST11 carbonated chimneys hosted at 47 mbsl showing a consolidated and likely ancient base topped with juvenile chimneys and small white juvenile protochimneys where hydrothermal fluids are discharged. (c) and (d) are detailed photographs of the young chimney sampled with transversal cut (d) showing the internal hydrothermal conduit (white arrow).
Figure S3. SEM images in AsB mode collected on hydrothermal chimneys sampled in various sites of the Prony Bay Hydrothermal Field: ST08 [(a) to (d), at 8kV for (b) and (c) and 10 kV for (a) and (d)], ST11 [(e) to (g), at 15 kV], and BdJ for Bain des Japonais [(h) to (k), at 10 kV for (h) and (j) and 15 kV for (i) and (k)]; see Supplementary Figure S1 and Supplementary Table S1. They indicate that the filament mineralization is common to all sampled vents, hence leading to consider this process as a general mechanism in early chimney construction at this hyperalkaline hydrothermal field.
Figure S4. Phylogenetic tree of 16S rRNA gene sequences showing the position of the filamentous Firmicutes (OTU HPst091-1-1 in red) systematically identified in the conduits of the PHF nascent chimneys (Table 1). The tree was constructed by maximum likelihood analysis, using 895 positions, including the closest possible uncultivated (black) and cultivated (blue) relatives as well as more distant representatives of cultivated Firmicutes. The OTU HPst091-1-1 sequence was notably aligned with two sequences of Firmicutes strains (A. hydrothermalis and A. pronyense, accession numbers KJ159210 and KJ626326, respectively; Ben Aissa et al., 2014; Bes et al., 2015) recently isolated from PHF chimneys (in green). Bootstrap values for nodes (>70% support) based on 1,000 replicates are displayed as percentages.