THÈSE PRESENTÉE A L'UNIVERSITÉ D'ORLÉANS
POUR OBTENIR LE GRADE DE
DOCTEUR DE L'UNIVERSITÉ D'ORLÉANS et DE L'UNIVERSITÀ DI BOLOGNA

PAR

Keyron Hickman-Lewis

ÉCOLE DOCTORALE EMSTU
Discipline : Sciences de la Terre et de l'Univers

Coupling instrumentation and methodology in the search for traces of life on the early Earth and Mars

Soutenue Publiquement
Le 10 octobre 2019 à 9h30
Amphithéâtre Charles Sadron, CNRS Orléans

MEMBRES DU JURY :

- **Bréhéret, Jean-Gabriel – Professeur, Université de Tours**
- **Westall, Frances – Directrice de Recherche, CNRS CBM**
- **Cavalazzi, Barbara – Assistant Professor, Università di Bologna**
- **Czaja, Andrew D. – Associate Professor, University of Cincinnati**
- **Vago, Jorge L. – Project Scientist, European Space Agency**
- **Viso, Michel – Thematic Leader, Exobiology, CNES**

RÉSUMÉ

Evaluating the nature of the earliest, often controversial, traces of life in the geological record (dating to the Palaeoarchaean, up to ~3.5 billion years before the present) is of fundamental relevance for placing constraints on the potential that life emerged on Mars at approximately the same time (the Noachian period). In their earliest histories, the two planets shared many palaeoenvironmental similarities, before the surface of Mars rapidly became inhospitable to life as we know it. Multi-scalar, multi-modal analyses of fossiliferous rocks from the Barberton greenstone belt of South Africa and the East Pilbara terrane of Western Australia are a window onto primitive prokaryotic ecoystems. Complementary petrographic, morphological, (bio)geochemical and nanostructural analyses of chert horizons and the carbonaceous material within using a wide range of techniques – including optical microscopy, SEM-EDS, Raman spectroscopy, PIXE, µCT, laser ablation ICP-MS, high-resolution TEM-based analytical techniques and secondary ion mass spectrometry – can characterise, at scales from macroscopic to nanoscopic, the fossilised biomes of the earliest Earth. These approaches enable the definition of the palaeoenvironments, and potentially metabolic networks, preserved in ancient rocks. Modifying these protocols is necessary for Martian exploration using rovers, since the diversity and power of space instrumentation is significantly reduced relative to terrestrial laboratories. Understanding the crucial observations possible using highly complementary rover-based payloads is therefore critical in scientific protocols aiming to detect traces of life on Mars.

CNRS Centre de Biophysique Moléculaire, et
Dipartimento BiGeA, Università di Bologna