DOM

Digital Oilfield Microbiology

Competitive Internal Research Award (CIRA), Khalifa University, Abu Dhabi, CIRA-2019-019

Project key information

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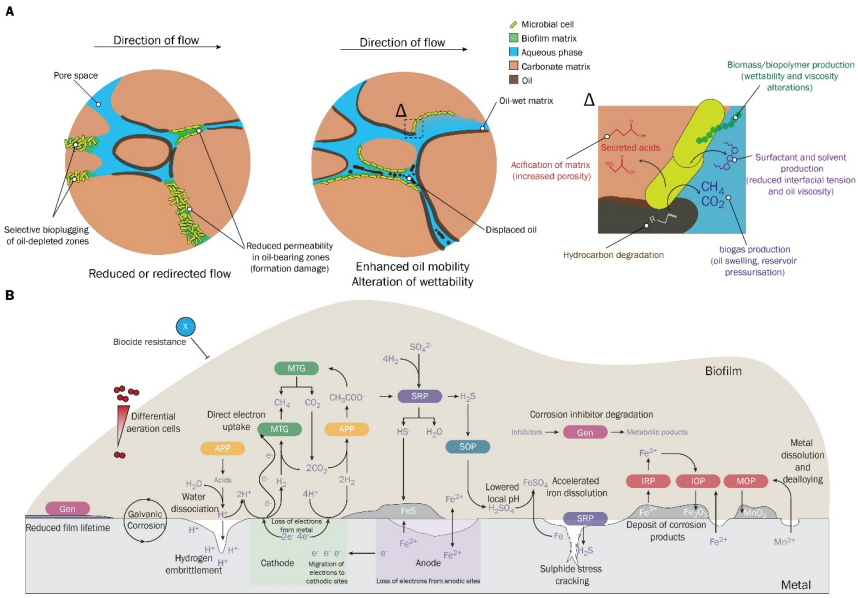
Project duration : 36 months
Starting date : December 2020
Total budget : 750 Kus$

Partners

Khalifa University, Abu Dhabi (**https://www.ku.ac.ae**), French National Research Institute for Sustainable development (**https://en.ird.fr/**, www.ummisco.fr), Danish Technological Institute ((**https://www.dti.dk**)

Summary

Microbes are inevitably present in hydrocarbon reservoirs wherein they contribute to emergent dynamics at reservoir scales. Their influence in driving these dynamics remains unexplored in UAE oilfields and there remains a pressing need for new tools (predictive/diagnostic) to mitigate unfavorable processes (souring, formation damage and corrosion) and highlight opportunities for biotechnologies to remediate contaminated soils, reduce operational costs and enhance recovery. The goal of this multidisciplinary work is to leverage recent advances in molecular microbiology, microscale imaging and computational modelling to address the influence of microbial activities on oilfield challenges. This work seeks to demonstrate proof-of-concept for AI-based modelling tools to predict emergent environmental properties that arise from microscale biological dynamics. Importantly, the development of such tools remains an ongoing and major scientific goal as these tools represent the only current strategy to predictively address timely societal issues of import (including climate and biosphere changes brought on by anthropogenic impacts).

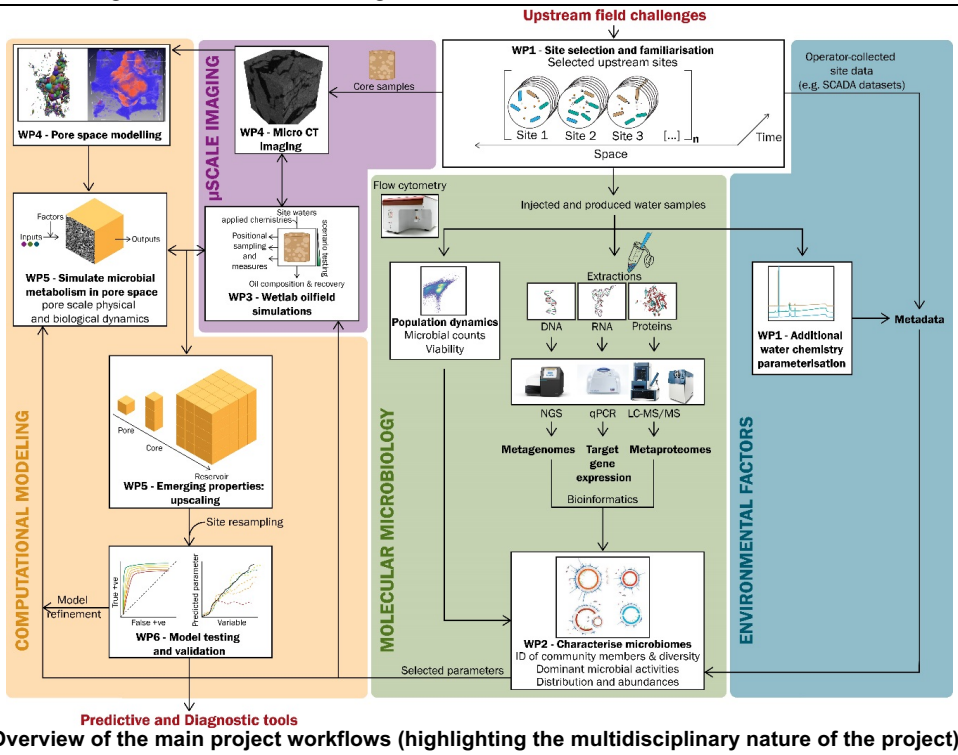


Oilfield microbiomes can profoundly influence upstream oil and gas operations. A Downhole communities can alter flow dynamics and oil mobility through their growth and secretion of microbial products. **B** Within the biofilm, microbes can influence corrosion through a variety of mechanisms.

Objectives

The primary objectives of this project are to:

1. Map the microbiome and key activities of its members in an ADNOC field (which represents an as yet set of uncharted environmental niches) with advanced culture-independent MMM techniques.
2. Model the pore space geometries (at high resolution) in the selected formation with advanced µCT imaging and computer vision approaches.
3. Model microbial dynamics in downhole and topside microenvironments to ascertain the influence of microbes on production and facilities integrity.
4. Develop upscaling methods for microscale microbial dynamics to reveal emergent properties at the macro (reservoir) scale.
5. Employ and evaluate AI-based strategies for utility in generating predictive and diagnostic tools for enhanced management and forecasting.



Overview of the main project workflows (highlighting the multidisciplinary nature of the project)

Impact

The multidisciplinary nature of this work will cover fundamental research areas involving mathematics, biology, physics and chemistry. This work will interface the disciplines of microscale imaging, computational sciences and molecular microbiology to lay the foundations for the development of new diagnostic and predictive tools. This project aligns with several key challenges including: **Hydrocarbon exploration and production** (by providing a clearer view of the field and associated issues), **Water and environment** (by aiming to reduce the environmental impact of operations, risks of loss of containment, and chemical usage), **Robotics, AI and data science** (by developing tools within this sphere). The computational predictive tools developed would facilitate enhanced proactive decision making and forecasting at site. Thereby, laying the foundations for a reduction in operational costs, environmental impact, improved HSE and equipment lifespan for upstream operations in the country. Indeed, given the uncharted nature of the oilfield microbiomes of the UAE, there is considerable bioprospecting potential for this study. It is quite possible that new microbial species and products (e.g. enzymes) with potential biotechnological applications will be identified through the metagenomic and metaproteomic aspects of this study. For example, several bioprospecting studies have uncovered thousands of biosynthetic gene clusters that produce compounds with interesting activities that have not been seen before (such as selective antibiotics, hydrolases and valorizing biocatalyst). Discoveries of this sort has led to the development of spin off biotechnology ventures and patents. Though such ventures are not the primary goal of this project, they represent an exciting possibility that would have significant impact on KU and of considerable benefit to the students and staff involved.