Progress meeting minutes

Pascal Breil, Ranya Amer, Ola Abdelwahab, Emmanuelle Vulliet, Ph. Namour

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Lyon (France)

28th March 2018

Partners present:

Ranya Amer	SRTA City (Egypt)
Emmanuelle Vulliet	ISA (France)
Pascal Breil	Irstea (France)
Ola Abdel Wahab	NIOF (Egypt)
Philippe Namour	Irstea (France)

Partners absent:

Jean-Michel Monier	Enoveo (France) excused

Meeting called to order at 10 am by PI Philippe Namour

Reading of meeting agenda by Ph Namour

Ph Namour reminds PHC Imhotep 2017 Mariout and Envi-Med 2015 El-Encobio projects and their commune objective: **the Implementation of electrochemical stimulation of self-purification in aquatic environment.**

WP1 ecosystem review

Objective: identification of relevant emerging pollutants according to the levels of sediment contamination, Pollutants will be chosen for their environmental relevance but also among those whose analytical standards of (bio)degradation products are commercially available.

From the study of sampling campaign results (November and December 2017) it follows that:

1. **Physical-chemical parameters** and **heavy metal concentrations** in sediments of Mariout Lake (only the sampling points #1 to #5) show that: not heavy metal contaminations of Mariout Lake sediment were detected, but the abnormally low metal concentrations for sediment measured in the first results (dilution coefficient not taken into account) are corrected by the new analyses presented by Rany Amer. The analyses will be carried out on sediment samples available at ISA.; the sampling points (new result set) near WWTP (#1 and #2) are the more contaminated. The metal contents are high but seem not exceed the geological background (to be confirmed). Where the metals come from? It seem more linked to WWTP discharges (urban type) than to agricultural area. We propose to select the sediment from sampling point #2 as sediment to use in electro-remediation pilot study.
2. **Organic compounds analyses performed by LC-MS-MS**, show carbamazepine (CBZ) as the most ubiquist organic compounds, so, it was suggested to be used for the pilot study as the indicator molecule.

Moreover, several metabolites or degradation products of CBZ are commercially available, which can help in the monitoring of the (bio)degradation. The sampling point 7 seems heavy contaminated by organic compounds (mainly pharmaceutical compounds, confirmation of urban origin of Mariout Lake's contamination). We propose to select CBZ as molecule model in electro-remediation study. According to literature, CBZ is principally metabolized in the liver to carbamazepine-10,11-epoxide (Epoxy), a therapeutically active compound which is further metabolized into 10,11-dihydro-10,11-trans-dihydroxycarbamazepine (Trans-CBZ). Oxcarbazepine (Ox-CBZ) is a keto analogue of CBZ which generates transformation products common with those of CBZ, such as Trans-CBZ and 10-hydroxy-10,11-dihydrocarbamazepine (or licarbazepine), its pharmacologically active metabolite. Once released in the environment, CBZ is considerably resistant to photo-degradation, but it can accumulate in aquatic species or in sediment where it can again undergo biotic or abiotic transformations leading. CBZ and numerous transformation products and metabolites have been quantified in surface or ground waters; among them 2-hydroxycarbamazepine (2 OH-CBZ), 3-hydroxycarbamazepine (3 OH-CBZ), 10,11-epoxycarbamazepine (CBZ-E), 9(10)acridone (acridinone), and acridine). Some transformation products can produce more adverse effects than CBZ itself, as for example acridine, one of the most frequently identified CBZ photoproduct, considered as a mutagenic and carcinogenic compound.

WP3 Lab scale study

Lab tests on **sediment microbial fuel cells (SMFCs)** were conducted during February and March 2018. An essay with two dual chamber SMFCs filled with Mariout Lake sediment from sampling point 2 (Figure 1). One device was running with an open electrical circuit (control cell), while the other one was running with an electric circuit closed by a1 kΩ resistance (test cell).

Figure 1 : sediment microbial fuel cell with anodic chamber fills with Mariout Lake sediment (sampling point 2) and cathodic chamber fill with water at the beginning (photo on the left) and after 45-day run (phot on the right. On the left of each photo the control cells (open circuit) and on the right the test cells (closed circuit).

Figure 2 left, displays the power delivered by the test and control fuel cells during 45 days. The electric circuit closure seems enhance the electric production, compared to control production. The Figure 2 right shows the maximum power measured during the essay. Unfortunately we don't have explored the resistance range between 1 and 100 Ω, also we couldn't know the maximum power around the 8th and the 11th day. At the 15th day the energy delivered seems decrease. Additional experiment will be necessary to better understand how the SMFC works with the Mariout Lake sediments.

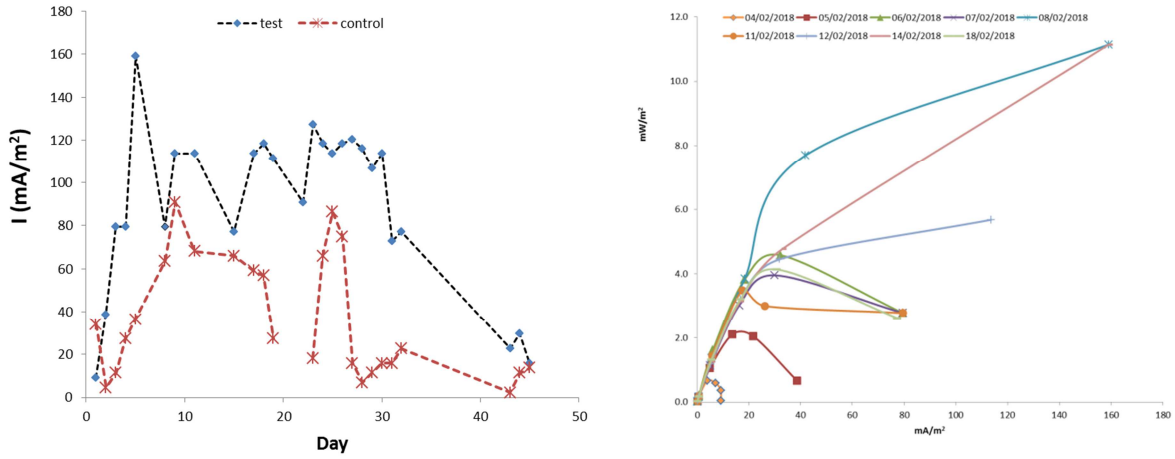

Figure 2 : on the left the power delivered during the 45 day running essay. On the right maximal power measured during the 45-day running essay.

It was planned to analyze the treated and untreated sediment to screen the carbamazepine biodegradation by-products and other organic compounds.

WP2 device design

Pilot device will be set up in June 2018 on El-Max research station (29° 41.1' to 29° 50.4' E and 31° 7.5' to 31° 9' N), NIOF's experimental site, located near sampling point #2. Two Tanks for pilot scale study (control and test) will be built according the Figure 3.

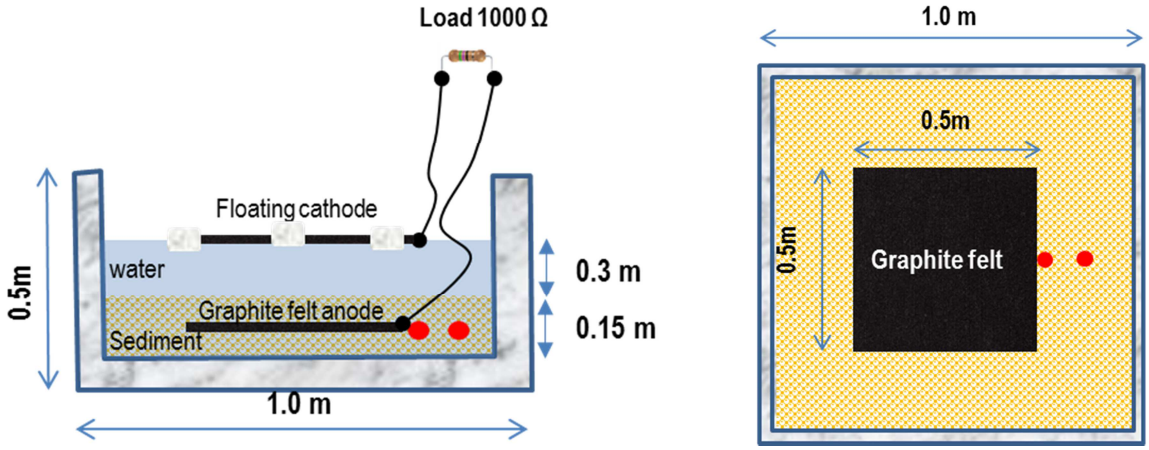

Figure 3 : schematic picture of the two experimental tanks for electrochemical remediation study at the pilot on the National Institute of Oceanography & Fisheries (NIOF) site

We select graphite felt as electrode material as easily functionalized surfaces (optimization of the microbial colonization and the electron transfer from microbial biofilm toward anode and from cathode toward oxygen). Graphite felt is little bit expensive (160 €/m^2) from Mersen (France) but carbon felt from China costs around 50 $/m^2 plus shipping cost.

Two sets of graphite felt anode and cathode (50cm x 50 cm) were cut and carry on by Ola. The cleaning and activating (introducing N and O atoms) protocol for new graphite felt is following:

- soak in acetone, 3 h;
- wash with water to eliminate acetone residue;
- soak and boil in distilled water for 3 h (change water every 0.5 h);
- soak in concentrated HNO3 5% overnight;

- wash with distilled water until the pH ≈ 7.0;
- dry in 100°C.

The main purpose of the cleaning procedure is to remove any metal ions, organic residues, and some other impurities such as dusts. Moreover, as carbon are rather hydrophobic (not optimal for bacterial attachment and biofilm formation), the pre-treatment increases the active surface area, enhances their electric conductivity by creating quinone functional groups.

The connecting material selected is Titanium wire, but stainless steel can be used to lower the total cost of the setup. The connections between electrodes and wires will be made by Optimized electrodes (anode & cathode) and connections will be designed in weaving Ti wire in graphite felt.

Gas sampling device to collect sediment gas to measure its volume was presented (because of the visual observation during the December 2017 sampling campaign). The device will be implemented on pilots as follow (Figure 4):

- A bottle of about one litre whose opening can be closed by means of a stopper which receives two pipes.
- The pipes are opaque to prevent the development of algae. Once the device is functional, the bottle is covered with aluminium foil.
- One of the pipes is connected to a funnel about 30 cm in diameter
- Both pipes are equipped with a valve each to allow isolating of the system once the gas collected. During collection, the valves remain open.
- Before starting the gas collection, the device is totally immersed to evacuate the air and replace it with water. The bottle is closed under water once it is full of water. The bottle is then released and hooked to a gallows taking care to leave the ends of the pipes under water. The broad part of the funnel is placed on the sediment.

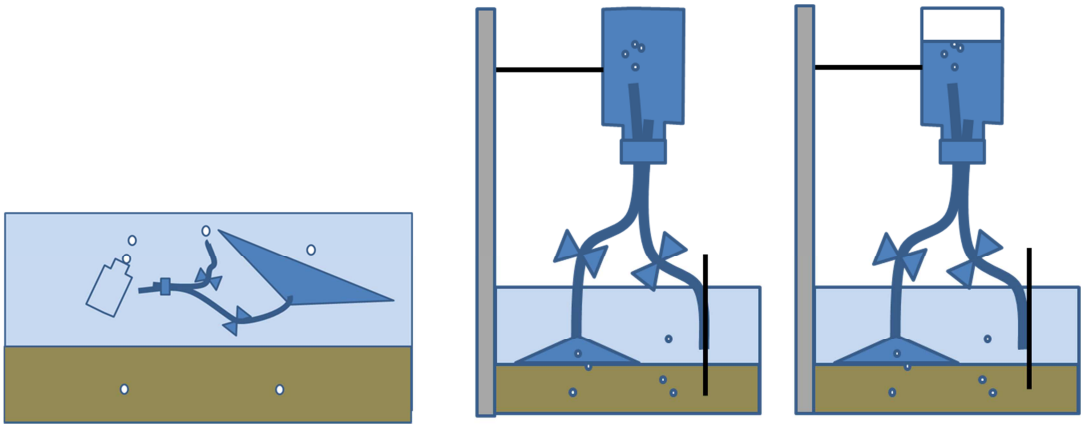

Figure 4 : schematic representation of gas collector device from its set up full of water on the left, to gas collecting, on the right.

WP4 sampling & analyses

For the monitoring of pilot scale setup (NIOF experimental site), two kinds of measurements are planned. Firstly a weekly monitoring for physical-chemical parameters at different points in the tanks, as: sediment redox potential, temperature, pH. Electrical production of the pilots (control and test) will be followed by means of a variable resistance (decade resistance box) weekly, then monthly according the measurement results

The sediment sampling on 15 cm depth will be made by sediment coring with a new sampling corer to test: a 1 cm diameter tube able to collect at least 6 gr of dry sediment (5 gr for chemical analyses, 1 gr for genomic analyses).

Monthly monitoring will be run for chemical analyses of contents in nitrogen salts (ammonium, nitrate and nitrite ions on interstitial water), organic carbon, carbamazepine and its metabolites, and microbiological biomass (on solid sediment phase).

The analyses of gas collected will be carried out by the SRTA City gas analysis laboratory. The gases analyzed will be N_2, CH_4, NH_3 and H_2S.

Planned exchanges and meetings:

The budget 2018 do not allow a final meeting in Alexandria (four people to move), also it is planned in Lyon (only one partner moving), and our biannual meeting is planned as side event of Sharm El Sheik ChinAfrica Water Forum in July in Egypt.

Mission	partners	target	Place	1	2	3	4	5	6	7	8	9	10	11	12
3th progress meeting	Ranya Amer Ola Abdel Wahab	progress meeting	Lyon			26-30									
PhD student exchange	Sudent 1 Sudent 2	Lab scale experiment Preparation of the electrode	Lyon				23/04 to 11/05								
Set up of the pilot study	Philippe Namour	Set up pilot study system and electrode	Alexandria						18-21						
Conference participation	Phillippe Namour Ranya Amer Pascal Breil	Dissemination of results	Sham El Sheik							22-27					
Analysis	Student 1	sediment samples after 6 months (ISA, Enoveo)	Lyon												06-21
	Ranya Amer	Workshop and data dissemination	Lyon												18-21

Table 1 : planned exchanges and meeting for 2018 according the granted financial possibilities

This schedule (table 1) demands a 2018 budget of € 5975, but we have only € 4850 for 2018. It will be necessary to find the missing € 1125 by optimizing the cost of air flights and finding other sources of funding. Otherwise the last exchange (06-21/12/2018) which has to analyze the withdrawals of the 6 months of the pilot's operating shall be canceled.

Next projects considered

1. Present partners decide to propose a new project to **PHC Imhotep Call 2019** (dead line 30/04/2018). It will focus on the nexus Food & Water (fish farming & fish-pond sediment electro-bioremediation) and address four prospective problems (if issues): generation of toxic by-products; pathogen stimulation; GHG production (control and stimulation); and bioaccumulation in water organisms. Philippe write a first draft for the next week, Pascal will be the PI.

   We should have a description of kind of anthropogenic activities surrounding Lake Mariout, using GIS tools, satellite images and published results from water quality and factory emission surveys. The overall idea is to connect water and sediment quality of the present and historical samples to the human activities. Canals have been built along the lake shore line and could intercept a lot of the pollution washed from the cultivated lands and factories.

   The effect of reeds belt that have naturally developed along the lake shore and sometime inside could explain the absence of several pollutants present but possibly trapped, biodegraded and assimilated by bacterial activities of reed roots and lake sediment. These natural functions (ecological service) must be

evidenced to promote them as a management tool in the future. A transect of water samples should be planned to verify the existence of a attenuation gradient of pollutants across the reed belt, from the shore line.

2. The possibility to propose a project to the call **Water JPI 2018** (deadline 24/04/2018), was studied with a partnership between South-Africa (CSIR), Egypt (SRAT and NIOF) and France (Irstea). A conference call is planned with Harrison Pienaar from the Council for Scientific and Industrial Research (South-Africa Pretoria) 4th of April afternoon (20 days to write 5 solidly argued pages!).

Meeting adjourned the 28th March 2018 at 4:30 p.m. by PI Philippe Namour