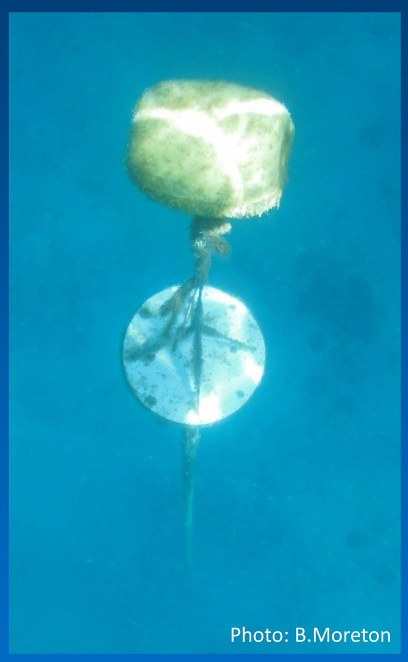
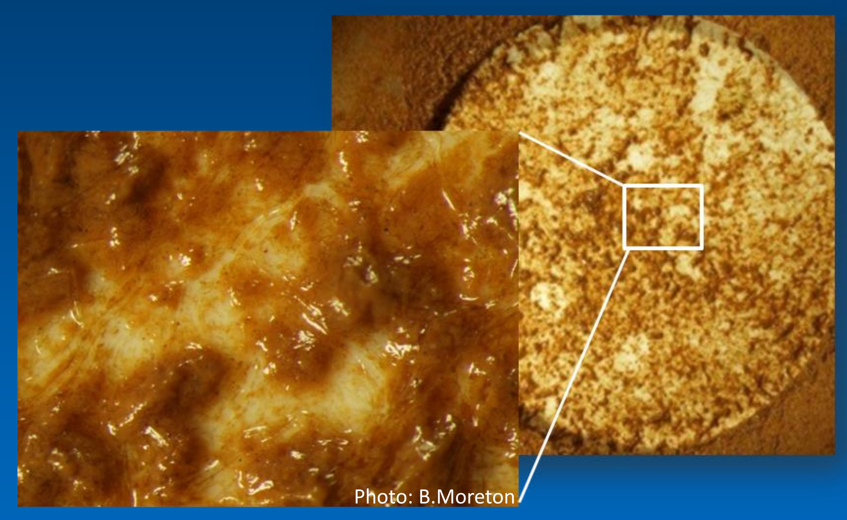


DETERMINATION OF THE EFFECT OF BIOFILM GROWTH ON THE SURFACE OF THE DGT MEMBRANE ON THE CALCULATED CONCENTRATIONS IN A TROPICAL LAGOONAL ENVIRONMENT



Benjamin MORETON[1], Hélène KAPLAN[1], Stéphanie PLUCHINO[1], Jean-Michel FERNANDEZ[1]

[1] AEL/LEA, Promenade Laroque, BPA5, 98848 Nouméa, New Caledonia --- info@ael-environnement.nc

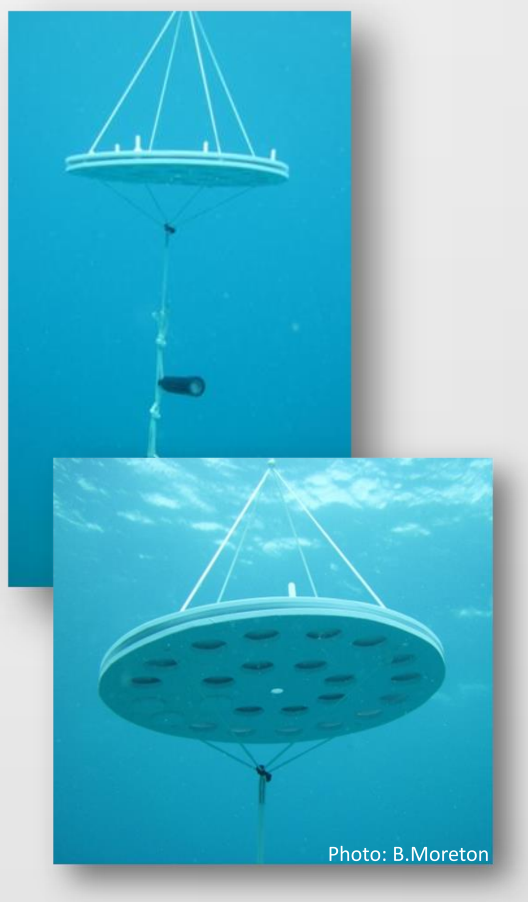
Introduction

The use of passive samplers, in particular DGT® devices, to determine concentrations of dissolved metals in seawater are becoming more common-place for use in regulatory monitoring. However, these devices are subject to undesirable biological growth (biofouling) on the DGT® devices membrane that may influence the flux of dissolved metals being transferred through the diffusive gel. The effect of the biofilm on these devices has already been a topic of discussion by a number of authors. Therefore, the main objective of this study was to specify the effect the biofilm has on the calculated dissolved metal concentrations measured in tropical areas with intense periodic primary production. In particular, this study demonstrated how the growth of the biofilm influences the transfer of the radiotracer Ni-63.

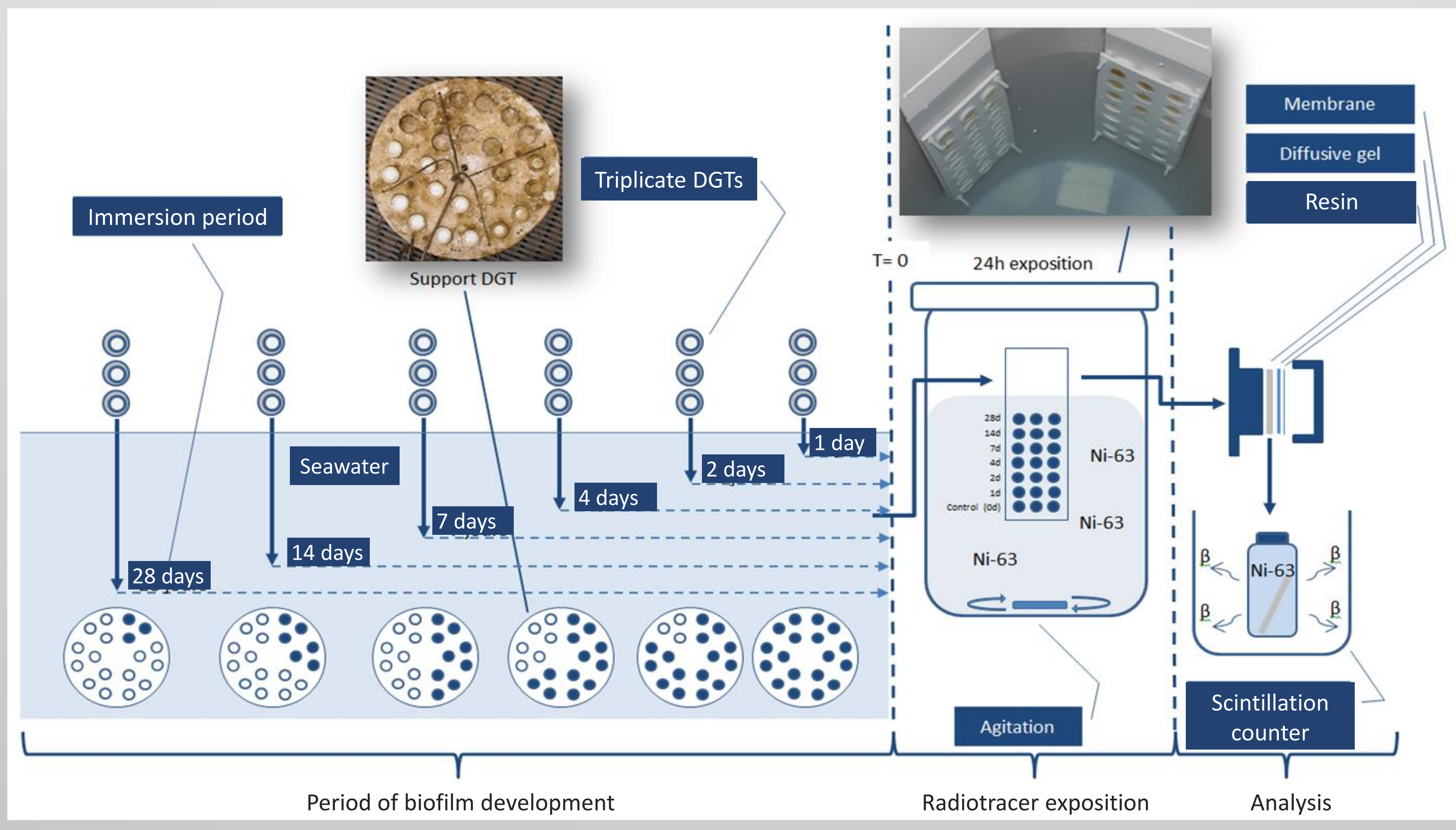
Methodology

In the SW lagoon of New Caledonia, triplicate DGT® devices were simultaneously immersed for periods of 1 up to 28 consecutive days at 4 different sites and during warm and cool periods to study the effects of both seasonal and varying physico-chemical conditions. (e.g. turbidity , nutrient concentrations, …).

At the end of the immersion period, all the DGT® devices were removed simultaneously from sites. The DGT® devices were re-immerged for a period of 24 hours in a tank of filtered seawater spiked with a radiotracer (Ni-63) to study the effect of the biofilm on the dissolved Ni transfer. DGT® devices without biofilms present (blanks) were used as controls for calculation of the radiotracer accumulation factors. The resulting spiked binding resins were recovered from the DGT devices, eluted with nitric acid (1M) and radioactivity was measured using a beta liquid scintillation counter.



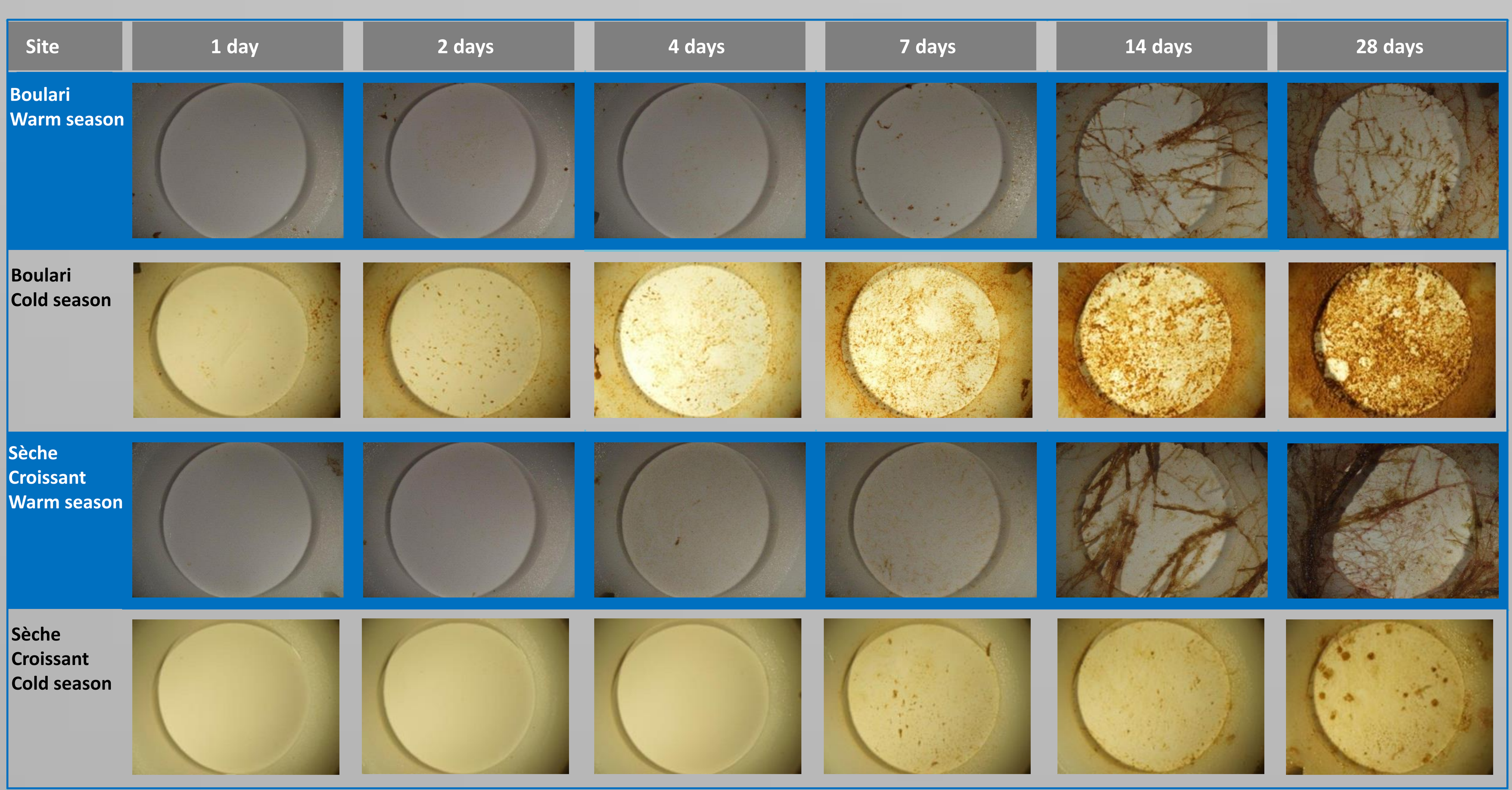
The Ni-63 radioactivity accumulated on the filter membranes colonised by the biofilm was also counted to help understand the role the biofilm plays in the transfer of metals to the resin binding layer.



Presentation of the experimental procedure to determine the effect of the biofilm on the DGT technique.

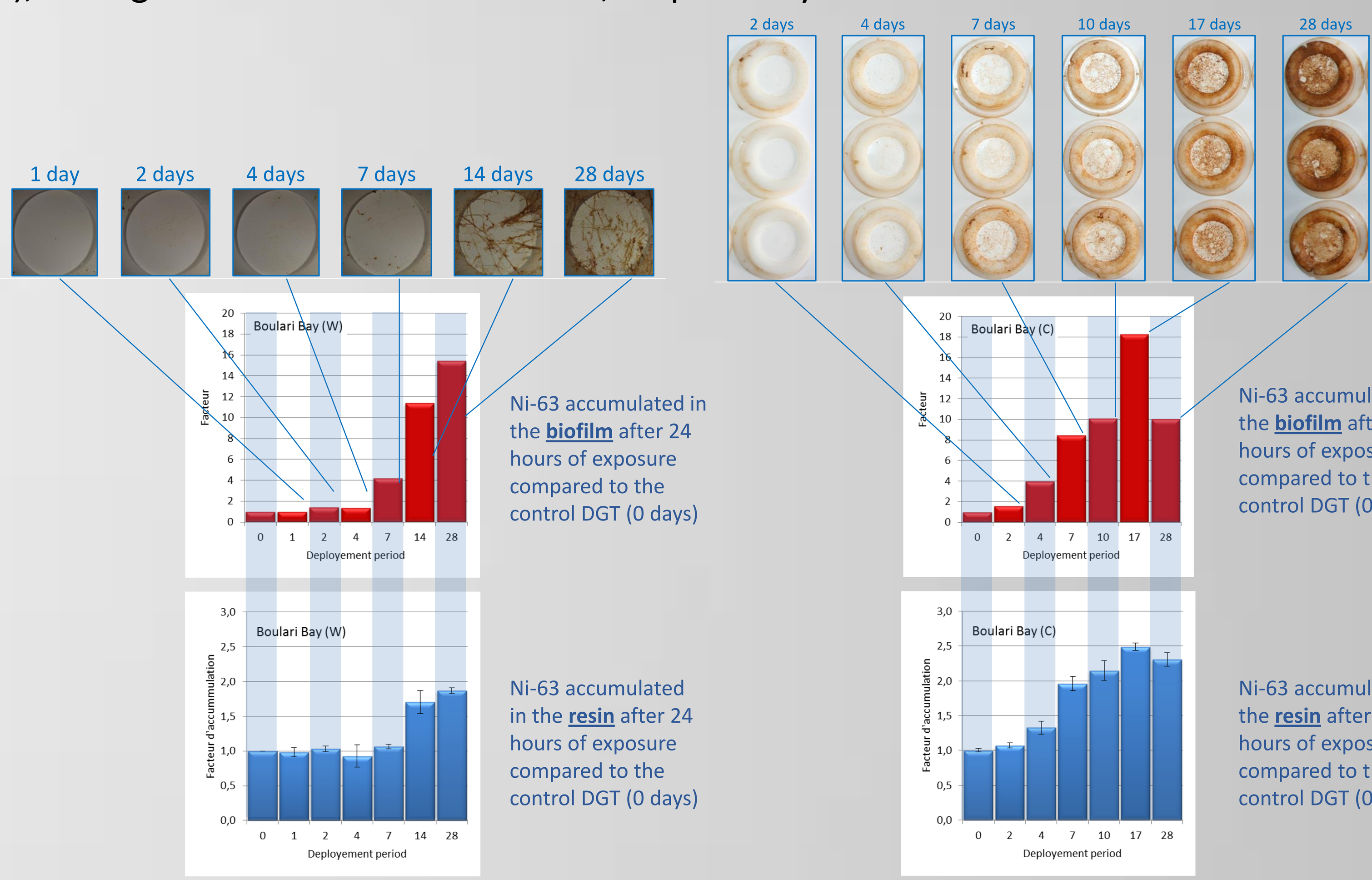
Results

The exposure of four sets (sites) of triplicates DGT® between 1 and 28 consecutive days showed that the membrane surface was clearly colonised by biofilms and that the type of growth and development speed were highly dependent on the season and site specific conditions (Figure below).



Degree of biofouling present on the membrane as a function of immersion time at two different sites during the warm season and cold seasons

Analysis showed that enrichment of the radionuclide in the biofilm increased with the immersion period of the DGT® devices. For example, in the Boulari site, after 28 days of exposure, the biofilm accumulated more than 15 and 10 times more Ni-63 than the control (blank), during the warm and cold seasons, respectively.

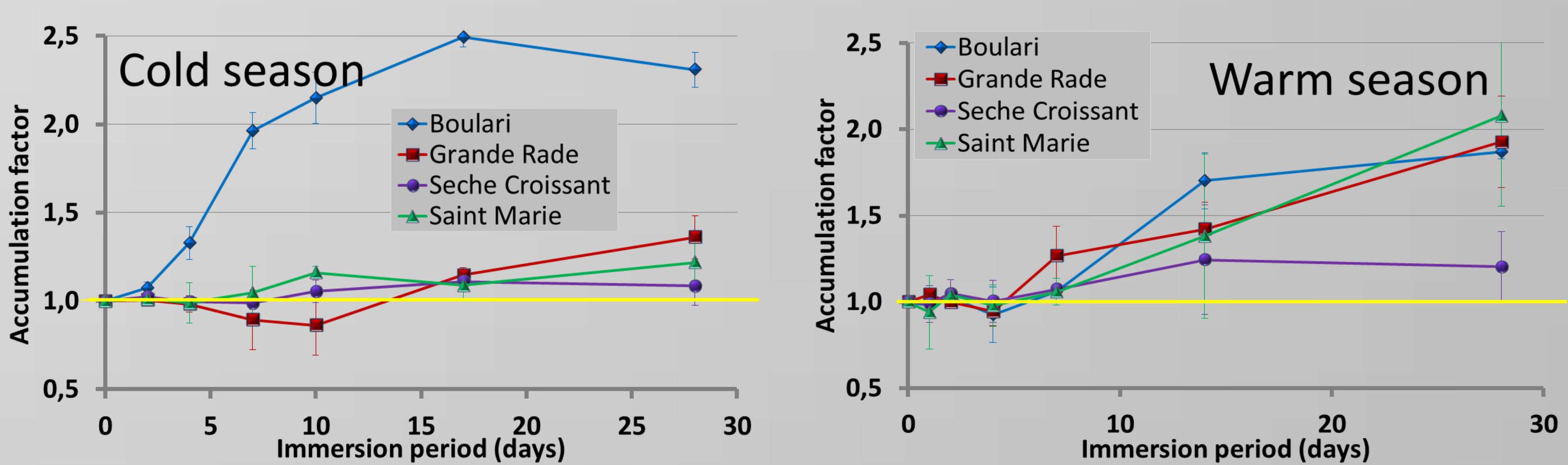


Accumulation factors of Ni-63 determined in DGT® biofilm as a function of biofilm development for the Warm season (left) and the Cold season (right) in the Boulari site

The 4 sets of DGT devices exposed during each season (warm and cool) to the dissolved Ni-63 showed the radionuclide was accumulated more rapidly in the binding resin when a biofilm was present. In addition, the Ni-63 accumulated in the resin binding layer was also site dependent.

Indeed, during the cold season, the highest accumulation factors, were observed in the Boulari site with over 1.3 times more Ni-63 radioactivity measured after just 4 days increasing to almost 2.5 times that of the control after 17 days. The three other sites studied during the cold period appeared less affected by the presence of the biofilm. The increased radioactivity observed in Boulari site is likely to be related to the high amounts of particles in seawater measured at this site during the cold season. This resulting turbidity depends on both the wind and the rain conditions.

For the warm season all sites showed significant accumulation factors above 1 after 14 days, for 3 of the 4 sites, when the biological activity is more dynamic.

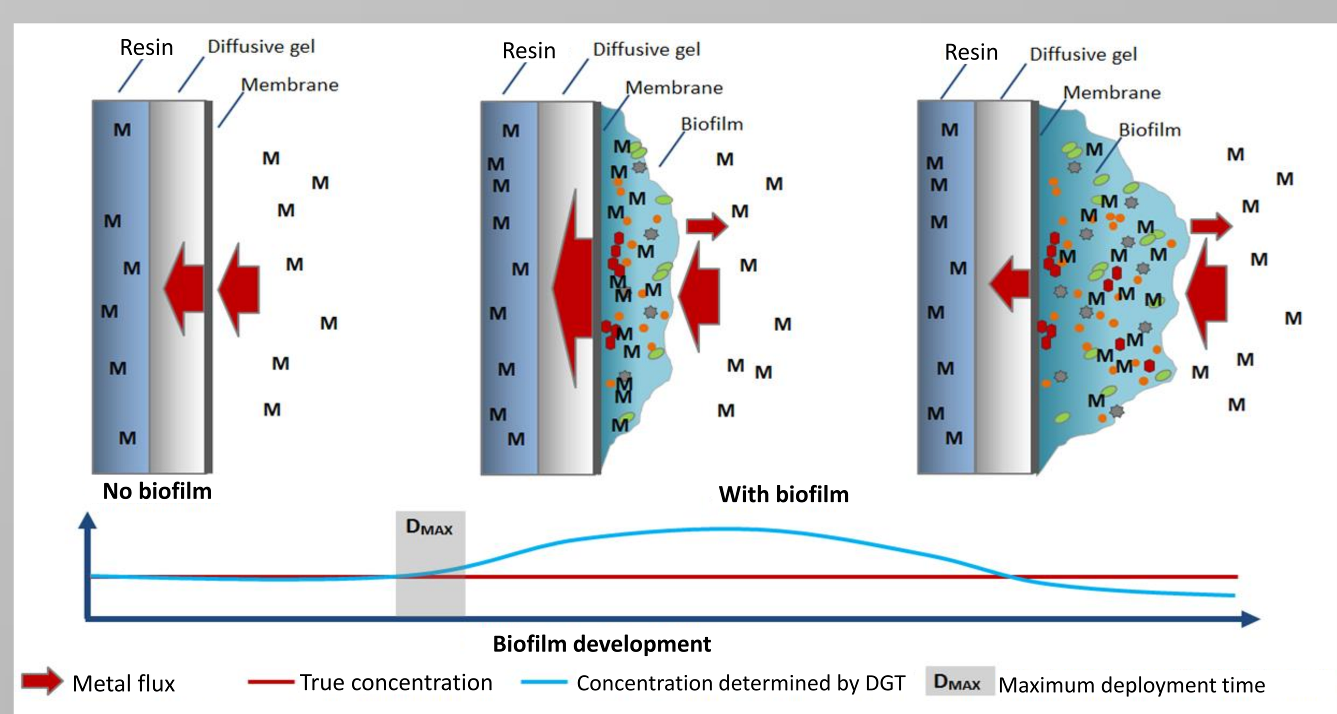


Accumulation factors of Ni-63 determined in DGT binding resins as a function of biofilm development (Yellow lines represents the control DGT with no biofilm present).

Conclusions

Biofilm development in the majority of cases resulted in an overestimation of the calculated Ni-63 concentrations relative to DGT® devices with no biofilm development. This over-estimation varied according to the duration, location and season, and is likely to be caused by an accumulation of metals in the biofilm that are subsequently available for transfer through the diffusive gel.

The results obtained meant it was possible to determine, for each specific area, **the maximum recommended period of immersion of these devices that varied from 5 to 10 days under tropical condition of the lagoon of New Caledonia**.



Schematic representation of the effect of the biofilm on dissolved metals concentrations determined in seawater by the DGT technique.

Acknowledgements

The authors would like to thank the *"CNRT-Le Ni et son environnement"* for their financial support

Reference

Moreton B, Gonzalez J-L, Fernandez JM, Pluchino S, Kaplan H, 2013. Utilisation d'échantilloneurs passifs en tant qu'indicateur de la pression chimique liée à l'activité minière en Nouvelle Calédonie (*Use of passive samplers as indicators of environmental pressure linked to mining in New Caledonia*). Programme ADIIP, CNRT « Le nickel et son environnement (2009) », 75p.

CNRT NICKEL & son environnement

www.ael-environnement.nc

AEL