FROM OLD MINES TO BROWN TROUTS – TRACING THE FATE OF Hg & Pb IN A HIGH MOUNTAIN CATCHMENT USING STABLE-ISOTOPES

Sophia V. Hansson[1]**, G. Le Roux**[1]**, J. Sonke**[2] **and Blast from the Past-team**[1]

[1]*Université de Toulouse; INP, UPS; EcoLab; ENSAT, Toulouse, France*

[2]*Observatoire Midi-Pyrénées, GET, CNRS/IRD/université Paul-Sabatier, Toulouse, France*

sophia.hansson@ensat.fr

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Introduction

High altitude soils are often shallow and thus fragile to erosional processes. Mountainous areas therefore sensitive to environmental changes (Whitehead et al. 2009), both humanly induced (e.g. agriculture, mining, clear cutting) as well as to impact of long-term climate change and rapid environmental changes (e.g. flooding). Further to this, peatlands, a reoccurring feature in mountainous environments, acts as reservoirs of organic matter. Due to peats ability to retain trace metals and radionuclides these natural environments can be considered as a pollutant "sponge" which have accumulated contaminants since the beginning of the metallurgy (Bindler, 2006) and have acted as natural filters for toxic elements (e.g. As, Hg, Pb) since the last deglaciation (Gonzalez et al., 2006).

Although we largely associate impacts from mining on the surrounding environment with the industrial era, pollution from mining activities in pre-industrial times, when there were few if any environmental controls, could be substantial (Bindler et al. 2012). Due to their geological features mountain environments have been exploited since the beginning of metallurgy and the French Pyrenees is no exception. Our previous results on trace metal concentrations in the Central Pyrenees, where extensive mining (Ag, Fe) occurred from the Antiquity to the 19th century, indicates that ≥600 tons of anthropogenic lead is stored in peat and organic soils. Similar conclusions can be drawn for other metals (Zn, Bi). The fate of these legacy pollutants (e.g. Hg and Pb), in respect to a changing climate, is currently unknown. Once released from surrounding organic soils the catchment can be highly enriched in the bioavailable fraction of these metals thereby causing a bioaccumulation of e.g. MeHg in river biota. In combination with predicted rise in global atmospheric mercury deposition, legacy Hg and Pb from old mines may pose a severe threat to the biota in these already sensitive high altitude areas.

By linking data from soil – peat – water – sediment – biota, and the transfer between these continuums, we aim to answer the following question; Can the release and relocation of legacy Pb and Hg be successfully traced and can an effect on the biota, exemplified here by brown trout (*Salmo trutta*), already be seen?

Methods

Our study include three lakes (Fig 1), all located in the Bassiès valley, French Pyrenees. We apply a holistic approach by studying not only the link between atmosphere – soil – peat – water – sediment, but also various aspect of the biotic food chain; biofilm, invertebrates, common minnow (*Phoxinus phoxinus)* and brow trout (*Salmo trutta*). By combining all of these continuums, we aim to infer the potential risk legacy Hg and Pb may pose on the river biota (i.e. fish) and the surrounding environment at large. To do so we combine traditional geochemical analysis (DMA, HR-ICP-MS) with stable isotopes (Pb and Hg, $\delta^{13}C$ & $\delta^{15}N$) and analysis of radiocarbon and radionuclides (^{210}Pb, ^{137}Cs and ^{241}Am) in order to investigate the origin of these elements. We also perform micronucleus analysis of the fish blood to test if any toxicological effects can already be seen.

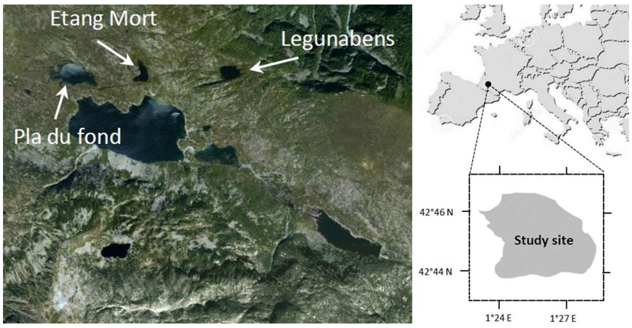

Figure 1. The valley of Bassiès, French Pyrenees, showing the location of each of our study sites three study sites; Etang Pla du Fond, Etang Mort and Etang Legunabens.

Results and Conclusions

Our preliminary results show that levels of tot-Hg in brown trout caught at our study sites surpasses literature values by 5 times or more and that differences in tot-Hg concentrations varies not only within the food chain, but also between lakes. Further to this, the MIF and MDF Hg-isotope signatures shows clear relationship with the size of the fish and also with $\delta^{15}N$. High levels of both Pb and Hg can be found in surrounding soils, yet for Pb this is not reflected in our fish samples. However, ecotoxicological proxies, i.e. micronucleus in blood, indicates that toxicological effects can be seen in the biota, but the potential link to legacy pollutants remains to be established.

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