IRON AND MANGANESE SURVEY IN AQUIFERS SURROUNDING LANDFILLS IN WALLONIA (BELGIUM)

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Introduction

The groundwater biogeochemistry around waste disposal facilities has been widely studied since twenty years. In particular, the formation of Fe-Mn rich zones downgradient from landfills due to the combined actions of leachates dispersion and anaerobic biodegradation is well known. The exact mechanisms conducing to these zones are not yet fully understood as many parameters may influence the Fe(II) and Mn(II) concentrations and their spatio-temporal distribution and dynamics in the aquifer.

Probably due to their non-hazardous nature, little environmental policies make Fe-Mn analyses required for aquifer periodic control around landfills. In particular Fe(II) and Mn(II) are not listed as "to be controlled groundwater parameters" in waste management legislations of Belgium (Wallonia).

ISSeP has been surveying for 10 years groundwater quality around 12 landfills within the framework of a wide control network set up by Walloon environmental authorities (DGRNE). This paper presents recent results of investigations focused on Fe-Mn concentration downstream from 4 landfills implanted above four different types of aquifers:

- Tenneville landfill (TEN) Primary bedrock aquifer (fractures only): heterogeneous geology and weak permeability, influence of topography, naturally rich in iron and manganese;
- Mont-Saint-Guibert landfill (MSG) Tertiary sand aquifer: homogeneous, good permeability, drained by surface water, medium to low Fe-Mn background concentrations;
- Cronfestu landfill (CRO) Cretaceous chalk aquifer: double porosity giving good permeability, homogenous, low Fe-Mn background concentration;
- Happe-Chapois landfill (CHA) Primary bedrock aquifer (fractures + weathered fringe): in contact with alluvial sediments, heterogeneous and weak permeability, influenced by topography, naturally low to medium iron and manganese background concentration.

Materials and method

ISSeP's sampling campaigns have been achieved using existing sampling wells networks, which are far from full minimal observation systems required for full scale 3D characterization of contamination plumes. Used sampling wells gives average concentrations characterizing the full thickness of aquifer (MSG, CRO) or at least a wide saturated layer (TEN, CHA).

Results and discussion

The obtained preliminary results (see Tables 1-4, for Fe and Mn only) are however interesting. The most important observations made by interpreting the obtained result can be summarised as follow:

- Whatever the type of aquifer, leachates contamination plumes are limited in space, which confirms, but on varied aquifer types, the observations made on reference sites in sandy aquifers.
- The only phenomenon observable by mean of any sampling network on any site seems to be substantial Fe(II) and Mn(II) concentration increases in downgradient sampling wells. Iron and manganese down/up factors are higher than those of any other leachate marker. This could be explained by the vertical distribution of redox zones as described on reference locations (Christensen & al, 2001): high concentrations of Fe(II) and Mn(II) are often detected on wider range of depth than any other redox markers or leachate conservative contaminant.
- Associated nickel and chlorides anomalies are often observable but not systematically and in weaker proportions. In particular, the apparent behaviour of chlorides seems less conservative in fractured aquifers conditions.

Without controlling Fe-Mn concentrations, conventional monitoring wells designed are thus not sufficient for evaluating impact of landfills on underlying aquifers, at the scale of their total thickness. On the other hand, monitoring wells designed with full aquifer thickness risers has a big advantage. It gives the concentrations that would be measured at a domestic water tap if one pumping well was installed at the same place. It gives thus the best evaluation of sanitary risks linked to the groundwater contamination. At this rough measuring scale, the effect of a landfill is to create a limited area of ferro-manganeous water. In case of exploitation, such water would not be toxic, but iron and manganese oxides would precipitate. It would create aesthetic (brown water) and water pipeline stopping problems.

Conclusion and further developments

By undertaking a sampling campaign focused on iron and manganese detection in groundwater around 4 MSW landfills in Wallonia, ISSeP hoped to open a discussion with scientific and politic authorities. The obtained results presented above are consistent enough to achieve this goal. They clearly demonstrate to administration that iron and manganese are required parameters for efficient detection and characterisation of leachates contaminated plumes. The study also worked on a more varied panel of aquifers types than previously. For each situation, it contributes to demonstrate that natural auto-remediation potentials of aquifers are high enough to avoid large-scale dispersion of contaminants.

ISSeP aims at looking further into this discussion by launching future dialog with local and international environmental authorities in order to make include Fe and Mn in future policies. At the scale of DGRNE's control network of MSW landfills, the use of multilevel sampling techniques and the optimisation of number and position of monitoring will be considered case-by-case with owners. From scientific point of view, this paper could help to initiate future collaborations with research teams specialised in the thematic of leachates contaminated aquifers. These teams hold essential knowledge's and know-how whereas DGRNE and ISSeP dispose of a wide variety of potentially interesting case studies, in an open network of sites.

Table 1. Fe and Mn concentration (µg/l) measured downgradient from 4 MSW landfills in Wallonia

1	TEN					
	F2	F1	F3	F4	F5	F14
Fe^{++}	70	87	39	4243	5613	4428
Mn^{++}	30	64	620	1141	636	877

2	CRO						
	P1	P2	P4	P5	P6	P7	P8
Fe^{++}	4,4	50	491	7792	2	2,6	2,9
Mn^{++}	<5	<5	50	220	11,5	<5	< 5

3	MSG										
	P20	P3	P4	P6	P8	P11	P13	P14	P28	P29	P30
Fe^{++}	5	6272	327	< 2	506	1103	17,9	892	2,2	2,1	495
Mn^{++}	< 5	1875	1466	64	<5	794	<5	667	201	91	224

4	CHA				
	Pz2	Pz3	Pz4	Pz5	Pz6
Fe^{++}	19	5,1	11,5	<2	11,4
Mn^{++}	83	125	158	144	513