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Technical and political concerns of site remediation: a German case

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Resumo

Em uma localidade no norte da Alemanha as águas subterrâneas estão contaminadas com cianetos. A fonte dessa contaminação é um aterro rodoviário construído com material de escória na década de 70. Modelos conceituais e matemáticos foram desenvolvidos para simular o fluxo das águas subterrâneas e o transporte de cianeto no aquífero. Os modelos matemáticos calibrados foram então aplicados para avaliar a viabilidade do sistema de *funnel-and-gate* para o local. Embora seja tecnicamente viável, a decisão sobre a implantação desta esta tecnologia foi objeto de debate político. Este estudo de caso mostra como aspectos técnicos, econômicos e sociais têm de ser devidamente levados em conta nos projetos de remediação.

Abstract

On a site in Northern Germany the groundwater is contaminated with cyanides. The source is the embankment of a road constructed with slag material in the 70's. Comprehensive conceptual and mathematical site models were developed to simulate the groundwater flow and the cyanide transport in the aquifer. The calibrated mathematical models were then applied to assess the feasibility of a funnel-and-gate system at the site. Although technically feasible, the decision for this technology was object of political discussion. This case study shows how technical, economical and social aspects have to be properly taken into consideration in clean-up projects.

Key words

Mathematical Modeling, Conceptual Site Model, Remediation, Funnel-and-Gate

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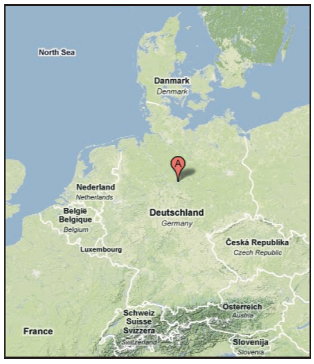
1 – Introduction

In the town of Beddingen, Northern Germany (Figure 1), a cyanide contamination was found in groundwater. The source of contamination is the embankment body of an industrial road constructed at the beginning of the 70's. The material used for the embankment construction was almost exclusively composed of slag material, having high cyanide content.



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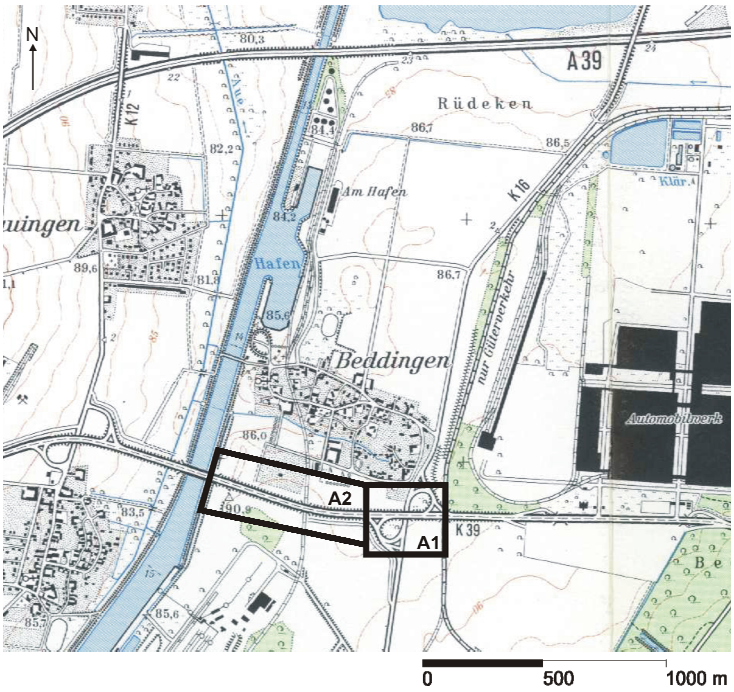

Figure 1. Site location and the areas of study (A1 and A2)

In area A1 (Figure 1) the road embankment and the adjacent areas were covered (i.e. sealed), in order to permanently prevent the infiltration of rain water and, consequently, the local aquifer recharge of cyanide contaminated seepage water. For the area A2 (Figure 1), a feasibility study of a funnel-and-gate system (FGS) downstream the road embankment was conducted. A FGS consists of a series of cutoff walls (funnel) and in situ permeable reactors (gates), designed to contain and clean-up contaminant plumes in situ [1]. This case study remarkably portrays how challenging the decision on the most appropriate remediation approach can be when an innovative (and relatively unknown) option like a FGS is to be weighed against a technically less complex alternative such as a soil coverage in an environment of conflicting interests of involved stakeholders.

2 – Conceptual Site Model Development

A comprehensive geological and hydrogeological site interpretation was carried out to support (i) the development of a conceptual site model and (ii) the definition of

appropriate boundary conditions for groundwater flow and cyanide transport modeling. Based on the performed geological interpretation, the studied area is located above a regional syncline formed due to salt tectonics. The Beddingen town is roughly situated above this syncline axis, which is filled with approximately 50 m of Quaternary glacial sediments (Figure 2). These sediments form two porous aquifers that are separated by a silty aquitard in their western parts, where the lower aquifer is therefore confined.

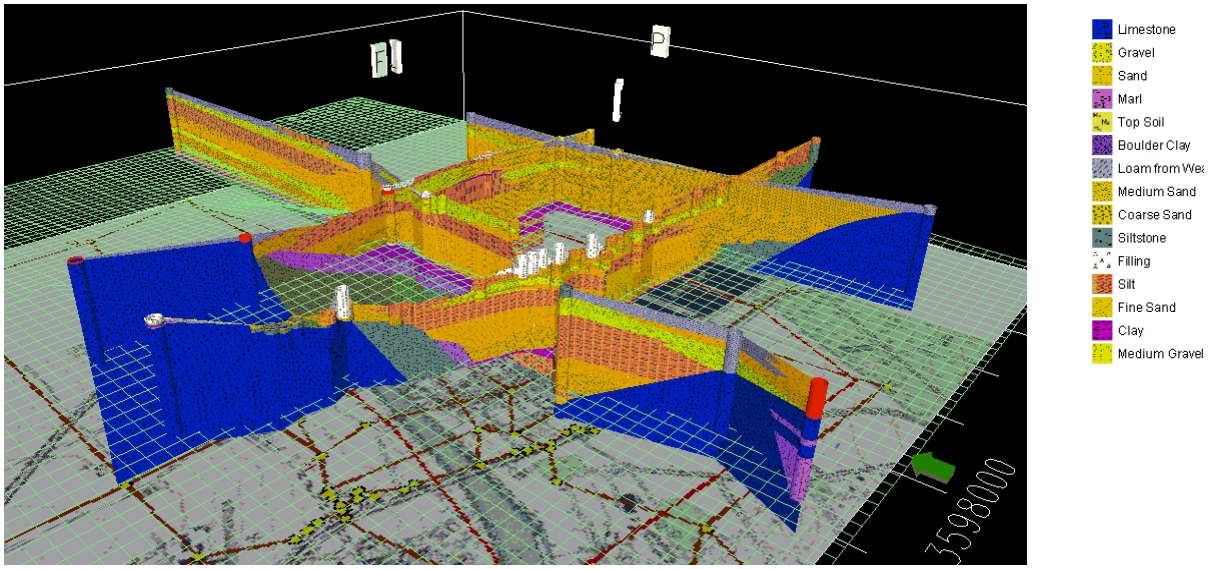

Figure 2. Fence diagrams constructed for the study area

Along the proximity of the western fold limb exists a water canal (Figure 1 and 2), which is unsealed close to the contaminated road embankment. Moreover, the extraction of considerable amounts of groundwater by an industrial mill in northern part of the model domain plays an important role on the complexity of the hydraulic situation.

3 – Flow and Transport Modeling

The groundwater flow was simulated with MODFLOW 2000 [2]. Calibration of hydraulic conductivities was carried out with an optimization module based on evolutionary algorithms [3]. Subsequently, cyanide transport was simulated with MT3DMS [4] and properly calibrated (Figure 3a). Particle tracking simulations were then carried out with MODPATH [5] (Figure 3b). The calibrated models were used for a feasibility study of the funnel-and-gate system for the considered area. The models simulations indicate that a system with 7 gates would be necessary to efficiently capture the cyanide plumes just downstream the embankment. Moreover, the models predict that after the installation of the system, approx. 5 years are necessary to clean-up the groundwater under Beddingen,

provided that reactors work properly, i.e. groundwater is essentially free of cyanide after passage through the reactor material (copper coated granular activated carbon).

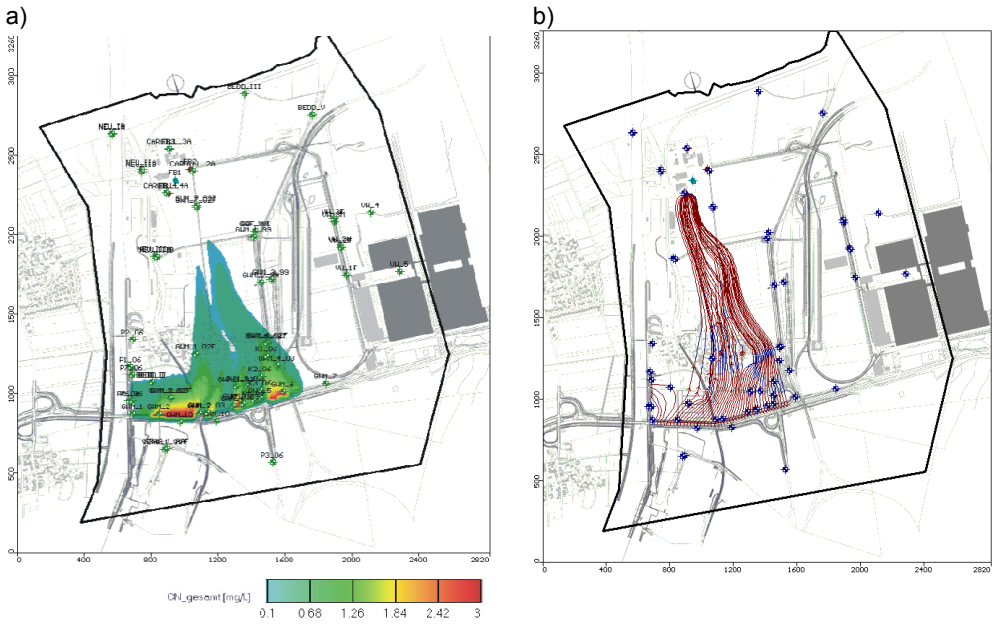

Figure 3. Simulated (a) cyanide plume (b) and groundwater flownet

4 – Conclusions and Aftermath

A comprehensive conceptual site model was developed to support the modeling of a cyanide contamination. The mathematical models improved and validated the assumptions made during the site data interpretation and showed that a funnel-and-gate system can efficiently isolate the source of contaminants. Although technically feasible, a debate about the best available technical option arose. Mainly because of technical and economic uncertainties perceived by the involved politicians and administrative staff the FGS has not been built to date.

5 - References

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