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The impact of cemented layers and hardpans on oxygen diffusivity in mining waste heaps A field study of the Halsbrücke lead-zinc mine tailings (Germany)

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Abstract:

This article reports fibre-optic oxygen measurements on a reactive mine waste heap located in the polymetallic sulphide mine district of Freiberg in south-eastern Germany. The heaped material consists of sulphide-bearing tailings from processing plant of a lead-zinc mine. Mine waste material was deposited in the water phase after separation of mining ores in a flotation process. The tailing impoundment is partly covered with coarse sand and topsoil. Oxygen profiles were monitored during one year at eleven locations showing different physical and mineralogical compositions. At each location a borehole was drilled where the optic sensors were installed at 2-5 different depths. After installation the oxygen profiles were monitored seven times during one year from 2006- 2007 and three to five oxygen profiles at each location were obtained. Oxygen measurements were accompanied by physical, chemical and mineralogical data of the tailing material. Additionally, a detailed mineralogical profile was analysed at a location representative for the central part of the heap, where the cemented layers show lateral continuity. Results showed that cemented layers have a significant influence on natural attenuation of the toxic As and Pb species owing to their capacity of water retention. The measured oxygen profiles are controlled by the zone of active pyrite weathering as well as by the higher water content in the cemented layers which reduces gaseous atmospheric oxygen supply. In contrast, gypsum bearing hardpans detected at three other locations have no detectable influence on oxygen profiles. Furthermore, the grain size distribution was proved to have a major effect on oxygen diffusivity due to its control on the water saturation. Temporal changes of the oxygen profiles were only observed at locations with coarse sediment material indicating also an important advective part of gas flux.

Key-words: Acid mine drainage; Oxygen diffusion; Pyrite oxidation; Fibre-optic oxygen measurements; Mine waste heap