Lateral differentiation of Albeluvisols under the impact of subsurface drainage

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Albeluvisols are temporarily waterlogged due to the argillic horizon that limits downward movement of rainfall water. These soils are hence frequently drained for cropping. Drainage modifies water movement in both direction and velocity, inducing a gradient in waterlogging conditions perpendicularly to the drain. Over time, it may induce a lateral differentiation of the soil solid phase with the distance from the drain. This study aims at characterising and quantifying this differentiation.
Albeluvisols are characterised by the following horizon succession: A, Eg&BT, BTgd. The two last horizons exhibit a complex juxtaposition of white-grey, ochre and pale-brown volumes, and numerous black concretions or impregnations. In order to study the impact of drainage on the evolution of such soils, we have to characterise the soil differentiation perpendicularly to the drain by quantifying changes in the quality and the abundance of the different pedological volumes.

The studied Albeluvisol was drained by subsoiling 16 years before the present study. A 4 meters long trench was dug perpendicularly to a drain. Four decimetric soil monoliths were sampled in both the Eg&BT- and in the upper part of the BTgd-horizon at 60, 110, 210 and 400 cm from the drain. These monoliths were cut into 8 horizontal slices. For each slice, the surface was photographed and the pedological volumes were manually sorted. The relative abundance of the different pedological volumes was quantified on the 8 slices by image analysis on the base of their colour. The sorted soil samples have been analyzed for particle size distribution and for Fe, Mn, Si and Ti contents by ICP-OES after HF digestion for Fe and Mn and after alkaline digestion for Ti and Si. A sequential extraction scheme focused on the different kinds of oxides was also performed on the different types of volumes. Extracts were analyzed for Fe and Mn contents by flame atomic absorption spectroscopy. Mineralogical composition of the different soil volumes and their associated < 2 µm fraction (lutum) was determined by X-ray diffraction and DTA/DSC analysis.

In the Eg&BT horizon, the relative abundance of the white-grey, the pale-brown and the black volumes increased as the distance to the drain decreased while that of the ochre volumes decreased. For each of these volumes, Fe, Mn and lutum contents decreased as the distance to the drain decreased while that of Si slightly increased and that of Ti was unchanged. Mass balance calculation showed that, Fe, and lutum contents of the Eg&BT have decreased of about 30 % within 16 years from 60 to 400 cm from the drain. In the ochre volumes, more ferrihydrite and less goethite were

identified near the drain than further from it. In the upper part of the BTgd horizon, similar changes have been observed although less pronounced.
The soil drainage affects both the quantity and the quality of the different pedological volumes. This impact seems to result from the physical translocation of soil particles combined with specific redox processes as suggested by respectively the decrease of lutum contents as the distance to the drain decreases and the changes in abundances of the different Fe oxides. With an average decrease of lutum and Fe contents of 2% per year in the Eg&Bt horizon, the drainage impact on the soil evolution is quantitatively significant and rapid by comparison to the age of soil.