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Development stages of Holocene soils formed in loess and loess bearing sediments at the Roman wall (Limes) in the Wetterau (Hesse, Germany)

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About 2000 years ago the Romans built a wall through Europe – named Limes (lat. border) in Middle Europe and Hadrian's wall in UK – with the aim to protect the borders of their empire. In many parts the Limes was constructed by digging a trench and by accumulating the excavated soil material at one side of the trench. The upper decimetres of the wall are mainly made of calcareous sediments, because the trench was dug to a depth of C horizons which are composed of loess with high carbonate content. One prerequisite for research on pedogenesis is to obtain most precise data about the age of the parent material of soil formation. Regarding this, the Limes gives an excellent opportunity to distinguish different stages of Late Holocene soil development.
The study area is part of the soilscape of the Wetterau (100 – 250 m asl) situated between Taunus and Vogelsberg in Hesse, Germany. The precipitation is around 500 mm per year. Wetterau's gentle rolling hills were originally covered with loess and periglacial slope deposits. The soilscape is characterized by (Albic) Luvisols, Haplic Phaeozems, Luvic Phaeozems as well as Calcaric Regosols on upper slopes and Anthrosols in footslope positions. Particulary Haplic Phaeozems and Luvic Phaeozems have been of a wider interest of pedogenic research, since they have been formed in the Early and Mid–Holocene and, therefore, they are relic. It is supposed that the Wetterau was a Chernozem soilscape during the Early Holocene changing to a soilscape characterised by (Luvic) Phaeozems and Luvisols during the Atlantic period.
Results of archaeological research on the Roman wall in the Wetterau showed that the wall was constructed in the 2nd century AD and that it had different functions over time. In this context soil investigations revealed three different stages of Holocene soil development: (i) a youngest (recent) soil situated in the wall, (ii) a paleosol conserved below the wall and (iii) a soil developed in the area nearby the wall
A section through the Roman wall in the northern part of the Wetterau reveals (i) a Luvisol with limpid to dusty yellow brown and brown clay coatings in the Bt horizon developed in the sediments of the wall during the last 1800 to 1900 years. A trampling horizon can be inferred from platy microplates and horizontally oriented organ residues in a depth of around 160 cm representing the old land surface. The former Ah horizon was most possibly removed before building up the wall. Below the wall (ii) a Luvic Phaeozem was found with dark brown and yellow brown clay coatings in the upper AhBt horizon. The lower humic Bt horizon reveals numerous fragments of clay coatings beside undisturbed yellow brown clay coatings. The buried Luvic Phaeozem is an archetype of the soil development stage at Roman times in that area. Since calcareous material was put on the upper decimetres of the wall, the following decalcification led to precipitation of carbonate in the humic Bt horizon of the Luvic Phaeozem and so conserved this stage of soil formation. The investigated (iii) Albic Luvisol situated about 30 m next to the wall section represents the present stage of soil development with (meanwhile) no macroscopic signs of the Chernozem/Phaeozem predecessors. To figure out soil development stages micromorphological data were combined with soil physical and chemical data as well as results from clay mineralogy. Due to secondary calcification the pH of the paleosol is around 7, whereas the occurrence of secondary chlorites in the upper part of the paleosol points at pH values ranging from 4-5 at Roman times.