1400 years of man-environment interactions and soil evolution in the Saint-Mont mountain (Remiremont, Vosges)

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**Context of the study**

The Saint-Mont site

- A relatively inhospitable mountain:
  - Hard climate, steep slopes,
  - On acid soils developed from a granitic rock,
  - Nowadays covered by forests.

Remains suggest human presence for at least 1400 years:
- At the top, the monastery Habërdum (from the 7th century to the French Revolution) and a late antique occupation (Chenal, 2016).
- Monumental enclosure dry-stones walls of unknown age (Grzesznik, 2019).
- The « Point des Fées »: An enigmatic structure

**Objectives**

To investigate traces of ancient anthropic activities in soils and landscapes, on areas where archaeological structures have not yet been detected.

**Material and methods**

Joint work involving soil scientists, archaeologists, geographers, geologists and computer scientists.

Approaches from the landscape to the microscopic scales.

- **Archaeological data**
- **Field prospections / rocks and soils descriptions and sampling, floristic surveys**
- **Software tools to extract and analyse geometric structures in LiDAR data**
- **Studies along gradients from highly to poorly human impacted areas.**

**Results**

Interactive extraction of linear structures from LiDAR raw data

Development of new algorithms based on digital geometry tools to directly process 3D ground points and get rid of digital terrain model approximations in forested areas (Even and Ngo, 2020).

- Immediate visualization of extracted structure, cross and longitudinal profiles and of geometric estimations (height or depth, width, volume, ...).
- Time and precision performance evaluated on well controlled structures: forest roads (Even and Ngo, 2021).
- Usability assessed on archaeomorphological enclosure walls and old holloways (Even et al., 2022).


**Landscape and geological materials**

- A tectonic and glacial heritage
  - 3 axes of fracturing highlighted from rock outcrops and preferential feldspar orientations in thin-sections measurements.
  - Tectonic fracturing guided the action of the Quaternary. Both factors structure the massif and control its triangular shape.

- Geological heritage
  - The rock descriptions (macroskopically and in thin sections) confirm that most of the Saint-Mont is composed of Remiremont granite (Vincent, 1976).
  - New informations, not noted on the geological map:
    - New vein of aplit (supposed by the presence of aplitic fragments in our studied profiles).
    - At the bottom of the vein, a严格落实 vein rock more basic than granite.

**Soil covers**

1. Soils not clearly disturbed
   - Far from any known archaeological remains, two main types of soil develop on granite:
     - **Humic alisols (Rho)**
     - **Rankosols (Rf)**

2. Highly anthropised soils on platform P6
   - **Antroposol (RP) = Transformed on a man made terrace**
     - Anisocular with a prismatic horizon (RHB)
     - Highly stratified structure
     - Earthworks → neutral to basic pH
     - Phytochemicals → organic soil deterioration
     - Anthropogenic artifacts affected by burnings and decayed material.
     - Weathered materials compounds:
       - No organic, no anthropogenic → natural soil mineral horizon?

   **Reference soils not affected by ancient activities**
   - Undisturbed soils associated to ancient walls:
     - Physico-chemical characteristics close to those of reference soils.
     - Low human activity?

   **Black unit (1m thick) very rich in organic matter.**
   - Almost neutral pH (pH4.14 ± 0.6) in the organo-mineral horizon and saturated soils (5±0.95%)
   - Acidicline to neuroline vegetation

   **Cues of long term tillage and regular manure inputs**

3. Other evidence of ancient human influence on soils?

   - Detection of same anomalies:
     - When pH is between 4 and 5
     - More significant when pH is > 5
     - Easily related to the long-lasting human occupation on the summit.
     - More surprising on some western or southern platforms:
     - Leads for future archaeological studies

**Conclusion and perspectives**

Our results confirm:
- A very strong imprint of historical human activities on soils close to the summit part of the massif.
- An heritage on the western slope mainly from natural glacial and pedogenetic processes.
- Possible other human activities on some western or southern platforms.

We hypothesize that the weak anomalies are due to older and different human activities than those that took place at the top of Saint-Mont (like breeding).

Other analyses are being acquired and interpreted on soils, rocks and LiDAR images.