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Spruce trees as a mean of dating soils – reforestation after the clearings in the Valley of St. Antönien (Switzerland)

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Abstract

During a search for evidence of former clearing activities in the valley of St. Antönien (Switzerland), slope deposits of translocated topsoil material were discovered that indicate a period of higher geomorphodynamic activity after a slash and burn period. These slope deposits were dated by dendrochronological studies of spruce trees (*Picea abies L.)*. The dendrochronological and pedological results were compared to a pollen diagram of the peat bog “Capelgin” on the same slope, showing a clear decrease of *Picea abies* during the late Middle ages which might be correlated with the slash and burn period and the development of the slope deposits.

Research area

St. Antönien (NE of Graubünden, CH) belongs to the areas in the Alps that are strongly influenced by geomorphodynamic activity. One main reason for this phenomenon is the instability of the Flysch sediments (Nänny 1948). The research area is situated on the NW-exposed slope of the Chrüz (2200 m a. s. l.), characterized by several sackungen of the Flysch. Often peat bogs developed in the resulting depressions. Below 1800 m a. s. l. these bogs are surrounded by subalpine *Picea abies* forest. Under the protection of the forest cover and due to the relatively slight inclinations (20 to 25 °), the old horizons of slash and burn activity as well as the slope deposit have been conserved.

Material and methods

This investigation aims to combine the results of three examined “natural archives”: trees, soils and a peat bog. The peat bog, “Capelgin“ (1680 m a. s. l.), is surrounded by a subalpine spruce forest that has conserved the slope deposits. 78 increment cores of 39 spruce trees were collected and subjected to the standard procedures used in dendrochronological research, such as sample surface preparation, cross dating and ring-width measurement (LINTAP/TSAP).

The soils and its horizons were described using the nomenclature of the AG Boden (1994), and the standard parameters ‘grain size’, pH, Corg., and Fe(d/o) were measured. In addition, three cores from the peat bog “Capelgin” were taken. The 2 m thick organic sediment was analysed using palynological methods. The programs TILIA and TILIA *GRAPH were used for producing a diagram, in which the visual zonation is based on the percentual distribution

and spectrum of the pollen. Time scales used for the diagram are based on AMS radiocarbon dates.

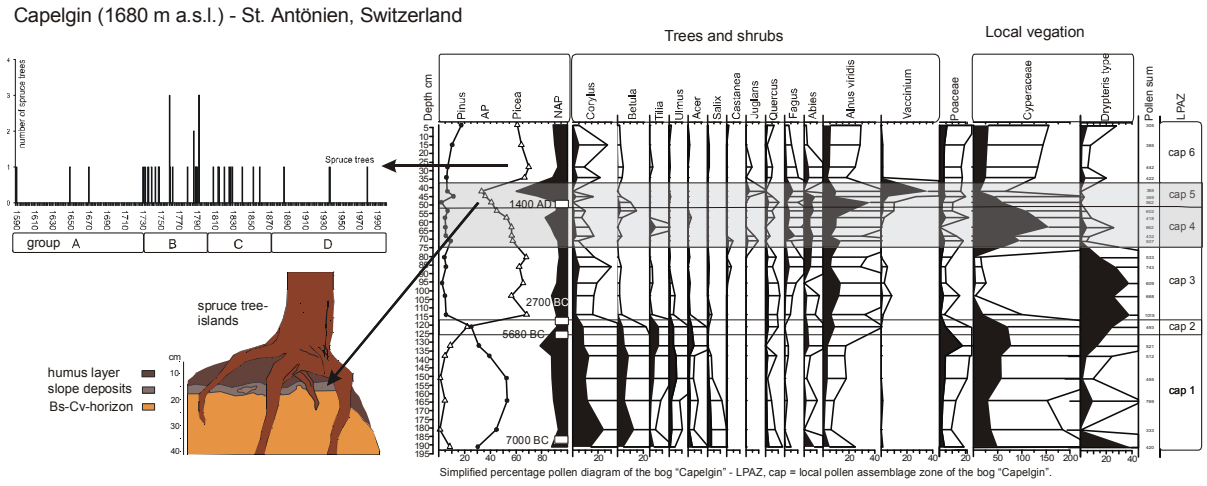

Figure 1: Simplified presentation of the combination of the dendrochronological, palynological and pedological results.

Results

1. Age structure and position of the spruce trees

Most of the 39 examined spruce trees grow directly on the slope. Only few are close to the peat bog, with one individual tree in the bog, which happens to be the oldest (ca. 1590 AD). Four age classes could be defined. The natural reforestation probably started in the 17th century. This is documented by the earliest trees (group A: Ad 1650 – 1730), which grow on relatively stable sites. The trees in the two largest groups, B and C, date to the 18th and 19th century. These groups not only differ by time but also by place. The site of the younger trees (Group C: AD 1800-1900) is located at the downhill border of the bog. In contrast to the older stand of spruce trees (group B :1730 – 1800 AD) these younger trees do not cover the soil deposits. In the middle of the 20th century the youngest trees (group D) germinated close to the border of the peat bog.

2. Slope deposits

During the Holocene the alpine podzol developed in the silty slope deposits of the Flysch under *Picea abies* cover. Especially the upper organic layer and the Ae-horizon were washed downhill after the burn and slash activity. The mixture of humus-, Ae- and Bs-material is preserved under spruce trees that grow on elevated islands (0,5 m high). The soil between the "tree islands" eroded by cattle driven into the forest.

3. Landscape and vegetation history

The peat bog "Capelgin" is about 9000 years old. After 3000 BC a general retreat of the forest limit occurred in many parts of the Alps (Wick & Tinner 1997; BURGA 1991; Oeggl & Wahlmüller 1994). This Mid-Holocene climate deterioration is documented in Figure 1 as a period of very slowly growing peat and a decline of *Pinus*. The change to a cooler and more

oceanic climate might have supported the expansion of *Picea abies.* Around 2200 BC the *Picea abies* forest became dominant. Simultaneously the *Cyperaceae* declined due to a lack of light and water (Fig 1., LPAZ cap 3).

Beginning at LPAZ cap 4 (Iron age), human impact occur combined with deforestations (Fig. 1). This is accompanied by the first appearance of anthropogenic indicators (i.e., *Cannabis, Plantago lanceolata, Juglans, Castanea and Cerealia*).

The strongest human interferences took place in the 15th century, showing a decrease of the Picea curve from 70 to 35%. After the 15th century it rises again to 60-7%.

Preliminary discussion - connecting the disciplines

At least since the Iron Age, in the secluded valley of St. Antönien evidence of human activities has been archived in buried slash and burn layers as well as in the pollen record and archeological sites (Rageth 1998). The timberline was lowered by human activity through the creation of pastures. Human impact was strongest during the Late Middle Ages, when the Walser people came into the valley. They lowered the timberline another 200 meter to the altitude of the peat bog “Capelgin”(1680 m a. s. L.). This is well recorded by the decline of the *Picea abies* pollen concentration. The clearings were followed by erosion, which led to the formation of slope deposits. At the beginning of the 17th century, spruce trees started to establish. The reason is possibly a cooling of the climate, which caused people to move out of the valley (Holzhauser & Zumbühl 1988; Pfister 1988). This reforestation marks the end of the period of increased geomorphodynamic activity. The whole process took about 150 years. During the last 300 years the examined areas of the slope have remained in a stable condition.

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