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"ALTITUDINAL SOIL SEQUENCE IN THE AUSTRIAN NORTHERN CALCAREOUS ALPS"

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1 INTRODUCTION

1.1 General informations about the excusion route

From Vienna we take the „Südautobahn A2“ till „Semmeringschnellstraße S6“ to Bruck/Mur and reach via Tragöss the Grüner See at the south oft the Hochschwabregion; see fig. 1.
Looking at the geology of the regions which we pass by bus: starting from the Quaternal formed terraces of Vienna we reach the Tertiary formed Vienna Basin at the begin of the „Südautobahn A2“. Remnants of historic clay pits are still visible, from where the raw material for the Viennese bricks originates.
Later we pass the eastern parts of the Northern Calcareous Alps (NCA), the Anninger, the Hohe Wand, Rax and Schneeberg. 20 mio. years ago before the Vienna Basin broke down, the NCA did not end here but extended to the Karpatian Alps.
Near Neunkirchen we leave the Vienna Basin and enter the Greywacke Zone and finally the Zentralzone. We pass the Semmering massif and follow the S6 in the Mürzvalley until Bruck/Mur. There we leave the Zentralzone, and enter again the Greywacke Zone and finally the Northern Calcareous Alps from the South.
Passing Tragöss we reach the „Grüner See“, the starting point to the Hochschwab field trip.

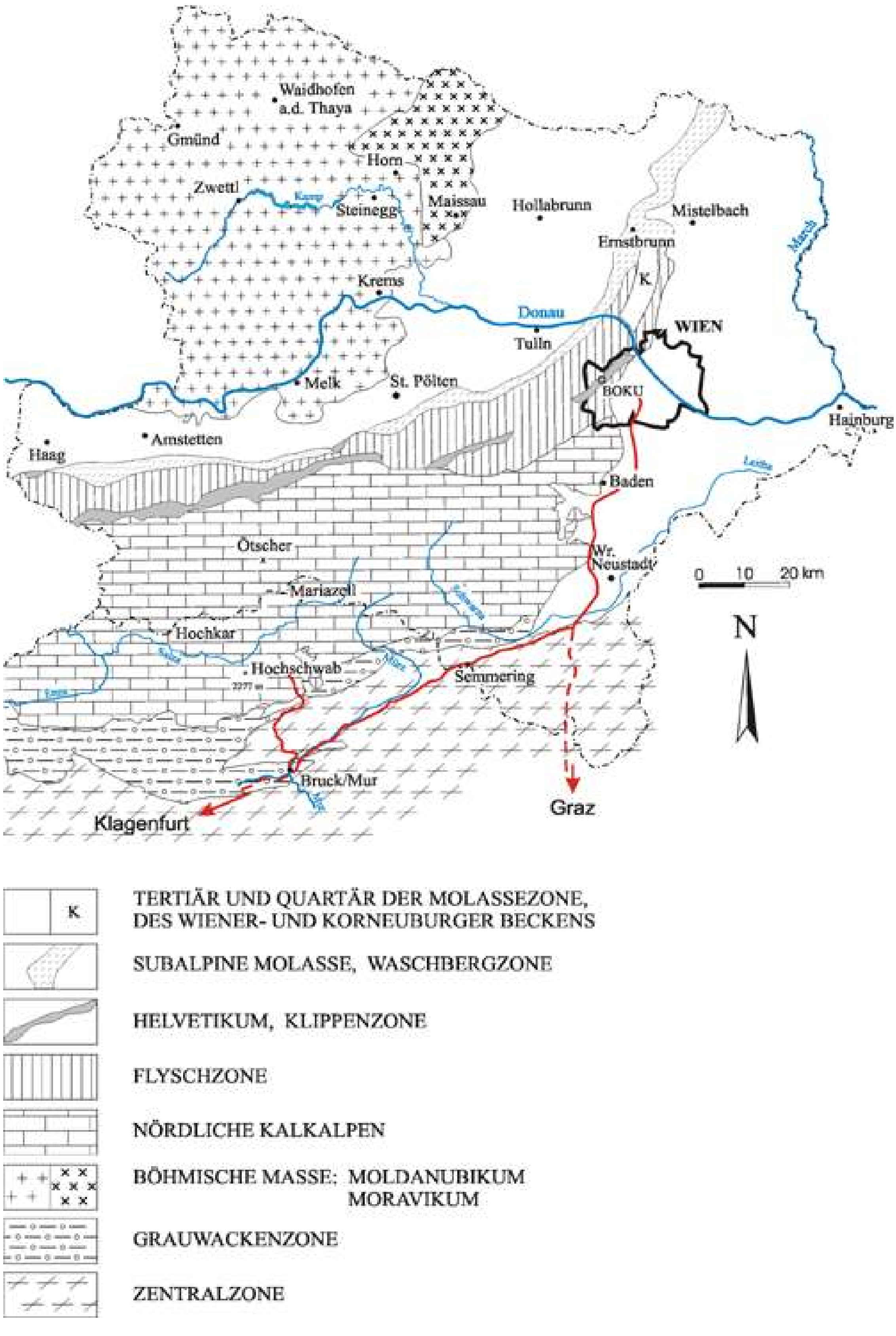

Figure 1: Excursion route and geology.

1.2 Geology and geomorphology of the Hochschwab

The Hochschwab is part of the Northern Calcareous Alps (NCA). In the Triassic Period the sediments oft the NCA were deposited in the Thetys Ocean in a shallow water shelf region, and became high mountains during the alpine orogenesis mainly in Tertiary time. The more than 2000m thick sediments were separated several times into many different nappes and now they build up one of the most complex overthrust mountains oft the world.
In the Hochschwab region we find two different main nappes:

1.) The Göller Nappe - belonging to the Tirolikum unit - in the basal parts and the mountains and the

2.) Mürzalpen Nappe – belonging to the Upper Juvavicum unit - above, which is overthrusted at the Göller Nappe

The mentioned nappes in the Hochschwab region are mainly dominated by different types of the Middle Triassic Wetterstein Limestone and Wetterstein Dolomite, Gutenstein Limestone and in the basal parts oft the mountain the Lower Triassic Werfen beds.
The Greywacke Zone follows in the south, consisting of mainly metamorphic rocks and Paleozoic limestones.
The Hochschwab region is one of the largest connected carst areas of Austria. It is about 590km² and almost hundred peaks – the highest of 2277m asl – belong to this mountain area.
The intense carstification of the Wetterstein Limestones and the impermeable Werfen beds below the limestones are responsible for the high amount of springs in that area.
About 1910 the 2nd waterpipe (Hochquellwasserleitung) for the City of Vienna was built and water from the Hochschwab area is collected for more than 1,7 million people. Graz and many Styrian communities situated in the south oft the Hochschwab get their water from this area too.

1.3 Further informations about the Hochschwab region

The fauna comprises, among others, alpine marmots (*Marmota monax*), chamois (*Rupicapra rupicapra*), alpine ibex (*Capra ibex*), capercailie (*Tetrao urogallus*), salamander (*Salamandra atra*) and common viper (*Vipera berus*). The Hochschwab has the biggest chamois area in Europe. For this reason, the regional cuisine comprises this delicacy. The flora is particularly varied: auricle (*Primula auricular*), lady's-slipper (*Cypripedium calceolus)*, orchids (*Nigritella*), edelweiss (*Leontopodium nivale* subsp. *alpinum*) and different arts of gentian (*Gentiana amarella*) can be found.

The one of the two water pipelines that supply Vienna with drinking water is fed by the *Kläffer-fount* in the northern Hochschwab area. At snow melting, the amount of water produced is approx. 10.000 liters/sec. There exist numerous alpine refuges, with traditional mountain pasture landuse, which provide meals and modest accommodation for hikers.

The south face of the Hochschwab is well known among climbers, because it offers all difficulty levels.

1.3 Climate and vegetation of the Hochschwab region

The location of the Hochschwab massif is in the transition zone of the moist climate of the Northern Alps and the subcontinental climate of the Central Alps, which have less precipitation and a more pronounced temperature amplitude. The average annual temperature is between 4 °C and 5 °C, the average annual precipitation is around 1450 mm (see table 1). The 3 climate charts (see fig. 2) represent the local climatic characteristics of the Hochschwab area. The local climate of the Hochschwab plateau is dominated by strong winds and the variation of snow cover. The unevenly distributed snow is strongly influencing the duration of the growing season, distribution of different vegetation and soil formation.

Table 1: Climate data of the Hochschwab area (period 2002-2006, source: Institute of Water Management and Environmental Engineering, section 19a, Graz).

Site	Elevation (m asl)	Average annual temperature (°C)	Average annual precipitation (mm)
St. Ilgen	740	5.3	1154
Jassing	890	5.7	1428
Trawies	1000	4.2	1969
Neuwaldalm	1260	4.4	1571
Bürgeralm	1500	3.6	1163

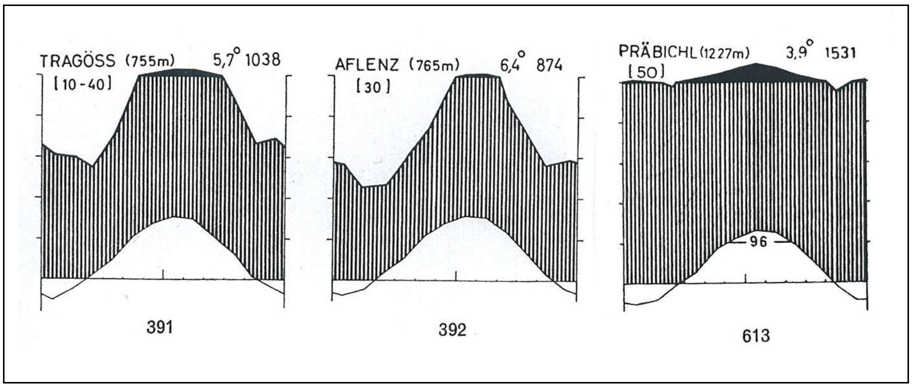

Figure 2: Climate chart: Tragöss (755 m asl), Aflenz (765 m asl) and Präbichl (1531 m asl) (Walter and Lieth, 1967).

Climate and soils of the Hochschwab area can be considered favourable for forest vegetation. Particularly well developed are the mountain forests, where either only few species of trees grow, or an assorted tall forbs assortment dominates. The climate is the most relevant factor for the distribution of tree species, horizontally as well as vertically. On the friable, base-rich and dry soils from limestone and dolomite, mixed forests of beech (*Fagus*) and fir (*Abies*) dominate. The silicate Werfener Schiefer („Werfen-schists“) with their acid, clayey soils are preferred by coniferous trees. Up to an altitude of 1400 m til 1500 m asl, alpine mixed forests are predominant. The natural vegetation of this mountainous climate type is a mixed forest of spruce (*Picea*), fir (*Abies*) and beech (*Fagus*. Sycamore maple (*Acer pseudoplatanus*) and wych elm (*Ulmus glabra*) occur as well, on unfavourable sites, larch (*Larix europea*) and pine (*Pinus*) dominate.

The composition of the vertical mountain walls offers no possibility to the trees to grow. It is also very difficult for trees to settle on the unstable detrital acclivities generated through erosion, they therefore reach their timberline far downwards. Due to the very rough relief, several plant communities do not reach the altitude level that the climate would facilitate.
The timberline) consists of populations of firs and larches, above them, mountain pine (*Pinus mugo*) grows.

1.4 History of the region around the Hochschwab

Settlement

The first settlement dates back to the Roman age. In the Upper Middle Age (about 1350) the highest settlement expansion could only be reached with respective uprooted areas.

Economy

In former times, cereals, potatoes, beetroot, flax and hemp were cultivated in Aflenz-Valley. Today, there is extensive pasturage, milk-cow breeding and pasture landuse.
The wooded slopes of the Hochschwab are used for forestry. Wood production in this region must be considered in close connection with the iron industry (the limestones of the Grauwacke-zone are rich in iron-ore). In order to cover the energy demand of the iron industry, the farmers used wood to produce charcoal. The traditional way was the clear cutting-burning–process. After clear-cutting a forested area, the wood was subsequently burned in situ. The wood demand of the metal industries (smithies, casting and milling factories) was enormous. In St. Ilgen alone, 72 carbon factories existed. Traces of the charcoaling in situ can be observed today as buried wood carbon-horizons in the soils (see excursion stop 5A-2).
A very important economical factor for this region nowadays is chamois and deer hunting.

Tourism

Already at the beginning of the 20th century, the Hochschwab region had touristic importance, but it could never really manifest itself as skiing region. Nowadays, competition between wood economy, hunting, nature protection, water utilization and tourism extist. The forest and its utilization forms a central issue in this conflict.

2 METHODS

2.1 Soil physical analyses

- Particle size distribution, (wet sieving-pipette-method), after BLUM et al.(1996);
- Bulk density (dry), total porosityafter BLUM et al., 1996;
- Vol% water contents, pore size distribution and available Field Capacity after HARTGE and HORN, 1992;
- Soil aggregate stability, after MURER et al. (1993);

2.2 Soil chemical analyses

- pH-value ($CaCl_2$), after BLUM et al.(1996);
- $CaCO_3$-content, SCHEIBLER-method, after BLUM et al.(1996);
- Electrical conductivity, after BLUM et al., 1996
- Ct, Nt, Corg, gas chromatographically, after BLUM et al. (1996);
- Effective Cation Exchange Capacity (CECeff), $BaCl_2$-extract, after BLUM et al.(1996);
- P and K in CAL-extract, after BLUM et al., 1996;
- Elements in aqua-regia-extract, after BLUM et al., 1996;
- Pedogenical Fe-oxides, after SCHWERTMANN, 1959, 1964;

2.3 Soil mineralogical analyses

- Total mineral distribution (semiquantitative) after SCHULTZ (1964).
- Clay mineral analysis after BRINDLEY & BROWN (1980), DIXON & WEED (1989), MOORE & REYNOLDS (1997);

3 EXCURSION STOPS

EXCURSION STOP 5A-1: Grüner See ("Green Lake").

The "Grüner See", which is very popular among divers, is located in Styria, close to the town of Tragöß, about 25 km north of Bruck a.d. Mur, surrounded by forest and the Hochschwab-massif. Its name derives from its emerald green water from the karst mountains and the snow melt, see fig. 3. It looks best from mid-May to June, when it reaches its maximum depth, about 12 m. The water is extremely clear and clean, but rather cold with temperatures of 6-8° C.

The fauna of the "Grüner See" comprises different species of trout (*Salmo*), many small animals like snails, water fleas (*Daphnia punex*), small crabs and fly larvae.

The flora is very poor, due to the rocky underground of the lake, but since it consists primarily of snow melting water, its depth is variable. In June, when its water level reaches the highest mark, divers can observe green flowering meadows in the edge zone of the see. The little bridge and the edge and the bench are also under water.

Figure 3: "Grüner See" (picture taken in September 2007).

Nature and water protection – project "Alliance For Nature"

The aim of this project was to put the "Grüner See" under official legal protection, in order to promote water protection for the whole area surrounding the lake.
The initiative was started in 1996/97, by the „Alliance For Nature", to prevent the discharge and uptake of big amounts of water with the risk of a long-term destruction of the lake.
After 10 years of political discussion, this initiative ended successfully with a resolution of the Styrian Government of 16. October 2006. This resolution declares the hydrologically extremly sensible karst area of the Hochschwab not only a landscape conservation area, where water uptake is regulated, but also a nature conservation area, which includes water quality protection.

EXCURSION STOP 5A-2: Hochschwab, soil profile haplic Fluvisol.

Coordinates: N 47°33'34.2'', E 15°01'53.2''

Altitude: 937m asl

Soil profile description (see fig. 4):

L (5-0 cm):
Ah (0-10 cm):
C (10-60 cm):
Cu1bur (60-140 cm):
Cu2 (140+ cm):

Soil type: haplic Fluvisol (WRB).

Parent material : Calcareous material

Figure 4: Soil profile haplic Fluvisol with the buried C-horizon.

Table 5A-2.1: Carbon and nitrogen contents of the carbon-horizon.

Horizon (cm)	Ct %	Nt %
Cubur (60-140)	48	0.43

EXCURSION STOP 5A-3: Hochschwab, soil profile rendzic Leptosol.

Coordinates: N 47°34'35.8'', E 15°02'22.4''

Altitude: 1452 m asl

Soil profile description (see fig. 5):

L (4-0 cm):	undecomposed litter layer , gradual boundary to:
Ah (0-20 cm):	loamy silt, < 1% skeleton, Munsell (moist) 10YR/2/2, crumby-subpolyhedrical structure, porouos, highly humous, pH very weakly acid, high carbonate content, strongly rooted, few earthworm channels, gradual boundary to:
(A)Cv (20-40 cm):	silty sand, 5-10% skeleton, Munsell (moist) 10YR/5/4, coherent structure, porous, weakly humous, pH neutral, high carbonate content, few roots, no earthworm activity, gradual boundary to:
C (40+ cm):	Wetterstein-dolomite

Soil type: haplic Fluvisol (WRB).

Parent material : Wetterstein-dolomite

Figure 5: Soil profile rendzic Leptosol.

Table 5A-3.1: Particle size distribution and texture type.

Horizon (cm)	weight % of humus free fine earth (< 2mm) sand (2000µm-63µm)	silt (63µm-2µm)	clay (<2µm)	texture class
L (4-0)	-	-	-	-
Ah (0-20)	38	49	13	loamy sand
(A)Cv (20-40)	57	40	3	silty sand
C (40+)	-	-	-	-

Table 5A-3.2: Bulk density, total porosity and water contents.

Horizon (cm)	bulk density Mg/m^3	total porosity vol%	vol% water at pF 1,8	2,0	2,5	4,2
L (4-0)	-	-	-	-	-	-
Ah (0-20)	0.60	77	37	35	31	14
(A)Cv (20-40)	-	-	-	-	-	-
C (40+)	-	-	-	-	-	-

Table 5A-3.3: Pore size distribution and available field capacity (aFC).

Horizon (cm)	pore size distribution in vol.% wide CP (> 50 µm)	narrow CP (50-10 µm)	MP (10-0.2 µm)	FP (< 0.2 µm)	aFC mmWC
L (4-0)	-	-	-	-	-
Ah (0-20)	40	6	17	14	46
(A)Cv (20-40)	-	-	-	-	-
C (40+)	-	-	-	-	-

Table 5A-3.4: General chemical parameters.

Horizon (cm)	pH ($CaCl_2$)	$CaCO_3$ %	humus %	Ct %	Nt %	C/N	el. conductivity µS/cm
L (4-0)	-	-	-	-	-	-	-
Ah (0-20)	6.7	47.3	12.4	12.9	0.38	19.05	234
(A)Cv (20-40)	6.9	86.6	2.7	12.0	0.05	30.32	68
C (40+)	-	-	-	-	-	-	-

Table 5A-3.5: Effective cation exchange capacity (CECeff), base saturation (BS) and saturation of exchangeable cations.

Horizon (cm)	CECeff mmolIÄ/kg	BS %	cation saturation in % of CECeff Ca	Mg	K	Na	Fe	Al	Mn
L (4-0)	-	-	-	-	-	-	-	-	-
Ah (0-20)	588	100	432	26	0.2	0.35	<0.1	<0.1	<0.1
(A)Cv (20-40)	72	100	51	28	0.4	0.63	<0.1	<0.1	<0.1
C (40+)	-	-	-	-	-	-	-	-	-

Table 5A-3.6: Elements in the aqua-regia-extract in mg/kg.

Horizon (cm)	Ca	Mg	K	Na	Fe	Al
L (4-0)	-	-	-	-	-	-
Ah (0-20)	39152	34037	2243	211	28490	-
(A)Cv (20-40)	161803	98724	845	252	6179	-
C (40+)	-	-	-	-	-	-

Table 5A-3.7: Dithionite (Fe_d)-, oxalate (Fe_o)-, pyrophosphate (Fe_p)- and total (Fe_t)-soluble Fe-contents in mg/kg.

Horizon (cm)	Fe_d	Fe_o	Fe_p	Fe_o/Fe_d	Fe_t	Fe_d/Fe_t
L (4-0)	-	-	-	-	-	-
Ah (0-20)	18964	8705	4227	0.46	28490	0.66
(A)Cv (20-40)	3246	861	511	0.26	6179	0.52
C (40+)	-	-	-	-	-	-

Table 5A-3.8: Semiquantitative total mineral composition in weight %.

Horizon (cm)	Quartz	Layer Silicates	Feldspars	Calcite	Dolomite
L (4-0)	-	-	-	-	-
Ah (0-20)	19	45	2	0	34
(A)Cv (20-40)	3	10	1	1	85
C (40+)	-	-	-	-	100

Table 5A-3.9: Semiquantitative clay mineral distribution in weight %.

Horizon (cm)	Smectite	Vermiculite	Illite	Kaolinite	Chlorite
L (4-0)	-	-	-	-	-
Ah (0-20)	-	-	25	10	65
(A)Cv (20-40)	-	-	35	15	50
C (40+)	-	-	-	-	-

EXCURSION STOP 5A-4: Hochschwab, soil profile rendzic Leptosol.

Coordinates: N 47°34'57.1'', E 15°02'09.5''

Altitude: 1533 m asl

Soil profile description (see fig. 6):

L (2-0 cm): undecomposed litter, gradual boundary to:

Ah (0-20 cm): loamy sand, < 1% skeleton, Munsell (moist) 10YR/2/1, crumby-subpolyhedrical structure, porous, highly humous, pH neutral, low carbonate content, strongly rooted, earthworm channels, gradual boundary to:

ACv (20-30 cm): silty sand, >20% skeleton, Munsell (moist) 10YR/4/2, coherent structure, medium porosity, weakly humous, pH neutral, very high carbonate content, rooted, few earthworm channels, gradual boundary to:

C (30+ cm): Wetterstein-dolomite.

Soil type: rendzic Leptosol (WRB).

Parent material : Wetterstein-dolomite.

Figure 6: Soil profile rendzic Leptosol.

Table 5A-4.1: Particle size distribution and texture type.

Horizon (cm)	weight % of humus free fine earth (< 2mm) sand (2000µm-63µm)	silt (63µm-2µm)	clay (<2µm)	texture class
L (2-0)	-	-	-	-
Ah (0-20)	39	53	8	loamy sand
ACv (20-30)	54	43	3	silty sand
C (30+)	-	-	-	-

Table 5A-4.2: Bulk density, total porosity and water contents.

Horizon (cm)	bulk density Mg/m^3	total porosity vol%	vol% water at pF 1,8	2,0	2,5	4,2
L (2-0)	-	-	-	-	-	-
Ah (0-20)	0.65	75	38	35	31	10
ACv (20-30)	1.10	58	39	35	23	5
C (30+)	-	-	-	-	-	-

Table 5A-4.3: Pore size distribution and available field capacity (aFC).

Horizon (cm)	pore size distribution in vol.% wide CP (> 50 µm)	narrow CP (50-10 µm)	MP (10-0.2 µm)	FP (< 0.2 µm)	aFC mmWC
L (2-0)	-	-	-	-	-
Ah (0-20)	37	7	21	10	54
ACv (20-30)	19	16	18	5	34
C (30+)	-	-	-	-	-

Table 5A-4.4: General chemical parameters.

Horizon (cm)	pH ($CaCl_2$)	$CaCO_3$ %	humus %	Ct %	Nt %	C/N	el. conductivity µS/cm
L (2-0)	-	-	-	-	-	-	-
Ah (0-20)	7.0	7.3	31.4	19.1	0.77	23.7	68
ACv (20-30)	7.0	91.1	2.9	12.6	0.07	23.4	69
C (30+)	-	-	-	-	-	-	-

Table 5A-4.5: Effective cation exchange capacity (CECeff), base saturation (BS) and saturation of exchangeable cations.

Horizon	CECeff	BS	cation saturation in % of CECeff						
(cm)	mmolIÄ/kg	%	Ca	Mg	K	Na	Fe	Al	Mn
L (2-0)	-	-	-	-	-	-	-	-	-
Ah (0-20)	631	100	74	26	0.2	0.1	<0.1	<0.1	<0.1
ACv (20-30)	108	100	74	25	0.2	0.4	<0.1	<0.1	<0.1
C (30+)	-	-	-	-	-	-	-	-	-

Table 5A-4.6: Elements in the aqua-regia-extract in mg/kg.

Horizon (cm)	Ca	Mg	K	Na	Fe	Al
L (2-0)	-	-	-	-	-	-
Ah (0-20)	17294	14781	1975	100	22720	-
ACv (20-30)	162194	95159	875	268	5287	-
C (30+)	-	-	-	-	-	-

Table 5A-4.7: Dithionite (Fe_d)-, oxalate (Fe_o)-, pyrophosphate (Fe_p)- and total (Fe_t)-soluble Fe-contents in mg/kg.

Horizon (cm)	Fe_d	Fe_o	Fe_p	Fe_o/Fe_d	Fe_t	Fe_d/Fe_t
L (2-0)	-	-	-	-	-	-
Ah (0-20)	15166	7640	3811	0.50	22720	0.67
ACv (20-30)	3464	1183	663	0.34	5287	0.65
C (30+)	-	-	-	-	-	-

Table 5A-4.8: Semiquantitative total mineral composition in weight %.

Horizon (cm)	Quartz	Layer Silicates	Feldspars	Calcite	Dolomite
L (2-0)	-	-	-	-	-
Ah (0-20)	15	61	3	-	21
ACv (20-30)	3	4	2	1	90
C (30+)	-	-	-	-	100

Table 5A-4.9: Semiquantitative clay mineral distribution in weight %.

Horizon (cm)	Smectite	Vermiculite	Illite	Kaolinite	Chlorite
L (2-0)	-	-	-	-	-
Ah (0-20)	-	-	44	9	48
ACv (20-30)	-	-	59	15	27
C (30+)	-	-	-	-	-

EXCURSION STOP 5A-5: Hochschwab, soil profile rendzic Leptosol.

Coordinates: N 47°35'04.3'', E 15°02'09.9''

Altitude: 1536m asl

Soil profile description (see fig. 7):

Ah (0-16 cm): silty sand, 5% skeleton, Munsell (moist) 10YR/2/2, crumby-subpolyhedrical structure, medium porosity, highly humous, pH weakly acid, medium carbonate content, strongly rooted, earthworm channels, gradual boundary to:

C (16+ cm): silty sand, 5% skeleton, Munsell (moist) 10YR/5/4, single grain/coherent structure, medium porosity, no humus, pH neutral-weakly alkaline, very high carbonate content.

Soil type: rendzic Leptosol (WRB).

Parent material : silty-sandy material from Wetterstein-dolomite.

Figure 7: Soil profile rendzic Leptosol.

Table 5A-5.1: Particle size distribution and texture type.

Horizon (cm)	weight % of humus free fine earth (< 2mm) sand (2000µm-63µm)	silt (63µm-2µm)	clay (<2µm)	texture class
Ah (0-16)	38	55	7	silty sand
C (16+)	52	48	0.5	silty sand

Table 5A-5.2: Bulk density, total porosity and water contents.

Horizon (cm)	bulk density Mg/m^3	total porosity vol%	vol% water at pF 1,8	2,0	2,5	4,2
Ah (0-16)	0.66	75	38	36	31	7
C (16+)	1.67	37	24	21	15	5

Table 5A-5.3: Pore size distribution and available field capacity (aFC).

Horizon (cm)	pore size distribution in vol.%				aFC
	wide CP (> 50 µm)	narrow CP (50-10 µm)	MP (10-0.2 µm)	FP (< 0.2 µm)	mmWC
Ah (0-16)	37	7	24	7	50
C (16+)	13	9	10	5	19

Table 5A-5.4: General chemical parameters.

Horizon (cm)	pH ($CaCl_2$)	$CaCO_3$ %	humus %	Ct %	Nt %	C/N	el. conductivity µS/cm
Ah (0-16)	6.7	17.0	22.8	15.2	1.00	13.2	203
C (16+)	7.1	98.4	0.3	12.0	<0.02	-	54

Table 5A-5.5: Effective cation exchange capacity (CECeff), base saturation (BS) and saturation of exchangeable cations.

Horizon (cm)	CECeff mmolIÄ/kg	BS %	cation saturation in % of CECeff Ca	Mg	K	Na	Fe	Al	Mn
Ah (0-16)	545	100	73	27	0.4	0.13	<0.1	<0.1	<0.1
C (16+)	42	100	71	28	0.2	1.00	<0.1	<0.1	<0.1

Table 5A-5.6: Elements in the aqua-regia-extract in mg/kg.

Horizon (cm)	Ca	Mg	K	Na	Fe	Al
Ah (0-16)	18881	21040	2687	128	27725	-
C (16+)	179504	106852	349	223	1977	-

Table 5A-5.7: Dithionite (Fe_d)-, oxalate (Fe_o)-, pyrophosphate (Fe_p)- and total (Fe_t)-soluble Fe-contents in mg/kg.

Horizon (cm)	Fe_d	Fe_o	Fe_p	Fe_o/Fe_d	Fe_t	Fe_d/Fe_t
Ah (0-16)	21278	9014	6338	0.42	27725	0.77
C (16+)	1624	660	541	0.41	1976	0.82

Table 4A-5.8: Semiquantitative total mineral composition in weight %.

Horizon (cm)	Quartz	Layer Silicates	Feldspars	Calcite	Dolomite
Ah (0-16)	23	57	3	-	17
C (16+)	2	-	-	-	98

Table 4A-5.9: Semiquantitative clay mineral distribution in weight %.

Horizon (cm)	Smectite	Vermiculite	Illite	Kaolinite	Chlorite
Ah (0-16)	-	-	39	32	29
C (16+)	-	-	42	25	33

EXCURSION STOP 5A-6: Hochschwab, soil profile leptic Cambisol.

Coordinates: N 47°35’04.7’’, E 15°02’13.2’’

Altitude: 1526 m asl

Soil profile description (see fig. 8):

Ah (0-13 cm): loamy sand, 5% skeleton, Munsell (moist) 10YR/2/1, crumby-subpolyhedrical structure, medium porosity, highly humous, pH weakly acid, very low carbonate content, rooted, no earthworm channels, gradual boundary to:

ABv (13-23 cm): loamy silt, 5% skeleton, Munsell (moist) 10YR/3/3, (sub)polyhedrical structure, medium porosity, highly humous, pH weakly acid, very low carbonate content, weakly rooted, no earthworm channels, gradual boundary to:

Bv (23-43 cm): loamy silt/silty loam, 5% skeleton, Munsell (moist) 10YR/4/4, polyhedrical-prismatic structure, low porosity, humous, pH weakly acid, traces of carbonate, no roots, no earthworm channels, gradual boundary to:

BvCv (43-48 cm): silty sand, 10% skeleton, Munsell (moist) 10YR/5/4, coherent/single grain structure, medium porosity, weakly humous, pH neutral-weakly alkaline, very high carbonate content, no earthworm channels, gradual boundary to:

C (48+ cm): Wetterstein-dolomite and Wetterstein-limestone.

Soil type: leptic Cambisol (WRB).

Parent material : Wetterstein-dolomite and Wetterstein-limestone.

Figure 8: Soil profile leptic Cambisol.

Table 5A-6.1: Particle size distribution and texture type.

Horizon (cm)	weight % of humus free fine earth (< 2mm) sand (2000µm-63µm)	silt (63µm-2µm)	clay (<2µm)	texture class
Ah (0-13)	48	44	8	loamy sand
ABv (13-23)	21	62	17	loamy silt
Bv (23-43)	10	65	25	loamy silt/silty loam
BvC (43-48)	57	39	4	silty sand
C (48+)	-	-	-	-

Table 5A-6.2: Bulk density, total porosity and water contents.

Horizon (cm)	bulk density Mg/m^3	total porosity vol%	vol% water at pF 1,8	2,0	2,5	4,2
Ah (0-13)	0.50	81	40	35	25	10
ABv (13-23)	0.68	74	38	36	32	18
Bv (23-43)	0.95	64	39	36	34	19
BvC (43-48)	-	-	-	-	-	-
C (48+)	-	-	-	-	-	-

Table 5A-6.3: Pore size distribution and available field capacity (aFC).

Horizon (cm)	pore size distribution in vol.%				aFC mmWC
	wide CP (> 50 µm)	narrow CP (50-10 µm)	MP (10-0.2 µm)	FP (< 0.2 µm)	
Ah (0-13)	41	15	15	10	39
ABv (13-23)	36	6	14	18	20
Bv (23-43)	25	5	15	19	20
BvC (43-48)	-	-	-	-	-
C (48+)	-	-	-	-	-

Table 5A-6.4: General chemical parameters.

Horizon (cm)	pH ($CaCl_2$)	$CaCO_3$ %	humus %	Ct %	Nt %	C/N	el. conductivity µS/cm
Ah (0-13)	5.9	0.8	30.0	17.5	1.22	14.3	233
ABv (13-23)	6.1	0.8	11.3	6.6	0.56	11.7	81
Bv (23-43)	5.9	<0.5	4.7	2.7	0.22	12.3	36
BvC (43-48)	7.1	74.4	2.1	10.1	0.06	21.2	103
C (48+)	-	-	-	-	-	-	-

Table 5A-6.5: Effective cation exchange capacity (CECeff), base saturation (BS) and saturation of exchangeable cations.

Horizon (cm)	CECeff mmolIÄ/kg	BS %	cation saturation in % of CECeff Ca	Mg	K	Na	Fe	Al	Mn
Ah (0-13)	587	100	76	23	0.7	0.18	<0.1	<0.1	<0.1
ABv (13-23)	349	100	77	22	0.3	0.17	<0.1	<0.1	<0.1
Bv (23-43)	183	100	74	25	0.5	0.29	<0.1	<0.1	<0.1
BvC (43-48)	77	100	79	19	0.6	0.60	<0.1	<0.1	<0.1
C (48+)	-	-	-	-	-	-	-	-	-

Table 5A-6.6: Elements in the aqua-regia-extract in mg/kg.

Horizon (cm)	Ca	Mg	K	Na	Fe	Al
Ah (0-13)	1471	5800	3666	113	29806	-
ABv (13-23)	579	6077	2863	100	37789	-
Bv (23-43)	119	6546	3186	107	40733	-
BvC (43-48)	139289	84213	2613	243	12421	-
C (48+)	-	-	-	-	-	-

Table 5A-6.7: Dithionite (Fe_d)-, oxalate (Fe_o)-, pyrophosphate (Fe_p)- and total (Fe_t)-soluble Fe-contents in mg/kg.

Horizon (cm)	Fe_d	Fe_o	Fe_p	Fe_o/Fe_d	Fe_t	Fe_d/Fe_t
Ah (0-13)	22023	12069	3383	0.55	29806	0.74
ABv (13-23)	35302	14752	3611	0.42	37789	0.93
Bv (23-43)	31135	9274	3236	0.28	40733	0.76
BvC (43-48)	8409	921	416	0.11	12421	0.68
C (48+)	-	-	-	-	-	-

Table 4A-6.8: Semiquantitative total mineral composition in weight %.

Horizon (cm)	Quartz	Layer Silicates	Feldspars	Calcite	Dolomite
Ah (0-13)	23	70	7	-	-
ABv (13-23)	30	62	8	-	-
Bv (23-43)	28	65	7	-	-
BvC (43-48)	14	10	-	4	72
C (48+)	-	-	-	-	-

Table 4A-6.9: Semiquantitative clay mineral distribution in weight %.

Horizon (cm)	Smectite	Vermiculite	Illite	Kaolinite	Chlorite
Ah (0-13)	-	-	66	17	17
ABv (13-23)	-	-	60	22	18
Bv (23-43)	-	-	52	24	24
BvC (43-48)	-	-	71	6	23
C (48+)	-	-	-	-	-

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