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Guidebook Tours D and E

Soils and Landscapes in Southern Germany
Bayern and Baden-Württemberg

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MITTEILUNGEN DER DEUTSCHEN BODENKUNDLICHEN GESELLSCHAFT

13th
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August 1986

Guidebook
for a
landscape, soils and land use tour
in the Federal Republic of Germany

Tour E

Baden-Württemberg

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and local colleagues

Introduction

In this excursion, soils of various geomorphic units (periglacial and glacial areas, old peneplains, cuestas and basement complexes) with different landscape history (including historical farming) are shown. In the Buntsandstein area of the northern Black Forest, effects of waterlogging, spread of Sphagnum and heath and their causes will be discussed in the "Missen" and "Grinden" areas; in the crystalline basement of the southern Black Forest (with glaciated Feldberg district) the dependence of Brown earths (with different forms and distributions of humus) on altitude is demonstrated as well as strong podzolization of fluvioglacial granite detritus. - In Oberschwaben, soil formation in till of different glaciations, in basin clays and gravels (here with subrelictic rubefication) is shown. - On the cuestas of the foreland of the Swabian Alb, the Keuper mountains and the Gäu area, soil development from claystones and marls with different clay mineral contents is shown with its consequences for water regime, structure and trophical character. - On the plateau of the eastern Swabian Alb, multiphase soil formation interrupted by redeposition in a karstified area is demonstrated with relictic loamy clays (with pisolitic iron ore and with chert) as residues of soil formation during the Tertiary; effects of waterlogging depending on the relief are shown.

Acknowledgement

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Staatliche Forstämter for preparation of profiles,
owners of the land for permission of access,
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Diplom-Landwirt Opitz for supplying sections of his unpublished soil map of Oberkochen.

General Itinerary

August 21: 12.30 Departure from Stuttgart-Hohenheim, Emil-Wolff-Straße, at the west wing of the Castle; via Autobahn - Herrenberg - Nagold - Altensteig

13.45-14.45 Profile 1, 2, 3 near Grömbach

15.00-15.30 Profile 4 near Klosterreichenbach; via Baiersbronn - Ruhestein

16.15-17.00 Profile 5a and b near Schliffkopf; via Freudenstadt - Alpirsbach - Haslach - Waldkirch

19.30 Arrival in Freiburg/Breisgau.

August 22: 8.00 Deparure from Freiburg, Rotteckring (in front of the "Schwarzwald-Reisebüro")

8.45- 9.45 Profile 6 near St. Märgen

10.15-12.00 Profile 7 and 8 near Hotel Thurner

12.30-13.45 Lunch at Hotel Thurner; via Titisee

14.45-15.00 Profile 9 near Altglashütten

15.45-16.45 Profile 10 at the Feldberg; then via Todtnau - Schauinsland

17.45 Arrival in Freiburg.

August 23: 8.30 Departure from Freiburg; via Neustadt - Geisingen - Autobahn - Engen

11.00-11.30 Profile 11 near Singen/Hohentwiel, then to Stockach

12.00-13.30 Lunch

13.45-14.45 Profile 12 at Besetze

15.00-16.00 Profile 13 near Zoznegg

16.15-17.30 Profile 14, 15 near Roth; return to Stockach

18.00 Arrival in Stockach.

August 24: 8.00 Departure from Stockach; via Autobahn - Geisingen

9.00-11.00 Profile 16, 17, 18 at "Dreilärchen"; via Autobahn - Deißlingen to Rottweil

12.00-13.30 Lunch ; via Schömberg - Dotternhausen

14.00-15.30 Profile 19, 20 at the Waldhof, via Leidringen

15.45-16.15 Profile 21 near Böhringen

16.45-17.15 Profile 22 near Dunningen, then return via Autobahn

19.00 Arrival in Stuttgart-Hohenheim

August 25: 8.30 Departure from Stuttgart-Hohenheim; via Autobahn - Geislingen - Steinheim - Heidenheim/Brenz

11.00-11.45 Profile 23 near Nattheim; then to Königsbronn

12.00-13.30 Lunch

13.45-14.15 Profile 24 near Ochsenberg

14.30-15.00 Profile 25 near Oberkochen; via Essingen

15.15-15.45 Profile 26 near Tauchenweiler

16.00 - 16.30 Profile 27 near Rötenbach; via Geislingen - Autobahn

18.30 Arrival in Stuttgart-Hohenheim

Environment and Land Use

Physiography and Geology

The excursion area is subdivided into Black Forest, cuestas (Gäu, Baar, Keuper Mountains, Swabian Alb and its footplains) and Oberschwaben. The Black Forest is ascending up to 1500 m with sharply incised deep valleys and has the oldest rocks. From the assyntic and Variscan orogenesis, different types of gneiss, granite, quartz porphyry and metamorphic sediments are preserved, in depressions following synclines also weathering products (Rotliegendes) from the Upper Paleozoic. Above a peneplain follows the Buntsandstein which is subdivided by two conglomerate layers; the Lower B. is rich in feldspars, the Middle B. has the largest thickness and forms the slopes especially in the northern part whereas the Upper B. is partly clayey and is widely preserved in the eastern part. The whole sequence seems to be of fluvial origin. Younger sediments have been removed since the Tertiary. The Pleistocene glaciation lead to plateau and valley glaciers in the southern part (at least twice) and to kars elsewhere, mostly in north-eastern direction; periglacial phenomena are blankets of debris (in the higher region with stone stripes) and block fields. - At an erosion border, younger sediments follow. The neighbouring hilly area of the Gäu lies about 400 m above sea-level and is dominated by marine limestones of the Middle Triassic (Muschelkalk, in the lower part marly, in the middle clayey with salt beds) and karstified; a loess cover is widespread and increases to the north. The transition to the Keuper Mountains is formed by plains with brackish sediments and a hilly zone of marly gypsum clays, both from the Upper Triassic. The cuesta itself with about 500 m consists of interbedded marly clays and sandstones (partly forming peneplains) of fluvial origin also from the Upper Triassic. Similar types of layers are found in the footplains and hills of the Swabian Alb (300-400 m high) from Lias and Dogger, stemming from an epicontinental sea, now covered with loess (especially in the flat parts of the landscape, such as the tectonical Graben zone of the "Filder" = fields). With increasing steepness of the schists to the southwestern direction, the area between the Black Forest and the Swabian Alb narrows to the depression of the Baar (about 700 m high). There the Swabian Alb rises to a height of 1000 m. It consists of a sequence, repeated three times, of marine marls and limestone banks from the Malm which are partly replaced by reefs of silica sponges and calcareous algae increasing to the higher parts of the strata series and starting from the west. Hence the relief is dominated by cliffs and reef mounds. In the surroundings, chert was formed which is common in old valley bottoms of the Ostalb. The karstified area keeps relics of tropical colluvia such as plinthite, kaolinitic clay and red loam in depressions, caves and crevices. Meteoritic

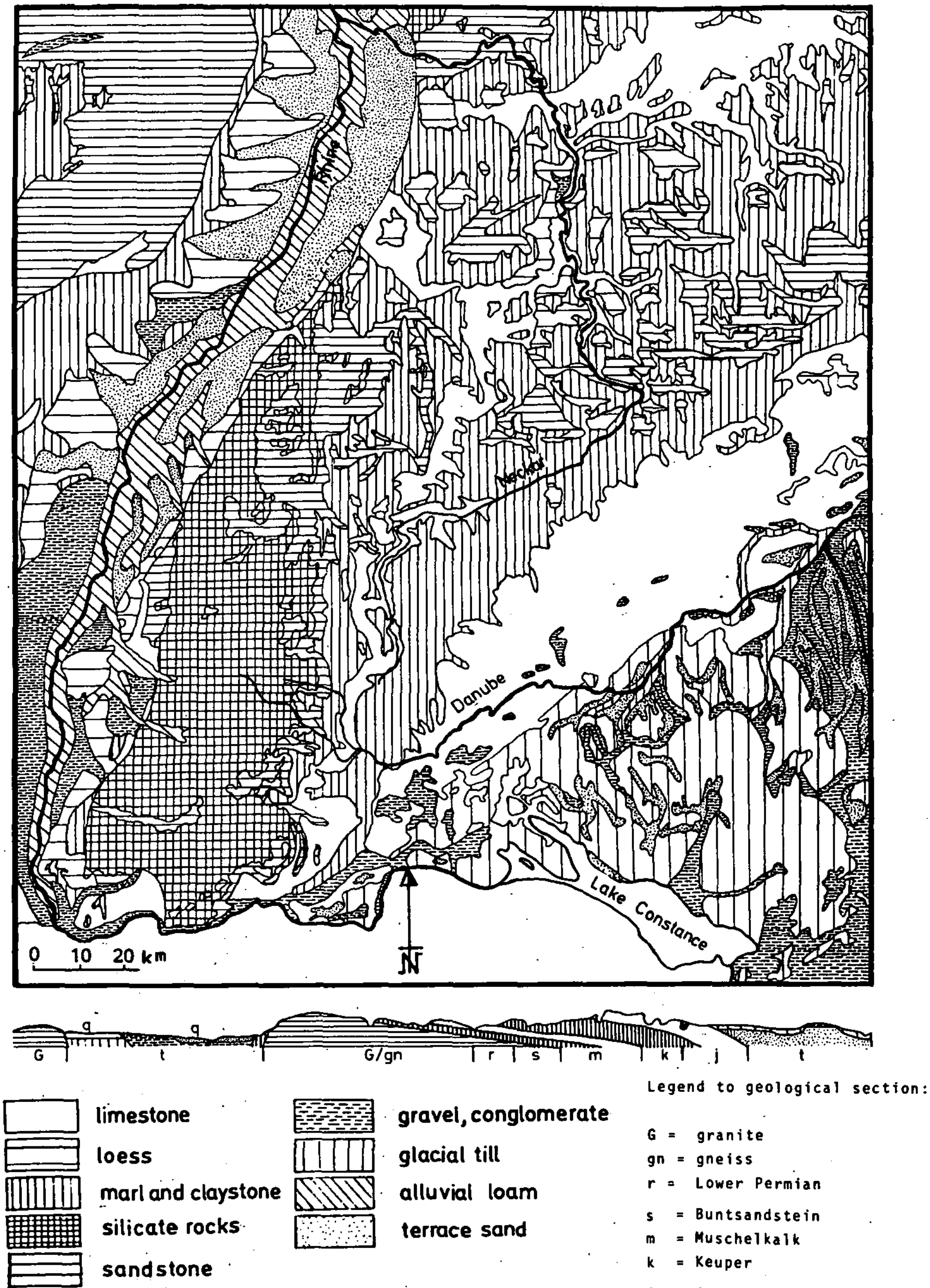


Fig. 1: Petrography and Geology

craters in the eastern part and Maars in the middle of the Alb are well preserved since the younger Tertiary (Tortonian), the latter forming domes and hills in the foreland by erosion. The upland area is subdivided by a shore line of the Tertiary (Burdigalian) south of which a flat area (= Flächenalb) leads over to the molasse basin of Oberschwaben (500 m high). It is evened up by Tertiary sediments, marine abrasion, fluviatile erosion and covering with loess. The neighbouring foreland of the Alps is dominated by glacial sediments (moraines, fluvioglacial fans) of Riss and Würm age from the Rhine glacier lying over fluvial and marine sands from the Tertiary. The latter sequence is pierced by volcanoes of two rock types (western file basaltic, eastern phonolithic) from the younger Tertiary, some of which have been nunataker in the Pleistocene.

Climate and Hydrology

Due to the changing relief there are great differences in climate between the landscapes. Generally, the Black Forest has a rough climate rich in precipitation; on the western slope it is mild, oceanic, fresh to moist by rains of ascent, on the ridge line it has the lowest temperature and the highest rainfall (<6° C/ >2000 mm annually) with nearly steady amount all over the year . To the eastern declivity it gets gradually warmer (>7° C) at decreasing rainfall with maximum in summer. The Baar is characterized by low temperatures (140 days with frost) and frequent late frost, whereas the Gäu is mild (8° C/700-750 mm) and sometimes slightly dry. The Keuper Mountains and even more the Swabian Alb show increasing precipitation (up to 1000 mm) at the northwestern border with decreasing temperature (Alb <6° C in the southwestern part) with pronounced continental character. Oberschwaben is characterized by increasing temperatures (western part of Lake Constance up to 9° C) and lower precipitation (750-800 mm).

Hydrology is no less varied. The Black Forest has a narrow network of rivers especially in the granite/gneiss area and many glacial lakes (Titisee, Schluchsee in tongue-like basins, others in kars). Abundant springs arise from sandstone and at its base; the water is soft and in the sandstone area sometimes poor in microelements. Thermal water springs in several places and is used in baths (since Roman times 2000 years ago). The Keuper Mountains, another large sandstone area, show a wide network of rivers and small springs often with very hard water (partly sulfatic from gypsum in the marls). Baar and foreland of the Swabian Alb again have a narrow network of rivers (mostly tributaries of the Neckar), but many insignificant strata springs, in the Upper Lias region with sulfidic and in the Dogger region partly with sulfatic water. Many carbonate springs issue around the zone of volcanoes in the area of the middle Neckar; as geothermal

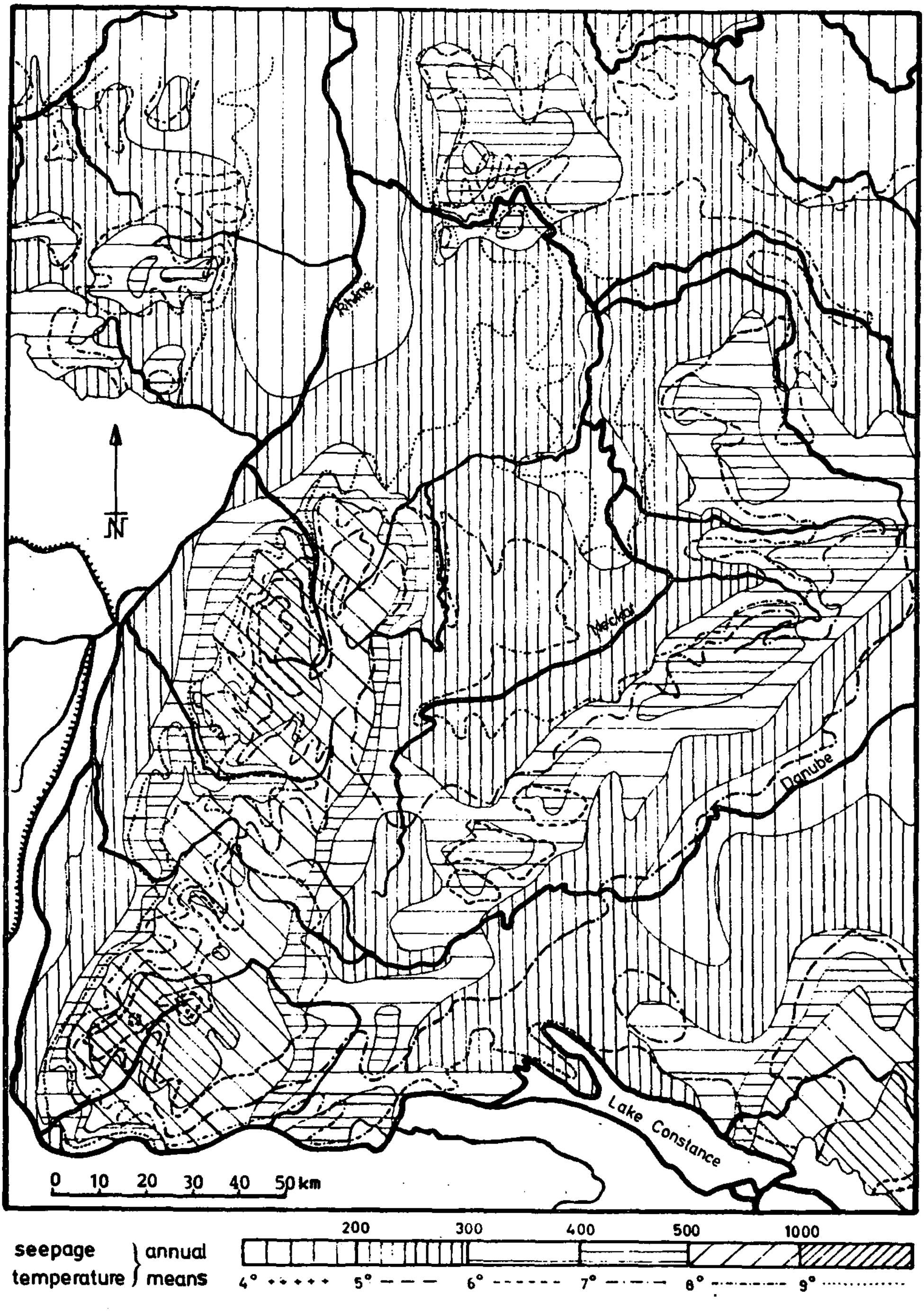


Fig. 2: Climate

step is smaller here than elsewhere in southwestern Germany, artificial wells of thermal water have been opened in some places for medical purposes. Gäu and Swabian Alb are two karstified areas with similar phenomena but typical differences. In the Gäu area karstification extends from the limestones of the Upper Muschelkalk to the gypsum marls of the Upper Triassic and is combined with solution of salt (in the Middle Muschelkalk) and gypsum. Consequently, hard, often sulfatic waters and partly salt brines occur in two important spring horizons and elsewhere. Mixed influence of volcanic carbondioxide, karstification in the neighbouring Gäu area and thermal character is typical for the large carbonate springs in Stuttgart (used by man for 250,000 years). The Swabian Alb has a narrow network of dry valleys which have developed and been widened under periglacial conditions in the Quarternary. Some of them are relics from former connections with the Danube (being the receiving stream for all of southwestern Germany up to the Late Tertiary). Today the European Watershed follows the ridge-line of the mountain, displaced subterraneously nearer to the Danube. Very abundant karstic springs (up to 25 m^3/sec.) are the beginning of rivers (Brenz, Blau, Kocher, Fils); the water is not harder than in springs of the foreland of the Alb due to shorter residence time. As karstic water is accumulated in two stories and may have a very large residence time in the deeper part, it is used for water supply of various communities. In addition, long-distance supply has been made available since the middle of the 19th century. Oberschwaben is separated by the Würm end moraine into the catchment areas of Danube and Rhine, but this is by-passed at the intake of the Danue, the water of which flows to the "Aachtopf" (karstic spring, more than 25 m^3/sec. maximum). Large glacial lakes are Lake Constance and Federsee (originating from lobes of the Rhine glacier), besides which small kettles occur. Springs are developed at the base of moraines; valley train accumulations are an important source of groundwater.

Vegetation

Originally, Baden-Württemberg is a woodland, but making the loess areas arable began more than 5000 years ago and went on in other regions until the Middle Ages. The forested area in all parts of the country today is dominated by fast-growing conifers, whereas the natural distribution of coniferous forest was restricted to mountainous areas rich in precipitation and the wood was interspersed with deciduous trees. Typical for the Black Forest is the combination of fir with beech and (above 1000 m) of spruce with beech, both together with pine. In the eastern and northern part of the sandstone area the forests are rich in moss and dwarf shrub (like blueberry, heather and broom). The Gäu area has poor remainders of forests with beech and oak (together with fir) on steep slopes; the Keuper Mountains are overgrown with spruce forest but originally had the same type as before. Partly the wood has been replaced by rich meadows, in the Muschelkalk area by dry pastures with juniper. The foreland of the Swabian Alb has forests with broad-leaved trees (oak, grove beech and red beech) besides coniferous forest, but most of the area is farmed. In the Baar, forests of fir and spruce with pine and beech are developed. The steep northwestern slope of the Swabian Alb is covered with beech forest alternating with spruce and (in the southwestern part) with fir, while the shady slopes of deeply incises valleys carry canyon forest with maple-tree, ash and linden-tree. On the top of the mountain, beech and spruce forest (with fir) alternate with farmed land and dry pastures with juniper, wild roses and many rare species of flowers normally growing in more southern and southeastern countries. Remarkably, the vegetation has a warmer character than would be expected at this altitude. Oberschwaben originally has beech forest, but spruce is widespread, whereas oak and grove-beech dominate near Lake Constance; around the volcanoes of the Hegau, deciduous forest rich in oak (in some locations only linden-trees) is preserved. The areas with moor have wood plants which moved in from the margin after drainage (such as mountainous pine, moor birch-tree, heather).

Soils

In the Black Forest Brown earths are widespread, in the granite/gneiss area together with Rankers and sometimes Podzols (depending on quartz contents and climate). In the Buntsandstein area on the ridge, above 900 m above sea-level, thin-iron-pan Podzols and Stagnogleys are associated with highmoors; gleysation is not restricted to valleys but also found on wet slopes. More to the east, podzolisation on slopes with sandstone debris is influenced by slope water; moist forms (Feuchtpodsol) occur in the shady part, and ortstein Podzols more on the sunny side. On the plateau of the cuesta, the Brown earths are replaced by Stagnogleys (locally turning into highmoors) in flat depressions, with a margin of Brown earth rich in iron oxide (Ockererde) at the lower end. The valley bottoms are dominated by colluvial soils, but previously there was moor in many places, also in most of the kars. The Gäu area is dominated by Lessivés; in some places with agricultural use, patches of Pararendzina are spreading rapidly due to erosion. Thus, the Vega in the valley is replaced

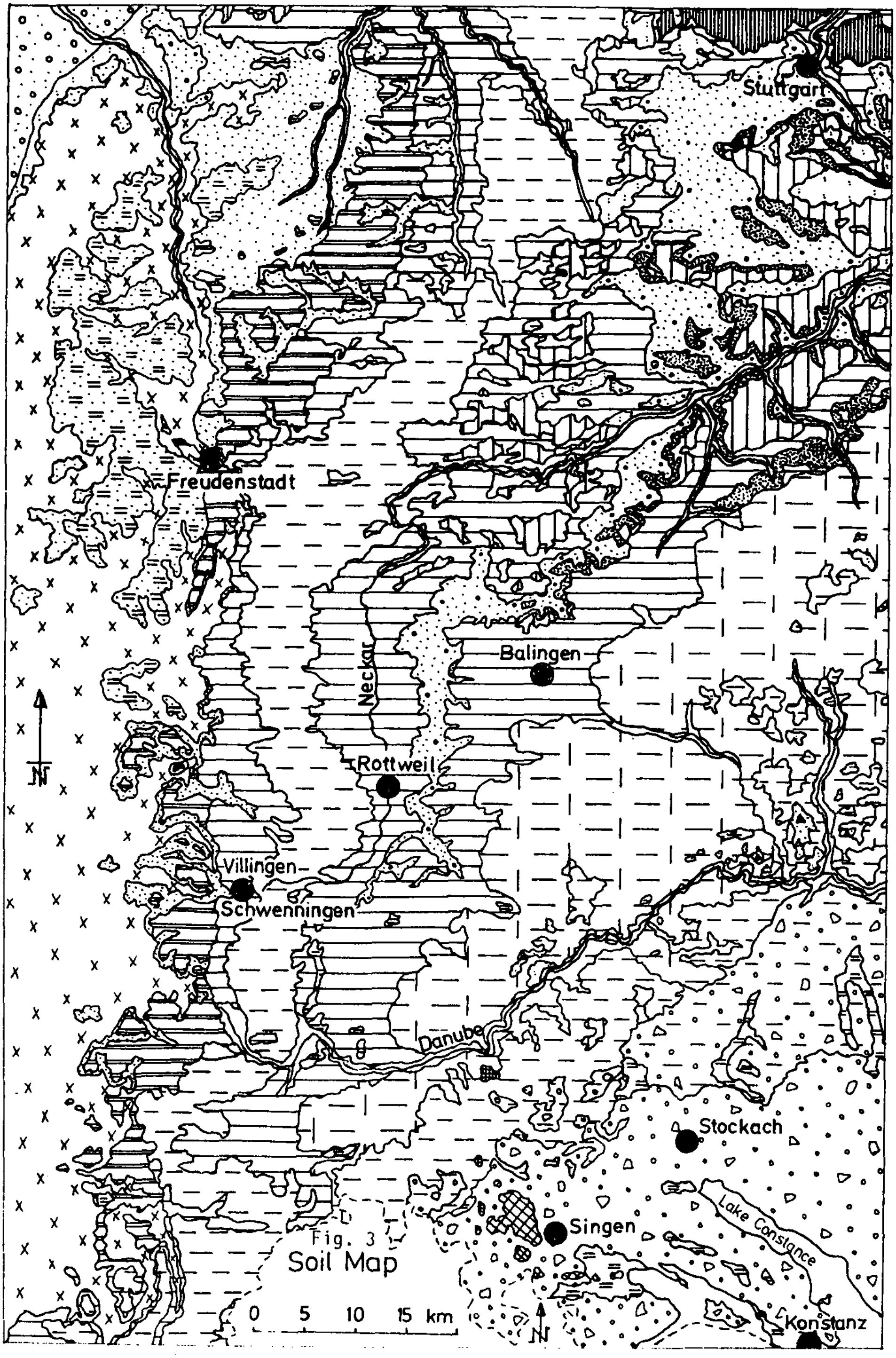


Fig. 3
Soil Map

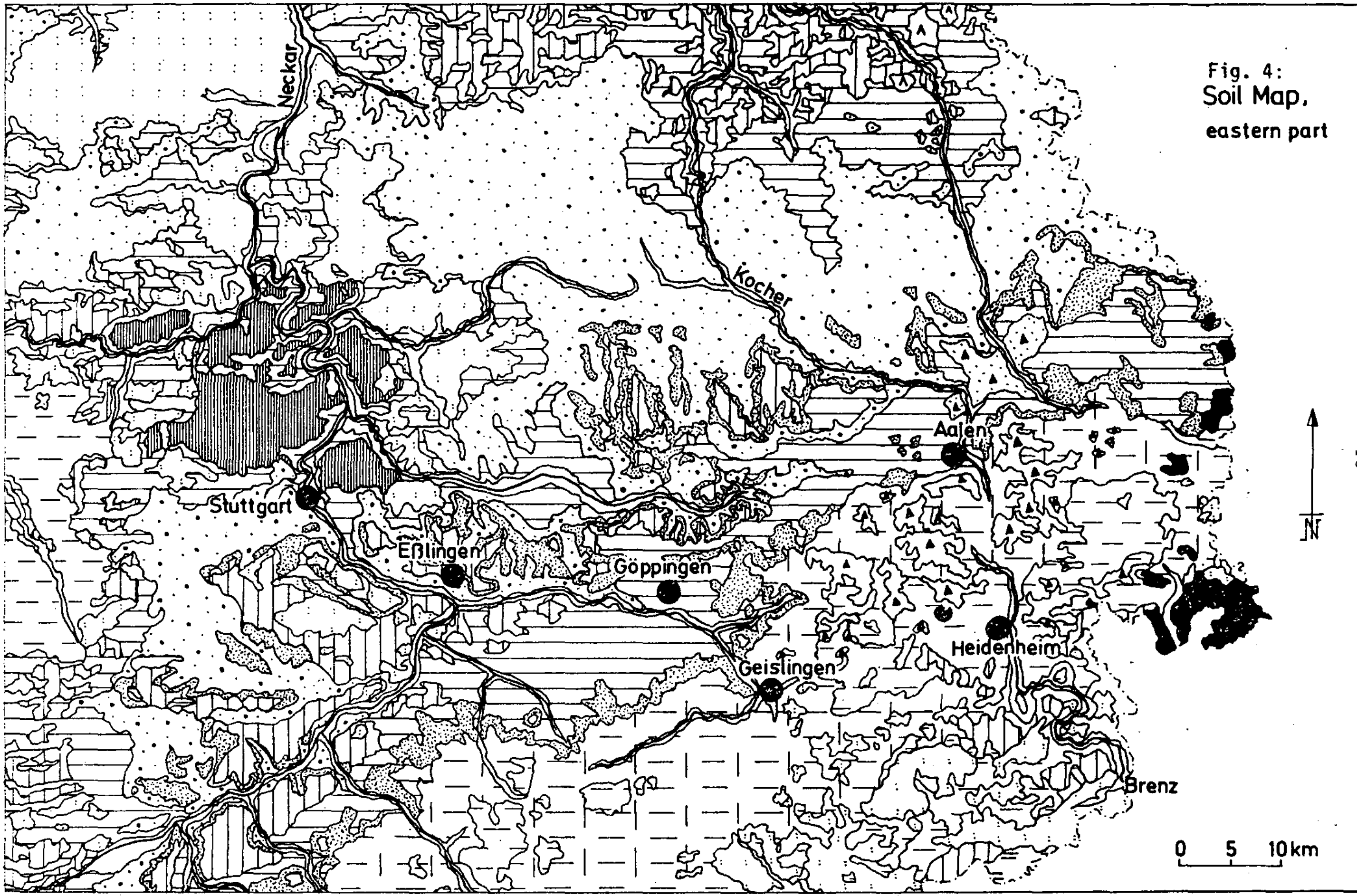


Fig. 4:
Soil Map,
eastern part
Neckar
Kocher
Aalen
Stuttgart
Eßlingen
Göppingen
Heidenheim
Geislingen
Brenz
10
N
0 5 10 km

Legend:

limestone (partly dolomitic) ± loess	domes and dry valleys	Rendzina-Terra fusca-Braunerde (partly humic) with relics of Red Loam
clayey marl and limestone banks	plateaus, hills and gentle slopes	Mergelpelosol und -rendzina-Pseudogley-and Braunpelosol-Parabraunerde-Braunerde (± clayey)-Vega with Rendzina, Braunerde-Terra fusca, Pseudogley-Parabraunerde and Pararendzina
clay-(silt-)stone and sandstone	plateaus, hills and gentle slopes	Pseudogley- and Braunerde-Pelosol-(Pelo)Pseudogley-Pelogley-Anmoor with Mergelpelosol, Pseudogley-Parabraunerde, Braunerde and Lowmoor
sandstone (partly clayey)	ridges and gentle slopes	Braunerde-Stagnogley-Ockererde-Podsol-Gley with Ranker and Pseudogley
silt-(clay-)sand-stone ± loess	ridges and gentle slopes	Braunerde-Pseudogley-Gley with Podsol-Braunerde, Ranker and Stagnogley
coarse sand (clay) and sandstone ± loess	plateaus, ridges and slopes	Pseudogley-Podsol-Braunerde-Gley with (Pseudogley-)Parabraunerde, Braunpelosol and Stagnogley
sandstone	plateaus, ridges and slopes	Braunerde-Podsol-Vega-Paternia with Ranker and Anmoor
sandstone	plateaus, ridges and slopes (partly kars)	Thin-iron-pan Stagnogley and Podzol with Highmoor, Ranker and Paternia
granite and porphyre	ridges and slopes	Ranker-Braunerde-Braunerde-Podsol-Gley with Syrosem, Gleyvega and Anmoor
phonolithe and tuff	mounts (volcanoes)	Ranker-Braunerde-Gley
basalt and tuff	mounts (volcanoes)	Ranker-Braunerde (partly humic)-Gley with Pararendzina
ejection of meteoritic crater	hills and gentle slopes	Rendzina-Braunerde-Pseudogley-Gley with Protorendzina
clay-with-flint colluvium ± loess	flat hills and slopes	Pseudogley-Parabraunerde-Braunerde with Rendzina, Terra fusca, Podsol, Stagno-gley and Highmoor, partly above large relics of Red Loam
(loamy) terrace sands ± loess	plateaus	Pseudogley-(Bänder-)Parabraunerde-(Podsol-)Braunerde-Pseudogley-Pelosol-Anmoor-Gley with Parabraunerde-Pseudogley
loess with flint	plateaus and ridges	Pseudogley-Parabraunerde-Pseudogley-Braunpelosol-Braunerde-Pelogley with Mergelpelosol and Sandbraunerde
loess	ridges and plateaus	Pararendzina-Chernosem-Parabraunerde-Parabraunerde-Braunerde-Vega with Mergel- and Braunpelosol
loess	ridges, hills and gentle slopes	Parabraunerde-Pararendzina-Braunerde-Vega with Kalk- und Pseudogley-Braunerde, partly vineyards with Rigosol
loess	ridges and plateaus	Parabraunerde-Pseudogley-Parabraunerde-Vegagley with Pseudogley, Braunerde and Anmoor
glacial till (Riss)	moraines, hills and plateaus	Pseudogley-Braunerde-Gley-Anmoor with Stagnogley, Parabraunerde and Lowmoor
glacial till (Wuerm)	moraines, hills, ridges and plateaus	Parabraunerde-Braunerde-Pseudogley-Gley-Anmoor with Pararendzina and Lowmoor
terrace sediments with loess	plateaus and hills	Parabraunerde-Braunerde-Vega-Gley-Anmoor with Podsol-Braunerde
alluvial sediments	hills and plains with ridges	Braunerde-Vega-Gley-Paternia with Mergelrendzina and Anmoor
loam	depressions (partly with lakes)	Gley-Anmoor-Lowmoor-Transitional Moor with Highmoor

by colluvial soils with increasing lime contents. In the surroundings of Stuttgart, Chernozems as relics of the middle holocene are preserved. Rigosols are formed on the slopes with vineyards. With decreasing Loess cover, Pseudogleys, Pelosols and brown soils of different types are spread, as well as Terry fusca and Rendzina in the limestone areas. The transition to the Keuper Mountains is characterized by Pelosols (in some karstic depressions with features like Vertisols), whereas clayey black soils rich in sulfate (Sumpfton) and Gleys are found in the valleys. On the upper slopes Pelosols are associated with various brown soils which also dominate the plateau, together with Pseudogleys on plains and shallow Podzols on ridges. The loess area in the foreland of the Swabian Alb is similar to the Gäu but with stronger Pseudogleysation especially where Würm loess is decreasing. Dark colluvial soils in valley depressions are used for intensive farming; in broad valley bottoms Vega is more widespread than Gleys and bordered by colluvial soils. Brown earths in sandstone areas often have a pseudogleyed topsoil; more common are Pelosols of different types (marly, brown and pseudogleyed) associated with clayey Gleys. In the western part where the climate is cooler (> 7° C annual means), Pelosols with very thick Ah-horizons are found instead of Pseudogley-Pelosols on large plains with upper liassic schists and marls. Towards the Baar, soils of clay colluvium are more and more widespread in the valleys; long depressions in front of the cuestas are occupied by moor. On the Swabian Alb, the dominating soils are various Rendzinas (among others marly, dolomitic, from tufaceous limestone), especially on the northwestern slope but also on the knobs between dry valleys, connected with gleysation on seasonally wet slopes. Borders of dry valleys and small karstic depressions are typical locations for the deeply developed Terra fusca, the topsoil of which is influenced by loess. These gradually change to mighty layers of Brown earths and various colluvial soils (blackish or brown, silty and clayey). The plains in the southeastern part (Flächenalb) have Lessivês (from loess and molasse sands). Red soil sediments are concentrated near the old cliff (bordering the Flächenalb in the northwest) and in high terraces of the Brenz river (as clay-with-flints); even Podzols from chert can be found there. Plinthic and kaolinitic clays from the Eocene are widespread but mostly as admixture of younger soils. Special locations such as a watershed area in the eastern part and a maar in the middle of the Alb are moist enough to form Stagnogleys and highmoor. The area of the Riss moraine in Oberschwaben is dominated by Pseudogleys with very deep development in flat parts and Lessivês on ridges and hills, whereas the depressions are occupied by Gleys; in old lake basins a moor succession has been formed from low- to highmoor. In the area of the Würm moraine Lessivês prevail; a red form is developed near Singen and seems to be a relic from the middle holocene. On the steep slopes around Lake Constance, Pararendzina is spread; wet slopes show typical gleysation. Pelosols are confined to varved clay, Rendzinas to calcareous gravels. The volcanoes are characterized by Rankers and Brown earths.

Agriculture and Forestry

At 42.7% (in 1980) of the country, the agricultural acreage has a less important share than in other parts of the Federal Republic of Germany. About 42.3% of these are meadows; cereals occupy 70.4% of the remaining part, fodder 17.5%, root crops only 8%. Special cultures such as fruit-growing, vine and vegetables are rather important (35% of all orchards of the Federal Republic are in Baden-Württemberg). The farmed areas for fodder (except silo maize), rye, leguminous plants and vegetables are decreasing, while maize and winter barley are increasing. - After 1949 the number of farms decreased to one third, whereas their size nearly doubled. Baden-Württemberg has the smallest farms in the Federal Republic, and nearly two thirds of the farmers work in the industries to augment their income. This is due to parcelling out in previous centuries; in the 18th and 19th centuries starvation compelled many people to emigrate (to Russia, Romania and America). - In the live stock, pigs (2.2 million) are more important than cattle (1.8 million), particularly in the Black Forest and Oberschwaben; pig farms are of small to medium sizes, cattle farms predominantly small, with increasing tendency. The returns for animal products are 2.5 times higher than those for plant products. Typical features are increasing application of mineral fertilizers (high in nitrogen, which leads to local nitrate problems in the ground-water), intensity of soil tilling (which leads to erosion problems especially in fields with sweet turnip in loess areas, perhaps together with increased fertilizing with potassium),and management with herbicides (which leads to various ecological problems).

In the Black Forest, clearings have been made arable in the early Middle Ages but perhaps pasturage in the woods and meadows on the valley bottoms existed before then. Use of litter, grass and dwarf shrubs for the cowsheds was common practice since long ago until the first World War. Especially in the southern part there is extensive use of meadows. In the Gäu area, the Muschelkalk region is dominated by hedges on stone walls (from cleaning of the fields); most of the remainder has been made arable in the early Neolithic and is dominated by corn-growing; steep slopes exposed to the south have vineyards. Fields prevail in the foreland of the Swabian Alb, in the surroundings of Hohenheim with "Filderkraut"; areas with shallow soils rich in nutrients are pastured. On the Swabian Alb, fields prevail in the flat southern part, in the north they are restricted to dry valleys; meadows are widespread. In Oberschwaben there is intensive farming, tillage especially in the southwest, whereas the surroundings of Lake Constance are used for fruit-growing, vineyards and hops.

The woods of Baden-Württemberg have been utilized for ages. Decrease from clearing-up ended in the middle of the 14th century; the forested area now occupies 36.4% of the country. Here, the first German wood regulation was issued between 1514 and 1519; pines have been sowed since the 16th century, plantations are made since the end of the 17th century (now about 10.000 hectars annually). Since the 19th century pine-trees were planted everywhere. From the second World War ecological aspects are taken into consideration increasingly, besides national preservation and use for recreation. - Yield and production have been balanced since about 200 years as a rule. Until the 19th century more than 90% (mostly stump sprouts) was used for fire-wood, today it is only 9%. Most of the wood is now used as timber (two thirds) and in the industries (one third). Thus, 80% of the wood consumption is covered; of this, three quarters come from conifers which form 65% of the stock. In the forests, spruce makes up 44% of the wood, beech 20% and fir 10%; pine, oak and Douglasia (where it is too dry for spruce) are of minor importance. Harvesting (after 80 to 250 years of growth, respectively) takes 55 to 60% of the total work volume and is now done mostly with large, modern machines (for clearing and for removing the bark). - The game stock is rather high and consists mainly of roe and hare as well as fox and (less frequent) wild boar and red deer.

In the northern part of the Black Forest most of the forest belongs to the state, but the share of communities and various corporations (e.g. "Murgschifferschaft") is twice as high as that of the country; the middle and southern part mainly are privately owned. Utilizing the wood commenced at least in the early Middle Ages (charcoal-burning, pasturing, harvesting of resin). Rafting flourished in the 17th and 18th centuries where fir trunks were used for carrying oak, the timber for ships, to the Netherlands. The wide spread of spruce in the 19th century is due to a great fire; besides this, fir and beech are used today. - Extensive forests can also be seen in the Keuper Mountains (mostly conifer), on the Swabian Alb (mostly beech), and in Oberschwaben (beech, conifer).

Route Description

August 21st: From Hohenheim via Autobahn across the Filder plain (graben with loess upon liassic layers, airport to the left, border fault in the ascent beyond) and through a forested part of the Keuper mountains; branch off southward to Böblingen - Sindelfingen (with important industries) in a hilly area with gypsum marls, leaving the Autobahn at

Herrenberg (Gothic church, part of the tower removed), cuesta of Keuper layers (with marginal fault) to the left. Through the Gäu area and crossing the valley of the Nagold river (town to the right, with ruins) to the Black Forest. Following the valley (with Middle Buntsandstein rocks in the walls) to

Altensteig and ascending to the plateau (of clay- and sandstone from the Upper Buntsandstein) with cleared field districts we reach

Grömbach, where profile 1, 2 and 3 are shown. Return to the Nagold valley (with river dam) and crossing a ridge, into the valley of the Murg (profile 4 on the slope) at

Klosterreichenbach (Romanic church of a monastery). Following the valley upward (gneiss quarries to the right) to the ridge-line of the Black Forest at the Ruhestein, in the right-hand background Hornisgrinde (1164 m above sea-level, as cuesta with Buntsandstein on crystalline base), view to the Rhine valley. Continuing in southerly direction, heathy grounds with mountain pine ("Grinden"); near the

Schliffkopf two variants of profile 5 are demonstrated. Hence to

Freudenstadt (ground plan from 1599, originally for silver miners, reconstructed after 2nd World War; church with two naves at right angles), through the valley of the Kinzig (incised in granite, with remains of Permo-Triassic peneplain as terrace in the slopes) to Alpirsbach (monastery with Romanic church and Gothic cloister), following the valley (now incised in gneiss) to Haslach, changing to the valley of the Elz, via Waldkirch to Freiburg/Breisgau.

August 22nd: From Freiburg along the Dreisam river through the basin of Zarten (Celtic fortress "Tarodunum"; fluvial and possibly glaciogenic erosion following a fault; terrace of Würm age dissected by creeks, ground-water lowering after river regulation), following the valley of Wagensteig (typical V-shaped valley of tributary to the Rhine, from Würm age, partly with flood-plain and talus cones from the sides), after visit of profile 6 to

St. Märgen (monastery founded in 1118) in the flat upland area rising continuously from 700 to 1100 m above sea-level (relics of dis-

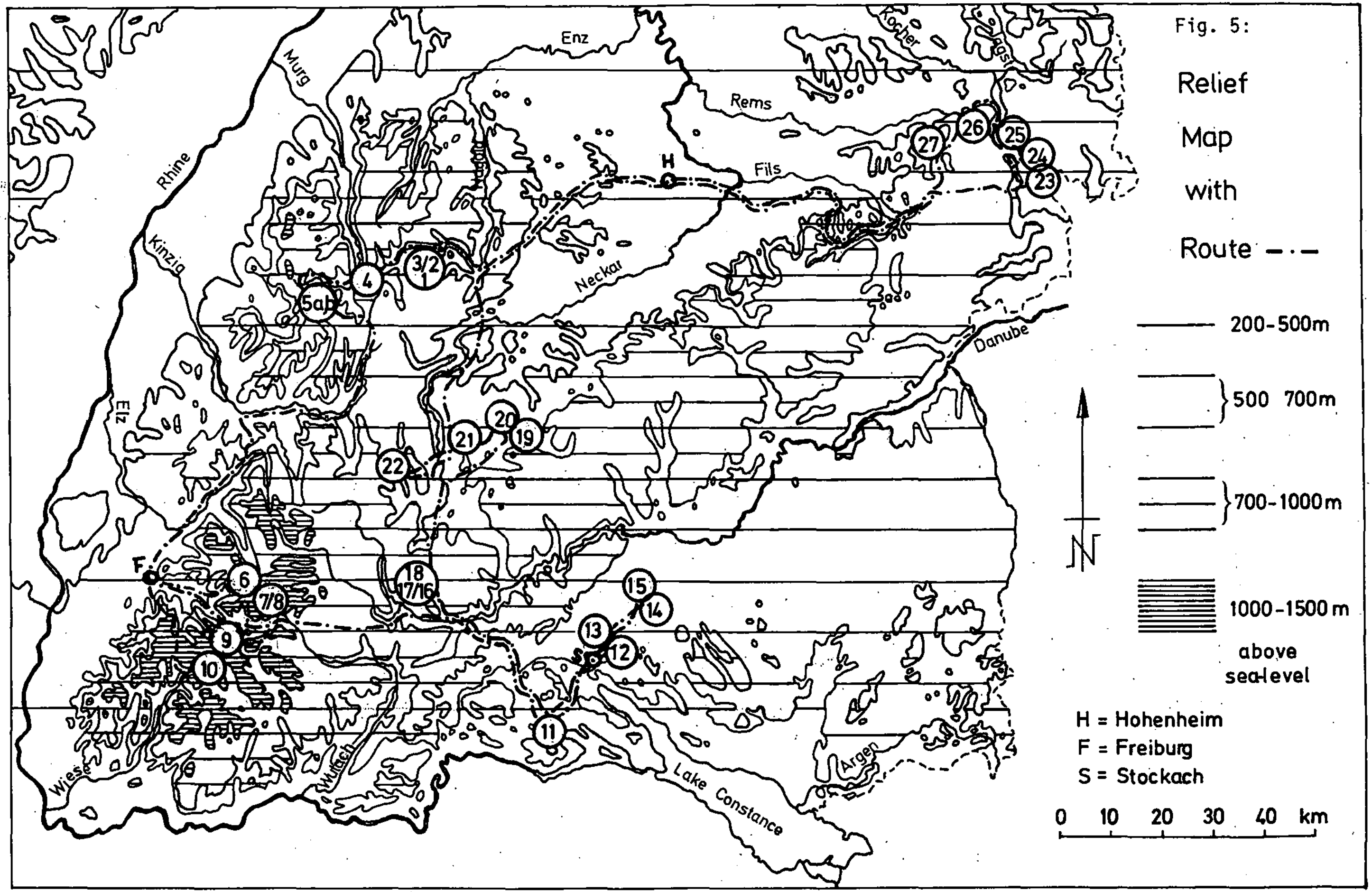


Fig. 5: Relief Map with Route

sected Permo-Triassic peneplain). In the surroundings profile 7 and 8. At

Breitnau we reach the distribution area of the Feldberg glacier in the Würm age (Breitnau lies in a trough valley of the Danubian relief type formerly draining via Titisee to the Danube, whereas now it belongs to the catchment area of the Dreisam; traces of glaciogenic erosion). View to the steeply incised valley "Höllental" on the way to Hinterzarten (Danubian valley with glaciogenic erosion), nearby valley-floor divide with highmoor occupied by mountain pines. To the Seebach-Gutach valley at

Titisee (best example for glaciogenic shaping, lake Feldsee in kar, lake Titisee in a tonguelike basin with end moraine; view to the sheer eastern wall of the Feldberg massif). - At

Feldberg-Bärental (region of the Bärhalde granite) former transfluence via the Rotmeer depression (with high moor and apron terrace; profile 9) to the valley of the Haslach, or to the Schluchsee basin, respectively. Between Hochkopf (with kar incised in granite) and Seebuck (gneiss-anatexite) lies the Feldberg pass (1231 m, with glaciogenic shaping). The area has been used extensively as high pasture since the 10th century. Not far from here, profile 10 is shown. The route follows the formerly glaciated valley of the Wiese until Todtnau. From here via Notschrei (1119 m) and Schauinsland (1284 m, with medieval mining for lead, zinc and silver) back to Freiburg.

August 23rd: From Freiburg through the gorge "Höllental" and along the Titisee basin to the Baar area (narrowing of Lower and Middle Triassic layers due to poor sedimentation and steeper inclination, peat formation in front of cuestas) and passing nearby

Donaueschingen (to the left, at the confluence of Brigach and Breg; castle of the Fürst von Fürstenberg with valuable collections, p.e. an edition of the "Nibelungenlied" from 1229) through the valley of the Danube (the Wartenberg, a basalt volcano, to the left) to

Geisingen (forested cuesta of the Swabian Alb), via Autobahn passing the graben of Bonndorf (with conglomerates from removing of mezozoic sediments in the Black Forest area during the Younger Tertiary; Basalt volcano "Neuhöwen" to the right, other volcanoes of the Hegau in the background beyond) to

Engen (basalt volcano "Hohenhöwen" to the right; nunatak in the Riß end moraine); formerly glaciated area with vast gravel plains, partly peat formation, along the road some more volcanoes (Mägdeberg and

Hohenkrähen as phonolite volcanoes, behind Hohenstoffeln as basalt volcano) until

Singen (phonolite volcano "Hohentwiel"; nunatak in the Würm moraine with mantle of tuff on the leeside; ruins of a fortress from the 16th century); in the gravel plain nearby is profile 11. From here to

Stockach (medieval town on a ridge of molasse sediments from the Tertiary), steep ascent to the forested Würm moraine (here profile 12); at the northern margin fluvioglacial fans and partly basin sediments (profile 13). Gentle transition to the Riß moraine area near Mindersdorf, not far from

Sentenhart profile 14 and 15 are presented. Return to Stockach.

August 24th: From Stockach via Autobahn back to

Geisingen (profile 16, 17 and 18 in the hilly area of claystones from the Lower Dogger), then via Autobahn to the valley of the Upper Neckar (incised into Upper Muschelkalk limestones in a large plain of clayey sediments from the Lower Keuper, partly with gravel of a high terrace, cuesta of the Middle Keuper unimportant) and to

Rottweil (medieval town, founded in Roman times, famous Cesar cults about 70 after Christ). Crossing various small cuestas of Keuper and Lias sediments via Schömberg to Dotternhausen (cement plant working on bituminous shales of the Upper Lias, in the Second World War tests of oil recovery), in the background to the right cuesta of the Swabian Alb with Hohenzollern (castle of the 19th century on a mount of Malm sediments in a graben with recent tectonical activity, earthquakes).

Waldhof: Wide plains formed by bituminous shales with forested ridge of claystones from the Lower Dogger (profile 19, beside the ridge not far from here profile 20). Descending to the plain of limestones from the Lower Lias around Leidringen and crossing the rather unimportant cuesta of Keuper layers to

Böhringen (hilly area with gypsum marls from the Middle Keuper, profile 21); then, traversing the Neckar valley, to

Dunningen (transition from the Gäu area to the Black Forest, profile 22). Back to the Autobahn (cuesta of Keuper layers with increasing dominance to the right), via Autobahn return to Hohenheim.

August 25th: From Hohenheim via Autobahn through the foreland of the Swabian Alb (Neckar valley with terrace, ruins of melilite-tuff volcanoes and partly eroded maar of Randeck), near the ascent at

Aichelberg wide plains of bituminous shales from the Upper Lias, bridging of claystone sequence from the Lower Dogger, shortly afterwards in the background to the left forested ridge of ferrous sandstones from the Lower Dogger (with erosional outliers of Malm limestones, f.e. the Hohenstaufen to the left), through a decapitated valley to the exit of the Autobahn at

Wiesensteig, following the valley of the Fils (incised in limestones and marls from the Lower to Middle Malm, with steep rocks of sponge-reefs; young erosion caused many landslides visible as hills, terraces and oversteepened walls) to

Geislingen/Steige (river diversion from the Danubian to the Rhenanian system with a bend). Through the valley of the Eyb (with dolomitic rocks from the Mittle and Upper Malm to

Steinenkirch (plateau of the eastern Swabian Alb as strongly eroded, karstified peneplain with flat dry valleys), then to

Steinheim/Albuch (in well preserved meteoritic crater with mostly eroded lake sediments from the Younger Tertiary),

Heidenheim/Brenz, after crossing the broad valley of the Brenz to

Nattheim (ancient center of digging for pisolitic iron ore, profile 23). Back to the valley of the Brenz river and to

Königsbronn (with source of the Brenz in the karstic spring "Brenztopf". North of here, valley-floor divide between Brenz and Kocher river); climbing up to

Ochsenberg (with terrace sands of the Brenz from the Late Tertiary, containing Keuper material, f.e. silicified wood), nearby profile 24 and further north profile 25. Descending to the Kocher valley at

Oberkochen (with source of the Kocher river as karstic spring in the background), passing by Aalen and via Essingen to

Tauchenweiler (again plateau of the Swabian Alb, profile 26). Return to Essingen and climbing up in westerly direction to Lauterburg on the border of the Swabian Alb, continuing to Bartholomä and

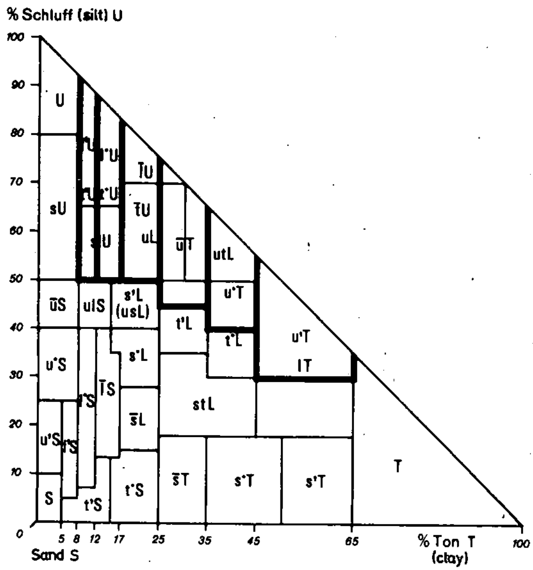
Rötenbach (ancient watershed in a dry valley of the Late Tertiary, profile 27). Then return to Hohenheim (from Böhmenkirch on the route of the morning).

Methods

a) field

Soil colour: (moist) according to Munsell Colour Charts

Soil texture: see graph below



b) laboratory (see data pages)

first page

Column 4: weight (percent) of >2 mm material of whole soil (in profiles 6 - 10: 2 - 20 mm)

5-13:

	c	m	f sand	c	m	f silt	clay	
2000	600	200	60	20	6	2		µm Ø

14: saturated hydraulic conductivity

16: dry (105 °C) bulk density

17: total pore volume

18-21: soil moisture characteristic values from desorption curves

22: soil:water = 1:2.5

23: soil:0.01 m $CaCl_2$ solution = 1:2.5

24: $Fe_{dithionite}$, extraction with dithionite-citrate at pH 7.3 (Schlichting, E. und Blume, H.-P. Nr. 555.3, 1966)

some samples were extracted with hot oxalate solution (comparable to the dithionite method)
determination of Fe by AAS respectively

25, 27: Fe, Mn oxalate, extraction with oxalate at pH 3.25 at room temperature in darkness (Schlichting, E. und Blume, H.-P. Nr. 555.2, 1966), determination of the elements by AAS

28: available P, acetate-lactate extractable (Schüller, H., 1969)

29: organic C, wet ignition with $K_2Cr_2O_7$+H_2SO_4 (Schlichting, E. und Blume, H.-P. Nr. 561.3, 1966)

30: total N, Kjeldahl-method (Schlichting, E. und Blume, H.-P. Nr. 562.3, 1966)

32: destruction with HCl, gasvolumetric determination of the developed CO_2 (Schlichting, E. und Blume, H.-P. Nr. 554.2, 1966)

33: potential CEC, NH_4-acetate, pH 7 (Soil Conservation Service, 5A1, 5A1b, 1972), displacement of NH_4^+ by $MgCl_2$

34: actual CEC, in profiles 6-10 sum of single cations (exchange with unbuffered $BaCl_2$ (Schlichting, E. und Blume, H.-P. Nr. 543.6, 1966) in profiles 1-5 and 11-27 with
pH $<$4.5 = sum of bases + NH_4Cl-extractable H, Al
pH $>$4.5 and $<$ 7.0 = sum of bases

35-38: NH_4-acetate (pH 7) exchangeable bases, determination of Ca, Mg by AAS, determination of K, Na by flame photometry

39-40: sum of exchangeable (Ca acetate, pH 7.2) H and Al (Schlichting, E. und Blume, H.-P. Nr. 543.2, 1966)

41: base saturation $= \dfrac{\Sigma \text{ exchangeable bases}}{100 \cdot (\Sigma \text{ exchangeable bases} + \Sigma \text{ exchangeable H, Al})}$

second page

column 4-15: determination by x-ray diffraction

25, 26: with 30% HCl-extractable reserve (Schlichting, E. u. Blume, H.-P., Nr. 551.3, 1966)

16-17, 29-34: total amounts, determination by x-ray fluorescence spektrometry

19-20: separation of heavy minerals by tetrabromethan, determination under polarizing microscope

35: $Al_{dithionite}$, method see Fe_d, determination of Al by AAS

36, 37: pyrophosphate-extractable Fe and C (Soil Conservation Service, 1972) after centrifuging (1 h, 3000 g) determination of Fe by AAS, determination of C by wet ignition (see organic C)

39, 40: NH_4Cl-exchangeable H and Al, determination of the sum by titration, ~ of Al by the aluminon method (Yuan, T.L. and Fiskell, J.G.A., 1959) and ~ of H by calculation ((H+Al)-Al).

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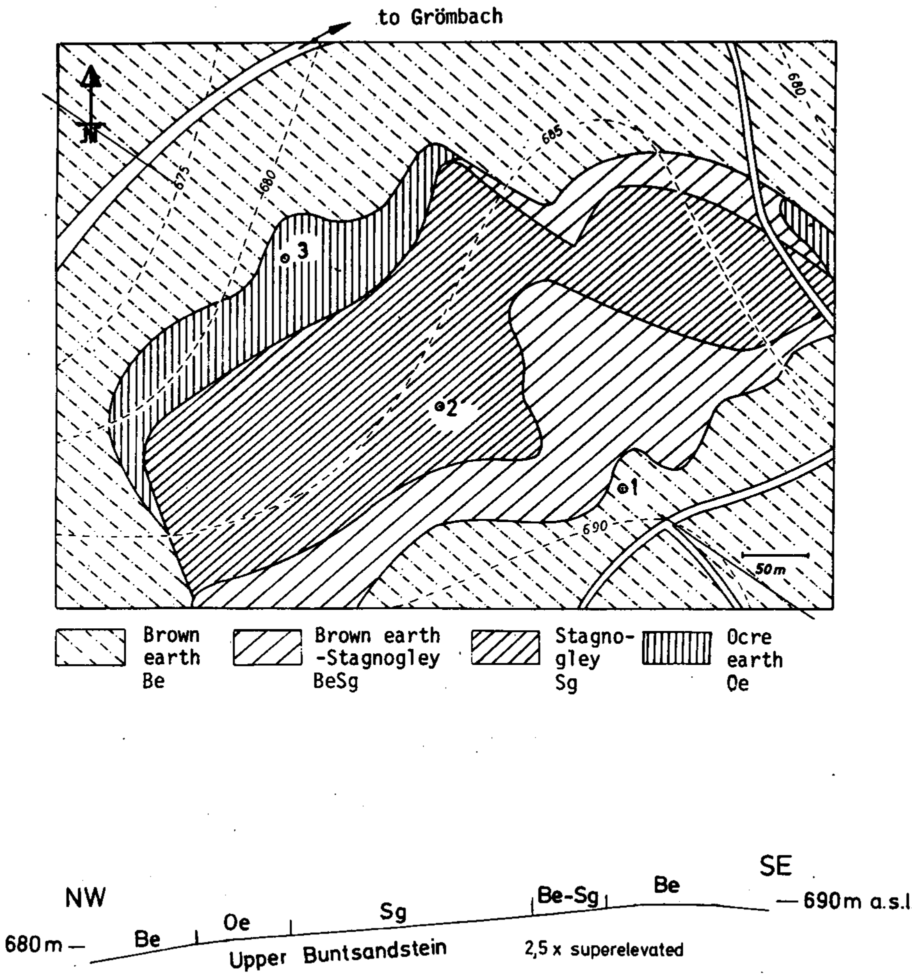

Fig. 6: Grömbach, soil map with section

Site Description Profile 1

Location: Southwest of Grömbach

Elevation: 689 m

Landform: Plateau

Slope: Northwest, 2,5%

Drainage: Moderate

Vegetation: Spruce with fir

Use: Forest

Soil Temperature: 7,5 °C Precipitation: 1200 mm

Parent material: Clayey sandstone from Upper Buntsandstein, upper part with cryoturbation

Soil classification; FAO: Dystric Cambisol

German: Schwach pseudovergleyte Moder-Braunerde mit kurzer Naßphase

US Soil Taxonomy: Typic Dystrochrept, loamy, siliceous, frigid

Profile Description

Horizon:		Depth cm:	Description:
L/Of	O	3-0	Litter of Sphagnum, many roots, diffuse boundary
Ah1	Ah1	0-5	brownish black (10 R 2/2), sponge-like to granular, many roots, diffuse boundary
Ah2	Ah2	-27	reddish brown (2,5 YR 5/5) sandy loam (SL), stony, granular, many roots, diffuse boundary
Bv	Bw	-40	grey reddish brown (10 R 5/4) sandy loam (sL), stony, granular to subangular blocky, many roots, diffuse boundary
SBv	B(g)w	-55	reddish orange (10 R 5/6) with few rusty mottles, sandy loam (SL), stony, subangular blocky, many roots, diffuse boundary
BvC	BCw	-85	grey reddish brown (10 R 4/4) loamy sand (lS), stony, single grains to coherent, some roots, diffuse boundary
Cv	Cw	-125	grey reddish brown (10 R 5/3) loamy sand (lS), many stones, coherent to imbedded, rare roots.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L/Of	3-0												
2	Ah1	0-5	0		4	45	40	22	16	4	42	9		
3	Ah2	-27	32		4	41	45	18	13	8	39	15	2246	
4	Bv	-40	28		3	41	44	20	10	6	36	20	432	
5	SBv	-55	35		4	45	49	18	10	8	36	15	121	
6	BvC	-85	35		5	51	56	16	6	8	30	14	15	
7	Cv	-125	42		4	47	51	22	7	8	37	12	717	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	L/Of							3,7	2,8	0	1,0		207	59,9
2	Ah1							3,2	2,6	3,1	1,4	0,45	16	13,1
3	Ah2	1,09	58	46	37	30	11	3,9	3,5	6,4	2,3	0,36	46	5,7
4	Bv	1,35	52	42	36	29	15	4,1	3,7	7,2	2,2	0,31	50	2,2
5	SBv	1,54	47	39	34	30	18	4,2	3,7	8,1	1,8	0,22	69	3,1
6	BvC	1,61	45	37	34	30	11	4,2	3,7	8,6	1,4	0,16	55	2,2
7	Cv	1,70	41	33	29	26	12	4,2	3,7	9,2	1,0	0,11	16	3,1

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L/Of	43,0	13,5	32	0	675	123	40,5	14,4	16,3	3,0	1150		6
2	Ah1	6,6	2,3	29	0	598	51	9,1	7,1	0,9	1,4	896		2
3	Ah2	1,8	0,6	29	0	126	62	2,1	1,0	1,2	0,7	170		3
4	Bv	0,7	0,3	25	0	95	43	1,7	0,8	1,4	0,6	100		4
5	SBv	0,4	0,3	15	0	81	37	1,4	0,7	1,4	0,5	83		5
6	BvC	0,2	0,2	10	0	71	33	2,0	1,0	1,4	0,5	83		6
7	Cv	0,2	0,2	10	0	68	34	0,8	0,5	1,3	0,5	80		4

No	hor.	depth cm	minerals in % f sand fsp	qu	gl	qu:fsp	c+m clay Kao	Ill	Mont	Chl	f clay Kao	Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L/Of	3-0												
2	Ah1	0-5	10	90		9,0	30	60	10	++	5	65	30	
3	Ah2	-27	10	90		9,0	25	60	15	++	25	55	20	
4	Bv	-40	8	92		11,5	45	40	15	+	35	40	25	
5	SBv	-55	10	90		9,0	50	40	10	0	40	40	20	
6	BvC	-85	15	85		5,7	80	20	+	0	45	45	10	
7	Cv	-125	8	92		11,5	70	30	+	0	80	20	0	

No	hor.	Ti %	Zr %	Ti: Zr	microelements in ppm Zn	Cu	Ni	Co	Pb	Cd	P_v ‰	K_v ‰		
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	L/Of	0,35	0,02	16,7							0,46	0,56		
2	Ah1	0,33	0,04	8,2	38	7,2	5,0	2,1	22	0,69	0,27	1,35		
3	Ah2	0,38	0,04	9,1	46	5,1	3,3	1,6	25	0,13	0,24	2,20		
4	Bv	0,38	0,04	9,6	25	5,2	5,9	3,2	20	0,11	0,20	2,68		
5	SBv	0,37	0,04	10,2	20	12	6,7	4,2	13	0,05	0,22	2,79		
6	BvC	0,37	0,04	10,4	25	5,2	6,7	4,3	14	0,04	0,22	2,75		
7	Cv	0,35		9,1	24	8,3	10	4,3	17	0,06	0,21	2,50		

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %	Al_d ‰	Fe_p ‰	C_p ‰		NH_4Cl me/kg H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L/Of	2,33			2,58		5,4	1,23	0,28	30,8		48	1	
2	Ah1	3,13		0,054	2,44		6,7	2,42	1,60	20,3		28	32	
3	Ah2	1,75		0,027	1,63		4,6	2,76	3,72	4,3		0	57	
4	Bv	1,84		0,020	1,89		5,2	3,31	2,72	1,5		0	38	
5	SBv	2,16		0,020	2,49		6,4	3,23	2,28	1,1		0	33	
6	BvC	2,15		0,020	2,55		6,2	2,92	1,54	0,6		0	28	
7	Cv	2,08		0,020	2,45		6,2	2,31	0,86	0,3		0	31	

Site Description Profile 2

Location: Southwest of Grömbach

Elevation: 686 m

Landform: Shallow depression

Slope: Northwest, 2.5%

Drainage: Strongly impeded; old ditches

Vegetation: Pine with spruce

Use: Forest

Soil Temperature: 7,5 °C Precipitation: 1200 mm

Parent material: Solifluidal loam with sandstone debris

Soil classification; FAO: Humic Planosol

German: Torf- Stagnogley, stark entwickelt, durchgehende Naßphase

US Soil Taxonomy: Histic Humaquept,fine-loamy, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
hHOf	H	20-8	Litter of Sphagnum, many roots, clear boundary
Oh	O	8-0	brownish black (5 YR 2/1) sponge-like, many roots, clear boundary
Ah	Ah	0-12	blackish grey (7,5 YR 3/2) sandy loam, silty (suL), granular, few roots, wedged boundary
Sew	Eg	-22	light brownish grey (5 YR 6/2), grey coatings, loamy silt (lU), weak prismatic to coherent, rare roots, diffuse boundary
Sw	EBg	-36	brownish grey (2,5 YR 5/2)/light brownish grey (7,5 YR 7/2), orange brown (7,5 YR 6/8) mottled sandy loam (sL), coherent to prismatic, wedged boundary
Sd	Bg	-52	grey (5 YR 8/1)/orange (5 YR 7/8) grey reddish brown (2,5 YR 5/4) mottled sandy loam, clayey (stL), few stones, prismatic to coherent, diffuse boundary
CSd	Cg	-65	grey reddish brown (2,5 YR 5/4)/orange (5 YR 7/8) light grey (5 YR 8/1) mottled, sandy loam, clayey (stL), few stones, coherent, diffuse boundary
Cv	CW	-80	grey brownish red (2,5 YR 5/4 sandy loam, clayey (stL), few stones, coherent.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	hHOf	20-8	0											
2	Oh	8-0	0											
3	Ah	0-12	0		11	32	43	24	9	8	41	16	778	
4	Sew	-22	0		17	41	58	24	6	2	32	10	47	
5	Sw	-36	0		9	48	57	12	6	8	26	17	32	
6	Sd	-52	21		3	39	42	22	6	3	31	27	9	
7	CSd	-65	24		7	31	38	9	9	8	26	36	20	
8	Cv	-80												

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	hHOf							3,2	2,7	0	0,6		57	28,0
2	Oh							3,2	2,7	3.0	7,1	2,37	0	30,5
3	Ah	0,99	60	57	58	41	17	2,9	3,5	0	0,4		0	8,7
4	Sew	1,50	44	42	38	29	6	4,1	3,7	0	0,2		0	4,4
5	Sw	1,57	42	39	37	33	20	4,2	3,7	2,5	1,3	0,52	0	4,4
6	Sd	1,55	43	41	39	38	22	4,2	3,7	7,0	1,6	0,23	0	4,4
7	CSd	1,69	40	40	39	36	22	4,2	3,7	10,4	1,2	0,12	0	4,4
8	Cv													

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	hHOf	44,0	10,5	42	0	1759	171	26,8	16,2	29,5	1,2	1884		4
2	Oh	30,0	11,1	27	0	1444	110	1,6	6,4	5,3	1,1	1500		1
3	Ah	4,1	1,6	25	0	183	68	1,7	2,3	2,5	1,0	200		4
4	Sew	0,7	0,3	19	0	53	30	1,1	0,9	0,6	0,5	76		4
5	Sw	0,4	0,2	20	0	78	46	1,5	0,8	1,2	0,5	94		4
6	Sd	0,2	0,2	10	0	85	43	1,1	1,0	1,8	0,4	85		5
7	CSd	0,1	0,1	10	0	104	52	1,8	2,2	2,8	0,5	111		6
8	Cv				0									

No	hor.	depth cm	minerals in % f sand fsp	qu	gl	qu:fsp	c+m clay Kao	Ill	Mont	Chl	f clay Kao	Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	hHOf	20-8												
2	Oh	8-0												
3	Ah	0-12	11	89		8,1		10	80	10		10	75	15
4	Sew	-22	13	87		6,7		40	55	5		15	70	15
5	Sw	-36	14	86		6,1		60	35	5		30	60	10
6	Sd	-52	11	89		8,1		85	15	0		90	10	+
7	CSd	-65	10	90		9,0		95	5	0		95	5	0
8	Cv	-80												

No	hor.	Ti %	Zr %	Ti:Zr	microelements in ppm Zn	Cu	Ni	Co	Pb	Cd	P_v ‰	K_v ‰		
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	hHOf	0,32	0,015	21,4	68	15	3,3	2,8	64	0,61				
2	Oh	0,42	0,038	11,1	57	18	5,8	2,2	71	0,44	0,15	1,65		
3	Ah	0,38	0,035	10.9	17	10	5,0	1,6	38	0,48	0,18	2,33		
4	Sew	0,27	0,034	8,0	19	11	6,7	1,5	19	0,61	0,17	1,18		
5	Sw	0,31	0,027	11,6	23	10	7,5	2,1	16	0,50	0,04	3,33		
6	Sd	0,30	0,033	9,2	22	7,1	16	5,0	14	0,25	0,05	4,83		
7	CSd	0,37	0,034	10,8	27	7,3	19	6,5	13	0,02	0,08	6,95		
8	Cv													

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %					NH_4Cl me/kg H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	hHOf	5,26		0,050	2,24		5,2					92	5	
2	Oh	1,74		0,041	1,96		6,4					75	21	
3	Ah	1,70		0,033	0,60		4,8					0	60	
4	Sew	1,45		0,012	0,34		3,0					0	27	
5	Sw	2,39		0,019	1,36		5,8					0	42	
6	Sd	3,15		0,012	2,24		7,1					0	39	
7	CSd	3,85		0,019	2,30		8,4					0	45	
8	Cv													

Site Description Profile 3

Location:	Southwest of Grömbach
Elevation:	681 m
Landform:	Flat slope
Slope:	Northwest, 2,5%
Drainage:	Impeded
Vegetation:	Fir with spruce
Use:	Forest
Soil Temperature:	7,5 °C Precipitation: 1200 mm
Parent material:	Solifluidal loam with sandstone debris

Soil classification; FAO: Dystric Cambisol

German: Torfige Hanggley-Lockerbraunerde (Ockererde) mit kurzer Naßphase

US Soil Taxonomy: Andic Dystrochrept, fine-loamy, siliceous, frigid

Profile Description

Horizon:		Depth cm:	Description:
Of	01	15-4	Litter of Sphagnum, many roots, clear boundary,
Oh	02	4-0	brownish black (5 YR 2/1), many roots, wedged boundary
Ah	Ah	0-10	dark greyish brown (2,5 YR 4/2, sandy loam, clayey (stL), few stones, granular, many roots, diffuse boundary
AhBvk	A/Bwc	-30	dark reddish brown (2,5 YR 4/4), loam (L), stony, granular with coated grains, many roots, diffuse boundary
Bkv	Bcw	-43	dark reddish brown (5 YR 3/4), loam (L), stony, granular with coated grains, many roots, diffuse boundary
BvSd	Bwg	-60	brownish red (2,5 YR 5/8), rusty mottled, sandy loam (sL), stony, coherent, some roots, diffuse boundary
SdCv	Cgw	-100	yellowish brown (10 YR 6/8), rusty mottled, sandy loam, clayey (stL), stony, coherent to imbedded, rare roots.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Of	15-4												
2	Oh	4-0												
3	Ah	0-10	3		5	25	30	16	15	5	36	34	5270	
4	AhBvk	-30	3		5	26	31	17	15	7	39	30	1814	
5	Bkv	-43	3		6	27	33	17	14	5	36	31	216	
6	BvSd	-60	35		8	35	43	18	11	7	36	21	138	
7	SdCv	-100	28		10	38	48	14	9	2	25	27	16	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Of							3,6	2,8	0	1,8		1120	62,9
2	Oh							3,1	2,7	7,1	7,3	1,03	228	19,6
3	Ah	0,53	82	58	37	33	4	4,1	3,8	10,4	12,0	1,15	1800	8,7
4	AhBvk	0,68	77	59	47	38	17	4,4	4,0	19,0	8,5	0,45	1950	2,2
5	Bkv	0,95	66	58	51	45	26	4,4	4,1	20,0	10,6	0,53	1650	4,4
6	BvSd	1,22	55	53	48	43	25	4,4	4,0	14,7	6,0	0,43	685	4,4
7	SdCv	1,75	35	32	31	30	19	4,5	3,9	10,6	1,6	0,15	430	6,5

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Of	41,0	15,8	26	0	1218	136	38,0	14,5	28,7	4,2	1248		6
2	Oh	31,2	10,9	29	0	429	99	5,9	3,4	2,9	0,9	520		3
3	Ah	7,0	3,8	19	0	313	39	1,7	1,9	2,1	0,9	345		2
4	AhBvk	3,5	1,9	18	0	372	40	2,3	2,1	3,0	0,7	390		2
5	Bkv	1,6	0,6	25	0	126	20	1,4	0,6	1,7	0,5	149		3
6	BvSd	0,6	0,3	18	0	74	20	1,4	0,7	1,3	0,5	69		5
7	SdCv	0,2	0,1	14	0	67	24	0,7	0,9	1,4	0,5	64		5

No	hor.	depth cm	minerals in % f sand fsp	qu	gl	qu:fsp	c+m clay Kao	Ill ˣ	Mont	Chl	f clay Kao	Ill ˣ	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Of	15-4												
2	Oh	4-0	8	92		11,5		30	45 25			35	55 10	
3	Ah	0-10	6	93		15,5		50	35 15			50	45 5	
4	AhBvk	-30	7	93		13,3		60	25 10			55	40 5	
5	Bkv	-43	7	93		13,3		65	25 10			70	30 0	
6	BvSd	-60	5	95		19,0		100	0 0			90	10 0	
7	SdCv	-100												

No	hor.	Ti %	Zr %	Ti: Zr	microelements in ppm Zn	Cu	Ni	Co	Pb	Cd	P_v ‰	K_v ‰		
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Of	0,32	0,01	24,9	49	15	12	3,6	68	0,50	0,46	1,1		
2	Oh	0,42	0,02	16,8	53	15	7,5	4,7	52	0,59	0,72	2,4		
3	Ah	0,41	0,02	16,4	33	12	10	8,6	27	0,42	0,82	3,7		
4	AhBvk	0,40	0,02	15,9	23	13	10	12	29	0,42	0,65	5,1		
5	Bkv	0,39	0,03	14,9	22	11	12	12	27	0,42	0,46	4,0		
6	BvSd	0,40	0,03	12,4	27	16	18	11	15	0,31	0,32	3,4		
7	SdCv	0,35	0,03	10,5	27	16	22	12	11	0,42	0,22	3,0		

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %	Al_d ‰	Fe_p ‰	C_p ‰	Al_p ‰	NH_4Cl me/kg H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Of	2,68		0,048	3,88		5,8	3,7	0,65	27,2		49	2	
2	Oh	1,96		0,015	4,10		7,6	6,4	13,82	26,0		6	80	
3	Ah	2,25		0,064	4,66		7,9	10,4	16,12	18,5		3	29	
4	AhBvk	2,52		0,041	4,28		7,9	7,4	42,81	27,4	17,3	1	31	
5	Bkv	2,50		0,033	4,28		7,4	6,6	8,94	4,8	9,3	2	14	
6	BvSd	2,25		0,023	3,46		5,9	5,0	5,09	2,5		1	15	
7	SdCv	2,58		0,025	2,88		5,9	3,3	1,73	0,5		0	20	

Interpretation for Profiles 1-3

The material from the Upper Buntsandstein is a platy quartzic sandstone with intercalated illitic clay layers, both being hematitic. It was fragmented by frost, mixed by cryoturbation (possibly leading to more sandy topsoils) and partly translocated by solifluction. Depletion of bases is strong in the whole catena, but weathering of sand silicates is only weak (cf. qu:fsp), whereas transformation of illites to mixed-layer minerals and montmorillonite is moderate and deep near the top of the catena, strong and shallow in the middle part with its dense subsoils and intermediate at the lower end. Lessivation is unlikely (fine clay:clay=constant in the profiles). (Trans-)Formation of iron oxides was followed by a pronounced Fe translocation, mainly by interflow along a redox gradient between the permanently wet Stagnogley (inputs including runto > seepage + evapotranspiration) and the temporarily well aerated Ockererde. Nevertheless, much organic matter was accumulated even in the latter case, though more in than on the soil (as raw humus), possibly due to a linkage with amorphous iron compounds (cf. Fe_o:Fe_d, Fe_p). Thus, here the topsoil is granular and loose, whereas in the dense Stagnogley only some prisms were segregated, the structure formation in the Braunerde being intermediate (subangular blocky).

The rooting space is deep in the Braunerde, medium in the Ockererde (with excellent penetrability) and shallow in the Stagnogley, which is anaerobic up to the surface all through the year, whereas wet phases are much shorter in the other soils. But even in the Braunerde the water supply is not limited by the field capacity (available in the upper m : 212 l/m^2). - The nutrient reserves are low in Braunerde and Stagnogley (here especially Mn), moderate in the Ockererde (connected with higher contents of Fe are those of some heavy metals, especially Mn, and P), but their availability is low (e.g. P_a:P_t). Consequently, these soils are very poor in exchangeable bases (even Ca and Mg) and rather rich in Al. - Amelioration is necessary already for timber production, could start in the Stagnogley either with drainage (fertilizing effect through increased mineralization) or with fertilization (drainage effect through increased transpiration), but should here comprise both and could be restricted in the Braunerde and Ockererde to fertilization (including liming).

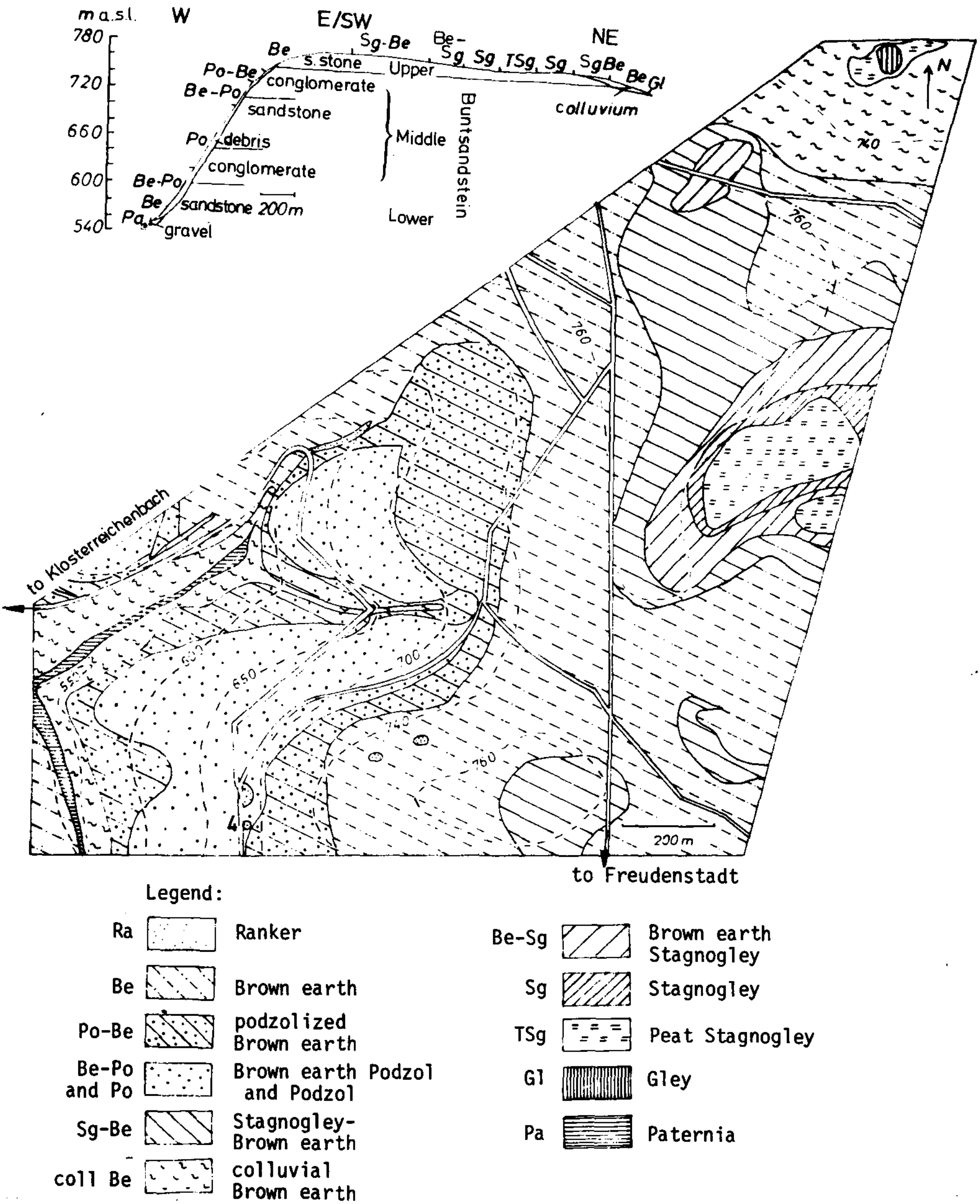

Fig. 7: Klosterreichenbach, soil map with section

Site Description Profile 4

Location:	East of Klosterreichenbach
Elevation:	680 m
Landform:	Steep slope
Slope:	West, 30 %
Drainage:	Perfect
Vegetation:	Pine with spruce
Use:	Forest
Soil Temperature:	7.5 °C Precipitation: 1300 mm
Parent material:	Sandstone debris with blocs from the Middle Buntsandstein

Soil classification: FAO: Cambic Arenosol

German: Hang-Eisenhumuspodsol mit Rohhumus

US Soil Taxonomy: typic Udipsamment, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
Of	01	12-5	greyish brown (10 R 2/1), litter of Vaccinium with needles of pine and spruce, clear boundary
Oh	02	5-0	blackish brown (10 R 1/1), sponge-like with grains, many roots, diffuse boundary
Ahe	AE	0-7	dark grey (10 R 3/2), pale quartz grains, stony sand (s), granular with single grains, many roots, diffuse boundary
Ae	E	-35	light grey (10 R 6/1) stony sand (S), single grains, many roots, clear boundary
Bh	Bh	-39	brownish red (10 R 4/3) loamy sand (lS), stony, coated grains, many roots, diffuse boundary
Bs	Bs	-46	light brownish red (10 R 5/6) loamy sand (lS), stony, coated grains, some roots, diffuse boundary
Bv	Bw	-60	reddish brown (2,5 YR 5/8) (loamy) sand (Sl) rich in stones, single grains, few roots, diffuse boundary
Cv1	Cw1	-80	red (7,5 R 5/6) (loamy) sand (Sl) rich in stones (partly parallel to slope surface, with silty caps), single grains, few roots, diffuse boundary
Cv2	Cw2	-100	greyish red (7,5 R 5/4) (loamy) sand (Sl) rich in stones, single grains

No	hor.	depth	sto.	texture in % of humus-/carb. free fine soil									kf	
				sand				silt				clay		
		cm	%	c	m	f	Σ	c	m	f	Σ		cm/d	var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Of	12-5												
2	Oh	5-0												
3	Ahe	0-7	7	35	41	13	89	2	3	3	8	3		
4	Ae	-35	17	36	37	16	89	2	3	4	9	2		
5	Bh	-39	37	33	36	12	81	2	2	3	7	12		
6	Bs	-46	43	40	28	12	80	2	2	3	7	13		
7	Bv	-60	29	38	34	10	82	2	4	4	10	8		
8	Cv1	-80	51	36	38	13	87	2	2	2	6	7		
9	Cv2	-100												

No	hor.	bulk dens.	GPV	water content in % at pF				pH		Fe_d	Fe_o	Fe_o: Fe_d	Mn_o	P_a
		g/cm^3	%	0.6	1.8	2.5	4.2	H_2O	$CaCl_2$	mg/g			mg/kg	
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Of							3,5	2,8	1,7	0,58	0,34	30	44.0
2	Oh							3,7	2,6	0,8	0,07	0,09	70	35,7
3	Ahe	0,64	75	66,7	49,6	37,9	6,0	3,6	2,7	0,6	0,03	0,05	0	<2
4	Ae	1,47	45	30,2	13,5	8,9	2,5	3,8	3,3	0,2	0,02	0,10	0	<2
5	Bh							3,9	3,2	3,4	0,57	0,17	5	<2
6	Bs	1,61	38	36,2	30,6	26,2	11,9	4,6	3,9	10,4	1,81	0,17	10	<2
7	Bv	1,56	42	30,1	19,4	13,7	3,0	4,9	4,4	3,1	0,41	0,13	5	<2
8	Cv1	1,69	37	20,4	9,9	7,6	3,0	4,7	4,3	2,3	0,32	0,14	10	<2
9	Cv2													

No	hor.	$C_{org.}$	N_t	C:N	$CaCO_3$	CEC		exchang. cations in meq/kg						V
						p	a							
		%	mg/g		%	meq/kg		Ca	Mg	K	Na	H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Of	41,5	6,2	67	0	1031	138	70,7	9,2	12,1	4,1	1096		8
2	Oh	33,0	6,6	50	0	721	80	5,4	10,5	5,6	3,0	944		3
3	Ahe	3,3	1,4	23	0	158	25	6,1	2,6	2,0	0,7	174		6
4	Ae	0,6	0,3	20	0	24	6	0,3	0,3	0,4	0,2	23		5
5	Bh	2,9	0,9	32	0	123	40	0,6	0,5	1,3	0,4	182		2
6	Bs	2,0	1,2	17	0	221	26	1,4	0,5	1,6	0,5	220		2
7	Bv	0,6	0,3	20	0	47	7	0,6	0,1	1,2	0,4	47		5
8	Cv1	0,4	0,2	20	0	25	11	1,7	0,6	1,2	0,4	30		12
9	Cv2				0									

No	hor.	depth cm		minerals in % clay: Kao	Ill		Mont	Chl		microelements in ppm: Zn	Cu	Ni	Co	Pb	Cd
1	2	3		12	13		14	15		19	20	21	22	23	24
1	Of	12-5													
2	Oh	5-0								91	10	10	5,9	70	1,04
3	Ahe	0-7		10	45	25	0	0		27	8,3	5,3	2,5	11	0,06
4	Ae	-35		15	40	15	0	5		21	3,2	2,0	2,5	8,9	1,04
5	Bh	-39		10	50	20	0	5		28	3,2	1,2	2,5	13	0,06
6	Bs	-46		5	45	25	0	20		20	7,6	1,6	4,2	15	0,02
7	Bv	-60		5	45	35	0	10		19	9,2	2,8	6,7	8,1	0,02
8	Cv1	-80		5	45	30	0	15		7,8	8,4	1,2	6,7	2,1	0,02
9	Cv2	-100		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]							

No	hor.	K_t %	Mg_t %	P_v ‰	K_v ‰		Al_d ‰	Fe_p ‰	C_p ‰	Al_p ‰		NH_4Cl me/kg H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Of						} 0,88	2,20	24,7			41	1	
2	Oh							3,00	15,8			53	2	
3	Ahe			0,10	0,10		1,16	0,16	4,7			9	5	
4	Ae			0,04	0,10		1,71	0,04	0,8			3	2	
5	Bh			0,12	0,65		1,57	3,07	10,2	4,7		18	19	
6	Bs			0,25	1,98		5,31	8,82	16,3	10,4		10	12	
7	Bv			0,12	0,92		1,40	2,17	2,1	2,2		1	4	
8	Cv1			0,10	1,06		2,98	0,38	0,7			1	6	
9	Cv2													

Interpretation for Profile 4

The material from the Middle Buntsandstein is a quartzic sandstone with hematite and some (illitic) clay. By weathering and solifluction it was differentiated in a more stony and loamy lower part (= Basisfolge with ice-wedge, at least early würmian) and an upper part with large blocs (= Deckfolge). Therefore, transformation of silicates is obscured (weathering of chlorites?), but that of iron oxides followed by a translocation of sequioxides is obvious (a lateral component can be derived from the thicknesses of the A_e decreasing and the B_{hs} increasing downslopes; therefore, "Hang"-Podsol). Depletion of bases is strong and, consequently, raw humus is accumulated. Except for some coating in the B_{hs} and hardening in the C_v (fragipan?) the original structure remained rather unchanged.

The rooting space is less restricted by the B_{hs} than the root penetrability by stone content and density of the soil. The field capacity (available until 1 m : 132 l/m²) is frequently filled by rain and occasionally by slope water, but does not prevent drought during dry periods. Nutrient reserves are low, as are the contents of available nutrients (except for the raw humus, in which also heavy metals are accumulated, Pb and Cd probably by contamination) and the turnover of the organic matter (amelioration cf. Grömbach).

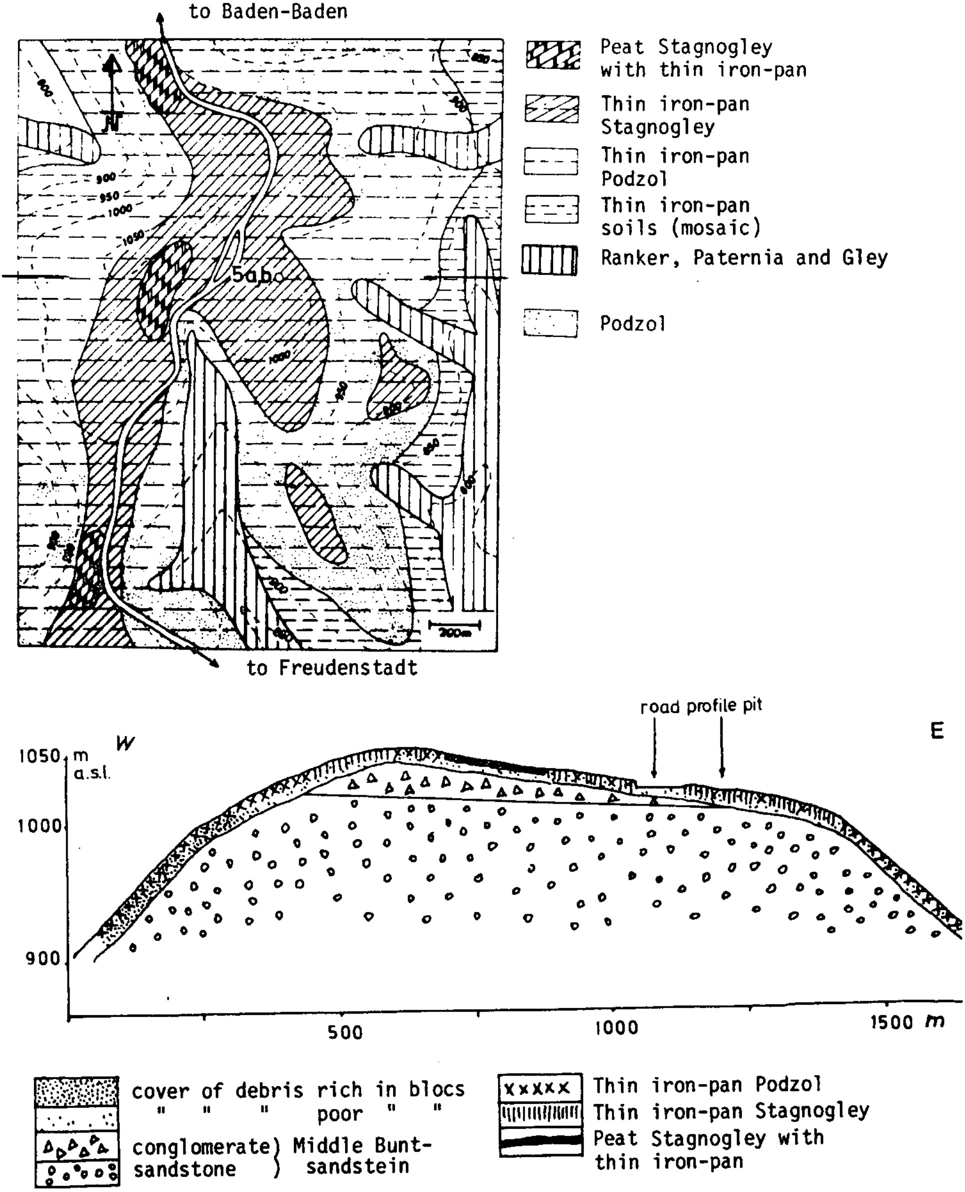

Fig. 8: Schliffkopf; soil map with section

Site Description Profile 5 a

Location:	East of the Schliffkopf
Elevation:	1020 m
Landform:	Plateau
Slope:	Northeast, 20 %
Drainage:	Strongly impeded
Vegetation:	Pine
Use:	Preserved area
Soil Temperature:	6 °C Precipitation: 2000 mm
Parent material:	Cover of sandstone debris from the Middle Buntsandstein

Soil classification; FAO: humic Planosol

German: Torfiger Bändchen-Stagnogley mit langer Naßphase

US Soil Taxonomy: Histic Placaquept, sandy, siliceous, frigid

Profile Description

Horizon:		Depth cm:		Description:
Of	01	17-10		brownish black litter, partly decomposed, clear boundary
Oh	02	10-0		black (N 1/0), sponge-like with grains, many roots, clear boundary
Sew	Eg	0-13	"Deckfolge"	light brownish grey (2,5 Y 5/2) silty sand (uS) with few stones, single grains, some roots, diffuse boundary
Shew	AEg	-25	"Deckfolge"	dark brown (10 YR 3/4) silty sand (uS) with few stones, single grains, some roots, coatings of organic matter, diffuse boundary
IISew1	IIEg1	-47	"Basisfolge"	yellowish grey (5 Y 6/2) silty sand (uS) with few stones, weak prismatic with single grains, rare roots, diffuse boundary
Sew2	Eg2	-65	"Basisfolge"	yellowish grey (5 Y 6/2)/reddish grey (10 R 5/2) mottled, silty sand (uS), stony, weak prismatic with single grains, rare roots, clear boundary
Bbs	Bms	-65,5		dark red (10 R 3/4) hardpan, partly divided, clear boundary
Cv	Cw	-73		brownish red (2,5 R 5/8) silty sand (uS), stony, single grains, diffuse boundary
C	C	-100		grey reddish brown (10 R 5/3), sandy silt (sU), stony, imbedded.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	m	f	Σ	silt c	m	f	Σ	clay	kf cm/d	var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Of	17-10												
2	Oh	10-0												
3	Sew	0-13	13	23	39	27	89	7	3	1	11	0	1728	
4	Shew	-25	8	16	40	21	77	8	7	7	22	1	95	
5	IISew	-47	9	4	18	49	71	13	7	6	26	3	121	
6	Sew2	-65	26	2	42	34	78	12	4	3	19	3	268	
7	Bbs	-65,5]												
8	Cv	-73	30	9	48	29	86	8	3	1	12	2	121	
9	C	-100	35	5	16	53	84	14	6	1	21	5	501	

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Of								} 3,4	1,47	1,13	0,77	33	27,7
2	Oh													
3	Sew	1,49	47,8	31,8	16,3	11,9	3,5	4,1	3,5	0,25	0	0	0	<2
4	Shew	1,47	44,0	37,3	33,3	27,6	5,5	4,1	3,4	0,25	0,05	0,20	0	2,1
5	IISew	1,52	43,6	36,8	29,9	23,3	4,7	4,0	3,8	0,25	0,05	0,20	0	<2
6	Sew2	1,51	42,0	33,5	18,2	13,5	5,5	4,1	3,9	0,40	0,10	0,25	5	<2
7	Bbs							4,3	4,1	1,50	57,60	0,63	43	<2
8	Cv	1,48	47,8	38,1	30,6	23,7	4,4	4,5	4,1	3,60	0,90	0,25	16	<2
9	C	1,56	42,6	32,7	16,6	11,5	2,1	4,4	4,0	6,10	0,20	0,03	43	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Of	40,5	1,3	32	0	}577	35	3,6	2,1	1,5	0,3	642		4
2	Oh	30,4	0,4	71	0									
3	Sew	0,9	0,4	23	0	101	38	0,8	0,3	0,3	0,2	108		2
4	Shew	0,6	0,3	20	0	33	6	0,3	0,2	0,2	0,2	43		2
5	IIsew	0,2	0,1	20	0	89	25	3,2	0,5	0,5	0,3	84		5
6	Sew2	1,1	0,3	37	0	55	19	0,6	0,4	0,3	0,2	55		3
7	Bbs	0,1	0,03	33	0	130	13	1,0	0,5	0,4	0,1	76		3
8	Cv	0,1	0,04	25	0	37	16	2,6	0,4	0,4	0,2	32		10
9	C	0,1	0,04	25	0	43	21	2,6	0,4	0,6	0,2	42		8

No	hor.	depth cm	minerals in % sand fsp	qu	gl		silt fsp	qu	gl		clay Kao	Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Of	17-10												
2	Oh	10-0												
3	Sew	0-13									30	45	25	
4	Shew	-25									40	55	5	
5	IISew1	-47									45	50	5	
6	Sew2	-65									-	-	-	
7	Bbs	-65,5									45	55	0	
8	Cv	-73									40	60	0	
9	C	-100												

No	hor.	Ti %	Zr %	Ti: Zr							P_v ‰	K_v ‰		
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Of													
2	Oh													
3	Sew	0,12	0,02	6,3							0,19	0,93		
4	Shew	0,18	0,02	10,6							0,40	0,88		
5	IISew1	0,20	0,02	10,0							0,53	0,56		
6	Sew2	0,14	0,01	12,7							1,14	0,61		
7	Bbs	0,12	0,01	15,0							0,48	0,61		
8	Cv	0,14	0,01	11,7							0,45	0,91		
9	C	0,24	0,02	12,0										

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %	Al_d ‰				NH_4Cl me/kg H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Of											13	13	
2	Oh											0	36	
3	Sew	0,82			0,42	0,003	1,5					1	4	
4	Shew	0,31			0,58	0,001	3,5					1	19	
5	IISew1	1,42			0,70	0,002	4,7					1	16	
6	Sew2	0,85			0,56	0,002	3,8	0,4				1	10	
7	Bbs	0,88			1,07	0,002	3,0	3,7				0	12	
8	Cv	1,00			0,97	0,003	3,6	3,5				0	17	
9	C	1,80			1,35	0,011	6,0							

Site Description Profile 5 b

Location:	East of the Schliffkopf
Elevation:	1020 m
Landform:	Plateau
Slope:	Northeast, 20 %
Drainage:	Impeded
Vegetation:	Pine
Use:	Preserved area
Soil Temperature:	6 °C Precipitation: 2000 mm
Parent material:	Cover of sandstone debris

Soil classification; FAO: Placic Podzol

German: Torfiger Bändchen-Staupodsol mit kurzer Naßphase

US Soil Taxonomy: Placorthod, sandy, siliceous, frigid

Profile Description

Horizon:		Depth cm:		Description:
Ofh	O1	12-7		black (N 1/0), many roots, clear boundary
Oh	O2	7-0	"Deck-"	black (N 1/0), sponge-like with grains, many roots, diffuse boundary
Ae	E	0-13		yellow brownish grey (2,5 Y 5/2) sand (S) with few stones, single grains, many roots, diffuse boundary
IIBhAe	IIBhE	-36	"Basisfolge"	light yellowish brown (10 YR 4/3) (loamy) Sand (Sl) with few stones, single grains, many roots, clear boundary
Bbs	Bms	-36,5		dark red (10 R 3/6) hardpan, partly with clay skins at the surface, rare roots, diffuse boundary
Bs	Bs	-63		reddish brown (2,5 YR 5/8) (loamy) sand (Sl) with few stones, single (coated) grains, diffuse boundary
BvC1	BwC1	-85		light reddish brown (10 R 5/4) (loamy) sand (Sl) with few stones, single grains, diffuse boundary
BvC2	BwC2	-108		light reddish brown (10 R 5/4) Sand (S) with few stones, single grains to imbedded, diffuse boundary
IIIC	IIIC	-128		light reddish brown (10 R 4/3) (loamy) sand (Sl) rich in stones, imbedded.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ofh	12-7												
2	Oh	7-0												
3	Ae	0-13	13	17	38	33	88	7	4	1	12	0	1728	
4	IIBhAe	-36	13	9	38	34	81	8	6	2	16	3	778	
5	Bbs	-36,5												
6	Bs	-63	12	4	45	34	83	6	4	3	13	4	259	
7	BvC1	-85	8	9	47	33	89	5	1	3	9	2	864	
8	BvC2	-108	22	7	29	50	86	8	2	0	9	5	432	
9	IIIC	-128	59	5	12	45	62	11	7	4	22	16		

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ofh							4,5	3,1	}0,7	0,51	0,73	13	}49,3
2	Oh							4,5	3,1					
3	Ae	1,68	39	28,8	19,2	14,1	1,7	3,9	3,4	0,1	0,05	0,50	2	}3,5
4	IIBhAe	1,67	40	32,3	26,5	23,2	2,8	3,5	3,5	0,1	0,1	1	0	
5	Bbs							3,8	3,9	75,0	42,0	0,56	1	<2
6	Bs	1,54	47	37,2	29,6	25,6	13,2	4,2	3,9	4,0	3,1	0,78	18	<2
7	BvC1	1,51	47	37,3	22,8	14,7	4,6	4,3	4,0	1,8	0,5	0,28	17	<2
8	BvC2	1,56	42	32,5	20,0	12,6	1,7	4,5	3,9	1,4	0,5	0,36	27	<2
9	IIIC							4,5	3,7	2,0	0,6	0,30	77	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ofh	}44,1	11,8	37	0	}300	30	3,9	1,7	1,7	0,3	294		3
2	Oh				0									
3	Ae	0,4	0,3	12	0	37	11	0,6	0,2	0,2	0,2	40		3
4	IIBhAe	1,0	0,2	50	0	91	25	0,6	0,2	0,4	0,2	104		1
5	Bbs	1,2	0,3	38	0	139	14	0,5	0,2	0,4	0,2	85		2
6	Bs	0,4	0		0	66	14	0,6	0,1	0,3	0,2	62		2
7	BvC1	0,1	0		0	42	12	0,5	0,1	0,3	0,3	38		3
8	BvC2	0,1	0		0	35	12	0,3	0,1	0,3	0,2	32		3
9	IIIC	0,1	0		0	80	28	0,3	0,1	1,1	0,1	63		3

No	hor.	depth cm	X clay Kao	Ill	Mont	Chl	Ti %	Zr %	Ti:Zr		P_v ‰	K_v ‰		
1	2	3	12	13	14	15	16	7	18		25	26	27	28
1	Ofh	12-7									0,37	0,26		
2	Oh	7-0												
3	Ae	0-13					0,14	0,02	8,5		0,25	0,90		
4	IIBhAe	-36	30	40	30		0,20	0,02	11,3					
5	Bbs	-36,5	20	40	40		0,18	0,01	18,6		0,69	0,84		
6	Bs	-63	-	-	-		0,16	0,01	12,2		0,40	1,10		
7	BvC1	-85	0	65	35		0,16	0,02	9,9		0,35	1,05		
8	BvC2	-108	0	65	35		0,14	0,01	9,9					
9	IIIC	-128	0	70	30		0,16	0,02	4,2		0,66	3,56		

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %	Al_d ‰	Fe_p ‰	C_p ‰	Al_p ‰	NH_4Cl me/kg H	Al	
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ofh													
2	Oh							1,3	0,59	16,1		6	16	
3	Ae	0,68			0,52	0,002	2,0	0,3	0,07	2,2		2	8	
4	IIBhAe	1,41			0,66	0,002	4,2	1,2	0,19	4,4		0	24	
5	Bbs	1,37			7,60	0,002	3,2	3,7	19,14	6,2	2,9	1	12	
6	Bs	1,29			1,17	0,004	3,5	1,2	6,73	3,3	1,8	0	13	
7	BvC1	1,22			0,83	0,004	3,2	0,4	1,05	1,6		1	10	
8	BvC2	1,10			1,07	0,005	3,3	0,3	0,38	0,7		1	10	
9	IIIC	1,90			2,34	0,014	7,5	0,3	0,71	0,9		0	26	

Interpretation for Profile 5a and b

The parent material and its stratification are similar to those of profile Klosterreichenbach (silt : clay and kaolinite : illite somewhat higher) as are depletion of bases and transformation of iron oxides (and uncertainties about that of silicates), but here a placic horizon was formed. It is underlain by a somewhat coarser and still reddish sediment in profile 5a and by a spodic horizon in 5b (Bändchen-Stagnogley and -Podsol, respectively, generally on a more loamy or sandy material and/or at convex or concave slopes, respectively) and in both cases overlain by horizons nearly deprived of mobile Fe and Mn (predominance of vertical or lateral translocation still unknown). Accumulation of peaty raw humus corresponds to that in the profiles Grömbach (1-3). Except for the formation of the hardpan and a slight segregation of prisms (a) or some coating (b), the original density and structure were preserved.

The placic horizons restrict penetrability and permeability, thus causing a medium (a) to shallow (b) rooting space and more (a) or less (b) extended wet phases and, consequently, a slow turnover of organic matter. Nutrient reserves and contents of available nutrients are as low as in profile Klosterreichenbach (4).

Southern Black Forest ; Physiography and Geology

The Black Forest as a fault-wedge mountain has its highest mountains on the western side where it shows a steep swing-up at the orographical clear main fault, in the change of the land-use system (sparsely wooded foreland to forest land) even visible as a boundary.

In the largest part of the excursion area gneiss and gneiss-anatexites are the solid bedrock. Especially, this rock material forms the central gneiss core of the Black Forest and is located within a radius of 20-30km round the city of Freiburg i.Br. . The variation in the mineralogical and chemical composition of the gneisses and gneiss-anatexites are limited (tab. 1)

Tab. 1 : Chemical composition of wide-spread rock types of the middle and high Black Forest after SCHREINER and WIMMENAUER (1979), (data in % by weight).

	1	2	3	4	5
SiO_2	67.21	70.54	65.90	66.50	75.40
TiO_2	0.73	0.39	0.62	0.67	0.07
Al_2O_3	15.46	14.55	16.75	16.39	13.60
Fe_2O_3	2.11	0.94	1.07	1.78	1.21
FeO	3.41	2.02	3.72	3.43	----
MnO	0.07	0.05	tr	0.04	0.03
MgO	1.69	1.20	1.76	1.72	0.17
CaO	1.93	2.34	2.83	2.36	0.31
Ma_2O	3.19	3.81	4.30	3.68	3.38
K_2O	2.97	3.01	2.25	2.70	5.01
P_2O_5	0.12	0.18	0.12	0.15	0.19
H_2O+	1.11	0.73	0.68	0.62	0,70

1: mean values of paragneisses of the Black Forest

2: mean values of 4 orthogneisses of the Black Forest

3: diatexite from the "Holzschlägermatte", massif of "Schauinsland"

4: calculated mean composition of the rocks from catchment area of the Dreisam river

5: mean values of the "Bärhalde-granite"

tr = trace

The main minerals are quartz, plagioklase and biotite; additionally orthoklase hornblende, cordierite, sillimanite, secondary muscovite and chlorite.
The weathering behaviour of the gneisses is different; according to the rock type and to the orographical conditions gritty and stony-loamy weathering products are developing. Rocks and blocky dumps often occur on very steep slopes.
The central gneiss core is surrounded by a series of Carboniferous granite massifs of which only the "Bärhalde"-granite near Altglashütten will be visited by the excursion. It is the most acid and also the poorest granite of dark minerals of the southern Black Forest. It contains little amounts of Fe, Ca, and Mg (tab. 1).
Main minerals are orthoklase, plagioklase rich in Na, quartz, and muscovite as well as decomposited biotite. The "Bärhalde"-granite is coarse-grained and is decaying to gruss due to weathering and soil formation (SCHREINER and WIMMENAUER 1979).
Due to the strong pleistocene erosion the Rhenanian side is characterized by numerous cragged, deeply incised towards the Rhine river draining valleys with V-shaped cross-sections in between which sharp-edged elevations are raising. Only few morphological plains occur. Flat upland areas are predominant due to little erosion efficiency for the Danubian type of the relief on the eastern side where the excursion is going through to reach St. Märgen. As a rule, the plains here are divided by trough- and flood-plain valleys which are not so deeply incised. At least the latest uplift after the Pliocene created the present differences in heights and the base structure of a landscape, which was finally formed by Rissian and Würmian glacials and the two competitive river systems of Rhine and Danube.
Mamillated rocks, trough valleys and kars were left behind by the glacial erosion. Moraines and little apron plains remained after the melting of the ice (profile 9). In the nonglacial region periglacial muds which are very important for the postglacial soil formation occured due to the frost weathering and transportational processes (STAHR 1979).

Climate and Hydrology

Along the excursion route from Freiburg to the east towards the highlands of the Black Forest the climatic conditions change evidently according to the heights and the position to the main wind direction (SW and W). The excursion will pass from the warm-temperated, drier upper Rhine plain to the increasingly cool-temperated more moist highland region of the Black Forest (tab. 2).

Tab. 2 : Mean annual temperatures and mean annual rainfall from selected stations along the excursion route (partly after TRENKLE 1980 and partly estimated)

	Breisach /Rhine r.	Freiburg	Buchenbach	St. Märgen	Titisee	Feldberg
t°C	9.5-10.0	10.5	8.5-9.0	6.0	5.9	3.2
mm	600	850	1100	1530	1230	1732+

On the eastern ramp of the Black Forest the temperatures are rising with decreasing altitdudes and the amounts of precipitation falling (Neustadt: 6° and 1210mm; Löffingen: ca. 6,5° and 840mm). Between the west and east side a significant asymmetry in the temperature- and precipitation gradients can be noticed Comparative absolute altitudes get higher rainfall on the west (weather-) side than on the east side (lee), whereas the west side is thermally favoured. The thermal favourableness of the middle and highland regions on the western side is mainly caused by the frequent formation of wintry inversions of temperatures whereby the higher positions get sunlight and heat and the lower positions get fog and cold air.
From the hydrological point of view it is significant that in the highlands the run-off throughout the year is comparatively proportionate due to the constant distribution of precipitation and the seasonally little fluctuating evaporation.
The storage capacity of the soil and the wintry snow cover play an important role for the run-off development in the Black Forest, because wide-spread thick loose sediments, which are rich in pores and moors for water storage, are missing or occur only locally.
The creeks in the Feldberg region show, considering the high amounts of annual rainfall of about 2000mm, an annual run-off of more than 1500mm (Feldsee lake run-off even 1850mm). These extreme values are not found in Germany in any other region than in the Alpes. In the high Black Forest the annual regional evaporation as a difference between annual precipitation and annual run-off is about 300mm; it is increasing towards the Rhine plain to 500-600mm. In the Feldberg area the percentage of run-off reaches 90% due to decreasing evaporation. The region with maximum precipitation and run-off of the high Black Forest lies in the west, southwest and south of the Feldberg. Towards north and northeast both values are decreasing (WUNDT 1948).

Vegetation

Western Black Forest

According to OBERDORFER (1979) not only a thermal and hygric differentiation but also a vegetational differentiation connected with the height can be noticed. Main tree species are common beech, silver fir and Norway spruce. Naturally, spruces were restricted to positions above 900m but were also advanced in more lower positions anthropically. Naturally 3 vegetational zones can be differentiated according to the altitudinal zone:

1. Submontane oak-beech area (up to 600 m a.s.l.)

Above all 2 subatlantic forest types in this zone are forming a characteristical mosaic which is changing depending on exposure and the depth of the soils. Within this zone the common beech trees are dominating, the durmast oaks are functioning as a subordinate tree species and the silver firs retain.

-woodrush-beech wood (Luzulo-Fagetum with quercus petraea) on dry to moderate fresh sites and

-melic grass-beech wood (Melico-Fagetum) at fresher sites.

2. Montane fir-beech area (ca. 600 - ca. 900m a.s.l.)

This is the zone with the best and the most beautiful silver for of the region. On somewhat lower positions
-woodrush-fir-beech wood (Luzulo-Fagetum with abies alba)
can be found on moderate fresh sites and

-fir-beech wood with Festuca altissima (Abieti-Fagetum occur on fresh sites)

3. Highmontane spruce-fir-beech area (ca. 900-1500m a.s.l.)
In this altitudinal zone Norway spruce is mixed with all beechwood societies. Two natural forest types growing on the slopes can be distinguished:

-species-poor-woodrush-fir-beech wood (Luzulo-Fagetum with picea abies) and

-fresh mountain maple-beech wood (Aceri-Fagetum)
which consists of common beech, silver fir and Norway spruce but also of common maple.
On rock slopes, in cold air depressions or at the edges of high moors (deeply developed and deeply humic soils) occur the real spruce wood (Bazzanio-Piceetum).

The highmontane zone is also the area of high moors (Oxycocco-Sphagnetea) developing in depressions or in silting zones of lakes due to glacial eroded basins.

Eastern Black Forest

In the eastern Black Forest dark conifer forests varying with grassland areas engrave on the scenery. The boundary line between the western and the eastern vegetational complexes is running from Breitnau via Hinterzarten, Bärental, Altglashütten to the Schluchsee. The forest vegetation of the eastern Black Forest consists of 2 forest types:

-moderate dry cranberry-spruce-fir wood (Vaccinio Abietetum with Pinus sylvestris ssp. hercynica)and
-fresh spruce-fir wood with herb rich ground cover (Galio-Abietetum)

Due to subcontinental, cool climate the subatlantic plants are diminishing in both communities. Forest associations rich in beeches are lacking generally. At present not only the common beech is strongly diminished but also the silver fir by reason of anthropic causes. Thus may also be due to the climatic deterioration of the past 500 years which at least supported strongly increased Norway spruce growing.

Soils

1. Submontane zone of the Black Forest influenced by loess (up to 600m a.s.l.)

"Braunerde-Parabraunerden" and "Parabraunerde-Braunerden" are concerned. Locally on lower parts of the slopes these soils are very dense due to higher amounts of loess so that "Pseudogley-Parabraunerden" and "Pseudogleye" are developing.

2. Basin of Zarten

In the basin of Zarten in the sediments of the lower terrace which are showing a small amount of loess also "Braunerde-Parabraunerden" and "Parabraunerden-Braunerden" as well as locally "Braunerden" without clay migration have been developed. In the flood land of the creeks there are different types of hydromorphic soils.

3. Slopes and flat upland areas of the montane zone (ca. 600-900m a.s.l.)

A cover of debris is wide-spread occuring as a soil-forming substratum. It consists of a ca. 1m thick, loose, stony-loamy main series above a dense, stony-sandy basic series. Iron oxide and clay formation acidification have lead to the development of typical "Braunerden" which are mainly differentiated by the humus form (mull or moder). Moder connected with stronger acidification have contributed to the formation of podzolized "Braunerde".

At the lower parts of the slopes of these altitudinal zone colluvial "Braunerden" have developed under agricultural utilization whereas the valleys are predominantly occupied by wet gley soils and half bog soils.

4. Hilltops and flat upland areas of the montane and highmontane zone in the formerly periglacial range (800-1100 m a.s.l.)

This range comprises the flat upland area from St. Peter and St. Märgen and is extending to the south up to the "Weißtannenhöhe" and Breitnau. Under forest conditions "Moderbraunerden" are spreaded widely (profile 8). At lower parts of the slope and natural forest vegetation and also under agricultural use "Mullbraunerden" are occuring. On hilltop positions and mostly under Norway spruce forest so-called "Sauerbraunerden" with raw humus, which are not podzolized are dominating. In depressions and on larger erosion surfaces different types of hydromorphic soils can be found.

5. Former glacial area in the highmontane zone between Breitnau, Neustadt and Feldberg (High Black Forest)

Within the gneiss region of the High Black Forest "Moderbraunerden" are the most frequent soils. Within the closer Feldberg district but also within the whole southern Black Forest (montane and highmontane zone) a special typ of "Mullbraunerde" was developed both in natural mixed forests and with higher Norway spruce percentage. The most important characteristic of it is a thick (up to 40cm) Ah-horizon. Nestwise humus enrichment deeply going into the B-horizon indicating the soil-forming activity of the earthworm Lumbricus badensis which is digging as deep as 2m (LAMPARSKI 1985). These "Mullbraunerden" are called "Humusbraunerden" (profile 10).
On the selected, base poor and sandy end moraine-, terrace- and apron sediments within the gneiss massif the only completely developed podzols are occuring. Furthermore there are all kinds of connecting links of the "Braunerde"-podzol-series.
In the area of the extremely acid and coarse-grained weathering "Bärhalde" granite the soil formation took a different course than in the gneiss area. A cool-humide climate enabled the development of humus-iron-podzols under Norway spruce rich in berry herbs in the periglacial covers of debris and in the occasionally occuring glaciofluvial sands (profile 9).
On somewhat more loamy substratums (longer periglacial conditions or participation of other types of rocks) "Braunerden" with mull, moder or raw humus developed.
The portion of hydromorphic soils within this elevation zone in the granite area is greater than in the whole gneiss area.
A typical representative of the dam water-influenced soils is the "Stagnogley". It is occuring on cirque floors, valley heads, flat slopes, erosion-surface planations, and on flat uplands. "Stagnogleye" are often associated with "Torfstagnogleyen" and boggy soils. Down the slope "Stagnogleye" and boggy soils are often dissolved by "Ockererden".
The soil association of the valley landscapes is formed by "Auenböden", "Gleyen", "Naßgleyen", "Torfgleyen", and "Niedermooren". Ancient lake mires of the drift- and morainic-belt topography are representing a particularity in the soil mosaic of this region. Thus includes the "Hinterzartener Moor", the "Michelsmoos", and the "Rotmeer" which is in the neighbourhood of profile no.9.

Agriculture and Forestry

Within the upper Rhine valley arable farming of the total agricultural used area is about 70-80% whereas within the western Black Forest arable farming is diminishing due to climatic and orographic conditions to 20-30% (grain and potatoes) in favour of grassland.
In the highlands of the Black Forest the agricultural land has diminished to 30%, the percentage of arable farming to less than 20% (grain).
The clear emphasis of the Black Forest agriculture lies on grassland-, and pasture farming as well as animal husbandry. Here the main issues are getting sufficient incomes under unfavourable site conditions (low temperatures, high rainfall, steep slopes , shallow and waterlogging soils) and conserving the landscape by agricultural use. Through controlled steps of agricultural policy

a certain stabilization of the situation of the upland farmers has been accomplished during the last decade. No spectacular changes have happened. The larger upland farms east and northeast of Freiburg have adapted more to today's necessities through intensivation of land use, more pieces of cattle per hectar and increasing of animal efficiency as well as constructional measures.

In contrast to the middle Black Forest the southern Black Forest has small- and smallest farming enterprises. Today agriculture is only operated as a subsidiary occupation. It has an extreme cultural and through tourism also an economical importance.
For the southern Black Forest a characteristical phenomena are the extensive common- and cooperative pastures, which have been used collectively for centuries (MÜLLER 1979).

In the Black Forest the percentage of the forest area is on average up to 80%. Locally, there are significant differences depending on the relief conditions. This is particularly evident on the flat upland area of St. Peter, St. Märgen, and Breitnau. The steep slopes situated towards the basin of Zarten are closed covered with wood, whereas the flat highlands are used for agriculture use. The surroundings of the Feldberg are another natural densly wooded area; but it was also partly reafforested after former clear-cutting.
22% of the forest area of the county of "Breisgau-Hochschwarzwald" is state forest, communal- or cooperation forest amounts to 45%, and 33% is private forest (1/3 large private forest, 2/3 is in small forest propriety).
The small forest propriety is mainly farm forest and in the middle Black Forest it belongs to the isolated farms with compact holding, whereas the propriety is always transmitted to the one and only heir to the farm. The small forest propriety in the southern Black Forest is fragmented due to partition of an inheritance.
In the first place the Black Forest is the region of the silver fir - Norway spruce - and common beech forest. In the lower and middle elevation zone growth production is above all depending on exposure, inclination, and soil depth. The higher one is climbing in the mountains, the more frequently spruces are occuring and the oftener mixed stands are interrupted by pure spruce stands or spruce afforestations. From 900m a.s.l. onwards the fir is considerably diminishing and from 1200m a.s.l. onwards the spruce is forming the growing stock with a f ew beeches, common maple, and rowans; e.g. on the western side of the Feldberg.
East of the Feldberg and in the Altglashütten-Titisee-Hinterzarten-Neustadt-region the spruce is already dominating in somewhat lower positions. The continental tinge of the climate, the wide-spread afforestations and the base poor parent materials are responsible for this phenomena (profiles 7+9). Doubtlessly here the beech was driven back by the strong selective beech wood utilization for glass work in the 18th century.
The tree-line on the Feldberg mountain has been pressed down anthropical strongly for a long time and the region has been taken into utilization of pastures. Originally, thinly stocked mixed forest with dominating spruce existed here. The solitary spruces, which seem to form the natural tree-line today, are nothing else but natural seeding on pasture land, which nature is trying to reconquer against the extreme climate conditions (profile 10).
In the Black Forest the conifers occupy 81% of the total forest area (59% spruces, 18% firs and others) and decidous trees occupy only 19% (15% beeches).

In the Black Forest the average stand volume amounts to about 300 $m^3.ha^{-1}$ and the mean annual increment is about 7,5 $m^3.ha^{-1}$. The timber management approximately amounts to 4-6$m^3.ha^{-1}$ according to growth conditions.
In the Black Forest silviculture is an important production factor; however, it also has an important conservation- (water supply, prevention of soil erosion) and recreational function. Thus the conservation of the forest on the one hand and the limitation and the formation of the reafforestation on the other hand is of great importance.
With reference to the management goals and the choice of tree species in the Black Forest the uneven aged mixed forest of fir, spruce, and beech is to be supported and is taken over by spruces with beech and common maple in the higher positions.
The formation of stands is taking place, if at all possible, through natural regeneration.
The silvicultural treatment has to be affected as intensively as possible in order to produce valuable stem timber, to conserve the tree species compositions and to secure the forest against storm and snow (GÜRTH 1979).

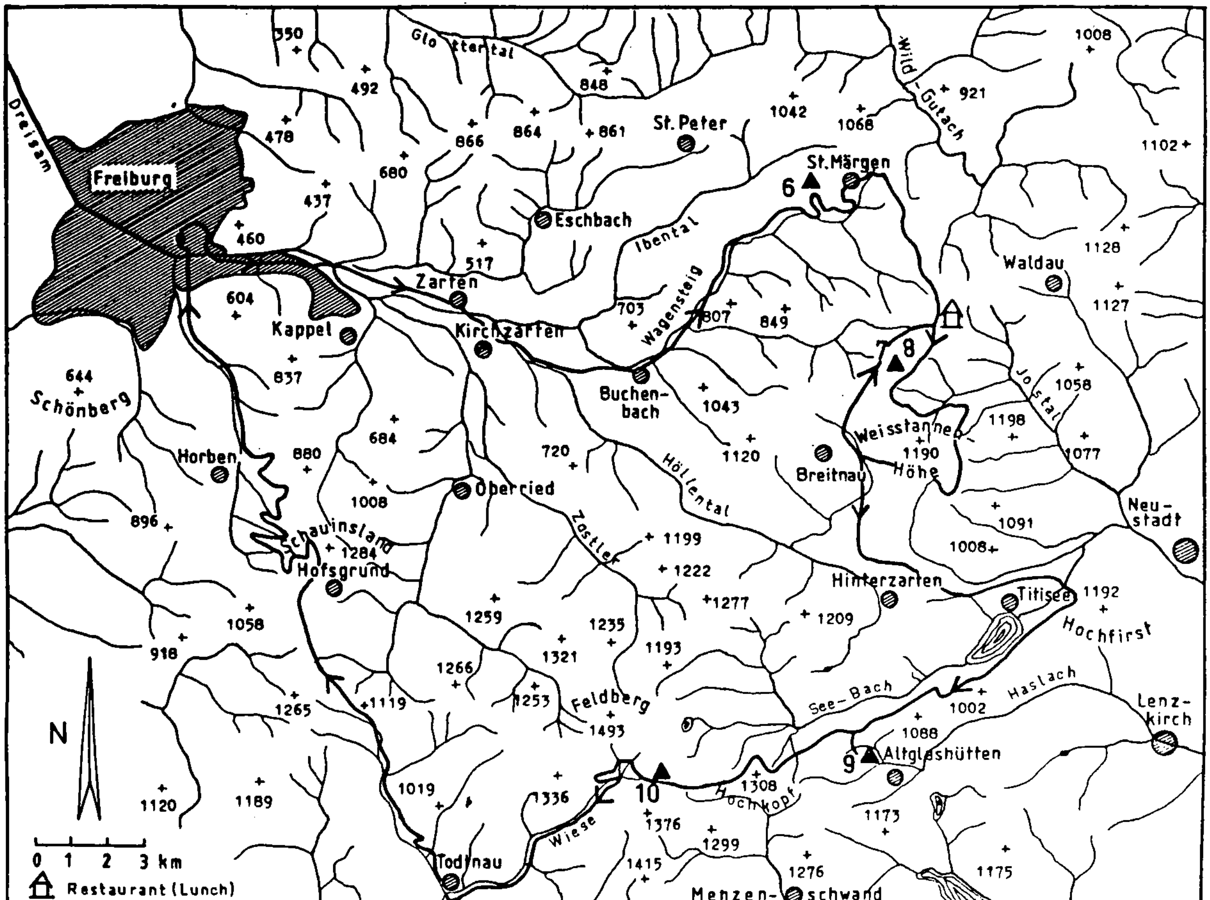

Fig. 9: Route of the Excursion E - Aug. 22nd (second day)

Site Description

Location: 17km east of Freiburg, close to St.Märgen

Elevation: 740m

Landform: V-shaped valley, very steeply southeast-facing slope

Slope: lower part of the slope, 63%, SE

Drainage: well drained, temporarily moderate runoff

Vegetation: fir-beech wood (Abieti-Fagetum with Festuca altissima)

Use: mixed forest (fir, beech, spruce)

Soil temperature: about 7,5°C

Parent material: periglacial mud derived from paragneiss-metatexite

Soil classification:

German : Braunerde(Mull-)
FAO : Dystric Cambisol
US-S.T.: Typic Haplumbrept, loamy-skeletal, mixed, frigid

Profile Description

Horizon:		Depth cm:	
Ah1	Ah1	0- 3	very dark gray(10YR3/1m), stony very loamy sand(l̄S), fine crumb to subangular blocky, very soft, very intensively rooted, main series,* clear smooth boundary
Ah2	Ah2	- 10	very dark grayish brown(10YR3/2m), stony very loamy sand (l̄S), fine crumb to subangular blocky, very soft, very intensively rooted, main series, clear smooth boundary
BvAh1	BwAh1	- 20	dark brown(10YR3/3m), stony very sandy loam (s̄L),subangular blocky, very soft, intensively rooted, main series, clear smooth boundary
BvAh2	BwAh2	- 40	brown to dark brown(10YR4/3m), stony sandy loam(sL), subangular blocky, few earthworm tubes, very soft, very intensively rooted, main series, clear wavy boundary
Bv1	Bw1	- 70	dark yellowish brown(10YR4/4m), stony loamy sand(lS), subangular blocky, soft, intensively rooted, main series, gradual wavy boundary
Bv2	Bw2	-100	yellowish brown(10YR5/5m), very stony very loamy sand(l̄S), subangular blocky, soft, intensively rooted, main series, gradual smooth boundary
BvC1	BwC1	-135	yellowish brown(10YR5/5m), very stony very loamy sand(l̄S), single grained, stones are oriented parallel to the slope (parallel texture) and covered with silty caps,compact, few roots, basic series**; sharp smooth bound.
BvC2	BwC2	-165	like BvC1, however rather stony
mCv	Cw	>165	yellowish brown(10YR4/4m), extremely stony weak silty sand(u'S), single grained, silty caps, few sandy lenses, compact, single roots, regolithic zone*** Zerfallszone (STAHR 1979)

* Hauptfolge

** Basisfolge

Profile 6 - St. Märgen

No	hor.	depth cm	sto.* %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah1	0 - 3	34	28	19	13	60	8	11	5	24	16		
2	Ah2	-10	37	28	19	12	59	10	10	5	25	16		
3	BvAh1	-20	35	24	17	13	54	11	11	5	27	19		
4	BvAh2	-40	36	21	17	13	51	13	12	6	31	18		
5	Bv1	-70	26	18	19	17	54	15	12	7	34	12		
6	Bv2	-100	32	18	20	14	52	12	13	7	32	16		
7	BvC1	-135	41	22	21	13	56	12	11	6	29	15		
8	BvC2	-165	44	28	20	13	61	12	10	6	28	11		
9	mCv	>165	56	35	27	13	75	9	8	4	21	4		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/g	Fe_t mg/g
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	Ah1	0.64	74	68	41	30	8.2	4.3	3.7	15	6.7	.44	.26	38
2	Ah2	0.66	74	68	34	25	6.3	4.4	3.9	15	7.3	.47	.38	40
3	BvAh1	0.80	69	66	33	25	8.3	4.7	4.2	18	8.2	.46	.48	49
4	BvAh2	0.88	67	62	32	26	9.0	4.6	4.3	18	7.2	.41	.51	45
5	Bv1	1.00	64	56	31	26	7.9	4.7	4.5	16	6.6	.42	.44	44
6	Bv2	1.02	63	54	27	23	6.0	5.3	4.8	15	4.8	.33	.34	43
7	BvC1	1.48	47	36	22	19	6.2	5.6	4.8	13	3.5	.27	.22	43
8	BvC2	1.52	46	35	23	19	2.7	5.6	4.8	11	2.5	.22	.21	42
9	mCv	-	-	-	-	-	-	5.5	4.7	12	1.0	.09	.19	39

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	Pa mg/kg	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah1	11.4	5.3	21	43		122	5	3	0.5	0.6	50	63	7.5
2	Ah2	5.8	2.7	21	50		76	2	1	0.2	0.3	21	51	4.6
3	BvAh1	4.4	2.0	22	67		51	1	1	0.1	0.3	21	28	4.7
4	BvAh2	3.6	1.5	24	76		37	0	0	0	0.5	17	19	1.4
5	Bv1	1.6	0.9		85		24	0	0	0.1	0.4	8	15	2.0
6	Bv2	1.2	0.6		80		10	1	0	0.2	0.6	3	5	18
7	BvC1	0.8	0.6		68		5	0	2	0	0.9	1	1	58
8	BvC2	0.5	0.1		73		4	0	1	0.1	0.6	1	1	43
9	mCv	0.2	-		75		5	0	1	0	0.1	4	0	22

* only fraction 2-20 mm

	total contents in mg/g						
	Na	K	Ca	Mg	P	Ti	Zr
2	42	43	44	45	46	47	48
Ah1	7.0	11.6	2.6	7.4	.955	4.6	.265
Ah2	8.3	12.2	1.8	8.4	.722	4.6	.274
BvAh1	7.9	13.0	3.6	8.9	.852	4.6	.290
BvAh2	7.8	13.0	2.8	9.4	.910	4.7	.289
Bv1	8.2	13.6	4.3	9.9	.865	4.7	.294
Bv2	9.4	14.4	4.1	11.0	.880	5.4	.301
BvC1	10.1	15.3	3.8	11.3	.885	6.0	.309
BvC2	10.1	5.6	4.0	11.2	.725	5.4	.322
mCv	11.0	16.0	5.0	10.6	.485	4.4	.261

	mg/g						
	Fe_p	Mn_p	Mn_t	Al_o	Al_t	Si_o	Si_t
2	49	50	51	52	53	54	55
Ah1	4.0	.015	.57	4.3	65.6	.2	261
Ah2	3.4	.110	.66	5.5	71.2	.4	297
BvAh1	3.4	.095	.78	7.1	78.2	.8	292
BvAh2	2.0	.060	.85	8.6	82.0	1.1	298
Bv1	0.7	.035	.79	9.6	86.7	1.8	310
Bv2	0.5	.040	.77	10.2	88.5	2.6	311
BvC1	0.3	.015	.66	9.2	90.9	2.4	313
BvC2	0.2	.020	.68	5.9	87.7	1.8	316
mCv	0.1	.015	.59	3.0	81.6	1.0	327

	clay minerals, % < 2 µ-fraction								
	K	I	S	V	Mg-C	Al-C	M-M *	Q	F
2	56	57	58	59	60	61	62	63	64
Ah1	25	-	-	-	25	50	-	-	-
Ah2	40	-	-	-	-	60	-	-	-
BvAh1	40	5	5	-	5	35	10	tr	tr
BvAh2	30	10	5	-	15	20	20	-	-
Bv1	30	10	5	-	10	20	25	-	-
Bv2	20	5	10	-	10	15	35	tr	5
BvC1	20	5	tr	-	10	10	50	tr	5
BvC2	25	10	-	-	15	-	50	tr	tr
mCv	20	10	5	-	10	-	50	10	5

*= mixed-layer minerals ; tr = trace

EXPLANATIONS TO PROFILE NO. 6

History of Landscape and Land Use

Periglacial area of the last glacial epoch with formation of stratiographic sequences of debris typical for this elevation zone; older soils and weathering products removed.

Use temporarily as pasture; very early reforestation (ca. 1800-1830).

Soil Association

Association of "Braunerden" with different humus forms; humus form hardly dependent from exposure but from thickness of the main series:
high thickness causes mull humus, medium thickness (ca. 50cm) moder humus, and low (ca. 30cm) raw humus ("Sauerbraunerden").
On rock slopes "Ranker" (lacking cover sediments), due to recently descending slope talus also locally "Syroseme"; "Ranker" and "Syroseme" with the humus form mull, moder, and raw humus according to vegetation.

Soil Genesis

- Substratum and stratification: favourable conditions for development of "Braunerden" through thick main series. Periglacial mud with stratiotype: main series/basic series/regolithic zone; gradual stratum transitions emphasized only by texture and structure; admixture of far-transported loess about 10% within the main series, however, mineralogically extensively homogeneous profile.
- Soil-forming process: high humus accumulation ($34kg.m^{-2}$)* in a thick humus body with gradually decreasing of the C-content with depth.

  Total base loss with 0.8 $ke.m^{-2}$* on average:
  Na 30(25)%, K10(12)%, Ca 17(26)%, and Mg 3(21)%
  (initial amounts = 100%; in brackets losses of 13 terrestrial soil profiles in the gneiss area); small losses of Mg.

  Iron-oxide formation medium to high, where 14% ($=4g.kg^{-1}$) of Fe_t is released.

  Clay formation on average ($44kg.m^{-2}$* = $20g.kg^{-1}$); in the regolithic zone iron-oxide formation clearly without stronger clay formation.

  Clay displacement still traceable, displacement < $1kg.m^{-1}$*.

  Al-displacement already very well recognizable, but still relatively insignificant with $2kg.m^{-2}$ and exclusively explainable through clay displacement.

Soil Ecology

Mechanical and physiological "Gründigkeit" (possibility of the potential root depth) very high (ca. 14dm); "Durchwurzelbarkeit" (rooting ability) up to 10dm (main series) not restricted; usable field capacity of the root zone high (155mm); according to calculations of STAHR (1979) a water excess** of 200mm is arising for this profile in the growing season; at that time the field capacity is not falling short of equal distribution of rainfall. But the aeration is not restricted.

High N-reserve ($960g.m^{-2}$) with average C/N-ratio (Ah=22).
Very high P-reserve ($820g.m^{-2}$) with low C/P-ratio (Ah=103).
High base reserve (K=$13kg.m^{-2}$; Ca=$3.5kg.m^{-2}$; Mg=$10kg.m^{-2}$).

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* Unless stated differently all data is referring to the profile depth. This is also valid for the other 4 profiles.

** Difference from maximum available soil water and potential evapotranspiration in the growing season; maximum available soil water calculated from rainfall + available field capacity in $1.m^{-2}$.

Site Description

Location: 5km south of St.Märgen, 1,5km SSW of the restaurant Thurner

Elevation: 1097m

Landform: flat upland area, nearly level

Drainage: well drained, moderate permeability

Vegetation: woodrush-fir-spruce wood (Luzulo-Abietetum)

Use: spruce stand

Soil temperature: about 6,5°C

Parent material: rock debris fragmented by freezing and thawing derived from paragneiss-metatexite

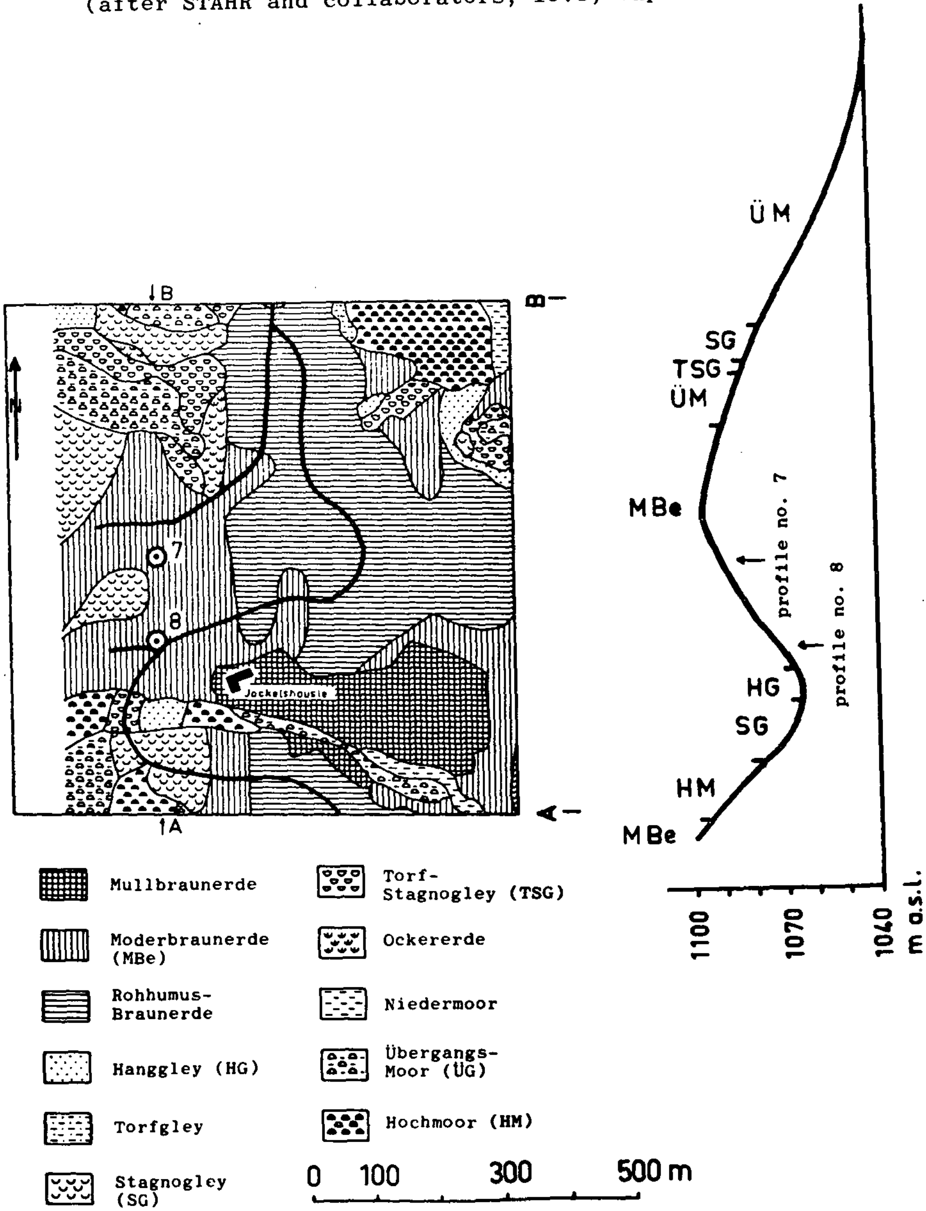
Soil classification:

German : Sauerbraunerde (Rohhumus-)
FAO : Dystric Cambisol
US-S.T. : Typic Haplumbrept, loamy-skeletal, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
L	O	15-14	spruce needles, moss and bilberry litter
Of	O	14-10	fermented and partly decomposed vegetational remains, soft, only weakly felted, many root remains, moderately rooted, sharp smooth boundary
Oh	O	10- 0	black(5YR2,5/1m), greasy when wet and blocky when dry, coherent, very soft, very intensively rooted, sharp smooth boundary
Ah	Ah	0- 6	very dark gray(5YR3/1m), moderately stony sandy loam(sL), fine coagulated, very soft, intensively rooted, main series, sharp tongued boundary
BvAh	BwAh	-12	very dark gray(7,5YR3/1m), stony very sandy loam(s̄L), gravelly, very soft, moderately rooted, main series, clear wavy boundary
AhBv	AhBw	-30	brown to dark brown(7,5YR4/3m), stony sandy loam(sL), gravelly, very soft, few roots, main series, gradual smooth boundary
Bv	Bw	-60	brown to dark brown(7,5YR4/4m), very stony very sandy loam(s̄L), gravelly to subangular blocky, silty caps, moderately compact, single roots, main series, clear smooth boundary
mCv	Cw	-90	brown(7,5YR5/3m), extremely stony very loamy sand(l̄S), single grained to coherent, very compact, no roots, stones are oriented parallel to the surface(parallel texture) and covered with silty caps, basic series passing into regolithic zone

Fig. 10: Soil association map and cross section (N-S) from the "Wildmooswald-Jockelshäusle"-area (after STAHR and collaborators, 1978, unpublished)



No	hor.	depth cm	sto.* %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L	15–14												
2	Of	14–10												
3	Oh	10– 0												
4	Ah	0– 6	37	12	25	17	54	10	9	8	27	19		
5	BvAh	–12	41	9	24	20	53	9	10	8	27	20		
6	AhBv	–30	48	8	25	20	53	9	10	9	28	19		
7	Bv	–60	47	8	26	21	55	8	10	9	27	18		
8	mCv	–90	65	18	24	14	56	10	11	10	31	13		

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o: Fe_d	Mn_o mg/g	Fe_t mg/g
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	L							3.6	3.3	0.4	0.2	.48	.16	0.6
2	Of							3.2	2.9	1.0	0.5	.46	.06	1.0
3	Oh	.17	89	83	56		8.7	3.1	2.7	3.0	1.8	.60	.06	3.8
4	Ah	.74	71	70	60		13.4	3.3	3.2	17.0	13.0	.75	.04	28.0
5	BvAh	.86	69	62	50		10.9	3.7	3.7	16.0	13.0	.78	.10	34.0
6	AhBv	1.00	63	56	48		9.2	4.1	4.2	16.0	9.3	.59	.15	31.0
7	Bv	.99	63	56	44		7.6	4.3	4.4	12.0	6.5	.55	.15	32.0
8	mCv	1.31	51	46	41		6.5	4.4	4.2	8.1	1.0	.13	.26	33.0

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	Pa mg/kg	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L	53.0	16.0	33			125	29	12	3.8	0.2	73	7	36.0
2	Of	53.1	19.0	28	236		201	17	12	2.2	0.2	148	22	16.0
3	Oh	46.8	18.0	25	32		342	5	12	0.6	1.6	215	108	5.6
4	Ah	10.0	5.4	19	42		350	0	1	0	0	159	190	0.3
5	BvAh	5.6	2.6	18	37		165	0	1	0.2	0	74	90	0.8
6	AhBv	3.4	1.5		37		62	0	0	0	0	24	38	0
7	Bv	1.6	0.8		52		31	0	0	0	1.6	10	19	5.2
8	mCv	0.2	0.3		31		43	0	0	0	1.6	17	24	3.7

* only fraction 2-20 mm

	total contents in mg/g						
	Na	K	Ca	Mg	P	Ti	Zr
2	42	43	44	45	46	47	48
L	0.1	0.9	2.8	0.4	.727	0.0	-
Of	0.1	0.7	1.6	0.4	.602	0.4	-
Oh	0.8	2.6	1.5	0.9	.590	0.8	-
Ah	6.2	11.4	0.8	3.8	.550	5.4	.259
BvAh	6.5	14.9	0.9	5.9	.400	5.8	.259
AhBv	6.7	16.6	0.9	6.1	.385	5.9	.275
Bv	7.3	18.0	0.9	7.4	.345	6.0	.271
mCv	7.0	22.0	0.8	9.6	.200	6.6	.258

	mg/g						
	Fe_p	Mn_p	Mn_t	Al_o	Al_t	Si_o	Si_t
2	49	50	51	52	53	54	55
L	0	.175	.21	0.1	6.5	0.0	6
Of	0.2	.090	.06	0.5	7.5	0.0	11
Oh	1.2	.070	.09	2.2	16.5	0.0	46
Ah	10.0	.030	.21	4.7	52.0	0.0	289
BvAh	7.7	.060	.32	6.1	62.0	0.0	309
AhBv	4.2	.055	.39	7.3	67.0	0.6	329
Bv	1.5	.030	.44	7.4	71.5	1.5	333
mCv	0.2	.030	.60	2.8	74.5	0.6	338

	clay minerals, % < 2 µ-fraction								
	K	I	S	V	Mg-C	Al-C	M-M *	Q	F
2	56	57	58	59	60	61	62	63	64
L									
Of									
Oh									
Ah	10	-	-	15	10	5	60	tr	-
BvAh	10	5	-	5	10	-	70	tr	-
AhBv	15	5	-	-	15	-	65	tr	-
Bv	15	-	-	-	20	-	65	-	-
mCv	15	15	-	-	15	-	50	5	-

*= mixed-layer minerals ; tr = trace

EXPLANATIONS OF PROFILE NO. 7

History of Landscape and Land Use

Flat upland area of eastern Black Forest; just beneath the permotriadic land surface; relicts of the surface rock (Mesozoic) or former soil sediments removed. During the glacial epoch firn glaciation occured locally; parent material are congelifracts formed in situ.

Uprooting during the Spanish War of Succession (1706); temporary pasture or selection forest using afterwards; the generation before last was fir-spruce- and broadleaved wood stand; today first spruce generation.

Soil Association

"Sauerbraunerde" typical forest soil of domes, crests, and on upper slopes, associated with other "Braunerde"-variants with favourable humus form due to the thickness of main series (profile 8) and vegetation. High percentage of hydromorphic soils.
Toposequence on flat upland areas or on flat slopes:
"Braunerde-Hanggley-Stagnogley-Waldmoor-Ockererde".
Frequently there are high moors surrounded by "Stagnogley-" or "Gley-" associations in hollows.

Soil Genesis

- Substratum and Stratification
  No mud, but very similar constitution of congelifracts; therefore stratiotype called: main series/basic series/regolithic zone.
  Not influenced by far-transported loess; between main- and basic series clear texture boundary and mineralogical differences within the fine earth.

- Soil-forming Processes
  High humus accumulation (36kg.m^{-2}); only 18kg.m^{-2} in the humus cover and only 8kg.m^{-2} in Ah-BvAh-horizons; thin humic mineral soil horizons; humus displacement within the profile limited by sorption on Fe-oxides.

  Base losses average: Na 32(25)%, K 11(12)%, Ca 24(26)%, Mg 20(21)% (initial amounts = 100%; in brackets losses of 13 terrestrial soil profiles in the gneiss area); total base loss only 0.4ke.m^{-2} due to low depth of soil development; very high base losses in the upper profile, therefore strong acidification.
  Iron-oxide formation relatively low, since only 7% of the Fe_t (=2g.kg^{-1}) are released; a high percentage of Fe_p and Fe_o in relation to Fe_d (50-60% respectively 80%).
  Clay formation low (24kg.m^{-2}=24g.kg^{-1}) with low total amount (76kg.m^{-2}); in the upper soil mean new formation rates; no clay displacement.

  Clear Al-displacement from the upper soil (1kg.m^{-2}, out of 0-12cm) without Al-losses of the profile.

  Podzolization (Fe-displacement) cannot be seized due to morphology and balance analyses.

  Clay mineral transformation is determined by the formation of alternate-bedding minerals; illite and Mg-chlorite are weathering under the formation of expandable layers and Al-chlorite layers.

Soil Ecology

Physiological shallowness limited due to unfavourable humus form and strong acidification; upper part of profile is very well rootable.
Usable field capacity in the root zone low (90mm), 60mm in the humus cover; water excess (see profile 6) in the growing season about 300mm; desiccation possible only after loss of humus cover.
Average N-reserve (640g.m^{-2}) with medium to high C/N-ratios (Oh=25, Ah=20); Therefore N-supply probably sufficient.
P-reserve in root zone low (40g.m^{-2}) with high C/P-ratios (Oh=792, Ah=182); P-supply probably limited due to restricted mobility in the mineral soil.
Low base reserve (K=0.8kg.m^{-2},Mg=0.2kg.m^{-2}); because of very low base saturation and high contents of exchangeable Al and Fe base supply is limited.

Site Description

Location: 5km south of St.Märgen, 110m S of profile 7, Wildmooswald

Elevation: 1075m

Landform: strongly inclined southeast-facing slope

Slope: middle to lower part of the slope, 21%, SE

Drainage: moderately drained, slow runoff

Vegetation: species poor spruce-fir-beech wood (Verticillato-Fagetum)

Use: coniferous mixed forest (spruce, fir)

Soil temperature: about 6,6°C

Parent material: periglacial mud derived from paragneiss-metatexite

Soil classification:
German : Braunerde (Moder-)
FAO : Dystric Cambisol
US-S.T. : Typic Haplumbrept, loamy-skeletal, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
LOf	O	15-12	litter material, partly fermented and decomposed
Of	O	12- 5	black(5YR2,5/1m), fermented and partly decomposed vegetational remains, sharp wavy boundary
Oh	O	5- 0	black(5YR2,5/1m), completely decomposed vegetational remains, greasy, coherent, soft, very intensively rooted, sharp wavy boundary
Ah	Ah	0- 4	dark reddish brown(5YR3/2m), stony very loamy sand ($\bar{l}$S), fine coagulated, very soft, very intensively rooted, main series, abrupt wavy boundary
BvAh	BwAh	-20	dark reddish brown(5YR3/3m), very stony, very sandy loam($\bar{s}$L), gravelly, very soft, intensively rooted, main series, gradual smooth boundary
AhBv	AhBw	-45	reddish brown(5YR4/4m), very stony very sandy loam(sL), subangular blocky, soft, moderately rooted, main series, gradual smooth boundary
Bv1	Bw1	-70	reddish brown(5YR4/4m), very stony very loamy sand($\bar{l}$S), subangular blocky, moderately compact, few roots, main series, gradual smooth boundary
Bv2	Bw2	-90	yellowish red(5YR4/6m), very stony very loamy sand($\bar{l}$S) to sandy loam(sL), subangular blocky to single grained, stones are oriented parallel to the slope(parallel texture), compact, single roots, basic series, sharp wavy boundary
mCv	Cw	-150	reddish brown(5YR5/3m), extremely stony loamy sand(lS), single grained, stones are oriented parallel to the slope(parallel texture), silty caps, compact, no roots, basic series

Profile 8 - Jockelshäusle

No	hor.	depth cm	sto.* %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	LOf	15–12												
2	Of	12– 5												
3	Oh	5– 0												
4	Ah	0– 4	47	15	26	19	60	9	9	6	24	16		
5	BvAh	–20	46	15	21	16	52	9	12	7	28	20		
6	AhBv	–45	46	12	20	19	51	10	12	8	30	19		
7	Bv1	–70	60	13	20	20	53	9	12	9	30	17		
8	Bv2	–90	61	13	20	21	54	10	12	7	29	17		
9	mCv	>150	54	12	21	27	60	12	13	5	30	10		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o: Fe_d	Mn_o mg/g	Fe_t mg/g
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	LOf							3.8	3.2	2.3	1.1	.46	.15	3.8
2	Of	0.19	89	86	59		11.0	3.1	2.6	4.8	2.6	.57	.03	6.8
3	Oh	0.20	87	82	51		6.5	3.3	2.8	12.0	5.1	.44	.03	21
4	Ah	0.97	63	61	47		14.0	3.8	3.2	19.0	9.3	.49	.07	36
5	BvAh	1.02	63	61	46		11.0	4.1	3.6	18.0	9.6	.54	.13	40
6	AhBv	1.14	58	53	40		10.0	4.5	4.1	16.0	9.1	.56	.18	42
7	Bv1	1.43	46	41	34		11.0	4.7	4.4	20.0	8.0	.40	.14	41
8	Bv2	1.59	43	36	27		10.0	4.8	4.4	16.0	6.5	.42	.12	41
9	mCv							4.8	4.3	11.0	1.3	.11	.18	41

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	Pa mg/kg	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	LOf	48	21	23	251		212	71	42	6.8	1.4	66	25	57
2	Of	43	19	23	145		300	28	17	1.3	1.3	156	96	16
3	Oh	22	13	17	74		295	3.0	0.6	0.4	0.4	161	130	2
4	Ah	6.1	4.0	15	40		278	1.0	0.2	0.1	0	141	136	1
5	BvAh	4.7	2.8	17	27		169	0	0.1	0.1	0	84	85	0
6	AhBv	3.0	1.6	18	27		56	0	0	0	0	29	27	0
7	Bv1	1.3	1.0		30		35	0	0	0	0	19	16	0
8	Bv2	1.0	0.9		34		20	0	0	0	0	12	8	0
9	mCv	0.4	0.4		71		16	0	0	0	0	10	6	0

* only fraction 2-20 mm

Profile 8 - Jockelshäusle

	total contents in mg/g						
	Na	K	Ca	Mg	P	Ti	Zr
2	42	43	44	45	46	47	48
LOf	0.5	2.7	1.1	2.4	.705	0.2	-
Of	1.5	4.1	1.0	1.4	.600	0.7	-
Oh	4.3	11.9	3.0	1.0	.652	3.0	-
Ah	6.2	18.4	6.4	1.1	.420	5.1	.234
BvAh	6.3	17.9	7.6	1.4	.408	6.4	.226
AhBv	7.0	19.2	8.2	1.5	.462	5.8	.239
Bv1	6.4	20.0	8.4	1.1	.305	6.8	.235
Bv2	6.6	21.0	8.8	1.1	.475	6.8	.244
mCv	8.0	24.4	10.6	1.2	.280	6.6	.262

	mg/g						
	Fe_p	Mn_p	Mn_t	Al_o	Al_t	Si_o	Si_t
2	49	50	51	52	53	54	55
LOf	0.4	.210	.20	.9	7.0	0.0	34
Of	2.0	.030	.04	2.1	15.5	0.0	71
Oh	4.7	.020	.15	3.1	44.0	0.0	200
Ah	6.4	.020	.32	3.8	67.5	0.2	294
BvAh	5.3	.050	.40	4.9	74.5	0.4	298
AhBv	3.5	.030	.46	7.4	85.0	0.8	299
Bv1	1.4	.020	.47	7.6	89.5	1.4	309
Bv2	1.0	.020	.46	6.0	87.5	1.0	316
mCv	0.4	.015	.50	4.3	90.0	1.2	313

	clay minerals, % < 2 µ-fraction								
	K	I	S	V	Mg-C	Al-C	M-M *	Q	F
2	56	57	58	59	60	61	62	63	64
LOf									
Of									
Oh									
Ah	15	5	-	-	10	15	55	-	-
BvAh	25	-	-	-	15	20	45	-	-
AhBv	15	tr	-	-	15	35	35	-	-
Bv1	20	tr	-	-	15	20	45	tr	-
Bv2	20	10	-	-	15	15	40	tr	-
mCv	15	15	-	-	15	5	50	tr	tr

*= mixed-layer minerals ; tr = trace

EXPLANATIONS OF PROFILE NO.8

History of Landscape and Land Use

like profile no. 7

Soil Association

like profile no. 7

Soil Genesis

- Substratum and Stratification
  Periglacial mud from stratiotype main series/basic series; gradual layer boundary, dominantly recognizable by structural characteristics, significant texture boundary primarily in between basic series; missing of far-transported loess admixture, although the mineral stock is relatively inhomogene.

- Soil-forming Processes
  In comparison to profile no. 7 more favourable conditions for "Braunerde"-development on account of thicker main series.

  High humus accumulation (39kg.m^{-2}), 16kg.m^{-2} in the humus cover and 17kg.m^{-2} in the humic horizons of the mineral soil; a thick humus body with gradual decreasing humus content in contradiction to the unfavourable humus form; eventual anthropic degradation of the site unknown.

  Base losses with total 0.8ke.m^{-2} are mean, but in particular very different: Na 36(25)%, K 3(12)%, Ca 5(26)%, Mg 53(21)%
  (initial amount = 100%, in brackets - average from 13 terrestrial soil profiles in the gneiss area); abnorm behaviour conditional to different initial contents (Ca and K higher, Mg lower as average).

  Iron-oxide formation due to Fe-release high - 16% (=4g.kg^{-1}) of Fe_t is released.

  Clay formation low to medium, 30 kg.m^{-2} (=22g.kg^{-1}) new formated clay in the whole profile; maximal clay formation rate in AhBv (188%), in the whole profile mean (141%).
  Iron-oxide and clay formation próceed parallel in the profile; the proportion Fe_d:clay content(%) is 0.1 in all horizons; clay displacement is not proofed.

  Al-displacement stronger as profile no. 7 (2kg.m^{-2}), but not more intensive, because the proceeding takes place in a greater soil mass; no Al-losses.

  Fe-displacement is not proofed - no podzolization.

  Clay mineral transformation: In the whole profile a strong tendency to Al-chlorite formation with a maximum within BvAh to Bv1 can be found; in alternate-beddings a high percentage of Al-chloritic layers besides expandable illites; illite in the upper horizon totally weathered.

Soil Ecology

Mechanically and physiologically deep profile; rooting ability up to AhBv-horizon very well, from that horizon limited through stone content; topical rooting more shallow than possible.
High usable field capacity of the potential root zone (180mm); because of high precipitation in the growing season water excess (see profile no.6) ca 400mm; dry periods and restrained aeration very improbable.

N-reserve high (1270g.m^{-2}) in the potential root zone with above average C/N-ratio (Oh=17, Ah=15), inspite of an unfavourable humus form good N-supply is to be expected.
A medium P-reserve (240g.m^{-2}) by medium to low C/P-ratios (Oh=337, Ah=144), but P-supply is not restricted.
High base reserves for K and Ca (K=10.6kg.m^{-2}, Ca=4.4kg.m^{-2}), medium for Mg (=0.7kg.m^{-2}), but a low base saturation with a high Al- and Fe-sorption.

Site Description

Location: 1km NNW of Altglashütten

Elevation: 965m

Landform: pleistocene-holocene fluviolacustrine plain, edge of a terrace

Drainage: moderately drained

Vegetation: cranberry-spruce-fir wood (Vaccinio-Abietetum with Pinus sylv.ssp.hercynica)

Use: spruce stand (natural regeneration)

Soil temperature: about 6,5°C

Parent material: glacifluvial sands derived from Bärhalde-granite

Soil classification:
German : Humus-Eisen-Podsol
FAO : Orthic Podzol
US-S.T. : Humic Haplorthod, sandy-skeletal, siliceous, frigid

Profile Description

Horizon:		Depth cm:	Description:
L	O	6- 3	light brown, undecayed litter of spruce needles and bilberry leafes, very soft
Of	O	3- 0	very dark brown to black, fermented and partly decomposed vegetational remains, first of all leafes of bilberry, very soft, sharp wavy boundary
OhAh	OAh	0- 3	black (10YR2,5/1m), Oh material irregularly mixed in the mineral soil, much charcoal, horizon partly up to 7cm thick, mineral part moderately stony weak loamy sand(l'S), single grained, soft, very intensively rooted, main series, abrupt wavy boundary
Ahe	AhE	- 9	dark brown(7,5YR3/2m), moderately stony weak loamy sand(l'S), single grained, soft, intensively, main series, abrupt wavy to lobate Boundary
Ae	E	-20	dark brown to brown(7,5YR4/2m), moderately stony weak loamy sand(l'S), single grained, moderately compact, moderately rooted, main series, abrupt to lobate wavy boundary
Bsh	Bsh	-28	dark reddish brown(5YR2,5/2m), moderately stony weak loamy sand(l'S), coated grains*, no hardened, moderately compact, intensively rooted, main series, irregular abrupt to sharp boundary
Bhs	Bhs	-45	dark reddish brown(5YR3/3m), stony sand(S), coated grains*, partly hardened to ortstein, parallel texture, imbedded, very compact, only few roots, basic series, gradual smooth boundary
Bs	Bs	-65	dark reddish brown(5YR3/2m), stony sand(S), coated grains*, imbedded, very compact, no roots, basic series, partly abrupt or sharp wavy to lobate boundary
BvC	BwC	-90	brown to strong brown(7,5YR5/5m), slightly stony sand(S), single grained to coherent, imbedded, very compact, no roots

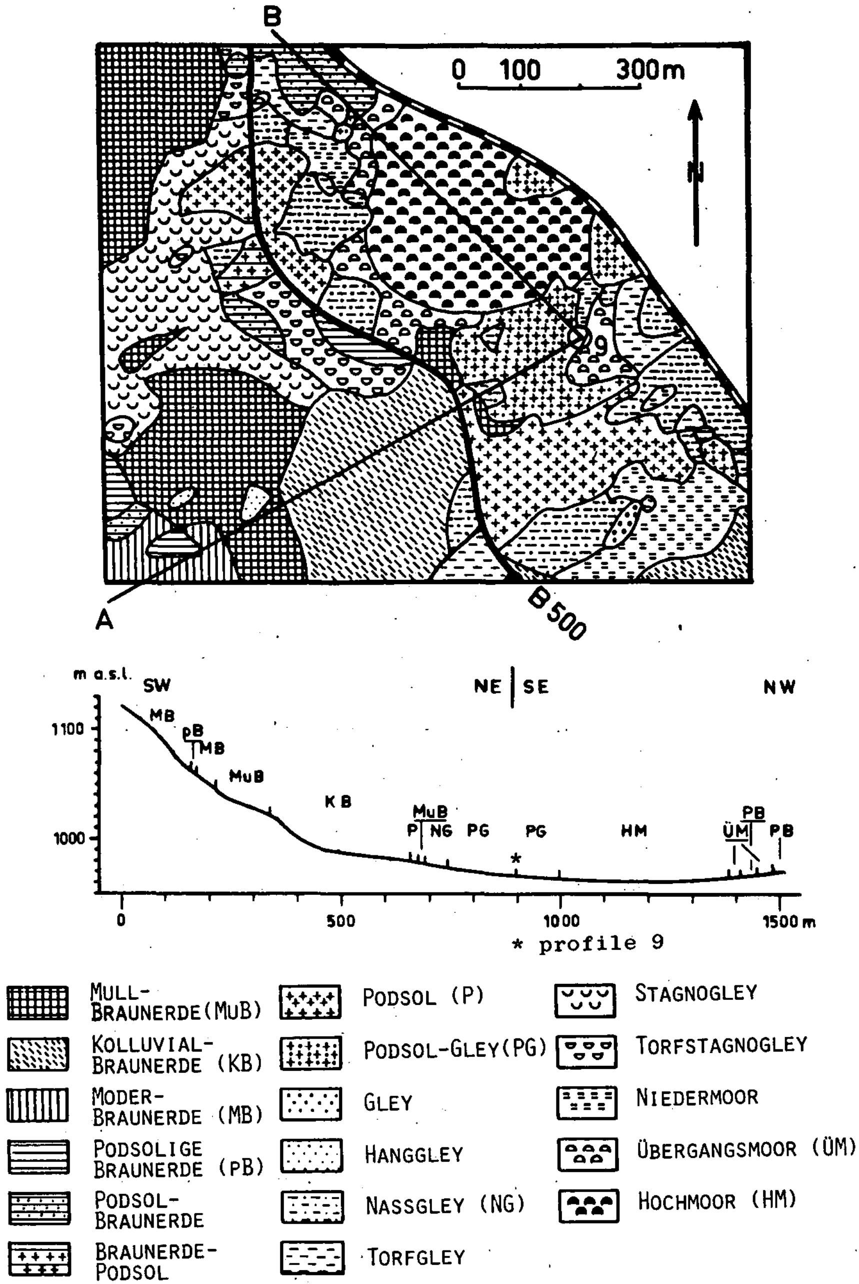


Fig. 11: Soil association map and cross section of the "Rotmeer"-area near "Altglashütten"(after STAHR and collaborators, unpublished)

No	hor.	depth cm	sto.* %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L	6-3												
2	Of	3-0												
3	OhAh	0-3	36	45	22	10	77	5	6	4	16	8		
4	Ahe	-9	41	48	22	9	79	4	6	3	13	8		
5	Ae	-20	44	45	25	11	81	5	4	3	12	7		
6	Bsh	-28	38	45	26	11	82	4	4	3	11	7		
7	Bhs	-45	51	45	38	9	92	2	2	1	5	3		
8	Bs	-65	60	54	32	7	93	1	2	1	4	3		
9	BvC	-90	11	62	30	4	96	1	1	0	2	2		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/g	Fe_t mg/g
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	L							4.0	3.6					0.8
2	Of							3.1	2.9					2.4
3	OhAh	0.69	74	66		32	4.4	3.5	2.9	2.0	0.3	.17	.00	4.4
4	Ahe	1.06	60	53		27	3.4	3.8	3.0	2.0	0.2	.12	.00	5.4
5	Ae	1.13	58	55		27	2.9	3.9	3.1	2.1	0.3	.16	.00	5.6
6	Bsh	1.21	50	47		28	8.9	4.2	3.3	7.3	5.0	.68	.00	11
7	Bhs	1.33	47	45		22	7.0	4.8	4.1	6.6	3.6	.55	.02	13
8	Bs	1.46	45	37		6.4	3.4	4.5	4.0	8.2	5.2	.63	.02	13
9	BvC	1.44	47	45		8.1	2.3	4.9	4.3	3.3	0.5	.14	.02	8.4

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	Pa mg/kg	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L	48	16	29			290	170	34	11.9	0.6	65	8	75
2	Of	43	16	26			288	93	27	6.7	0.6	131	30	44
3	OhAh	5.8	2.7	22	60		132	2	2	0.5	2	69	56	5
4	Ahe	2.8	1.4	20	62		112	1	1	0.2	2.2	56	52	6
5	Ae	2.0	0.6	33	54		125	1	0	0.1	0.8	63	60	1
6	Bsh	3.9	1.7	23	40		170	1	0	0.4	1.9	83	84	2
7	Bhs	2.9	0.9	32	62		32	1	0	0.1	1.3	14	16	7
8	Bs	2.2	0.4	55	56		51	0	0	0.1	2.1	24	25	4
9	BvC	0.5	0.1		72		2	0	0	0	0.9	0	1	47

* only fraction 2-20 mm

Profile 9 - Rotmeer

	total contents in mg/g						
	Na	K	Ca	Mg	P	Ti	Zr
2	42	43	44	45	46	47	48
L	.4	1.8	9.6	.6	.975	-	-
Of	1.4	4.6	3.6	.6	.825	-	-
OhAh	13.4	24.2	.9	.6	.640	1.2	.140
Ahe	15.0	29.4	.9	.7	.537	1.6	.168
Ae	14.4	29.8	.9	.7	.550	1.4	.135
Bsh	13.0	27.1	.9	.8	.625	1.2	.110
Bhs	16.4	30.3	1.2	1.1	.637	1.0	.122
Bs	13.8	27.6	.9	.9	.555	1.0	.081
BvC	18.5	34.8	1.2	1.0	.580	.9	.071

	mg/g						
	Fe_p	Mn_p	Mn_t	Al_o	Al_t	Si_o	Si_t
2	49	50	51	52	53	54	55
L			.32		1.6		
Of			.13		8.4		
OhAh	0.3	.010	.06	1.6	59.8	.4	335
Ahe	0.2	.010	.08	1.0	74.0	.4	342
Ae	0.3	.000	.08	1.3	70.8	.4	354
Bsh	3.8	.000	.09	4.0	69.2	.4	354
Bhs	1.8	.000	.13	4.8	74.8	.8	343
Bs	3.1	.000	.14	8.1	67.6	.4	330
BvC	0.2	.010	.13	2.6	75.5	.4	353

	clay minerals, % < 2 µ-fraction								
	K	I	S	V	Mg-C	Al-C	M-M *	Q	F
2	56	57	58	59	60	61	62	63	64
L									
Of									
OhAh									
Ahe									
Ae	10	10	10	45	tr	-	20	5	-
Bsh	15	15	30	15	tr	10	10	tr	5
Bhs	15	20	30	5	tr	10	10	5	5
Bs	-	-	-	-	-	-	-	-	-
BvC	-	50	-	-	tr	15	35	tr	-

*= mixed-layer minerals   tr = trace

EXPLANATIONS OF PROFILE NO. 9

History of Landscape and Land Use

Last glaciation in "Würm"-high glacial; accretion of an apron terrace in late glacial; undercutted by a little flood land in the Holocene.

First logging operation from 1660 to 1680; today third possibly fourth growth; spruce - natural tree species.

Soil Association

On the apron terrace all terrestrial soils are podzolized. To the W and N gleyization increases ("Podsol-Gleye" and "Gley-Podsole"), combined with peat formation and development up to high moores.
Apron terrace in the S (today grassland) was ploughed for a long time, today "Kulto-Podsol" with 20-30cm Ah- or Aeh- over old Bs- respectively BvC-horizons are found. In the flood lands "Naßgleye" and "Torfgleye".

Soil Genesis

- Substratum and Weathering

  In mineral stock and grain size a clear visible boundary between Bsh and Bhs; overlying stratum (= main series) more loamy than the underlying sands of the basic series; in the bleached zone a high percentage of expandable clay minerals including alternate-beddings; in the accumulation zone including Bh clear tendency to Al-chlorite formation; caolinite part by transport sorting decreased respectively in the glacial outwash clays of the "Rotmeer"-depression incorporated.

- Soil-forming Processes

  A medium humus accumulation (29kg.m^{-2}), 5kg.m^{-2} in the humus cover, 6kg.m^{-2} in the Ah- and Ae-horizons, and at least 18kg.m^{-2} dislocated (Bh+Bs); balance-sheeting through displacement and material sorting caused by transportation rendered.

  Base losses with totally $>$0.4e.m^{-2} only average; Na ca. 20% and K ca. 10% and mainly concentrated on the shallow upper profile part.

  6% (=1g.kg^{-1}) of Fe_t released by weathering and iron-oxide formation, primarily 20% were oxidical bounded.

  Clay formation with 5kg.m^{-2} (=4g.kg^{-1}) only low; clay formation maximum in Ae; a high percentage of coarse sand and gruss impede clay formation.

  Al-dislocation mobilized 4kg.m^{-2} with impoverishment including Bsh; Al-loss of profile 11% (=7kg.m^{-2}).

  A heavy podzolization caused dislocation of ca. 10% of Fe_t (≈1kg.m^{-2}) by a stable total balance (102%).

Soil Ecology

Low mechanical and even lower physiological deepness. Rooting ability in O- and A-horizons is not restricted;
low usable field capacity (35mm) in the root zone; sufficient rainfall during the growing season caused a satisfactory water supply; dry periods during summer or spring could lead to water scarcity; aeration in the root zone after heavy rainfall can be unfavourable for a short time.

N-reserve in the root zone with 0.2kg.m^{-2} (0.6kg.m^{-2} in the whole soil) low, and medium C/N-ratios (Of=27, OhAh=21, Ahe=20, Ae=33); N-supply probably bad.
Low reserves of P and bases - inspite of a good availability - they could be growth limiting. P-supply relatively best (C/P in OhAh = 91); because of shallowness tendency to windthrow in mature forests.

Site Description

Location: 325m WNW of Feldberg-Hebelhof(youth hostel)

Elevation: 1260m

Landform: steeply south-facing slope

Slope: middle part of the slope, 54%, SSW

Drainage: moderately drained, slow runoff

Vegetation: high montane to subalpine mat grass pasture (Leontodonto helvetici-Nardetum)

Use: extensive pasture

Soil temperature: about 5,6°C

Parent material: periglacial mud from paragneiss-metatexite

Soil classification:

German : Humusbraunerde (hangvergleyt)

FAO : Gleyic Cambisol

US-S.T. : Cumulic Haplumbrept, loamy-skeletal, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
L	O	2- 0	undecayed litter from grass and herb vegetation
Ah1	Ah1	0- 5	very dark grayish brown(10YR3/2m), stony sandy loam(sL), crumb, very soft, very intensively rooted, high earthworm activity, main series, gradual smooth boundary
Ah2	Ah2	- 20	dark brown(7,5YR3/2m), stony sandy loam(sL), crumb, very soft, very intensively rooted, high earthworm activity, main series, gradual smooth boundary
Ah3	Ah3	- 40	dark brown to brown(7,5YR4/2m), very stony sandy loam(sL), crumb to subangular blocky, very soft, intensively rooted, nestwise humus enrichment due to earthworm activity, main series, gradual smooth boundary
AhBv	AhBw	- 60	dark brown to brown(10YR4/3m), very stony sandy loam(sL), subangular blocky, soft, moderately rooted, earthworm tubes and nestwise humus enrichment due to earthworm activity, main series, gradual smooth boundary
GoBv	Bg1	- 90	dark yellowish brown(10YR4/4m), extremely stony sandy loam(sL), subangular blocky, moderately compact, few roots, rust mottles and earthworm tubes, main series, gradual smooth boundary
Go	Bg2	-130	dark brown to brown(10YR4/3m), extremely stony sandy loam(sL), coherent, compact, single roots, rust and manganese mottles, basic series, stones are oriented parallel to the slope and are covered with silty caps, sharp wavy boundary
CGr	Cr	-150	dark brown(10YR3/3m), extremely stony very loamy sand (l̄S), coherent to single grained, compact, no roots, zones of reduction and rust mottles, stones are covered with silty caps, regolithic zone, abrupt wavy boundary
C	R	>150	rock of paragneiss-metatexite

Profile 10 - Feldberg

No	hor.	depth cm	sto.* %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L	2–0												
2	Ah1	0–5	37	15	17	17	49	10	12	8	30	21		
3	Ah2	–20	30	13	17	15	45	10	13	8	31	24		
4	Ah3	–40	31	13	16	15	44	10	13	9	32	24		
5	AhBv	–60	48	13	17	16	46	10	13	9	32	22		
6	GoBv	–90	55	15	19	18	52	11	13	7	31	17		
7	Go	–130	56	16	17	16	49	9	12	9	30	21		
8	CGr	–150	65	25	25	14	64	6	9	5	20	16		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/g	Fe_t mg/g
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
1	L							–	4.4	4.5	1.7	.38	.40	10
2	Ah1	.87	68	63	33	29	12	5.1	4.2	11	6.6	.58	.15	36
3	Ah2	.80	71	65	38	32	8	5.3	4.4	11	6.7	.60	.14	36
4	Ah3	.99	63	60	42	36	9	5.4	4.5	11	6.6	.58	.13	38
5	AhBv	.99	64	56	38	34	8	5.5	4.5	14	8.1	.59	.19	42
6	GoBv	1.12	58	52	39	36	4	5.7	4.7	14	8.6	.60	.48	40
7	Go							6.0	4.9	24	15	.62	.58	55
8	CGr							6.1	4.9	10	3.4	.34	.05	38

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	Pa mg/kg	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L	41	11	38			105	44	20	5.4	1.1	16	18	67
2	Ah1	7.6	4.2	18	53		70	7	6	0.3	0.4	26	30	20
3	Ah2	5.0	3.4	15	45		45	4	4	0.2	0.5	17	19	19
4	Ah3	4.0	2.5	16	55		40	4	3	0.2	0.8	16	16	20
5	AhBv	3.5	2.2	16	55		26	5	1	0	1.0	10	9	27
6	GoBv	2.7	1.7	16	44		21	7	1	0	0.7	6	6	42
7	Go	3.4	2.5	14	30		33	21	4	0	1.1	4	3	79
8	CGr	2.1	1.4	15	51		23	14	2	0	0.8	4	2	74

* only fraction 2-20 mm

Profile 10 - Feldberg

	total contents in mg/g						
	Na	K	Ca	Mg	P	Ti	Zr
2	42	43	44	45	46	47	48
L	2.2	4.2	4.0	3.2	1.034	1.2	.102
Ah1	12.0	13.4	4.2	10.0	0.960	3.8	.209
Ah2	12.2	14.2	4.1	10.1	0.870	4.4	.202
Ah3	12.4	13.2	4.8	10.2	0.825	4.0	.210
AhBv	13.7	14.0	4.2	11.2	0.922	4.3	.217
GoBv	13.8	14.2	4.2	10.1	0.965	4.2	.210
Go	13.4	15.2	4.8	11.2	1.210	4.3	.190
CGr	15.6	16.9	5.7	11.3	1.225	4.1	.167

	mg/g						
	Fe_p	Mn_p	Mn_t	Al_o	Al_t	Si_o	Si_t
2	49	50	51	52	53	54	55
L	1.0	.440	.54	2.0	17.0	0.2	-
Ah1	3.2	.065	.50	6.7	78.0	0.6	268
Ah2	3.2	.040	.51	7.1	82.1	0.6	284
Ah3	2.9	.030	.50	7.3	84.9	0.8	291
AhBv	3.5	.040	.62	12.7	91.2	1.9	283
GoBv	2.8	.055	.84	15.0	89.4	3.0	294
Go	4.4	.075	1.09	15.3	97.0	2.7	264
CGr	1.4	.020	.48	13.0	95.0	2.9	292

	clay minerals, % < 2 µ-fraction								
	K	I	S	V	Mg-C	Al-C	M-M *	Q	F
2	56	57	58	59	60	61	62	63	64
L									
Ah1	30	5	-	-	15	20	25	tr	5
Ah2	30	5	-	-	10	20	30	tr	5
Ah3	30	-	-	-	15	40	10	-	5
AhBv	35	tr	-	-	10	25	25	-	5
GoBv	25	10	5	-	15	15	25	tr	5
Go	15	10	5	-	15	10	35	-	10
CGr	25	15	5	-	20	-	35	-	tr

*= mixed-layer minerals ; tr = trace

EXPLANATIONS OF PROFILE NO. 10

History of Landscape and Land Use

Center of the Würmian glaciation; ice cap up to late Würmian glacial; the thin morainic cover were remodeled by a very short periglacial phase, but subrounded pebbles still visible.

Transformation of the naturally mixed forest into pastures ca. 1000 years ago.

Soil Association

"Humusbraunerden" with mostly slope gleyization pattern in the Feldberg region on thick to very thick loose covers of debris in all exposures also under forest vegetation.
At medium to shallow or dense debris covering nearly exclusive hydromorphic soils also on steep slopes ("Stagnogley", "Hanggley", "Torfstagnogley", "Waldmoor").
On scars "Syroseme" or "Ranker".

Soil Genesis

- Substratum and Bedding
  Clear grain size boundarys between AhBv- and GoBv-horizon, between GoBv- and Go-horizon (boundary main series/basic series) and between Go- and CGr-horizon (boundary basic series/regolithic zone); mineral stock of the profile very homogeneous.

- Soil-forming Processes
  Humus accumulation very high (55kg.m^{-2}), 26kg.m^{-2} in Ah-horizons; very thick humus body with a constant decreasing of the humus contents with depth; intensive bioturbation.

  Base losses with totally 0.5ke.m^{-2} relatively low, it is different for single elements:
  Na 21(25)%, K 6(12)%, Ca 0(26%), Mg 11(21)%
  (initial amount=100%; in brackets average losses from 13 terrestrial soil profiles in the gneiss are); Ca intensively included in the bio-cycle or/ and supply through slope-water possible.

  Iron-oxide formation relatively low, only 7% (=2g.kg^{-1}) of Fe_t released.

  Clay formation very high (77kg.m^{-2}=41g.kg^{-1}) at a total amount of 186kg.m^{-2} in the profile; clay formation in the subsoil still comparatively high (water influence?);
  clay displacement and podzolization not proofed.

  Al-displacement with 1kg.m^{-2} evident; balance-sheeting because of eventual lateral supply questionable.

  Clay mineral transformation: Consumption of illites and partly of Mg-chlorites - formation of Al-chlorites; in the upper Ah-horizons more intensive expansion on alternate-beddings recognizable.

Soil Ecology

Up to 9dm (main series) no restriction of rooting depth; because of loose structure and moderate stone content root ability up to 6dm well. Current vegetation does not utilize the root zone.
High usable field capacity (175mm) and high rainfall guarantee very good water-supply. Mean water excess (see profile no. 6) during growing season 430mm and lateral water supply guarantee that field capacity is not remained under. Aeration of the profile is inspite of high water retention always well, on account of a high coarse-pore percentage.
Very high N-reserves (1240g.m^{-2}) with a relatively narrow C/N-ratio (Ah=16) guarantee a good N-supply.
Very high P-reserves (460g.m^{-2}) with a very narrow C/P-ratio (Ah=55) makes the P-supply optimal.
High base-reserves (K=7kg.m^{-2}, Ca=2.2kg.m^{-2}, Mg=5.2kg.m^{-2}) in combination with a base saturation above average (25-30%) and a relatively low exchangeable Al do not limit growth.

Site Description Profile 11

Location:	East of Singen/Hohentwiel
Elevation:	537 m
Landform:	Terrace, hill at the border of a hollow
Slope:	Northwest
Drainage:	Good
Vegetation:	Oak
Use:	Forest
Soil Temperature:	9 °C Precipitation: 770 mm
Parent material:	Fluvioglacial gravel (Würm)

Soil classification; FAO: chromic Luvisol

German: Rubefizierte Parabraunerde, stark entwickelt, mit Kalkanreicherung

US Soil Taxonomy: Typic Hapludalf, fine, mixed, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-10	Dark greyish brown (7,5 YR 4/2) (loamy) sand (Sl) rich in stones, granular with single grains, many roots, clear boundary
Al	E	-45	brown (7,5 YR 6/4) (loamy) sand (Sl) rich in stones, subangular blocky with single grains, some roots, clear boundary
Bt	Bt	-90	brownish red (5 YR 4/6) sandy loam (sL) rich in stones, angular blocky with single grains, clay skins around pebbles, few roots, sharp boundary
Cc	Ck	-100	grey (2,5 Y 5/3) sand (S) rich in stones, singlegrains, lime coatings on the lower edge of pebbles as crenellated crusts.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-10	41	7	21	18	46	16	10	8	34	20		
2	Al	-45	62	15	21	18	54	15	9	7	31	15		
3	Bt	-90	56	5	14	18	37	14	7	4	35	38		
4	Cc	-100	78	20	53	9	82	4	3	3	10	8		

No	hor.	bulk dens. g/cm^3	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg	P_v ‰	K_v ‰	Mg_v ‰	NH_4Cl me/kg H	NH_4Cl me/kg Al
1	2	16	22	23	24	25	26	27	28					
1	Ah	0,96	5,4	5,1	7,8	2,96	0,38	365	9,7	0,25	1,27	2,5	4	4
2	Al	1,16	5,2	4,3	7,7	1,40	0,18	275	2,1	0,15	1,34	3,0	6	8
3	Bt	1,23	5,7	4,8	15,2	2,32	0,15	415	<2	0,25	3,80	5,0	1	4
4	Cc	1,69	8,5	7,3	3,2	0,38	0,12	88	3,8	0,41	0,90	6,1	0	0

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	4,1	2,2	19	0	171	149	125	13	2,1	0,8	85		62
2	Al	0,8	0,5	16	0	84	44	20	8	1,0	0,7	65		31
3	Bt	0,5	0,5	10	0	221	177	125	43	2,4	1,5	68		72
4	Cc	0,1	0,1	10	23,1	27	-	275	11	0,9	0,6	0		100

Interpretation for Profile 11

The sandy gravel (calcite-marly, illite-loamy) from the late-Würmian Rhine glacier was moderately deeply decalcified and enriched with secondary lime in the C_c. Formation of iron oxides (the reddish ones probably under warmer conditions than at present, pre-subatlantic according to Moll 1970) and illitic clay minerals (CEC ≃ 500 meq/kg clay in all horizons) was followed by their lessivation (Fe_d:clay 0.04-0.05 in all horizons). The base saturation is still moderate, as is the accumulation of mull humus (9.5 kg/m²). Towards the surface the material was increasingly loosened (scarcely condensed by illuviation), weakly segregated to (sub)angular blocky in the subsoil and granulated in the topsoil.

The rooting space is less restricted by the argillic horizon than is the penetrability of the soil by the stone content. Presumably, the water capacity is low, the air capacity high. The low N reserves (325 g/m²) point to a high - and low P_a values to a low availability of these nutrients. Intense agriculture would require fertilization with K as well.

Site Description Profile 12

Location: East of Besetze

Elevation: 584 m

Landform: End moraine (Würm)

Slope: West, 10%

Drainage: Moderate

Vegetation: Beech

Use: Forest

Soil Temperature: 9 °C **Precipitation:** 800 mm

Parent material: Glacial till (Würm)

Soil classification; FAO: Orthic Luvisol

German: Parabraunerde, im Unterboden pseudovergleyt, stark entwickelt, mit kurzer Naßphase

US Soil Taxonomy: Typic Hapludalf, fine-loamy, mixed, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ah1	Ah1	0-9	Brownish grey (7,5 YR 6/2) loamy sand (lS), rare stones, fine granular, many roots, diffuse boundary
Ah2	Ah2	-20	brownish grey (7,5 YR 6/1) loamy sand (lS), rare stones, granular, many roots, diffuse boundary
Al1	E1	-38	yellowish grey (10 YR 8/2) loamy sand (lS), few stones, subangular blocky to platy, some roots, diffuse boundary
Al2	E2	-55	grey orange (10 YR 7/3) loamy sand (lS), some stones, angular blocky, few roots, clear boundary
Bvt	Bwt	-73	yellowish grey orange (10 YR 7/4) sandy to clayey loam (stL), some stones, angular blocky, vertical clay skins, rare roots, diffuse boundary
BtSd1	Btg1	-97	yellowish grey orange (10 YR 7/4) with grey cracks, sandy loam (sL), few stones, angular blocky, few blackish brown concretions, diffuse boundary
BtSd2	Btg2	-120	as before, but with more concretions
BC	Cw	-150	yellowish grey orange (10 YR 7/3) sandy loam (SL) with few stones, angular blocky to coherent.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah1	0-9	7,6	1	14	29	44	18	13	11	42	14		
2	Ah2	-20	5,5	1	15	29	45	19	14	9	42	13		
3	Al1	-38	11,2	2	15	28	44	18	13	8	39	17		
4	Al2	-55	12,6	2	15	29	46	16	11	7	34	20	623	
5	Bvt	-73	8,2	2	10	23	35	15	11	8	34	31	34	
6	BtSd1	-97	9,3	2	9	23	34	16	15	6	37	29	3	
7	BtSd2	-120	12,1	3	11	26	40	18	11	4	33	27		
8	BC	-150	13,3	2	13	34	49	18	13	2	33	18		

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah1	1,04	62	47	36	30	12	6,1	5,6	2,09	1,88	0,90	235	9,9
2	Ah2	1,29	56	38	31	26	12	6,0	5,3	1,96	1,76	0,90	220	4,6
3	Al1	1,46	48	32	25	21	8	6,8	5,9	2,49	2,16	0,87	310	<2
4	Al2	1,58	45	32	28	24	10	7,1	6,1	2,93	2,40	0,82	358	<2
5	Bvt	1,55	47	35	32	29	18	7,2	6,5	6,42	4,20	0,65	465	<2
6	BtSd1	1,50	49	38	36	34	18	7,4	6,7	6,33	3,84	0,61	533	<2
7	BtSd2	1,42	53	40	37	33	16	7,5	6,8	5,77	3,53	0,61	570	<2
8	BC	1,53	42	37	34	29	11	7,9	7,3	4,29	2,52	0,59	416	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah1	3,5	2,3	15	0	155	142	123	16	2,0	0,9	38		79
2	Ah2	1,8	1,3	14	0	96	86	73	11	1,3	0,8	30		74
3	Al1	0,6	0,5	12	0	76	71	59	10	1,3	0,7	13		85
4	Al2	0,4	0,4	10	0	84	84	70	12	1,5	0,8	8		91
5	Bvt	0,3	0,3	10	0	160	167	135	28	3,3	1,1	6		97
6	BtSd1	0,3	0,3	10	0	161	182	148	30	3,1	1,3	3		98
7	BtSd2	0,3	0,3	10	0	144	169	138	27	2,6	1,3	2		99
8	BC	0,3	0,3	10	0,8	107	-	174	21	2,0	1,0	1		100

No	hor.	depth cm	minerals in % sand fsp	qu	gl		silt fsp	qu	gl		clay Kao	X Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah1	0-9									15	25 25	5	30
2	Ah2	-20									15	25 25	5	30
3	Al1	-38									15	25 25	10	25
4	Al2	-55									15	30 25	10	20
5	Bvt	-73									10	30 30	20	10
6	BtSd1	-97									10	30 30	25	5
7	BtSd2	-120									10	30 30	25	5
8	BC	-150									10	30 30	25	5

No	hor.	Ti %	Zr %	Ti:Zr	microelements in ppm Zn	Cu	Ni	Co	Pb	Cd	P_v ‰	K_v ‰		Fe_t %
1	2	16	7	18	19	20	21	22	23	24	25	26		32
1	Ah1				40	10	10	6,5	17	0,03	0,15	0,55		1,3
2	Ah2										0,10	0,40		
3	Al1				83	17	12	8,6	15	0,19	0,02	0,85		1,4
4	Al2				46	7,8	17	11	17	0,16	0,04	1,25		1,8
5	Bvt				59	11	18	14	19	0,07	0,08	3,05		3,0
6	BtSd1				64	32	42	14	16	0,06	0,30	2,30		3,0
7	BtSd2				63	20	38	15	21	0,31	0,36	2,50		2,5
8	BC				60	17	43	12	18	0,19	0,60	1,20		2,6

Interpretation for Profile 12

The calcite-marly, illitic-montmorillonitic glacial till from the Würm end-moraine was decalcified rather deeply but scarcely deprived of bases. Formation of iron oxides (less crystallized than in the profile Singen, amount ≃ 500 g/m², i.e. 5% of the original) and (trans)formation of clay minerals (≃85 kg/m², i.e. +30%, in the topsoil mainly chlorites) was followed by a lessivation more of the latter (Fe_d:clay 0.015 in A versus 0.022 in B horizons). Thus, the loosening effect and granulation increasing upwards was countervailed in the lower, angular blocky horizons which have a low permeability. This caused some mottling and slightly higher Mn_o contents in the lower B, but did not influence the accumulation of mull humus (14.2 kg/m²) markedly.

The rooting space is deep, (available) water and air capacity (both about 180 l/m² until 1 m) are medium, and poor aeration of the deeper subsoil is of short duration only. The nutrient reserves are medium (N: 760 g/m²), making this soil a good forest site. Intense agriculture, however, would require rather high amounts of K and P.

Site Description Profile 13

Location:	South of Zoznegg
Elevation:	589 m
Landform:	Hill of dissected lake sediments
Slope:	North, 10%
Drainage:	Impeded
Vegetation:	Meadow
Use:	Grassland
Soil Temperature:	8,5 °C
Parent material:	Varved clay (Würm)

Soil classification; FAO:	Calcaric Gleysol
German:	Brauner Pseudogley-Pelosol mit kurzer Naßphase
US Soil Taxonomy:	Aeric Haplaquept, fine, mixed, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-20	Brownish grey (10 YR 4/3) loam (L), granular, many roots, diffuse boundary
AhBv	AhBw	-45	greyish brown (10 YR 4/4) loam to loamy clay (L-LT), granular to subangular blocky, few roots, diffuse boundary
PSd	Bwg	-70	greyish brown (2,5 Y 4/2)/greenish grey (10 Y 5/2) mottled loamy clay (LT), angular blocky to prismatic, blackish brown concretions, rare roots, diffuse boundary
lCSd	Ckg	-100	greenish grey (10 Y 5/2)/yellowish brown (2,5 Y 5/6) mottled loam to loamy clay (L-LT), coherent to imbedded, few blackish brown concretions, small carbonate concretions.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-20	0				6	31	22	13	66	28	11587	
2	AhBv	-45	0				2	28	24	12	64	34	2346	
3	PSd	-70	0				2	22	20	13	55	43	569	
4	1CSd	-100	0				0	20	22	16	58	42	11	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o: Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,81	66,3	61,9	38,4	28,5	21,7	7,8	7,0	10,1	2,46	0,24	565	<2
2	AhBv	1,09	61,5	51,1	30,8	28,7	17,6	8,0	7,1	10,0	1,74	0,17	450	<2
3	PSd	1,23	53,7	48,6	36,8	32,5	23,4	8,0	7,0	11,0	1,40	0,13	750	<2
4	1CSd	1,36	48,5	48,5	44,7	39,7	38,8	8,6	7,5	7,0	0,58	0,08	415	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	1,6	1,6	10	0,6	209	-	231	23	4.9	0,9	0		100
2	AhBv	0,6	0,8	8	0,2	206	-	210	26	4,1	0,9	0		100
3	PSd	0,6	0,5	12	0,2	211	-	213	40	4,3	1,1	0		100
4	1CSd	0,15	0,3	5	17,4	145	-	413	34	3,7	1,1	0		100

No	hor.	depth cm	minerals in % sand fsp	qu	gl		silt fsp	qu	gl		clay Kao	Ill	X	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13		14	15
1	Ah	0-20									20	30	25	20	5
2	AhBv	-45									20	30	25	20	5
3	PSd	-70									20	30	25	20	5
4	lCSd	-100									20	35	20	20	5

No	hor.	Ti %	Zr %	Ti: Zr	heavy minerals in % Ap	Zrc	Tur	Rut	Gar	Hbl	P_v ‰	K_v ‰	Mg_v ‰	
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah										0,33	4,20	5,0	
2	AhBv										0,29	2,95	4,5	
3	PSd										0,82	2,60	9,4	
4	lCSd										0,76	4,15	11,5	

Interpretation for Profile 13

The marly and upwards increasingly silty, illitic-montmorillonitic clay from a Würm basin lost most of its carbonates (partly reprecipitated at the profile basis), but is still saturated with bases. Formation of iron oxides is stronger than the weak (trans)formation of clay minerals (Fe_d:clay increasing upwards from 0.02 to 0.04). The originally dense and fine-porous material was in the subsoil segregated only weakly to angular blocky and prisms, towards the surface more loosened and transformed to subangular-blocky and granular. The resulting strong downward decrease of the permeability causes the formation of some concretions, but not an increase of the mull humus accumulation (13.4 kg/m²).

The rooting space is medium, equally limited by size and orientation of the pores (larger ones only vertical). The water/air-regime is characterized more by drought in dry periods (available FC to 1 m only 118 l/m²) than by poor subsoil aeration in the short wet phases (AC 186 l/m²). The nutrient reserves are medium (N 750 g/m²) to high (especially Ca). The contents of available nutrients are medium to high, except for those of P (which would have to be improved for agricultural use).

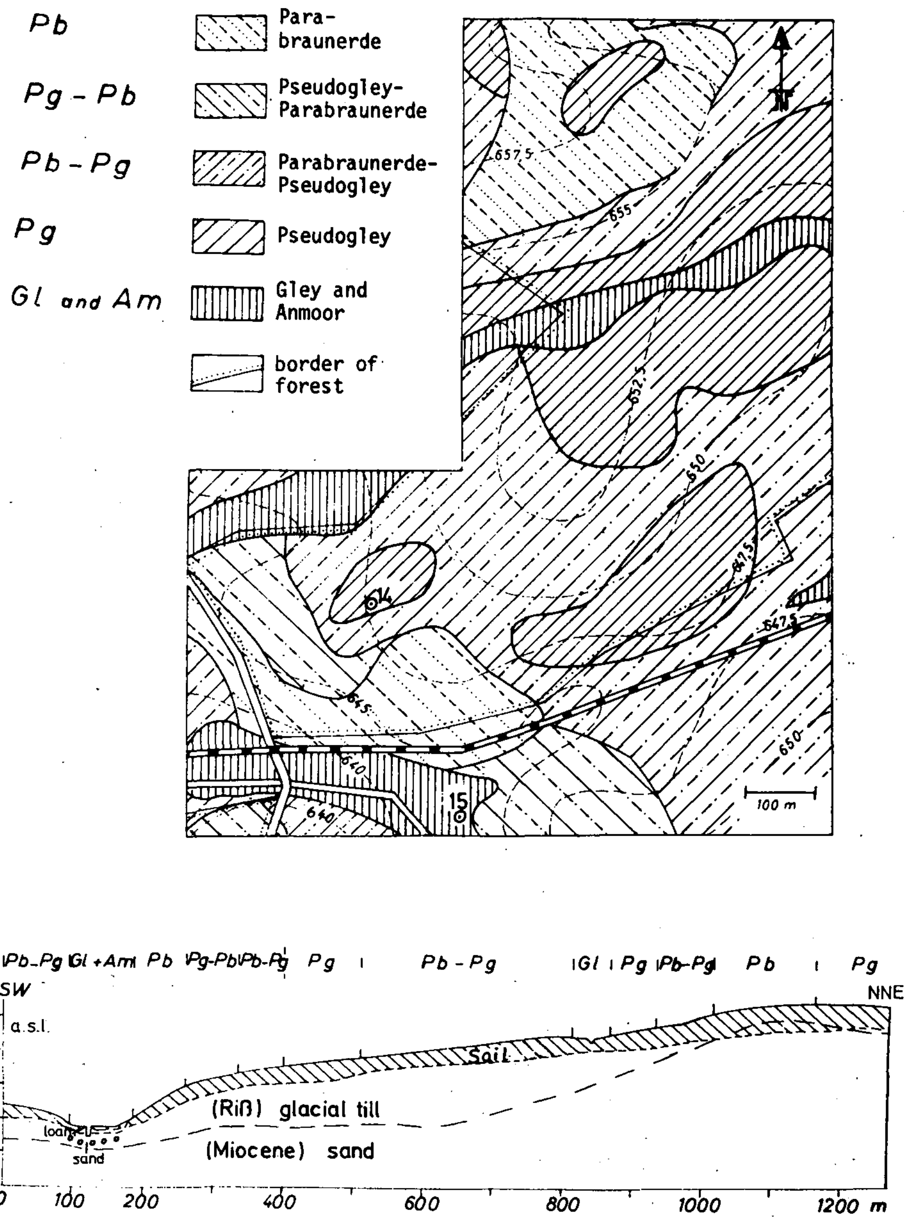


Fig. 12: Sentenhart, soil map with section

Site Description Profile 14

Location: North of Sentenhart

Elevation: 648 m

Landform: Flat ridge in ground moraine

Slope: Southwest, 3%

Drainage: Strongly impeded

Vegetation: Spruce

Use: Forest

Soil Temperature: 8 °C Precipitation: 850 mm

Parent material: Glacial till (Riß)

Soil classification; FAO: Gleyic Podzoluvisol

German: Typischer grauer Pseudogley, mit Rohhumus, Naß-phase lang

US Soil Taxonomy: Umbric Fragiaqualf, fine-loamy, mixed, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ofh	O	5-0	Blackish brown (10 YR 2/2), downward granular, many roots, diffuse boundary
Ah	Ah	0-3	dark grey (5 YR 2/1) silty loam (uL) without stones, granular to sponge-like, many roots, diffuse boundary
Swe	AE	-10	grey (7,5 YR 5/3) sandy silty loam (suL) without stones, weak subangular blocky, many roots, diffuse boundary
Skw	Ecg	-35	light grey (10 YR 6/2)/rusty mottled, blackish brown concretions, sandy silty loam (suL) without stones, platy to fine subangular blocky, some roots, wedged boundary
Skd	Bcg	-65	light grey (10 YR 7/1)/reddish yellow (10 YR 5/8) mottled, many blackish brown concretions, sandy silty loam (suL) without stones, coarse prismatic, rare roots, diffuse boundary
(Bt)Sd	B(t)g	-150	light grey (5 YR 7/1) reddish yellow (10 YR 6/8) mottled, few blackish brown concretions, few clay coatings, sandy silty loam (suL) without stones, coarse prismatic, "fragipan", diffuse boundary
BvSd	Bwg	-210	light grey/reddish yellow/yellowish brown mottled sandy loam (sL) without stones, coarse prismatic, diffuse boundary
SdCv	BgwC	-240	brownish yellow (2,5 Y 6/6), rusty mottled, sandy loam (SL) with few stones, coherent, diffuse boundary
BC	Cw	-250	light brownish yellow (2,5 Y 7/8), sandy loam (sL) with few stones, coherent

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ofh	5-0	0											
2	Ah	0-3	0											
3	Sew	-10	0	4	8	15	27	25	20	8	53	20	3000	
4	Skw	-35	0	8	7	23	38	24	11	10	44	17	330	
5	Skd	-65	0	3	6	18	27	23	17	9	49	24	15	
6	(Bt)Sd	-150	0	3	7	18	28	21	20	8	49	23	3	
7	BvSd	-210												
8	SdCv	-240												
9	BC	-250												

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ofh	0,60						3,9	3,1	4,1	2,40	0,59	50	75,5
2	Ah	0,98						3.6	3,4	7,2	4,26	0,59	33	20,6
3	Sew	1,31	62	49	44	37	20	4,0	3,7	5,4	3,21	0,59	213	13,5
4	Skw	1,38	52	44	38	32	21	4,3	3,8	11,3	2,53	0,22	500	8,7
5	Skd	1,59	45	41	37	32	22	4,4	3,9	18,3	1,96	0,11	279	3,5
6	(Bt)Sd	1,64	38	38	38	36	28	5,0	4,1	11,6	1,83	0,16	80	<2
7	BvSd	1,69	37	36	34	33	20	5,8	4,6	17,2	1,79	0,10	130	
8	SdCv							7,5	6,8	9,3	1,42	0,15	450	
9	BC									8,7	0,92	0,11		

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ofh	23,0	5,30	43	0	705	58	8	4,1	2,8	2,1	732		2
2	Ah	11,5	3,86	30	0	280	85	8	6,4	2,3	1,1	318		5
3	Sew	3,1	1,80	17	0	109	37	2	1,6	1,1	0,7	105		5
4	Skw	1,5	0,92	16	0	144	63	20	12,9	1,2	1,0	130		21
5	Skd	0,2	0,11	18	0	147	86	50	22,4	2,2	1,2	104		42
6	(Bt)Sd				0									
7	BvSd				0									
8	SdCv				1,8									
9	BC				11,0									

No	hor.	depth cm	c clay Kao	Ill	Mont	Chl	f clay Kao	Ill	Mont	Chl	P_v ‰	K_v ‰	NH_4Cl meq/kg H	Al
1	2	3	8	9	10	11	12	13	14	15	35	36	39	40
1	Ofh	5-0											35	6
2	Ah	0-3	10	20	0	70	10	10	10	70	0,42	2,16	13	54
3	Sew	-10											0	32
4	Skw	-35	10	40	10	40	10	15	15	60	0,23	2,88	0	28
5	Skd	-65	10	40	0	50	5	20	40	35	0,24	3,58	2	8
6	(Bt)Sd	-150	10	35	5	50	5	20	45	30	0,22	2,72		
7	BvSd	-210	10	35	5	50	< 5	20	60	15	0,49	2,32		
8	SdCv	-240												
9	BC	-250									0,47	2,05		

Interpretation for Profile 14

The marly, scarcely stony glacial till from the Riss groundmoraine was deeply decalcified (probably already preholocene) and in the upper part strongly depleted of bases. Extent of clay formation is uncertain, but according to analyses from a similar profile transformation of illites and montmorrillonite to mixed-layer minerals and chlorites is pronounced. Strong formation of iron oxides ($\simeq$ 15 kg/m², i.e. +30%) and translocation vertically with the clay minerals (Fe_d:clay about 0.07 in Skw and Skd) as well as laterally under bleaching (possibly even loss from the pedon) and formation of concretions rather rich in Mn in top- and mottling in the subsoil. The originally dense and fine-porous material was segregated to coarse prisms in the subsoil (but not loosened) and transformed to a subangular-granular material (increasingly loosened) in the topsoil, thus causing good conditions for infiltration but poor ones for percolation (see above). In this dystrophic and poorly aerated soil much moder humus was accumulated (38.5 kg/m²).

The rooting space is shallow to medium, the wet phase being rather long. Therefore, the water/air supply is less determined by the water capacity in dry periods than by the air capacity in wet ones (to 1 m available FC 150 and AC 77 l/m²). The nutrient reserves are moderate (N 807 g/m²), but the contents of available nutrients including N are low (though especially Ca and Mg not as low as in profiles 4-5) and those of exchangeable Al are high (as in profiles 1-3). Already increasing of timber production would require deep loosening and liming, agricultural use additionally P, K fertilization.

<u>Site Description</u> Profile 15

Location: North of Sentenhart

Elevation: 643 m

Landform: Valley-floor

Slope: No

Drainage: Ground-water level now between 40 and 60 cm

Vegetation: Meadow

Use: Grassland

Soil Temperature: 8 °C Precipitation: 850 mm

Parent material: Alluvial loam

Soil classification; FAO: Eutric Gleysol

German: Entwässerter Anmoorgley, stark entwickelt

US Soil Taxonomy: Mollic Haplaquept, coarse-loamy, mixed, mesic

<u>Profile Description</u>

Horizon:		Depth cm:	Description:
Ah	Ah	0-20	Blackish brown (7,5 YR 3/4), rusty root channels (7,5 YR 4/6), loamy sand (lS), granular to subangular blocky, many roots, diffuse boundary
Go	Bg1	-40	light grey (7,5 YR 4/2)/rusty brown (7,5 YR 5/8) mottled silty sand (uS), granular to coarse subangular blocky, some roots, diffuse boundary
Gor	Bg2	-60	light grey (7,5 YR 6/1), few rusty brown channels (7,5 YR 5/6), silty sand (uS), coherent, rare roots, diffuse boundary
Gr	Cr	-75	light greenish grey (7,5 Y 5/1 -10 GY 4/1) silty sand (uS), coherent, rare roots, clear boundary
IIGr	IICr	-100	light olive grey (10 Y 5/1) silty sand (uS), single grains.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-20	0	3	7	43	53	12	13	10	45	12	550	
2	Go	-40	0	2	4	40	46	24	11	13	48	6	2900	
3	Gor	-60	0	1	5	42	48	25	9	13	47	5	2400	
4	Gr	-75	15	2	4	34	40	25	12	11	48	12	8000	
5	IIGr	-100	32	20	15	27	62	9	16	8	33	5		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,78	70,5	66,9	60,1	55,2	11,6	6,2	5,7	19,3	9,92	0,51	688	28,3
2	Go	1,20	57,0	51,3	48,3	44,0	11,4	6,6	5,9	27,4	3,88	0,14	170	<2
3	Gor	1,32	51,3	48,3	46,3	43,1	9,8	6,6	6,0	6,2	1,67	0,27	10	<2
4	Gr	1,43	48,4	45,3	43,4	40,6	13,6	6,5	5,7	3,5	1,44	0,40	5	<2
5	IIGr							8,0	7,3	2,8	2,48	0,88	10	3,5

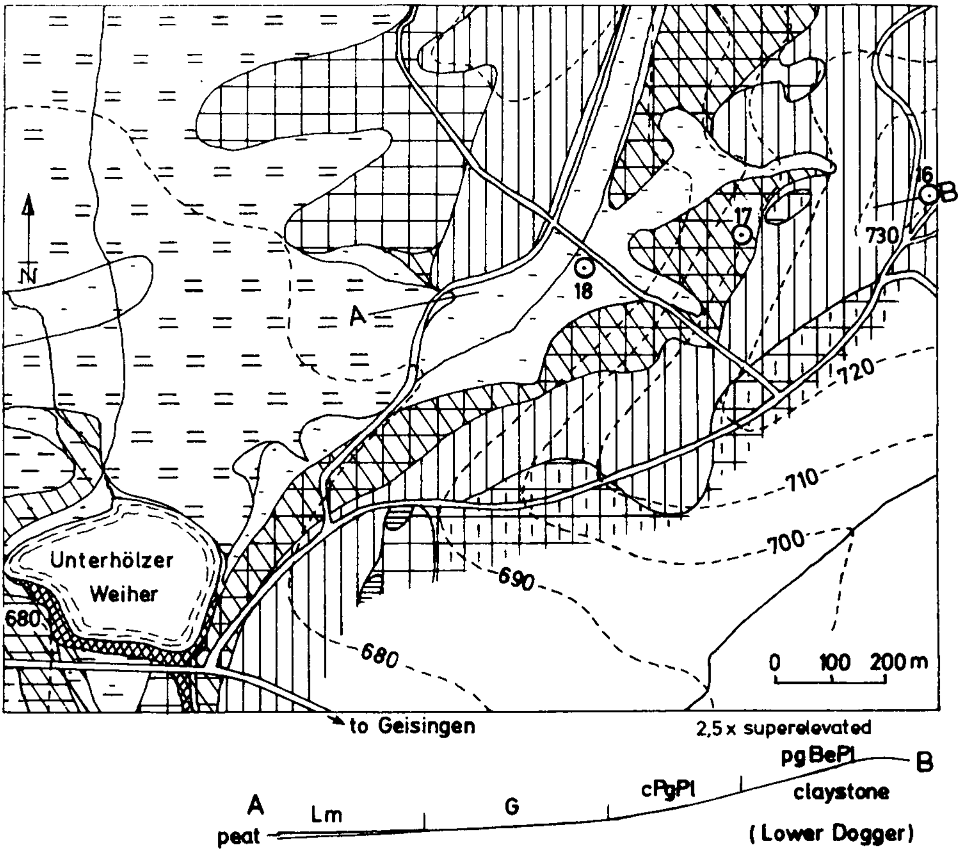
No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	5,5	4,8	12	0	250	291	269	18	1,1	2,4	52		85
2	Go	1,4	1,0	14	0	144	174	150	22	1,2	1,1	32		84
3	Gor	0,5	9,5	10	0	137	153	125	25	1,1	1,5	22		87
4	Gr	0,7	0,5	14	0	161	191	156	33	1,3	1,2	30		87
5	IIGr	1,5	0,3	5	7,6	69	-	313	15	1,6	1,0	0		100

No	hor.	depth cm	minerals in % sand fsp	qu	gl		c clay X Kao	Ill	Mont	Chl	f clay Kao	Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-20					<5	15	30	50	5	5	65	25
2	Go	-40					<5	10	35	50	5	10	85	0
3	Gor	-60					<5	25	40	50	5	5	60	30
4	Gr	-75												Verm.
5	IIGr	-100					<5	60	20	15	5	15	50	30

No	hor.	Ti %	Zr %	Ti:Zr	heavy minerals in % Ap	Zrc	Tur	Rut	Gar	Hbl	P_v ‰	K_v ‰		
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah										0,89	0,88		
2	Go										0,39	0,87		
3	Gor										0,26	0,71		
4	Gr										0,36	0,87		
5	IIGr										0,50	0,74		

Interpretation for Profile 15

The stratification of this strongly sorted over a less sorted alluvium makes statements about decalcification and (trans)formation of clay minerals difficult, but formation of iron oxide mottles in the capillary fringe at the expense of the subsoil is obvious, even more in the case of Mn (Fe_o:Mn_o decreasing upwards from >200 to <20). Though the soil was drained, base saturation and amount of organic matter (29.5 kg/m²) are still high. The coherent parent material was se- and aggregated only weakly to subangular blocky-granular in the topsoil (with decreasing density and permeability, possibly due to a change in the orientation of the pores). - The rooting space is still medium, the water/air regime being governed by the groundwater fluctuations and the air capacity (until 0.75 m only 56 l/m²). Except for P and N (1230 g/m²) the nutrient reserves are low, as are the amounts of available P and K (fertilization advisable).



pgBePl	pseudogleyed Brown earth-Pelosol	BePg	Brown earth-Pseudogley from sandy loess
bPgPl	brown Pseudogley-Pelosol	c	colluvial cover
PgPl	Pseudogley-Pelosol	Gl	Gley
			dam
TPg	Pseudogley from clay	Am	Anmoor, shallow (decomposed) moor
Pg	Pseudogley from sandy loess	Lm	Low moor

Fig. 13: Geisingen, soil map with section.

Site Description Profile 16

Location:	West of Geisingen
Elevation:	732 m
Landform:	Ridge
Slope:	No
Drainage:	Moderate
Vegetation:	Beech with spruce
Use:	Forest
Soil Temperature:	7,5 °C Precipitation: 750 mm
Parent material:	Marly claystone from the Lower Dogger

Soil classification; FAO: Gleyic Cambisol

German: Braunpelosol, im Unterboden schwach pseudovergleyt, mit kurzer Naßphase

US Soil Taxonomy: typic Eutrochrept, fine, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-15	Brownish grey (10 YR 4/3) sandy loam (sL), granular to subangular blocky, many roots, diffuse boundary
Bv	Bw	-40	yellowish brown (10 YR 5/6) loamy clay (LT), angular blocky, few roots, diffuse boundary
SdP	B(g)w	-60	yellowish brown (10 YR 5/6) with few grey mottles, loamy clay (LT), angular blocky, rare roots, diffuse boundary
SdC	C(g)	-100	olive grey (2,5 YR 4/3)/rusty brown (7,5 YR 5/8) mottled sandy loam to loam (sL-L), coherent to imbedded.

No	hor.	depth cm	sto. %	texture in % of humus- carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-15	0				13	29	23	11	63	24	226	
2	Bv	-40	0				10	33	11	10	54	36	2505	
3	SdP	-60	0				9	19	11	14	44	47	354	
4	SdC	-100	2,5				10	21	14	9	44	46	3	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o: Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,96	60,8	60,3	54,4	47,8	19,1	4,8	4,3	15,5	5,7	0,37	163	12,1
2	Bv	1,29	49,2	43,6	38,8	35,4	24,6	5,0	4,3	15,5	6,6	0,43	158	7,1
3	SdP	1,38	49,8	47,2	45,2	43,5	38,5	5,4	4,6	17,0	5,8	0,34	178	16,1
4	SdC	1,47	46,4	44,9	43,2	39,6	23,6	7,7	7,4	10,0	0,5	0,05	178	2,0

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	3,62	2,5	15	0	208	96	77	13,2	5,4	0,5	154	19	38
2	Bv	1,04	1,0	10	0	171	72	62	6,8	2,3	0,4	138	42	34
3	SdP	0,59	0,8	7	0	204	107	93	9,7	3,5	0,6	88	20	55
4	SdC	0,43	0,5	8	11,5	146	-	328	3,9	2,5	0,6	1	1	100

No	hor.	depth cm	minerals in %: sand fsp	sand qu	sand gl	sand	silt fsp	silt qu	silt gl	silt	X clay: Kao	Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-15									40	20 25	5	10
2	Bv	-40									40	20 25	5	10
3	SdP	-60									40	20 25	10	5
4	SdC	-100									40	25 20	10	5

No	hor.	Ti %	Zr %	Ti: Zr	heavy minerals in %: Ap	Zrc	Tur	Rut	Gar	Hbl	P_v ‰	K_v ‰	Mg_v ‰	Ca_v ‰
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,62	0,032	19,4							0,92	2,63	2,0	0,9
2	Bv	0,65	0,032	20,3							0,80	2,40	2,5	0,9
3	SdP	0,62	0,027	23,0							1,02	2,95	3,5	1,3
4	SdC	0,57	0,022	25,9							1,26	3,80	3,7	45,3

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Cr mg/g	Ni mg/g						%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	1,76	0,54	0,11	3,41	0,04	0,012	0,03						
2	Bv	1,69	0,54	0,09	3,72	0,04	0,015	0,03						
3	SdP	1,77	0,63	0,11	4,58	0,04	0,023	0,04						
4	SdC	1,89	0,90	0,13	4,62	0,04	0,015	0,03						

Site Description	Profile 17
Location:	West of Geisingen
Elevation:	710 m
Landform:	Mountain ridge
Slope:	Northwest, 20%
Drainage:	Strongly impeded
Vegetation:	Beech
Use:	Forest
Soil Temperature:	7,5 °C Precipitation: 750 mm
Parent material:	Claystone of the Lower Dogger with colluvial cover

Soil classification; FAO: gleyic Cambisol

German: Tiefhumoser Pseudogley-Pelosol mit langer Naßphase

US Soil Taxonomy: pachic Haplumbrept,, fine, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
Ah1	Ah1	0-7	Dark brownish grey (10 YR 3/2) sandy loam (sL), granular to subangular blocky, many roots, diffuse boundary
Ah2	Ah2	-30	brownish grey (10 YR 3/3) sandy loam to loam (sL-L), subangular to angular blocky, some roots, diffuse boundary
Ah3	Ah3	-50	brownish grey (7,5 YR 4/2) loam to loamy clay (L-LT), angular blocky to prismatic, few roots, clear boundary
SdP	Bwg	-80	yellowish brown (5 YR 7/8)/grey (5 Y 6/1) mottled loamy clay to clay (LT-T, coherent, diffuse boundary
PSd	Bg	-100	greenish grey (7,5 Y 5/4)/rusty brown (7,5 YR 6/8) mottled loamy clay to clay (LT-T), coherent (weakly imbedded).

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah1	0-7	0				10	20	8	13	41	49	11050	
2	Ah2	-30	0				7	25	16	7	48	45	1659	
3	Ah3	-50	0				6	24	14	2	40	54	55	
4	SdP	-80	0				} 5	20	12	9	41	54	35	
5	PSd	-100	0										23	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah1	0,50	77,2	41,5	37,5	34,0	22,1	5,3	5,1	21,0	8,2	0,39	273	29,2
2	Ah2	0,97	61,0	53,5	46,3	43,2	33,2	5,1	4,4	23,5	14,4	0,61	248	8,8
3	Ah3	1,11	57,3	52,5	45,6	42,2	32,1	5,7	4,8	23,5	8,6	0,37	223	1,4
4	SdP	1,32	52,5	49,9	48,8	46,6	34,2	5,7	4,7	22,5	5,0	0,22	30	2,1
5	PSd	1,51	45,1	46,4	44,3	41,4	30,3	5,9	5.9	23,5	3,8	0,16	310	9,9

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah1	12,9	5,5	24	0	437	328	258	62	6,7	1,5	225	1,0	59
2	Ah2	5,7	2,7	21	0	284	102	63	34	3,7	1,1	255	45,0	29
3	Ah3	2,2	1,8	12	0	296	171	113	53	3,6	1,3	123	10,0	58
4	SdP	0,6	0,7	9	0	237	146	93	48	3,9	1,2	81	} 7,0	64
5	PSd	0,5	0,5	10	0	193	161	113	43	3,5	1,0	57		74

No	hor.	depth cm	sand fsp	sand qu	sand gl		silt fsp	silt qu	silt gl		clay Kao	clay Ill (X)	clay Mont	clay Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah1	0-7									40	10 20	5	20
2	Ah2	-30									40	10 20	5	20
3	Ah3	-50									40	10 20	5	20
4	SdP	-80									} 40	15 30	5	10
5	PSd	-100												

No	hor.	Ti %	Zr %	Ti:Zr	heavy minerals in %: Ap	Zrc	Tur	Rut	Gar	Hbl	P_v ‰	K_v ‰	Mg_v ‰	Ca_v ‰
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah1	0,58	0,021	27,6							1,30	3,45	3,6	2,8
2	Ah2	0,66	0,024	27,3							1,34	3,70	3,8	1,2
3	Ah3	0,65	0,023	28,6							1,14	5,40	5,2	1,4
4	SdP	} 0,59	0,024	25,1							} 0,82	5,20	4,3	1,3
5	PSd													

No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Cr mg/g	Ni mg/g						%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah1	1,34	0,64	0,19	4,57	0,09	0,018	0,03						
2	Ah2	1,44	0,60	0,13	4,84	0,07	0,023	0,03						
3	Ah3	1,44	0,66	0,12	5,24	0,07	0,031	0,04						
4	SdP	} 1,63	0,64	0,06	5,06	0,02	0,028	0,03						
5	PSd													

Site Description Profile 18

Location: West of Geisingen

Elevation: 683 m

Landform: Valley floor

Slope: No

Drainage: Strongly impeded

Vegetation: Alder-tree, ash

Use: Forest

Soil Temperature: 7,5 °C Precipitation: 750 mm

Parent material: Alluvial loam

Soil classification; FAO: Mollic Gleysol

German: Tiefhumoser Gley, mäßig entwickelt

US Soil Taxonomy: Cumulic Haplaquoll, fine, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-10	Dark grey (10 YR 2/2) loam (L), granular to subangular blocky, many roots, diffuse boundary
AhGo1	AhBg1	-16	grey (2,5 YR 4/0)/rusty brown (7,5 YR 5/8) mottled loam (L), coarse angular blocky, some roots, diffuse boundary
AhGo2	AhBg2	-32	dark grey (2,5 YR 2/0)/rusty brown (7,5 YR 5/6) mottled loam to loamy clay (L-LT), subangular to angular blocky, reddish brown concretions, few roots, diffuse boundary
AhGo3	AhBg3	-65	dark grey (10 YR 2/1)/rusty brown (7,5 YR 5/6) mottled loam to loamy clay (L-LT), coarse angular blocky to coherent, root channels, diffuse boundary
IIGor	IIBg	-100	grey (2,5 Y 5/2)/rusty brown (7,5 YR 5/6)/ orange (5 YR 7/8) mottled loamy clay (LT), coherent, traces of roots.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-10	0				2	10	10	6	26	72	1452	
2	AhGo1	-16	0				1	23	4	6	33	66	20	
3	AhGo2	-32	0				} 3	27	8	12	47	50	2	
4	AhGo3	-65	0										130	
5	IIGor	-100	1				5	20	13	9	42	53	46	

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,59	75,3	74,1	62,5	57,1	40,6	5,7	4,9	14,5	13,8	0,95	118	20,5
2	AhGo1	0,79	69,7	67,8	66,1	61,3	42,5	5,7	5,0	14,5	15,5	1,07	20	4,0
3	AhGo2	0,72	70,3	70,4	68,6	64,1	49,7	5,5	4,9	13,5	11,0	0,82	25	5,0
4	AhGo3	0,92	65,4	70,5	64,5	62,6	51,6	5,5	5,0	11,3	8,4	0,74	35	28,4
5	IIGor	1,24	54,9	51,2	49,1	47,1	28,0	5,7	5,1	26,3	11,9	0,45	60	7,2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	8,2	7,9	10	0	478	372	321	43	6,5	1,8	236	2	61
2	AhGo1	6,4	4,6	14	0	473	326	279	40	5,1	1,9	179	4	65
3	AhGo2	8,4	5,7	15	0	539	340	289	43	5,5	2,7	208	4	62
4	AhGo3	2,3	1,6	15	0	251	140	113	24	1,8	1,4	107		57
5	IIGor	0,4	0,5	8	0	231	149	113	31	3,1	1,6	55	4	73

No	hor.	depth cm	minerals in % sand fsp	qu	gl		silt fsp	qu	gl		clay Kao	Ill ×Mont		Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-10									40	10 20	10	20
2	AhGo1	-16									40	10 20	10	20
3	AhGo2	-32									40	10 20	10	20
4	AhGo3	-65									40	15 20	10	15
5	IIGor	-100									40	20 20	10	10

No	hor.	Ti %	Zr %	Ti: Zr	heavy minerals in % Ap	Zrc	Tur	Rut	Gar	Hbl	P_v ‰	K_v ‰	Mg_v ‰	Ca_v ‰
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,59	0,021	28,2							1,57	5,27	4,9	2,8
2	AhGo1	0,54	0,014	38,0							1,26	6,93	6,0	3,15
3	AhGo2	0,52	0,014	38,0							0,99	5,95	5,3	1,77
4	AhGo3	0,61	0,029	20,9										
5	IIGor	0,59	0,025	23,7							0,73	5,71	5,2	1,84

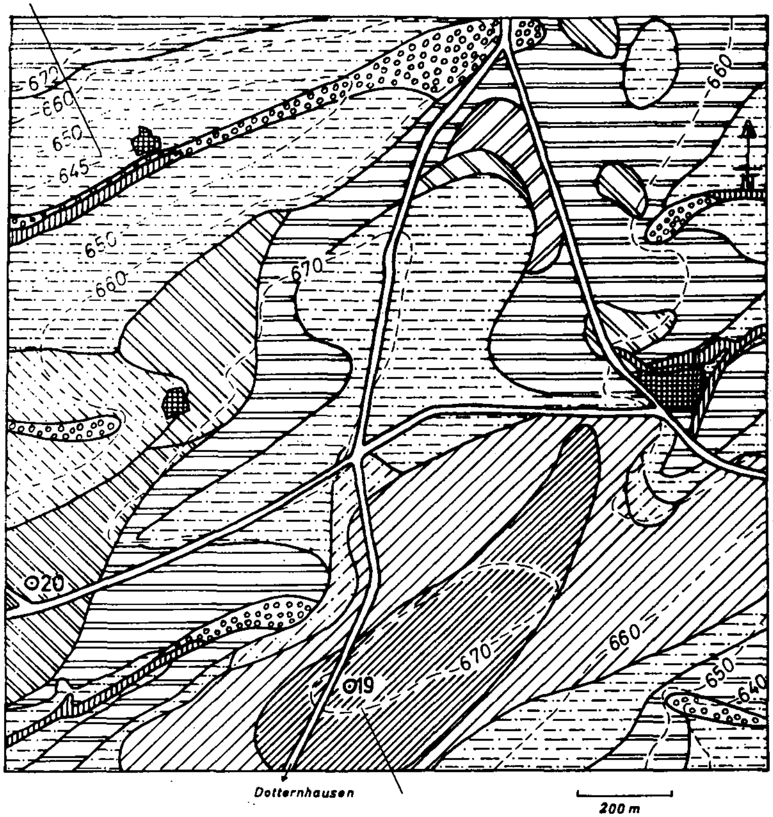
No	hor.	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Cr mg/g	Ni mg/g						%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	1,38	0,64	0,17	4,40	0,08	0,017	0,03						
2	AhGo1	1,39	0,79	0,13	4,69	0,01	0,024	0,06						
3	AhGo2	1,42	0,79	0,12	4,74	0,01	0,023	0,07						
4	AhGo3	1,53	0,58	0,08	3,08	0,02	0,017	0.04						
5	IIGor	1,65	0,66	0,07	5,05	0,03	0,019	0,05						

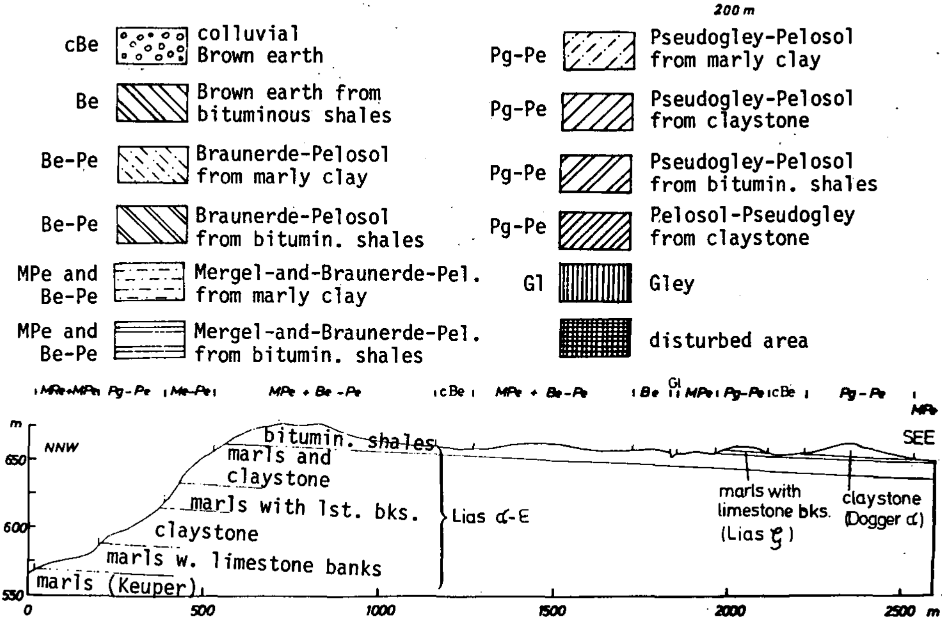
Interpretation for Profiles 16 - 18

The material from the Lower Dogger is a more or less marly, kaolinitic-illitic silty claystone. On the top of the ridge it was moderately deeply decalcified and impoverished in bases. Transformation of nonclay to clay silicates is obscured by possible effects of a stratification (but sand:silt nearly constant 0.2 in the solum) or - more likely - of a lateral translocation (which, however, must have acted not only on but also in the soil, presumably on the denser subsoil), leading to increasing clay contents downslope . The shift from illites to chlorites not only upward in the profiles but also downward in the catena support this idea. Formation of iron oxides is pronounced in the top profile ($\simeq$ 5 kg/m², i.e. +45%), though also Fe was translocated laterally on/in the soils. It was immobilized mainly in the slope-topsoil and scarcely in the valley profile (average Fe_d:clay for 1 m depth of the profiles 0.035, 0.046 and 0.037, respectively). This applies even more to Mn. Though the oxides are not well crystallized there (cf. Fe_o:Fe_d), no accumulation can be noted in the valley-topsoil (except for Mn in the A_h). It obviously receives its water from the catchment area more directly by runto and interflow than indirectly via the subsoil by capillary rise, thus is only weakly recharged with bases. Due to increasing sedimentation and/or decreasing mineralization downward ,considerably increasing amounts of organic matter are accumulated (from 25.3 over 52.1 to 52.7 kg/m²). The original slaty structure was weakened by swelling, segregated to angular blocky in the subsoils (even to prisms in the slope profile, possibly due to a higher moisture amplitude) and aggregated rather stably in the topsoils.

The rooting space is medium in the first profile of the catena, medium to deep in the second (restricted to the coarse vertical pores) and shallow in the third with its high swelling potential (water content at pF>0.6 pore volume). The top profile has a rather high water and low air capacity (to 1 m available 172 and 66 l/m², respectively). Since the former is located mainly in the scarcely penetrable and slowly permeable subsoil and the latter in the topsoil, deficiency of water in dry periods is more likely than that of air in the short wet ones. In spite of a lower water and a higher air capacity (133 and 103 l/m², respectively), this is much less so in the second profile, being additionally supplied with slowly moving slope water. And the opposite is true, at least as far as the aeration is concerned, for the valley soil (a FC 178 and AC 46 l/m²). - The nutrient reserves are high to very high in the case of N (1180, 1700 and 2042 g/m², respectively, but with decreasing availability in this sequence, see aeration), high also for P (but with generally low availability), medium to high for K (with availability decreasing downslope) as well as for Ca. The risk of Al, Cr or Ni toxicity is low. - Already for increasing timber production a decrease of runoff and/or interflow, e.g. by trenches in the contours, would be advisable and probably more effective than the direct drainage of the nearly impermeable valley soil (fertilizing effects of drainage, see profiles 1-3). For a possible use as pasture or meadow, additionally liming and fertilization expecially with P would be required.

Fig. 14: Waldhof, soil map with section





Site Description Profile 19

Location:	Southwest of the Waldhof
Elevation:	671 m
Landform:	Flat ridge
Slope:	No
Drainage:	Strongly impeded
Vegetation:	Spruce
Use:	Forest
Soil Temperature:	7,5 °C Precipitation: 800 mm
Parent material:	Claystone of the Lower Dogger with shallow loess cover

Soil classification; FAO: gleyic Cambisol

German: Typischer Pelosol-Pseudogley, Naßphase lang

US Soil Taxonomy: typic Haplaquept, very fine, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-8	Blackish brown (10 YR 3/2) loamy clay (LT), subangular blocky, many roots, diffuse boundary
AhSw	Ahcg	-32	brownish grey (10 YR 4/2) to yellowish grey (10 YR 6/4) loamy clay (LT), angular blocky, small blackish brown concretions, many roots, diffuse boundary
PSd	Bwg	-60	yellowish brown (10 YR 5/6)/light grey (N 7/0) mottled clay (T), coarse angular blocky to prismatic, few roots, diffuse boundary
SdP	Bgw	-85	brown (7,5 YR 4/6)/light grey (N 7/0) mottled clay (T), prismatic to coherent, rare roots, diffuse boundary
PC	BgCw	-100	grey (N 6/0) clay (T), coherent to prismatic (slicken sides), diffuse boundary
C	C	-110	light grey (N 7/0) clay (T) to imbedded claystone.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-8	0		3	4	7	5	8	18	31	62	2200	
2	AhSw	-32	0		4	2	6	6	8	18	32	62	3600	
3	PSd	-60	0		1	2	3	1	4	15	20	77	2800	
4	SdP	-85	0		1	1	2	2	7	17	26	72	0,6	
5	PC	-100	0		1	1	2	2	8	18	28	70	0,2	
6	C	-110	0		68	12	80	8	9	1	18	2	0,1	

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,76	67	57,2	51,9	49,9	18,3	6,6	6,0	40,5	13,4	0,33	2000	6,5
2	AhSw	1,02	62	55,1	50,8	49,4	26,0	6,7	6,0	25,0	15,5	0,62	1500	<2
3	PSd	1,28	53	49,2	47,3	46,7	33,9	5,5	4,7	23,2	6,6	0,28	310	<2
4	SdP	1,41	51	49,8	48,9	48,2	31,8	5,6	4,4	18,5	6,1	0,33	195	<2
5	PC	1,44	48	46,7	45,5	44,7	28,3	6,1	5,4	25,0	4,9	0,20	1250	7,1
6	C	1,54	45	39,2	37,6	36,6	29,5	7,5	7,3	28,0	2,1	0,08	800	3,6

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	6,4	3,6	18	0	362	381	350	25	5,2	1,0	56		87
2	AhSw	1,9	1,2	15	0	275	241	215	21	3,3	1,3	38		86
3	PSd	0,5	0,7	8	0	287	151	113	22	5,1	1,2	108		57
4	SdP	0,4	0,7	6	0	280	190	150	31	5,2	1,2	78		71
5	PC	0,5	0,7	7	0	260	220	179	35	4,6	1,3	45		83
6	C	0,7	0,5	12	0,8	226	-	325	28	4,5	1,8	6		100

No	hor.	depth cm	Qu	Mixed layer min. clay						P_v	K_v		NH_4Cl meq/kg	
				Kao	Ill +	Verm	Chl			‰	‰		H	Al
1	2	3	11	12	13	14	15			25	26		39	40
1	Ah	0-8	14	49	21	4	12			1,61	6,96		0	0
2	AhSw	-32	10	47	26	5	12			1,77	4,08		0	0
3	PSd	-60	7	46	27	8	12			1,09	4,22		2	8
4	SdP	-85	-	-	-	-	-			1,10	6,06		0	3
5	PC	-100	7	43	29	9	12			1,50	5,37		0	0
6	C	-110	7	44	30	13	6			1,44	6,16		0	0

Interpretation for Profile 19

The sediment is similar to that of the catena Geisingen (profiles 16-18), though with a lower silt:clay ratio and some vermiculite instead of montmorillonite. It was deeply decalcified, but just moderately depleted of bases. Clay "formation" by weakening of the consolidated material is obvious. The contribution of stratification (but sand:silt decreasing gradually downwards), lessivation (but no cutanes, sand:silt see before) or ejection of sand+coarse silt (relation to medium+fine silt increasing from SdP upwards) to the clay maximum is not clear, however, though the clay "transformation" reveals the same trend as in the catena Geisingen (illites to chlorites). As compared with its top profile, accumulation of mull humus (25.6 kg/m²) and average Fe_d:clay for 1 m depth are similar, but here the latter ratios (and even more the Mn contents) increase from SdP upwards, pointing to some capillary rise from the nearly impermeable subsoil under formation of concretions (cf. base saturation). The transformation of the structure is here even more pronounced than there, resulting in prisms bordered by slickensides in the subsoil and in (sub)angular blocs in the topsoil.

Rooting space (medium) as well as air and available water capacity (64 and 192 l/m², respectively) are similar to the top profile of the catena Geisingen, but due to a higher permeability in the topsoil and a lower in the subsoil the wet phases are much longer, making air instead of water the limiting factor. Except for N (1160 g/m²) the nutrient reserves are higher here, as are the contents of available K, Mg and especially Ca, but available P and probably N (see aeration) are lower. Amelioration would require improvement of the structure rather than drainage and additionally P fertilization.

Site Description Profile 20

Location:	West of the Waldhof
Elevation:	665 m
Landform:	Plateau
Slope:	Southwest, 2%
Drainage:	Impeded
Vegetation:	Fir with spruce
Use:	Forest
Soil Temperature:	7,5 °C Precipitation: 800 mm
Parent material:	Marly bituminous shale, Upper Lias

Soil classification; FAO: Haplic Phaeozem

German: Humus-Braunerdepelosol mit kurzer Naßphase

US Soil Taxonomy: Fluventic Haploboroll, very fine, mixed, frigid

Profile Description

Horizon:		Depth cm:	Description:
L/Of	0	1-0	Blackish litter of needles
Ah1	Ah1	0-6	blackish brown (10 YR 3/1) loamy clay (LT), granular to subangular blocky, many roots, diffuse boundary
Ah2	Ah2	-22	blackish brown (10 YR 3/2) clay (T), subangular blocky, many roots, diffuse boundary
BvP	Bw	-60	yellowish brown (10 YR 6/6)/dark grey (10 YR 4/1) mottled clay (T), coarse angular blocky, few roots, clear boundary
Cv	Cw	-80	light brownish grey (10 YR 5/1-2) clay (T), coarse angular blocky to imbedded, small rusty brown concretions, diffuse boundary
mC	C	-100	grey (10 YR 5/1), imbedded shale.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L/Of	1-0	0											
2	Ah1	0-6	0				2	10	14	11	35	63	320	
3	Ah2	-22	0				2	5	12	11	28	70	73	
4	BvP	-60	0				1	4	10	13	27	72	2	
5	Cv	-80	0				3	2	12	16	30	67	0,4	
6	mC	-100	100											

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	L/Of													
2	Ah1	0,55	76	52,4	49,0	46,1	17	5,6	5,1	36,0	5,1	0,14	800	35,3
3	Ah2	0,88	65	39,3	44,0	39,9	19	5,4	4,6	49,6	7,0	0,14	850	13,1
4	BvP	1,20	56	37,6	36,5	35,0	25	6,5	5,7	43,6	2,2	0,05	1250	4,4
5	Cv	1,37	46	40,9	40,2	37,9	17	7,7	7,3	37,9	0,9	0,02	350	2,1
6	mC													

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L/Of													
2	Ah1	15,0	7,5	21	0	521	447	413	27	4,8	1,7		190	70
3	Ah2	5,0	3,5	15	0	423	347	325	17	3,4	1,1		186	65
4	BvP	2,6	1,6	19	0	344	332	319	7	4,1	1,4		53	86
5	Cv	5,8	1,5	45	16,7	268	-	672	4	3,6	1,2		0	100
6	mC													

No	hor.	depth cm	minerals in % X clay: Qu	Kao	Ill	Mont	Chl	microelements in ppm: Zn	Cu	Ni	Co	Pb	Cd
1	2	3	11	12	13	14	15	19	20	21	22	23	24
1	L/Of	1-0						158	63	140	42	58	1,10
2	Ah1	0-6	5	27	12	55		211	67	148	41	50	0,88
3	Ah2	-22	5	26	13	56		172	75	164	79	55	1,10
4	BvP	-60	5	26	14	55		183	69	165	58	47	0,80
5	Cv	-80	5	24	23	48		190	81	182	71	13	1,29
6	mC	-100											

No	hor.	P_v ‰	K_v ‰	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	S_t %	S_s ppm	S_{org} ‰	P_{org} ‰		%
1	2	25	26	29	30	31	32	33	34	35	36	37	40	41
1	L/Of						4,91							
2	Ah1	1,46	4,55	1,63	0,46		8,08		0,13	38	1,3	0,82		
3	Ah2	1,14	4,75	1,64	0,42		8,61		0,08	33	0,8	0,51		
4	BvP	1,14	5,45	1,77	0,79		6,62		0,08	30	0,7	0,18		
5	Cv	1,30	5,50	1,82	0,86		5,85		0,28	155	2,6	0,11		
6	mC													

Interpretation for Profile 20

The material from the Upper Lias is a calcite-marly, sulfidic and bituminous (wide C:N, C:P and narrow C:S) shale, in which mixed-layer clay minerals predominate. It was moderately deeply decalcified but only weakly depleted of bases. Except for the effect of weakening (see profile 19) and an expansion of illites there are no indications of a clay (trans)formation (in view of a gradual upward increase of sand+coarse silt : medium+fine silt in the solum, the clay maximum could be explained as in the case of profile 19). Iron oxides seem to have been formed from sulfides rather than from silicates (Fe_d:clay $\simeq$ 0.08 independent of colour differences) and obviously were not translocated vertically. The rather high amount of mull humus (even if only 1/2 of the BvP-$C_{org.}$ is taken into account: 35.8 kg/m²) is due to pedogenic accumulation and not pretended by lithogenic organic matter (^{14}C-age in the A like that in comparable soils from other sediments). In spite of similar clay contents as in profile 19, the degree of segregation is lower (coarse angular blocky only) and that of aggregation (up to granular) is higher, thus leading to a rather coarse-porous solum which, nevertheless, is slowly permeable at its basis.

Because of less deep weathering the water capacity (available 150 l/m²) is somewhat lower than in profile 19, but in spite of it the air capacity (136 l /m²) is twice as high, the duration of wet phases much shorter and, consequently, the rooting depth medium, like there (the penetrability much better). Except for N (1880, of which about 1130 g/m² can be considered as pedogenic), the nutrient reserves are similar, as are the contents of available K, whereas those of P and Ca are higher and of Mg lower. These soils are very rich in total heavy metals, but their availability as well as that of anthropogenic additions (e.g. with sewage) is lower than in several "poorer" soils. For intense agricultural use they are drained, moderately limed and fertilized with (N)P and K.

Site Description Profile 21

Location:	South of Böhringen
Elevation:	563 m
Landform:	Hilly slope of Triassic cuesta
Slope:	South, 10%
Drainage:	Good
Vegetation:	Meadow
Use:	Grassland
Soil Temperature:	8 °C Precipitation: 800 mm
Parent material:	Marly claystone with gypsum, lower part of the Middle Keuper

Soil classification; FAO: vertic Cambisol

German: Tiefhumoser Braunpelosol, stark entwickelt

US Soil Taxonomy: vertic Eutrochrept, very fine, illitic, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-5	Reddish grey brown (5 YR 2/2) loamy clay (LT), subangular to angular blocky, many roots, diffuse boundary
BvP1	Bw1	-30	reddish grey brown (5 YR 3/2) loamy clay to clay (LT-T), angular blocky, few roots, diffuse boundary
BvP2	Bw2	-55	reddish grey brown (5 YR 3/2) loamy clay to clay (LT-T), coarse angular blocky, slickensides, rare roots, diffuse boundary
BvP3	Bw3	-80	reddish grey brown (5 YR 3/2) loamy clay to clay (LT-T), prismatic, slickensides, rare roots, diffuse boundary
C	Cw	-100	brownish grey (100 YR 5/1) and greenish grey (10 Y 6/1) imbedded, weakened marly claystone.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-5					3	6	16	18	40	57	5223	
2	BvP1	-30					3	4	12	22	38	59	22016	
3	BvP2	-55					3	5	9	19	33	64	174	
4	BvP3	-80					2	5	9	17	31	67	32	
5	C	-100					1	4	6	14	24	75	10	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o: Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	1,07	59,6	58,8	43,2	36,1	20,3	7,2	7,1	52,0	2,5	0,05	425	42,5
2	BvP1	1,13	57,1	56,8	42.7	36,9	23,7	7,2	7,0	26,0	2,5	0,10	1175	6,8
3	BvP2	1,15	57,6	54,9	41,7	36,4	25,7	7,6	6,9	42,0	3,7	0,09	750	<2
4	BvP3	1,37	48,0	60,2	53,0	48,7	31,4	7,4	6,9	22,0	4,3	0,20	825	≤2
5	C	1,30	51,2	61,0	55,0	51,6	32,7	7,5	7,0	39,5	1,5	0,04	200	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	1,96	1,3	15	12,2	277	-	375	70	14,3	0,6		0	100
2	BvP1	2,33	1,5	15	6,4	295	-	294	78	11,3	0,9		0	100
3	BvP2	1,25	1,1	12	1,3	300	341	209	122	8,8	1,0		10	97
4	BvP3	0,96	0,8	12	0,4	325	333	200	122	9,0	1,5		11	97
5	C	0,57	0,5	11	0	326	371	250	111	8,3	1,8		5	99

No	hor.	depth cm			clay Kao	Ill	Mont	Chl			P_v ‰			
1	2	3			12	13	14	15			25	26	27	28
1	Ah	0-5			5	40 25	25	5			0,49			
2	BvP1	-30			5	40 25	25	5			0,59			
3	BvP2	-55			5	40 25	25	5			0,39			
4	BvP3	-80			5	40 25	25	5			0,30			
5	C	-100			5	35 20	30	10			0,19			

Interpretation for Profile 21

The material from the lowest Middle Keuper is a dolomitic-marly, illitic-montmorillonitic claystone, more or less stratified (in some strata gypsic and with montmorillonite-chlorite interstratified minerals), here probably also colluviated. Therefore, statements about decalcification and (trans)-formation as well as translocation of clay minerals are difficult, also about mull humus accumulation (32.0 kg/m²) in situ. Pronounced are the weakening of the originally dense imbedded material and its subsequent segregation to prisms and coarse angular blocs (bordered by slickensides) in the subsoil and to (sub)angular blocs in the topsoil, the former having a high swelling potential (water content even at pF 2.5 > pore volume) but, nevertheless, a considerable permeability (possibly due to some rather stable cracks).

The rooting space is deep but in the subsoil restricted to cracks (tapestry on prism surfaces). Air and water capacity (84 and available 177 l/m², respectively) are moderate to high, but because of the slope position deficiency of air is less likely than that of water. Nutrient reserves (N 1215 g/m²) are presumably very high in the case of Ca, Mg and K but only moderate for P. The same applies to the contents of available nutrients.

Site Description Profile 22

Location:	West of Dunningen
Elevation:	682 m
Landform:	Hill slope
Slope:	West, 5%
Drainage:	Strongly impeded
Vegetation:	Spruce with pine
Use:	Forest
Soil Temperature:	7° C Precipitation: 800 mm
Parent material:	Marly clay from the Lower Muschelkalk

Soil classification; FAO:	Gleyic Cambisol
German:	Pseudogley-Pelosol, mäßig entwickelt, Naßphase lang
US Soil Taxonomy:	typic or aeric Haplaquept, fine, illitic, frigid

Profile Description

Horizon:		**Depth cm:**	**Description:**
Ah	Ah	0-3	Dark greyish brown (2.5 Y 3/2) silty, loamy clay (uLT), granular to angular blocky, few blackish brown concretions, many roots, clear boundary
AhSw	AhBwg	-15	dark greyish brown (2.5 Y 4/2) with few rusty mottlings, silty, loamy clay (uLT), angular blocky, concretions rare, some roots, diffuse boundary
SdP	Bwg	-37	olive grey (5 Y 5/3)/light grey (5 Y 7/1)/ brown (7.5 YR 5/8) mottled silty, loamy clay (uLT), prismatic, blackish brown concretions, roots rare, diffuse boundary
SdPCc	BgCwk	-67	olive grey (5 Y 5/2)/brown (7.5 YR 5/8)/ orange (7.5 YR 7/8) mottled silty clay (uT), silt stones rare, prismatic, some blackish brown concretions, lime precipitations, diffuse boundary
SdlCc	BgCk	-95	olive grey (5 Y 5/2)/brown (7.5 YR 6/8) mottled silty clay (uT), coherent, few concretions, lime as white coatings, layer of silt-stone at the base.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-3	0				3	13	29	15	57	40	8	
2	AhSw	-15	0				1	9	29	15	53	46	4	
3	SdP	-37	0				1	5	22	14	41	58	0	
4	SdPCc	-67	0				0	12	25	15	52	48	0	
5	SdlCc	-95	0				1	16	28	11	55	44	0	

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,89	69	68,2	61,7	48,1	16	5,9	5,3	18,0	6,1	0,34	1000	9,0
2	AhSw	1,13	54	53,4	50,2	41,2	17	6,2	5,6	20,0	6,2	0,31	1363	2,3
3	SdP	1,31	46	45,3	44,3	42,1	18	7,7	7,2	14,1	2,8	0,19	2920	<2
4	SdPCc	1,61	38	37,0	34,5	32,0	15	8,2	7,5	6,9	2,7	0,40	265	<2
5	SdlCc	1,74	55	54,9	53,5	49,2	12	8,3	7,6	7,0	3,3	0,47	413	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	6,0	2,9	20,9	0	294	240	188	46	5,2	0,9	88		73
2	AhSw	2,9	2,2	13,4	0	215	204	128	71	4,3	0,8	45		82
3	SdP	0,8	0,6	12,9	12,2	156	-	169	71	4,4	0,8	3		99
4	SdPCc	0,4	0,4	9,3	29,4	100	-	163	53	3,2	0,6	0		100
5	SdlCc	0,3	0,4	7,8	35,0	90	-	306	40	3,3	0,7	0		100

No	hor.	depth cm	minerals in % clay Kao	Ill	X	Mont	Chl	silt f:p	qu	gl				P_t %	Fe_t %
1	2	3	12	13		14	15	8	9	10	11	12		31	32
1	Ah	0-3	10	50	25	5	10							0,045	3,95
2	AhSw	-15	10	50	25	5	10							0,037	4,20
3	SdP	-37	10	55	20	-	15							0,047	4,01
4	SdPCc	-67	10	55	20	-	15							0,050	2,86
5	Sd1Cc	-95	10	55	20	-	15							0,057	2,83

Interpretation for Profile 22

The material from the Lower Muschelkalk is a dolomite-marly, illitic clay with siltstone layers. It was shallowly decalcified with reprecipitation of secondary lime (calcitic, see increase of exchangeable Ca:Mg towards depth) and only weakly desaturated of bases. (Trans)formation of nonclay to clay silicates is obscured by possible effects of stratification,and clay maximum in SdP can be explained as in the case of profile 19 (sand+coarse silt : medium+fine silt increasing up- and downward from this horizon). But formation of iron oxides is obvious (Fe_d:clay increasing from about 0.02 to 0.05, in the upper four horizons per m² 2.6 kg Fe_d more and 2.9 kg Fe_t-Fe_d less than in the lowest), mainly in the SdP as concretions rich in Mn (and possibly more crystallized, see Fe_o:Fe_d). The accumulation of mull humus (23.0 kg/m²) is slightly lower than in profile 19. In spite of lower clay contents the degree of segregation of the originally very dense and coherent material is even stronger (prismatic), but not the loosening effect; thus, the whole solum is very fine-porous too and the permeability very low.

Consequently, the rooting space is shallow and the air capacity very low (25 l /m²), whereas the water capacity is very high (available at pF 2.5 254 l/m²). With a higher permeability of the topsoil and less slope the wet phases would be even longer than they are. Nutrient reserves (N 972 g/m²) are presumably very high in the cases of Ca, Mg and K, but are only moderate in that of P. The same applies for the contents of available Ca and Mg, but K and P are only moderate and low, respectively. For timber production, deeper-rooting trees should be preferred, possibly improving the structure, and for use as pasture, fertilization at least with P would be required.

Site Description Profile 23

Location:	Northeast of Nattheim
Elevation:	637 m
Landform:	Karstic depression
Slope:	No
Drainage:	Impeded
Vegetation:	Spruce
Use:	Forest
Soil Temperature:	7,7 °C Precipitation: 800 mm
Parent material:	Lateritic clay with chert and shallow loess cover

Soil classification; FAO:	Dystric Gleysol
German:	Brauner Pseudogley, stark entwickelt, mit kurzer Naßphase
US Soil Taxonomy:	aeric Haplaquept, very fine, kaolinitic, frigid

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-5	Dark reddish brown (5 YR 2/4) loam (L), few stones, granular to subangular blocky, pisolitic iron ore rare, many roots, diffuse boundary
Bv	Bw	-30	yellowish brown (10 YR 5/8) loam (L), few stones, subangular to angular blocky, pisolitic iron ore rare, some roots, clear boundary
IISw	Bg	-90	light grey (N 8/0)/dark red (10 R 3/6)/brown (7.5 YR 5/8) mottled loam (L), few stones, angular blocky to coherent, pisolitic iron ore rare, few roots, diffuse boundary
Sd1	IIBwg1	-150	dark red (10 R 3/6)/light grey (N 8/0) mottled loamy clay to clay (LT-T), few stones, angular blocky to coherent, pisolitic iron ore rare, diffuse boundary
Sd2	Bwg2	-190	as before but rich in stones,
Sd3	Bwg3	-230	as before but rich in stones and pisolitic iron ore,
Sd4	Bwg4	-290	brownish red (2.5 YR 4/6)/light grey (N 8/0) mottled loamy clay to clay (LT-T), few stones, angular blocky to coherent, much pisolitic iron ore, diffuse boundary
Sd5	Bwg5	-480	yellowish brown (10 YR 6/8)/dark red (10 R 2/3)/light yellowish grey (7.5 YR 8/1) mottled loamy clay to clay (LT-T), few stones but rich in pisolitic iron ore, coherent.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil sand c	m	f	Σ	silt c	m	f	Σ	clay	kf cm/d	var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0- 5	5				15	26	48		74	11	3208	
2	Bv	-30	8				3	13	20		33	64	59344	
3	IISw	-90	1				4	5	17		22	74	64	
4	Sd1	-150	1				2	4	12		16	82	3	
5	Sd2	-190	1				2	4	11		15	83	0	
6	Sd3	-230												
7	Sd4	-290												
8	Sd5	-480												

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	$CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	0,44	81,8	63,8	29,0	24,9	14,8	4,4	4,0	24,0	2,61	0,11	720	29,1
2	Bv	1,17	56,7	49,7	31,1	28,4	14,7	4,5	3,9	29,3	2,61	0,09	630	<2
3	IISw	1,29	54,4	45,0	37,5	35,9	26,9	4,7	3,9	70,0	1,86	0,03	20	<2
4	Sd1	1,42	50.2	42,3	38,0	37,1	30,8	4,6	3,8	77,0	2,58	0,03	10	<2
5	Sd2													
6	Sd3													
7	Sd4													
8	Sd5													

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	9,50	4,36	22	0	326	72	55	7	2,3	0,9	295		18
2	Bv	1,52	0,76	20	0	192	72	16	8	1,2	0,6	215		11
3	IISw	0,42	0,33	13	0	307	211	139	50	1,2	1,0	170		
4	Sd1	0,28	0,19	15	0	334	219	161	40	1,1	0,6	120		
5	Sd2													
6	Sd3													
7	Sd4													
8	Sd5													

No	hor.	depth cm	minerals in % sand fsp	qu	gl		silt fsp	qu	gl		clay Kao	Ill	Mont	Qu
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0- 5												
2	Bv	-30									80		15	5
3	IISw	-90									80		15	5
4	Sd1	-150									85		15	0
5	Sd2	-190									95		5	0
												X		
	mC	>1620	(Zementmergel?)								5	10 75	10	0
	mC	von Auernheim (Hangende Bankkalke)									5	75 10	10	0

No	hor.	Ti % (< 20 µm)	Zr ‰ (< 20 µm)	Ti:Zr (< 20 µm)	K_t % (< 20 µm)	Mg_t % (< 20 µm)	P_t % (< 20 µm)	Fe_t % (< 20 µm)	Mn_t % (< 20 µm)	Al_t % (< 20 µm)	Si_t % (< 20 µm)	NH_4Cl me/kg H	NH_4Cl me/kg Al	%
1	2	16	7	18	29	30	31	32	33	34	38	39	40	41
1	Ah											1	6	
2	Bv	0,88	0,36	25	1,2			6,2	0,07	10,3	30	0	46	
3	IISw	1,22	0,32	38	0,2			6,6	0,01	11,6	29	1	19	
4	Sd1	1,17	0,24	48	0,1			11,7	0,02	12,7	24	0	16	
5	Sd2	1,24	0,22	56	0,1			9,7	0,07	12,1	26			
6	Sd3	1,53	0,36	43	0			11,3	0,08	14,0	26			
7	Sd4	1,73	0,43	40	0			10,9	0,11	16,6	25			
8	Sd5	1,71	0,40	43	0			12,4	0,33	11,9	26			
									<2 mm					
	mC	0,27	0,10	27	1,4			2,6		6,5	43			

Interpretation for profile 23

Relics of intense Eocene (or older) soil formation from Upper Malm-limestone ("Hangende Bankkalke") were preserved in a karstic depression. Under periglacial conditions this kaolinitic clay with pisolitic ironstone ($SiO_2:R_2O_3$ 1.3 - 2 in the fraction <0.02 mm, Fe_t-Fe_d approaching zero, Fe_d:clay 0.095, Fe_o:Fe_d very low) was covered by and partly mixed with a reddish loam rich in cherts and finally with some loess (see silt and K contents). Statements about (sub)recent soil formation in this stratified material are difficult; and the degree of mottling before and after the clay was covered with a permeable blanket cannot be judged. But the depletion of bases is certainly strong (higher saturation in the kaolinitic and oxidic subsoil probably pretended by sorption of acetate used in the H+Al determination, much lower is that of chloride, see negative ΔpH). Accumulation of moder humus (19.2 kg/m²) is moderate. The segregation of the kaolinitic clay is only weak (angular blocky at most), the aggregation in the loamy topsoil somewhat better.

The rooting space is rather deep, but the horizontal penetrability strongly decreasing downwards. Aeration is probably better (AC 204 l/m²) than could be concluded from the (more or less relictic!) mottling and - because of the impeded drainage - the water supply is better than indicated by the water capacity (aFC 110 l/m²). Except for the topsoil (containing 1/2 of the 575 g N/m²) the nutrient reserves are presumably very low (see K), as are the contents of available K and P, whereas Ca and Mg are medium (much higher than in profiles 1-5). Nevertheless, liming is advisable to (im)mobilize (Al and) P in the topsoil.

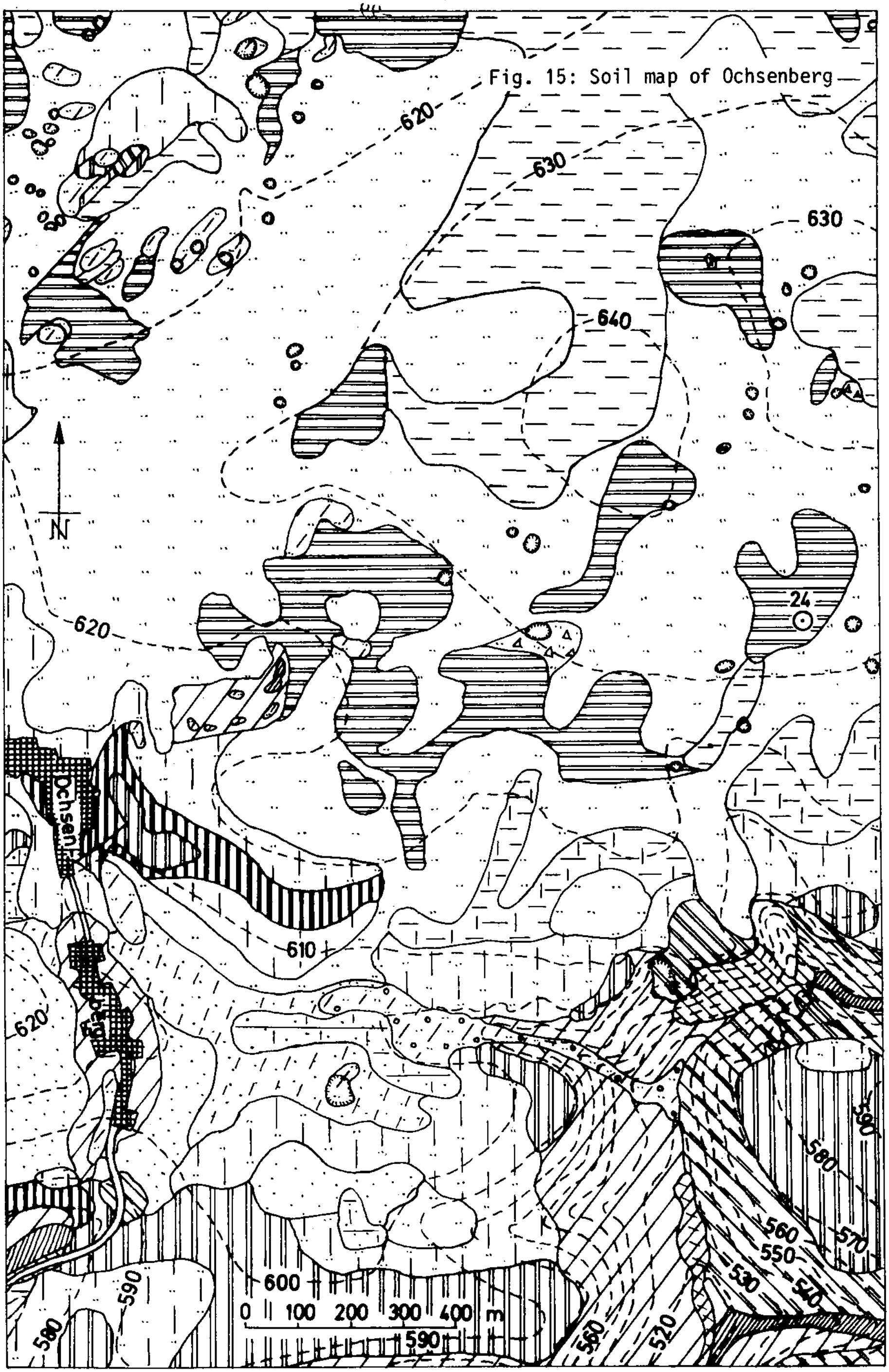


Fig. 15: Soil map of Ochsenberg

Legend for Fig. 15 - 17:

- Sand-Parabraunerde from terrace sands
- Sand-Parabraunerde from sand over limestone
- Podsol-Parabraunerde from loam with chert
- Parabraunerde from silty loam (local loess)
- same, over Terra fusca B
- colluvial Parabraunerde from silty loam (aqueous loess)
- same, over gravel from limestone
- Terra fusca, deeply developed, partly with silty topsoil
- Terra fusca with silty topsoil, middle developed to shallow
- Braunerde-Rendzina
- Mergelpelosol
- Braunerde-Rendzina and Rendzina from frost debris
- Gley
- Sand-Parabraunerde from loess over sand
- Podsol-Braunerde from solifluidal loam with chert over limestone
- Podsol from chert debris
- Pseudogley-Parabraunerde from silty loam (local loess)
- same, over Terra fusca B
- Grey Pseudogley from silty loam (local loess)
- colluvial Brown earth
- Brown earth from solifluidal loam (silty and clayey)
- Terra fusca, clayey, middle developed to shallow
- Rendzina from limestone
- Mergelrendzina
- colluvial Kalk-Braunerde
- disturbed area
- dolines

Site Description Profile 24

Location:	East of Ochsenberg
Elevation:	635 m
Landform:	Karstic depression
Slope:	Southeast, 5%
Drainage:	Strongly impeded
Vegetation:	Spruce with fir and beech
Use:	Forest
Soil Temperature:	8° C Precipiration: 900 mm
Parent material:	Loess (over Red Loam)

Soil classification; FAO: dystric Planosol

German: Grauer Pseudogley, stark entwickelt, Naßphase lang

US Soil Taxonomy: aquic Dystrochrept, fine-silty, mixed mesic

Profile Description

Horizon:		**Depth cm:**	**Description:**
Ofh	0	4-0	Blackish brown (5 YR 2/1) sponge-like, many roots, diffuse boundary
Ah	Ah	0-3	greyish brown (7.5 YR 5/3) sandy loam (sL), stones rare, granular to subangular blocky, many roots, diffuse boundary
Sew	Ecg	-43	light greyish brown (10 YR 7/3) sandy loam (sL), stones rare, subangular blocky to platy, many blackish brown concretions, some roots, wedged boundary
Sd1	Bcg1	-63	brown (7.5 YR 5/4)/light brownish grey (10 YR 7/2) mottled loam (L) with few stones, coarse angular blocky to prismatic, many blackish brown concretions, roots rare, diffuse boundary
Sd2	Bcg2	-110	brown (7.5 YR 5/6)/light brownish grey (10 YR 7/2) mottled loamy clay (LT) with some stones, prismatic to coherent, many blackish brown concretions.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ofh	4-0												
2	Ah	0-3	8,0	3	2	2	7	33	37	10	70	23	535	
3	Sew	-43	5,4	3	1	2	6	29	31	9	69	25	201	
4	Sd1	-63	4,6	2	1	3	6	32	29	7	68	26	59	
5	Sd2	-110	3,2	2	1	3	6	25	30	9	64	30	2	

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ofh							4,2	3,2	1,7	0,6	0,35	4000	160,1
2	Ah	0,42	82,4	68,2	47,3	43,0	15,1	4,6	3,7	4,5	3,0	0,67	810	67,1
3	Sew	1,43	47,4	47,7	37,0	32,0	14,4	4,7	3,9	11,5	3,2	0,28	930	10,2
4	Sd1	1,43	47,4	40,9	36,2	34,1	17,5	4,9	3,9	14,5	3,8	0,26	570	15,8
5	Sd2	1,51	44,3	40,6	38,4	37,0	17,0	5,2	4,3	18,5	1,8	0,10	480	6,1

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ofh	42,0	16,60	25	0	430	179	87,7	41,4	20,4	5,4	452		26
2	Ah	10,1	6,05	17	0	331	53	25,2	8,3	7,3	1,2	350		11
3	Sew	1,03	0,65	16	0	106	35	1,5	4,1	1,0	0,6	90		7
4	Sd1	0,47	0,39	12	0	137	67	15,2	11,7	1,7	0,5	98		23
5	Sd2	0,18	0,34	5	0	156	87	25,6	48,9	2,4	0,8	71		52

No	hor.	depth cm	minerals in % sand fsp	qu	gl		c silt fsp	qu	gl	qu:fsp	clay Kao	Ill	Mont	Ou
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ofh	4-0												
2	Ah	0-3					16,1	76,5	3,3	4,75	3	7	63	19
3	Sew	-43					16,3	66,3	7,6	4,07	1	8	68	14
4	Sd1	-63					16,3	61,3	9,0	3,76	1	9	68	13
5	Sd2	-110					14,3	71,0	6,4	4,96	6	13	67	4
No	hor.	Ti %	Zr %	Ti:Zr	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %	Si_t	NH_4Cl meq/kg H	Al	%
1	2	16	7	18	29	30	31	32	33	34	35	39	40	41
1	Ofh											23	1	
2	Ah	0,55	0,051	10,9	1,32			1,4		4,4	32,0	4	7	
3	Sew	0,53	0,043	12,1	1,50			2,2		4,8	28,5	1	27	
4	Sd1	0,51	0,040	12,8	1,52			2,8		5,6	27,5	1	38	
5	Sd2	0,51	0,035	14,6	1,35			2,9		5,7	27,5	1	9	

Interpretation for profile 24

The loess cover, mixed by cryoturbation and/or solifluction with weathering products of limestone (e.g. chert) over the Red Loam is much thicker than at Nattheim (profile 23). It is (was always?) free of lime and strongly depleted of bases. There are no indications for an upwards increasing weathering (cf. qu:fsp and mica contents) and a subsequent clay translocation (no cutanes) nor clear ones for a downward increasing proportion of red loam (related to clay contents Ti:Zr and SiO_2:R_2O_3 nearly constant, only a slight increase in kaolinite), just for a preference of (less crystallized) iron oxides versus clay (Fe_d:clay from 0.025 to 0.062). Thus, statements about clay (trans)formation are difficult, but the redistribution of iron in mottles and concretions (rather poor in Mn!) is obvious. The accumulation of moder humus (31.4 kg/m²) of which 2/5 are on the soil) is pronounced. The segregation of this monmorillonitic loam is much stronger (up to prisms) than that of the kaolinitic clay (profile 23), but the permeability of the subsoil is equally low.

The rooting space is medium, but restricted by poor aeration in wet phases. These are, as judged by the proportion of bleached parts in the profile (mottling here not relictic), rather long. Consequently, they determine the supply more than the medium to high air and water capacity (AC 96 and aFC 217 l/m²). The nutrient reserves (N 978 g/m², 1/4 on the soil) presumably are rather low (see K_t), but the contents of available nutrients are - except for Ca - surprisingly high, at least in the (fertilized?) topsoil, whereas the subsoil is poor and rich only in exchangeable Al. Already for increasing the timber production liming would be advisable, for agricultural use also deep loosening or drainage as well as complete fertilization.

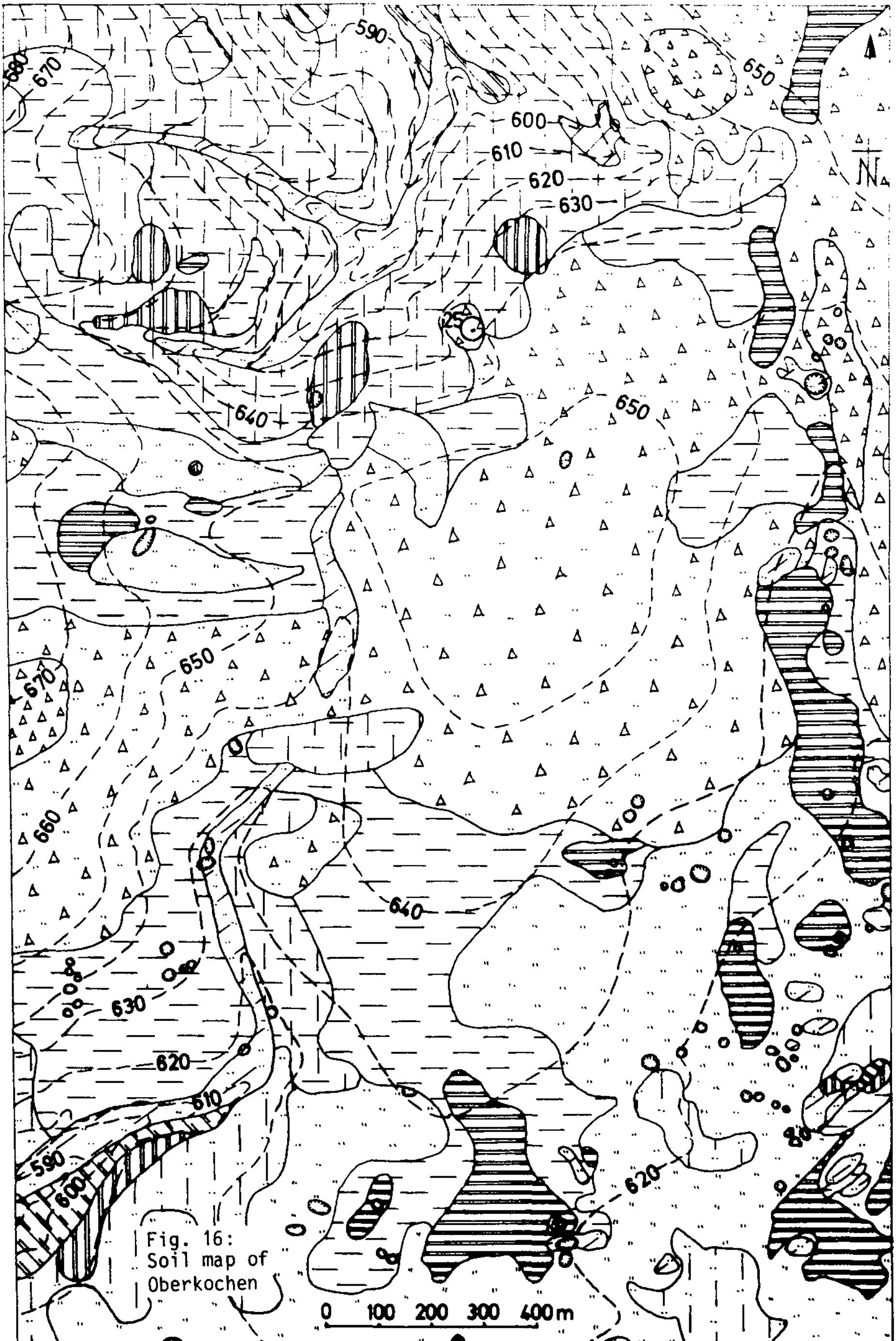


Fig. 16:
Soil map of
Oberkochen

Site Description Profile 25

Location: East of Oberkochen

Elevation: 635 m

Landform: Hilly slope

Slope: Northwest, 10%

Drainage: Moderate, downward decreasing

Vegetation: Spruce with dwarf shrub (Vaccinium)

Use: Forest

Soil Temperature: 8° C   **Precipitation:** 900 mm

Parent material: Talus of chert debris upon solifluidal lobe of clay

Soil classification; FAO: dystric Cambisol

German: Podsol, im tieferen Unterboden pseudovergleyt

US Soil Taxonomy: typic Haplumbrept coarse loamy over clayey siliceous, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ofh	O	8-0	Dark brown (5 YR 3/2), sponge-like, many roots, diffuse boundary
Ah	Ah	0-7	brownish black (7.5 YR 1/1) sandy loam (sL) rich in stones, granular with single grains, some roots, clear boundary
Ae	E	-23	grey (7.5 YR 6/2) sandy loam (sL) rich in stones, single grains, few roots, clear boundary
Bh	Bh	-27	dark greyish brown (7.5 YR 4/3) sandy loam (sL) rich in stones, coated grains, few roots, diffuse boundary
Bs	Bs	-47	dark brown (7.5 YR 4/4) sandy loam (sL) rich in stones, coated grains, rare roots, diffuse boundary
Sd1	Bwg1	-88	light yellowish brown (7.5 YR 6/4) sandy loam (sL) rich in stones, single grains to coherent, blackish brown concretions, diffuse boundary
Sd2	Bwg2	-160	light yellowish brown (7.5 YR 6/8) sandy loam to loam (sL-L) rich in stones, coherent, blackish brown concretions, diffuse boundary
IISd	IIBwg	-165	light yellowish brown (7.5 YR 6/6) loamy clay (LT) rich in stones, coherent, blackish brown concretions, diffuse boundary
IIISrd1	IIIBg1	-300	light brownish yellow (10 YR 7/4) loamy clay (LT), coherent, diffuse boundary
Srd2	Bg2	-330	greyish brown (10 YR 6/3) loamy clay (LT), coherent, sharp boundary
IVmC	C		limestone (Upper Malm)

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ofh	8-0												
2	Ah	0-7	52,8	38	8	10	56	17	16	6	39	5		
3	Ae	-23	51,5	37	5	8	50	16	17	9	42	8		
4	Bh	-27	44,2	31	5	7	43	16	18	10	44	13		
5	Bs	-47	50,0	32	5	7	44	12	22	8	42	14		
6	Sd1	-88	62,0	33	6	10	49	17	13	6	36	15		
7	Sd2	-160	50,3	23	5	8	36	9	11	6	26	38		
8	IISd	-165	34,8	4	2	4	10	6	7	6	19	71		
9	IIISrd1	-300	3,5	2	1	4	7	4	6	6	16	77		
10	Srd2	-330	4,0											
11	IVmC													

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ofh							4,8	4,4	1,3	0,3	0,23	1920	133,6
2	Ah	1,2						4,7	4,1	1,5	0,2	0,13	170	24,4
3	Ae	1,2						5,2	4,4	2,0	0,1	0,05	20	3,7
4	Bh	1,3						4,1	3,5	5,5	2,2	0,40	45	4,9
5	Bs	1,3						4,3	3,8	9,0	3,0	0,33	25	5,9
6	Sd1	1,3						4,8	3,9	3,7	0,3	0,08	25	<2
7	Sd2	1,5						5,1	4,1	12,8	0,4	0,03	438	<2
8	IISd	1,7						5,3	4,2	4,4	1,2	0,27	440	<2
9	IIISrd1	1,8								4,0	0,2	0,05		
10	Srd2	1,8								5,5	0,2	0,04		
11	IVmC													

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ofh	42,2	14,61	29	0	1038	531	430,0	30,5	31,2	4,0		544	48
2	Ah	12,1	4,65	26	0	62	35	27,6	1,8	0,9	0,5		174	15
3	Ae	0,63	0,34	19	0	34	22	16,2	1,8	0,9	0,6		29	40
4	Bh	3,13	0,47	67	0	86	26	7,1	1,8	1,2	0,7		103	10
5	Bs	1,95	0,57	34	0	123	34	5,2	1,3	1,5	0,5		137	6
6	Sd1	0,54	0,21	26	0	103	40	5,2	0,8	1,5	0,5		113	7
7	Sd2	0,19	0,17	11	0	149	72	52,8	4,3	1,6	0,8		81	42
8	IISd	0,11	0,15	7	0	445	283	249,2	18,8	5,0	1,0		130	68
9	IIISrd1				0									
10	Srd2				0									
11	IVmC				>75									

No	hor.	depth cm	minerals in % sand fsp	qu	gl		c silt fsp	qu	gl	qu:fsp	clay Kao	Ill	Mont	Qu
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ofh	8-0												
2	Ah	0-7					3,6	87,7	0,1	24,4	0	0	72	28
3	Ae	-23					4,9	91,4	0,7	18,6	0	3	67	26
4	Bh	-27					4,7	91,6	0,7	19,5	0	5	69	23
5	Bs	-47					7,2	86,6	1,7	12,0	0	5	64	21
6	Sd1	-88					0,7	94,9	0,6	135,6	1	5	77	15
7	Sd2	-160					0,4	97,5	0,6	243,8	5	7	71	7
8	IISd	-165					0	76.4	0,3					
9	IIISrd1	-300					0,5	95,7	0,9	191,4				
10	Srd2	-330												

No	hor.	Ti %	Zr %	Ti:Zr	K_t %	Fe_t %	Al_t %	Si_t %	Al_d ‰	Fe_p ‰	C_p ‰	NH_4Cl meq/kg H	Al	Al_p ‰
1	2	16	7	18	29	32	34	35	36	37	38	39	40	41
1	Ofh											34	1	
2	Ah	0,15	0,008	17,7	0,20	0,3	0,8	37,0	0,35			3	1	
3	Ae	0,17	0,01	17,4	0,21	0,3	0,8	42,0	0,14			1	1	
4	Bh	0,19	0,01	18,3	0,30	0,7	1,4	38,0	0,66	3,0	3,61	1	14	1,4
5	Bs	0,19	0,01	19,7	0,36	1,0	2,3	36,5	1,89	4,8	5,27	0	25	3,8
6	Sd1	0,08	0,003	28,9	0,23	0,6	1,8	37,5	1,68			0	32	
7	Sd2	0,18	0,005	37,5	0,41	1,7	4,2	34,0				0	12	
8	IISd	0,56	0,015	36,8	0,54	3,8	7,1	24,6				0	9	
9	IIISrd1	0,55	0,014	38,7	0,34	2,4	7,6	21,9						
10	Srd2	0,54	0,015	35,7	0,55	2,5	7,8	24,8						

Interpretation for profile 25

Relics of intense young-Miocene (or older) soil formation from Upper Malm-limestone with cherts are spread on the highest ridges along the Brenz valley (material below 160 cm with rather conflicting properties: clay with $SiO_2:R_2O_3$ around 2.8 and CEC:clay around 0.6 meq, mineral composition not investigated yet, cf. profile 23). Under periglacial conditions a talus of chert debris was formed on the slope below, the upper part being deprived of most of the finer material but supplied with some loess during the transport (see coarse silt contents and composition). In this part silicate weathering is obvious (see qu:fsp and mica contents), whereas (trans)formation of clay minerals is obscured by the heterogeneity of the material. Taking Sd1 as "parent substratum", a formation of iron oxides can be calculated ($\simeq$700 g/m² or +45%, Fe_d:clay increasing from 0.025 to an average of 0.053), but at any rate the translocation of sesquioxides is obvious. Depletion of bases is strong and raw humus is accumulated (19.2 kg/m² in and probably another 15 kg on the soil). Except for some coating in the B horizons, the original structure remained rather unchanged.
The rooting space is less restricted by the B_h,B_s-horizon than the penetrability is by the high stone contents. Presumably slope water contributes to the recharge of the low water capacity but does not prevent drought during dry periods. Nutrient reserves (N about 600 g/m², of which 2/5 are on the soil) are low, as are the contents of available nutrients at least in the subsoil, where the contents of exchangeable Al are relatively high.

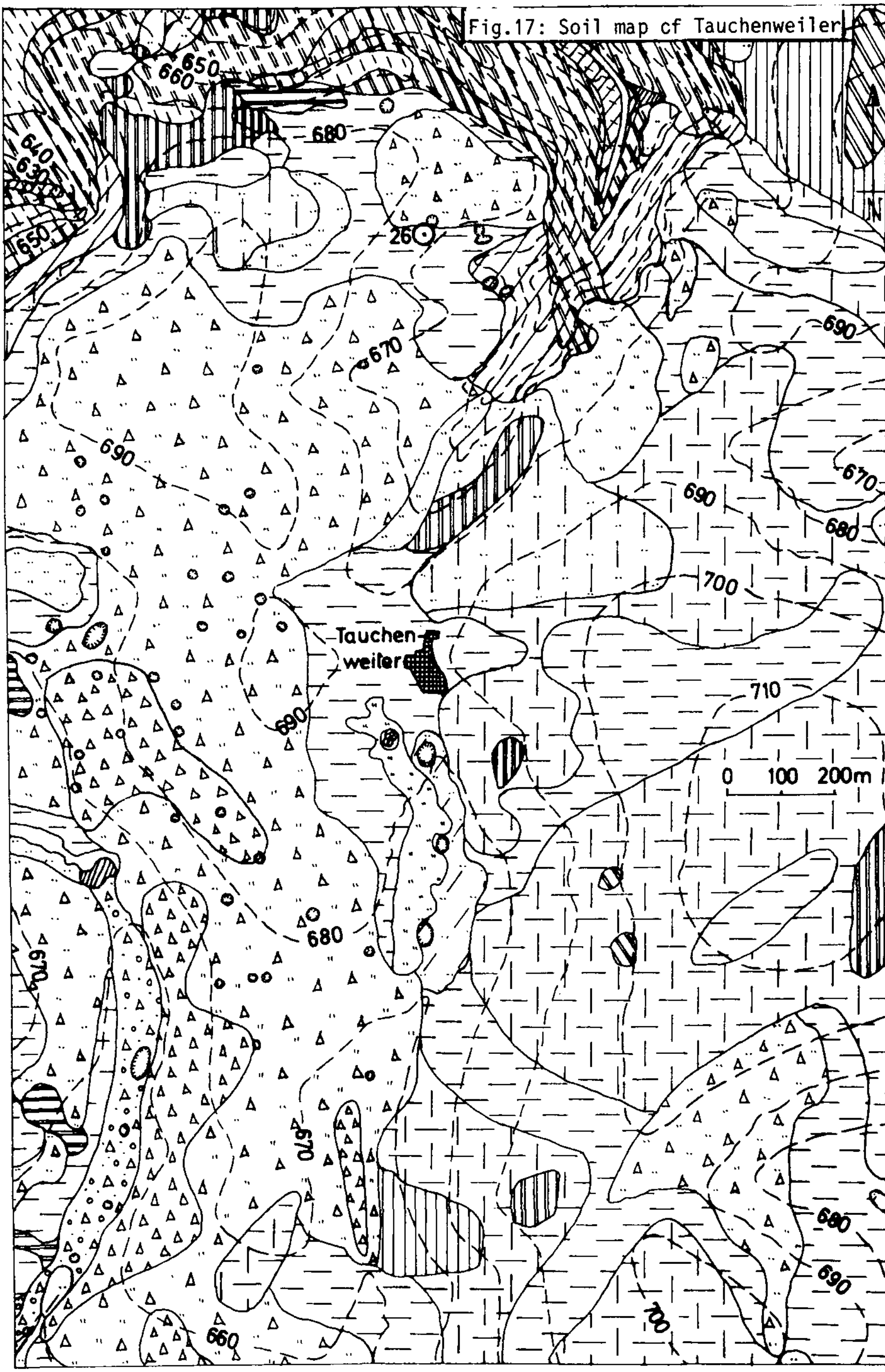


Fig.17: Soil map cf Tauchenweiler

Site Description Profile 26

Location:	North of Tauchenweiler
Elevation:	680 m
Landform:	Margin of ancient karstic depression
Slope:	Southeast, 8%
Drainage:	Moderate, downward decreasing
Vegetation:	Beech with fir
Use:	Forest
Soil Temperature:	8° C Precipitation: 900 mm
Parent material:	Red clay-with-flint with shallow loess cover

Soil classification; FAO: Dystric Nitosol ?

German: Rubefizierte Parabraunerde, im tieferen Unterboden vernäßt, stark entwickelt

US Soil Taxonomy: Typic Paleudult? very fine, kaolinitic, mesic

Profile Description

Horizon:		Depth cm:	Description:
Ah	Ah	0-3	Dark brown (7.5 YR 2/3) sandy loam (sL) rich in stones, granular, many roots, diffuse boundary
Alv1	E1	-25	brown (7.5 YR 5/8) loam (L) rich in stones, subangular to angular blocky, many roots, diffuse boundary
Alv2	E2	-43	reddish brown (5 YR 5/8) loam (L) rich in stones, subangular to angular blocky, some roots, diffuse boundary
Bt1	Bt1	-55	reddish brown (5 YR 4/8) loamy clay (LT) rich in stones, coarse angular blocky, clay coatings around stones, few roots, diffuse boundary
Bt2	Bt2	-80	red (2.5 YR 4/6) loamy clay (LT) rich in stones, coarse angular blocky, clay coatings around stones, small blackish brown concretions, diffuse boundary
SBt	Bgt	-100	red (2.5 YR 4/6) with light grey zones, loamy clay (LT) rich in stones, coarse angular blocky to coherent, clay coatings with blackish brown films around stones, small blackish brown concretions.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-3	42,9	13	6	8	27	16	22	13	51	22		
2	Alv1	-25	31,9	10	3	5	18	16	23	15	54	28		
3	Alv2	-43	38,8	5	3	4	12	12	17	10	39	49		
4	Bt1	-55	24,1	3	2	4	9	9	11	8	28	63		
5	Bt2	-80	18,6	2	3	7	12	11	10	8	29	59		
6	SdBt	-100	19,7	3	4	8	15	9	6	6	21	64		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	Ah	1,2						4,9	4,3	14,7	3,0	0,20	2460	25,6
2	Alv1	1,2						4,8	4,1	19,3	2,0	0,10	1050	<2
3	Alv2	1,3						4,4	3,9	26,0	1,8	0,07	1350	2,5
4	Bt1	1,3						4,3	3,9	35,5	1,2	0,03	900	<2
5	Bt2	1,3						4,5	3,8	38,5	0,5	0,01	330	<2
6	SdBt	1,3						4,9	3,9	39,5	0,5	0,01	1020	<2

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	Ah	5,17	3,59	14	0	189	67	54,9	5,0	3,5	0,2		145	
2	Alv1	1,57	0,63	25	0	85	24	1,5	0,8	1,3	0,4		81	
3	Alv2	0,46	0,47	10	0	115	34	0,6	0,6	0,4	0,4		95	
4	Bt1	0,40	0,40	10	0	145	41	0,6	0,3	0,7	0,7		104	
5	Bt2	0,26	0,26	10	0	185	49	2,4	0,8	0,4	0,4		104	
6	SdBt	0,10	0,17	6	0	210	49	5,7	3,9	0,9	1,0		88	

No	hor.	depth cm	minerals in % sand fsp	qu	gl		c silt fsp	qu	gl	qu:fsp	clay Kao	Ill	Mont	Chl
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Ah	0-3					7,1	84,1	1,6	11,8	4	0	73	13
2	Alv1	-25					6,5	84,5	1,5	13,0	9	4	67	11
3	Alv2	-43					9,0	79,1	4,6	8,8	22	4	61	3
4	Bt1	-55					4,6	86,4	1,6	18,8	42	5	40	1
5	Bt2	-80					1,2	85,8	1,6	71,5	56	0	32	0
6	SdBt	-100					0,1	83,9	1,2	839,0	60	0	25	0

No	hor.	Ti %	Zr %	Ti:Zr	K_t %	Mg_t %	P_t %	Fe_t %	Mn_t %	Al_t %	Si_t %		NH_4Cl meq/kg H	Al
1	2	16	7	18	29	30	31	32	33	34	35		39	40
1	Ah	0,076	0,04	18,9	0,61			2,0		3,3	31,0		0	3
2	Alv1	0,078	0,04	19,7	0,66			2,4		4,4	32,0		0	20
3	Alv2	0,074	0,03	13,7	0,77			3,5		7,1	27,0		0	32
4	Bt1	0,084	0,03	28,8	0,43			4,2		8,5	23,7		0	39
5	Bt2	0,098	0,04	27,1	0,21			4,4		7,9	25,0		0	45
6	SdBt	0,099	0,04	26,7	0,17			4,5		9,0	23,3		0	37

Interpretation for profile 26

In a karstic depression the relics described for profile 26 were preserved (below 40-60 cm reddish kaolinitic clay with $SiO_2:R_2O_3$ around 2.3 and CEC:clay around 0.3 meq, Fe_d:clay 0.06 and very low $Fe_o:Fe_d$) and under periglacial conditions mixed with some loess (see coarse silt contents and mineral composition). Towards the surface these silicates were increasingly transformed (see qu:fsp and mica contents, montmorillonite:illite), but the extent of clay mineral and iron oxide formation is obscured by the heterogeneity of the material and by clay translocation. The latter does not discriminate between iron oxides and clay minerals but possibly comprises more the loess-derived montmorillonite than the red clay-minerals. Depletion of bases is certainly not less in the red clay (possible reason for underestimation see profile 23). The accumulation of mull humus is rather low (11.7 kg/m²). The segregation of the kaolinitic clay is only weak (coarse angular blocky), the aggregation in the montmorillonitic loam somewhat better.

The rooting space is medium to deep but the penetrability is restricted by the high stone contents. The water/air regime seems to be balanced rather well but the nutrient reserves are presumably low (except for N with 1010 g/m²), as are the contents of the available nutrients (even lower than in profiles 23 and 25). On the other hand, the contents of Mn_o in the topsoil and of exchangeable Al in the subsoil are rather high (toxicity possible).

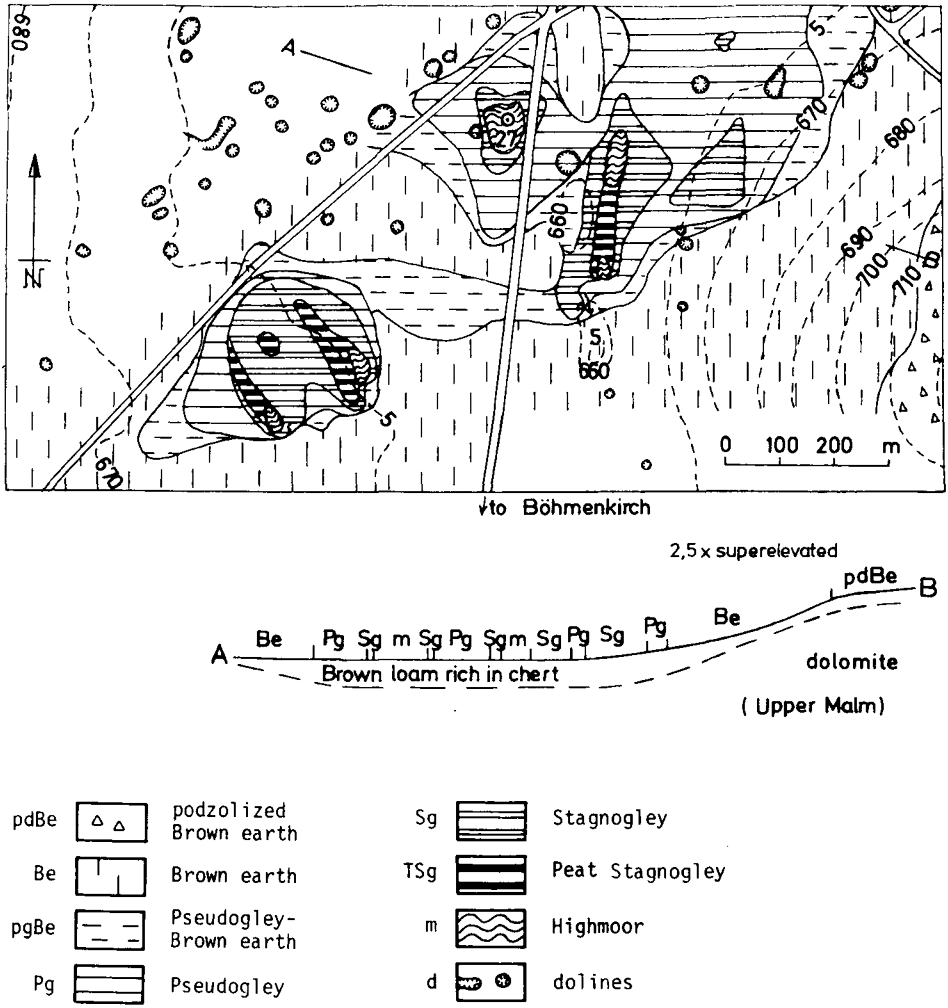


Fig. 18: Rötenbach, soil map with section

Site Description Profile 27

Location:	Southwest of Rötenbach
Elevation:	661 m
Landform:	Ancient valley floor divide
Slope:	No
Drainage:	Strongly impeded
Vegetation:	Meadow with spruce
Use:	Grassland
Soil Temperature:	8° C Precipitation: 1000 mm
Parent material:	Silty loam (loess)

Soil classification; FAO: Dystric Histosol

German: Moorgley (stark vererdetes Hochmoor)

US Soil Taxonomy: Terric Sphagnofibrist, clayey, mixed dystric, mesic

Profile Description

Horizon:		Depth cm:	Description:
hH1	H1	39-15	Dark reddish grey (10 R 3/1), sponge-like peat, many roots, diffuse boundary
hH2	H2	15-0	reddish black (10 R 2/1), sponge-like peat, few roots, clear boundary
Aha	O	0-16	brownish black (2.5 YR 3/2) loam (L), stones rare, subangular to angular blocky, root channels, diffuse boundary
Gor	Bg	-100	yellowish grey (2.5 Y 5/2) with small rusty mottlings, loam (L), subangular blocky to coherent.

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	hH1	39-15	0										} 174	
2	hH2	15-0	0											
3	Aha	0-16	2,1				1	18	33	15	66	33	40	
4	Gor	0-100	0				1	20	35	5	60	39	26	

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o:Fe_d	Mn_o mg/kg	P_a mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	hH1	} 0,25	79,2	70,6	62,8	57,9	14,4	3,6	2,8	3,8	3,3	0,87	10,0	36,6
2	hH2							3,4	2,7	1,0	0,9	0,88	2,5	13,6
3	Aha	0,74	68,9	66,8	57,8	54,3	29,1	4,0	3,3	0,5	0,3	0,60	1,3	26,7
4	Gor	1,38	49,1	45,0	41,9	40,2	39,4	4,5	3,5	1,0	0,9	0,90	5,0	7,0

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	$CaCO_3$ %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	Mg	K	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	hH1	67,9	14,6	47	0	800	56	13,5	0,7	2,7	0,7	1092		2
2	hH2	63,9	10,4	62	0	1317	74	14,3	1,6	1,4	1,2	1332		1
3	Aha	19,9	3,0	67	0	434	97	2,5	1,8	1,4	1,1	465		1
4	Gor	1,2	0,5	24	0	205	82	3,8	5,1	1,8	0,9	214		5
		P_v ‰	K_v ‰	Mg_v ‰	Ca_v ‰							NH_4Cl meq/kg		
1	hH1	0,97	4,19	0,25	0,31							27	11	
2	hH2	0,67	2,60	0,11	0,32							25	30	
3	Aha	0,67	2,48	4,00	0,16							0	90	
4	Gor	0,10	2,36	4,25	0,31							0	70	

Interpretation for profile 27

Similar to profile 24, the loess cover is mixed with weathering products of limestone, free of lime and strongly depleted of bases. Redistribution of iron oxides in mottles is only weak and probably due to drainage 50 years ago. Nevertheless, the amount of organic matter is still high (156.5 kg/m²). The coherent and dense parent material was se- and agregated only weakly (subangular to angular blocky) in the topsoil (with decreasing density, but not permeability). The rooting space is shallow, the water/air regime being governed by the fluctuations of stagnant water and not by the (medium) air capacity (115 l/m²) or the (high) water capacity (available 246 l/m²). Except for N (1840 g/m²) the nutrient reserves are moderate, as is the case with the available nutrient contents.

Glossary for the maps

Anmoor = humic Gleysol
Bänder-Parabraunerde = Luvisol or luvic Arenosol
Braunerde = Cambisol
Braunpelosol = ±vertic Cambisol
Chernosem = Phaeozem
Gley = Gleysol
Gleyvega = Fluvisol
Highmoor = dystric Histosol
Kalkbraunerde = calcic Cambisol
Lowmoor = eutric Histosol
Mergelpelosol = ±vertic Cambisol (from marl)
Mergelrendzina = Rendzina (from marl)
Moor-Stagnogley = humic Planosol
Ockererde = chromic Cambisol
Parabraunerde = Luvisol
Pararendzina = calcaric Regosol
Paternia = ±calcaric Fluvisol
Pelogley = Gleysol (clayey)
Pelosol = vertic Cambisol
Podsol = Podzol
Protorendzina = Lithosol
Pseudogley = gleyic Luvisol
Ranker = Ranker
Rendzina = Rendzina
Sandbraunerde = Cambisol (from sandy or cambic Arenosol)
Stagnogley = dystric Planosol
Syrosem = Lithosol or Regosol
Terra fusca = chromic Cambisol
Bändchen - (Podzol, Stagnogley) = placic (Podzol, dystric Planosol)
Transitional moor = Histosol
Vega = eutric Fluvisol

Mitteilgn. Dtsch. Bodenkundl. Gesellsch. 49, 131 - 244 (1986)

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Hamburg, Germany

August 1986

Guidebook

for

a tour of landscapes, soils and land use

in the Federal Republik of Germany

Tour D

Bayern

Content

Excursion D: Route Description

by O. DREXLER+

Preface: In all remarks concerning Excursion D, the provinces will be named as given in the "Standortkundliche Landschaftsgliederung von Bayern" (O. WITTMANN 1983), which is reproduced in detail on the enclosed excursion map. The numbers with which the landscapes are marked on the map will be added in parentheses to the landscape names in the texts.

1st day: From Bayreuth to Seedorf near Waldsassen

Route: From Bayreuth in a northeastern direction through the Upper Main Basin Range (7.1, 7.2) into the excursion areas of the High Fichtelgebirge (8.3) and of the Waldsassen Slate District (10.2.1).

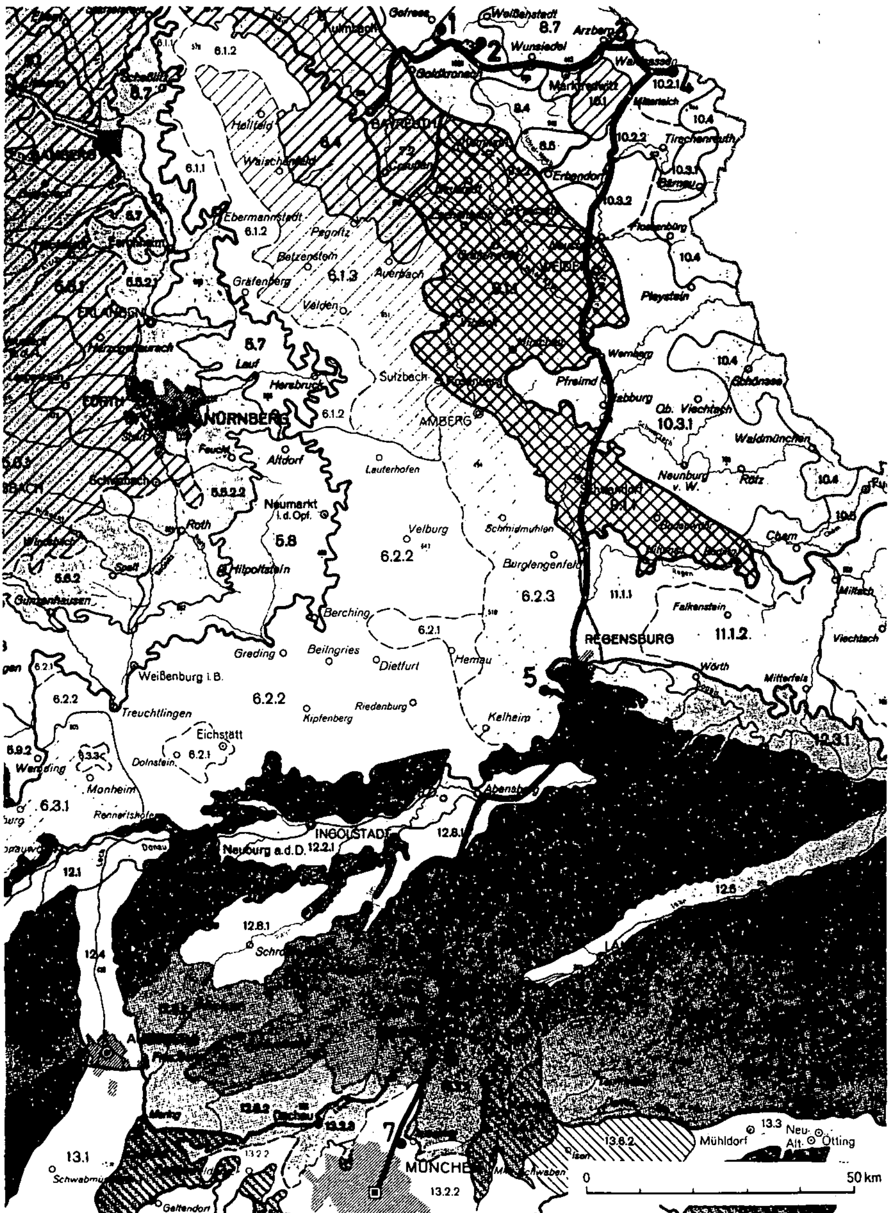
Bayreuth: Between Keuper slopes in the valley of the Red Main. Founded in the 12th century; historical buildings from the 17th and 18th centuries; adopted city of Richard Wagner, since 1876 Wagner Festivals; since 1976 university city.

Northeastern Upper Main basin range (7.2): Tectonic fault blocks of Triassic sedimentary rocks between step faults in the foreland of the Variscan folded crystalline mountains; relief: asymmetrical crests (relative height 100 - 150 m) with steeper SW flanks of Lower and Middle Triassic rocks and a less steep NE slope, which leads down with the tilted stratification into the Keuper valley zone in front of the mountain rise; the area is utilized primarily for agriculture; soils (DIEZ 1974): on the Lower Triassic sandstone slope "Braunerden" originated in slope debris; on Middle Triassic limestone "Rendzinen" and "Terra fusca-Rendzinen" as well as "Rendzina-Pelosole" in marl; on the Keuper slope "Pelosole" in claystone, "Braunerden" (in part "pseudovergleyt") in sand, slope debris and loess loam; in the valley lowlands "Gleye" and "Gley-Braunerden" .

Bindlach Valley: Since the river diversion through the Red Main in the Würm Ice Age, a dry valley; wide loess-covered Riss Ice Age terraces; in the valley the Kulmbacher Fault, it shifts Keuper (SW flank) against Lower and Middle Triassic

+ Bayer. Geologisches Landesamt, Heßstr. 128, D-8000 München 40

Fig. 1: Excursion D, course with excursion stops



Part of the general map 1:1 000 000 "Standortkundliche Landschaftsgliederung von Bayern" (O. WITTMANN+).For descriptions of the ecological districts see text.

+) Refernce: Materialien, Heft 21, Bayer. Staatsministerium für Landesentwicklung und Umweltfragen, München 1983 rocks to the NE.

Bad Berneck: Climatic resort and Kneipp treatment spa; southwest of the town over the "Fränkische Line", a fault on which the crystalline mountain range was lifted by up to 2000 m above the foreland during the Cretaceous and the Tertiary. Trip continues through the valley of the White Main into the High Fichtelgebirge (8.3; see description of the excursion area).

Goldmühl (-Brandholz-Goldkronach): In the Middle Ages and up to modern times intensive gold mining from placer gold deposits and in mines (STETTNER 1977). From here through a narrow valley section deeply cut into the epigneisses utilized for forestry.

Glasermühle near Bischofsgrün: Bifurcation to the NW to the plateau of Wülfertsreuth, a relic of a Tertiary plain;

Schweinsbacher Saddle (east of Wülfertsreuth): Excursion point 1:

Profile 1.1: "Podsol-Braunerde" on phyllite; experimental grounds for studies on soil acidification and spruce damages;

Profile 1.2: "Pseudovergleyter Podsol" on deeply kaolinized gneiss;

Bischofsgrün: Climatic health resort with summer and winter season (skiing).

Schneeberg: (1050 m): Excursion point 2 lies on the S flank: Deep humic "Braunerde" on granite weathering; experiments with respect to acid damages on red beech and forest perishing with spruce.

Karches Pass (770 m): Further trip through wooded, granite area of the High Fichtelgebirge with high relief intensity.

Silberhaus: Down from the mountain range to the Selb-Wunsiedler Basin (8.7) and to the Röslau Valley formed as early as in the Tertiary.

Wunsiedel: County seat with textile and porcelain industry, is bypassed on the northern foot of the Kösseine granite massif (940 m).

Marktredwitz: like Wunsiedel elevated to the rank of city in the 14th century; heavily industrialized, most important supply point of the region.

Arzberg: Super-power station; first commissioned in 1914/15 on the basis of the Miocene lignite in the Röslau Valley; in the 15th to 19th century mining and smelting of iron ore from the marble strata series of the Arzberger Series. Bifurcation to the range of hills of the Kohlwald lying south of the Röslau Valley (Waldsassen Slate District, 10.2.1).

Seedorf: Excursion point 3, kaolin quarry with Tertiary sediments and weathering loams.

2nd day: From Waldsassen to Regensburg

Route: From Waldsassen around 5 km to the east to excursion point 4; then on B299 to Mitterteich - Falkenberg; to the west of Falkenberg on Federal Autobahn A93 to Weiden; from there on on B15 and then approximately from Pfreimd on A93 via Nabburg - Schwandorf to Regensburg (120 km). The route leads from the Eastern Bavarian basement (part of the Precambrian-Paleozoic crystalline complex of the Bohemian Massif) into the Mesozoic foreland situated to the SW and near Regensburg reaches the Danube Valley and the northern edge of the South German molasse basin.

Waldsassen Slate District (10.2.1): Excursion point 4 located near the Waldsassen - Hatzenreuth road: Fertilization experiment with pines

Profile 4.1 "Podsol-Braunerde" on phyllite

Profile 4.2 "Podsol-Braunerde" on decomposition product of phyllite

Waldsassen: Cistercian Monastery with famed library, founded in 1133 at the time the area was settled. Trip in the Wondreb Valley to the SW through the Waldsassen Slate District (10.2.1; see excursion area description).

Mitterteich: The valley broadens toward the Naab-Wondreb Depression (10.2.2), a Tertiary tectonic depression in the southwestern extension of the Eger Rift Valley (ČSSR).
The mostly gently sloped flat relief (in the center of the basin around 500 - 530 m m.s.l.) with slightly incised valleys developed from a subsided peneplain, on which kaolinitic clays were sedimented among other materials in the Neogene. The granitic bedrock was intensively allitically weathered in the Tertiary and forms large up to 30 m thick kaolin deposits; mined for the porcelain and other industries, e.g. Tirschenreuth (SCHMID & WEINELT, 1978). Flat relief and clayey subsurface cause widespread wet areas (now drained in many places) and provide favorable conditions for the fish culture which has been carried on for centuries in numerous ponds. The extensive forests in the southern part of the basin sheltered from the west by the Steinwald mountains (annual precipitation 650-700 mm, mean annual temperature 6 - 7° C) have naturally large shares of spruce (continentally toned spruce-pine woods. All data on the natural forest composition come from FOERST & KREUTZER, 1978). Soil formations: "Braunerden" and "Podsole" on the ± granular disintegrated granites and the commonly occurring sandy-gravelly cover sheets, with greater terrain inclination also "Regosole"; impermeable Tertiary clays in the subsoil cause "Pseudovergleyung"; in the valley areas near the ground water "Gleye" and "Gley-Braunerden".

Mitterteich basalt district (10.1): The heavily wooded elevations (up to 700 m m.s.l.) in the NW of the basin consist largely of basaltic tuff and basalt (age according to TODT & LIPPOLD, 1975: Aquitan-Burdigal). On the nutrient-rich basalt soils (mostly ± eutrophic "Braunerden", on slopes "Ranker"), beech-ashtree-maple-fir woods have their stand.

Steinwald (8.5): 940 m high granite massif in the west of the Naab-Wondreb Depression, above which it was elevated by around 200 m in the Upper Miocene (LOUIS 1984). The almost solid stands of spruce on its higher locations display great forest damages. Prevailing soils: "Braunerden", partly stagnant wet "Podsole" and "Ranker".

Falkenberg: The route from Falkenberg to Altenstadt passes through the "Naab Upland Hills" (10.3.2) belonging to the "Oberpfälzer Wald", the eastern part of which consists of granite and its western part (near Windisch-Eschenbach, west of the Waldnaab) of folded Precambrian gneisses and metabasites. The hilly shaped Tertiary plateau at an altitude of around 500-530 m. m.s.l. was depply dissected by the antecedent Waldnaab to a depth of 100 m after the Upper Miocene uplift (LOUIS 1984). Whereas the granite area is heavily wooded, the metamorphic western part is extensively used for agriculture (clearing for cultivation in the 12th/13th century). The soils: on the metabasites principally "Braunerden" (locally "pseudovergleyt"), on gneiss and granite besides also "Podsole"; on steep valley slpes "Ranker" and "Regosole" with transitions to "Braunerden". Natural forest stands: (sub)mountaineous beech-spruce-fir woods.

Altenstadt: The route crosses the "Fränkische Linie", a fault on which the South German Block with thick, principally Mesozoic sedimentary cover borders on the Crystalline of the Bohemian Massif. Along this line, the basement has been uplifted since the Lower Cretaceous by up to 2000 m, so that in the recent relief an over 100 m high fault scarp leads down to the foreland around Weiden (Oberpfälzer Basin and Upland Hills; 9.1.1). Block tectonics in the foreland caused the entire strata series from Rotliegendes (Lower Permian) up to the Cretaceous to crop out in a narrow space. The relief consists of mostly gently shaped crests and plateau relics and small valleys usually not deeper than 50 m. The main valleys have wide bottoms and terraces. Level remains at around 450 m m.s.l. testify to a Neocene flat relief, which the 595 m high basalt pipe of the Parkstein (Aquitan) visibly towers over from afar. The low nutrient, dry locations on the here consistently sandy Triassic sediments usually bear "Podsole" and are utilized for forestry (large stands of pine). On the partly clayey Createaceous deposits, "Pelosole", "Braunerden" and "Pseudogleye" are widely distributed.

Weiden (45,000 inhabitants): important supply point of the northern Upper Palatinate with textile, porcelain and glass industry.

Wernberg-Köblitz: In the south, the Basin of Weiden borders on the Naab Hills composed of granites and gneisses, a spurlike part of the Oberpfälzer Wald (10.3.1) projecting to the west. The only 500 to 600 m high mountainous region originated through multiphase erosive disintegration of a Tertiary relief. The steeply cut epigenetic transverse valleys (e.g. Naab Valley) were formed after Miocene filling of an old original Naab system. Among the soils, "Braunerden" and "Podsole" dominate, on slopes also "Ranker" and "Regosole". The Naab Hills were cleared and settled as early as in the 6th century. Forest stands (originally submountainous beech-spruce-fir woods) remain chiefly on steeper relief sections. In the Nabburg-Wölsendorf area an important fluorite deposit is mined, which in peak periods provides 10 % of the world supply (HF production in Stulln; SCHMID & WEINELT 1978).

Schwarzenfeld: With a fault already active in the Cretaceous, the 'Naab Mountains' border on the Depression of Bodenwöhr , a tectonic fault semitrough with Mesozoic strata series (part of the Upper Palatinate Basin and Upland Hills 9.1.1). The landscape consists of a downthrown block with Cretaceous sediments in the N (district with numerous fish culture ponds) and a predominantly wooded mountainous district in the area of the Jurassic and Triassic strata heaved up to the south (450 - 500 m m.s.l.; Schwandorf - Wackersdorf - Bruck i.d.Opf.). Kilometer wide valley courses of the original Naab system filled with Miocene sands and clays cross the depression, from which up until 1982 near Wackersdorf 180 million tons of lignite were mined in open pit mining some of it 60 m deep (SCHMID & WEINELT 1978). This was the basis for development of the Schwandorf industry (700 MW power plant, aluminum works, iron works in Maxhütte-Haidhof).

Maxhütte-Haidhof: To the east of the route, the Forward Bayerischer Wald ("Western Vorwaldrand", 11.1.1) rises up, which here is composed of granite. The intensively dissected mountain relief reaches heights of over 550 m m.s.l. The steep terrain at the edge of the mountains is largely wooded (natural composition: beech-oak woods, beech woods with fir and spruce). Soils: primarily "Podsole" and "Braunerden", in steeper terrain also "Ranker" and "Regosole".

Middle Frankenalb: The Keilberg fault running from N to S separates the Forward Bayerischer Wald, which according to BAUBERGER et al. (1969) was elevated by at least 650 m in the Tertiary, from the Middle Frankenalb adjoining it to the west (6.2.3). The carbonate rocks of the Malm otherwise characteristic for the Alb are almost completely covered here by Cretaceous and Tertiary deposits and by loessloam. The wavy to hilly contoured district with partly asymmetrical valleys is extensively used for agriculture. Soils: predominantly "Braunerden" on sands and sandstones (partly podsolized) and - associated with "Parabraunerden" - on loessloam ("pseudovergleyt" in part), "Rendzinen" and "Terrae fuscae" on the Malm limestones cropping out here mostly on slopes.

Regensburg (135,000 inhabitants): Developed in over 2000 years at the junction of the Regen into the Danube from a Celtic settlement and a Roman legion camp; renowned medieval structures (Stone Bridge, Gothic Cathedral, etc.); seat of the Regional Commissioner of the Upper Palatinate, industry and university city.

<u>3rd and 4th day: from Regensburg to Munich</u>

Route: From Regensburg over the Nürnberger Autobahn to excursion point 5 (Weiherholz, Middle Frankenalb); on the Autobahn Regensburg-Munich and starting from Abensberg on the B 301 through various subregions of the "Tertiärhügelland" south to Freising-Weihenstephan (excursion point 6), and then over the Munich gravel plain to Munich and on the next day to excursion point 7 on the northern outskirts of the city.

Regensburg: Over the Danube terraces to the hills of Cretaceous and Tertiary sediments south of the city. The excursion touches briefly the Regensburg-Straubinger Danube flood plain here (12.3.1) and the terraced landscape of the "Dungau" (12.3.2.1) adjoining it to the south; both of them are intensively utilized old settlement areas with village foundings from the 6th century (KREUZER 1968).

Weiherholz: From Prüfening on the Nürnberger Autobahn into the Middle Frankenalb (6.2.3; see excursion area description) covered with Cretaceous sediments and on the other side of

the Danube deeply cut into the Malm limestone to the excursion point 5:
Profile 5.1 "Podsol-Parabraunerde" from "Knollensandstein",
Profile 5.2 "Podsol-Parabraunerde" on Bronze Age tumulus.

"Tertiärhügelland": from Weiherholz back to Prüfening and over the Autobahn Regensburg-Munich southwest into the "Tertiärhügelland" (12.9.2, 12.8.1, 12.8.3), a part of the South German molasse trough. It consists of coarse and fine clastic sediments of the Miocene and is formed by a closely meshed, for the most part approximately 40to 70 m deeply cut valley relief with pronounced asymmetry principally in the approximately meridionally running valleys (east exposed gentle slopes, west exposed steep slopes). Soils: on the widely distributed loess and loessloam of the loessloam rich "Tertiärhügelland" (12.9.2, 12.8.3) "Braunerden" and "Parabraunerden" dominate (frequently "pseudovergleyt"), on the Molasse substrata (depending on grain sizes) "Pelosole" and (particularly in the sandy "Tertiärhügelland", 12.8.1) "Braunerden" and "Podsole".

Abensberg: On the boundary of the sandy "Tertiärhügelland" (12.8.1) toward the Ingolstadt Danube flood plain; lordly founding of the 13th century. Further trip on B 301 upstream in the Abens Valley to the south.

Siegenburg: To the south of the town, transition from the sandy (12.8.1) to the loessloam rich "Tertiärhügelland" (12.9.2, 12.8.3).

Mainburg and Au i.d. Hallertau: Seats of the nobility founded before 825 (Mainburg) and 990 A.D.; economic centers of the Hallertau, the world's largest coherent hop cultivation district (see Section "Hop Cultivation" in the guide for Excursion A.)

Freising: County seat on the steep margin of the "Tertiärhügelland" toward the Munich gravel plain; founding of the Bishopric of Freising and the Benedictine Monastery Weihenstephan in the 8th century, in whose buildings the Agricultural Faculty of the former Munich Institute of Technology was accommodated. Excursion point 6: Demonstration of a rain simulator for soil erosion studies and demonstration of erosion protection experiments.

Munich Gravel Plain (13.2.1-3): Gravel field inclined to the north, deposited by meltwater runoffs of the Würm Ice Age Isar foreland glacier. The ground water stream in the gravel due to the thinning out of the gravel caused the formation of extensive fens in the northern part of the plain, which today are largely cultivated (13.2.3: Dachauer and Erdinger Moos); the thicker gravel further to the south just outside Munich (northern Munich Gravel Plain, 13.3.3) causes dry locations (e.g. Garchinger Heath) with original pine forest growth (LUTZ 1960). The soils: in the north (13.2.3) fen, calcareous "Anmoorgleye", "Gleye" and "vergleyte Rendzinen"; in the south (13.2.2) "Rendzinen", "Braunerden" and "Parabraunerden". Utilization: primarily agricultural; under the influence of the million city Munich, increasing settlement and special use.

Grosslappen: On the northern periphery of Munich past the refuse dump, which will be visited on the following day from Munich as excursion point 7:

7.1: Morphological, geological and pedological survey of the gravel plain, moraine areas and periphery of the "Tertiärhügelland".

7.2: "Pararendzina" on calcareous gravel

7.3: "Pararendzina" on calcareous gravel with coating of sewage sludge

7.4: Results of the sewage sludge experiments

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Excursion D: Agricultural Utilization in the eastern and southern Bavarian production areas

by O. DREXLER *

In its eastern Bavarian route, Excursion D passes between Bayreuth and Munich through a scenery with greatly varying natural potentials (geology, morphology, climate, soils), which result in greatly ddifferent conditions for agricultural utilization. The structural and production areas (according to WÜRFL et al. 1984) compiled in the enclosed table are intended to illustrate this. The district numbers in column 2 give the spatial relationship to the district division of WITTMANN (1983), which is presented in details on the excursion map.

Agricultural and forestry utilization: The high proportions of forest in the mountain regions reflect the unfavorable relief and climatic conditions; the High Fichtelgebirge is even more heavily wooded than is indicated by the figure calculated for the neighboring areas of Frankenwald and Fichtelgebirge (57.9%). The broad forest areas in the Oberpfälzer Hügelland (50.6%) are due primarily to the dinstinctly low nutrient content of the sands and sandstones prevailing there. In contrast, the proportion of the agriculturally cultivated area increases to 70 to 80 % in the loess covered, flat to moderately contoured and climatically favored areas of the "Tertiärhügelland" and of the "Regensburg-Straubinger Gäu"(region).

Rating of the agriculturally used areas "LN" classified as favorable "V", average "D" and unfavorable "U" production conditions (as defined in the Agrarian Master Plan):

Unfavorable production conditions predominate in the Fichtelgebirge (54% of the LN);
Utilization: relatively high proportion of meadows (fodder areas: 51.8 %)

Average productions conditions prevail in the Vorderer Oberpfälzer Wald and in the Oberpfälzer Hügelland; mixed utilization with 59 to 66 % arable land and fodder areas between between 46 and 53 % of the LN;
Favorable production conditions characterize the southern Frankenalb (68%) and in particular also the southern Bavarian arable

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Table 1: Agricultural structure in the area of excursion D
(in 1979; according to WÜRFL et al. 1984)

agricultural districts	ecological districts (WITTMANN 1983)	precipitation mm/year	aver. annual temperature (°C)	land use (in%) agric. land	forest	productivity class (in % of agric. land) V	D	U[1]
Obermain-Schollenland (Upper Main Basin Range)	5.4, 7.1 partly 4.1.1+2	650- 900	7.0-8.0	59.4	36.7	52	33	15
Hohes Fichtelgebirge und Frankenwald (High-Fichtelgeb...)	8.1, 8.3 to 8.5	800-1100	4.5-7.0	37.2	57.9	9	37	54
Selb-Wunsiedler Bucht u.Münchberger Gneismasse (Selb Wunsiedel Basin and Gneiss Massif of Münchberg)	8.2, 8.6, 8.7	650-1000	5.0-6.5	56.3	39.8	38	31	31
Vord. Oberpfälzer Wald; mit Wondreb-Senke (Anterior Upper Palatinate Forest with Naab-Wondreb-Depression)	10.1, 10.2.1 and 2, 10.3, 1 and 2, 10.5	650-1000	5.0-7.5	50.2	45.8	21	41	38
Oberpfälzer Hügelland (Upper-Palatinate Hill Country)	9.1.1, 11.1.1	650- 800	7.0-7.5	43.7	50.6	33	41	26
Donautal (Danube Valley)	12.3.1	650- 800	7.0-8.0	65.0	31.2	74	15	11
Regensburg-Straubinger Gäu	12.3.2.1-3	650- 800	7.5-8.0	80.5	17.1	89	9	2
Südliche Frankenalb (Southern Franconian Alb)	6.2.1 to 6.2.3, 6.3.1	700- 800	6.5-7.5	54.4	42.5	68	23	9
Nördl. Tertiär-Hügelland (Northern Donau-Isar Hills)	12.5 a. 6, 12.8.2 a.3, 12.9. 1a.2, 12.9.4 a.5	700- 900	7.0-8.0	73.2	23.4	79	15	6
Tertiär-Hügelland: sand.Teil (Donau-Isar Hills, sandy Part)	12.8.1	700- 800	7.5-8.0	62.4	34.3	57	30	13
Münchener Schotterebene mit Moorgebieten (Munich Gravel Plain with moorlands)	13.2.1 to 3	800-1100	6.5-7.5	66.1	29.6	76	19	5

[1] V = favourable, D = average, U = unfavourable conditions of production

continuation:

agricultural districts	average farm size agric land in ha	use of agricultural land (% of land) ploughed land	small grain	cereal maize	root crops	fodder area	special crops	livestock density animals per 100 ha agricultural land cattle	hogs	sheep
Obermain-Schollenland (Upper Main Basin Range)	13.1	67.6	48.3	0.2	5.8	45.6	0.2	117	136	7
Hohes Fichtelgebirge und Frankenwald	11.4	57.1	40.8	-	8.0	51.8	-	107	68	5
Selb-Wunsiedler Bucht u.Münchberger Gneismasse (Selb Wunsiedel Basin and Gneiss Massif of Münchberg	18.4	64.9	46.7	-	9.9	45.6	-	116	103	7
Vord. Opfälzer Wald; mit Wondreb-Senke (Anterior Upper Palatinate Forest) (with Naab-Wondreb-Depression)	13.1	58.8	40.4	0.1	6.7	52.9	0.1	139	60	2
Oberpfälzer Hügelland (Upper-Palatinate Hill Country)	13.7	66.1	46.2	0.3	7.3	45.8	0.2	121	95	6
Donautal (Danube Valley)	13.3	76.1	41.0	2.5	19.6	37.4	0.3	111	115	13
Regensburg-Straubinger Gäu	18.9	91.6	50.1	4.7	28.9	15.8	0.2	57	189	6
Südliche Frankenalb (Southern Franconian Alb)	13.0	75.1	47.9	0.8	6.6	45.3	0.2	123	168	12
Nördl. Tertiär-Hügelland (Northern Donau-Isar Hills)	14.7	77.0	45.8	7.4	6.4	37.1	3.2	122	227	5
Tertiär-Hügelland: sand.Teil (Donau-Isar Hills, sandy Part)	12.9	67.0	40.9	1.4	12.3	36.5	9.7	105	176	6
Münchener Schotterebene mit Moorgebieten (Munich Gravel Plain with moorlands)	20.4	77.7	44.7	1.7	9.4	40.9	0.3	139	73	8

districts (Danube Valley 74 %, Munich gravel plain 76 %, northern "Tertiärhügelland" 79 %, Regensburg-Straubinger Gäu 89%); arable land proportions between 75.1 and 91.6 % of the LN; fodder areas at 37.1 to 45.3 %, in the Gäu only 15.8%.

Grain : In the excursion area between 40% of the LN (in the NE-Bavarian mountains and in the hop district of the sandy "Tertiär-hügelland") and 50 % (Regensburg-Straubinger Gäu). Wheat and barley predominate. Wheat proportions in the northeast mountains and in the Oberpfälzer Hügelland between 4.0 and 9.9 %, in the southern Bavarian production areas (except in the hop district), the southern Frankenalb and the "Obermain-Schollen-land" over 15 % (34.1 % in the Regensburg-Straubinger Gäu). Barley proportions of the LN in the northern Bavarian unfavorable districts between 17.3 and 28.6 %, in the other provinces between 10.5 and 23.6 %.

Cereal maize: In the northern "Tertiärhügelland" 7.4 %, in the Regensburg-Straubinger Gäu 4.7% and in the other southern Bavarian excursion area between 1.4 and 2.5%; in the climatically less favorable area of northeastern Bavaria only 0.0 to 0.3 % of the LN.

Root crops: In the Danube Valley 19.6%, in the Gäu 28.9 % of the LN (principally sugar beets); notable sugar beet cultivation (3.3%) also in the northern "Tertiärhügelland" (root crops 6.4%); in the sandy "Tertiärhügelland" and on the Munich gravel plain 12.3 and 9.4 % respectively (potatoes); similar root crop proportions (potatoes) also on the frequently gritty soils of the NE Bavarian mountains (8.0 and 9.9 % respectively in the Fichtelgebirge and the Selb-Wunsiedel Basin); in the other excursion areas root crop proportions between 5.8 and 7.3 %.

Special crops: Only in the northern and sandy "Tertiärhügelland" of importance with 3.2 and 9.7 % by area respectively (hops).

Livestock density: Cattle density in the excursion area (105 to 139 animals per 100 ha LN) less differentiated and just below the Bavarian average (140); greatly deviating is only the Regensburg-Straubinger Gäu (57; lowest livestock density and smallest fodder area proportion in Bavaria; primarily bull fattening); high hog density in the southern Frankenalb (168) and the southern Bavarian favorable areas (Gäu 189 animals per 100 ha LN; 176 in the sandy and 227 in the northern "Tertiärhügelland"); far below the average hog density in the Oberpfälzer Wald (60), in the Fichtelgebirge (68) and in the Munich gravel plain (73).

References: see route description.

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The Exkursion Areas in the Fichtelgebirge

with the excursion points Schweinsbacher Saddle, Schneeberg, Seedorf and Waldsassen

by O. DREXLER *

Exkursion points 1 to 4 of Excursion D lie in the Fichtelgebirge, a central section of the European "Mittelgebirge", what means the Palaeozoically folded mountains with a young relief, rising not higher than 1500 m and formed above all by the fluvial dissection of Tertiary peneplains and by periglacial denudation. In the Fichtelgebirge converge Hercynian (SE-NW) extending elements (Frankenwald, Oberpfälzer Wald) with Variscan (SW-NE) oriented mountain sections (Erzgebirge). The Fichtelgebirge thus possesses a mountain system open to the NE, which with its Hercynian and Variscan running chains of hills rising up to over 1000 m, surrounds a somewhat 600 m high more weakly contoured highland core (Selb-Wunsiedeler Basin, 8.7). The excursion points Schweinsbacher Saddle (3 km northwest of Bischofsgrün) and Schneeberg lie in the western part of the mountain system in the High Fichtelgebirge (8.3), whereas the excursion goals Seedorf and the Waldsassen forest area are located in the Waldsassen slate district (10.2.1), the northern half of which is a part of the southeastern range of the Fichtelgebirge, and whose southern part(beyond the Wondreb Valley) is likewise counted geologically as belonging to the Fichtelgebirge (STETTNER 1981).

Geology and Morphogenesis of the Fichtelgebirge

Geologically, the Fichtelgebirge forms an anticline extending to the NE, which was folded up during the Variscan orogenesis in the Upper Carboniferous (Sudeten Phase) form what was then already predominantly metamorphic sediments. At the same time, the Depression of Waldsassen developed.

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Even during the Upper Carboniferous, large granite batholiths intruded into the fold structure. In the course of later erosion they became exposed ant today they constitute the main part of the High Fichtelgebirge and the Selb-Wunsiedel Basin (STETTNER 1981). Sediments of the Triassic and the Jurassic, which also are supposed to have been deposited in the Fichtelgebirge (EMMERT 1981), were already eroded at the beginning of the Upper Cretaceous according to SCHRÖDER (1976).
Since then, the Fichtelgebirge has been subject to an erosion taking place in several phases, which during the Cretaceous-Paleogene phase under warm and alternately moist climate led to development of a fundamentally allitically weathered peneplain. Tectonic movements at the end of this phase created the Miocene sedimentation basins of the Röslau and Naab-Wondreb Depression. Simultaneously, the erosion in the adjacent areas was intensified so that the Lower Miocene (TODT & LIPPOLD, 1975) basalt volcanism poured onto a hilly contour with elevation differences up to around 100 m in the southern Fichtelgebirge system (LOUIS, 1984). Formation of the Miocene plain generation (e.g. in the area of the Selb-Wunsiedler Basin) took place under greatly reduced weathering intensity; the old saprolite profiles were no longer formed, but rather topped down to the slightly decomposed roots (DREXLER, 1981). Neocene block movements disintegrated this peneplain scenery and raised the mountain system partly by several hundred meters (LOUIS, 1984; STETTNER, 1964). Heavy dissection and intensive solifluction under the periglacial conditions of the Pleistocene finally created the current landscape of the Fichtelgebirge.

Excursion Area "High Fichtelgebirge" (8.3)

Landscape: The "High Fichtelgebirge" includes primarily the central massif with the highest elevations of the mountain range (Schneeberg 1051 m, Ochsenkopf, 1024 m) as well as other parts of the mountain system. The mountainous country dissected mainly toward the west has relative altitudes up to around 400 m. The slopes are inclined for the most part between 7° and 15°, in the fault scarp to the Selb-Wunsiedel Basin as well as on the narrow valley sections (e.g. of the Weisser Main) steep slopes with inclinations of up to more than 30° occur. The mountain crests are crowned in many cases at elevations between around 700 and 900 m by residues of a Tertiary plains, on which scattered allitic saprolites have remained preserved (e.g. in the vicinity of Wülfertsreuth).

Climate: The average annual precipitation in the High Fichtelgebirge is between 850 and more than 1000 mm depending on altitude, 20 to more than 25 % as snow. In the area of the highest elevations, the mean actual annual temperature is between 4-5° C, at lower elevations 5 - 6 ° C. The mean annual fluctuation of the air temperature lies between 17.5 and 18.5° C depending on altitude (KNOCH, 1952).

Soils: The High Fichtelgebirge consists predominantly of granites; in addition gneiss, phyllite, mica slate and quartzite are also found: For the most part, the soil did not develop directly on the outcropping rock, but rather in solifluction covers, in which the petrographic composition of the upward adjoining terrain is mixed in weathered condition. "Braunerden" and "Podsole" predominate among the soils present. Wherever paleoweatherings seal the subsoil, water-logged characteristics appear. "Ranker" and "Regosole" are found on steeper slopes.

Excursion area "Waldsassen Slate District" (10.2.1)

Landscape: The district is located in the area of a Tertiary depression field, which lacked both higher mountains and strong erosion impulses. The hilly relief consists of shallowly channeled and periglacially superimposed old surface residues lying mostly at altitudes of around 550 to 600 m m.s.l. The scattered higher elevations reach a maximum of 650 m m.s.l., so that the relative heights above the Wondreb Valley do not exceed 170 m. The slopes of this country side in many cases have an inclination of around 5 to 10°; slope angles of 15° are rarely exceeded.

Climate: The Waldsassen Slate District has mean annual precipitation rates between 650 and 800 mm depending on the relief position, 20 to 25% falling as snow. The mean annual temperature is 5.5 to 6.5° and the mean annual fluctuation of the air temperature reaches 18.5° C, in valley locations 19° C (KNOCH, 1952).

Soils: Predominantly "Braunerden" developed on the clay slates, mica slates, phyllites and quartzites as well as on the resulting solifluction covers, and - particularly with heavily sandy cover sheets - "Podsole". Stagnant percolation water over the widely distributed Tertiary weathering residues frequently leads here to "Pseudogley" formations.

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SOILS OF THE FICHTELGEBIRGE

by

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GENERAL INFORMATION

The soils of the Fichtelgebirge (1051 m, mean annual precipitation 1200 mm, mean annual temperature 4,5°C), mainly derived from phyllites, granites and epigneisses. During the Tertiary parent materials had been preweathered deeply. The latter can be seen in Profile No. 1.2 (Schweinsbacher Sattel) where a subhorizon rich in Kaolinite has been formed. During the Quarternary soils were often rearranged by solifluction and enriched by aolian deposits (Dill and Zech, 1980). Thus most soils of the Fichtelgebirge exhibit layers of different parent materials within their solum. Under the present climate mainly Dystric Cambisols (Profiles Nos. 1.1+1.2 = Braunerde Podsol and Podsol Braunerde) and Leptic Podsols (Profile No. 2 = Podsol) have been formed. Besides Rankers Gleysols and Histosols can be found in the Fichtelgebirge. Rankers are mainly restricted to erosion surfaces on steeper slope positions whereas Histosols and Gleysols are restricted to wet planes (spring fens) and head-water regions, respectively.

PROFILE NO. 1.1 = PODSOL-BRAUNERDE

Site description:

Location Wülfersreuth

Grid Reference Top. Map 1:50 000 L 5936 Münchberg
R = ^{44}83200 H = ^{55}47400

Parent material phyllite, solifluction covers

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Topography	5° slope; westerly aspect; middle slope
Elevation	680 m
Vegetation	spruce forest (Vaccinio-Pinion) with Picea abies, Pinus sylvestris, Vaccinium myrtillus, Vaccinium vitis-idaea, Calluna vulgaris, Betula pendula, Dryopteris dilatata, Deschampsia flexuosa, Polytrichum formosum, Dicranum scoparium, Bazzania trilobata, Pleurozium schreberi, Dicranella heteromalla
Drainage	temporarily lateral water
Humusform	Moder
Soil Classification	Podsol-Braunerde (DBG), Typic Fragiochrept (Soil Taxonomy) Dystric Cambisol (FAO)

Profile description:
(GLA-Kartieranleitung, 3. ed. 1982)

Horizon	Depth (cm)	
L	8-6	spruce litter; partially light brownish; fresh needles; some broken branches and bough pieces; loose, confused storage; less than 10% amorphous humic materials; clear boundary
Of	6-3	moderate decomposed needles and needle fragments; first fine roots; partially weakly bleached; weakly compacted; needles are partly netted by fungi; about 40-50% amorphous humic materials; clear boundary
Oh	3-0	strongly rooted (coarse roots); black-brownish amorphous humic materials (70-80%) with little rest of litter; increasing portions of bleached mineral particles; clear boundary
Aeh	0-5	loose, brownish-black (7,5 YR 2/2 wet; 7,5 YR 3/4 dry); weakly bleached, gravelly (gr 4), loamy silt (U13-U14); platy to subangular blocky structure; many roots abundant; smooth boundary

Bhsv	5-10	loose, dark brown (10 YR 3/3 wet; 10 YR 6/4 dry) angular gravelly (gr 4), loamy silt (Ul4); crumb to platy structure; many roots; smooth boundary
Bvs	10-30	loose, brown (10 YR 4/6 wet; 10 YR 7/6 dry) angular gravelly (gr 4), loamy silt (Ul4); crumb structure; many roots abundant; smooth boundary
Bv	30-50	loose, dull yellowish brown (10 YR 5/6 wet; 10 YR 7/4 dry); angular gravelly (gr 4), loamy silt to silty loam (Ul4 - Lv); subangular blocky structure; clear wavy boundary
IICvBv	50-85	compact, dull yellowish brown (10 YR 4/3 wet; 2.5 Y 7/3 dry); angular gravelly (gr 5), loamy silt (Ul 3); subangular blocky structure; smooth boundary
IICv	85 +	compact; yellowish brown (2.5 Y 5/3 wet; 5 Y 8/2 dry), angular gravelly (gr 4), weak loamy silt (Ul 2); subangular blocky structure; silt cutans on skeleton grains and stones

Profile No. 1.1 . Wülfersreuth

No	hor.	depth cm	>2mm sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	L	2												
2	O_f	3												
3	O_h	3												
4	A_{eh}	0-5	55	3	1	3	7	32	24	20	76	17	810	310
5	B_{hsv}	5-10	57	3	1	3	7	31	21	20	72	21	966	26
6	B_{vs}	10-30	49	4	2	3	9	30	21	22	73	18		
7	B_v	30-50	53	7	2	3	12	27	22	21	70	18	710	209
8	IIC_vB_v	50-85	64	10	4	4	18	28	21	17	66	16	617	5
9	IIC_v	85+	59	11	4	4	19	35	24	11	70	11	79	4

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Al_o mg/g	C_o $E\cdot10^3$
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	L	0.02						4.63	3.55	2.05	0.35	0.46	0.64	66
2	O_f	0.09						4.59	3.44	4.00	1.60	0.40	1.11	55
3	O_h	0.17						4.28	3.02	5.25	3.35	0.64	2.28	133
4	A_{eh}	0.86	65.2	60.7	40.9	32.1	21.3	3.76	2.92	20.50	10.25	0.50	2.06	457
5	B_{hsv}	1.16	56.7	47.5	28.6	24.6	13.7	3.96	3.30	30.00	17.50	0.58	2.66	174
6	B_{vs}							4.07	3.87	26.50	13.00	0.49	3.32	91
7	B_v	1.43	47.5	39.7	24.7	21.7	9.9	4.13	4.02	22.50	11.50	0.51	3.71	62
8	IIC_vB_v	1.36	49.8	42.6	27.1	18.6	6.7	4.35	4.19	11.25	2.35	0.21	3.25	78
9	IIC_v	1.44	46.4	43.1	34.9	32.2	6.8	4.48	4.31	6.75	0.85	0.13	1.38	35

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	carbonate %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg: Ca	K	Mg	Na	H	Al	V akt. %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	L	47.0	14.4	32.6	-	837.4	207.8	107.3	19.2	14.8	2.4	55.5	7.3	70
2	O_f	41.7	16.3	25.6	-	1008.	238.1	132.1	12.1	16.5	2.9	63.3	6.2	69
3	O_h	38.4	13.3	28.9	-	993.2	184.7	55.1	5.1	9.9	2.6	66.6	24.7	40
4	A_{eh}	6.65	2.6	25.6	-	421.3	138.8	3.3	1.5	1.0	0.8	27.0	94.7	6
5	B_{hsv}	3.48	1.6	21.8	-	332.5	110.0	1.2	0.9	0.3	1.3	1.2	105.1	3
6	B_{vs}	1.73	0.9	19.2	-	193.8	67.5	0.7	1.4	0.1	0.8	16.6	47.9	4
7	B_v	1.24	0.7	17.7	-	150.0	57.7	0.4	0.7	<0.1	1.9	24.0	30.4	5
8	IIC_vB_v	0.57	0.4	14.3	-	92.5	36.3	0.4	0.6	<0.1	0.3	11.3	23.6	4
9	IIC_v	0.24	0.3	8.0	-	61.3	26.3	0.3	6.3	<0.1	0.0	12.8	12.8	3

PROFILE NO. 1.2 = BRAUNERDE-PODSOL

Site description:

Location	Schweinsbacher Sattel
Grid Reference	Top. Map 1:50 000 L 5936 Münchberg R = ^{44}83800 H = ^{55}47240
Parent material	epigneiss, weathered during the Tertiary
Topography	nearly flat, relict of an old peneplain
Elevation	700 m
Vegetation	spruce and pine forest, about 60-80 years old with Pinus sylvestris, Picea abies, Vaccinium myrtillus, Vaccinium vitis-idaea, Calluna vulgaris, Deschampsia flexuosa, Molinia caerulea, Cetraria islandica, Cladonia digitata, Hypnum cupressiforme, Pleurozium schreberi, Dicranum scoparium, Leucobryum glaucum, Bazzania trilobata
Drainage	drainage slightly restricted
Humusform	Mor
Soil Classification	Braunerde-Podsol (DBG), Typic Fragiochrept (Soil Taxonomy), Dystric Cambisol (FAO)

Profile description:

(GLA-Kartieranleitung, 3 ed. 1982)

Horizon	Depth (cm)	
L	10-8	spruce litter; entire, light brown needles with few, scarcely attacked branch and bough fragments; less than 10% amorphous humic materials; clear boundary
Of	8-4	moderate decomposed, partially first fine roots, bleached needle fragments; bulky to compact layering substance, netted by fungi, amorphous humic materials about 50%

Oh	4-0	black amorphous humic materials, fine humus about 90%, with scarcely recognizable portion of litter rests; many coarse roots; compact; sharp boundary to the mineral soil
Aeh	0-11	loose, brownish black (10 YR 3/1 wet; 10 YR 6/1 dry); angular gravelly (gr 3), sandy silt (Us) with many bleached mineral particles; crumb to subangular block structure, many roots abundant; clear boundary
Ae	11-24	loose, dull brown (7.5 YR 5/3 wet; 7.5 YR 8/1 dry); angular gravelly (gr 4), weak loamy silt (Ul2), platy structure; few roots abundant, clear boundary
Bhs	24-35	loose, bright brown (7.5 YR 5/8 wet; 10 YR 7/4 dry); angular gravelly (gr 3); weak loamy silt (Ul3); platy structure; many roots abundant; clear boundary
IIBv	35-65	compact, dull yellow orange (10 YR 6/4 wet; 2.5 Y 8/3 dry); angular gravelly (gr 3); weak loamy silt (Ul2); platy structure; few roots abundant; clear wavy boundary
IICvg1	65-85	compact; bright yellowish brown (2.5 Y 7/6 wet; 2.5 Y 8/2 dry); angular gravelly (gr 2) sandy silt (Us); somme yellow orange mottles (7.5 YR 8/4-8); weak subangular blocky to coherent structure; smooth boundary
IICvg2	85-185	compact, bright yellowish brown (2.5 Y 7/6 wet; 2.5 Y 8/2 dry); angular gravelly (gr 2); sandy silt (Us); coherent structure; yellow orange (7.5 YR 8/4-8) iron mottles; smooth boundary
IICvg3	185+	compact, light gray (2.5 Y 8/2 wet); angular gravelly (gr 2); sandy silt (Us); coherent structure.

Profile 1.2 Schweinsbacher Sattel

No	hor.	depth cm	>2 mm sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	L	2											639	244
11	O_f	4												
12	O_h	4											n.d.	n.d.
13	A_{eh}	0-11	33	6	8	10	24	42	18	10	70	6	270	170
14	A_e	11-24	12	5	6	8	19	40	22	10	72	9	21	12
15	B_{hs}	24-35	24	5	6	8	19	37	22	7	66	15	146	28
16	IIB_v	35-65	20	8	7	8	23	34	25	8	67	10	100	28
17	IIC_{vg1}	65-85	2	2	7	7	16	42	26	9	77	7	9.5	5.5
18	IIC_{vg2}	85-185	2	2	7	8	17	42	25	[illegible]	76	7	14	4.0
19	IIC_{vg3}	185	2	2	8	8	18	42	26	8	76	6	n.d.	n.d.

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Al_o mg/g	C_o E·10^3
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
10	L	0.03	90	45	24.5	17.7	9.5	4.55	3.23	0.70	0.65	0.93	0.25	41
11	O_f	0.08						3.95	3.02	2.13	1.05	0.49	0.63	33
12	O_h	0.09	n.d.	n.d.	n.d.	n.d.	n.d.	3.89	2.75	2.38	1.70	0.71	1.60	43
13	A_{eh}	0.73	69.7	54.7	41.9	39.5	9.1	3.58	2.80	1.80	1.35	0.75	1.31	179
14	A_e	1.20	53.9	47.6	34.5	30.6	7.5	3.85	3.13	1.85	0.20	0.11	0.74	75
15	B_{hs}	1.06	58.6	49.2	40.9	35.4	14.7	4.49	4.09	14.25	8.25	0.58	3.64	123
16	IIB_v	1.54	42.7	40.4	38.4	34.1	9.2	4.67	4.46	6.00	0.75	0.13	2.29	55
17	IIC_{vg1}	1.46	45.3	41.6	36.4	32.3	5.2	4.66	4.48	4.25	0.20	0.05	0.64	42
18	IIC_{vg2}	1.69	40.1	39.0	35.8	31.4	4.4	4.70	4.30	3.75	0.16	0.04	0.39	28
19	IIC_{vg3}	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	4.78	4.15	1.10	0.01	0.01	0.11	16

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	carbonate %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	K	Mg	Na	H	Al	V akt %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
10	L	50.4	12.1	41.7	–	789.2	165.5	49.3	16.0	12.3	3.6	80.6	3.1	49
11	O_f	50.2	14.6	34.4	–	974.7	181.3	58.0	10.7	14.8	2.7	84.0	10.4	48
12	O_h	47.8	12.7	37.6	–	1153.6	191.5	55.1	6.5	14.0	1.1	92.9	21.2	40
13	A_{eh}	5.58	2.0	27.9	–	343.8	91.3	1.6	1.4	0.6	2.6	44.9	40.2	7
14	A_e	0.62	0.3	20.7	–	131.3	68.8	0.4	0.3	0.1	3.1	15.5	49.4	6
15	B_{hs}	1.35	0.5	27.0	–	160.0	41.3	0.1	0.3	<0.1	0.5	17.6	22.7	2
16	IIB_v	0.27	0.1	27.0	–	63.8	23.8	0.1	0.5	<0.1	0.4	11.9	10.8	5
17	IIC_{vg1}	0.14	0.1	14.0	–	42.5	21.3	0.1	0.3	<0.1	1.0	10.1	9.7	7
18	IIC_{vg2}	0.11	0.1	11.0	–	57.5	25.0	0.1	0.3	<0.1	0.1	18.2	6.2	2
19	IIC_{vg3}	0.05	0.1	5.0	–	43.8	21.3	<0.1	0.1	<0.1	0.5	14.3	6.2	4

PROFILE NO. 2 = PODSOL

Site description

Location	Farrenleite
Grid reference	Top. Map 1:50 000 L 5936 Münchberg R =[44]89880 H = [55]45140
Parent material	granite
Topography	14° slope; southerly aspect
Elevation	920 m
Vegetation	beech forest, about 108 years old (Luzulu-Fagetum) with Fagus sylvatica, Vaccinium myrtillus, Pteridum aquilinium, Deschampsia flexuosa, Calamagrostis arundinacea, carex sylvatica, Plagiothecium curvifolium, Polytrichum formosum, Dicranum scoparium
Drainage	good
Humusform	Moder
Soil Classification	Podsol (DBG), Entic Fragiorthod (Soil Taxonomy) Orthic Podzol (FAO)

Profile Description:
(GLA-Kartieranleitung, 3 ed. 1982)

Horizon	Depth (cm)	
L	9-6	fresh fallen beech litter, brownish, entire beech leaves beside broken branches and bough pieces; extremely loose; no fine humic materials; clear boundary
Of	6-2	older leaves and leaf fragments; attached to packages and netted by fungi; fine roots; few attacked fruit bowls; 30-40% amorphous humic materials; clear boundary
Oh	2-0	coarse and fine roots; black brownish amorphous humic substances (70-80%) with few litter rests and bleached quartz grains; loose to weak brittle structure; smooth boundary

OhAeh	0-4	loose, black (10 YR 1.7/1 wet; 10 YR 4/1 dry); angular gravelly (gr 3); weak loamy sand (Sl 3) with high portion of amorphous humic materials (30%) and bleached mineral particles; crumb structure; many roots abundant; clear boundary
Ae	4-12	loose, grayish brown (7.5 YR 4/2 wet; 7.5 YR 6/2 dry); angular gravelly (gr 3) silty to loamy sand (Sl 3 - Sl a); crumb structure; many roots abundant; clear boundary
Bsh	12-17	loose, brownish black (17.5 YR 3/2 wet; 7.5 YR 5/4 dry); angular gravelly (gr 3); sandy loam (Ls 3); crumb structure; many roots abundant; wavy boundary
Bs	17-29	loose, dark brown (7.5 YR 3/4 wet; 10 YR 5/4 dry); angular gravelly (gr 3); silty to loamy sand (SlU); crumb structure; many roots abundant; smooth boundary
Bv	29-40	loose, brown (7.5 YR 4/4 wet; 10 YR 5/4 dry); angular gravelly (gr 4); silty sand (Su 4); crumb structure; many roots abundant; smooth boundary
IICvBv	40 -	compact, brown (7.5 YR 4/4 wet; 10 YR 7/4 dry); angular gravelly (gr 4); weak silty loam (Su 3); subangular blocky structure; few roots abundant

Profile No. 2 Farrenleite

No	hor.	depth cm	>2mm sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
20	L	3												
21	O_f	4												
22	O_h	2												
23	O_hA_{eh}	0-4	36	27	12	11	50	18	15	6	39	11	86.7	49.0
24	A_e	4-12	43	24	11	15	50	19	14	7	40	10	38.0	4.4
25	B_{sh}	12-17	36	23	11	11	45	16	15	8	39	10		
26	B_s	17-29	40	23	10	10	43	22	16	8	46	11	198.0	94.0
27	B_v	29-40	49	25	11	11	47	20	18	9	47	6		
28	IIC_vB_v	40 +	54	31	15	11	57	13	15	8	36	7	882.0	16.0

No	hor.	bulk dens. g/cm³	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Al_o mg/g	C_o E·10³
1	2	16	17	18	19	20	21	22	23	24	25	26	27	28
20	L	0.01						5.59	4.70	0.13	0.10	0.56	0.03	
21	O_f	0.09						6.59	5.81	2.35	1.65	0.45	0.69	78
22	O_h	0.15						4.84	3.28	3.50	1.95	0.56	1.40	63
23	O_hA_{eh}	0.73	70.0	47.7	30.5	23.2	3.7	4.24	3.44	4.00	1.55	0.39	0.86	102
24	A_e	1.12	55.0	43.2	26.0	22.1	6.2	4.31	3.30	4.25	1.95	0.45	0.80	101
25	B_{sh}							4.55	3.66	25.50	19.50	0.76	4.85	503
26	B_s	0.84	65.0	41.6	29.2	33.6	11.9	4.45	3.96	21.00	18.50	0.88	8.85	447
27	B_v		n.d.	n.d.	n.d.	n.d.	n.d.	4.60	4.20	8.50	4.45	0.52	7.80	287
28	IIC_vB_v	1.26	50.0	43.7	35.2	23.4	16.9	4.68	4.34	5.25	1.65	0.20	4.10	100

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	carbon %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	K	Mg	Na	H	Al	V akt. %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
20	L	50.2	11.6	43.3	0.19	770.4	277.7	133.6	70.3	46.1	4.1	25.2	0.5	92
21	O_f	41.0	17.2	23.8	1.39	1192.4	409.3	232.1	10.4	178.1	1.5	13.4	1.1	96
22	O_h	42.0	20.9	20.1	-	1003.5	230.8	129.1	6.2	25.9	2.8	55.6	9.7	72
23	O_hA_{eh}	14.4	7.1	20.2	-	486.3	117.5	56.6	5.3	37.4	3.2	7.7	7.3	87
24	A_e	2.1	0.9	23.1	-	143.8	65.0	4.1	1.2	2.1	0.9	25.3	31.4	13
25	B_{sh}	5.8	2.6	22.3	-	318.8	75.0	3.9	1.6	1.4	1.0	14.1	53.0	11
26	B_s	5.1	2.2	23.0	-	260.0	61.3	2.3	1.0	0.5	0.5	24.6	32.4	7
27	B_v	3.2	1.4	22.8	-	143.8	38.8	2.0	0.5	0.6	0.8	11.3	23.6	10
28	IIC_vB_v	0.8	0.4	20.5	-	63.8	31.3	0.4	0.4	0.3	0.3	16.5	13.4	4

whereas in the Entic Fragiorthod (Profile No. 2) feldspars and biotites are abundant. Weathering of skeleton grains is confirmed by expansion of micas and decomposition of feldspars. As a matter of fact the degree of weathering increases with decreasing profile depth.

INTERPRETATION OF PROFILES NOS.1.1,1.2AND 2

According to the German soil classification system profile No. 1.1 is classified as a Podsol-Braunerde whereas profiles Nos.1.2 and 2 resemble Braunerde-Podsols. In contrast to that only soil No. 3 satisfies the requirements for Spodsols in the U.S. Soil Taxonomy and for Podzols in the FAO system. Profiles Nos.1.1 and 1.2are classified in these taxonomies as Typic Fragiochrepts (Soil Taxonomy) and as Dystric Cambisols (FAO), respectively.

Depth functions of pH-values show all soils to be strongly acidified. The lowest pH-Values can be found in the Aeh- and Oh-horizons, which only come up to 2.92 (Aeh No.1.1, Ca Cl_2-value), 2.75 (Oh, No.1.2), and 3.28 (Oh, No. 3). pH-values are increasing from these horizons into both directions to the top and the bottom of soils. Higher pH-values in L- and Of-horizons result from the enrichment of bases by the vagetation in the organic layers (base pump). [The very high pH-values of 5.59 and 6.59 in the L- and Of layers of profile No. 2 are due to fertilizers]. The latter is also confirmed by a higher base saturation of the exchange complex (V-values) in the organic layers. V-values of L- and Of-horizons range between 48% (Of profile No.1.2 to 96% (profile No. 2). In contrast, the mineral horizons show base saturations below 10%. The exchange capacities (= CEC_a) of all soils under investigation are very low within the mineral soil horizons (20-140 meq/kg) and relatively high within the organic layers (130-409 meq/kg). Corresponding to the low pH of soils there are marked differences to be found between potential and actual CEC of all horizons. The latter is especially true for the organic layers where mainly humic substances contribute to the CEC.
Humus layers of all soils are classified as moder (Nos.1.1 and 2) and as mor (No.1.2). Thus all soils exhibit wide C/N-ratios ranging from 20 to 43 in L, O and Aeh-horizons of Profiles Nos.1.1 and 2 and 28 to 42 in profile No. 1.2

The process of podzolation can be confirmed in all soils by the depth functions of Fe_d, Fe_o, Al_o and C_o. All these parameters show

MICROMORPHOLOGICAL DESCRIPTION OF PROFILE NOS.1.1,1.2 + 2 AT WÜLFERSREUTH, SCHWEINSBACHER SATTEL AND FARRENLEITE

The investigated soils are mainly characterized by stratification due to periglacial solifluction, by podzolation and the formation of cambic horizons.
The Bhsv-,Bhs-and Bsh-horizons of all soils present an intertextic to agglomeroplasmic-intertextic related distribution between plasma and skeleton grains. Fluffy aggregates have been formed due to illuvation of humic substances and sesquioxides. The plasmic fabric is mainly silasepic. Only the plasma of the Bsh-horizon of Profile No. 2 at Farrenleite can be classified as isotic to silasepic due to the intense accumulation of organic matter.
The voids of the intertextic microfabric are channels, chambers and vughs, respectively. The majority of channels have been formed by roots.
The Bv-horizons of profile Nos.1.1 and 2 exhibit also an intertextic related distribution.
In contrast, the IIBv-horizon of the Typic Fragiochrept (Profile No.1.2)has got a channeled porphyroskelic microfabric, which can be also found in the underlying IICvg-horizons.
It is assumed the differences of microfabrics between the Bhs- and IIBv horizon of Profile No.1.2are due to the fact, that the latter horizon is part of the compacted solifluction cover formed during the periglacial period from materials intensively weathered during the Tertiary.
As mentioned before, all Cv-horizons exhibit a porphyroskelic related distribution.The plasmic fabric is silasepic. C-horizons of profiles Nos.1.1and 2 exhibit destinct silt cutans on the surface of the skeleton grains. They have probably been formed by ice stress during the Pleistocene (Zech 1979).
The C-horizons of the three soils have been classified as fragipans.
Common skeleton of the Typic Fragiumbrept (Profile No.1.1) are phyllite grains, quartzes, muscovites and few feldspars. In the Typic Fragiochrept (Profile No. 1.2 quartz is the dominant mineral

Table 4   Results of needle and leaf analyses

sample		% of dry matter						ppm				
		N	P	K	Ca	Mg	S	Fe	Mn	Cu	Zn	Al
1	Wülfersreuth (profile 1.1) spruce needles, 6 months old	1.63	0.21	0.95	0.44	0.099	n.d.	50	490		25	n.d.
2	Schweinsbacher Sattel (profile 1.2 spruce needles, 6 months old	1.40	0.20	0.81	0.17	0.062	0.20	53	93	3	13	65
	Farrenleite (profile 2)											
3a	beech healthy, 4 months old	2.20	0.144	0.70	0.49	0.051	n.d.	129	940	8	30	133
3b	beech chlorotic, 4 months old	1.15	0.11	0.71	0.17	0.038	n.d.	127	164	6	16	127
4	Oberwarmensteinach spruce with yellow tip disease needles, 6 months old	1.51	0.23	0.57	0.16	0.026	0.23	52	311	3	8	92

minima ih eluvial horizons (e.g. Oh, Aeh, Ae) and maxima in the illuvial horizons (e.g. Bvs, Bsh and Bsv).

Results of texture analyses reveal the soils Nos.1.1 and 1.2 to be mainly composed of silts and the No. 2 to be composed of sand. As a matter of fact all soils especially Nos.1.1 and 2 are rich in skeletal grains which has been inherited from the parent materials. Depth functions of the clay contents show slight maxima in the illuvial horizons. We believe this to result from an enrichment of sesquioxides.

All soils are highly permeable except No.1.2 (Schweinsbacher Sattel) which shows an abrupt decrease of permeability in the Ae-horizon (kf = 21 cm/d). The soils are well areated.
This is not true for the Ae- and the IICvg²-horizons of the Podsol-Braunerde at Schweinsbacher Sattel (No.1.2) which have only about 5% air capacity. The available water capacities range between 10% and 30%.

ECOLOGICAL ASPECTS

Since 1980 most trees on acid soils above 700 m have exhibited decline phenomenas with chlorosis and necrosis. Needles of affected Picea abies showed ample N and P concentrations. However, needle concentrations of Mg were very low, those of Ca, K, Zn of affected spruce (sample 4, table 4) were relatively low. Al, Fe and Cu laid in the normal range but usually S-concentrations were above the critical threshold. At the Farrenleite-site (profile 2) Fagus sylvatica exhibited visible leaf injuries which could be correlated with low N, P, K, Ca and very low Mg leaf concentrations. There are no symptoms of Al-toxicity. Theories about this and for the wide spread Mg-defiancy and the results of our studies on nutriant cycles will be discussed during the field trip.

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Trace metals in soils of the Fichtelgebirge

by H. Ruppert *

A detailed description of the soil profiles is given by Zech et al. in this excursion guide. The source material of the investigated soils are phyllite (profile 1), epigneiss (profile 2), and granite (profile 3), all covered by periglacial solifluction material.

Nearly all of the cadmium and lead and a part of zinc, nickel and copper in the humic layers are accumulated by anthropogenic immissions. Horizons as Bhs, Bsh, Bhsv, Bs and Bsv, which are characterized by illuvation of humic substances and/or sesquioxides, show pronounced enrichments of iron and anthropogenic lead. The solifluction covers can easily be identified by their chemical compositions. The upper horizons of the phyllite-profile contain less Cr, Ni, Cu, Mn and Zn and more Fe than the horizons near the substratum and the substratum itself. The Braunerde-Podsol-profile on epigneis show three chemically distinguishable layers: below the humus layer a quartz-rich podsolic solifluction cover with low metal contents (Aeh, Ae, Bhs); the IIBv-horizon with enrichments of all the investigated elements; the quartz-rich and kaolinite containing IICvg-horizons with low stone contents and low metal concentrations except for Pb. The enrichment of Pb in these horizons may be explained by the following mechanism: The IICvg-horizons consist of epigneiss material intensively weathered during the Tertiary. Lead was liberated by weathering of Pb-containing potassium feldspar and accumulated in the weathering products. The epigneiss studied here contains approximately 15 to 25 % potassium feldspar (Stettner, 1977). A translocation of lead form the soil surface to the IICvg-horizons can be excluded because lead is very immobile in the soil column (excepting illuvation), and because the C- and Fe-concentrations are very low in these horizons. Additionally, this mechanism should produce larger Pb-concentrations in the Bhs-horizon.

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The main variation of the metal concentrations in the Podsol-profile on the granite is produced by podzolization. The Bv- and IICvBv-horizons have somewhat elevated contents of Cr, Mn, Co, Ni, Cu and Zn due to primary differences in the parent material.

Reference:

G. Stettner (1977): Geologische Karte von Bayern 1 : 25.000; Erläuterungen zu Blatt Nr. 5936, Bad Berneck. 225 pp, Bayerisches Geologisches Landesamt, München.

Metal concentration in soil profiles of the Fichtelgebirge (in ppm):

horizon	depth	Cr	Mn	Fe %	Co	Ni	Cu	Zn	Cd	Pb	clay %	silt %	sand %
Podsol-Braunerde; parent material:phyllite, solifluction covers (Profile No. 1; Wülfersreuth)													
L	2	13	218	0.2	<3	8	11	48	0.33	66	-	-	-
Of	3	48	150	0.7	4	15	18	82	0.57	178	-	-	-
Oh	3	38	101	0.9	3	17	17	85	0.93	181	-	-	-
Aeh	0- 5	81	201	2.5	5	6	11	45	0.13	51	17	76	7
Bhsv	5-10	72	266	3.3	5	7	14	49	0.05	42	21	72	7
Bvs	10-30	79	281	3.9	6	11	14	65	0.06	27	18	73	9
Bv	30-50	86	321	3.7	8	15	17	73	0.06	27	18	70	12
IICvBv	50-85	77	405	3.2	18	35	21	91	0.05	28	16	66	18
IICv	> 85	79	362	3.4	27	40	25	93	0.06	29	11	70	19
Braunerde-Podsol; parent material: epigneiss, weathered during the Tertiary (Profile No. 2; Schweinsbacher Sattel)													
L	2	9	60	0.1	<3	4	8	37	0.22	50	-	-	-
Of	4	21	53	0.3	3	11	19	60	0.39	128	-	-	-
Oh	4	28	55	0.3	3	14	17	80	0.68	147	-	-	-
Aeh	0- 11	19	33	0.5	3	4	6	22	0.21	39	6	70	24
Ae	11- 24	19	42	0.7	<3	<3	9	26	0.03	12	9	72	19
Bhs	24- 35	26	65	2.0	<3	3	4	29	0.01	17	15	66	19
IIBv	35- 65	29	103	1.5	4	7	15	39	0.02	15	10	67	23
IICvgl	65- 85	10	35	1.0	<3	<3	4	25	0.01	20	7	77	16
IICvg2	85-185	11	29	0.8	<3	<3	8	29	0.01	77	7	76	17
IICvg3	>185	11	20	0.7	<3	<3	5	39	0.01	106	6	76	18
Podsol; parent material: granite (Profile No. 3; Farrenleite)													
L	3	8	766	<0.1	<3	<3	5	62	0.23	15	-	-	-
Of	4	39	457	0.3	<3	19	21	97	0.74	152	-	-	-
Oh	2	81	128	0.5	4	34	27	124	1.44	316	-	-	-
OhAeh	0- 4	18	93	0.7	<3	3	11	46	0.39	123	11	39	50
Ae	4-12	14	64	0.8	<3	<3	4	21	0.08	36	10	40	50
Bsh	12-17	22	109	2.9	<3	<3	4	33	0.20	67	10	39	45
Bs	17-29	18	211	2.6	<3	<3	5	39	0.27	31	11	46	43
Bv	29-40	25	218	1.9	4	5	7	56	0.23	21	6	47	47
IICvBv	>40	21	241	1.6	4	9	5	60	0.10	20	7	36	57

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The Tertiary Sediments and Weathering Loams in the Seedorf Kaolin Loam Pit

(Northwest of Waldsassen, Northeastern Bavaria)

by O. Drexler+)

SUMMARY

Sediments, probably of Upper Miocene age, have been discovered in the Seedorf loam pit. The sedimentation of a white, silty clay, which in places can change over into quartz gravel followed the deposition of a red clay. The sediments are characterized by allitically marked composition. They were deposited limnetically-fluvially in a lateral valley of the Röslau Valley probably formed in the Presarmation period. The outcropping phyllite below the sediments has become weathered to a brightly colored, high-kaolinite, loamy silt.

1. INTRODUCTION

Tertiary sediments above loamy weathered phyllite have been found in a loam pit near Seedorf in the southeastern Fichtelgebirge (location: TK 25 - Sheet 5939 Waldsassen; R^{45} 17500 to ^{45}17620, N^{55} 45 740 to ^{55} 45 780; 545-550 m m.s.l.). The regional framework of this loam occurrence is provided by the southern wing of the High Fichtelgebirge extending from SW to NE, which in this section is composed of phyllitic "Phycodenschiefer ", metamorphic sediments of the Ordovician. The hilly landscape consists of numerous smaller remnants of earlier developed planes between 560 and 600 m which are dominated by elevations of no more than 650 m m.s.l. The valleys commence in the plateau with weakly indented, slightly embanked and in some cases with flat-bottomed initial valley basins. The Seedorf loam pit lies on the edge of such an initial valley basin belonging to the valley system of the Freisnitz draining westward to the Röslau.

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2. DESCRIPTION OF THE SEDIMENTS AND THE PHYLLITE WEATHERING

The loam extraction forms a five to eight meter deep pit. At the time of the sedimentological processing, a white to light gray loamy sediment appeared in the western part over the entire exploration depth, which according to information received from the company allegedly has a maximum thickness of 12 m. The material consists of approximately equal parts of clay and silt (see Tab. 1); a minor sand component passes over to the sparing content of poorly rounded quartz gravel. Friable weathered quartzite pebbles also are embedded quite scattered in the loam. The phyllosilicates of the clay fraction consist primarily of illite and mica and around one third of kaolinite (investigation methods at KÖRBER & ZECH 1984). A stratification of the sediment is evident only sporadically through sparsely illuviated strata of plant chaff. The sediment contains charred, black pieces of wood.

A rich red (10R4/8 to 7.5 R4/6) clay had been exposed in a section of the north wall of the pit further to the east - likewise here over the entire exploration depth of around 5 meters. Almost three quarters of the material has grain sizes of less than 2 µm; silt and sand each make up around 13 %. In the clay fractions, kaolinite dominates with around 65 %; illite and mica make up the remainder. Macroscopically, the material appears to be unstratified, but the inclusions of poorly rounded shingle reveal nevertheless the sedimentary origin.

Because of the storage of removed material and an accumulation of water on the bottom of the pit, the stratigraphic relationship between the red and the white sediment pack could not be determined with absolute certainty. But apparently the white sediment with greatly differing thickness overlies the red material on very undulatingly formed erosion discordance. Information from the company and drilling reports from the vicinity of the pit appear to confirm this. The drilling reports also indicate a considerable granulometric variability within the white sediment

Table 1: Particle-size-distribution (Wt.pct.)

	2 µm	2 - 6 µm	6 - 20 µm	20 - 60 µm	0,06 - 0,2 mm	0,2 - 0,6 mm	0,6 - 2,0 mm	2,0 (-20) mm
1. Sediments:								
white	47,5	20,0	19,4	10,7	2,0	0,2	0,1	0,1
red	72,6	3,5	5,4	3,6	7,3	4,5	1,8	1,3
2. Phyllite-decomposition:								
white	12,6	13,9	29,5	32,9	7,8	1,9	0,5	0,9
ocher	13,8	12,8	28,8	36,1	4,6	2,2	1,7	0,0
red	11,7	9,8	24,5	28,7	12,1	9,2	3,4	0,6

Table 2: Mineralogical composition of the clay fraction (Pct.)

	Sediments		Phyllite-decomposition		
	white	red	white	ocher	red
Kaolinite	45	65	35	40	40
Mica(+Illite)	55	35	65	60	60

pack. It is therefore assumed that the white gravel fill in the SE corner of the pit, which was cut during the working period, should be classified as a facies variant of the formation of the white, younger sediment sequence. This is a typical residual gravel made up of around 90 % quartz shingle. The medium gravel fraction dominates; the components are poorly rounded.

The sediments described form the fill of an erosion channel cut into the underlying rock of Ordovician phyllite. At the time it was worked, the flank of the channel was exposed on the eastern edge of the pit. On the base of the sedimentary overlay, there is a reddish-violet,hematitic iron crust, remnants of which were found in the pit (processed by Prof. Schwertmann, Chair for Pedology of the TU-München). The visible phyllite is intensively weathered; even the lowest sections are greatly disintegrated and red in color (7.5R3-4/4). The original rock structure is still clearly recognizable, although a sandy-loam silt is now present as weathering product (see Tab. 1). The clay fraction consists of 40 % kaolinite and 60 % mica. As a result of increasing mottling, the red weathering zone passes over within a few decimeters upwards into an ochre-colored (2.5Y6/6 to 10YR 5/8) loamy silt. The clay faction here has the same composition as in the red weathered rock. The original rock structures have already been largely eliminated. Toward the top an approximately white loamification zone follows in which no more rock structures are contained - the sequence described occurs within an interval of 1 to 2 meters. Granulometrically it resembles the ochre weathered rock, but clay mineralogically, a somewhat higher mica content is apparent.

3. MORPHODYNAMIC AND MORPHOGENETIC INTERPRETATION

The white and red deposits apparently represent fluvially transported sediments because of their gravel admixture and the settling in erosion cavities. The settling of the fine components, in particular of the clay masses required a stagnation of the flow movements, leading to the conclusion that ponding influences or drying-up flows were present.

Allitically weathered material of the tropoid, probably at least Lower Miocene, weathered covering was carried away in the drainage area of the stream (for the age of greatly desilicated weathering products in our region, cf. WURM 1961, p. 301; DREXLER 1980b, p. 39; STETTNER 1982 1982, p. 56; LOUIS 1984, p. 22). The phyllite disintegration product originated under the same weathering conditions. In consideration of the weathering states, the sediments are classified as Neocene. They appear to be older than the "Espich"-sediment in the vicinity of Kulmbach dated as Pliocene, closely resembling the white fill (DREXLER 1980 a). The "Espich"-sediment contains not only allitic disintegration material, but also slightly weathered components abundantly. Furthermore, the underlying rock of the "Espich"-sediment is not allitically, but rather siallitically weathered (DREXLER 1980 b, p. 40). It would appear to be justified in concurrence with STETTNER (in EMMERT & STETTNER 1981) on the basis of this comparison to consider a Miocene age of the Seedorfer deposits until a more secure dating has been established.

In view of the fact that the Seedorfer sediment lies in an initial valley basin, one would first of all think of a considerably lesser age. But it must be taken into consideration that the Quaternary valley shape is immersed into the described sedimentary fill of a considerably older previous form (cf. v. GAERTNER 1938-1941). Even WURM (1961, p. 306) regards the Freisnitz Valley course to be genetically connected with the Röslau Valley, whose Miocene age is proved by the presence of lignite. LOUIS (1984, p. 15) states that the prebasaltic Miocene relief in the study area was not a peneplain but rather a "knobby hill country" and that the Freisnitz Valley existed even before the uplift of the Steinwald range which took place in the Sarmatian (1984, p. 21). This uplift affected the western part of the block considerably more than the eastern. Since the valley even then drained to the west, it could have caused the ponding already postulated above for sedimentological reasons. This would mean that a Sarmatian age of the Seedorf deposit should be considered.

4. ACKNOWLEDGEMENT

The analyses of the grain sizes and of the clay minerals was able to be conducted at the Chair for Pedology of the Bayreuth University. We wish to thank Prof. Dr. W. Zech most heartily for this. We are also deeply indebted to the DFG for its financial support.

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Excursion Waldsassen

Contribution of the Chair of Soil Science, University of München,
Dr. F. Makeschin, Prof. Dr. K.E. Rehfuess, cand. geogr. D. Schramm +)

Profiles 4.1 and 4.2: Podsol-Braunerde

Site description

Growth region:	Oberpfälzer Wald
Growth district:	Waldsassener Schiefergebiet
Location:	State Forest District Waldsassen, compartments Pfaffenwinkel and Dachsbau
Elevation:	530 m above sea level
Topography:	NW-aspect, 5 - 9 % indination
Climate:	subcontinental, mean annual temperature 5,8 °C; mean annual precipitation 610 mm.
Vegetation:	Anthropogencically degraded coniferous pine (and pine-spruce) forests. Ground vegetation: Acidophytic dwarf shrubs, mosses and lichens.
Parent rock:	Phyllite debris-slope deposits, highly weathered, sometimes overlying phyllite saprolithe.

Classification:	German:	Podsol-Braunerde.
	FAO:	Dystric Cambisol.
	Soil taxonomy:	Typic dystrochrept.

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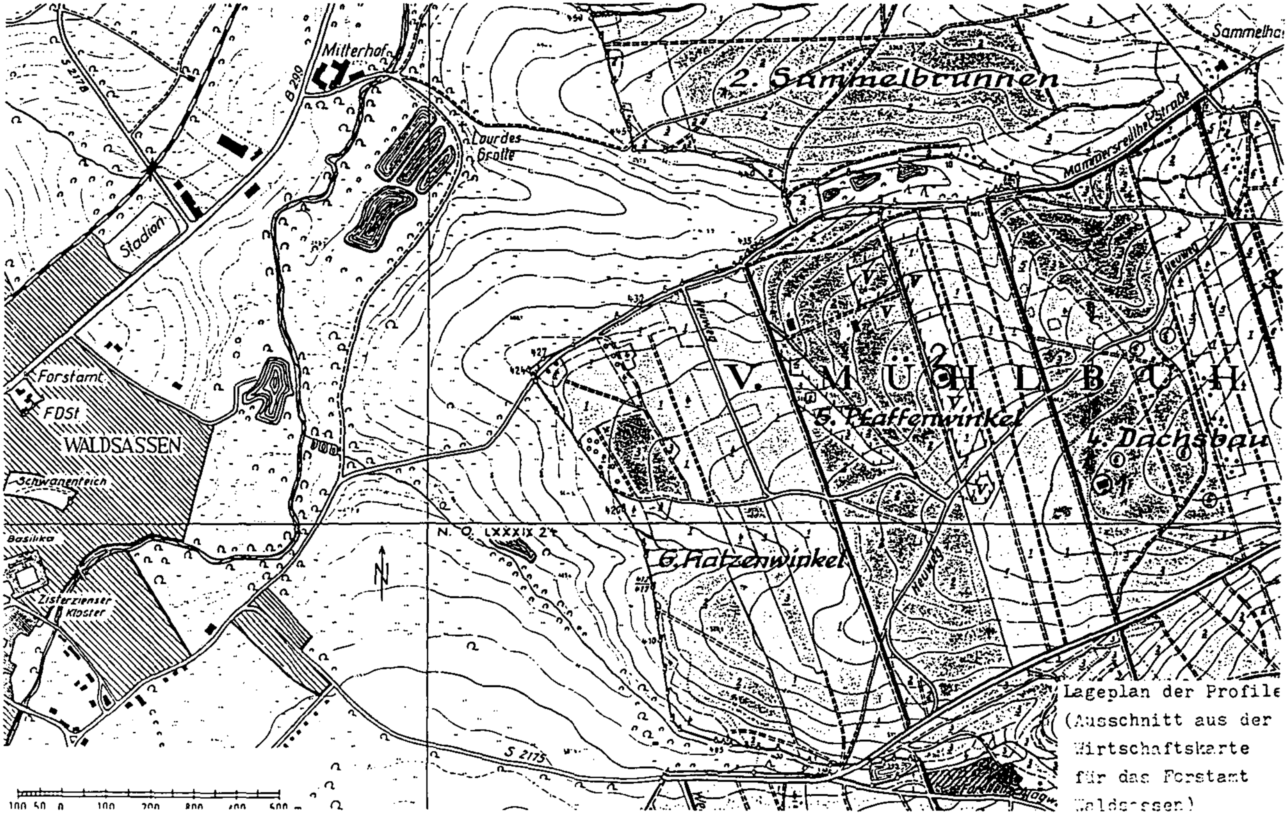
1 = profile 4.1
2 = profile 4.2



Lageplan der Profile
(Ausschnitt aus der
Wirtschaftskarte
für das Forstamt
Waldsassen)

Profile descriptions

Profile 4.1 (Dachsbau)

Horizon	depth	Description
L	8.5 - 8	fresh litter of Scots pine, loose.
Of	8 - 2	needle fragments and remains, partially decomposed, fungal hyphae.
Oh	2 - 0	dark brown to black, high percentage (> 80) of fine coprogenous aggregates, coherent, shape-edged breakable, many roots.
A_{eh}	0 - 6	pale-greyish to pale ochreous-brown (7.5 YR 1.7/1 to 7.5 YR 5/3)[x], silty loam (uL), with moderate humus content and fine skeleton, platy structure, moderate dense to loose, many roots, gradual (sometimes wavy) boundary.
B_{sv}	6 - 16	light ochreous brown (7.5 YR 6/8), silty loam (uL), with weak humus content, skeleton > 10 % (fine), subangular blocky structure, moderate dense, moderate roots, gradual boundary.
B_{v1}	16 - 30	ochreous brown (7.5 YR 5/6), clayey silt (t·´U), low in humus, fine skeleton (> 10 %), subangular blocky structure, moderate dense, moderate roots, gradual boundary.
B_{v2}	30 - 38	dark ochreous brown (7.5 YR 5/8), clayey silt (t·´U) low in humus, fine skeleton (≥10 %), subangular blocky structure, moderate dense, very few roots, gradual boundary.
B_{v3}	38 - 56	ochreous- to yellow-brown (7.5 YR 6/6), clayey silt (t·´U) coarse skeleton (30 %), subangular blocky structure, moderate dense, very few roots, wavy gradual boundary.

[x]after Munsell color charts (moist conditions)

Horizon	depth	Description
C_vB_v	56 - 71	ochreous- to yellow brown with pale and violet-red stains (7.5 YR 6/6), clayey silt (t·´U), skeleton 40 %, subangular blocky structure, dense, very few roots, wavy gradual boundary.
BvC_v	71 - 130	yellow- and red-brown (5.0 YR 5/4), with grey and violet-red stains, clayey silt (t·´U), skeleton 50 %, massive and subangular blocky structure, dense, no roots.

Classification: German: Podsol-Braunerde.
FAO: Dystric Cambisol.
Soil taxonomy: Typic dystrochrept.

Podsol-Braunerde, profile 4.1(Dachsbau)

1. Soil physics

No.	horizon	depth cm	stone %	texture in % of humus-free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	composition of clay minerals % +)	bulk dens. g/cm^3	GPV %	Watercontent in % at pF 0.6	1.8	2.5	4.2
1	Of	8- 2																	
2	Oh	2- 0																	
3	A_{eh}	0- 6	11.4	11.0	4.5	4.5	20.0	17.0	28.5	16.5	62.0	18.0	K19,I63,W10,V8	1.17	55.6	2.6	11.1	2.3	25.5
4	Bsv	6-16	16.2	15.5	5.0	5.5	26.0	16.5	22.5	15.5	54.5	19.5	K19,I71,W6,V4	1.37	50.8	2.4	7.5	2.3	21.8
5	B_{v1}	16-30	16.5	17.5	7.0	4.5	29.0	13.5	27.0	14.0	54.5	16.5	K23,I48,W12,V7	1.51	45.7	2.6	3.5	2.2	20.5
6	B_{v2}	30-38	16.5	17.0	7.5	5.5	30.0	15.5	26.5	15.0	57.0	13.0	K22,I74,W-,V4	1.60	41.9	2.1	2.8	1.9	21.2
7	B_{v3}	38-56	29.2	13.5	7.0	5.0	25.5	12.0	32.5	15.5	60.0	14.5	K39,I53,W-,V8	1.69	40.0	2.2	3.8	1.6	13.4
8	C_vB_v	56-71	39.1	16.5	8.5	4.5	29.5	12.0	30.5	15.0	57.5	13.0	K37,I60,W-,V3	1.79	37.4	2.8	4.8	1.5	17.9
9	BvCv	71-130	51.2	13.0	7.5	6.5	27.0	16.0	30.5	14.5	61.0	12.0	K35,I65,W-,V-	1.83	35.6	3.1	5.3	1.4	13.2

+) K = Kaolinit
I = Illit
W = Mixed layer minerals
V = Vermikulit

Podsol-Braunerde, profile 4.1

No.	horizon	depth cm	pH H_2O	pH $CaCl_2$		$C_{org.}$ %	N_t mg/g	C/N	P_t mg/g		$P_{citric\ acid\ soluble}$ mg/kg	K_t mg/g	Ca_t mg/g	Mg_t mg/g
1	Of	8-2	3.65	2.90		45.00	12.58	35.8	0.71		49.13	2.8	1.93	0.65
2	Oh	2-0	3.45	2.62		39.8	10.75	37.0	0.66		21.59	5.8	1.53	0.79
3	Aeh	0-6	3.75	3.03		2.08	1.37	15.2	0.49		1.03	27.5	0.37	1.25
4	Bsv	6-16	4.03	3.50		1.01	0.94	10.8	0.52		3.41	29.7	0.30	1.40
5	Bv_1	16-30	4.37	3.98		0.82	0.87	9.4	0.45		1.87	31.1	0.28	1.72
6	Bv_2	30-38	4.42	4.13		0.59	0.80	7.4	0.44		1.27	30.1	0.32	1.70
7	Bv_3	38-56	4.53	4.06		0.28	0.77	3.6	0.41		0.60	31.8	0.24	1.42
8	C_vB_v	56-71	4.50	4.03		0.21	0.74	2.8	0.42		0.46	33.1	0.18	1.34
9	B_vC_v	71-130	4.43	4.05		0.11	0.63	1.8	0.45		0.17	32.0	0.21	1.26

Podsol-Braunerde, profile 4.1 (Dachsbau)

No.	horizon	depth cm	Fe_t mg/g	Fe_d^* mg/g	Fe_o^* mg/g	Fe_p^* mg/g	$Fe_o:Fe_d$	$Fe_d:Fe_t$	Al_t mg/g	Al_d^* mg/g	Al_o^* mg/g	Al_p^* mg/g	Mn_t mg/kg	Mn_d^* mg/kg	Mn_o^* mg/kg	Mn_p^* mg/kg
1	Of	8-2	9.3						16.5				191			
2	Oh	2-0	12.5						24.9				132			
3	A_{eh}	0-6	33.2	17.4	1.82	0.97	0.10	0.52	89.0	1.47	0.42	0.27	239	97	24	8
4	B_{sv}	6-16	42.3	27.5	1.62	0.92	0.06	0.65	98.3	2.72	0.52	0.37	294	143	23	10
5	B_{v1}	16-30	43.6	27.6	0.30	0.27	0.01	0.63	105.5	3.21	0.57	0.40	222	96	10	7
6	B_{v2}	30-38	43.8	25.2	0.32	0.25	0.01	0.58	99.6	2.99	0.55	0.37	229	68	11	7
7	B_{v3}	38-56	47.8	30.8	0.14	0.07	<0.01	0.64	107.1	2.23	0.22	0.25	396	64	13	6
8	C_vB_v	56-71	48.0	31.2	0.14	0.05	<0.01	0.65	110.3	2.11	0.19	0.16	297	65	5	5
9	BvCv	71-130	50.1	34.8	0.12	0.03	<0.01	0.69	108.6	2.22	0.15	0.11	269	88	4	5

*absolute concentrations, not corrected by humus content

Podsol-Braunerde, Profile 4.1

No.	horizon	depth cm	CEC pot NH_4-acet. meq/kg	exchang. cations in meq/kg (NH_4-acetate)								V
				H^+	Al	Fe	Mn	Na	K	Ca	Mg	%
1	Of	8-2	715	652.2	2.6			5.4	7.8	39.9	7.5	8.5
2	Oh	2-0	813	760.4	1.3			7.2	9.3	28.1	6.7	6.3
3	A_{eh}	0-6	72	66.7	1.5			0.9	1.0	1.7	0.3	5.4
4	Bsv	6-16	45	40.2	1.5			0.5	0.9	1.6	0.3	7.3
5	B_{v1}	16-30	22	17.9	1.1			1.3	0.9	0.5	0.1	12.8
6	B_{v2}	30-38	30	26.7	0.3			0.9	0.7	0.8	0.1	8.5
7	B_{v3}	38-56	15	12.6	0.2			0.5	0.5	0.6	0.1	11.7
8	C_vB_v	56-71	8	4.7	0.9			0.7	0.9	0.2	0.1	25.3
9	B_vC_v	71-130	15	2.0	0.4			2.0	9.3	0.9	0.4	84.0

Podsol-Braunerde, Profile 4.1

No.	horizon	depth cm	CEC_{eff} NH_4Cl meq/kg	exchang. cations in meq/kg (NH_4Cl)								V
				H^+	Al	Fe	Mn	Na	K	Ca	Mg	%
1	Of	8-2	183.8	60.4	33.4	3.6	3.3	3.7	5.4	67.0	7.0	45.2
2	Oh	2-0	200.8	79.1	65.6	1.4	2.2	4.6	6.7	34.2	7.0	26.2
3	Aeh	0-6	72.0	10.6	56.1	0.8	0.1	1.2	0.8	1.9	0.5	6.1
4	B_{sv}	6-16	51.1	3.9	44.4	0.1	0.1	0.7	0.6	0.9	0.4	5.1
5	B_{v1}	16-30	30.7	0.6	28.7	0	0.1	0.4	0.4	0.3	0.2	4.2
6	B_{v2}	30-38	32.2	0.4	30.3	0	0.1	0.5	0.4	0.3	0.2	4.4
7	B_{v3}	38-56	23.8	0.3	22.0	0	0.1	0.5	0.4	0.3	0.2	5.9
8	C_vB_v	56-71	21.4	0.5	19.5	0	0.1	0.5	0.4	0.2	0.2	6.1
9	BvCv	71-130	15.7	0.4	13.9	0	0.1	0.7	0.2	0.3	0.1	8.3

Profile 42(Pfaffenwinkel)

Horizon	depth	Description
L	7 - 6	fresh litter mainly of Scots pine, blueberry, and mosses, loose scattered.
Of	6 - 3	needle fragments and remains, partially decomposed, interwoven by fungal hyphae.
Oh	3 - 0	dark brown to black, high percentage of coprogene aggregates, sharply separated from the mineral soil, many roots, coherent, shape-edged breakable.
A_{eh}	0 - 3	partially $A_{eh}B_{sv}$, dark-grey (0-1 cm) and brown-grey (1-3 cm) (7.5 YR 1.7/1 and 7.5 YR 4/6), clayey silt ($\bar{t}$U), moderate content of humus, platy structure, moderate dense to loose, well rooted, gradual boundary.
B_{sv}	3 - 13	ochreous-brown (7.5 YR 5/8), silty loam (uL), low in humus, subangular blocky to granular structure, loose, well rooted, gradual boundary.
B_{v1}	13 - 18	reddish brown (5.0 YR 6/8), clayey silt (t·'U), skeleton (>10 %) comperatively coarse, mainly quartz-fragments, subangular blocky structure, loose, common roots, gradual boundary.
B_{v2}	18 - 30	reddish brown (2.5 YR 5/8), silty loam (uL), skeleton (10 %), comperatively coarse, mainly quartz, few phyllite fragments, subangular blocky structure, moderate loose, common roots, gradual boundary.
B_{v3}	30 - 43	weak reddish to ochreous brown (5.0 YR 5/8), clayey silt (t·'U), skeleton (<10 %) coarse, mainly quartz, subangular blocky structure, moderate dense, few coarse roots, distinct boundary.

Horizon	depth	Description
II $B_v$rel	43 - 65	stained: yellow, weak reddish brown, violet-red, (7.5 YR 6/8) stains not clearly orientated, loamy silt (t'U), skeleton 5 %, subangular blocky to massive structure, dense, few roots, distinct boundary.
III $B_v$rel	65 - 100	sometimes wavy boundary till 115 cm, yellow-brown, reddish layers, sometimes yellow grey to violet-red (10 YR 7/8), silt (U), skeleton 1 %, massive structure, moderate dense, very few roots, distinct boundary.
IV $B_v$rel	100 - 140	violet-red (2.5 YR 6/4), without skeleton, brittle phyllite saprolithe (sometimes white), sandy silt (sU), massive structure, no roots, dense.

Classification: German: Podsol-Braunerde über reliktischem Gelblatosol über reliktischem Rotlatosol

FAO: Dystric Cambisol over xentic ferrasol over rhodic ferrasol

Soil taxonomy: Typic dystrochrept over (probable) Orthox

Podsol-Braunerde, profile 4.2 (Pfaffenwinkel)

1. Soil physics

No.	horizon	depth	stone	texture in % of humus-free fine soil									composition of	bulk	GPV	Watercontent in %			
			%	sand				silt				clay	clay minerals	dens.	%	at pF			
		cm		c	m	f	Σ	c	m	f	Σ		%*	g/cm³		0.6	1.8	2.5	4.2
1	Of	6-3																	
2	Oh	3-0																	
3	A_{eh}	0-3	7.1	4.0	1.5	8.5	14.0	32.0	24.5	12.5	69.0	17.0	K23,I39,W26,V12	1.12	59.6	2.1	8.0	6.8	30.2
4	Bsv	3-13	9.2	7.0	1.5	7.5	16.0	26.0	26.5	13.5	66.0	18.0	K36,I53,W-,V11	1.16	57.1	1.9	5.2	7.0	33.0
5	B_{v1}	13-18	14.8	5.0	1.5	7.0	13.5	26.5	30.5	13.5	70.5	16.0	K37,I33,W15,V15	1.42	46.2	1.8	4.2	3.0	24.5
6	B_{v2}	18-30	11.6	11.5	3.5	6.5	21.5	18.5	29.0	12.0	59.5	19.0	K26,I45,W17,V12	1.48	45.4	2.0	4.0	2.8	23.7
7	B_{v3}	30-43	7.8	6.5	2.5	7.0	16.0	28.0	29.5	11.5	69.0	15.0	K32,I46,W13,V9	1.61	44.8	2.4	2.9	2.2	22.4
8	$IIB_v rel$	43-65	4.1	1.5	2.0	9.0	12.5	29.5	36.0	10.5	76.0	11.5	K33,I39,W19,V9	1.53	47.1	2.7	2.4	2.3	33.1
9	$IIIB_v rel$	65-100	1.0	2.5	3.0	9.0	14.5	43.0	29.5	7.0	79.5	6.0	K59,I29,W12,V-	1.65	45.8	4.1	2.6	2.2	33.1
10	$IVB_v rel$	100-140	0	1.5	5.0	33.5	40.0	37.0	16.5	3.5	57.0	3.0	K54,I33,W-,V13	1.68	44.3	4.4	2.6	2.2	27.9

*K = Kaolinit
I = Illit
W = Mixed layer minerals
V = Vermikulit

Podsol-Braunerde, profile 4.2 (Pfaffenwinkel)

2. Soil chemistry

No.	horizon	depth cm	pH H_2O	pH $CaCl_2$	C_{org} %	N_t mg/g	C/N	P_t mg/g	$P_{citric\ acid}$ soluble mg/kg	K_t mg/g	Ca_t mg/g	Mg_t mg/g
1	Of	6-3	3.73	3.05	51.50	16.13	31.9	0.88	40.48	1.1	3.13	0.76
2	Oh	3-0	3.52	2.80	46.75	12.91	36.2	0.65	20.95	2.3	2.91	0.66
3	Aeh	0-3	3.63	2.85	4.28	1.64	26.1	0.46	4.37	19.7	0.53	1.24
4	Bsv	3-13	4.36	3.85	1.50	0.87	17.2	0.59	11.35	24.0	0.41	1.54
5	B_{v1}	13-18	4.50	4.13	0.72	0.63	11.4	0.49	1.70	26.0	0.50	1.90
6	B_{v2}	18-30	4.50	4.13	0.35	0.48	7.3	0.48	1.29	28.0	0.41	2.26
7	B_{v3}	30-43	4.50	4.13	0.24	0.43	5.7	0.46	1.05	26.3	0.32	2.05
8	$IIB_v rel$	43-65	4.45	4.10	0.14	0.42	3.4	0.45	0.76	28.1	0.16	1.82
9	$IIIB_v rel$	65-100	4.42	4.12	0.10	0.35	2.9	0.49	0.51	21.5	0.15	1.22
10	$IVB_v rel$	100-140	4.43	4.12	0.07	0.26	2.7	0.21	2.41	17.5	0.08	0.79

Podsol-Braunerde, profile 4.2(Pfaffenwinkel)

No.	horizon	depth cm	Fe_t mg/g	Fe_d^* mg/g	Fe_o^* mg/g	Fe_p^* mg/g	$Fe_o:Fe_d$	$Fe_d:Fe_t$	Al_t mg/g	Al_d^* mg/g	Al_o^* mg/g	Al_p^* mg/g	Mn_t mg/kg	Mn_d^* mg/kg	Mn_o^* mg/kg	Mn_p^* mg/kg
1	Of	6-3	6.7						10.4				345			
2	Oh	3-0	6.5						12.8				183			
3	A_{eh}	0-3	29.2	19.4	1.14	0.88	0.06	0.66	67.8	2.82	0.52	0.34	151	75	11	9
4	B_{sv}	3-13	40.0	25.0	0.79	0.62	0.03	0.63	84.4	4.50	0.93	0.76	320	100	11	9
5	B_{v1}	13-18	42.4	29.5	0.34	0.28	0.01	0.70	91.1	3.80	0.69	0.44	282	82	8	7
6	B_{v2}	18-30	48.5	37.0	0.23	0.10	< 0.01	0.76	89.5	3.63	0.58	0.36		79	5	6
7	B_{v3}	30-43	45.7	35.0	0.18	0.06	< 0.01	0.77	85.7	3.27	0.47	0.30		73	4	5
8	$IIB_v rel$	43-65	41.8	31.1	0.16	0.03	< 0.01	0.74	94.1	2.60	0.27	0.18		52	4	6
9	$IIIB_v rel$	65-100	48.8	27.4	0.05	0.03	< 0.01	0.56	76.5	1.91	0.13	0.10		23	1	6
10	$IVB_v rel$	100-140	42.9	22.1	0.06	0.02	< 0.01	0.52	56.9	1.01	0.05	0.07		18	0	4

*absolute concentration, not corrected by humus content

Podsol-Braunerde, profile 4.2 (Pfaffenwinkel)

No.	horizon	depth cm	CEC pot NH_4-acet. meq/kg	exchang. cations in meq/kg (NH_4-acetate)								V %
				H^+	Al	Fe	Mn	Na	K	Ca	Mg	
1	Of	6-3	1001	921.1	2.8			12.0	12.4	44.3	13.4	8.2
2	Oh	3-0	755	699.7	4.0			10.9	5.2	26.6	8.1	6.7
3	A_{eh}	0-3	174	155.0	1.9			5.1	1.5	7.6	2.9	9.8
4	Bsv	3-13	128	118.0	2.4			4.4	1.2	1.7	0.5	6.1
5	B_{v1}	13-18	78	73.3	2.1			0	1.5	0.7	0.4	3.3
6	B_{v2}	18-30	84	75.5	1.3			3.8	1.9	0.7	0.8	8.6
7	B_{v3}	30-43	69	63.1	2.5			0	1.8	0.8	0.8	4.9
8	IIB_vrel	43-65	63	59.3	1.8			0	1.2	0.3	0.4	3.0
9	$IIIB_v$rel	65-100	48	43.8	2.9			0	0.3	0.3	0.2	1.7
10	IVB_vrel	100-140	8	5.0	2.9			0.2	0.1	0	0	3.7

Podsol-Braunerde, profile4.2(Pfaffenwinkel)

No.	horizon	depth cm	CEC_{eff} NH_4Cl meq/kg	exchang. cations in meq/kg (NH_4Cl)								V
				H^+	Al	Fe	Mn	Na	K	Ca	Mg	%
1	Of	6-3	200.1	79.1	59.3	8.1	7.5	5.5	9.9	17.2	13.5	23.0
2	Oh	3-0	182.0	79.1	53.8	0.6	2.3	4.5	3.6	30.3	7.8	25.4
3	A_{eh}	0-3	88.5	19.4	48.9	6.1	0.1	1.2	1.6	10.1	1.1	15.8
4	Bsv	3-13	54.0	1.7	38.6	1.2	0.1	0.4	1.0	10.5	0.5	23.0
5	B_{v1}	13-18	44.3	0.4	37.4	0.3	0.1	0.8	1.4	3.4	0.5	13.8
6	B_{v2}	18-30	41.6	0.5	34.9	0.1	0.1	0.7	1.8	2.7	0.8	14.4
7	B_{v3}	30-43	32.7	0.7	25.5	0	0.1	0.4	1.8	3.4	0.8	19.6
8	$IIB_v rel$	43-65	31.7	0.8	22.2	0	0	0.2	0.9	7.2	0.4	27.4
9	$IIIB_v rel$	65-100	19.7	0.7	11.0	0	0.1	0.4	0.9	6.5	0.1	40.1
10	$IVB_v rel$	100-140	4.2	0.5	1.3	0	0	0.1	0.3	1.8	0.2	57.1

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Amelioration of degraded pine sites (Pinus sylvestris) on phyllite in Waldsassen, Northeastern Bavaria

by

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under cooperation of S. Francke, U. Maier, H. Rodenkirchen and J. Völkl

During the last centuries human influences caused a serious decline in the fertility of extensive forest areas in Northeastern Bavaria. Such interferences were e.g. intensive litter raking, grazing, burning, and repeated pine cultivation. These practices resulted in a deterioration of the nitrogen-, phosphorus- and base-status and the humus form of the soils; both the total amounts and the available fractions of these nutrients were reduced, and biologically inactive raw humus now prevails.

In the Waldsassen region these interferences resulted in more drastic soil devastation than elsewhere due to the poor base status of the substrates. On the one hand the parent rock phyllite from its mineralogy shows high contents of potassium, but very low contents of calcium and magnesium. On the other the present soils are partly very old and characterized by intensive weathering and pauperization since the tertiary period. Therefore not only low amounts of available Ca and Mg are characteristic, but also the replacement through weathering is supposed to be very small. These soils show thick raw humus layers, high contents of oxides (hydroxides) of Fe and Al in the B-horizon, a very acid soil reaction, and a significant but only flat podzolization. Base saturation doesn't exceed values of about 5%, aluminum takes more than 90% of the exchange sites. Fungal decomposition dominates. Among the animal decomposers there are mainly nematodes, mites, and springtails. Soil dwellers, especially earthworms, are vastly missing. Fragmentation of litter is only slow and incorporation into the mineral soil almost absent. The organic layer therefore is sharply separated from the mineral soil. These sites show a characteristic ground vegetation formed by dwarf shrubs, acidophytic mosses, and lichens. They are stocked with pine forests of very low production, often suffering from moderate to extreme deficiency of N, Mg and Ca.

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The best way of ameliorating these soils has been discussed since the beginning of this century. The objectives of the amelioration were to improve the nutrition ,growth, and regeneration of pine stands as well as to condition these sites for the implantation of more pretentious tree species like spruce, douglas-fir, hardbeam, pendulate oak, or little-leaf linden. During the early decades emphasis was laid on ploughing or tillage combined with (sometimes heavy) liming and phosphate dressing either on clearcut areas or in open old stands. A series of investigations summarized by Rehfuess(1981), however, has demonstrated these practices to cause only minor growth responses in the following generation, but considerable humus and nitrogen losses during the early phases of stand establishment. Therefore the amelioration of poor soils under close pine stands is now recommended , aiming to keep the nutrients within the element cycle of the ecosystem, irrespective of whether they are added by fertilization or released by stimulated organic matter decay. The evaluation of two long term amelioration trials after 19-23 years of experimentation offers a new basis to discuss the effects of various amelioration procedures applied during the midlife of pine rotation.

Description of experiments

In the Waldsassen forest district (location Pfaffenwinkel) two amelioration experiments in older pine stands are presented. Among the treatments are repeated N-fertilization, biological N-input via lupins (Lupinus polyphyllus) and moderate input of phosphorus and bases. Tab.1 informs about the amelioration procedures.

The experiment WAL 228 was established 1960 in a 52-years old pine pole stand (site class III.5 - IV.0 according to Wiedemannn), experiment WAL 234 1964 in a 86-years old pine forest (site class IV.6). WAL 228 has two plots (0.15ha), WAL 234 three plots (0.12ha) per treatment. Control plots are included.

Volume growth and nutritional status of the pines were checked since the early beginning by the Chair of Forest Growth Research and the Chair of Soil Science, University of Munich, respectively. Soil chemical and soil biological properties as well as ground vegetation were investigated during 1982-1984 by the Chair of Soil Science.

Results

Humus form and soil biological characteristics

19-23 years after beginning of the experiments the initial biologically inactive raw humus layers changed in all ameliorated sites to moder-like forms. The status of decomposition improved, resulting in an increased percentage of dark fine humus formed by coprogenous aggregates. The Of+h layers are partially loosened; a macroscopically visible incorporation of organic floor material into the top soil however is not recognizable.

Soil microbiological and zoological characteristics are presented in Tab. 2 and 3.

Soil chemistry and ground vegetation

The results are presented in Fig. 1 and 2 and in Tab. 4-9

Volume growth and nutritional status of pines

Results are presented in Tab. 10 and 11.

Conclusions

A first series of fertilization trials, established in pine stands on degraded acidic soils between 1955 and 1960, had given evidence after 5-8 years of experimentation, that N was the only factor limiting growth. A more comprehensive experiment evaluated recently after 20 years of observation, however, demonstrated that repeated fertilization with N alone in the longer run may induce P and Mg (K) deficiency on soils low in these elements. Therefore PMg (K) fertilization is now recommended on larger areas of poor pine forests than had been anticipated before, always in combination with the application of N and with moderate liming. The necessity for involving P and Mg (and eventually K) in the amelioration concept is also supported by the fact that precipitation in Central Europe nowadays imports considerable amounts of N into the ecosystems, whereas the deposition of P, Mg, and Ca from the atmosphere is restricted. Moderate liming is necessary to stimulate the organic matter turnover, to stabilize nutrient cycling on a higher level of intensity and to counteract for potential adverse effects of acid deposition.

There are two common practices in Southern Germany for adding N to degraded older pine forests: N-fertilization and undergrowth of perennial lupins. Fertilization of N has proven to be the more efficient and more reliable technique for improving the N-economy of these pine ecosystems. Even moderate amounts of applied N together with CaPMg(K) are sufficient to immediately accelerate the volume growth of pines; root damage is avoided, the humus- and N-losses from the soil are minimized, the biological activity and the mineralization of N increase. There is even some experimental evidence that three to five dressings of N, each one applied after 5-7 intermediate years, will raise top soil fertility and stimulate pine growth for decades. In contrast lupine underplanting, which is possible only after CaPMg(K) fertilization and tillage, improves the nutritional status and volume increment of pine only after an extend lag phase. These practice also induces considerable humus- and N-losses from the soils, the latter occuring either via nitrate leaching or denitrification. Nitrate leaching results also in calcium losses. The period of active symbiotic N-fixation is generally short, due to the fact that lupins are soon overgrown and shaded out by grasses and herbs.

Literature

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Makeschin, F., Francke, S., Rehfuess, K.E., and Rodenkirchen, H., 1985: Melioration saurer, devastierter Phyllitstandorte unter Kiefer im Bayer. Forstamt Waldsassen. Der Forst- und Holzwirt 40, 499-506.

Rehfuess, K.E., 1981: Waldböden. Entwicklung, Eigenschaften und Nutzung Pareys Studientexte 29, Paul Parey Verlag.

Tab.1: Description of the amelioration procedures

	Experiment WAL 228		Experiment WAL 234	
Treatments:	KAS	KST	VOLL	LUP
Beginning of the experiment:	1 9 6 0		1 9 6 4	
Soil cultivation:	---	---	---	tillage (1964)
Fertilization:	15 dt Thomas slag (1960)		40 dt $CaCO_3$ (1964)	
(per ha)	5 x 5 dt nitrochalk	5 x 4.7 dt calcium-cyanamide	10 dt Thomas slag(1964)	
	(1960,1962,1964,1966,1975)		4 dt potassium magnesium (1964)	
	2 x 2 dt potassium magnesium (1966,1975)		3 x 5 dt nitrochalk (1964,1966,1972)	---
			3 dt superphosphate(1967)	
Lupine seed:	---	---	---	20 kg (1964)
Total fertilized bioelements:				
N	515	500	370	(lupine)
P	105	105	95	95
kg/ha K	83	83	90	90
Ca	815	1520	2095	1900
Mg	37	37	32	32

Explanations: KAS=nitrochalk, KST= calcium cyanamide, Voll=complete fertilization, lup=lupine undersowing, Kon= control plots.

Tab.2: Microbiological properties of the substrates in experiment WAL 234

	W A L 2 3 4					
	KON		VOLL		LUP	
	org. layer	soil 0-10	org. layer	soil 0-10	org. layer	soil 0-10
microbial biomass (% of Ct)	0.84	0.86	1.18	0.98	1.47	0.88
protease activity*	0.024	0.027	0.048	0.064	0.072	0.083
catalase activity*	2.2	10.4	2.7	10.0	3.2	9.9
ammonification* (ug 10g dm day)	0.09	0.12	0.05	0.21	0.34	0.16
Nmin-contents before incubation (ug 10g dm)	135	18	187	17	243	21

* corrected by Ct

Tab.3: Abundance of important groups of the soil macrofauna (Individuals/m^2)

	WAL 228 (June 83) KON	WAL 228 (June 83) KAS	WAL 228 (June 83) KST
Lumbricidae *	<0.1	<0.1	<0.1
Diplopoda	9	11	9
Tipulidae	9	0	0
Chilopoda:			
Lithobiomorpha	48	37	45
Geophilomorpha	40	45	40
Staphylinidae	<1	54	20
Elateridae: larvae	26	48	20
Arachnidae	178	241	294

	WAL 234 KON		VOLL		LUP	
	Oct82	May83	Oct82	May83	Oct82	May83
Lumbricidae *	<0.1		<0.1		<0.1	
Diplopoda	10	9	30	10	17	15
Tipulidae	0	0	4	4	4	11
Chilopoda:						
Lithobiomorpha	4	17	10	23	32	63
Geophilomorpha	34	111	21	96	36	62
Staphylinidae	19	19	27	43	55	64
Elateridae: larvae	19	66	15	62	15	60
Arachnidae	147	206	158	166	255	285

* sparsely occurence of D.octaedra, D.rubida and L.rubellus

Tab.4: Amounts of total bioelements in the organic layer and the mineral soil (0-30cm) of the experimental plots. Unit values followed by different letters differ significantly.

	WAL 228 KON	WAL 228 KAS	WAL 228 KST	WAL 234 KON	WAL 234 VOLL	WAL 234 LUP
C t/ha	76.8 a	79.0 a	73.7 a	89.2 a	81.7 b	72.2 c
N kg/ha	3671 a	3969 b	3782 a	3668 a	3685 a	3386 b
P kg/ha	1940 a	2257 a	2084 a	1731 a	1687 a	1764 a
Ca kg/ha	917 a	1236 b	1470 c	2105 a	3574 b	2903 c

Tab.5: Amounts of exchangeable K, Ca, Mg und Al in organic layer and mineral soil (0 - 30 cm) of the experimental plots (in kmol IÄ/ha)

		WAL 228			WAL 234		
		KON	KAS	KST	KON	VOLL	LUP
K	org. layer	0.2	0.2	0.2	0.4	0.3	0.3
	0 - 30 cm	0.9	0.8	0.8	0.9	0.9	0.9
	total	1.1	1.0	1.0	1.3	1.2	1.2
Ca	org. layer	5.1	9.4	17.1	6.9	33.2	14.5
	0 - 30 cm	4.6	13.4	21.8	5.1	20.1	25.6
	total	9.7	22.8	38.9	12.0	53.3	40.1
Mg	org. layer	0.7	0.9	0.9	1.9	2.3	1.4
	0 - 30 cm	0.8	1.2	1.1	0.5	0.8	0.9
	total	1.5	2.1	2.0	2.4	3.1	2.3
Al	org. layer	4.3	4.2	3.4	8.0	1.2	0.8
	0 - 30 cm	120.1	117.6	105.4	109.8	91.0	88.6
	total	124.4	121.8	108.8	117.8	92.2	89.4

Tab.6: Chemical characteristics of the soil solution (Gleichgewichtsbodenlösung after Ulrich) of the experimental plots in April 1984

		WAL 228			WAL 234		
	depth (cm)	KON	KAS	KST	KON	VOLL	LUP
pH-value	0-10	3.6	3.9	3.9	3.7	4.4	4.5
	10-20	4.2	4.5	4.5	4.5	4.8	4.8
	20-30	4.3	4.4	4.4	4.4	4.5	4.6
Al	0-10	5.3	16.9	15.6	7.0	24.6	21.0
mg/l	10-20	1.7	1.4	3.5	2.1	1.2	3.1
	20-30	2.8	1.9	2.1	2.1	1.1	1.2
Ca	0-10	4.2	14.4	15.5	3.9	15.4	14.9
mg/l	10-20	2.3	10.8	10.4	2.1	10.4	13.2
	20-30	2.9	6.1	9.3	2.2	8.4	10.5
Mg	0-10	1.1	1.6	1.8	1.4	1.7	1.9
mg/l	10-20	0.8	1.0	0.9	0.8	0.7	0.9
	20-30	0.5	0.6	0.4	0.5	0.4	0.7

Tab.7: Chemical characteristics of the 2:1 water extract of the experimental soils in april 1984

	depth (cm)	WAL 228 KON	WAL 228 KAS	WAL 228 KST	WAL 234 KON	WAL 234 VOLL	WAL 234 LUP
pH-value	0-10	3.2	3.4	3.4	3.3	3.6	3.6
	10-20	3.9	4.1	4.1	4.0	4.0	4.2
	20-30	4.2	4.2	4.3	4.2	4.4	4.3
Al	0-10	49.7	46.3	54.9	40.8	28.9	42.4
mg/l	10-20	22.0	22.0	21.7	17.7	13.1	14.0
	20-30	8.9	7.8	6.5	7.6	5.4	6.[illegible]
Ca	0-10	7.2	34.4	61.4	7.3	54.7	69.2
mg/l	10-20	2.2	16.4	13.5	2.1	15.4	20.3
	20-30	3.0	8.4	6.6	2.4	8.2	10.8
Mg	0-10	2.6	3.4	3.8	2.4	6.2	4.2
mg/l	10-20	1.0	1.5	1.5	1.0	1.1	1.3
	20-30	0.4	0.6	0.5	0.3	0.5	0.6

Tab.8: Mol-ratios of Ca/Al and Mg/Al on exchange sites, in soil solution (GBL) and in 2:1 water extract of the soils

		depth(cm)	WAL 228 KON	WAL 228 KAS	WAL 228 KST	WAL 234 KON	WAL 234 VOLL	WAL 234 LUP
exchangeable cations	mol Ca / mol Al	0-10	0.04	0.14	0.32	0.04	0.33	0.59
		10-20	0.02	0.04	0.06	0.03	0.11	0.16
		20-30	0.02	0.04	0.04	0.03	0.06	0.06
	mol Mg / mol Al	0-10	.006	.008	.010	.005	.010	.018
		10-20	.004	.005	.005	.002	.005	.007
		20-30	.004	.004	.006	.003	.003	.003
GBL	mol Ca / mol Al	0-10	0.53	0.57	0.67	0.38	0.42	0.48
		10-20	0.91	5.19	2.00	0.67	5.83	2.87
		20-30	0.70	2.16	2.98	0.71	5.14	5.89
	mol Mg / mol Al	0-10	0.23	0.11	0.13	0.22	0.08	0.10
		10-20	0.52	0.79	0.29	0.42	0.65	0.32
		20-30	0.20	0.35	0.21	0.26	0.40	0.65
2:1 WE	mol Ca / mol Al	0-10	0.10	0.50	0.75	0.12	1.27	1.10
		10-20	0.07	0.50	0.42	0.08	0.79	0.98
		20-30	0.23	0.72	0.68	0.21	1.02	1.14
	mol Mg / mol Al	0-10	0.06	0.08	0.08	0.07	0.24	0.11
		10-20	0.05	0.08	0.08	0.06	0.09	0.10
		20-30	0.05	0.09	0.09	0.04	0.10	0.10

Tab.9: Some properties of ground vegetation, July 1984

Properties	WAL 228 KON	WAL 228 KAS	WAL 228 KST	WAL 234 KON	WAL 234 VOLL	WAL 234 LUP
Percentage cover of different life forms						
-dwarf shrubs	42	29	23	53	32	25
-grasses	<1	19	14	1	7	19
-herbs (dicot.)	0	20	39	0	36	52
-ferns	0	10	7	0	12	17
-shrubs: R. idaeus	0	4	7	0	5	5
-mosses and lichens	45	28	30	63	28	22
Floristic diversity of field layer						
-number of species	6	23	25	5	17	26
-Shannon-Wiener index	0.74	1.99	1.83	0.91	1.79	2.45
Ecological indicator values						
-average nitrogen indicator value of field layer (based on Ellenberg)	2.3	4.9	4.7	2.1	4.9	5.0
-average soil reaction indicator value (based on Ellenberg)	1.8	3.1	3.3	1.7	3.2	3.6
-percentage of cryptogamic species indicating strongly acid forest soils	67	44	43	70	41	36

Tab. 10: Average annual increment of bole wood (VfmS) during the monitoring phases (Kennel 1967, Preuhsler u. Rehfuess 1982, Preuhsler et al. 1984)

WAL 228	PERIOD 1960 - 64 (4 years)	1964 - 71 (7 years)	1971 - 78 (7 years)	1978 - 83 (5 years)	$\bar{x}$/year (23 years)
Kon	4.72	6.45	7.42	8.18	6.82
KAS	8.22	11.28	11.02	11.36	10.69
KST	6.44	10.70	10.41	9.78	9.67

WAL 234	PERIOD 1964 - 67 (3 years)	1967 - 69 (2 years)	1969 - 74 (5 years)	1974 - 78 (4 years)	1978 - 83 (5 years)	$\bar{x}$/year (19 years)
Kon	4.33	7.80	8.57	6.24	7.30	6.99
VOLL	6.57	11.60	9.97	9.84	7.98	9.05
LUP	4.17	8.23	10.22	9.48	8.72	8.50

Tab. 11: Nutritional status of half-year old pine needles (mg/g needle dry matter) during the monitoring phase 1974 - 1983. Unit values followed by different letters differ significantly (Kreutzer 1967, Rehfuess u. Schmidt 1971, Preuhsler u. Rehfuess 1982, Hüser pers. communication).

	WAL 228 (6 dates of investigation)			WAL 234 (10 dates of investigation)		
	KON	KAS	KST	KON	VOLL	LUP
N	14.8 a	17.5 b	17.5 b	14.4 a	15.9 b	16.5 b
P	1.58 a	1.70 a	1.71 a	1.60 a	1.72 b	1.80 b
K	6.10 a	5.89 a	5.97 a	5.97 a	5.70 a	5.73 a
Ca	2.09 a	2.27 a	2.42 a	2.13 a	2.69 b	2.74 b
Mg	0.71 a	0.78 a	0.74 a	0.65 a	0.72 a	0.73 a

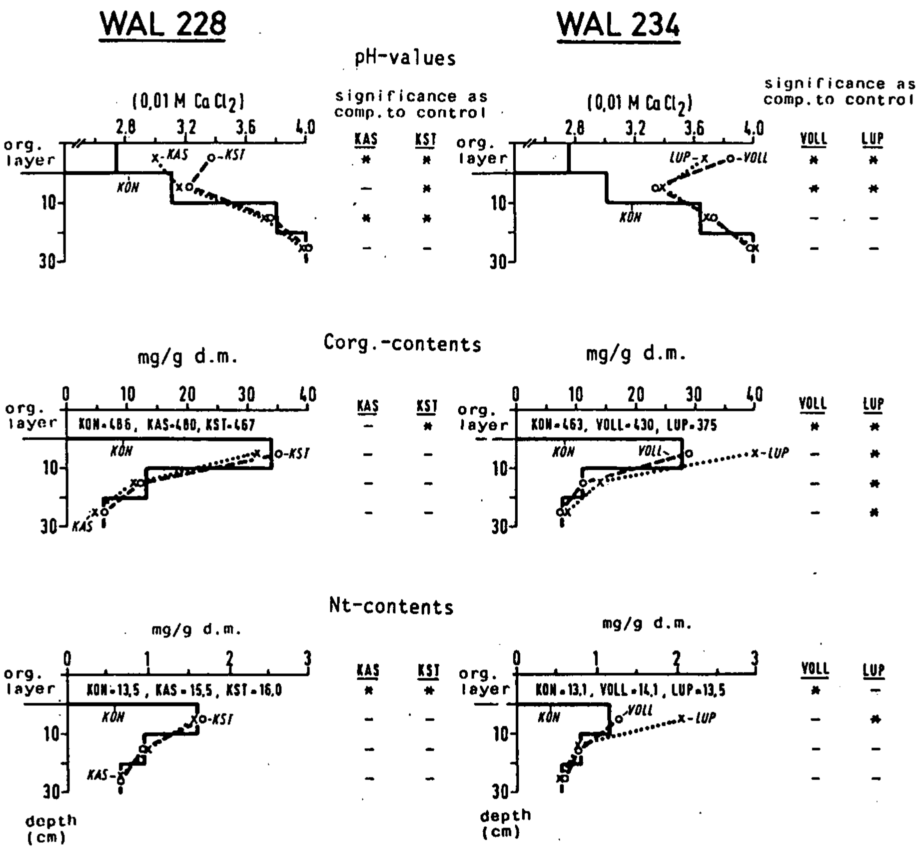

Fig.1: pH-values, contents of organic carbon and total nitrogen content in the experimental soils

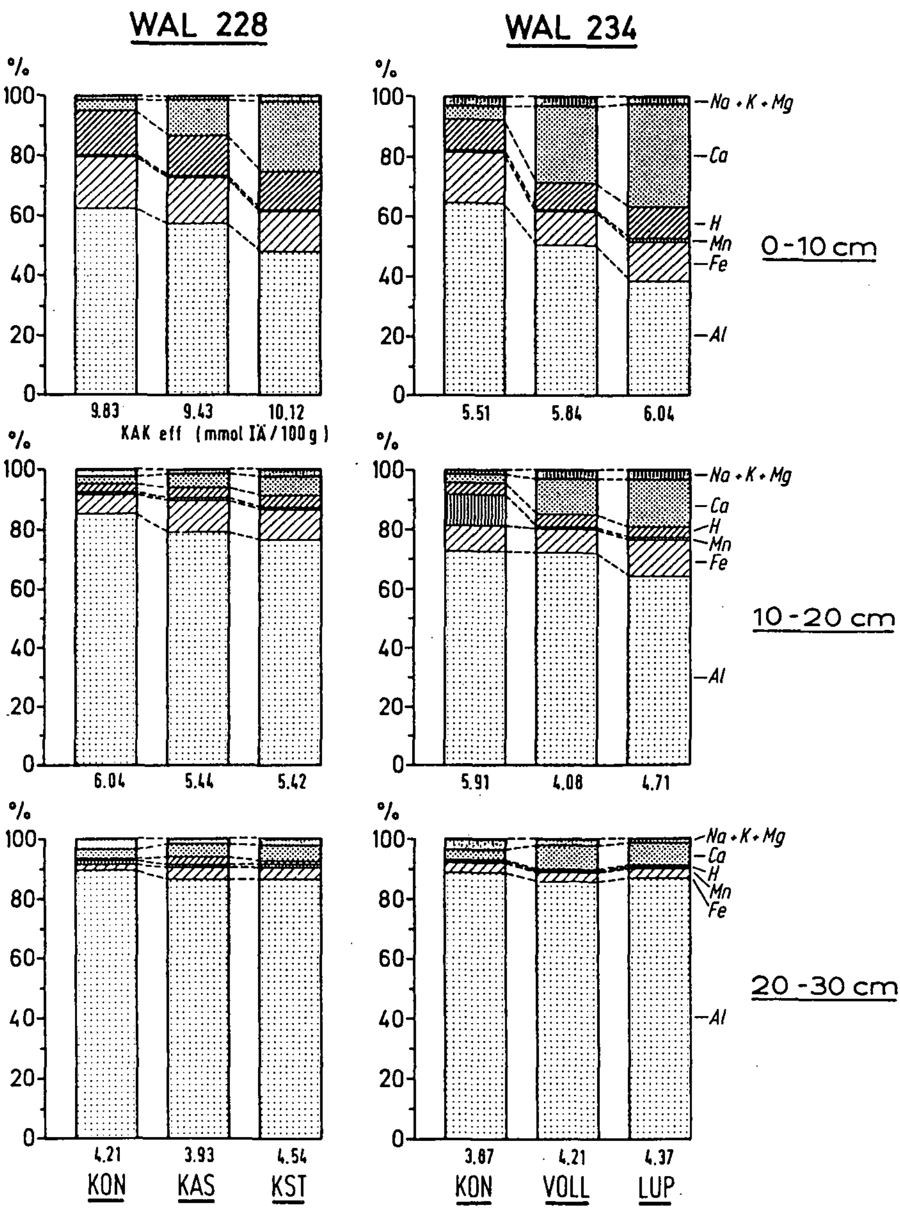

Fig.2: Effective cation exchange characteristics of the experimental soils

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Regensburg Excursion Area

by O. WITTMANN *
with contributions by W. BRAUN,
J. van EIMERN and K. KREUTZER

Geographical Survey

A number of natural units converge in the Regensburg area: the Southern and Middle F r a n k e n a l b (6.2, actual excursion area) extend from the west and northwest up to the outskirts of Regensburg. The F a l k e n s t e i n e r V o r w a l d (11.1) as part of the Bayerischer Wald joins toward the east. The Danube Valley with the accompanying loess plates lying to the south is called D u n g a u (12.3.2, Gäu). It is bordered on the south and southwest by the T e r t i ä r h ü g e l l a n d (1.2.8+9).

The district is drained exclusively by the Danube and its tributaries. The bottoms of the main valleys have an altitude of between 300 and 350 m m.s.l. The heights rise to 400 - 600 m on the "Alb", up to 700 m and higher in the "Vorwald" and around 450 m m.s.l. in the "Tertiärhügelland".

Geology and Geomorphology

F a l k e n s t e i n e r V o r w a l d (11.1): granites and gneisses of the Moldanubic basement.

The basement and Mesozoic strata converge directly at the K e i l b e r g fault northeast of Regensburg, which according to P. CRAMER (1969) have sunk there at least 650 m. A similar tectonic rift took place along the present course of the Danube downstream from Regensubrg (Danube edge fault).

"A l b " district around Regensburg: is built up on the surface by a regular JURASSIC-CRETACEOUS strata series starting in the valleys with steep limestone and dolomite scarps. Further in the west between the Altmühl and Laaber where the strata series end with the Malm, they pass over into plateaus. If Cretaceous deposits follow, the initially adjoining carbonaceous G r ü n - s a n d s t e i n of the Cenoman (Upper Cretaceous; thickness:

*Bayerisches Geologisches Landesamt, Heßstr. 128, 8000 München 40

5-15 m) also forms morphologically the transition to the band-shaped flattening of the E i b r u n n e r M e r g e l (thickness: 6-12 m) accompanying the slopes. The ± carbonaceous fine sandstones of the R e i n h a u s e n e r S t r a t a (Lower Turonian, thickness: 15 - 22 m) and mainly of the K n o l l e n - s a n d s t e i n (thickness: 15 - 27 m) close upward usually in flat domes and crests. In places they are still superimposed with the sandy limestones and marls of the H o r n s a n d - s t e i n (Lower Turonian, thickness: 0.5 - 5.0 m), of the E i s b u c k e l and P u l v e r t u r m strata (Middle Turonian, thickness: greatly fluctuating in each case between 10 -25 m). These strata resulted mainly in the plateaulike terrain situations. The Upper Turonian finally is also represented in the vicinity of Regensburg by calcareous sandstones (G r o s s - b e r g e r S a n d s t e i n) and marl (W e i l l o h e r M e r g e l).

With the Tertiary deposits (Miocene, Lower Pliocene) the molasse basin begins south of Regensburg. In a marginal formation these sediments lie also in the area of the Alb and on the basement, in greater thickness usually in valleys and depressions, which have a course similar to the old Tertiary channels. Only the so-called hanging Tertiary makes a surface-forming appearance. It is composed of ± gravelly sands and clays.

L o e s s respectively l o e s s l o a m occurs commonly in the entire district with the exception of the Neopleistocene valley terraces and the interior crystalline "Vorwald". Greater thicknesses are reached particularly on the sedimentation-favored eastern flanks of lateral valleys near the Danube and on the high terraces of the Danube. The loessloam thickness decreases as the distance from the Danube as main wind-erosion area increases. The entire cover sheets are then characterized by soil developments. Raw loess has been preserved only in places.

The main valleys are filled with g r a v e l and s a n d of the l o w - l y i n g t e r r a c e (early Würm glacial). The H o l o c e n e r i v e r f l o o d p l a i n d e p o s i t s are usually free from carbonate near the Naab and the Regen, but in the vicinity of the Danube they are very strongly carbonaceous because of the inflow from the Alpine streams.

Climate
after J. van EIMERN

Regensburg and its immediate vicinity lie in the rain shadow of the Franconian Jura: Regensburg has an annual precipitation of less than 650 mm. From the Regen Valley toward the east there is a rapid increase in the amount of precipitation, over 900 mm in the "Frankensteiner Vorwald". Also toward the west (Frankenalb) and south (Danube-Isar- "Tertiärhügelland") there is a marked increase to 700 - 750 mm.

A relatively continental climate prevails with a relatively large fluctuation of the air temperature of 20.4° C; mean annual temperature is 8° C , in the adjacent higher-lying districts up to 0.7 degrees lower.

Soil associations
Frankenalb

Malm without lapping of Createceos or Tertiary sediments (6.2.1/2) at high plateaus:

limestone - and dolomite - "Braunlehme" (Brownloam), frequently covered by loessloam of relief-dependent thickness (2-8 dm); "Parabraunerden"; in depressions colluvium above solifluction layers;

at tops and crests, at steep slopes of high plateau borders: under extensive pasture and agriculture "Rendzinen", under forest frequently thin limestone - or dolomite - "Braunlehme";

in valleys: generally dead valleys with colluvium and deeply developed "Braunerden" originated in loamy solifluction material; in waterbearing main valleys mostly "Braune Auenböden", marginal "Gleye".

Malm with lapping Cretaceous and Tertiary sediments (6.2.3)
at the steep Malm-pedestal:
"Rendzinen", thin limestone or dolomite - "Braunlehme";
originated in overlying calcareous sandstones or Cretaceous:
sandy "Podsol-Parabraunerden" , sandy - loamy "Parabraunerden", with appropriate contents of carbonate proceedings to limestone - "Braunlehmen"; often very deeply developed relic-"Parabraunerden" as Paleo-soils;
originated in Tertiary sediments: Braunerden of loamy sand, locally overlying clayey-sandy or clayey layers (partly solifluction layers);
originated from loess and loessloam: "Parabraunerden, Braunerden" with weak clay displacement, sometimes "Pararendzinen;
in valleys: frequently dead valleys with colluvium, sometimes, because of clayey Tertiary sediments groundwater soils.

Tertiärhügelland (12.8/9)

The preponderant part of the molasse is covered by loess and loessloam (loesscovered molasses; soil proportions cf. description of the excursion area "Tertiärhügelland"). A small chip of uncovered molasses reaches the area.

Dungau (12.3.2)

High terrace: "Parabraunerden" originated in loess;
Lower terrace: "Braunerden" originated in sandy gravel, partly with loamy - sandy to sandy - loamy cover sheets; at deep lying plains with floodings: "Braune Kalkauenböden". At marginal positions to the high terrace frequently "Gleye" and fen peat because of ground water near the surface; there also lappings of water displaced loess.
Flood plain of the Donau-river (12.3.1): finesand - and siltrich, partly gravelly "Auenrendzinen"; in flood channels and silted up river arms calcareous "Auengleye" and proceeding types.

Valleys of Naab- and Regen-river

Silty, finesandyand loamy "Braune Auenböden", at valley margins "Auengleye" and proceeding types.

Falkensteiner Vorwald (11.1)

Soils derived from granite and gneiss

at upper- and middles parts of the slopes:

predominantly stony-grusy loamy-sandy to sandy "Braunerden"; weakly podsolized;

at lower parts of the slopes, in depressions and at the foot of the slopes:

deeply developed, grusy loamy-sandy to sandy-loamy "Braunerden", partly originated in solifluction layers;

in valleys: loamy-sandy to loamy "Gleye" and proceeding types.

Vegetation

after W. BRAUN

The vegetation in the vicinity of Regensburg is marked principally by growing areas of six potential natural forest societies: on more or less southern exposed slopes with soil formation of Malm limestones: cinquefoil-oak woods (Potentillo-Quercetum) - on corresponding northern exposed slopes composed of Cretaceous strata: for the most part pine-oak woods (Pino-Quercetum), only on scattered domes and northern slopes , rush-red beech woods (Luzulo-Fagetum) - flood plains of the Danube Valley: oak-elm woods (Querco-Ulmetum), Naab and Regen Valley: bird cherry - alder-ash woods (Pruno-Fraxinetum).

Mixed forests close to nature have been preserved principally on steep slopes. On domes they have been largely replaced by pine and spruce-pine forests.

On shallow rendzinas of Malm there are extensive pastures: semidry and dry turfs; grasslands in the Danube Valley: predominantly carrot-tall oat grass meadows (Danco-Arrhenatheretum); in the Regen and Naab Valley as well as in the smaller lateral valleys principally lady's mantle-tall oat grass meadows (Alchemillo-Arrhenatheretum); on highly calcareous fields association of the night-blooming campion (Melandrietum noctiflori) (under winter grain), speedwell-fumitory fields (Veronico-Fumarietum) (under summer grain and root crops); on slightly calcareous locations lady's mantle-camomile (Alchemillo-Matricarietum) and goosefoot-wood sorrel fields (Chenopodio-Oxalidetum).

The Forests around Regensburg
after K. KREUTZER

Five forestry growth districts can be distinguished in the area around Regensburg: Dungau (12.3.2) with Danube plain (12.3.1): on the loessloam covered terraces, originally continentally tinged oak-hornbeam forests with linden, service, maple and cherry: in the river plains: elm-oak woods.

Lower Bavarian "Tertiärhügelland" (12.9.2)

Originally oak-hornbeam forests, in which the beech was only very slightly represented because of the somewhat more continental toning (in comparison with the Upper Bavarian "Tertiärhügelland"); today: spruce and pine.

Southern Frankenalb (6.1.1+2):

Originally: beech forests with oak, also with fir on fresh locations; today: in the state forests southwest of Regensburg mainly on the slopes on "Rendzinen" and shallow "Terrae Calcis" formations; on deeper soils, spruce, on fresh locations, particularly on the shadow expositions, also fir; in rural forests predominantly pine and spruce.

Frankenalb with Cretaceous cover (6.2.3. to the west and the north of Regensburg):

Originally pine-oak-birch woods on the plateaus with deeply weathered acid covers from the Cretaceous sediments.
Today: predominantly pine.

"Falkensteiner Vorwald" (11.1.2) with "Vorwald" periphery (11.1.1)

The "Vorwald" periphery has favorable warmth, accordingly the oak prevailed originally. Originally, beech forests with fir and spruce in the higher locations of the "Vorwald", also with oak, linden and hornbeam on the southern slopes.

Spruce and pine predominate today, but there are frequently mixed stands of beech, spruce and larch on the slopes down to the Regen and the Danube.

Excursion Point 5: Soils of calcareous fine sandstones of the Cretaceous in the Weiherholz (west of Regensburg)

Two "Podsol-Parabraunerden" are presented: one is the normal post-Ice Age formation from the weathering products of the calcareous fine sandstone, the other originated in a Bronze Age tumulus fill (around 3000 years old) of the same material (but with lower carbonate content).

Parent Material

The calcareous fine sandstones belong to the "Knollensandstein" of the Lower Turonian. Generally they have a carbonate content of 30 % and less. Lime-sandstones with carbonate contents in excess of 35 % are enclosed in layers usually as lumps. In the first weathering stage, the fine sandstones disintegrate into calcareous sand. Inclusions with a greater carbonate content are considerably more resistant to weathering and remain as stones. The tumulus fill contains around 8 % carbonates in the Cv horizon.

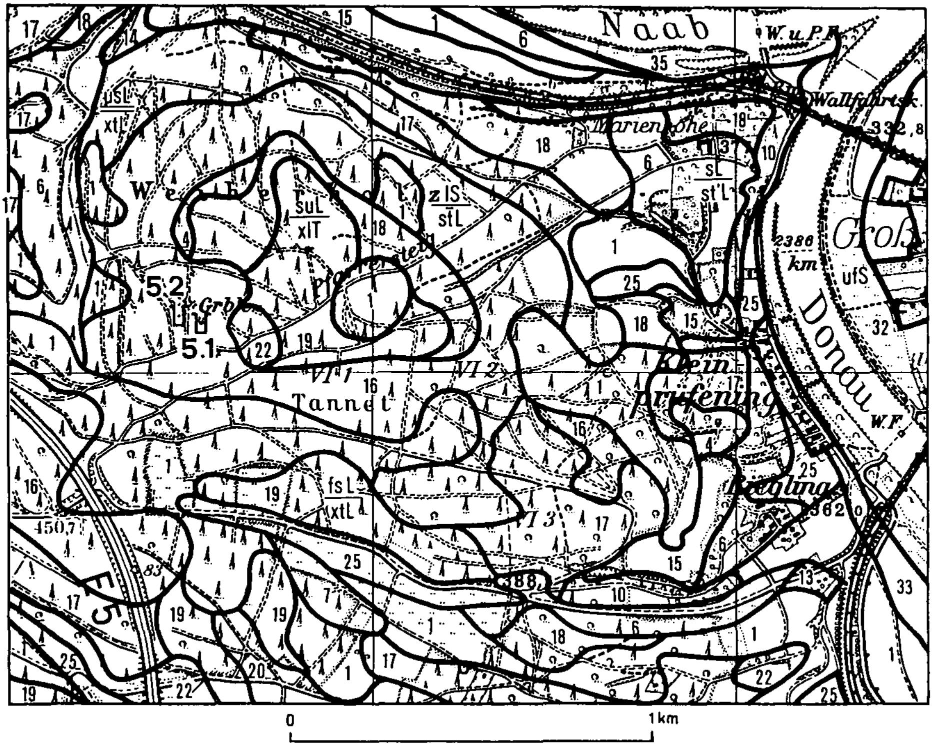
Soils

"Parabraunerden" developed from the stated substrata, which are differentiated by texture, podzolization tendency and also to a certain degree by development depth, depending on the carbonate and silt contents of the substrata. Lower limestone but high sand contents signify sandy, usually markedly podzolized Al and clayey-sandy Bt horizons (20-30% clay) as well as greater development depths, as are evidenced by meter-thick "Podsol-Parabraunerden" from Bronze Age tumulus fills (Profile 5.2). More calcareous intermediate strata hinder such depth development and are therefore frequently found on the lower limit of the solum (Profile 5.1).

With even more highly calcareous "Knollensandstein "-material, loamy-sandy Al- and fine-sandy-clayey to fine sandy-clayey-loamy

Excursion point 5: Weiherholz (west of Regensburg)

Section of the soil map of Bavaria 1:25 000, sheet No.6938 Regensburg



1 "Parabraunerde, Braunerde" with clay displacement originated from loess and loessloam, locally weakly "pseudovergleyt",

a) medium development depth

b) large development depth

4 "Braunerde", under forest partly podsolized,

a) originated in sandy

b) in sandy-loamy cover sheet above ±clayey weathering of the Tertiary

6 "Braunerde" of large development depth originated in solifluction layer
a) because of high content of loessloam, sandy-silty-loamy
b) sandy-loamy to loamy-sandy

10 "Mullrendzina", locally "Mullartige Rendzina" originated in congelifracts of limestone or stony-marly weathering (Malm), partly dolomitic

13 "Rendzina-Braunerde" of shallow development depth originated in calcareous rocks of the Malm or the Cretaceous and shallow cover sheets with loessloam or sand

15 "Terra fusca-Braunerde" originated in limestone or dolomite with loamy or ±podsolized sandy cover sheet

16 "Parabraunerde" of large to medium development depth, under forest ±podsolized, originated in calcareous sandstone (Cretaceous)

17 "Parabraunerde" of medium (to large) development depth, under forest weakly podsolized, originated in calcareous sandstone (Cretaceous)

18 "Parabraunerde" of medium development depth originated in sandy limestone (Cretaceous)

19 "Parabraunerde" (relic) of large development depth, under forest ±podsolized, originated in calcareous sandstone (Cretaceous); clayey-loamy subsoil starting
a) at 3-6 dm, b) at 6-9 dm depth

20 "Braunerde" of medium to large development depth, under forest weakly podsolized, locally also "Podsol-Braunerde", originated in sandstone (Cretaceous, Jurassic, Upper Triassic); ±loamy sand (4-7 dm) above ±clayey sand

22 "Pelosol" originated in partly marly claystones (Cretaceous, at Keilberg Jurassic and Upper Triassic); locally with 1,5-4 dm sandy or loamy cover sheet ("Pelosol-Braunerde")

25 humic colluvium 4 dm (a),
brown colluvium 6 dm (b)

35 "Brauner Auenboden" originated in silty, fine sandy and loamy deposits of the Regen and Naab river

32 Grey "Auenrendzina" (a),
Greybrown "Auenrendzina" (b) originated in silty-fine sandy to fine sandy-loamy silty deposits of the Danube river, locally ±gravelly

Bt-horizons must be expected (in the Bt generally 30 - 45 % clay). Podzolization phenomena are markedly less, often also because of a weak loessloam component in an upper layer.

PROFILE No. 5.1 - PODSOL-PARABRAUNERDE

Site description:

Location	Weiherholz, west of Regensburg
Grid Ref.	Top.Map 6938 Regensburg R 00510 H 30140
Parent Material	Knollensandstein of the Upper Cretaceous
Topography	upper slope of a flat crest, inclination 4^{o} to southwest
Elevation	457 m m.s.l.
Land use	forest
Vegetation	pine with larch and birch; age 65-70 years, productivity class: pure II.5, quality: low

Natural wooded community:
oak-beech forest without pine (after H. KOCH)

Humusform: moric moder

Ecological moisture degree:
moderately dry (to moderately moist)

Soil classification:
Podsol-Parabraunerde (DBG) originated from calcareous sandy weathering (partly developed as cover sheet) of the Knollensandstein (Upper Cretaceous)
Alfic Haplorthod (Soil Taxonomy)
Podzol-Luvisol (FAO)

Of 3 cm	decomposed litter; many roots abundant
Ahe 0-2 cm	dark gray brown (10 YR 4/1), humic, weak silty fine sand, single grain structure, many roots abundant
Ae 2-12 cm	light brown gray (10 YR 6/2), weakly humic fine sand, single grain structure, many roots
BhsAl 12-15 cm	gray brown (10 YR 5/4), weakly humic fine sand, single grain structure, many roots
Al 15-33 cm	light yellowish brown (10 YR 6/4), very weakly clayey fine sand, single grain structure, many roots
Bt 33-40 cm	yellowish brown (10 YR 5/8), clayey fine sand, cohesive structure, compact, some roots

Profile 5.1 Weiherholz, Regensburg W.
(Podsol-Parabraunerde from Knollensandstein)

No	hor.	depth	sto.	texture in % of humus-/carb. free fine soil									kf	
				sand				silt				clay		
		cm	%	c	m	f	Σ	c	m	f	Σ		cm/d	var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	OF	3	-											
2	Ahe	0-2	-	0,2	0,5	92,8	93,5	0,8	2,4	0,7	3,9	2,6		
3	Ae	- 12	-	0,3	0,4	91,6	92,3	3,3	2,4	0,2	5,9	1,8		
4	BhsAl	- 15	-	0,4	0,2	88,7	89,3	2,2	2,3	0,5	5,0	5,7		
5	Al	- 33	-	0,3	0,2	87,9	88,4	1,6	2,3	0,4	4,3	7,3		
6	Bt	- 40	-	0	0,1	72,8	72,9	2,4	1,8	0,4	4,6	22,5		
7	BtCv	- 50	6	0,1	0,2	78,0	78,3	0,9	1,5	0,3	2,7	19,0		
8	Cv11	- 80	-	0,2	0,4	85,0	85,6	1,5	1,5	5,1	8,1	6,3		
9	Cv12	-120	-	0	0,2	84,2	84,4	1,9	1,1	1,2	4,2	11,4		

No	hor.	bulk dens.	GPV	water content in % at pF				pH		Fe_d	Fe_o	Fe_o : Fe_d	Mn_o	P_t
		g/cm^3	%	0.6	1.8	2.5	4.2	H_2O	$CaCl_2$	mg/g			mg/kg	
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	OF								2,8					
2	Ahe								3,0	0,71	0,04	0,06	<10	367
3	Ae								3,2	1,11	0,10	0,09	<10	354
4	BhsAl	1,41	46,2		14,2	8,0	3,2		3,3	2,46	0,85	0,34	<10	336
5	Al								3,7	3,10	0,77	0,24	50	362
6	Bt	1,53	41,8		23,8	17,9	10,5		4,8	8,54	1,12	0,13	150	541
7	BtCv								7,4	5,93	0,51	0,09	90	581
8	Cv11								7,8	1,85	0,10	0,05	10	463
9	Cv12								7,6	1,40	0,07	0,05		471

No	hor.	$C_{org.}$	N_t	C:N	carbon.	CEC		exchang. cations in meq/kg						V
						p	a							
		%	mg/g		%	meq/kg		Ca	K	Mg	Na	H	Al	%
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	OF													
2	Ahe	3,9	1,1	35										
3	Ae	0,8	0,3	27		40		3	0	0		37		8
4	BhsAl	0,5	0,1	38		47								19
5	Al	0,4				56		0	0	0		56		0
6	Bt	0,4				128		82	2	0	3	41		68
7	BtCv				18,6	98		97	1	0		0		100
8	Cv11				32,2	46		45	1	0		0		100
9	Cv12				34,6	37		36	1	0		0		100

BtCv	40-50 cm	light yellowish brown (10 YR 6/4), weakly stony to stony, weakly clayey fine sand, partly calcareous, cohesive structure, compact, some roots
Cv11	50-80 cm	light gray green (5Y 6/4), weakly stony, loamy fine sand, very calcareous, single grain structure, scarcely roots
Cv12	80-120 cm	light gray green (5Y 6/4), weakly stony, very weakly loamy fine sand, very calcareous, single grain structure

PROFILE No. 5.2 - PODSOL-PARABRAUNERDE

Site description:

Location Weiherholz, west of Regensburg

Grid Ref. Top. Map 6938 Regensburg
R 00460 H 30160

Parent Material
Bronze Age Tumulusfill (age about 3000 years)

Elevation 455 m m.s.l.

Land use forest

Vegetation (survey immediately beside the Bronze Age tumulus, after W. BRAUN):
Leucobryo-Pinetum
Tree layer: Pinus sylvestris, Picea abies, Fagus silvatica,
Shrub layer: Picea abies, Fagus silvatica, Rhamnus frangula
Moss layer: Pleurozium schreberi, Hylocomium splendens, Dicranum rugosum, Ptilidium ciliare, Hypnum ericetorum, Dieranum scoparium
Herb layer: Vaccinium myrtillus, Avenella flexuosa, Quercus robur juv., Fagus silvatica juv., Abies alba juv., Picea abies juv., Melampyrum pratense, Picea abies Klg.

Humusform moder

Profile 5.2 Weiherholz, Regensburg W. (Bronze Age tumulus)

No	hor.	depth cm	sto. %	texture in % of humus-/carb. free fine soil: sand c	sand m	sand f	sand Σ	silt c	silt m	silt f	silt Σ	clay	kf cm/d	kf var.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	OF	5												
2	Ahe+e	0-9	0	0,8	1,0	79,5	81,3	7,5	6,9	2,0	16,4	2,3		
3	BhsAl	-19	2	0,8	0,5	74,3	75,6	6,6	5,3	2,6	14,5	9,9		
4	Al11	-40	3	0,7	0,6	77,4	78,7	6,7	5,6	2,4	14,7	6,6		
5	Al12	-65	5	1,3	0,9	75,0	77,2	6,9	6,2	2,7	15,8	7,0		
6	Bt1	-80	6	1,7	1,3	63,4	66,4	4,3	3,9	2,9	11,1	22,5		
7	Bt2	-95	1	0,7	1,0	57,5	59,2	3,7	4,1	2,8	10,6	30,2		
8	IICv	-110	18	9,9	7,8	60,4	78,1	3,7	4,2	3,0	10,9	11,0		

No	hor.	bulk dens. g/cm^3	GPV %	water content in % at pF 0.6	1.8	2.5	4.2	pH H_2O	pH $CaCl_2$	Fe_d mg/g	Fe_o mg/g	Fe_o : Fe_d	Mn_o mg/kg	P_t mg/kg
1	2	16	7	18	19	20	21	22	23	24	25	26	27	28
1	OF								2,9					
2	Ahe+e								3,3	0,49	0,07	0,14		358
3	BhsAl								3,7	2,73	1,89	0,69		393
4	Al11								4,2	1,61	0,77	0,48		393
5	Al12								4,1	1,61	0,91	0,56		432
6	Bt1								4,0	5,31	1,19	0,22		493
7	Bt2								4,9	8,53	0,91	0,11		533
8	IICv								7,6	5,81	0,77	0,13		589

No	hor.	$C_{org.}$ %	N_t mg/g	C:N	carbon. %	CEC p meq/kg	CEC a meq/kg	exchang. cations in meq/kg Ca	K	Mg	Na	H	Al	V %
1	2	29	30	31	32	33	34	35	36	37	38	39	40	41
1	OF													
2	Ahe+e	1,4	0,5	30		57		0	1	0	1	55		4
3	BhsAl	0,7	0,3	26		65		3	< 1	0	<1	62		5
4	Al11	0,4				49		0	0	1	1	47		4
5	Al12	0,3				47		0	0	0	1	46		2
6	Bt1	0,2				95		0	1	1	2	91		4
7	Bt2	0,2												
8	IICv				8,2									

Soil classification

Podsol-Parabraunerde (DBG) originated from calcareous fine sand (weathering of the Knollensandstein, Upper Cretaceous; manmade aggradation; Bronze Age tumulus fill)

Alfic Haplorthod (Soil Taxonomy)

Podzol-Luvisol (FAO)

Of 5 cm	decomposed litter, many roots abundant
Ahe + e 0-9 cm	light yellowish gray (2.5 Y 6/2), at Ahe-horizon strongly humic, weakly loamy fine sand, single grain structure, many roots abundant
BhsAl 9-19 cm	gray brown (10 YR 5/4), weakly humic, weakly loamy to loamy fine sand, single grain structure, many roots abundant
Al 19-65 cm	light yellowish brown (10 YR 6/4), weakly loamy fine sand, single grain structure, some roots
Bt1 65-80 cm	yellowish brown (10 YR 5/6), very clayey fine sand, cohesive structure, scarcely roots
Bt2 80-95 cm	brown (7.5 YR 5/6), very fine sandyclay, subangular structure
II Cv 95-110 cm	light yellow gray, (2.5 Y6/4) sandstones, ∓ weathered, calcareous

References:

WITTMANN, O., 1975. Bodenkarte von Bayern 1 : 25 000, Erläuterungen zum Blatt Nr. 6938, Regensburg

WITTMANN, O., 1975. Der Raum um Regensburg, Mitteilungen Deutsch. Bodenkundl. Gesellsch. 21

Mitteilgn. Dtsch. Bodenkundl. Gesellsch., 49, 217 (1986)

Trace metals in soils of calcareous sandstones ("Knollensandstein", Upper Cretaceous)

by H. Ruppert*

Excursion D: point 5; Weiherholz/Regensburg

The soil profiles presented here are separately described by Wittmann in this excursion guide. According to their high quartz contents, both of the profiles have very low metal concentrations. They increase with rising clay and iron oxide contents within the profiles reflecting their participation on soil forming processes (clay, humus, and iron migration). Due to the low background concentrations of metals in quartz sandstones, anthropogenic immissions of lead, cadmium, zinc, copper and nickel may be easily derived from their concentrations in the humus layer. Portions of zinc, manganese, copper and iron also participate on physiological processes in the system plant - soil. Lead is translocated downward by eluviation together with sesquioxides and humic substances facilitated by low pH-values around 3 in the humus layers and by the large porosities of sand. The Bh-, Bs-, Bhs-, or Bsh-horizons show corresponding enrichments. This behaviour of lead is typical for podsolic soils.

Metal concentrations in "Podsol-Parabraunerde"-profiles of "Knollensandstein" (in ppm):

horizon	depth	Cr	Mn	Fe %	Co	Ni	Cu	Zn	Cd	Pb	clay %	silt %	sand %
profile 5.1													
(L)+Of	3	18	105	0.5	<3	6	16	108	0.76	83	-	-	-
Ahe	0- 2	27	43	0.2	<3	<3	3	10	0.09	12	3	4	93
Ae	2-12	28	36	0.2	<3	<3	<2	6	0.02	4	2	6	92
BhsAl	12-15	32	39	0.4	<3	<3	2	6	0.01	7	6	5	89
Al	15-33	34	66	0.5	<3	<3	3	7	<0.01	8	7	4	89
Bt	33-40	72	225	1.6	<3	11	4	17	<0.01	4	22	5	73
BtCv	40-50	51	198	1.2	<3	7	4	13	<0.01	<4	19	3	78
Cvl1	50-80	32	96	0.5	<3	3	3	7	<0.01	<4	6	8	86
Cvl2	80-120+	28	116	0.6	<3	3	3	7	<0.01	<4	11	4	85
profile 5.2													
Of	5	12	157	0.5	<3	7	12	100	0.38	78	-	-	-
Ahe+e	0- 9	20	39	0.2	<3	<3	3	9	0.06	8	-	-	-
BhsAl	9-19	33	147	0.5	<3	<3	2	9	0.01	14	9	16	75
All1	19-40	34	149	0.4	<3	<3	2	9	0.01	7	6	16	78
All2	40-65	52	253	0.5	3	<3	2	10	<0.01	6	7	17	76
Bt1	65-80	56	309	1.1	3	7	3	17	0.01	6	22	10	68
Bt2	80-95	65	241	1.7	3	15	5	25	0.02	7	30	12	58
IICv	95-110+	-	-	-	-	-	-	-	-	-	11	11	78

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Mitteilgn. Dtsch. Bodenkundl. Gesellsch., 49, 218 - 223 (1986)

Excursion area Upper Bavarian "Tertiärhügelland"

by B. Hofmann +)

Geographical-geomorphological survey

The Upper Bavarian "Tertiärhügelland" (Tertiary upland hills) (Region 12.8) extends from the Munich gravel plain and the "Altmoränen"-regions in the south up to the Danube Valley in the north. The Upper Bavarian "Tertiärhügelland" slopes from the southwest (approx. 560 m m.s.l.) to the northeast to the Danube (approx. 360 m m.s.l.) and to the east to the Isar (approx. 410 m m.s.l.). The largely autochthonous stream systems of the Paar and the Ilm drain to the Danube, those of the Glonn and Amper to the Isar. The Paar and the Amper themselves originate in the moraine region of the Alpine foothills. The "Tertiärhügelland is divided by a closely meshed, finely ramified valley network into numerous hills and crests rising sometimes slightly and sometimes steeply 30-60 m above the bottoms of the valleys on the average. Kreutenbach (463 m m.s.l.) lies in the high loess-loam part of the Upper Bavarian "Tertiärhügelland" (12.8.3) and Höglwald in the loess-loam-influenced part. These two subregions have a more pronounced relief than the lower-lying, undulating sandy Tertiary upland hills (12.8.1) which change over into the wash-away region of the "Donaumoos".

+)Bayer. Geologisches Landesamt, Heßstr. 128, D-8000 München 40

Geological survey

The Upper Bavarian "Tertiärhügelland" (region 12.8) lies in the area of the South German molasses basin, a sedimentary trough, which as fore deep accommodated during the Tertiary the debris of the rising peripheral areas, in particular of the emerging Alpine chains. The surface is formed in the deposits of the Upper Freshwater Molasse . All those coarse and fine sediments of the foreland are described by this term, which were formed under mainland conditions after the ocean had retreated from the molasses basin, that is fluviately and limnetically. The sedimentation of the Upper Freshwater Molasses occurred during the Upper Miocene, around 15 to 10 million years ago. Its thickness is around 150-250 m.

The deposits of the Upper Freshwater Molasse form an alternating sequence of gravelly sands, sands, silts, marls and clays. These sediments were filled into the Molasse basin from the eastern limestone and central Alps by means of a far-reaching stream system from the east (Landshut area) to the west (Augsburg area). With increasing distance from the delivery area, ever more finely grained sediments were deposited. A great reduction of the shingle sizes and a depletion of the petrographic constituents through transport screening can already be recognized in the Upper Bavarian upland hills.

Grain size distribution:

- sandy gravels; maxima in the fine gravel and medium sand fraction
- sands: maximum in the medium sand fine sand fraction
- clays: clay content only rarely above 50 % clay (< 2 µ).

Petrographic constituents:

- gravels: 90 % quartzes, 10 % crystalline and sedimentary rocks.

Clay mineral constituents:

- clays:predominantly montmorillonite; kaolinite 0 - 2 %.

After the depositing in the Upper Fresh Water Molasse, the sedimentation area, tectonically removed, became the erosion area. The present upland hills were last formed during the Pleistocene in the periglacial zone. The valley asymmetry with preferred western steep slope exposure characteristic for the relief of the Tertiary upland hills is also of periglacial origin. The preferred eastern exposed slight slopes are for the most part covered with loess-loam and in the vicinity of the blow-off areas with loess. Potential blow-off areas of the loess were the gravel flats of the Lech, Amper and Isar valleys.

Climate

(shortened afterJ. van EIMERN 1975)

The climate of the Upper Bavarian "Tertiärhügelland" is characterized by an annual average precipitation from 700 to 850 mm (measured between 1931 and 1960). The average annual temperature is 7-8° C.

The higher lying regions have markedly higher precipitation amounts than the lower lying ones on both sides of the lower Paar, Ilm and Amper valleys. The broad valleys of the Ilm and the Glonn have somewhat less rain than the surrounding heights. The large amount of precipitation in the summer is notable, almost three times as much in July as in March, in the summer half year, almost twice as much as in the winter half year.

The Tertiary upland hills with their heights are a rain barrier area, even though not so pronouncedly as with a highland area. It is notable that summer thunderstorm rains and also hail are not infrequent.
Great terrain climatological contrasts exist with respect to the temperature. The broad valleys of the Ilm, Glonn, Amper, etc. may be regarded as being endangered by late and early frost, to a certain extent also the numerous asymmetrical valleys.

The soils

The formation, distribution and association of the soils in the Upper Bavarian "Tertiärhügelland" (region 12.8) are closely related to the parent material (coarse- and fine-grained deposits of the Molasse on the one hand, and loess and loess-loam as wind-formed covering sheets on the other), the (moderately moist) climate, the hilly undulating relief characterized by valley asymmetry and the water relationships determined particularly by the change between water-permeable and water-retaining deposits.

Water permeability:

- gravelly sands, sands: very great to great
- silts, clays: medium to small and very small respectively
- loess: medium to small
- loess-loam, loess-loam solifluction layer: small and very small respectively.

Vegetation
(shortened after W. BRAUN 1975)

The vegetative cover of the Upper Bavarian "Tertiärhügelland" is characterized essentially by growth areas of five potential natural wooded communities:

- lower locations	
on strongly basic soils:	Labkraut-Eichen-Hainbuchenwald (bedstraw-oak-hornbeam woods)
on weakly basic soils:	hainsimsenreicher Labkraut-Eichen-Heinbuchenwald (abundant wood rush bedstraw-oak-hornbeam woods)
- higher locations	
on strongly basic soils:	Waldmeister-Tannen-Rotbuchenwald (sweet woodruff-fir-red beech woods)
on acidic soils	Hainbuchen-Rotbuchenwald (hornbeam-red beech woods)
- moist depressions and valley bottoms	Traubenkirschen-Erlen-Eschenwald (bird cherry-alder-ash woods)

Except for insignificant relics, mixed forests close to nature have scarcely been preserved. On the contrary, the landscape appearances in lower locations are characterized by pine and pine-spruce forests, in higher locations by pure spruce forests.

Forestry

The "Tertiärhügelland" is an old farming country. The farmer's forest is closely related with his fields, the proportion of the state forest is small. In the 19th century spruce was planted on the forest areas that had become deteriorated through forest grazing and dispersed utilization on the fresher, high-fine loam locations, on the drier, sandy-gravelly, mostly steeply slope locations pine or spruce with pine.

The forestry goal is to stabilize unstable spruce stands on locations with changing moisture with fir and red alder wherever

precipitation conditions are appropriate, and on the locations with changing dryness with oak, hornbeam and also pine. Dry locations can be enriched with Douglas fir.

Hop Cultivation

(shortened after G. ROSSBAUER & F. GMELCH, 1981)

The Hallertau, the world's largest coherent hop cultivation district is located between Munich and Ingolstadt around the towns Pfaffenhofen, Wolnzach and Mainburg. The Hallertau encompasses the central territory of the loess-loam rich "Tertiärhügelland" (12.8.3 and 12.9.2) and the sandy "Tertiär-hügelland" adjoining to the north (12.8.1). In 1985 it had a cultivated area of 16,681 hectares (166.81 Km^2) and the average size of the area devoted to hop growing was 4.41 hectares (44,100 m^2) per farm. The 10-year average yield was 1,760 kg per hectare (10,000 m^2). 60% of the hop harvest of 35,561 tons was exported in 1984 to over a hundred countries. The Purity Decree of 1516 (brewing only with hops, malt and water) and the Hop Origin Act of 1919 established the world fame of Hallertau hops.

The hop requires a great deal of sunshine for good aroma and sufficient rainfall particularly in June, July and August for a high yield and a high content of bitter substances. Such conditions exist in the Hallertau, both on the loamy and on sandy soils (the latter with appropriate fertilization).

The hop is a deep-rooted plant with root depths down to 4 m and more. Within a short time, it forms large plant masses. Its root system reacts sensitively to soil compaction. Accordingly, the following requirements result for the soil:

- deep and readily rootable down to 2 m if possible
- soil structure with small to medium compaction without hardpans
- balanced water economy without stagnation
- adequate resupply of nutrients.

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A SWANSON-TYPE RAINFALL SIMULATOR FOR EROSION STUDIES

by K. Auerswald+)

In the course of adapting the Universal Soil Loss Equation for German conditions (Schwertmann et al., 1981) it was necessary to evaluate some of the factor values with a rainfall simulator. Among the different types of rainfall simulators, suitable for erosion studies, the Swanson-type was chosen (Swanson, 1965). This type is easy to handle and highly mobile, both needed to test a broad range of factor combinations within a short time. The second advantage is the use of the Veejet-80100 nozzle, which produces rainfall characteristics comparable to natural erosive rain (Meyer, 1958). Therefore this type of nozzles is being used for erosion studies since almost 30 years and their capability for the evaluation of USLE factors was proved by several authors (Barnett & Dooley, 1972; Young & Burwell, 1972; Laflen & Colvin, 1982).

The modified rotating boom simulator was built in collaboration with the Institute of Agricultural Engineering of the Technical University of Munich. To improve handling and rain structure the original Swanson rotating-boom rainfall simulator was modified in some parts. The pipe connections were made according to German (metric) standards to avoid problems with the supply of spare parts. The water turbine driving the original simulator was replaced by a diesel engine, so that the simulator rotates already when the water is turned on and still rotates when the water is turned off. This avoids high rain intensities at the boom positions at the beginning and end of a run. Each nozzle is mounted on a membrane valve, that shuts off, when the water pressure declines at the end of the simulation run. Without these valves the water was running out without being devided in single drops until the booms were emptied. This unnatural high-intensity rain lasted a few minutes.

The simulator is mounted on a chassis. The transport velocity on roads is 50km/h. The tandem axis allows to change the simulation plots without disassemblage of the simulator even

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on rough fields as far as no official roads have to be used. During the transport all the necessary equipment can be moved with the simulator: the water pump, 400 m of water hose, the booms, and the iron support plates on which the simulator rests during the runs. The supporting plates allow an easy removal of the simulator even from very wet fields.

The simulator can be leveled on slopes and lifted with hydraulic cylinders. On horizontal surfaces the elevation height is 3.6 m. On slopes the maximum height at the bottom part of the plots is even higher, because the front cylinders produce a greater hoisting height. Therefore, even in tall crops like corn a sufficient falling height of the drops can be achieved.

The rain intensity is 63 mm/h as it is with the original simulator. The rainfed area is about 17 m in diameter. Two plots, 4 m wide and 10 m long on each side of the simulator are tested simultaneously. To minimize border effects, the plots are surrounded by a 270 m^2 area that also receives rain.

Until the end of 1985 about 350 simulations were satisfactorily run with this modified rainfall simulator mainly for determining C factors specific for crop management systems in our area (Auerswald, 1984; Kainz, 1986; W. Martin, unpublished).

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Erosion Control under Corn

Th. Diez[1] and M. Kainz[2]

Corn, virtually unknown in Bavaria 40 years ago, has become a major crop in many regions. 90 % of the corn is used for silage and is grown in rotation with wheat and barley. Due to their rolling topography and highly erodible silty soils these areas are subject to erosion. In order to control water erosion the following methods have been tested:

1. Minimum tillage (slit planting)
2. Winter cover crops and reduced secondary tillage
3. Protection measures under conventional moldboard plowing
4. Contour farming, strip tillage

1. Minimum tillage

Permanent ground cover and minimum tillage with slit planting gives severe yield reductions in years with cold and wet conditions during establishment of corn (May, June). Because of the limited practicability of this method no erosion measurements were done, so far.

2. Cover crops and reduced tillage

After deep ploughing or chiseling the stubble in August Phazelia tanacetifolia or other plants sensitive to frost are planted. In spring tillage is done with a rotor harrow or a chisel (5 - 10 cm deep) or with a strip-rotorvator (strips 20 cm wide, 10 cm deep, no tillage between strips) combined with the planter. In table 1 the experimental scheme of the 1986 experiment near Freising is shown.

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Table 1: Experimental scheme of reduced tillage plots (Dürnast 1986):

Winter cover crops (Sinapis alba and Phazelia tanacetifolia) between winter barley and corn; corn planting with conventional machinery

Treatment number	Soil management before planting the cover crop	Treatment of of cover crop in the fall	Secundary tillage in spring
13	chiseling + moldboard plow	none	strip rotorvating
14	chiseling + moldboard plow	none	rotor harrow
15	chiseling + moldboard plow	disk harrow	harrow
16	2 x chiseling	none	strip rotorvating
17	2 x chiseling	none	rotor harrow
18	2 x chiseling	disk harrow	harrow

In 1984 a similar experiment with reduced tillage (Nr. 16 and 17) was established on an Arenic Hapludalf near Pfaffenhofen/Ilm. Tillage was done up and down slope, planting across slope (6 to 23 %). Erosion measurements were done in mid of May using the Rotating Boom Rainfall Simulator described above on plots 10 m long and 4 m wide with 10 % slope. Herbicides were sprayed just after rainfall simulation. Results of yield and erosion measurements are given in table 2.

Table 2: Yields, runoff and soil loss ratios (SLR) of reduced tillage methods in 1984

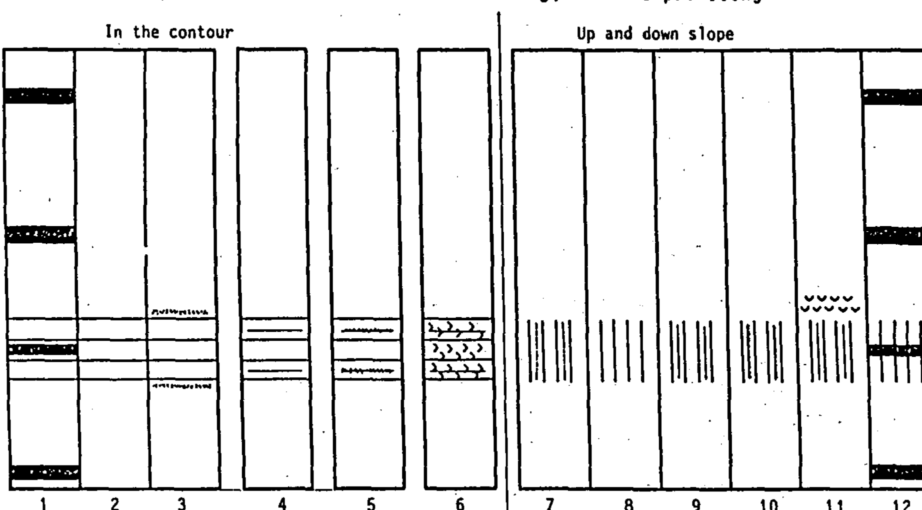
	canopy cover	total cover	runoff (%of rain)	SLR	95 % conf. interval	yield (% dry mass) (BLBP 1984)
Conventional	0	9	58.3	75.6	4.7	100
16 Striprotor	0	40	14.9	2.1	0.2	105
17 Harrow	0	18	25.9	7.7	0.7	106

Reduced tillage systems reduced runoff by 55 to 75 % and soil loss by over 90 %. These effects are due to the high coverage which reduces splash (less sediment to transport downslope) as well as runoff velocity and runoff volume (shear stress and transport capacity). The corn yields were statistical equal.

3. Protection measures under conventional tillage

The experimental scheme of the measures tested in 1986 is given in table 3.

Table 3 Erosion control field trial 2
Strip interseeds, wheel track loosening, surface profiling



1) Strips of winterbarley, 1 m wide, 20 m apart, seeded immediately after corn
2) Standard
3) Double row of winterbarley, after every 4th row of corn
4) Wheel track loosening
5) same as 4), combined with a row of winterbarley
6) same as 4), combined with surface profiling

7) One row of winterbarley in the wheel trac
8) same as 2), (standard)
9) same as 4)
10) same as 5)
11) same as 6)
12) same as 1)

Experiments to measure runoff and soil loss ratios with the Rainfall Simulator were established on a Hapludalf (in 1983) and an Eutrochrept (in 1984 and 1985) near Freising. The plots were 3.75 m wide (5 rows of corn) and 10 m long with a slope of 10 to 11 %. After moldboard ploughing in the fall, secondary tillage was done just before planting (up and down) in the last days of April. Herbicides were sprayed 5 weeks later. The different management practices are described in table 4. Simulated rains were applied in June and early July; the results are given in table 5.

Table 4: Corn management systems with conventional tillage

8 Conventional	No protecting measures
11^Profiling	Soil surface pitting with shallow, round bowls (0.15 m wide, 0.08 m deep) with a spade machine
9 WTL	Loosening the wheel tracks (0.25 m deep)
7 BI	One row of winter barley in every wheel track

^ but without wheel track lossening

Table 5: Runoff and Soil Loss Ratios (SLR) of corn management systems with conventional tillage

1983 AUERSWALD 1985	canopy cover	total cover	runoff (% of rain)	SLR	95 % confid. interval of SLR
8 Conventional	21	39	25	14.1	2.0
11 Profiling	16	35	18	15.3	5.9
9 WTL	22	39	17	12.4	1.6
7 BI	20	61	9	1.9	0.4
1984					
8 Conventional	5.2	19	67.4	73.4	4.5
11 Profiling	5.2	20	65.3	69.8	2.8
9 WTL	6.0	20	40.1	47.6	4.6
7 BI	6.0	30	46.1	31.9	2.7
1985					
8 Conventional	23	31	80.4	37.7	1.8
11 Profiling	41	46	62.4	41.1	5.9
9 BI	39	55	55.4	17.5	0.8
8 Conventional	57	61	42.6	17.7	1.0

The lower runoff and soil loss ratios in 1983 as compared to 1984 and 1985 can be explained by a better crop establishment in 1983, resulting in a higher canopy cover. In 1983 also the stand of barley was better; the soil loss ratio (SLR) dropped by 87 % of the conventional system by planting winter barley on the wheel tracks (7). Surface profiling and wheel track loosening had no reducing effect. In 1984 and 1985 growth of winter barley was not as good and therefore reduction of SLR was only 55 - 57 %. Wheel track loosening had a significant effect in 1984 (infiltration rate was raised) but was uneffective in 1985, when loosening was done under very wet conditions so that the slits were compacted (runoff velocity increased) and runoff water could easily carry the loosened soil downslope.

Profiling had no influence on yields; wheel track loosening can raise yields in years with very wet conditions in May and June (better drainage during establishment of corn). Interseeding of winterbarley can hamper yields very seriously in years with good growth of barley and poor one of corn. It is necessary to suppress the barley with herbicides when leaves of barley and corn touches each other. To reduce the risk of yield reduction, it is recommended to plant barley only between every second row of corn (Nr. 7). One meter wide strips of winter barley or rye every 20 m in contourline reduces yield at a maximum of 5 %. The soil and water loss reduction observed depends on shape and slope of field. Often protection against erosion is not satisfying.

4. Contour farming, strip cropping

No soil loss measurements are available. The extension service, however, recommends contour farming to the farmers.

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Excursion area: Northern "Münchner Schotterebene" (Munich gravel plain)

by G. Rückert*

Geography, Geology and Climate

The northern part of the "Münchner Schotterebene", a terrace plain based on glacial and postglacial gravel, slightly inclined to the north, extends between the "Tertiärhügelland" and the State Capital of Munich. To the south it extends beyond Munich and terminates in the moraine walls of the foreland glacier from the Riss and Würm ice age. The elevation in the northern part is between 470 - 550 m m.s.l.

The gravel containing also residues of Middle Pleistocene deposits, rests on a stratum of Tertiary clayey silt, the so-called Flinz, which provides the ground water carrier for the top ground water level.

The plain is traversed by several streams, the Moosach, the Amper and the Isar. The Isar in particular has carved out a valley with a steep elevated bank, which widens out like a funnel to the northeast.

The northern part of the gravel plain has an annual average precipitation of 800 - 1000 mm and a mean annual temperature of 7° C.

Parent material and soils

Northern "Münchner Schotterebene" (13.2.2)

"Parabraunerden" of slight to great development depth, which usually display large humic Ah horizons (> 40 cm thickness) developed on both sides of the Autobahn on Neopleistocene, calcareous gravel. "Braunerde-Pararendzinen", "Ackerpararendzinen" and "Pararendzinen" are found scattered. The soils referred to above are also found in the area of the fluviatile marls, which occur stratified in varying thickness in the gravels or lie on them in small patches.

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"Dachauer" and "Erdinger Moos" including the Isar valley plains between Munich and Freising (13.2.3)

East of the Isar Valley as well as west of the gravel tongue on which the Autobahn takes its course, the ground water streams of the gravel plain come to the surface. Fens develop in the damp areas, which are called "Moos" in Bavaria; in the east, the "Erdinger Moos" and in the west, the "Dachauer Moos". Semi-terrestrial calcareous soils of gravel, partly with fluviatile marl cover are common here: "Gley-Pararendzina", "Pararendzina-Gley", calcareous "Gley", calcareous "Anmoorgley". (These areas have been extensively and heavily drained and today occur as deep humic pararendzinas.) To the north, these mineral soils are followed by soils with increasing amounts of organic substance: "Anmoorgley", shallow "Moore", "Niedermoore" (partly calcareous) and "Übergangsmoore".

The lime deposits, called "Alm" in Bavaria, occurring principally in the southern part of the fens are a special feature. The Alm originated through precipitation of the lime from the calcareous ground water (through dissociation of the calcium carbonate) and in exceptional cases reached a thickness in excess of 10 m. The Alm can have a $CaCo_3$ content of 95-99% (BRUNNACKER, K. et al., 1964). "Rendzinen", "Gley-Rendzinen", "Rendzinen-Gleye", "Kalkgleye" and "Kalkanmoorgleye" developed in it depending on the height of the ground water level.

In the flood plain area of the Isar, the series of soils extend from the "Auencarbonatrohboden" (Kalkrambla)" through the "Hellgraue, Graue, Braungraue" and "Graubraune" to the "Braune Auenrendzina (Kalkpaternia)" of fine sandy-silty fluviatile sediments over gravel, but also more humic soils such as "Grauschwarze Auenrendzina (Borowina)" as well as "Schwarzerdeähnliche Auenböden (Tschernitza)" have been plotted. "Auenbraunerden (autochthone Vega)" and "Braune Auenböden (allochthone Vega)" of sandy or silty, clayey fluviatile sediments are common in areas remote from ground water. In areas of the river valley near ground water, "Auenrendzina-Gleye" as well as calcareous "Auengleye" and "Auengleye" of fluviatile sediments predominate.

The Refuse Dumping Ground

The Refuse Dumping Ground of the City of Munich operated since 1954 lies just outside Munich east of the Autobahn. Up to the present, around 7 million m^3 of refuse and covering material on an area of around 50 hectares have been deposited directly on sandy fine to coarse gravel. The degree of contamination of the ground water is constantly checked at around 100 measuring points. On a relatively narrow stream flowing to the northeast with a constant tapering, electrolytic water conductivity, high chloride values and high $KMnO_4$ consumption as well as increased water temperatures indicate the degree of contamination. The rise in temperature of the water is concurrent with the increased outside temperature in spring and early summer. Exothermic reactions evidently occur then in the refuse heap. The contamination caused by the refuse dumping ground was able to be found in the ground water at a distance of up to 4000 m.

In the meantime, the entire refuse dumping ground has been enclosed with a diaphragm wall extending into the cohesive Tertiary. The seepage water is now removed in two pump wells and conducted to the sewage purification plant.

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Agricultural Use of Sewage Sludge in Densely Populated Areas Demonstrated at the Example of the City of Munich

by Th. Diez +)

The city of Munich is presented as an example for the way by which the entire sewage sludge of a densely populated area is utilized for agricultural purposes on a relatively small acreage (about 1000 ha) over a period of several decades. In 1925 the sewage plant of Munich was established.

The sewage sludge produced was spread over the agriculturally used fields in the northeastern area of the city from 1925-1978. The heaviest applications amounted up to 800 t of sewage sludge (dry matter). As a consequence of that enormous input of organic matter, combined with deeper ploughing, the shallow soils became more fertile and balanced in yield.

Environment and land use:

Outwash plain of the Isar-river; rainfall 850 mm, 7,5°C; ground water table >5 m, extensively used farm land.

Original soil (before treatment with sewage sludge): Braunerde-Pararendzina

Parent material: Gravel consisting of ca. 80 % limestone and dolomite.

Profil description:

Horizon	Depth	
Ap	0-10	dark greybrown, stony sandy clayloam
BvCv	10-18	reddish brown, stony sandy clayloam, wavy boundary
C	18-40 +	gravel

The influence of continued massive sludge application on soil (properties) and yields is shown in table 1 and graph 1. Contamination of the soil with heavy metals was the negative side-effect (cf.table 2). It is the result of prolonged and very heavy applications of sewage sludge containing extremly high proportions of heavy metals. During the last years amounts up to 100 t of sludge (dry matter) were spread in one application. For this reason agricultural use of the sludge was stopped in 1978. At present the sludge is dehydrated, mixed with Calciumoxide and put on dumps.

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Table 1 Analytical Data of Differently Sludge-treatet Soils

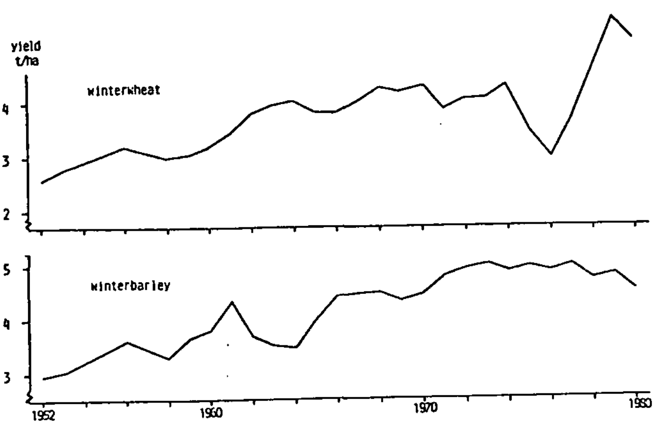
Soil / Treatment	Solum depth cm	pH ($CaCl_2$)	$CaCO_3$	Org.matter %	C/N	mg/100 g Soil P_2O_5 total	P_2O_5 CAL	K_2O CAL *
without Sludge	18	7,2	13	3,4	9,0	68	1	2
400 t Sludge/ha	28	6,7	9	9,2	8,3	920	180	23
800 t Sludge/ha	38	6,4	12	12,4	9,0	1335	189	28

	Texture (%) Clay 0,2 µm	Silt 0,2-60 µm	Sand 60 µm	avail. Vol. % /dm	Field Capacity mm/ Rootzone
without Sludge	31	29	40	16	29
400 t Sludge/ha	26	34	40	19	53
800 t Sludge/ha	25	39	36	22	84

*) Extraction with calcium ammonium lactate

Table 2 Heavy Metal Contents of the Soils (ppm, total)

Soil / Treatment	Cu	Zn	Cr	Ni	Pb	Cd
without Sludge	4	11	8	5	24	0.5
400 t Sludge/ha	214	1022	150	38	872	41
800 t Sludge/ha	343	1863	175	51	1348	42
tolerable Contents	100	300	100	50	100	3



Graph 1:

Development of yields on fields with continued sewage sludge application

Concerning the heavy metal contaminated areas of about 1000 ha, the following questions had to be answered:

1. What is the transfer of heavy metals from soil to plant?
2. Can such areas be used agriculturally without risk, and if so, how?
3. How can the uptake of heavy metals in plants be reduced?
4. What happens if contaminated areas continue to receive sludge applications?

I. To answer questions 1 und 2, soil and plant samples were taken from the sludge-treated fields and the relationship of heavy metal content in soils und plants was established.

Results:

A significant correlation could be found (cf.graph 2) only for Cd; Zn und Cu. Only the Cd increase constitutes a problem. Cd is stored to a relatively high degree in the grain of winterwheat, winterbarley and oats, to a relatively low degree in the grain of rye and springbarley (cf.graph 3).

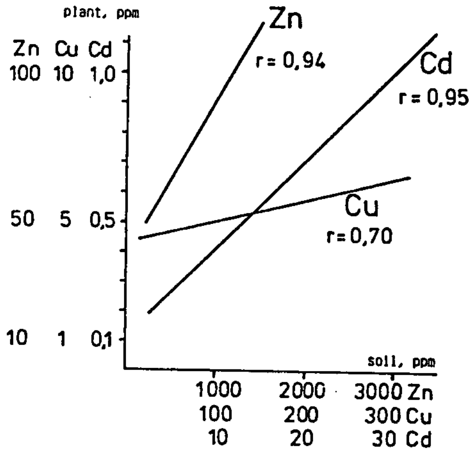
Conclusion:

The above mentioned crops with the exception of rye and springbarley cannot be used for human consumption. They may be used as feed grain or silage. Feed trials with these products showed that the Cd is not transferred to the meat of beefcattle, hog or lamb.
Other possible uses are: Seedproducts, production of bioalcohol and beer (springbarley).
In conclusion it can be said that soil even with a high degree of contamination can be used for agricultural purposes with certain restrictions as stated above.

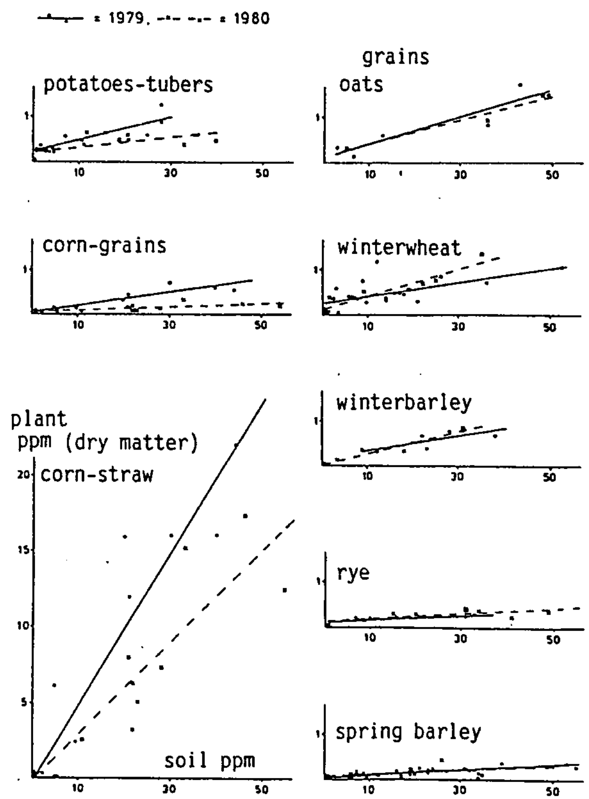
II. To answer question 3 and 4, a research project was started in 1979 with 12 crops and the following variants:

1. Area with a high degree of heavy metal contamination (standard)
2. same as No 1 plus 100 t sewage sludge/ha
3. same as No 1 plus 400 t sewage sludge + lime/ha
4. same as No 1 plus 2000 t sewage sludge + lime/ha (ratio sludge/CaO = 1/0.7)

If variant No 3 were carried out (400 t, providing a cover of 2.8 cm) the complete sludge production of the city of Munich could be spread on the now existing contaminated area.



Graph 2: Heavy metal uptake of winterwheat (grains) dependent on heavy metal contents of the soil



Graph 3: Cd-uptake by plants depending on Cd-content of soils

Results:

1. The strong applications of sludge and sludge plus lime had no reducing effect on the yields.
2. After the city of Munich succeeded in reducing heavy metal contamination of the sewage the sludge now contains considerably lower amounts of heavy metals. Therefore, if the sludge applications are continued, the soil is neither enriched by heavy metals nor is there an increase in the heavy metal transfer from soil to plant.
3. Sewage sludge plus lime on strongly contaminated soil reduces the Cd transfer from soil to plant considerably (cf.table 3).

Conclusion:

Continued applications of sewage sludge on the contaminated soils not only constitute an economical but also an ecologically sound solution. Legal restrictions and political considerations prohibit it for the city of Munich for the time being.

Table 3:
Cadmium contents of different crops grown on heavily contaminated soil (standard) and their variation by continued application of high amounts of sewage sludge (ss) and a mixture of sludge and lime (ss + 1), average of 2 - 4 years

Crop	standard	+ 100 t ss /ha	+ 400 t ss +1 /ha	+ 2000 t ss + 1 /ha	reduction of Cd-uptake by ss+1, %
winterwheat	2,6	2,0	1,3	1,2	54
springwheat	2,5	2,9	1,6	1,5	40
winterrye	0,68	0,7	0,5	0,3	56
winterbarley	1,1	1,1	0,7	0,7	37
canola	0,55	0,55	0,40	0,40	28
springbarley	0,50	0,51	0,46	0,44	12
oats	2,1	2,1	1,2	1,2	43
clover	5,9	4,7	3,2	2,6	56
lolium perenne	2,0	2,4	1,5	1,4	30
potatoes	0,72	0,73	0,58	0,54	25
beats	6,2	5,9	3,2	2,8	55

Used laboratory methods	Profile, No.						
	1.1	1.2	2	4.1	4.2	5.1	5.2
Particle-size analyses (<2mm): a) Combined sieving and burette method				X	X		
b) Combined sieving and pipette method						X	X
Clay minerals: X-ray diffraction				X	X		
pH (soil suspensions): a) Water dilution	X	X	X	X	X	X	X
b) Ca Cl_2	X	X	X	X	X	X	X
Carbonate: a) Dry combustion, gasanalytical measurement of Carbonate-Carbon after combustion of organic Carbon at 500°C	X	X	X				
b) Carmhomat				X	X		
c) HCl treatment, gas volumetric						X	X
Carbon: Total Carbon; Dry combustion, gasanalytical measurement	X	X	X				
–: Organic Carbon; a) Total Carbon minus Carbonate Carbon	X	X	X				
b) Carmhomat				X	X		
c) Acid dichromate digestion, colorimetry						X	X
–: Oxalate extraction, colorimetry	X	X	X				
Nitrogen: Kjeldahl digestion	X	X	X	X	X	X	X

Used laboratory methods	Profile, No. 1.1	1.2	2	4.1	4.2	5.1	5.2
Cation-exchange capacity: NH_4Cl a) at current soil pH	X	X	X	X	X		
b) at pH7	X	X	X				
–: NH_4OAc				X	X		
–: $BaCl_2$, pH8.2, flame photometry						X	X
Extractable bases: NH_4 OAc extraction, a) Atomic adsorption ofAl,Na,K,Ca,Mg	X	X	X				
b) Atomic adsorption of Al,Fe,Ca,Mg; flame photometry of K,Na				X	X		
–: $BaCl_2$, pH 8.2, Flame photometry						X	X
hosphorus: Total Phosphorus a) HF digestion, colorimetry	X	X	X				
b) $HF/HClO_4$ digestion, atomic adsorption				X	X		
c) H_2O_2 treatment, $HClO_4$ digestion, colorimetry						X	X
–: Citric acid extraction after Soil Conservation Service (1972)	X	X	X	X	X		
otassium: $HF/HClO_4$ digestion, flame photometry				X	X		
alcium: $HF/HClO_4$ digestion, atomic adsorption				X	X		
agnesium: $HF/HClO_4$ digestion, atomic adsorption				X	X		
ron: a) Oxalate extraction, atomic adsorption	X	X	X	X	X	X	X
b) Dithionite extraction, atomic adsorption	X	X	X	X	X	X	X
c) $HF/HClO_4$ digestion, atomic adsorption				X	X		
d) Na-pyrophosphate extraction, atomic adsorption				X	X		

Used laboratory methods	Profile, No. 1.1	1.2	2	4.1	4.2	5.1	5.2
Aluminium: a) Oxalate extraction, atomic adsorption	X	X	X	X	X		
b) Dithionite extraction, atomic adsorption	X	X	X	X	X		
c) $HF/HClO_4$ digestion, atomic adsorption				X	X		
d) Na-pyrophosphate extraction, atomic adsorption				X	X		
Manganese: a) Oxalate extraction, atomic adsorption				X	X	X	X
b) Dithionite extraction, atomic adsorption				X	X		
c) $HF/HClO_4$ digestion, atomic adsorption				X	X		
d) Na-pyrophosphate extraction, atomic adsorption				X	X		
Needle analyses: a) Elements exept N and S: dry combustion at 450°C, HCl digestion, atomic adsorption	X	X	X				
b) Nitrogen: Kjeldahl digestion	X	X	X				
c) Sulfur: after LANDERS, DAVID & MITCHELL (1983)	X	X	X				
Trace metals: HF, $HClO_4$, HNO_3 digestion, atomic adsorption	X	X	X			X	X