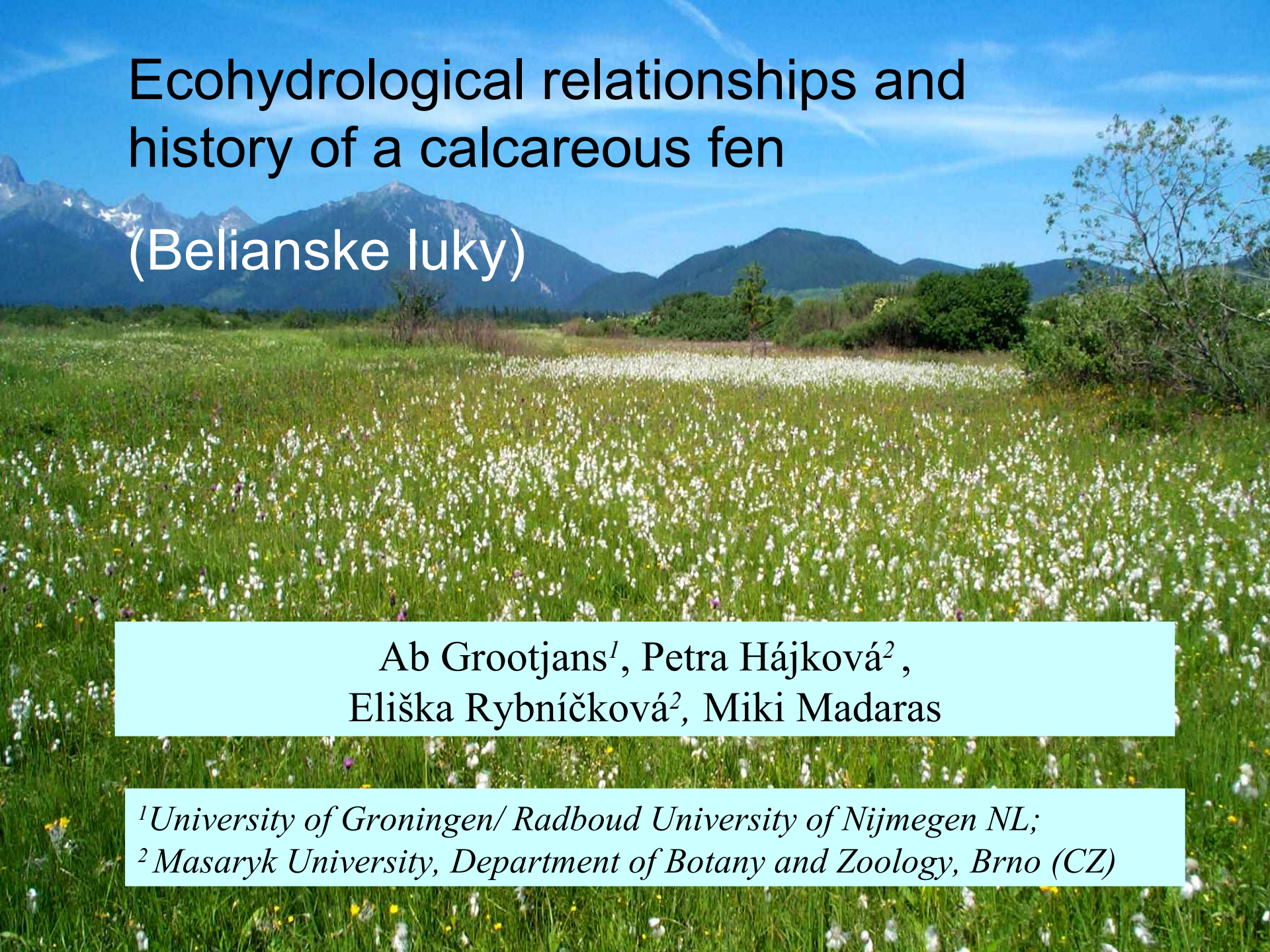
Ecohydrological relationships and history of a calcareous fen

(Belianske luky)

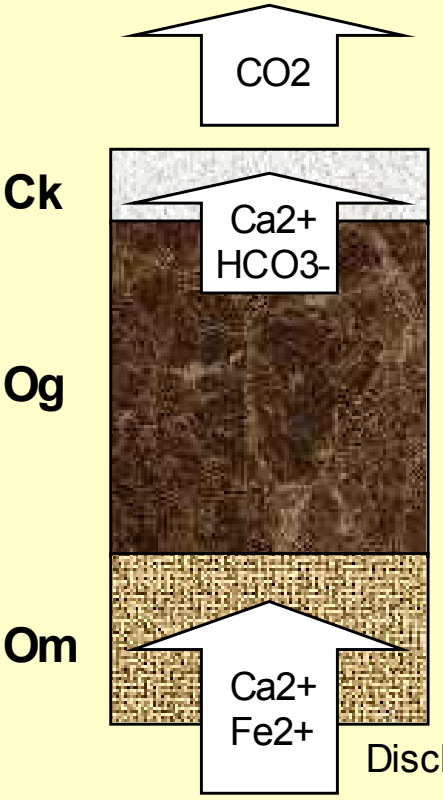


Ab Grootjans[1], Petra Hájková[2] ,
Eliška Rybníčková[2], Miki Madaras

[1]*University of Groningen/ Radboud University of Nijmegen NL;*
[2] *Masaryk University, Department of Botany and Zoology, Brno (CZ)*

Belianske luky consists of a complex of fens and fen meadows and is locally depositing travertine (terrestrial chalk = marl = lime = $CaCO_3$)

Principles of travertine deposition



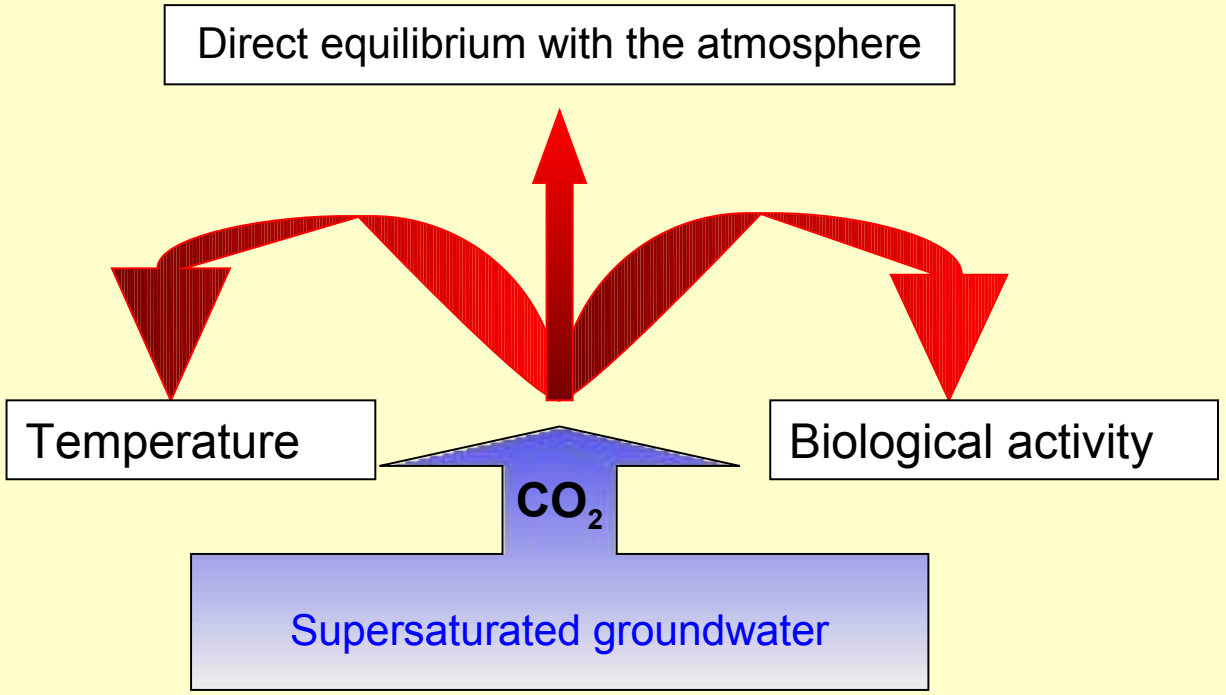
Precipitation of CaCO3

Decomposition OM -> HCO3- and S2-
Formation of FeS

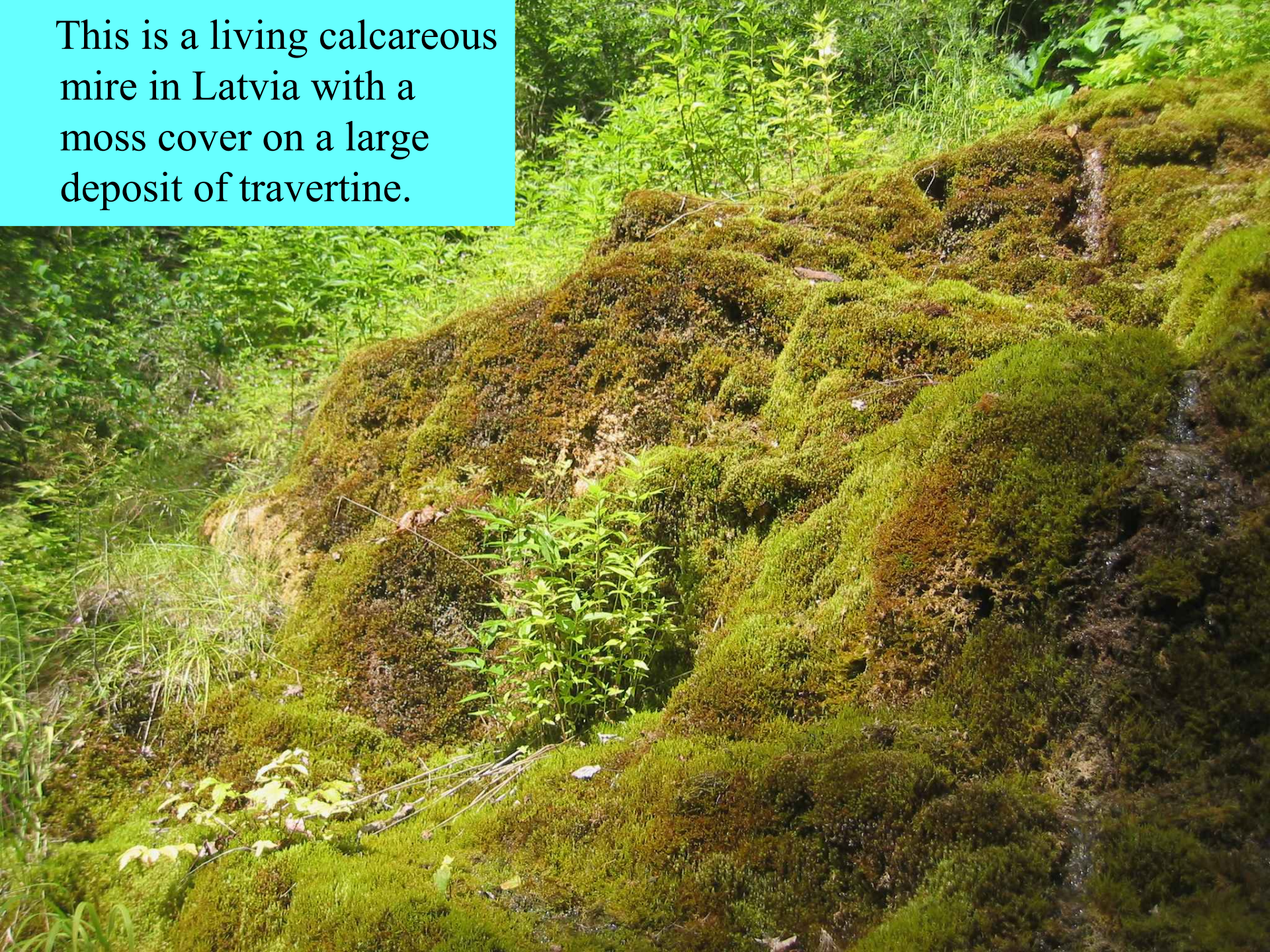
Discharging groundwater

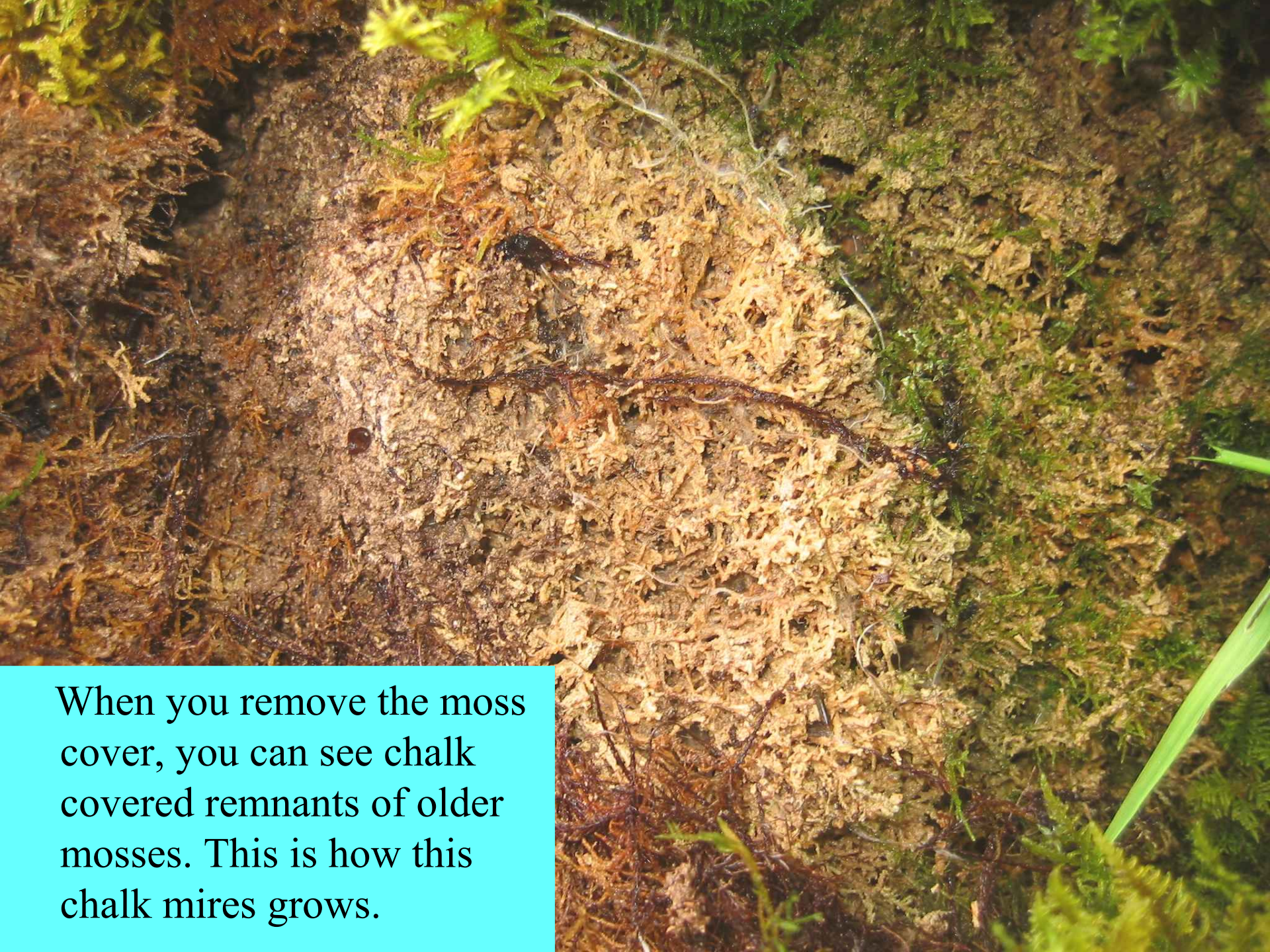
Principles of chalk deposition

- CO_2 release (degassing) in groundwater can trigger chalk deposition
- Increase in temperature increases CO_2 release
- Biological activity (Moss species, algae, Chara species take up CO_2 and stimulate chalk deposition



$$Ca^{2+} + 2\,HCO_3^- \leftrightarrow CaCO_3 + H_2O + CO_2$$


This is a living calcareous mire in Latvia with a moss cover on a large deposit of travertine.

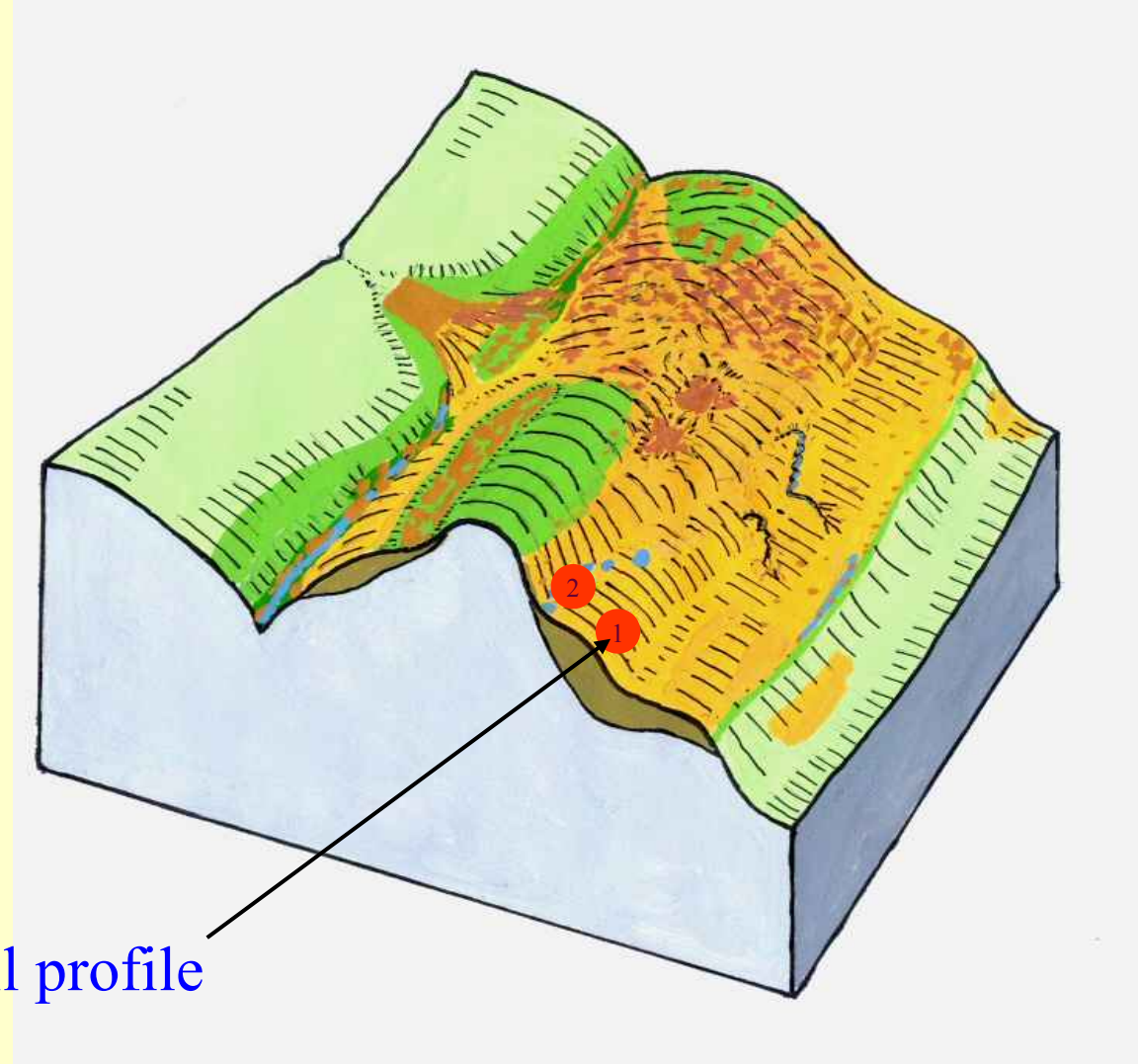


When you remove the moss cover, you can see chalk covered remnants of older mosses. This is how this chalk mires grows.

Recent history of Belianske luke

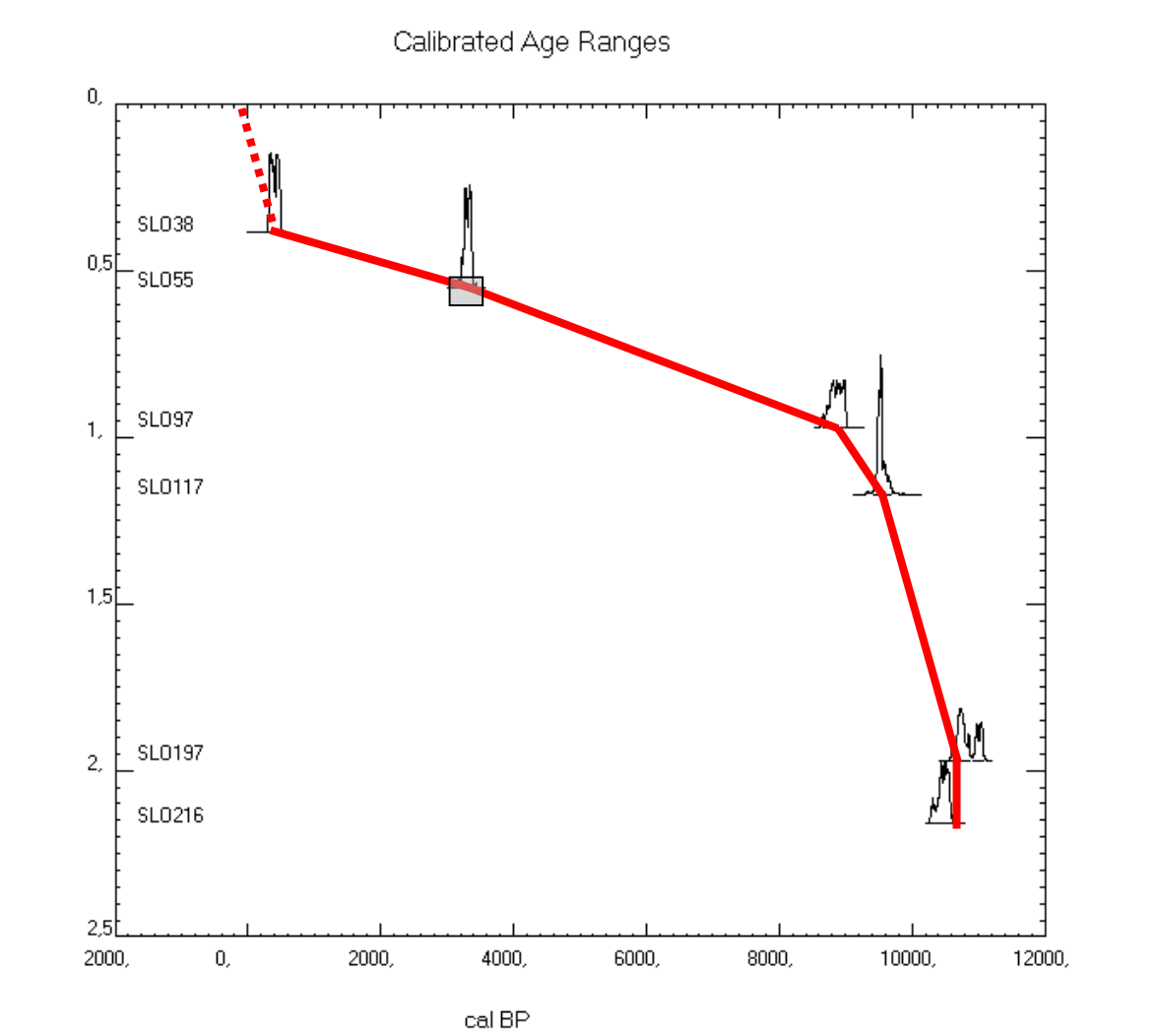

1992

Belianske luky

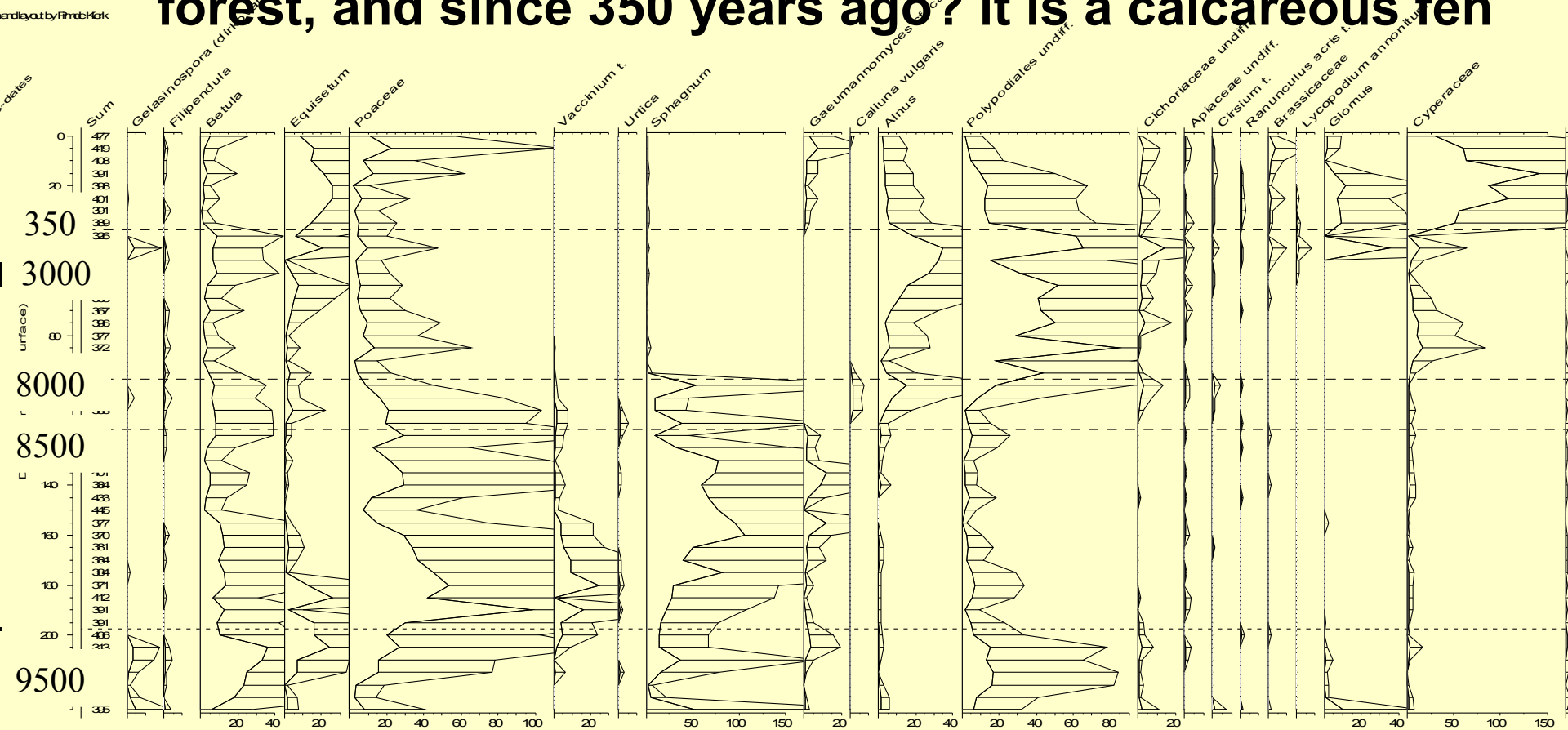


Pollen and macro-fossil profile

Belianske luky is about 10,000 years old

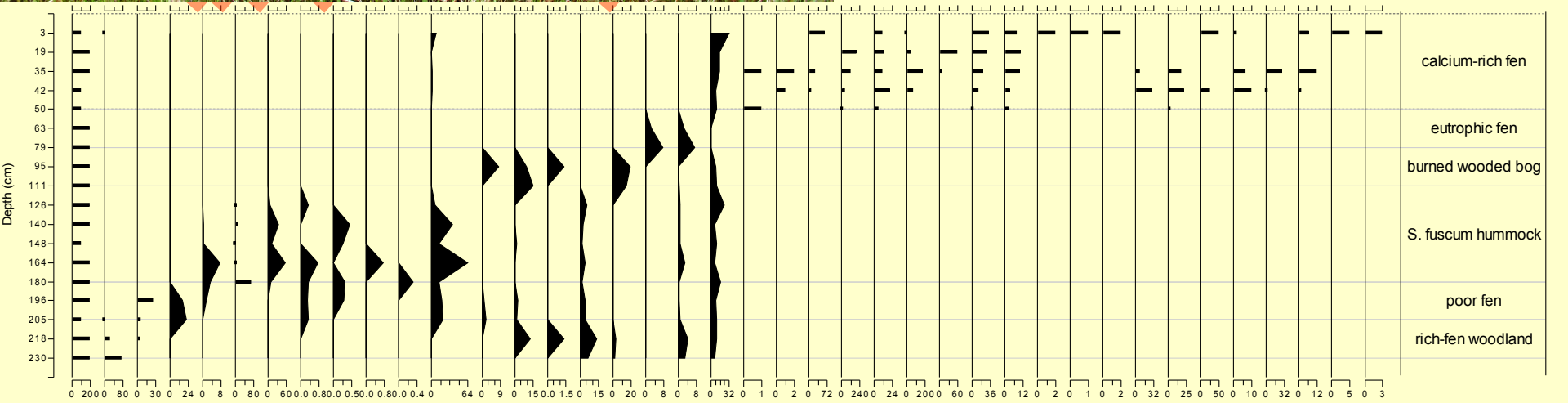


Between 10,000 and 8000 it was an open mire, with Sphagnum fuscum hummocks, then it became a forest, and since 350 years ago? it is a calcareous fen



Eliška Rybníčková, Petra Hájková

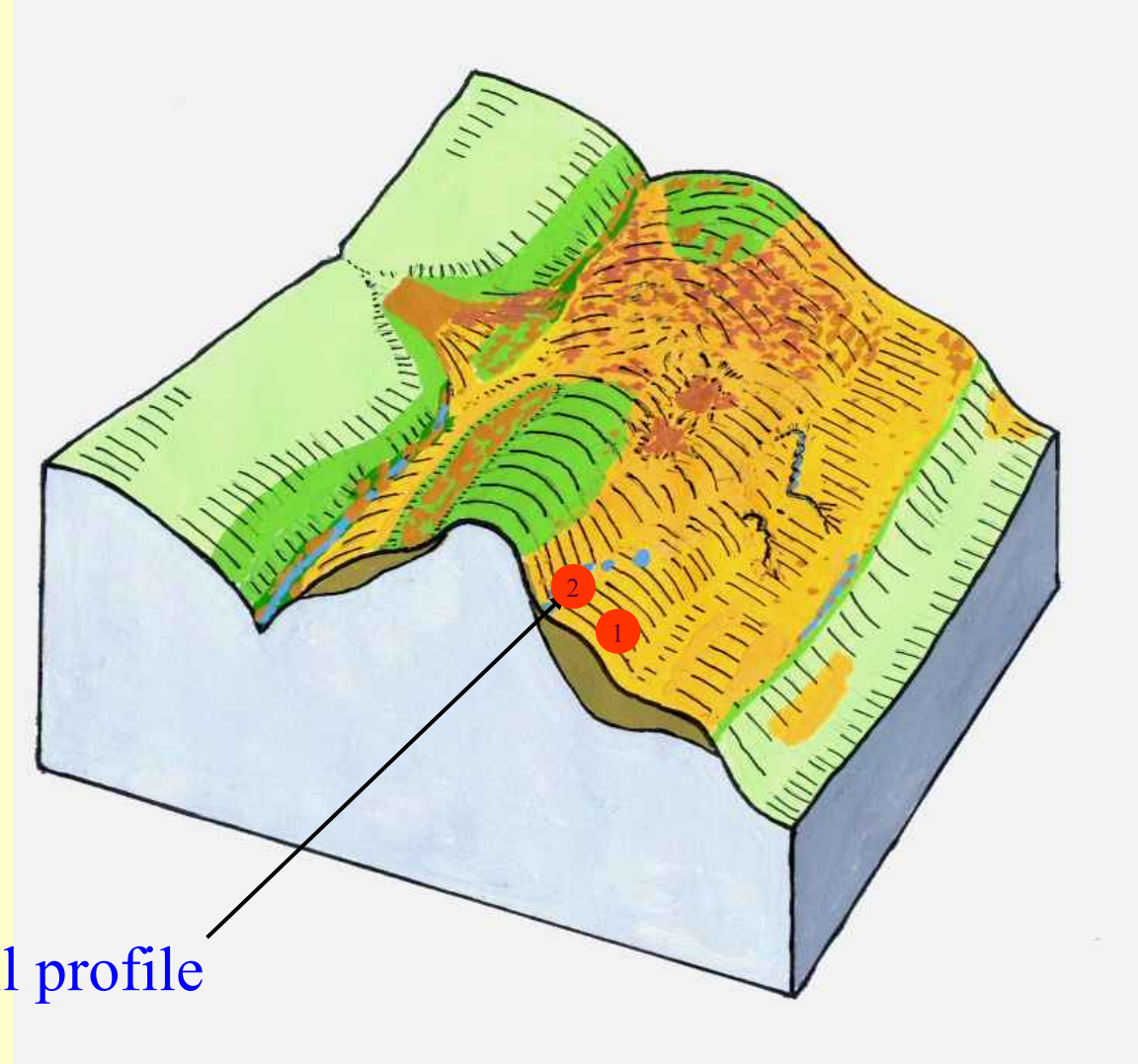
Pollen analysis transect 1



Petra Hájková

Macro fossils transect 1

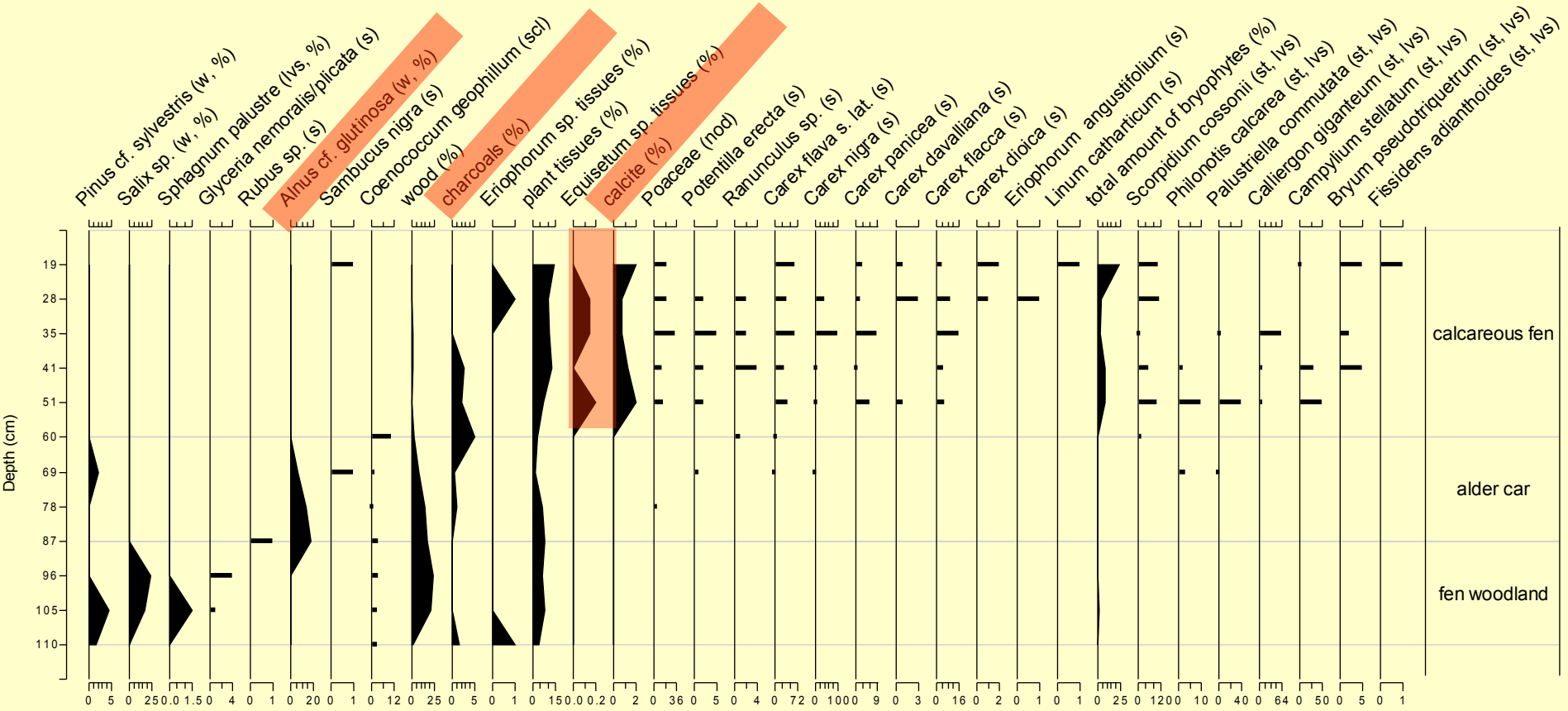
Belianske luky



Pollen and macro-fossil profile

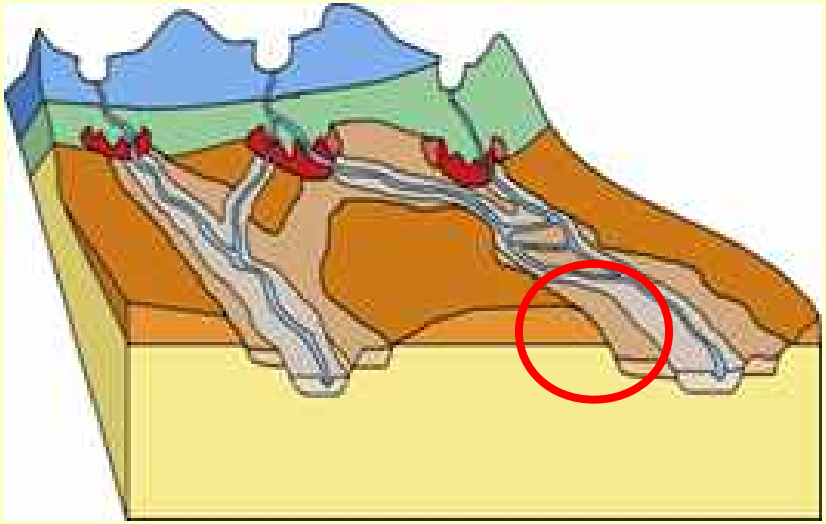
Makro-remains Transect 2

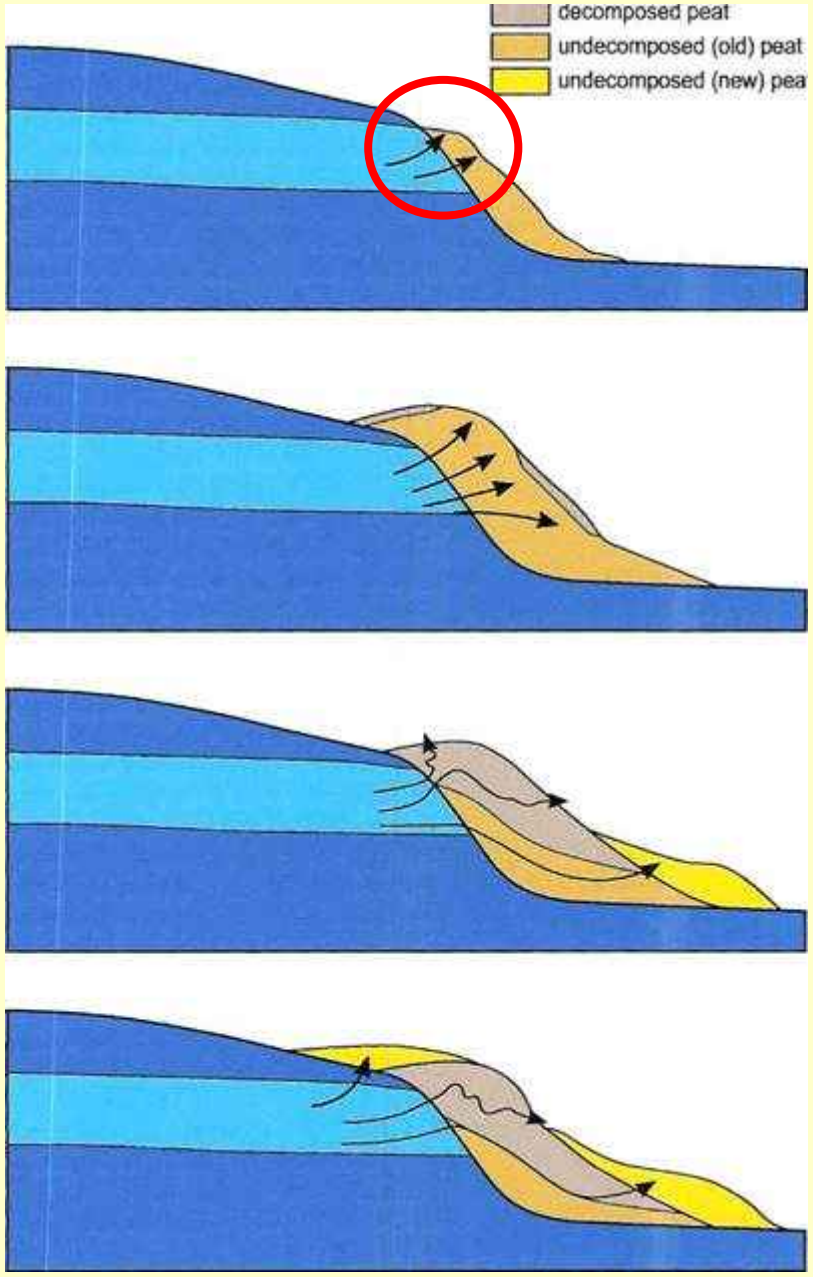
In this profile *Sphagnum fuscum* is absent



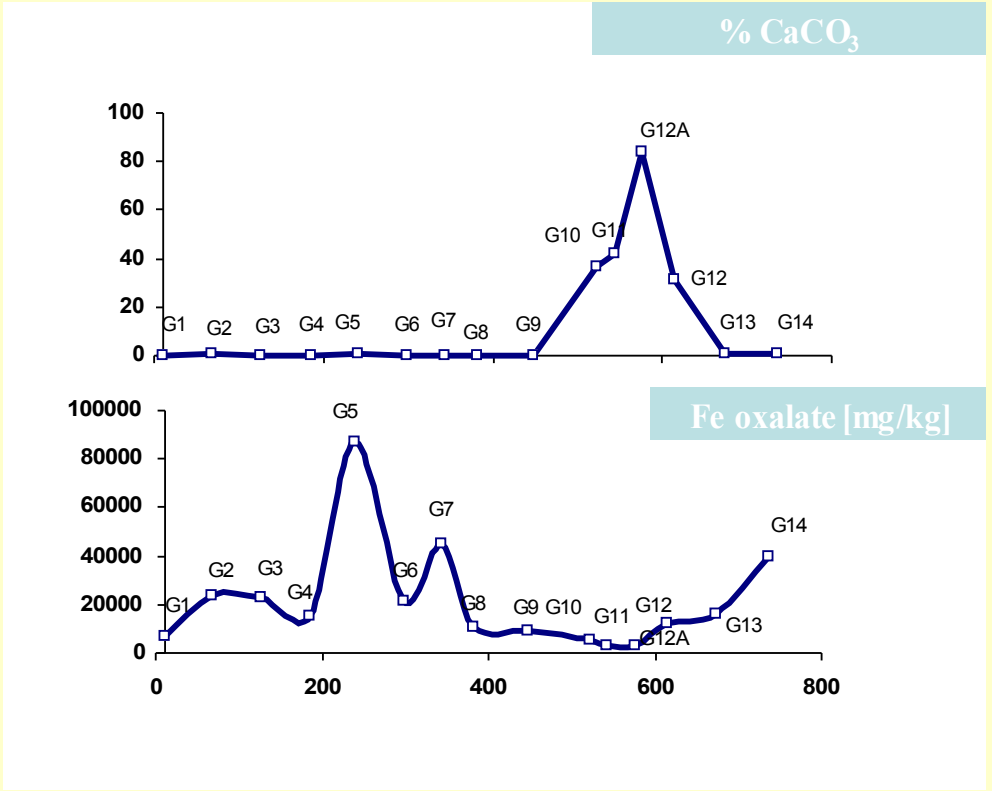
Macro fossils transect 2

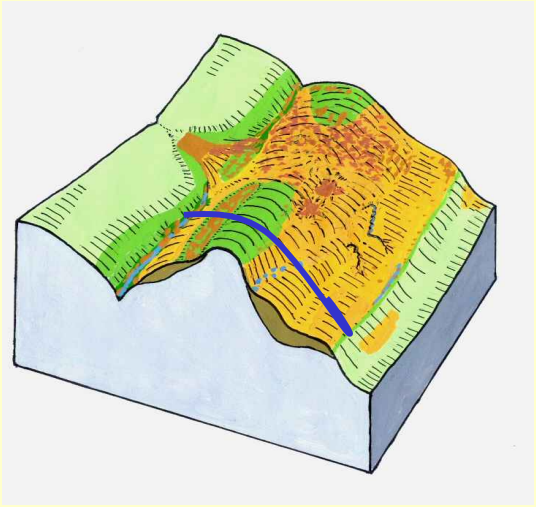
Geological history of Belianske luky



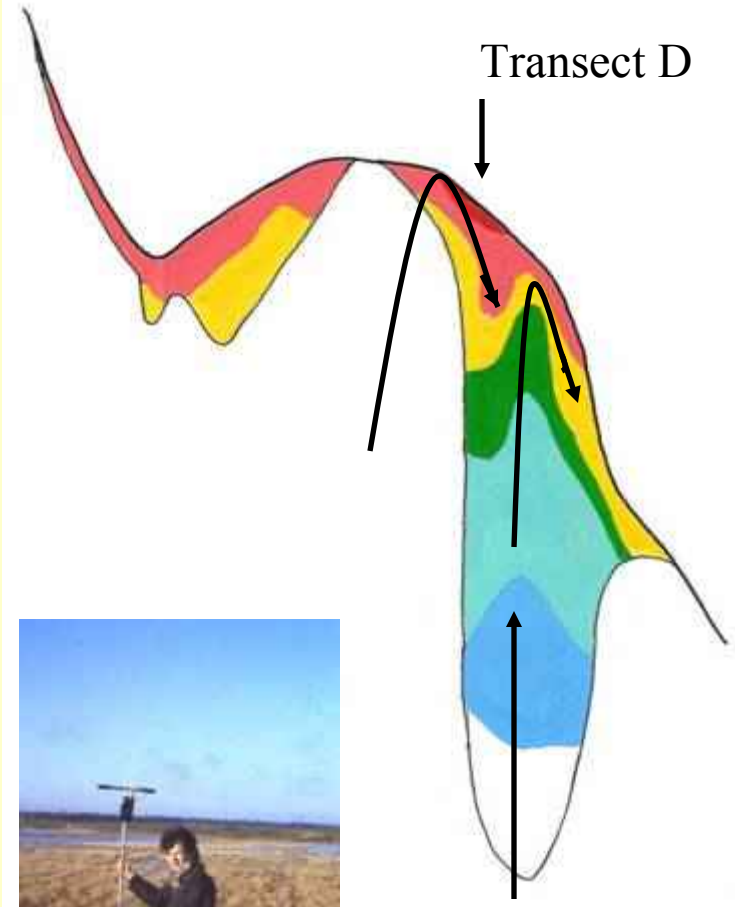


Hydrology

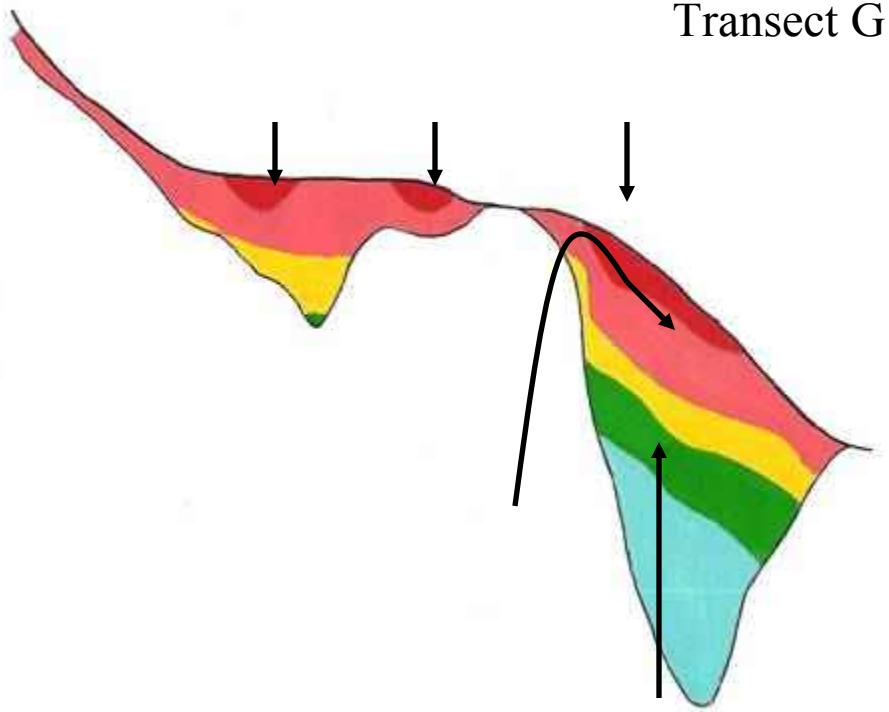

% $CaCO_3$
100
80
60
40
20
0
G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12A G12 G13 G14
Fe oxalate [mg/kg]
100000
80000
60000
40000
20000
0
0 200 400 600 800
G1 G2 G3 G4 G5 G6 G7 G8 G9 G10 G11 G12A G12 G13 G14



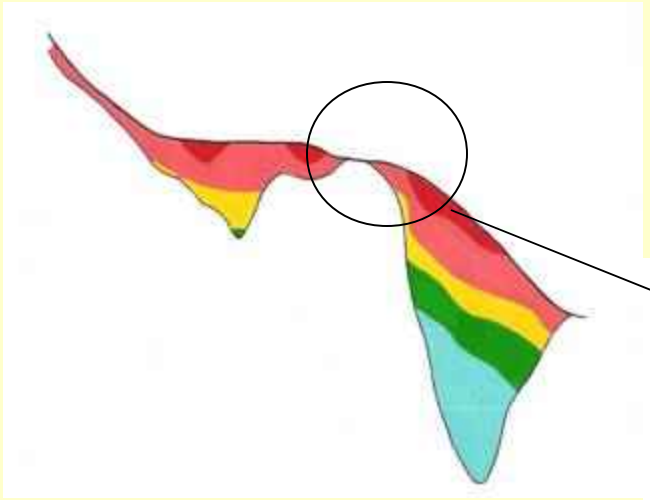
Hydrology

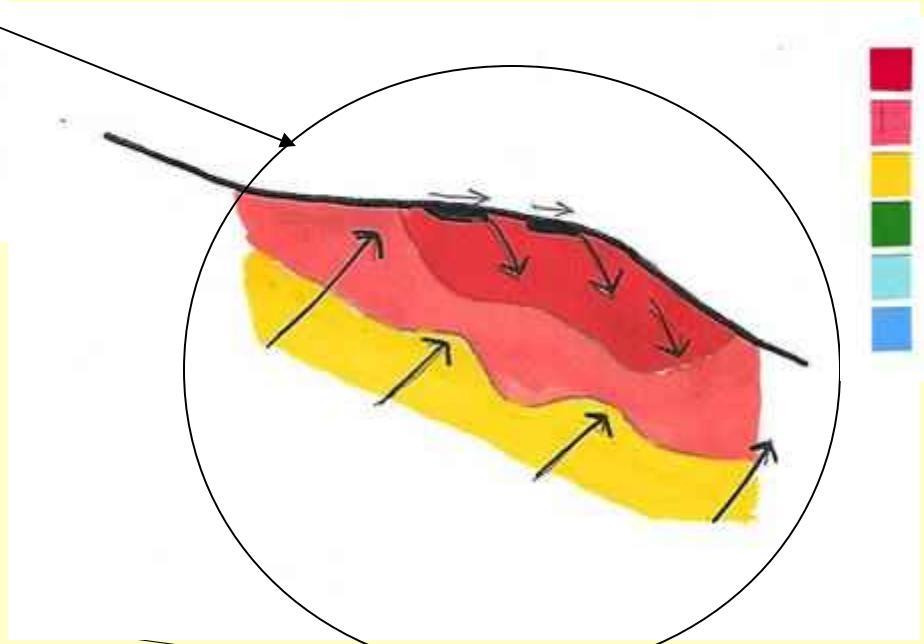


- Upwelling of cold groundwater
- Infiltration at the top



Belianske luke Pool system:
Temperature profile in transect G



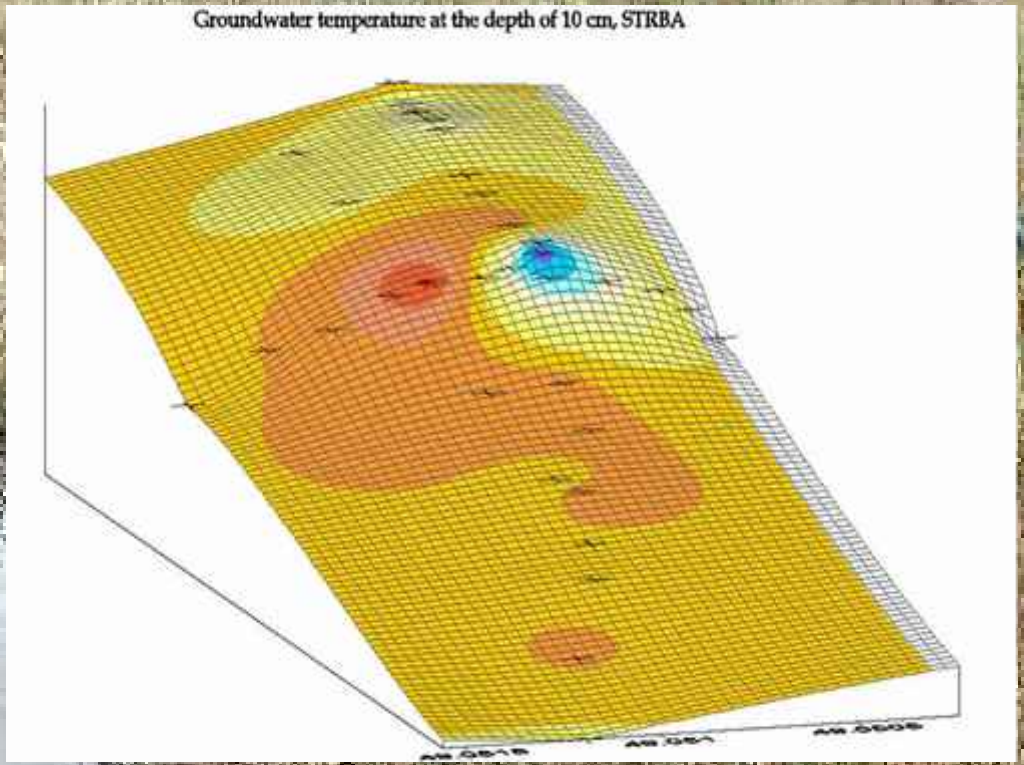


>14°C
12 - 14
10-12
8 - 10
6 - 8
< 6

11.9 11.8
13.2 13.4
11.2 12.0 13.8
13.3 13.4 13.2
9.6 10.8 13.5
11.0 12.8 13.5
8.4 9.1 12.8
9.6 11.7 11.7
8.0 8.4 11.1
8.2 10.4 10.8
9.8
9.2
8.7

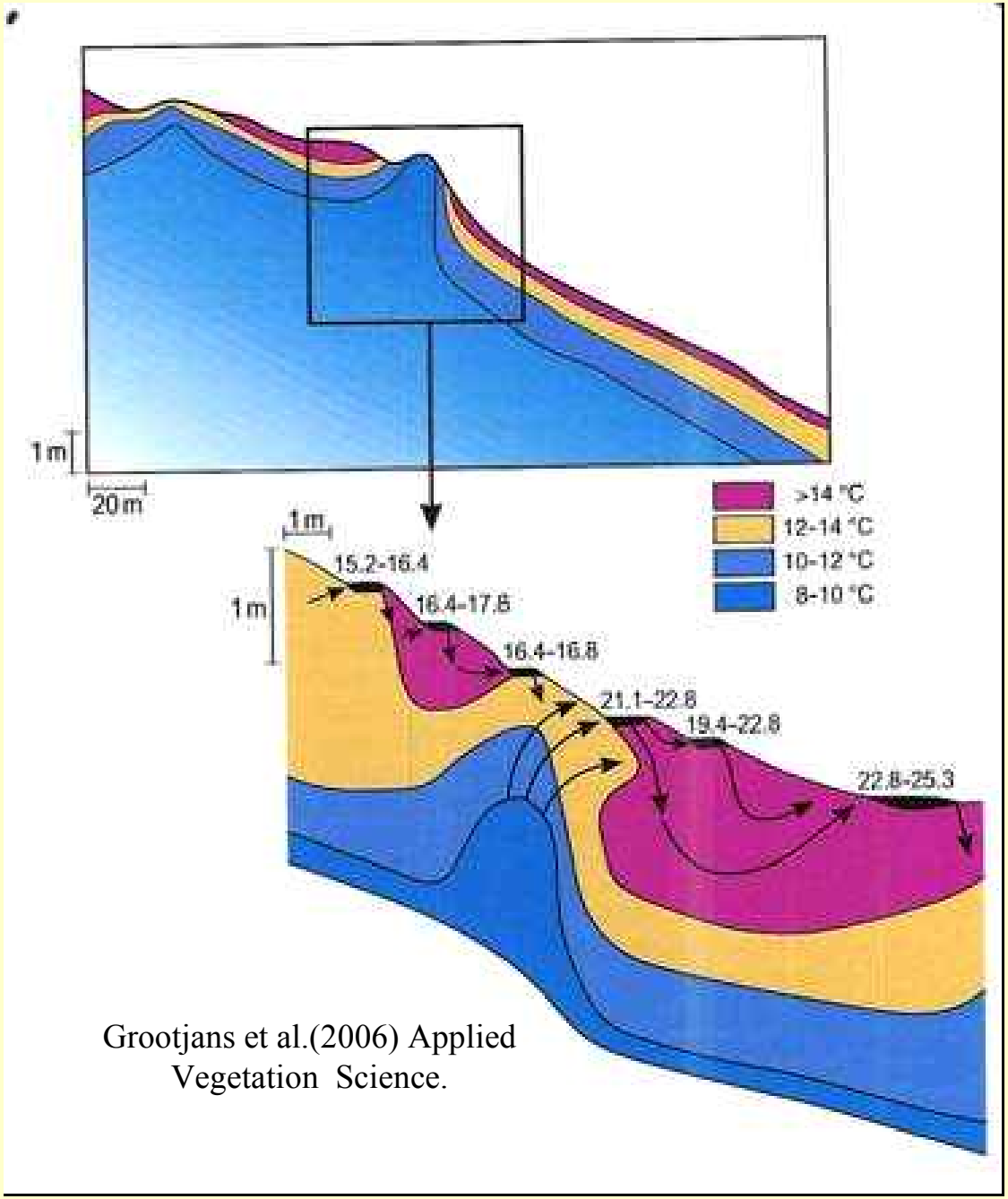
Štrba

- Temperature measurements at 10 cm below surface show that cold water emerges, which is warmed up in an area with many small water pools



Štrba

Inlet and outlet temperature

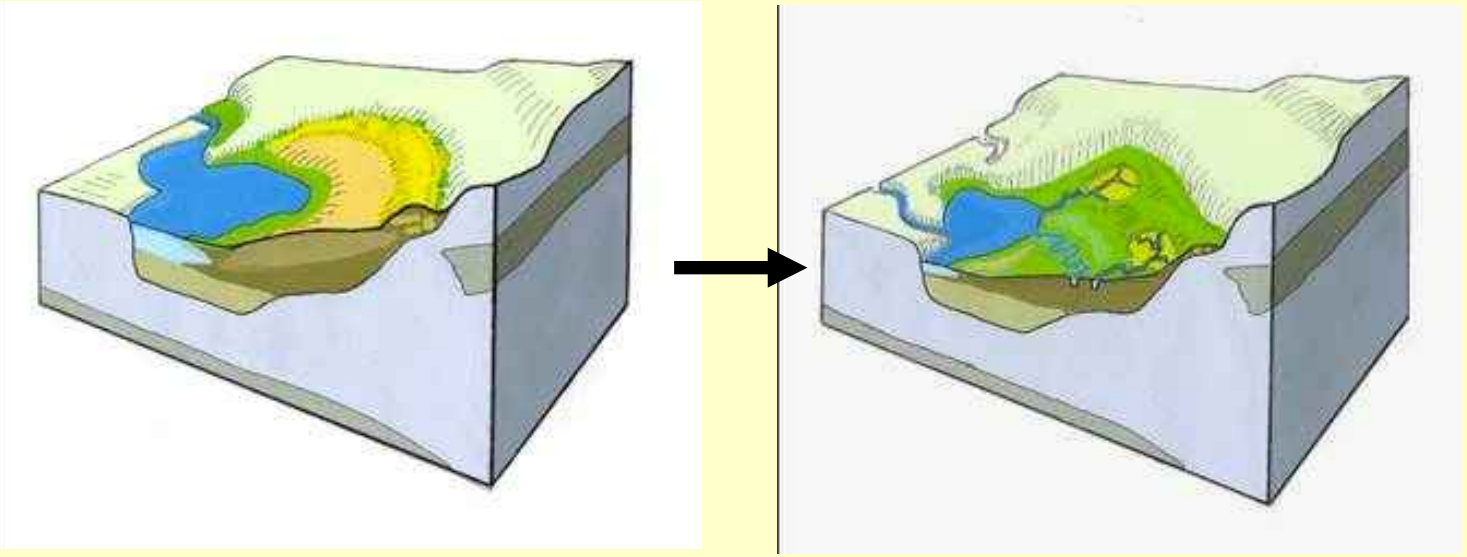


Grootjans et al.(2006) Applied Vegetation Science.


Also in winter the pools are warmer

Poland

Dehydration of peat lands



- Lowering of groundwater level
- Increased flow resistance
  - Increased peat erosion
  - Increased stream velocity

Wolejko et al (1992).

Van Andel & Arondson (eds) (2006)

Poland

What if?

Recz
Poland

Building the pool system

- **Pool Experiment**

In an eroded spring mire we cut the alder trees

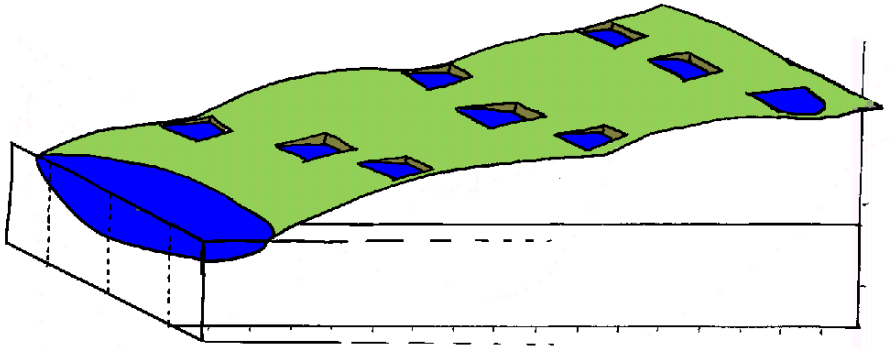
and

reduced the flow velocity


Recz
Poland

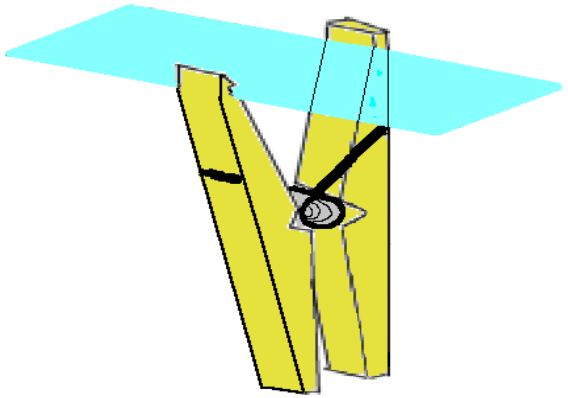
Pool experiment

- Cascade system
- 3 transect



- Deposition of chalk measured with microscope slides

(Lu et. al. 2000)



Recz
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Temperature profiles

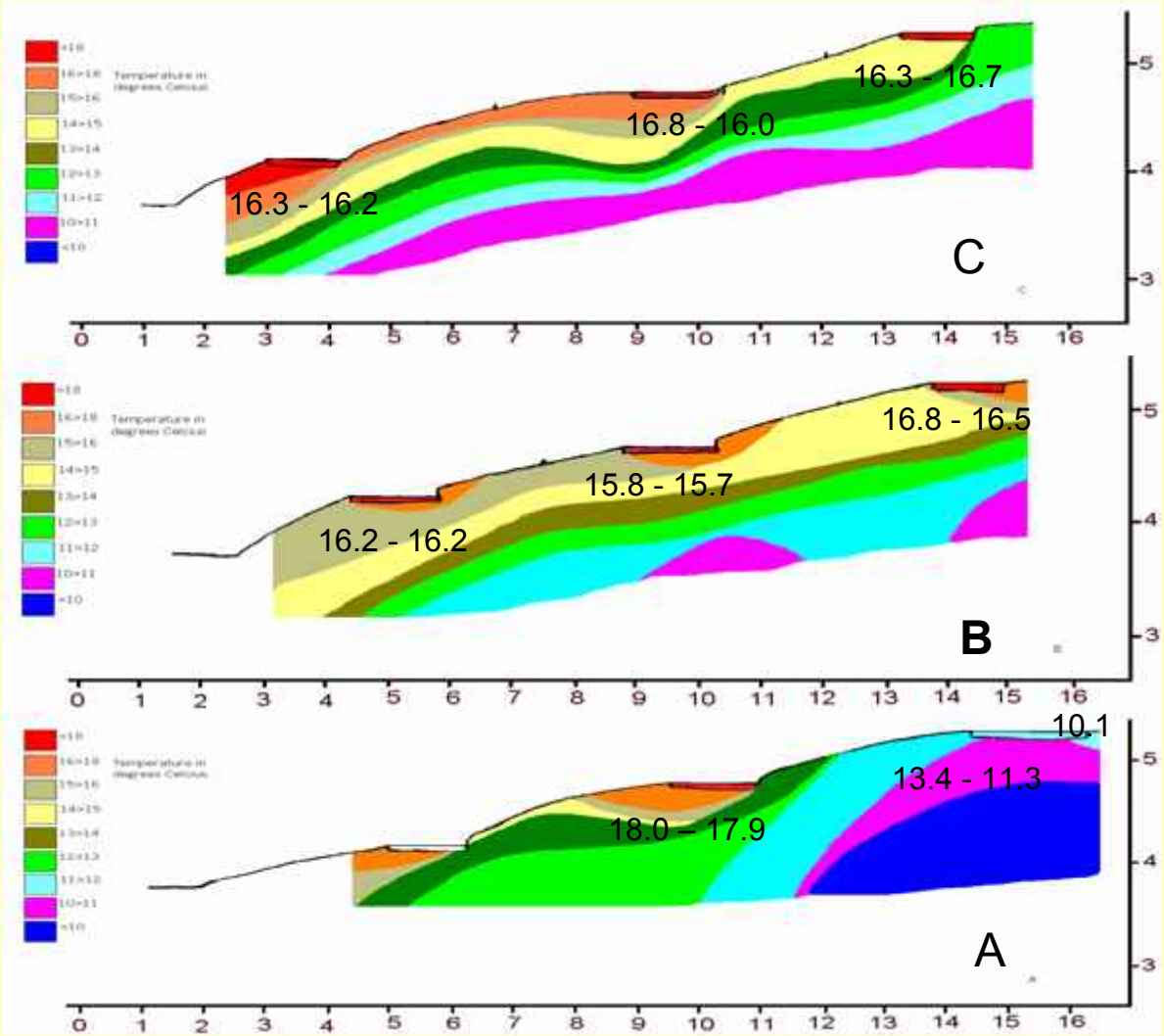
- **Pool**

  Experiment

Cold groundwater

only reaches

some pools



Slotow
Poland

Słotow; rewetted meadow

Results

CALCIUM DEPOSITION	**Recz**	
µg Ca per cm2	A	B
1	**1,9**	1,5
2	1,0	1,5
3	1,2	1,4
	Złotow	
	A	B
1	**4,9**	**5,7**
2	**3,4**	**11,1**
3	2,0	2,1
	Mazirbe	
1	**77,1**	
2	17,5	
	Sliteres	

CALCIUM CONTENT	**Recz**	
µMol/l		
Ground water	1577[a]	
Surface water	A	B
1	1478	1501
2	1492	1515
3	1512	1515
	Złotow	
Ground water	**2330**	
Surface water	**A**	**B**
1	**3146**	**3113**
2	**2542**	**2244**
3	**2001**	**2259**

Recz
Poland

Saturation index

- **Pool Experiments**

SATURATION INDEX	Recz	
	A	B
1	0.113648	-0.19074
2	-0.62007	-0.05832
3	0.147174	-0.22652
	Złotow	
	A	B
1	0.491424	0.495234
2	0.54976	0.10354
3	0.320094	0.338668

Conclusions

- No adequate fen meadow restoration without a proper assessment of hydrological functioning.
- Slow groundwater flow in fen systems is essential.
- References from the past are important in fen/ fen meadow restoration
- But you cannot repeat history.