Permafrost Organic Matter Study in the Lower Kolyma Lowland (Eastern Siberia) Based on Drilling Record

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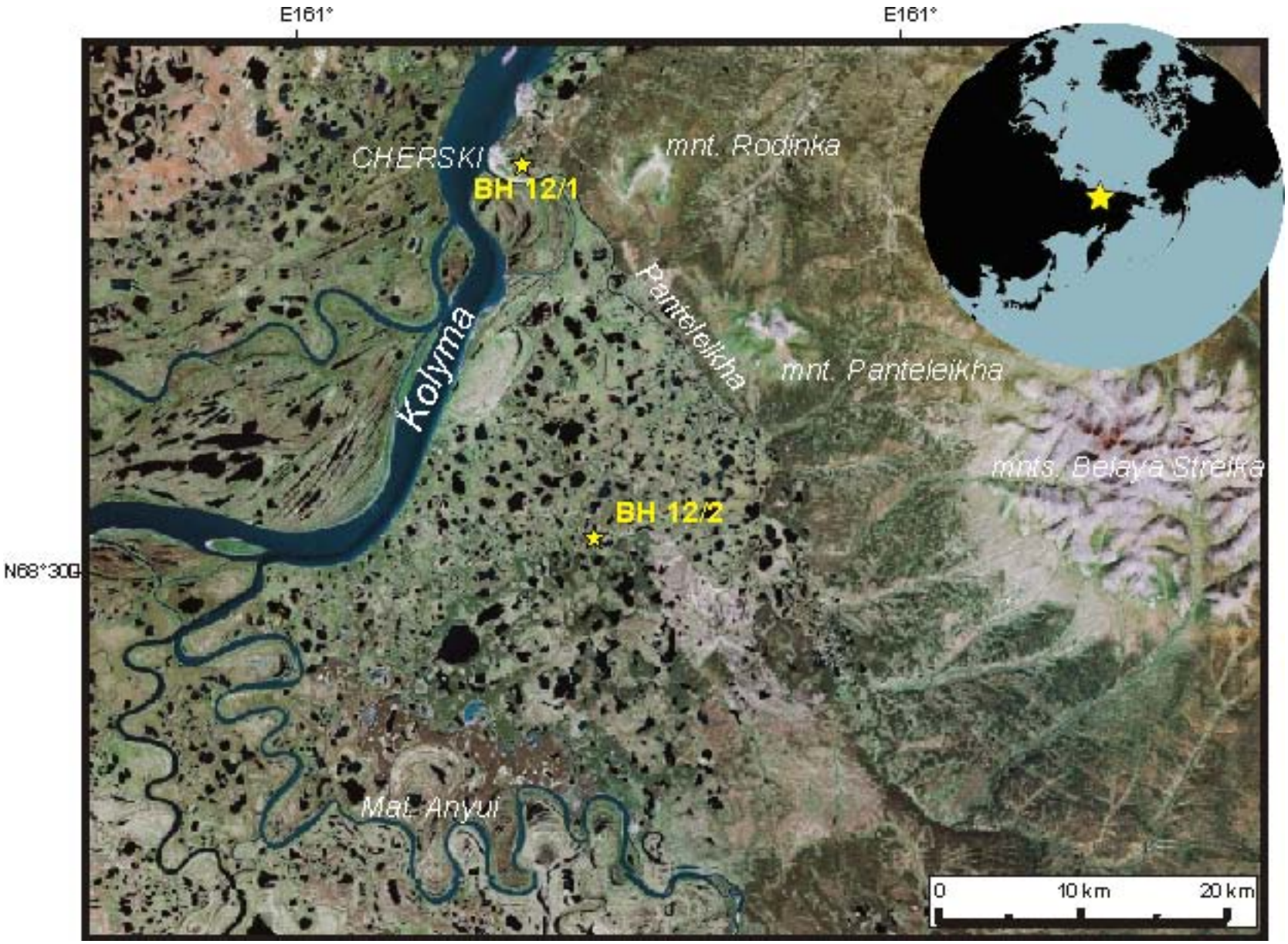
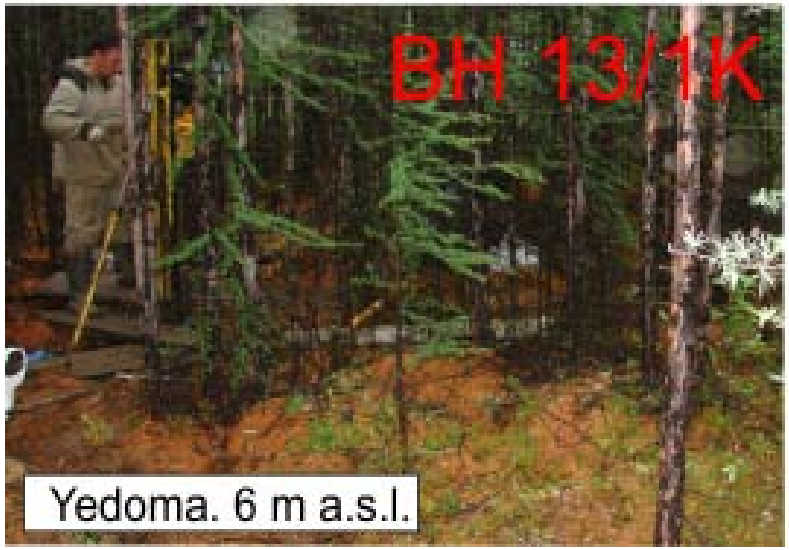
Kolyma-Panteleikha Rivers floodplain. View from mnt. Rodinka

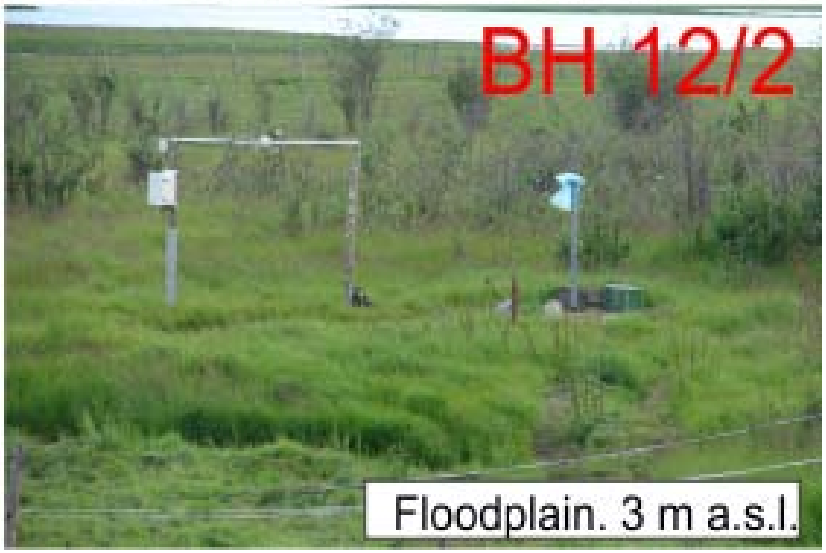
Locations of the Boreholes drilled in 2012



Borehole 12/1 location

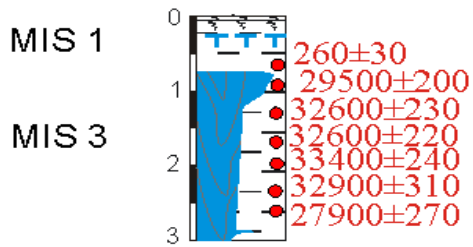
Borehole 12/2 location

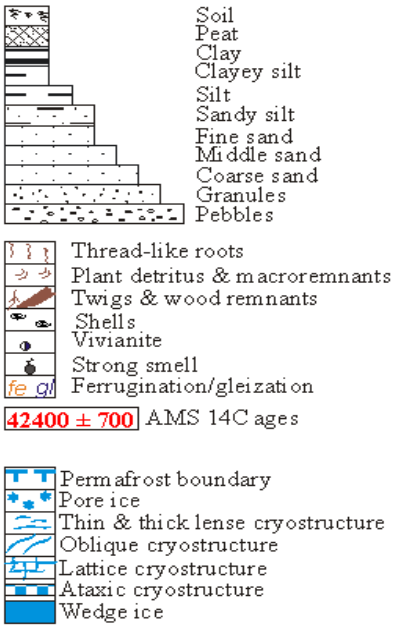




Yedoma 40 m a.s.l.

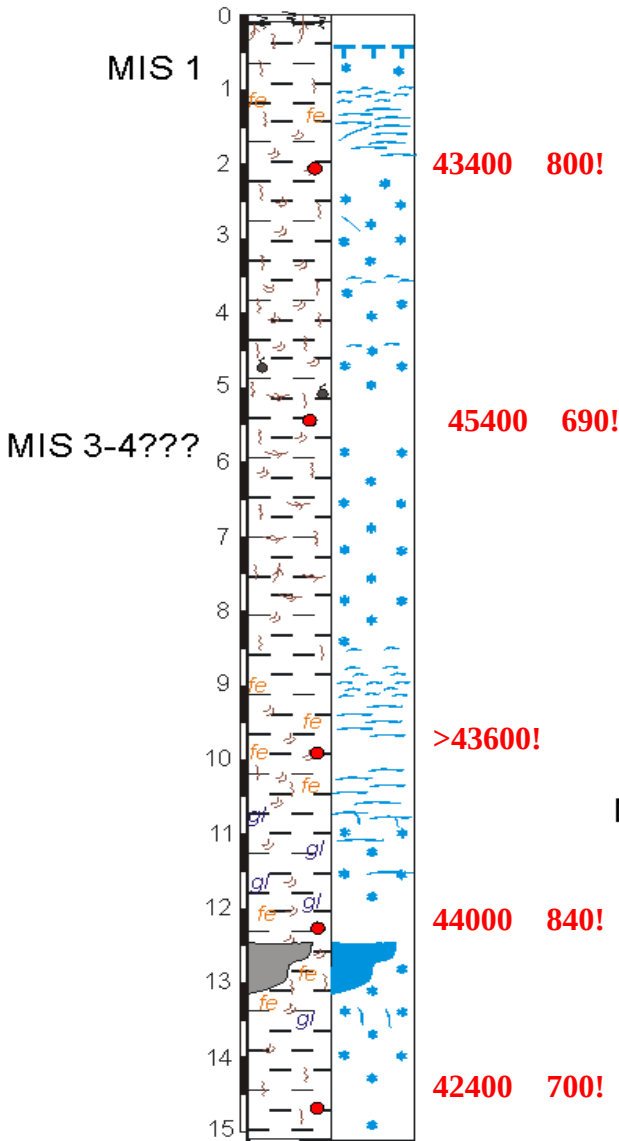
Section 08/1
Duvanny Yar





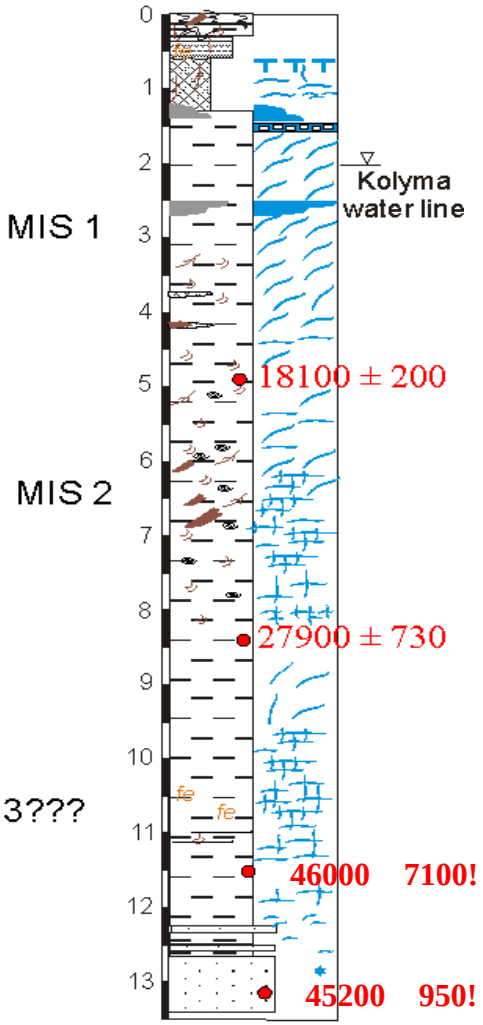
Yedoma 60 m a.s.l.

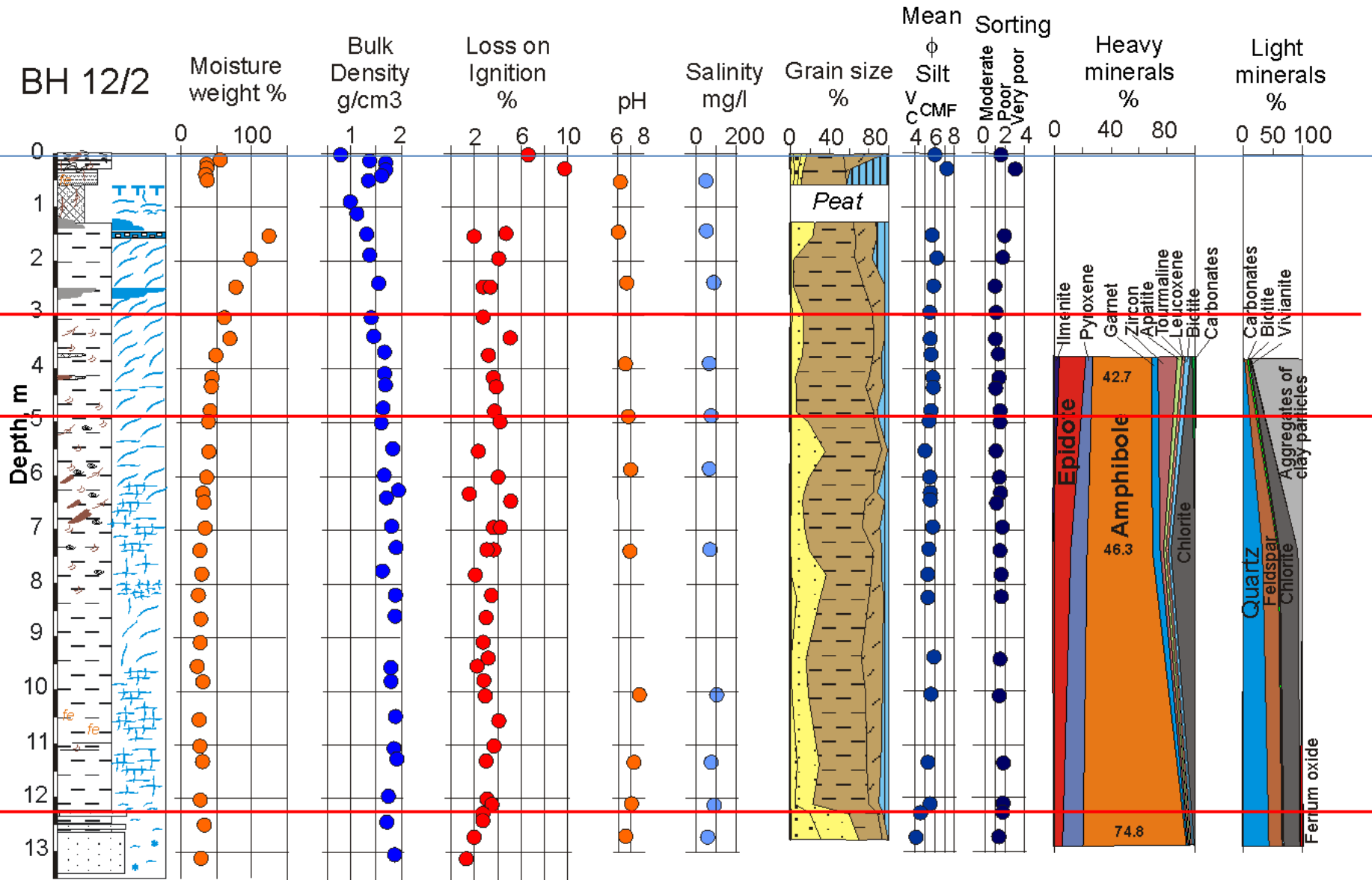
BH 12/1
Schuch'e lake

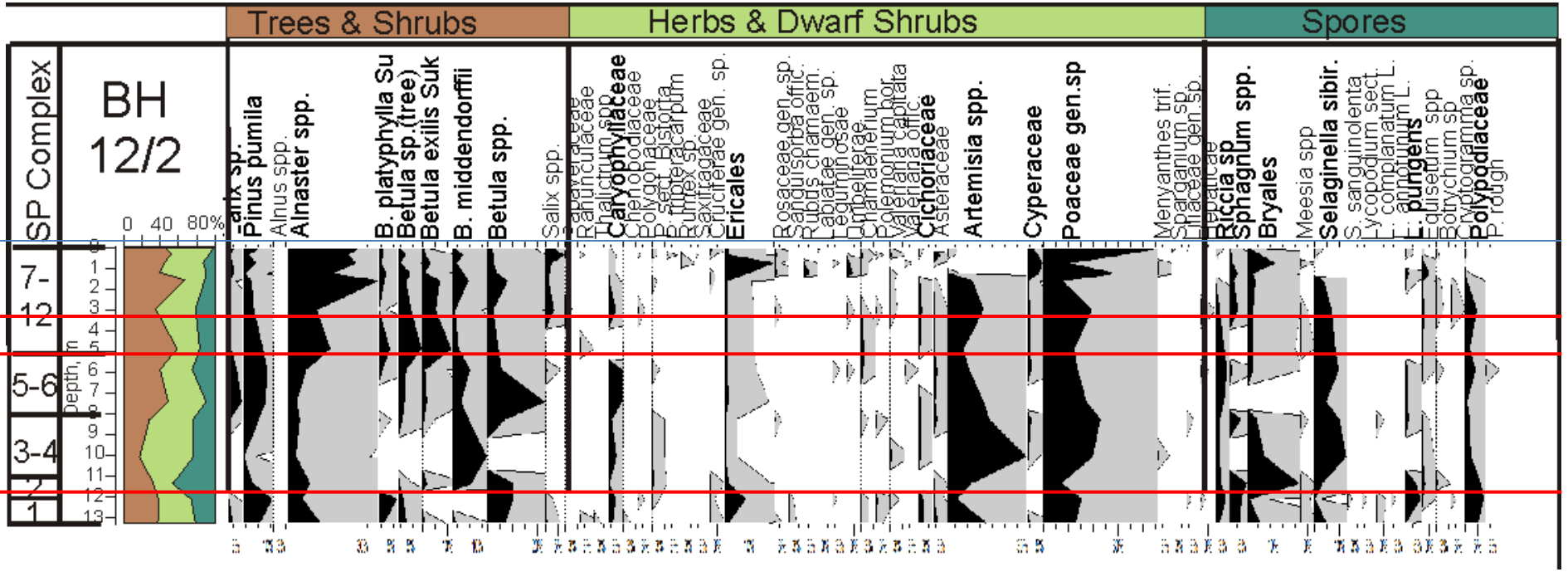


Floodplain 3 m a.s.l.

BH 12/2
Pleistocene Park




BH 12/2
Depth, m
Moisture weight %
Bulk Density g/cm3
Loss on Ignition %
pH
Salinity mg/l
Grain size %
Peat
Mean ϕ Silt
V
C
CMF
Sorting
Moderate
Poor
Very poor
Heavy minerals %
Ilmenite
Pyroxene
Garnet
Zircon
Apatite
Tourmaline
Leucoxene
Biotite
Carbonates
Epidote
42.7
Amphibole
46.3
Chlorite
74.8
Light minerals %
Carbonates
Biotite
Vivianite
Aggregates of clay particles
Quartz
Feldspar
Chlorite
Ferrum oxide


Trees & Shrubs
Herbs & Dwarf Shrubs
Spores
BH 12/2
SP Complex
0 40 80%
depth, m
Pinus pumila
Alnus spp.
Alnaster spp.
B. platyphylla Su
Betula sp.(tree)
Betula exilis Suk
B. middendorffii
Betula spp.
Salix spp.
Caryophyllaceae
Ericales
Cichoriaceae
Artemisia spp.
Cyperaceae
Poaceae gen.sp
Sphagnum spp.
Bryales
Selaginella sibir.
E. pungens
Polypodiaceae
7-12
5-6
3-4

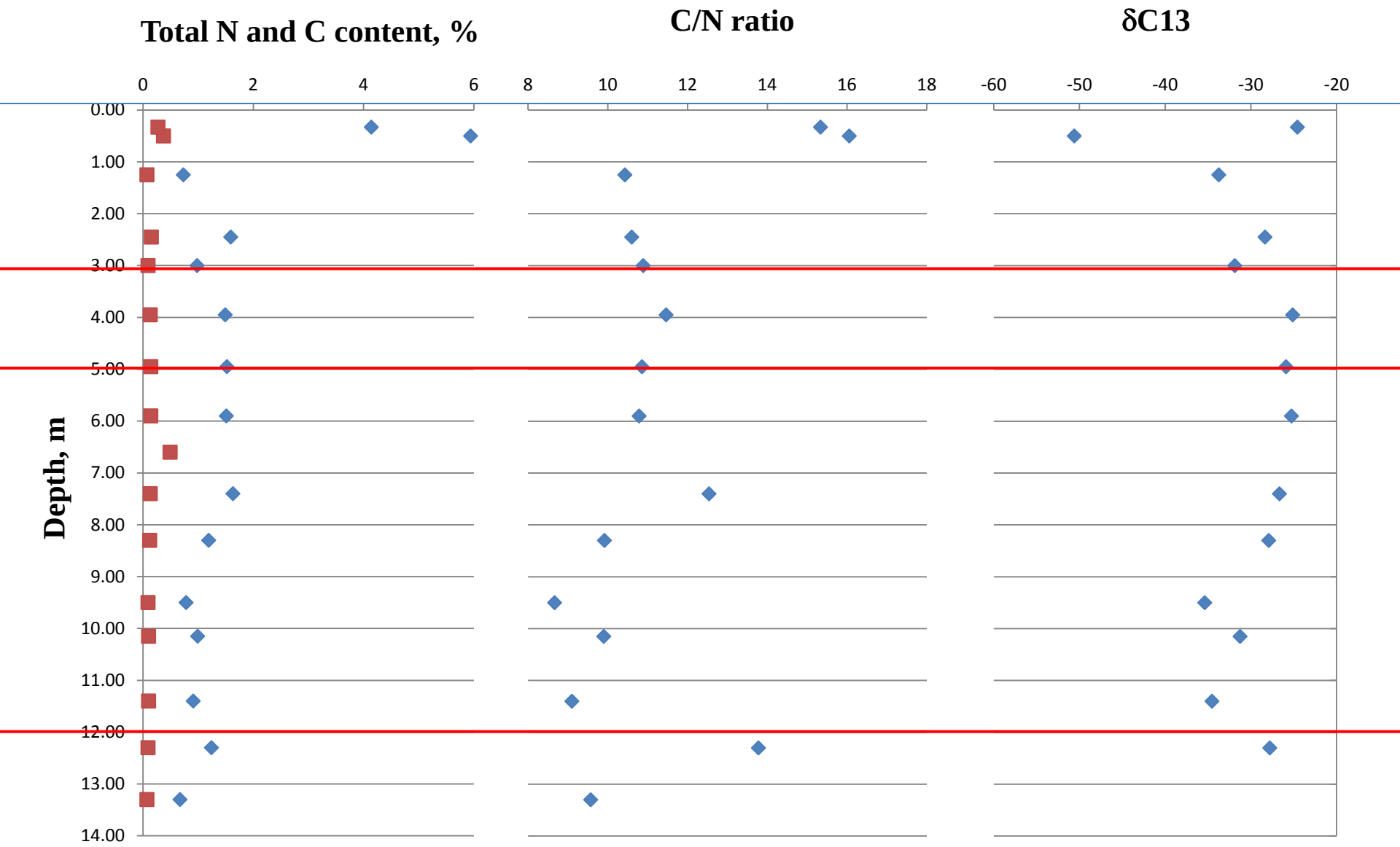
Unit 1 (12-13 m interval) was accumulated under stream channel conditions with active hydrological regime (strong current)

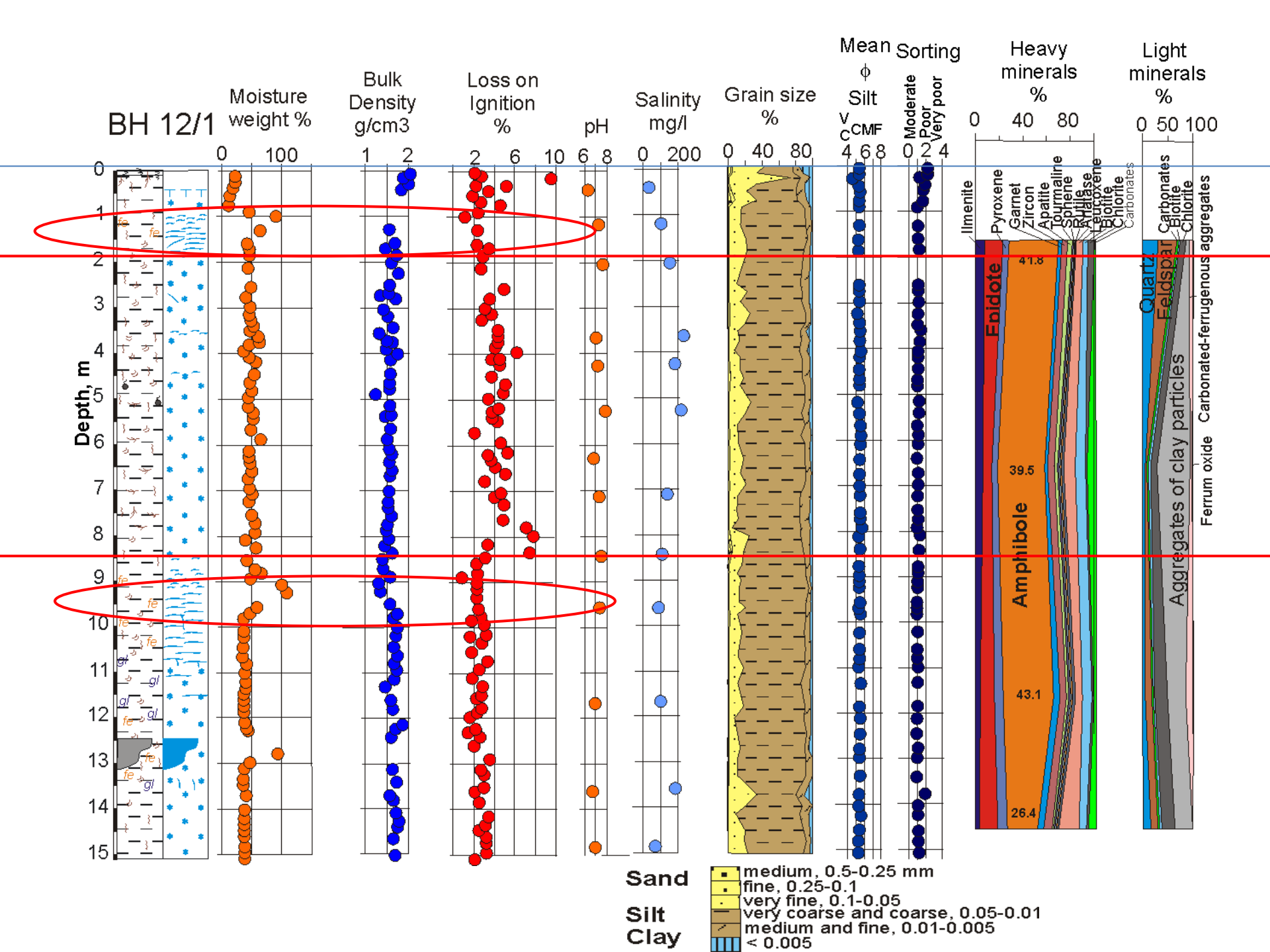
Unit 2 (5 to 12 m interval) corresponds to the next stage of stream valley development of channel fluctuations. And changes of strong current to old channel lakes hydrological regime.

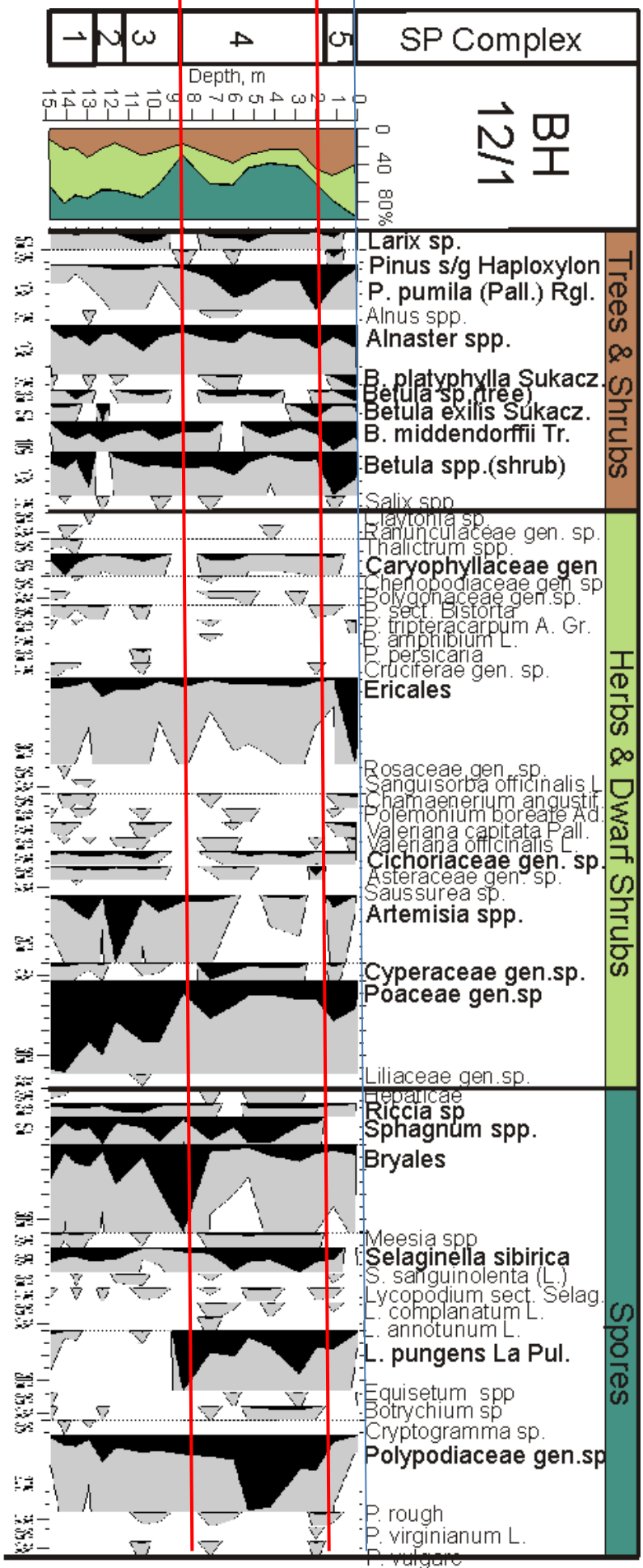
Unit 3 (5 to 3 m interval) was formed under the old channel lake conditions

Unit 4 (0 to 3 m) corresponds to transition from subaqual to subaeral conditions of modern floodplain with polygonal surface and modern ice wedges.

Borehole 12/2. Variations of main organic matter features vs depth




BH 12/1
Moisture weight %
Bulk Density g/cm3
Loss on Ignition %
pH
Salinity mg/l
Grain size %
Mean ϕ
Silt
Sorting
Moderate
Poor
Very poor
Heavy minerals %
Light minerals %
Depth, m
Ilmenite
Pyroxene
Garnet
Zircon
Apatite
Tourmaline
Sphene
Rutile
Andalase
Leucoxene
Biotite
Chlorite
Carbonates
Epidote
Amphibole
41.8
39.5
43.1
26.4
Quartz
Feldspar
Aggregates of clay particles
Ferrum oxide
Carbonated-ferrugenous aggregates
Sand
Silt
Clay
medium, 0.5-0.25 mm
fine, 0.25-0.1
very fine, 0.1-0.05
very coarse and coarse, 0.05-0.01
medium and fine, 0.01-0.005
< 0.005

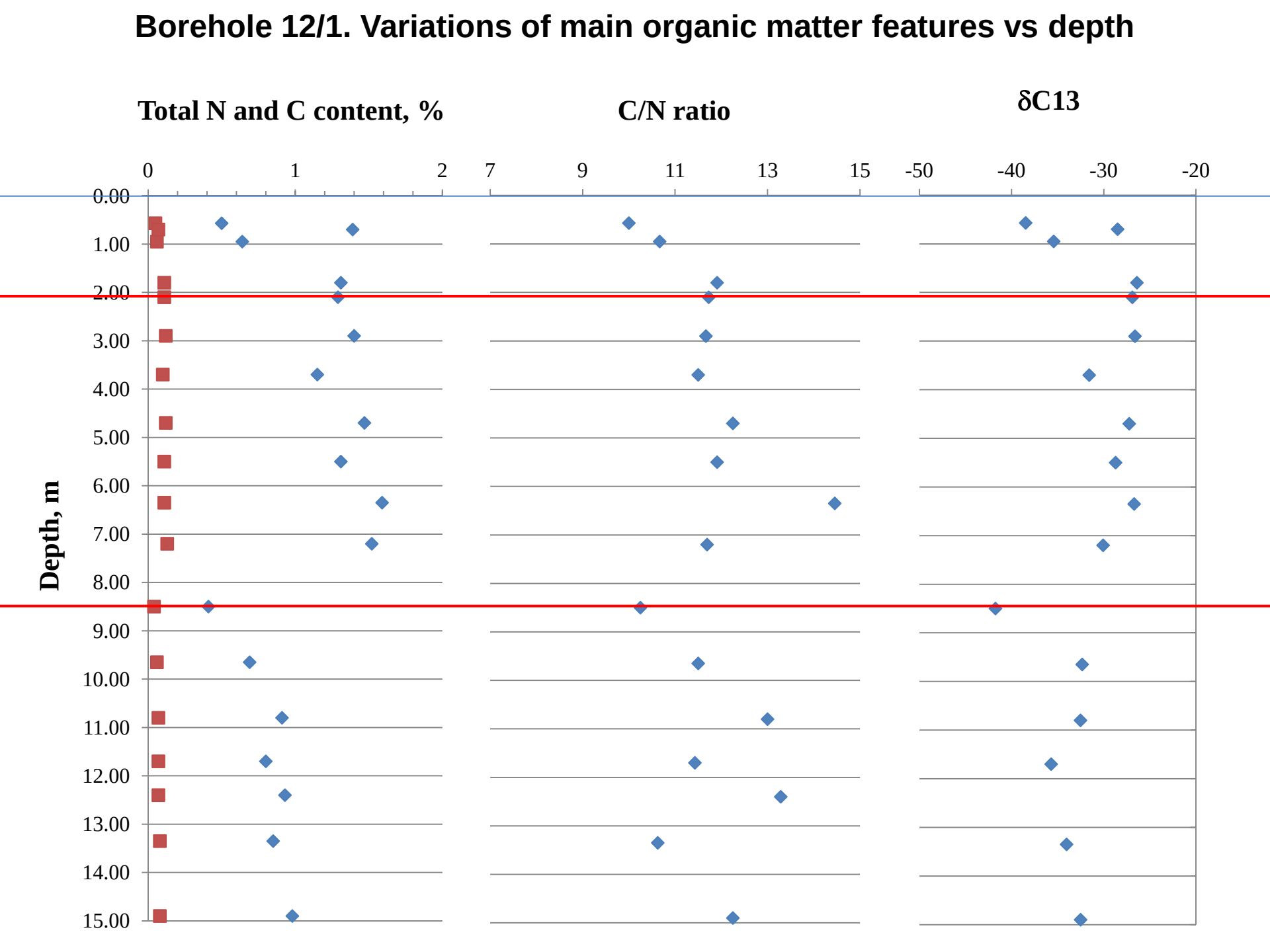

1
2
3
4
5
SP Complex
BH 12/1
Depth, m
0 40 80%
Trees & Shrubs
Larix sp.
Pinus s/g Haploxylon
P. pumila (Pall.) Rgl.
Alnus spp.
Alnaster spp.
B. platyphylla Sukacz.
Betula sp.(tree)
Betula exilis Sukacz.
B. middendorffii Tr.
Betula spp.(shrub)
Salix spp.
Herbs & Dwarf Shrubs
Claytonia sp.
Ranunculaceae gen. sp.
Thalictrum spp.
Caryophyllaceae gen
Chenopodiaceae gen. sp.
Polygonaceae gen.sp.
P. sect. Bistorta
P. tripteracarpum A. Gr.
P. amphibium L.
P. persicaria
Cruciferae gen. sp.
Ericales
Rosaceae gen. sp.
Sanguisorba officinalis L.
Chamaenerium angustif.
Polemonium boreale Ad.
Valeriana capitata Pall.
Valeriana officinalis L.
Cichoriaceae gen. sp.
Asteraceae gen. sp.
Saussurea sp.
Artemisia spp.
Cyperaceae gen.sp.
Poaceae gen.sp
Liliaceae gen.sp.
Spores
Hepaticae
Riccia sp
Sphagnum spp.
Bryales
Meesia spp
Selaginella sibirica
S. sanguinolenta (L.)
Lycopodium sect. Selag.
L. complanatum L.
L. annotunum L.
L. pungens La Pul.
Equisetum spp
Botrychium sp
Cryptogramma sp.
Polypodiaceae gen.sp
P. rough
P. virginianum L.
P. vulgare

Unit 1 (9 to 15 m interval) was formed under the conditions of dry grassy-shrub tundra-steep. At the end of this unit formation increasing of surface wetness and, probably, even local thermokarst process took place. The former indirectly confirmed by the ice rich horizon.

Unit 2 (9 to 2 m interval) has a fluvial origin and was formed within the stream valley or wetland environment close to conditions of Units 2 and 3 of borehole 12/2 formation.

Unit 3 (0 to 2 m interval) is a cover layer, which was thawed from the top during Holocene climatic optimum and, then refrozen due to climate cooling. Accumulation environment was close to recent.

Borehole 12/1. Variations of main organic matter features vs depth



ENZIME ACTIVITIE

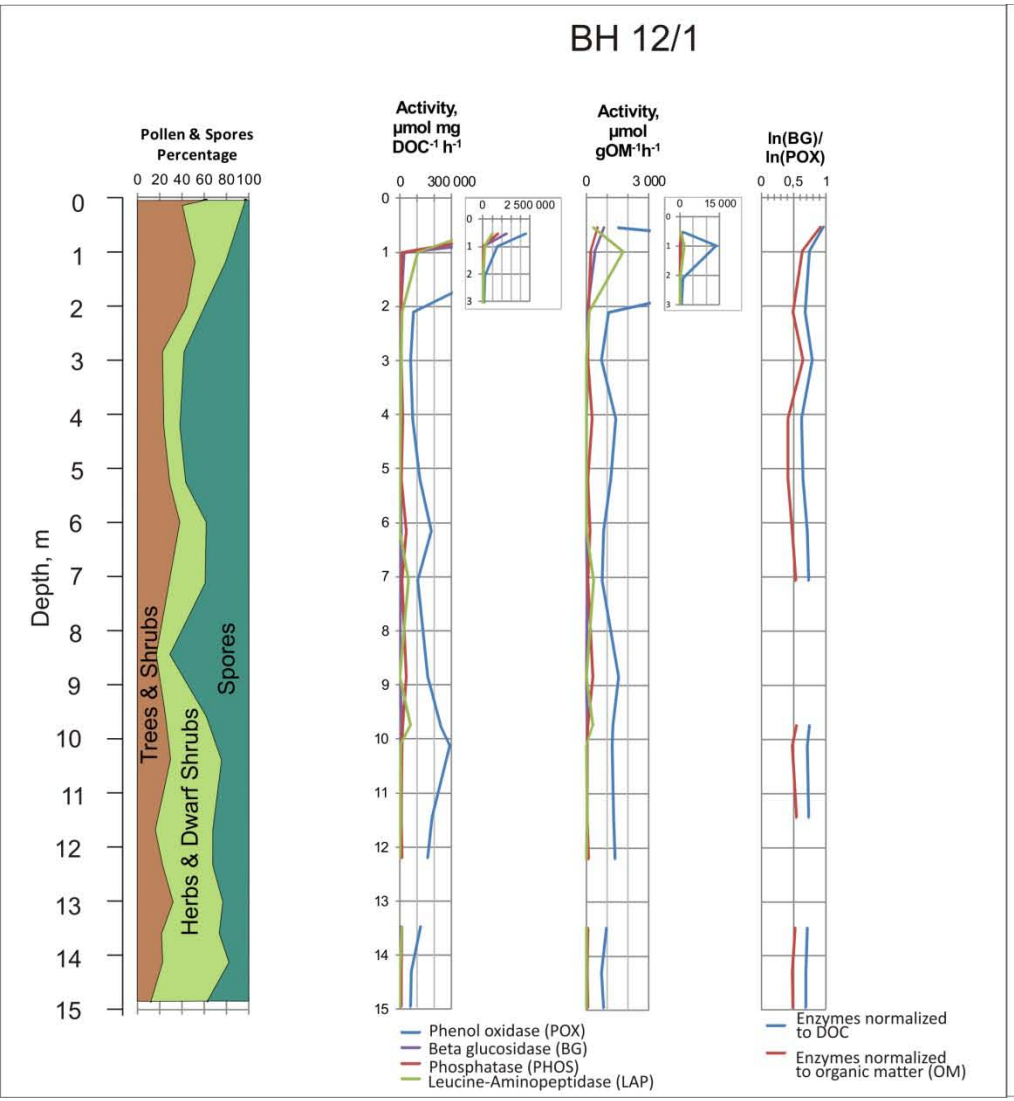
Phenoloxidase (POX) - lignin

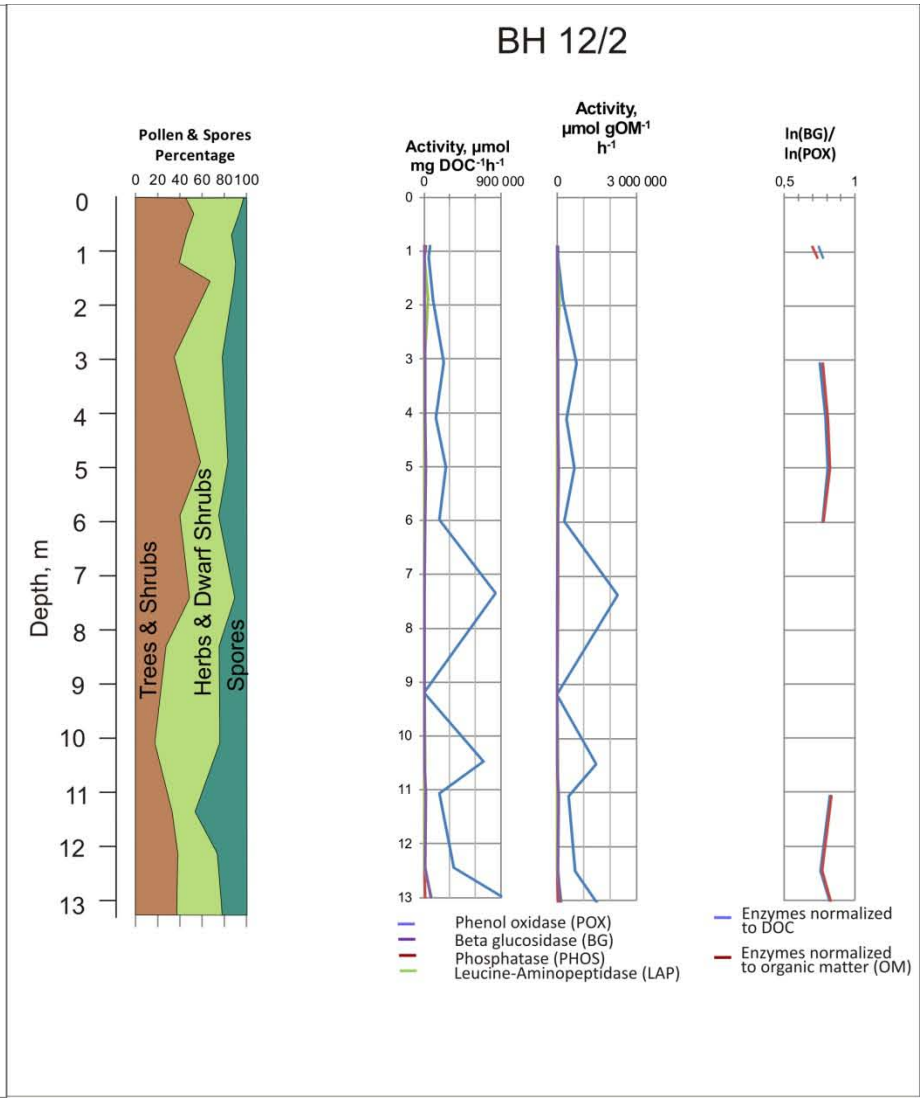
β-glucocidase (BG) – carbon

Phosphotase (PHOS) – phosphorous

Leucene-aminopeptidase (LAP) - nitrogene

ENZIME ACTIVITIE





CONCLUSIONS

1. Organic matter content in the investigated deposits resulted in lost on ignition is in a range from 1.75 to 9.5%.

2. Mean TOC of deposits have been formed in relatively “dry” conditions is 0.79%, while in wetland or aquatic deposits it is 1.25%.

3. Conditions of sediments formation strongly impact on both total organic content in this permafrost strata and its quality.

4. Subaqual environment of sedimentation under shallow lakes or wetlands has a higher potential for carbon accumulation because of both autochthonic and allochthonic OM deposition.

5. Mean C/N ratio and δC13 values are in deposits had been formed in relatively dry conditions are 11.76 and -34.8‰ while in aquatic or wetland sediments 11.27 and -29.21‰.

6. Positive correlation with coefficient 0.67 between δC13 and C/N ratio was determined.

7. Main portion of OM in permafrost represented by lignin.

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