

# EVIDENCE OF CLIMATE CHANGES IN LUBĀNS WETLAND DEPOSITS: EXAMPLE OF SŪĻAGOLS AND ASNE SITE

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## Introduction

The research area is located in the Austrumlatvija (East Latvia) Lowland (Fig. 1.), Lubāns Plain and Lubāns Wetland. The characteristics of Lake Lubāns are its complicated geological structure, hydrographic network and large areas covered by peatlands. Wetland area is also rich with Stone Age settlement sites. Palaeoclimate and palaeogeographic condition changes have influenced palaeovegetation composition and sediment accumulation processes during the development of Lake Lubāns.

Research about Sūļagols and Asne took place in overgrown and paludificated areas of ancient Lake Lubāns (Fig. 5., 7.). During the late glacial Lubāns palaeolake was at least three times larger in size as in nowadays. The aim of this research is to find out evidence of climate changes during the formation of Sūļagols Bog and Asne Fen (Fig. 3.) which characterize diverse development conditions.

## Data and methods

During the research different types of data and materials were collected and used, including sediment samples obtained during field works (Fig. 2.), author's prepared cartographic materials (Fig. 3., 5., 7.), performed laboratory analysis and visualised results in corresponding diagrams (Fig. 10., 11., 12., 13., 14., 15., 16., 18.). In addition to get samples for further investigations during field works geological coring and probing was carried out. All sediment monoliths (Fig. 8., 9.) were well obtained, documented and transported to the laboratory of Quaternary Environment at the University of Latvia. As a result of plant macroscopic remain analysis visualised macroscopic remain material was made (Fig. 17.).

A combination of different laboratory methods like loss on ignition and macroscopic remain analysis was used to get the best results. Loss on ignition analyses of the Quaternary lake sediments provides an opportunity to investigate changes in the past environment. Curve fluctuations in diagrams indicates water level fluctuations, sediment accumulation condition changes, lake shore overgrowing and paludification processes. Loss on ignition analyses was used for understanding of sediment composition, to estimate ratio of organic, mineral and carbonate matter. With these method two geological cores were analysed: Sūļagols – U1 and Asne – U1 with a total length of 6.0 m of sediment samples. Each sediment monolith was analysed with 1 cm accuracy, meaning 600 samples in total.

Macroscopic remain analysis reveal important information about changing local palaeovegetation and palaeoclimate. Results of this method also give evidence about early human impact on vegetation and the beginning of agriculture. Samples from two sediment cores were analysed: Sūļagols – U1 and Asne – U1. In total 44 sediment samples with 5 cm intervals were studied by macroscopic remain analyses.

## Results

According to the results of loss on ignition analyses, changes in percentage values of carbonates, mineral and organic matter are indicating sediment accumulation condition changes in the southern (Sūļagols) and western (Asne) part of Lake Lubāns. Depending on the changes in sediment composition four zones (I-IV) were subdivided for Sūļagols and also four for Asne. Both borehole results for this method show similar tendencies. In both boreholes zone I is represented by highest mineral matter content – fine sand and clay. Possibly these sediments accumulated during the late glacial. Zone II represents sharp increase of organic matter that shows the evidence of warm climate conditions and rapid development of vegetation. Zone III is dominated by peaty gyttja and peat where organic matter keeps increasing. That may have been influenced by fluctuations of lake water levels. While zone IV is dominated by peat that shows the evidence about intensive lake's overgrowing and paludification processes.

Based on macroscopic remain analysis results borehole Sūļagols – U1 and Asne – U1 in general also show similar tendencies. The smallest amount of macroscopic remain variety was found at the bottom of the core while the biggest – at the top. The lowest sediments in both sites contain similar remains of lake flora and fauna. Aquatic plant and animal remains were found: cattail *Typhaceae*, moss mite *Oribatida*, sponge *Porifera* and insect *Insecta*. Covering sediments are more rich in organic matter that represents rapid increase of aquatic plant and animal variety. It is represented by *Typhaceae*, water lily *Nymphaeaceae*, sedge *Carex*, sorrel *Rumex*, water flea *Cladocera*, ostracod *Ostracoda* and *Porifera*.

The middle part of sediment section is characterised by the biggest variety of macroscopic remains. Mostly this interval is dominated by aquatic plant and animal remains but also dryland plant seeds were found. In both sections *Typhaceae*, rush *Juncus*, arrowhead *Sagittaria*, water-plantain *Alisma*, buzzer midge *Chironomus*, fungus *Fungi*, *Porifera*, *Cladocera* and charcoal was found. Also many water chestnut *Trapa natans* remains were found in Asne – U1 borehole sediments. Upper part of a section is represented by typical bog and fen macroscopic remains, like moss *Sphagnum*, fungus, wood, leaf and charcoal remains.

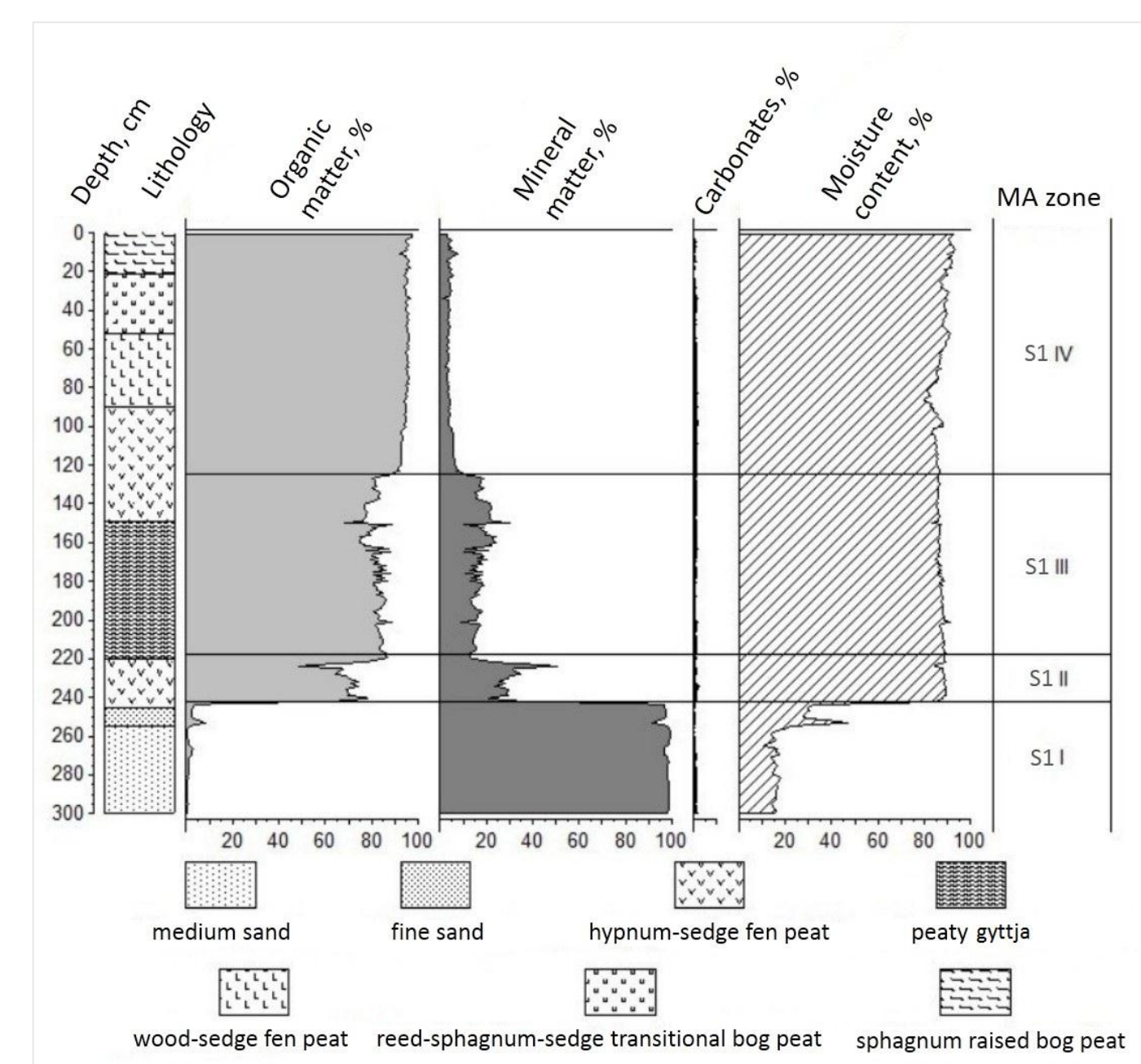


Fig. 4. Loss on ignition results for Sūļagols – U1 core

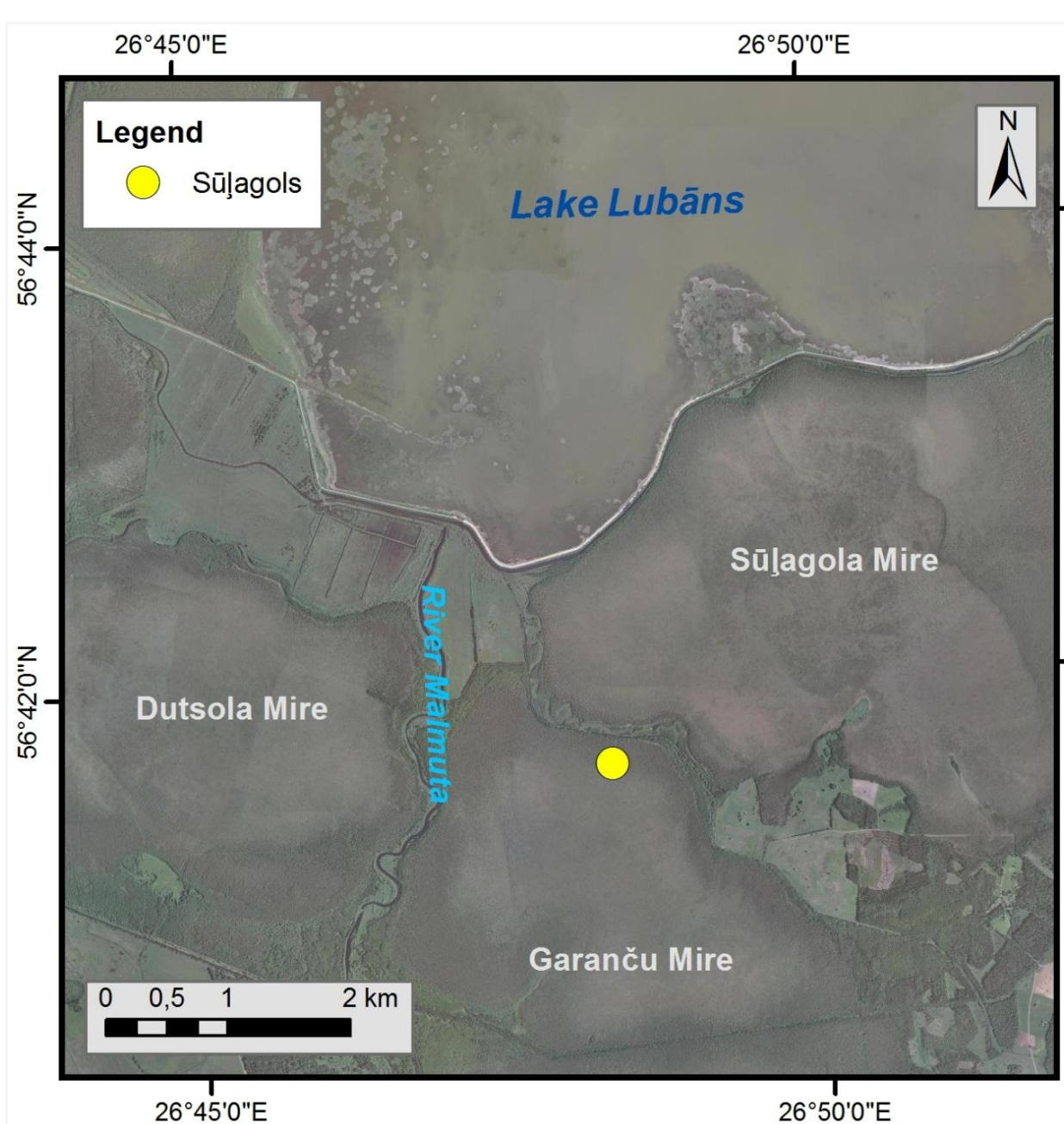


Fig. 5. Sūļagols – U1 sediment sampling point in the Northern part of Garanču Mire

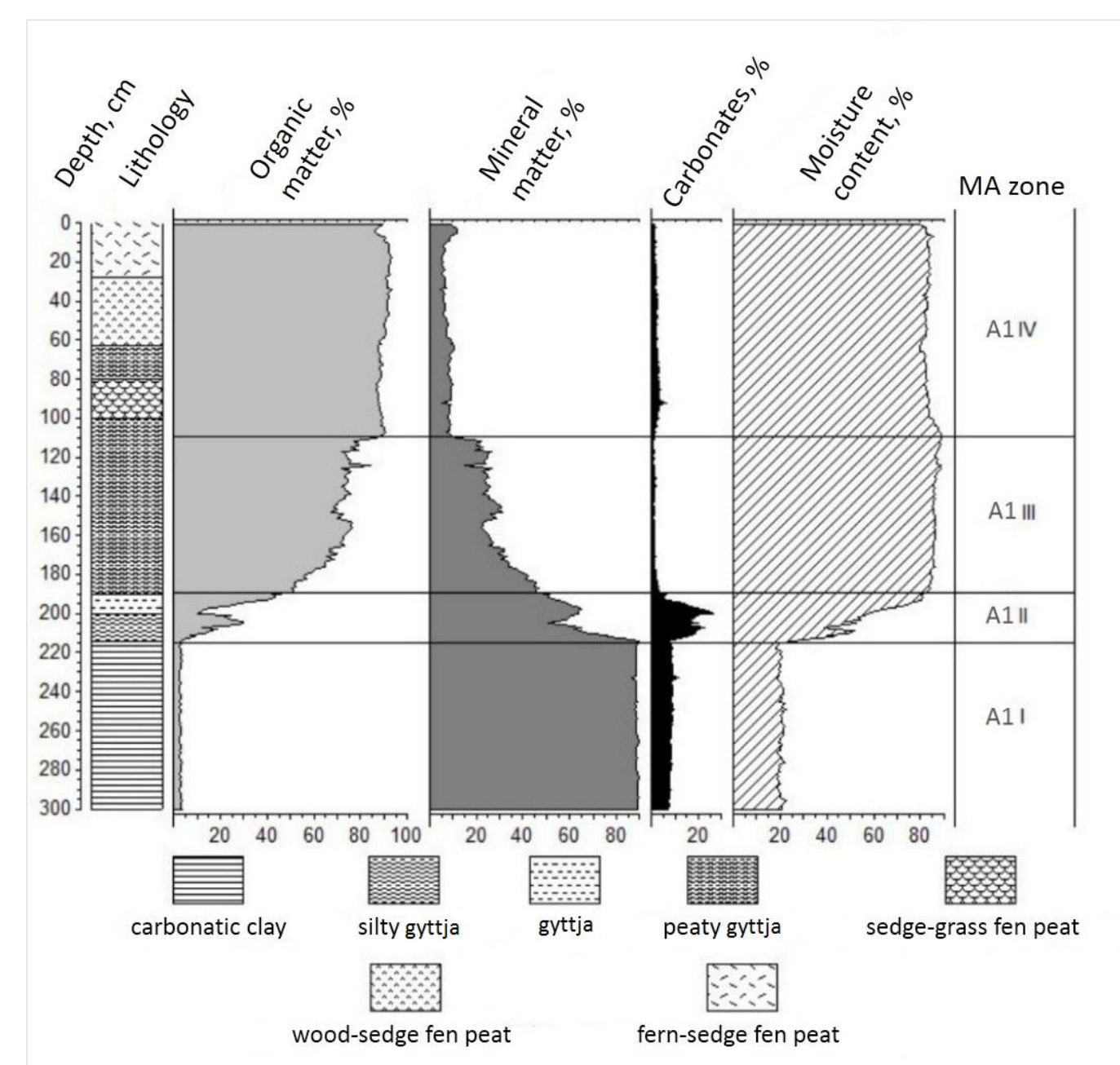


Fig. 6. Loss on ignition results for Asne – U1 core

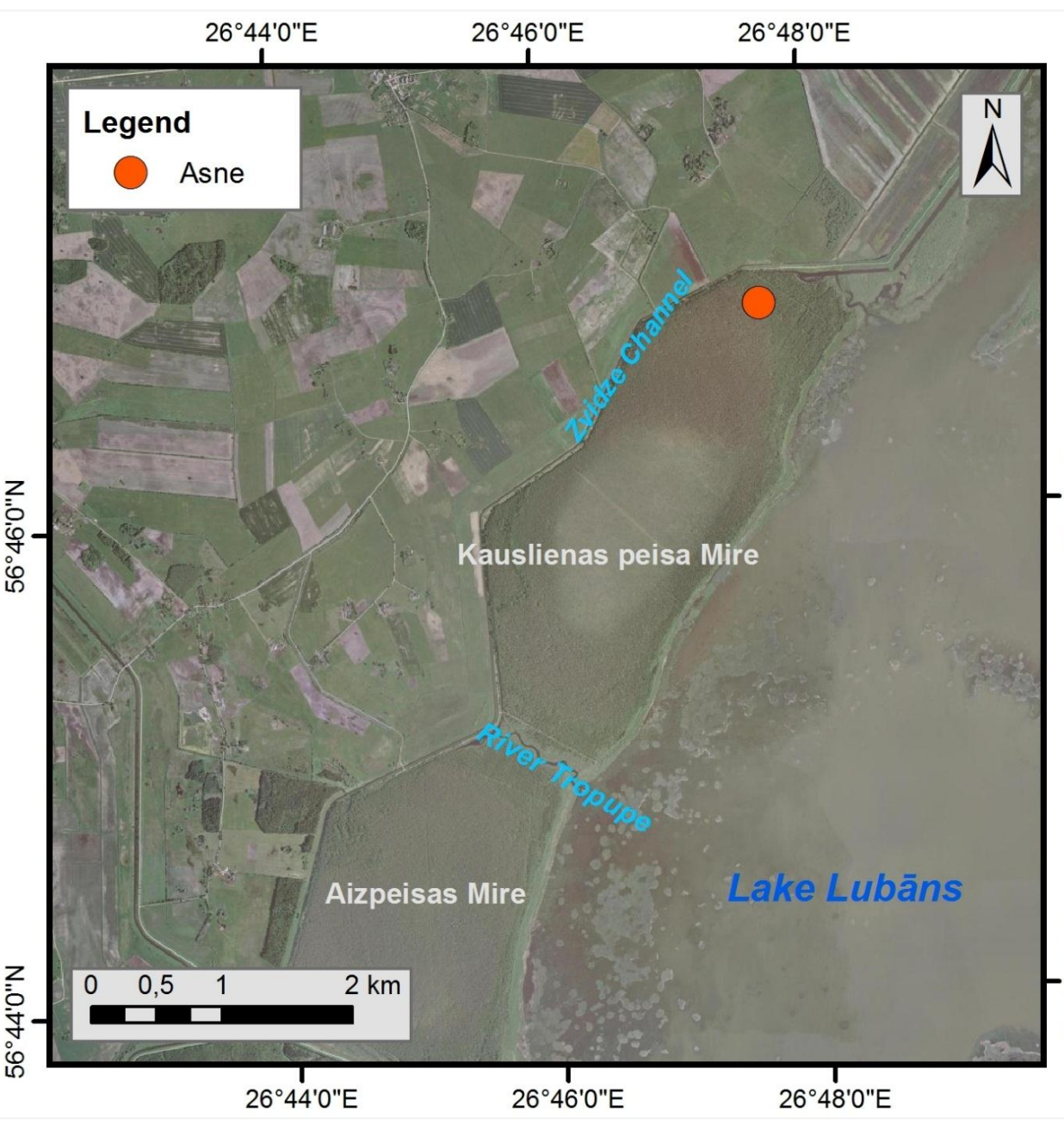


Fig. 7. Asne – U1 sediment sampling point in the Northern part of Kauslienais peisa Mire



Fig. 8. Sediment sample monolith from Sūļagols site

Used laboratory methods: Loss on ignition – LOI; plant macroscopic remain; degree of peat decomposition analysis



Fig. 9. Sediment sample monoliths from Asne site

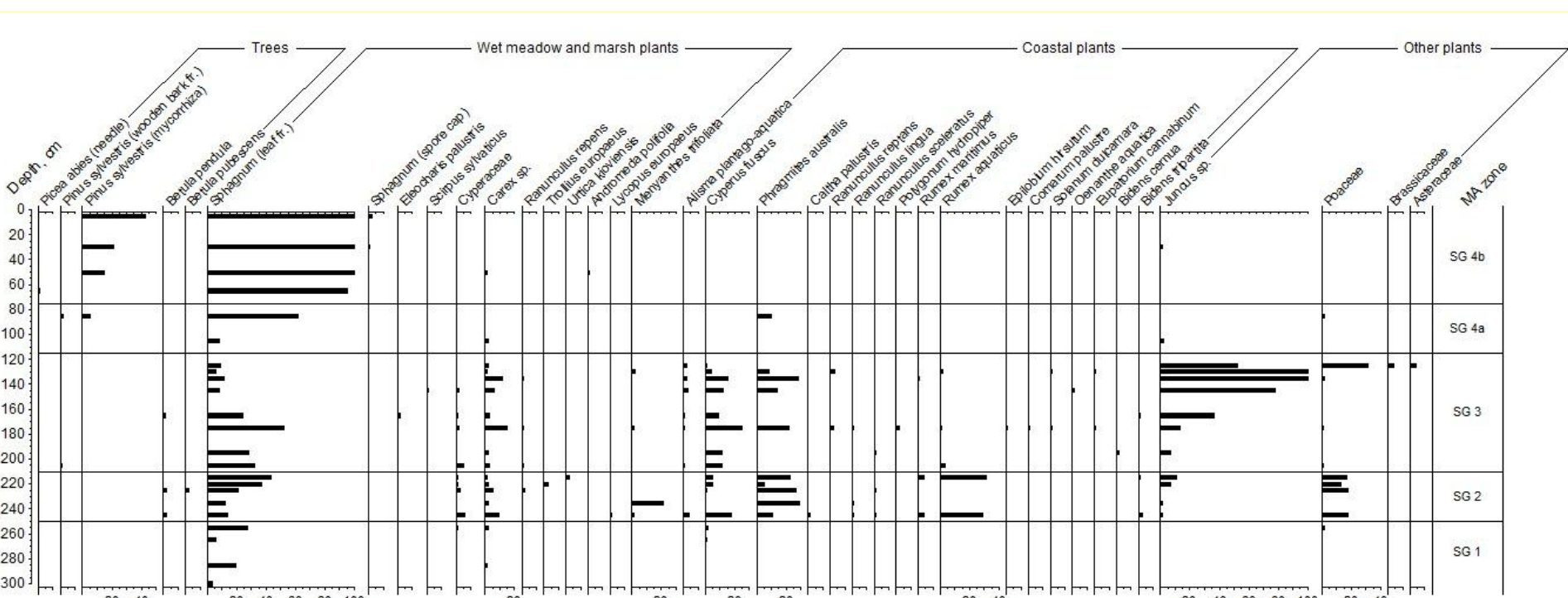


Fig. 10. Sūļagols – U1 macroscopic remain diagram (part 1)

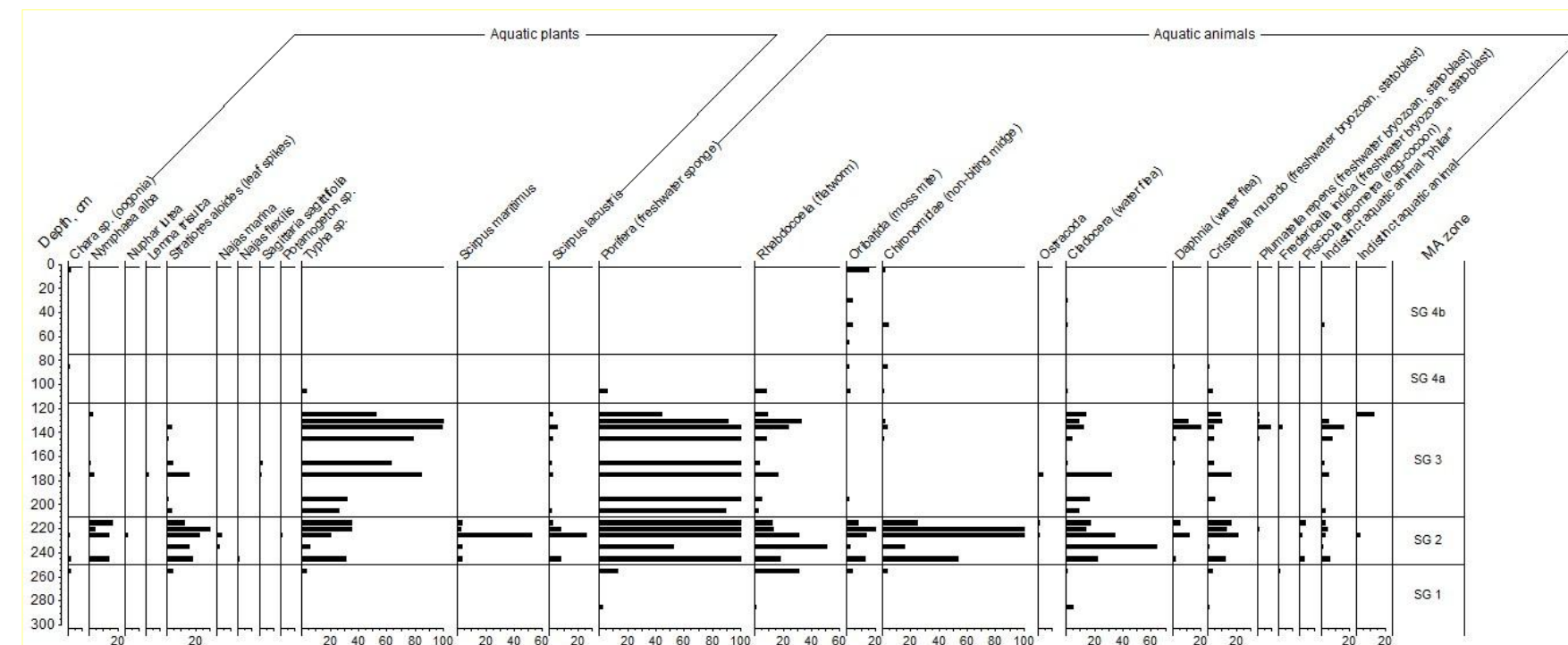


Fig. 11. Sūļagols – U1 macroscopic remain diagram (part 2)

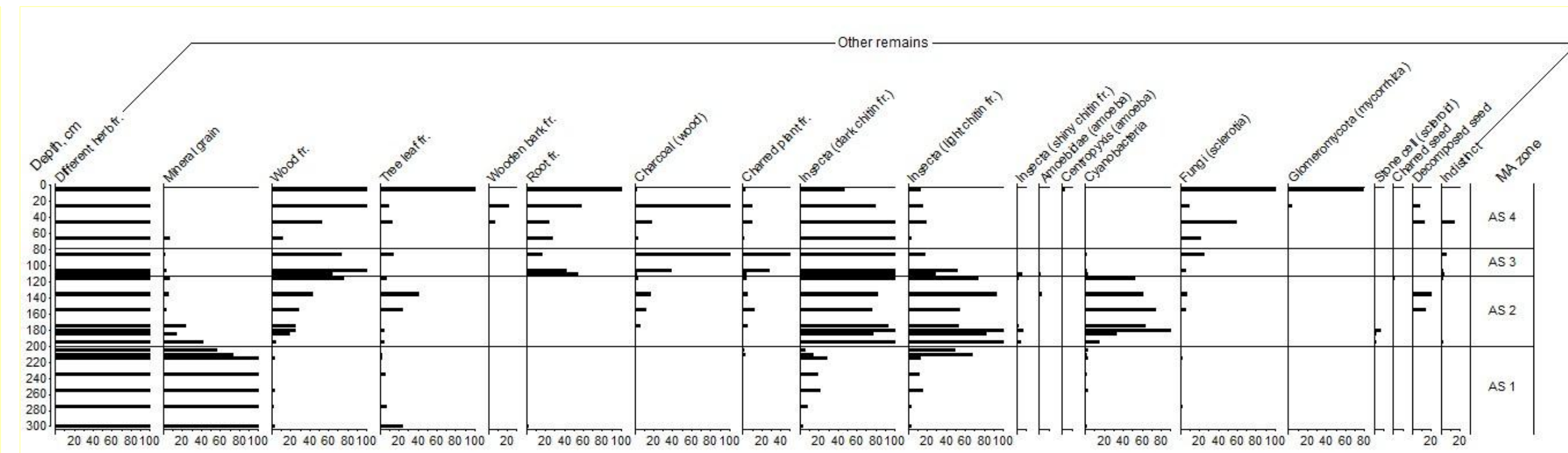


Fig. 12. Sūļagols – U1 macroscopic remain diagram (part 3)

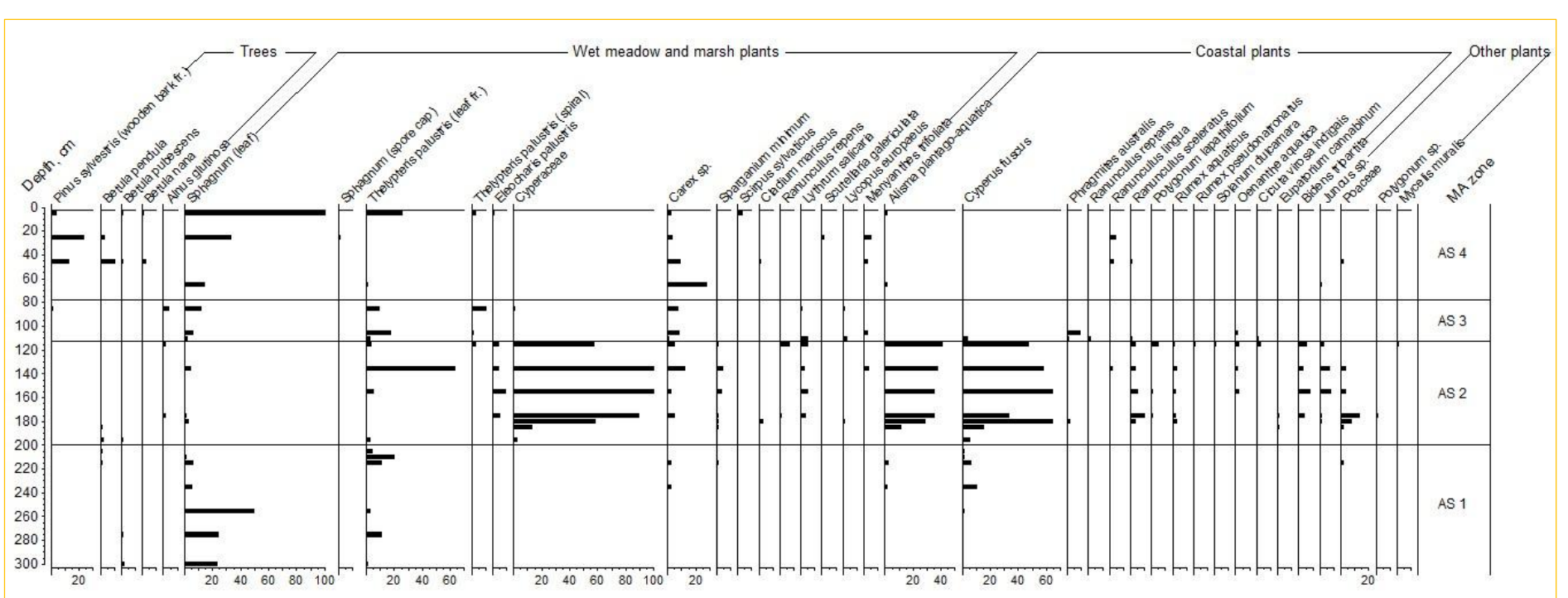


Fig. 13. Asne – U1 macroscopic remain diagram (part 1)

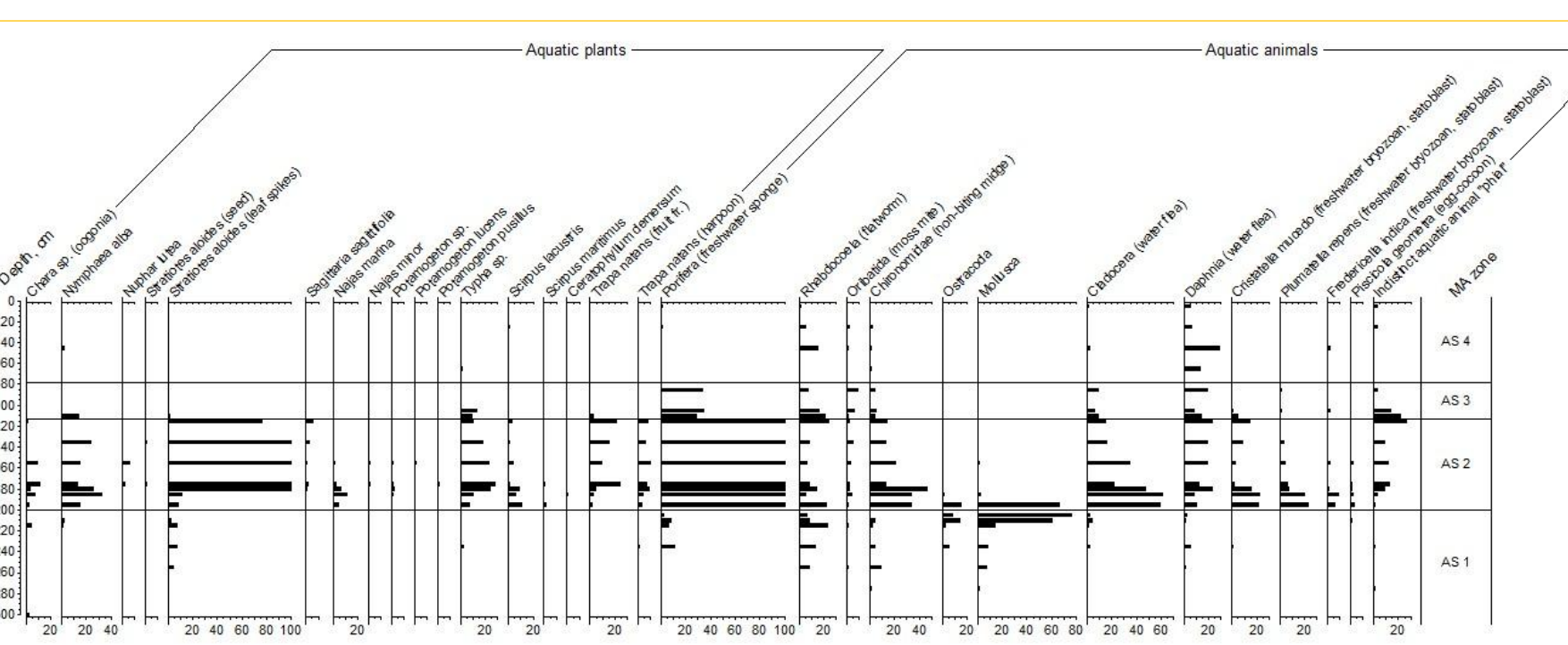


Fig. 14. Asne – U1 macroscopic remain diagram (part 2)

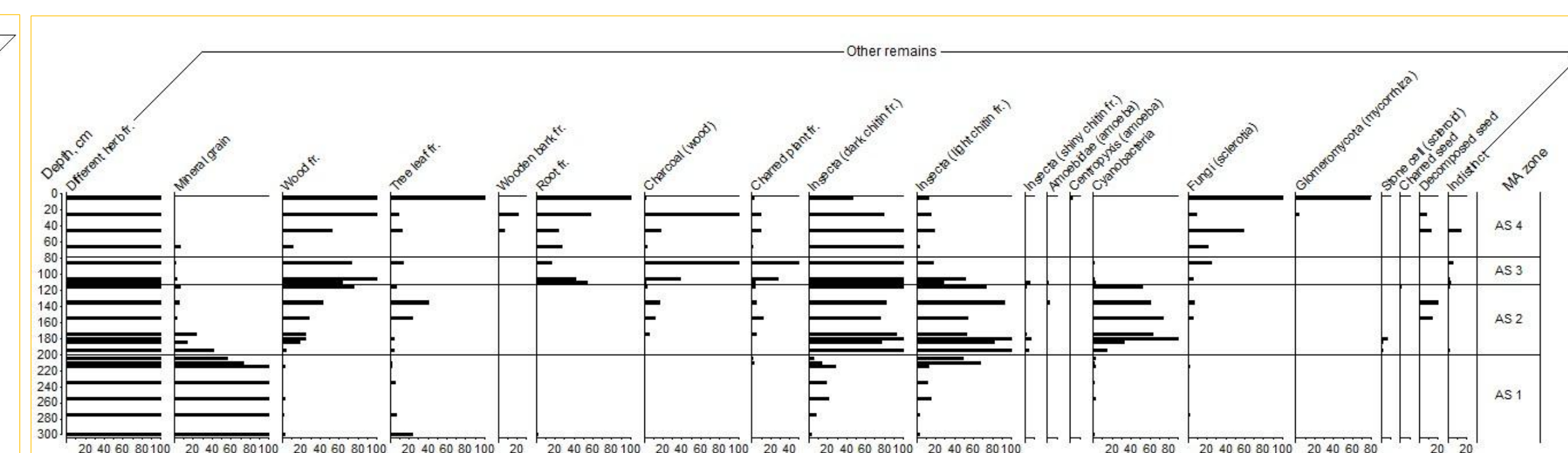


Fig. 15. Asne – U1 macroscopic remain diagram (part 3)

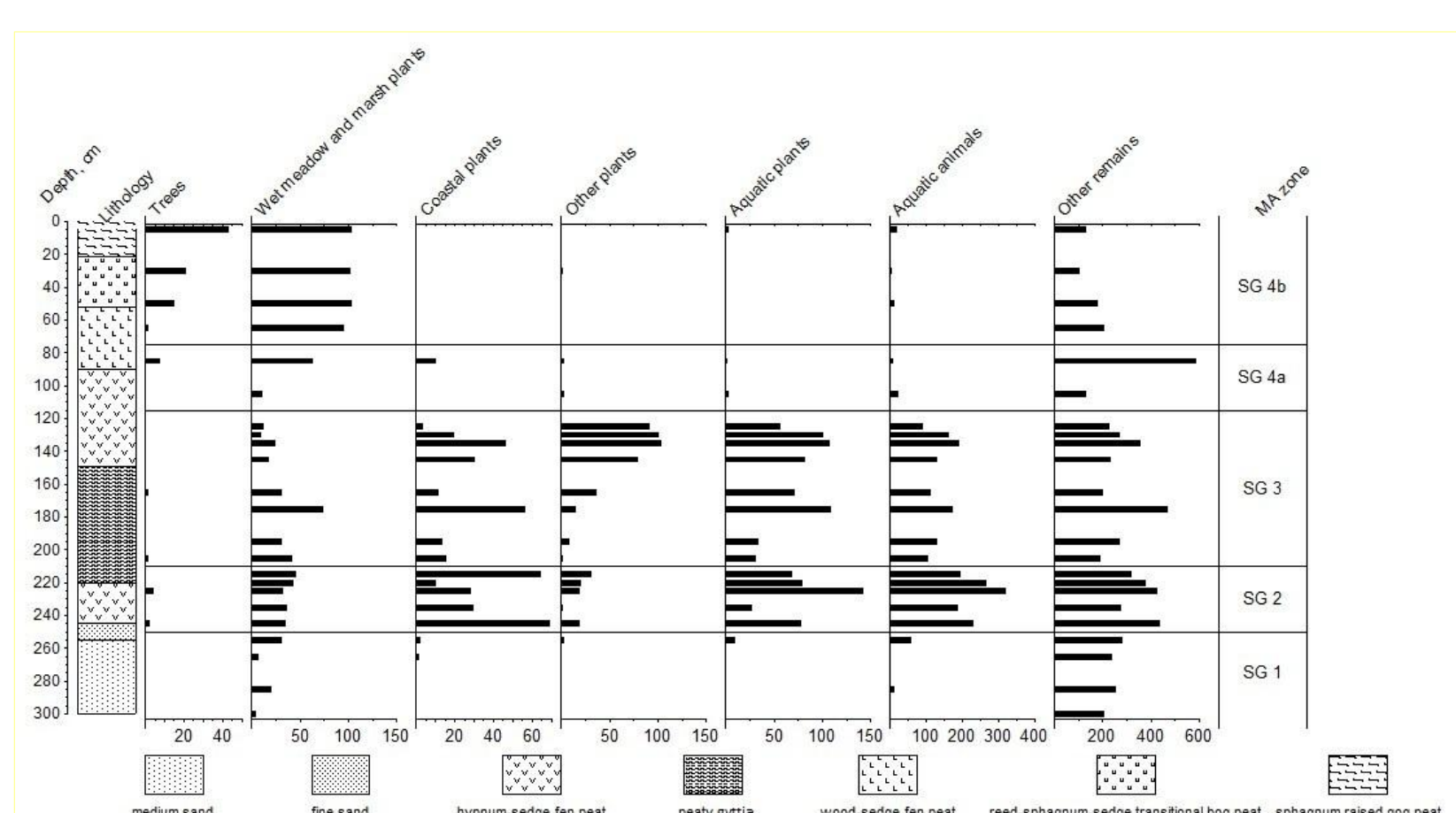


Fig. 16. Sūļagols – U1 macroscopic remain diagram (part 4)

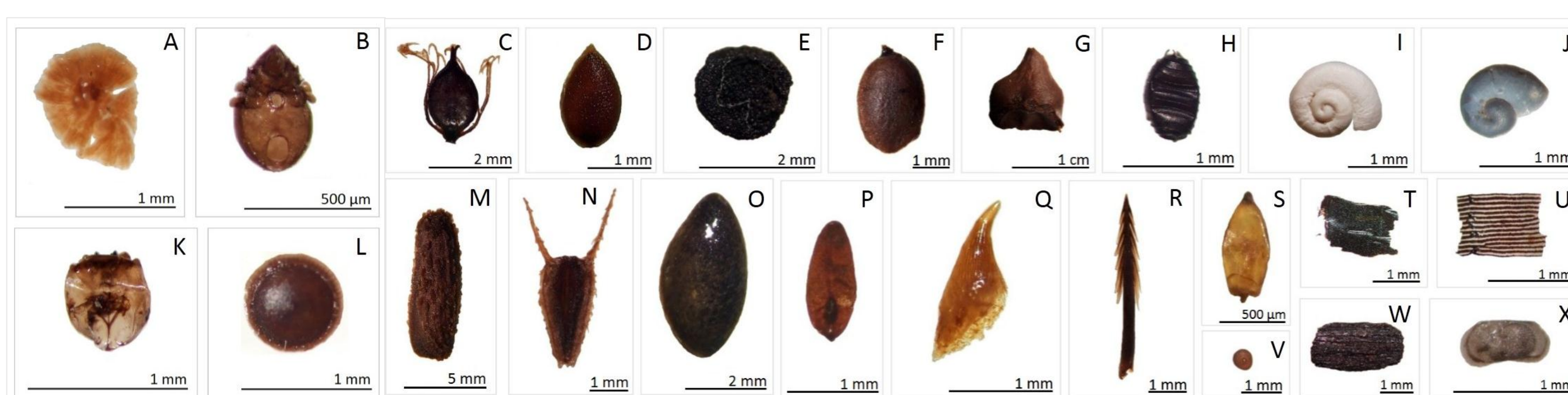


Fig. 17. Macroscopic remains from Sūļagols – U1 and Asne – U1 sediments:  
A – *Cyanobacteria*; B – *Oribatida*; C – *Polygonum lapathifolium* seed; D – *Urtica kioviensis* seed; E – charred *Solanum dulcamara* seed; F – *Nuphar lutea* seed; G – *Trapa natans* fruit fr.; H – *Characeae* oogonia; I, J – *Mollusca*; K – *Chironomidae*; L – *Cristatella mucedo* statoblast; M – *Stratiotes aloides* seed; N – *Bidens tripartita* seed; O – *Najas marina* seed; P – *Poaceae* seed; Q – *Stratiotes aloides* leaf spike; R – *Trapa natans* harpoon; S – *Typha sp.* seed; T, U – *Insecta* chitin fr.; V – *Porifera*; W – *Charcoal* (wood); X – *Ostracoda*.

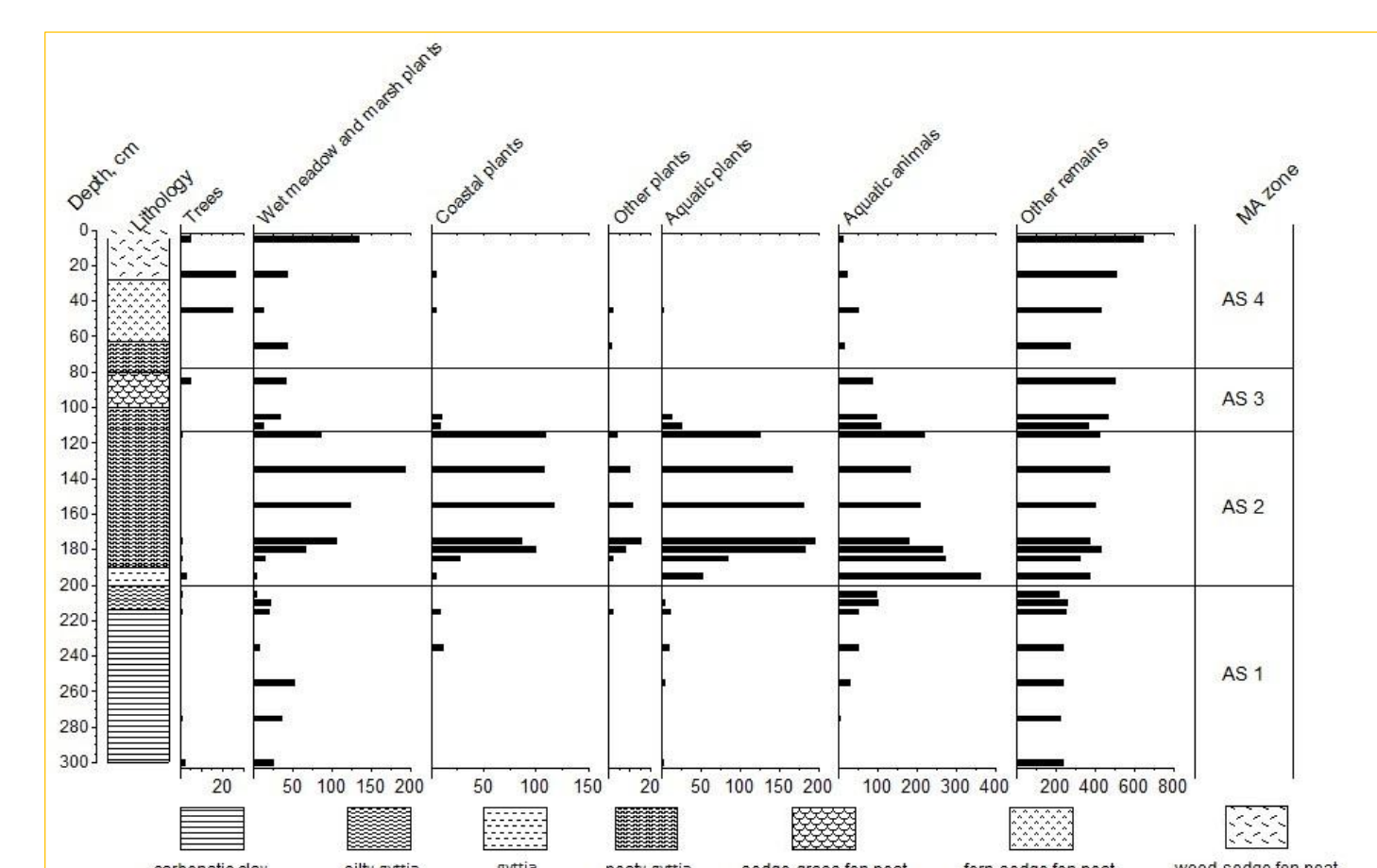


Fig. 18. Asne – U1 macroscopic remain diagram (part 4)

## Conclusion

- The results of sediment studies in southern and western parts of Lake Lubāns allow to find out changes in sediment accumulation condition dynamics and vegetation caused by climatic changes.
- Loss on ignition analyses results show that in lower part of both sections sediment composition is dominated by mineral matter. Differences are only in larger carbonatic content in the Asne section.
- The results of loss on ignition analysis show that in all investigated sections in the upper layer the amount of organic matter increases, which is related to coastal overgrowing intensification processes in the surrounding areas of nowadays Lake Lubāns.
- Macroscopic remain analyses results represents changes in aquatic and coastal species that have been influenced by palaeoclimate variations and palaeohydrological regime revealing changes from lake conditions to peatlands.
- Research allows to conclude that palaeovegetation changes reflect changes of sediment accumulation conditions that are related to climatic and water level fluctuations.