# Traces of Human Activities in Pollen Diagrams from Biržulis Lake with a Short Review of Geological and Geomorphological Conditions in the Biržulis Area

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## Introduction

Geological investigations in the Žemaičių uplands took place in 1965. A set of geological and geomorphological maps, scale 1:200000 were produced following these investigations (Rupšlaukytė 1965:12). A detailed geomorphological plan of the lake environs was compiled by one of the authors of this article. Archaeological investigations took part in the lake environs, and a very rich and interesting material from the Mesolithic and Neolithic was found (Kunskas, Butrimas 1985:66-78, Butrimas 1985:25-65, Butrimas 1992:4-10). New investigations began around the lake in 1994-1995. Palynological investigations focusing on human influence in the area were one of the aims of the project.

## The Site

Biržulis lake is situated in the Žemaičių uplands, in the west part of Lithuania (Fig. 1). Water level in the lake is under human control, and the land around the lake has been reclaimed. The lake itself, covers approximately 100 ha, and is today surrounded by wet boggy plots to the west and south – west, and by cultivated fields to the east and north – east. Biržulis lake is fed by a stream flowing in from the south, and another stream flows out of the north – west part of the lake.

## Geological and Geomorphological Conditions

Biržulis lake is situated in the central part of the Žemaičių uplands, in a pit of the Varniai depression. The lake was formed after the ice of the Baltija (Pomeranian) stage of the Weichselian glaciation melted. Because of its central hillocky massifs and hills, the insular highlands of Žemaičių upland became free of ice long before the main body of the glaciers melted in the south and south-east of

Lithuania. The depth of Quaternary deposits in the upland is about 100 - 150 metres on average, and reaches up to 314 metres in the central part. The hills surrounding the depression are covered by thin clay on the top and dominate the other features of the landscape. These hills were the earliest basins for melt-water in the area, and were approximately 190 – 200 metres above sea level. Later, once the melting of the ice became more intense, many local basins were formed in the Varniai depression. Lakes Biržulis and Stervas are situated in the deepest of these depressions (Fig. 2). The slopes created by the glacial ice are very steep (up to 15 – 20 metres) in the east part of the depression. In the west and south, the slopes are more gradual. The maximum depths of Biržulis – Virvytė (150 – 152 meters above sea level) and Stervas (154 metres above sea level) depressions were determinate based of the aerial photographs.


**Fig. 1.** Site map

The composition of the pit sediments is variable: peat, lake marl, sand, silt. The second level of the lake shore is situated between 155 and 157 metres above sea level. This level is composed of different sediments, with layers formed by accumulative genesis and others resulting from abrasion genesis. The first consist of fine to very fine sand, sometimes mixed with silt and clay. The sediments are situated close to the present lakes, and have a flat, or occasionally undulating surface. The abraded sediments of sandy loam are situated at the foot of slope. Their surface are undulating, with small hills in many places.

## Lithological Composition

Samples from two sections have been investigated. The samples of the first section were taken from the wall of a test pit, the second section is from a core. The distance between two sections is about 45 cm. The first section is from 0.1 m to 1.45 m, the second from 1.45 to 2.63 m. In the Biržulis 2 section (Fig. 4) green silt with fine sand was found at a depth from 2.60 m to 2.63 m. A green homogeneous silt lies from 2.60 m to 2.35 m. A dark silt with organic remains, formed layer from 2.35 to 2.05 m. A coarse sand with abundant organic remains and charcoal is situated at the top of the core, from 2.05 to 1.45 m. The sediments from the test-pit Biržulis 1 (Fig. 3) prolonged the sequence: coarse sand with



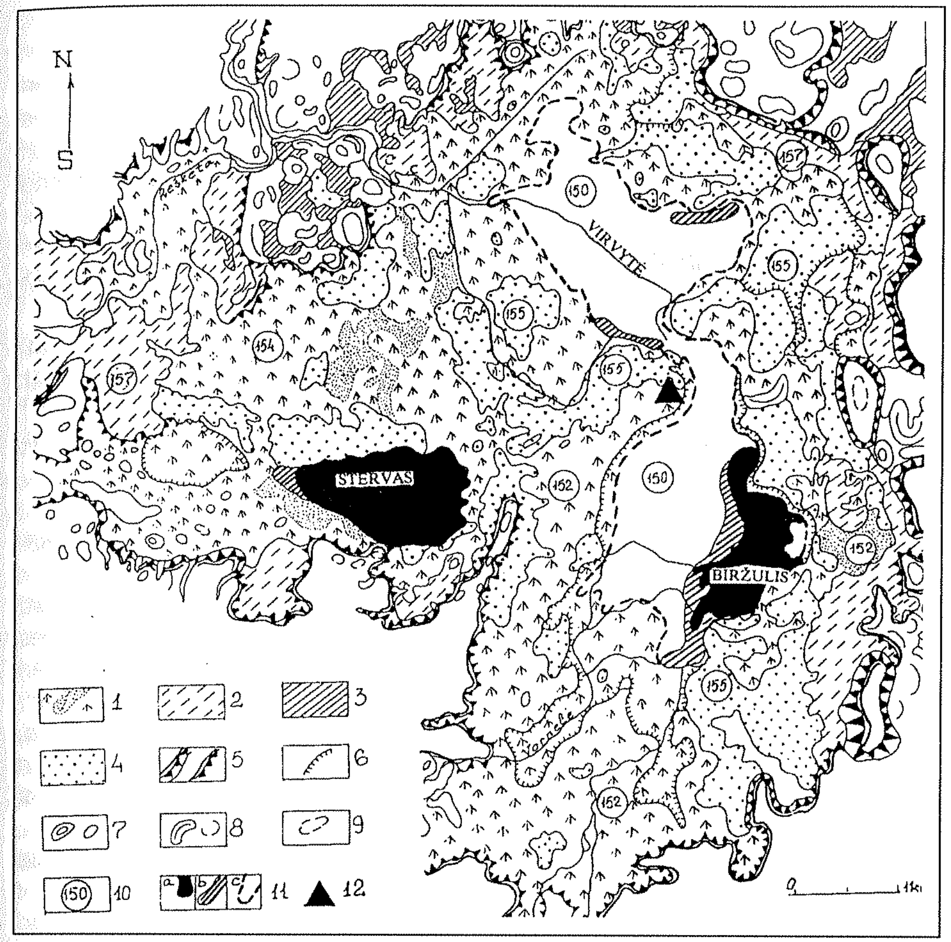
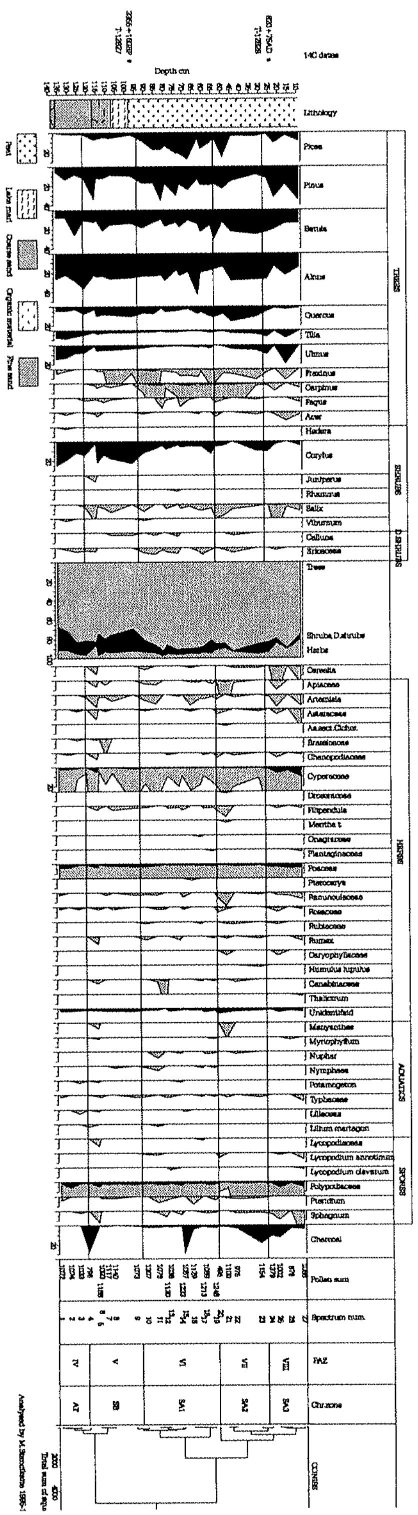



**Fig. 2.** Geomorphological scheme of Biržulis area (compiled by R.Guobytė 1996). 1. The bottom of the depression, with sand and peat. 2. The fragments sediments? areas? of abrasion relief in Varniai depression. 3. Boggy inter-hill depressions, with peat in the bottom. 4. The fragments sediments? areas? of accumulative relief in Varniai depression. 5. Slopes of ice contact and abrasion origin. 6. Slopes of accumulative origin. 7. Moraine hills, medium and large. 8. Low elongated morainic hills. 9. Small moraine hills. 10. Altitudes above sea level for relief in the Varniai depression. 11. Outlines of the lakes: a) on the satellite orthophoto map of 1992, b) on the aerial photo of 1979, c) on the aerial photo of 1952. 12. Location of palynological investigations

organic matter from 1.45 m to 1.36 m. Fine sand comprised the layer from 1.36 m to 1.14 m. A layer of coarse sand with small pieces of charcoal was distinguished in the 1.14 – 1.07 m interval. A thin layer of lake marl covered the sand layer, from 1.07 – 0.98 m, and the upper-most part of the section, from 0.98 m to 0.1 m consisted of peat. The top of the section, about 0.1 m, consisted of soil, plants and roots.



## Pollen Analyses

Percentage pollen diagram presented in article. The sum $\sum AP+\sum NAP=100\%$ was taken to be the basis of calculation's in pollen diagram. Pollen of aquatic plants and spores were excluded from this sum. The total amount of counted pollen ($\sum AP+\sum NAP$) is more than 1000 in each sample.

Names of periods are used, but because establishing the exact limits of the periods was not possible (no enough $C^{14}$ dates), names have no strict chronostratigraphic significance.

Local pollen assemblage zones

PAZ I: *Betula*-Cyperaceae-Poaceae (263-235cm)

Trees pollen prevailed in the PAZ I. *Betula* reached up to 56%, *Pinus* - 44%. Other trees have been represented by single pollen grains or appeared sporadically. Solitary grains of broad-leave trees fixed (*Tilia*, *Ulmus*). *Salix* and Ericaceae have been found in minor amounts. Total amount of the herbs pollen reached 14.2%. Herbs, typical for poor soil, unfavourable climate thrived in the lake environs. Pollen of Poaceae (7.5%), Cyperaceae (4.2%) and *Artemisia* prevailed, and many other herbs species have been found: Apiaceae, Chenopodiaceae, *Filipendula*, *Thalictrum*, Rubiaceae. Single grains of aquatic taxa fixed (Typhaceae). Diversity of spores was very low and only Polypodiaceae (7-8%) and Sphagnum have been detected.

I PAZ could be correlated with Younger Dryas (DR2) chronozone, according Mangerud *et* al (1974:109-128).

PAZ II: *Betula*-Poaceae (235-212 cm)

*Betula* was dominant (68%) and *Pinus* slightly decreased. Diversity of non-arboreal (NAP) pollen decreased but total amount of the herbs pollen occurred in abundant quantities. Ericaceae and *Calluna* were represented. PAZ II is characterised by high representation of Cyperaceae and Poaceae (6.5%). Chenopodiaceae, *Artemisia* well represented.

II PAZ could be correlated with Preboreal (PB) chronozone, according Mangerud *et* al (1974:109-128).

PAZ III: *Pinus-Corylus-Betula* (212-200cm)

$\sum AP$ prevailed over the $\sum NAP$. NAP continuously decreased and diversity of the NAP species as well. *Corylus* representation increased throughout the zone. *Pinus* reached 37.1%. Cyperaceae and Poaceae had have lower values compered with PAZ II. Curve for *Picea* rise slightly. Radiocarbon date confirmed Boreal age of the sediments 8980±160BP (TU-a 1913, BC 8090-7920).

III PAZ could be correlated with Boreal (BO) chronozone, according Mangerud *et* al (1974:109-128).

PAZ IV: *Ulmus-Alnus-Corylus-Tilia* (200-146 cm (Biržulis 2) and 136-122 cm (Biržulis 1))

Percentages of the broad-leave trees (*Ulmus* (14.5%), *Tilia* (7.5%), *Quercus* (4.8%)) increased. *Alnus* (31%) and *Corylus* (26%) reached high values. Fall in *Pinus* representation (20.5%). Single pollen of *Calluna* and Ericaceae found. Representation of Cyperaceae and Poaceae gradually decreased.

IV PAZ could be correlated with Atlantic (AT) chronozone, according Mangerud *et* al (1974:109-128).

**Fig. 3.** Biržulis 1 pollen diagram (analysed by M.Stančikaitė 1995-1996).

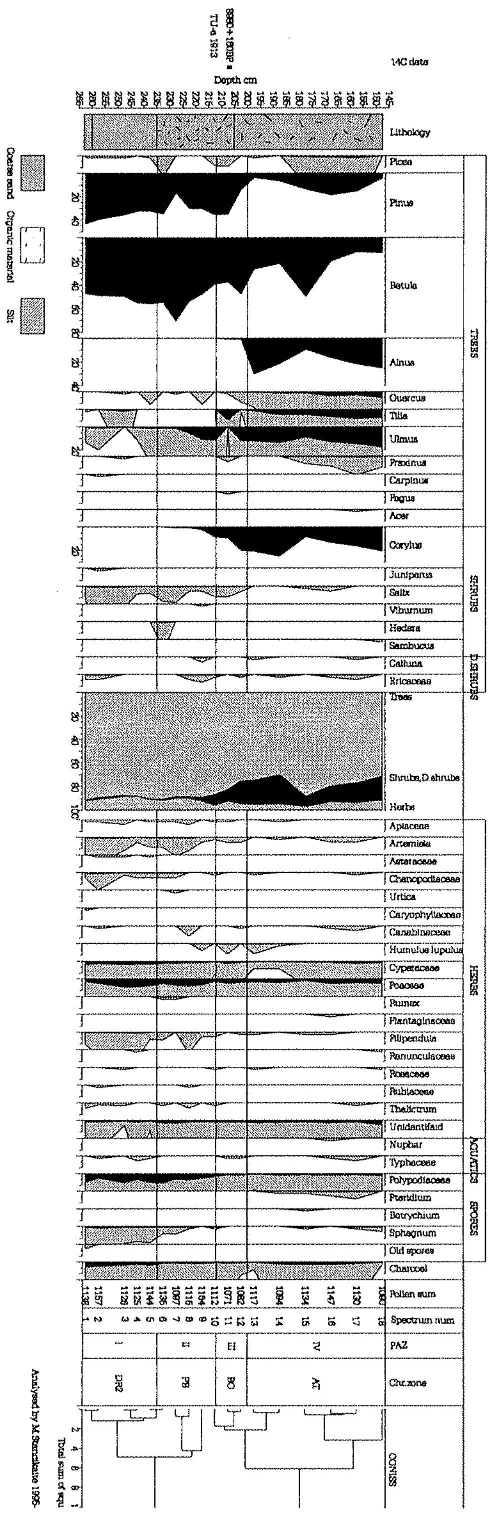


**Fig. 4.** Biržulis 2 pollen diagram (analysed by M.Stančikaitė 1995-1996)

PAZ V: *Quercus-Corylus-Alnus* (122-95 cm)
*Corylus* and *Alnus* are dominant. *Corylus* max. (26%) fixed. *Tilia* and *Ulmus* representation gradually decreased, but *Quercus* increased. The curve for *Picea* slightly rising. Diversity of the NAP species increased. Total amount of the herb pollen came to 8%. High Cyperaceae and Poaceae representation , especially at the lower boundary of the PAZ, fixed. Individual NAP curves culminated at the same level as Cyperaceae and Poaceae did and formed continuous curves after that (Rosaceae, *Artemisia*). Curves for *Rumex*, Chenopodiaceae, *Cerelia* increased at the lower limit of the PAZ. Rezults of radiocarbon dating confirmed Late Subboreal age of the sediments 3355±50BP (T-12827, BC1690-1550).
V PAZ could be correlated with Subboreal (SB) chronozone, according Mangerud *et* al (1974:109-128).

PAZ VI: *Picea-Pinus* (95-55 cm)
*Picea* is dominant (28%), *Pinus* and *Alnus* have a high values as well. *Quercus* representation gradually decreased at the middle of the PAZ, but increasing started at the upper limit of the PAZ. *Corylus* representation fall and the curves for *Carpinus*, *Fraxinus* rise. Very high diversity of the herbs species fixed. *Artemisia* formed a continuous curve. Aquatic taxa have represented by single pollen grains.
VI PAZ could be correlated with Early Subatlantic (SA1), according Mangerud *et* al (1974:109-128).

PAZ VII: *Quercus-Alnus-Betula* (55-27 cm)
*Quercus* is dominant (16.2%). *Alnus*, *Betula*, *Tilia* and *Ulmus* increased especially at the upper boundary. *Picea* declined as well as *Pinus*. Curve for *Salix* increased and *Carpinus* had have a high values. NAP curves culminated at the lower limit of the PAZ (8.7%). *Filipendula*, Ranunculaceae, Apiaceae thrived, but at the upper boundary representation of such species decreased.
VII PAZ could be correlated with Middle Subatlantic (SA2) chronozone, according Mangerud *et* al (1974:109-128).

PAZ VIII; *Cerealia-Pinus*-Cyperaceae (27-10 cm)
*Pinus* dominated among the trees(35%) and *Alnus*, *Picea*, *Betula* represented well. Broad-leave trees representation increased. *Cerealia* spreaded in area (1.6%) and amount of NAP increased as well. Cyperaceae achieved the higher representation than elsewhere in the section (11%). Curves for *Artemisia*, Ranunculaceae, Asteraceae culminated as well. Radiocarbon date confirmed Late Subatlantic age of the sediments 820±75BP (T-12828, AD1170-1275).
VIII PAZ could be correlated with Late Subatlantic (SA3) chronozone, according Mangerud *et* al (1974:109-128).

## Sediment Stratigraphy and Palaeogeographical Conditions

The oldest sediments recovered in the course of the palynological investigations date to the Younger Dryas (DR2) (Fig. 4). The climate of this period was cold, windy (Kabailienė 1990:175). Inorganic sediments prevails over the organic ones at this time. Birch and pine predominated in area. Poaceae, Chenopodeaceae, *Artemisia* predominated among grass's and such plant communities thrived in area. The total amount of the grass pollen is rather high - up to 14.2%. Such



plants as Cyperaceae typical for the tundra vegetation, gained more ground (Aleksandrova 1983:127).

The determination of the beginning of the Holocene in the samples is problematic. The composition of tree pollen is typical for the Preboreal (PB) time, with very high amount of tree pollen dominated by *Betula* (68%) and *Pinus* (17.5%). The total amount of grass pollen is very similar to the Younger Dryas (DR2), and more species of grass pollen were identified: *Artemisia*, Chenopodeaceae, Cyperaceae, Poaceae, *Urtica*. Such high amount of grass pollen is not typical of Holocene sediments in Lithuania, but age of the sediments have been confirmed by the results of radiocarbon dating (TU-a 1913, 8980±160BP, BC8090-7920). At the beginning of Holocene, open forest of *Pinus* and *Betula* were typical of what is now Lithuania (Kabailienė 1990:175). Palaeogeographical conditions around Biržulis lake at the beginning of this period were very similar to the conditions during the Late Glacial. Silts with some admixture of organic material continued to be deposited during the Preboreal (PB) as well. Pollen species typical of the Younger Dryas (DR2) and Preboreal (PB) were also identified in Boreal (BO) sediments. The climate wormed slightly and pollen of *Tilia*, *Ulmus* and *Fraxinus* appeared in minor amounts.

With the beginning of the Atlantic (AT), the sedimentation conditions and type of the sediments changed. The warm, wet climate is characteristic of this period. The number of broad-leave trees and grass species increased. Sedimentation of coarse sand with organic particles began. During the Atlantic, the water level in the Biržulis lake was higher when in earlier periods, and lake was surrounded by the wet forest (Kunskas 1985:85-30). Large amounts of lime, oak, elm flourished in lake vicinities. *Alnus*, *Corylus* were identified in the pollen diagrams (Fig. 3, Fig. 4) and such species occupied wet habitats around water basins.

At the beginning of the early Subboreal, the climate become colder, and the number of the broad – leave species decreased. The lake was surrounded by wet, dense forests with many *Picea* trees. During the late Subboreal period, when the climate became drier, the composition of the forests changed, and more open forests spreaded. During the Subatlantic period, especially the first part of it, precipitation increased and hazel, alder, oak occupied large areas. Composition of tree pollen during the second part of this period is more varied: *Pinus, Betula, Alnus* and *Ulmus* pollen have been identified. Changes in the grass curves during the Subboreal and Subatlantic will be discussed in the next section, as the main indicators of human influence on the environment.

## Sings of Human Economic Activity in the Diagrams

Changes in the pollen curves, identified in a few levels of the pollen diagram (Fig. 3), are not natural and must have been produced by people who settled in the territory and began to change the landscape. Generally, attention is paid to changes in the composition of trees and herbs pollen. A number of scientific publications by I.Vuorela (Vuorela 1975:2-53, 1981:47-61), M.Tolonen (Tolonen 1983:157-168), P.Huttunen (Huttunen 1980:1-45), K.E.Behre (Behre 1981:222-245), K.D.Vorren (Vorren 1986:1-18), M.J.Gaillard and B.E.Berglund (Gaillard, Berglund 1988:408-428) suggest that pollen indicators of human activities will form a group: cereals, plants characteristic of fallow land, indicators of wet and dry pastures, plants of ruderal communities and paths. Attention has also been paid to charcoal. The particles of charcoal (Ø>20μ) were counted in every one slide, and a charcoal curve was created.

The first changes in the pollen curves related to human activity were identified at a depth 1.16 m, at the beginning of Subboreal (SB1). A large amount of *Cerealia* (1.4%) pollen was identified in this level. The second pollen group, identified in this level consisted of plants characteristic of fallow lands: *Rumex acetosa*, *Ranunculus acris*, Brassicaceae, Poaceae, Chenopodeaceae, Cannabinaceae, and *Artemisia*. An important indicator of human activity in an area is plant of ruderal communities and paths: Apiaceae, *Rumex*, Asteraceae, and Brassicaceae. Increases of the pollen of dry and wet pasture species indicate open areas. Apiaceae, Poaceae, Asteraceae, Plantaginaceae, *Rumex acetosa, Juniperus communis* were identified in this level. Such a sudden increase in the amount of grass pollen in a diagram is not typical of the natural changes that occur in plant communities. Another important sing of human activity is the sudden drop in the *Ulmus* curve, around 5000 BP. Many scientists explain such a drop as an indicator of human impact on the environment (Iversen, 1973:1-123, Peglar, Birks 1993:61-68; Moe, Kihno, Pirrus 1992:79-95). A decrease in *Tilia* pollen is also connected with human activities by some scientists (Aaby, 1986:73-94; Vuorela, 1986:53-84). During the second half of the Subboreal (SB2) time man influence in to environment decreased. Single pollen grains, typical for ruderal communities, paths have been found, but they constituted insignificant part of the pollen spectra.

A few separate levels with pollen composition typical of human activities were identified from the first half of the Subatlantic (SA1). The beginning of the Subatlantic (SA1) marked a decrease in stock-keeping and agriculture in Lithuania (Savukynienė 1974:247-251, Savukynienė, Seibutis 1976:91-101). The main course of this drop was probably the wetter climate. Human activities decreased in Biržulis as well, but the appearance of *Cerealia* and charcoal in the diagram confirm that people were still present around the lake. *Cerealia* pollens were found at depths 0.91 m and 0.67 m. Human indicator species are not as prevalent as at the beginning of the Subboreal (SB1), but the high amounts of grass pollen (up to 7.2% and 12.5%) indicate the open areas. At the end of this period, the intensity of stock-keeping increased, as we have many pasture species in the diagram.

During the second part of the Subatlantic (SA2) the amount of grass pollen increased, as well as amount of *Cerelia* pollen. Continuous man interference in to environment determinated. Plants, typical for pastures thrived in area, especially at the beginning of the period. Charcoal curve showed sudden increase as well.

Intensive agriculture spread into the territory (the amount of *Cerealia* pollen reached 1.8%), and the large representation of pasture-plant pollen indicates intensive stock-keeping during the first millennium AD. Herbs pollen reached up to 20%, open areas spreaded in vicinities of Biržulis lake.

## Conclusions

On the basis of resent investigations, the various levels or terraces around Biržulis lake were identified. The upper-most level (from 156 m to 157 m above sea level) was formed during Younger Dryas / Preboreal / Boreal period. The lower terrace (from 152 m to 154 m above sea level), was formed during the Subatlantic.

The earliest indicators of human activity and agriculture were identified at a depth of 1.16 m, belonging to the early Subboreal (SB1). During the Subboreal and Subatlantic, the intensity of human activities in the region changed several times. Human impact on the lake environs increased or decreased periodically. From the Late Subatlantic (SA3), the area around Biržulis lake was in continuous human use.

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## Žmogaus veiklos pėdsakai Biržulio ežero žiedadulkių diagramose. Trumpa geologinių ir geomorfologinių sąlygų apžvalga

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### *Santrauka*

Biržulio ežero apylinkėse vykdomi archeologiniai tyrimai, gretinami su geologiniu ir geomorfologiniu teritorijos įvertinimu, suteikia galimybę naujai pažvelgti į žmonių įsikūrimą bei jų gyvenimo sąlygas.

Biržulio ežeras liko viename iš Varnių depresijos duburių centrinėje iškiliausioje Žemaičių aukštumos dalyje, ištirpus paskutiniojo apledėjimo Baltijos stadijos ledynui. Aukštuma vadinama „saline", nes aukščiausi jos kalvynai pradėjo išledėti jau tuomet, kai tirpstančio ledyno pakraštys buvo dar toli Pietų ir Pietryčių Lietuvoje. Varnių glaciodepresijos poledynmečio ir holoceno geologinė-geomorfologinė situacija restauruota dešifravus stambaus mastelio aerofotonuotraukas. Glaciodepresijos dugnas nelygus, joje ryškūs trijų lygių paviršiai. Ypač raiškūs užpelkėję Biržulio-Virvytės ir Stervo ežerų duburiai. Jų paviršiaus absoliutaus aukščio žymos +150 -+ 152 ir 154 m. Patikimai dešifruotos smėlingos duburių sausmės, kurių lygus, kartais banguotas paviršius yra ties +155 m a.a. žyma. Depresijos pašlaitėse ryškūs abrazinio priesmėlingo reljefo fragmentai, kurių paviršiai yra +156 -+157 m ab s, aukštyje.

Palinologinių tyrimų duomenys rodo, kad viršutinioji Biržulio duburyje susiklosčiusių nuogulų dalis yra subatlančio laikotarpio. Taigi akivaizdu, kad giliausiuose Varnių glaciodepresijos duburiuose, kur šiuo metu likę telkšoti Biržulio ir Stervo ežerai (+152 -+ 154 m), egzistavo subatlančio ežeras.

Palinologiškai ištirti du pjūviai, esantys Biržulio ežero sąsmaukoje. Seniausios nuosėdos susiklostė vėlyvojo driaso metu. Sedimentacija holoceno metu vyko nepertraukiamai, susiklostė smėlio, ežerinio mergelio, durpių storymė. Nuosėdos klostėsi preborealio, borealio, atlančio, suborealio ir subatlančio metu.

Diagramoje (3 pav.) išskirti keli lygiai, kuriuose stebimi aiškūs žmogaus poveikio supančiai aplinkai pėdsakai. 1,16 m, 0,91 m, 0,67 m gylyje stebimas staigus grūdinių kultūrų, pėsčiųjų takų, dirbamų laukų, ganyklų žiedadulkių pagausėjimas. Analogiškai padidėja ir angliukų kiekis nuosėdose. Patys ankstyviausi žmonių veiklos pėdsakai aptikti ankstyvojo suborealio metu (SB1). Vėlyvojo suborealio (SB2) ir subatlančio (SA) metu žmonių ūkinė veikla buvo nevienodai intensyvi.



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# Excavation and Documentation Methods - some Problems and Possibilities with Examples from Norwegian sites

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## Introduction

This paper describes the methods of excavation and documentation applied on rescue projects in Western Norway. Advantages and possibilities of the methodology are discussed, along with some points relating to problems or shortcomings. Some points concerning possibilities and problems we are faced with when trying to reach scientific goals are also briefly focused on.

## Background

The term "rescue projects" or "salvage projects" can in short be said to apply to archaeological surveys and excavations prior to building projects. The excavations are characterized by limited time available, as developers often want to enter the development area quickly. Funding for the projects is provided by developer. The funding is most often quite sufficient for covering excavation expenses and a short report, but is not meant to cover research expenses. In this way funding may be said to be a restricted resource as well. Due to the limitations, field and documentation methods must be rational and efficient, but also prove sufficient for achieving the different scientific goals. We try to minimize the negative effects of the limitations and at the same time to maximize the results through improving our methods and being very clear in formulating scientific goals. In the following, this will be elaborated. It will be shown how these conditions are handled in practice on rescue projects organized through Bergen Museum.

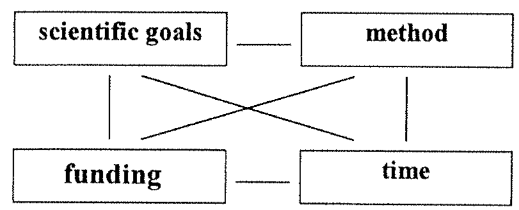


**Fig. 1.** Preconditions. Rescue projects along with most other projects are characterized by different limiting factors such as time available and funding for the investigation and for research. Due to these limitations, field and documentation methods must be rational and efficient, but also prove sufficient for reaching scientific goals