Extended abstract No. 61

14C, 210PB AND BULK PEAT COMPOSITION AS CRUCIAL PROXIES FOR THE RECONSTRUCTION OF HUMAN IMPACT IN A PEAT BOG FROM SOUTHERN POLAND

Barbara Fiałkiewicz –Kozieł [1)], Natalia Piotrowska [2)], Piotr Kołaczek [1)], Adam Michczyński[2)], Barbara Sensuła [2)], Michał Woszczyk[3)], Edyta Łokas [4)], Przemysław Wachniew [5)]

[1] Department of Biogeography and Paleoecology, Faculty of Geographical and Geological Sciences, Adam Mickiewicz University. Dzięgielowa 27, 61-680 Poznań, Poland; 00 48 618296211; basiafk@amu.edu.pl.
[2] Department of Radioisotopes, Institute of Physics, Silesian University of Technology, GADAM Centre of Excellence, Krzywoustego 2, 44-100 Gliwice, Poland
[3] Department of Quaternary Geology & Paleogeography, Faculty of Geographical and Geological Sciences, Adam Mickiewicz Uniwersity. Dzięgielowa 27, 61-680 Poznań, Poland
[4] H. Niewodniczanski Institute of Nuclear Physics, Polish Academy of Sciences, Radzikowskiego 152, 31-342 Kraków, Poland
[5] AGH – University of Science and Technology, Mickiewicza 30, 30-059 Kraków, Poland

SUMMARY

A detailed age model of peatland located in southern Poland, was constructed using both ^{210}Pb and ^{14}C measurements, further compared with pollen diagrams. Described peatland represent two thousand years of paleoecological and geochemical changes. TOC/N and bulk density correlate with the results of palynological studies, and reflect external forcing on peat formation process, including land-use changes, water level fluctuations. Main historical events linked to anthropogenic and climatic changes are recorded in a peatbog.

KEY WORDS: age-depth model; C,NS; human activity

INTRODUCTION

Peatlands are reliable archives for the detection of palaeoclimate change, hydrology and human impact on local and regional scales (Mauquoy, Barber, 1999; Piotrowska et al., 2010). Environmental changes are recorded in a wide spectrum of palaeoecological, physical and chemical features of peat deposits. Bulk composition of peat is one of the most sensitive markers (Chambers et al., 2011). Past climatic and anthropogenic influence is well reflected in fluctuations of bulk density, ash content as well as in the chemical composition of carbon, sulfur and nitrogen (eg. Malmer, Holm, 1984; Moore et al., 2004; Chambers et al., 2011). Fewer studies report the bulk composition as a tracer of human activity.

^{14}C dating as well as the ^{210}Pb method are the most important techniques applied to establish chronostratigraphic schemes of investigated peatlands, especially in high resolution. The chronologies based on low-resolution dating, and consequently correlation of events recorded in pollen spectra with the activities of particular groups of human and/or duration of those processes involved the risk of considerable misinterpreting.

The Orawsko -Nowotarskie peatlands, our study area, are a unique complex of ombrotrophic mires, the largest in southern Poland. For the first time we prepared a high resolution age/depth model with ^{14}C and ^{210}Pb for peatland from this area, further correlated with pollen and bulk composition analysis. The 2,000 years long reconstructions extended our knowledge of human impact in the Pre-Carpathian region from the Roman Period to the present.

MATERIAL AND METHODS

The ombrotrophic, piedmont peatland, Puścizna Mała is located in The Orawa-Nowy Targ Basin (Southern Poland). The investigated peatbog is covered by typical plants: *Andromeda polifolia, Ledum palustre, Oxycoccus palustris, Vaccinium uliginosum* and *Sphagnum* species. The profile consists of *Sphagnum* peat. More detailed information about the contemporary flora, climate and geology can be found in Kołaczek et al. (2010).

The monolith (PM0) was taken in spring 2006 from the dome of Puścizna Mała and cut into 1-cm slices using a stainless steel knife. Bulk composition of peat, including ash content, bulk density and carbon, nitrogen and sulfur content was assessed using standard methods. 55 samples of 1 cm^3 were chosen. Every sample was prepared using standard preparation procedures and then acetolysis was applied (Berglund, Ralska-Jasiewiczowa, 1986).

The activity of unsupported ^{210}Pb was determined indirectly through measurement of its decay product ^{210}Po using alpha spectrometry. Alpha activity was measured with a spectrometer (Alpha Analyst Canberra-Packard, S570) with a surface-barrier Si semiconductor detector.

Radiocarbon dating was carried out according to Piotrowska *et al*. (2011). 26 bulk sediment samples from Puścizna Mała were selected for ^{14}C dating. They were treated with the standard Acid-Alkali-Acid procedure. Measurements were performed in the GADAM Centre, Gliwice with the use of liquid scintillation counting (LSC) for 13 samples. Radiocarbon age of remaining 13 samples was determined using gas proportional counting (GPC) technique (Pazdur et al., 2003). Calibration of radiocarbon dates was undertaken using the Intcal09 calibration curve (Reimer *et al*., 2009). The calibration was performed by “Bacon” software used for building the age-depth models (Blaauw, Christen, 2011).

RESULTS

Bulk physical and chemical features in the Puścizna Mała profile display distinct differences between the lower (200 – 1400 AD) and the upper section of the core (1400 AD – present).

Dry bulk density is low and varies between 0.08 and 0.14 g cm^{-3}. Ash content is below 2%. The content of sulfur changes from 0.08 to 0.17% and after a slight drop at the bottom, it apparently increases towards the top. TOC is between 51 and 45% and the contents of nitrogen vary from 1.5 to 0.6%. Stratigraphic patterns of TOC, N and BD reveal well pronounced culminations dated to pre-300 AD, 500-750 AD and 1000-1200 AD. The former two can be also identified on the ash content curve and to a lesser degree on the S plot.

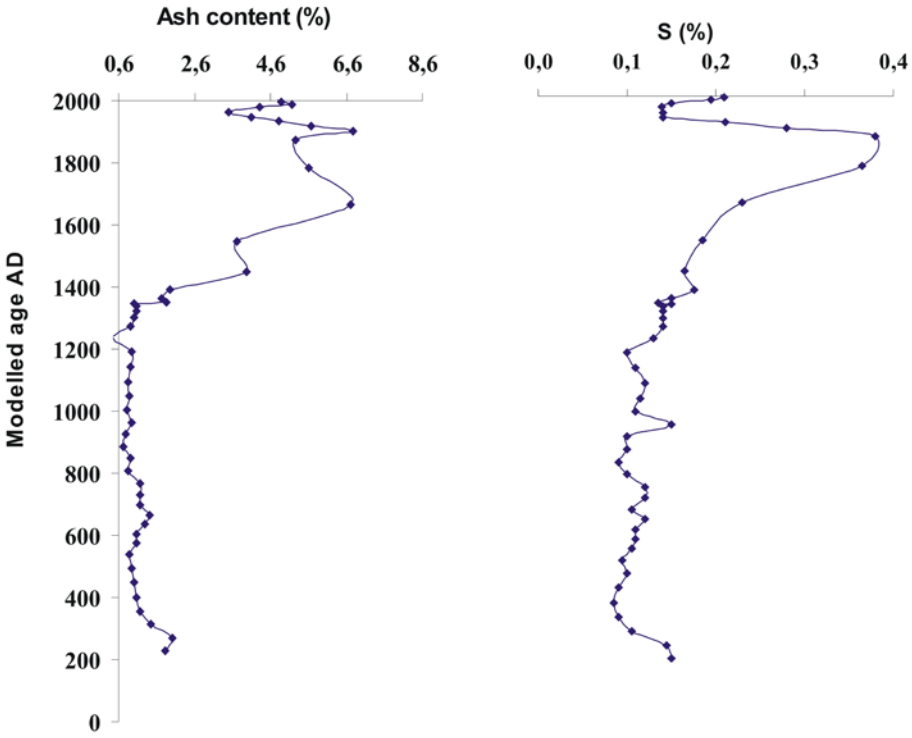

Fig.1 Ash and sulfur content in the Puścizna Mała profile

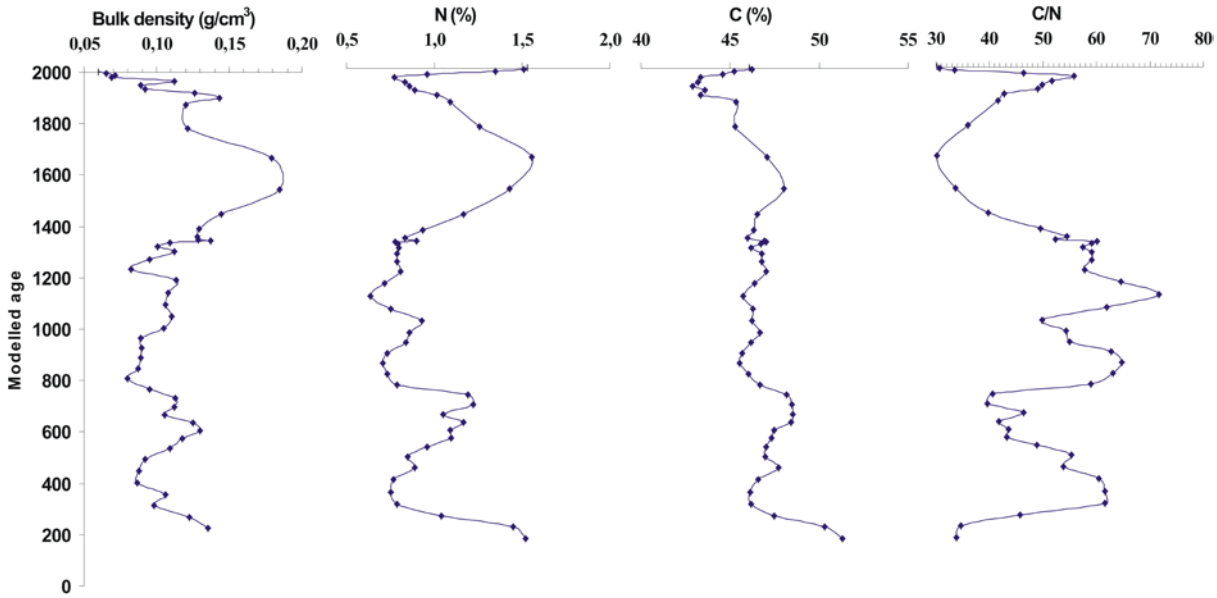

Fig.2 Bulk composition of the Puścizna Mała profile

The upper part of the PM profile is characterized by relatively high values of bulk density, increased ash content as well as strong enrichment in sulfur and nitrogen. On the other hand, TOC percentage is similar to the lower section of the core.

The ^{210}Pb activities decrease with depth in a relatively regular manner.

The constructed age-depth model for Puścizna Mała shows, that the core covers time frame since ca. 1700 yrs. The average accumulation rate is 0.48 mm a $^{-1}$. A detailed description of palinological analysis can be found in Kołaczek et al. (2010).

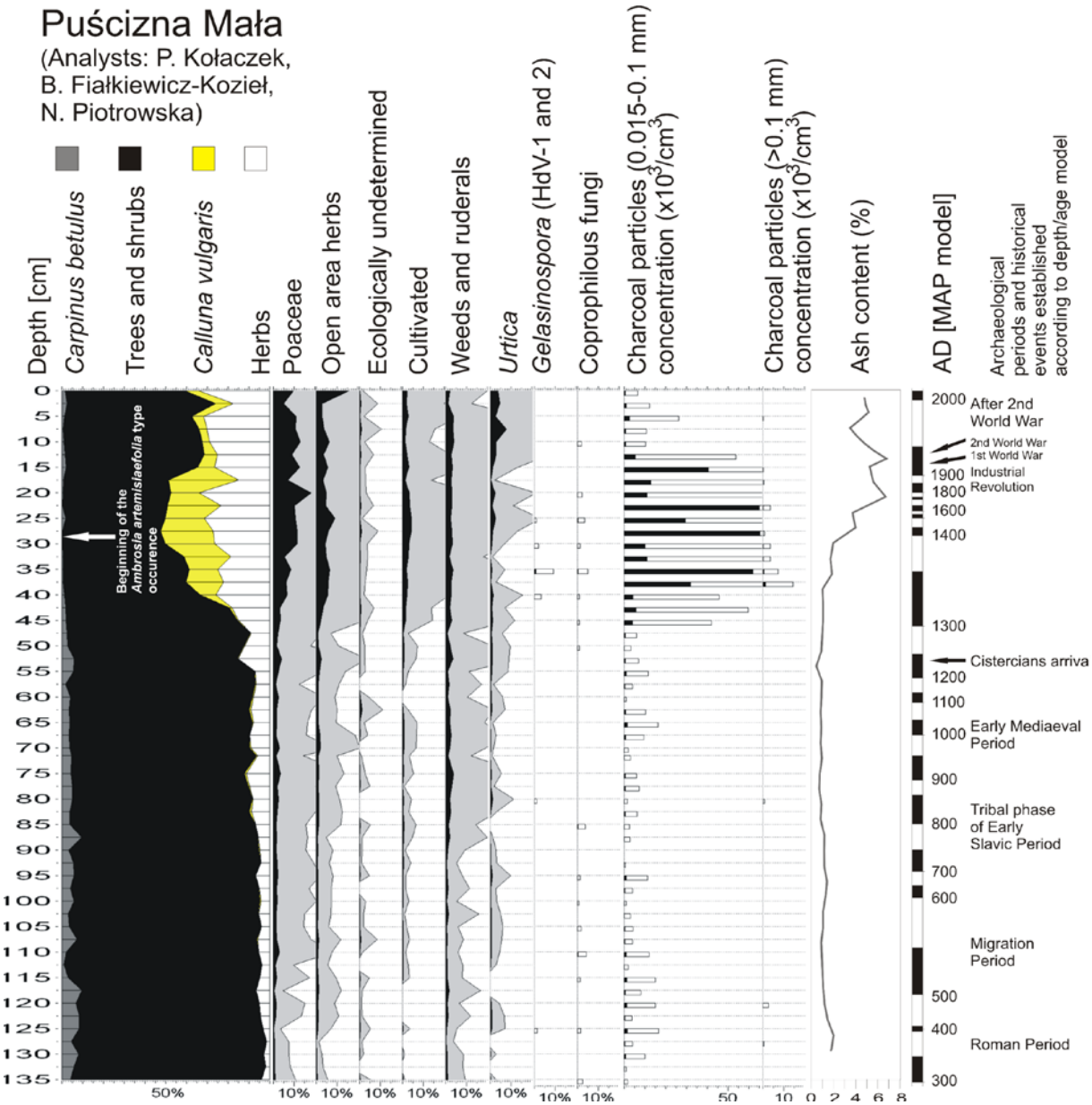

Fig.3 Human impact in the light of palinological analysis

CONCLUSIONS

The peat profile in southern Poland records two thousand years of palaeoecological and geochemical changes. Main historical events linked to anthropogenic and climatic changes are recorded, what confirms the reliability of age/depth model. Namely, the Roman Period, Migration Period, Medieval Times, first permanent colonization in the investigated site and Industrial Revolution is reflected in pollens (*Cerealia typ* pollen as a tracer of colonization

and agriculture; *Gelasinospora* and *Poaceae* as an evidence for grazing, etc. comp. Fig.3) and bulk composition of peat. TOC/N and bulk density correlate with results of palynological studies and reflect external forcing on the peat formation process, including agricultural activity, water level fluctuations, as well as natural climatic factors, which might have influenced the distribution of radionuclides. Distinct enrichment of sulfur in the 19th century is associated with ash content, and thus might indicate the predominance of inorganic sulfur fraction in the peat and anthropogenic emission to the atmosphere. At the same time the S maximum poorly coincidences with TOC/N which may mean that intensive industrial activity during the last two centuries has not significantly influenced the accumulation/degradation tendencies in the studied peat bog.

The post-depositional mobility of ^{210}Pb is evidenced by the discrepancy between the ^{210}Pb-based chronostratigraphy and the history of invasive *Artemisia artemissifolia* appearance in Europe. Bulk composition of peat can be used as an anthropogenic tracer (Fig.2).

ACKNOWLEDGEMENTS

We would like to thank Dr hab. Bernard Palowski, Prof. dr hab. Anna Pazdur, Prof. dr hab. Kazimierz Różański, mgr Paulina Wach, mgr Monika Karpińska – Kołaczek and Władysław Lipian. The research was funded by the Polish Ministry of Science and Higher Education (grant NN304275134) and the National Centre of Science (NCN) - grant nr 2011/01/D/ST10/02579.

REFERENCES

Berglund B.E. Ralska-Jasiewiczowa M. (1986). Pollen analysis. In Berglund B.E. (ed.) Handbook of Holocene. Palaeoecology and Palaeohydrology, 455–484. John Wiley & Sons, Chichester–New York–Brisbane–Toronto–Singapore.

Blaauw M., Christen A., (2011). Flexible paleoclimate age-depth models using an autoregressive gamma process. Bayesian Analysis **6**(3): 1-18.

Chambers, F.M., van Geel, B. & van der Linden, M. (2011). Considerations for the preparation of peat samples for palynology, and for the counting of pollen and non-pollen palynomorphs. Mires and Peat 7(11). (Online: http://www.mires-and-peat.net/map07/map_07_11.htm)

Kołaczek P., Fiałkiewicz-Kozieł B., Karpińska-Kołaczek M., Gałka M., (2010). The last two millennia of vegetation development and human activity in the Orawa-Nowy Targ Basin (south-eastern Poland). Acta Palaeobotanica **50**(2): 133–148.

Malmer N., Holm E. (1984). Variations in the C/N- quotient of peat in relation to decomposition rate and age determination with ^{210}Pb. Oicos **43**: 171-182.

Mauquoy, D. and Barber, K. E. (1999). A replicated 3000 yr proxy-climate record from Coom Rigg Moss and Felecia Moss, The Border Mires, northern England. Journal of Quaternary Science **14:** 263-275.

Moore T., Blodau C., Turunen J., Roulet N., Richard P.J. (2004). Patterns of nitrogen and sulfur accumulation and retention in ombrotrophic bogs, eastern Canada. Global Change Biology **11**: 356-367.

Pazdur, A., Fogtman, M., Michczynski, A. & Pawlyta, J. (2003) Precision of ^{14}C dating in Gliwice Radiocarbon Laboratory. FIRI programme. Geochronometria **22**: 27–40.

Piotrowska N., Blaauw M., Mauquoy D., Chambers F.M. Constructing deposition chronologies for peat deposits using radiocarbon dating. Mires and Peat **7**: Art. 10, (2011). (Online: http://www.mires-and-peat.net/map07/map_07_10.htm)

Reimer, P.J., Baillie, M.G.L., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E., Burr, G.S., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Hajdas, I., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., McCormac, F.G., Manning , S.W., Reimer, R.W., Richards, D.A., Southon, J.R., Talamo, S., Turney, C.S.M., van der Plicht, J. & Weyhenmeyer, C.E. (2009) IntCal09 and Marine09 radiocarbon age calibration curves, 0–50,000 years cal BP. Radiocarbon **51**:1111–50.