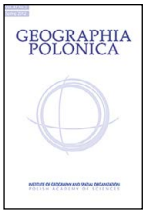

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CONTEMPORARY RESEARCH TASKS AND CHALLENGES FOR QUATERNARY SCIENCES

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Abstract

The article briefly characterises the Quaternary, defines the criteria for its identification within the stratigraphic table and discusses the principles of its internal division. International and national organisations that bring together Quaternary researchers are presented from a historical perspective. The importance of research related to the Quaternary is indicated, especially in terms of determining climate–environment interactions and taking into account increasing human impact. The second part of the article presents a brief description of the scientific issues raised in a post-conference collection of articles.

Key words

Quaternary • chronostratigraphy • Quaternary organisations • interdisciplinary research

The Quaternary: outline of chronostratigraphy

The Quaternary is the youngest of the three periods of the Cenozoic era and is still ongoing. The name was probably coined by the Italian mining engineer Giovani Arduino during his geological explorations in the Venice and Tuscany regions of Italy (Arduino, 1760; Gibbard, 2019). In 1829, examining sediments in the Seine Valley, the French geologist Jules Desnoyers (1829) used the term Quaternary to describe all formations younger than the Tertiary (Head & Gibbard, 2015). Both the status and the lower limit of the Quaternary have changed many times (Gibbard et al., 2005; Marks, 2007; Gibbard & Head, 2020). In 2008, the International Commission on Stratigraphy (ICS) set its lower limit at 2.58 million

years, and a year later this limit was ratified by the International Union of Geological Sciences (IUGS; Gibbard et al., 2010). This border is unrelated to any catastrophic event or rapid species extinction. It was determined based upon magnetostratigraphic criteria – specifically, the change in the polarity of the Earth's magnetic field at the border of the Gauss-Matuyama Reversal. The Quaternary follows the Neogene and is divided into two eras: the Pleistocene (from 2.58 Ma years to 11.7 ka ago) and the Holocene (11.7 ka ago to present day) (Head, 2019; Fig. 1).

Quaternary organisations: research tasks and challenges

For the above and many other reasons, the Quaternary is studied by scientists from various scientific fields and disciplines: from geological, physical geography and physical sciences to biological and archaeological sciences. Since 70% of Poland's surface is covered with Quaternary sediments, they are intensively studied by interdisciplinary research teams here, and the history of Quaternary

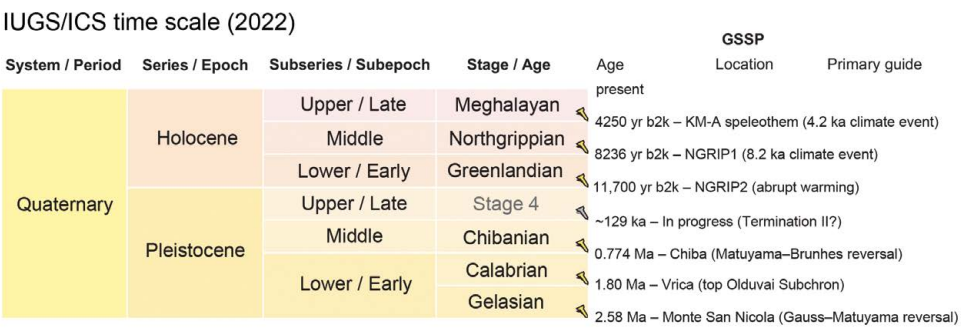

Figure 1. The current IUGS-ratified timescale for the Quaternary System/Period (July 2022). The age, location and primary guide for each Global Boundary Stratotype Section and Point (GSSP) is also included. Golden nail or golden pin lower indicates boundary of ratified stages. The Upper/Late Pleistocene Subseries/Subepoch is ratified in name only, pending its definition and that of its corresponding stage by GSSP. Abbreviations: b2k – before the year 2000; ka – thousands years before present; Ma – millions of years before present (http://quaternary.stratigraphy.org/major-divisions/)

From a geological point of view, this is a short period during which relatively little change occurred in the geography of the continents due to lithospheric plate tectonics. For obvious reasons, the geological record of the Quaternary is preserved in much greater detail than that of earlier periods. A characteristic feature of the Quaternary period has been its cyclical climate changes, which at mid- and high latitudes manifested in the development and disappearance of huge continental ice sheets. In the Quaternary, *Homo sapiens sapiens* evolved, spread over the entire Earth and was the first species in the history of our planet that could decide its future fate.

research in Poland dates back to the beginning of the 19th century (see Marks, 2023; Jary & Marks, 2024). At the global scale, Quaternary research is coordinated by the International Union for Quaternary Research (INQUA). INQUA was established in 1928, and Polish geologists, especially Professor Mieczysław Limanowski, played a fundamental role in its creation (Kalinowska & Sadurski, 1998; Alexandrowicz, 2006). In Poland, the Committee for Quaternary Research of the Polish Academy of Sciences (CQR-PAS) serves as the National Committee for Cooperation with INQUA. It was established by the resolution of the Presidium of the Polish Academy of Sciences of June 30, 1964. The organiser and

first chairman of CQR-PAS was Prof. Stefan Zbigniew Różycki. The Committee consists of thirty independent research workers elected in a secret ballot for a four-year term of office.

For the past more than decade, the idea of establishing an open organisation integrating the activities of Polish Quaternary researchers has been maturing in Poland. The decision to establish the Polish Quaternary Union (POLQUA) was taken during the 27th "Stratigraphy of the Pleistocene of Poland" conference in Stara Kiszewa in September 2022 (Skurzyński et al., 2022; Fig. 2). POLQUA is a scientific and professional association whose primary task is to work for the development of Quaternary sciences by creating and stimulating interdisciplinary scientific and research work in the field of Quaternary sciences, developing and shaping the scientific qualifications of Quaternary researchers and popularising content from the field of Quaternary sciences in non-scientific environments. POLQUA protects the natural environment and sites of exceptional scientific importance. Association achieves its goals by submitting scientific and research projects and organising specialised and interdisciplinary conferences, symposia, seminars and scientific workshops. POLQUA develops cooperation with foreign organisations that bring together Quaternary researchers, including primarily INQUA, and in Poland it cooperates mainly with CQR-PAS and the Association of Polish Geomorphologists.

One of the most important challenges facing Earth sciences is to address global climate change and related changes in the natural environment. The substantive basis for scientific discussion on this topic must be our knowledge of the Earth's climatic and environmental past in the Quaternary, and especially in interglacial periods. This is why there is so much value in analyses of palaeo-environmental changes in sediments from various Quaternary sedimentary environments conducted by multidisciplinary research teams. Lake and peatbog sediments occupy a special place among them, as they usually occur in the immediate living space of humans. Their detailed analysis not only enables reference to past climate changes and the responses of the natural environment, but also allows the role of humans in these interactions to be determined. An example of such multidisciplinary research, based on the analysis of annually laminated lake sediments collected from the bed of Lake Czechowskie in the Kociewie Lake District, was presented

Figure 2. Founding members of the Polish Quaternary Union (POLQUA) in Stara Kiszewa (September 2022, photo O. Tomeniuk)

during a field trip related to the aforementioned POLQUA conference (Fig. 3). Anthropogenic changes in the natural environment are becoming increasingly important in Quaternary research, especially in the context of the lively discussion on the identification of a new stratigraphic unit from the Holocene, namely the Anthropocene (Zalasiewicz et al., 2008; Lewis & Maslin, 2015).

Scientific issues of the post-conference special publication

During the 27th "Stratigraphy of the Pleistocene of Poland" conference, which took place in Stara Kiszewa in September 2022 under the slogan "Late Quaternary sedimentary environments of Eastern Pomerania" (Skurzyński et al., 2022), 49 papers were delivered and 24 posters were presented. They confirm the wide range of topics and interdisciplinarity of Quaternary sciences. A special volume of *Geographia Polonica* was prepared, primarily for the broadly understood Earth science community. It contains six articles on various areas of Quaternary science and certainly does not exhaust the issues. The most important message for the prospective reader is to be aware of the need to constantly verify our knowledge about the Quaternary, because despite clear progress in research methods, most questions in this field still await a fully satisfactory answer.

In the first paper of this issue, Marks & Jary (2024) draw the reader's attention to the need to properly use varied stratigraphic categories in Quaternary research in Poland, including lithostratigraphy, biostratigraphy, chronostratigraphy, geochronology, magnetostratigraphy, climatostratigraphy and isotope stratigraphy. The former Polish loess stratigraphy schemes are mostly of historical importance and should be verified using new research methods and the implementation of the international unified loess labelling system. Arbitrary stratigraphic correlations should be avoided, and a reliable stratigraphic subdivision of the Quaternary of Poland should be based on the recognised international standards as well as stratotype sections and areas. This is important both for the Quaternary sciences themselves and for the needs of human society.

Hrynowiecka et al. (2024), based on palaeobotanical analyses (pollen and plant macrofossil analysis) of organic sediments filling

Figure 3. Conference trip to Lake Czechowskie with annually laminated lake sediments – palaeoclimatic and palaeo-environmental issues of the late glacial and Holocene (Błaszkiewicz et al., 2015; Słowiński et al., 2017, 2021; Ott et al., 2016, 2018) (September 2022, photo O. Tomeniuk)

the Żabieniec palaeolake in central Poland, made a palaeoclimatic and palaeo-environmental reconstruction of the Eemian interglacial. The research results enabled, on the one hand, a determination of climate changes for this interglacial period, taking into account the degree of climate continentality, and, on the other hand, reference to diverse environmental responses mainly resulting from local hydrogeological conditions.

In turn, Forysiak et al. (2024) referred to the problem, often discussed in geomorphological literature, of the shaping of meltwater outflow in central Poland during the Last Glacial Maximum (LGM). The spatial relations of glaciolimnic sediments in the Warsaw Basin to fluvioglacial and fluvial sediments occurring at the bottom of the Warsaw–Berlin ice-marginal spillway indicated that the spillway played an important role in the westwards outflow of meltwaters of the last ice sheet from Poland. A reinterpretation of existing views indicates that large ice-marginal valley forms in the Central European Lowlands are polygenetic in nature.

The next article (Marciszak et al., 2024) compared and analysed 125 sites with finds of Pleistocene large-mammal fossils in Wielkopolska. In total, 18 species were documented at these sites, including carnivores, proboscideans, perissodacts and artiodactylsyls. Most of the finds are associated with cold-adapted members of mammoth fauna dating to the late Pleistocene, but thermophilic faunal species from the Eemian interglacial are also documented. Although the faunal finds at most sites occur without a broader stratigraphic context, they constitute a valuable addition to knowledge about the palaeogeography of the Pleistocene in this part of Europe.

The article by Wiśniewski et al. (2024) critically reviews chronological data on Late Middle Palaeolithic (MP) and Early Upper Palaeolithic (EUP) sites in Poland, which have recently been introduced into the literature. It was mainly based on the results of optoluminescence (OSL) dating. It was concluded, among other things, that MP industries could have reached H5 cooling. There is no conclusive data on the later dating of MP sites. It is currently unclear whether sites associated with the EUP overlap with MP industries. It is possible that sites related to the Lincombian-Ranisian-Jerzmanowician complex may have overlapped slightly with the development period of the oldest Aurignacian phase. The results obtained significantly modify the previous model of chronological differentiation in MIS 3.

The last article (Czubla et al., 2024) in this collective study is a very interesting example of a combination of geological and cultural approaches to millstones built into the walls of some medieval churches in northern Poland and north-western Germany. The authors addressed various geological aspects, such as the genesis and origin of the rocks from which millstones were made, as well as the degree of their weathering related to, among other things, their exposure and salinity. The results of the research work carried out in connection with the economic history of millstone use, as well as their sacral function, have great geotourism and educational potential. Hence, Gothic churches with built-in millstones may become an important feature on routes dedicated to learning about geocultural heritage.

Editors' note:
Unless otherwise stated, the sources of tables and figures are the author's, on the basis of their own research.

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