Poznań
17.03.2023 r.

Jak pęd do nowoczesności przyczynił się do powstania nowej epoki, czyli teoria antropocenu

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Pracownia Biogeochemii

ROŻNE OBLICZA GEOGRAFII

Ministerstwo Edukacji i Nauki

Uniwersytet im. Adama Mickiewicza w Poznaniu

Wydział Nauk Geograficznych i Geologicznych

Geology of mankind

Paul J. Crutzen

For the past three centuries, the effects of humans on the global environment have escalated. Because of these anthropogenic emissions of carbon dioxide, global climate may depart significantly from natural behaviour for many millennia to come. It seems appropriate to assign the term 'Anthropocene' to the present, in many ways human-dominated, geological epoch, supplementing the Holocene — the warm period of the past 10–12 millennia. The Anthropocene could be said to have started in the latter part of the eighteenth century, when analyses of air trapped in polar ice showed the beginning of growing global concentrations of carbon dioxide and methane. This date also happens to coincide with James Watt's design of the steam engine in 1784.

Mankind's growing influence on the environment was recognized as long ago as 1873, when the Italian geologist Antonio Stoppani spoke about a "new telluric force which in power and universality may be compared to the greater forces of earth," referring to the "anthropozoic era". And in 1926, V. I. Vernadsky acknowledged the increasing impact of mankind: "The direction in which the processes of evolution must proceed, namely towards increasing consciousness and thought, and forms having greater and greater influence on their surroundings." Teilhard de Chardin and Vernadsky used the term 'noösphere' — the 'world of thought' — to mark the growing role of human brain-power in shaping its own future and environment.

The rapid expansion of mankind in numbers and per capita exploitation of Earth's resources has continued apace. During the past three centuries, the human population has increased tenfold to more than 6 billion and is expected to reach 10 billion in this century. The methane-producing cattle population has risen to 1.4 billion. About 30–50% of the planet's land surface is exploited by humans. Tropical rainforests disappear at a fast pace, releasing carbon dioxide and strongly increasing species extinction. Dam building and river diversion have become commonplace. More than half of all accessible fresh water is used by mankind. Fisheries remove more than 25% of the primary production in upwelling ocean regions and 35% in the temperate continental shelf. Energy use has grown 16-fold during the twentieth century, causing 160 million tonnes of atmospheric sulphur dioxide emissions per year, more than twice the sum of its natural emissions. More nitrogen fertilizer is applied in agriculture than is fixed naturally in all terrestrial ecosystems; nitric oxide production by the burning of fossil fuel and biomass also overrides natural emissions. Fossil-fuel burning and agriculture have caused substantial increases in the concentrations of 'greenhouse' gases — carbon dioxide by 30% and methane by more than 100% — reaching their highest levels over the past 400 millennia, with more to follow.

So far, these effects have largely been caused by only 25% of the world population. The consequences are, among others, acid precipitation, photochemical 'smog' and climate warming. Hence, according to the latest estimates by the Intergovernmental Panel on Climate Change (IPCC), the Earth will warm by 1.4–5.8 °C during this century.

Many toxic substances are released into the environment, even some that are not toxic at all but nevertheless have severely damaging effects, for example the chlorofluorocarbons that caused the Antarctic 'ozone hole' (and which are now regulated). Things could have become much worse: the ozone-destroying properties of the halogens have been studied since the mid-1970s. If it had turned out that chlorine behaved chemically like bromine, the ozone hole would by then have been a global, year-round phenomenon, not just an event of the Antarctic spring. More by luck than by wisdom, this catastrophic situation did not develop.

Unless there is a global catastrophe — a meteorite impact, a world war or a pandemic — mankind will remain a major environmental force for many millennia. A daunting task lies ahead for scientists and engineers to guide society towards environmentally sustainable management during the era of the Anthropocene. This will require appropriate human behaviour at all scales, and may well involve internationally accepted, large-scale geo-engineering projects, for instance to 'optimize' climate. At this stage, however, we are still largely treading on *terra incognita*. ■

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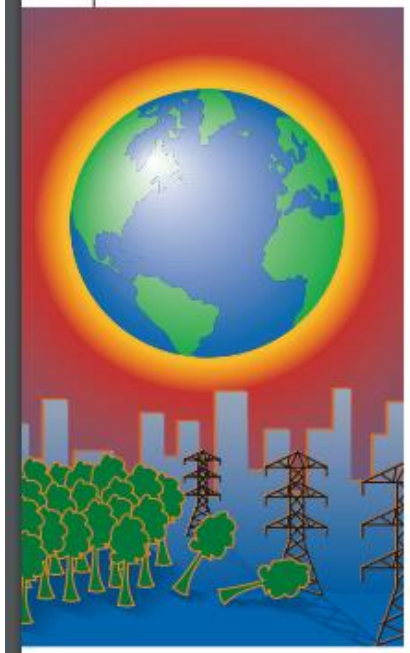
The Anthropocene

The Anthropocene could be said to have started in the late eighteenth century, when analyses of air trapped in polar ice showed the beginning of growing global concentrations of carbon dioxide and methane.



FURTHER READING

Marsh, G. P. *Man and Nature* (1864). (Reprinted as *The Earth as Modified by Human Action* (Belknap Press, Cambridge, Massachusetts, 1965)).

Crutzen, P. J. & Stoermer, E. F. *IGBP Newsletter* 41 (Royal Swedish Academy of Sciences, Stockholm, 2000).

Clark, W. C. & Munn, R. E. (eds) *Sustainable Development of the Biosphere* Ch. 1 (Cambridge Univ. Press, Cambridge, 1986).

Vernadski, V. I. *The Biosphere* (translated and annotated version from the original of 1926) (Springer, New York, 1998).

Turner, B. L. *et al. The Earth as Transformed by Human Action* (Cambridge Univ. Press, Cambridge, 1990).

McNeill, J. R. *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (W. W. Norton, New York, 2000).

Houghton, J. T. *et al.* (eds) *Climate Change 2001: The Scientific Basis* (Cambridge Univ. Press, Cambridge, 2001).

Berger, A. & Loutre, M.-F. *C. R. Acad. Sci. Paris* 323 (IIA), 1–16 (1996).

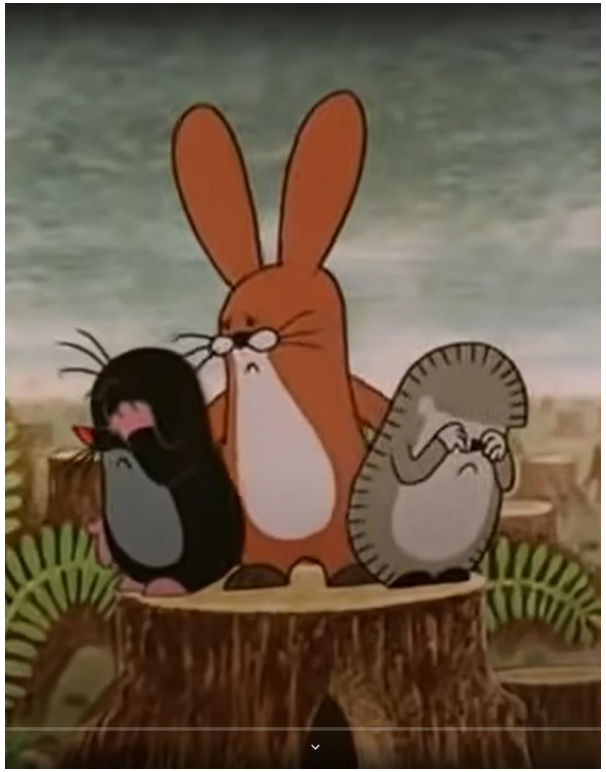
Schellnhuber, H. J. *Nature* 402, C19–C23 (1999).

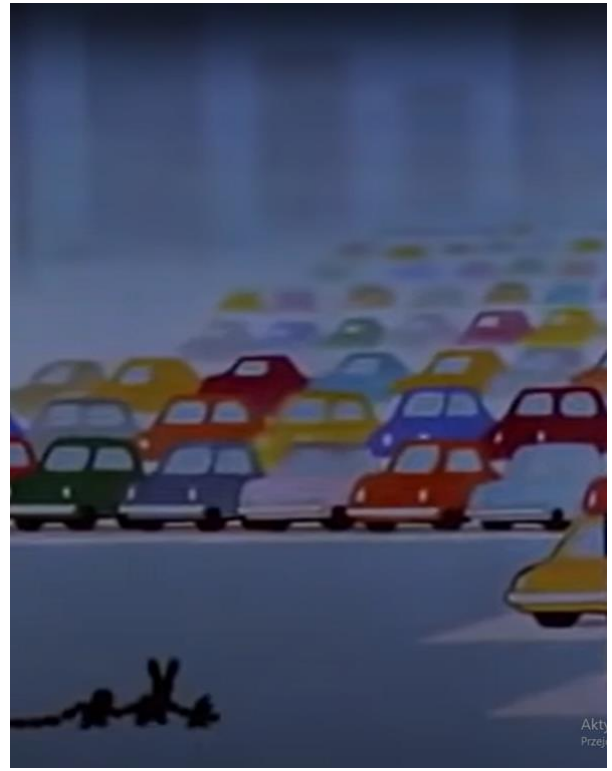
Paul Crutzen, chemik, laureat nagrody nobla

W 2009 roku powołano Grupę Roboczą ds. Antropocenu (Anthropocene Working Group)

Zadaniem Grupy Roboczej ds. Antropocenu (należącej do Podkomisji Stratygrafii Czwartorzędu), jest zebranie i przedstawienie Międzynarodowej Komisji Stratygrafii dowodów, które będą stanowiły podstawę sformalizowania antropocenu jako jednostki chronostratygraficznej.

Krecik w mieście
czyli jak przekształcaliśmy powierzchnię naszej planety



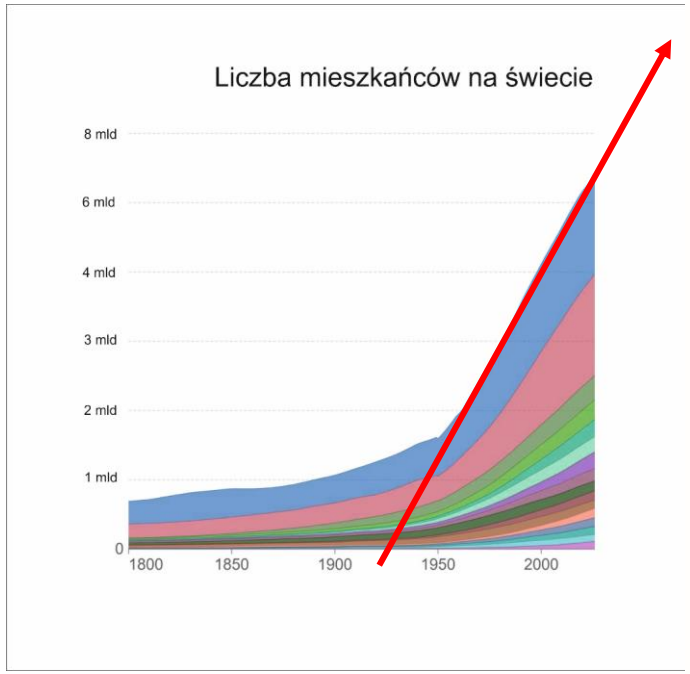


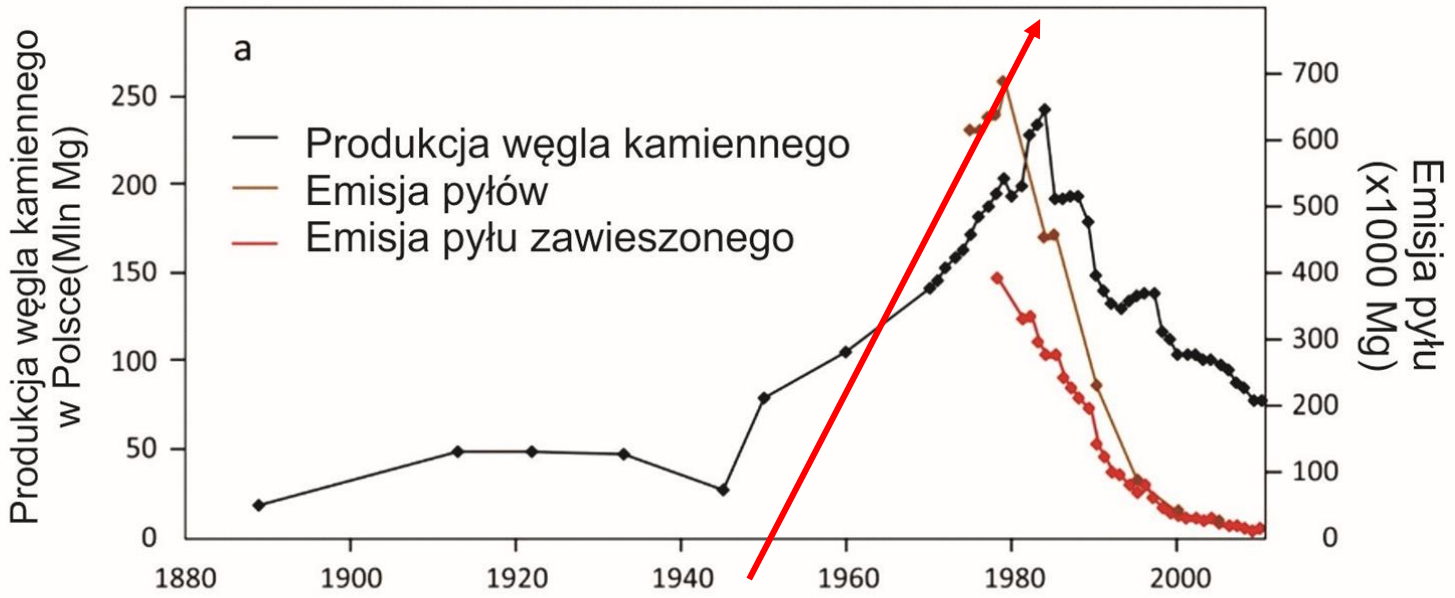

Bangkok
https://www.national-geographic.pl/traveler/galeria/oto-9-najpiekniejszych-metropolii-swiata-zobacz-ich-imponujace-p

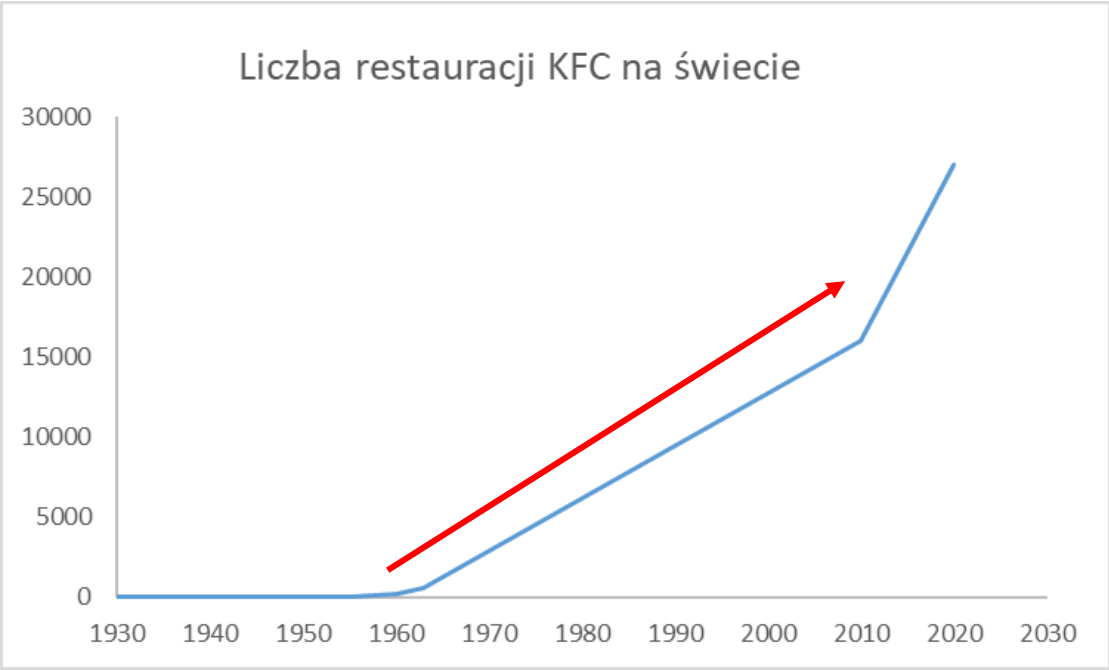
Tokyo

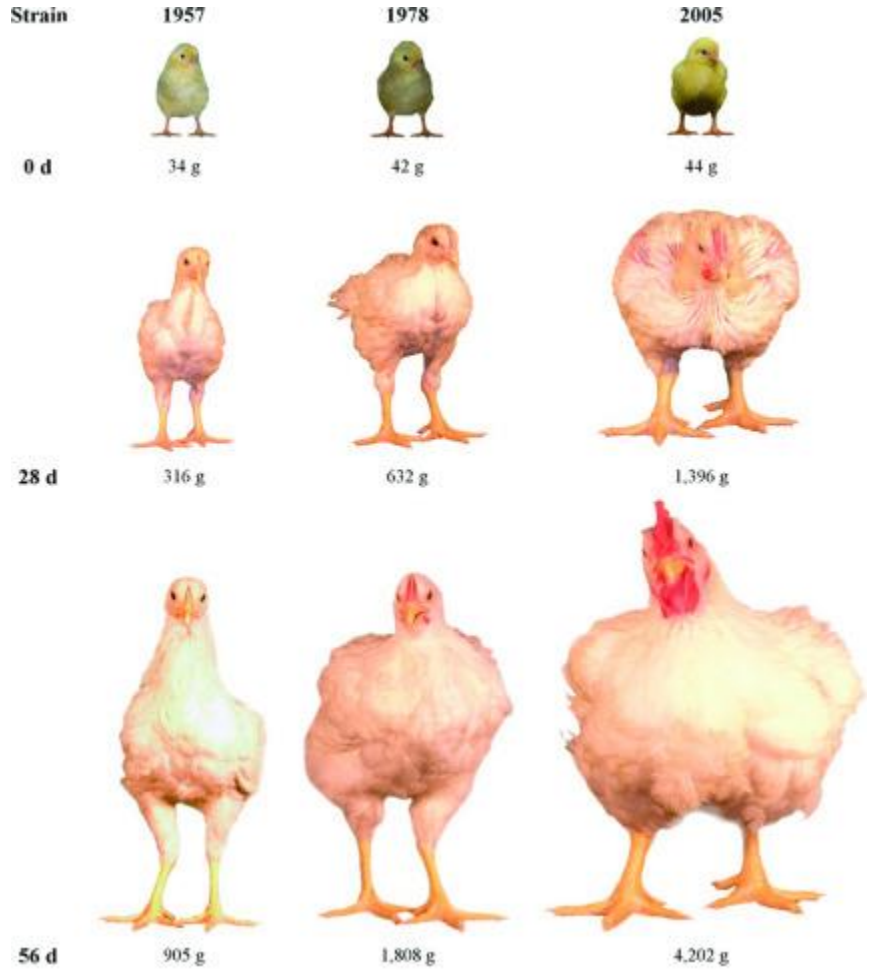

Nairobi

Wielkie Przyspieszenie – *Great Acceleration*







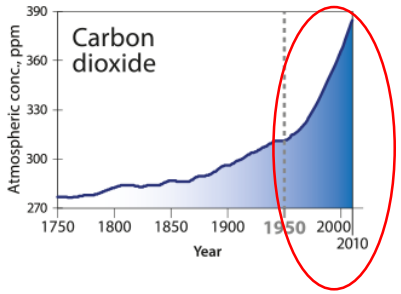


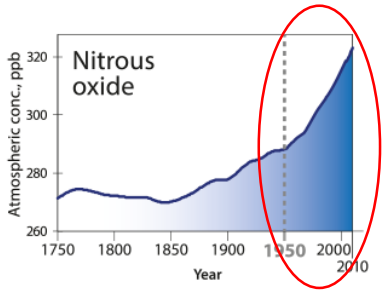
Wzrost masy brojlerów

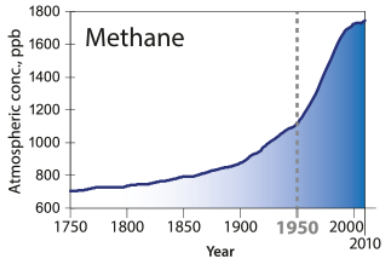
M.J. Zuidhof, B.L. Schneider, V.L. Carney, D.R. Korver, F.E. Robinson. Growth, efficiency, and yield of commercial broilers from 1957, 1978, and 2005 Poult. Sci, 93 (2014), pp. 2970-2982

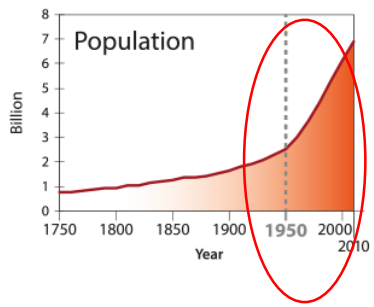
Earth system trends

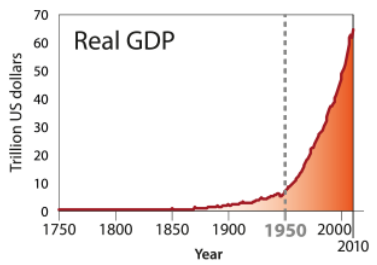
Socio-economic trends

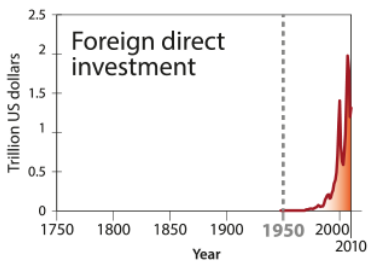


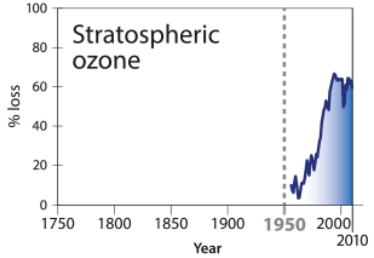


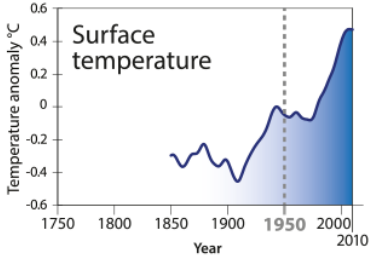


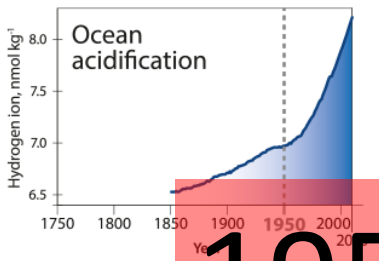


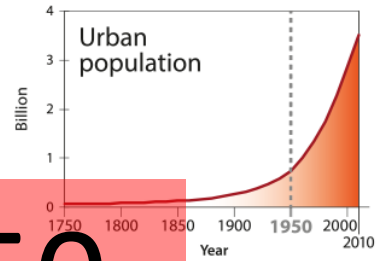


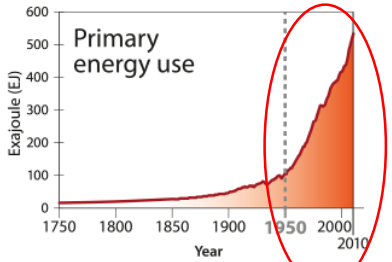


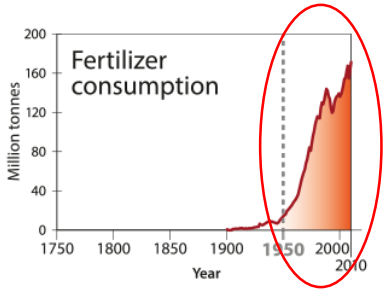












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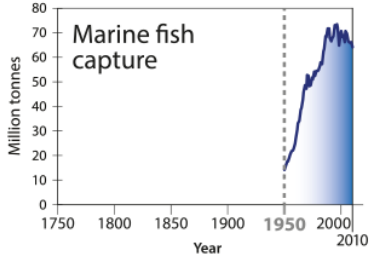
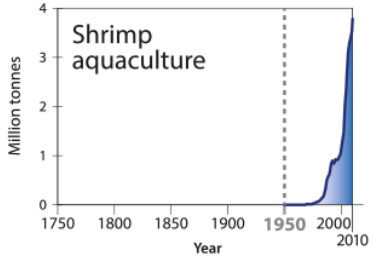
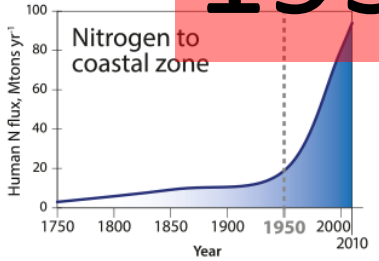
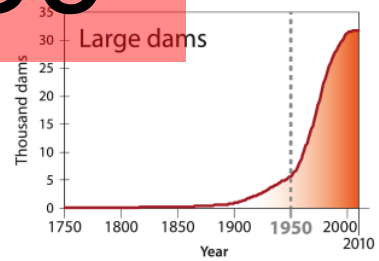
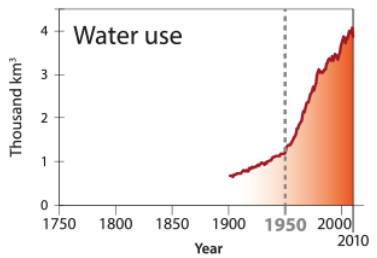
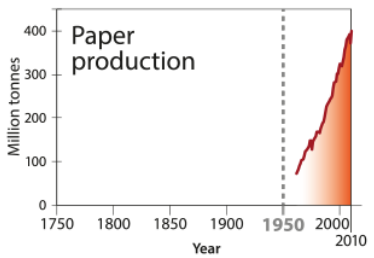


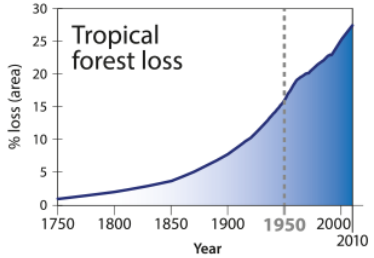


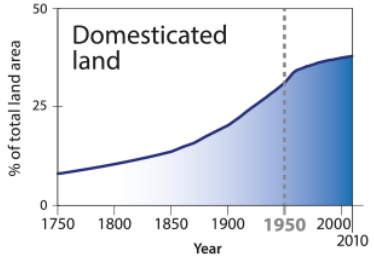


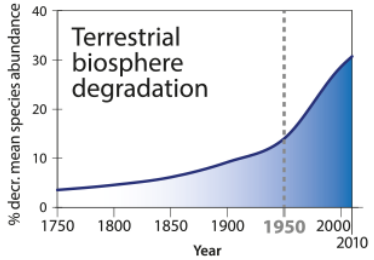


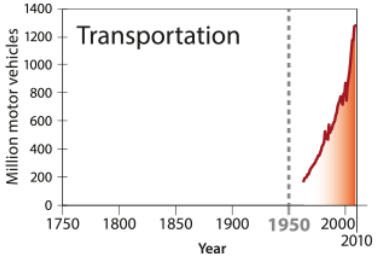


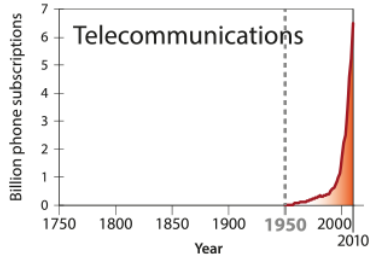


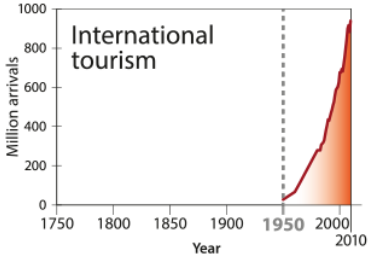












https://futureearth.org/2015/01/16/the-great-acceleration/

Antropocen,

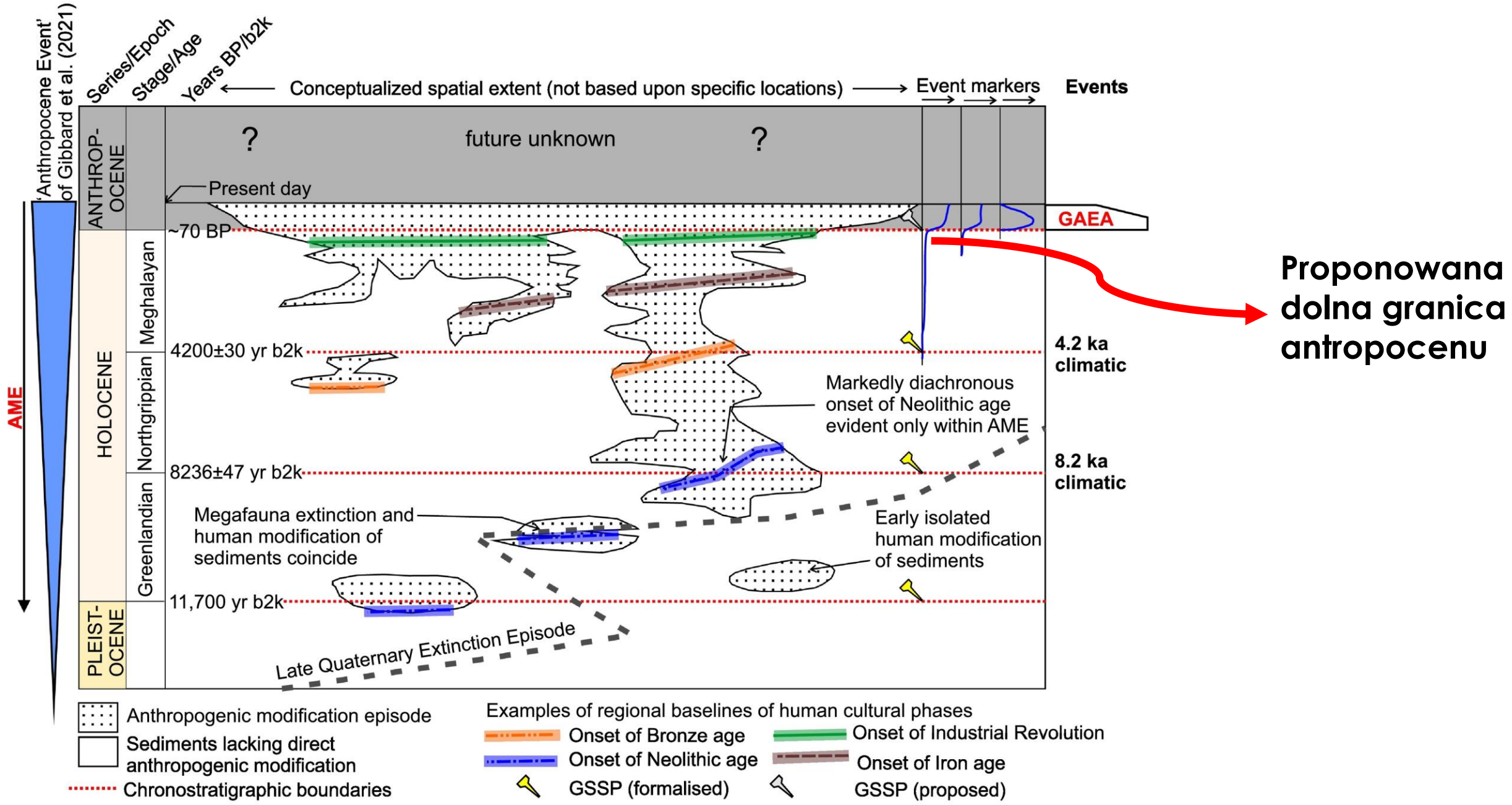
proponowana nowa epoka geologiczna, którą rozumie się jako

globalnie identyfikowany od lat 50. XX wieku

zbiór wskaźników pochodzenia antropogenicznego

o odmiennej trajektorii w stosunku do holocenu

(Waters i in., 2022).



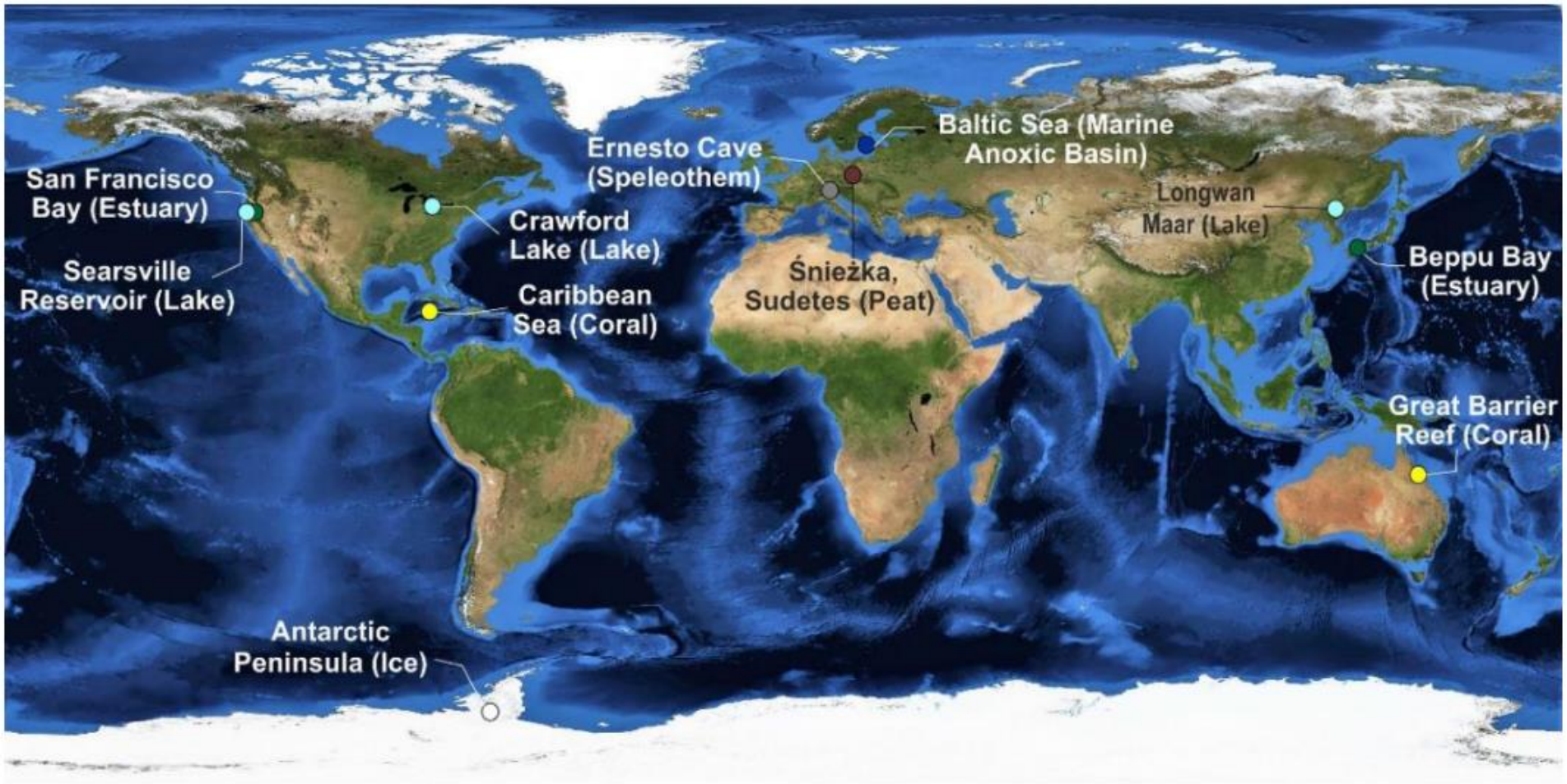
Proponowana dolna granica antropocenu

Waters i in., 2022

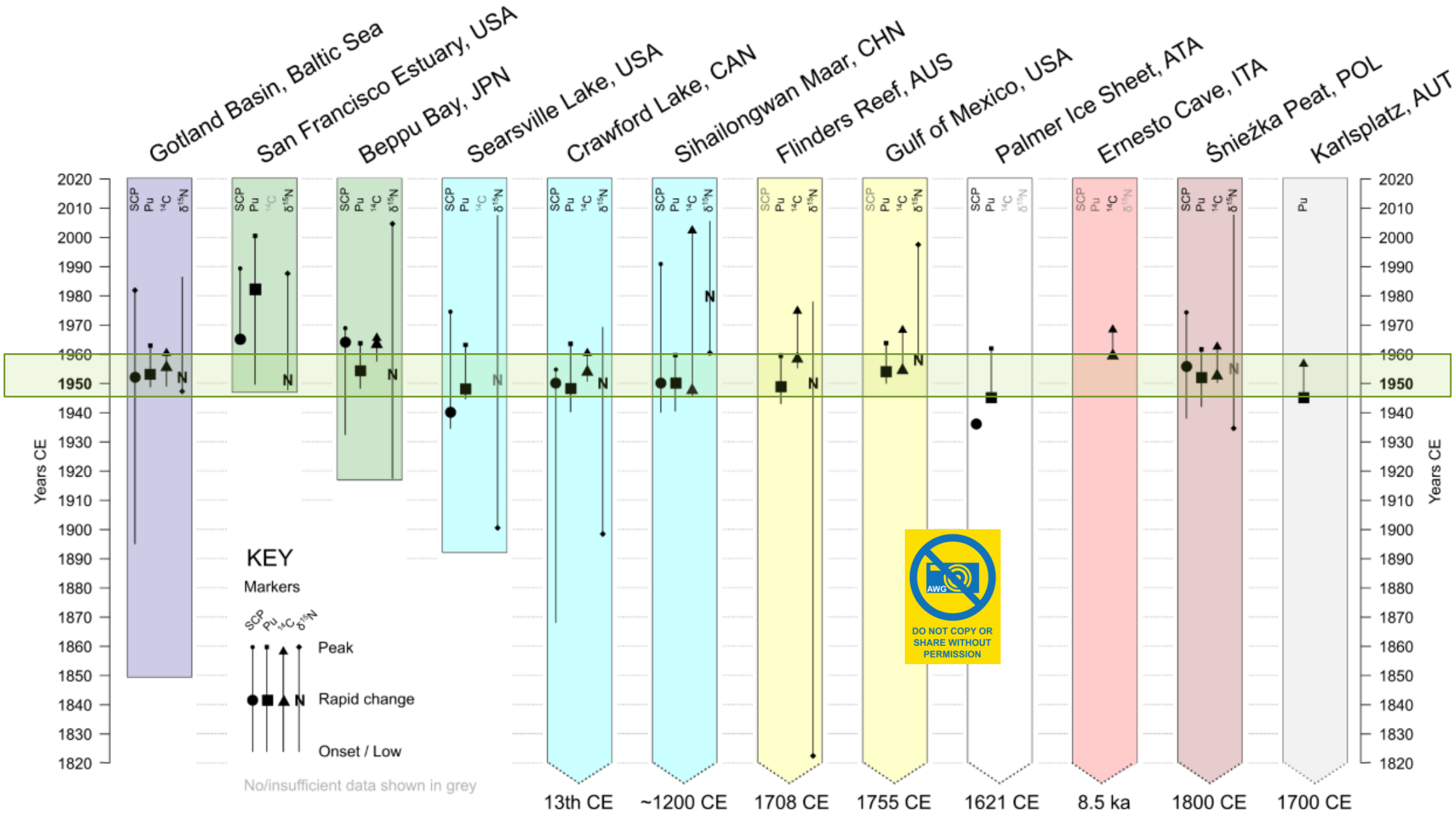
Obecny etap prac AWG obejmuje wybranie modelowego stratotypu dolnej granicy antropocenu (Global Stratotype Section and Point – GSSP)

Stratotyp granicy stratygraficznej jest warstwą charakterystyczną w obrębie wybranego następstwa osadów o ciągłej depozycji, stanowiący wzorzec dla definicji danej jednostki stratygraficznej przez wyróżnienie jej granicy (Marks i in., 2014)

Lokalizacja kandydatów na złotego gwoździa antropocenu



Location of candidate GSSP sites currently under investigation. Satellite image credit: NASA Visible Earth.



Waters i in., 2022

W jaki sposób Śnieżka stała się kandydatem na stratotyp granicy antropocenu?

ELSEVIER

Quaternary Science Reviews

Volume 230, 15 February 2020, 106162

Influence of transboundary transport of trace elements on mountain peat geochemistry (Sudetes, Central Europe)

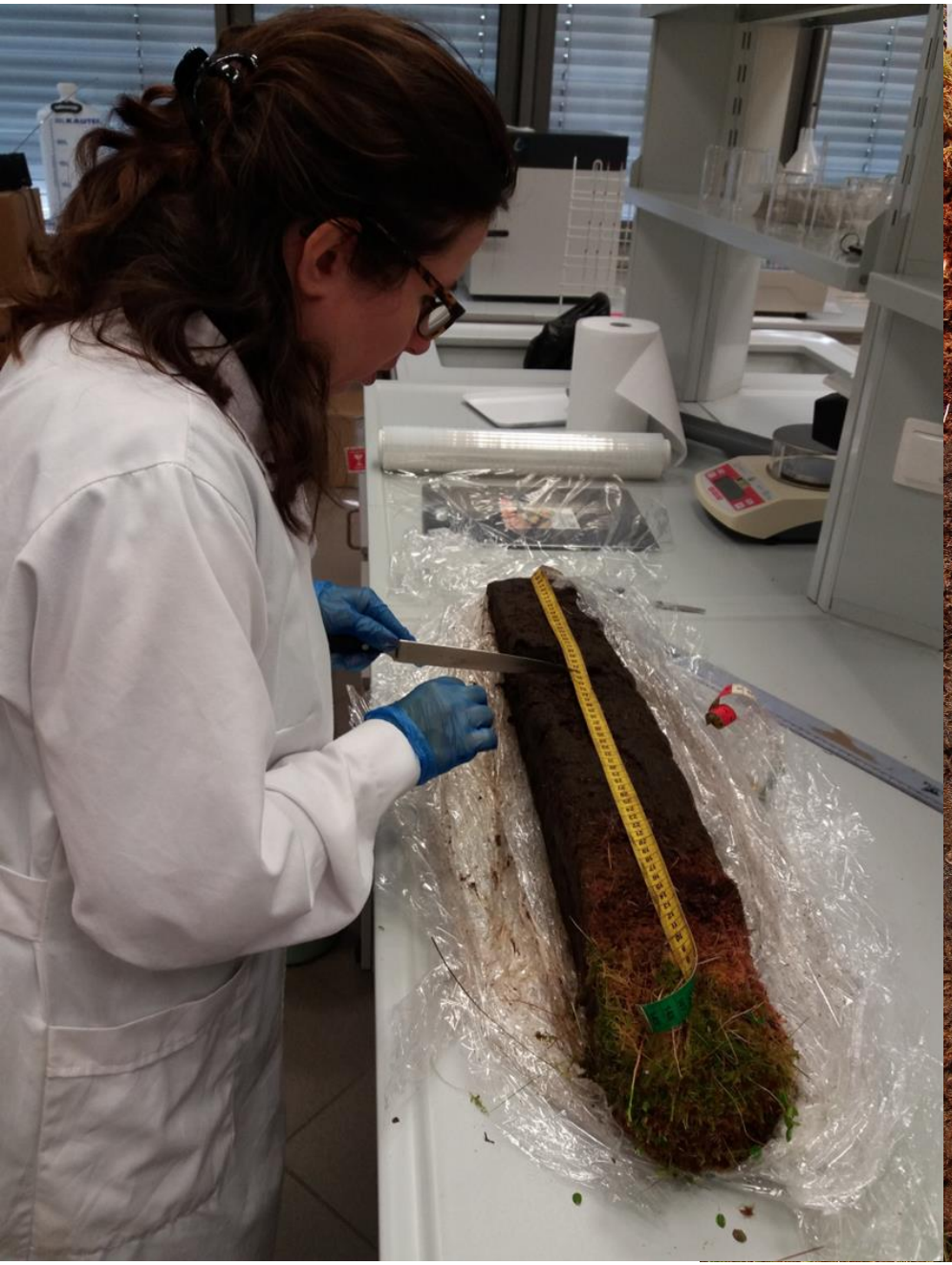
Barbara Fiałkiewicz-Kozieł [a], Edyta Łokas [b], Mariusz Gałka [c], Piotr Kołaczek [a], Francois De Vleeschouwer [d], Gael Le Roux [e], Beata Smieja-Król [f]

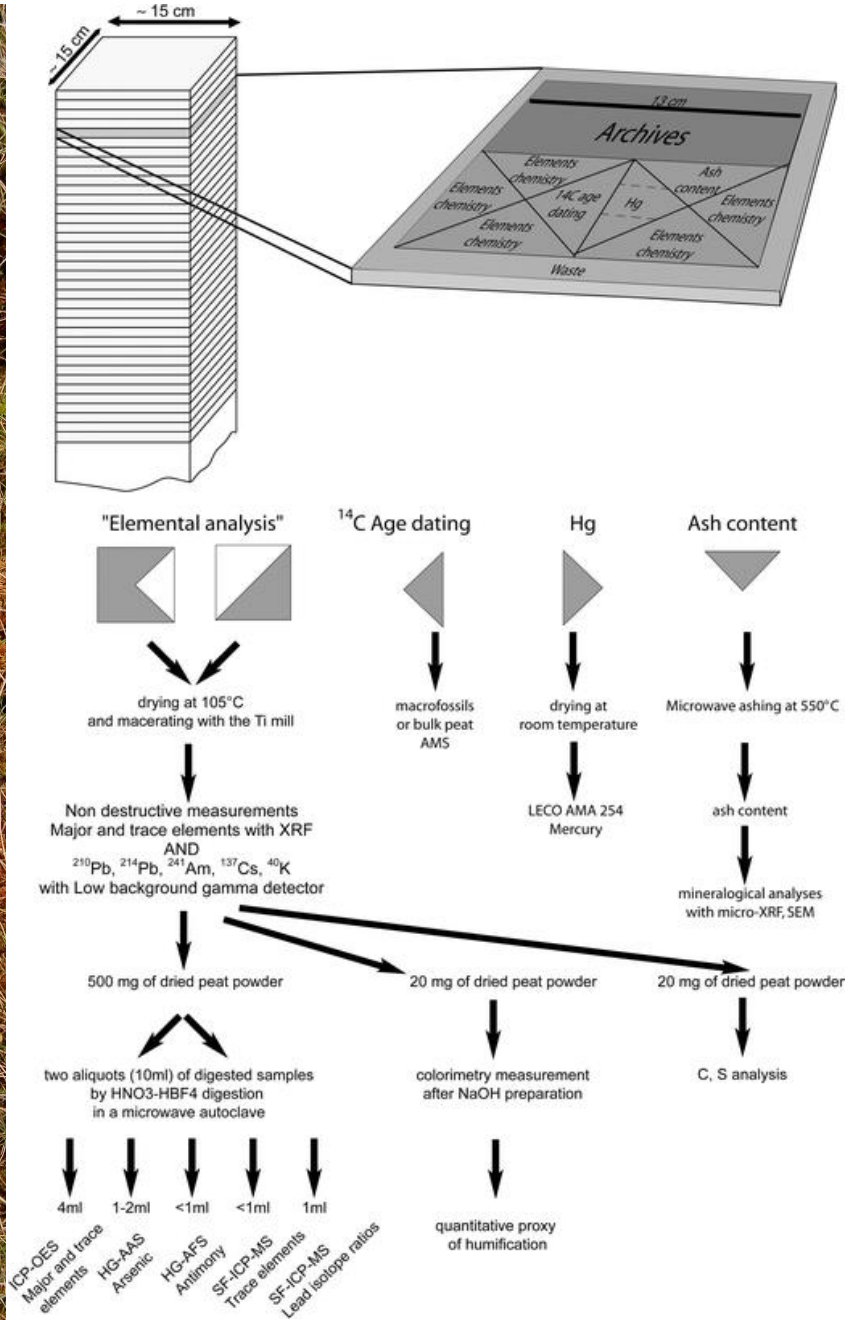

15°E
Główne kierunki wiatru
NRS
N
NE
E
SE
S
SW
W
NW
30%
20%
10%
0%
Polska
Wrocław
Dresden
Śnieżka
Niemcy
Krusné hory
Sudety
50°N
Praga
Czechy
100 km

Na równi pod Śnieżką


Mchy Sphagnum


KATEDRA EKOLOGII

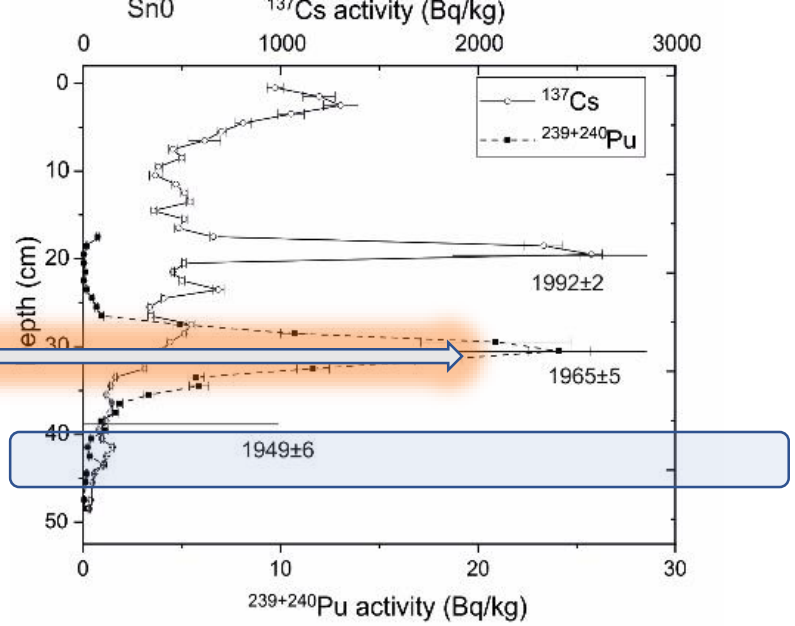


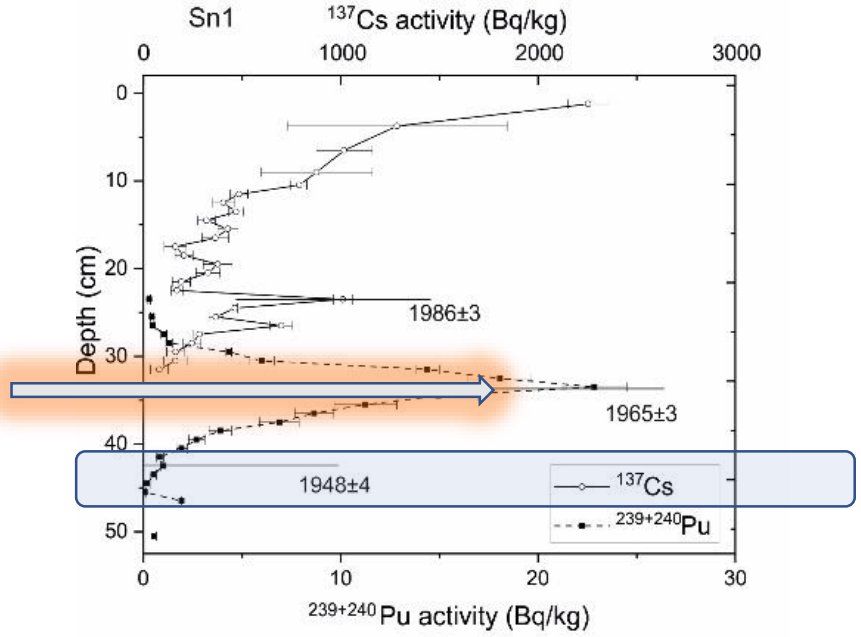


Givelet et al.. (2004)

Określenie wieku
kluczowym etapem analizy osadów

- ^{14}C radiowęgiel
- ^{210}Pb ołów
- ^{137}Cs cez
- $^{239+240}Pu$ pluton



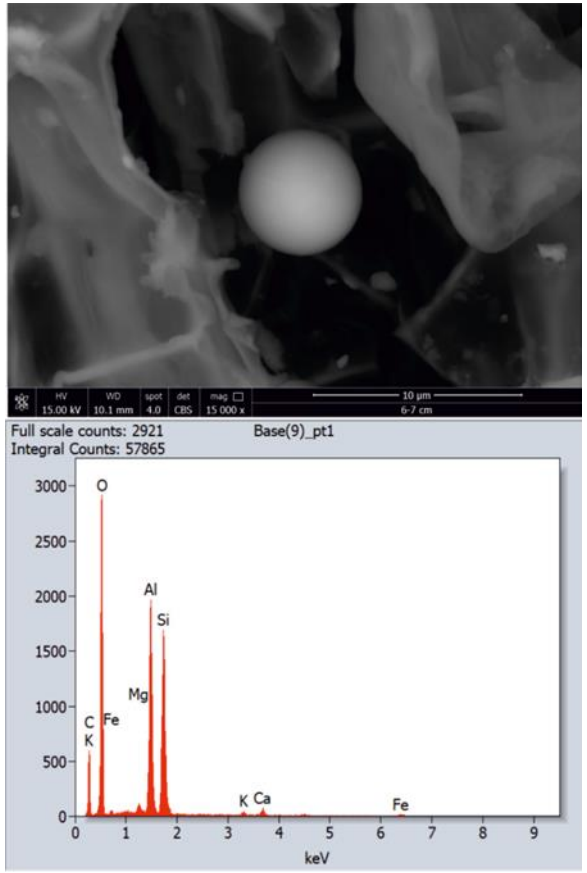


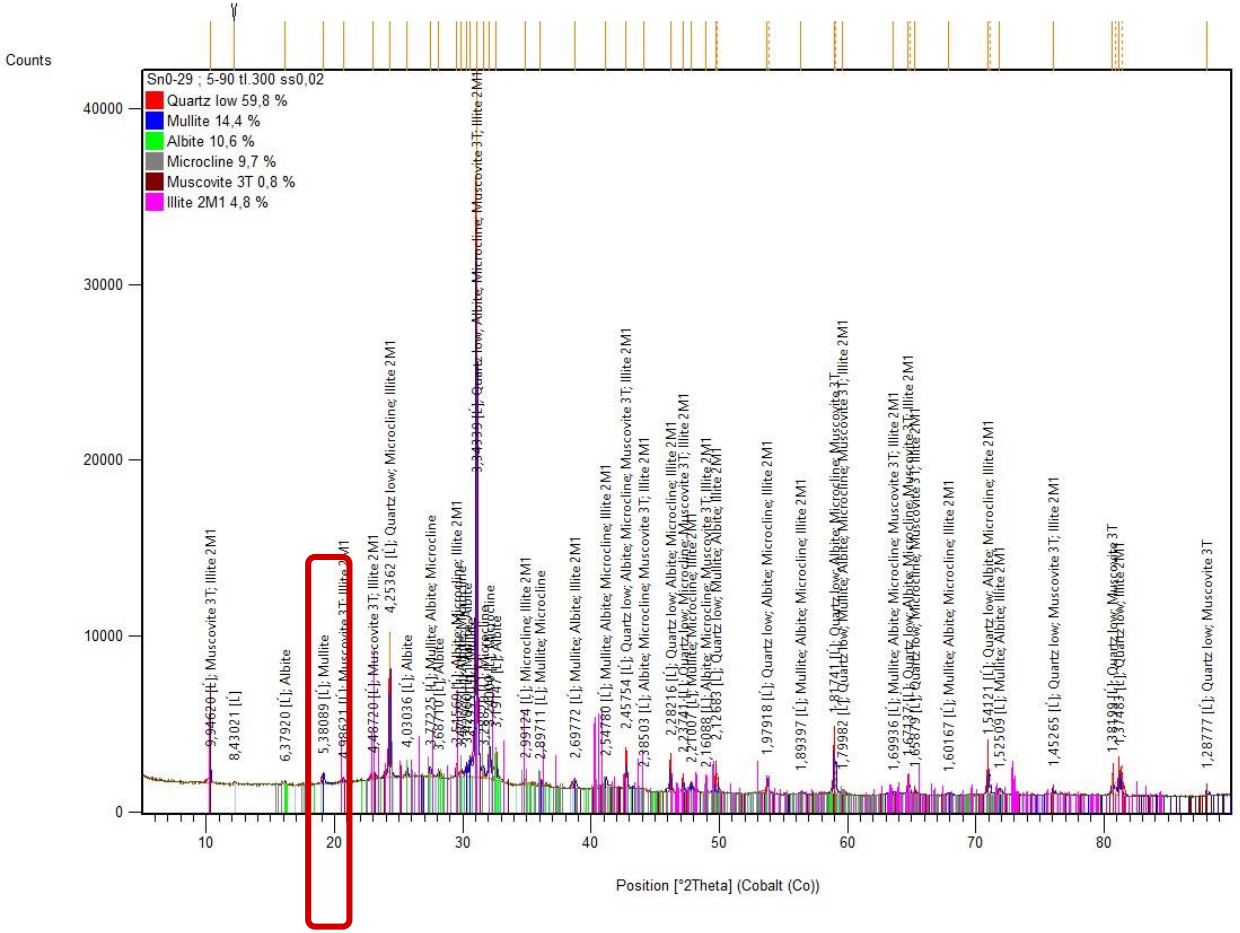
Rola plutonu w wyznaczeniu granicy nowej epoki

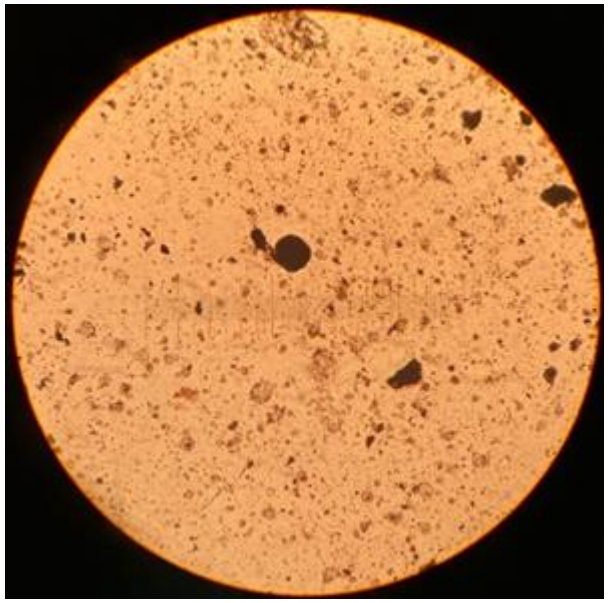
W kontekście wyznaczenia granicy antropocenu kluczowym markerem są antropogeniczne izotopy ^{238}Pu, $^{239+240}$Pu, które zostały uwolnione do wyższych warstw atmosfery w wyniku prób z bronią jądrową i opadały systematycznie na powierzchnię Ziemi jako tzw. globalny opad promieniotwórczy.

Działalność przemysłowa jako siła sprawcza indukująca powstanie nowej epoki

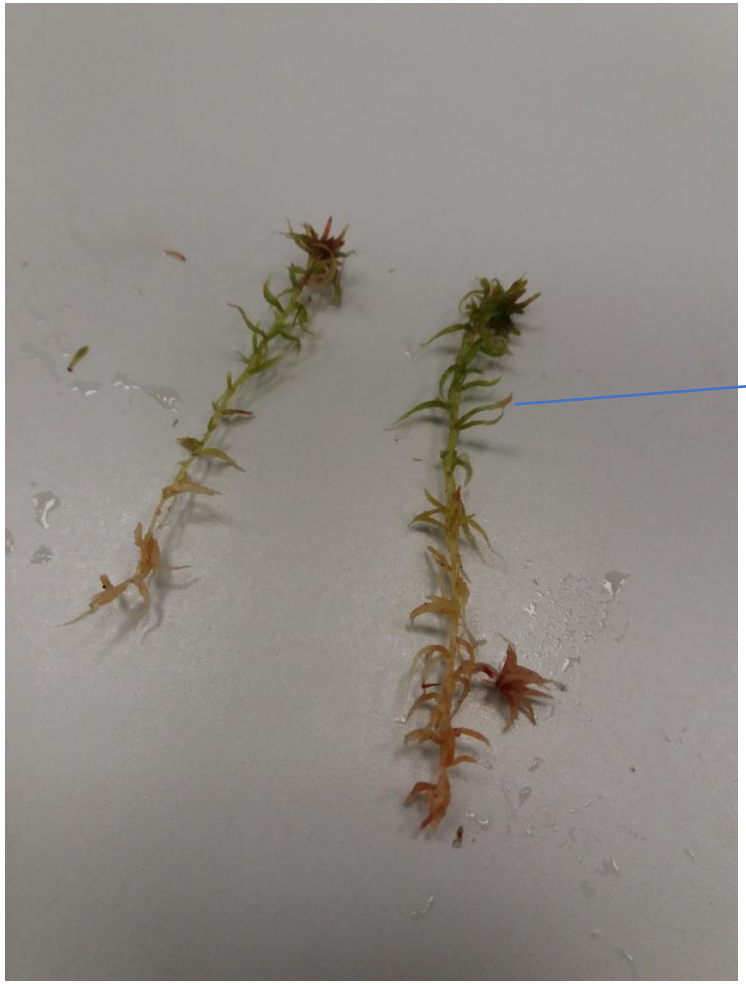
3 rodzaje markerów spalania węgla
mikrosfery glinokrzemianowe(SAP), mullit, mikrosfery węglowe (SCP)

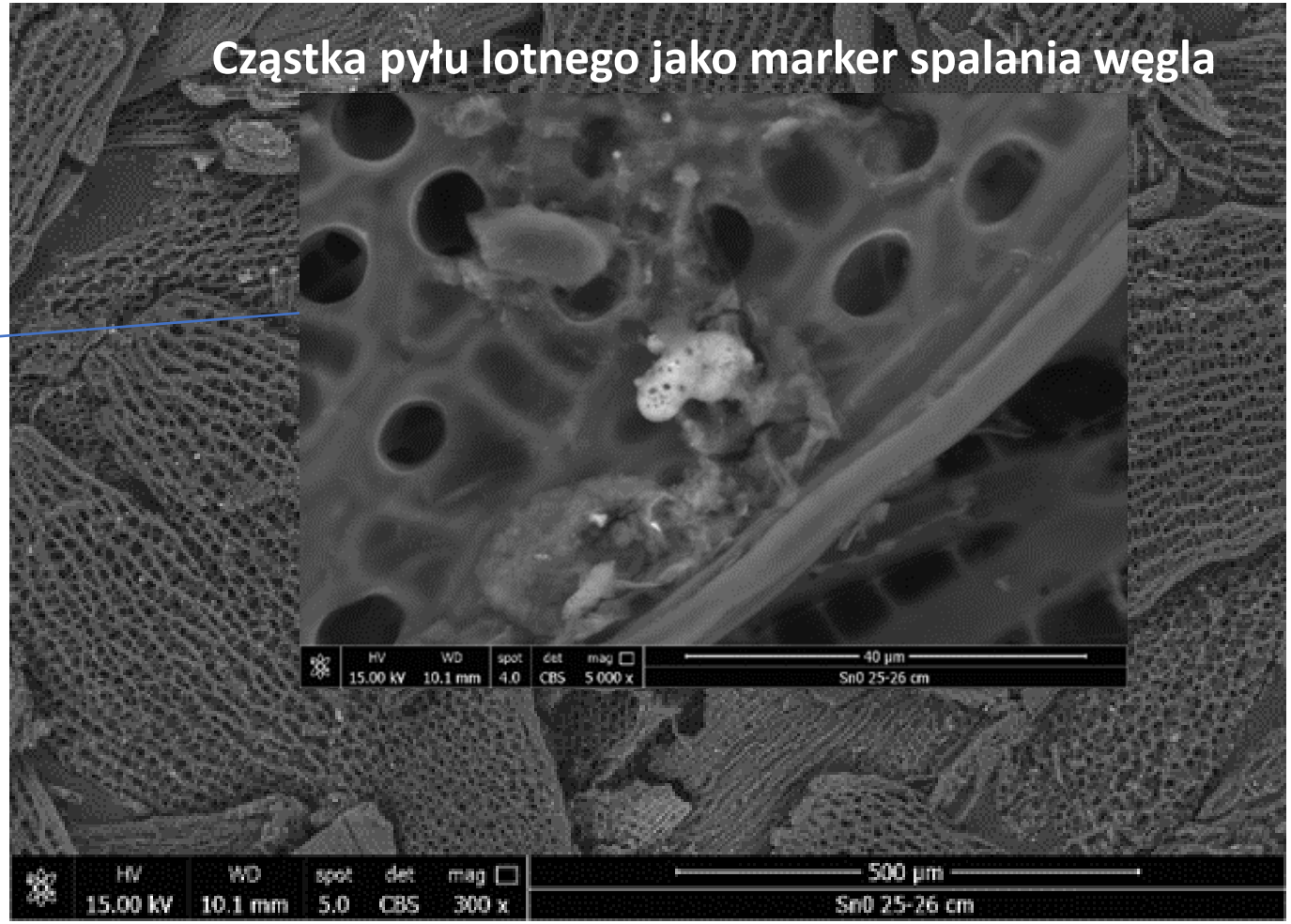






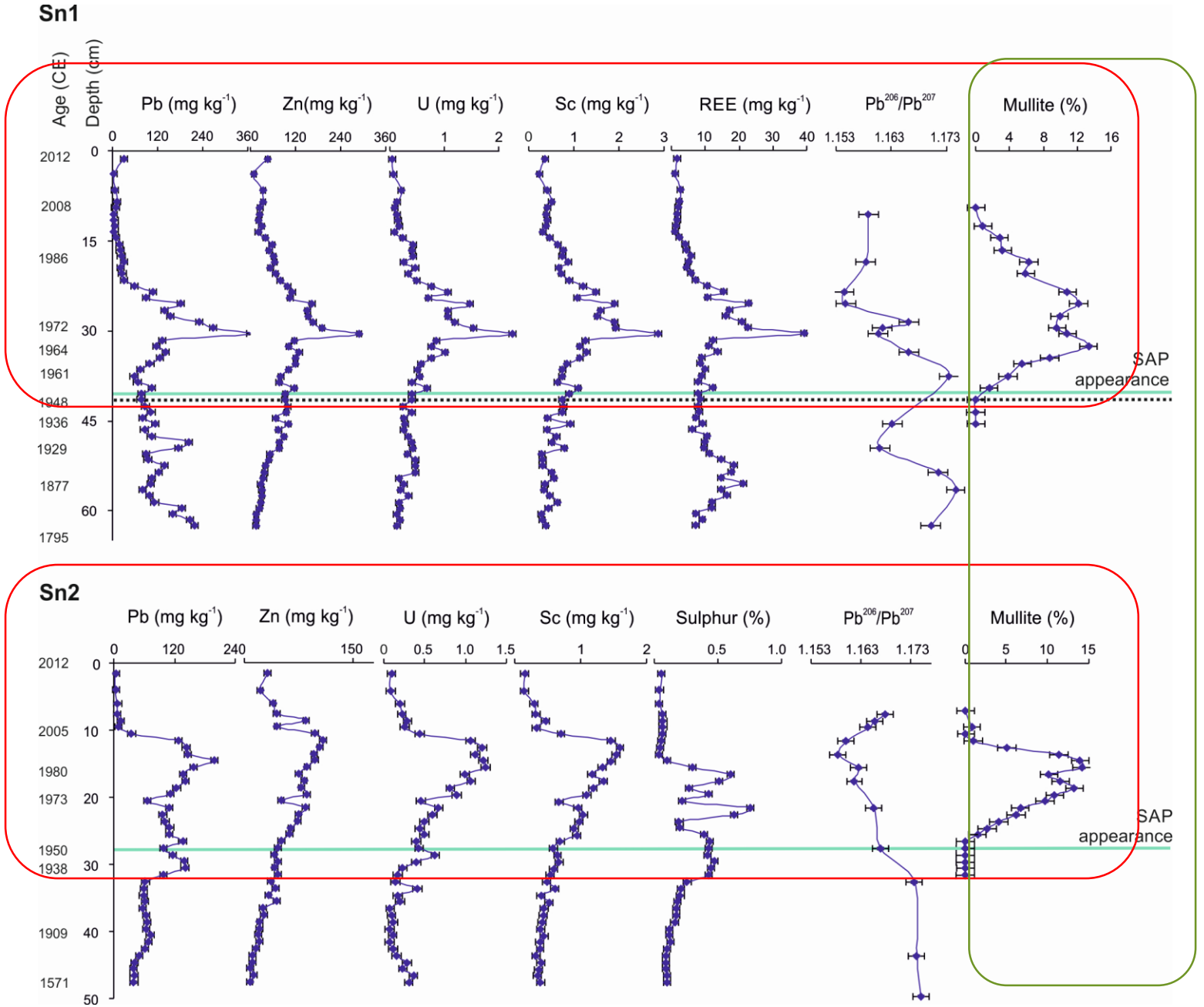
Torfowisko wysokie jest zbudowane z mchów *Sphagnum,* które rejestrują opad pyłów lotnych ze spalania węgla





1952 sygnał Pu

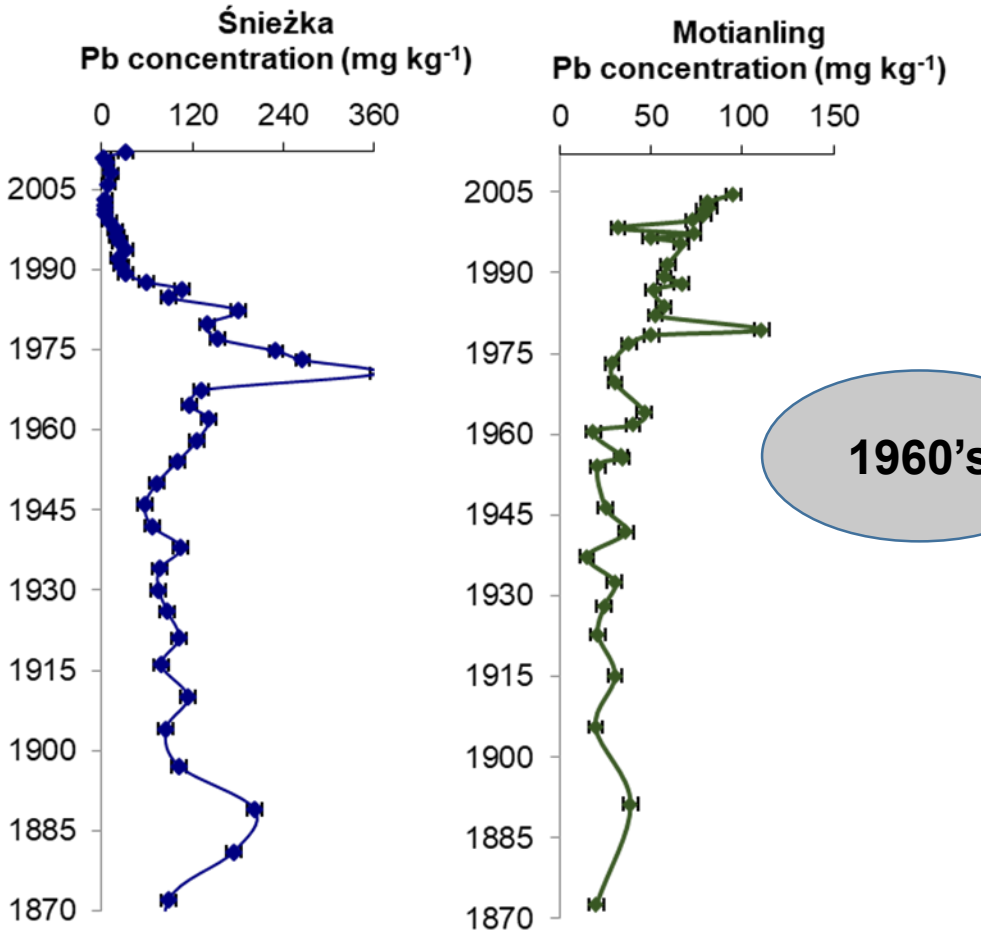
Pierwsze pojawienie się markerów wysokotemperaturowego spalania węgla



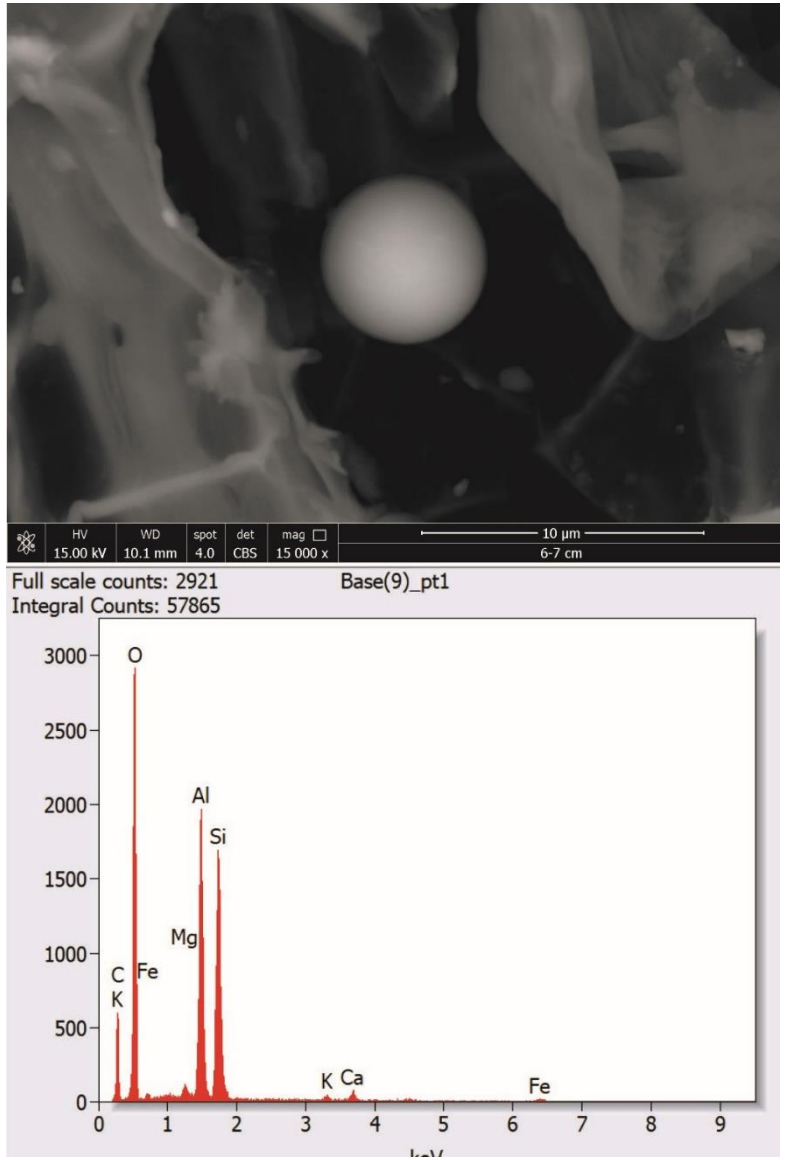
Fiałkiewicz-Kozieł i in. (2020; 2022)

Synchroniczne pojawienie się mikrosfer glinokrzemianowych w Polsce i Chinach

1950's



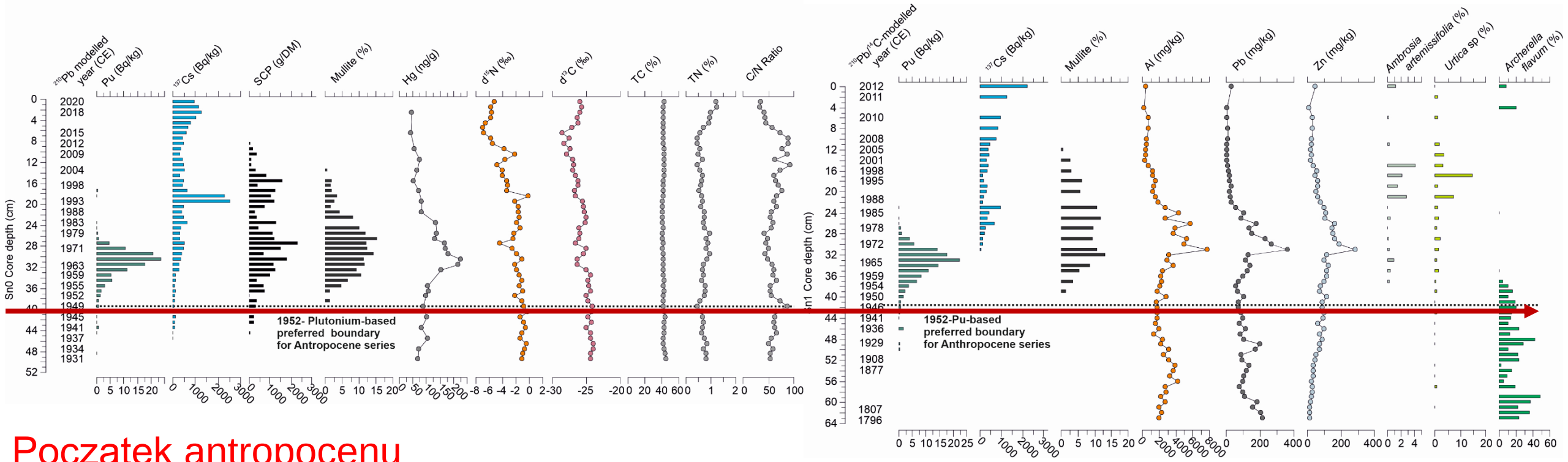
1960's



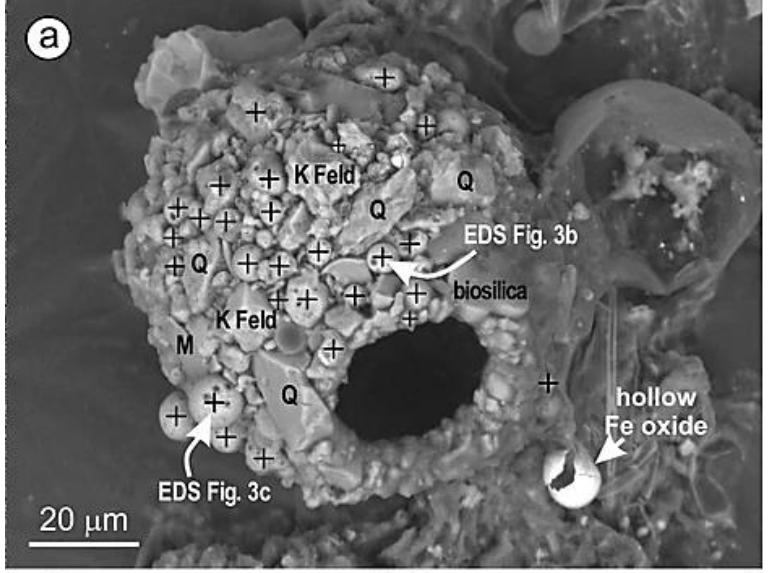
Sumaryczne zestawienie najważniejszych wskaźników antropocenu w dwóch profilach torfowych Sn0 i Sn1

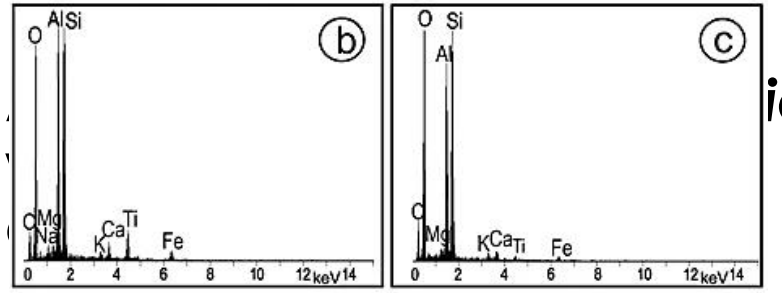
Sn0

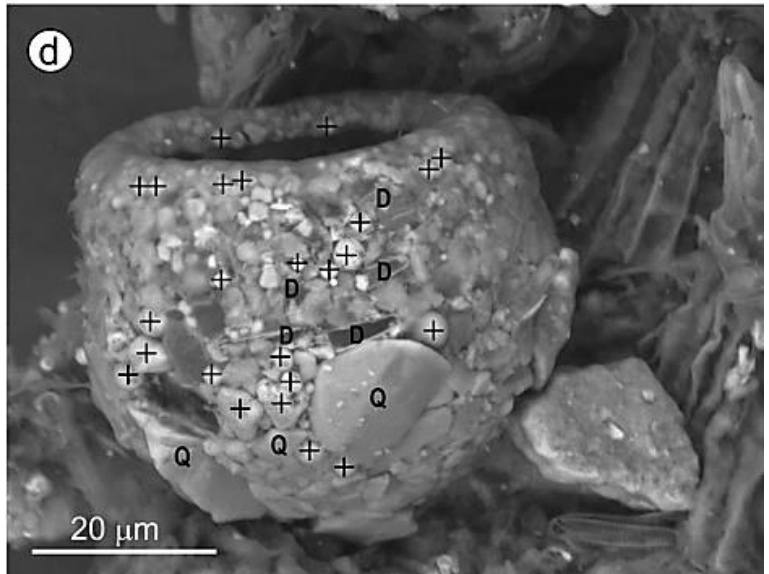
Sn1



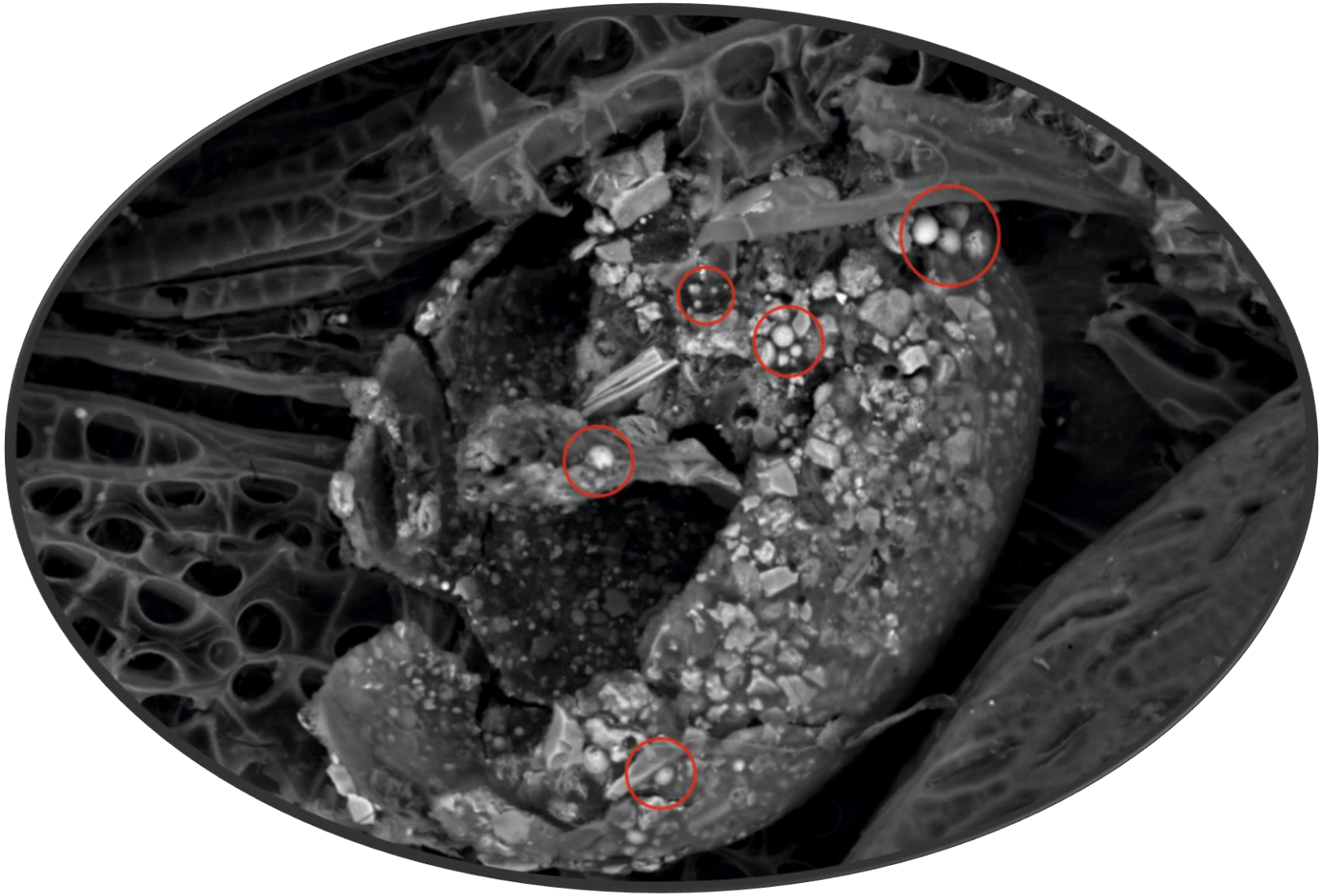
Początek antropocenu







ides



Fiałkiewicz-Kozieł i in., 2015; 2022.

Projekt dofinansowany ze środków budżetu państwa w ramach programu
Ministra Edukacji i Nauki pod nazwą
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