Veronika KOUKAL & Michael WAGREICH (Eds.)

IGCP 732
KICK-OFF MEETING

LANGUAGE of the Anthropocene

Abstracts

University of Vienna, 18-19 October 2021

An interdisciplinary online meeting on the Anthropocene, with focus on the UNESCO IGCP 732 project "LANGUAGE"- Lessons in anthropogenic impact: a knowledge network of geological signals to unite and asses global evidence of the Anthropocene.

IGCP 732 KICK-OFF MEETING 18-19 October 2021

Introduction

Dear IGCP 732 Colleagues and participants, dear interested colleagues,

Welcome to the UNESCO-IGCP 732 “LANGUAGE of the Anthropocene”!

The first workshop and thus Kick-Off-meeting of UNESCO-IGCP 732 took place online from 18-19 October 2021, organized at the University of Vienna, Department of Geology. The IGCP732 was established by UNESCO in spring 2021. The Kick-Off-meeting was, thanks to you, a great success with more than 50 participants from 19 countries, thereof 10 from developing countries. Due to the given circumstances, we had to host this event online only, which, on the other hand, provided the chance to join without any extra costs. You can find all abstracts in this conference abstract book and on the website of IGCP 732.

At this meeting, a comprehensive overview on the status and recent investigations on the Anthropocene in various countries (Austria, Brazil, Germany, Kenya and eastern Africa, Nepal, Pakistan, Philippines, South Korea, Sudan, Turkey) were given. In addition, general and local issues connected to the definition of the Anthropocene were discussed. Colin Waters and Simon Turner provided insights into the stratigraphic work of the Anthropocene Working Group (AWG), a recording of these interesting talks is also available on the webpage: https://igcp732.univie.ac.at/meetings/

The open discussion rounds every afternoon delivered an opportunity to connect, network and chat about collaborations and project ideas.

Feel free to distribute this abstract book and file among potentially interested colleagues, especially young scientists, to encourage them to join our network.

Sincerely,

Michael Wagreich & Veronika Koukal

PI of IGCP 732 IGCP 732 secretary

The melting glaciers and people's livelihood in the Nepal Himalaya

Basanta Raj Adhikari

Department of Civil Engineering, Pulchowk, Campus, Institute of Engineering, Tribhuvan University, Nepal,

Email: bradhikari@ioe.edu.np

Himalaya is a produce of collision between Indian and Eurasian plates where global climate change has played an important role for natural hazards and people's livelihood. The number of glacial lakes are increasing due to melting of glaciers which are potentially dangerous for outburst i.e., 21 lakes are potentially critical in the Nepal Himalaya only. In 2010, a total of 3808 glaciers were identified in whole Hindu Kush Himalaya (HKH) and these glaciers are retreating on an average of 38km^2 per year. People have already shifted from high mountains to low land or changed their livelihood options because of this erratic rainfall and glacier melt. Villages are trapped between snow covered peaks and roaring rivers running out of water. The life would be more difficult in near future because warming will likely be at least 0.3^0 C higher in the HKH region even if global warming is kept to 1.5^0 C. The negative effect of melting glaciers on tourism industry is very huge because of periods of high snowfall triggering avalanches, landslides and flooding. This has pushed lots of people below the poverty line. Local people are adapting with changing climate but the adaptation measures needs to be done in broader level.

A systematic review of human behaviour in and around flood zones – Tales from two sites (Khartoum, Sudan & Ahrweiler, Germany)

* Ahmed Alhuseen[1] & Miklós Kázmér[2]

[1]Department of Landscape Carbon Capture, Global Change Research Institute, Academy of Sciences of the Czech Republic, Lipová 1789/9, 370 05 Ceské Budejovice, Czech Republic
E-mail: Corresponding author: Ahmed Alhuseen (ahmedalhuseen@yahoo.com)

[1] Institute of Economics and Agricultural Policies, Agricultural Research Corporation Khartoum, Sudan (Visting Researcher)

[2]Department of Palaeontology, Eötvös University & MTA-ELTE Geological, Geophysical and Space Science Research Group, Budapest, Hungary. E-mail: mkazmer@gmail.com

Although floods benefit ecosystems and nature in many ways, they can also affect and seriously damage human lives, settlements and economies. The massive and sophisticated settlement and economic expansions that characterise contemporary human civilisation do not take sufficient account of disaster-prone areas, which repeatedly claim lives and resources, prompting some scholars to redefine the concept of natural disasters and emphasise the human dimension in their occurrence. The behaviour of individuals, businesses and government agencies before, during and immediately after a disaster can drastically affect the impact and recovery time.

Understanding human behaviour in flood management and flood risk response can be critical for both individuals and communities. It is widely recognised that the relationships between risk awareness, risk understanding, attitudes to risk and behavioural responses are extremely complex and therefore it can be difficult to promote positive behaviours.

Climate change is an additional natural stress that requires both responsive and proactive management practises and wise human behaviour to offset the negative impacts of flooding and other natural disasters. Khartoum, the capital of Sudan, will be most affected by the expected impacts of climate change. Currently, poorly functioning urban plans, obvious climate variability, irrational behaviour of the inhabitants and the high poverty rate among them claim a considerable number of lives and resources even at the slightest deviation from natural averages. Human behaviour during flood disasters has been increasingly researched since the 1980s, and many theories have been put forward to explain why people in developing countries are continously affected by natural disasters, especially floods, every year. However, in the developed world, repeatedly flood disasters have recently affected many settlements in Europe, leaving many people homeless.

We bring examples from two sites: the city of Khartoum (Sudan), where decadal historical records testify to human behaviour, and Ahrweiler (Germany), where millennial archaeological and historical records testify to the ways humans (mis)calculate natural hazards.

Climate change and glacier lake outburst flood risk-assessment in Hunza area, north Pakistan

Rahima Ali[1] and Shahid Iqbal[1]

1. Department of Earth Science, Quaid-i-Azam University, Islamabad, Pakistan

Corresponding Author: siqbal@qau.edu.pk

Glacial lakes formation in high-altitude regions of the Himalayas, Karakorum, and Hindu Kush ranges of north Pakistan is a common process. Historical records indicate the occurrence of multiple Glacial Outburst Floods (GLOF) downstream Indus, linked to failure of such glacial lakes. The present global warming and climate change with a substantial anthropogenic component has significantly increased the rate and magnitude of land sliding in region that is causing increasing drainage blockage and lakes formation in the area. This has increased the probability of GLOF that poses threat to human lives, infrastructure, and agricultural lands in downstream areas. Thus, there is a need for a comprehensive GLOF risk assessment for proper planning, mitigation, and adaptation strategies. The present study presents a methodological approach for risk assessment by GLOF simulation and downstream impact assessment using Shishper Glacier Ice Dammed Lake in Hunza area, north Pakistan. The model uses hydraulic softwares (HEC-RAS and ARCGIS) and the hydrological DEM generated from ASTER DEM, while the land use data was acquired from National Agriculture Research Council (NARC). The inundation flood threat was modelled using three profiles to create a flood by first digitizing the river centerline, banks, flow paths, cross-sections, Bridge, and obstructions. The results show the relationship between flow velocities and water depth variations and the resulting threat to the local inhabitants, infrastructure, and agricultural land during possible low, medium, and high flood events. This modelling may help in the preliminary identification of potential high-risk areas thereby allowing the local authorities to spread awareness among all the stakeholders on how to avoid any GOLF related future disaster. Furthermore, it may also allow the local climate change and meteorology departments in issuing timely warnings during such emergency situations.

Significance of archaeological sites as markers for historical anthropogenic contamination: Evidence from the Peshawar, Pakistan

Mehwish Bibi[1,2*], Shahid Iqbal[1] and Michael Wagreich[2]

1. Department of Earth Sciences, Quaid-i-Azam University, Islamabad, Pakistan
2. Department of Geology, University of Vienna, Austria

Corresponding author's email: bibimehwish15@gmail.com

Stratified gravels at archaeological sites can preserve historical development of the related areas. Such sedimentary archives also preserve signals of anthropogenic activity and thus have been widely used for the understanding of historical anthropogenic contamination. The Gor Khuttree archaeological site in the walled city of Peshawar, NW Pakistan preserve stratified gravels with a potential to unravel the historical anthropogenic controls on the distributions of trace elements in the area. Archaeological trench at the site preserves a 2500-year-old record of human civilization. Geochemical analysis of high-resolution samples at the site reveals signals for anthropogenic distribution of As, Zn, Cu, Mo, Pb, Hg, Ag, and Au during the Meghalayan Stage of Holocene with progressive gain in concentration since the 18th century. The consistent, anthropogenic Ag, Au, and Mo contribution to the system throughout the site's archaeological history is a significant finding. High concentrations of precious elements (Ag and Au) present Gor Khuttree as a major silver-gold processing center. The existence of the present day sarafa market (gold market) that is known since the Gandhara Civilization (2500 years old) in the area strengthens this argument. The Anthropogenic signals from the site correlate to the widespread Greek and Roman mining European signals for the early Anthropocene at around 2000 BP. Signals during the Hindu Shahi period correlate well with the Medieval period mining and smelting peak signals observed in Europe and China. Hg, Ag, and Au concentrations in the area since the start of the 19th century CE correlate to the start of industrialization. During the mid-20th century, these geochemical signals reflect anthropogenic contributions to the local system and correlate to the suggested base of a formalized Anthropocene.

Language of the Anthropocene and the First Post-Industrial Revolution

Professor Mike Bruton
Mike Bruton Imagineering, 22 Forth Road, Rondebosch 7700, Cape Town, South Africa

The concept of the 'Language of the Anthropocene' provides a very useful opportunity to raise concerns about, and find solutions for, the rapidly accelerating loss of plant and animal species and the disruption of essential ecological processes and life-support systems that is taking place now. The Anthropocene project would be strengthened if it was conceptualized in parallel with another event that is occurring simultaneously – the changed mind-set of the 'First Post-Industrial Revolution'.

Although the eminent economist, Klaus Schwab, has declared that we are living in the Fourth Industrial Revolution, I disagree. I do not think that it is an industrial revolution at all but a Post-Industrial Revolution, maybe even an Anti-Industrial Revolution. It is characterized, not by smoke billowing from chimneys, but by the interconnected community of human brains and the 'Internet of Things' that have created multiple gig economies and a global community that is more interlinked than ever before. Furthermore, we are not just connected linearly but irreversibly entangled, not only with a vast network comprising nearly half the world's population, but also with over 10 billion computers and other internet-connected things.

This unprecedented connectivity, combined with robotics, artificial intelligence, quantum computing, 5G wireless technology, telemedicine, 3D printing and major advances in nanotechnology, biotechnology, alternative energy and other fields, as well as a sincere concern for the impact of our activities on climate change and biodiversity conservation, creates problem-solving opportunities that we have never had before.

What is most exciting about the First Post-industrial Revolution, and the opportunities created by an awareness of the Anthropocene, is that it is not confined to an educated elite, as in past industrial revolutions. Male and female, rich and poor, young and old, digitally competent and globally connected people from all continents will contribute ideas, innovations and solutions. Furthermore, many post-industrial developments facilitate technology leapfrogs that allow historically disadvantaged communities to quickly enter the Information Age and contribute to, and benefit from, its services. This trend is particularly obvious in Africa and many futurists are predicting that this will be Africa's century. Although African countries and people have done the least to bring about climate change, they stand to be impacted the most. For this and many other reasons the voice of Africa needs to be heard.

The First Post-Industrial Revolution has created a multi-brained, multi-generational super-organism, a kind of ‘collective genius’, that has the potential to help us redress the wrongs created by previous socio-political regimes and the first three industrial revolutions which have led to the Anthropocene crisis. It is an opportunity for humankind to use the new tools at its disposal to preserve the ‘Internet of Living Things’ (biodiversity), a network of neural and genetic connections that exists between us and all other living endpoints of evolution. Should this interconnectedness with the rest of Nature not be the ultimate source of our communal spirit of self-preservation and biodiversity conservation during the Anthropocene? This approach would remove the human self-centredness that dominates our thinking and decision making and replace it with a humbler ‘we are part of a multispecies network’ mindset.

Painting the bigger picture from creatures, big and small

(macro- and microfossils as indicators of environment change in the Philippines)

Alyssa M. Peleo-Alampay[1], Allan Gil S. Fernando[1]*, Leopoldo P. de Silva, Jr. [1], Caroline Marie B. Jaraula[2], Maria Luisa G. Tejada[3], Kevin L. Garas[4]
[1] Nannnoworks Laboratory, National Institute of Geological Sciences, University of the Philippines Diliman, Quezon City; asfernando@up.edu.ph
[2] Marine Science Institute, University of the Philippines - Diliman, Quezon City, Philippines
[3] Japan Agency for Marine-Earth Science and Technology
[4] Mines and Geosciences Bureau, Diliman, Quezon City

This presentation will introduce research activities done by paleontologists from the academe and government agencies in the Philippines in the last few years, highlighting the relevant research topics that can be aligned with the goal of the IGCP 732 Project. The presentation will include research initiatives in microfossils such as calcareous nannofossils and foraminifera, and corals which all provide a wealth of information regarding past and present geologic and oceanographic environments and processes.

Calcareous Nannofossils (Coccolithophores)

Calcareous nannofossils (coccolithophores) as well as other microfossils such as foraminifera and radiolarians are the main index fossils found to be useful in delineating the different geologic periods and epochs of the Philippines. Because of their sensitivity to atmospheric and oceanographic conditions, their occurrences and abundances in rock, sediment and water samples enable interpretations of the paleoceanography and paleoclimate of investigated sites in the Philippines and surrounding waters. The earliest studies of nannofossils in the Philippines focused on their use in biostratigraphy to aid in prospecting fossil fuels like natural gas and petroleum. In more recent times, nannofossil assemblages from sediments and sediment cores in Philippine waters were also used to correlate with regional and global climatic and oceanographic conditions. Their distribution in surface sediments from the South China Sea and Philippine waters was used to verify ecological preferences of certain taxa, while their distribution in the water column through the study of sediment traps were used to study surface water productivity and the transport of these organisms from the ocean surface to the deep sea. Using sediment cores, calcareous nannofossils, in conjunction with geochemical and isotope data, were also used to infer the occurrence of global paleoclimatic and paleoceanographic events during the Late Pleistocene and Holocene in the Philippines. A more recent undertaking of the laboratory is the inventory of living coccolithophores in Philippine waters which were

compiled into an Atlas. Although this work primarily aims to further the understanding and appreciation of the coccolithophores in the Philippines and in the region, it also presents an opportunity to illustrate how these organisms (especially the calcification process) are possibly affected by global warming through ocean acidification.

Corals

Corals derive their skeleton from both seawater bicarbonate and metabolic CO_2, incorporating key geochemical tracers (Sr/Ca, Mg/Ca, Ba/Ca, $\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$) during calcification. In the last 70 years, the rapid increase of atmospheric CO_2 is considered as the main driver of global temperature rise and significant changes in the ocean's pH. These changes have been affecting the skeletal architecture and chemical composition of carbonate-secreting marine organisms. The atmospheric CO_2 also modulates the hydroclimate systems in Southeast Asia. Philippine corals are good indicators of complex ocean response to the Southeast Asian Monsoon, Intertropical Convergence Zone (ITCZ) and El Nino Southern Oscillation (ENSO). Coral records contain seasonally-resolved environmental archives that were pivotal in early societal activities such as farming/foraging, water consumption and community abandonment/resettlement. Coral sampling and core drilling projects of living massive Porites corals are being conducted in Luzon Island. These modern corals are expected to have a ~100 year-record of ocean-climate conditions that were already influenced by massive land development and human-induced coastal modifications. Modern coral data will be compared to the Holocene coral climate reconstructions from the Philippines, which recorded the climate background before the period of urbanization/industrialization.

Potential Topic: The Eutrophication of Manila Bay and the Anthropocene

Manila, the current capital of the Philippines, is one of the oldest settlements in the Philippines dating pre-Spanish colonization. A prominent embayment, Manila Bay, then and now, played an important role in the development of Manila. Currently, the bay is one of the most polluted bodies of water in the Philippines, characterized by high organic matter loading and heavy metal pollution. This study aims to document how human development (and therefore the Anthropocene) have led to the progressive eutrophication of this bay using sediment cores. A multi-proxy approach will be employed but will focus

mostly on benthic foraminifera, supplemented by calcareous nannofossils and the geochemical and/or isotope characteristics of the sediments.

The development of Manila and surrounding areas is probably similar to other highly urbanized areas in tropical developing countries. With increasing human settlement, forested areas gave way to agricultural lands, and eventually into urban centers. We suspect the shift in land use would have left an imprint in the marine sediments in Manila Bay. Specifically, we would like to investigate the following: (1) increase in siltation rate with deforestation; (2) increase in organic loading with the use of fertilizers; (3) increase in run-off with rapid urbanization; (4) increase in heavy metal pollution with the rise of industries; (5) increase is organic loading due to sewerage; and (6) response of marine organisms (e.g., benthic foraminifera, coccolithophores, corals and fishes) to each of these changes.

Benthic foraminifera are prolific contributors of sediments in shallow marine environments. Their relatively short life cycles and preservable hard parts result in temporal records from which environmental changes can be interpreted. Currently the shallow marine sediments are dominated by the opportunistic taxa *Ammonia beccarii* and *Ammonia tepida* (Militante-Matias, 1992). Eutrophication of Manila Bay most likely was accompanied by a shift from a mixed assemblage to an assemblage dominated by opportunistic species. The proportion of K-strategists (symbiont bearing large benthic foraminifera) and R-strategists (opportunistic species) is the basis for several benthic foraminifera indices used for environmental monitoring and assessment (Hallock et al., 2003; Dimiza et al., 2015). The timing of this shift can be relevant in separating the Holocene from the Anthropocene.

The recent discovery of coral communities in the northern Manila Bay presents a huge potential in understanding the response of biogeochemical systems to the rapid urbanization in the last few centuries. Corals derive their skeleton from both seawater bicarbonate and metabolic CO_2 incorporating key geochemical tracers during calcification. In high-stress environments like Manila Bay, linear extension (growth) rates are very low (Goodkin et al., 2001). River runoff supplies sediments, metals and pollutants that could have altered the chemical and mineralogical composition of carbonate-secreting organisms during the Anthropocene. Local land developments from agriculture and industries are reflected by changes in coral Ba/Ca ratio and calcification rate patterns (Sowa et al., 2014; Ito et al., 2020). Other metallic elements such as Fe and Mn are enriched in coral skeleton following the enrichment of metals in ambient seawater. Past

temperature, salinity and nutrient records from coral Sr/Ca, $\delta^{18}O$, $\delta^{13}C$, $\delta^{15}N$ before and after the onset of Anthropocene would give us insights on the possible shift of oceanic conditions. Coral records contain seasonally-resolved environmental archives that were already influenced by human activities such as farming/foraging, trade and urbanization/industrialization.

Given the relatively young age of the sediments to be used in this study, chronology (age model) may be difficult to establish using standard techniques (e.g., Carbon 14, oxygen isotope). We propose to look for unique marker events which may have left signatures in the sediments: (1) radioactive nucleotide from nuclear bomb use/testing; (2) pesticides (e.g., DDT) use and mis-use; (3) the use of plastics; (4) Pb from gasoline (use and mis-use); and (5) Mt. Pinatubo volcanic ash. We think that the timing of these marker events are more or less synchronous at least in the Philippine setting.

Globally Distributed Peatlands as Valuable Deposits of the Anthropocene Signal

Fiałkiewicz-Kozieł Barbara[1], Smieja-Król Beata[2], Łokas Edyta[3], Siepak Marcin[1], Wąsowicz Paweł[4], Mezhibor Antonina[5]

1.Adam Mickiewicz University, WNGIG, Krygowskiego 10, Poznan

2.Silesian University, WNP, Będzińska 60, Sosnowiec

3.Institute of Nuclear Physics Polish Academy of Sciences: Cracow

4.Icelandic Institute of Natural History, 600 Akureyri

5.Tomsk Polytechnic University, 634050, Lenina ave, 2a/5 Tomsk,

Peatlands, spanning 3% of the Earth surface, are crucial archives of stratigraphically defined Great Acceleration of human impact and are valuable deposits of the Anthropocene evidence. Here we present first results of the project, which was developed on the basis of the international network between Poland, Russia, China, Iceland, and Estonia to investigate globally spread humankind-induced geochemical signals supporting the discussion about the new geological period.

50 cm-long peat cores were collected from the Sudetes in Poland, near Tomsk city (Russia) and north-western part of Iceland to identify Pb and $^{239+240}$Pu concentration and origin in the peat.

The maximum concentration of Pb is strongly distinct between investigated sites (360, 31, 4.3 mg kg^{-1} for the Sudetes, Tomsk, and Iceland, respectively) and differs with the time of deposition. Spheroidal aluminosilicates from coal combustion appeared at the beginning of 20th century in Russia, around 1938 in the Sudetes, but are absent in Iceland. A pronounced peak in $^{239+240}$Pu level (22.86, 10, 7.67 Bq kg^{-1}), which refers to the 1960's was established.

High Pb concentration in Polish profile can be explained as a result of simultaneous power plant activity from Germany-Czech Republic-Poland Black Triangle in the 1970's (comp. Fiałkiewicz-Kozieł et al. 2020). Increase of Pb in Russian profile is affected by a boost of local industry in the middle of the 20th century. Volcanic activity was the main driver of slightly enhanced Pb concentration in Iceland.

While individual peatlands differ with industrial Pb history, a clear nuclear weapon test signal was determined in all the profiles, confirming the value of peatlands as archives of globally expanded human-driven changes of the Earth.

The study was supported by grant no. 2017/27/B/ST10/00428 from National Science Centre, Poland and IGCP 732.

Fiałkiewicz – Kozieł B. et al. 2020, Quaternary Science Reviews 230, 106162.

Climate change and monsoon variability: Anthropogenic role in floods in Pakistan

Shahid Iqbal[1] and Mehwish Bibi[1]

1. Department of Earth Science, Quaid-i-Azam University, Islamabad, Pakistan

Corresponding author: siqbal@qau.edu.pk

Monsoon rainfall during summer is the major fresh water source for fluvial systems in Pakistan. Anthropogenic contribution to global warming and thus climate change has induced a disturbance in the monsoon rainfall in Pakistan. During the 21st century various parts of the country have faced multiple floods. The 2010 floods were the biggest in the history of Pakistan in which approximately one fifth of the total land area of the country (160,000 km^2) was affected by floods. The floods directly affected ca. 20 million people with a total economic impact of around 43 billion (USD) and a total death of around 2000. The Khyber Pakhtoonkhwa province faced the most damage and more than 90% of the total deaths occurred in the province. The Swat and Peshawar valleys in the province suffered the most. The heavy rainfall in the mountainous regions due to monsoon intensification was the primary factor that forced the local rivers to overflow. However, the anthropogenically induced blockage of the natural drainage system substantially contributed to the destruction of property, livelihood and infrastructure, and human lives. In Swat valley people had constructed residential settlements, hotels, and agricultural forms in the main channels of the River Swat and its tributaries. Similarly, the in the Swabi, Mardan, Nowshera, and Charsadda areas of the Peshawar Basin the recently constructed Motor Way (M-1) with its orientation perpendicular to the local drainage (flow) proved to be a dam wall and flood the entire region. Similarly, the comparison between the floods of July 2001 and July 2021 in Islamabad provides clear consequences of anthropogenic interference into the Earth's system. The July 2001 flood in Islamabad was the result of a cloud burst with a total rainfall of 620 mm in just 10 hours. It did not result in any loss of human life due to the lack of any man-made obstacle as the present-day sectors D-12 and E-11 of Islamabad had not been constructed back then. On the contrary the July 2021 flood was the result of just 103 mm of rainfall. Unfortunately, most parts of the local drainage had been blocked to construct the residential sectors, especially in E-11/2, that induced flood in the area. Precious lives were lost, and infrastructure suffered damage. Thus, the climate change and anthropogenic interference into the Earth's System has posed new challenges that has put our survival at risk.

The archaeology of Plastics: plastics artefacts, human's culture and the geological Anthropocene

Juliana A. Ivar do Sul[1], Ana Luzia Lacerda [2], Michael Wagreich [3], Matt Edgeworth[4]

[1] Leibniz Institute for Baltic Sea Research, Germany, juliana.ivardosul@io-warnemuende.de

[2] Sorbonne University, France, analuzialacerda@gmail.com

[3] University of Vienna, Austria, michael.wagreich@univie.ac.at

[4] University of Leicester, UK, me87@leicester.ac.uk

Plastic is perhaps the most versatile material humans have ever produced. It can be melted, shaped and melded in any imaginable object. It is also light, resistant to most forms of degradation, and relatively cheap to produce, and therefore indispensable in human modern society. Along with plastics benefits to humans is a list of environmental-related problems ─currently studied by physical scientists─ and are out of the scope of this presentation. But plastics are everywhere in the natural environment and are part of our daily lives, thus they are also explored by social scientists, including archaeologists studying human past through material remains (i.e., pottery). In this context, plastic objects represent physical remains of the *recent* past, are useful tools to a broad understanding of human culture, and are important stratigraphic markers in the Anthropocene (McMullan, 2021). To illustrate, perhaps you have watched "Indiana Jones" ─an archaeologist searching for valuable artefacts in the movies─ or read Agatha Christie crime books ─married with an archaeologist, she wrote many of her most famous books at excavations sites in the middle East─ so replace those fictional ceramic and metal artefacts with toothbrushes, disposable straws, an IPhone, or with a TV. These are modern archaeological artefacts, and following the law of superposition, oldest plastics will lie at the bottom of a stratigraphic sequence, while newer plastics will lie at the surface to form new deposits over time. The Archaeology of Plastics emerges therefore as a research/education field, and our ordinary plastic objects or artefacts can figure in archaeology museums and exhibitions to represent the human culture in the Anthropocene. The Archaeology of Plastics starts now to be explored by researchers working in the recently installed UNESCO-IUGS IGCP732 project. Here, we gathered initial information to propose and structure an itinerant/temporary exhibition, where plastic artefacts are collected, identified and organized for example chronologically, from the oldest and now extinct polymer types (e.g., Bakelite) to modern polymers (i.e., polyethylene, Teflon); or

according to their use (i.e., domestic, single-use, industrial, etc.), always within an archaeological perspective. Plastic fragments might represent the most common finds in recent sedimentary deposits, such as pottery fragments are the most common finds of archaeologists during excavations. In this presentation, we use and adapt standard documentation and classification of fragments of pottery to classify fragments of plastics, contributing to understand plastic/polymers fragmentation and preservation in archaeological sites and beyond. The Archaeology of Plastics has potential to merge and explore research areas of museology, archaeology, education, polymer sciences, and other related research fields, and represents a fertile ground for international cooperation among social and physical scientists.

Reference

McMullan, T., 2021. https://onezero.medium.com/the-future-of-archeology-is-plastic-80fc689161d

Anthropogenic markers on some coasts of the Philippine archipelago

Caroline Marie B. Jaraula[1,*], Erika Grace M. Gernato[1], Chris Carl A. V. Toyado[1]

[1]Marine Science Institute, University of the Philippines, Diliman, Quezon City, 1101 Philippines

*e-mail: cjaraula@msi.upd.edu.ph

The highly coupled terrestrial and marine systems from the Philippine archipelago provide rapid response in climatic perturbations and anthropogenic interferences, sites of which with good sediment preservation can potentially record the shift to Anthropocene. We explore possible markers of the Anthropocene to indicate industrialization; e.g. trace metals, persistent organic pollutants, and the effects of extensive and intensive mariculture on the benthos.

Manila and its neighboring cities, Philippines' capital since at least the 17th century, are within one watershed draining westward to the adjacent Manila Bay. Kwan et al. (2014) reported that total polychlorinated biphenyls (PCBs) rapidly increased from 1950's to up to the mid-1990s, consistent with economic growth up to this time. On the other hand, polybrominated diphenyl ether (PBDE) accumulation lagged as expected since its industrial production started later. A drop in concentration in both groups of compounds reflected the financial crisis in 1997, which eventually recovered in the 2000s, consistent with the trends in total PCBs and PBDEs.

East of Manila Bay, the largest freshwater and shallow (~2.5 m average depth) lake in the Philippines, Laguna de Bai, and also the third largest in Southeast Asia has high preservation potential for anthropogenic markers. For example, Pb levels in this lake, consistently depleted since mid-Holocene (EF=0.5-1), has been increasing since the late 1960s and attained concentrations fourfold that of average shale by the end of the 1990s. Other transition metals did not co-vary with Pb, possibly due to local biogeochemical overprinting.

In an archipelagic country, at the center of marine biodiversity, the extent of anthropogenic influence is not just confined in the landscape, but also in the seascapes *via* mariculture for food security. In Bolinao, Pangasinan, Northern Philippines, the terrestrial signal of increasing K/Al and Pb/Al is consistent with increased sedimentation rate. Bulk density, however, continues to decrease along with at least fourfold increase in total organic carbon, much higher than expected from terrestrial contribution and depleting the $\delta^{13}C$ by at least 4‰ at the same time shifting C/N closer to aquatic and fish feed signal, Overall effects were the increase in planktonic productivity

and almost persistent deoxygenation of the bottom waters. DNA data indicate shifts of microbial communities to nitrate and sulfur oxidizers which is consistent with low Mn/Al, a proxy for (de)oxygenation. Introduction and rapid expansion of mariculture may induce eutrophication as seen in this example.

REFERENCES

Kwan, C. S., Takada, H., Boonyatumanond, R., Kato, Y., Mizukawa, K., Ito, M., Dung, L. Q., Zakaria, M. P., Santiago, E. C. (2014). Historical occurrences of polybrominated diphenyl ethers and polychlorinated biphenyls in Manila Bay, Philippines, and in the upper Gulf of Thailand. *Science of the Total Environment, 470-471*, 427-437. DOI: 10.1016/j.scitotenv.2013.09.076

The vision of Paul Crutzen (1933-2021) for the Anthropocene "to guide society"

Emlyn Koster, Adjunct Professor, Marine, Earth and Atmospheric Sciences, NC State University, NC 27695, USA

As an emerging addition to the Geologic Timescale, the two-decade journey of the Anthropocene concept has been a crucial step. Referring to the latest nanosecond in the Earth's 4.5-billion-year history and named for one predominant species, *Homo sapiens*, but dismissed by some as an exaggeration of our impacts, the term encompasses today's environmental and societal crises with their linked causes. With the same public rationale that names hurricanes and pandemics, the Anthropocene is the best megaphone for the world's urgently needed grasp of The Great Acceleration—first synthesized in 2004 and updated in 2010 and 2015—which summarizes two dozen adverse Earth System scale trends since the mid-20th century. As well, with extreme weather dominating the news, the Anthropocene underscores the fact that atmospheric warming is causing ocean-level rise and the resulting exodus from low-lying coastal regions as well as disruptions of ecosystems.

Nobel laureate Paul Crutzen was prescient when he anticipated in his 2002 'Geology of Mankind' article in Nature that the most important value of the Anthropocene would be "to guide society". While the Anthropocene Working Group—a constituent body of the International Commission on Stratigraphy and the International Union of Geological Sciences responsible for proposing the best base-defining reference locality—builds a proposal to formalize the term in the Geologic Timescale, informal adoption has already occurred in many other disciplines, including the humanities and social sciences, climatology, geography, ecology, and big history. This momentum followed establishment of working groups of the Geological Society of London and Geological Society of America in 2006-08; coverage by *The Economist, The New York Times* and *The Guardian* in 2009-11; and launch of *The Anthropocene* and *The Anthropocene Review* journals in 2013-14 and Future Earth's magazine *Anthropocene, Innovation in the Human Age* in 2016. However the encompassing relevance of the Anthropocene concept is not yet close to where it needs to be in terms of scientific embrace and public vocabulary.

Coordinated communication planning for the formal and informal outcome possibilities of the Anthropocene with respect to the Geologic Timescale is a major rallying opportunity. Leveraging UNESCO's imprimatur of this IGCP project, the public's grasp of the Anthropocene would also leap forward if the International Science Council—the umbrella body for the natural and social sciences—undertook a campaign comparable to the efforts behind seatbelts and

vaccinations. This should include outreach to networks of art, history, nature, science, and children's museums. With expertise to illuminate our changing world, these accessible school and public resources depend on visionary partners.

BOHOL ISLAND, THE FIRST PROPOSED UNESCO GLOBAL GEOPARK OF THE PHILIPINES: CHALLENGES AND OPPORTUNITIES

by

L.S.J. Manzano
Mines and Geosciences Bureau-Department of Environment and Natural Resources, Philippines

Bohol island province, dubbed as “The Heart of the Islands” is located in central Philippines between Latitudes 9°30' and 10°15' North and Longitudes 123°40' and 124°30' East. The evolution of the amazing karst landscape of Bohol Island is attributed to the wonders of geomorphic processes, polished by the periodic uplift and subsidence due to past and present tectonic events. The recent movement of the North Bohol Fault (NBF) that generated the 7.2 M_w earthquake on October 15, 2013 has rendered instability of the karst landscape, exposing more amazing cavities underneath. The fault explains the linear distribution of sinkholes and cave systems, as well as the formation of angular cave openings. It also caused the uplift of a reef flat in the southwestern coast to about 2.0 masl and, as a result, the shoreline receded 50 to 100 meters. In addition, movement of this northeast-southwest reverse fault along the western sector of Bohol Island uplifted a farmland 3.0 masl.

Generally, about 80% of Bohol Island is underlain by sedimentary rock formations that are predominantly reefal limestone. These are the Pliocene to Pleistocene Maribojoc Limestone, the Late Miocene Sierra Bullones Limestone, and the Middle Miocene Carmen. The karst landscape is a product of both solutional and polygenetic degradation of formerly Maribojoc reefal flats. The landscape can be characterized into three distinct landforms, namely: 1) the uplifted marine terraces, 2) the young, mature and old kegelkarsts, and 3) Karst pavement with tecto-furrows and tower karsts. These are areas with numerous sinkholes, uvalas and caverns. Sinkholes could be found anywhere, from ridge to reef. The 1,776 isolated hillocks popularly known as the Chocolate Hills” was declared a National Geologic Monument by the National Committee on Geological Sciences of the Philippines in 1988. Moreover, the Maribojoc reefal flat that was uplifted due to the 7.2 Mw earthquake, was also declared a Geological Monument by the Department of Environment and Natural Resources in 2015.

There are opportunities and challenges identified relative to the declaration of the Bohol island province as the first aspiring Geopark in the country. The challenges include the cost of Geopark development; the understanding and appreciation of the local communities and the support of stakeholders; and the concern on protection of proposed Geosites due to rapid infrastructure

development of the booming tourism destination site. The opportunities are well exemplified by the very supportive provincial government, and that the island is already a renowned tourist destination, locally and overseas.

Keywords: GEOPARK, Challenges, Opportunities

Supervising Science Research Specialist[1]

Pharmaceutical residues and antibiotics in the coastal waters of the Philippines

Shyrill Mae Mariano*[a], Chris Carl Toyado[a], Maria Luisa Tejada[b], Allan Gil Fernando[c], Caroline Marie Jaraula[a]

[a] Marine Science Institute, University of the Philippines - Diliman, Quezon City, Philippines

[b] Japan Agency for Marine-Earth Science and Technology

[c] National Institute of Geological Sciences, University of the Philippines - Diliman, Quezon City, Philippines

*Presentor

Corresponding author contact: cjaraula@msi.upd.edu.ph

Pharmaceuticals and personal care products (PPCPs) have been widely used by humans and animals since the golden age of antibiotics in the 1950s. In recent years, PPCPs are considered “contaminants of emerging concern” due to the increasing analytical capabilities in the laboratory to study trace levels of organic contaminants and possible negative effects they pose to the organism or environment. The most alarming of which is the proliferation of antimicrobial resistant genes, hence, USA’s Environmental Protection Agency and the European Union promoted surveillance of PPCPs in the natural environment over the past few decades. Common sources of PPCPs are untreated wastewater of hospitals, residential, industrial, and agricultural areas. Though common wastewater treatment methods can remove some pharmaceuticals in the wastewater, some still persist and are discharged with natural waters, ultimately draining into the coasts. Regions without proper wastewater treatment are especially susceptible to such contamination. PPCPs are also known to accumulate in the sediments. Sulfamethoxazole, a type of sulfonamide antibiotic, was found to ubiquitously occur in tropical Southeast Asian waters, reaching concentrations of 800 ppb in Philippine samples, second only to Vietnam and higher compared to other countries such as Japan, the USA, Canada, Australia, Germany, UK, Switzerland, and Spain (Shimizu et al., 2013). For this study, coastal waters from areas of differing levels of contact with population, from pristine to highly populated watershed (Tubbataha Reefs, Palawan; Boracay Island, Aklan; Mabini, Batangas; Davao Gulf, Davao City; Macajalar Bay, Cagayan de Oro; Manila Bay) were studied to capture a more comprehensive image of the situation of pharmaceutical contamination in the coastal waters of the Philippines. Acetaminophen is present in most sites and with concentration of up to 105.92 ppb . Caffeine is present in all sites, amounting to as high as 107.32 ppb. Sulfamethazine, a common veterinary antibiotic, is detected from a river site in Cagayan de Oro, reaching up to 311.29 ppb. Sulfonamides, macrolides, and ciprofloxacin are detected in Cagayan de Oro hospital wastewaters, and in

Manila Bay, specifically near the Pasig River outflow and hospital area. In and around Boracay Island, water samples were collected during the island closure and just after opening. Comparison of both these sample sets will be discussed. A short sediment core was also collected, and analytical results indicated two episodes of earlier high freshwater fluxes with relatively isotopically enriched $\delta^{15}N$ and C/N ratios bordering sewage values. Untreated wastewaters and their emerging contaminants of concern can be traced in the sediment record.

References:

Shimizu, A., et al. (2013). Ubiquitous occurrence of sulfonamides in tropical Asian waters. *Science of the Total Environment*, *452–453*, 108–115. https://doi.org/10.1016/j.scitotenv.2013.02.027

The Anthropocene in Brazil: an overview of the history of the studies, of the array of researches, and a more detailed view of Technogenic Ground.

ÉRIKA CRISTINA NESTA SILVA[1]

[1] Independent Research (2500 Rosas lane, house 565, Rondonópolis, Brazil, E-Mail: erikanesta@yahoo.com.br)

Research on the theme of the Anthropocene has become more frequent in Brazil over the last two decades. However, even before the discussions concerning the Anthropocene, the characteristics of reliefs and surface geological materials (soils and sedimentary depositions) have been studied considering the human geological and geomorphological action (Oliveira, 1990; Peloggia, 1998). In this sense, the objective is to briefly report the history of these researches in Brazil. Another objective of this presentation is to report an overview of the array of studies developed in Brazil that is related to the perspective of the Anthropocene, including highlighting the presence of an area of expertise, called Anthropocene and Technogene, within the Brazilian Association of Quaternary Studies (ABEQUA, in Portuguese), as well as the existence of special volumes in scientific journals and specific sections in congresses related to the theme, which points to the recognition of the relevance of the topic in Brazilian science. Among the themes presented in journals, events and research, the following are exemplified: climate change; soils, sediments and reliefs of anthropogenic origin; technofossils; anthropogenic biomes; studies related to the classification of technogenic grounds and theoretical aspects. Finally, it highlights works in which the present author has directly dedicated herself in recent years, in her master's and doctoral research (Silva, 2012; 2017), in addition to her practice as a professor in higher education. Thus, it focuses on the discussion about the depositions and reliefs of the anthropogenic origin, components which are of the classified technogenic ground (classification present in Peloggia et al., 2014). Based on the experience in teaching, the relevance of the Anthropocene approach and its landmarks present on the terrestrial surface, as observed in field classes, is pointed out as a potential for discussion regarding society-nature relations, including the issue of social and environmental vulnerability.

OLIVEIRA, A. M. S (1990). In: Congresso Brasileiro de Geologia de Engenharia, 6, 1990, Salvador. 6º CBGE and IX COBRAMSEF. Salvador: ABGE: ABMS. p. 411-416.

PELOGGIA, A. U. G. (1998). São Paulo: Xamã.

PELOGGIA, A. U. G.; OLIVEIRA, A. M. S.; OLIVEIRA, A. A.; SILVA, E. C. N., NUNES, J. O. R. (2014). Quaternary and Environmental Geosciences, 5(1), 28–40.

SILVA, E. C. N. (2012). Dissertation (Master in Geography). São Paulo State University (UNESP), Faculty of Science and Technology, Presidente Prudente.

SILVA, E. C. N. (2017). Thesis (PHD in Geography). São Paulo State University (UNESP), Faculty of Science and Technology, Presidente Prudente.

An East African perspective of the Anthropocene

Lydia A. Olaka [1], Daniel O Olago [1], Eric O Odada [1]

[1] Department of Earth and Climate Sciences University of Nairobi, P.O BOX 30197, Nairobi

Lydiaolaka@uonbi.ac.ke

It is now widely accepted that humans are a formidable force of nature, the terrestrial and aquatic environments have been modified by human activities. We carried out a review of the studies reporting environmental changes to understand the environmental and ecosystem changes induced by anthropogenic activities associated with the "Anthropocene" the proposed new geological epoch in Earth history in East Africa. Humans have occupied East Africa for thousands of years but until about 300 Years ago, their impact on the environment was localized and transitory. A number of contemporary natural archives have been considered, including lake and marine sediments, peat sequences and corals. These show that the impacts of human activities intensified during the 19th century due to rapid population growth and extension and intensification of agriculture that was largely driven by colonists: the overprinting of natural environmental changes by human activities is clear and it is marked by increased sedimentation, heavy metals deposition, changes in sediment properties and lake water quality increased pesticides and pharmaceuticals in the environment. This results from land and water degradation and overexploitation of terrestrial and aquatic ecosystem good and services. The impacts of such changes include changes in ecosystems, and associated biodiversity losses. These changes however are not uniform across the region and there are some temporal and spatial lags depending on the locality. They have been spread out over a 100-year period (1880-present) but with intensification noted in the mid-1900s, thus supporting the AWG (2019) proposed date of 1950 for the start of the Anthropocene. The most significant are increase in land degradation, deforestation, siltation of water bodies and extinction/disappearance of key terrestrial and aquatic species these are mostly linked to agricultural land expansion and extensive land degradation, over-exploitation of natural resources, and increase in human and livestock populations. The environmental changes during the Anthropocene seen here are not as pronounced as those witnessed in the Northern Hemisphere; however, the trends identified of extinction of species, poaching and environmental degradation need to be curtailed. Furthermore, a number of studies need to be carried out with different range of anthropogenic markers in different sites for the onset of Anthropocene in East Africa.

Provincializing the Anthropocene: The Case of South Korea

Buhm Soon Park[1]

[1] Korea Advanced Institute of Science and Technology (Daejeon, South Korea, parkb@kaist.edu)

What stories can we tell, and what evidence should we collect, if we seek to make sense of the Anthropocene from the shore of East Asia? The familiar themes of the Anthropocene – e.g., the accelerated use of fossil fuels and its contribution to greenhouse gases, the continued population growth and the loss of biodiversity, and the accumulated mass of plastics, concretes, chicken bones, and nuclear wastes – have been explored and will be further studied on this side of the world. But in order to have this new geological concept get a traction in society, it would be necessary to find a way to analyse the workings of not only capitalism and energy consumption but also nationalism and developmentalism. This paper aims to share the activities of the Center for Anthropocene Studies, established in Korea Advanced Institute of Science and Technology in 2018, in terms of translating our concerns about the Earth into tangible policy suggestions, technological interventions, and civic participations. It discusses the opportunities and difficulties presented to the Center, such as the assessment of Green New Deal policy from the Anthropocene perspective. The application of AI technology to ecological studies, and the opening of the Anthropocene Exhibit in Seoul.

Rivers in the Anthropocene

Catherine Russell[1,2]; Jan Zalasiewicz[1]; Colin Waters[1]

[1] University of Leicester, University Road, Leicestershire, LE1 7RH, UK

[2] Louisiana State University, Baton Rouge, LA 70803, USA

Wild rivers across the globe have been transformed by humans for many thousands of years. The human impact on rivers is a present and ever-growing challenge that manifests as complex social, physical, and geographical constraints. Rivers have been used to sustain agriculture and urban centers, whilst themselves being mined for their resources, and subsequently altered to fit increasing societal requirements. Arguably, no river now remains natural, as even remote rivers have been impacted by global climate change and airborne pollution. As such, we consider the signals and deposits that future geologists will see preserved and reworked in the geological record. However, many of the models presently used to understand river systems have limited applicability for understanding present regimes, as they represent natural systems acting by their own autonomy. Today in the Anthropocene, we find that many rivers are limited in their capacity to be wild via a spectrum of scenarios imposed upon them through human action. Here, we examine the changes made to Earth's rivers and demonstrate a novel approach to studying Anthropocene rivers. We have developed new models to demonstrate the diversity of human changes to rivers focused around anticipated future pressures, including urbanization and climate change. One growing challenge is understanding the lateral connectivity of fluvial deposits that have been artificially abandoned in favor of a more convenient, imposed river path. To describe such lateral connectivity, we categorize Anthropocene rivers as Wild, Managed, Modified, or Transposed. Additionally, we consider intra-system connectivity, including effects of major engineered structures, such as dams or levees. Through these models, we place the rivers in a new geological context to identify challenges for their management. Additionally, we combine our findings with existing principles to predict and understand the sedimentary record of Anthropocene fluvial systems, including signal modification.

Victims of the Anthropocene: Philippine Coral Reefs

M.L.G. Tejada[1]*, C. Jaraula[2], A.G. Fernando[3]

[1] Institute for Marine Geodynamics, Japan Agency for Marine-Earth Science and Technology
[2] Marine Science Institute, University of the Philippines
[3] National Institute of Geological Sciences, University of the Philippines

One of the most pressing global issues today is the deteriorating conditions and decimation of coral reefs, together with the fish stocks and marine biodiversity associated with them. Warming waters, pollution, ocean acidification, overfishing, and physical destruction due to human activities, which are all hallmarks of the Anthropocene present multiple threats. Philippine coral reefs make up an area of 27,000 km^2 of fringing reefs. Based on a survey from late 1970's to 1990, 512 (70%) of the 732 coral reefs had less than 50% live coral cover and 39 or only 5.3% had 75-100% live coral cover and were rated to be in poor to fair and excellent conditions, respectively. By 1990-1999 estimates, only 4.3% of coral reefs in the Philippines are in excellent condition, i. e., with coral cover exceeding 75%. More recently, a survey found no excellent coral reefs in the country's Pacific Coast, with only 3 out of 105 surveyed exceeding 50% live coral cover and only 10% of the reefs surveyed nationwide had more than 50% live coral cover. Consequently, fisheries and ecosystems services are also diminishing. To help increase catch, fisherfolks resort to illegal methods such as dynamite or blast fishing, cyanide fishing, and indiscriminate use of trawl nets, all of which are detrimental to corals, as well as fish juveniles and spawning grounds. This trend further magnifies the threats to coral reefs. Alarmingly massive destruction is also happening in the last few years by island building in the adjacent waters.

Global initiatives in recent years have come up with schemes to save the world's coral reefs, including the establishments of marine protected areas (MPAs) and, more recently, genetics research in hope of restoring reefs with more heat tolerant corals. In the Philippines, there is also a growing awareness of the threats of climate change, pollution, and dwindling resources. Unfortunately, at the rate that anthropogenic activities and changing climate and environment is happening, these measures need to be enhanced with better conservation efforts and mitigation measures.

Through discussions among country partners in the Philippines, there is an emerging idea that Anthropocene research has a potential to help improve management policies and practices in marine protected areas and the ecosystems within. By investigating Anthropocene markers, important knowledge will be gained about the historical synergy between human activities and

coastal ecosystem changes in each MPA, which can guide policies and socio-economic research aimed at improving conservation and sustainable use of coastal resources.

References:

[1] Panga et al., 2021. Through the Boundaries: Environmental Factors Affecting Reef Benthic Cover in Marine Protected Areas in the Philippines. Frontiers in Marine Science; [2] DA-BFAR, 2003. In Turbulent Seas: The Status of Marine Fisheries

Recognising the Anthropocene Epoch in geological strata: the ongoing process of detecting a potential "golden-spike" section.

SIMON TURNER, COLIN N WATERS & the AWG/HKW GSSP project.

[1] Geography, University College London, London, UK. simon.turner@ucl.ac.uk

[2] Geography, Geology and the Environment, University of Leicester, Leicester, UK. cw398@leicester.ac.uk

The Anthropocene Working Group (AWG) has assembled scientific teams to analyse stratigraphic successions around the world to help define the Anthropocene as a geological epoch starting in the mid-twentieth century. Stratigraphic records of geochemical and biological signals spanning the mid-twentieth century interval of unprecedented human activity and industrialisation are being gathered. A point in a single core section will be the location of a proposed Global Boundary Stratotype Section and Point (GSSP, or 'golden spike') marking the onset of the Anthropocene. Geological data is now being assembled from 11 candidate stratotype sections. The results from one core (and auxiliary stratotypes) as selected by the AWG, will comprise the formal submission to the Subcommission on Quaternary Stratigraphy, International Commission on Stratigraphy. The results will also be presented in May 2022 in Berlin at an event exploring the decade long collaboration between the AWG, Haus der Kulturen Welt (HKW) and Max Planck Institute for the History of Science (MPIWG). A final decision by the AWG on the prospective Anthropocene GSSP will be announced in December 2022.

While the compilation of stratigraphic data to define intervals of deep-time is as old as the science of geology, the demarcation of an epoch within living history that signifies human activity as a global geological agent is unparalleled. Similarly, there is no precedent of a stratigraphic formalisation process being pivotal to the framing of so much contemporary social, ecological, artistic, historical, and political thought. The May 2022 exhibition in Berlin will include a discursive and performative programme as a public forum to explore the scientific, cultural, and socio-political impact of the geochronological research carried out by the international research project on the Anthropocene.

This presentation will (i) outline the recent work of the GSSP team members in detecting anthropogenic markers of the stratigraphic onset of the Anthropocene in their core sections and (ii) provide an update on the collaborative artistic and cultural work embedded in the process.

Reading

Waters, C.N. *et al*. 2016. *Science* 351(6269):137. doi: 10.1126/science.aad2622

Zalasiewicz, J. *et al*. 2021. *Earth's Future*, 9(3), e2020EF001782 https://doi.org/10.1029/2020EF00189

Websites

Haus der Kulturen der Welt (HKW) - https://www.hkw.de/de/index.php
Anthropocene Curriculum (HKW) https://www.anthropocene-curriculum.org
Max Planck Institute for the History of Science (MPIWG) https://www.mpiwg-berlin.mpg.de

Introduction to UNESCO IGCP International Geoscience Program and IGCP 732 LANGUAGE of the Anthropocene

WAGREICH M.[1]

[1] Department of Geology, University of Vienna, michael.wagreich@univie.ac.at

IGCP 732: LANGUAGE of the Anthropocene (Lessons in anthropogenic impact: a knowledge network of geological signals to unite and assess global evidence of the Anthropocene). Present and future Geology – the global scale evidence of the Anthropocene was granted as a new UNESCO IUGS IGCP project in spring 2021 and will run for 5 years. The former International Geological Correlation Project, now International Geoscience Program started in 1972 as a knowledge hub of UNESCO to facilitate international scientific cooperation in the geosciences. IGCP Projects bring together scientists for workshops and field trips and support especially participation from developing countries.

The aims of IGCP 732 are to involve a global community in geoscientific research into the Anthropocene and the anthropogenic predominance of the Earth System. Thus, the Anthropocene establishes a powerful concept associated with unprecedented global change. Both recognizing and managing this novel situation in a sustainable way requires a planetary network and accompanying knowledge framework. IGCP 732 aims to engage new ideas and networks in the development of the Anthropocene concept by cooperating globally with scientists, especially those in developing and less developed countries. The core aims are to unite and assess global evidence of the Anthropocene and to establish the Anthropocene as a fertile framework for future geosciences. This will be achieved by 1) developing a network of expertise and project partners globally; 2) designing and running workshops in developing countries; and 3) designing and collating an open database of existing information and expertise on the Anthropocene.

Anthropogenic sediments and the Anthropocene of Vienna

MESZAR, M. [1], WAGREICH, M. [1], LAPPÉ, K. [1], KOUKAL, V. [1], HAIN, K. [2]

[1] Department of Geology, University of Vienna, maria.meszar@univie.ac.at, michael.wagreich@univie.ac.at, kira.lappe@univie.ac.at, veronika.koukal@univie.ac.at, [2] Isotope Physics Group, University of Vienna, karin.hain@univie.ac.at

Vienna's anthropogenic sediments were described and mapped as geological units as early as in the second half of the 19th century by Eduard Suess. These anthropogenic strata form the layered urban archive in the underground of large cities, the archaeosphere. In a transdisciplinary project involving geosciences, isotope physics, urban archaeology and artists, funded by the Vienna Science and Technology Fund (WWTF), we looked for artificial isotopes in urban layers around the proposed starting date of the Anthropocene in the middle of the 20th century. The tested archaeological site is situated in the heart of Vienna, in a park area at Karlsplatz, adjacent to the renovated Vienna Museum. Excellent 3D archaeological data and a clear stratigraphy sets age constraints around 1922, post-1945, and at 1959. A layer on top of the WWII rubble that fills fundaments of a 1922 building post-dates 1945, and pre-dates the finishing shaping of the artificial park ground of 1959. We focused on the fine-grained (clayey-sandy) sediment matrix on top of the WWII rubble, at the base of the post-WWII layer, mixed with backfilled soil material. The sieved fraction below 2 mm grain size was dried and pulverised. This sediment sample was prepared for chemical separation of actinides which were then analysed by Accelerator Mass Spectrometry (AMS) using the setup at the Vienna Environmental Research Accelerator (VERA, Isotope Physics Group). We identified several artificial radionuclides including U-236, Np-237, Pu-239, Pu-240. Isotope ratios like Pu-240/Pu-239 and in particular U-233/U-236, which was only recently introduced as anthropogenic tracer by the VERA group, clearly point to the presence of atmospheric atomic bomb fallout material of the 1950s to 1960s. A significant input of Chernobyl (1986) material in this layer can be excluded based on the ratio Pu-241/Pu-239. Thus, the 1952-1964 bomb-spike, introduced as a primary stratigraphic marker by the Anthropocene Working Group, can be identified and used in coarse urban anthropogenic sediments of big cities, exemplifying the correlation potential of these radionuclide markers.

The role of the Anthropocene Working Group (AWG) in assessing the Anthropocene as a potential Geological Time Unit

Colin N Waters[1], Simon Turner[2] and Jan Zalasiewicz[1]

[1] Geography, Geology and the Environment, University of Leicester, Leicester, UK. cw398@leicester.ac.uk and jaz1@leicester.ac.uk

[2] Geography, University College London, London, UK. simon.turner@ucl.ac.uk

Human activity is leaving a pervasive and persistent signature on Earth and vigorous debate continues about whether this warrants recognition as a new geological time unit. This presentation outlines the origin of the term within the Earth System science community and subsequent work of the AWG of the Subcommission on Quaternary Stratigraphy since 2009 in gathering evidence to constrain and assess the Anthropocene as a potential new formal chronostratigraphic unit. Anthropogenic influence on stratigraphic signals commenced thousands of years ago, but the most pronounced shift in most global trends away from Holocene patterns is in the mid-20th century, which represents the preferred timing of onset for the proposed Anthropocene Epoch/Series. Thus, its start coincides with the 'Great Acceleration' in rates of population growth, energy consumption, global trade and technological innovation. Evidence presented includes the appearance and rapid dispersal of many new mineral forms (including metals, plastics and industrial fly ash), rock types (including concrete) and sediment bodies including artificial ground, together with sediments modified by land use changes. Chemical signals can provide widespread, sometimes global, and geologically isochronous markers that can be used to characterise the onset of the Anthropocene. These include: changes in atmospheric gas concentrations preserved in glacial ice and as isotope patterns altered by perturbations to the carbon and nitrogen cycles driven by burning fossil fuels and use of artificial fertilizers at rates and magnitudes unprecedented in Quaternary times; disseminated heavy metals; persistent organic pollutants; and artificial radionuclide traces; many of these are novel signatures. Biological evidence includes the irreversible consequences of extinctions (currently on a trajectory towards the sixth major mass extinction event), and unprecedented trans-continental species transfers and the dominance of humans plus domesticated species (now >95% of terrestrial vertebrate biomass). Recent climate

and sea level trends are outside the trajectory of the Holocene Epoch, with global temperatures now the warmest for 125,000 years and sea levels lagging the climate warming.

Crutzen, P.J. 2002. *Nature*, 415 (3 January), 23.

Syvitski, J. *et al*. 2020. *Communications Earth & Environment* 1, 32, doi.org/10.1038/s43247-020-00029-y.

Waters, C.N. *et al*. 2016. *Science* 351(6269):137. doi:10.1126/science.aad2622.

Zalasiewicz, J. *et al.* (eds) 2019. The Anthropocene as a Geological Time Unit. Cambridge University Press, 361p

Zalasiewicz, J. *et al*. 2021. *Earth's Future*, 9(3), e2020EF001782 https://doi.org/10.1029/2020EF00189

APPROACH FOR PROVENANCE OF THE LIMESTONE BLOCKS OF THE WALLS OF THE GREAT TEMPLE OF HATTUSHA, CENTRAL TURKEY BY GEOCHEMICAL AND PETROGRAPHIC ANALYSIS

İsmail Ömer YILMAZ[1]*, Andreas SCHACHNER[2], İbrahim Tonguç UYSAL[3], Ezgi ÜNAL-İMER[1]

1- Department of Geological Engineering, Middle East Technical University, 06800, Ankara, Turkey
2- Deutsches Archäologisches Institut, 34437, Istanbul, Turkey
3- Department of Geological Engineering, Ankara University, Ankara, Turkey

The building stones of the Great Temple in the Lower City of the Hittite capital city, Hattusha (Çorum province), are studied for their possible provenance by petrographic and geochemical analysis (Sr isotope, stable isotope and trace element geochemistry). The carbonate microfacies of the stone samples are analyzed and compared for their possible sources.

Stable isotope ($\delta^{13}C$ and $\delta^{18}O$) analysis presented different origins. The presence of 5 clusters in isotope values showed the differences between the samples; cluster 1 with $\delta^{13}C$ 3.467943‰, and $\delta^{18}O$ -0.10841‰, cluster 2 with $\delta^{13}C$ 3.610557‰, $\delta^{18}O$ as -0.46918‰, cluster 3 with $\delta^{13}C$ 3.756123‰, $\delta^{18}O$ -0.76762‰, cluster 4 with $\delta^{13}C$ 2.940174‰, $\delta^{18}O$ -1.17223‰, cluster 5 with $\delta^{13}C$ 3.298059‰, $\delta^{18}O$ -2.24651‰.

Trace element analysis of the same clusters displayed considerable difference among them and $^{87}Sr/^{86}Sr$ isotope ratios of the samples change between 0.70697 and 0.706867.

Five different sources can be stated for the origin of the building stones for Archaeological point of view. Hittite people were so careful in choosing rock materials to use in daily life. It puts a light for the construction process of the buildings and the acquisition of the building materials.

Keywords: Great Temple, Hattusha, stone samples, petrography, geochemistry, provenance

Radioactive Iodine-129: A Novel Marker for The Anthropocene

Zhang Luyuan [1,2,3]*, Chen Ning [1], Hou Xiaolin [1,2,3], Zhou Weijian [1,2,3]*, Han Yongming [1,2,3], Tan Liangcheng [1,2,3], Cheng Peng [1,2,3], Lan Jianghu [1], An Zhisheng [1,2,3]

[1] State Key Laboratory of Loess and Quaternary Geology, Shaanxi Key Laboratory of Accelerator Mass Spectrometry Technology and Application, Xi'an AMS Center, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710061, China (No.97 Yanxiang Road, Xi'an, 710061, China. weijian@loess.llqg.ac.cn; zhangly@ieecas.cn); [2] Center for Excellence in Quaternary Science and Global Change, Chinese Academy of Sciences, Xian 710061, China; [3] Open Studio for Oceanic-Continental Climate and Environment Changes, Pilot National Laboratory for Marine Science and Technology (Qingdao), Qingdao 266061, China

The start of Anthropocene is a hot topic under discussion for its geological, economic and political implications [1–3]. A large number of radioactive materials from human nuclear activities as of the mid-20th century have been released to the environment and deposited into strata, which provide a good indicator for definition of the Global Boundary Stratotype Section and Point (GSSP). Anthropogenic radioactive ^{129}I is one of key fission products of human nuclear activities, and thus we compiled abundant ^{129}I fingerprints of human activity in multiple historical archives for the purpose of defining the Anthropocene onset, including marine and terrestrial sediments, ice cores, seaweeds, corals, tree rings, atmospheric fallout, as well as other potentially available archives. The IEECAS Anthropocene team has paid great efforts on analyse stratigraphic successions in two Chinese maar lakes (Huguangyan and Sihailongwan) aiming to submit a formal report to the Anthropocene Working Group (AWG). The collection and dating have been accomplished recently. Here, we present the preliminary results of radioactive ^{129}I in the Huguangyan Maar Lake (Fig. 1). It is clear that, in contrast to the pre-nuclear era, the concentration of ^{129}I and ^{129}I/^{127}I atomic ratio began to significantly increase from 1940s as a result of nuclear weapons testing, then continued to rise even after the Partial Nuclear Test Ban Treaty in 1963 due to the discharges from nuclear spent fuel reprocessing (NFR). Our work shows that ^{129}I not only can be used as a vital marker for defining the onset of the Anthropocene, but also indicates the continued human nuclear activity and the current and subsequent impacts.

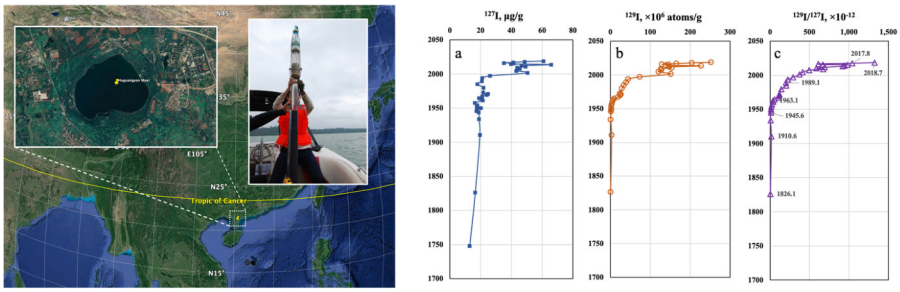

Fig.1 Sampling of sediment cores and Depth profiles of natural ^{127}I (a), radioactive ^{129}I (a), and $^{129}I/^{127}I$ atomic ratios (c) in Huguangyan Maar Lake, Guangdong, China

Reference

(1) Waters, C. N.; Zalasiewicz, J.; Summerhayes, C.; et al. *Science.* **2016**, *351* (6269), aad2622.

(2) Lewis, S. L.; Maslin, M. A. *Nature* **2015**, *519* (7542), 171–180.

(3) Wang, T.; Tan, L.; Xu, H.; Zang, J.; Li, D.; Lan, J.; Han, Y.; Li, L. *Sci. Bull.* **2019**, *64* (22), 1643–1645.