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Joakim Mansfeld

Editor
Mikaela Krona

Cover photo, front: Salanny Gol in southwestern Mongolia. Photo by: Timothy Topper.
Cover photo, back: A signpost from Bergslagen. Photo by: Mikaela Krona.

In this volume

Spring, it's running away!

*Mikaela Krona**

After a stubborn winter season, it has finally given in to the warmth and sun of spring. As the days go by, the wind gets slightly warmer and the different species of flowers are popping up. These past days, the cherry trees have been blooming but as the end of spring is beginning, they change their leaves from pink to green.

This spring, we have organised two excursions for the members of Geologklubben.

*Contact: geologklubben@gmail.com

Fig. 1: Cherry tree season.

In a sunny day of April, we ventured out for a stroll through Stockholm with Joakim Mansfeld during which he talked about the dimension stones that have been used to build our city. Personally, I thought the detailed carvings in sandstone on the old post office building were so beautiful and something that I'd never noticed before, despite having walked down Vasagatan many times. On a completely different topic, we organised an excursion in collaboration with the Natural History Museum in May. Thomas Mörs, a researching paleontologist at the museum, guided us through the Evolution of Life exhibit. We walked through geologic time and learned about every step in the evolution of life.

If you have ideas or proposals about future excursions or development of Berg & Dalbladet, don't hesitate to contact us. Send us an email or grab us when you see us walking about.

During summer, some of us will enjoy some holiday and taking the opportunity to appreciate the quiet season. For others, this is one of the most hectic seasons of the year, when most of the fieldwork needs to be done before the blanket of snow covers the outcrops or the ground freezes again. With that, we would like to thank all of you for supporting Geologklubben and participating in all our events. We hope to see you all again in the fall!

The geology of our capital

*Robert Dunst**

On the 1st of April, one of the first sunny day of spring, members of the Geologklubben gathered outside the central station, next to the statue of Nils Eriksson to explore the history behind the rocks that built Stockholms. Joakim Mansfeld from Stockholm University, our guide for the day, started with giving us a general background on the evolution of architecture in Sweden and told us that rocks as building material is relatively new in Sweden where the traditional building material is wood. This is mainly due to the high costs of manufacturing building blocks and their transportation, especially in older buildings it is therefore a sign of wealth.

In the Stockholm Central station Joakim showed us the Kolmården marble and Brunflo limestone which are used for the floor plates and the pillars in the main hall. The Kolmården marble is characterized by the green color, caused by serpentine veins. This special mineralogy also makes it one of the hardest marbles in the world.

The Brunflo limestone can be recognized by its typical calcite-filled worm tubes and calcite filled fractures. These veins are in fact diagnostic and distinguish it from other orthoceratite limestones in Sweden and stem from deformation caused by the Caledonian orogeny.

*Contact: robert.dunst@geo.su.se

Fig. 1: The beautiful carvings of birds in Öved sandstone on the old postal office on Vasagatan.

We continued our tour to the old Central postal house, which has a plint made of the Vätö granite and a facade and ornaments carved out of the Öved sandstone. The longer one looks at the carvings the more hidden details one notices. At the main entrance the sandstone grades into a half relief of ornamental carrier pigeons, carrying letters in their beaks.

Another building just further down Vasagatan is the Norrland house of Commerce and it is constructed of a more unusual combination of dimension stones. To emphasize its origin in northern Scandinavia the facade plates are made of the Revsund granite from Kalix (a porphyritic granite) with narrow horizontal bands of larvikite, rare a monzonite containing all endmembers of feldspar occurring in northern Norway.

In my walks in town, I have never noticed the loomy feel of the diabase-covered walls of the Central Bank of Sweden, which tower several stories high with 15cm thick diabase blocks. The building looks intimidating to say the least, the architects P. Celsing and J. Henriksson obviously wanted to underline the stability and weight of this finance institute.

Towards the end of the tour we walked through the Parliament district where Joakim pointed out that most buildings were of the same age as they were built after a large part of the old town was torn down and had to make space for palaces of the flourishing trading companies around the turn of the century. The facades are mostly in Öved sandstone and depict the traded colonial goods, as cacao coffee.

We concluded the excursion at the Gustav Adolfs square looking at the impressive base of the statue made of red Vätö granite below and grey Härnö granite.

Fig. 2: The ornaments on one of the buildings in the parliament district along Drottninggatan.

On the lookout for the oldest fossil animals in Mongolia

*Timothy Topper**

I woke abruptly to the sound of my alarm blaring. It was 6 o'clock in the morning and the sun had just reached the base of my tent. Unzipping the front door, I realised it had actually snowed last night and a thin layer of white blanketed the landscape. Isn't this meant to be summer, I thought, as I worked up the courage to exit the cosy confines of my tent and venture out into the wilderness. Tempted by the smell of boiled mutton and milk tea that wafted through the air I stood up and took in my surroundings. I was in a spectacular gorge, sweeping, snow-capped mountains providing a picturesque backdrop and a series of light, craggy pinnacles rose 50 meters above the grassy plains in front of me. I was in Salaany Gol in the Zavkhan Basin and this was my first trip to southwestern Mongolia (Fig. 1).

*Contact: timothy.topper@nrm.se

Fig. 1: Salanny Gol in southwestern Mongolia.

Why was I missing a 'nice' Swedish summer for freezing nights and snow in the Mongolian Alps? All in the name of science of course. Mongolia hosts one of the most complete Ediacaran-Cambrian successions in the world. This period, 540 million years ago, defines one of the most profound phases of evolutionary change in the history of life where the enigmatic 'simple' creatures of the Ediacaran were suddenly replaced by the first complex animal ecosystems. This evolutionary burst is one of the key events in the history of life on Earth and is known as the Cambrian radiation.

For the first time on Earth, the oceans were filled with an astonishing array of animals, but what ignited this intriguing event continues to perplex scientists. Many theories have been proposed, some think it was a rapid rise in oxygen, availability of nutrients or maybe it was global warming that sparked the change.

Fig. 2: An early mollusc.

Regardless of the exact causes, Mongolia records this interval in exceptional fidelity. The first animals however, were not particularly large and in fact we're not entirely sure what the majority of them are. These fossils are commonly referred to as Small Shelly Fossils and include a great diversity of typically millimetric-sized skeletal fossils that represent the earliest members of a variety of animal groups with mineralized hard parts.

Some you can instantly recognize like molluscs (Fig. 2) or brachiopods (Fig. 3C), but others likely represent fragmentary parts of a larger, armoured animal (Fig. 3A). They are typically made of phosphate or at least secondarily phosphatised and are retrieved from carbonate rocks by acid dissolution. They predominantly lived in shallow water reef environments and those light, craggy pinnacles I mentioned earlier represent some of the earliest large, animal reefs in the world.

Small shelly Fossils can be used for a variety of things, everything from studying the early evolution of specific animal phyla, to biostratigraphy and correlation of strata and also perhaps as a source of $\delta^{18}O$ data that could help constrain the temperature of ancient marine environments.

I was not always fascinated by Cambrian Shelly fossils. Growing up, perhaps unsurprisingly, I was one of those children who were completely obsessed with dinosaurs, spending my free time reading dinosaur books, or searching for fossils in mum's garden rather than watching cartoons or annoying my sister.

My obsession with dinosaurs faded when I went to university in Sydney, Australia where the main palaeontology lecturer and my future PhD supervisor was a shelly fossil fanatic. After tagging along for fieldwork once in the amazing Flinders Ranges in South Australia I was hooked. The search for Cambrian shelly fossils has taken me all over the globe from China, to Canada, Mongolia and Morocco and I've thoroughly enjoyed every minute.

If you have an interest in fossils and find yourself googling obscure fossil species whilst at home, there is a Masters Course in Palaeontology (GG7023) that is run at the Swedish Museum of Natural History in January-February where you can learn more about the early evolution of animals (as well as many other topics). We are also more than happy to host projects, at any level (Undergrad, Masters or PhD), so if you're interested drop us a line, we'd love to hear from you.

Timothy Topper is a researching paleontologist at the Natural History Museum in Stockholm who has focused his research on understanding one of the most important events for the evolution of life, the Cambrian Explosion (540 Ma). Specifically, he studies Small Shelly Fossils as a window to the Early Cambrian.

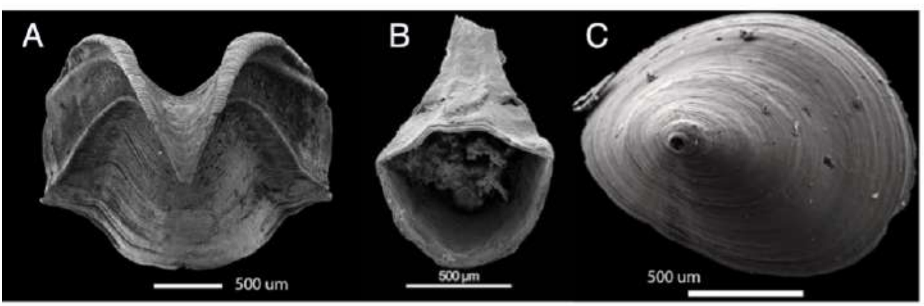


Fig. 3: Small shelly fossils after they have been liberated from the rock. a) Dailyatia, an enigmatic taxon. b) Protohertzina, the oldest chaetognath and c) Treptotreta, an early brachiopod.

A short account of the Kiruna seismic event

Joaquim Otero *

On May 18, 2020 the town of Kiruna in northernmost Sweden was shaken by its strongest seismic event ever recorded with a magnitude of 4.1 according to the Swedish National Seismic Network (4.9 Mw according to USGS). The hypocenter was 900 m below surface in the Kiirunavaara mine next to the town and it was related to the mining of magnetite ore. What follows here is a short personal account from a geologist's perspective.

The event struck at night after the blast of the daily blasting cycle (at 1:30 AM). Like almost all workers in the mine at that time I was asleep in town. The extraordinary shaking did however not disturb my sleep. In hindsight, some colleagues told me that the vibrations were unusual during the night. I only recall noticing more "blasts" or shakings than normal. It was when I arrived at work on Monday morning that I was told about the great shaking and the widespread damages. Large tracts of the mine were cordoned off while "bergmek", our geotechnical division, inspected each part of the extensive tunnel network to decide whether to continue using them, repair them or abandon them.

I did not think or speculate much about the event, since if there is one thing I learned from the 2010 Chile earthquake it's that you shouldn't draw hastened conclusions. At the time of that earthquake, I was on the summit of the Puyehue volcano in the southern Andes, where, with my then newly acquired geological knowledge, I was lecturing Israeli hikers about the probable origin of the shakings in the Liquiñe-Ofqui fault that ran beneath us and about the possibility of an explosive eruption (this was the same volcano that erupted in 1960 responding to the strongest earthquake ever recorded). My "lecture" could not have been more wrong as the epicenter was offshore and hundreds of kilometers further north.

Back to Kiirunavaara. During the noon shift I joined an informative Teams meeting hosted by a senior seismologist. Although I had heard that our seismologist was prone to overdramatize the impact of the event I found the information given quite calming and the tone equanimous. Sometime later I learned that a "Ring of Fire" had formed in the mine as a result of the quake. The "Ring of Fire" was a roughly circular zone (when mapped in profile) where small tremors concentrated. Geologically, it seemed as a zone where stresses associated with the event had not yet been relieved.

More than a year later, one of the new footwall drifts reached a crosscut where a large bolting machine had been isolated ever since the event. Mould had grown on it wherever it could, but the battery and lights

*Contact: jqotero@gmail.com

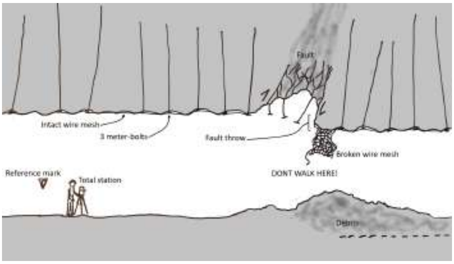


Fig. 1: Schematic of a structurally well defined part of the collapse. In most other places the collapse structures are more spread out, complex or concealed by debris.

were intact. Some small rocks had fallen into the cabin.

For a geologist primarily trained in petrology it was hard to make sense of this event. I had always thought that earthquakes were associated with ruptures and faulting. None of these things were visible after the event, damaged and collapsed parts did not show any obvious displacement. It seemed that there had simply been a big shaking. This changed one day when I was mapping the new footwall drift and came across yet another partly collapsed crosscut. But this one was different. The roof of the crosscut had shifted downwards by 0.7 to 0.8 m and a magnetite rock face was visible. It was a high angle reverse fault.

This was “The Fault”. Or it was not, as it later turned out, it had limited length and continued elsewhere as a typical damage zone related to the event. It was “a fault”, but it fitted very well with the focal mechanism inferred from seismic data. While other indicators of displacement imply normal faulting they all have in common a high angle and ore-parallel strike (N-S).

At this point the reader may be wondering: Why was there an earthquake in Kiirunavaara in the first place? Mines like Kiirunavaara create a large-scale linear area of disturbed rock masses which alter the natural stress field at depth. Mining at great depths brings greater stresses that are no longer only related to gravity as they are near the surface.

The first more specific explanation I heard was that the quake was caused by the failure of a pillar of resistant waste rock which had been spared to hold the forces while cross cuts were driven nearby. The large stresses that are found at these depths had built up in the pillar over time until it eventually failed. This is matched by the observation that parts of the ground above the mine had undergone little or no deformation around the time of the event, as if the rock masses had been blocked in anticipation of readjustment by a single large event. This gives one an unexpected positive view on ground deformation which is generally seen as a bad thing that has forced the city of Kiruna to be relocated further east.

In conclusion, despite the risk and all the material losses, the 2020 event leaves a positive legacy that marks not only the beginning of further earthquake-related measures but also the beginning of an increased earthquake awareness in Kiirunavaara.

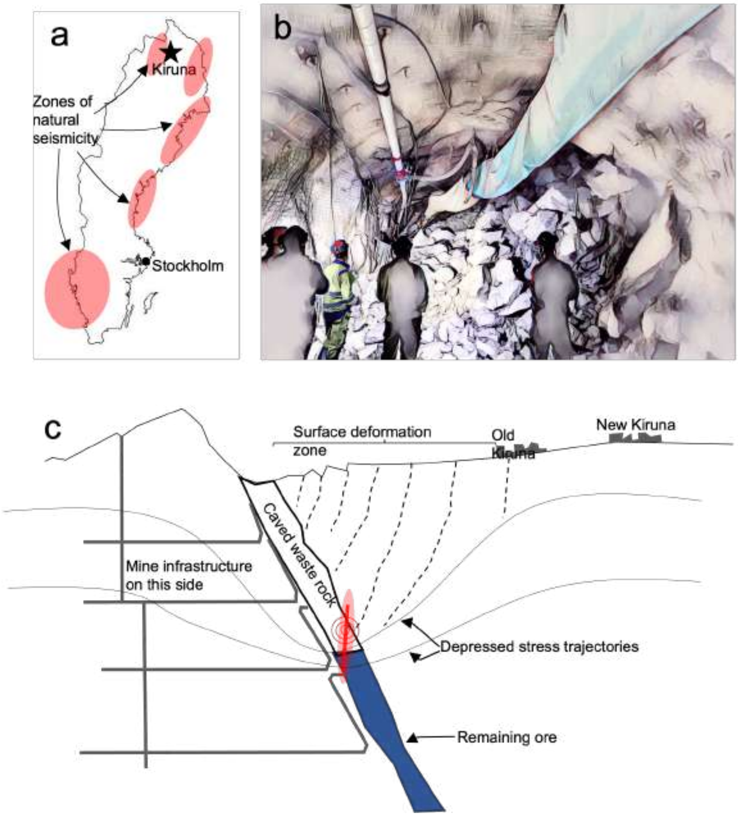


Fig. 2: a) Location of Kiruna and Kirunavaara mine in Sweden. Albeit there is a seismically active zone nearby, the seismic event was unrelated to it. b) Picture of a footwall drift that collapsed during the seismic event. Note that the debris obstructs the view of structures that may be locally associated with the collapse. c) West to east profile sketch of Kiirunavaara mine.

The history of plate tectonics

Mikaela Krona *

It is arguably one of the most revolutionizing concepts in Geology, but the plate tectonics theory had a rocky road before being globally accepted. Today, we learn it in the introductory courses to geology and it lays the foundation to modern geology. Here we unravel the story of how this theory developed from a simple observation to a breakthrough concept.

When the first accurate world maps were drawn, in the late 1500's and the 1600's, it was noted that South America and Africa seemed to fit together like jigsaw pieces. This caused various early thinkers to the idea that all continents were once joined as giant landmass. Later, it was found that identical plant fossils occurred on either side of the Atlantic Ocean. To explain this, in the 1800's, geographer Antonio Snider-Pelligrini proposed that the lands must have fit together when the plants were alive.

In 1912, famous geologist Alfred Wegener formally proposed the theory of continental drift. He believed that the continents were once part of one supercontinent which he named Pangea (Greek for 'all land'). He proposed several arguments for continental drift in his paper. As previously suggested by other scientists, he said that the continents seemed to fit together by shape. During his research, he investigated mountain ranges in Europe and North America where he found that the Caledonides and the Appalachian mountains are related. Furthermore, he studied fossils of Mesosaurus, a one-meter-long freshwater reptile which only occurs in southern Africa and South America. He deduced that the landmasses must have fit together since the reptile couldn't have swum across the Atlantic Ocean.

Wegener conducted several Arctic expeditions during his career. He studied plant fossils on Svalbard where he found species that only live in tropical climate. Based on this observation Wegener argued that Svalbard must have moved from a more southern position to the high Arctic. Despite presenting many arguments for continental drift, Alfred Wegener's theory was not received well in the community. One of the main reasons as to why his theory was rejected was the lack of a driving mechanism for the theory. Sadly, Wegener died in an expedition to Greenland and never experienced the breakthrough of his hypothesis in the mid-1900's.

The rapid development of new technologies in the early 20th century gave geologists a set of completely new tools as bathymetry, gravimetry and magnetometry. In the 1950's the first topographic profiles across the Atlantic Ocean produced by Marie Tharp and Bruce Heezen revealed a large mountain chain in the middle of

*Contact: mikaela.krona@gmail.com

the Atlantic called the Mid-Atlantic-Ridge. Following this discovery Tharp, Heezen and others produced Bathymetric maps of all world oceans and discovered that this mountain ridge was present in the center of all major oceans.

Geologist Harry Hess suggested that hot magma was rising in these regions erupting on the seafloor and forming new rock when it solidified in contact with the cold seawater. This idea was further developed by him to the theory of seafloor spreading. Stating that the newly produced seafloor at the mid-oceanic ridges pushes older seafloor away to either side. Where the oceans border the continents, he envisaged that the old seafloor would sink into the Earth forming deep-sea trenches (later named subduction zones). His theory was later corroborated when alternating magnetic stripes were discovered in the seafloor in the 1960's.

And things started to fall in place when it was realized that the seismically active zones plunging under the continents along the coastlines of the Pacific Ocean, discovered by Kiyoo Wadati 1939 and Hugo Benioff 1949 were likely a result of subducting plates. Finally, more than 50 years after Wegener published the complete hypothesis in 1912, the plate tectonics theory had enough solid evidence to be accepted. It took many years, but the theory of continental drift finally developed into the concept of plate tectonics. And from the 1960's to the 1980's the theory became more or less globally accepted and laid the base for modern tectonics.

Today, it is sometimes hard to imagine that this fundamental theory isn't all that old. Imagine if Wegener had not died during his expedition to Greenland in 1930, and he had lived to see how the theory of continental drift turned from something ridiculous to the accepted truth among all geologists.

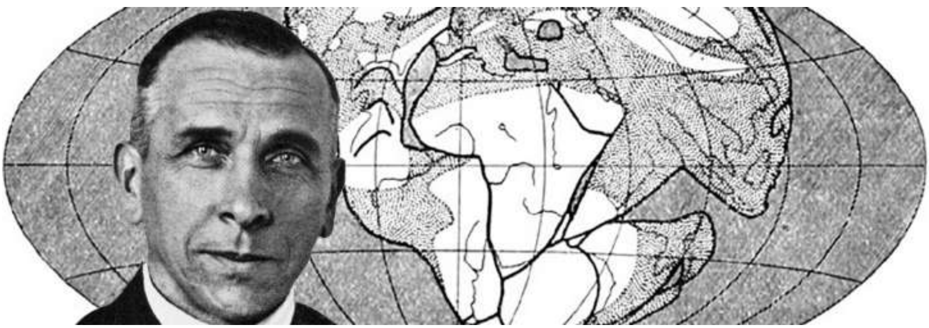


Fig. 1: Alfred Wegener. Image from: https://www.bbvaopenmind.com/.

A guided tour at the Natural History Museum

Vicent Doñate *

On the 9th and 10th of May, almost 30 members of the Geology Club enjoyed a tour through the "Fossil and Evolution" exhibition at The Swedish Museum of Natural History, held by Thomas Mörs. During this tour, we traveled from the Paleozoic to the Cenozoic learning the major evolutionary steps of the macrofaunal and macrofloral taxa, thanks to Thomas' explanations and amazing fossils, fossil models, and habitat reconstructions (Fig. 1).

*Contact: vidofelip@gmail.com

Thomas Mörs is a Senior Curator at The Swedish Museum of Natural History, in charge of the fossil vertebrate collection. Also, he is a paleontology lecturer at Stockholm University and an Associate Professor of paleontology and historical geology at Uppsala University. As most of you know, in Stockholm we can find the world's largest Solar System model in scale, where the building Globen (officially the Avicii Arena) represents the Sun. The Earth and the Moon, are casually located at the museum, so this was our first stop.

Fig. 1: Group of the 10th of May in front of Carboniferous habitat reconstruction, listening to explanations of this period given by Thomas Mörs.

After that, Thomas talked about the museum's history, the exhibitions and when they change or renovate them, and how they present the information to the public. Then we headed for the "Fossil and Evolution" exhibition, starting with the first vertebrates of the Ordovician and Silurian. The jawless and toothless fishes with external bony armor, and also with the sea scorpion, one of the largest predators of the Silurian.

In the Devonian, also known as the Age of Fishes due to huge diversification and rise in the number of organisms of this taxon, fish started to develop jaws and teeth parallel to the development of speed efficiency, which can be considered as our first ancestors, sharing 70% of the bones that are present today in our bodies. During this period, terrestrial vegetation went from a few organisms in the beginning, to forests in the late Devonian when the first tetrapods appeared. These organisms were still unable to walk outside the water (they probably used outer gills for respiration), and they had more than five fingers at the hands and feet.

In the Carboniferous, the huge forests increased atmospheric oxygen concentrations, which enhanced the development of gigantic arthropods. Here, small amphibians that needed water bodies for reproduction evolved to achieve independence from the water, thus colonizing drier terrestrial environments. Therefore, amphibians took two separate paths, one towards the actual amphibians and the other towards reptilomorph organisms. We then crossed to the Permian, where big crocodile-looking amphibians with massive skulls were the top predators. At that moment, some reptilians that could feed on plants appeared, and others evolved to mammal-like reptiles. What is surprising is that from the Carboniferous, reptiles evolved to colonize dry terrestrial environments. However, in the Permian, you can find some species that come back to water.

During the Triassic, these big amphibians were still the top predators of almost all ecosystems (excluding some places in China) until crocodiles and dinosaurs took that position. At the Jurassic corner, they exhibit a nice collection of ammonites of all sizes. With an ichthyosaur model hanging from the ceiling, we could understand one of the differences between these organisms and contemporary marine mammals. This is a phylogenetic difference: reptiles crawl laterally, so marine reptiles had the caudal fin perpendicular to the sea surface (when the dorsal fin is pointing upwards) to propel themselves also laterally, whereas the result of marine mammal evolution was a caudal fin parallel to the sea surface with vertical propulsion.

Arriving at the Cretaceous, Thomas exemplified with the model of the *Tyrannosaurus rex*, how they update the models and exhibitions with the new findings. During this period, the dinosaurs increased in size, finding the biggest forms at the end of the Cretaceous, while the mammals remained small. The therapods are the dinosaurs characterized by hollow bones that also pre-

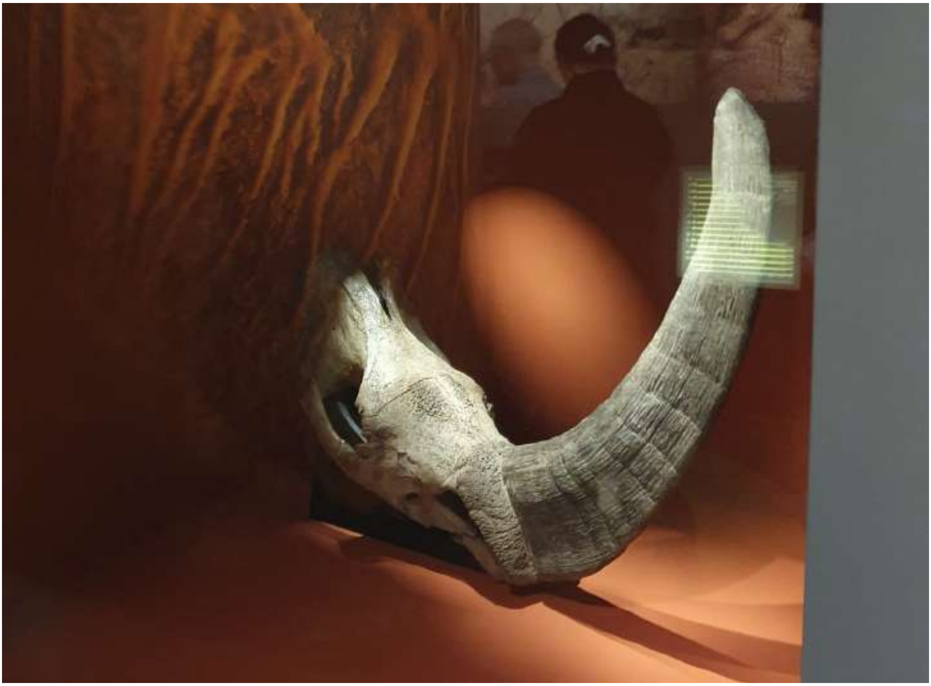


Fig. 2: Fossilized rhino horn at The Human Journey exhibition of The Swedish Museum of Natural History.

sented feather-like filaments and metatarsus partially welded, and as you can guess, they are the ancestors of birds. Even though the birds appeared during the Jurassic, at the end of the Cretaceous, they still presented teeth. Thus, although it is an ongoing discussion, is not crazy to think that all the archosaurs but the crocodiles are homeotherms (meaning warm- blooded).

The Cretaceous-Tertiary extinction happened, and we entered the Cenozoic Era, the Age of Mammals. The time flew, and at that moment, through the loudspeakers, the staff were announcing that the museum was already closed. At least we had time for a proper farewell and a quick look at The Human Journey exhibition. Here, among others, they keep fossils and models from mammoths, sabertooth cats, hominids, and a fossilized rhino horn (Fig. 2), which is exceptional if you keep in mind that these are composed primarily of keratin.

Recycled orogens: Chemical and isotopic records in a subducted continental crust

*Fransesco Nosenzo**

At convergent plate margin, part of the continental crust can be subducted and exhumed. During continental subduction a pre-existing crust is reworked. Remnants of an older orogen are recycled and subjected to (ultra)-high-pressure metamorphism. During subduction, polycyclic rocks undertake a second metamorphic cycle, whereas monocyclic rocks are metamorphosed for the first time. In reworked rocks the pre-subduction record is overprinted and partially or completely lost. Despite this difficulty, reconstructing the pre-subduction history of the recycled crust is crucial, because pre- subduction characters (such as H2O content) can strongly influence how rocks respond to reworking during subduction.

The Dora-Maira Massif is worldwide renowned as a (ultra)-high-pressure continental terrane. However, its northern part remained essentially unexplored in recent times. In this thesis work the northern Dora-Maira Massif is used as a case study to investigate recycling of continental crust. The aim is to constrain what type of crust is subducted and exhumed and to unravel the role of fluids during subduction of polycyclic material. Field work, petrology, thermodynamic modelling and geochronology are integrated.

New field and geochronological evidence indicate that the northern Dora-Maira Massif displays an internal architecture more complex than what previously thought. It is subdivided in several tectonic units likewise the southern Dora-Maira Massif. Chemical and isotopic records of the reworked rocks reveal a pre-Alpine history spanning from the Lower Palaeozoic to the Mesozoic. A polycyclic basement preserves relicts of a pre-Alpine Barrovian metamorphism connected with the Variscan orogenesis. The absence of granulite-facies partially molten pre-Alpine rocks indicates that only the upper crust was reworked in the Dora-Maira Massif.

Thermodynamic modelling indicates that polycyclic micaschists were rehydrated between the Variscan and the Alpine peak metamorphism. Polycyclic garnet texture and chemistry and metamorphic zircon record a main episode of fluid infiltration at the end of the Variscan cycle and not during the Alpine cycle. Pre-Alpine re-hydration of the upper crust allowed high-pressure re-equilibration during subduction.

If you are interested in reading the PhD thesis, you can find it at URN: urn:nbn:se:su:diva-215338.

*Contact: fransesco.nosenzo@geo.su.se

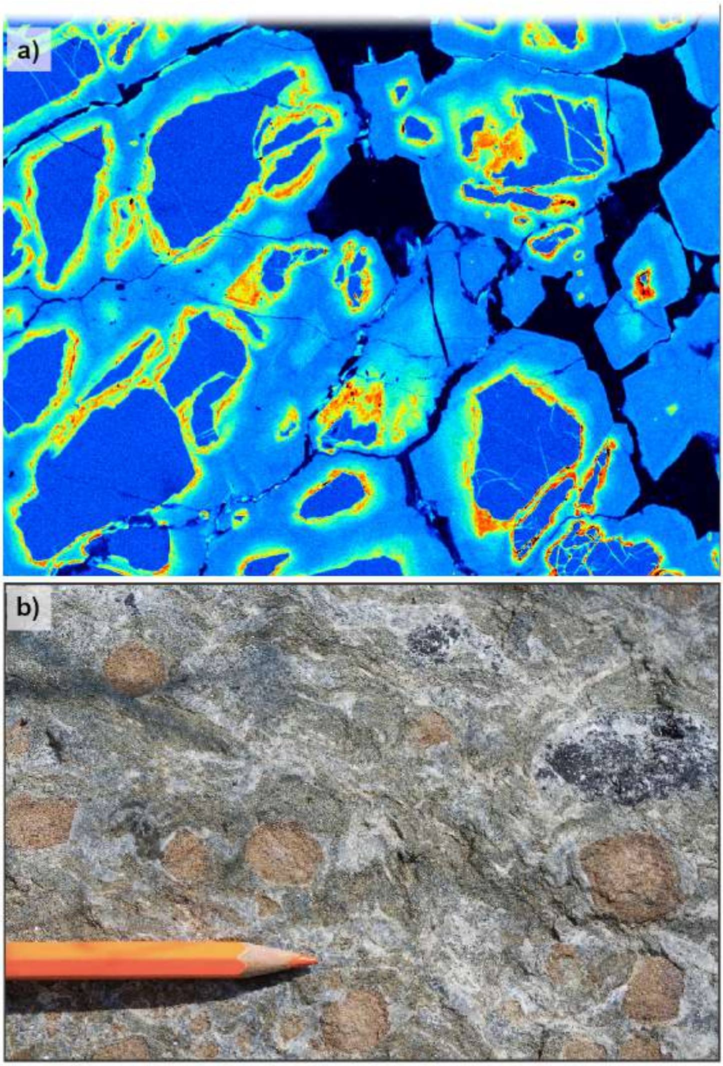


Fig. 1: a) Polycyclic garnets. b) X-ray map of calcium showing polycyclic garnet textures. Field of view: 0.6x0.5mm. Image processing by Martin Robyr.

Dr Christian Stranne

Associate professor of Marine geophysical mapping and modelling

Contact: christian.stranne@geo.su.se

What is your research area?
Although I have a PhD in physical oceanography, I am mostly active within the field of marine geophysics - more specifically within midwater acoustics and numerical modelling of multiphase fluid transport in marine sediments.

What made you choose marine geophysics?
I guess that, in a sense, marine geophysics chose me! After receiving my PhD in physical oceanography, I came to IGV for my first postdoc. I was supposed to do some ocean modeling but after a couple of weeks, Martin Jakobsson asked me if I could have a look at the problem of subseafloor gas hydrate stability. It was sort of love at first sight and I have continued to investigate this problem for past nine years. I also started to do research on midwater acoustics in parallel, as a result of my second postdoc at the Center for Coastal and Ocean Mapping at the University of New Hampshire in the US.

What courses do you teach?
I lead the course “Marine Geophysics 7.5 ECTS” which runs as both on-site and distance versions. In this course we go through the basics within marine geophysics from a theoretical point of view. I also try to mix in lectures about my ongoing research in the course, but there is no field component. I try to compensate for that by also teaching on “The Ocean 7.5 ECTS”, “Marine Geophysical Mapping Methods 7.5 ECTS” and on “Environmental Field Studies 7.5 ECTS” (at ACES), all of which include field work on Stockholm University’s research vessel Electra.

Fig. 1: Christian Stranne.

What are you working on right now?
There’s a lot going on right now! I’m currently preparing for a French expedition to the Amazon deep-sea fan with focus on gas hydrates (one month in May-June). I am also involved in a collaboration between Stockholm University and the University of Helsinki called CoastClim (coastclim.org) where I’m leading a study about methane emissions in coastal waters and the role of

gas bubble transport.

I have two postdocs working on greenhouse gas emissions in the coastal areas north of Greenland, and I have a collaboration with USGS about gas hydrate stability along the eastern USmargin. Many of us on the marine side of IGV are currently writing applications for programs onboard icebreaker Oden on the GEOEO – North of Greenland 2024 expedition next year. Also, I recently received a 4 year grant from the Swedish Research Council which means that I will hire a new postdoc and am preparing for a period of intense field work, to collect data needed for the project.

Tell us a non-science fact about you!
I was an enthusiastic backpacker before my PhD and I have visited more than 50 countries on all continents (including Antarctica).

What do you look forward to in 2023?
Two of my PhD students will defend this spring which is quite exciting. I also look forward to the Amazon deep-sea fan expedition. We will embark the research vessel on Barbados which is a nice contrast to the high latitude polar expeditions I'm used to. I am also very much looking forward to a long summer holiday with my family!

Fig. 2: R/V Electra Af Askö, a research vessel owned by the Stockholm University Baltic Sea Centre.

Dr Qiong Zhang

Professor in Paleoclimate modelling

Contact: qiong.zhang@natgeo.su.se

Fig. 1: Qiong Zhang.

What is your research area?
My research area is focused on studying climate change and climate variability using the Earth System Model EC-Earth. This model allows me to investigate changes in Earth's climate over the past, present, and future, giving us insights into how our planet is evolving.

What made you choose Earth Sciences?
I grew up in a meteorological observation station where my father worked as a local weather forecast man. From a young age, I was fascinated by the natural changes happening around me, and I wanted to learn more about the science behind it. Later, I pursued a PhD in meteorology to better understand how the Earth's climate works.

What courses do you teach?
I teach three courses: an undergraduate course called Climate and Society and two courses in our master's program: Climate Model Simulations and Methods in Physical Geography and Quaternary Geology. Through these courses, I hope to inspire and educate the next generation of Earth scientists.

What are you working on right now?
Currently, I spend 70% of my time on research and 30% of my time teaching. My ongoing research project focuses on understanding multi-centennial climate variability using Earth System Model simulations and paleo proxy data. By studying changes in the past climate, I hope to gain a better understanding of how our planet's climate system is evolving.

Tell us a non-science fact about you!
When I'm not researching or teaching, I love playing and watching tennis!

What do you look forward to in 2023?
In 2023, I hope to see excellent learning outcomes from my courses and help my students reach their full potential. I'm also excited to continue my research and explore new model simulations to uncover exciting findings about our planet's climate. And of course, I'm looking forward to winning more tennis games!

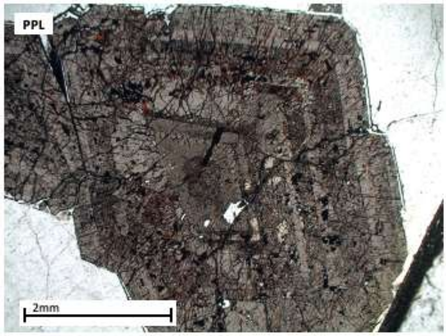
Featuring: Zircon

$ZrSiO_4$

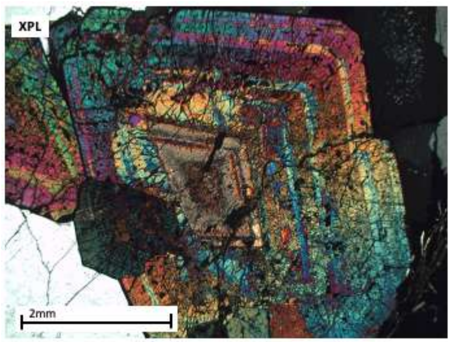
Zircon is a common accessory mineral in igneous, sedimentary and metamorphic rocks. Throughout history, zircon has had many names in different languages but ultimately it is thought to derive from Persian *zargun* meaning gold-hued. It is most frequently used for geochronological studies, which utilises the U-(Th)-Pb system. It can be used to determine the age of a magmatic protolith or for detrital studies of sedimentary rocks.

In hand sample it can display many colors such as yellow, red or green. It has a vitreous or greasy luster and is relatively hard, 7.5 on the Mohs scale. Zircon has a tetragonal crystal structure which displays the characteristic square base.

Fig. 1: Zircon in hand sample.



(a)



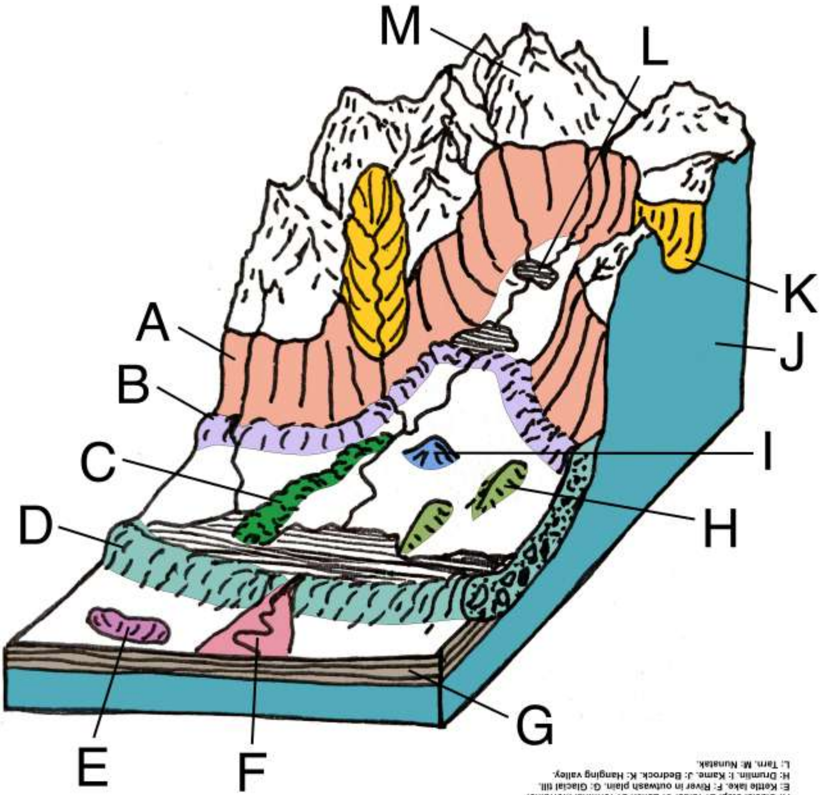
(b)

Fig. 2: Zircon observed in an optical microscope.

Optical properties: Zircon tends to form elongated crystals and has very high relief. It is colorless and can display two poorly defined cleavages. In XPL, it is easily recognized due to its very strong third to fourth order interference colors.

The forgotten landforms

Difficulty level: Sweating geomorphologist



A: Glacial step. B: Talus. C: Esker. D: Terminal morraine.
E: Kettle lake. F: River in outwash plain. G: Glacial till.
H: Drumlin. I: Kame. J: Bedrock. K: Hanging valley.
L: Tarn. M: Nunatak.

Get involved!

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We accept all types of articles, as long as they are somehow related to Earth sciences. Your article may inform of new research findings, your abstract from your thesis, an anecdote from an excursion or about your own experience as a student, enthusiast or researcher. The article may be in English or Swedish and will be published in the language the author has submitted. Send your article to geologklubben@gmail.com and assign Berg & Dalbladetas subject.

We look forward to reading your submitted article!

Fig. 1: Where the rocks meet the ocean.

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Alternatively, you can pay by cash to one of the board members.

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Contact the board

If you want to come into contact with the board, send us an email or a DM on Facebook or Instagram. You can also talk to us if you see us running around the building.

Email: geologklubben@gmail.com
Facebook: Geologklubben
Instagram: geologklubben_su

List of figures

Finally, Geologklubben would like to thank all authors who have contributed with articles to this issue.

Geologklubben
Institutionen för Geologiska Vetenskaper
Stockholms Universitet
106 91 Stockholm

Responsible Editor under Swedish law
Joakim Mansfeld

Editor
Mikaela Krona