Fossil seep carbonates (Late Jurassic – Late Paleocene) of the greater Barents Shelf area.

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During the last ten years a research project with focus on the Mesozoic of Spitsbergen has been conducted by geologists and paleontologists at the Natural History Museum, Oslo. Remarkable vertebrate fossils from the Jurassic have been described in detail, and for the next years the focus is on Triassic faunas.
A parallel project has been devoted to the study of Jurassic-Cretaceous hydrocarbon seep occurrences in Spitsbergen (Agardhfjellet Fm.) (Hryniewicz et al. 2015a) and Novaya Zemlya (Arctic Russia) (Hryniewicz et al. 2015b), as well as late Paleocene seeps of Spitsbergen (Hryniewicz et al. 2016). The carbonates are significantly depleted in heavy carbon isotopes (δ13C values as low as ca. −40 to −50 ‰) and show textures typical for carbonates formed under the influence of hydrocarbons, such as fibrous carbonate cements and corrosion cavities.
Sixteen seep carbonate bodies from the Jurassic-Cretaceous of Spitsbergen have been sampled and analyzed. They contain an unusual fauna for seeps, lacking most of the species characteristic for roughly coeval seep deposits. These seeps formed in a shallow epicontinental sea with widespread deposition of fine-grained, organic-rich sediments. They are spread over a relatively large area and are positioned roughly in the same interval, indicating seepage over extensive areas of the palaeo-Barents Sea for around 9 Myr. The seep fauna is very species rich and with low dominance, comprising 54 species, with a composition similar to that of Jurassic –Cretaceous normal-marine environments of other Boreal seas. Seep-restricted fauna is not abundant and is represented by four species only. We suggest that chemosymbiosis was a source of nourishment for some of the seep-restricted and 'background' organisms. The high diversity and low dominance of the fauna and significant richness and abundance of 'background' species is typical for shallow water seeps.
The analyzed Late Jurassic–Early Cretaceous seep carbonate boulders from Novaya Zemlya were collected in 1875 by A.E. Nordenskiöld during his expedition to Siberia. They contain index fossils of Late Oxfordian–Early Kimmeridgian, Late Tithonian (Jurassic) and latest Berriasian–Early Valanginian (Cretaceous) age. The fossil fauna is species rich and dominated by molluscs, with subordinate brachiopods, echinoderms, foraminifera, serpulids and ostracods. Most of the species, including two chemosymbiotic bivalve species, likely belong to the 'background' fauna. Only two species can be interpreted as restricted to the seep environment. Other seep faunas with similar taxonomic structure are suggestive of rather shallow water settings, but in case of Novaya Zemlya seep faunas such a faunal structure might have been because of the high northern latitude occurrence.
Based on an initial study of museum collections and field work in 2015 a late Paleocene-aged methane seep faunal association of sunken wood was discovered in the Basilika Fm. of Fossildalen (Spitsbergen). The invertebrate fauna within the seep carbonates is of moderate diversity (17 species) and has a shallow water affinity. Wood specimens within the carbonates contain borings and shells of wood-boring bivalves, and are associated with abundant specimens of the thyasirid genus *Conchocele*, common to other seeps of similar age.
Our results have shed new light onto the history of methane seepage on Svalbard, and the evolution and ecology of seep and wood-fall faunas during the latest Jurassic–early Paleogene time interval.

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The Thermo-tectonic History of a Gneiss-Amphibolite Sequence, Iddefjord, Østfold

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The Iddefjord terrane of the Sveconorwegian Orogen, consists of rocks formed in an arc setting, mainly between 1650 and 1550 Ma (Åhäll and Connelly 2008), and affected by Sveconorwegian deformation and metamorphosis in varying degrees. At Remmen, near Halden (Østfold), 150 meters of diamond-wire-cut outcrops have been investigated. The study is based on traditional structural field analysis and utilizes Pb-U dating of zircon, monazite, titanite and rutile by ID-TIMS. The thermo-tectonic evolution, which includes plastic and brittle compressional and extensional events, was investigated. The Remmen outcrops display a sequence of biotite-gneiss, garnet amphibolite and several generations of pegmatite veins. The geometric and time relations between the biotite-gneiss and the garnet-amphibolite are prominent in the outcrops. In one area (C), the amphibolite consists of rectangular homogeneous boudins in the semi-chaotic foliated gneiss. In other parts of the outcrops (A), the amphibolite is migmatitic with internal foliated slivers of leucosome, defining lens-shaped bodies. The foliation in the gneiss dips towards the north, with large variance in the vicinity of the amphibolites, as stress shadows form on the sides of the boudins. This plastic deformation event was bracketed in time by two dated generations of pegmatite, as the

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