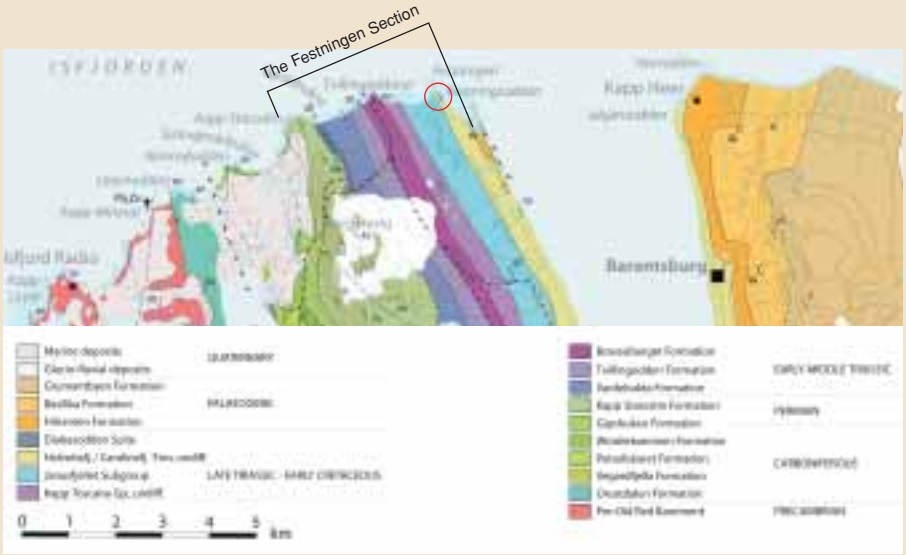
A World Renowned Section

With relatively easy access from Longyearbyen, the Festningen Section is a very popular geological attraction that displays an almost complete section of sedimentary rocks throughout the Mesozoic. Scientists, students and oil company geoscientists come every year from all over the world to learn basic principles of sedimentology and sequence stratigraphy.

Atle Mørk is Senior Geologist with SINTEF Petroleum Research and has more than 25 field seasons in Svalbard.

Photo: Hans Arne Nakrem

In August, "the Sub-commission on Triassic Stratigraphy" have there annual meeting in Longyearbyen. http://natmus.uio.no/triassic-2006/



An almost continuous section, although folded and partly repetitive, from the Late Permian to the basal Cenozoic is well exposed along the coastal cliffs of the Festningen Section. Organic rich shales that should be considered potential hydrocarbon source rocks occur in the Middle Triassic and Upper Jurassic, while sandstones with reservoir quality are found in the Upper Triassic and Lower Cretaceous. The outcrops thus constitute important analogues for petroleum geologists exploring the Barents Sea further south.

Sandstones of the early Cretaceous Helvetiafjellet Formation that are exposed on the Festningen Islet continue onshore and stand out as a prominent ridge. Dinosaur footprints (mentioned in the text) were first found on these beds in the 1960'. Students and professional geoscientists visit Svalbard - and the Festningen Section in particular - because of excellent exposures that are not covered by vegetation.

Atle Mørk, SINTEF Petroleum Research

The Festningen Section is a world-renowned geological profile with excellent exposures of sedimentary rocks ranging in age from the Carboniferous to the Cenozoic. Located strategically in the outer Isfjorden of western Svalbard, it is easily spotted by tourists as well as geoscientists on their way by boat to Longyearbyen, the "capital" of Svalbard and the world's northernmost city.

A continuous section from late Precambrian to Cenozoic can be studied in this location. This is because it is practically turned vertical by folding when Greenland and Svalbard collided during the initial phase of opening of the North Atlantic Ocean during the early Cenozoic. Along the shoreline you can walk five km along well-exposed coastal cliffs. Harsh winter storms with rough waves and drifting ice wash the section clean, and in this way we get new, clean exposures every year.

The section is named after Festningen ("The Castle"), a small islet with a lighthouse. It is formed by the indurated Festningen Sandstone of Cretaceous age that consists of river deposits. It is now also famous for its large dinosaur footprints.

Dinosaur footprints

During the early part of the 20th century, Norwegian geologists and palaeontologists measured the section bed-by-bed and collected numerous fossils. International specialists later studied them for the purpose of making a detailed stratigraphy.

The discovery of dinosaur footprints was made on an international geological field-trip in 1960 attended by Professor De Lapparent. *Iguanodon* was kept responsible for the traces that were 68 cm long with a distance between them of 2m showing that quite a big beast had wandered around in Late Cretaceous time. Casts in plaster were made of the traces the year after, luckily, as the rocks have now fallen down due to weathering. These casts can be seen at museums in Longyearbyen and at the Paleontological museum in Oslo. When I visited the place 20 years later, new traces - however not so big and nice - were exposed in the vertical cliff, and visitors to Festningen can still see well-preserved footprints. At the time of formation, the area had already drifted to high latitude indicating that the dinosaurs needed to be warm blooded to survive the winter.

Renewed interest for the Festningen Section started with the Norwegian oil industry moving into the Barents Sea. Student groups from the universities in Oslo and Bergen began detailed investigations. The purpose was primarily to understand the sedimentology and depositional history of the area. This also started the use of the Festningen Section for excursions during the short summer from June through August. Following the universities, the Norwegian Petroleum Directorate visited the section through several summers, and thereafter Statoil, Norsk Hydro and other oil companies as well as IKU (now SINTEF Petroleum Research) made several field trips. A series of master and doctor thesis resulted.

The organic rich and soft Middle Triassic shales (Bravaisberget Fm) have been strongly folded making stratigraphic studies complicated.

The Paleozoic

Carboniferous fluvial conglomerates and some carbonate beds are found only locally, but from the late Permian Kapp Starostin Formation (named after this locality) and upwards, the section is well exposed. Limestone banks with brachiopods form the base of the exposure. The limestones grade into shales found in this deep cold-water shelf sediment. Towards the top of the Permian, soft clays silicified by sponge skeletons have produced a glassy unit standing out as a peninsula towards the bay eroded into soft Triassic shales.

The Mesozoic

The Lower Triassic Vardebukta Formation is named after the cairn on the coastal cliff used for navigation by trappers along the coast in earlier days. Results of the extraordinary mass extinction at the end of the Permian can be seen as fossils are sparse in the uppermost Permian sediments and almost absent in the lower 100 meters of the Triassic. Even trace fossils are quite sparse.

A major transgression that can be traced all over the arctic, and also globally (see article by Ashton Embry in GEO ExPro No. 2/2006, p.26). It occurs at the base of the Middle Triassic resulting in organic rich, dark mudstones that has been strongly affected by the early Cenozoic folding. This unit forms a major source rock for oil further east and in the central part of the Barents Sea (Steinkobbe Fm). The coastline later prograded eastwards and prominent well-cemented shallow marine sandstone were deposited all along western Spitsbergen.

In Svalbard the polar bear is a constant threat making it necessary to carry guns. When big groups it is normal to have a guard watch for this very dangerous animal.

CENOZOIC

CRETACEOUS

Firkanten Fm.

2200

Carolinefjellet Fm.

2000

Helvetiafjellet Fm.

Rurikfjellet Fm.

JURASSIC

Agardhfjellet Fm.

1500

TRIASSIC

Wilhelm-ya Subg r.

UPPER

De Geerdalen Fm.

MIDDLE

Bravaisberget Fm.

1000

LOWER

Tvillingodden Fm.

Vardebukta Fm.

500

PERMIAN

Kapp Starostin Fm.

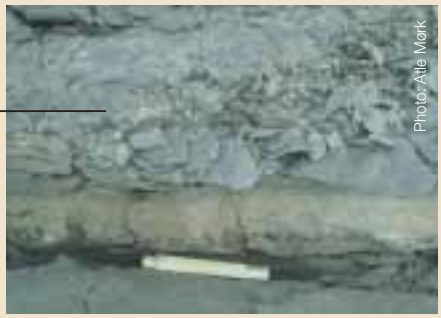
0 m

M Silvi I m Sst Cgl

The basal Cenozoic conglomerate overlies shallow marine shelf deposits; tens of millions of years are missing at this contact.

Dark Cretaceous shales are overlain by the fluvial channel deposits of the Festningen Sandstone.

Limestone bank deposits formed by phosphatic ooids (inset) demonstrate a high energy period within the Middle Triassic.



Galleries of phosphate nodules, mostly formed as tunnel infillings, and phosphate nodular beds in the organic rich sediments show that life flourished at times between anoxic periods.

Bivalve (aquatic mollusks) bank deposits forms the first mass occurrence of life in the Triassic.

A major sequence boundary occurs on top of the hard Permian cherts that are overlain by soft Triassic shales.

Bryozoans are important fauna elements in limestones of the Upper Permian Kapp Starostin Fm.

This section nicely displays a transgression with continental deposits to the right (Helvetiafjellet Fm) and marine deposits (Carolinefjellet Fm) to the left.

A new major transgression took place in the Upper Triassic. This was accompanied with a dramatic shift in sedimentation pattern. The marine dark sediments were replaced with shallow marine sandstones deposited on a shallow shelf. In the Barents Sea, thick deltaic units were formed at this time.

A condensed section of only 20 m thickness spans the Triassic – Jurassic boundary at Festningen. Further to the east and in the Barents Sea, this unit consists of sandstones with excellent reservoir quality. At Festningen, spectacular conglomerates form the boundaries at base and top.

Above the conglomerates, a thick, dark shale unit represents the Cretaceous – Jurassic boundary. The Jurassic has abundant organic matter and is an equivalent to the Hekkingen Formation of the Late Jurassic source rock system in the Barents Sea. The Helvetiafjellet Formation at Festningen has several distributary channels with thin interbedded coals and represents the deltaic environment where dinosaurs wandered around.

The Cenozoic

A major erosional gap spanning 60 – 70 million years separates the Cretaceous sandstones from the basal Cenozoic conglomerates initiating the last depositional succession on Svalbard.

The Tertiary is also well known for its coal beds that have been mined for more than 100 years. Today, Store Norske Spitsbergen Kulkompani is producing nearly 3 million tonnes of coal per year in the mine Svea Nord, while the Russian company Trust Arktikugol has a far lower output from Barentsburg. An abandoned coal mine is found a few meters above the base of the Cenozoic at Festningen and demonstrates early prospecting for this important energy resource.

Visiting the Festningen Section

Detailed planning is necessary if you want to do field work in Svalbard as there is no public transport. You will need a helicopter or a boat that can be rented in Longyearbyen. The Festningen Section can be reached by boat from Longyerbyen in about 3-5 hours.

The old hunting cabin at the base of the section with scattered Carboniferous conglomerates provide a natural harbour at a river outlet. In the Upper Permian and Mesozoic sections, access is easiest on high tide. Note that access has to be parallel with the strike. If not, your propeller may map sandstone ridges.

The pioneers of Svalbard used large, sturdy wooden boats when doing fieldwork, surely creating hazardous episodes. The detailed work they carried out during long summers is therefore quite impressive. Even today, with modern rubber-boats and survival suits, landing can be rough and wet. The reward is, however, worth the effort as the Festningen Section displays one of the most complete continuous sections through the Mesozoic anywhere in the world.

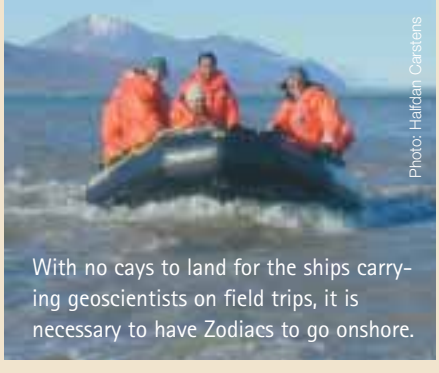
Svalbard

Svalbard is an uplifted corner of the Barents shelf made up of islands totalling some 63,000 km^2 (the equivalent of more than 10 North Sea quadrants). The main island is Spitsbergen, a name given by the Dutch explorer Wilhelm Barents in 1756 because of its jagged, frost-splintered peaks and valleys submerged in huge glaciers, which can be seen far away from the coast. "Svalbard", a name given by the Norwegian Vikings, means the "cold coast". With summer temperatures generally below 10 °C, visitors have no problem in accepting this. However, with four months of 24 hours daylight in Longyearbyen (April 22nd to August 22nd), Svalbard also deserves the nickname "land of the midnight sun".

It is often said that Svalbard is like a complete geology textbook, neatly representing all the formations from the Precambrian through to the Quaternary. The lack of vegetation enables geoscientists to study the rocks with relative ease. However, most locations are difficult to access as there are no roads outside Longyearbyen, necessitating transport by boat or helicopter, and the polar bear is a constant nuisance for tourists and geologists alike.

Several exploration wells have been drilled on the archipelago since 1960. No discoveries have been made, but good oil shows were reported in two wells drilled by the Russians in the 1990's and gas shows have been recorded in several wells. It is widely believed that Svalbard does not contain significant amounts of oil and gas because of tight reservoirs.

The real value of Svalbard for petroleum geologists is excellent outcrops that can be used as analogues of North Sea depositional systems and to the geology of the Barents Sea.



With no cays to land for the ships carrying geoscientists on field trips, it is necessary to have Zodiacs to go onshore.