Brufjell

Teacher's Sheet



From Rv44, exit towards Roligheten and drive until designated parking lot. Follow the road for about 1 km and start on the marked path. There are several different paths leading to Brufjell with different levels of difficulty. The chosen path for this route is the least challenging. Brufjell has an altitude of about 180 meters above sea level.

Walking down to the Brufjell potholes is challenging and climbing on pre-attached steps will be necessary (black route on map). We therefor recommend only to take older students down to the potholes and only in dry weather.

For a shorter route walking back to the parking lot, other paths can be chosen.

Location Map

Location Map

Teacher's Notes

SUGGESTED STOPS	POINTS TO NOTE
Access:	The parking lot has spots designated for busses in addition to large space for cars. (58°16'52.8"N 6°24'20.0"E)
1	**Fjord** (58°16'40.3"N 6°23'27.7"E) The boundary between Rogaland and Vest-Agder county stretches the length of the Åna fjord. The fjord has been formed through glacial processes during the last Ice Age. Glaciers can be thought of as very thick and viscous water flowing over the landscape. At the base of a moving glaciers heavy erosion slowly form a valley and a fjord. It is reasonable to believe that the fjord was created exactly here due to an already existing weakness zone in the bedrock. A weakness zone is often related to faults where brittle movement in the rock along a linear feature has crushed the rock. There are two evidences for this being true. For both you need a map (ngu.no, bedrock map 1:50 000). 1. Looking at a map it is evident that the Åna fjord is parallell and subparallel to other fjords and valleys in the region (Ørsdalen, Fedafjorden etc.) indicating a larger fault system. 2. Looking at the geological map the anorthosite dominates the bedrock, but there a few linear doleritic dykes trending NW-SE. Studying the map these dykes are displaced on either side of the Åna fjord. The displacement happened due to movement on a fault.
2	**Sandvika** (58°16'33.1"N 6°23'09.8"E) The pebble beach Sandvika is situated in a bay among the mountains of anorthosite causing the pebbles to consist almost completely out of anorthosite. This makes Sandvika different. Normally the pebbles forming a beach comes from many different sources transported to a location by rivers, glaciers and ocean currents. Through time, the continuous washing of the pebbles in the wave zone makes them rounded. The sheltered location has been the reason for the beach only to consist of pebbles made from the same type of rocks.
3	**Scree** (58°16'34.1"N 6°23'18.8"E) Screes are a normal sight in Norway. The rocks constituting a scree are characterized by having sharp edges and varying in size but showing signs of being sorted. The sorting is due to gravity – heavier objects move further – leaving the smaller boulders often in the higher parts of the scree. During the last Ice Age glaciers covered the land forming the landscape. Fjords and valleys went through heavy erosion forming steep mountain sides and flat valley floors. When the Ice Age ended about 10 000 years ago and the ice melted away, newly formed and steep mountain got unstable. This caused an abundant of rock falls which we can study as screes today.
4	**Erratic boulder** (58°16'32.5"N 6°23'33.6"E) Yet another sign of glacial activity is the glacial erratics laying scattered around in the terrain. A glacial erratic was most likely a rock that at one point fell on to a glacier through a rock fall or got loosed from the subsurface by the erosive powers of a glacier. In both cases, the boulder would be transported with the movement of the glacier. When the last Ice Age came to an end and glaciers started to melt / retreat, sedimentary material transported by glaciers were just left on the spot where the glacier could no longer hold and transport it. This is the reason for glacial erratics to be both on mountain tops and in valleys, alone or in groups, sometimes even stacked upon each other.

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Texture in rock (58°16'26.9"N 6°23'43.0"E)

The mountains around Brufjell consists more or less of anorthosite – a massive magmatic rock with coarse grain size. When it is weathered is has a grey to light pink matt color while on fresh surfaces the color is brown to redish to grey.

The texture varies, both homogenouse grains of plagioclase, and phenocrysts of plagioclase and orthopyroxene can be observed. Phenocryst means large crystals in a matrix of equal grain size. Orthopyroxene, in contrast to the plagioclase, is a dark mineral and easy to spot.

The different grain sizes and minerals gives the surface of the mountain different textures interesting to study, and if you are lucky you can even find grains of the ore ilmenite!

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Glacial landscape (58°16'24.3"N 6°23'43.0"E)

Magma Geopark has rocks formed in a magma chamber almost 1 billion years ago, but the landscape is formed by glaciers during Quaternary time.

From the top of Brufjell the views are great and you can see a long way in all directions. Valleys and mountains, and steep ocean cliffs and fjords. One aspect important to notice is the maximum height of the mountains. There are many the same height and no mountain a lot higher than others.

This is called a peneplain – meaning land eroded down to equal topography through millions of years. The landscape here was lower at one point and a peneplain was formed. Later, due to geological processes, the landmasses were uplifted which made it possible for erosion below the old base of erosion (peneplain) to happen, leading to fjords and valleys to be formed.

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Rock shelter and alteration of anorthosite (58°16'22.7"N 6°23'35.6"E)

This rock shelter holds many stories. Not only has it been working as a shelter for animals and people through decades, but it also tells an interesting geological history.

The anorthosite was formed about 930 million years ago in a magma chamber situated about 20 km below the surface of the earth. Hot molten rock (magma) intruded into the already existing rocks and with time it crystallized (solidified) to anorthosite. When rocks are crystallized from a magma you can see on the grain size normally the speed of crystallization – fine grain size mean quick cooling and short time for the crystals to grow whilst coarse grain size means slow cooling and time for crystals to grow larger. Under the rock shelter, the anorthosite show a coarse grain size, even with some phenocrysts of plagioclase.

There is one more interesting feature – the white lines cutting across the anorthosite. These white lines are an alteration of the anorthosite and is caused by hydrothermal fluids. When the anorthosite was still deep below the surface of the earth, hot fluids started to move through the cracks in the mountain. If anorthosite is affected by hot fluids there will be a chemical alteration in the mineral structure causing the mineral to change from plagioclase to a zoisite. This zoisite is white. This is the reason for white lines in the anorthosite – they are old cracks with altered anorthosite.

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Brufjell potholes (58°16'21.3"N 6°23'23.9"E)

At the end of the last ice age, large volumes of melt water meant that sea level rose quite rapidly; it reached a level about 20 meters higher than today along the coast of the western part of Vest-Agder. The ice was several kilometres thick in this part of Scandinavia, and its weight pushed the earth's crust down into the underlying mantle. The last ice age started about 120.000 years ago and lasted until about 11.000 years ago.

After the rapid rise in sea level the sea and land rose at the same slow rate for a period that lasted 3-4.000 years. It was during this period that the wave cut platform and associated caves were formed.

Since then the land has been gradually rising relative to sea level in a delayed response to the removal of the weight of the ice sheet. In this area, sea level has again been rising slightly faster than the land for about the last 100 years.