APPLICATION

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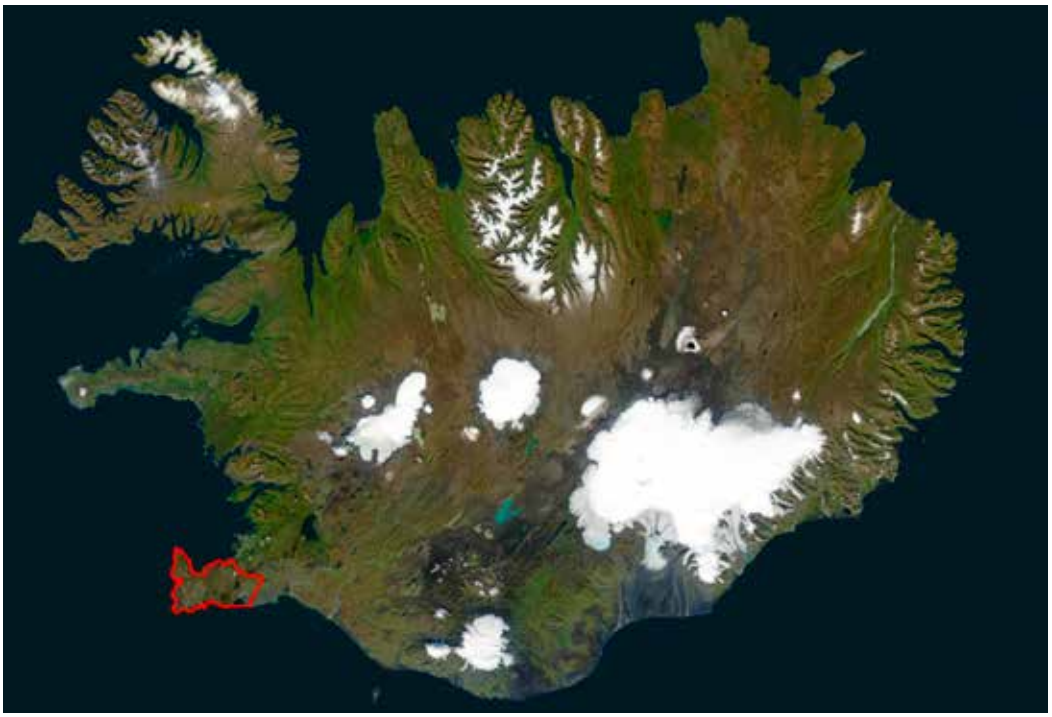
A– IDENTIFICATION OF THE AREA

1. NAME OF THE PROPOSED GEOPARK

The name of the region for nomination as a European Geopark is “Reykjanes Geopark“ (RGP). The Reykjanes Geopark Project gets its name from the Reykjanes peninsula, where the Mid-Atlantic Ridge rises above sea level. Originally the peninsula got its name from the high-temperature geothermal areas found on the peninsula but the Icelandic word „reykur“ can be translated as steam.

2. SURFACE AREA PHYSICAL AND HUMAN GEOGRAPHY CHARACTERISTICS OF THE PROPOSED GEOPARK



A- Administrative size

Reykjanes Geopark has a total administrative area of 875 km2 which is 0,85% of Iceland. The Geopark covers five municipalities (Grindavík, Reykjanesbær, Sandgerðisbær, Sveitarfélagið Garður and Sveitarfélagið Vogar), total population is around 21.500.

B- Physical characteristics and land use

The Reykjanes Geopark area is a peninsula which offers a variety of landscapes, including fissures, lava fields and geothermal activity. Large parts of the lowland are covered by extensive lava fields allowing little vegetation. Because of little vegetation making it difficult to practice traditional agriculture at Reykjanes and for a long time, agriculture has not been an important factor for the local economy. The lava is mostly covered with moss which doesn’t require much soil. The area is relatively flat with the highest point being 391 meters. The lava fields contain many cracks and fissures both below and at the surface. The rift and geosite Hrafnagjá is the longest, nearly 12 km.

The Geopark area is rich in natural resources. Several high temperature geothermal areas are found along the peninsula. In the eastern part of the Geopark are mountains called Brennisteinnsfjöll or Sulfur Mountains. As the name implies, there were small mines in the area in the late 19th century but mining

didn't last long. Traditionally, fisheries have always been the main economic activity in Reykjanes. There is a large number of landing sites, where local fishermen would push their boats out to sea and then drag them back full of fish. Today there are eight harbours along the peninsula, including some of the nation´s biggest fishing-industry harbours.

C- Holistic Geopark philosophy

The establishment of a Geopark in the Reykjanes region at the end of 2012 is part of a long process. For decades, people in the region have discussed how to promote and raise public awareness of the region´s geological heritage. The idea has always been to establish some kind of a park for that purpose, often referred to as "Volcano Park".

In 2008 Grindavíkurbær, one of the municipalities, started working on a policy regarding the use and protection of natural resources. The idea of Reykjanes Geopark was conceived at the same time and the municipality published a report on the idea.

The idea was well received by the other municipalities in the region, the local community and other partners. It is now part of the Regional Plans for Reykjanes 2008-2024. Large parts of the Geopark area are defined as nature reserve areas according to Icelandic laws. These areas have different stipulations as to what actions are permissible within their boundaries. The policy of the regional plan was not to define new nature protection areas, but instead, to establish a Geopark for the Reykjanes region. The plans state that the Reykjanes region should be eligible as a Geopark due to its geological history, formation, resource utilization and culture. The emphasis for the Reykjanes region is to illustrate the diverse conjunction of nature and culture, to inform and educate and to create jobs that are based on the uniqueness of the area.

The aims of the governors of the Geopark at the Reykjanes peninsula will be to define a common vision for a Geopark, to make a development plan for necessary build-up and operation and to create jobs for people with academic degrees in the respective specialties. The Geopark will also be add addition to the framework for the geothermal utilization, or other resource utilization in the region. The Geopark can make a major contribution in reaching the goals of the "European Strategy 2020" over the next decade.

The preparations for the Geopark have been led by the municipalities and later funded partly by Iceland 2020 – governmental policy statement for the economy and community. A working committee, consisting of one governor from each municipality, has met regularly since then to form a shared vision and strategy for the proposed Geopark. It consists of one government official from each municipality. There are also representatives from Heklan regional development centre, Reykjanes Tourist Board, Keilir - Atlantic Center of Excellence, geothermal power company HS Orka Ltd. and Blue Lagoon Ltd. Other organizations, companies and individuals have also participated in the project.

Reykjanes Geopark Project was formally established on the 13th of November 2012. A new board was formed at that point.

D- Population

The total population of the area was 21.500 people as of January 1st, 2012. The largest town is Reykjanesbær municipality, which, with a population of 14.000, is the second largest settlement outside of the greater Reykjavík area. 2.900 people live in Grindavík, around 1.750 in Sandgerði, 1.550 in Garður and 1.200 in Vogar. About 99% of the population lives in towns and villages. The population

density of the Geopark is 25,96 people per km2, compared to 3,1 people per km2 in the whole of Iceland island. This is mostly due to the high population density in Reykjanesbær, 97,18 people per km2. Next is Garður with 72,14 people per km2, Sandgerði with 27,58 people per km2, Vogar with 7,31 people per km2 and finally Grindavík with 6,68 people per km2.

Since the year 2000, the population in Iceland has increased by 14,5%. In the Geopark area, the population has increased by 31,88%. However, the Geopark area is suffering the highest unemployment ratio in Iceland with roughly 50% higher unemployment than the Icelandic average. It is further worth noting that the unemployment population of the area differs from the Icelandic average in the fact that 74% of the unemployed only possess the lowest educational degree (mandatory minimum education) compared to 51% of the country's overall unemployed.

The average age of the population of the area is lower that of the rest of the country. The Geopark has the highest proportion of young people (17 years and younger) in Iceland, 28,2%, compared to 25,3% average in Iceland. It is also worth noticing that only 92,3% of the students who graduate from elementary schools in the Geopark area attends upper secondary schools, which is low compared to 95,2% of the country as a whole. The Geopark also has a lower proportion of people with higher education than is the average of Iceland with the proportion in Reykjanes being 17,7% compared to 33% in the whole of Iceland.

E- Trade and Industry

The Geopark is one employment zone which features five towns along the seaside. Reykjanes has been known for decades for its fishing industry. Both fishing and fish processing in the region have declined in recent years in some parts of the region. Fishing and associated business is still very important for the area. Some of the fish processors in the Geopark area are quite forward thinking in marketing their products as local food production.

As mention before, the Reykjanes region suffers from the highest unemployment rate and the lowest educational levels in Iceland. One of the most important factors affecting the situation of the region was the closing in 2007 of the US army base, which for years provided jobs and prosperity for the region. The well-paid jobs it provided did not require higher education. The base was closed with very short notice leaving the region with a sudden high unemployment, just a year before the Icelandic financial collapse. In comparison with other parts of the country, the region was very badly affected by the economic collapse in the autumn of 2008. Since 2007, the Icelandic government has put substantial effort into re-inventing the former base area today named Asbru. One of the main institution in Asbru is Keilir – Atlantic Centre of Excellence – an educational community. Other activities are being developed.

In recent years, Keflavík International Airport, and the associated businesses around it, have become the biggest employer in southwest Iceland, providing jobs for up to 1.800 people. Another big employer, the Blue Lagoon Spa, is located in the Geopark.

F- Accessibility

Most visitors to Iceland arrive by air through Keflavik International Airport which is located in the region with total of 2.112.017 passengers in 2011. The airport plays an important role as the biggest airport in Iceland and a hub for many airlines using its strategic location in the mid-Atlantic. Directs flights are available from several destinations in both Europe and North-America. There is a regular ferry schedule between Iceland and Northern Europe by the international ferry Norröna which uses

the port in Seyðisfjörður, located in the East of Iceland. From there it's around 7 hours drive to the eastern-most part of the Geopark. Besides the ferry, several cruise ships make a regular visit to Iceland. Iceland does not have a public railway system but Reykjanes Geopark can be reached by car, bus, boat or plane.

G- Tourism

Tourism in Iceland is becoming a more significant part of the national economy every year, like it has been doing for the last two or three decades. The share of tourism in Iceland's GDP was 5.9% in the year 2009, compared to 4.1% in the year 2005. Tourism accounted for around 17% of foreign currency in Iceland in the year 2008. Fisheries had a share of around 26% and aluminium and ferrosilicon smelters around 30%.

The number of international visitors in Iceland has almost doubled since the year 2000. In the year 2011 around 565.000 visitors came to Iceland. In the last ten years, the annual increase of visitors to Iceland has been 6,8%. Visitors to Iceland could be one million by the year 2020, assuming an annual increase of 6,8%.

Around 50% of the visitors come during the three summer months (June, July, August) and about a third come in the spring (April, May) or the autumn (September, October). For the last years, the number of international visitors during the spring, autumn and winter has been increasing. Because of the location and good weather condition, there is a great potential for winter tourism in Reykjanes Geopark.

Figure 2. The Bridge between continents was built as a symbol for the connection between Europe and North America where two of the Earth's tectonic plates split.

Nature in its various forms is the main attraction of the Reykjanes peninsula. When visitors were asked how they got the idea of coming to Iceland, 61,7% mentioned interests in nature/country. 79,7% of the visitors stated that an interest in nature affected their decision to travel to Iceland. Icelandic culture and history was mentioned by 38,6%. These surveys also ask vistors what places in Iceland they visited. 46,6% said they visited the Reykjanes peninsula. Even though polls give this statistic, more than 400.000 guests visit the Blue Lagoon thermal spa alone. The Blue Lagoon is, without a doubt,

one of the most popular tourist attraction in Iceland. 21,3% visited Reykjanesbær municipality and 14,7% visited Reykjanes lighthouse/Gunnuhver. According to another survey from 2011, 68% of foreign tourists stated that they visited the Reykjanes peninsula. 13% visited Reykjanes lighthouse, 12% visited the Bridge between continents and 7% visited Garðskagi. It is worth noticing that only 56% of the guests visited the Bridge between continents, also visited the Reykjanes lighthouse. This indicates opportunities in connecting better the most popular and places worth seeing in Reykjanes with establishment of a Geopark.

Because of the location and the various landscapes, the area is popular for day tours from Reykjavík. A new primary road connecting the towns of Grindavík and Þorlákshöfn on the south coast of Iceland have provided opportunities for tourism development.

There are many popular hiking trails/walking paths in the proposed Geopark. Some of them are ancient national routes, connecting the urban areas in the Geopark. Skógfellavegur e.g. is a 15 km long walk between the towns of Grindavík and Vogar. Skipsstígur is a 16 km long path between the towns of Grindavík and Njarðvík. Prestasígur is 16 km long path connecting the former regional centre at Húsatóftir to Hafnir.

It is easy to find various types of maps and brochures for the Geopark area: for example geological maps, road maps, hiking maps, history and heritage maps and maps for place of interest.

3. ORGANIZATION IN CHARGE AND MANAGEMENT STRUCTURE OF THE PROPOSED GEOPARK

A- Description of the joint partnerships committee

The committee consists of seven members; four members representing the municipalities and three members representing other members of the Geopark, i.e. the tourism, research and development sectors.

B- Activities and responsibilities of the association

Reykjanes Geopark main activities and responsibilities are to develop, support and promote geotourism in the area; promote effective co-operation between independent partners, local governments and international partners; make inhabitants and guests become aware of the Geopark and its main policy; engage with local communities and stimulate sustainable development through the use of the geological heritage; co-ordinate, organize and develop activities to promote tourism e.g. in the areas of education, training, publication, consulting, intervention and provision; preserve of nature for tourism development; and raise funds for projects and operational costs.

C- Membership

The founders of the Reykjanes Geopark Project are the five municipalities; Grindavík, Reykjanesbær, Sandgerðisbær, Sveitarfélagið Garður and Sveitarfélagið Vogar; also Heklan - Regional development centre, Reykjanes Tourist Board, Keilir - Atlantic Center of Excellence, HS Orka Ltd., and Blue Lagoon Ltd. The membership is open to associations, corporations, individuals and others, following an application and payment of the membership fee.

D- The structure of the association

The Reykjanes Geopark is an autonomous independent corporate body. Its mission and aims are co-operation among all of the partners with the aim of a sustainable development of the whole territory in the field of geotourism, together with the preservation of natural and cultural values. It is important

for the whole area that conservation and economic benefits be not sources of conflict, but rather that all work toward a holistic strategy for the area as a whole. The proposed Geopark is managed by a partnership of the five municipalities and five other organizations. Internationally the partnership is fronted by Reykjanes Geopark but each of the municipalities will act within their own territory and can apply for finance financial support. The administration board, a statutory organ of the association, manages the Geopark. Each of the 7 members is elected to one-year terms.

The board has to decide on all matters of management matters concerning the association, submit the financial audit and the plan of the functioning of the association, and be responsible of the project financing and communicates with other partners in the area.

The board hires a professional manager for organizational and coordinating work The professional manager carries out policies adopted by the administration board, prepares an annual budget, applies and administers grant funding, develops short-term and long-range plans, and prepares board meetings.

An Executive Council will include the tourism officers in the area. It's main purpose is to coordinate projects in the Geopark and develop a marketing plan. The council meets at least every four weeks. An Expert Council, an advisory group of specialists from the region, will meet two to three times a year. Its primary role is to give advices about continued development of the Geopark, geological conservation, natural and cultural heritage and sustainable regional economy.

The main Geopark offices will be in Eldey - Entrepreneur Centre where the regional development centre and Reykjanes Tourist Board are located. Kvikan - House of Culture and Natural Resources in Grindavík, The Nature Centre in Sandgerði, Vikingaheimar in Reykjanesbær, and the Garðskagi Folk Museum in Garður will also house Geopark offices, and at the same time represent interpretation centres.

E- The budget of the association

The manager prepares a budget for the committee. Heklan, Regional Development Agency, does has supervision of the budget and has to submit the annual financial audit.

F- The revenues of the association

The revenue of the proposed Geopark comes from various sources. Members of the Geopark (municipalities and other members) will pay a membership fee decided at the annual meeting. Reykjanes Geopark will apply for sponsorship through various programs, funds or foundations, with or without partners. In some cases, the financing will be through smaller programs in each municipality. The Geopark will also well be financed by direct revenue such as souvenirs, publication, advertising and admission fees.

4. APPLICATION CONTACT PERSON

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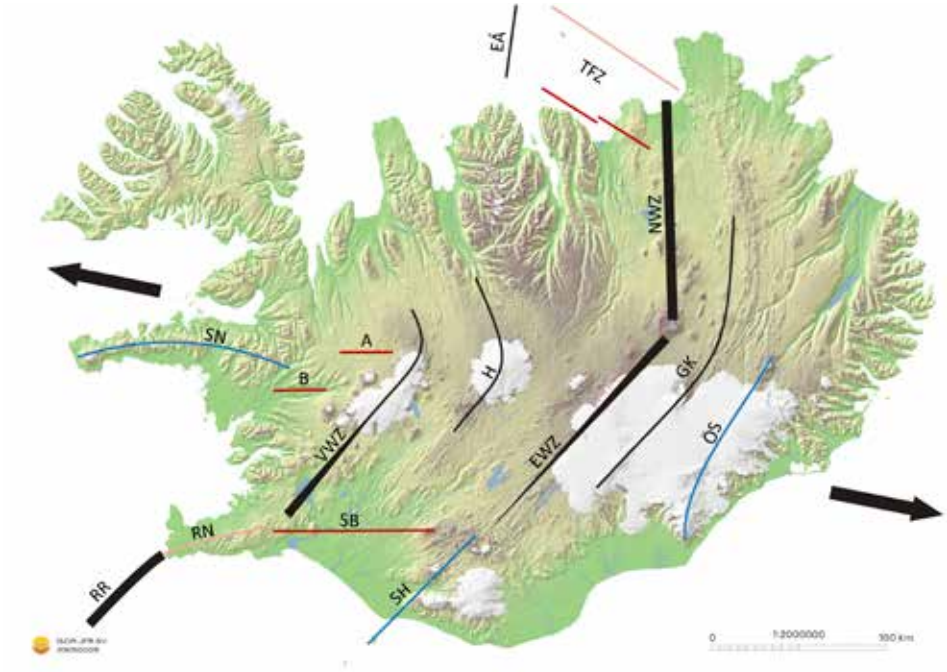
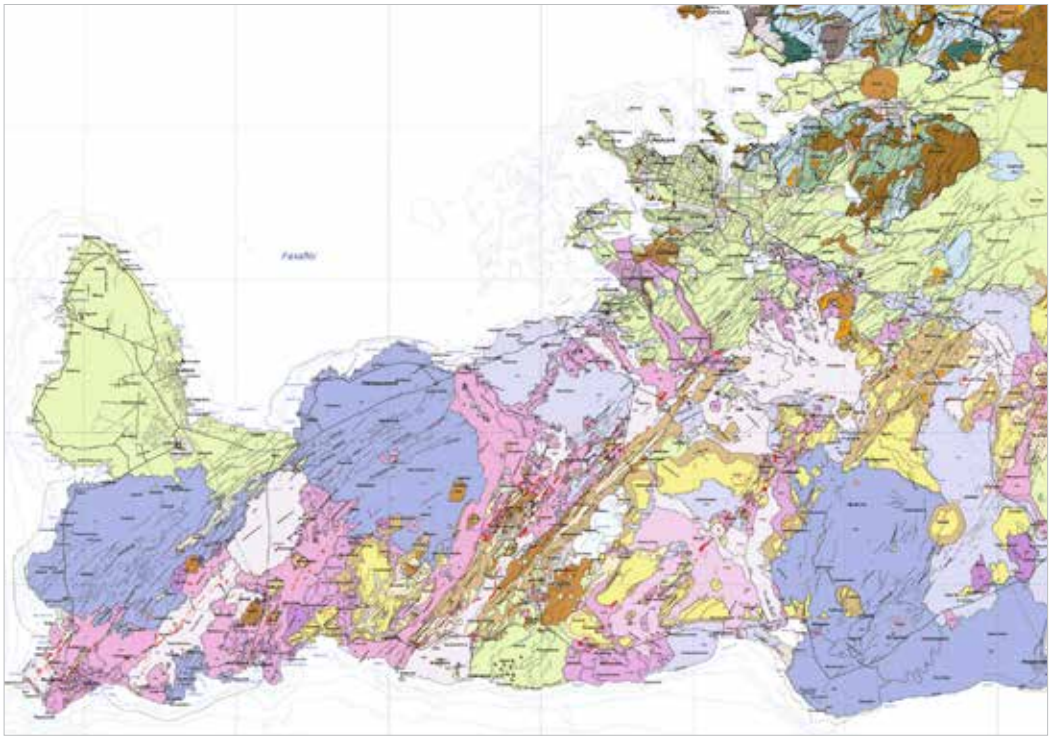
B– GEOLOGICAL HERITAGE

1. LOCATION OF THE PROPOSED GEOPARK

The nominated area for the Reykjanes Geopark Project is located on the Reykjanes Peninsula at latitude 64°N, between longitudes 21° and 23° W. It reaches from Reykjanes in the west, where the Mid Atlantic Ridge axis comes ashore, to the inlet of Herdísarvík in the east. It occupies the uninhabited part of the Peninsula outside the municipalities of Reykjanesbær, Grindavík and Vogar. From Reykjavík it is a 20 minute drive to the boundary of the Geopark. The geology of the Reykjanes Peninsula is dominated by NE-SW trending volcanic systems. Their structures characterize the landscape and establish the geological basis for the Geopark. The volcanically most active part of three of them occurs within its area, i.e. those of Reykjanes, Krýsuvík, and Brennisteinsfjöll. Each volcanic system consists of a fissure swarm with open faults and ground fissures, Holocene lava fields and crater rows, and their Pleistocene intraglacial equivalents. Solfatara fields mark their centres where also the volcanic production is highest and most varied, as at Krýsuvík which is renowned for its explosion craters caused by the interaction of geothermal steam with magma. All these features are easily accessible within the Reykjanes Geopark. Lavas cover the flat ground of the Peninsula whereas the Pleistocene volcanics, being confined by ice when erupted, piled up to form mountains. The lava shields were erupted from single vents. They are as a rule voluminous, the largest and oldest over 100 km² by area. The crater rows produce smaller flows which rarely exceed 30 km2. Intraglacial single vent eruptions left large equidimensional mountains (tuya), whereas fissure eruptions resulted in the formation of ridges (tindar) which may extend up to 20 km in length, while only a few hundred meters in width. The main rock types of these are pillow lava, breccia and tuff.

The Reykjanes Peninsula marks a plate boundary of the transtensional type with periods of rifting and volcanism alternating with periods of earthquake activity and transcurrent faulting on north-south trending fractures. Each cycle of up to 1000-1200 years involves about 300-400 years of volcanism and about 800 years of tectonism. The last volcanic period lasted from 800-1240 AD. It involved episodes of volcanic activity affecting one or two volcanic systems at a time, separated by up to 150 years of volcanic rest. The geological history indicates that the present earthquake period may be nearing its end after almost 800 years of volcanic rest.





2. THE GEOLOGY OF ICELAND AND REYKJANES PENINSULA

Reykjanes Geopark: The geographic setting

The Reykjanes Geopark is located in SW-Iceland, close to the capital area. Within the park limit there are 5 smaller towns and fishing villages with a total of about 20.000 inhabitants. Also, within the park is the main international airport of Iceland (Keflavik Intl. Airport) through which 1.5 million tourists pass annually. The Geopark covers landscapes from the seashore to highlands of 500-600 meters above sea level, and comprises about 50% of the Reykjanes Peninsula (Reykjanesskagi), at its southern and western part.

The Reykjanes Geopark Project area is a direct continuation of the Reykjanes Ridge (RR), a part of the Mid-Atlantic Ridge (MAR) axis. The region is characterized by a highly varied shoreline, many lava flows, low-profile lava shields, crater rows, faults and fissures. Subglacially erupted tuff, breccia and pillow lava form the high-rise landscape as serrated ridges, cones and chest-shaped mountains. Some of the lava flows have recently formed new land in front of old sea cliffs. No central volcanoes, glaciers or rivers to speak of are present but a few lakes adorn the landscape. Colourful high-temperature geothermal fields occur locally.

The five towns and scattered settlements inside the park area bear witness to a millennium-long history of human activities, ranging from agriculture and fishing to modern industry and innovation, including geothermal utilization, along with fruitful cultural activities.

The main morphological features within the area are volcanic or rooted in tectonic activity, mainly rifting. Widespread coastal erosion is at hand. The area represents unique geological diversity at divergent plate margins and has a very important geological heritage value. For somewhat similar study sites one would have to blend the Galapagos Islands with the Afar Triangle in East Africa.

A- The Geology of Iceland: The framework

Iceland is a large volcanic landmass in the middle of the North Atlantic, bordering the Arctic Circle. It was formed when the Mid-Atlantic Ridge became positioned over the world's most powerful mantle plume. Magma production from the plume and rising material beneath the ridge are sufficient to form up to a 40 km thick crustal expanse of basalt (Ó. Guðmundsson 2003, and B. Brandsdóttir and W. H. Menke 2008). This basalt platform is well over 200,000 km2 in total, of which 103,000 km2 rise above sea level as the island of Iceland. The oldest dated rocks above sea level are about 16 million years old (K. Saemundsson 1979). Some 90% of the bedrock is igneous, of which about 80% is basalt from three different petrogenetic series. Andesite-dacite-rhyolite comprise less than 10% and about 10% classify as sedimentary rocks (S. P. Jakobsson 1979). Metamorphic rocks do not exist.

Iceland is a rare section of the Mid-Atlantic Ridge, being above sea level, and the only part that is large and accessible. Nowhere else is it as easy to examine an ocean ridge on land. The spreading rate is approximately 2 cm per year. The spreading axis is localised within rift zones. Centuries elapse between rifting episodes in a particular segment of them. During each rifting episode, the plates move apart a few meters with associated earthquakes and fracture formation, as a rule on existing, so called growth faults.

In the North Atlantic, the ridge southwest of Iceland is known as the Reykjanes Ridge (RR), while north of the country the Kolbeinsey Ridge extends into the Arctic Ocean. On land, the plate margins trend north or northeast, making it possible to witness and study geological activity that would generally occur on the sea-floor, unseen. Inland, interaction of ice and volcanism, during glacial periods of the Quaternary has produced mountains made of hyaloclastites (i.e. cemented palagonite tuff and breccia), termed móberg in Icelandic. The other main product of this interaction is the so-called pillow basalts which form under water. By area they are the most common rock type on Earth, comprising most of the ocean floor. Freshly erupted, this rock type is rarely accessible for direct observation on land. Depending on water depth, submarine and sub-glacial eruption mode changes from pillow lava, at great water depths (high pressures), to breccia and tuff as water depth decreases. If a subaquatic eruption surfaces, phreatic eruption style causes tephra cones to form followed by flowing lavas if eruption continues long enough to seal off the eruption conduit. Within the Reykjanes Geopark area all the above mentioned morphological types of subaquatic volcanism can be observed and enjoyed, even at the very tip of Reykjanes.

Presently in Iceland, volcanic eruptions occur on average every four years. Hundreds of fractures, many volcanic fissures, and dozens of central volcanoes are localized in around 30 volcanic systems on dry land, while others are found in tectonically active areas on the shelf (K. Saemundsson 1978, and H. Johannesson and K. Saemundsson 1998). On land, most of the volcanic systems are arranged obliquely (en echelon) in the volcanic zones, which occupy about 25% of the land area. Volcanism varies for a number of reasons. The crust is relatively thick and part of it is partially re-melted as three intraplate volcanic zones occur on the flanks of the spreading zones. The volcanic products also vary. Within the spreading zones, basaltic fissure eruptions, typical of sea-floor volcanism, are common and, inland, central volcanoes occur, with rhyolite volcanism and calderas.

In the flank zones, eruptions tend to be more explosive in nature, where evolved basalts or intermediate and acid, silica-rich magmas are extruded through high-rise stratovolcanoes. In these cases, the volcanism is akin to the activity in continental settings. Of other major volcano types, rhyolite volcanoes and shield volcanoes of the Hawaiian type occur, many of them with calderas. Almost all the different types of volcanic structures can be found: crater rows with spatter and scoria cones, pumice

craters, tephra rings, rows of explosion craters, lava shields, flow domes and groups of rootless craters. Submarine eruptions are common, and ice caps cover three of the most active central volcanoes with the result that huge melt-water floods may cause havoc.

The plate margins, i.e. a continuous system of rift zones, transtensional zones and transform fracture zones are the playground of giant forces. Earthquakes of up to Ms =5 on the Richter scale occur in the rift zones, up to 6+ in the transtensional zones and up to 7+ in the transform fracture zones. The transform fracture zones in South-Iceland (SISZ) and just north of Iceland (HFZ) pose the main earthquake threat. Together with the Reykjanes transtensional zone (RPR) they are included within a seismic surveillance network. Thousands of small, so-called micro-earthquakes are sometimes registered every year, while earthquakes in the range Ms = 6–7+ occur only a few times every century.

The oldest part of the country´s bedrock is found in NW- and East-Iceland. This is a fairly complex formation of mostly overlapping lava flows that were formed in the Pliocene and late Miocene, 2.6–16 million years ago. It contains intrusions, including dykes and sills, sheets and plugs. A number of laccoliths composed of plutonic rocks occur also. These formed in the roots of central volcanoes as magma chambers of their day, but are now exhumed by erosion. Rhyolitic rocks are a characteristic feature of central volcanoes.

Shallow depth to magma or hot crustal rocks, in addition to their high permeability and the presence of plentiful groundwater, means that geothermal activity is a striking feature in Iceland. The active volcanic zones contain many powerful and extremely hot geothermal areas with solfataras and fumaroles. In the older parts of Iceland, there are also geothermal areas. They are typified by boiling or lukewarm water springs, but with lower energy output. They are termed low-temperature areas. Geothermal activity has a marked influence on the surface, particularly in the high-temperature areas. Being located in the volcanic centres, they are underlain by a dense complex of intrusions from which deeply circulating ground water derives its heat. A plume of hot water rich in dissolved solids and volcanic gases rises toward the surface and boils off steam and gas. This mixes with and heats local surface water and causes alteration of the primary surface rock to clay and deposits of minerals such as sulphur in the oxidizing environment of the air. Several geothermal areas of the high temperature type are to be found within the boundaries of the projected Geopark, among them Krýsuvík, formerly an important supplier of sulphur.

While no glaciers or ice caps occur within the Reykjanes Geopark area, it was intermittently covered by ice during the Pleistocene, and glacial vestiges are common, as are the rather dominant sub-glacially formed volcanic formations. No rivers occur in the Geopark area and no traces of them have been left. Only small brooks are found in areas of extensive bedrock alteration. They deposit their load on well grown flats but end by seeping into the permeable lava and fissures. Consequently within the Reykjanes Geopark there is a huge ground water resource in the young porous volcanic rocks. It forms a lens in the west, floating on sea water. It is 10-20 m thick at Reykjanes but thickens towards east as the groundwater level rises. The flow rate of low-tide spring water has been assessed as 10-12 m3/s (Sigurðsson, 1986). This is a unique feature of the Reykjanes Geopark and enables utilization of the varied sort.

B- Reykjanes Peninsula: Volcanism and tectonics – interesting geosites

The Reykjanes peninsula is rather unique. Here, the spreading ocean ridge emerges on dry land while the fused margin of the North American Plate and the Eurasian Plate bend to the east towards the South Iceland Fracture Zone (SISZ). The bend is due to the strong influence of the transform fault

zone stress field on rifting on the Peninsula. This type of rifting and spreading along an oblique plate boundary is termed trans-tensional, leading to both trans-form strike-slip faulting and tensional normal faulting, alternately active. The plate margins are clearly seen from the distribution of earthquake foci along a 2–5 km wide deformation zone. The Reykjanes Peninsula borders Early Quaternary bedrock north and east of Reykjavík and Late Quaternary bedrock closer to it in the Reykjavík area. The bedrock of the peninsula itself dates from the last three glacial/interglacial cycles of the Late Quaternary with Holocene lavas covering more than half of it. Only basalts have been erupted on the Reykjanes Peninsula. They range from picrite (a primitive mantle based rock) to olivine tholeiite and slightly evolved tholeiite. The tholeiite is the most common rock on the Peninsula and olivine tholeiite the second most common (S. P. Jakobsson et al. 1978). According to data from deep drilling, some 20-60% of the crustal rock below 1,000-1,600 m is composed of intrusive rock. Three volcanic systems transect the proposed Geopark area exclusive of their northernmost parts where non-volcanic fissures have taken over from their eruptive sections. Those three are part of a longer en echelon array which joins up with the South Iceland Fracture Zone (SISZ) and the Western Spreading Zone (WVZ) at a triple junction farther east (S. Hreinsdottir et al. 2001). The volcanic centres of the Peninsula developed where the volcanic systems are crossed by the plate boundary as defined by earthquake foci. The volcanic centres play a key role in volcanism of the Peninsula. During volcanic and rifting episodes they act as shallow crustal magma depositories from where magma is expelled, firstly into veins and sheets in the roof area, and secondly as dykes propagating along the fissure swarms. The surface expression of the former are the high- temperature geothermal fields; the crater rows and non-eruptive ground fissures of the latter. Fissure eruptions are confined to the proximal area of the centres but the dykes continue far beyond. accompanied by ground fissuring.

1. Reykjanes –Eldvörp- Svartsengi Volcanic System

The westernmost volcanic system is 35 km long (40–45 km including a submarine section) and 5–15 km wide. There are about 50 eruptive units extending in age back into the second last glacial period. The oldest unit is a 250 m high mountain (Þorbjörn) composed of pillow basalt up to the top. The main road to Grindavík passes by it. At least eight lava shields formed after retreat of the Pleistocene ice sheet. The oldest of them (Sandfellshæð) was recently dated as 14,500 years old. It issued the Peninsula´s second largest shield lava of 120 km2. Its volume has been estimated at 4.8 km3 (M.J. Rossi 1996). Another much smaller shield, Háleyjabunga, is composed of very olivine-rich picrite. An impressive section of it is exposed inside its crater. The last volcanic episode (Reykjanes Fires) lasted intermittently from 1211–1240 AD. The second and third last episodes occurred some 1,800-2,000, and about 3,200 years ago. All produced lava flows from several km long crater rows. Two of the crater rows extended beyond the shore causing phreatic eruptions (M. A. Sigurgeirsson 1995). The craters and the feeder dykes are exposed and accessible in the sea cliff. A lava flow from the 13th century episode bounds the Blue Lagoon on the west.

2. Fagradalsfjall Volcanic Complex

Hitherto, the Fagradalsfjall volcanic complex has not been distinguished as a separate volcanic system nor assigned to either of the ones next to it. However, detailed geological mapping of the entire Reykjanes Geopark area, funded by HS Orka Ltd. and just about to be completed by K. Sæmundsson and co-workers, warrants the recognition of a separate, perhaps embryonic, Fagradalsfjall system. It is a 13 km long and 5 km wide complex consisting mostly of tuyas and lava shields. It is exceptional in lacking a fissure swarm and a geothermal area. Some of the Peninsula´s most dominating features belong to it. Among these are two large volcanic units, one tuya (Fagradalsfjall) at the centre of the complex, the other a lava shield (Þráinsskjöldur), the largest of the Peninsula, estimated 5.2 km3 by volume and of the same age as Sandfellshæð. The famous landmark Keilir, a hyaloclastite cone, is also a part of this complex. Many of its units are picrite. A few short hyaloclastite ridges cluster around Fagradalsfjall.

3. Krýsuvík Volcanic System

The system is 4–7 km broad and about 50 km long, of which half is volcanic. There are about 100 separate volcanic units reaching three glacial/interglacial cycles back in time. Only one lava shield occurs, Hrútagjárdyngja. It has been recently dated at about 7,000 years. A 3 km2 area near the crater has been inflated to form a lava rise up to 30 m high. Otherwise, the system consists of hyaloclastite ridges and crater rows, mostly of tholeiite (S. P. Jakobsson et al. 1978). Krýsuvík comes close to be accepted as a central volcano. It has a prominent, circular resistivity anomaly of some 10 km diameter which coincides with geothermal manifestations. A buried caldera has been suggested, but not confirmed. In the Holocene most of the volcanic activity has been in the northwestern part of the system. At Krýsuvík, a few fissure eruptions occurred in early Holocene. They are insignificant in terms of volume but remarkable as forming explosion craters and being located on fissures of the north-southerly tectonic trend. Those craters occur in the very active solfatara area where steam may have been the prime explosive agent. The main crater, Grænavatn, ejected a large amount of gabbro xenoliths of variable mineralogy, suggesting a layered intrusion at depth. Three successive eruptive episodes have been dated. The most recent, Krýsuvík Fires, occurred in 1151-1180. It had a forerunner in about 800 AD, at the start of the last eruption period of the Reykjanes Peninsula. Both occurred on the same fissure system. The northern half erupted first, the southern half 350 years later, and the extreme northern part again in 1180. The second last volcanic episode has been dated at 2300-2000 years and the third last at 3200 years. The lava flow on which the aluminium smelter at Straumsvík stands belongs to the latter, as does the Ögmundarhraun lava flow west of Krýsuvík. It destroyed the original settlement of Krýsuvík of which the remains can be seen at Húshólmi, partly buried by lava (H. Johannesson and S. Einarsson 1988, S. Einarsson et al. 1991).

4. Brennisteinsfjöll Volcanic System

Brennisteinsfjöll is an extensive highland plateau culminating at over 600 m altitude. It is formed by a tuya on the west and a lava shield on the east. A fissure swarm with numerous hyaloclastite ridges and crater rows cuts across it. The system is 45 km long and 5–10 km wide. It has the highest volcanic production of the volcanic systems on the Peninsula. Volcanic units are believed to number 50-60 from two glacial/interglacial cycles. Eight lava shields occur including the oldest and largest of Heiðin há. The six youngest were erupted at intervals of about 1000 years. One of them, (Breiðdalshraun), Iceland´s youngest lava shield, formed in historical time around 900 AD. The last confirmed eruptions in the 9th and 10th centuries. The latter ones produced the youngest lavas near the Bláfjöll skiing area and the lava flow Svínahraunsbruni which is crossed by the main (ring) road 20 km east of Reykjavík. The lava flow in the Elliðaá valley in Reykjavík (from Leitin lava shield) dates from around 5.200 years.

The igneous rocks of the Reykjanes Peninsula

The bedrock of the Reykjanes Peninsula is made of different basalts. They range from primitive picrate, of relatively high MgO and low silica (SiO2) content, to tholeiite, low in MgO and higher in SiO2. These rocks are of shallow origin underneath spreading centres. The main rock types are distinctive and go by different names.

Picrite has a high content of olivine phenocrysts, often around 20%, and small, black chromite set in a grey groundmass. Phenocrysts of plagioclase and pyroxene are common. Due to their high density, the olivine phenocrysts settle in the hot lava, and as a result, the bottom part of the flows or pillows is crowded with them, whereas the topmost part is almost without. This phenomenon is very clearly illustrated in the flow units of the Háleyjabunga lava shield, and in pillow lava quarried at Stapafell. Picrite is of low viscosity and very hot when erupted (1,300°C). It is a rare rock type found mainly on the Reykjanes Peninsula.

Olivine tholeiite is a grey (grágrýti in Icelandic), fine to medium grained rock without large phenocrysts. Individual mineral grains (0.3–1 mm) are often visible to the naked eye: white plagioclase, yellow olivine, black pyroxene. Olivine tholeiite classifies as primitive basalt with MgO-content >8%. It probably erupts directly from the mantle, since the magma is hot and very liquid. It usually solidifies as smooth pahoehoe lava. It is chiefly erupted from lava shields or tuyas, their intraglacial equivalents, but occurs also among lavas erupted by crater rows. It is the commonest rocks in Iceland after tholeiite.

Tholeiite varies from almost black (microcrystalline) to dark grey (fine grained). Groundmass crystals can generally not be discerned, not even with a lens. Tholeiite is somewhat evolved, with a MgO content of <5–8%. It probably resided for some time in crustal magma reservoirs underneath the volcanic centres before eruption. Tholeiite is erupted from fissures, often several km in length. The volcanic edifices are scoria and spatter cones lined up on crater rows. Tholeiite flows are more viscous than those of olivine tholeiite and usually solidify as rubbly aa lava. Flow banding is a common feature observed in section. Tholeiite is the most common rock in Iceland.

Porphyritic basalt is a variety of olivine tholeiite and tholeiite. Its characteristic are phenocrysts of white plagioclase which constitute 5-10% of the rock and even more in the so called cumulate type variety. Pyroxene (augite) and olivine may also occur as phenocrysts, usually as accessory minerals with the plagioclase in the same flow. Porphyritic basalt is common on the Reykjanes Peninsula both fissure fed and as shields. The lava of the Hrútagjá shield is an example. Richly porphyritic rocks occur also, the hyaloclastite ridge Trölladyngja, yet to be mentioned for another reason, being an example.

Gabbro is an intrusive rock with the same minerals as basalt. Its place is in the roots of the volcanic centres as laccoliths or stocks. There the magma cools slowly and the constituent minerals grow larger than in lavas. On the Reykjanes Peninsula gabbro is only found as xenoliths in lavas and tephra. Some are fragments broken off from intrusions already solidified, others are cumulates from melts not yet fully crystallized. The gabbro bombs of Grænavatn at Krýsuvík are an example of the former. Widespread occurrences on the Peninsula of loosely bound crystal aggregates resembling gabbro, represent the cumulate type. They are abundant in late glacial spatter lavas west of Krýsuvík.

Lively tectonics

Two types of fracture systems occur on the trans-tensional plate boundary on the Reykjanes Peninsula. The fissure swarms of the volcanic systems are oriented to the northeast (about N40°E). They are characterised by tensile normal faults and open fractures as well as eruptive fissures and cut diagonally across the Peninsula. The Vogar fissure swarm and the Reykjanes graben are good examples (A. Gudmundsson, 1987). The plate boundary of the Peninsula is marked by shorter, north-south trending fractures which exhibit right lateral strike-slip movement. The maximum compressive stress of the peninsula seems to vary with time and place. In periods of maximum horizontal NE-SW oriented compressive stress, the resulting tectonic activity is in the form of transcurrent slip on north-south fractures. The largest earthquakes may reach a magnitude of Ms 5–6.2. The last major earthquake episode of this type (Ms = ca. 5.5) was triggered by the South Iceland earthquake of 2000. During volcanic periods the maximum compressive stress is vertical and stress release occurs with rifting and subsidence on fractures trending NE-SW. The associated earthquakes are weaker (Ms = 4–5) (A. Clifton, et al. 2003). At intervals of ca. 800 years there are periods when sufficient magma is present under the volcanic centres on the plate margin for volcano-tectonic episodes to occur with rifting of the fissure swarms. Such episodes affect one or two volcanic systems at a time. The last one of about 800-1240 AD shifted from one system to the next at intervals of 50-150 years.

Lava flows and related formations

Many interesting lava features are seen among the numerous Holocene lava flows of the Reykjanes Peninsula. The most common surface types are the plate-like pahoehoe lava and the rough, crumbly aa lava. Flow features such as ropy lava and tumuli are ubiquitous on pahoehoe flows. Lava blisters from puffing gas bubbles and inflated lava rises, sometimes pitted, occur also. Small caves, long lava tubes, and lava runnels, channelling fluid lava from craters are frequent. Around the shield craters, in particular, gas/spatter vents called hornitos are seen, and shelly pahoehoe with a dangerously thin crust is common near them. Solidified lava lakes are found locally. Volcanic vent formations are varied: scoria cones, spatter cones and spatter lava are the main types but maars and tephra rings occur also, caused by explosive boiling of water in the conduits. Collapse craters usually form at the top of lava shields in the closing phase if their activity. These are some of the interesting lava formations to be found in the Geopark area.

Abundant geothermal activity

All the high-temperature geothermal areas on the Reykjanes Peninsula occur at the intersection of the actual plate boundary and the cross-cutting volcanic fissure swarms. Based on surface geothermal manifestations and electric conductivity patterns (resistivity maps) they can be grouped into four main geothermal areas. Their locations are shown in Figure 5, i.e. the Reykjanes-, the Eldvörp-Svartsengi-, the Krýsuvík- and the Brennisteinsfjöll high temperature areas.

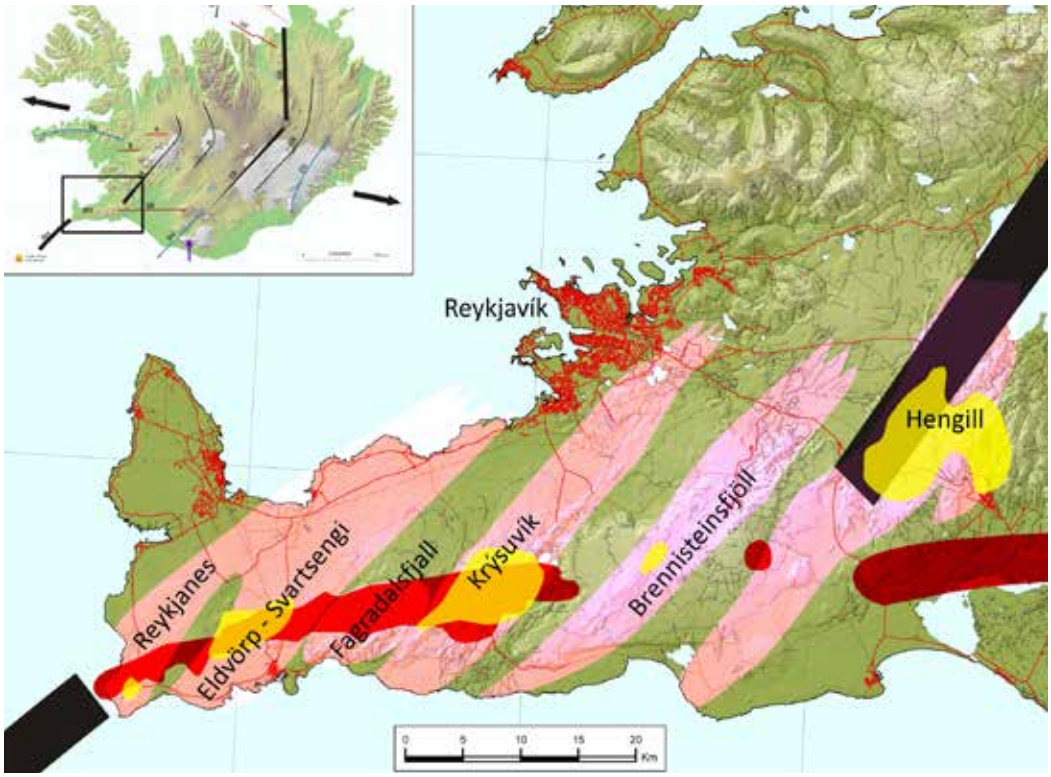


Figure 5.

Without the existence of a huge cold ground water resource, utilization of the high temperature geothermal systems in the western part of the Geopark would have been difficult.

The cold ground water is piped to a geothermal power plant and passed through heat exchangers utilizing geothermal steam and brine. As seen in figure 6, the groundwater table is just about 1 m.a.s.l. all along the coastline, as well as inland within the rifted volcanic fields, until the water table rises with increasing ground elevation towards the Krýsuvík area in the east. The reason for the low ground water elevation is the very porous volcanic rocks which are so permeable that rainwater seeps into the ground and forms a ground water reservoir. It has a thickness of several tens of meters (40-70 m) within the rift zone. No run-off rivers occur on the Peninsula. Small brooks seep into the ground as does the outflow of lakes. The ground water overflow along the shoreline measures in several tonnes of water each second. Not only is the ground water resource utilized as a cold water supply for the inhabitants and the fishing and other industries, but it is also used for all domestic heating, where the heated ground water is piped from the combined heat and power plant at Svartsengi (CHP-plant). Thus, both hot and cold water is distributed through a pipeline system to all the communities in the western part of the Geopark, while the eastern part of it is not inhabited.

In relation to the geothermal systems on the Reykjanes peninsula, a new concept in geothermal, **a geothermal resource park**, was developed by HS Orka Ltd. and its predecessor, Hitaveita Sudurnesja Ltd. The resource park concept is simple, all energy extracted from the ground should be used in a sustainable manner to the extreme, to create revenue streams and employment for the inhabitants. Numerous examples of this policy are to be found within the Geopark area, something that could take a day or two to explore. The Blue Lagoon and its revenue streams of cosmetic line and medical research is a good example (see later discussion). Annually, almost ½ a million people visit the Blue Lagoon alone, almost twice the entire population of Iceland.

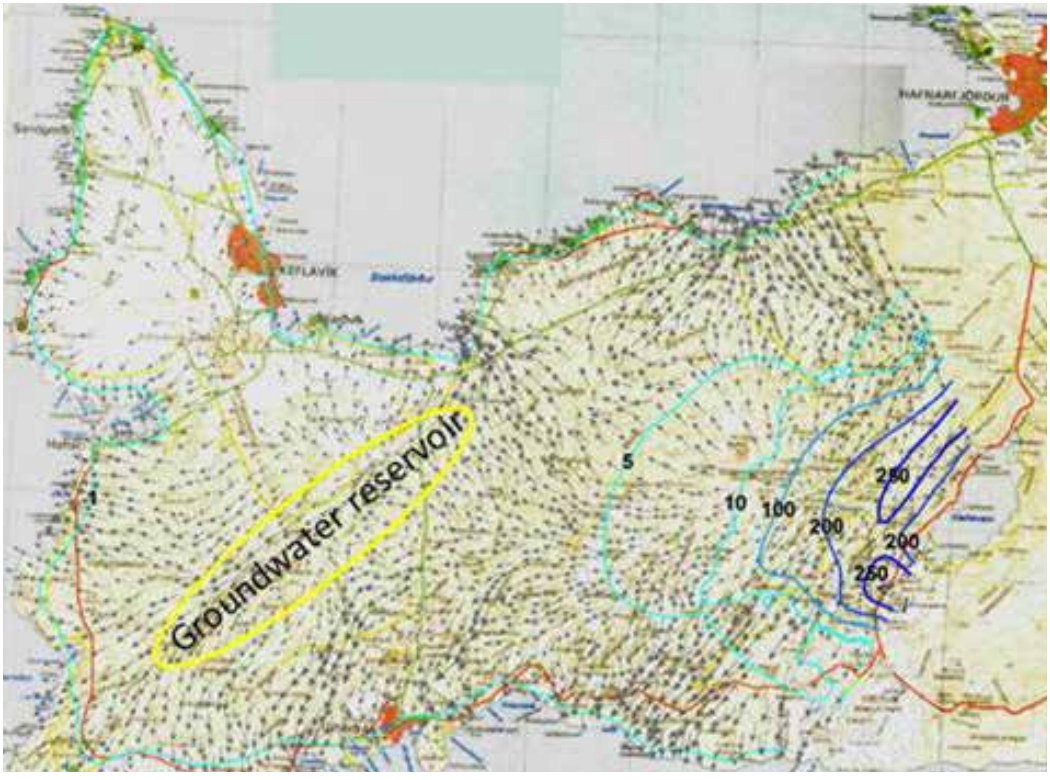


Figure 6. A map showing the depth to the groundwater table (metres above sea level: m.a.s.l.).
The arrows show the groundwater flow directions.

Figure 7. View across the Reykjanes geothermal field over to Svartsengi in the distance to the right.

1. Reykjanes

The Reykjanes high temperature geothermal area, at the very tip of the Peninsula where the Reykjanes ridges emerges from the ocean, is the westernmost of the geothermal areas within the Geopark.Within the uppermost 3 km of the crust the geothermal area is elongated within the Reykjanes rift zone, extending over an area of some 10-15 km2, several km submarine, even though the surface geothermal manifestations in the Gunnuhver hot spring field only covers about 1.5 km2.

The Reykjanes geothermal system is fed by seawater. It is one of two close analogues in the world of black smokers on land, which otherwise occur only on the oceanic spreading centres. The Eldvörp-Svartsengi geothermal system is about 2/3 seawater, while Krýsuvík and all other inland high temperature geothermal systems in Iceland are fed by fresh ground water of meteoric origin. The seawater origin of the Reykjanes geothermal brine makes it very unique. By drilling deep into the Reykjanes geothermal system the physic-chemical conditions resemble the black smoker conditions on the ocean floor. For instance, the black smoker chimneys are composed of Zn-Cu-Fe-sulphide precipitates, which also contain considerable amounts of precious metals. Similar sulphide scales occur in the pipeline system of the Reykjanes geothermal field. Examples of these are shown in the “Energy Earth” exhibition in the Reykjanes Power Plant.

Another unique phenomenon of the Reykjanes geothermal system is that episodically saline geyser activity follows in the wake of earthquake episodes, which occur approximately twice a century. The last one occurred in 1967. While the earthquakes at Reykjanes are relatively weak, mostly Ms <5, they occur in earthquake swarms over several weeks or months. Some have caused minor slip on faults that pass through the solfatara field, Gunnuhver. Then saline geysers have left silica sinter deposits behind, the Kisilhóll (yet to be described) is a prominent example. The last active geyser of this kind formed in year 1919 and died in the early 1980s.

In modern times many of the active high temperature geothermal areas in Iceland have been extensively studied for economic purposes. Reykjanes is no exception to this, while serious harvesting of the field did not begin until 2006 when a 100 MWe electric power plant was commissioned. Prior to that, serious exploration began in the late 1960s, when 7 exploration wells were drilled into the field (RN-2 to RN-8). Well RN-8 was used for experimental salt processing plant, which was operated for some 20 years, harvesting different kinds of mineral salts from the geothermal brine. Fish processing plants were also built at Reykjanes at that time, utilizing geothermal steam for drying fish products. In

1983 a new deep well (RN-9) was drilled for additional supply of brine for the salt factory. All these early drill holes are now out of use and abandoned, as is the salt factory, which has been demolished as well, while two fish processing plants are still in operation. Prior to all this activity, from 1930 to 1960, geothermal clay (kaolinite) from Reykjanes, mixed with Pleistocene marine clay from West Iceland, was successively used in ceramic production, and the Gunnuhver solfatara field was also used for small greenhouses and the warm ground around it as a potato field. Remnants of that early activity can still be seen, almost reaching archaeological age.

Since 1999, some 20 new deep production wells have been drilled by HS Orka Ltd. energy company (wells RN-10 to RN-30). The reservoir fluid is sea water in the range 280-310°C, and a 100 MWe electric power plant has been in operation since 2006. The current plan is to expand that plant to 180 MWe. Now, a 2000 ton/year fish farm for cultivating a warm water sole Benegalensis, is being built close to the power plant, utilizing off flow-heated seawater from it for its fish farming purposes. The Reykjanes power plant is unique in being the only power plant in the world using cold seawater as a cooling agent to condense the geothermal steam. One of the reasons for this power plant design relates to the policy of the energy company to establish a resource park in association with the geothermal utiliztion. One of the main goals of the resource park concept is industry without waste.

Rock samples from all the drill holes at Reykjanes and Svartsengi provide a magnificent insight into the geological evolution of the earth's crust below Reykjanes and the history of the geothermal systems. For instance, hyaloclastite mountains are found buried in the rock pile, submerged in sediments and lavas, and for quite a long time the Reykjanes geothermal field was on the ocean floor, i.e. below present sea level. Fluid inclusions in hydrothermal minerals have also shown that for some time during Pleistocene (ice age), the geothermal system was fed by meteoric fresh water related to overlying icecap. This contrasts to the seawater recharge of the present geothermal reservoir. Another striking feature of interest is the fact that old shallow water and tidal zone shell fragments can be found in marine sediments at several hundred meter depths within the Reykjanes geothermal system. Water fossils at 630 m depth witness that a substantial subsidence of the rift zone takes place in geological time. By deducing the age of the rocks, geologists estimate that the subsidence rate of the rift zone is about 0.6 cm/year (Friðleifsson and Richter 2010). The extension, or spreading rate, of the Reykjanes ridge is between 1.8-1.9 cm/year (e.g. F. Sigmundsson and K. Sæmundsson, 2008) so the ratio of ground-sinking/ground-spreading is about 1/3. This phenomenon is also confirmed by the position of the oldest Holocene lavas, which are found way below the present sea level in some of the Reykjanes drill holes.

Figure 8. Microscopic images of shell fragments from 630 meters in well RN-10.
The upper is probably a mollusk and the two lower barnacle fragments, which seem to be somewhat re-crystallized.

Another striking and somewhat unique feature of the geothermal systems at both Reykjanes and Svartsengi, is the development of steam caps at shallow depths within the geothermal reservoirs. Harvesting the geothermal fluid through deeply cased drill holes leads to a pressure drop in the deep reservoir (drop in a water table) which equals tens and hundreds of meters with time. That induces boiling at high pressures at the dropping water table itself. The high pressure steam then rises upwards where most of it collects at depths below some type of a dense cap rock, which act as a lid on a bowl. Some of that steam though may reach the surface through fractures. The cap rocks may be composed of relative dense marine sediments as discussed above and mineral scales, etc. But importantly and most economically, this clean high pressure steam at relatively shallow depths can then be harvested for steam turbines.

Considerable part of the electric power produced in both power plants relates to this unique phenomenon of a steam cap, which, for instance, does not appear to take place in other Icelandic geothermal power plants, presumably due to different rock types. Nevertheless, while the pressure drop in the saline geothermal reservoirs on the Reykjanes peninsula is necessary for the harvesting of the systems, it also needs to be balanced by re-injecting some of the extracted geothermal fluid. That levels or raises the deep water table, and the colder injected fluid also extracts “new” heat from the hot rocks at depths, and is then used again within the production fields. In this respect, the geothermal industry is very comparable to proper farming, while its harvesting requires somewhat different type of farmers, like mechanical maintainers and engineers, as well as chemical and reservoir engineers, plumbers, electricians, and various types of geoscientists.

2A. Eldvörp (5 km west of Svartsengi plant)

Eldvörp is a name of a crater row midway between Reykjanes and Grindavík. It erupted in 1226 AD. Minor steam vents indicated that a geothermal resource might exist below it. This was supported by a resistivity survey and proven by an exploration borehole, drilled in 1985, which struck a reservoir of 260°C. Monitoring has shown that Eldvörp is the westernmost part of the Svartsengi geothermal field. Geothermal harvesting is being planned at Eldvörp.

Figure 9. The Eldvörp volcanic crater row erupted in 1226. A high-temperature geothermal exploration well was positioned on the west side of the one of the craters in a steaming field. The Svartsengi steaming field is seen in the background, just north of the Þorbjörn hyaloclastite mountain.

2B. Svartsengi - Blue Lagoon

The Svartsengi-Eldvörp area should be treated as an entity, but it is convenient to discuss them separately. The Svartsengi geothermal field has been exploited for hot water and power generation for almost 40 years, commissioned in 1976. Surface manifestations before drilling were very weak steam emanations in a rubbly aa lava, and rumours of formerly warm ground north of Mt. Þorbjörn existed. Drilling in the early 1970ties revealed a reservoir of about 240°C. A total of 26 geothermal wells have been drilled, the deepest approaching 2.5 km. The geothermal water is used to heat fresh water via heat exchangers for domestic use in the settlements of the Peninsula, while the steam is used for power production in different types of turbines. Now the rated production capacity is 150 MWt and 75 MWe. The effluent water is used directly in the Blue Lagoon health resort and half of it is re-injected into the geothermal reservoir 2.5 km west of the power plant. Production from the reservoir has caused a drawdown within the reservoir and the development of a steam zone as a result. Production from the steam zone yields pure steam that drives turbines after cleaning of non-condensable gases.

Prior to drilling there was hardly any evidence of geothermal activity on the surface, only extinct clayish surface manifestations in Pleistocene hyaloclastite mountains nearby, Þorbjörn and Svartsengisfell, and minor steam emanation visible on cold clear days. Today, steaming ground characterizes part of the field around the CHP Svartengi power plant, as well as effluent water, part of which is used directly in the Blue Lagoon health resort. The Svartengi power plant is like a museum itself. It was commissioned in 1976 as a local heating company for the nearby fishing villages in response to the oil crisis of the early 19seventies. Then, as the almost unknown geothermal resource at Svartsengi turned

out to be colossal in size, the need grew very fast for expanding the company to supply hot water for domestic heating in the entire Geopark area. With growing hot water production it soon became clear, that without a topping unit to produce electricity, a large amount of energy would be wasted from the 240°C hot geothermal brine. Thus electricity production increased in incremental steps from 2 x 1 MWe turbines, to additional 6 MWe turbine, with 7 additional binary turbines of 1.2 MWe each, to an additional 30 MWe turbine in 2001, and finally a prototype triplet turbine of 30 MWe, called the Octopus by the Japanese Fuji company, which manufactured all the electric turbines being used at both the Svartsengi and the Reykjanes power plants.

The resource park around the Svartsengi power plant deserves a closer description. The Blue Lagoon has three main activity centres: (i) The geothermal Spa located in the middle of the black lava field which attracts more than 400 000 visitors every year, (ii) The R&D Clinic treats people from all over the world with different kinds of skin disorders mainly psoriasis, and (iii) the R&D centre in which silica (SiO_2) in the right form for the human skin to absorb is precipitated from the high temperature sterile brine mixed with two types of cultivated local and very special geothermal green algae. The product affects the human skin in a very positive way. Today, there are two more state of the art companies operated in the Svartsengi resource park: Carbon Recycling International produces renewable methanol from CO_2 from the geothermal gas of the power plant and ORF Genetics grows barley for molecular farming. Another, but very different resource park, is around the Reykjanes power plant. The Reykjanes resource park is in a way a high tech marine park in which clean human food is produced. Today, there are three companies comprising the Reykjanes resource park: Háteigur and Haustak both of which operate fish drying facilities, and the new Stolt Fish Farm. The new company is constructing at the present the biggest land based fish farm in the world, growing flat fish (Sole Senegalensis, 2000 ton/year). A distinct character of both of these resource parks is powerful R&D activity in a state of the art companies. One of the main goals of the resource park concept is "industry without waste". The resources utilised by the resource park companies are effluent streams from the geothermal power plants.

3 Krýsuvík is the largest geothermal area within the Geopark. It covers an area of some 100 km2, defined as an entity based on both the distribution of surface geothermal manifestations, and on acircular resistivity anomaly, which is some 10 km across. Conveniently, the Krýsuvík geothermal area has been split into 4-5 geothermal sub-fields: **Krýsuvík/Seltún** (south west of Lake Kleifarvatn), **Austurengjar** (within and south of lake Kleifarvatn), Köldunámur (to the northwest of Sveifluháls in Móhálsadalur), **Trölladyngja-Sog** (in the western part of the Krýsuvík volcanic system), and **Sandfell** (furthest to the south west within Krýsuvík geothermal area). Surface geothermal activity in Köldunámur and Sandfell is meagre, in both cases very small steaming fields and minor surface alteration, perhaps similar to what was observed in both Eldvörp and Svartsengi.

he entire Krýsuvík area was licenced to HS Orka Ltd. for geothermal exploration. The research permit, extending from 2006 to 2016, allows all kinds of geological, geochemical and geophysical surveys to be undertaken, and an incremental part of such research permits assume that several deep exploration drill holes could be drilled as well. Just prior to this permit, two deep wells were drilled in the Trölladyngja field. They provide valuable information on that part of the Krýsuvík area, but not so much on the rest of the area. Several 2.5-3 km deep exploration wells are needed in the other fields to estimate the resource potential. Decisions on any such development rest with the local communities and need not be discussed any further here, while it is quite clear that the Krýsuvík geothermal resource could be harvested for prosperity in many different ways within the resource park concept.

Trölladyngja. The main geothermal activity of fumaroles and mud pools concentrates on the north eastern half of the Trölladyngja field, while cold and extinct hydrothermal alteration is very prominent and colourful in the Sog field. In Sog, the alteration bulges east across a depression south of Trölladyngja, with strongly altered tuff and sediment. It has fumaroles and mud pools at the very entrance but most of the surface area is cold now. The central part of geothermally active area is dotted with explosion craters. Some are of late glacial age, but a younger group formed about 2000 years ago on eruptive fissures of the second last eruption period. Most likely explosive boiling of geothermal water played a key role in the explosiveness. Exploration drilling there has revealed a geothermal reservoir of 260 to 350°C. Harvesting of the geothermal resource there has not been decided upon.

Figure 10. View over Sog valley , the center of Late Pleistocene to early Holocene solfatara field. Trölladyngja mountain is on the left and Grænadyngja in the center. The geothermal activity at surface cooled and was covered by brown soil and vegetation, dating back some 4-5000 years, while the Sog valley itself drained out by erosion less than 2000 years ago.

Krýsuvík/Seltún and Austurengja fields are the core of a large geothermal area extending for 6 km from the settlement (so called "school") to the middle of Lake Kleifarvatn and across the adjoining Sveifluháls hyaloclastite ridge complex to the west. The main zone of mud pools, fumaroles and sulphur deposition is on the mountain slope west and north of the "school". The solfatara field of Seltún close by is a popular tourist attraction which also offers good walking paths. Krýsuvík has a long history of sulphur exploitation since 100-300 years ago, and later of drilling for power production with totally inadequate equipment 70-50 years ago. Nevertheless, useful information about the geothermal system was acquired. In the drilled area it proved to be inverted in temperature. The last wells, drilled 20-30 years ago on the lower slope of the mountain, however, were not. Their temperature follows the boiling point curve to over 230°C at 300 m depth. Some of the old wells of Seltún pose a threat due to corrosion of their casing. One blew its top off 12 years ago and a mud crater of 20x40 m in diameter formed. The Krýsuvík area is under volcanological surveillance due to observed ground deformation, microseismic spasms, and a new fumarole field coming up.

4. Brennisteinsfjöll (10 km east of Kleifarvatn)

Geothermal manifestations occur along a 3 km section of the fissure swarm. There is only one solitary fumarole depositing sulphur in a lava flow, about 2000 years old, and a mofette a few hundred meters north of it. Cold alteration along faults marks the continuation towards northeast. Resistivity indicates a size of about 6 km2 at 800 m depth. The area offers a variety of geological interests but it is rarely visited. Plans for exploration have met opposition from conservationist groups. Sulphur mining was last attempted in the 19th century but was given up due to difficulties with transportation.

References and selected bibliography

S. Arnorsson 1995. Geothermal systems in Iceland. Structure and conceptual models.
1. High temperature areas. Geothermics 24:561-601

T. Arnadóttir, H. Geirsson and W. Jiang 2008. Crustal deformation in Iceland:
Plate spreading and earthquake deformation. Jökull 58:59-74.

K. Beddam 2002. Primitive melt from the Iceland mantle plume. Journal of Petrology 43:345-373.
I
. Th. Bjarnason, W. H. Menke, O. G.Flovenz and D. Caress 1993.Tomographic image of the Mid-Atlantic
plate boundary in Southwestern Iceland, Journal of Geophysical Research 98:6,607-6,622.

B. Brandsdottir and W. H. Menke 2008. The seismic structure of Iceland. Jökull 58:17-34

B. Brandsdottir (ed.) 2008. The dynamic Geology of Iceland (44 authors), Jökull No.58, Reykjavík. 422 pp.

A. Clifton, C. Pagli, J. F. Jonsoóttir, K. Eythorsdóttir and K. Vogfjörð 2003. Surface effects of triggered fault
slip on Reykjanes Peninsula, SW-Iceland. Tectonophysics 369:145-154.

P. Einarsson 1991. Earthquakes and present-day tectonism in Iceland. Tectonophysics 189:261-279.

S. Einarsson, H. Johannesson and A. E. Sveinbjornsdottir 1991. Krýsuvíkureldar II. Kapelluhraun og gátan
um aldur Hellnahrauns. Jökull 41:61-80.

Th. Einarsson 1994. The geology of Iceland - rocks and landscape. Mál og menning, Reykjavik. 330pp.

O. G. Flovenz and K.Saemundsson 1993. Heat flow and geothermal processes in Iceland. Tectonophysics 225:123-138.

G.R. Foulger and D.L. Anderson 2005. A cool model for the Iceland hotspot. Journal of Volcanological
and Geothermal Research 141:1-22.

G.Ó. Friðleifsson, and , B., Richter2010. The Geological Significance of two IDDP-ICDP Spot Cores from the
Reykjanes Geothermal Field, Iceland. Proceedings World Geothermal Congress 2010, Bali, Indonesia, 6 p. Also available at: **www.iddp.is**.

A.T. Gudmundsson 2011. Living Earth. Mál og menning. Reykjavik, 408pp.

A. Gudmundsson 1986. Mechanical aspects of postglacial volcanism and tectonics of the Reykjanes Peninsula,
Southwest Iceland. Journal of Geophysical Research 91, no. B12:12,711-12,721.

A. Gudmundsson 1987. Geometry, formation and development of tectonic fractures on the Reykjanes
Peninsula, Southwest Iceland. Tectonophysics 139:295-308.

A. Gudmundsson 1995. Infrastructure and mechanics of volcanic systems in Iceland. Journal of Volcanological
and Geothermal Research 64:1-22.

Ó. Guðmundsson 2003. The dense root of the Iceland crust. Earth and Planetary Science Letters 206: 427-440.

S. Hreinsoóttir, P. Einarsson and F. Sigmundsson 2001. Crustal deformation at the oblique spreading Reykjanes
Peninsula, SW-Iceland: GPS-measurements from 1993-1998. Journal of Geophysical Research 106:13,803-13,816.

S. P. Jakobsson, J. Jonsson and F. Shido 1978. Petrology of the Western Reykjanes Peninsula, Iceland. Journal of Petrology 19:669-705.

S.P. Jakobsson 1979. Outline of the petrology of Iceland. Jökull 29: 57-73.

H. Johannesson and S. Einarsson 1988. Krýsuvíkureldar I. Aldur Ögmundarhrauns og miðaldalagsins. Jökull 38:71-87.

H. Johannesson and K. Saemundsson 1998. Geological map of Iceland. Tectonics. Icelandic Inst. of Natural History, Reykjavík.

J. T. Jónasson, 1968. Grunnhitamælingar á Reykjanesi sumarið 1968, Orkustofnun.

J. Maclennan, M. Jull, D. Mackenzie, L. Slater and K. Gronvold 2002. The link between volcanism and deglaciation in Iceland. Geochem. Geophys. Geosyst. 3(11), 1062, doi:10.1029/2001GC000282.

N. Oskarsson, S. Steinthorsson and G. E. Sigvaldason 1985. Iceland Geochemical Anomaly: Origin, volcanotectonics, chemical fractionation and isotope evolution of the crust. Journal of Geophysical Research 90:10,011-10,025.

M. J. Rossi 1996. Morphology and mechanism of eruption of postglacial shield volcanoes in Iceland. Bulletin of Volcanology 57:530-540.

F. Sigurðsson, 1986. Hydrogeology and Groundwater on the Reykjanes Peninsula. Jökull, v. 36, pp. 11-29.

K. Saemundsson 1978 Fissure swarms and central volcanoes of the neovolcanic zones of Iceland. Geological Journal 10 (Special issue): 415-432.

K. Saemundsson 1979. Outline of the geology of Iceland. Jökull 29:7-28.

R. C. Searle, J.A., Keaton et al. 1998. The Reykjanes Ridge: structure and tectonics of a hot-spot-influenced, slow-spreading ridge, from multibeam bathymetry, gravity and magnetic investigations. Earth and Planetary Science Letters 160:463-478.

F. Sigmundsson 1991. Postglacial rebound and asthenosphere viscosity in Iceland. Geophysical Research Letters 18:1,131-1,134.

F. Sigmundsson 2006. Iceland Geodynamics – Crustal deformation and divergent plate tectonics. Springer-Praxis, Chichester, UK. 209 pp.

F. Sigmundsson, and K. Saemundsson 2008: Iceland: a window on North Atlantic divergent plate tectonics and geological processes. Episodes, 31:92-97.

M.A. Sigurgeirsson 1995. Miðaldalagið. Eyjar í eldhafi, 189-199. Gott mál, Reykjavík.

E. Sturkell, F. Sigmundsson et al 1994: Strain accumulation 1986-1992 across the Reykjanes plate boundary, Iceland, determined from GPS-measurements. Geophysical Research Letters 21:125-128.

T. Thordarson and G. Larsen 2007. Volcanism in Iceland in historical time: Volcano types, eruption styles and eruptive history. Journal of Geodynamics 43:118-152.

T. Thordarson and A. Hoskuldsson 2002., Iceland. Road-guide by Classical Geology in Europe 3. Terra. 200 pp.

R.S. Williams, S. Thorarinsson and E.C. Morris 1983. Geomorphological classification of Icelandic volcanoes. Jökull 33:19-24.

3. LISTING AND DESCRIPTION OF GEOLOGICAL SITES WITHIN THE PROPOSED GEOPARK

The classification of sites of interests in Reykjanes Geopark consists of three main categories: geological sites (G), natural sites (N), and cultural- or historical sites (C). Geological sites, or geosites, are supposed to represent the geological heritage of the proposed Geopark. Natural sites will represent richness of fauna and flora, and landscape that have unique or outstanding beauty. The third category is sites with archaeological, historical or cultural value. Some sites belong to two or three of these categories while others belong only to one.

Importance of the sites can also be ranked in three categories: sites of International importance (INT), sites of National importance (NAT) and sites of Regional importance (REG).

From the point of view of protection, the sites are ranked in six natural, local or archaeological categories: Nature Reverses (NR), Country Park (CP), Natural Monuments (NM), Sites of Natural Interest (SI), Local Regulation (LR) and Archaeological Protection (AP).

The following sites are divided into three groups when it comes to usage: scientific, educational, and tourist. Scientific sites are valuable for geological, biological, archalogical or cultural reasons. Educational sites are important for geological, natural, cultural or historical reasons and suitable to interpretation for all target groups. Tourist sites do not always have a special scientific or aesthetic value but are assigned for recreation.

It is Reykjanes Geopark policy to have all sites open to the public. On the other hand, there are some sites closed due to safety reasons or to protect vulnerable flora or fauna, e.g. Eldey. Finally, some sites are private property and closed to the public without permission.

No	Non-geological	Type	Importance	Protection	Scientific	Educationa	Touristic
1	Arnarsetur	G	REG		X		X
2	Brennisteinsfjöll	G/C	NAT	CP	X	X	
3	The coast west of Grindavik	G/C/N	REG	SI		X	
4	Eldborgir by Geitahlíð	G	NAT	NM		X	
5	Eldey	G/C/N	NAT	NR	X	X	X
6	Eldvörp	G/C	NAT	SI	X	X	X
7	Festarfjall / Hraunsvík	G/C	NAT	SI	X	X	X
8	Grænadyngja/ Trölladyngja	G	REG	CP	X	X	
9	Grænavatn/ Gestastaðavatn	G/N	REG	CP		X	X
10	Gunnuhver	G/C/N	REG	LR	X	X	X
11	Hafnaberg	G/N	NAT	SI			X
12	Hafnasandur / Sandvíkur	G/N	REG			X	X
13	Háleyjabunga	G	REG	LR		X	
14	Hrafnagjá	G/N	NAT	SI	X	X	
15	Hrólfsvík	G	REG		X	X	
16	Hrútagjárdyngja	G	REG		X	X	
17	Hvassahraun-skatlar	G	NAT	SI		X	
18	Katlahraun	G	NAT	SI, CP			X
19	Keilir og Keilis-börn	G/C	NAT	SI			X
20	Kleifarvatn	G/C/N	NAT	LR, CP	X	X	X
21	Krýsuvíkurberg	G/C/N	NAT	CP		X	X
22	Lambafellsgjá	G	REG	CP			X
23	Méltunnuklif	G	REG			X	
24	Ósar	N	REG	SI	X	X	X
25	Pattersonvöllur	G/N	NAT			X	
26	Reykjanestá	G/C/N	INT	SI	X	X	X
27	Rosmhvalanes	G/C/N	NAT	SI		X	
28	Sandfellshæð	G/N	REG			X	
29	Seltjörn	G/C/N	REG	SI		X	X
30	Seltún	G/C	NAT	CP	X	X	X
31	Skálafell	G	REG			X	
32	Snorrastaðat-jarnir	G/N	NAT	SI			X
33	Sog	G/N	NAT	CP	X		X
34	Stampar	G/C	NAT	LR	X	X	X
35	Sundhnjúksröðin	G	NAT	SI		X	
36	Svartsengi	G/C	NAT		X		X
37	Sveifluháls	G	REG	LR, CP	X		X
38	Tjarnir á Vatnsl-eysuströnd	C/N	REG	SI	X	X	
39	Valahnúkamöl	G	REG				X
40	Þorbjörn	G/C	REG			X	X
41	Ögmundarhraun by Núpshlíð	G/C	REG	CP	X	X	X

4. DETAILS ON THE INTEREST OF THESE SITES IN TERMS OF THEIR INTERNATIONAL, NATIONAL, REGIONAL, OR LOCAL VALUE

At the Reykjanes peninsula it is possible to see the unique power in the earth unified with the natural landscape of the land to create a completely unique setting. The ground takes on spectacular forms in immense lava fields, caves, hot springs and volcanic craters. Reykjanes is, in fact, itself a part of the longest mountain range in the world; the mid-Atlantic ridge, and is one of the few peaks which rise above the ocean surface. The area is particularly active, with several volcanic eruptions in historical times, due to the fact that the space between the two plates widens by around two centimetres every year.

The Reykjanes Geopark geosites are constantly being researched by scientists and have great educational value. They are interesting from geological point of view and have a great diversity. Some of the sites still lack more detailed research, but monitoring volcanic active zones like Reykjanes is a never ending research.

The site with the most international value is the „toe" of Reykjanes. It is the where the spreading ocean ridge emerges on dry land while the fused margin of the North American Plate and the Eurasian Plate bend to the east towards the South Iceland Fracture Zone (SISZ), and one can literally walk on its surface. There are also excellent exposures into recent volcanic formations, e.g. Kerlingarbás where the Dyke can clearly be seen.

There are several geosites of educational value inside Reykjanes Geopark. One of them is The Bridge between two continents at Sandvík, a small footbridge over a major fissure which provides clear evidence of the presence of a diverging plate margin. It is a great example how the Eurasian and North American tectonic plates are continuously drifting apart with great forces under the gaping rifts. Another site is Gunnuhver, an extremely helpful site when it comes to showing people how the earth's energy bursts through the earth's crust in the form of bubbling mud, boiling water or vapour. This frequently causes a wide array of colours to appear in the landscape, which often causes amazement and wonder for visitors. Gunnuhver is allegedly a haunted hot spring which has seen a considerable rise in geothermal energy in recent times. Legend has it that long ago a spectre named Guðrún caused a great disturbance in the area, until a priest set a trap for her which ultimately led to her falling into the hot spring.

The last volcanic eruption took place in the 14th century and earthquakes are frequent in the Geopark. Geological eruption can always be expected. Reykjanes Geopark will be the source of information answering peoples´ questions about earth's behaviour in the past, present and possibly the future.

It's no wonder that a number of prominent artists have sought inspiration – many successfully – from the raw, unique and colourful landscape of the Reykjanes peninsula. It is the proposed aim of the Geopark to inspire more people, visitors, artists, students and scientist in the future.

C– GEOCONSERVATION

1. CURRENT OR POTENTIAL PRESSURE ON THE PROPOSED GEOPARK

One of the main purposes of The Nature Conservation Act no. 44 from 1999 is to ensure, to the extent possible, that Icelandic nature can develop according to its own laws, and ensure conservation of its exceptional or historical aspects. The Act shall as well facilitate the nation's access to, and knowledge of, Icelandic nature and cultural heritage and encourage the conservation and utilization of resources based on sustainable development.

The following types of landscape shall enjoy special protection and their disturbance shall be avoided if at all possible, according to the Act.

a. volcanic craters, rootless vents (pseudocraters) and lava fields;

b. freshwater lakes and pools, 1000 m2 or more in area;

c. bogs and fens, 3 hectares or more in area;

d. waterfalls, hot springs and other thermal sources, as well as surfacial geothermal deposits (sinter and travertine), 100 m2 or more in area;

e. salt marshes and mudflats.

Umhverfisstofnun (the Environment Agency of Iceland) is responsible for the daily operations of most of the protected areas in Iceland. This is done in cooperation with local authorities and committees. The Agency has limited resources which is reflected in the infrastructure and limited supervision.

The number of visitors to the proposed Geopark is constantly increasing and in some places the number of tourists is so high that it is at the upper limits of tolerance of the present infrastructure and management.

The Environment Agency of Iceland registered the condition of nature preservation areas in the year 2010. Reykjanesfólkvangur Country Park is on the red alert list, because of, for example, illegal off-road driving, land destruction, and overgrazing. The Country Park area is popular and not so far from the Reykjavik area. Some sites, e.g. the geothermal areas inside the park, are more sensitive to tramping than others. A management strategy for the park is being developed.

More than 100.000 tourists visit the geothermal area in Krýsuvík every year. It is a popular hiking area and for the last years tourism infrastructure has been developed there, such as wooden pathways. Same kind of wooden pathways have been built next to Gunnuhver geothermal area. It is estimated that the same number of tourists will visit amount of tourists visit the "toe" of Reykjanes and Gunnuhver. During the summers of 2010 and 2009 65.000 tourists visited the "toe" of Reykjanes and the Bridge between continents, two of the most visited sites in the area. There are ideas about new geothermal power stations in Eldvörp, Krýsuvík and Trölladyngja, according to Master Plan for hydro and geothermal energy resources in Iceland. Power plants are always accompanied by electric power lines that may affect the experience of tourists.

2. CURRENT STATUS IN TERMS OF PROTECTION OF GEOLOGICAL SITES WITHIN THE PROPOSED GEOPARK

Large part of the proposed Geopark is defined as nature protection areas according to Icelandic laws. These areas have different terms as to what actions are permissible within their boundaries.

The Environment Agency of Iceland, under the auspices of the Ministry for the Environment, oversees, operates and supervises protected areas in Iceland. Those sites of natural interests are classified in five groups: National Parks (þjóðgarðar), Nature Reserves (friðlönd), Country Parks (fólkvangar), Natural Monuments (náttúruvætti) and other protected areas (önnur friðuð svæði).

There are no sites or areas with National Park status within the area of the Geopark, and Eldey is the only Nature Reserves. Austur-Engjar Geothermal Area, Brennisteinsfjöll, Grænadyngja/Tröllad yngja, Grænavatn/Gestastaðavatn, Katlahraun, Kleifarvatn, Krýsuvíkurberg, Lambafellsgjá, Seltún, Sog, Sveifluháls and Ögmundarhraun by Núpshlíð are part of Reykjanesfólkvangur Country Park. Eldborg is then classified as a Natural Monument. Some geosites are registered as sites of natural interest like: Keilir, Höskuldarvellir Katlahraun, Hraunsvík, Festarfjall, Sundhnúksröðin, Fagridalur, the coast west of Grindavík, Reykjanes, Eldvörp, Hafnarberg, Ósar, coasts and lakes at Rosmhvalanes, Seltjörn, Snorrastaðatjarnir, part of Hrafnagjá, lakes at Vatnleysuströnd, the coast from Fagravík to Straumsvík, and Hvassahraunsgígar.

Some of those sites are also classified as local conservation provision sites. Local conservation provision is a provision in a regional, municipal or local plan regarding the conservation of the characteristics of buildings or other remains of historical or cultural value, e.g. Staðarborg , a several hundred year old stone-built sheep fold.

3. DATA ON THE MANAGEMENT AND MAINTENANCE OF THESE SITES

The Environment Agency is responsible for managing protected sites but in practice they are managed by the local municipalities. Reykjanesfólkvangur Nature Reserve is managed by a special board appointed by the surrounding local municipalities, including Grindavík, Reykjanesbær and Vogar. Park Rangers operate in the area during the summer months, providing information as well as monitoring and tending the area.

Current planning system is based on the Planning and Building Act No. 123/2010 which came in effect in the beginning of 2011. There are three planning levels according to the Act; local, regional and municipal. Local authorities shall prepare those plans. They shall examine applications for permissions, grant building permits and development permits and carry out building inspection with the assistance of elected committees and specialized employees. The Minister for the Environment does have supreme control of planning and building under the Act and is assisted by the Planning Agency. There shall be internal cohesion between regional, municipal and local development plans. Regional- and municipal, which are approved by the minister, are legally binding. Local plans adopted by local authorities are also legally binding.

Local plan

All municipalities are responsible for having a municipal plan prepared for the municipality. The municipal plan shall cover all the land within the municipality's boundaries. The municipal plan shall set out the local authority's policy regarding land use, transportation and service systems, environmental matters and the development of settlement during a period of at least 12 years.

Regional plan

There are two administrative levels in Iceland, local and national. Yet, two or more municipalities can prepare a regional plan at the initiative of the relevant local authorities or the Planning Agency with the aim of co-ordinating the policy of local authorities on development of settlement and land use over a period of at least 12 years. Reykjanes Geopark got a chapter in the Regional Plan for Suðurnes 2008-2024.

A regional plan shall be regarded as being adopted when, and to the degree that, all the local authorities involved have adopted it. When a proposal has been adopted, the joint committee shall send it to the Planning Agency, which shall then submit proposals to the minister regarding the final approval of the regional plan.

National plan

The Planning and Building Act include only one article about plans and land use at national level. The Planning Agency shall gather information and have access to and preserve plans produced by other public entities on land use which apply to the country as a whole, e.g. regarding transportation, tele-communications, power structures and nature conservation.

4. LISTING AND DESCRIPTION OF NON-GEOLOGICAL SITES AND HOW THEY ARE INTEGRATED INTO THE PROPOSED GEOPARK

In addition to the geological sites listed in chapter B.3, Reykjanes Geopark has much to offer. Guests can experience culture, history and nature all on the same day. Below are listed various non-geological sites. The classification is the same as in chapter B.3.

No	Non-geological sites	Type	Importance	Protection	Scientific	Educational	Touristic
1	Básendar	C/N	REG		X	X	X
2	Brimketill	N	REG	LR			X
3	Drykkjarsteinn	C/N	REG				X
4	Gálgaklettar	C	REG			X	X
5	Gálgar	C	REG				X
6	Hafurbjarnarstaðir	C	NAT			X	
7	Hópsnes / Þórkötlustaðanes	C	REG	LR / AP		X	X
8	Húshólmi / Óbrennishólmi	G/C	NAT		X	X	X
9	Selatangar	C	NAT			X	X
10	Skagagarðurinn	C	REG			X	
11	Sogasel	G/C	REG			X	
12	Staðarborg	C	REG	AP		X	X
13	Útilegumannabyggði í Eldvörpum	G/C	NAT		X	X	
14	Vigdísarvellir	C	REG				X

Many of the sites mentioned above have a strong geological connection, e.g. the foaming cauldron Brimketill which looks like a man made swimming pool, but is made by the surf splashing on the lava rock for a long time. A trail lies towards the shore where after a few steps in rough lava one can enjoy the phenomenon.

The Húshólmi area is a so called “clearing” over which the lava Ögmundarhraun didn´t flow during an eruption in the year 1151. Húshólmi is reported to be the first farm in Krýsuvík. It is still possible to see

the remains of an old house and a church partly buried under lava rocks. Scientists have come to the conclusion that these are the oldest remains of ruins since the settlement of Iceland, around 870 AD. It is a great example of interaction between settlement and volcanic activity.

Archalogists have found cultural remains south of Eldvörp, a 10 km long row of craters formed in volcanic eruption in 1226 BC and earlier. Those remains suggest a band of outlaws resided in the lava tubes whence they raided the countryside and stole livestock from neighbouring farms. In older days, people from Grindavík would also walk along a special pathway to one of the craters in Eldvörp and bake bread. The pathway, still used today, is called “The Bread Trail”.

D– ECONOMIC ACTIVITY & BUSINESS PLAN

1. ECONOMIC ACTIVITY IN THE PROPOSED GEOPARK

For a long time, the Reykjanes region was known mainly for its fishing industry and the long lasting presence of the US Iceland Defence Force at Keflavík Airport. Both provided a great deal of work for the local population. As mention earlier, the army base was closed in 2006 and fishing and fish processing in the region have declined in recent years. There are, on the other hand, opportunities in tourism and business operation connected with Keflavík Airport, the power utility HS Orka Ltd. and the industrial port of Helguvík. In Ásbrú, the old defence area, a number of companies, both long standing and start-ups, have been established. The Keflavík Development Corporation, Kadeco, is in charge of putting the real-estate assets in the area to good use, and is working on attracting more enterprises to settle in the area. The region has many strengths which are important to draw on and support, not least while unemployment is a problem.

The five municipalities in the Geopark area also own Heklan, Regional Development Agency. It is financed by the municipalities and the Icelandic Regional Development Institute. Heklan supports employment development in the area in cooperation with individuals, businesses, organizations, municipalities, and other stakeholders. Some of Heklan's main roles is to strengthen the competitiveness in the area and the marketing the region. For the last two years, Heklan has coordinated efforts of Reykjanes Growth Agreement, an initiative aimed at supporting growth sectors in the region. The Growth Agreement is set up as a contract between the Icelandic government and the municipalities.

The last few years have seen an increase in tourism in the Suðurnes region. All the municipal areas in the region have something to attract the visitor: Fræðasetrið in Sandgerði, the lighthouse Garðskagaviti with the rugged landscape and teeming bird life in the area around it, Duus hús and Víkingaheimar, the geothermal power museum and cultural centre Kvikan in Grindavík and, last but not least, the Blue Lagoon. There has been an expansion in health-related tourism in the area, enabling people from Iceland and abroad to combine medical treatment with a holiday trip. Work is also in progress on the development of a health-related centre at Ásbrú, where there is more than adequate housing available for a range of activities. The proximity of the international airport at Keflavík has proved an advantage for tourism in the region.

The five municipalities

The village **Garður** was named after one of the many earth walls erected on the boundaries between properties, some of which are still clearly defined. Nowadays, Garður is better known for its two lighthouses. The older one, in use until recent times, is now a centre for the studying of the thousands of migrating birds arriving from Greenland and North America to breed. The other lighthouse houses the Folk Museum. Garður also has a Local History Museum and well equipped camping grounds. Garður is in the northwest part of the proposed Geopark. Inhabitants in Garður are about 1500. The rich fishing grounds by the shore remain the town's economic base.

South of Garður is **Sandgerði**, covering the entire western coast of Miðnes (Rosmhvalanes) north from Garðskagi to Ósabotnar in the south. Sandgerði is a friendly fishing town of about 1700 people. Sandgerði is one of the country's major fishing communities in Iceland. In recent years tourism has become more important for the economy in Sandgerði, with the International Airport at the municipality's boundaries.

South and east of Sandgerði and Garður is the **Reykjanesbær** municipality. The town of Reykjanesbær is rapidly growing. The population has increased signifantly in past years and is now about 14.500. Reykjanesbær profits from its proximity to the capital and the airport. Ásbrú, the former US navy base, is now part of Reykjanesbær and has been turned into an innovative and progressive educational community.

In the northwest corner of the Geopark is the municipality **Vogar**. The town of Vogar is a commercial and service centre for the municipality. Food production is important in the municipality, especially pig, chicken and egg farming. In recent years the municipality has been developing toward a fully green regional economy.

Grindavík is at the south coast of the proposed Geopark. The local population is about 2900, most of whom base their livelihood on fishing or fish related industry. Grindavík alone provides more than 40% of Iceland's salt fish production with one of the most active harbours in the country. Yet, the town offers many attractions and activities for visitors and has grown significantly as a tourist destination in recent years. By far, the best known attraction of Grindavík is the Blue Lagoon. Grindavík has five restaurants, a hotel, a guesthouse Grindavík has five restaurants, a hotel, a guesthouse and a new camping site.

The other partners

Blue Lagoon Ltd. is a market leader in the development of health related tourism, both in the area of spa and wellness, and in developing medical treatments for psoriasis. It also develops and markets a skin care line based on the geothermal seawater's active ingredients. It is an innovative company in health, wellness and skin care powered by geothermal energy. Its operation is powered one hundred percent by Iceland's clean geothermal energy. Located in the heart of the Svartsengi Resource Park, Blue Lagoon is significant for the geothermal energy - an increasingly important element in today's world. Blue Lagoon communicates a world of healing power, wellness and beauty, and is founded on a unique source of geothermal seawater that originates in Iceland's extreme environment.

Keilir, Atlantic Center of Excellence, is an educational institution founded in 2007. It is building up an educational community on the site of the former US Military Air-Base in Keflavik, now called Ásbrú Enterprise Park, and is a leader in rewriting the possibilities for Icelandic education through innovative approaches in bringing together businesses and academia, knowledge and finance on an international

basis. Keilir consists of four different schools: Aviation Academy, Health Academy, Institute of Technology, and a Preliminary Department where the main objective is to prepare students who have a vocational training and/or sufficient practical experience in industry, with the knowledge and competency necessary for further studies at university level.

Heklan, Suðurnes Regional Development Agency supports employment development in the area in cooperation with individuals, businesses, organizations, municipalities and other stakeholders. It is located in Eldey incubator, where young businesses and entrepreneurs are offered service and facilities. Heklan is also a cooperative between the municipalities in the area, and the Ministry of industry, energy and tourism. Suðurnes Tourist Board was founded in 1984 by the municipalities in the region, local companies, and individuals. The board works as a grassroots association. In recent years the association has been working on building infrastructure in the region and strengthening the financial base of the organizations. The association has been working on providing better access to popular tourist's sites in the region especially for the disabled, for example by marking old folk routes, refining the access to Garðskagi lighthouse, building new wooden paths around Gunnuhver hot mud spring area, putting a view dial on top of Keilir mountain, and rebuilding an old natural pool close to the Reykjanes lighthouse. The Tourist Board founded **Suðurnes Marketing Office** in 2009. Its main role is to market, promote and strengthen the image of the region. The Marketing Office runs two information centres in the area.

HS Orka is a leading provider of sustainable and renewable geothermal electricity and heating in Iceland. The company provides electricity, geothermal water for heating, and cold water for consumption and fire fighting in the Reykjanes area. The company has always supported and stimulated innovation and business growth in the Reykjanes region, e.g. as the main shareholder in the Blue Lagoon. In recent years, the company has, for example, supported hiking trail markings in the region.

2. EXISTING AND PLANNED FACILITIES FOR THE PROPOSED GEOPARK

Museum and Culture centres

Kvikan is the name of house of Culture and Natural Resources in Grindavík. It houses two exhibitions. The Saltfish Museum brings to light the seafaring history and the history of Iceland in the processing and sales of dried salted cod and its significance to Iceland's economy. The other is the Earth Energy Exhibition, featuring geology, geothermal heat and the harnessing of energy from the bowels of the earth. The exhibition shows many video films and guides the viewer from general geology through the geology of Iceland and Reykjanes, explaining how different branches of learning join in preliminary research and monitoring of high-temperature geothermal areas.

Viking world is the home of the Viking ship Íslendingur. It is also home of the Viking millennium exhibition, shedding light on the Norse settlement and explorations of unknown lands. In an exhibition about the Nordic gods, visitors are guided through the ancient ideology of the Old Norse religion. Near the Viking world is a settlement zoo providing children a chance to see lambs, goats, ducks, calves, rabbits and hens.

In a cluster of buildings in Reykjanesbær, called **Duushús – Cultural Center**, are four exhibitions: The Reykjanes Art Museum, The Reykjanes Heritage Museum, The Reykjanes Art Museum and Old Cinema, and The Reykjanes Martime Centre. The Reykjanes Heritage Museum opened in the spring 2012 a new exhibition covering the winter fishing season. For centuries, Icelanders travelled on foot from their homes to fishing ports in Reykjanes late in January and after working and fishing there for three months and then walked back.

Suðurnes Science and Learning Center is a non-profit organization. Reykjanes Environmental Research Institute and The University of Iceland´s Research Center in Suðurnes are part of the center. Suðurnes Science and Learning center´s main objectives are: research and development in the field of science and related areas, to support and enhance higher education and lifelong learning in the Suðurnes region and cooperation with other educational and research institutions. At the centre, visitors can look at various kinds of organisms from Icelandic nature, and living animals in seawater tanks. Small sea creatures from the bottom of the sea or the nearby pond can be observed through binocular microscopes. The staff of the Nature Centre organizes field work for the pupils in elementary and high schools. Now the Centre houses an exhibition about the famous French explorer and biologist Jean-Baptiste Charcot.

An old fish processing house in Garðskagi is houses the **Municipal Museum in Garður**, first opened in 1995. Many important items from the municipal history of Garður are located in the museum, items which were essential for livelihood, both on land and at sea.

In May 2006, electrical generation began in Reykjanes power station and through connection to the power plant an exhibition in a show room was assembled and named **Earth Power Plant**. The show covers various ways of developing energy recources in the earth. The planets of our solar system have been situated in right proportion all around the Reykjanes area but the sun is in the lava outside of Reykjanes power station at the main entrance to the show room.

Marked hiking trails

There is a number of marked hiking trails in the proposed Geopark. The longest one, **Reykjavegur**, is the trail extending from the lighthouse at the "toe" of Reykjanes right across the middle of Reykjanes peninsula and all the way to Þingvellir, 130 km in all. It can be divided into seven sections, each convenient for a day's walk.

The other marked trails are shorter, like the old national routes; Prestastígur (13 km), Skógfellavegur (15 km), Þórustaðastígur (18 km), Krýsuvíkurgata (13 km), Skipsstígur (16 km), Árnastígur (12 km) og Dalaleið (23 km).

Annually, during the Bank Holiday Weekend, there is a cultural- and historical Hiking Festival in Grindavík called "GET GOING on Reykjanes". Those who participate in the festival are offered to hike some of the old paths and trails in and around Grindavík with a hiking guide who is a specialist in the area.

The mountain and geosite **Keilir** is one of the most popular hiking mountains in Iceland. At the top is a guest book where all the hikers who get to the peak can sign their name. Because of its pyramid shape and how visible it is from large area, Keilir has become an icon for the area. Reykjanes Geopark uses Keilir, for example, in the Geoparks logo.

The geosite **Þorbjarnarfell** by the Blue Lagoon is another popular hiking mountain and easily accessible. It is next to the town of Grindavík and has a marked trail to the peak. The mountain is hiked by the people of Grindavík and their guests every year at the summer solstice (June 20-22). At the top, the group lights a campfire and listens to some musicians in the lunar landscape of Reykjanes.
There are more marked hiking trails up to the mountains in the proposed Geopark, e.g. the geosites **Trölladyngja** and **Lambafell**.

Sites open to public

The majority of the geosites mentioned in chapter B.3 and the non-geological sites in C.4 of the nomination dossier are open to public via trails. Because of protection value, some places have limited access and other areas are open by arrangement, e.g. Eldey.
Outdoor recreational areas known by locals have not been marked.

In addition to the museums, exhibitions and specially marked trails, many public buildings are open to the public all year round or by request. This includes churches, lighthouses and other community buildings, but not important local, historical places.

The most popular sites do have information boards and interpretation panels, providing better understanding of the places. The aim of Reykjanes Geopark is to give all panels at the geosites a uniform Geopark-identity in the coming years.

Other sites with facilities, accessible and open to public

The lighthouse at Garðskagi is open to the public during the summer time but the lighthouse at Reykjanes is only open by request. Lavatories are at both places. All churches in the area are open to the public by request.

Sport facilities and recreation service

In total, there are six high quality swimming pools in the proposed Geopark. All of them use the geothermal heat from the area, where it is possible to luxuriate in water of 27–29°C and relax in the hot tubs, with temperatures varying from 38 to 42°C. The open air swimming pools in Iceland are a unique experience and a perfect way to relax after visiting the geological sites of the Geopark. In fact, Icelanders use the swimming pools not only to swim, but to socialize with friends, families or strangers. In the swimming pools people are most open to talk to strangers. Another way to relax, renew the relationship to the nature, soak up the scenic beauty, enjoy breathing the clean, fresh air and recharge for more exciting adventures, is to take a bathe in the Blue Lagoon spa. The lagoon holds six million litres of geothermal seawater, which is renewed every 40 hours.

The area also boasts several fitness training facilities where it is possible to work out and get the body into shape; four golf courses where golfers can play all night long in the midnight sun during the summer time due to Iceland's northern location surrounded by lava fields and majestic ocean views; horse riding services offering tours and lessons; as well as many hiking, ATV 4-wheeling, and bus tour services. Bikes can also be rent in Reykjanesbær for those who want to experience the Geopark´s geosites in that way. Djúpavatn and the geosites Kleifarvatn and Seltjörn are popular for trout angling during the summer time. Fishing license can be obtained at short notice, often the same day.

Reykjanes Geopark is a venue for many types of athletics events, e.g. the Blue Lagoon challenge, an annual cycling challenge between Hafnarfjörður and the Blue Lagoon on a mountain bike in beginning of June; and the Reykjanes Marathon in beginning of September. It is also worth mentioning the annual hiking festival in Grindavík. Each year people hike some old paths and trails in and around Grindavík during the Bank Holiday Weekend.

The Geopark region has a range of cultural activities and entertainments, including events in music and the arts, museums, exhibitions, and the theatre. The region has a high level of musical activity, and

many prominent musicians and bands have originated there. Annual local festivals, such as Nigth of Lights in Reykjanesbær, The Happy Sailor in Grindavík, Midsummer Night Hike on Þorbjörn, Family Day in Vogar, The Sunset Festival in Garður, and Sandgerði Days in Sandgerði attract large numbers of people and are prominent in the different communities. There is also a range of entertainment in the region for children. Reykjanesbær holds an annual children's festival. Furthermore, there is a zoo in Reykjanesbær with domestic animals that preserve the traits of the original stocks brought by the Viking settlers.

Figure 14. Musicians sing and play by a camp fire on the top of the mountain Þorbjörn at midsummer night.

Icelanders sometimes refer to themselves as a "storytelling nation". Through the centuries storytellers have brought to life elves, ghosts, trolls and other mysterious beings. The mountainous landscape, wide-open spaces, struggle with hunger, the harsh forces of nature, and the darkness of the Artic winter must have made it easy to imagine those creatures. A good example of mixing together native folklore and geology is "the giantess" in Reykjanesbær. Even though Icelandic trolls are described as being extremely old human-like beings, very strong and are considered dangerous to human beings, the giantess in Reykjanesbær is a kind one with a big heart so the kids don't have to fear her. She lives in Skessuhellir in Reykjanesbær with a superb view over the bay of Keflavík and Faxaflói. The giantess is „400 years" old and, over 5 meters high and with eyes the size of footballs.

Management

On the basis of a mutual agreement, the municipalities of the Reykjanes Geopark area have worked hard on formally establishing the Geopark. Following the agreement other organizations were invited to take part in the project. Representatives from the municipalities and the other 5 partners formed a preparing committee handling the establishment of the Geopark. A project manager has been working on the project with experts working part-time position, as members of the project. A Development and Management plan for the proposed Geopark will be validated within next months. Each year a re-evaluation will take place concerning the Management and Development plan, e.g. geosites and further development.

The steering committee is comprised of 5 representatives from the municipalities and 5 representatives from other members of the Geopark. The committee is supported by two advisory groups; one

consists of scientists and experts, nominated by the different organizations providing advice regarding the Geopark´s development; the second group advises on marketing issues. This group is made up of Marketing and Communications representatives from the municipalities, plus members from the Suðurnes Tourist Board.

The members of the Geopark are responsible for securing the appropriate budget for its activities. The Geopark must contribute to the budget so as to be able to apply for funding. Resources will come from the municipalities, national resources, Geopark direct revenues, regional and international projects, membership fees and donations.

3. ANALYSIS OF GEOTOURISM POTENTIAL OF THE PROPOSED GEOPARK

In recent years, the emphasis in the region´s marketing for tourists has been on the geology of the area. Reykjanes Geopark has a great potential for geotourism due to the region´s rich geological heritage, great geo-diversity, local knowledge and people's awareness of the land and volcanism. The region already enjoys some tradition in geotourism, geological attraction, local food and handcraft. The establishment of Reykjanes Geopark will further these activities.

Reykjanes Geopark will cooperate with various partners in tourism by creating a network of guides, museums, tour operators, hotels, restaurants, and so on. This cooperation will be based on the concept of responsible and sustainable tourism, conserving the geological and geographical character of the area, as well as the natural and cultural heritage. The goal is the prosperity of the local population.

Geologically, Reykjanes peninsula is the youngest part of Iceland, at least of the populated areas. The youngest lava fields came to be in an eruption in the 14th century, when the whole peninsula literally came on fire. The eruption before that dates back to 1151. Thus, the lava fields are of a different origin and nature, and are therefore different in appearance and have various amounts of flora. In these fields there have been recorded over 200 caves of various shapes and sizes have been recorded in these lava fields. Tour operators offer organized and guided tours to explore volcanoes, caves and lava fields. The tourism industry is thus closely connected to the geology of the area.

There are many opportunities in geotourism in the area. Better cooperation will further help tourism and encourage tourists to stay longer. This will be greatly helped by the Geopark. Marketing of local products in this context presents still another opportunity for growth and development as jobs and revenue would be created. The locals would thus become more aware of the importance of the area and be more willing to partake in sustainable activities.

4. OVERVIEW AND POLICIES FOR THE SUSTAINABLE DEVELOPMENT OF:

- geo-tourism and economy

Tourism is one of the fastest-growing sectors of the Icelandic economy. It is very important to the Reykjanes area and one of the main sources of income for many families. Statistics for 2011 show around 113.000 overnight stays in the Reykjanes Geopark area. The overnight stays in the period 2007-2011 the growth is 25%. The growth will continue if new hotels and guesthouses open in the next years as planned.

There are great opportunities in tourism industry in the Reykjanes area due to the closeness of Keflavik International Airport, the largest airport in Iceland serving the capital city, Reykjavík. The summer of 2012 15.000 passengers go through the terminal daily during high season in June, July and August. A total of 2.112.017 passengers passed through the terminal in 2011.

The Blue Lagoon is the most popular tourist site in the proposed Geopark and one of the most popular sites in whole of Iceland with more than 400.000 visitors per year. According to a survey carried out among tourists leaving Iceland from September 2009 to August 2010 it is estimated that 322.000 foreign tourists travelled around Reykjanes. 94.000 guests visited the town of Grindavík and 30.000 the town of Sandgerði, according to the same survey. In the summer of 2011 the Krýsuvík area was visited by more than 100.000 tourists, the "toe" of Reykjanes and the Bridge between continents by 65.000 tourists. The same number of visitors is estimated to have visited Gunnuhver. And 110.000-120.000 tourists visited at least one site in the Hundred Crater Park at the "toe" of Reykjanes in 2011. The two lighthouses at Garðskagi were visited by 21.000 guests during the same period.

Tourists today are more educated than tourists were 20 years ago. They expect and demand good service, safety and experience; last, but not least, they expect and demand information. Establishment of a Geopark opens new opportunities to give those tourists the information they are searching for and to educate and offer tourists insight into the geology and the society of Reykjanes. By doing so and by making the information and the education material accessible and widely distributed, it is our belief that tourists will stay longer in the Reykjanes Geopark area and be happier with the stay there. At the same time, local people gain benefits from tourism taking place in their locality when travellers are likelier to choose a service from a local business, e.g. accommodation, restaurants, tour operators and so on.

Tourism is vital to the local economy in the Reykjanes area, especially tourism connected to nature and culture. Establishment of the Geopark is seen as the greatest opportunity in the area to improve tourism in a theme-based way. The Geopark will do so by focusing on developing geotourism further on. It is the Geopark´s aim to create a high quality destination by building on the strengths of the region, e.g. geology, nature, cultural heritage, and local foods. The area and the inhabitants will benefit from the Geopark, especially by creating more specialized jobs requiring specialization and education.

It is no coincidence Icelanders have through the centuries talked about the Reykjanes area as a food basket. In former times, people travelled to the peninsula and brought fish back to their homes. The population of Grindavík increased, for example, tenfold during the fishing season, from 200 people to 2000. Today, in many restaurants in the area there is a significant emphasis on local foods, such as fish, crabs, meat, herbs and vegetables. The Geopark's emphasis on food fits well with the strategy of the area being a food production area. One of Reykjanes Geopark projects will be the creation of new local food products and the development of new distribution channels.

The Geopark is also seen as an opportunity for local handcrafters in the area. At the present, there are quite a few individuals and small companies designing and producing handcraft and souvenirs. Many of the handcrafters and designers today seek inspiration in the Old Icelandic handcraft tradition from the time when farmer or fisherman needed to be self-sufficient with tools, clothes and other things needs.

- geo-education

The Geopark is able to make a major contribution to formal and informal education by sharing knowledge. The Reykjanes Geopark will be a good educational resource, allowing people to experience geo-

logical environment through outdoor field work and promoting interest in earth sciences. It also makes it possible to raise the awareness of the need to preserve the geological heritage of the region.

It is the Geopark´s aim to raise awareness of geo-conservation and promote the geological heritage of the region by informing the public. The Geopark and its cooperators will produce and provide education materials explanatory signs and booklets.
Reykjanes Geopark will develop educational programs in good cooperation with Keilir - Atlantic Center of Excellence and MSS - Continuing Education Center to inform the participants about the philosophy of Geoparks. Special emphasis will be on the Reykjanes region, e.g. a program for local guides. The Reyjanes region has in recent years become a popular site for geography oriented school trips to Iceland. One of the tour operators in this field is GeoCamp, a sicence camp based in the area. It is a camp for young students who are interested in geology and all other aspects of scientific education and who want to explore these subjects further.

Some of the museums in the proposed Geopark have produced teaching materials about the region´s nature, geological- and cultural heritage. Most of these materials focus on Primary and Secondary schools. The teaching materials are available to foreign students, but the region is popular among student groups who visit during the winter time. Establishment of a Geopark in Reykjanes will strengthen those visits and open doors to serve those students better.

It is important that knowledge about the local geological heritage is available and accessible to local schools and the public in the region. The region has a number of solid educational institutions, including the Suðurnes Comprehensive School, the Icelandic College of Fisheries, the Centre for Lifelong learning in Suðurnes, vocational rehabilitation centre and third-level educational community, a centre for science, education and commercial development. In total, there are 30 schools and educational institution in the Geopark area; fifteen Nursery schools, ten Primary schools, two Secondary schools, one Continuing Education centre, one vocational rehabilitation centre, and two educational institutions offering education at university level in collaboration with the University of Iceland and the University of Akureyri.

- geo-heritage‘

Each municipality is responsible for having a municipal plan prepared for the municipality. The municipal plan shall cover all the land within the municipality's boundaries. It shall set out the local authority's policy regarding land use, transportation and service systems, environmental matters and the development of settlement during a period of at least 12 years. If there exist within the boundaries of the planning area individual buildings, structures, groups of buildings, natural features or vegetation which is considered desirable to conserve because of their historical, natural or cultural value, without statutory protection, then local conservation provisions shall be included in the relevant development plan. Number of geosites and non-geological sites like Eldvörp, Stampar, Rosmhvalanes, Keilir, Staðarborg, Gunnuhver, Brimketill, Hópsnes are protected according to those local conservation provisions.

Reykjanesbær is a member of Local Agenda 21, a plan where local community defines a sustainable development strategy in line with the declarations from the World Summit in Rio in 1992. Grindavík is the first and only municipality in Iceland to agree on policy on the use and protection of natural resources. The policy assesses the Grindavík area‘s natural resources in their entirety, and attempts to look at their future, with all the variables that this entails. This systematic documentation of natural resources is the basis for being able to make informed decisions on their utilization, to the future benefit of the local community.

The Iceland 2020 policy statement is a vision for the future, which developed through dialogue and collaboration between hundreds of Icelanders throughout the country and in consultation with regional associations, local authorities, trade unions and economic interest groups. Establishment of a Geopark in Reykjanes is one of the key projects in the region and therefore fits well with the national plan for the next decade.

5. POLICIES FOR, AND EXAMPLES OF, COMMUNITY EMPOWERMENT IN THE PROPOSED GEOPARK

The Geopark has already created, and will continue to create, links between local tourist enterprises, restaurants, hotels, guesthouses, museums and exhibitions in order to create new products and increase the number of the region´s visitors and to extend the visiting period. One example of this is cooperation between restaurant owners and the Reykjanes Heritage Museum. The museum´s newest exhibition covers the winter fishing season in the late 19th century and beginning of 20th century.

6. POLICIES FOR, AND EXAMPLES OF, PUBLIC AND STAKEHOLDER AWARENESS IN THE PROPOSED GEOPARK

In the Geopark's master plan there is a chapter about community links. It is important for the project that communities in the region will be involved in the development of the proposed Geopark. The aim is to build active and sustainable community on grounds of people's empowerment. People in the region should benefit from the legacy of the region. The recognition of being a Geopark and working as a Geopark is one way to do so. At the same time people will be more proud living in the region and will recognize their self-evident heritage as special, precious and interesting.

Local people and people in the tourism industry have been informed about the project, the concept of Geopark, and the area, with meetings and regular newsfeed and information posts. The plan also assumes that local people will be regularly aware of the Geopark and be encouraged to participate in the Geopark development and activities. Special emphasis will be on local people when it comes to forums, conferences, and activities organized by the Geopark.

The proposed Geopark will both national and local media have featured a good relationship with the press, especially the two local newspapers published in the Reykjanes region. Both of them are distributed free of charge to all homes in the region. From 16th of December 2011 to 13th of November 2012 both national and local media have featured around 30 news or articles about the proposed Geopark.

Reykjanes Geopark will run its first Geopark week in the spring 2013. The aim is to raise public awareness and promote the geological heritage. This promotion is done in good cooperation with the local schools.

The Geoparks website will contain information about all the geosites as well as other sites of interest. The website will be fully developed in 2013.

E– INTEREST AND ARGUMENTS FOR JOINING THE EGN/GGN

1. "WE HAVE A STORY TO TELL..."

Many travellers feel like they have just landed on the moon when they land for the first time at the Keflavík airport, located in Reykjanes Geopark. That's how alien the first impression of the landscape of Reykjanes can be. On a closer look, the area reveals many magnificent wonders in both geological and aesthetical terms. In addition, Reykjanes is one of the best regions in Iceland to get to know the Icelandic fishing industry and the history connected with it.

Reykjanes is a peninsula of contrasts and diversity. We, the people living here on this peninsula and the people who lived here before us, have learned to adapt to the powerful forces of the earth and how important it is for us to live in harmony with nature. People in the region have been regularly reminded of the importance of geology, both for good and bad.

For the last two decades there have been talks about establishing some kind of a park in the region, based on geology. After much discussion and analysis a decision was reached in 2008 to work further on the establishment of a Geopark in the region. This application dossier is the outcome of that work.

All of our goals may be achieved within the framework of EGN and GGN, with the support of, and in cooperation with, other Geoparks. Reykjanes Geopark´s primary focus is to raise public understanding and awareness of geoheritage and geoconservation in the Reykjanes peninsula by developing various programs. Other goals are promotion of tourism, education, and research and development of tourist infrastructure in the region. It is our belief that we can create new tourism products as a Geopark, with regards to geotourism, biotourism and cultural tourism.

Geoturism is already quite well established in the Reykjanes region. By joining UNESCO Global Geoparks Network through European Geoparks Network we see opportunities to develop our Geopark project further, share our knowledge and gain new knowledge from other Geoparks.

Reykjanes Geopark members are dedicated to further development of sustainable tourism in the region. Therefore, it is one of the Geoparks´s tasks to monitor sites, particularly regarding conservation, environmental degradation and carrying capacity.

In cooperation with its members, Reykjanes Geopark will train tourist guides to the Geopark concept and support program that involve sustainable tourism. In the coming years, the aim is to have a team of trained guides to offer tours in the Geopark area.

The proposed Geopark will in cooperation with its members publish maps for the area for various purposes. It will also design uniform looks for road maps and interpretation of geological sites. Later, our logo will be customized for local food and handcraft.

The Geopark will work closely with educational institutions in the region to develop educational programs and motivate individuals to form new activities in nature. By encouraging young researches we contribute to basic research of the region. By doing so we are, thereby improving our knowledge of our home region.

Geological features have attracted tourists to the region for a long time. Reykjanes Geopark covers the peninsula of Reykjanes, one of the world's most interesting geological sites, where the Mid-Atlantic Ridge rises above sea level. It is a region of star attraction like endless lava fields, geothermal wonders, abundance of hot springs, volcanic craters, spectacular cliffs, and the relentless pounding surf all along its coastline. It is also the home of the Blue Lagoon, the most visited site in Iceland.

Figure 15. One of the most impressive sites at the Reykjanes peninsula is at the "toe" of Reykjanes where a dyke can clearly be seen. It belongs to the two Stampar crater rows, running approximately 4 km inland from the coast. They formed c. 1900 and 800 yrs. ago.

The strange and beautiful landscape of Reykjanes has, since the first's settlers came to Iceland, been explained through oral tradition. Elves, trolls, ghosts, outlaws and magical spells play a large role in those stories. Icelanders do not battle trolls any more but the beliefs still remain. They know that man must both live with and preserve nature. By doing so, good overcomes evil. Those stories have passed on from generation to generation of Icelanders. It is our job to pass on those stories as well as to inform people about the geology of the region based on new knowledge and science. The main story we will focus on in the Reykjanes Geopark is how a peninsula is still being born today. You don't have to read the book, just look under your feet. The Reykjanes peninsula is a living textbook of geology. In the Reykjanes Geopark, we have a story to tell!

REYKJANES **GEOPARK** PROJECT 2012

reykjanesgeopark.is

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