Geology of Iceland

An overview compiled by

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Reykjavík © 2011

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1. Introduction.

The following is a review of the geology of Iceland. It is based on accumulated knowledge of the author and no reference is made to the source of information found in the text (except for figures and graphs- a list of those references is at the end).

2. Geology of the world – plate tectonics.

In order to understand the geology of Iceland one needs to understand the basic concepts of plate tectonics and the internal structure of the earth.

The earth's **core** is composed of iron and to a lesser extent nickel. It extends from earth´s centre at 6370 km up to depths of 2900 km (figure 2.1). Even though the temperature in the centre is 7000°C the core remains solid to depths of 5100 km due to high pressure (**inner core**). From that point to depths of 2900 km it is molten (**outer core**).

The temperature at the base of the **mantle** is 3250°C. Pressure conditions in the mantle are, however, such that the metal rich rock of the mantle is for most parts crystallised. At the surface of the earth is the crust. It is of two types: a thin (5-10 km) **oceanic crust** which consist of relatively dense **basaltic** material and a thick (40-80 km) **continental crust** which consists of less dense silica rich rock.

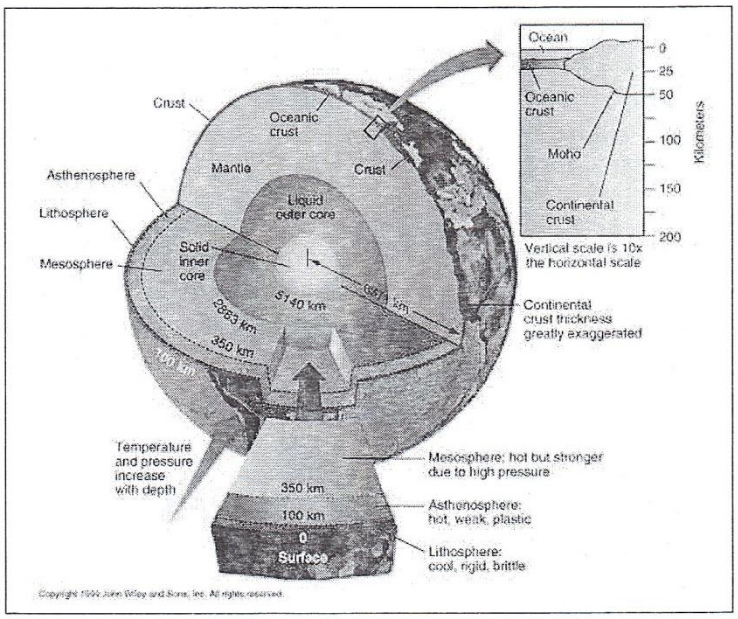


Figure 2.1: The internal structure of the Earth reveals layers of different composition and physical properties. Note 1) that the vast majority of Earth material resides in both the Mantle and the Core, 2) that the crust is thicker under the continents than under the ocean, 3) that layers may show more than one state (e.g. solid <u>and</u> liquid) which itself leads to 4) that boundaries between zones of different physical properties (e.g. lithosphere, astenosphere, mesosphere) do not coincide with compositional boundaries. Source: Skinner et. Al., 1999.

The earth's crust breaks up into 15 large plates (and numerous smaller ones) that move relative to each other (figure 2.1). Although the mantle of the earth is for mostly composed of crystallised material it contains a zone at depths of 100-200 km where the combination of pressure and temperature allows the rock to be plastic. This zone of highly viscous mechanically weak deforming rock is called the **asthenosphere.** Its existence is of great importance since it acts a share plane in plate movement.

The part of the mantle above the asthenosphere is called the **upper mantle** and the part below it is called the **lower mantle.** The upper mantle and the crust form the actual plates that moves on the asthenosphere.

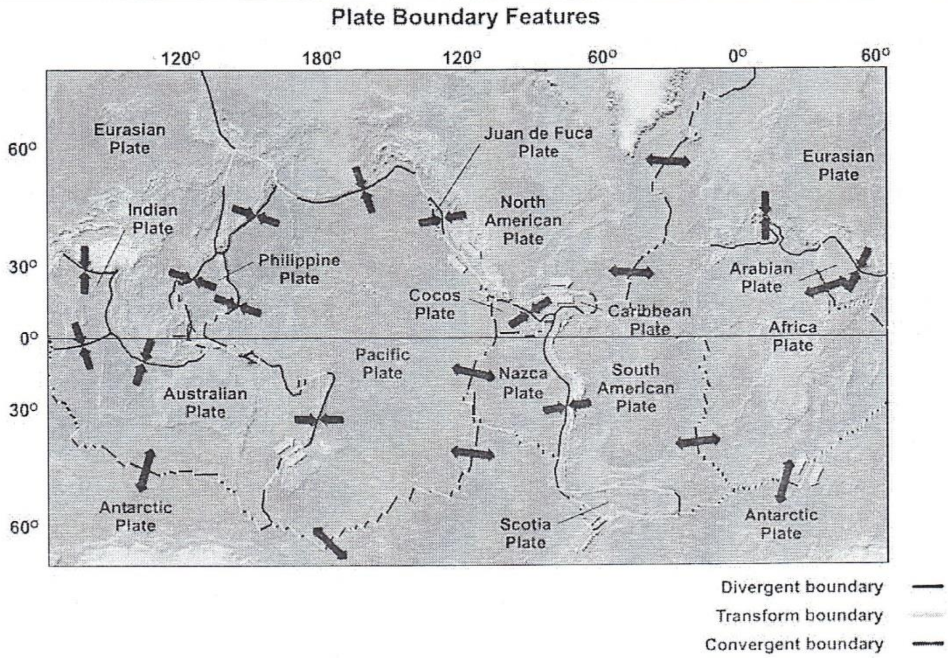


Figure 2.2: The earth's main plates. The three different types of plate margins are shown. Please not that Iceland is divided into two by a divergent or constructive plate margin. Source: *Tom L. McKnight & Darrel Hess, 2008.*

The driving forces of plate tectonic are two: a) gravity and b) heat energy from the earth's core. The heat is generated when complicate elements (such as uranium) break down to form simple elements through the process of nuclear decay. This process generates tremendous heat which maintains the 7000°C temperature at the core. This would eventually lead to an ever warmer inner core and ultimately to an explosion of the earth. That however does not happen since the heat is to a large extent conducted from the core to the surface in so called **mantle plumes**. Volcanic and geothermal activity characterise the areas where these mantle plumes reach the surface. Such areas are called **hot spots** (figure 4.1).

The transfer of heat in the form of molten rock within the mantle plumes sets of a convective circulation within the mantle which in turns causes the movement of the plates. Once the movement has been initiated and the oceanic plate starts to re-enter the mantel (in so called **subduction zones**) the pull of the subducted plate accelerates the movement (this is similar to a table cloth falling of a table). Thus gravity places an important role in plate tectonics.

In some areas the plates are moving apart and new oceanic crust is being formed. They are characterised by mid-oceanic ridges that rise 2000-3000 m above the surrounding ocean floor. These margins are called **constructive or divergent plate margins**. Volcanic activity is mostly intrusive with **pillow basalt** forming where the **mafic** (basaltic) magma reaches the surface. **Seismic activity** i common on constructive margins but it is mostly associated with magma intrusions in the crust sc consequently the earth quacks are shallow (typically at depths of 2-10 km) and numerous but smal (figure 2.3).

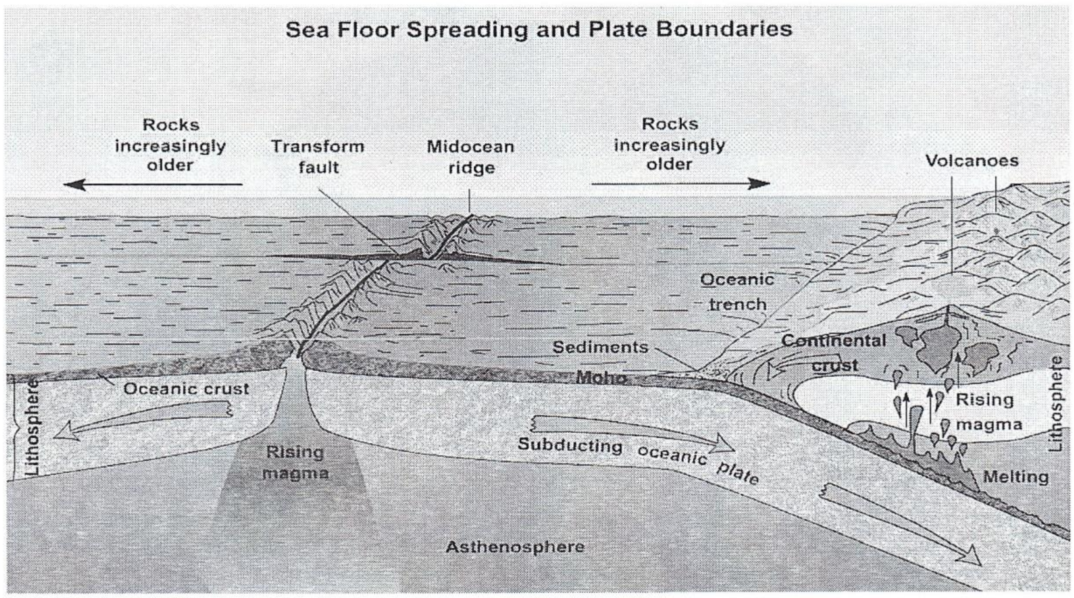


Figure 2.3: Cross section showing constructive and destructive margins. New oceanic crust is created at the constructive margin which are characterised by midocean ridges and transform faults. The magma rises from the boundary of the crust and mantle. The oceanic crust is then moved to both sides towards the subductive zones of the destructive plate margins where it is re-introduced to the mantle except for lower density material which rises to the surface as acid and gas rich magma. Features that mainly characterise the destructive zones are the oceanic trench and volcanoes. Source: *Tom L. McKnight & Darrel Hess, 2008.*

The margins where plates collide are called **destructive or convergent plate margins** (since they ar usually associated with the destruction of the oceanic crust). These margins can be of three sub types:

1. **Oceanic crust colliding with oceanic crust:** Deep sea trenches that extend long distance ar the surface expression of these margins. As the crust is subducted into the mantel it melt (partly) creating a felsic (acidic) or intermediate magma that rises to the surface to forn island arches along the trench (e.g. the Aleutian Islands).
2. **Oceanic crust colliding with continental crust:** Since the oceanic crust is denser than th continental crust it is pulled down and rejoins the mantle. As with type 1 the deep ocea trench are the dominating feature in the ocean. The process of partial melting creates rising felsic and intermediate magma (see chapter 3). Mountain folding is associated witl these margins as well as volcanic activity (e.g. the Andes Mountains of South America).
3. **Continental crust colliding with continental crust:** Mountain folding and lifting characterize these areas as well as great seismic activity (e.g. The Himalayan Mountain range).

A great deal of seismic activity is associated with destructive margins. It is generated when built up energy is released. The energy is created as the plates rub together in the subduction zone. These earth quakes are powerful and often at great depths (typically below 50 km).

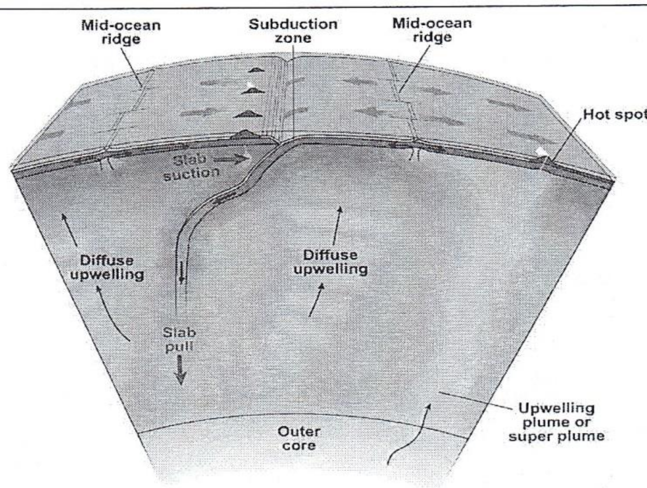


Figure 2.4: Basic components of plate tectonics. The driving forces are two; the heat transfer from the core to the surface in the form of mantle plumes. The surface expressions of such plumes are hot spots. Hot spots rise some 2000-3000 m above their surroundings and are characterised by volcanic (basaltic) and geothermal activity. The other force is gravity which creates a slap pull on the oceanic plate which is then pulled down into the subduction zone. The formation of new oceanic crust occurs at the midocean ridges but the destruction is in the subduction zone. This sets of a convective circulation within the mantle (diffused upwelling). Source: *Tom L. McKnight & Darrel Hess, 2008.*

Transcurrent or **transform** margins are the third type. The plates slide side by side thus producing great deal of stored energy which eventually is released as seismic activity (e.g. The St. Andrea fault).

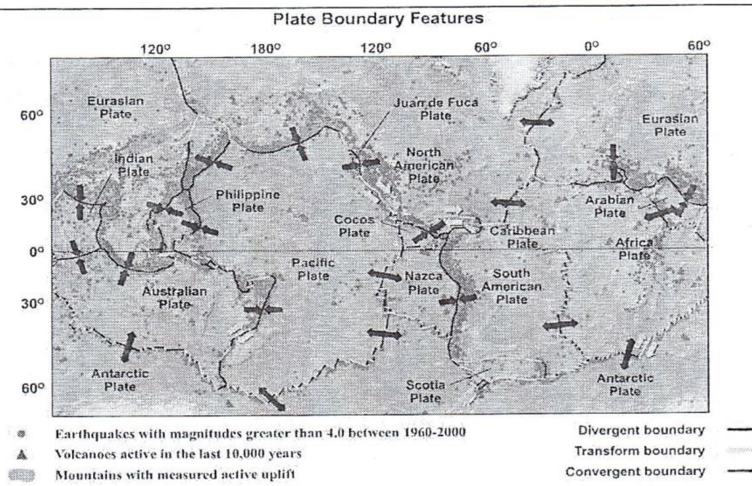


Figure 2.5: volcanic, seismic and geothermal activities as well as active fold mountains are all associated with active plate margins. Source: *Tom L. McKnight & Darrel Hess, 2008.*

For most parts geological activity (excluding weathering processes) on earth is confined to plate margins. This includes volcanic and seismic activity as well as mountain folding and geothermal activity (figure 2.5).

3. Classification of igneous rock.

Several different classification schemes exist for igneous rock. The best known is based on chemical composition and texture (table 3.1). Texture refers to the crystal size within the rock. If the rock crystallises slowly the crystal become large and the rock is said to be of **coarse texture.** This is the case in intrusions and magma cambers under the surface. For this reason coarse textured rock is also referred to as **plutonic rock.** At the surface the magma (lava) cools rapidly so the crystals grow to be small and the rock gets a **fine texture.** Such rock is referred to as **volcanic rock**. Under certain circumstances the cooling is so rapid that the rock does not crystallise and becomes glass. The non crystallised rock is called **obsidian**. It is common at the outer surfaces of lavas.

The silica (SiO_2) content of the rock is of main interest when it comes to chemical composition. If the content is less than 52% the rock is classified as **basic** or **mafic**, if it is greater than 65% it is said to be **acid** or **felsic** and if it is between 52% and 65% it is classified as **intermediate**. **Basalt** is by far the most common rock in Iceland representing 95% of all surface rock found in the island. Acid and intermediate rocks are commonly associated with central volcanoes that have developed their own magma chamber (more on that in future chapters).

The different types of igneous rocks are shown in table 3.1. As stated earlier basalt is the most common type of volcanic rock in Iceland. Of the plutonic rock **gabbro** is the most common. **Rhyolite** and **granite** are found in the island in association with central volcanoes; granite especially in areas that are geologically old (figure 3.1).

		Chemical composition		
		SiO_2 > 65% Acid or felsic rock (light coloured)	SiO_2 52-65% intermediate rock	SiO_2 < 52% basic or mafic rock (dark coloured)
Texture	Fine	Rhyolite	Andesite/Icelandite	Basalt
	Coarse	Granite/Granophyre	Diorite	Gabbro
	Glass		Obsidian	
	Vescular	Pumice		Scoria
	Common mineral	Quartz, K-Feldspar, Na Plagioclase	Na-Ca Plagioclase, Amphibole	Pyroxsen, Olivine, magnetite

Table 3.1: Classification of igneous rock based on chemical composition and texture. This is one of many classification schemes used to classify igneous rocks most of which are more complex. True granite is uncommon in Iceland but finer grained variety granophyres is more common.

Other more complex classification schemes for igneous rock exist but this one is convenient for igneous rock in Iceland. Although the light coloured rhyolite is uncommon in Iceland its light colour (white, yellow and brown) make it even more unique and distinctive where it is found within the dark coloured basalt (figure 3.2 and 6.6).

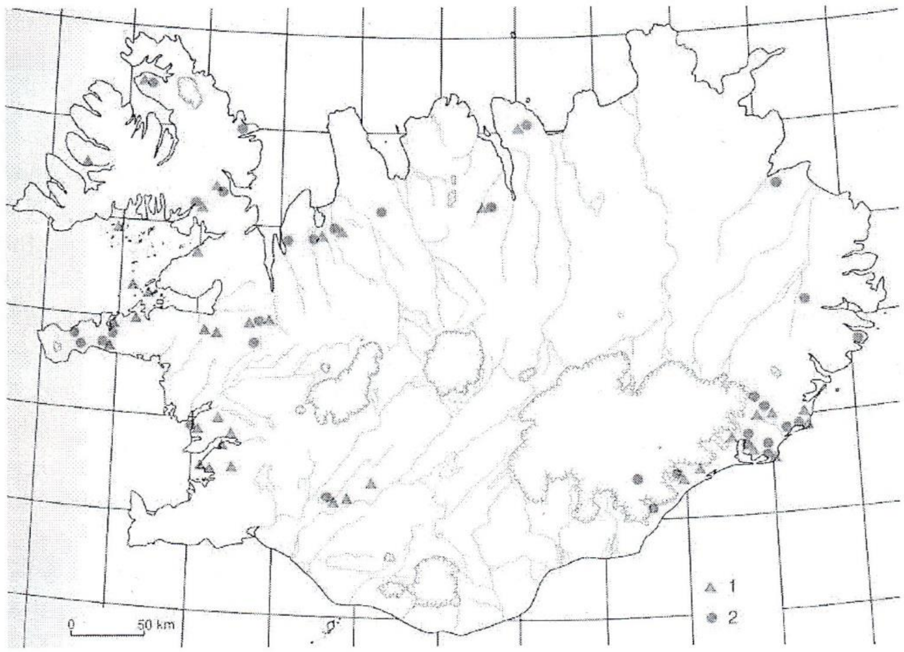


Figure 3.1: Map showing the distribution of plutonic rocks-granophyre and gabbro. Green symbols show gabbro, yellow granophyre. Plutonic rock is only phoned in geologically oldest parts of the island since they are formed under the surface and can only surface due to extensive erosion. Source: Þorleifur Einarsson 1994.

Figure 3.2: Light coloured rhyolite in Landmannalaugar central Iceland. An uncommon sight in an otherwise basaltic island.

4. Three types of volcanic activity.

From the above we can summarize that volcanic activity on earth is of three main types or origins:

1. **Volcanic activity associated with constructive plate margin**. The magma is basaltic and originates from the boundary between the crust and mantle. It is often called primitive magma. The oceanic crust is of this type (basalt and gabbro). At the ocean floor the volcanic activity creates **pillow basalt** but on land **flood basalt**. The magma has low gas content thus explosive activity is at minimum during eruptions. One of the few places on earth where these types of eruptions can be seen on land is Iceland. There they are typically associated with fissures which can extend several hundred meters up to 30 – 40 km. They fall in a category of their own and are called here Icelandian eruptions.
2. **Volcanic activity associated with destructive plate margins**. The magma is acid or intermediate and formed through the process of partial melting of the oceanic crust. The chemicals with low melting point (and low density) melt first and rise to the surface while other chemicals of the crust are reintroduced to the mantel. The magma is rich in silica and gas and the eruptions are explosive due to de-gassing of the magma in the volcanic vent. This magma is often called developed magma.
3. **Volcanic activity associated with mantle plumes or hot spots**. The magma is basaltic and originates deep from the mantle. It is similar to the magma produced at constructive plate margins but richer in trace metals which are in abundance in the mantle. Flood eruptions associated with single vents are common. These are often long-lasting and generated so called **shield volcanoes**.

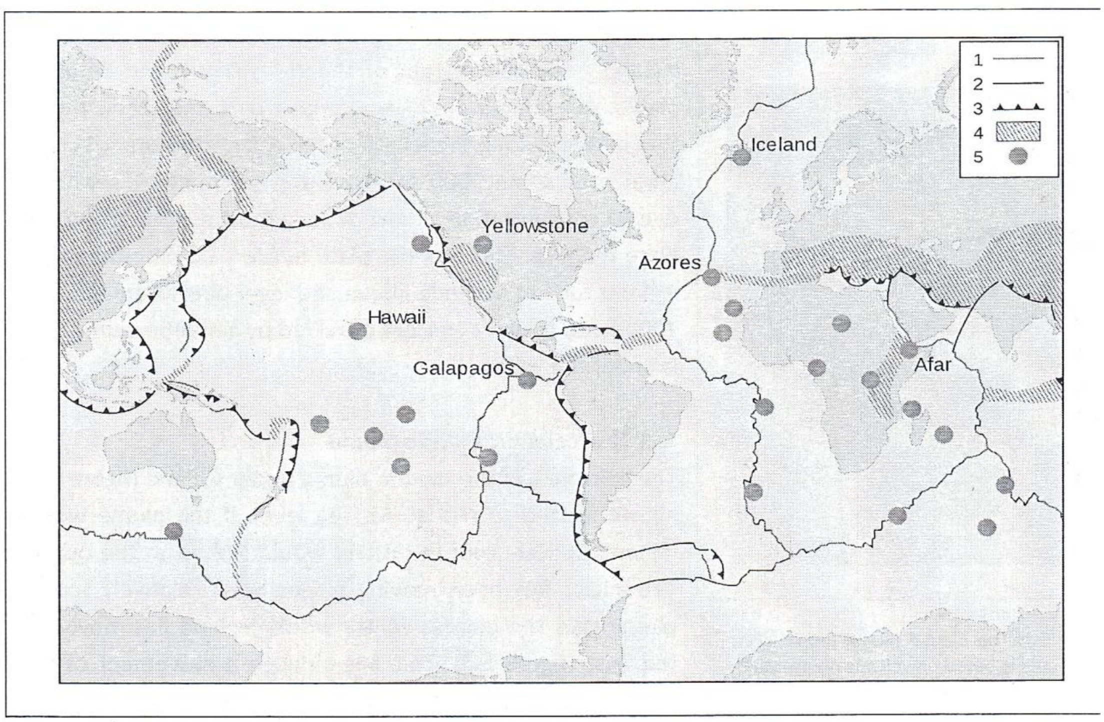


Figure 4.1: Known active hotspots on earth. The red line indicates constructive margins; the black line with triangles represents destructive margins. Hot spots are often associated or close to plate margins but not necessarily. Note that not only is Iceland divided in two by a constructive plate margin it is also a hot spot e.g. sits on a mantle plume. This explains why this part of the midocean ridge rises above sea level. Source: http://is.wikipedia.org/

Volcanic activity in Iceland falls into category one and two above - volcanic activity associated with constructive plate margins and a hot spot (see figure 4.1.)

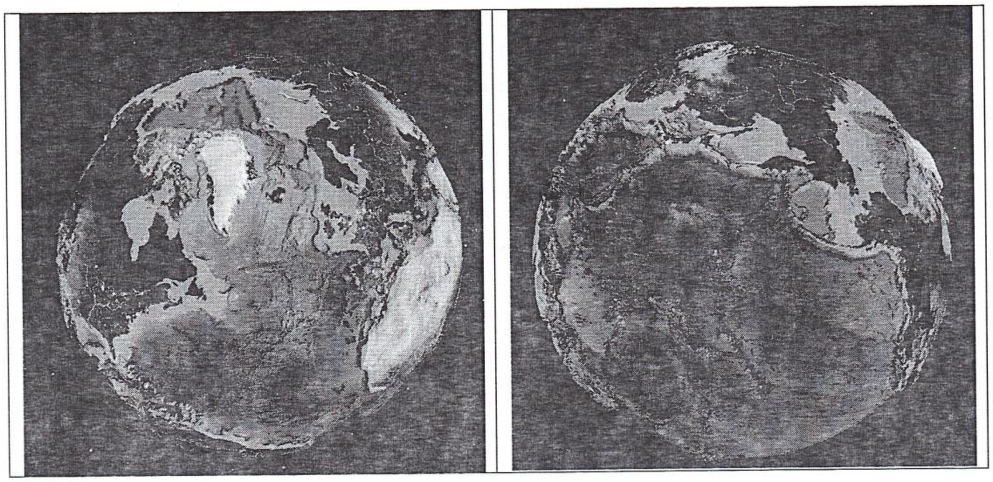


Figure 4.1: Important features of earth topography the midocean ridges associated with constructive margins and the deep sea trenches associated with destructive margin. Also visible is the volcanic mountain chain created by the Hawaiian hot spot. Source: screen capture from the software 3D world.

5. The geology of Iceland.

Iceland is on the margin of the N-American and Eurasian plates. The margins is characterised by a midocean ridges that extends along the length of the Atlantic (figure 4.1). The ridge rises some 2000 m above the surrounding sea floor due to concentration of low density (hot) magma along the plate margins. This lifts the plate borders up on either side. Iceland further ascends above sea level due to an addition 2000-3000 m uplift which is provided by a mantle plume that is under the island (figure 5.1).

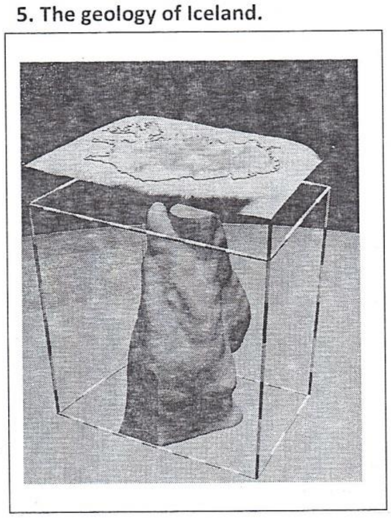


Figure 5.1: The mantel plume under Iceland. The image is based on seismic measurements done by Ingi Þ. Bjarnason at the University of Iceland.

5. 1 The Icelandic mantle plume

The existence of the mantle plume under Iceland (figure 5.1) allows Iceland to rise above sea level. If the plume would instantaneously cool the island would sink in to the ocean. The island has been moving to the west relatively to the plume thus the plumes centre within Iceland has moved to the east (figure 5.2). This has induced a movement of the plate margins to the east which is further explained in the following chapters (figure 5.5).

The Icelandic mantle plume has been active for 120 million years and is the one of the most powerful on earth, second only to the Hawaiian plume. The existence of such a powerful plume on the plate margins makes Iceland the only place on earth where it is possible to study features which are typical for the midocean ridge on dry land. This is also why volcanic activity in Iceland differs from other areas in the world. The relative movement of the mantle plume has been instrumental in moving the plate margins within the island a topic that demands a further discussion in the next chapters.

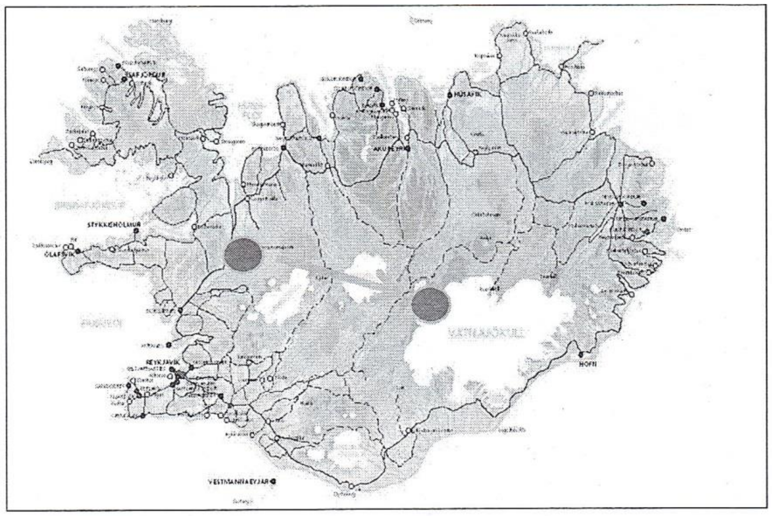


Figure 5.2 The movement of the centre of the mantle plume in Iceland in the last 20 million years. Remember that the mantle plume is stationary but the island is moving relative to the plume to the west.

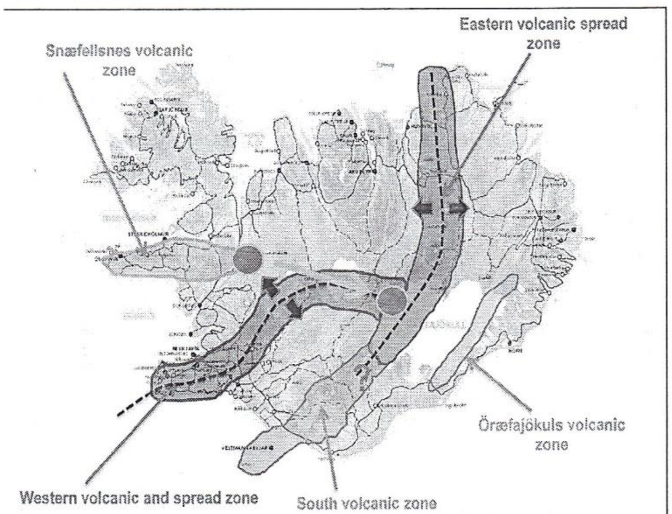


Figure 5.3 Volcanic zones of Iceland. The dark coloured broken line shows the actual plate margins. The arrows indicate direction of spread. The blue coloured areas are zones with volcanic activity but without spread. Their existent is explained in the main text. Please note that the location of these zones is not accurate.

5. 2 Plate margins and other features.

Volcanic activity in Iceland is confined to five zones (figure 5.3). Active volcanoes are not found in other areas in the island (although such areas are littered with extinct volcanoes). Keep in mind that the generation of new crust (and volcanoes) takes place at the actual plate margins and then the crust is moved to the sides one centimetre per year in each direction. The oldest bedrock of the island is therefore found at the coastal areas in the northwest and southeast of Iceland (figure 5.4).

Figure 5.3 also shows the actual plate margins, the rift axis, through the island (black broken line). As was to be expected they coincide with the main volcanic zones. These are the **Western volcanic spread zone** and the **Eastern volcanic spread zone**. They are characterised by volcanic activity and spreading. Three additional zones with volcanic activity but no spreading are found within the island. Their origin needs further explanation.

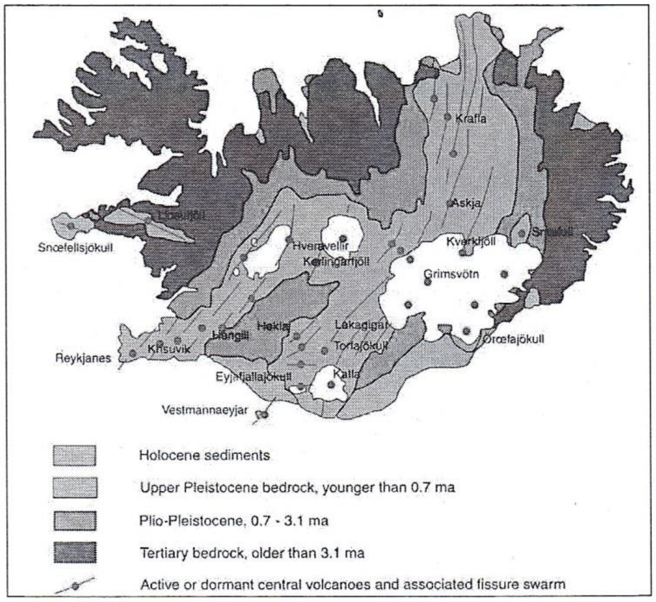


Figure 5.4 Simplified geological map of Iceland Note that the ages of the rocks increase perpendicular to the rift axis. Tertiary rocks are the oldest (blue) and upper Pleistocene rocks the youngest (pink) Source: Jóhannesson & Sæmundsson (1998).

First is the **Snæfellsnes volcanic zone**. Volcanic activity here owes its existence to the fact that the plate margins went through the area 10 million years ago but have migrated to the present day position since then. This is therefore a zone of dying volcanic activity.

The South volcanic zone in south Iceland has been the site of some of the more vigorous volcanic eruption in Iceland in the past millennia. Here we can name Katla, Laki, Eyjafjallajökull, Eldgjá and numerous eruptions in the Vestmanneyjar archipelago. It has been suggested that the current plate margin will shift to this zone accordingly the Vestmannaeyjar archipelago is then the first sign of a new peninsula similar to the Reykjanes and Snæfellsnes peninsula. This is therefore an emerging rift axise.

The **Öræfajökuls zone** is east of the South zone; a small and poorly researched zone that extends from Iceland's highest volcano in the south (Hvannadalshnúkur) to Snæfell in the north. This may be a new spread zone in the making which will ultimately replace the South volcanic zone in a much more distance future.

Shifts in plate margins are well known along the Atlantic ridge. The individual shifted sections are connected with transform faults (such faults are in fact found within Iceland, connecting the eastern spread zone to the western spread zone). The apparent shift in the rift axis in Iceland from the west to the east is likely due to the westward movement of the country relative to the centre of the mantle plume. As this occurs the centre of the plume moves to the east and the rift axis follows. This explains why the plate margins migrated from Snæfellsnes to Reykjanes and will possibly be extended into the South volcanic zone in the near future and eventually may jump to the Öræfajöklus zone in a more distant future (figure 5.5). It must be stressed that this is all speculative but recent studies have supported this and indicated that the movement of the rift axis is more complex than presented here. Studies indicate that two to three old spread axis exist in the Vestfjords of Iceland (they are all older than 10 million years).

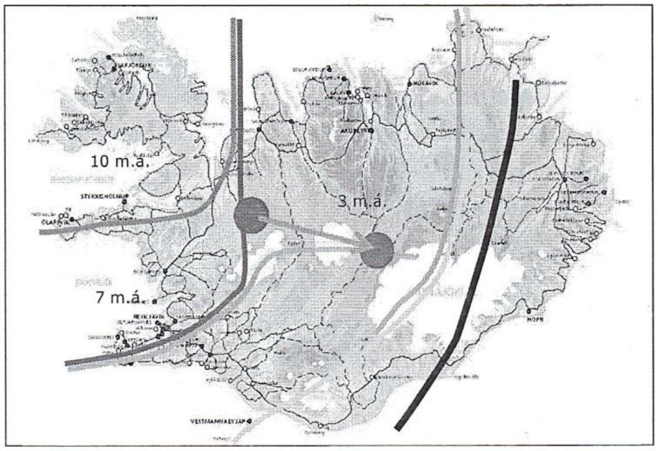


Figure 5.5: The figure show the rough location of the rift axis at different times in Iceland's geological history. The axis went along the Snæfellsnes peninsula and north to Vatnsnes 10 million years ago (blue line). Circa 7 million years ago it had shifted to the Reykjanes peninsula (red line) and 3 million years ago it had taken its present day position (green line). The yellow and black lines show the possible location of the rift axes in the future. This explains the present day volcanic activity outside of the current rift zone (green line). The figure also shows the movement of the centre of the mantle plume the past 10 million years. It is not a far fest assumption that the plate margins are following the centre and in fact surpassing it.

5. 3 Volcanic systems, magma tanks, magma chambers and central volcanoes.

On the bases of chemical composition each volcanic zone can be subdivided into **volcanic systems** (Figure 5.6). A total of 26 such systems are found within Iceland. The chemical properties of the magma/lava from each volcano in the same system are similar suggesting that each system is fed by a common and independent magma source or **tank** (for the lack of a better word). The number of independent tanks is therefore 26, the same as the number of systems (since each system has its own tank).

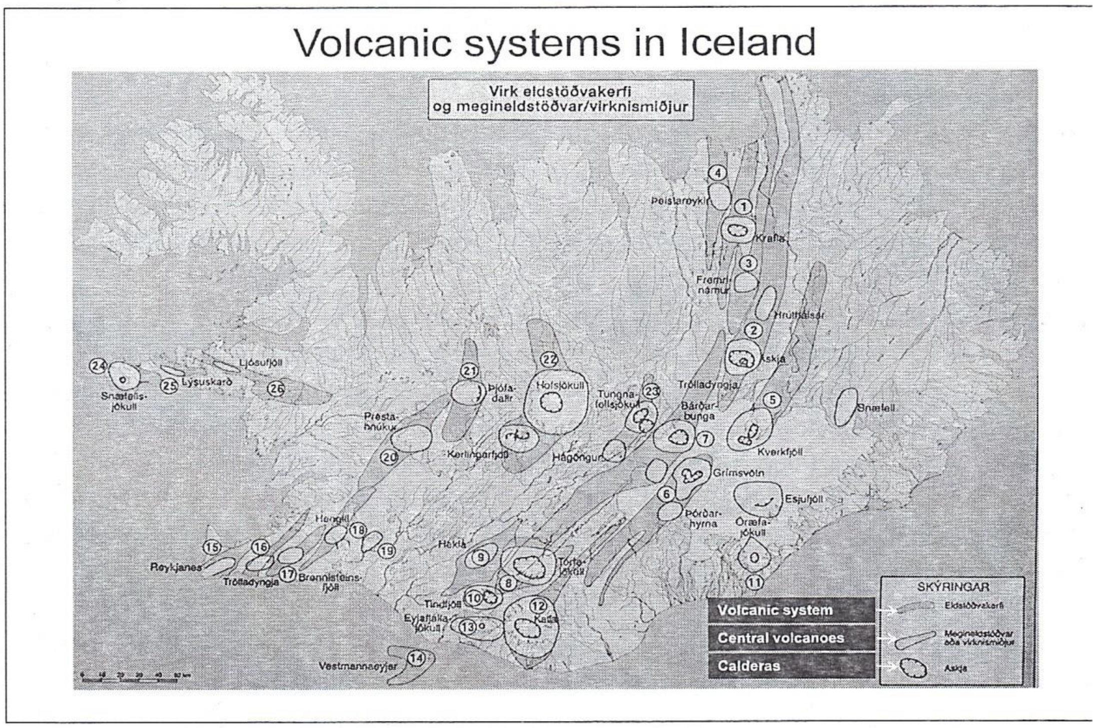


Figure 5.6: Volcanic systems in Iceland. The orange shade areas show the outline of each system and hence the extent of the underling magma tank (see text). One tank for each system. The red line outlines the central volcanoes of each system. These are the centres of activity within each system and with time high rising or massive volcanoes develop within these areas most of which have their own magma chamber which in turn is fed by the underling tank of the system in question. Most system typically have one central volcano while others may have two. Calderas form within well developed central volcanoes (black line with jagged edges). Source: Ari Trausti Guðmundsson, 2000.

The systems are 10-100 km long and tenths of km wide with numerous active volcanic vents. The magma tank that feeds each system has the same area and a thickness of tenths to several hundred meters. These tanks are at great depths in the upper part of the mantle or at the boundary of the crust and mantel. Geophysical studies have not yet been able to verify the existence of these tanks but some such studies suggest that they are not unlikely. This model is at least the one that best describes the measurements.

The systems display different degrees of maturity. The best matured are found in relatively older volcanically active zones (e.g. Snæfellsnes peninsula) and the least matured are found in younger zones (e.g. Reykjanes peninsula). With time and maturity each system develops a centre of activity (that needs not be in the centre of the system). Repeated eruptions occur in the centres of activity through time and eventually a large mountain builds up. These are called central volcanoes. An independent **magma chamber** develops below the central volcano typically at depths of 2-5 km. These chambers are fed by the underlying magma tank that feeds the system (figure 5.7) their volume is typically 1-2 km^3. Usually each system has one central volcano but in some cases they can have two (see figure 5.6)

The morphology of the central volcanoes differs. In some areas they are cone shaped and rise high above their surroundings (e.g. Snæfellsjökull) but in other areas they are flat and massive (e.g. Askja in central Iceland). All well developed central volcanoes have calderas which are formed when the magma chambers collapse after large eruptions.

5. 4 Origin of magma in volcanic eruptions.

Magma can take two main routes to the surface. It can follow cracks and fissures within the bedrock from the magma tank to the surface (see figure 5.7). This magma is highly basaltic, low in gas content relatively hot and therefore thin flowing. It typically erupts from fissures that can vary in length, from several meters to tenths of km. In the Laki eruption (1783 AD) the fissure extended some 25-30 km.

In the beginning the fissure eruption is continues along the **fissure** and the wall of fire may be as high as 1000 m. As the eruption continues the activity becomes concentrated on several vents on the fissure the resulting product is a **row of craters**. This is a typical **Icelandian eruption** (see chapter 5.4). The thin flowing lava flows long distances creating extensive lava fields. Three of the largest lava fields in the world created during the Holocene were formed in Iceland in this type of eruptions. These are, in the order of size, Eldgjárhraun (932 AD), Þjórsárhraun (8500 BC) and Skaftáreldahraun (1783 AD). In some cases these flood eruptions take place on single vents. Then they form so called **shield volcanoes**.

The magma also makes its way from the magma tank into the magma chamber of the central volcano. There it can sit for long periods before erupting. During that time the magma cools and its chemical composition changes. Several processes contribute to these changes but the end results is that the basaltic (mafic) magma becomes richer in silica and becomes intermediate and in some cases felsic. Silica rich magma can bind more gases so the gas content increases. The eruptions that follow are therefore more explosive and the magma that reaches the surface is rhyolitic or andesitic. These lavas are thick flowing and massive, their thickness often exceeding several hundreds of meters. The longer the intervals between eruptions in the central volcano the stronger is this affect.

It must be stressed that the above description of the different routes and types of volcanic eruptior is to some extent a simplification and a generalisation of a much more complex and diversifiec processes.

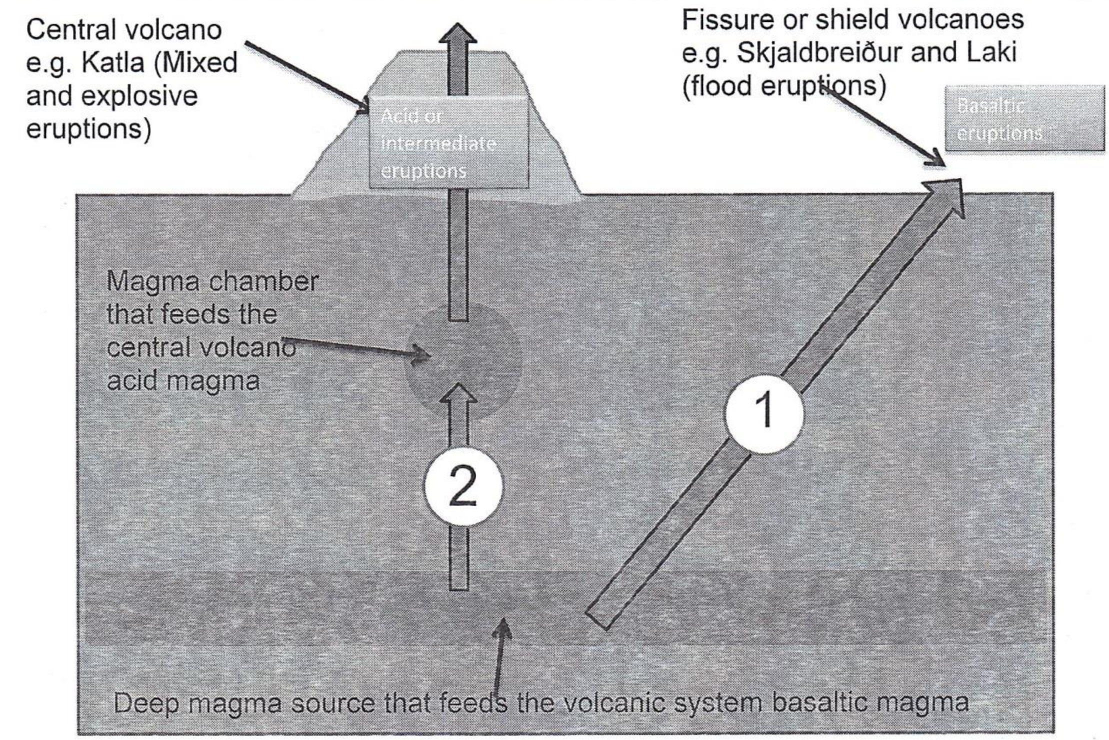


Figure 5.7: The diagram shows the main features of a volcanic system. Underneath is the magma tank. The magma can go directly from this deep source to the surface. These eruptions are basaltic and usually occur on fissure but can also occur on single vents. Fissure eruptions create crater rows, while single vent eruptions create shield volcanoes. The magma can also move from the tank into the magma chamber underneath the central volcano. Once in the chamber the primitive basaltic magma starts to develop through the process of partial melting of neighbouring bed rock (felsic material introduced) and partial crystallisation of the magma (mafic material removed). The eruptions of the central volcano can therefore be andesitic (intermediate) or acidic.

5. 6 Classification of volcanoes (international and Icelandic).

The most common classification scheme for volcanoes is shown in figure 5.8. I have taken the libert of adding Icelandian eruptions to the list. Those would be typical flood eruptions on fissures. Th classification is based (amongst other things) on explosiveness of the eruption and temperature o the magma. In fact the explosiveness depends on gas content (which in turn depends on the silic content) and the viscosity of the magma. We can therefore say as we go up the y-axis on the graph i figure 5.8 viscosity decreases, gas content increases and explosiveness increases.

The temperature of the magma increases as we go along the x-axis. This shows that hot magm tends to be basaltic, gas depleted and viscous, while cold magma tends to be acidic, thick flowing an rich in gas.

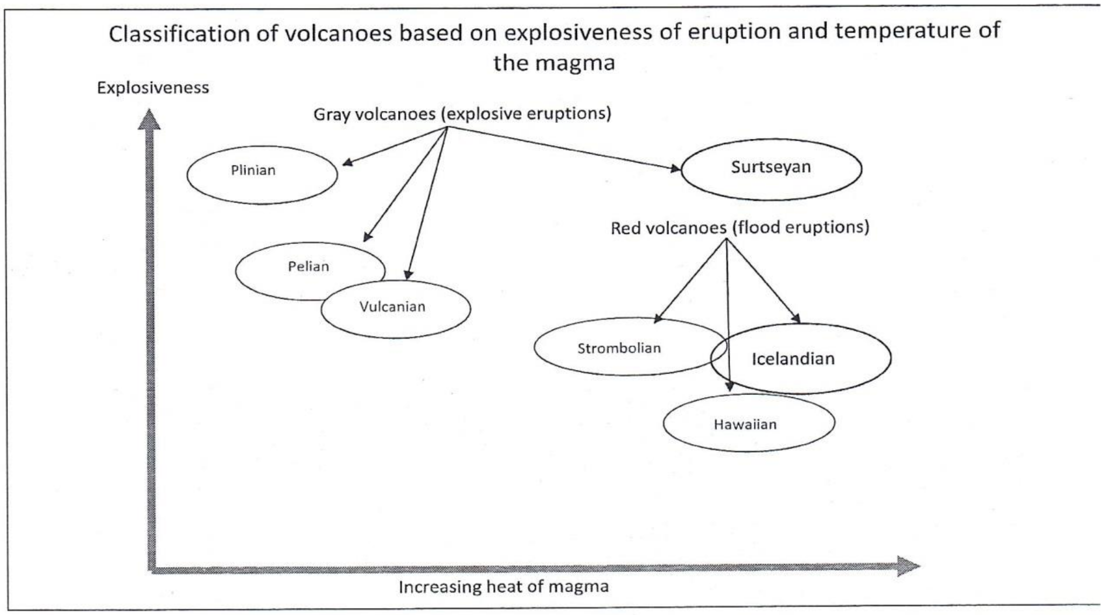


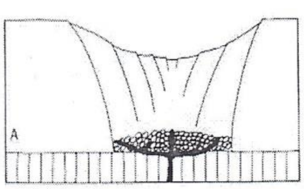
Figure 5.8: Classification of volcanoes based on explosiveness and temperature of the magma. See text for further description and table 5.1.

Table 5.1 contains a description of each volcano type describing the type of eruptions, material produced during the eruption and the mountain/landform left behind after the eruption.

Most Icelandic volcanoes fall into one category in this classification. Icelandic geologists have therefore constructed classification schemes that better fits volcanoes in Iceland. These schemes exist in several varieties but the one presented here is from Þorleifur Einarsson, 1992. The classification takes notice of the morphology and the internal configuration of the volcano. These features are in turn determined by the type of the volcanic vent (circular or elongated) and the nature and behaviour of the eruption (explosive, mixed or flood eruptions, short or long) (figure 5.2). Table 5.3 describes each type of volcano in this classification. Chapter six contains photographs that show different types of volcanoes (and other geological features).

5. 7 Sub-glacial eruptions (Palagonite tuff/Hyaloclastiet mountains)

Palagonite table mountains are very dominant in Icelandic landscape. Guðmundur Kjartansson (1947) suggested a model that explained the formation of these plug like table mountains. According to his model they are formed during sub glacial eruption and are close relatives of Surtseyan volcanoes which are formed during oceanic eruptions. Their development is in three main stages and the eruption can stop at any particular stage. We therefore have three sub-categories of these mountains.



1. Stage: formation of pillow lava core. An eruption stars under the glacier and the heat creates a water filled cavity within the ice. High pressure conditions prevent explosive activity even though the magma is in contact with water. Pillow basalt is formed. If the activity stops at this stage a pillow basalt mound or a ridge is created (figure 6.5).

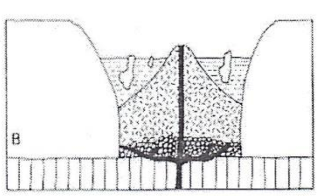
Table 5.1 Description of volcanoes according to international classification presented in figure 5.8				
Type of eruption	Magma	Characteristics of eruption	Eruption products	Type of a volcano after the eruption
Hawaiian	Very mafic (basaltic)	Flood eruptions (single vent)	Pahoehoe lava	Shield volcano, spatter ring crater
Icelandian	Very mafic or mafic	Flood eruptions on a fissure	Pahoehoe or Aa lava	Scoria and spatter craters
Strombolian	Mafic or intermediate	High lava fountains occasional explosions	Aa lava, scoria and cinder	Scoria and cinder crater
Surtseyan	Mafic	Water in contact with magma causing continues explosive activity.	Tephra and volcanic bombs	Tephra crater.
Vulcanian	Felsic (acidic) and gas rich	Continues explosions.	Volcanic bombs, pumice and tephra	Tephra crater.
Pelian	Felsic	Catastrophic eruption with pyroclastic flows	Gases, tephra and pumice.	Shattered strata volcano and a caldera, ignimbrite
Plinian	Felsic	Short lasting catastrophic eruptions	Gases, tephra and pumice.	Remnants of a strata volcano and a caldera

Table 5.1 Classification of volcanoes based on explosiveness and temperature of the magma. Description of each volcano type. See text for further description and figure 5.8.

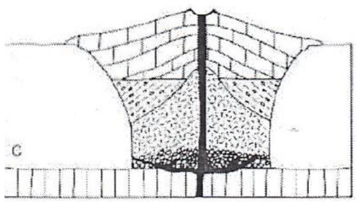
Icelandic classification of volcanoes

		Shape of eruption vent	
		Circular	Elongate
Type of eruptive products	Lava (flood eruption)	Shield volcano	
		Spatter ring crater (figure 6.7)	
	Lava and tephra (mixed eruption)	Scoria and cinder crater	Scoria and spatter crater row
		Strata volcano	Linear strata volcano
	Tephra (phreatic and explosive eruptions)	Tephra crater	Tephra crater row
		Explosion crater (figure 6.4)	Explosion crater row

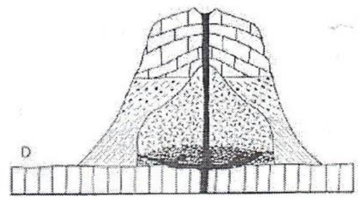
Table 5.2. At the core of this classification are the morphology and the internal configuration of the volcano. These features are in turn determined by the type of volcanic vent (circular or elongated) and the nature of the activity (explosive, mixed or flood eruptions). Source: Þorleifur Einarsson, 1992.



2. Stages – formation of the hyaloclastite veil: The pressure falls within the cavity as its roof caves in. Contact with water cause continues explosions thus preventing lava from flowing. Thick layer of hyaloclastite accumulates on top of the pillow lava formed in stage 1. Hyaloclastite is composed of volcanic glass shards that fuse together with time to form tuff (figure 6.8). In some cases the eruption stops at this stage resulting in a cone shaped palagonite tuff mountain (figure 6.1). If the eruption is on a fissure the resulting form is a palgonite/hyaloclastic ridge. Such ridges and cones are common within areas that were volcanically active during the last glacial period of the ice age.



3. Stage – Formation of the lava cover: Eventually the tuff cone builds out of the water and lava can flow in a normal fashion. This lava covers the existing tuff. In due course the ice melts and the lava covered hyaloclastic table mountain is revealed. The mountain is plug-like in form since the build up took place in the confined space of the ice cavity. Weathering processes quickly cover the hyaloclastite slopes with material that weathers out of the lava above (figure 6.2). Very similar stages are seen during Surtseyan eruptions. Pillow basalt builds up at the core, next is the hyaloclastite and finally, as the crater builds out of the ocean, a lava cover is formed. This process was observed during the Sursteу eruption 1963-1967



6. Pictorial guide to the geology of Iceland.

The following pages contain photographs (by the author) that show some of the features descried in this text.

Figure 6.1: Mælifell a palagonite cone in south central Iceland. Eruption stopped at stage 2.