
# A survey of helium isotopes in Icelandic volcanic materials and geothermal fluids using spatial analyses in ArcGIS

Sunna Harðardóttir

**Faculty of Earth Science**
**University of Iceland**
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# A survey of helium isotopes in Icelandic volcanic materials and geothermal fluids using spatial analysis in ArcGIS

Sunna Harðardóttir

10 ECTS thesis submitted in partial fulfilment of
*Baccalaureus Scientiarum* degree in Geology

Advisor
Sæmundur Ari Halldórsson

Faculty of Earth Science
School of Engineering and Natural Sciences
University of Iceland
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Faculty of Earth Science
School of Engineering and Natural Sciences
University of Iceland
Askja, Sturlugata 7
101 Reykjavík

Telephone: 525 4000

Registration information:
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# Abstract

The distribution of helium isotope ratios ($^3He/^4He$) in Icelandic geothermal fluids, volcanic glasses and phyric lavas was investigated. Published data from previous studies were compiled and a data base with all available data constructed. Modifications of primary (i.e., mantle-derived) helium isotope ratios, due to additions of, for example, air-derived helium and radiogenic ingrowth, were evaluated and the data base was filtered accordingly. The geographical information system ArcGIS (ESRI) was used to perform spatial analysis on the filtered data base. An interpolation method called Natural Neighbor was used to calculate representative helium isotope ratios for all parts of Iceland, including off-axis regions. In accordance to prior studies, the results show that helium isotope ratios in the whole of Iceland vary from 5.1 to 37.7 $R_A$ (where $R_A$ is the $^3He/^4He$ ratio of air (Füri et al., 2010)). However, this study allows for a fine-scale distinction to be made between individual rift segments and off-rift regions. The results clearly reveal that each rift zone has its own distinctive isotope signature: 12-17 $R_A$ in the Western Rift Zone (WRZ), 8-11 $R_A$ in the Northern Rift Zone (NRZ) and 18-21 $R_A$ in the Eastern Rift Zone (ERZ). A high helium plateau, characterized by values $\geq 20$ $R_A$ is located in Central Iceland and covers an area of 85 × 50 km. This plateau continues down the propagating ERZ and through the South Iceland Seismic Zone (SISZ) and coincides with many geological features, e.g., eruption rates, seismic velocity and gravity anomalies. Such high helium isotope ratios have been associated with undegassed and primordial mantle sources that have been isolated in the lower mantle over Earth's history. The high helium plateau therefore, marks the conduit of the mantle plume underlying central Iceland.

# Útdráttur

Dreifing helíum samsætna var rannsökuð í íslenskum jarðhitavökvum, glerjum og dílóttum hraunum. Útgefnum gögnum frá fyrri rannsóknum var safnað saman og út frá þeim var settur saman gagnagrunnur. Breytingar á upphaflegu samsætuhlutfalli helíums, vegna til dæmis, helíums sem er upprunið í lofti og myndunnar $^{4}$He við geislavirkt niðurbrot, voru metnar og gagnagrunnurinn var síaður í samræmi við það. Landupplýsingakerfið ArcGIS (ESRI) var notað til að framkvæma rýmdargreiningar á síuðu gagnasafninu. Brúunaraðferðin Natural Neighbor var notuð til að reikna samsætuhlutfall helíums fyrir allt landið, þar með talið svæði utan rek- og gosbelta. Í samræmi við fyrri rannsóknir, sýna niðurstöðurnar að samsætuhlutfall helíums fyrir allt Ísland nær frá 5.1 til 37.7 $R_A$ (þar sem $R_A$ er hlutfall $^{3}$He/$^{4}$He í andrúmslofti (Füri et al., 2010)). Þessi rannsókn gefur hins vegar möguleika á aðgreiningu milli mismunandi rekbelta og svæða utan þeirra. Niðurstöðurnar sýna greinilega að öll gliðnunarbelti landsins hafa sitt einkennandi samsætuhlutfall: 12-17 $R_A$ fyrir vestra gliðnunarbeltið (WRZ), 8-11 $R_A$ fyrir nyrðra gliðnunarbeltið (NRZ) og 18-21 $R_A$ fyrir eystra gliðnunarbeltið (ERZ). Hágilda helíum svæði sem einkennist af gildum $\geq$ 20 $R_A$ er staðsett yfir miðju Íslandi og þekur svæði sem er 85 × 50 km. Þetta svæði heldur áfram niður eftir eystra gliðnunarbeltinu (ERZ) og í gegnum þverbrotabeltið á Suðurlandi (SISZ) og samsvarar öðrum jarðfræðilegum einkennum, t.d. tíðni eldgosa, hraða jarðskjálftabylgna og þyngdarfrávikum. Þessi háu samsætuhlutföll helíums hafa verið tengd við óafgasaða frummöttulgeyma sem hafa verið einangraðir í neðri möttli frá árdögum jarðar. Þar af leiðandi afmarkar hágilda helíum svæðið rás möttulstróksins undir Íslandi.

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# Abbreviation

MORB - Mid Ocean Ridge Basalt

OIB - Ocean Island Basalt

SCLM - Sub-Continental Lithospheric Mantle

WRZ - Western Rift Zone

ERZ - Eastern Rift Zone

SISZ - South Iceland Seismic Zone

NRZ - Northern Rift Zone

SIVZ - South Iceland Volcanic Zone

TFZ - Tjörnes Fracture Zone

ÖVZ - Öræfajökull Volcanic Zone

SNVZ - Snæfellsnes Volcanic Zone

Ma - Million years

km - Kilometers

cm - Centimeters

N - North

E - East

W - West

STP - Standard temperature and pressure

$ncm^3$ - Cubic Nano centimeters

g - Grams

mGal - Milli Gal

# Acknowledgements

I wish to think my advisor Sæmundur Ari Halldórsson for proposing this project and for professional guidance. Gunnlaugur Magnús Einarsson is thanked for his help with analysis in ArcGIS. Finally I would like to thank my sister Daney Harðardóttir for reviewing this thesis.

# 1 Introduction

Helium is a noble gas that is chemically inert. It has two naturally occurring isotopes, $^{3}He$ and $^{4}He$, that have contrasting origins (Graham, 2002). Helium isotopes are valuable tracers in a number of geological processes, especially in processes related to mantle geochemistry. Mantle-derived materials are enriched in $^{3}He$ relative to $^{4}He$, over three orders of magnitude, compared to He produced by radioactive decay in the continents (Hilton et al., 1990).

Iceland is located at a divergent plate boundary and is also a hotspot (Einarsson, 2008). The result of this unique geological setting is a broad range in the helium isotope ratio, where both mid ocean ridge basalt (MORB) and ocean island basalt (OIB) ratios are observed. The distribution of the helium isotopes can be used to get a better understanding of the mantle plume beneath Iceland. The observations of $^{3}He$ enrichments in the mantle have been used to make inferences about its deep structure and evolutionary history (Hilton et al., 1990).

In this study the helium isotope ratio ($R/R_A$) in geothermal fluids, volcanic glasses and phyric lavas from Iceland was investigated. The objective of this study is to compile previously published data about helium isotopes reported from Iceland. A data base, with a total of 707 samples, was constructed from published data. The data was filtered, since air-derived helium can contaminate the samples. The filtered data base was used to conduct spatial analysis in ArcGIS and investigate the regional variability of the helium isotope ratio in Iceland. The results of these analysis are compiled and displayed on maps. This study demonstrates that the $^{3}He/^{4}He$ ratio correlates with geophysical measurements, e.g. seismic velocity and gravity parameters which have implications for depicting the structuring of the Iceland mantle plume.

# 2 Geochemistry of helium and its isotopes

## 2.1 Helium and helium isotopes in Earth

Helium is a noble gas, which has a filled outer electron shell. This makes helium chemically inert and volatile. Helium is the second lightest element and the second most abundant element in the universe, with an abundance of 25%. As with other light elements, helium formed during the Big Bang and is being created by nuclear fusion of hydrogen in stars (White, 2013). The first evidence of helium was observed during the solar eclipse in 1868 as an unknown yellow line in the spectrum of sunlight. Twenty seven years later, in 1895 William Ramsay isolated helium on Earth by extracting it from a uranium mineral (Petrucci et al., 2011).

Two naturally occurring isotopes of helium exist, $^{3}He$ and $^{4}He$. Helium-4 is much more abundant relative to $^{3}He$, as it is constantly forming in Earth‘s materials by radioactive decay. Alpha-particles (α) are $^{4}He$ nuclei, so $^{4}He$ is produced by α-decay of $^{238}U$, $^{235}U$, $^{232}Th$ and other decay series elements over geological time. On the other hand nearly all of $^{3}He$ is primordial. Degassing from the Earth‘s interior is the most important terrestrial source of $^{3}He$. Other sources of $^{3}He$ to the atmosphere are the auroral precipitation of solar wind, direct accretion from cosmic rays and flux of cosmic dust and meteorites. Small but measureable quantities of $^{3}He$ are produced in rocks at the Earth‘s surface by high energy cosmic rays, mostly from spallation of O, Si, Mg and Fe atoms. Very small quantities of $^{3}He$ are produced by the nuclear reaction $^{6}Li(n,\alpha)\rightarrow{}^{3}H(\beta)\rightarrow{}^{3}He$, which is a part of the radioactive decay of U and Th. In this reaction $^{6}Li$ is excited by a capture of a neutron, It decays through the emission of an alpha particle to tritium. The tritium then beta decays to $^{3}He$ (Graham, 2002).

Helium is not preserved on Earth, therefore much of the helium present when the Earth formed, has been lost. It diffuses very rapidly and therefore any helium brought to Earth‘s surface finds its way quickly into the atmosphere. When it reaches the top of the atmosphere it will eventually escape from Earth‘s gravity because of its low mass. (White, 2013). This gravitational escape from the thermosphere and helium‘s short atmospheric residence time of 1 to 10 Ma causes it not to be recycled by plate tectonics to the Earth‘s interior. This makes the $^{3}He/^{4}He$ ratio unique among isotope tracers of mantle sources (Graham, 2002).

The isotope ratio of $^{4}He/^{3}He$ varies in the Earth. $^{4}He$ is continually produced, through radioactive decay, but $^{3}He$ is not so the $^{4}He/^{3}He$ ratio in the Earth is a very large number. The isotope ratio of helium is generally expressed as $^{3}He/^{4}He$, (R). This is in contradiction to the regular convention of placing the radiogenic isotope in the numerator. The atmospheric ratio of $^{3}He/^{4}He$ ($R_A$), is uniform and therefore makes a convenient standard and provides the basis for a convenient normalization. The $^{3}He/^{4}He$ ratio of the atmosphere ($R_A$), is $1.384 \times 10^{-6}$ and helium isotope ratios are reported and discussed relative to the atmospheric value ($R/R_A$) (White, 2013). The absolute terrestrial $^{3}He/^{4}He$ ratio varies by

several orders of magnitude from high values (>$10^{-5}$) in mantle-derived lavas and fluids, to low values (~$10^{-8}$) in continental regions due to increased amounts of radiogenic $^4$He (Graham, 2002).

The most reliable noble gas samples are subglacial and oceanic lavas. These lavas cool rapidly and form quenched rims of glass that trap measureable amounts of volatiles, including helium. Subaerial basalts are of little use in analysis of noble gases since they are largely degassed. However minerals like olivine and pyroxene can trap noble gases in melt or fluid inclusions during crystal growth (Kurz et al. 1982; Graham 2002).

## 2.2 Helium in terrestrial reservoirs

Helium isotope ratio differs in various reservoirs (Figure 1). Figure 1 shows both the absolute terrestrial $^3$He/$^4$He ratio and the normalized ratio ($R/R_A$) in various terrestrial and solar system materials. The highest $^3$He/$^4$He ratios are cosmogenic and higher ratios are measured in meteorites and at the Sun than on the Earth. The highest ratios on Earth are measured in OIBs, while the lowest ratios are observed in crustal rocks. In Iceland two reservoirs exist, MORB and OIB, which show different values and ranges for the $^3$He/$^4$He ratio. Below, the helium isotope ratios of MORB, OIB and sub-continental lithospheric mantle (SCLM) will be discussed in more detail, since these three reservoirs form magmas.

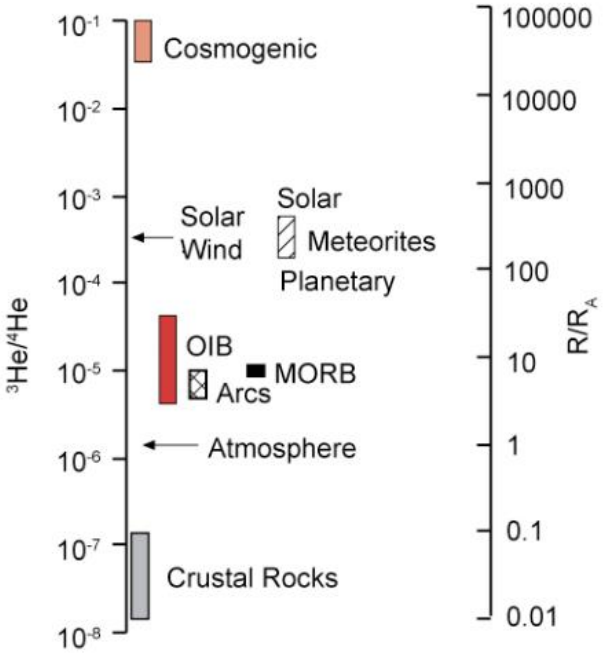


***Figure 1:*** *Helium isotope ratios in different reservoirs (White, 2013)*

### 2.2.1 MORB

MORBs are basalts that erupt at mid-ocean ridges where new oceanic crust is continually forming as tectonic plates diverge. MORB is olivine and quartz-normative tholeiite. (Frost & Frost, 2014). Tholeiitic basalts form by partial melting as the ascending mantle beneath mid-ocean ridges reaches it solidus temperature. MORBs are thought to represent a sampling of the upper mantle that has been argued to be relatively degassed. MORBs have consistent values of 8±1 $R_A$ for the $^3$He/$^4$He ratio (Graham, 2002).

### 2.2.2 OIB

OIBs are basalts that erupt at off-ridge, intraplate locations, ocean islands and oceanic plateaus, and includes both tholeiitic and alkali basalts (Frost & Frost, 2014). OIBs have a wider range than MORBs and show high magmatic $^3He/^4He$ ratios, values higher than 30 $R_A$ have been reported in locations such as Hawaii and Iceland. The difference observed between MORBs and OIBs in helium isotope ratios is accepted by most investigators as evidence for two distinct mantle source regions (Graham, 2002). The high $^3He/^4He$ ratios at OIB localities are usually associated with mantle upwellings or mantle plumes of relatively undegassed mantle that has remained isolated at depth (Breddam et al., 2000). Over geological time these deep regions might have been more or less isolated, resulting in deep regions that are less degassed and have lower time-integrated $(U+Th)/^3He$ than shallower mantle sources (Graham, 2002).

### 2.2.3 SCLM

The mantle portion of continental plates is called the SCLM. It is rather different from the lithosphere beneath the ocean basins and instead of being subducted and recycled, like oceanic lithosphere, the SCLM has largely remained stationary under the overlying continent since its formation (Winter, 2014). The SCLM‘s mineralogy and geochemistry is different from the oceanic mantle. The SCML has developed its own signature in terms of major and trace elements and isotope signature, that is distinct from the MORB source. The SCML has similarities with the depleted oceanic mantle but is re-enriched by fluids either from the asthenosphere or from slab dehydration added during past subductions. Typical SCLM values for the $^3He/^4He$ ratio are $6.1\pm0.9$ $R_A$ (Gautheron & Moreira, 2002).

## 2.3 Helium studies in Iceland

### 2.3.1 Early studies utilizing geothermal fluids

Russian scientist were the first to analyze helium isotopes in geothermal fluids from Iceland. Polak et al. (1976) made measurements in Iceland to compare with measurements from geothermal fluids and gases from tectonically stable, intraplate, areas. Torgersen and Jenkins (1982) also included measurements of helium isotopes in Icelandic geothermal fluids in their survey of fluids from different geological environments. Results showed that there is a great variety in the isotope composition of helium in different geological environments and Iceland was identified as a region with a high $^3He/^4He$ ratio. Hilton et al. (1990) confirmed that excess $^3He$ is measured in Iceland, both within the neovolcanic zones but also in older parts of the Icelandic crust. The high $^3He/^4He$ ratios in the older crust were thought to result from release of magmatic volatiles due to mantle melting rather than dispersion by groundwater flow from the neovolcanic zones (see also section 6.1.2.).

### 2.3.2 Studies on recent volcanic glasses and phyric lavas

Condomines et al. (1983) were the first to analyze helium isotopes in volcanic glasses. Their results showed a consistent range for basaltic glasses with the previously recorded range for Icelandic geothermal systems. Intermediate and acid samples were all severely contaminated by atmospheric helium and showed values close to 1 $R_A$. From measured helium isotope ratios in glasses, Kurz et al. (1985) showed, that each rift zone has a

distinctive basaltic $^{3}He/^{4}He$ isotopic signature. Since then, the highest ratios within the neovolcanic zones (up to ~34 $R_A$) have been measured in central Iceland (Breddam et al., 2000; Macpherson et al., 2005). These high values coincide with geophysical measurements and have been connected to the mantle plume situated below Iceland.

Helium and other noble gases have been studied extensively in Icelandic subglacial volcanic glasses in most cases to get a better understanding of mantle sources. Studies of Icelandic subglacial basalts (Harrison et al., 1999; Dixon et al., 2000; Trieloff et al., 2000; Moreira et al., 2001; Dixon, 2003; Füri et al., 2010) have led to the interpretation that high $^{3}He/^{4}He$ ratios are caused by an undegassed, deep mantle source for mantle plumes. The upper mantle or the MORB source is on the other hand degassed and contains less $^{3}He$ (Moreira et al., 2001). In particular have combined studies of He-Ne-Ar-Xe provided crucial evidence supporting a notion that the Icelandic mantle plume source is sampling a primitive and volatile-ich reservoir from early in Earth‘s history (Mukhopadhyay, 2012).

Helium is still being investigated in Iceland and the latest analysis were conducted by Halldórsson et al. (2016) in which analysis of nitrogen and other noble gases were combined, to investigate the recycling of crustal material by the Icelandic mantle plume.

### 2.3.3 Helium studies in older parts of the Icelandic crust

In some parts of the older Icelandic crust unusually high $^{3}He/^{4}He$ ratios have been measured. Polak et al. (1976) measured a value of 23.8 $R_A$ in a geothermal fluid from Hveravík, Vestfirðir. A large number of measurements have been done on both geothermal fluids and phenocrysts from Vestfirðir since then (Hilton et al. 1990; Poreda et al. 1992; Hilton et al., 1998; Hilton et al., 1999; Ellam & Stuart, 2004; Füri et al., 2010). The highest ratio of 37.7 $R_A$ was measured by Hilton et al. (1999) in a phenocryst sample from Selárdalur. In other parts of the older Icelandic crust measurements have not been carried out with the same intensity. The few measurement that have been done in Eastern Iceland show a range of 5.1-14.6 $R_A$ (Kononov & Polak; Poreda et al., 1992; Ellam & Stuart, 2004), which is considerably lower than the range of 6.2-37.7 $R_A$ reported from Vestfirðir.

### 2.3.4 Cosmogenic dating studies utilizing $^{3}He$

Measurements of $^{3}He$ have also been used to determine the age of lavas (Licciardi et al., 2006) and table mountains (Licciardi et al., 2007; Eason et al., 2015) in Iceland. In these studies cosmogenic $^{3}He$ production rates in olivine phenocrysts were calculated from the measured $^{3}He/^{4}He$ ratio. The age of the landforms were then calculated from the $^{3}He$ production rate. The results of Licciardi et al. (2006) were similar to previous results gained by using radiocarbon to determine the age of the lavas. No comparison is available for the table mountains, since Licciardi et al. (2007) and Eason et al. (2015) provided the first direct chronology for these landforms.

# 3 Geological setting

Iceland is a subaerial section of the Mid-Atlantic Ridge, that is distinguished by high basaltic melt production and an anomalously thick crust.(Darbyshire et al., 2000) Iceland is situated at a divergent plate boundary which separates the Eurasia Plate from the North American Plate. The two plates move apart about 2 cm per year in E-W direction. Iceland is a hotspot and is presumed to be fed by a deep mantle plume. The center of the plume is assumed to be located under central Iceland (Einarsson, 2008; Bjarnason, 2008).

The neovolcanic zones are a surface expression of the mid-ocean ridge in Iceland or the zones of active volcanism (Figure 2). The neovolcanic zones are covered with rocks that are younger than 0.8 Ma (Guðmundsson, 2000). There are two types of neovolcanic zones, axial rift zones, that represent the landward extensions of the Mid-Atlantic Ridge, and off-rift volcanic zones. The axial rift zones cross Iceland from southwest to northeast, linking the Reykjanes Ridge in the southwest to the Kolbeinsey Ridge in the north (Figure 2). In the north the Tjörnes Fracture Zone (TFZ) connects Kolbeinsey Ridge to the NRZ, which continues south to Vatnajökull. There the axial rift zone splits up into two branches, the WRZ and the ERZ. The WRZ and the ERZ are separated by the transform fault system, SISZ. The off-rift zones are South Iceland Volcanic Zone (SIVZ), Snæfellsnes Volcanic Zone (SNVZ) and Öræfajökull Volcanic Zone (ÖVZ). SIVZ is a direct continuation of the ERZ, but SNVZ and ÖVZ are intraplate and not connected to the active plate boundary. The axial rift zones erupt lava of tholeiitic composition. The off-rift volcanic zones erupt lavas of transitional-alkalic to alkalic composition (Jakobsson et al., 2008).

The Icelandic crust is often considered in terms of three major units (Figure 2). These units are: the Tertiary flood basalts, Plio-Pleistocene flood basalts and subglacial deposits and upper Pleistocene volcanics. The Tertiary flood basalts are located in the north, northwest and eastern parts of Iceland. They range in age from 3 Ma in the center of Iceland to 13 Ma in the East and 16 Ma at Vestfirðir. The Plio-Pleistocene formation is found adjacent to the neovolcanic zones and at Skagi in Northern Iceland. It consist of hyaloclastites and volcanogenic sediments. The upper Pleistocene formation are hyaloclastites and subaerial basalts that are associated with active rifting and volcanism in the neovolcanic zones and on Snæfellsnes in the last 0.8 Ma (Jóhannesson & Sæmundsson, 1998).

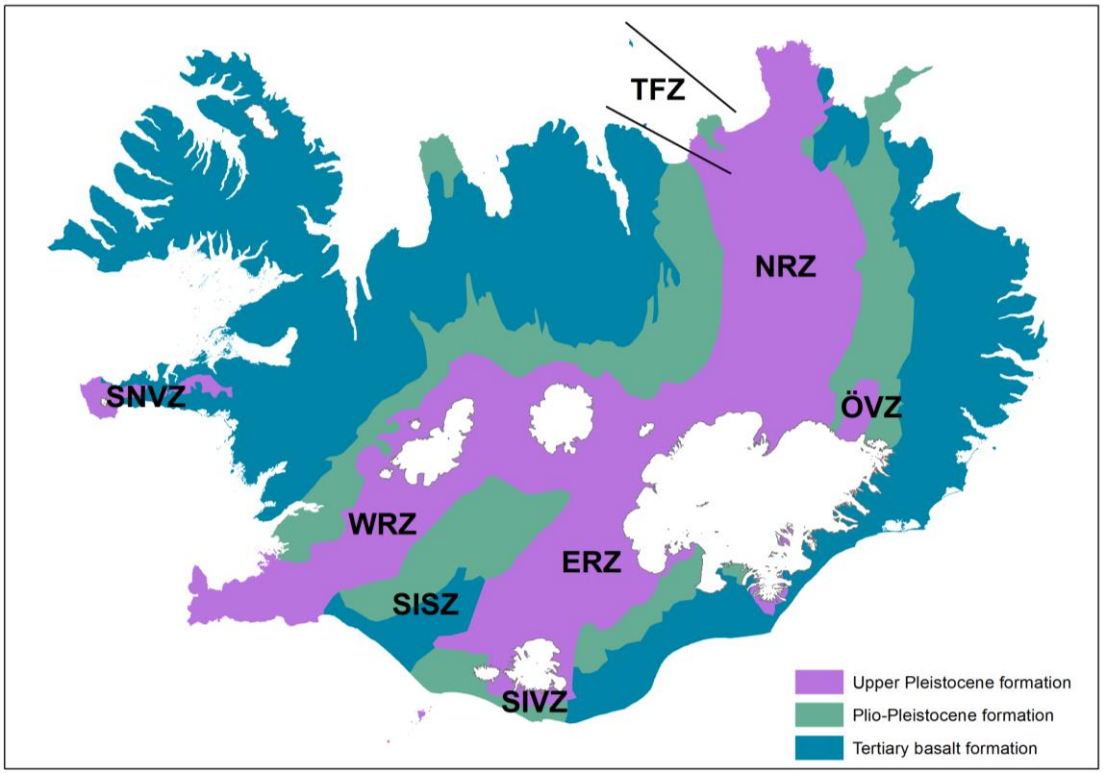


***Figure 2:*** *The neovolcanic zones of Iceland. The rift zones are NRZ (Northern Rift Zone), WRZ (Western Rift Zone) and ERZ (Eastern Rift Zone). The volcanic zones are SNVZ (Snæfellsnes Volcanic Zone), SIVZ (South Iceland Volcanic Zone) and ÖVZ (Öræfajökull Volcanic Zone). The transform fault zones are SISZ (South Iceland Seismic Zone) and TFZ (Tjörnes Fracture Zone). Based on Jóhannesson and Sæmundsson (1998)*

# 4 Methods

Data for the maps came from several places. The data base IS 50V, operated by Landmælingar Íslands was used for the Icelandic coastline and glaciers. Data from Náttúrfræðistofnun Íslands about the age of geological formations was also used. In addition, a data base involving published helium isotopes in Icelandic volcanics, glasses and phyric lavas, as well as geothermal fluids was constructed from 30 articles, which are shown in Table 1.

***Table 1:*** *Articles used to construct the data base*

| Article | Year | Geothermal Fluids[a] | Glasses[a] | Phenocrysts[a] | Breccia[a] |
|---|---|---|---|---|---|
| Kononov & Polak | 1975 | 46 | | | |
| Polak et al. | 1976 | 10 | | | |
| Hauksson & Goddard | 1981 | 4 | | | |
| Torgersen & Jenkins | 1982 | 8 | | | |
| Condomines et al. | 1983 | | 20 | | |
| Kurz et al. | 1985 | | 19 | 2 | 1 |
| Sano et al. | 1985 | 11 | | | |
| Poreda et al. | 1986 | | 3 | 4 | |
| Hilton et al. | 1990 | 64 | | | |
| Marty et al. | 1991 | 18 | | | |
| Poreda et al. | 1992 | 52 | | | |
| Burnard et al. | 1994 | | 6 | 2 | |
| Hilton et al. | 1998 | 34 | | | |
| Harrison et al. | 1999 | | 2 | | |
| Hilton et al. | 1999 | | | 6 | |
| Breddam et al. | 2000 | | 21 | 8 | |
| Dixon et al. | 2000 | | 10 | 10 | |
| Trieloff et al. | 2000 | | 2 | | |
| Moreira et al. | 2001 | | 7 | | |
| Dixon | 2003 | | | 8 | |
| Ellam & Stuart | 2004 | | | 5 | |
| Burnard & Harrison | 2005 | | 10 | | |
| Macpherson et al. | 2005 | | 12 | 13 | |
| Licciardi et al. | 2006 | | | 22 | |
| Brandon et al. | 2007 | | 4 | 14 | |
| Licciardi et al. | 2007 | | | 42 | |
| Debaille et al. | 2009 | | | 5 | |
| Füri et al. | 2010 | 71 | 78 | 21 | |
| Peate et al. | 2010 | | | 16 | |
| Halldórsson et al. | 2016 | | 16 | | |

[a]: values indicate the numbers of He isotopes data extracted from each reference.

Excel was used to construct the data base, which included 12 columns with different attributes. These attributes were: sample name, phase, area, location, longitude, latitude, $R_M/R_A$, X-factor, $R_C/R_A$, concentration of helium, the reference and since not all values had reported values for X-factor and $R_C/R_A$ 1 more column was added that contained the $R/R_A$ value used for analysis in ArcGIS. $R_C/R_A$ was used where it was reported, otherwise $R_M/R_A$ was used. The data base included a total of 707 samples, 318 geothermal fluids, 211 glasses, 177 phenocrysts and 1 breccia (see Appendix).

The constructed data base was made uniform. First coordinates were found for every sample in the data base. To find coordinates the map at ja.is was used along with articles including coordinates of samples taken in same places. Kononov & Polak (1975) presented their results on a map, since no locations were reported ArcGIS was used to calculate the coordinates of the samples. The map from Kononov & Polak (1975) was georeferenced in ArcGIS and a new point layer was drawn on top of the sample sites presented in the study. The coordinates of the new point layer were calculated by using the method Calculate Geometry. Coordinates for all the samples in the data base were calculated to the form decimal degrees.

## 4.1 Evaluation of the data base and filtering criterion

### 4.1.1 Air contamination

To recognize air contamination the X-factor is used. To calculate the X-factor the $^4He/^{20}Ne$ ratio is measured. It is assumed that all of the neon is of atmospheric derivation. The ratio of $^4He/^{20}Ne$ in laboratory air is used for calculations.

$$X = \frac{(\,^4He/^{20}Ne)_{measured}}{(\,^4He/^{20}Ne)_{air}}$$

This correction is valid for mantle and crust samples since the $^4He/^{20}Ne$ ratio of the mantle and the crust is many orders of magnitude greater than that of air. For fluid samples different solubility's of helium and neon in water have to be considered. The Bunsen solubility coefficients for neon ($\beta_{Ne}$) and helium ($\beta_{He}$) are used to account for this, at the temperature and salinity of the water when the atmospheric helium was dissolved.

$$X = \frac{(\,^4He/^{20}Ne)_{measured}}{(\,^4He/^{20}Ne)_{air}} * \frac{\beta_{Ne}}{\beta_{He}}$$

The corrected $^3He/^4He$ ratio ($R_C/R_A$) can be calculated when the X-factor is known.

$$R_C/R_A = \frac{(R_M/R_A * X) - 1}{X - 1}$$

The higher the X-factor the less difference between $R_M/R_A$ and $R_C/R_A$. The X-factor can also be used to calculate the corrected helium concentration ($[He]_C$), that is related to the measured helium concentration ($[He]_M$) in the following way (Hilton, 1996).

$$[He]_c = [He]_M \frac{X-1}{X}$$

It was determined that all samples which had X-factor ≤ 5 were too contaminated considering air-derived helium. Figure 3 shows that for higher X-factor the variability in $R_M/R_A$ increases. Where the X-factor is smaller than 5 almost all samples have $R_M/R_A$ between 1 and 5 $R_A$. This indicates that samples with X-factor smaller than 5 have been contaminated by air-derived helium. The X-factor was only reported for 247 samples, which is approximately one third of the data base. The 247 samples included 224 geothermal fluids, 20 glasses and only 3 phenocrysts.

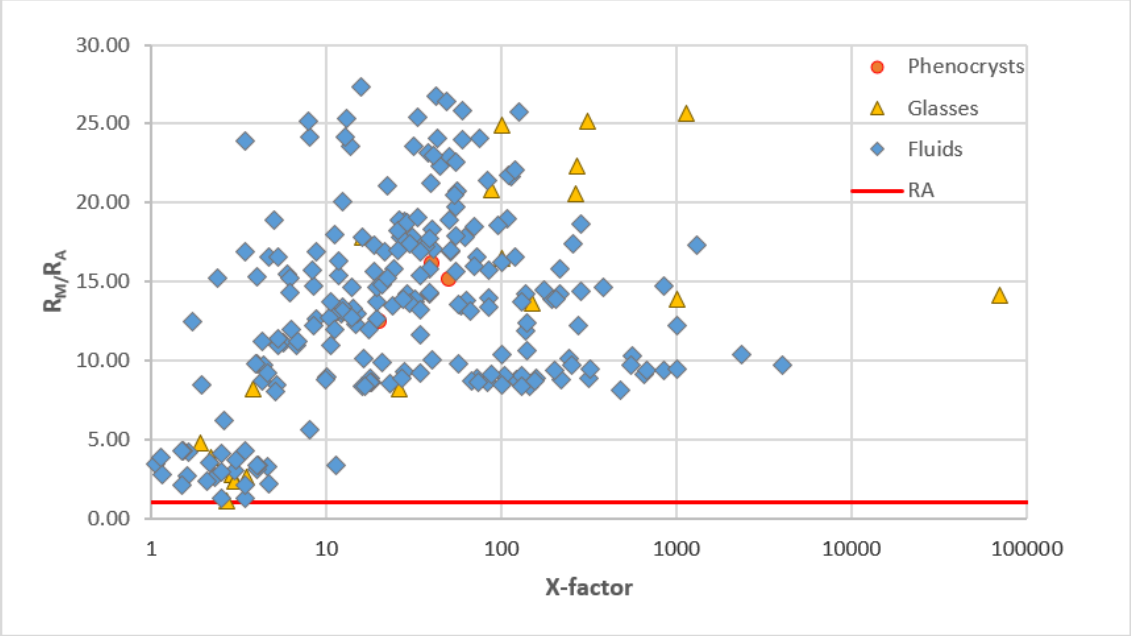


***Figure 3:*** *Helium isotope ratios plotted against the X-factor for geothermal fluids, glasses and phenocrysts*

### 4.1.2 Helium concentration

As the X-factor was not reported for all the samples, other methods had to be applied for evaluation. The helium concentration is a factor that can be used to observe air-contamination. Concentration of helium in air and water is low compared to concentrations frequently observed in samples. Since crustal or primordial helium are added components, the higher the helium concentration, the less significant air contamination (Torgersen & Jenkins, 1982). Helium concentrations were plotted against the measured helium isotope ratio, both for glasses (Figure 4) and phenocrysts (Figure 5) to investigate if the helium concentration affected the $R_M/R_A$. Figure 4 shows more variability in the $^3He/^4He$ ratio for higher helium concentration. However $^3He/^4He$ ratios close to $R_A$ are observed for both low and high helium concentrations. For phenocryst (Figure 5) variability in the $^3He/^4He$ ratio is observed for all concentrations. Due to the great variability in $R_M/R_A$, for both low and high concentrations, the data was not filtered considering helium concentrations.

Samples from Burnard et al. (1994) were not included in Figure 4 and Figure 5 since there might be an error in how the concentrations are reported. Concentrations are reported in

$cm^3STP/g \times 10^{-13}$, which is three orders of magnitude lower than the lowest samples shown in Figure 4 and Figure 5. It is also noted that the detection limit used for helium concentrations in Burnard et al. (1994) is $2\times10^{-11}$ $cm^3STP/g$, which is higher than the reported concentrations.

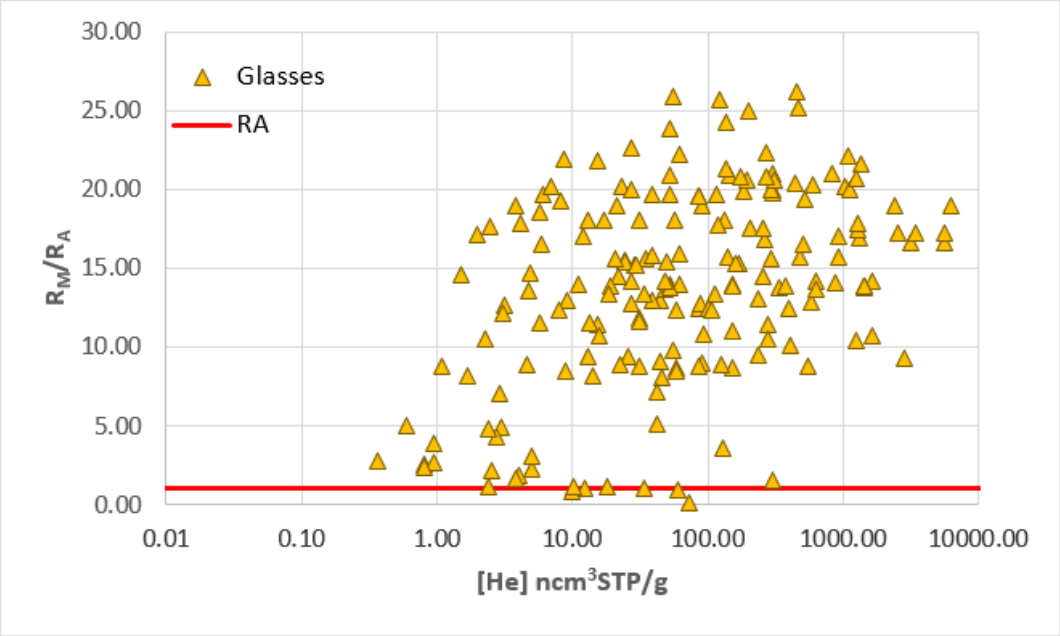


***Figure 4:*** *Helium isotope ratios plotted against helium concentrations for volcanic glasses*

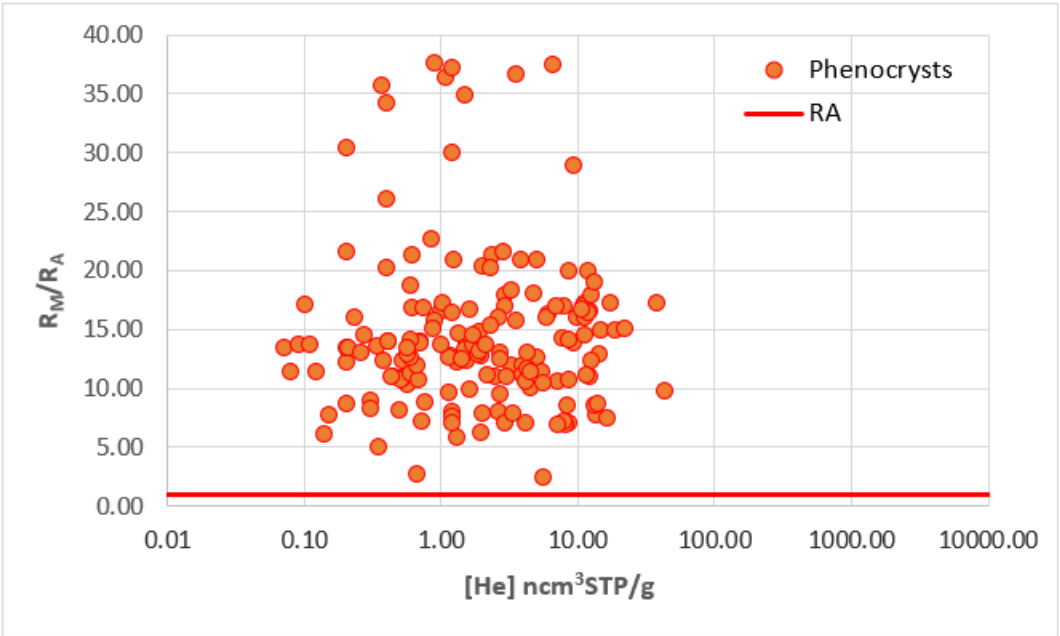


***Figure 5:*** *Helium isotope ratios plotted against helium concentrations for phenocrysts*

### 4.1.3 Duplicate samples

For duplicate samples, the sample with the higher helium isotope ratio was used. For example, the sample SK82-13 from Þríhyrningur was measured by Moreira et al. (2001) to

have a ratio of 25.6 $R_A$ and Kurz et al. (1985) to have a ratio of 26.2 $R_A$. The ratio from Kurz et al. (1985) was included in the final data base.

### 4.1.4 Samples from the same general region yielding different results

Samples that are significantly lower than other samples in the same general region were also filtered from the data base. For example, at Kverkfjöll $^3He/^4He$ ratios of 8-9 $R_A$ are observed. Füri et al. (2010) measured a ratio of 2.27 $R_A$ and Macpherson et al. (2005) measured a ratio of 1.6 $R_A$ at Kverkfjöll, which were not included in the final data base.

### 4.1.5 Other problems

The location of a few samples was not known with certainty, these samples were not included in the final data base. Following this procol, the data base decreased to a total of 605 samples, 273 geothermal fluids, 163 glasses, 168 phenocrysts and 1 breccia.

## 4.2 Methods in ArcGIS

To investigate the distribution of the samples, maps that show the helium isotope ratio ($R/R_A$) of each sample as a point were made. The data was classified into 8 breaks. Manual breaks were used since the aim was to show how the helium isotope ratio changes with location. Maps were made for each phase and for the combined data, both filtered and unfiltered.

The filtered data was used for interpolation. Interpolation is a method or a mathematical function that estimates the values of cells at locations that lack sampled points. Interpolation is based on spatial dependence, which measures degree of dependence between objects. The two types of interpolation techniques are deterministic and geostatistical. Deterministic techniques create surfaces based on measured points or mathematical formulas. Geostatical techniques are based on statistics and are used for more advanced surface modeling. The Spatial Analyst extension was used to make the interpolation maps. The Spatial Analyst extension provides tools for spatial data analysis that apply statistical theory and techniques to the modeling of spatially referenced data (Childs, 2004).

Many interpolation methods were executed, those were Spline, Spline with Barriers, Natural Neighbor, IDW, Kriging and Trend. Different methods showed similar results in most cases, except Spline and Trend that showed a very different results from the other methods. It was decided to use the Natural Neighbor method, since it showed good results and it is a relatively simple method.

The Natural Neighbor method can be used for both interpolation and extrapolation. It generally works well with clustered scatter points and the method can efficiently handle large input point data sets. The method is based on a weighted average. Each cell value is determined by using a linear-weighted combination set of sample points. The weight assigned is a function of the distance of an input point from the output cell location. The greater the distance, the less influence the point has on the output value (Childs, 2004).

Interpolation methods do not show values outside the extremities of the data set. So interpolation could be executed for all the country, data outside of Iceland had to be added to the data set. Data points were added around Iceland so interpolation could be done for the whole country. All samples outside of Iceland were given the ratio 5 for $R/R_A$. These points were located far from the Icelandic coastline so results would only be affected in areas were no sampling had occurred.

Contours were made from the interpolation raster. Contours are used to define a common characteristic along a line. They join locations of equal value to each other (Childs, 2004). The method Contour List was used, since values that contours are drawn for can be chosen with this method. Contours were drawn for the same ratios that were used to make breaks on the distribution maps (7, 9, 12, 14, 17, 20 and 24 $R_A$). Contour was also drawn for 30 $R_A$ so the highest ratios would be seen on the map.

# 5 Results

## 5.1 Geothermal fluids

The distribution of samples for each phase was examined, each phase has its own unique distribution. The geothermal samples (Figure 6) are distributed over most of the country, the distribution is restricted to geothermal areas, both high- and low-temperature areas. Plenty of sampling has been carried out in Vestfirðir. The $^{3}He/^{4}He$ ratios in Vestfirðir are diverse, showing both low and high ratios. A cluster of samples is located in low-temperature areas in Southern Iceland, where the SISZ and the WRZ merge. This cluster shows high $^{3}He/^{4}He$ ratios, which decreases to the West throughout the Reykjanes peninsula. Along the Snæfellsnes peninsula $^{3}He/^{4}He$ ratios seem to increase from the West of Snæfellsnes to the East, with the highest $^{3}He/^{4}He$ ratio measured at Rauðamelsölkelda. In Borgarfjörður moderately high $^{3}He/^{4}He$ ratios are measured. Along the NRZ low ratios are measured, the helium isotope ratio seems to increase to the West in northern Iceland and at Borðeyri moderately high $^{3}He/^{4}He$ ratio is measured. In eastern Iceland sampling has been done at Þveit, Vopnafjörður and Lagarfljót, in all cases low ratios are obtained. In central Iceland high ratios are observed at Köldukvíslarbotnar and Vonarskarð, close to Vatnajökull. Lower ratios are observed in the western part of central Iceland at Hveravellir and Kerlingarfjöll.

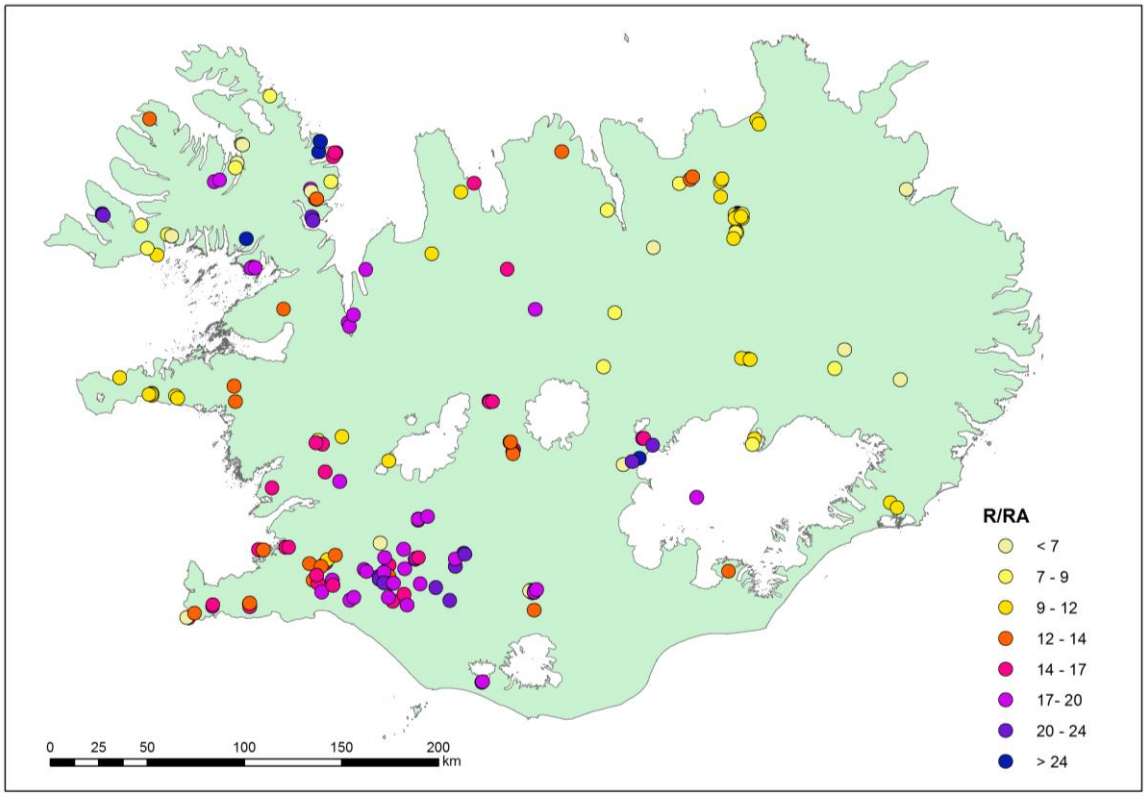


***Figure 6:*** *Helium isotope ratios for geothermal fluids*

The samples located at the high-temperature area Grímsvötn under the Vatnjökull ice cap were sampled during a jökulhlaup by Hilton et al. (1990). Grímsvötn is drained periodically by a jökulhlaup to the river Skeiðará at the southern ice margin. Two samples were taken at the point of emergence of the river from the glacier during a jökulhlaup. One sample was contaminated but the other one had a reasonably high X-factor and could be used for further analysis. The sample is used to represent the $^{3}He/^{4}He$ ratio of the Grímsvötn high-temperature area and is located over the geothermal field at Vatnajökull.

## 5.2 Subglacial lavas

The distribution of glass samples (Figure 7) is confined by the rift and volcanic zones. Most of the samples are located within the rift zones and a few samples are located in the volcanic zones. One sample is located outside of these zones that is an obsidian sample from Þingmúli central volcano in Eastern Iceland. The sample was measured by Condimines et al. (1983) and shows a low $^{3}He/^{4}He$ ratio, most likely due to air contamination. The glass samples cover most of the rift zones, which each show a distinctive helium isotope ratio. Low ratios are measured in the NRZ, with the exception of higher ratios from Dyngjufjöll Ytri (Breddan et al., 2000; Füri et al. 2010). In the WRZ moderate ratios are observed. In central Iceland high ratios are observed from northwestern Vatnajökull to Arnarbæli between Langjökull and Hofsjökull. In Southern Iceland along the ERZ the samples show bimodal distribution considering the helium isotope ratio. Most of the samples show either high ratios or very low ratios. In Snæfellsnes, at Öræfajökull and Grímsvötn low ratios are measured. These samples along with other low ratio ($\leq 7$ $R_A$) samples are most likely contaminated by air-derived helium.

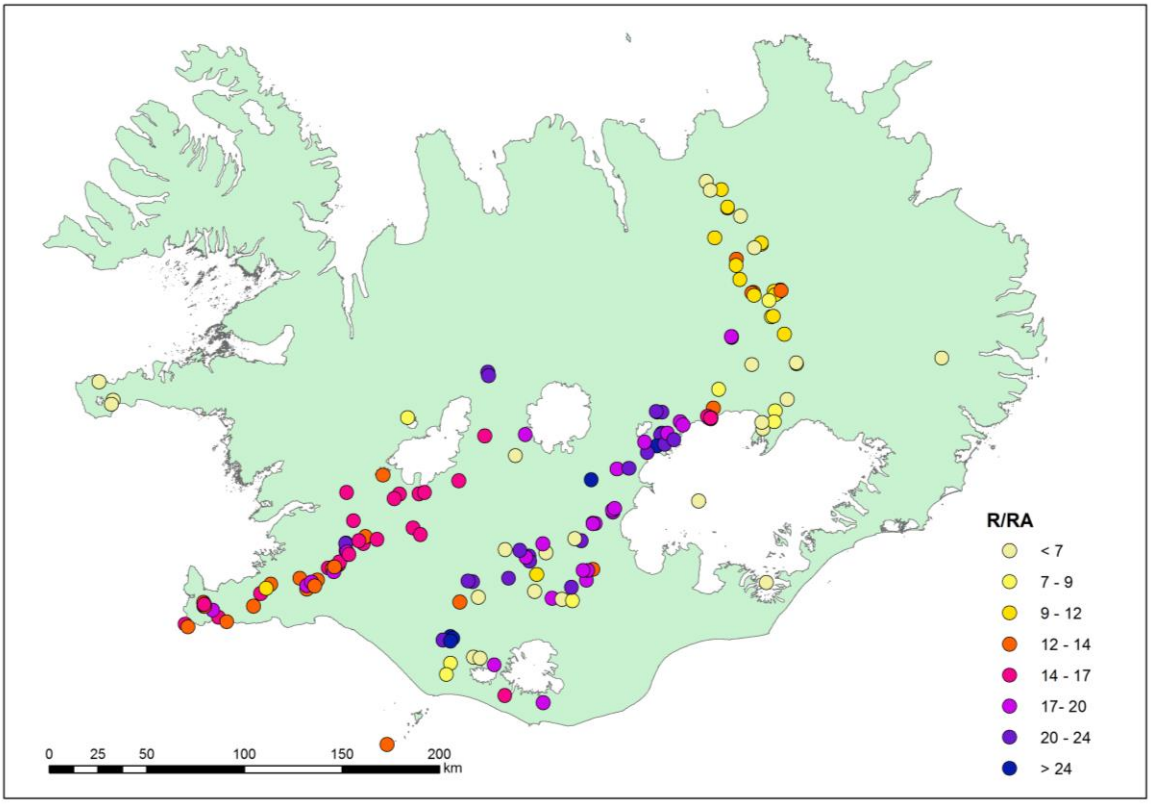


***Figure 7:*** *Helium isotope ratios for volcanic glasses*

## 5.3 Phyric lavas

Olivine and few clinopyroxene phenocrysts from phyric lavas have been used to measure the helium isotope ratio. Phenocryst samples (Figure 8) have been sampled in rather restricted areas over the country. Most of the sampling has been carried out in the NRZ and the WRZ. The phenocrysts in the NRZ show, like geothermal fluids and glasses, low ratios, with few exceptions. Samples around Melrakkaslétta measured by Liccardi et al. (2007) show higher ratios than the surrounding samples. Macpherson et al. (2005) also measured high values at Fjallsendi and at Vaðalda. In the WRZ moderate ratios, similar to ratios from glasses and geothermal fluids, are observed. Sampling has been carried out along Snæfellsnes all the way to Bjarnardalsá. The $^{3}He/^{4}He$ ratio seems to be constant throughout the Snæfellsnes peninsula, but a higher ratio is measured at Bjarnardalsá. Samples in Vestfirðir show the highest ratios measured for phenocrysts, except one sample that shows a very low ratio. The phenocryst samples in Vestfirðir are different from the geothermal fluids in Vestfirðir that showed a big variability in the helium isotope ratio. In Vopnafjörður one sample with moderate $^{3}He/^{4}He$ ratio was measured by Ellam and Stuart (2004). Peate et al. (2010) sampled phenocrysts in the ÖVZ, these samples show ratios in the MORB range. Finally some sampling took place in Southern Iceland, both around Mýrdals- and Eyjafjallajökull, in Þjórsárdalur and in Vestmannaeyjar and Surtsey. High ratios were measured in Southern Iceland, with lower ratios measured in Vestmannaeyjar and Surtsey.

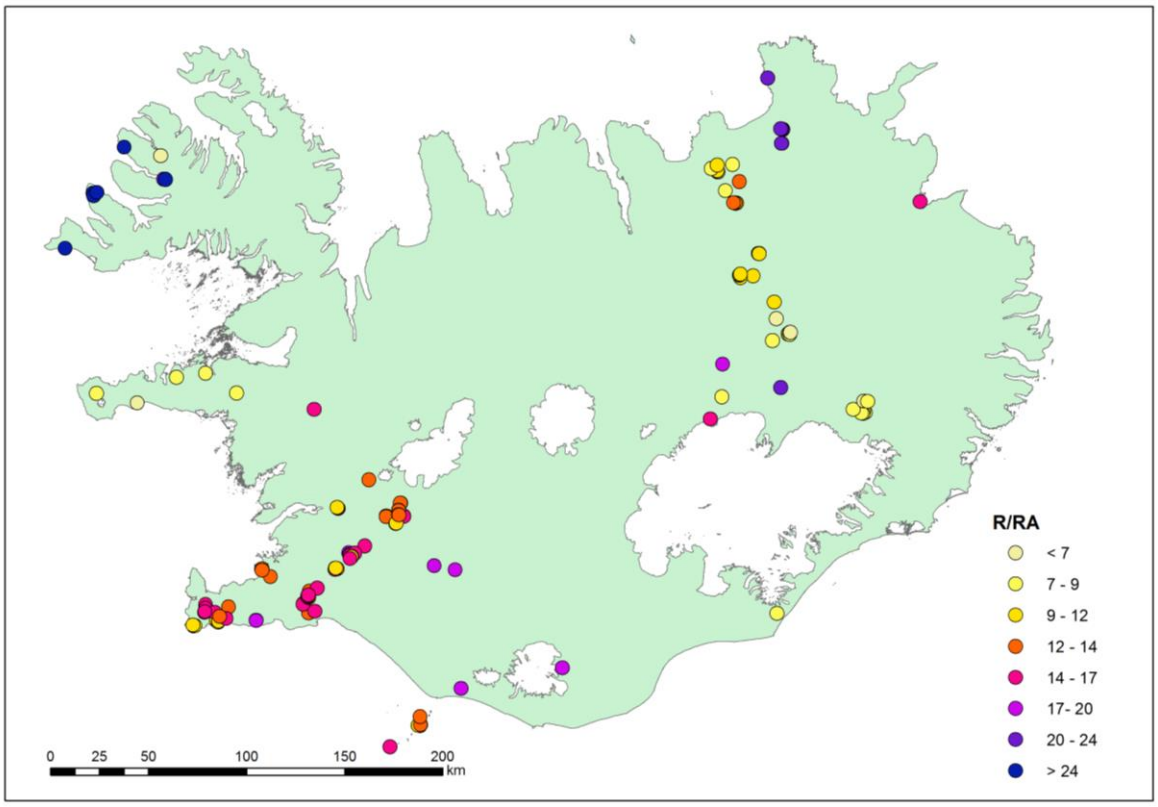


***Figure 8:*** *Helium isotope ratios for phenocrysts*

## 5.4 Combined data

Figure 9 shows the combined data. The combination of the data strengthens the distribution of the samples, since different phases have been sampled in different localities. The data density is strongest along the rift zones and through the SISZ. It is fairly strong at the SNVZ, SIVZ and in Vestfirðir. The ÖVZ is mostly covered by Vatnajökull, sampling has been conducted in areas outside of Vatnajökull, but no sampling has been carried out on the glacier itself. This results in poor data density along the ÖVZ. The poorest data density is observed in eastern Iceland. Only few samples have been taken to the east of the NRZ and most of these samples are located at Snæfell in the ÖVZ. The data density is also poor in northern Iceland, with only few samples taken outside of the NRZ. In western Iceland the data density is moderately good. No data is available in the area close to the shore between Mýrdalsjökull and Vatnajökull, since no sampling has been conducted in that area.

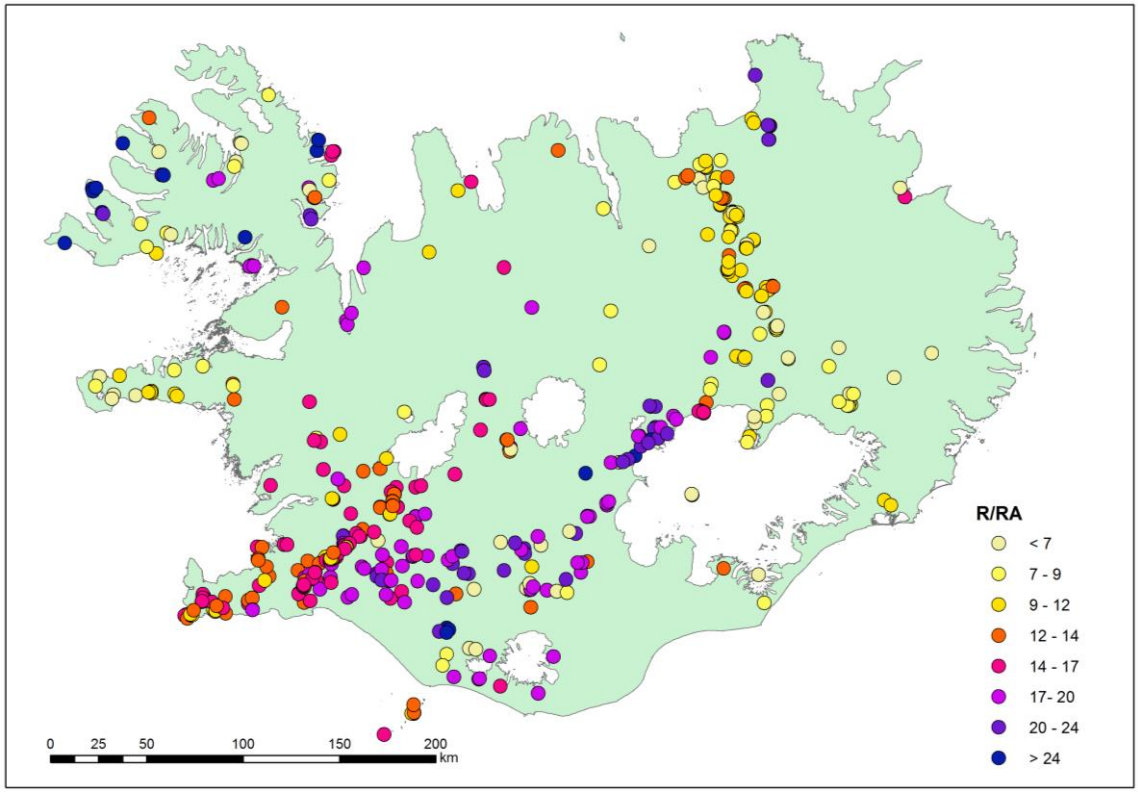


***Figure 9:*** *Helium isotope ratios for the combined data*

## 5.5 Filtered data

The data was filtered considering: (1) the X-factor, were it was reported, (2) outliers, both compared to other samples from the same general region and from duplicate measurements and (3) certainty of the location. The filtered data shows clearly the variability in the helium isotope ratio ($R/R_A$) between different neovolcanic zones (Figure 10). This variability is most obvious in the rift zones. Low ratios in the NRZ, moderate ratios in the WRZ and high ratios in the ERZ, which continue through the SISZ.

The most notable changes in the data after filtering are observed in southern Iceland and at Vestfirðir. In southern Iceland the distribution is no longer bimodal and low ratios have completely disappeared during filtering. In Vestfirðir many low ratio samples have also disappeared due to low X-factor or outliers. Notable changes are observed along the NRZ, in eastern Iceland and along the SNVZ, where low ratio samples have also decreased.

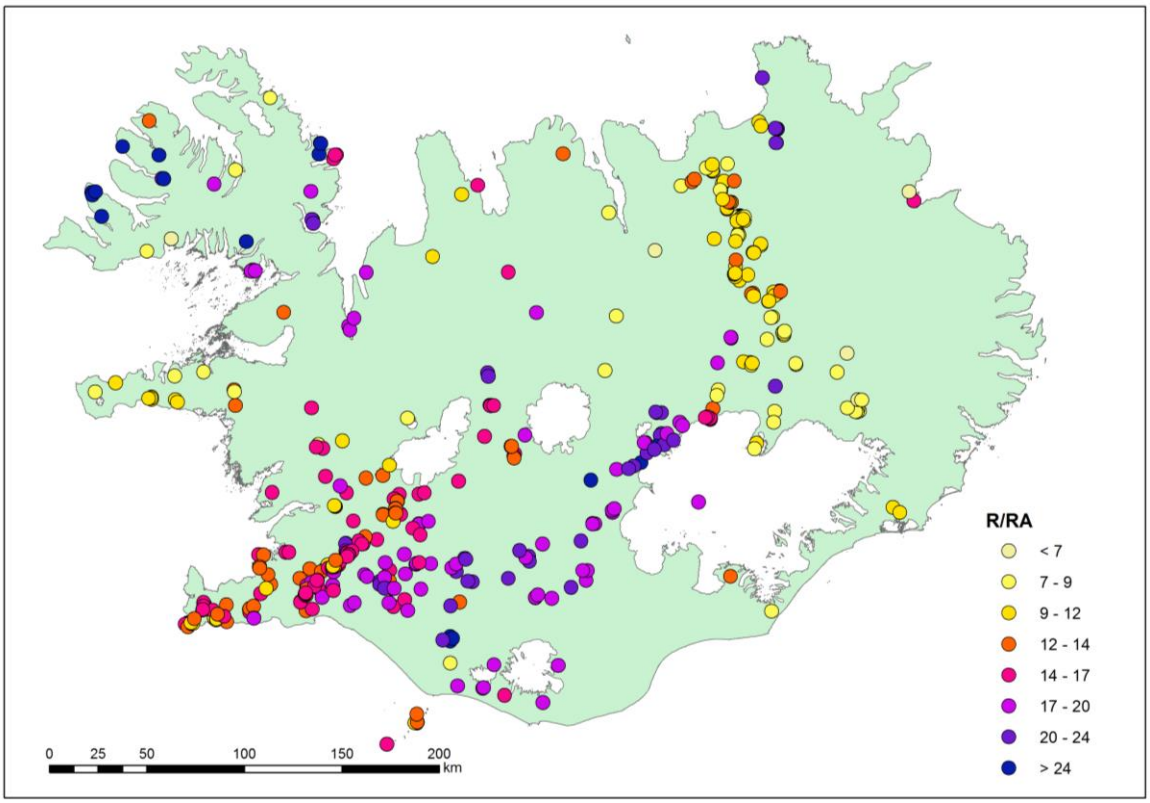


***Figure 10:*** *Helium isotope ratios for the filtered data*

## 5.6 Interpolation

The filtered data set was interpolated with the Natural Neighbor method (Figure 11) to estimate the helium isotope ratio where no measurements are available. The dashed lines (Figure 11) define areas were no sampling has occurred, results in these areas should be discounted, since there could be changes in the results if more data was gathered in these areas.

The interpolation shows high isotope ratios in Central Iceland, down the ERZ and through the SISZ. High ratios are also observed at Melrakkaslétta. In Vestfirðir both high and low ratios are observed. Low ratios are observed in Eastern Iceland, at Snæfellsnes and along the NRZ. Moderate ratios occur along the WRZ, in western Iceland and in the northwestern part of Iceland.

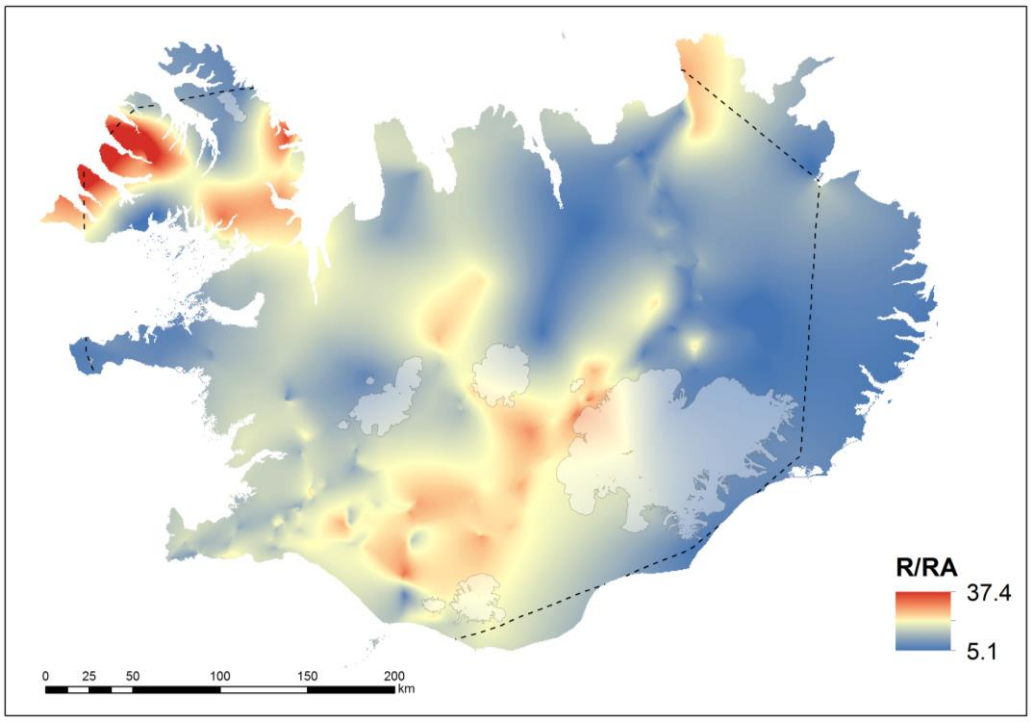


***Figure 11:*** *Representative helium isotope ratios calculated with the Natural Neighbor method, areas where no sampling has occurred are shown with the dashed line*

Contours were made to connect places with the same helium isotope ratio (Figure 12). The contours show where the same helium isotope ratios are expected. Contours are made from the same filtered data base as Figure 9. Contours were made for 8 different values, 7, 9, 12, 14, 17, 20, 24 and 30 $R_A$.

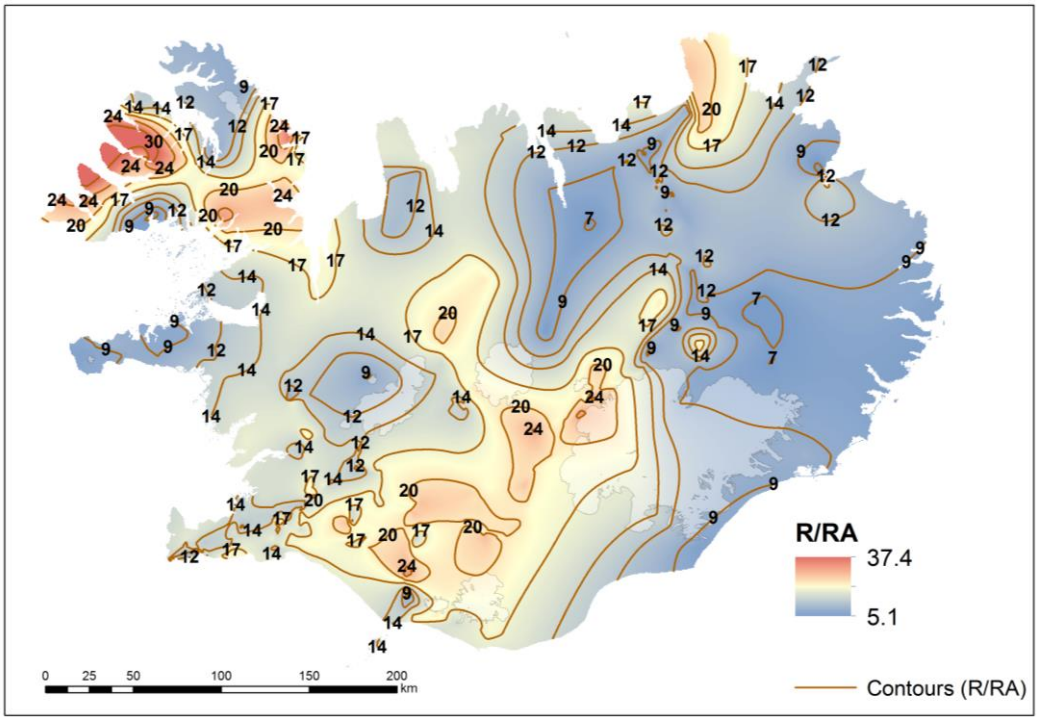


***Figure 12:*** *Contours that connect the same helium isotope ratios*

# 6 Discussion

## 6.1 Regional variability

The data set used in this study shows that the helium isotope ratios ($R/R_A$) in the whole of Iceland vary between 5.1 and 37.7 $R_A$ and that there is a regional variability in the helium isotope ratio. Below, I will systematically consider the isotope signature for different areas in Iceland, the rift zones, the SISZ, Vestfirðir and the volcanic flank zones.

### 6.1.1 The active rift zones and the SISZ

Histograms, based on the filtered data, for the rift zones and the SISZ (Figure 13) show a distinctive isotope signature for each zone.

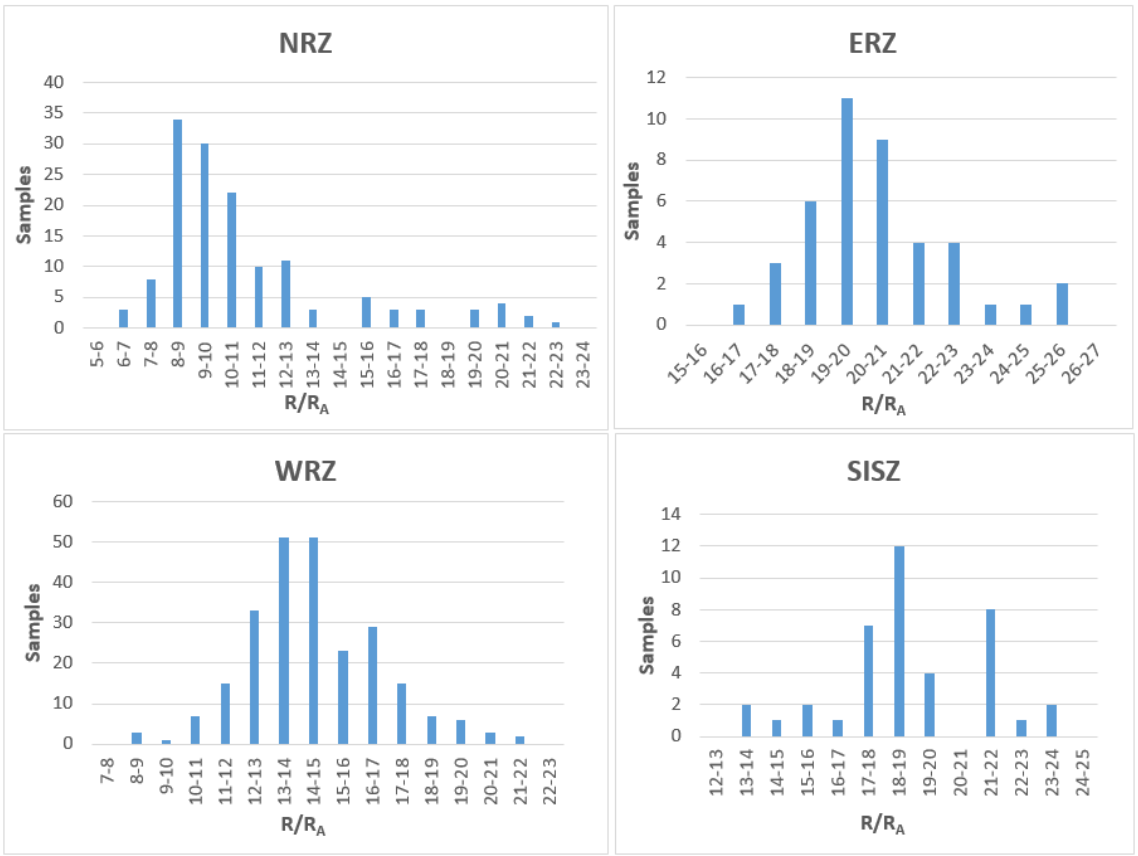


***Figure 13:*** *Histograms showing the helium isotope ratios along different rift zones and the SISZ*

The histograms show that the NRZ has a range from 7-23 $R_A$, which can be broken into three smaller ranges. The first one is 6-14 $R_A$, this range includes the majority of the samples. Distinctive values are from 8 up to 11 $R_A$. The other two ranges include fewer samples and show higher values, 15-18 $R_A$ and 19-23 $R_A$. Liccardi et al. (2007) measured

high $^{3}He/^{4}He$ ratios (20.2-22.7 $R_A$) in the northernmost part of the NRZ at Hafrafell, Sandfell and Snarstaðarnúpur. Values between 15 and 18 $R_A$ are measured at Fjallsendi, Kistufell and Dyngjufjöll Ytri (Breddam et al., 2000; Macpherson et al., 2005; Füri et al., 2010), all localities that are close to the mantle plume. The highest ratios of 34.3 $R_A$ and 30.5 $R_A$ measured in olivines and a value of 20.2 $R_A$ measured in clinopyroxene at Vaðalda by Macpherson et al. (2005) are not shown in the histogram.

The ERZ shows higher ratios than the NRZ and has a range from 14-26 $R_A$, where ratios of 18-21 $R_A$ characterize the area. The WRZ has a range from 9-22 $R_A$, where ratios from 12-17 $R_A$ characterize the area. These ratios are intermediate between the other two rift zones but significantly higher than MORB values. The SISZ, that connects the ERZ and the WRZ, has a range similar to the ERZ from 13 up to 24 $R_A$. Characteristic ratios are 18-19 $R_A$ and 21-22 $R_A$. The distinctive isotope signatures for each rift zone coincide with signatures reported in Kurz et al. (1985).

A high helium plateau (≥20 $R_A$) has been located over central Iceland (Condomines et al., 1983; Kurz et al., 1985, Breddam et al., 2000; Macpherson et al., 2005; Füri et al., 2010). The high ratios in central Iceland continue down the ERZ and through the SISZ (Figure 10). The elevated helium isotope ratios found in lavas along the ERZ may reflect melts generated from the mantle plume being transferred through the ERZ (Breddam et al., 2000) and possibly the SISZ. The high ratios continue to the west from Vatnajökull to near Langjökull. At Langjökull there is a major change in the strike of the rift zone. This change in strike is associated with a change in helium isotope ratios, which start to lower from Langjökull down the WRZ (Kurz et al., 1985).

### 6.1.2 Vestfirðir

Vestfirðir is characterized among the highest helium isotope ratios worldwide, and considerable variation in the isotope ratio occurs over relatively short (10-50 km) distances (Hilton et al., 1998). The isotope ratio in Vestfirðir varies between 6.2-37.7 $R_A$. The highest ratio reported for Iceland was measured in late Tertiary basalts from Selárdalur (37.7 $R_A$) (Hilton et al., 1999). The reasons for the high isotope ratios in Vestfirðir and the off-rift degassing are not clear. Hilton et al. (1990; 1998) suggested that mantle-derived melts that act as a carrier phase for $^{3}He$, are being intruded into the lithosphere under Vestfirðir. Hilton et al. (1998) also suggested that mantle-derived volatiles, trapped within the volcanic pile since eruption, are being released by hydrothermal fluids through chemical alteration and leaching. Poreda et al. (1992) suggested that deep fractures in the basalt have facilitated the transport of gases from the mantle into the crust or that these high ratios mark the plume center at ~9 Ma.

### 6.1.3 Volcanic flank zones

The off-rift volcanic zones, SNVZ and ÖVZ, are characterized by low helium isotope ratios. The ÖVZ shows MORB values. The SNVZ shows slightly higher ratios, ~9 $R_A$. The SIVZ which is a continuation of the ERZ (Jakobsson et al., 2008), shows higher ratios than the other volcanic flank zones but slightly lower ratios than the ERZ. The area has a wide range from 8 $R_A$ up to ratios as high as 26.2 $R_A$, measured at Þríhyrningur (Kurz et al., 1985; Halldórsson et al., 2016).

## 6.2 Consistency between geothermal fluids, volcanic glasses and phyric lavas

Helium isotope ratios were compared between volcanic glasses, phyric lavas and geothermal fluids. Areas were comparison is possible are the rift zones, NRZ, WRZ and ERZ, and two of the volcanic zones, SNVZ and SIVZ. Previous studies (Hilton et al., 1990; Barry et al., 2013) have shown that geothermal fluids in Iceland have a similar range in most cases in the helium isotope ratio as basalt samples. This suggest that various sample phases are capturing helium from the same mantle source and that there is a close relationship between helium released by hydrothermal activity and helium released by volcanism.

For the western NRZ (Figure 14) it is clearly seen that the $^{3}He/^{4}He$ ratio decreases to the north. The samples closest to Vatnajökull show considerably higher ratios than other samples along the western NRZ. Geothermal fluids show values from 6 to 12 $R_A$ throughout the zone. Phenocryst and glasses in the northern part of the zone are in most cases consistent with geothermal fluids, showing values up to 14 $R_A$. Close to Vatnajökull values up to 20 $R_A$ are observed in volcanic glasses and phenocrysts show values up to almost 18 $R_A$.

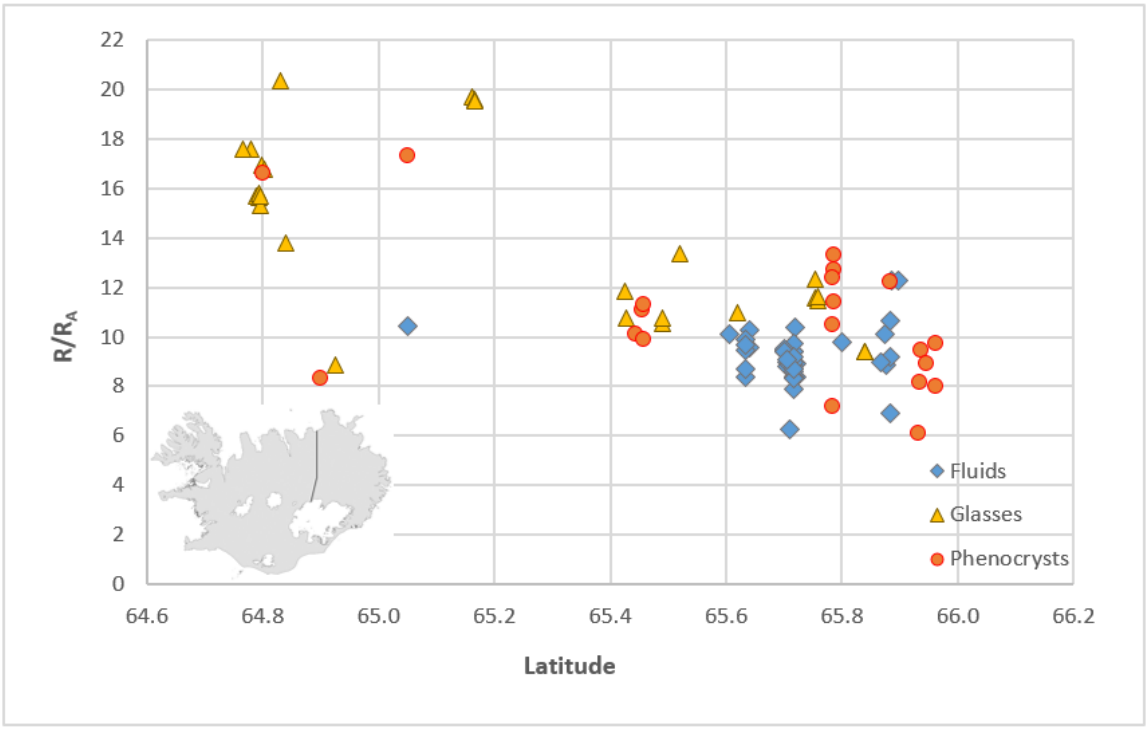


***Figure 14:*** *Helium isotope ratios in different sample phases along the western NRZ plotted against latitude*

The eastern NRZ (Figure 15) shows $^{3}He/^{4}He$ ratios between 7 and 13 $R_A$ for almost all the samples. Geothermal fluids show values from 8 to 10 $R_A$, but glasses and phenocrysts show values up to 13 $R_A$. There is a good consistency between various phases, with an exception for the northernmost samples where there is a discrepancy between phenocrysts

and geothermal fluids. The northernmost phenocrysts show ratios between 20 and 23 $R_A$, while fluids show values of 10 $R_A$.

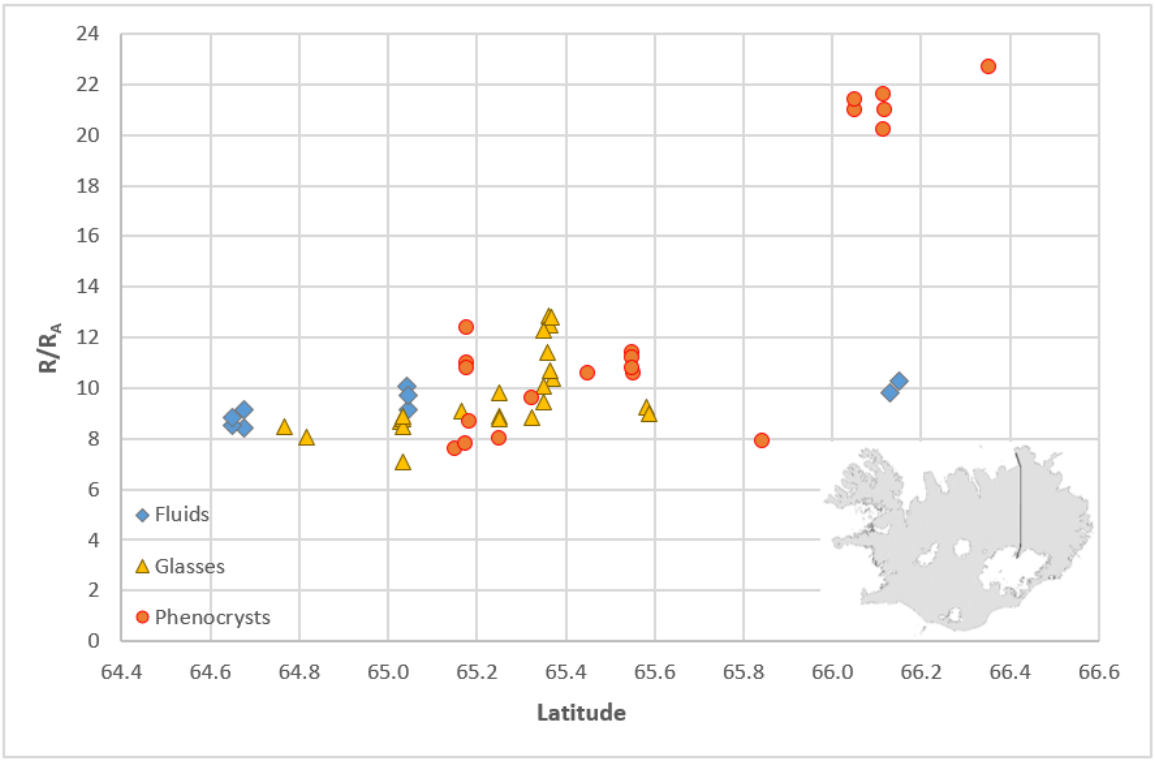


***Figure 15:*** *Helium isotope ratios in different sample phases along the eastern NRZ plotted against latitude*

Geothermal fluids correspond well to volcanic glasses and phenocrysts along the WRZ (Figure 16). An exception to that is seen in the easternmost part of the zone, where glass samples show higher values than geothermal fluids. Geothermal fluids from the SISZ are also plotted on Figure 16. Some of the fluids from the SISZ are consistent with geothermal fluids from the WRZ. However, the highest helium isotope ratios reported from the SISZ are considerably higher than ratios from the WRZ. It is also noted that the highest isotope ratios for geothermal fluids in the WRZ are measured at longitudes where the WRZ and SISZ merge.

Along the ERZ (Figure 17) there is an excellent consistency between volcanic glasses and geothermal fluids over a range of 16-26 $R_A$. The geothermal fluids from the SISZ also show a good consistency with samples from the ERZ, except for the lowest ratios measured from the SISZ. Along the SIVZ lower helium isotope ratios are observed, the samples cover a large range but various phases seem to overlap each other. Glass samples from Þríhyrningur show much higher ratios (~ 26 $R_A$) than other samples from the SIVZ and are therefore not consistent with other samples.

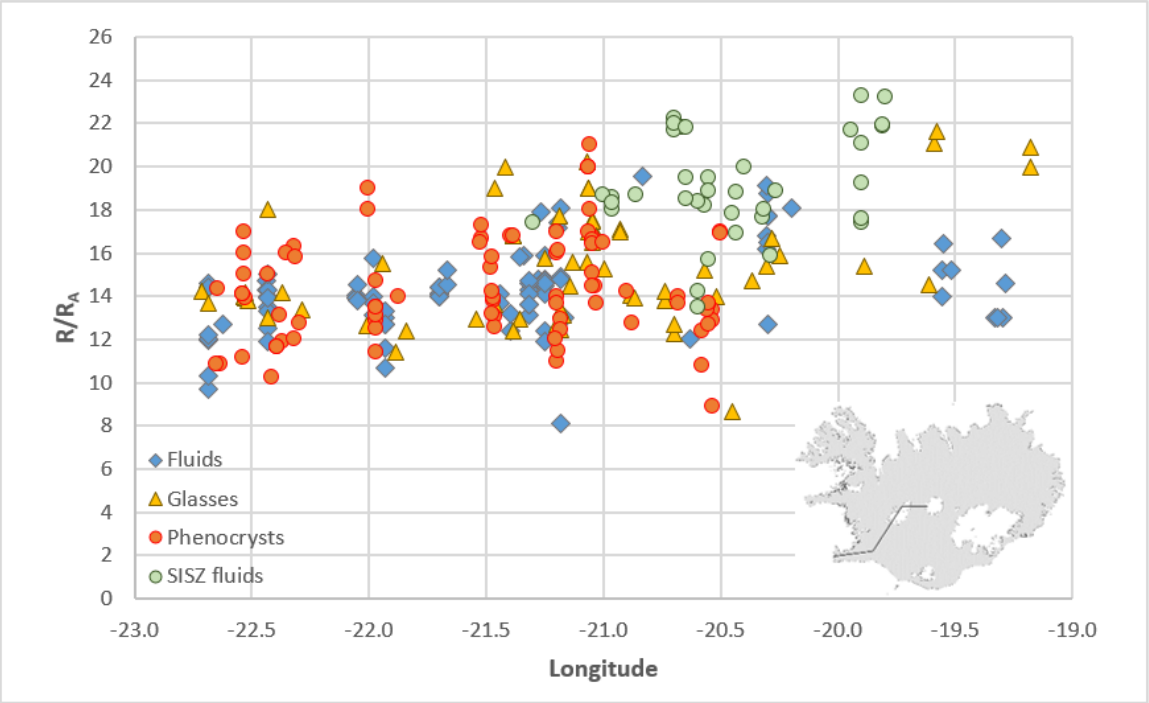


***Figure 16:*** *Helium isotope ratios in different sample phases along the WRZ and geothermal fluids from the SISZ plotted against longitude*

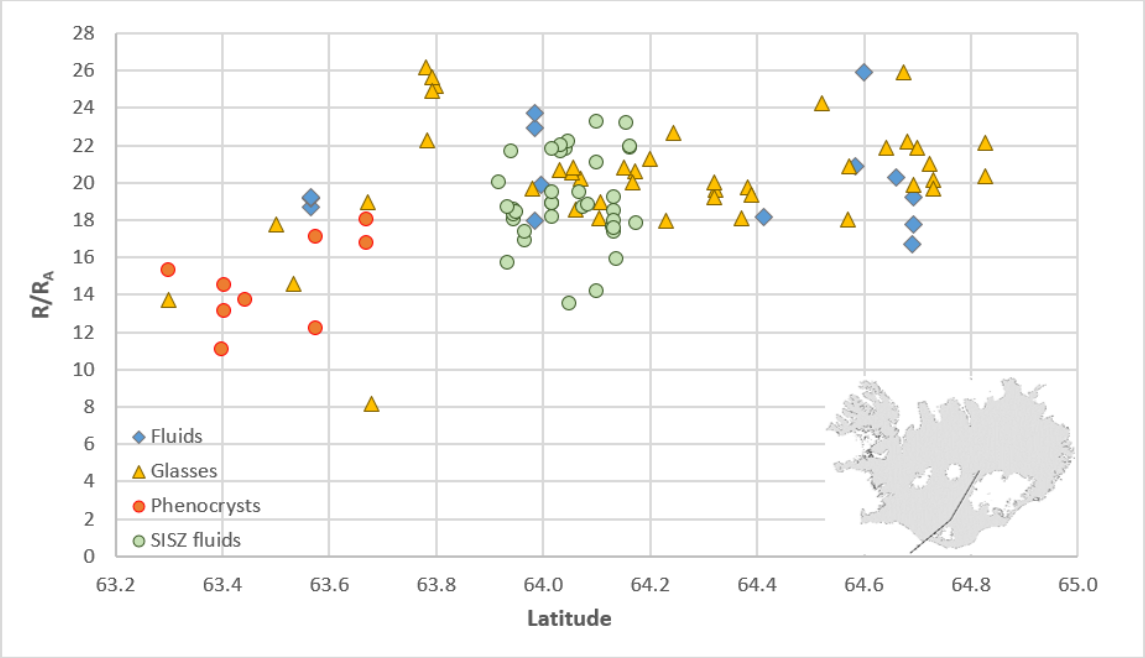


***Figure 17:*** *Helium isotope ratios in different sample phases along the ERZ and the SIVZ and geothermal fluids from the SISZ plotted against latitude*

Phenocrysts and geothermal fluids along the SNVZ (Figure 18) overlap each other. Helium isotope ratios seem to rise to the east for geothermal fluids, but they are consistent through the peninsula for phenocrysts. Therefore, there is a discrepancy between geothermal fluids and phenocrysts at the eastern part of the peninsula.

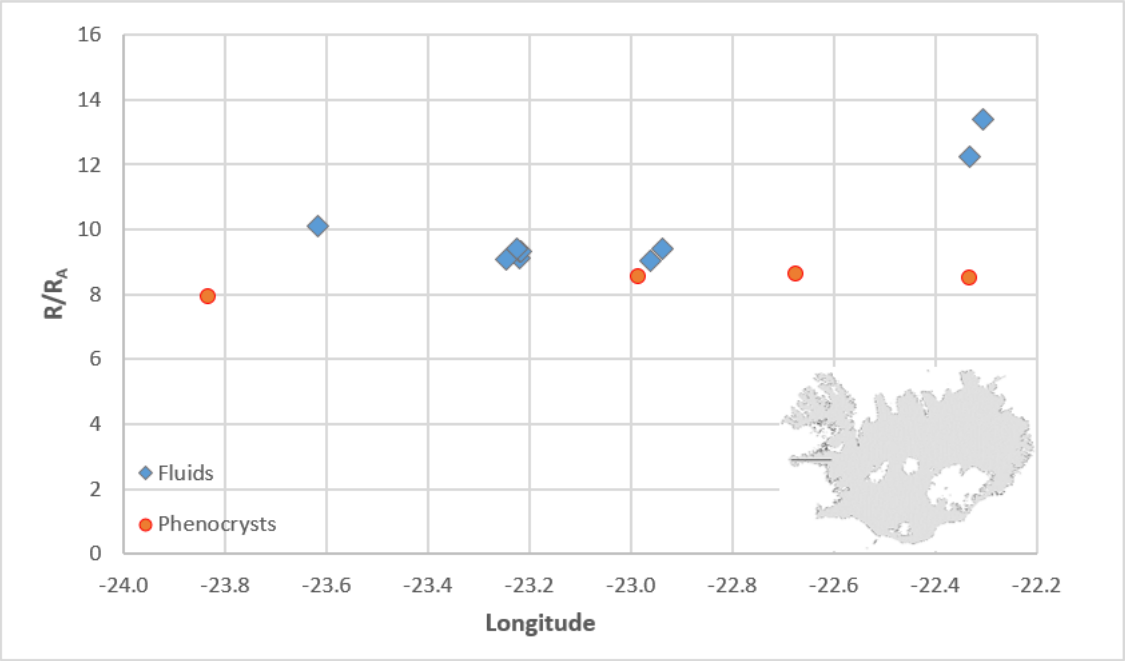


***Figure 18:*** *Helium isotope ratios in different sample phases along the SNVZ plotted against longitude*

Overall there seems to be a consistency between geothermal fluids, volcanic glasses and phenocrysts, with some exceptions at the NRZ and the SNVZ, where there is a discrepancy between phenocrysts and geothermal fluids. The overall good consistency indicates that helium is coming from the same mantle source for various phases (Barry et al., 2013).

## 6.3 Comparison with geophysical data

A number of geological properties are most anomalous in central Iceland, over northwest Vatnajökull. These properties include eruption rates, elevation, geoid, seismic velocity and gravity. It is assumed that the center of the mantle plume lies under this region. High helium isotope ratios that are observed in central Iceland are consistent with these properties (Kurz et al., 1985). The maximum seismic velocity (-4.2%) and gravity deviation (-55 mGal) occur over the northwestern part of Vatnajökull (Breddam et al., 2000). A low-velocity anomaly is located in the upper 400 km beneath central Iceland and has been described by many investigators (e.g. Tryggvason et al., 1983; Wolfe et al., 1997; Bijwaard & Spakman, 1999; Bjarnason, 2008). Seismic data shows a cylindrical zone, with a 150 km radius, of low P- and S-wave velocities, this zone extends from 100 km to at least 400 km depth below central Iceland. (Wolfe et al., 1997). The low-velocity anomaly may be rooted deeper, even in the lower mantle (Breddam et al., 2000). The Bouguer gravity anomaly (Figure 19) corresponds well with the high helium plateau in central Iceland. The gravity anomaly differs from the high helium plateau since it does not continue down the ERZ.

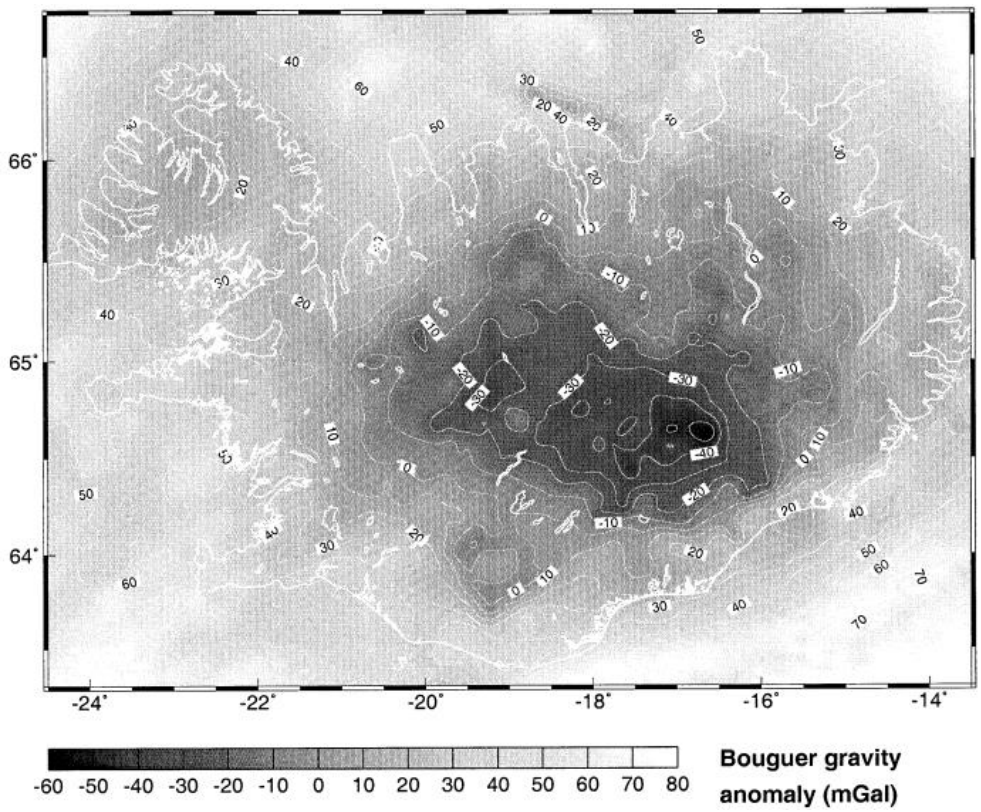


***Figure 19:*** *The Bouguer gravity anomaly over Iceland (Darbyshire et al., 2000)*

Seismic and gravity measurements have been used to provide a model of the crustal thickness in Iceland. The results of these studies have been interpreted in the way that the thickest crust (~40 km) lies above the center of the mantle plume. Thick crust (~35 km) is also found in Eastern Iceland. The crust thins away from the plume center in other areas and the thinnest crust (≤ 20 km) is located in the far southwest of Iceland and in the northern part of the NRZ (Darbyshire et al., 2000). This interpretation coincides with helium isotope ratios, but has been questioned by Bjarnason and Schmeling (2009) which estimated the average crustal thickness of Iceland to be 25-26 km, using shear waves. They argue that the thickest crust is under eastern Iceland (29-32 km) and Vestfirðir (29 km) and the thinnest part of the crust lies above the mantle plume and in the WRZ (19 km). This crustal thickness is supported by dynamic crust formation models that show a differential flow within the lower crust, that causes crustal material accreted in the central emplacement zone to move sideways with a higher velocity than the spreading velocity.

Bjarnason & Schmeling (2009) also estimated the thickness of the lithosphere to be thinnest below central Iceland and the NRZ (20 km). Under the WRZ and the western part of central Iceland the lithosphere is 30-35 km. The 40-km-deep seismic discontinuity under central Iceland measured by Darbyshire et al. (2000) can then be interpreted as the lithosphere-asthenosphere boundary or a reflector within the mantle asthenosphere. Guðfinnsson (2010) suggested that the 40-km-deep seismic discontinuity is a transition zone in the mantle where spinel peridotite transforms into plagioclase peridotite. The thickness of the lithosphere increases to 55-65 km under Vestfirðir and under eastern Iceland the thickest lithosphere is measured, which is minimum 100 km thick. The thick lithosphere under eastern Iceland is most likely due to an age unconformity that exist between the crust and the mantle under eastern Iceland (Bjarnason & Schmeling, 2009).

## 6.4 Implications for the Iceland plume structure

The high helium isotope ratios measured in Iceland imply that the source of the Icelandic mantle plume is an undegassed, deep mantle reservoir, whereas the MORB source is a degassed, upper mantle (Moreira et al., 2001). He-Ne systematics from the Icelandic neovolcanic zones suggest a binary mixing between two endmembers, one with a isotope signature similar to depleted MORB-mantle and the other with a more primordial isotope composition (Dixon, 2003; Füri et al., 2010). Local geophysical anomalies, both seismic velocity and gravity anomalies, coincide with the high helium plateau in central Iceland. This suggests that the lateral distribution of plume material is being outlined by helium isotope ratios and that the focus of the mantle upwelling is located in central Iceland (Breddam et al., 2000).

The high helium isotope ratios reported from Vestfirðir and the thick crust beneath the area can also be used to make interpretations about the mantle plume. One explanation for the thick crust under Vestfirðir is that the center of the mantle plume was once located at Vestfirðir. GPS measurements do not support this explanation and suggest that the center of the mantle plume was previously located in Dalasýsla and before that in Breiðafjörður, south to Vestfirðir and the Greenland-Iceland ridge (Bjarnason, 2013). However, the Greenland-Iceland ridge is not well constrained considering plate spreading models and the fixed Pacific hot spot frame (Bjarnason, 2008). The high helium isotope ratios in Vestfirðir support that the center of the mantle plume was once located at Vestfirðir, since OIB values for the $^{3}He/^{4}He$ ratio indicate that the mantle source is an undegassed lower mantle. The low isotope ratios observed at Snæfellsnes also support this theory. The isotope ratio at Snæfellsnes is characterized by MORB values, which indicate that the mantle source at Snæfellsnes is a degassed, upper mantle.

# 7 Conclusions

A data base for helium isotopes, that included 707 samples, was compiled for this study. Filtering of the data showed that many samples were not suitable for analysis, due to contamination or lack of information about locality of the sample. A total of 102 samples were filtered from the data base, before spatial analysis were executed.

Helium isotope ratios in the whole of Iceland vary from 5.1 to 37.7 $R_A$. The highest ratios are measured in the older part of Iceland at Vestfirðir. Within the neovolcanic zones the highest ratios are measured over northwestern Vatnajökull, where the mantle plume is located. The rift zones are characterized by distinctive helium signatures: 8-11 $R_A$ in the NRZ, 12-17 $R_A$ in the WRZ and 18-21 $R_A$ in the ERZ. The SISZ is characterized by ratios between 18 and 19 $R_A$, which is similar to the ERZ and slightly higher than the WRZ. The off-rift volcanic zones, SNVZ and ÖVZ, show ratios similar to MORB values. The SIVZ, that is a continuation of the ERZ, shows higher ratios than the other off-rift volcanic zones but lower values than the ERZ. There is a good consistency between various phases, which suggests that helium is coming from the same mantle source for various phases.

A high helium plateau ($\geq$ 20 $R_A$) is located in central Iceland. This plateau correlates with geophysical measurements, both seismic velocity and gravity measurements. The high helium isotope ratios are thought to indicate that the source of the mantle plume is an undegassed, deep mantle source and the plateau is thought to outline the lateral distribution of plume material. The high helium isotope ratios and the thick crust at Vestfirðir indicate that the center of the mantle plume was once located there.

# References


Barry P. H., Hilton D. R., Fischer T. P., de Moor J. M., Mangasini F. & Ramirez C. (2013) Helium and carbon isotope systematics of cold "mazuku" $CO_2$ vents and hydrothermal gases and fluids from Rungwe Volcanic Province, southern Tanzania. *Chem. Geol.* **339,** 141-156.

Bijwaard H. & Spakman W. (1999) Tomographic evidence for a narrow whole mantle plume below Iceland. *Earth Planet. Sci. Lett.* **166,** 121–126.

Bjarnason I. Þ. (2008) An Iceland hotspot saga. *Jökull* **58,** 3-16.

Bjarnason I. Þ. (2013). *Jarðeðlisfræðilegur samanburður a tertíer beltum Austurlands og Vestfjarða og slóð heita reitsins á Íslandi og nágrenni.* Paper presented at Autumn Congress of the Geological Society of Iceland, Reykjavík.

Brandon A. D., Graham D. W., Waight T. & Gautason B. (2007) $^{186}$Os and $^{187}$Os enrichments and high-$^{3}$He/$^{4}$He sources in the Earth's mantle: evidence from Icelandic picrites. *Geochim. Cosmochim. Acta* **71**(18), 4570–4591.

Breddam K., Kurz M. D. & Storey M. (2000) Mapping out the conduit of the Iceland mantle plume with helium isotopes. *Earth Planet. Sci. Lett.* **176**(1), 45–55.

Burnard P. & Harrison D. (2005) Argon isotope constraints on modification of oxygen isotopes in Iceland Basalts by surficial processes. *Chem. Geol.* **216**, 143-156.

Burnard P. G., Stuart F. M., Turner G. & Óskarsson N. (1994) Air contamination of basaltic magmas: implications for high $^{3}$He/$^{4}$He mantle Ar isotopic composition. *J. Geophys. Res. – Sol. Earth* **99**(B9), 17709–17715.

Childs C. (2004) Interpolating surfaces in ArcGIS Spatial Analyst. *ArcUser* **3**, 32-35.

Condomines M., Grönvold K., Hooker P. J., Muehlenbachs K., O'Nions R. K., Óskarsson N. & Oxburgh E. R. (1983) Helium, oxygen, strontium and neodymium isotopic relationships in Icelandic volcanics. *Earth Planet. Sci. Lett.* **66**(1–3), 125–136.

Darbyshire F. A., White R. S. & Priestley K. F. (2000) Structure of the crust and uppermost mantle of Iceland from a combined seismic and gravity study. *Earth Planet. Sci. Lett.* **181**(3), 409-428.

Debaille V., Trønnes R. G., Brandon A. D.,Waight T. E., Graham D.W. & Lee C. A. (2009) Primitive off-rift basalts from Iceland and Jan Mayen: Os-isotopic evidence for a mantle source containing enriched subcontinental lithosphere. *Geochim. Cosmochim. Acta* **73**, 3423-3449.

Dixon E. T. (2003) Interpretation of helium and neon isotopic heterogeneity in Icelandic basalts. *Earth Planet. Sci. Lett.* **206**(1–2), 83–99.

Dixon E. T., Honda M., McDougall I., Campbell I. H. & Sigurdsson I. (2000) Preservation of nearsolar neon isotopic ratios in Icelandic basalts. *Earth Planet. Sci. Lett.* **180**(3–4), 309–324.

Eason D. E., Sinton J. M., Grönvold K. & Kurz M. D. (2015) Effects of deglaciation on the petrology and eruptive history of the Western Volcanic Zone, Iceland. *Bull. Volcanol.* **77**(47) 27 pp.

Einarsson P. (2008) Plate boundaries, rifts and transforms in Iceland. *Jökull* **58,** 35-58.

Ellam R. M. & Stuart F. M. (2004) Coherent He–Nd–Sr isotope trends in high $^{3}He/^{4}He$ basalts: implications for a common reservoir, mantle heterogeneity and convection. *Earth Planet. Sci. Lett.* **228**(3–4), 511–523.

Frost B. R. & Frost C. D. (2014) *Igneous and Metamorphic Petrology.* New York: Cambridge University Press.

Füri E., Hilton D. R., Halldórsson S. A., Barry P. H., Hahm D., Fischer T. P. & Grönvold K. (2010) Apparent decoupling of the He and Ne isotope systematics of the Icelandic mantle: The role of He depletion, melt mixing, degassing fractionation and air interaction. *Geochim. Cosmochim. Acta* **74**, 3307-3332.

Gautheron C. & Moreira M. (2002) Helium signature of the subcontinental lithospheric mantle. *Earth Planet. Sci. Lett.* **199,** 39-47.

Graham D. W. (2002) Noble gas isotope geochemistry of mid-ocean ridge and ocean island basalts: characterization of mantle source reservoirs. In *Noble Gases in Geochemistry and Chosmochemistry*, vol. 47 (eds. D. Porcelli, C. Ballentine and R. Wieler), pp. 247-317. Rev. Mineral. Geochem. Mineral. Soc. Am., Washington DC.

Guðfinnsson G. H. (2010). *Stafar endurkastsflötur á um 40 km dýpi undir Íslandi af fasabreytingum í möttli?* Paper presented at Autumn Congress of the Geological Society of Iceland, Reykjavík.

Guðmundsson Á. (2000) Dynamics of volcanic systems in Iceland: Example of tectonism and volcanism at juxtaposed hot spot and mid-ocean ridge Systems. *Annu. Rev. Earth Planet. Sci.* **28,** 107-140.

Halldórsson S. A., Hilton D. R., Barry P. H., Füri E. & Grönvold K. (2016) Recycling of crustal material by the Iceland mantle plume: New evidence from nitrogen elemental and isotope systematics of subglacial basalts. *Geochim. Cosmochim. Acta* **176**, 206-226.

Harrison D., Burnard P. & Turner G. (1999) Noble gas behaviour and composition in the mantle: constraints from the Iceland Plume. *Earth Planet. Sci. Lett.* **171**(2), 199–207.

Hauksson E. & Goddard J. B. (1981) Radon earthquake precursor studies in Iceland. *J. Geophys. Res.* **86,** 7037-7054.

Hilton D. R. (1996) The helium and carbon isotope systematics of a continental geothermal system; results from monitoring studies at Long Valley Caldera (California, U.S.A.). *Chem. Geol.* **127**(4), 269-295.

Hilton D. R., Grönvold K., O'Nions R. K. & Oxburgh E. R. (1990) Regional distribution of $^{3}$He anomalies in the Icelandic crust. *Chem. Geol.* **88**(1–2), 53–67.

Hilton D. R., Grönvold K., Sveinbjörnsdóttir A. E. & Hammerschmidt K. (1998) Helium isotope evidence for off-axis degassing of the Icelandic hotspot. *Chem. Geol.* **149**(3–4), 173–187, *Earth Planet. Sci. Lett.* **173**(1–2), 53–60.

Hilton D. R., Grönvold K., Macpherson C. G. & Castillo P. R. (1999) Extreme $^{3}$He/$^{4}$He ratios in northwest Iceland: constraining the common component in mantle plumes. *Earth Planet. Sci. Lett.* **173**(1–2), 53–60.

Jakobsson S. P., Jónasson K. & Sigurðsson I. A. (2008) The three igneous rock series of Iceland. *Jökull* **58,** 117-138.

Jóhannesson H. & Sæmundsson K. (1998). *Geological map of Iceland*. Bedrock geology, scale 1:500.000. Reykjavík: Náttúrufræðistofnun Íslands (2nd edition).

Kononov V. I. & Polak B. G. (1975) Indicators of abyssal heat recharge of recent hydrothermal phenomena. Proc. *2nd United Nations Symposium on the Development and Use of Geothermal Resources.* **2,** 767-773.

Kurz M. D., Jenkins W. J. & Hart S. R. (1982) Helium isotopic systematics of oceanic islands and mantle heterogeneity. *Nature.* **297,** 43-47.

Kurz M. D., Meyer P. S. & Sigurðsson H. (1985) Helium isotopic systematics within the neovolcanic zones of Iceland. *Earth Planet. Sci. Lett.* **74**(4), 291–305.

Licciardi J. M., Kurz M. D. & Curtice J. M. (2006) Cosmogenic $^{3}$He production rates from Holocene lava flows in Iceland. *Earth Planet. Sci. Lett.* **246**, 251-264.

Licciardi J. M., Kurz M. D. & Curtice J. M. (2007) Glacial and volcanic history of Icelandic table mountains from cosmogenic 3He exposure ages. *Quat. Sci. Rev.* **26**(11–12), 1529–1546.

Macpherson C. G., Hilton D. R., Day J. M. D., Lowry D. & Grönvold K. (2005a) High-$^{3}$He/$^{4}$He, depleted mantle and low-$\delta^{18}$O, recycled oceanic lithosphere in the source of central Iceland magmatism. *Earth Planet. Sci. Lett.* **233**(3–4), 411–427.

Marty B., Gunnlaugsson E., Jambon A., Óskarsson N., Ozima M., Pineau F. & Torssander P. (1991) Gas geochemistry of geothermal fluids, the Hengill Area, southwest rift zone of Iceland. *Chem. Geol.* **91**(3), 207–225.

Moreira M., Breddam K., Curtice J. & Kurz M. D. (2001) Solar neon in the Icelandic mantle: new evidence for an undegassed lower mantle. *Earth Planet. Sci. Lett.* **185**(1–2), 15–23.

Mukhopadhyay S. (2012) Early differentiation and volatile accretion recorded in deep-mantle neon and xenon *Nature* **486,** 101-104.

Peate D. W., Breddam K., Baker J. A., Kurz M. D., Barker A. K., Prestvik T., Grassineau N. & Skovgaard C. (2010) Compositional Characteristics and Spatial Distribution of Enriched Icelandic Mantle Components. *J. Petrology* **51**(7), 1447-1475.

Petrucci R. H., Herring F. G., Madura J. F. & Bissonnette C. (2011) *General chemistry Principles and Modern Applications* (10th edition). Toranto, Ontario: Pearson Canada Inc.

Polak G., Kononov I., Tolstikhin I., Mamyrin B. A. & Khabarin L. V. (1976) The helium isotopes in thermal fluids. In thermal and chemical problems of thermal waters. *Int. Assoc. Hydrogeol. Sci.* **119**, 17-33.

Poreda R. J., Craig H., Arnórsson S. & Welhan J. A. (1992) Helium isotopes in Icelandic geothermal systems: I. $^{3}$He, gas chemistry, and $^{13}$C relations. *Geochim. Cosmochim. Acta* **56**(12), 4221–4228.

Poreda R., Schilling J.-G. & Craig H. (1986) Helium and hydrogen isotopes in ocean-ridge basalts north and south of Iceland. *Earth Planet. Sci. Lett.* **78**(1), 1–17.

Sano Y., Urabe A., Wakita H., Chiba H. & Sakai H. (1985) Chemical and isotopic compositions of gases in geothermal fluids in Iceland. *Geochem. J.* **19**(3), 135–148.

Torgersen T. & Jenkins W. J. (1982) Helium isotopes in geothermal systems: Iceland, The Geysers, Raft River and Steamboat Springs. *Geochim. Cosmochim. Acta* **46**(5), 739–748.

Trieloff M., Kunz J., Clague D. A., Harrison D. & Allégre C. J. (2000) The nature of pristine noble gases in mantle plumes. *Science* **288**(5468), 1036–1038.

Tryggvason K., Husebye E. S. & Stefánsson R. (1983) Seismic image of the hypothesized Icelandic hot spot. *Tectonopysics* **100,** 97–118

White W. M. (2013). *Geochemistry.* West Sussex: Wiley-Blackwell.

Winter J. D. (2014) *Principles of Igneous and Metamorphic Petrology* (2nd edition). Essex: Pearson.

Wolfe C. J., Bjarnason I. Þ., VanDecar J. C. & Solomon S. C. (1997) Seismic structure of the Iceland mantle plume. *Nature* **385,** 245–247

# Appendix

*The data base used for analysis. The phase is designated with Gf = geothermal fluid, Gl = glass, Ph = phenocryst and Br = breccia.*

| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| | Gf | | 65.5118 | -23.3822 | 7.6 | | | | Kononov & Polak (1975) |
| | Gf | | 65.5756 | -23.1230 | 6.2 | | | | Kononov & Polak (1975) |
| | Gf | | 65.4522 | -22.1695 | 17.4 | | | | Kononov & Polak (1975) |
| | Gf | | 65.9100 | -22.4489 | 8.7 | | | | Kononov & Polak (1975) |
| | Gf | | 65.4650 | -20.9424 | 18.1 | | | | Kononov & Polak (1975) |
| | Gf | | 65.5449 | -20.2055 | 10.9 | | | | Kononov & Polak (1975) |
| | Gf | | 65.8741 | -19.7545 | 16.7 | | | | Kononov & Polak (1975) |
| | Gf | | 65.4785 | -19.3690 | 15.9 | | | | Kononov & Polak (1975) |
| | Gf | | 66.0221 | -18.7613 | 13.8 | | | | Kononov & Polak (1975) |
| | Gf | | 65.5727 | -17.7375 | 6.7 | | | | Kononov & Polak (1975) |
| | Gf | | 65.8965 | -17.2779 | 12.3 | | | | Kononov & Polak (1975) |
| | Gf | | 65.8000 | -16.9666 | 9.8 | | | | Kononov & Polak (1975) |
| | Gf | | 65.7059 | -16.7528 | 9.1 | | | | Kononov & Polak (1975) |
| | Gf | | 65.6051 | -16.8412 | 10.1 | | | | Kononov & Polak (1975) |
| | Gf | | 66.1311 | -16.5099 | 9.8 | | | | Kononov & Polak (1975) |
| | Gf | | 65.7929 | -14.8819 | 6.0 | | | | Kononov & Polak (1975) |
| | Gf | | 64.3249 | -15.1954 | 9.4 | | | | Kononov & Polak (1975) |
| | Gf | | 64.9843 | -15.7871 | 8.3 | | | | Kononov & Polak (1975) |
| | Gf | | 65.0678 | -15.6708 | 5.1 | | | | Kononov & Polak (1975) |
| | Gf | | 65.0425 | -16.7094 | 10.1 | | | | Kononov & Polak (1975) |
| | Gf | | 64.6593 | -17.7895 | 20.3 | | | | Kononov & Polak (1975) |

*Continued*

| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He]$^a$ | Reference |
|---|---|---|---|---|---|---|---|---|---|
| | Gf | | 64.1567 | -19.8006 | 23.2 | | | | Kononov & Polak (1975) |
| | Gf | | 64.6781 | -19.3291 | 13.0 | | | | Kononov & Polak (1975) |
| | Gf | | 63.9952 | -19.0447 | 19.9 | | | | Kononov & Polak (1975) |
| | Gf | | 63.9415 | -19.9470 | 21.7 | | | | Kononov & Polak (1975) |
| | Gf | | 64.3284 | -20.1967 | 18.1 | | | | Kononov & Polak (1975) |
| | Gf | | 64.5810 | -20.6327 | 12.0 | | | | Kononov & Polak (1975) |
| | Gf | | 64.1367 | -20.2882 | 15.9 | | | | Kononov & Polak (1975) |
| | Gf | | 64.0419 | -21.3565 | 15.8 | | | | Kononov & Polak (1975) |
| | Gf | | 64.1381 | -21.1650 | 13.0 | | | | Kononov & Polak (1975) |
| | Gf | | 64.4382 | -21.8710 | 16.7 | | | | Kononov & Polak (1975) |
| | Gf | | 64.5224 | -21.3105 | 15.9 | | | | Kononov & Polak (1975) |
| | Gf | | 64.6889 | -21.1375 | 12.0 | | | | Kononov & Polak (1975) |
| | Gf | | 63.8398 | -22.6242 | 12.7 | | | | Kononov & Polak (1975) |
| | Gf | | 65.2528 | -21.0558 | 17.8 | | | | Kononov & Polak (1975) |
| | Gf | | 64.8637 | -19.5161 | 15.2 | | | | Kononov & Polak (1975) |
| | Gf | | 64.6780 | -19.3183 | 13.0 | | | | Kononov & Polak (1975) |
| | Gf | | 65.0255 | -18.3100 | 7.2 | | | | Kononov & Polak (1975) |
| | Gf | | 65.2925 | -19.0605 | 19.6 | | | | Kononov & Polak (1975) |
| | Gf | | 65.2745 | -18.1805 | 8.0 | | | | Kononov & Polak (1975) |
| | Gf | | 64.9058 | -23.5836 | 10.1 | | | | Kononov & Polak (1975) |
| | Gf | | 64.8378 | -23.2467 | 9.1 | | | | Kononov & Polak (1975) |
| | Gf | | 64.8280 | -22.9380 | 9.4 | | | | Kononov & Polak (1975) |
| | Gf | | 64.8278 | -22.3056 | 13.4 | | | | Kononov & Polak (1975) |
| | Gf | | 64.4807 | -21.1490 | 18.8 | | | | Kononov & Polak (1975) |
| | Gf | | 64.6558 | -21.4225 | 15.2 | | | | Kononov & Polak (1975) |
| | Gf | Hveravík | 65.6833 | -21.5500 | 23.8 | | | | Polak et al. (1976) |
| | Gf | Furubrekka | 64.8390 | -22.9626 | 9.03 | | | | Polak et al. (1976) |
| | Gf | Lýsuhóll | 64.8402 | -23.2245 | 9.39 | | | | Polak et al. (1976) |

*Continued*

| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| | Gf | Hveravellir, Kjölur | 64.8627 | -19.5535 | 15.2 | | | | Polak et al. (1976) |
| | Gf | Great Geysir | 64.3139 | -20.3022 | 19.1 | | | | Polak et al. (1976) |
| | Gf | Hveravellir, Reykjahverfi | 65.8864 | -17.3096 | 12.3 | | | | Polak et al. (1976) |
| | Gf | Árhver | 64.6500 | -21.3500 | 17.0 | | | | Polak et al. (1976) |
| | Gf | Kerlingarfjöll | 64.6237 | -19.2958 | 1.45 | | | | Polak et al. (1976) |
| | Gf | Kerlingarfjöll | 64.6237 | -19.2958 | 13.0 | | | | Polak et al. (1976) |
| | Gf | Landmannalaugar | 63.9837 | -19.0672 | 18.0 | | | | Polak et al. (1976) |
| | Gf | Hlemmiskeið | 64.0167 | -20.5500 | 18.9 | | | 1040 | Hauksson & Goddard (1981) |
| | Gf | Selfoss | 63.9462 | -20.9606 | 18.3 | | | 1380 | Hauksson & Goddard (1981) |
| | Gf | Flúðir | 64.1333 | -19.9000 | 17.4 | | | 1720 | Hauksson & Goddard (1981) |
| | Gf | Flúðir | 64.1333 | -19.9000 | 17.6 | | | 1740 | Hauksson & Goddard (1981) |
| G-31 | Gf | Reykjavík | 64.1500 | -21.9333 | 11.6 | | | 201 | Torgersen & Jenkins (1982) |
| | Gf | Reykjavík | 64.1500 | -21.9333 | 10.7 | | | 201 | Torgersen & Jenkins (1982) |
| G-10 | Gf | Reykjavík | 64.1500 | -21.9333 | 12.7 | | | 172 | Torgersen & Jenkins (1982) |
| KJ-7 | Gf | Krafla | 65.7167 | -16.7333 | 8.4 | | | 23570 | Torgersen & Jenkins (1982) |
| KG-8 | Gf | Krafla | 65.7167 | -16.7333 | 7.9 | | | 11740 | Torgersen & Jenkins (1982) |
| | Gf | Krafla | 65.7167 | -16.7333 | 9.0 | | | 4160 | Torgersen & Jenkins (1982) |
| | Gf | Krafla | 65.7167 | -16.7333 | 8.3 | | | 1070 | Torgersen & Jenkins (1982) |
| | Gf | Hafralækur | 65.8667 | -17.4333 | 9.0 | | | 203 | Torgersen & Jenkins (1982) |
| 138413 | Gl | Stapafell, south part | 63.9000 | -22.5167 | 23.9 | | | 52 | Condomines et al. (1983) |
| 115619 | Gl | Stapafell, west part | 63.9000 | -22.5167 | 13.8 | | | 52.1 | Condomines et al. (1983) |
| RP | Gl | Reykjanes | 63.8000 | -22.6833 | 13.7 | | | 640 | Condomines et al. (1983) |
| Krísuvík | Gl | Reykjanes peninsula | 63.8333 | -22.2833 | 13.4 | | | 33.8 | Condomines et al. (1983) |
| HEN 1 | Gl | Hengill | 64.0167 | -21.3833 | 12.4 | | | 101 | Condomines et al. (1983) |
| TOR103 | Gl | Þórisjökull | 64.5333 | -20.7000 | 12.3 | | | 106 | Condomines et al. (1983) |
| TOR108 | Gl | Þórisjökull | 64.5333 | -20.7000 | 12.7 | | | 27 | Condomines et al. (1983) |
| 138359 | Gl | Hrauneyjarfoss | 64.2000 | -19.2333 | 21.3 | | | 136 | Condomines et al. (1983) |
| A2 | Gl | Askja | 65.0333 | -16.7167 | 7.1 | | | 42.6 | Condomines et al. (1983) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|
| NAL 33 | Gl | Hvammsfjöll | 65.3500 | -16.6667 | 10.1 | | 404 | Condomines et al. (1983) |
| NAL 34 | Gl | Eggert | 65.2500 | -16.4667 | 9.8 | | 55.2 | Condomines et al. (1983) |
| KRA 81 | Gl | Krafla | 65.7167 | -16.7833 | 5.07 | | 42.3 | Condomines et al. (1983) |
| Tephra | Gl | Grímsvötn | 64.4167 | -17.3333 | 3.59 | | 129 | Condomines et al. (1983) |
| KER 226 | Gl | Kerlingarfjöll | 64.6333 | -19.2833 | 1.5 | | 300 | Condomines et al. (1983) |
| H´70-16 | Gl | Hekla | 63.9833 | -19.6667 | 1.02 | | 12.5 | Condomines et al. (1983) |
| SAL 74 | Gl | Öræfajökull | 64.0333 | -16.6500 | 1.14 | | 18 | Condomines et al. (1983) |
| A1875 | Gl | Askja | 65.0333 | -16.7167 | 0.93 | | 60 | Condomines et al. (1983) |
| KK 26 | Gl | Krafla | 65.7167 | -16.7833 | 1.06 | | 34 | Condomines et al. (1983) |
| ATHO | Gl | Krafla | 65.7167 | -16.7833 | 0.82 | | 10 | Condomines et al. (1983) |
| 87841 | Gl | Þingmúli | 65.0167 | -14.6500 | 0.072 | | 73 | Condomines et al. (1983) |
| EZ-274 | Ph | Stapafell | 63.9000 | -22.5300 | 13.9 | | 9.3 | Kurz et al. (1985) |
| VM-10 | Ph | Heimaey | 63.4000 | -20.2800 | 11.0 | | 12 | Kurz et al. (1985) |
| EZ-274 | Gl | Stapafell | 63.9000 | -22.5300 | 14.0 | | 11 | Kurz et al. (1985) |
| SK82-29C | Gl | Stapafell | 63.9000 | -22.5300 | 13.9 | | 151.3 | Kurz et al. (1985) |
| SK82-12 | Br | Kálfstindar | 64.2400 | -20.7400 | 13.8 | | 1430 | Kurz et al. (1985) |
| SK82-28 | Gl | Kálfstindar | 64.2400 | -20.7400 | 14.2 | | 1630 | Kurz et al. (1985) |
| HS-785 | Gl | Botnsheiði | 64.4500 | -21.0800 | 15.2 | | 30 | Kurz et al. (1985) |
| SK82-01B | Gl | Vestur Jarlhettur | 64.4600 | -20.2500 | 15.9 | | 62 | Kurz et al. (1985) |
| HS-806 | Gl | Eiríksjökull | 64.8000 | -20.4500 | 8.67 | | 154 | Kurz et al. (1985) |
| IC-117 | Gl | Dvergalda | 65.0000 | -19.5800 | 21.6 | | 1360 | Kurz et al. (1985) |
| SK82-05 | Gl | SW of Blágnípa | 64.7300 | -19.1800 | 20.9 | | 143 | Kurz et al. (1985) |
| SK82-06 | Gl | SW of Blágnípa | 64.7300 | -19.1800 | 20.0 | | 1110 | Kurz et al. (1985) |
| EZ 125B | Gl | Innsta-Bálkafell | 64.6800 | -17.6800 | 22.2 | | 62 | Kurz et al. (1985) |
| EZ 120 | Gl | Tindafell | 64.7300 | -17.6500 | 19.7 | | 39.2 | Kurz et al. (1985) |
| EZ-179 | Gl | Heljargjá | 64.3200 | -18.4600 | 20.0 | | 302 | Kurz et al. (1985) |
| EZ-149B | Gl | Grasatangi | 64.2300 | -18.9900 | 18.0 | | 13 | Kurz et al. (1985) |
| SK82-27 | Gl | Sigalda | 64.1500 | -19.1300 | 20.8 | | 175 | Kurz et al. (1985) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| EZ-210 | Gl | Faxasund | 64.0300 | -18.6900 | 20.7 | | | 1240 | Kurz et al. (1985) |
| HE-35 | Gl | Sauðleysur | 64.0700 | -19.3500 | 20.2 | | | 23.5 | Kurz et al. (1985) |
| HE-24 | Gl | Stóraskógsbotnar | 63.9600 | -19.8600 | 13.9 | | | 19 | Kurz et al. (1985) |
| SK82-13 | Gl | Þríhyrningur | 63.7800 | -19.9500 | 26.2 | | | 455 | Kurz et al. (1985) |
| IC-152 | Gl | Krafla | 65.6200 | -17.0800 | 11.0 | | | 152 | Kurz et al. (1985) |
| | Gf | Krafla | 65.7167 | -16.7333 | 9.1 | 86.75 | 9.2 | 20.9 | Sano et al. (1985) |
| | Gf | Krafla | 65.7167 | -16.7333 | 8.6 | 73.73 | 8.7 | 135 | Sano et al. (1985) |
| | Gf | Hverageröi | 64.0000 | -21.1833 | 8.1 | 477 | 8.1 | 36 | Sano et al. (1985) |
| | Gf | Námafjall | 65.6333 | -16.8167 | 8.7 | 156 | 8.7 | <100 | Sano et al. (1985) |
| | Gf | Víðigerði | 64.6667 | -21.4000 | 8.4 | 16.48 | 8.9 | | Sano et al. (1985) |
| | Gf | Geysir | 64.3167 | -20.3000 | 12.0 | 17.35 | 12.7 | | Sano et al. (1985) |
| | Gf | Geysir | 64.3167 | -20.3000 | 17.0 | 25.59 | 17.7 | 121 | Sano et al. (1985) |
| | Gf | Laugarvatn | 64.2000 | -20.7000 | 2.1 | 3.43 | 2.6 | | Sano et al. (1985) |
| | Gf | Reykjanes | 63.8167 | -22.7000 | 3.5 | 2.13 | 5.7 | 9 | Sano et al. (1985) |
| | Gf | Reykjanes | 63.8167 | -22.7000 | 3.7 | 3.04 | 5 | | Sano et al. (1985) |
| | Gf | Krísuvík | 63.9000 | -22.0500 | 13.7 | 130 | 13.8 | 11 | Sano et al. (1985) |
| | Gl | Stakksá | 64.2667 | -20.2833 | 16.5 | 100 | 16.7 | 5.9 | Poreda et al. (1986) |
| | Gl | Kálfstindar | 64.2500 | -20.8667 | 13.9 | 1000 | 13.9 | 380 | Poreda et al. (1986) |
| | Gl | Surtsey | 63.3000 | -20.5833 | 13.6 | 150 | 13.7 | 4.8 | Poreda et al. (1986) |
| RE-78 | Ph | Vatnsheiði | 63.8667 | -22.3833 | 12.5 | 20 | 13.1 | 1.4 | Poreda et al. (1986) |
| | Ph | Miðfell | 64.1833 | -21.0000 | 16.1 | 40 | 16.5 | 2.6 | Poreda et al. (1986) |
| | Ph | Surtsey | 63.3000 | -20.5833 | 15.1 | 50 | 15.3 | 22 | Poreda et al. (1986) |
| | Ph | Hvammsmúli | 63.5740 | -19.8700 | 12.2 | | | 0.2 | Poreda et al. (1986) |
| R-Nes-N | Gf | Reykjanes | 63.8167 | -22.6833 | 11.0 | 10.6 | 12 | | Hilton et al. (1990) |
| R-Nes-M | Gf | Reykjanes | 63.8167 | -22.6833 | 9.9 | 20.9 | 10.3 | | Hilton et al. (1990) |
| R-Nes-S | Gf | Reykjanes | 63.8167 | -22.6833 | 13.9 | 31.8 | 14.4 | | Hilton et al. (1990) |
| 8 | Gf | Reykjanes | 63.8167 | -22.6833 | 12.2 | 275.8 | 12.2 | | Hilton et al. (1990) |
| 6 | Gf | Svartsengi | 63.8833 | -22.4333 | 13.4 | 83.8 | 13.5 | | Hilton et al. (1990) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| 6 | Gf | Svartsengi | 63.8833 | -22.4333 | 13.6 | 30.1 | 14 | 360 | Hilton et al. (1990) |
| 8 | Gf | Svartsengi | 63.8833 | -22.4333 | 13.1 | 65.8 | 13.3 | | Hilton et al. (1990) |
| 9 | Gf | Svartsengi | 63.8833 | -22.4333 | 12.4 | 140.6 | 12.5 | | Hilton et al. (1990) |
| 9 | Gf | Svartsengi | 63.8833 | -22.4333 | 14.2 | 137.6 | 14.3 | 280 | Hilton et al. (1990) |
| 10 | Gf | Svartsengi | 63.8833 | -22.4333 | 13.0 | 15 | 13.9 | | Hilton et al. (1990) |
| 11 | Gf | Svartsengi | 63.8833 | -22.4333 | 11.6 | 34 | 11.9 | | Hilton et al. (1990) |
| 11 | Gf | Hengill | 64.1000 | -21.2667 | 15.2 | 6.2 | 17.9 | | Hilton et al. (1990) |
| Geysir | Gf | Geysir | 64.3167 | -20.3000 | 14.7 | 8.5 | 16.5 | 140 | Hilton et al. (1990) |
| Great Geysir | Gf | Geysir | 64.3167 | -20.3000 | 15.7 | 8.3 | 17.7 | 310 | Hilton et al. (1990) |
| 3110 | Gf | Torfajökull | 63.9000 | -19.0667 | 9.8 | 4 | 12.8 | | Hilton et al. (1990) |
| Skeiðará | Gf | Grímsvötn | 64.4123 | -17.3326 | 17.3 | 18.7 | 18.2 | 1000 | Hilton et al. (1990) |
| Skeiðará | Gf | Grímsvötn | 64.4123 | -17.3326 | 15.3 | 4 | 19 | 400 | Hilton et al. (1990) |
| BJ-3153 | Gf | Námafjall | 65.6333 | -16.8167 | 8.0 | 5.1 | 9.7 | | Hilton et al. (1990) |
| BJ-12 | Gf | Námafjall | 65.6333 | -16.8167 | 8.4 | | | | Hilton et al. (1990) |
| KG-8 | Gf | Krafla | 65.7167 | -16.7667 | 8.6 | 82.2 | 8.7 | | Hilton et al. (1990) |
| KJ-15 | Gf | Krafla | 65.7167 | -16.7667 | 9.4 | | | | Hilton et al. (1990) |
| KJ-16 | Gf | Krafla | 65.7167 | -16.7667 | 9.4 | | | | Hilton et al. (1990) |
| Víti | Gf | Krafla | 65.7167 | -16.7500 | 8.4 | | | | Hilton et al. (1990) |
| Leirhnjúkur | Gf | Krafla | 65.7167 | -16.8167 | 8.6 | | | | Hilton et al. (1990) |
| Hveragil | Gf | Krafla | 65.7167 | -16.7667 | 8.7 | 66.8 | 8.8 | 820 | Hilton et al. (1990) |
| G-1 | Gf | Þeistareykir | 65.8833 | -16.9500 | 8.9 | 27 | 9.2 | | Hilton et al. (1990) |
| G-7 | Gf | Þeistareykir | 65.8833 | -16.9500 | 6.9 | | | | Hilton et al. (1990) |
| | Gf | Eyvík | 64.0333 | -20.7000 | 21.4 | 83.2 | 21.7 | 3080 | Hilton et al. (1990) |
| | Gf | Herríðarhóll | 63.9333 | -20.5500 | 14.6 | 13.9 | 15.7 | 750 | Hilton et al. (1990) |
| | Gf | Hjallanes | 63.9667 | -20.4333 | 14.3 | 6.2 | 16.9 | 410 | Hilton et al. (1990) |
| | Gf | Hlemmiskeið | 64.0167 | -20.5667 | 17.9 | 54.9 | 18.2 | 1310 | Hilton et al. (1990) |
| | Gf | Laugaland | 63.9167 | -20.4000 | 19.7 | 54.7 | 20 | 630 | Hilton et al. (1990) |
| | Gf | Ormsstaðir | 64.0333 | -20.7000 | 21.1 | 22.2 | 22 | 8430 | Hilton et al. (1990) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| | Gf | Þjórsárdalur | 64.1000 | -19.9000 | 20.7 | 55.7 | 21.1 | 1520 | Hilton et al. (1990) |
| | Gf | Þjórsárholt | 64.0167 | -20.2667 | 17.8 | 16.1 | 18.9 | 3350 | Hilton et al. (1990) |
| | Gf | Þorleifskot | 63.9500 | -20.6000 | 17.8 | 30.9 | 18.4 | 920 | Hilton et al. (1990) |
| | Gf | Þóroddsstaðir | 63.9667 | -21.3000 | 17.0 | 51 | 17.4 | 2660 | Hilton et al. (1990) |
| | Gf | Þorlákshver | 64.1000 | -20.6000 | 13.3 | 14.2 | 14.2 | 320 | Hilton et al. (1990) |
| | Gf | Reykir Skeið | 64.0500 | -20.6000 | 13.2 | 34.2 | 13.5 | 900 | Hilton et al. (1990) |
| | Gf | Skarð | 64.0000 | -20.1000 | 16.6 | 4.7 | 20.8 | 610 | Hilton et al. (1990) |
| | Gf | Sólheimar | 64.0667 | -20.6500 | 18.8 | 27.8 | 19.5 | 700 | Hilton et al. (1990) |
| | Gf | Spóastaðir | 64.1333 | -20.6500 | 17.8 | 26.3 | 18.5 | 2130 | Hilton et al. (1990) |
| | Gf | Vatnsnes | 64.0167 | -20.6500 | 20.1 | 12.4 | 21.8 | 180 | Hilton et al. (1990) |
| | Gf | Borðeyri | 65.2167 | -21.1167 | 17.4 | 257.7 | 17.4 | 32600 | Hilton et al. (1990) |
| | Gf | Gjögur | 65.9833 | -21.3500 | 13.4 | 12.3 | 14.5 | 620 | Hilton et al. (1990) |
| | Gf | Hveravík | 65.7000 | -21.5667 | 25.4 | 33.2 | 26.2 | 580 | Hilton et al. (1990) |
| | Gf | Laugarhóll | 65.7833 | -21.5167 | 4.1 | 2.5 | 6.1 | 320 | Hilton et al. (1990) |
| MG-5 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 13.1 | 12.3 | 14.1 | 520 | Hilton et al. (1990) |
| MG-5 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 12.8 | 10.8 | 14 | 490 | Hilton et al. (1990) |
| MG-16 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 13.7 | 19.3 | 14.4 | 1180 | Hilton et al. (1990) |
| MG-17 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 12.6 | 8.8 | 14.1 | 370 | Hilton et al. (1990) |
| MG-18 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 12.0 | 6.3 | 14.1 | 330 | Hilton et al. (1990) |
| MG-35 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 13.5 | 24 | 14 | 1020 | Hilton et al. (1990) |
| MG-37 | Gf | Mosfellssveit | 64.1667 | -21.7000 | 13.9 | 27.6 | 14.4 | 90 | Hilton et al. (1990) |
| G-5 | Gf | Reykjavík | 64.1500 | -21.9333 | 11.0 | 6.7 | 12.7 | 340 | Hilton et al. (1990) |
| G-35 | Gf | Reykjavík | 64.1500 | -21.9333 | 11.2 | 6.9 | 13 | 480 | Hilton et al. (1990) |
| G-37 | Gf | Reykjavík | 64.1500 | -21.9333 | 9.7 | 4.4 | 12.3 | 260 | Hilton et al. (1990) |
| RG-30 | Gf | Reykjavík | 64.1500 | -21.9333 | 11.0 | 5.3 | 13.3 | 330 | Hilton et al. (1990) |
| RG-31 | Gf | Reykjavík | 64.1500 | -21.9333 | 9.8 | 3.9 | 12.8 | 900 | Hilton et al. (1990) |
| SN-4 | Gf | Seltjarnarnes | 64.1500 | -21.9833 | 12.7 | 10.4 | 14 | 1060 | Hilton et al. (1990) |
| SN-4 | Gf | Seltjarnarnes | 64.1500 | -21.9833 | 12.0 | 11.1 | 13.1 | 530 | Hilton et al. (1990) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| SN-5 | Gf | Seltjarnarnes | 64.1500 | -21.9833 | 12.2 | 8.4 | 13.7 | 580 | Hilton et al. (1990) |
| | Gf | Hafragil | 65.8333 | -19.9000 | 10.1 | 16.4 | 10.7 | 890 | Hilton et al. (1990) |
| | Gf | Laugaland | 65.7500 | -18.2500 | 8.4 | 15.9 | 8.9 | 370 | Hilton et al. (1990) |
| NG09 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.8 | | | 4.62 | Marty et al. (1991) |
| NJ11 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.5 | | | 0.79 | Marty et al. (1991) |
| NJ13 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.6 | | | 1.59 | Marty et al. (1991) |
| NES1 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.7 | | | 3.05 | Marty et al. (1991) |
| NES2 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.1 | | | 14.62 | Marty et al. (1991) |
| NES3 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.7 | | | 3.39 | Marty et al. (1991) |
| NES4 | Gf | Nesjavellir | 64.1167 | -21.2500 | 12.4 | | | 3.90 | Marty et al. (1991) |
| NES5 | Gf | Nesjavellir | 64.1167 | -21.2500 | 14.6 | | | 1.71 | Marty et al. (1991) |
| NES6 | Gf | Nesjavellir | 64.1167 | -21.2500 | 11.9 | | | 2.00 | Marty et al. (1991) |
| HEL1 | Gf | South Hengill | 64.0833 | -21.3167 | 13.1 | | | 4.65 | Marty et al. (1991) |
| HEL4 | Gf | South Hengill | 64.0833 | -21.3167 | 13.6 | | | 1.21 | Marty et al. (1991) |
| HEL7 | Gf | South Hengill | 64.0833 | -21.3167 | 14.3 | | | 2.55 | Marty et al. (1991) |
| HEL2 | Gf | South Hengill | 64.0833 | -21.3167 | 14.6 | | | 1.25 | Marty et al. (1991) |
| HEL3 | Gf | South Hengill | 64.0833 | -21.3167 | 14.7 | | | 0.35 | Marty et al. (1991) |
| HEL5 | Gf | South Hengill | 64.0833 | -21.3167 | 14.1 | | | 0.39 | Marty et al. (1991) |
| HEL6 | Gf | South Hengill | 64.0833 | -21.3167 | 13.6 | | | 1.26 | Marty et al. (1991) |
| HVG1 | Gf | Hveragerði | 64.0000 | -21.1833 | 14.9 | | | 0.68 | Marty et al. (1991) |
| HVG2 | Gf | Hveragerði | 64.0000 | -21.1833 | 14.8 | | | 0.68 | Marty et al. (1991) |
| 79-1 | Gf | Flúðir | 64.1333 | -20.3167 | 17.4 | 30 | 18 | 96.9 | Poreda et al. (1992) |
| 79-2 | Gf | Hlemmiskeið | 64.0167 | -20.5500 | 18.9 | 26 | 19.5 | 76.7 | Poreda et al. (1992) |
| 79-3 | Gf | Syðra Langholt | 64.0833 | -20.4333 | 18.2 | 25.7 | 18.8 | 73.8 | Poreda et al. (1992) |
| 79-4 | Gf | Selfoss | 63.9333 | -21.0000 | 18.3 | 40 | 18.7 | | Poreda et al. (1992) |
| I81-6 | Gf | Geysir | 64.3167 | -20.3000 | 11.41 | 5.3 | 13.6 | 13.2 | Poreda et al. (1992) |
| I83-118 | Gf | Geysir | 64.3167 | -20.3000 | 18.56 | 95 | 18.73 | 49.2 | Poreda et al. (1992) |
| I81-7 | Gf | Reykholt | 64.1749 | -20.4482 | 17.82 | | | 175 | Poreda et al. (1992) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| I81-8 | Gf | Flúðir | 64.1333 | -19.9000 | 18.72 | 29 | 19.23 | 43.1 | Poreda et al. (1992) |
| I81-10 | Gf | Seltjarnares | 64.1500 | -21.9833 | 15.4 | 34 | 15.76 | 27.0 | Poreda et al. (1992) |
| I81-17 | Gf | Reykir | 64.1667 | -21.6667 | 14.23 | 39 | 14.54 | 23.6 | Poreda et al. (1992) |
| I81-18 | Gf | Reykir | 64.1667 | -21.6667 | 14.62 | 19.2 | 15.23 | 72.5 | Poreda et al. (1992) |
| I81-19 | Gf | Reykjanes | 63.8167 | -22.6833 | 14.3 | 39 | 14.62 | 7.89 | Poreda et al. (1992) |
| I81-20 | Gf | Reykjanes | 63.8167 | -22.6833 | 14.38 | 286 | 14.42 | 5.87 | Poreda et al. (1992) |
| I81-21 | Gf | Svartsengi | 63.8833 | -22.4333 | 13.68 | 10.5 | 15 | 12.0 | Poreda et al. (1992) |
| I81-22 | Gf | Hverageröi | 64.0000 | -21.1833 | 17.69 | 39 | 18.09 | 7.80 | Poreda et al. (1992) |
| I83-119 | Gf | Nesjavellir | 64.1167 | -21.2500 | 15.8 | 215 | 15.86 | 13.2 | Poreda et al. (1992) |
| I83-124 | Gf | Klausturhólar | 64.0667 | -20.8333 | 19.07 | 33 | 19.53 | 6.00 | Poreda et al. (1992) |
| 84-3105 | Gf | Krísuvík | 63.8833 | -22.0500 | 14.46 | 175 | 14.53 | 8.38 | Poreda et al. (1992) |
| I83-101 | Gf | Árhver | 64.6500 | -21.3500 | 15.61 | 55 | 15.85 | 72.6 | Poreda et al. (1992) |
| I83-102 | Gf | Lýsuhóll | 64.8333 | -23.2167 | 9.32 | | | 251 | Poreda et al. (1992) |
| I83-104 | Gf | Rauðamelsölkelda | 64.9000 | -22.3333 | 12.25 | 1000 | 12.25 | 34.8 | Poreda et al. (1992) |
| I83-107 | Gf | Sælingsdalur | 65.2667 | -21.8333 | 12.73 | 14 | 13.6 | | Poreda et al. (1992) |
| I83-106 | Gf | Reykhólar | 65.4500 | -22.2000 | 16.93 | 34 | 17.4 | 101 | Poreda et al. (1992) |
| I83-108 | Gf | Borðeyri | 65.2000 | -21.1000 | 17.27 | 1300 | 17.28 | 2002 | Poreda et al. (1992) |
| I85 | Gf | Svannshóll | 65.7833 | -21.5333 | 11.2 | 4.3 | 14.2 | 10.10 | Poreda et al. (1992) |
| I85 | Gf | Krossnes | 66.0000 | -21.5167 | 27.3 | 15.8 | 28.8 | 7.40 | Poreda et al. (1992) |
| I85 | Gf | Hveravík | 65.7000 | -21.5667 | 25.8 | 60 | 26.2 | 154 | Poreda et al. (1992) |
| I83-116 | Gf | Hveravellir | 64.8667 | -19.5500 | 16.26 | 100 | 16.4 | 18.2 | Poreda et al. (1992) |
| I83-117 | Gf | Kerlingarfjöll | 64.6333 | -19.3000 | 16.56 | 120 | 16.68 | 6.42 | Poreda et al. (1992) |
| I81-9 | Gf | Þjórsárdalur | 64.1000 | -19.9000 | 22.87 | 50 | 23.27 | 315 | Poreda et al. (1992) |
| I81-33 | Gf | Landmannalaugar | 63.9833 | -19.0667 | 22.57 | 55 | 22.93 | 20.0 | Poreda et al. (1992) |
| I83-120 | Gf | Landmannalaugar | 63.9833 | -19.0667 | 18.91 | 5 | 23.4 | 2.22 | Poreda et al. (1992) |
| I83-123 | Gf | Landmannalaugar | 63.9833 | -19.0667 | 23.14 | 38 | 23.74 | 2.18 | Poreda et al. (1992) |
| 85-3092 | Gf | Köldukvíslarbotnar | 64.6000 | -17.9333 | 25.77 | 125 | 25.95 | 36.0 | Poreda et al. (1992) |
| 85-3014 | Gf | Vonarskarð | 64.5833 | -18.0167 | 20.5 | 54 | 20.87 | 2.57 | Poreda et al. (1992) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| I83-110 | Gf | Askja | 65.0500 | -16.8000 | 10.37 | 100 | 10.45 | 6.47 | Poreda et al. (1992) |
| I83-111 | Gf | Kverkfjöll | 64.6500 | -16.7167 | 8.47 | 100 | 8.54 | 5.80 | Poreda et al. (1992) |
| I83-112 | Gf | Kverkfjöll | 64.6500 | -16.7167 | 8.81 | 220 | 8.84 | 8.02 | Poreda et al. (1992) |
| I83-114 | Gf | Námafjall | 65.6333 | -16.8167 | 9.24 | 34 | 9.46 | 3.78 | Poreda et al. (1992) |
| I83-115 | Gf | Námafjall | 65.6333 | -16.8167 | 9.77 | 57 | 9.91 | 14.2 | Poreda et al. (1992) |
| 85-3020 | Gf | Námafjall | 65.6333 | -16.8000 | 8.8 | 9.8 | 9.68 | 3.97 | Poreda et al. (1992) |
| I83-113 | Gf | Krafla, Víti | 65.7167 | -16.7500 | 9.74 | 4000 | 9.74 | 21.4 | Poreda et al. (1992) |
| 85-3015 | Gf | Krafla | 65.7000 | -16.7333 | 9.44 | 320 | 9.46 | 10.7 | Poreda et al. (1992) |
| 85-3016 | Gf | Krafla | 65.7000 | -16.7333 | 9.41 | 840 | 9.42 | 15.3 | Poreda et al. (1992) |
| 85-3017 | Gf | Krafla | 65.7000 | -16.7333 | 9.48 | 1000 | 9.49 | 39.0 | Poreda et al. (1992) |
| 85-3019 | Gf | Krafla, Leirhnúkur | 65.7000 | -16.8167 | 9.36 | 200 | 9.4 | 21.4 | Poreda et al. (1992) |
| I85 | Gf | Ærlækjarsel | 66.1500 | -16.5333 | 10.05 | 40 | 10.28 | 175 | Poreda et al. (1992) |
| 85-3018 | Gf | Þeistareykir | 65.8833 | -16.9500 | 10.6 | 140 | 10.66 | 19.1 | Poreda et al. (1992) |
| 85-3088 | Gf | Þveit | 64.3500 | -15.2667 | 9.73 | 250 | 9.76 | 7.97 | Poreda et al. (1992) |
| 85-3089 | Gf | Bæjarstaðaskógur | 64.0667 | -17.0167 | 13.57 | 57 | 13.76 | 66.5 | Poreda et al. (1992) |
| 85-3086 | Gf | Seljavallalaug | 63.5667 | -19.6000 | 17.98 | 11.2 | 19.2 | 5.83 | Poreda et al. (1992) |
| 80 | Gf | Lagarfljót | 64.9167 | -15.0833 | 2.7 | 1.6 | 5 | 0.34 | Poreda et al. (1992) |
| MIDgl cr2 | Gl | Miðfell | 64.1667 | -21.0333 | 16.8 | | | 0.00089 | Burnard et al. (1994) |
| HENglb cr1 | Gl | Hengill | 64.0167 | -21.3833 | 16.8 | | | 0.0005 | Burnard et al. (1994) |
| HENglb cr2 | Gl | Hengill | 64.0167 | -21.3833 | 16.8 | | | 0.00018 | Burnard et al. (1994) |
| HENglb cr3 | Gl | Hengill | 64.0167 | -21.3833 | 16.8 | | | 0.000033 | Burnard et al. (1994) |
| NAL216 cr2 | Gl | Hvammsfjöll | 65.3500 | -16.6667 | 12.3 | | | 0.00009 | Burnard et al. (1994) |
| NAL281 cr4 | Gl | Herðubreiðarfjöll | 65.3667 | -16.3667 | 12.8 | | | 0.00006 | Burnard et al. (1994) |
| MIDol cr2 | Ph | Miðfell | 64.1667 | -21.0333 | 13.7 | | | 0.000009 | Burnard et al. (1994) |
| HENol cr2 | Ph | Hengill | 64.0167 | -21.3833 | 16.8 | | | 0.000006 | Burnard et al. (1994) |
| | Gf | Djúpidalur | 65.5833 | -22.2833 | 23.6 | 13.7 | 24.9 | 1580 | Hilton et al. (1998) |
| | Gf | Djúpidalur | 65.5833 | -22.2833 | 24.2 | 12.7 | 25.7 | 996 | Hilton et al. (1998) |
| | Gf | Flókalundur | 65.5833 | -23.1667 | 6.23 | 2.61 | 8.36 | 185 | Hilton et al. (1998) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| | Gf | Goðdalur | 65.8167 | -21.5833 | 3.42 | 1.06 | 9.48 | | Hilton et al. (1998) |
| | Gf | Goðdalur | 65.8167 | -21.5833 | 2.81 | 1.15 | 6.28 | 29 | Hilton et al. (1998) |
| | Gf | Gjögur | 66.0000 | -21.3333 | 15.8 | 24.4 | 16.3 | | Hilton et al. (1998) |
| | Gf | Gjögur | 66.0000 | -21.3333 | 14.8 | 20.7 | 15.3 | 473 | Hilton et al. (1998) |
| | Gf | Hörgshlíð | 65.8500 | -22.6167 | 16.9 | 3.45 | 21.3 | 119 | Hilton et al. (1998) |
| | Gf | Hörgshlíð | 65.8500 | -22.6167 | 16.6 | 5.32 | 19.2 | 203 | Hilton et al. (1998) |
| | Gf | Hveratunga | 65.8667 | -21.3667 | 4.21 | 1.62 | 7.02 | 28.1 | Hilton et al. (1998) |
| | Gf | Hveratunga | 65.8667 | -21.3667 | 4.31 | 1.53 | 7.56 | 26 | Hilton et al. (1998) |
| | Gf | Hveravík | 65.7000 | -21.5667 | 22.3 | 44.2 | 22.7 | 1206 | Hilton et al. (1998) |
| | Gf | Hveravík | 65.7000 | -21.5667 | 23.0 | 40.5 | 23.4 | 1113 | Hilton et al. (1998) |
| | Gf | Kirkjuból | 66.2500 | -22.1000 | 8.85 | 17.7 | 9.17 | | Hilton et al. (1998) |
| | Gf | Kirkjuból | 66.2500 | -22.1000 | 8.63 | 18 | 8.97 | 655 | Hilton et al. (1998) |
| | Gf | Kirkjuból | 66.2500 | -22.1000 | 8.6 | 17.7 | 8.94 | 480 | Hilton et al. (1998) |
| | Gf | Krossholt | 65.4833 | -23.2667 | 9.22 | 4.62 | 10.8 | 482 | Hilton et al. (1998) |
| | Gf | Krossnes | 66.0500 | -21.5000 | 24.1 | 42.6 | 24.5 | | Hilton et al. (1998) |
| | Gf | Krossnes | 66.0500 | -21.5000 | 23.9 | 3.43 | 30.4 | 918 | Hilton et al. (1998) |
| | Gf | Krossnes | 66.0500 | -21.5000 | 25.3 | 13.1 | 26.8 | | Hilton et al. (1998) |
| | Gf | Krossnes | 66.0500 | -21.5000 | 24.2 | 7.98 | 26.6 | 504 | Hilton et al. (1998) |
| | Gf | Krossnes | 66.0500 | -21.5000 | 25.2 | 7.82 | 27.8 | 518 | Hilton et al. (1998) |
| | Gf | Laugaland | 66.0167 | -22.3833 | 3.4 | 4.06 | 3.95 | | Hilton et al. (1998) |
| | Gf | Laugaland | 66.0167 | -22.3833 | 3.34 | 3.98 | 3.89 | | Hilton et al. (1998) |
| | Gf | Laugaland | 66.0167 | -22.3833 | 2.9 | 2.51 | 3.72 | 181 | Hilton et al. (1998) |
| | Gf | Laugarhóll | 65.7833 | -21.5167 | 8.44 | 1.95 | 13.2 | | Hilton et al. (1998) |
| | Gf | Laugardalsá | 65.6500 | -23.9000 | 12.5 | 1.71 | 21.6 | 73.8 | Hilton et al. (1998) |
| | Gf | Laugardalsá | 65.6500 | -23.9000 | 15.2 | 2.39 | 21.8 | 134 | Hilton et al. (1998) |
| | Gf | Reykhólar | 65.4500 | -22.2167 | 15.2 | 22.3 | 15.7 | | Hilton et al. (1998) |
| | Gf | Reykhólar | 65.4500 | -22.2167 | 16.9 | 21.4 | 17.4 | | Hilton et al. (1998) |
| | Gf | Reykjanes | 65.9333 | -22.4333 | 2.08 | 1.48 | 3.21 | 37.9 | Hilton et al. (1998) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| | Gf | Reykjanes | 65.9333 | -22.4333 | 2.36 | 2.09 | 3.14 | 36.3 | Hilton et al. (1998) |
| | Gf | Reykjafjörður | 65.6167 | -23.4667 | 3.82 | 1.14 | 9.36 | | Hilton et al. (1998) |
| | Gf | Reykjafjörður | 65.6167 | -23.4667 | 4.29 | 1.5 | 7.66 | 35.9 | Hilton et al. (1998) |
| Dice 11 | Gl | Dagmálafell | 64.1769 | -21.0503 | 16.59 | | | 5630 | Harrison et al. (1999) |
| Dice 10 | Gl | Dagmálafell | 64.1769 | -21.0503 | 17.46 | | | 1290 | Harrison et al. (1999) |
| SE13 | Ph | Selárdalur | 65.7667 | -24.0000 | 37.3 | | | 1.21 | Hilton et al. (1999) |
| SE-21 | Ph | Selárdalur | 65.7667 | -24.0000 | 18.8 | | | 0.6 | Hilton et al. (1999) |
| 3951 | Ph | Selárdalur | 65.7667 | -24.0000 | 37.7 | | | 0.89 | Hilton et al. (1999) |
| 3951 | Ph | Selárdalur | 65.7667 | -24.0000 | 30.1 | | | 1.2 | Hilton et al. (1999) |
| SEL97 | Ph | Selárdalur | 65.7667 | -24.0000 | 35.7 | | | 0.37 | Hilton et al. (1999) |
| SEL97 | Ph | Selárdalur | 65.7667 | -24.0000 | 37.5 | | | 6.5 | Hilton et al. (1999) |
| 408709 | Gl | Kistufell | 64.7939 | -17.1819 | 15.65 | | | 293 | Breddam et al. (2000) |
| 408710 | Gl | Kistufell | 64.7939 | -17.1806 | 15.79 | | | 39.2 | Breddam et al. (2000) |
| 408706 | Gl | Kistufell | 64.7958 | -17.1811 | 15.33 | | | 162 | Breddam et al. (2000) |
| 408707 | Gl | Kistufell | 64.7958 | -17.1811 | 15.69 | | | 480 | Breddam et al. (2000) |
| 408712 | Gl | Kistufell | 64.8033 | -17.2153 | 16.79 | | | 261 | Breddam et al. (2000) |
| 408702 | Gl | Kambsfell | 64.8297 | -17.7681 | 20.37 | | | 440 | Breddam et al. (2000) |
| 408713 | Gl | Dyngjufjöll Ytri | 65.1656 | -16.9250 | 19.58 | | | 86 | Breddam et al. (2000) |
| 408714 | Gl | Dyngjufjöll Ytri | 65.1658 | -16.9308 | 19.53 | | | 85.1 | Breddam et al. (2000) |
| 408730 | Gl | Bláfjall | 65.4903 | -16.8519 | 10.54 | | | 281 | Breddam et al. (2000) |
| 408729 | Gl | Bláfjall | 65.4911 | -16.8492 | 10.76 | | | 92.7 | Breddam et al. (2000) |
| 408732 | Gl | Bláfjall | 65.5194 | -16.8450 | 13.38 | | | 18.66 | Breddam et al. (2000) |
| 408718 | Gl | Gæsafjöll | 65.7544 | -16.9258 | 11.56 | | | 13.34 | Breddam et al. (2000) |
| 408719 | Gl | Gæsafjöll | 65.7544 | -16.9258 | 12.34 | | | 58.2 | Breddam et al. (2000) |
| 408722 | Gl | Gæsafjöll | 65.7592 | -16.9239 | 11.49 | | | 5.72 | Breddam et al. (2000) |
| 408723 | Gl | Gæsafjöll | 65.7592 | -16.9239 | 11.63 | | | 31.1 | Breddam et al. (2000) |
| sk82-05 | Gl | SW of Blágnípa | 64.7300 | -19.1800 | 20.9 | | | 143 | Breddam et al. (2000) |
| sk82-06 | Gl | SW of Blágnípa | 64.7300 | -19.1800 | 20.0 | | | 1110 | Breddam et al. (2000) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| sk82-13 | Gl | Þríhyrningur | 63.7800 | -19.9500 | 26.2 | | | 455 | Breddam et al. (2000) |
| sk82-27 | Gl | Sigalda | 64.1500 | -19.9167 | 20.8 | | | 175 | Breddam et al. (2000) |
| sk82-28 | Gl | Kálfstindar | 64.2400 | -20.7400 | 14.2 | | | 1630 | Breddam et al. (2000) |
| sk82-29 | Gl | Stapafell | 63.9000 | -22.5300 | 13.9 | | | 1430 | Breddam et al. (2000) |
| 207901 | Ph | Háleyjabunga | 63.8167 | -22.6333 | 10.89 | | | 0.52 | Breddam et al. (2000) |
| 208222 | Ph | Vatnsheiði | 63.8389 | -22.3942 | 11.65 | | | 4.26 | Breddam et al. (2000) |
| 408672 | Ph | Lagafell | 63.8811 | -22.5394 | 14.09 | | | 1.53 | Breddam et al. (2000) |
| 408634 | Ph | Þeistareykir | 65.9353 | -17.0778 | 8.16 | | | 0.49 | Breddam et al. (2000) |
| 408635 | Ph | Þeistareykir | 65.9369 | -17.0800 | 9.47 | | | 2.69 | Breddam et al. (2000) |
| 408643 | Ph | Þeistareykir | 65.9467 | -17.1419 | 8.92 | | | 0.3 | Breddam et al. (2000) |
| 408640 | Ph | Þeistareykir | 65.9611 | -17.0756 | 9.75 | | | 42.6 | Breddam et al. (2000) |
| 408647 | Ph | Þeistareykir | 65.9625 | -16.9039 | 7.99 | | | 2.59 | Breddam et al. (2000) |
| ice-9a | Ph | Búrfell í Ölfusi | 64.1833 | -21.0667 | 20.0 | | | 8.5 | Dixon et al. (2000) |
| ice-9b | Ph | Búrfell í Ölfusi | 64.1833 | -21.0667 | 29.0 | | | 9.3 | Dixon et al. (2000) |
| ice-9c | Ph | Búrfell í Ölfusi | 64.1833 | -21.0667 | 17.0 | | | 7.9 | Dixon et al. (2000) |
| ice-9d | Ph | Búrfell í Ölfusi | 64.1833 | -21.0667 | 20.0 | | | 11.7 | Dixon et al. (2000) |
| ice-18b | Ph | Stapafell | 63.9167 | -22.5333 | 16.0 | | | 9.7 | Dixon et al. (2000) |
| ice-19a | Ph | Súlur | 63.9000 | -22.5333 | 17.0 | | | 11 | Dixon et al. (2000) |
| ice-19b | Ph | Súlur | 63.9000 | -22.5333 | 15.0 | | | 14.5 | Dixon et al. (2000) |
| ice-30 | Ph | Landmannahellir | 64.2167 | -20.9000 | 14.2 | | | 8.5 | Dixon et al. (2000) |
| ice32.1a | Ph | Svartengisfell | 63.8833 | -22.4333 | 15.0 | | | 18.7 | Dixon et al. (2000) |
| ice34-a | Ph | Ísólfsskáli | 63.8608 | -22.3178 | 12.0 | | | 3.9 | Dixon et al. (2000) |
| ice-9g1 | Gl | Búrfell í Ölfusi | 64.1833 | -21.0667 | 17.0 | | | 932.7 | Dixon et al. (2000) |
| ice9g2 | Gl | Búrfell í Ölfusi | 64.1833 | -21.0667 | 19.0 | | | 6237.5 | Dixon et al. (2000) |
| ice9g3 | Gl | Búrfell í Ölfusi | 64.1833 | -21.0667 | 19.0 | | | 2377.2 | Dixon et al. (2000) |
| ice-18g2 | Gl | Stapafell | 63.9167 | -22.5333 | 14.0 | | | 52 | Dixon et al. (2000) |
| ice-18g3 | Gl | Stapafell | 63.9167 | -22.5333 | 14.0 | | | 61.9 | Dixon et al. (2000) |
| ice32.2g1 | Gl | Svartengisfell | 63.8833 | -22.4333 | 13.0 | | | 39.1 | Dixon et al. (2000) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| ice-32.2g2 | Gl | Svartengisfell | 63.8833 | -22.4333 | 18.0 | | | 17.3 | Dixon et al. (2000) |
| ice-47g | Gl | Sigalda | 64.1667 | -19.1667 | 20.0 | | | 292.8 | Dixon et al. (2000) |
| ice-54g | Gl | Lambafell | 64.0167 | -21.4667 | 19.0 | | | 21.4 | Dixon et al. (2000) |
| ice-55g | Gl | Kóngsgil | 64.0333 | -21.4167 | 20.0 | | | 27 | Dixon et al. (2000) |
| Dice 10 | Gl | Dagmálafell | 64.1769 | -21.0503 | 17.2 | | | | Trieloff et al. (2000) |
| Dice 11 | Gl | Dagmálafell | 64.1769 | -21.0503 | 17.39 | | | | Trieloff et al. (2000) |
| KBD 408 702 | Gl | Kambsfell | 64.8297 | -17.7681 | 20.6 | | | 430 | Moreira et al. (2001) |
| KBD 408 706 | Gl | Kistufell | 64.7958 | -17.1811 | 15.5 | | | 10000 | Moreira et al. (2001) |
| KBD 408 707 | Gl | Kistufell | 64.7958 | -17.1811 | 16.1 | | | 1200 | Moreira et al. (2001) |
| KBD 408 709 | Gl | Kistufell | 64.7939 | -17.1819 | 16.0 | | | 1600 | Moreira et al. (2001) |
| KBD 408 730 | Gl | Bláfjall | 65.4903 | -16.8519 | 10.0 | | | 290 | Moreira et al. (2001) |
| SK 82-13 | Gl | Þríhyrningur | 63.7800 | -19.9500 | 25.6 | | | 304 | Moreira et al. (2001) |
| SK 82-28 | Gl | Kálfstindar | 64.2400 | -20.7400 | 14.3 | | | 2860 | Moreira et al. (2001) |
| ice-1a | Ph | Miðfell | 64.1760 | -21.0570 | 18.0 | | | 2.9 | Dixon (2003) |
| ice-1b | Ph | Miðfell | 64.1760 | -21.0570 | 21.0 | | | 5 | Dixon (2003) |
| ice-2.2a | Ph | Sandfell | 64.1100 | -21.1990 | 14.0 | | | 0.7 | Dixon (2003) |
| ice-2.2b | Ph | Sandfell | 64.1100 | -21.1990 | 11.0 | | | 2.5 | Dixon (2003) |
| ice-10.2 | Ph | Mælifell | 64.1040 | -21.2020 | 16.0 | | | 5.8 | Dixon (2003) |
| ice-11.2 | Ph | Sandfell | 64.1100 | -21.1990 | 17.0 | | | 6.9 | Dixon (2003) |
| ice-16 | Ph | Eldborg | 63.8570 | -22.0050 | 18.0 | | | 12.3 | Dixon (2003) |
| ice-25 | Ph | Bleikhóll | 63.8630 | -22.3560 | 16.0 | | | 11.2 | Dixon (2003) |
| VEY/1 | Ph | Valseyri | 65.8500 | -23.2500 | 32.7 | | | | Ellam & Stuart (2004) |
| SKI/NWP | Ph | Sauðanes/Skagafjall | 65.9833 | -23.7333 | 35.1 | | | | Ellam & Stuart (2004) |
| SDA1 | Ph | Selárdalur | 65.7500 | -24.0333 | 37.0 | | | | Ellam & Stuart (2004) |
| ED1 | Ph | Hestur | 65.5000 | -24.3000 | 30.0 | | | | Ellam & Stuart (2004) |
| VP/1 | Ph | Vopnafjörður | 65.7500 | -14.8333 | 14.6 | | | | Ellam & Stuart (2004) |
| DICE5 | Gl | SW of Mælifell | 64.0964 | -21.2019 | 12.7 | | | 88 | Burnard & Harrison-(2005) |
| DICE7 | Gl | Bæjarfjall | 64.1061 | -21.1711 | 13.1 | | | 234 | Burnard & Harrison-(2005) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| DICE8 | Gl | Ölfusvatnsfjöll | 64.1303 | -21.1311 | 15.6 | | | 21 | Burnard & Harrison-(2005) |
| DICE10 | Gl | Dagmálafell | 64.1769 | -21.0503 | 17.8 | | | 1285 | Burnard & Harrison-(2005) |
| DICE13 | Gl | Kálfstindar | 64.2311 | -20.9311 | 17.1 | | | 2 | Burnard & Harrison-(2005) |
| DICE15 | Gl | Kálfstindar | 64.2311 | -20.9311 | 17.0 | | | 12 | Burnard & Harrison-(2005) |
| DICE9 | Gl | Arnafell | 64.2158 | -21.0728 | 20.2 | | | 7 | Burnard & Harrison-(2005) |
| DICE43 | Gl | Hrómundartindur | 64.0842 | -21.1892 | 17.7 | | | 120 | Burnard & Harrison-(2005) |
| MAE | Gl | Mælifell | 64.1061 | -21.1833 | 13.4 | | | 113 | Burnard & Harrison-(2005) |
| DICE11 | Gl | Dagmálafell | 64.1769 | -21.0503 | 17.2 | | | 5630 | Burnard & Harrison-(2005) |
| Th-29 | Ph | Þeistareykir | 65.8833 | -16.8333 | 12.2 | | | 1.3 | Macpherson et al. (2005) |
| NAL-611 | Ph | Kistufell | 64.8000 | -17.2333 | 16.6 | | | 1 | Macpherson et al. (2005) |
| NAL-688 | Ph | Eggert | 65.2500 | -16.4833 | 8.0 | | | 1.2 | Macpherson et al. (2005) |
| NAL-688 | Ph | Eggert | 65.2500 | -16.4833 | 5.9 | | | 1.3 | Macpherson et al. (2005) |
| NAL-239 | Ph | Ketildyngja | 65.4500 | -16.7167 | 10.6 | | | 7 | Macpherson et al. (2005) |
| NAL-625 | Ph | Vaðalda | 64.9333 | -16.4667 | 34.3 | | | 0.4 | Macpherson et al. (2005) |
| NAL-625 | Ph | Vaðalda | 64.9333 | -16.4667 | 30.5 | | | 0.2 | Macpherson et al. (2005) |
| NAL-625 | Ph | Vaðalda | 64.9333 | -16.4667 | 20.2 | | | 0.4 | Macpherson et al. (2005) |
| #9613 | Ph | Ódáðahraun | 65.1500 | -16.5333 | 7.6 | | | 1.2 | Macpherson et al. (2005) |
| TRO-53 | Ph | Trölladyngja | 64.9000 | -17.1000 | 8.3 | | | 0.3 | Macpherson et al. (2005) |
| NAL-626 | Ph | Fjallsendi | 65.0500 | -17.0833 | 17.3 | | | 17.4 | Macpherson et al. (2005) |
| THJOR | Ph | Þjórsárdalur | 64.1333 | -20.1667 | 18.3 | | | 3.2 | Macpherson et al. (2005) |
| Herðubreið | Gl | Herðubreið | 65.1667 | -16.3500 | 9.1 | | | 44.5 | Macpherson et al. (2005) |
| NAL-496 | Gl | Gæsahnjúkur | 64.7667 | -17.4833 | 17.6 | | | 2.5 | Macpherson et al. (2005) |
| SAL-306 | Gl | Bárðarbunga | 64.7000 | -17.5833 | 21.9 | | | 8.8 | Macpherson et al. (2005) |
| NAL-688 | Gl | Eggert | 65.2500 | -16.4833 | 8.9 | | | 127 | Macpherson et al. (2005) |
| NAL-688 | Gl | Eggert | 65.2500 | -16.4833 | 8.8 | | | 85 | Macpherson et al. (2005) |
| NAL-355 | Gl | Upptyppingar | 65.0333 | -16.2333 | 8.8 | | | 31 | Macpherson et al. (2005) |
| NAL-356 | Gl | Upptyppingar | 65.0333 | -16.2333 | 8.5 | | | 58.2 | Macpherson et al. (2005) |
| NAL-355/6 | Gl | Upptyppingar | 65.0333 | -16.2333 | 8.9 | | | 22.3 | Macpherson et al. (2005) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| KVK-169 | Gl | Jarðfræðingaslóð | 64.7667 | -16.5000 | 8.5 | | | 8.9 | Macpherson et al. (2005) |
| NAL-357 | Gl | Upptyppingar | 65.0333 | -16.2333 | 5.0 | | | 0.6 | Macpherson et al. (2005) |
| KVK-147 | Gl | Hvannalindir | 64.8667 | -16.3500 | 2.6 | | | 0.8 | Macpherson et al. (2005) |
| KVK-168 | Gl | Jarðfræðingaslóð | 64.7667 | -16.6333 | 1.6 | | | 3.8 | Macpherson et al. (2005) |
| SAL-575 | Gl | Sólheimajökull | 63.5333 | -19.3833 | 14.6 | | | 1.5 | Macpherson et al. (2005) |
| IC02-16-19084 | Ph | Lambahraun | 64.3843 | -20.5549 | 13.6 | | | 0.34 | Licciardi et al. (2006) |
| IC02-17-17338 | Ph | Lambahraun | 64.3836 | -20.5564 | 13.4 | | | 0.2 | Licciardi et al. (2006) |
| IC02-19-19323 | Ph | Lambahraun | 64.3644 | -20.5531 | 12.7 | | | 0.59 | Licciardi et al. (2006) |
| IC02-20-16373 | Ph | Lambahraun | 64.3629 | -20.5514 | 13.7 | | | 0.11 | Licciardi et al. (2006) |
| LEIT-1-1067 | Ph | Leitahraun | 63.9726 | -21.4674 | 13.8 | | | 1.68 | Licciardi et al. (2006) |
| LEIT-2-1374 | Ph | Leitahraun | 63.9738 | -21.4671 | 13.9 | | | 0.7 | Licciardi et al. (2006) |
| LEIT-3-1191 | Ph | Leitahraun | 63.9765 | -21.4783 | 15.3 | | | 2.29 | Licciardi et al. (2006) |
| LEIT-4-1131 | Ph | Leitahraun | 63.9822 | -21.4773 | 14.2 | | | 0.6 | Licciardi et al. (2006) |
| LEIT-5-1315 | Ph | Leitahraun | 63.9839 | -21.4727 | 13.2 | | | 1.87 | Licciardi et al. (2006) |
| LEIT-5-1129 | Ph | Leitahraun | 63.9838 | -21.4727 | 15.8 | | | 0.88 | Licciardi et al. (2006) |
| BUR-1-2410 | Ph | Búrfellshraun | 64.0592 | -21.8744 | 14.0 | | | 0.41 | Licciardi et al. (2006) |
| BUR-2-2401 | Ph | Búrfellshraun | 64.0892 | -21.9679 | 12.9 | | | 0.56 | Licciardi et al. (2006) |
| BUR-3-2713 | Ph | Búrfellshraun | 64.0896 | -21.9690 | 12.5 | | | 2.66 | Licciardi et al. (2006) |
| BUR-3-2780 | Ph | Búrfellshraun | 64.0896 | -21.9690 | 11.4 | | | 0.08 | Licciardi et al. (2006) |
| BUR-4-2585 | Ph | Búrfellshraun | 64.0917 | -21.9704 | 13.5 | | | 0.21 | Licciardi et al. (2006) |
| BUR-4-2854 | Ph | Búrfellshraun | 64.0917 | -21.9704 | 14.7 | | | 1.35 | Licciardi et al. (2006) |
| BUR-5-2732 | Ph | Búrfellshraun | 64.0935 | -21.9685 | 13.1 | | | 0.26 | Licciardi et al. (2006) |
| BUR-6-2792 | Ph | Búrfellshraun | 64.0871 | -21.9689 | 13.5 | | | 0.56 | Licciardi et al. (2006) |
| IC02-1-18787 | Ph | Þingvallahraun | 64.1645 | -21.0369 | 14.5 | | | 1.69 | Licciardi et al. (2006) |
| IC02-7-10543 | Ph | Þingvallahraun | 64.1649 | -21.0368 | 11.0 | | | 0.43 | Licciardi et al. (2006) |
| IC02-10-25131 | Ph | Þingvallahraun | 64.1562 | -21.0480 | 15.1 | | | 0.87 | Licciardi et al. (2006) |
| IC02-11-17430 | Ph | Þingvallahraun | 64.1561 | -21.0480 | 14.5 | | | 0.27 | Licciardi et al. (2006) |
| ICE 3 | Gl | Stapafell | 63.9106 | -22.5224 | 13.9 | | | 1430 | Brandon et al. (2007) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| Ice 5 | Gl | Dagmálafell | 64.1747 | -21.0485 | 17.2 | | | 2560 | Brandon et al. (2007) |
| DMF 9101 | Gl | Dagmálafell | 64.1747 | -21.0467 | 16.5 | | | 512 | Brandon et al. (2007) |
| DMF 9101 | Gl | Dagmálafell | 64.1747 | -21.0467 | 17.53 | | | 258 | Brandon et al. (2007) |
| ICE 0 | Ph | Hrúthálsar | 65.3250 | -16.5000 | 9.62 | | | 1.14 | Brandon et al. (2007) |
| ICE 2 | Ph | Lagafell | 63.8851 | -22.5367 | 11.18 | | | 3.9 | Brandon et al. (2007) |
| ICE 2 | Ph | Lagafell | 63.8850 | -22.5367 | 14.09 | | | 1.53 | Brandon et al. (2007) |
| ICE 4a | Ph | Mælifell | 64.1114 | -21.1959 | 11.46 | | | 5.36 | Brandon et al. (2007) |
| ICE 5 | Ph | Dagmálafell | 64.1747 | -21.0485 | 16.62 | | | 12.2 | Brandon et al. (2007) |
| DMF 9101 | Ph | Dagmálafell | 64.1747 | -21.0467 | 16.4 | | | 11.7 | Brandon et al. (2007) |
| ICE 8b | Ph | Skriðufell | 64.1168 | -19.9469 | 17.3 | | | 37.3 | Brandon et al. (2007) |
| ICE 10 | Ph | Hrúðurkarlarnir | 64.5211 | -20.8760 | 12.76 | | | 1.16 | Brandon et al. (2007) |
| 9805 | Ph | Háleyjabunga | 63.8197 | -22.6525 | 10.89 | | | 0.52 | Brandon et al. (2007) |
| 9806 | Ph | Vatnsheiði | 63.8442 | -22.3914 | 11.65 | | | 4.26 | Brandon et al. (2007) |
| 9809 | Ph | Fagradalshraun | 63.9117 | -22.2947 | 12.74 | | | 1.92 | Brandon et al. (2007) |
| 9810 | Ph | Eldborg | 63.8558 | -22.0020 | 19.0 | | | 13 | Brandon et al. (2007) |
| 9812 | Ph | Ásar | 63.9089 | -21.3978 | 16.8 | | | 0.61 | Brandon et al. (2007) |
| 9815 | Ph | Lyngfell | 63.8586 | -22.3120 | 15.83 | | | 3.48 | Brandon et al. (2007) |
| IC02-60 | Ph | Herðubreið | 65.1782 | -16.3614 | 12.4 | | | 0.52 | Licciardi et al. (2007) |
| IC02-61 | Ph | Herðubreið | 65.1770 | -16.3588 | 11.0 | | | 0.44 | Licciardi et al. (2007) |
| IC02-62 | Ph | Herðubreið | 65.1773 | -16.3587 | 10.8 | | | 0.51 | Licciardi et al. (2007) |
| IC04-19 | Ph | Herðubreið | 65.1747 | -16.3465 | 7.8 | | | 0.15 | Licciardi et al. (2007) |
| IC04-20 | Ph | Herðubreið | 65.1838 | -16.3391 | 8.7 | | | 0.2 | Licciardi et al. (2007) |
| IC04-21 | Ph | Herðubreið | 65.1833 | -16.3370 | 5.0 | | | 0.35 | Licciardi et al. (2007) |
| IC03-29 | Ph | Bláfjall | 65.4434 | -16.8587 | 10.1 | | | 4.52 | Licciardi et al. (2007) |
| IC03-30 | Ph | Bláfjall | 65.4551 | -16.8678 | 11.1 | | | 2.18 | Licciardi et al. (2007) |
| IC03-31 | Ph | Bláfjall | 65.4568 | -16.8661 | 9.9 | | | 1.63 | Licciardi et al. (2007) |
| IC03-32 | Ph | Bláfjall | 65.4588 | -16.8565 | 11.3 | | | 0.6 | Licciardi et al. (2007) |
| IC03-25 | Ph | Búrfell | 65.5510 | -16.6429 | 10.6 | | | 4.18 | Licciardi et al. (2007) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| IC03-26 | Ph | Búrfell | 65.5501 | -16.6507 | 11.4 | | | 4.49 | Licciardi et al. (2007) |
| IC03-27 | Ph | Búrfell | 65.5486 | -16.6483 | 11.2 | | | 11.5 | Licciardi et al. (2007) |
| IC03-28 | Ph | Búrfell | 65.5488 | -16.6431 | 10.8 | | | 8.54 | Licciardi et al. (2007) |
| IC02-52 | Ph | Gæsafjöll | 65.7838 | -16.8822 | 10.5 | | | 5.61 | Licciardi et al. (2007) |
| IC02-53 | Ph | Gæsafjöll | 65.7847 | -16.8839 | 7.2 | | | 0.71 | Licciardi et al. (2007) |
| IC02-54 | Ph | Gæsafjöll | 65.7856 | -16.8709 | 12.7 | | | 1.12 | Licciardi et al. (2007) |
| IC02-55 | Ph | Gæsafjöll | 65.7848 | -16.8710 | 12.4 | | | 1.54 | Licciardi et al. (2007) |
| IC02-56 | Ph | Gæsafjöll | 65.7868 | -16.8926 | 11.4 | | | 0.12 | Licciardi et al. (2007) |
| IC02-57 | Ph | Gæsafjöll | 65.7867 | -16.9071 | 13.3 | | | 1.49 | Licciardi et al. (2007) |
| IC03-22 | Ph | Hafrafell | 66.0500 | -16.3452 | 21.0 | | | 3.84 | Licciardi et al. (2007) |
| IC03-23 | Ph | Hafrafell | 66.0503 | -16.3464 | 21.4 | | | 2.32 | Licciardi et al. (2007) |
| IC03-19 | Ph | Sandfell | 66.1145 | -16.3271 | 21.6 | | | 2.85 | Licciardi et al. (2007) |
| IC03-20 | Ph | Sandfell | 66.1161 | -16.3353 | 20.2 | | | 2.3 | Licciardi et al. (2007) |
| IC03-21 | Ph | Sandfell | 66.1171 | -16.3466 | 21.0 | | | 1.24 | Licciardi et al. (2007) |
| IC02-58 | Ph | Snarstaðarnúpur | 66.3525 | -16.4723 | 22.7 | | | 0.84 | Licciardi et al. (2007) |
| IC02-63 | Ph | Hlöðufell | 64.4171 | -20.5379 | 8.9 | | | 0.75 | Licciardi et al. (2007) |
| IC02-64 | Ph | Hlöðufell | 64.4180 | -20.5340 | 13.4 | | | 0.07 | Licciardi et al. (2007) |
| IC02-65 | Ph | Hlöðufell | 64.4180 | -20.5380 | 12.9 | | | 1.83 | Licciardi et al. (2007) |
| IC04-6 | Ph | Högnhöfði | 64.3583 | -20.4996 | 17.0 | | | 2.94 | Licciardi et al. (2007) |
| IC04-8 | Ph | Högnhöfði | 64.3574 | -20.4998 | 16.9 | | | 0.73 | Licciardi et al. (2007) |
| IC04-11 | Ph | Skriða | 64.3557 | -20.6842 | 14.0 | | | 0.41 | Licciardi et al. (2007) |
| IC04-12 | Ph | Skriða | 64.3537 | -20.6819 | 13.7 | | | 0.98 | Licciardi et al. (2007) |
| IC03-14 | Ph | Rauðafell | 64.3234 | -20.5818 | 2.5 | | | 5.59 | Licciardi et al. (2007) |
| IC03-15 | Ph | Rauðafell | 64.3248 | -20.5785 | 12.4 | | | 0.38 | Licciardi et al. (2007) |
| IC03-16 | Ph | Rauðafell | 64.3248 | -20.5782 | 10.8 | | | 0.68 | Licciardi et al. (2007) |
| IC03-11 | Ph | Hvalfell | 64.3848 | -21.1945 | 16.1 | | | 0.23 | Licciardi et al. (2007) |
| IC03-12 | Ph | Hvalfell | 64.3876 | -21.2010 | 13.7 | | | 0.09 | Licciardi et al. (2007) |
| IC03-13 | Ph | Hvalfell | 64.3886 | -21.2055 | 12.0 | | | 0.66 | Licciardi et al. (2007) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| IC03-6 | Ph | Geitafell | 63.9410 | -21.5226 | 16.7 | | | 1.62 | Licciardi et al. (2007) |
| IC03-7 | Ph | Geitafell | 63.9421 | -21.5216 | 17.3 | | | 1.03 | Licciardi et al. (2007) |
| IC03-8 | Ph | Geitafell | 63.9405 | -21.5235 | 16.5 | | | 1.2 | Licciardi et al. (2007) |
| HAIN | Ph | Heimaey | 63.4000 | -20.3000 | 11.05 | | | 2.95 | Debaille et al. (2009) |
| SAL690 | Ph | Katla | 63.6700 | -18.8300 | 16.78 | | | 10.7 | Debaille et al. (2009) |
| SAL690B | Ph | Katla | 63.6700 | -18.8300 | 18.06 | | | 4.75 | Debaille et al. (2009) |
| SAL768 | Ph | Öræfajökull | 63.9000 | -16.6000 | 7.69 | | | 13.6 | Debaille et al. (2009) |
| NAL759 | Ph | Snæfell | 64.8000 | -15.5700 | 7.06 | | | 8.58 | Debaille et al. (2009) |
| ICE-3 | Gf | Nesjavellir | 64.0960 | -21.2800 | 14.75 | 839 | 14.77 | | Füri et al. (2010) |
| ICE08-11 | Gf | Nesjavellir | 64.0935 | -21.4412 | 13.97 | 84.5 | 14.13 | | Füri et al. (2010) |
| ICE08-12 | Gf | Nesjavellir | 64.0935 | -21.4412 | 13.48 | 59 | 13.69 | | Füri et al. (2010) |
| ICE-5 | Gf | Svartsengi | 63.8758 | -22.4352 | 14.67 | 383 | 14.7 | | Füri et al. (2010) |
| ICE-6 | Gf | Svartsengi | 63.8758 | -22.4352 | 14.24 | 214 | 14.3 | | Füri et al. (2010) |
| PBICE-1 | Gf | Reykjanes | 63.8185 | -22.6846 | 8.99 | 10.1 | 9.69 | | Füri et al. (2010) |
| PBICE-2 | Gf | Reykjanes | 63.8185 | -22.6846 | 11.91 | 137 | 11.97 | | Füri et al. (2010) |
| PBICE-3 | Gf | Krísuvík | 63.8953 | -22.0553 | 13.87 | 194 | 13.92 | | Füri et al. (2010) |
| PBICE-4 | Gf | Krísuvík | 63.8953 | -22.0553 | 2.62 | 2.3 | 3.5 | | Füri et al. (2010) |
| ICE08-14 | Gf | Krísuvík | 63.8953 | -22.0554 | 13.83 | 63.3 | 14.03 | | Füri et al. (2010) |
| ICE08-15 | Gf | Krísuvík | 63.8953 | -22.0554 | 13.89 | 205 | 13.95 | | Füri et al. (2010) |
| PBICE-9 | Gf | Hengill | 64.0200 | -21.3949 | 12.27 | 14.7 | 12.39 | | Füri et al. (2010) |
| PBICE-12 | Gf | Hengill | 64.0200 | -21.3949 | 12.67 | 19.3 | 13.18 | | Füri et al. (2010) |
| ICE08-22 | Gf | Hengill | 64.0069 | -21.3418 | 15.69 | 84.7 | 15.86 | | Füri et al. (2010) |
| PBICE-13 | Gf | Little Geysir | 64.3107 | -20.3024 | 16.59 | 72.8 | 16.77 | | Füri et al. (2010) |
| PBICE-14 | Gf | Little Geysir | 64.3107 | -20.3024 | 15.99 | 70 | 16.17 | | Füri et al. (2010) |
| PBICE-10 | Gf | Kerlingarfjöll | 64.6436 | -19.2881 | 14.22 | 28.7 | 14.61 | | Füri et al. (2010) |
| PBICE-11 | Gf | Hveravellir | 64.8654 | -19.5583 | 13.68 | 32.1 | 14.01 | | Füri et al. (2010) |
| PBICE-16 | Gf | Hveragerði | 64.0223 | -21.1940 | 16.89 | 51.1 | 17.15 | | Füri et al. (2010) |
| PBICE-8 | Gf | Hveragerði | 64.0223 | -21.1940 | 17.08 | 40.7 | 17.41 | | Füri et al. (2010) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| PBICE-5 | Gf | Landmannalaugar | 63.9812 | -19.0893 | 1.26 | 2.5 | 1.39 | | Füri et al. (2010) |
| ICE08-26 | Gf | Landmannalaugar | 63.9924 | -19.1005 | 1.24 | 3.4 | 1.35 | 17.5 | Füri et al. (2010) |
| ICE08-29 | Gf | Landmannalaugar | 63.9892 | -19.1117 | 3.28 | 4.6 | 3.92 | | Füri et al. (2010) |
| ICE08-30 | Gf | Landmannalaugar | 63.9908 | -19.0629 | 4.28 | 3.4 | 5.64 | 680.1 | Füri et al. (2010) |
| ICE08-17 | Gf | Köldukvíslarbotnar | 64.5709 | -18.1111 | 3.04 | 3 | 4.05 | 6.3 | Füri et al. (2010) |
| ICE08-18 | Gf | Köldukvíslarbotnar | 64.5709 | -18.1111 | 2.19 | 4.7 | 2.51 | 10.9 | Füri et al. (2010) |
| ICE08-16 | Gf | Vonarskarð | 64.6923 | -17.8965 | 17.27 | 33.4 | 17.77 | | Füri et al. (2010) |
| ICE08-21 | Gf | Vonarskarð | 64.6923 | -17.8965 | 18.86 | 50.5 | 19.22 | | Füri et al. (2010) |
| ICE08-13 | Gf | Vonarskarð | 64.6908 | -17.8816 | 15.41 | 11.8 | 16.74 | 191.9 | Füri et al. (2010) |
| ICE-11 | Gf | Krafla | 65.7045 | -16.7451 | 8.86 | 72.1 | 8.97 | | Füri et al. (2010) |
| ICE-12 | Gf | Krafla | 65.7045 | -16.7451 | 8.75 | 121 | 8.81 | | Füri et al. (2010) |
| ICE-10 | Gf | Krafla | 65.7087 | -16.7608 | 5.58 | 7.94 | 6.24 | | Füri et al. (2010) |
| ICE-17 | Gf | Krafla | 65.7087 | -16.7608 | 8.84 | 158 | 8.89 | | Füri et al. (2010) |
| PBICE-20 | Gf | Krafla | 65.7217 | -16.7876 | 8.36 | 144 | 8.4 | | Füri et al. (2010) |
| ICE08-06 | Gf | Krafla | 65.7217 | -16.7876 | 8.89 | 314 | 8.91 | | Füri et al. (2010) |
| ICE08-10 | Gf | Krafla | 65.7194 | -16.7882 | 10.36 | 2361 | 10.36 | | Füri et al. (2010) |
| PBICE-15 | Gf | Námafjall | 65.6418 | -16.8099 | 3.1 | 4 | 3.63 | | Füri et al. (2010) |
| ICE08-03 | Gf | Námafjall | 65.6408 | -16.8096 | 9.27 | 28 | 9.58 | | Füri et al. (2010) |
| ICE08-02 | Gf | Námafjall | 65.6408 | -16.8084 | 10.26 | 558 | 10.28 | | Füri et al. (2010) |
| PBICE-7 | Gf | Þeistareykir | 65.8759 | -16.9567 | 8.58 | 23 | 8.86 | | Füri et al. (2010) |
| ICE08-09 | Gf | Þeistareykir | 65.8731 | -16.9702 | 10.1 | 242 | 10.13 | | Füri et al. (2010) |
| PBICE-18 | Gf | Askja, Víti crater | 65.0446 | -16.7254 | 9.08 | 130 | 9.13 | | Füri et al. (2010) |
| ICE08-05 | Gf | Askja, Víti crater | 65.0467 | -16.7248 | 9.7 | 550 | 9.71 | | Füri et al. (2010) |
| ICE08-19 | Gf | Kverkfjöll | 64.6750 | -16.6927 | 8.37 | 131 | 8.43 | | Füri et al. (2010) |
| ICE08-20 | Gf | Kverkfjöll | 64.6750 | -16.6927 | 9.06 | 103 | 9.14 | | Füri et al. (2010) |
| ICE-8 | Gf | Seljavellir | 63.5656 | -19.6086 | 18.46 | 69.9 | 18.72 | 6232.5 | Füri et al. (2010) |
| ICE-9 | Gf | Seljavellir | 63.5656 | -19.6086 | 19.02 | 107 | 19.19 | 4502.9 | Füri et al. (2010) |
| ICE-18 | Gf | Lýsuhóll | 64.8446 | -23.2196 | 9.09 | 646 | 9.11 | | Füri et al. (2010) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He]$^a$ | Reference |
|---|---|---|---|---|---|---|---|---|---|
| ICE-7 | Gf | Lýsuhóll | 64.8446 | -23.2196 | 9.34 | 672 | 9.34 | | Füri et al. (2010) |
| ICE-22 | Gf | Hæðarendi | 64.0755 | -20.8601 | 18.62 | 283 | 18.69 | | Füri et al. (2010) |
| PBICE-17 | Gf | Selfoss | 63.9462 | -20.9606 | 16.92 | 8.8 | 18.55 | | Füri et al. (2010) |
| PBICE-19 | Gf | Selfoss | 63.9462 | -20.9606 | 17.79 | 62 | 18.01 | | Füri et al. (2010) |
| ICE08-27 | Gf | Þjórsárdalslaug | 64.1616 | -19.8115 | 21.67 | 114 | 21.86 | | Füri et al. (2010) |
| ICE08-28 | Gf | Þjórsárdalslaug | 64.1616 | -19.8115 | 21.74 | 110 | 21.93 | | Füri et al. (2010) |
| ICE08-23 | Gf | Flúðir | 64.1293 | -20.3236 | 17.21 | 36.7 | 17.67 | 793.5 | Füri et al. (2010) |
| ICE08-25 | Gf | Ormsstaðir | 64.0416 | -20.6629 | 21.27 | 39.6 | 21.8 | 3262.4 | Füri et al. (2010) |
| ICE08-24 | Gf | Eyvík | 64.0468 | -20.6998 | 22.04 | 119 | 22.22 | 8645.6 | Füri et al. (2010) |
| ICE-23 | Gf | Hveravík | 65.6984 | -21.5598 | 24.09 | 74.2 | 24.4 | 1316.4 | Füri et al. (2010) |
| ICE-24 | Gf | Hveravík | 65.6984 | -21.5598 | 24.02 | 59.7 | 24.41 | 1544.9 | Füri et al. (2010) |
| ICE-25 | Gf | Laugarhóll | 65.7810 | -21.5203 | 8.43 | 5.16 | 10.22 | | Füri et al. (2010) |
| ICE-26 | Gf | Laugarhóll | 65.7810 | -21.5203 | 8.73 | 4.32 | 11.06 | | Füri et al. (2010) |
| ICE-28 | Gf | Goðdalur | 65.8277 | -21.5917 | 15.48 | 6.01 | 18.37 | 179.1 | Füri et al. (2010) |
| ICE-29 | Gf | Gjögur | 66.0005 | -21.3201 | 15.83 | 38.5 | 16.22 | | Füri et al. (2010) |
| ICE-30 | Gf | Gjögur | 66.0005 | -21.3201 | 15.61 | 18.6 | 16.44 | 457 | Füri et al. (2010) |
| ICE-31 | Gf | Krossnes | 66.0505 | -21.5063 | 26.76 | 42.4 | 27.38 | | Füri et al. (2010) |
| ICE-33 | Gf | Krossnes | 66.0505 | -21.5063 | 26.38 | 48.7 | 26.91 | | Füri et al. (2010) |
| ICE-34 | Gf | Laugaland | 66.0199 | -22.3955 | 3.39 | 11.4 | 3.62 | | Füri et al. (2010) |
| ICE-36 | Gf | Heyárdalur | 65.8397 | -22.6778 | 16.32 | 11.7 | 17.75 | 323.7 | Füri et al. (2010) |
| ICE-37 | Gf | Laugar | 66.1113 | -23.4548 | 11.11 | 5.63 | 13.3 | 8659.3 | Füri et al. (2010) |
| ICE-38 | Gf | Laugardalsá | 65.6564 | -23.9102 | 23.59 | 31.2 | 24.34 | 1389.3 | Füri et al. (2010) |
| ICE-39 | Gf | Reykhólar | 65.4544 | -22.1980 | 12.93 | 12.2 | 13.99 | 172.9 | Füri et al. (2010) |
| SKARD-1 | Gl | Skarðsmýrarfjall | 64.0438 | -21.3583 | 12.94 | | | 9.27 | Füri et al. (2010) |
| VIF-1 | Gl | Vífilsfell | 64.0487 | -21.5402 | 12.97 | | | 45.18 | Füri et al. (2010) |
| MID-1 | Gl | Miðfell | 64.1747 | -21.0475 | 16.65 | | | 3177 | Füri et al. (2010) |
| MID-1 | Gl | Miðfell | 64.1747 | -21.0475 | 17.22 | | | 3447 | Füri et al. (2010) |
| MID-2 | Gl | Arnarfell | 64.2173 | -21.0700 | 15.58 | | | 35.35 | Füri et al. (2010) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| MID-3 | Gl | Kálfstindar | 64.2184 | -20.8858 | 14.06 | | | 868.19 | Füri et al. (2010) |
| NES-1 | Gl | Nesjavellir | 64.1003 | -21.2473 | 15.75 | | | 139.64 | Füri et al. (2010) |
| OLF-1 | Gl | Ölfusvatnsfjöll | 64.1158 | -21.1407 | 14.49 | | | 258.17 | Füri et al. (2010) |
| THREN-1 | Gl | Þrengsli | 64.0013 | -21.4626 | 13.62 | | | 48.8 | Füri et al. (2010) |
| REY-1 | Gl | Reykjanes viti | 63.8124 | -22.7137 | 14.2 | | | 623.43 | Füri et al. (2010) |
| HRA-1 | Gl | Hraunsvík | 63.8519 | -22.3687 | 14.16 | | | 27.06 | Füri et al. (2010) |
| MAE-1 | Gl | Mælifell | 64.1071 | -21.1819 | 12.48 | | | 400.04 | Füri et al. (2010) |
| LON-1 | Gl | Lönguhlíðar | 63.9717 | -21.9451 | 15.49 | | | 24.74 | Füri et al. (2010) |
| KLE-1 | Gl | Kleifarvatn | 63.9112 | -22.0121 | 12.64 | | | 3.19 | Füri et al. (2010) |
| HEL-2 | Gl | Helgafell | 64.0161 | -21.8424 | 12.37 | | | 7.91 | Füri et al. (2010) |
| ICE08R-07 | Gl | Stakur | 63.9964 | -21.8887 | 11.43 | | | 15.53 | Füri et al. (2010) |
| A1 | Gl | Ármannsfell | 64.3204 | -20.9955 | 15.26 | | | 168.51 | Füri et al. (2010) |
| A2 | Gl | Þórólfsfell | 64.4488 | -20.5173 | 14.01 | | | 154.03 | Füri et al. (2010) |
| A3 | Gl | Hlöðufell | 64.4290 | -20.5704 | 15.18 | | | 29.23 | Füri et al. (2010) |
| A4 | Gl | Fagradalsfjöll | 64.4528 | -20.3061 | 15.36 | | | 24.23 | Füri et al. (2010) |
| A6 | Gl | Bláfell | 64.5156 | -19.8878 | 15.36 | | | 50.36 | Füri et al. (2010) |
| A8 | Gl | Þverbrekknamúli | 64.7232 | -19.6146 | 14.52 | | | 22.08 | Füri et al. (2010) |
| A9 | Gl | Arnarbæli | 65.0141 | -19.5891 | 21.05 | | | 831.47 | Füri et al. (2010) |
| STAK-1 | Gl | Stakksá | 64.2949 | -20.3648 | 14.73 | | | 4.93 | Füri et al. (2010) |
| KVIH-1 | Gl | Kvíhólafjöll | 65.8402 | -16.9862 | 9.39 | | | 13.04 | Füri et al. (2010) |
| NAL-837 | Gl | Kvíhólafjöll | 65.8402 | -16.9862 | 9.41 | | | 26.08 | Füri et al. (2010) |
| NAL-213 | Gl | Hvammsfjöll | 65.3638 | -16.6741 | 12.49 | | | 85.51 | Füri et al. (2010) |
| NAL-216 | Gl | Hvammsfjöll | 65.3608 | -16.6865 | 12.84 | | | 578.61 | Füri et al. (2010) |
| NAL-263 | Gl | V-Skógamannafjöll | 65.5822 | -16.5648 | 9.25 | | | 2826.9 | Füri et al. (2010) |
| NAL-265 | Gl | V-Skógamannafjöll | 65.5883 | -16.5655 | 9.01 | | | 91.63 | Füri et al. (2010) |
| NAL-281 | Gl | Herðubreiðarfjöll | 65.3696 | -16.3749 | 10.36 | | | 1255 | Füri et al. (2010) |
| NAL-440 | Gl | Hrímalda | 64.9248 | -17.0856 | 8.84 | | | 4.68 | Füri et al. (2010) |
| NAL-455 | Gl | Kverkfjöll | 64.7384 | -16.6223 | 2.27 | | | 5.04 | Füri et al. (2010) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| NAL-458 | Gl | Búrfell | 65.5678 | -16.6430 | 3.04 | | | 5.07 | Füri et al. (2010) |
| NAL-460 | Gl | Þeistareykir/Kistufjall | 65.8792 | -17.1556 | 4.91 | | | 2.96 | Füri et al. (2010) |
| NAL-461 | Gl | Þeistareykir/Lambafjall | 65.8385 | -17.1126 | 4.27 | | | 2.74 | Füri et al. (2010) |
| NAL-500 | Gl | Gæsavatn | 64.7806 | -17.5113 | 17.57 | | | 205.34 | Füri et al. (2010) |
| NAL-537 | Gl | Herðubreiðarfjöll | 65.3583 | -16.4009 | 11.4 | | | 277.95 | Füri et al. (2010) |
| NAL-541 | Gl | Herðubreiðarfjöll | 65.3651 | -16.4437 | 10.71 | | | 15.85 | Füri et al. (2010) |
| NAL-543 | Gl | Herðubreiðarfjöll | 65.3492 | -16.4318 | 9.44 | | | 234.01 | Füri et al. (2010) |
| NAL-584 | Gl | Dyngjufjöll Ytri | 65.1617 | -16.9243 | 19.69 | | | 53.1 | Füri et al. (2010) |
| NAL-585 | Gl | Upptyppingar | 65.0280 | -16.2290 | 8.66 | | | 58.58 | Füri et al. (2010) |
| NAL-595 | Gl | Kistufell | 64.7899 | -17.1823 | 15.69 | | | 916.96 | Füri et al. (2010) |
| NAL-600 | Gl | Urðarháls | 64.8394 | -17.1515 | 13.78 | | | 336.62 | Füri et al. (2010) |
| NAL-611 | Gl | Kistufell | 64.7984 | -17.2003 | 16.94 | | | 1323.7 | Füri et al. (2010) |
| NAL-828 | Gl | Hrúthálsar | 65.3238 | -16.5028 | 8.82 | | | 545.68 | Füri et al. (2010) |
| HS92-15 | Gl | Bláfjall | 65.4266 | -16.8156 | 10.75 | | | 1636.7 | Füri et al. (2010) |
| HS92-16 | Gl | Bláfjall | 65.4251 | -16.8161 | 11.83 | | | 31.4 | Füri et al. (2010) |
| KVK 77 | Gl | Kverkfjöll | 64.8167 | -16.4833 | 8.05 | | | 46.37 | Füri et al. (2010) |
| A11 | Gl | Hnottóttaalda | 64.5220 | -18.4717 | 24.26 | | | 136.41 | Füri et al. (2010) |
| A12/ICE08R-08 | Gl | N- og S-Hágöngur | 64.5697 | -18.1997 | 18.06 | | | 31.77 | Füri et al. (2010) |
| A13/ICE08R-09 | Gl | Skerðingar | 64.5716 | -18.0706 | 20.86 | | | 52.48 | Füri et al. (2010) |
| A15 | Gl | Vatnsfellsvirkjun | 64.2018 | -19.3883 | 7 | | | 2.91 | Füri et al. (2010) |
| A16/ICE08R-10 | Gl | Bláfjall | 64.3717 | -18.2484 | 18.09 | | | 56.71 | Füri et al. (2010) |
| A18/ICE08R-12 | Gl | Outcrop close to Dór | 64.3813 | -18.2506 | 19.79 | | | 302.16 | Füri et al. (2010) |
| ICE08R-13 | Gl | Bláfjall | 64.3896 | -18.2292 | 19.39 | | | 517.69 | Füri et al. (2010) |
| A19/ICE08R-14 | Gl | Ljósufjöll | 64.2433 | -18.5827 | 22.65 | | | 27.32 | Füri et al. (2010) |
| A20/ICE08R-15 | Gl | Kambsfell | 64.8274 | -17.7555 | 20.33 | | | 597.3 | Füri et al. (2010) |
| A21/ICE08R-16 | Gl | Gnjótsá near Kambsfell | 64.8269 | -17.7023 | 22.16 | | | 1099.82 | Füri et al. (2010) |
| A22/ICE08R-17 | Gl | North of Valafell | 64.7305 | -17.7085 | 20.15 | | | 1033.66 | Füri et al. (2010) |
| A23/ICE08R-18 | Gl | Gully near Valafell | 64.7237 | -17.7222 | 21.02 | | | 298.54 | Füri et al. (2010) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| A24 | Gl | Mið-Bálkafell | 64.6730 | -17.7661 | 25.91 | | | 56.2 | Füri et al. (2010) |
| A25/ICE08R-19 | Gl | Svarthöfði | 64.6425 | -17.8686 | 21.86 | | | 15.62 | Füri et al. (2010) |
| A26 | Gl | Vonarskarð | 64.6923 | -17.8965 | 19.89 | | | 186.36 | Füri et al. (2010) |
| A27 | Gl | Kirkjufellsvatn | 63.9790 | -18.8963 | 19.67 | | | 115.5 | Füri et al. (2010) |
| A28 | Gl | Klappagil | 63.9741 | -18.7922 | 1.87 | | | 4.09 | Füri et al. (2010) |
| A29 | Gl | Hörðufell | 63.9690 | -18.6798 | 8.76 | | | 1.09 | Füri et al. (2010) |
| A30 | Gl | Hellnaá | 64.0614 | -18.5340 | 18.59 | | | 5.72 | Füri et al. (2010) |
| A31 | Gl | Hrútabjörg | 64.1103 | -18.4616 | 12.17 | | | 3.09 | Füri et al. (2010) |
| A32 | Gl | NW of Grænifjallgarður | 64.1058 | -18.5154 | 18.07 | | | 132.44 | Füri et al. (2010) |
| A33 | Gl | Breiðbak | 64.1059 | -18.5687 | 18.99 | | | 3.79 | Füri et al. (2010) |
| A34 | Gl | Hnausar | 64.0878 | -19.0542 | 10.55 | | | 2.3 | Füri et al. (2010) |
| A35 | Gl | Sigalda | 64.1722 | -19.1385 | 20.59 | | | 193.15 | Füri et al. (2010) |
| A36/ICE08R-23 | Gl | Heljargjá | 64.3222 | -18.4605 | 19.65 | | | 6.05 | Füri et al. (2010) |
| A37/ICE08R-24 | Gl | Miklagljúfur | 64.3205 | -18.4326 | 19.23 | | | 8.31 | Füri et al. (2010) |
| A38/ICE08R-25 | Gl | Fellsendavatn | 64.1885 | -18.9570 | 2.19 | | | 2.55 | Füri et al. (2010) |
| ICE08R-20 | Gl | Fontur, craters | 64.2518 | -18.6523 | 1.16 | | | 2.41 | Füri et al. (2010) |
| RET-1/VES-1 | Gl | Réttarfell (Þórsmörk) | 63.6721 | -19.4923 | 18.93 | | | 90.56 | Füri et al. (2010) |
| MID-1 | Ph | Miðfell | 64.1747 | -21.0475 | 16.23 | | | 10.44 | Füri et al. (2010) |
| MID-1 | Ph | Miðfell | 64.1747 | -21.0475 | 17.28 | | | 11.11 | Füri et al. (2010) |
| BUR-1 | Ph | Búrfell | 63.8999 | -21.4622 | 13.05 | | | 2.69 | Füri et al. (2010) |
| THREN-1 | Ph | Þrengsli | 64.0013 | -21.4626 | 12.59 | | | 5.04 | Füri et al. (2010) |
| D-2 | Ph | Háleyjarbunga | 63.8154 | -22.6453 | 14.34 | | | 7.71 | Füri et al. (2010) |
| GRIN-1 | Ph | Grindavík | 63.8460 | -22.4139 | 10.27 | | | 0.57 | Füri et al. (2010) |
| VATN-1 | Ph | Vatnsheiði | 63.8593 | -22.3718 | 11.92 | | | 3.28 | Füri et al. (2010) |
| ISO-1 | Ph | Ísólfskáli | 63.8608 | -22.3178 | 16.3 | | | 6.09 | Füri et al. (2010) |
| MAE-1 | Ph | Mælifell | 64.1071 | -21.1819 | 12.94 | | | 14.37 | Füri et al. (2010) |
| MAE-1 | Ph | Mælifell | 64.1071 | -21.1819 | 12.44 | | | 12.37 | Füri et al. (2010) |
| Th-29 | Ph | Þeistareykir | 65.9310 | -17.0726 | 6.11 | | | 0.14 | Füri et al. (2010) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| BORG-1 | Ph | Borgarhraun | 65.8425 | -16.9925 | 7.91 | | | 1.97 | Füri et al. (2010) |
| ICE08R-01 | Ph | Bjarnardalsá | 64.8339 | -21.4891 | 20.34 | | | 2.02 | Füri et al. (2010) |
| ICE08R-01 | Ph | Bjarnardalsá | 64.8339 | -21.4891 | 14.78 | | | 1.91 | Füri et al. (2010) |
| ICE08R-02 | Ph | Selárdalur | 65.7621 | -24.0431 | 34.92 | | | 1.5 | Füri et al. (2010) |
| ICE08R-02 | Ph | Selárdalur | 65.7621 | -24.0431 | 36.76 | | | 3.55 | Füri et al. (2010) |
| ICE08R-03 | Ph | Vatnseyri | 65.8514 | -23.2534 | 26.08 | | | 0.4 | Füri et al. (2010) |
| ICE08R-04b | Ph | Ekkisdalur | 65.9568 | -23.3186 | 36.38 | | | 1.08 | Füri et al. (2010) |
| ICE08R-04b | Ph | Ekkisdalur | 65.9568 | -23.3186 | 2.7 | | | 0.67 | Füri et al. (2010) |
| Lambadalur | Ph | Dýrafjörður | 65.8500 | -23.2667 | 21.64 | | | 0.2 | Füri et al. (2010) |
| Lambadalur | Ph | Dýrafjörður | 65.8500 | -23.2667 | 21.39 | | | 0.61 | Füri et al. (2010) |
| 408738 | Ph | Snæfell | 64.8050 | -15.5990 | 6.93 | | | 7.99 | Peate et al. (2010) |
| 408739 | Ph | Snæfell | 64.8070 | -15.5900 | 7.12 | | | 4.11 | Peate et al. (2010) |
| 408740 | Ph | Snæfell | 64.7960 | -15.5990 | 7.14 | | | 1.19 | Peate et al. (2010) |
| 408744 | Ph | Snæfell | 64.7990 | -15.6100 | 7.2 | | | 7.8 | Peate et al. (2010) |
| 408754 | Ph | Snæfell | 64.8170 | -15.6970 | 7.02 | | | 2.93 | Peate et al. (2010) |
| 408755 | Ph | Snæfell | 64.8530 | -15.5790 | 6.95 | | | 7.13 | Peate et al. (2010) |
| 408757 | Ph | Snæfell | 64.8500 | -15.5370 | 7.51 | | | 16.3 | Peate et al. (2010) |
| 408764 | Ph | Gullborgarhraun | 64.8930 | -22.3320 | 8.52 | | | 13.3 | Peate et al. (2010) |
| 408765 | Ph | Búðahraun | 64.8190 | -23.3870 | 6.25 | | | 1.95 | Peate et al. (2010) |
| 408767 | Ph | Hreggnasi | 64.8500 | -23.8330 | 7.93 | | | 3.34 | Peate et al. (2010) |
| 408770 | Ph | Bersekjahraun | 64.9480 | -22.9850 | 8.54 | | | 8.42 | Peate et al. (2010) |
| 408771 | Ph | Svelgsárhraun | 64.9760 | -22.6750 | 8.64 | | | 13.8 | Peate et al. (2010) |
| 408775 | Ph | Hvammsmúli | 63.5740 | -19.8700 | 17.13 | | | 0.1 | Peate et al. (2010) |
| 408783 | Ph | Heimaey/Stórhöfði | 63.4040 | -20.2750 | 14.51 | | | 11.2 | Peate et al. (2010) |
| 408784 | Ph | Heimaey/Stórhöfði | 63.4040 | -20.2770 | 13.11 | | | 4.26 | Peate et al. (2010) |
| 408785 | Ph | Heimaey/Há | 63.4420 | -20.2830 | 13.7 | | | 2.08 | Peate et al. (2010) |
| STAP-1 | Gl | Stapafell | 63.9081 | -22.5250 | 14.15 | 70485 | 14.15 | 48.4 | Halldórsson et al. (2016) |
| FROST-1 | Gl | Frostastaðavatn | 64.0106 | -19.0769 | 1.1 | 2.7 | 1.16 | 10.3 | Halldórsson et al. (2016) |

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| Sample | Phase | Location | Latitude | Longitude | $R_m/R_A$ | X | $R_c/R_A$ | [He][a] | Reference |
|---|---|---|---|---|---|---|---|---|---|
| TRI-1 | Gl | Þríhyrningur | 63.8000 | -19.9519 | 25.2 | 309 | 25.28 | 473 | Halldórsson et al. (2016) |
| TRI-2 | Gl | Þríhyrningur | 63.7928 | -19.9247 | 25.66 | 1125 | 25.68 | 123 | Halldórsson et al. (2016) |
| TRI-3 | Gl | Þríhyrningur | 63.7925 | -19.9243 | 24.94 | 100 | 25.18 | 203 | Halldórsson et al. (2016) |
| ENG-1 | Gl | Engifjall | 63.7839 | -20.0265 | 22.29 | 271 | 22.37 | 271 | Halldórsson et al. (2016) |
| THOR-1 | Gl | Þórólfsfell | 63.7080 | -19.7086 | 2.79 | 2.9 | 3.72 | 0.37 | Halldórsson et al. (2016) |
| THOR-2 | Gl | Þórólfsfell | 63.7042 | -19.6409 | 2.62 | 3.5 | 3.27 | 0.94 | Halldórsson et al. (2016) |
| STORID-1 | Gl | Stóri-Dímon | 63.6781 | -19.9476 | 8.17 | 26 | 8.45 | 1.69 | Halldórsson et al. (2016) |
| SELJA-1 | Gl | Seljalandsfoss | 63.6255 | -19.9873 | 8.18 | 3.8 | 10.74 | 14.1 | Halldórsson et al. (2016) |
| BHE-43 | Gl | Ófærugil | 64.0534 | -19.7311 | 20.58 | 264 | 20.66 | 307 | Halldórsson et al. (2016) |
| BHE-44 | Gl | Ytri-Rangá | 64.0555 | -19.7751 | 20.79 | 87 | 21.02 | 274 | Halldórsson et al. (2016) |
| SAL601 | Gl | Katla | 63.5011 | -18.9881 | 17.79 | 16 | 18.92 | 4.12 | Halldórsson et al. (2016) |
| OLAF-1 | Gl | Ólafsvíkurenni | 64.8942 | -23.7967 | 2.36 | 3 | 3.03 | 0.81 | Halldórsson et al. (2016) |
| HNAUS-1 | Gl | Hnausagil | 64.8158 | -23.6311 | 4.79 | 1.9 | 9.03 | 2.41 | Halldórsson et al. (2016) |
| BOTN-1 | Gl | Botnsfjall | 64.7961 | -23.6469 | 3.88 | 2.2 | 6.3 | 0.96 | Halldórsson et al. (2016) |

[a]: [He] is reported in $ncm^3STP/g$ for all glass and phenocryst samples. For geothermal samples [He] is reported in $ncm^3STP/gH_2O$ in most cases, exceptions are Poreda et al. (1992) and Sano et al. (1985) report [He] in ppm and Marty et al. (1991) report [He] in μmole/kg.