Surtsey 50th Anniversary Conference

Geological and Biological Development of Volcanic Islands

Programme and Abstracts

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Programme and Abstracts

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Welcome address

Dear conference guests.

On behalf of the Surtsey Research Society, it is my pleasure to welcome you to the event marking the 50th anniversary of the island of Surtsey. Fifty years have passed since Surtsey emerged from the sea in the Vestmannaeyjar Archipelago. On the 14th of November 1963 a submarine eruption began approximately 20 miles off the south coast of Iceland leading to the formation of an island the day after. The eruption continued until 5th of June 1967. The new island was named Surtsey, after Surtur the lord of the fire demons in the old Norse mythology. Two other islands were created a few hundred metres east and west of Surtsey itself, but they both disappeared after the eruption ceased. Surtsey remains and will remain for an unforeseeable future.

Surtsey in a scientifically unique area. It offers an outstanding example of a virgin, volcanic island that is being actively created and shaped by geological, geomorphological and ecological processes. This happened at the same time as a debate on two important paradigms in the 20th century was taking place; that of the tectonic plates and the biogeography of islands. Surtsey contributed evidence to both theories.

The new island immediately caught the interest of scientists as a singular opportunity to study geology in the making as well as the settlement of life on a relatively sterile piece of land out in the ocean. The media at the time showed great interest in the phenomenon, publishing black and white pictures in the press as well as on television.

This is the third conference in a series of international conferences on Surtsey. The Surtsey Biology Conference was held in Reykjavík in April 1965 and the Surtsey Research Conference was held in June 1967. Besides those scientific conferences, the 30 and 40 years anniversaries were commemorated with open meetings in Reykjavík. In 2005 a conference was held in Vestmannaeyjar islands where scientists outlined the development of Surtsey and the future of the island was discussed.

On the 7th of July, 2008 the island of Surtsey and the surrounding sea was awarded a World Heritage Site status by the UNESCO´s World Heritage Committee. In the committee´s justification for this decision it is considered important that scientific work has continuously been carried out on the island from the start of the eruption and furthermore, that the surrounding sea has, since shortly after the island appeared, been declared a nature reserve, and thus been protected from human impact, as far as possible. The Surtsey Research Society has been instrumental in the planning and organising the access and expeditions to the island for scientific purposes as well as in the protection of the island from human influences.

The bibliography on Surtsey is extensive. Numerous articles and books have been published on the island´s development. The publications of The Surtsey Research Society, the Surtsey Research Progress Report, and from 2000 the Surtsey Research, has been issued twelve times, the last one in 2009. These twelve reports contain 217 papers. Most of them demonstrate the works of scientists from various research institutes in Iceland that have closely followed developments and changes on Surtsey through the years. The contributions of the Icelandic Institute of Natural History, the Marine Research Institute, the University of Iceland, the Agricultural University of Iceland, the National Energy Authority, the Icelandic Meterological Office, the Icelandic Coast Guard, the Environment Agency of Iceland, and several others not mentioned here, are specially acknowledged. It is our hope that you enjoy the Surtsey 50th Anniversary Conference, Geological and Biological Development of Volcanic Islands, as well as the excursion.

For The Surtsey Research Society

Hallgrímur Jónasson, Chairman

The Committees

National Organizing Committee

Borgþór Magnússon (chair), Icelandic Institute of Natural History
Bjarni D. Sigurðsson, Agricultural University of Iceland
Ingvar Atli Sigurðsson, South Iceland Nature Centre
Karl Gunnarsson, Marine Research Institute, Iceland
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Borgþór Magnússon, Icelandic Institute of Natural History
Kesara Anamthawat-Jónsson, University of Iceland
Karl Gunnarsson, Marine Research Institute, Iceland
Sveinn P. Jakobsson, Icelandic Institute of Natural History

Key Note Speakers

Plenary session I

Dr. Sveinn P. Jakobsson, J.G. Moore, I.H. Thorseth:
Palagonitization and lithification of the Surtsey tephra, Iceland.

Dr. Borgþór Magnússon, S.H. Magnússon, S. Friðriksson:
Plant succession and ecosystem development on Surtsey

Plenary session II

Dr. Nemesio M. Pérez:
The 2011–2012 submarine eruption off El Hierro, Canary Islands

Professor Robert Whittaker, K. Triantis:
Volcanic island biogeography: development and evaluation of dynamic models for dynamic platforms

Plenary session III

Professor emeritus Haraldur Sigurðsson:
The volcanological significance of the Surtsey eruption

Professor Stephen C. Jewett, G. Drew:
Recolonization of the intertidal and shallow subtidal community following the 2008 eruption of Alaska's Kasatochi Volcano

Plenary session IV

Professor Patrick J. Mc Keever:
Earth Science in UNESCO: World Heritage Sites and Global Geoparks – A Comparision

Professor emeritus Timothy New:
Colonisation, succession and conservation: the invertebrates of Anak Krakatau, Indonesia

Session overview

August 12

18:00-19:30	Early registration and Icebreaker	

August 13

09:00-10:00	**Plenary session I**	
10:30-12:10	**Session A:** Island and submarine volcanism	**Session B1:** Island biogeography
14:00-15:00	**Plenary session II**	
15:30-17:30	**Session A:** Island and submarine volcanism	**Session B1:** Island biogeography

August 14

07:15-20:00	Field excursion to Vestmannaeyjar archipelago. Bus leaves from the Hilton Reykjavik Nordica Hotel	

August 15

09:00-10:00	**Plenary session III**	
10:30-12:10	**Session B2:** Biological colonization and succession	
14:00-15:00	**Plenary session IV**	
15:30-17:30	**Session C:** Ecosystem processes	**Session D:** Protection of volcanic islands and areas

Programme

August 12, Monday

	Arrival in Iceland, foreign participants
18:00-19:30	**Early registration and Icebreaker** at the conference Hilton Reykjavik Nordica Hotel

August 13, Tuesday

07:45	Registration opens
08:30-09:00	**Welcoming ceremony and address**
08:30	*Hallgrímur Jónasson*, Chairman of the Surtsey Research Society
08:45	*Sturla Friðriksson*
09:00-10:00	**Plenary session I** Chair: *Lovísa Ásbjörnsdóttir*
09:00	O-01 Palagonitization and lithification of the Surtsey tephra, Iceland. *Sveinn P. Jakobsson*, James G. Moore, Ingunn H. Thorseth
09:30	O-02 Plant succession and ecosystem development on Surtsey. *Borgþór Magnússon*, Sigurður H. Magnússon, Sturla Friðriksson.
10:00-10:30	***Coffee break and posters***

10:30-12:10 **Session A: Island and submarine volcanism**
Chair: *Lovísa Ásbjörnsdóttir*

10:30 O-03 Volcanic activity at the end of a propagating rift: Surtsey 1963–1967, Heimaey 1973, and Eyjafjallajökull 2010.
Páll Einarsson.

10:50 O-04 Evolution of the Vestmannaeyjar volcanic system, Iceland.
Ingvar Atli Sigurðsson, Sveinn P. Jakobsson.

11:10 O-05 Chemical mobility associated with the alteration of Icelandic hyaloclastite tuffs.
Guðmundur H. Guðfinnsson, Hjalti Franzson.

11:30 O-06 Continuing subsidence and deformation of the Surtsey volcano,1991–2002, Iceland.
Erik Sturkell, *Páll Einarsson*, Freysteinn Sigmundsson, Halldór Geirsson, James G. Moore, Sveinn P. Jakobsson.

11:50 O-07 Post-eruptive morphological evolution of island volcanoes: Surtsey as a modern case study.
Claudia Romagnoli, Sveinn P. Jakobsson.

10:30-12:10 **Session B1: Island biogeography**
Chair: *Bjarni D. Sigurðsson*

10:30 O-08 Colonization and distribution of vascular plant species on Surtsey.
Sigurður Hjalti Magnússon.

10:50 O-09 Colonization of land-invertebrates and birds on Surtsey.
Erling Ólafsson.

11:10 O-10 Dispersal of life to Surtsey and other islands.
Sturla Friðriksson.

11:30 O-11 Surtsey and Mount St. Helens: a comparison of early succession rates.
Roger del Moral, Borgþór Magnússon.

11:50 O-12 Sublittoral colonisation in Surtsey.
Karl Gunnarsson, Erlingur Hauksson.

12:10-14:00 ***Lunch***

14:00-15:00 **Plenary session II**
Chair: *Páll Einarsson.*

14:00 O-13 The 2011–2012 submarine eruption off El Hierro, Canary Islands.
Nemesio M. Pérez.

14:30 O-14 Volcanic island biogeography: development and evaluation of dynamic models for dynamic platforms.
Robert Whittaker, Kostas Triantis.

15:00-15:30 ***Coffee break and posters***

15:30-17:30 **Session A: Island and submarine volcanism**
Chair: *Páll Einarsson.*

15:30 O-15 Lava shields at Surtsey volcano, Iceland: Volcanic architecture and emplacement processes.
Þorvaldur Þórðarson.

15:50 O-16 Surtseyan eruption and a new island in the Zubair (Red Sea) archipelago (Dec. 2011–Jan. 2012) studied using high-resolution radar and optical remote sensing.
Wenbin Xu, Sigurjón Jónsson.

16:10 O-17 A volcano arriving from the sea – Capelinhos, Azores 1957–58.
Victor Hugo Forjaz.

16:30 O-18 The 1973 Heimaey eruption; lava barriers and water cooling.
Birgir Jónsson.

16:50 O-19 An extreme wind erosion event of the fresh Eyjafjallajökull 2010 volcanic ash.
Ólafur Arnalds, Jóhann Thorsson, Elín Fjóla Thorarinsdóttir, *Pavla Dagsson-Waldhauserova*, Anna María Ágústsdóttir.

17:10 O-20 Geologic Remote Sensing of Surtsey and NASA's Investigation of Mars.
James Garvin.

15:30-17:30	**Session B1: Island biogeography** Chair: *Karl Gunnarsson*
15:30	O-21 Immigration, extinction and the MacArthur-Wilson plot based on real data. *Henning Adsersen.*
15:50	O-22 Observations on seals on Surtsey in the period 1980–2012. *Erlingur Hauksson.*
16:10	O-23 New data on the benthic megafauna of the deeper slopes off Surtsey (30–130 m depth). *Stefán Áki Ragnarsson*, Julian Mariano Burgos, Eric Dos Santos.
16:30	O-24 Microbial colonisation in different soils of Surtsey and diversity analysis of its subsurface microbiota. *Viggó Thor Marteinsson*, Alexandra Klonowski, Árni R. Rúnarsson, Sveinn H. Magnússon, Eyjólfur Reynisson, Pauline Vannier, Magnús Ólafsson.
16:50	O-25 Spatial genetic structure of the sea sandwort on Surtsey: An immigrant´s journey. *Sigurður Árnason*, Ægir Þ. Þórsson, Borgþór Magnússon, Marianne Philipp, Kesara Anamthawat-Jónsson.
17:10	O-26 Hybridisation, introgression and phylogeography of Icelandic birch. *Kesara Anamthawat-Jónsson.*
17:30-18:30	***Posters and refreshments (cash bar)***

August 14, Wednesday

07:15-20:00	**Field excursion to Vestmannaeyjar archipelago.** Bus leaves from the Hilton Reykjavik Nordica Hotel.

August 15, Thursday

09:00-10:00 **Plenary session III**
Chair: *Starri Heiðmarsson*

09:00 O-27 The volcanological significance of the Surtsey eruption.
Haraldur Sigurðsson.

09:30 O-28 Recolonization of the intertidal and shallow subtidal community following the 2008 eruption of Alaska's Kasatochi Volcano.
Stephen C. Jewett, Gary Drew.

10:00-10:30 ***Coffee break and posters***

10:30-12:10 **Session B2: Biological colonization and succession**
Chair: *Starri Heiðmarsson*

10:30 O-29 The potential role of micro-climate facilitation in primary succession at the Surtsey island gull colony.
James O. Juvik, Borgþór Magnússon, Michealene Iaukea-Lum.

10:50 O-30 Pattern and process of vegetation change on two northern New Zealand island volcanoes.
Bruce D. Clarkson, Beverley R. Clarkson, James O. Juvik.

11:10 O-31 Different trajectories of primary succession after eruption events on Raoul Island, New Zealand.
Carol West.

11:30 O-32 The funga of Surtsey.
Guðríður Gyða Eyjólfsdóttir.

11:50 O-33 Mycorrhiza and primary successions.
Håkan Wallander.

12:10-14:00 ***Lunch***

14:00-15:00 **Plenary session IV**
Chair: *Hallgrímur Jónasson*

14:00 O-34 Earth science in UNESCO: World Heritage Sites and Global Geoparks – A Comparison.
Patrick J. Mc Keever.

14:30 O-35 Colonisation, succession and conservation: the invertebrates of Anak Krakatau, Indonesia.
Timothy New.

15:00-15:30 ***Coffee break and posters***

15:30-17:30 **Session C: Ecosystem processes**
Chair: *Borgþór Magnússon*

15:30 O-36 Carbon fluxes on Surtsey during 2006–2013 and a comparison with older islands.
Bjarni Diðrik Sigurðsson.

15:50 O-37 Effects of seabird nitrogen input on biomass and carbon accumulation during 50 years of primary succession on a young volcanic island, Surtsey.
Niki Leblans, Bjarni D. Sigurðsson, Borgþór Magnússon, Ivan Janssens.

16:10 O-38 Accumulation of carbon and nitrogen in different-aged *Leymus arenarius* colonies on Surtsey, Iceland.
Guðrún Stefánsdóttir, Bjarni D. Sigurðsson, Ása L. Aradóttir.

16:30 O-39 The influence of volcanic tephra on ecosystems.
Ólafur Arnalds.

16:50 O-40 Community assembly on nunataks.
María Ingimarsdóttir, Jörgen Ripa, Tancredi Caruso, Ólöf Birna Magnúsdóttir, Anders Michelsen, Katarina Hedlund.

17:10 O-41 The influence of small topographical variation on plant colonization in early succession.
Bryndís Marteinsdóttir, Kristín Svavarsdóttir, Þóra Ellen Þórhallsdóttir.

15:30-17:10	**Session D: Protection of volcanic islands and areas** Chair: *Hallgrímur Jónasson*
15.30	O-42 Surtsey Nature Reserve. *Þórdís Vilhelmína Bragadóttir.*
15:50	O-43 Surtsey as a World Heritage Site. *Sigurður Á. Þráinsson.*
16.10	O-44 Geoheritage in Iceland with special reference to Surtsey. *Sigmundur Einarsson,* Lovísa Ásbjörnsdóttir, Kristján Jónasson.
16.30	O-45 Managing sensitive habitats around Laki and Eldgjá in the Vatnajökull National Park. *Snorri Baldursson.*
16:50	O-46 Katla Geopark. *Steingerður Hreinsdóttir.*
17:30-18:00	**Closing of Conference**
18:00-18:30	***Posters and refreshments (cash bar)***
20:00-23:00	**Conference banquet** at the Hilton Reykjavík Nordica Hotel. Volcanologist, poet, entertainer: Sigurður Þórarinsson, 101 years anniversary. Samples of his most popular songs.

August 16–17, Friday–Saturday

Optional post-conference field excursion to the Volcanic Zone of Southern Iceland. Departure from the Hilton Reykjavik Nordica Hotel at 9:00 on August 16.

Posters, Geology

P-01 Capelinhos, Azores,a
Victor Hugo Forjaz, Zilda Melo França.

P-02 Fast coastal processes on volcanic coastlines: the case of Stromboli, Italy.
Claudia Romagnoli.

P-03 Constraints on primitive magma genesis and magma transfer time at Surtsey Volcano, Iceland, from U-series disequilibrium.
Olgeir Sigmarsson.

P-04 Statistical prediction of eruptions in Mount Hekla.
Þórir Sigurðsson.

P-05 A pilot risk assessment for volcanic hazards in Iceland: Vestmannaeyjar.
Melissa Anne Pfeffer, Sigrún Karlsdóttir, Trausti Jónsson.

Posters, Biology

P-06 Early- to mid-Holocene vegetation development in northern Iceland.
Sigrún Dögg Eddudóttir, Guðrún Gísladóttir, Egill Erlendsson.

P-07 Long-term effects of revegetation on plant succession in Iceland.
Járngerður Grétarsdóttir, Ása L. Aradóttir, H. John B. Birks, Vigdis Vandvik, Einar Heegaard.

P-08 Algal colonisation in the littoral zone in Surtsey.
Karl Gunnarsson, Svanhildur Egilsdóttir.

P-09 The lichen funga of Surtsey compared to other islands in the Vestmannaeyjar archipelago.
Starri Heiðmarsson, Hörður Kristinsson.

P-10 Bryophytes on Surtsey.
Gróa Valgerður Ingimundardóttir, Henrik Weibull, Nils Cronberg.

P-11 Is the reproductive system in *Honckenya peploides* on Surtsey under change?
Marianne Philipp, Henning Adsersen.

P-12 The effect of long distance dispersal on reproductive system and genetic variation in *Cordia lutea* – a comparison between the coast of Ecuador and the Galápagos Islands.
Marianne Philipp, Ida Hartvig, Henning Adsersen, Hafdís Hanna Ægisdóttir.

P-13 Effects of vegetation cover on annual, seasonal and diurnal fluctuations in soil temperature and soil water content in Surtsey, Iceland.
Bjarni D. Sigurðsson, Sigvaldi Árnason.

P-14 Nematode generic diversity and density in different habitats in Surtsey.
Bjarni D. Sigurðsson, Krassimira Ilieva-Makulec, Brynhildur Bjarnadottir.

P-15 Founder effect in *Empetrum* and *Festuca* species on Surtsey.
Agniezka Sutkowska, Kesara Anamthawat-Jónsson, Borgþór Magnússon, Józef Mitka.

Abstracts, Oral Presentations

13/08/2013 09:00

O-01 Palagonitization and lithification of the Surtsey tephra, Iceland

Sveinn P. Jakobsson[1], *James G. Moore*[2], *Ingunn H. Thorseth*[3].

[1] *Icelandic Institute of Natural History (Garðabær, IS).* [2] *U.S. Geological Survey (US).* [3] *University of Bergen (Bergen, NO).*

During the explosive phase of the Surtsey eruption (1963–1967), basaltic tephra was deposited. Some 85% of the original tephra was basaltic glass. In 1967 a hydrothermal system formed in the central part the island. The first sign of alteration of the tephra was observed in 1969, and since then the process of alteration has been followed closely. Furthermore, a 181 m hole was drilled in 1979 to study the structure and alteration of tephra at depth. The palagonitization of the basaltic glass and lithification of the tephra is strongly temperature dependent. At 100°C more than 90% of the glass is palagonitized in few years. The lithification of the tephra results from the palagonitization, as well as from the precipitation of secondary minerals. Chemical analyses of the basaltic glass and the palagonite reveal extensive mobilization of all elements except Ti and Fe. Some of these elements are restored in the palagonite following the crystallization of smectites. Signs of bacterial activity have been found in many tuff samples. Evidence is still lacking for the involvement of bacteria during the main alteration phase of the Surtsey tephra. The area of Surtsey has shrunk from 2.65 km^2 in 1967 to 1.35 km^2 in 2012. By estimate, some 90–92% of the volume of tephra above sea level has been transformed into palagonite tuff. The tuff is resistant to marine abrasion, indicating that the core of the island will last for a long time, possibly thousands of years.

13/08/2013 09:30

O-02 Plant succession and ecosystem development on Surtsey

***Borgþór Magnússon*[1]**, *Sigurður H. Magnússon*[1], *Sturla Friðriksson*[2].

[1] *Icelandic Institute of Natural History (Garðabær, IS).* [2] *Skildingatangi 2, IS-101 Reykjavík.*

The young ecosystem on Surtsey makes an interesting comparison with the neighbor volcanic Vestmannaeyjar islands, formed several thousand years earlier. Surtsey gives an insight into how the older islands were formed and colonized while they reflect what will be the fate of Surtsey, its species and ecosystem.

The first vascular plant was found on Surtsey in 1965. The number of living species on the island peaked at 65 in 2007 followed by a decline. By 2012 a total of 70 species had been discovered on the island of which 58 were alive and 38 with viable populations. This compares to 2–30 species recorded on the smaller neighbor islands and stacks.

Plant succession and soil development was studied within permanent plots on Surtsey. Development of plant richness and cover was slow during the first decades. This changed with a formation of a dense colony of seagulls in 1985. By 2012 areas without seagulls still remained barren with an average of 4.4 plant species and 8% cover within p.p., while fertile seagull areas had 7.7 species and 92% cover. These differences were also reflected in plant biomass, soil organic matter, abundance of invertebrates and presence of breeding land birds. *Honckenya peploides* was the dominant species of the barrens in 2012 while the seagull areas had developed grasslands swards with *Poa*, *Leymus*, *Festuca* and *Puccinellia* as dominant taxa. Studies have been initiated on the neighbor islands to compare the grassland ecosystem developing on Surtsey to the older seabird grasslands.

13/08/2013 10:30

O-03 Volcanic activity at the end of a propagating rift: Surtsey 1963–1967, Heimaey 1973, Eyjafjallajökull 2010

Páll Einarsson[1]

[1] *Institute of Earth Sciences, University of Iceland (Reykjavík, IS).*

The Iceland hotspot interacts with the mid-Atlantic plate boundary, leading to ridge jumps and rift propagation. The Eastern Volcanic Zone, presently the main divergent branch of the bondary in South Iceland, has been propagating southwards for the last 3 million years. The volcanoes at its southern tip are emplaced unconformably on top of older oceanic crust, and thus have a certain affinity to ordinary oceanic hotspot volcanoes. These volcanoes are Eyjafjallajökull, Katla, and the nascent Vestmannaeyjar volcanic system with its recent eruption sites of Surtsey and Heimaey. The Surtsey eruptions (1963–1967) began on the ocean floor at about 140 m ocean depth. Three islands were formed, one of which remains, but it is eroding fast by the oceanic wave action. The Heimaey eruption (1973) occurred on the main island of the Vestmannaeyjar archipelago. It was primarily a lava eruption accompanied by earthquakes at 15–25 km depth. Eyjafjallajökull is located on the mainland. Its two eruptions in 2010 were preceded by intrusions of sills in 1994, 1999, 2009, and 2010, that finally resulted in a small flank eruption. Further intrusions triggered a new eruption of trachyandesite from the summit of the volcano. The basaltic material was fed from a depth of at least 35 km. The rather mild activity of Eyjafjallajökull stands in strong contrast to that of the neighbouring volcano Katla, which is one of Iceland's most active volcanoes. Their magmatic sources are chemically separated in spite of their apparent sympathetic behaviour.

13/08/2013 10:50

O-04 Evolution of the Vestmannaeyjar Volcanic System, Iceland

***Ingvar Atli Sigurðsson*[1]**, *Sveinn P. Jakobsson*[2].

[1]*South Iceland Nature Centre (Vestmannaeyjar, IS).* [2] *Icelandic Institute of Natural History (Garðabær, IS).*

The Vestmannaeyjar archipelago forms the southernmost tip of the Eastern Volcanic Zone in Iceland. The volcanic islands, along with numerous submarine eruption sites, constitute the Vestmannaeyjar volcanic system. It has been suggested that the age of the system is about 0.1 Ma and that the Heimaey area is evolving into a central volcano. A 2,277 m deep hole drilled on Heimaey in 2005 shows that the alkaline Vestmannaeyjar formation is only about 300 m thick, resting on 700 m of marine sediments and then alternating transitional alkaline pillow lavas and marine sediments to the bottom of the hole. A detailed mapping of Heimaey indicates that the island is built up from at least 9 eruptive units, ranging in composition from alkali olivine basalt to mugearite. The northern part of Heimaey is the oldest exposed part of the island. It consists of at least 5 eruptive units that have been dated to 40,000 years BP (± 12000) and were largely formed in sub-glacial eruptions. The central and southern part was formed during the Holocene. First Stórhöfði about 6500 BP, followed by Sæfjall and Helgafell approximately 6200 BP and last Eldfell in AD 1973. Most of the other islands are believed to be of similar age as the southern part of Heimaey, with the exception of Surtsey. The Vestmannaeyjar rock suite divides into three groups based on mineralogy and rock chemistry. These are two groups of alkali basalts and a group of hawaiites-mugearites.

13/08/2013 11:10

O-05 Chemical mobility associated with the alteration of Icelandic hyaloclastite tuffs

***Guðmundur H. Guðfinnsson*[1]**, *Hjalti Franzson*[1].

[1] *Iceland GeoSurvey (Reykjavík, IS).*

With their high porosity, sometimes exceeding 60%, basaltic hyaloclastite tuff formations are important hosts of groundwater and geothermal systems in Iceland. Basaltic glass is highly susceptible to alteration which starts with palagonitization at low temperatures, followed by higher grade alteration and rapid reduction in permeability. Iceland GeoSurvey has conducted a study of how petrophysical properties and chemistry of hyaloclastite tuffs change with time and increasing intensity of hydrothermal alteration. Several petrophysical parameters and whole-rock chemistry were determined in 140 core samples of hyaloclastite tuffs. The tuffs of interest were produced in subglacial eruptions in south and southwest Iceland in the last 2–3 million years. The samples generally experienced relatively low temperature alteration and are 25–100% altered. Here, we focus on chemical mobility as a consequence of the alteration. The whole-rock chemical analyses included 25 major, minor and trace elements. As noted in earlier studies, palagonitization involves hydration and oxidation, and the mobilization of many elements. We find that among major cations only Fe and Ti are nearly immobile. However, when element transport is assessed at the scale of hand samples, it appears that the mobility of most elements is minor, even when considerable deposition of secondary minerals has occurred. Notable exceptions include some alkali and alkali earth elements, especially Na and to a lesser extent Ca. Interestingly, in most cases the samples appear to have experienced Na loss. In the samples that have undergone highest grade alteration, there are signs that more elements are becoming mobile.

13/08/2013 11:30

O-06 Continuing subsidence and deformation of the Surtsey volcano, 1991–2002, Iceland

*Erik Sturkell[1], **Páll Einarsson[2]**, Freysteinn Sigmundsson[2], Halldór Geirsson[3], James G. Moore[4], Sveinn P. Jakobsson[5].*

[1] Department of Earth Sciences, University of Gothenburg (Gothenburg, SE). [2] Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland (Reykjavík, IS). [3] Pennsylvania State University (Pennsylvania, US). [4] U.S. Geological Survey (US). [5] Icelandic Institute of Natural History (Garðabær, IS).

The Surtsey island was built from the seafloor at 130 m depth. Two tephra cones formed above the sea level, later covered by a lava shield when the magma conduit became isolated from the seawater and the activity changed into lava effusion. As the lava flowed into the sea a lava-fed delta was made. The final volume of Surtsey was about 0.8 km^3 and the surface 2.65 km^2. Crustal deformation observations, levelling and GPS, are used to follow the development of the island and to unravel the different processes at work. The vertical signal gives the most information on the active processes. GPS data tie the vertical displacements to a reference frame outside the island. Surtsey subsided rapidly during the first 10–15 years and later on the rates decayed. In the period 1992–2000 the rate was approximately 1 cm/yr, and for the 2000–2002 period approximately 0.5 cm/yr. The deformation processes are: compaction of the volcanogenic material, slumping of the flanks of the island, the lithostatic loading of the erupted material and compaction of the seabed sediments. Palagonitization of the tephra counteracts the compaction. The amount of final subsidence caused by the flexure of the lithosphere is estimated to be in the range 0.31–0.53 m. The highest rate of subsidence is observed (15 cm in 11 years) along the side of the tuff cones where the lava overlays the delta and submarine slope failure of the side of the island is occurring.

13/08/2013 11:50

O-07 Post-eruptive morphological evolution of island volcanoes: Surtsey as a modern case study.

Claudia Romagnoli[1], *Sveinn P. Jakobsson*[2].

[1] *Dip. Scienze Biologiche, Geologiche ed Ambientali, University of Bologna (Bologna, IT).* [2] *Icelandic Institute of Natural History (Garðabær, IS).*

The competition between constructive and destructive processes in the growth and evolution of insular volcanoes results in their present-day morphology. At Surtsey, the eruptive stage leading to the island emersion was active for 3,5 years (1963–1967), however destructive forces have been active for 50 years (1963–2013) during which Surtsey has suffered rapid subaerial and submarine erosion. Surtsey represents a rare modern analogue for the post-eruptive degradational stage of island volcanoes, providing the opportunity to observe and quantify rates of geomorphic processes. A comparison with the Aeolian insular volcanoes (Italy) is proposed: here, the distribution of insular shelves in the submarine flanks resulted to be a useful proxy for relative chronological and paleo-morphological reconstructions of volcanic edifices, previously based only on their subaerial portions. Older portions of the Aeolian volcanoes are, in fact, characterized by the occurrence of wider and deeper submarine shelves that, due to their present-day depth, cannot be related to modern (Holocenic) physical processes, but are instead considered to be partly inherited features. Their distribution and geometrical parameters suggest, in fact, that variable geological/local factors combined with sea level fluctuations in controlling the development and morphology of insular shelves, being not only function of time.

Observations from the submarine portions of other insular volcanoes, located in different climatic conditions, wave regimes and geological contexts, testify common aspects in the post-eruptive morphological evolution of insular volcanoes and attest the time-dependent character of related geomorphic processes.

13/08/2013 10:30

O-08 Colonisation and distribution of vascular plant species on Surtsey

Sigurður Hjalti Magnússon[1].

[1] Icelandic Institute of Natural History (Garðabær, IS).

The objective of the study was to describe colonisation of vascular plants on Surtsey, explore relationship between the surface types and colonization, identify the main vegetation types on the island and changes during recent years.

Colonisation of vascular plants on Surtsey has been followed since the formation of the island in 1963. In the early years the island was divided into 100 x 100 m quatrats and all new plant species and individuals were labeled and mapped.

During 1996–1997 and 2005–2006 surveys of the whole island were repeated and the distribution and commonness of vascular plant species mapped. The vegetation data from the quadrats were analysed by DCA-ordination and TWINSPAN-classification.

Colonisation of vascular plants on Surtsey was fastest during the first 10 years and also shortly after seagulls started nesting in a colony on the island by 1986. Colonisation varied greatly between surface types; being highest on sandy lava but lowest on sand and palagonite substrate. Individual plant species differed greatly in their rate of colonization.

Four main vegetations types were identified on the island, forming a gradient from strand vegetation to forb rich grassland developed within the seagull colony. The greatest vegetation changes occurred within the gull colony on the southern lava field but significant changes also occurred in the largest crater on the island where effects of seabirds were small. During 1996–2006 the number of species per ha increased from 4.5 to 6.5 on the average, being highest within the gull colony.

13/08/2013 10:50

O-09 Colonization of land-invertebrates and birds on Surtsey

Erling Ólafsson[1].

[1] *Icelandic Institute of Natural History (Garðabær, IS).*

The first land-invertebrate was observed on Surtsey in 1964. Organized studies started in 1965, led by prof. Carl H. Lindroth. The research was on regular bases in the following years but more irregular during a period of slow succession in 1980ies and 1990ies except for an expedition in 1995 to investigate soil invertebrates. Since 2002 the research has been performed on annual bases and synchronized with other biological studies.

Methods of distribution have been defined and confirmed from sources in Vestmannaeyjar, mainland Iceland and continental Europe, the first settlers documented, also development of communities of invertebrates from the very beginning.

Till 2006 (inclusive) 354 species, or equivalent taxa, belonging to Insecta, Arachnida, Gastropoda and Oligochaeta have been identified of which 144 were regarded permanent settlers, 29 of uncertain status, and 181 not settled. The material from 2007 onwards is being processed, including a number of new species and conformations of additional settlers.

Birds were confirmed breeding in 1970, Black Guillemot and Fulmar. The first settlers were dependent on food supplied by the ocean. A colony of breeding seagulls arose on the lava field on the southern part of the island in 1985 and influenced a quick step forward in plant succession and development of ecosystems with plants and animals. Colonization and succession of ecosystems has since been well documented.

Altogether 16 bird species have nested on Surtsey, not all successfully, seabirds and landbirds, insect feeders, grazers and carnivores. Eleven species have become regular breeders on annual bases.

13/08/2013 11:10

O-10 Dispersal of life to Surtsey and other islands

Sturla Friðriksson[1].

[1] *Skildingatangi 2, IS-101 Reykjavík.*

The major ways of dispersal by living beings to Surtsey are by ocean or air. Seeds and parts of plants can be carried by ocean. But plants and lower animals can also be carried by drifting objects along the sea. Many lower life forms as well as insects, birds and and a few other animals can come to Surtsey by air and these can carry seeds and small animals with them. Then man can also dispers life forms to the island.

13/08/2013 11:30

O-11 Surtsey and Mount St. Helens: a comparison of early succession rates

Roger del Moral[1], *Borgþór Magnússon*[2].

[1] *Department of Biology, University of Washington (Seattle, US).* [2] *Icelandic Institute of Natural History (Garðabær, IS).*

Surtsey and Mount St. Helens are very famous volcanoes. Long-term permanent plots allow comparisons that reveal what controls the rate of succession (Baasch et al. 2009). We estimated rates from species composition analyzed by detrended correspondence analysis (DCA), changes in Euclidean distance of DCA vectors and by principal components analysis (PCA) of DCA.

On Surtsey, rates determined from DCA trajectory analyses descended as follows: gull colony on lava with sand > gull colony on lava, no sand >> lava with sand > sand spit > block lava > tephra. On Mount St. Helens, plots on lahar deposits near woodlands were best developed. The succession rates of open meadows declined as follows: Lupinus-dominated pumice > protected ridge with Lupinus > other pumice and blasted sites > isolated lahar meadows > barren plain. Despite the stark contrasts between the volcanoes, common themes were revealed. Isolation restricted the number of colonists on Surtsey and to a smaller degree on Mount St. Helens. Nutrient input from outside the system is crucial. On Surtsey, birds produced very fertile substrates, while on Mount St. Helens first wind and then lupines made modest improvements that promoted succession. Environmental stress limits succession in each case. On Surtsey, bare lava, compacted tephra and infertile sands restrict development. On Mount St. Helens, exposure to wind and infertility where Lupinus is sparse restrict establishment.

13/08/2013 11:50

O-12 Sublittoral colonisation in Surtsey

Karl Gunnarsson[1], *Erlingur Hauksson*[2].

[1] *Marine Research Institute of Iceland (Reykjavík, IS).* [2] *The Icelandic Seal Center (Hvammstangi, IS).*

The island Surtsey was formed south of Iceland during an eruption that lasted form 1963 to 1967. The settlement of marine benthic organisms has been monitored at the island from the beginning. First with visits every year but after 1971 with some years between each visit. Since 1984 standard photographs have been shot of the hard substrate in the sublittoral to monitor species composition, cover and density. Data collected 2012 are presented here. In the shallower part of the sublittoral, algae are dominant. Below 15 m depth the cover and density of animals increases and that of algae decreases and at 30 m algae have disapeared. Kelp forests have extended their distribution. For some years they were only found at the east coast of the island where the substrate seemed more stable than elsewhere along the coast. In 2012 kelp forest was found at the west coast as well. Multivariate analysis shows two separate sublittoral communities.

13/08/2013 14:00

O-13 The 2011–2012 submarine eruption off El Hierro, Canary Islands

Nemesio M. Pérez*[1]*.

[1] *Enviromental Research Division, Instituto Tecnológico y de Energías Renovables (Tenerife, ES).*

13/08/2013 14:30

O-14 Volcanic island biogeography: development and evaluation of dynamic models for dynamic platforms

Robert Whittaker[1], *Kostas Triantis*[2].

[1] *University of Oxford (Oxford, GB).* [2] *National and Kapodistrian University of Athens (Athens, GR).*

In the last fifty years, island biogeography theory has largely followed the premise that the dynamics of the islands themselves do not require close attention: the islands provide the stage and we come to watch the biological play. Yet for volcanic islands the stage is rarely set the same for very long. We will review progress in developing and evaluating models that recognize the importance of island ontogeny and which attempt to identify general patterns and processes, commenting briefly on the lessons from a near-mainland and fast-changing system (Krakatau) and at greater length on remote oceanic island systems (e.g. Canaries, Hawaii). In particular, we will provide an update on empirical evaluations of the general dynamic theory of oceanic island biogeography, which is based on the intersection of a simplistic model of island ontogeny with the elemental island biogeographical forces of migration, evolutionary change and extinction.

13/08/2013 15:30

O-15 Lava Shields at Surtsey Volcano, Iceland: Volcanic Architecture and Emplacement Processes

Þorvaldur Þórðarson[1].

[1] *Institute of Earth Sciences, University of Iceland (Reykjavík, IS).*

The Surtsey volcano was formed by a prolonged submarine volcanic eruption between November 1963 and June 1967. The prominent features on Surtsey are two abutting ~ 140 m high tuff cones and small pahoehoe lava flow field that caps the southern half of the island. Although best known for its Surtseyan explosive activity, the eruption featured two distinct subaerial effusive phases that produced two small pahoehoe lava shields. The first effusive phase lasted for 13.5 months and produced a 100m high lava shield with a total volume of 0.25–0.30 km^3. The second effusive phase formed a 70m high lava shield (volume ~ 0.1 km^3) and lasted for 9.5 months. The Surtsey lava shields consist of two principal structural units, the lava cone and the outer lava apron. The lava cones formed during the early stages of each effusive phase by surface flows that emanated from lava ponds in the summit lava craters and produced shelly pahoehoe and fountain-fed sheet flows that were emplaced rapidly, with flow velocities up to 20 m/s. The lava apron is a later stage construction, formed when the level of the lava ponds had dropped well below the rims of the summit lava craters. At this stage the flow of lava to the active flow fronts was essentially confined to subsurface pathways or lava tubes. As the lava emerged from the tubes it spread as a series of decimeter-size inflating lava lobes that coalesced to form broad, meters-thick sheet lobes

13/08/2013 15:50

O-16 Surtseyan eruption and a new island in the Zubair (Red Sea) archipelago (Dec. 2011–Jan. 2012) studied using high-resolution radar and optical remote sensing

***Wenbin Xu*[1]**, *Sigurjón Jónsson*[1].

[1] *King Abdullah University of Science and Technology (Jeddah, SA).*

The Surtseyan eruption in the Zubair archipelago, southern Red Sea, from December 2011 to January 2012, provided an opportunity to study magma-ocean interaction, new-island formation and coastal erosion. However, no in-situ ground-based geophysical or geodetic measurements were obtained during this eruption, we therefore use high-resolution (50 cm) WorldView-2 optical satellite imagery and TerraSAR-X radar data to study how the island evolved during and after the eruption. The co-eruption images show explosive activity, with a thick white plume and black tephra rising from the eruptive vent. The images also reveal that the eruption was fed from a short fissure and that it ended between 9 and 12 January 2012. The new island consists of a single elongated cone, oriented approximately parallel to the axis of the Red Sea rift. During the first few months significant wind and coastal erosion, as well as possible landslide activity resulted in changes of both the size and the shape of the island. Regular TerraSAR-X satellite acquisitions of the area did not start until on 20 January 2012 with one image acquired every 11 days. At the time of writing this abstract, the data had not yet been released by the German Space Agency, as only data older than 18 months are distributed. However, we hope TerraSAR-X radar interferometry can be used to make a high-resolution DEM of the new island and provide information about post-eruption deformation associated with a possible underlying magma-chamber.

13/08/2013 16:10

O-17 A volcano arriving from the sea – Capelinhos, Azores 1957–58

Victor Hugo Forjaz[1].

[1] *Observatorio Vulcanologico e Geotermico dos Açores (S.Miguel, Azores, PT).*

A CD of 20 minutes describing the submarine phase and the subaerial activities of the most known Azores volcanoes (CD based on several films; the author was one of the CD advisers during the 50th Capelinhos anniversary).

13/08/2013 16:30

O-18 The 1973 Heimaey Eruption; lava barriers and water cooling

Birgir Jónsson[1]*.*

[1] *University of Iceland (Reykjavík, IS).*

From January to June 1973 a volcanic eruption took place on the island of Heimaey in the Westman Islands archipelago, off South Iceland. Attempts were made to stop or divert the lava that eventually flowed over part of the small town Vestmannaeyjar (pop. 5300) on Heimaey. The methods used were mainly construction af barriers, made of the ash and pumice formed in the same eruption, and by cooling the lava by pumping sea water in large amounts on the lava front. Much has been written about the water cooling but very little attention has been paid to the effect of the barriers, which stopped the movement of the lava front long enough for the water cooling to take effect and obstruct or divert the lavaflow. The barriers stopped the lava front for a considerable time, and the lava would not advance over the barrier until the lava front had become about 4–5 times higher than the barrier. In hindsight it is highly likely that if the barriers and dykes had been aligned differently, or additional dykes had been constructed early enough, up to 200 houses would have been saved on Heimaey, including costly fish factories and the power station.

13/08/2013 16:50

O-19 An extreme wind erosion event of the fresh Eyjafjallajokull 2010 volcanic ash

Ólafur Arnalds[1], Jóhann Þórsson[2], Elín Fjóla Þórarinsdóttir[2], ***Pavla Dagsson-Waldhauserova[1,2,3]****, Anna María Ágústsdóttir[2].*

[1] Agricultural University of Iceland (Reykjavík, IS). [2] Soil Conservation Service of Iceland (Gunnarsholt, IS). [3] University of Iceland (Reykjavík, IS).

Volcanic eruptions can generate widespread deposits of ash that are subsequently subjected to erosive forces which causes detrimental effects on ecosystems. We measured wind erosion of the freshly deposited Eyjafjallajokull ash at a field site the first summer after the 2010 eruption. The BSNE wind erosion samplers to measure an aeolian particle transport were employed together with the saltation sensor (SENSIT) and an automatic weather station in situ during this event.

Over 30 wind erosion events occurred (June–October) at wind speeds > 10 m s^{-1} in each storm with gusts up to 38.7 m s^{-1}. Surface transport over one m wide transect (surface to 150 cm height) reached 11,800 kg m^{-1} during the most intense storm event with a rate of 1,440 kg m^{-1} hr^{-1} for about 6.5 hrs. The maximum saltation was of 6825 pulses per minute. The mean grain size of the particles moved and sampled in erosion samplers ranged from 0.13 to 0.69 mm but grains > 2 mm were also moved. This storm is among the most extreme wind erosion events recorded on Earth. The Eyjafjallajokull wind erosion storms caused dust emissions extending several hundred km from the volcano affecting both air quality and ecosystems showing how wind erosion of freshly deposited ash prolongs impacts of volcanic eruptions.

13/08/2013 17:10

O-20 Geologic Remote Sensing of Surtsey and NASA's Investigation of Mars

James Garvin[1].

[1] *NASA Goddard Space Flight Center (Greenbelt, MD, US).*

The geologic evolution of Surtsey since the end of its volcanic construction phase in 1968 has offered NASA an ideal „test site" for evaluating new aircraft and spaceborne remote sensing approaches for quantifying landscapes in three dimensions over various scales. As part of its efforts to pioneer geodetic laser altimetry of Mars, the Moon, and Earth, NASA has deployed aircraft laser altimeters and synthetic aperture radar (SAR) sensors to measure aspects of landscape and land-cover change on Surtsey since 1989, when the first GPS-tracked flights took place. A time series of geodetic-quality digital elevation models (DEM) were acquired in 1991, 1996, and 2001, and older contour maps of topography were digitized for comparison. New datasets acquired by Canada's Radarsat-2 have provided spaceborne SAR views of the island to complement ongoing sub-meter-scale visible wavelength imaging. As a result of these high resolution datasets, we developed several areal and volumetric (dV/dt) models for Surtsey's future evolution as a sub-arctic island. Using the most recent NASA laser-altimeter-based DEM and Radarsat-2 Spotlight SAR data, the best fitting model for subaerial volume evolution is represented by a power-law as follows: V = 0.10 t ^-0.985, with t in years since 1968 and V in cubic km. Meter-scale topographic and radar backscatter changes at Surtsey since 2001 are now being compared with models for sub-polar landscape dynamics on Mars as measured by NASA's MRO mission at similar scales.

13/08/2013 15:30

O-21 Immigration, Extinction and the MacArthur-Wilson plot based on real data.

***Henning Adsersen*[1].**

[1] *Department of Biology, University of Copenhagen (Copenhagen, DK).*

The 50 years old equilibrium theory of island biogeography of MacArthur and Wilson is one of the important scientific paradigms of the 20th century. The almost beautiful simplicity of the MacArthur-Wilson plot of immigration and extinction rates on islands versus species number has almost seduced several generations of ecologists and it is still and indispensable element of ecological textbooks. The theory may explain the robustness of the Arrhenius equation S = cAz for islands – but surprisingly few have published Mac Arthur Wilson plots base on real data. One of the reasons is that there are few studies carried out for sufficient time and regularity to assess immigration and extinction rates in the real world.

The series of meticulous yearly survey of plant occurrences on Surtsey through 50 years constitutes probably the best opportunity to set up MacArthur Wilson plots. Such plots will be presented in my contribution, and they will be compared to a few other examples. The conclusion is that the MW plot in its simple form rarely explains the real processes. It can be shown, however, that in some cases the MW plot explain the processes very well if the change in the species pool size during successional processes is taken into account.

13/08/2013 15:50

O-22 Observations on Seals on Surtsey in the Period 1980–2012

***Erlingur Hauksson*[1].**

[1] *The Icelandic Seal Center (Hvammstangi, IS).*

Records of sightings of seals in Surtsey from 1980 to 2012 is presented. Seals in Surtsey have been counted regularly, as a part of a bigger project of aerial censusing of seals around the coast of Iceland. The grey seal (*Halichoerus grypus* Fabricius) has established a considerable breeding site on the northern spit of the Surtsey island, in October and November, which is now one of the biggest rookeries on the southern shores of Iceland. On the other hand, the harbour seal (*Phoca vitulina* L.) has not been numerous in Surtsey during the breeding and moulting time in the summer. They have, however, been hauling-out in great numbers on the northern shores during the winter, presumably resting there after making feeding trips to the adjacent waters of Surtsey.

13/08/2013 16:10

O-23 New data on the benthic megafauna of the deeper slopes off Surtsey (30–130 m depth).

***Stefán Áki Ragnarsson*[1]**, *Julian Mariano Burgos*[1], *Eric Dos Santos*[1].

[1] *Marine Research Institute of Iceland (Reykjavík, IS).*

The fauna of the upper slopes (< 30 m) of Surtsey has been extensively studied, while data from deeper waters is very limited. The aim of this study was to obtain baseline data on the megafauna found in the deeper slopes of Surtsey. In 2010, the seabed was surveyed using a remote operated vehicle (ROV) fitted with a high-definition camera. A total of 9.5 hrs of video footage was collected in 4 dives at the submarine mounds Jólnir and Syrtlingur and along the southern slopes off Surtsey (30–130 m depth), from which benthic organisms were identified to the lowest taxonomic level possible and the substrate was characterised. Of the sites examined, Jólnir had the lowest species richness. The tephra at the Jólnir mound appeared highly mobile, thus providing a very hostile environment where only few organisms (such as cumaceans) can survive. The benthic fauna on the Syrtlingur was more diverse compared to Jólnir. The fauna at the knoll at the top of Syrtlingur was rich in epifauna, predominately *Alcyonium digitatum*. The composition of the megafauna on the southern slopes off Surtsey was highly influenced by the substrate composition. Of particular interest was the pillow lava, which provides an important habitat for various epifauna, especially sponges and various fish species such as redfish (*Sebastes spp*.). This study shows that the successional patterns of benthic megafauna appear to be highly related to the erosion rates of the submarine mounds and the substrate type.

13/08/2013 16:30

O-24 Microbial colonisation in different soils of Surtsey and diversity analysis of its subsurface microbiota

Viggó Thor Marteinsson[1], *Alexandra Klonowski*[1], *Árni Rafn Rúnarsson*[1], *Sveinn H. Magnússon*[1], *Eyjólfur Reynisson*[1], *Pauline Vannier*[1], *Magnús Ólafsson*[2].

[1] *Matís ltd. (Reykjavík, IS).* [2] *Iceland GeoSurvey (Reykjavík, IS).*

Although prokaryotes such as bacteria and blue-green algae were the first colonisers on Surtsey, most studies have been focusing on colonization of plants and animal and less on microbial succession. To explore surface colonization and the influence of nutrients on numbers of bacteria, we collected 45 samples from different soils around the island. Total viable bacterial counts were performed with plate count at 22°, 30° and 37°C for all soil samples. Selected samples were also tested for faecal and anaerobic bacteria at 30°C and colonisation of pathogenic bacteria i.e. Salmonella, Campylobacter and Listeria. The amount of organic matter and nitrogen was measured. To explore subsurface microbial colonisation we collected subsurface samples from a borehole. Diversity analysis of uncultivated biota was performed by 16S rRNA gene sequence analysis. Correlation was observed between the nutrient deficits and the number of microorganisms in soil samples. The lowest number of bacteria (1 x 104–1 x 105/g) was detected in pumice but the count was significant higher (1 x 106–1 x 109/g) in vegetated soil or pumice with bird drop. The number of faecal bacteria correlated to higher numbers of bacteria and soil. Bacteria belonging to Enterobacteriaceae were only detected in vegetated and sample containing bird drop. No pathogenic microbes were detected in any selected sample. Both bacteria and archaea were detected in the subsurface samples collected at 14 5m and 172 m depth at 80°C and 54°C respectively. The microbiota sequences showed low affiliation to known 16S rRNA gene sequences.

13/08/2013 16:50

O-25 Spatial Genetic Structure of the Sea Sandwort on Surtsey: An immigrant's Journey

Sigurður Árnason[1], *Ægir Þ. Þórsson*[1], *Borgþór Magnússon*[2], *Marianne Philipp*[3], *Kesara Anamthawat-Jónsson*[1].

[1] *University of Iceland (Reykjavík, IS).* [2] *Icelandic Institute of Natural History (Garðabær, IS).* [3] *University of Copenhagen (Copenhagen, DK).*

Honckenya peploides is one of the first plants to successfully colonize and reproduce on the island of Surtsey. Using amplified fragment length polymorphism (AFLP) markers we examined levels of genetic variation and differentiation among populations of *H. peploides* on Surtsey in relation to populations on Heimaey and from the southern coast of Iceland. Selected populations from Denmark and Greenland were used for comparison. In addition, we tested whether the effects of isolation-by-distance can be seen in the Surtsey populations. Using two primer combinations, we obtained 173 AFLP markers from a total of 380 plant samples. The resulting binary matrix was then analyzed using the appropriate statistics. The main results include: (i) Surtsey held the highest gene diversity (55.5%P; 0.227 Ht) and Denmark the lowest (31.8%P; 0.132 Ht), indicating an early stage of population establishment on Surtsey; (ii) the total genetic differentiation (Fst) among Surtsey (0.0714) and Heimaey (0.055) populations was less than half of that found among the mainland populations in Iceland (0.1747), indicating significant gene flow on the islands; (iii) positive and significant associations were detected between genetic differentiation and geographic distance (in km) at the broad scale; (iv) most of the genetic variation (79%, $p < 0.001$) was found within localities, possibly due to the outcrossing nature of the species; and (v) there is a significant genetic distance (supported by Bootstraps) within Surtsey, among sites, and this appears to correlate with the age of plant colonization.

13/08/2013 17:10

O-26 Hybridisation, introgression and phylogeography of Icelandic birch

Kesara Anamthawat-Jónsson*[1]*.

[1] *University of Iceland (Reykjavík, IS).*

Birch woodland is an integral component of the tundra biome, which covers expansive areas of the Arctic. In natural woodland in Iceland two species of birch co-exist: diploid dwarf birch *Betula nana* and tetraploid tree birch *B. pubescens*. Both species are extremely variable, morphologically, and this is believed to be due to introgressive hybridisation between the two species. In this paper an overview of our research on Icelandic birch over the past ten years will be presented. Qualitative and quantitative assessments of morphological variation of birch in natural woodlands clearly indicate introgressive hybridisation, and this, as also shown by the extensive sharing of maternally inherited cpDNA haplotypes across ploidy groups, is supported by the statistical analysis of introgression indices and the variation components. The molecular data also reveal a geographical structure of introgression and phylogeographical patterns, both within Iceland and in relation to Europe. By using ploidy-based morphometric standards on pollen in peat sediments from different sites in Iceland, we have further shown that birch hybridisation occurred since early on, from the time birch vegetation began to develop soon after the deglaciation. In conclusion, our botanical, cytogenetic, palynological and molecular studies show that hybridisation between *B. nana* and *B. pubescens* is widespread in Iceland; the resulting gene flow via introgressive hybridisation is bi-directional; and that the process is continuous through time and space. Present-day birch in Iceland is most probably post-glacial in origin, migrating from Western Europe and colonizing Iceland in the early Holocene.

15/08/2013 09:00

O-27 The volcanological significance of the Surtsey eruption

Haraldur Sigurðsson*[1]*.

[1] *Volcano Museum (Stykkishólmur, IS).*

The eruption that led to creation of Surtsey was a landmark event in the history of volcanology. At the time, a debate raged on the relative importance of magmatic water as a major agent in explosive eruption, versus the role of external water, such a ice or the ocean. This debate has major significance for understanding of origin of hyaloclastites and other basaltic tuffs. Gudmundur Kjartansson advanced the theory of importance of external water in the formation of hyaloclastites on basis of studies of subglacial tuffs in Iceland. The Surtsey eruption provided a firm proof of his hypothesis. Subsequent monitoring of the Surtsey tuffs later elucidated the progress og palagonitization and consolidation of basaltic tuffs as a rapid low-temperature metamorphic reaction. The effusive lava flow stage of the Surtsey eruption also allowed for one of the first high quality sampling campaigns for magmatic gases, carried out by Gudmundur Sigvaldason and colleagues. High-temperature gas samples were the purest obtained anywhere on Earth up to that time, containing virtually no atmospheric air or nitrogen. They provided a basis for computing gas/magma equilibria at high temperature and for evaluation of oxygen fugacity in the magmatic source. When the Surtsey eruption was set in a structural context, it became clear that it is part of a propagating rift south from the eastern volcanic zone. This realization has helped in our understanding of rift propagation and evolution in mid-ocean ridge system world-wide.

15/08/2013 09:30

O-28 Recolonization of the intertidal and shallow subtidal community following the 2008 eruption of Alaska's Kasatochi Volcano

***Stephen C. Jewett*[1]**, *Gary Drew*[2].

[1] *Institute of Marine Science, University of Alaska Fairbanks (Fairbanks, Alaska, US).* [2] *Alaska Science Center, U.S. Geological Survey (Alaska, US).*

The intertidal and nearshore benthic community of Kasatochi Island is described following a catastrophic volcanic eruption in 2008. Prior to the eruption, the island was surrounded by a dense canopy kelp bed of *Eualaria (Alaria) fistulosa* which supported a productive nearshore community. The eruption extended the coastline of the island approximately 400 m offshore, mainly along the south, southeast and southwest shores, to roughly the 20 m isobath. One year following the eruption a reconnaissance survey found the intertidal zone devoid of life. Subtidally, the canopy kelp, as well as limited understory algal species and associated benthic fauna on the hard substratum, were apparently buried by debris from the eruption. The resulting substrate was comprised almost entirely of medium and coarse sands with a depauperate benthic community. Comparisons of habitat and biological communities with other nearby Aleutian Islands confirm dramatic reductions in flora and fauna consistent with the initial stages of recovery from a large-scale disturbance event. Four years following the eruption a brief visit revealed dramatic intertidal and subtidal recolonization of the flora and fauna, with commensurate increases in nearshore foraging seabirds suggest a rapidly recovering system.

15/08/2013 10:30

O-29 The potential role of micro-climate facilitation in primary succession at the Surtsey island gull colony

James O. Juvik[1], *Borgþór Magnússon*[2], *Michealene Iaukea-Lum*[1].

[1] *Department of Geography, University of Hawai`i at Hilo (Hilo, US).*
[2] *Icelandic Institute of Natural History (Garðabær, IS).*

Beginning in the mid-1980s an increased rate of plant colonization and accelerated primary succession on Surtsey is associated with the establishment and expansion of a gull colony, and has been well studied, particularly with respect to nutrient transfer and soil development as a preeminent driver in direct facilitation and general island ecosystem development. Also associated with rapid successional development, the growing plant biomass itself begins to modify and buffer the above and below surface microclimate, further promoting additional change in the successional chronosequence. In July 2005 we established a micro-climate transect (50 m) with 4 stations measuring hourly air (+30 cm) and soil (-5 cm) temperatures from bare cinder outside the gull colony to the densely vegetated interior for one year. For each station we calculated a crude, proxy plant biomass index by simply adding the % plant cover (range < 1–100%) to the mean plant height (< 1–87 cm). Analysis of our microclimate dataset (focusing on the summer plant growing season) revealed little difference in seasonal or diurnal variation in air temperature (+30 cm), which could be expected given persistent winds and the comparatively low stature of even the gull colony plants 40–90 cm). The soil temperatures however, responding to dramatic biomass gradient showed substantial differences, with mean maximum daily summer temperatures decreasing from 220°C to 120°C along the 50 m transect from bare cinder to dense grassland. Such non-trivial micro-climate differences potentially impact a range of early succession processes including soil respiration and decomposition.

15/08/2013 10:50

O-30 Pattern and process of vegetation change on two northern New Zealand island volcanoes

Bruce D. Clarkson[1], *Beverley R. Clarkson*[2], *James O. Juvik*[3].

[1] *University of Waikato (Hamilton, NZ).* [2] *Landcare Research (Hamilton, NZ).*
[3] *Department of Geography, University of Hawai`i at Hilo (Hilo, US).*

The pattern and process of vegetation change on the island volcanoes White Island and Rangitoto Island in New Zealand have now been monitored for more than 100 years. Both islands have the potential to support tall forest but because of ongoing disturbance they have a range of early succession vegetation, principally young *Metrosideros excelsa* (Myrtaceae) dominated forest. *Metrosideros excelsa* is a mass seeder with wind dispersed seed and has the ability to recover from canopy damage by epicormic resprouting. Significant differences between the islands in disturbance type and frequency, substrate type, and isolation from the mainland result in major compositional differences. On White Island, characterized by continuous volcanic eruption, a tephra substrate, and 50 km distant from the mainland, *M. excelsa* remains the only tree species represented. Change can be classed as direct succession of *M. excelsa* resulting from recovery of an existing population by epicormic resprouting, or colonization of a newly emplaced surface by *M. excelsa* seed. On Rangitoto Island eruptions have long ceased (> 600 years), the substrate is mainly aa lava and the island is only 5 km from the mainland. *Metrosideros excelsa* is the prime lava colonizer and facilitates patch development leading to patch coalescence and formation of continuous forest.

15/08/2013 11:10

O-31 Different trajectories of primary succession after eruption events on Raoul Island, New Zealand

Carol West[1].

[1] *Department of Conservation (Wellington, NZ).*

Raoul Island, in the Kermadec Group north of New Zealand, is an active volcano with a known, recent eruption history. Warm-temperate forest, dominated by *Metrosideros kermadecensis* is the climax vegetation of Raoul Island. Endemism of the principal forest trees and shrubs is high, despite the young age of the volcano (< 2 million years). Most volcanic activity in the past century has centred on Green Lake in the central caldera. Each eruptive event has knocked down and buried vegetation within range with ejecta. Between Green Lake and Blue Lake is a ridge, named Devastation Ridge, on which forest succession has been studied. After an eruption in 1964 a stand of *M. kermadecensis* arose that was actively self-thinning until an eruption in 2006 that killed many of those trees and buried the site in ejecta from 0–1 m deep. After the 2006 eruption, vegetation establishing on the site is more diverse and includes fleshy fruited shrubs. In the interval between the two eruptions goats, rats and cats were eradicated from Raoul Island. It is hypothesised that the presence/absence of goats and rats as well as the different nature of the eruptions is responsible for the different successional outcomes.

15/08/2013 11:30

O-32 The funga of Surtsey

***Guðríður Gyða Eyjólfsdóttir*[1].**

[1] *Icelandic Institute of Natural History (Akureyri, IS).*

A summary of research on the funga of Surtsey from 1965 to 2012 and the species of fungi discovered on the island is presented. The first fungi were found on dead algae and driftwood in 1965, some were isolated from cultures of algae from fumaroles in 1968 and from soil samples collected in 1972, all microfungi. The first mushroom, *Lichenomphalia sp*., a basidiolichen appeared in 1971 in Racomitrium moss on lava. In 1990 another omphaloid species, *Arrhenia rustica* s.l., was fruiting on soil in the gull colony. In 2005 two fungi were seen fruiting by *Salix phylicifolia* their mycorrhizal host, and *Entoloma sericeum* in grassland in the gull colony. By 2007 twenty microfungi and seven macrofungi, had been recorded in Surtsey. In July 2008 microfungi on plants and decaying material were collected and in August fruiting bodies of seven fungi forming mycorrhizae with the three *Salix* species were collected along with three other macrofungi. Five samples of dry goose dung were sent to a specialist who identified eight coprophilous fungi which matured on rehydrated dung over a period of up to four months. Late August 2010, after heavy rain, fruiting bodies of several basidiomycetes were collected, most saprophytic fruiting in or around the oldest part of the gull colony. Of these, five macrofungi and one myxomycete species have been identified. Three additional agaric species were identified to genus only. Lastly two basidiomycetes have been collected on driftwood. Presently at least 21 macrofungi and 29 microfungi are known from Surtsey.

15/08/2013 11:50

O-33 Mycorrhiza and primary successions

Håkan Wallander*[1]*.

[1] *Department of Biology, Lund University (Lund, SE).*

The first plants establishing in primary successions are usually non-mycorrhizal and these are usually replaced by more competitive plants colonized by arbuscular mycorrhizal (AM) fungi when inoculum arrive (Reeves 1979). Plants colonized by Ectomycorrhizal (EcM) or ericoid mycorrhizal (ErM) fungi come later in the succession when organic matter start to accumulate. Such a patterns has also been suggested for Surtsey were non-mycorrhizal plants species were first to colonize, followed by facultative AM colonizers, more AM dependent species and finally EcM species such as Salix (Magnusson et al. 2009, Greipsson & El-Mayas 2000 and Eyjolfsdottir 2009).

The importance of mycorrhizal fungi for shaping plant successions is also dependent on dispersal of the fungal propagules. EcM and ErM spores are wind spread while the much larger AM spores are spread by soil movement caused by animals or physical factors such as landslides. This will make AM colonization in primary successions more stochastic, especially in remote areas such as Surtsey where it is difficult for the inoculum to reach the island. In a survey of AM colonization of plant species in arctic Canada, Olsson et al. (2004) found heavy colonization of *Potentilla pulchella* on Bank island while colonization was absent in more northern sites. Closely related *Potentilla anserina* have been found on Surtsey and It would be interesting with a thoroughly investigation of the mycotrophic status of this and other species on Surtsey in order to gain a better understanding of the importance of the mycorrhizal fungi for primary successions.

15/08/2013 14:00

O-34 Earth Science in UNESCO: World Heritage Sites and Global Geoparks – A Comparision

Patrick J. Mc Keever[1].

[1] United Nations Educational, Scientific and Cultural Organization (Paris, FR).

Currently, areas of internationally important geological heritage can receive global recognition either through UNESCO's World Heritage Programme or it's Global Geoparks Network initiative. However, why is there are need for two mechanisms to recognise globally important geological heritage? World Heritage recognises sites of geological or geomorphological importance through the concept of outstanding universal value in terms of fulfilling criteria vii and/or viii of the world heritage convention. By contrast Global Geoparks assess the holistic value of an areas geological heritage in terms of it's contribution to society across a range of facets that include natural, cultural and intangible heritages as well as it's potential for development as a sustainable economic asset for local communities through the development of geotourism. Since the ratification of the world heritage convention in 1972, only 23 areas have been inscribed on the world heritage list solely using criteria vii and viii (a further 33 sites are inscribed in conjunction with one of the other 8 criteria). Since it's inception in 2004 97 areas have received the Global Geopark label of which 90 remain as part of the network. This presentation will discuss whether this reflects less stringent criteria in use for membership of the Global Geoparks Network or whether the Global Geopark brand is proving more attractive for areas of important geological heritage than world heritage status.

15/08/2013 14:30

O-35 Colonisation, succession and conservation: the invertebrates of Anak Krakatau, Indonesia

Timothy New[1].

[1] Department of Zoology, La Trobe University (Melbourne, AU).

Anak Krakatau, Indonesia, has attracted comparisons with Surtsey as being of similar size, topography and age, and provides a basis for studying parallels in colonisation and successional processes in very different climatic and political environments. Unlike Surtsey, the possible source areas of propagules for Anak Krakatau are poorly documented, and it is usually unclear whether the Anak Krakatau invertebrates have come from the older islands of the archipelago (only 2–4 km distant) or from Java or Sumatra, distances of 20–40 km and with somewhat different biota either side of the Sunda Strait. Information is summarised on ecological composition and change, through some successional trajectories as demonstrated through colonising invertebrates, predominantly insects, on Anak Krakatau, and the significance of aeolian communities and the development of ecological complexity through vegetation-based successions are outlined. The groundwork laid for this in the 1980s–1990s is compared with parallel studies on Surtsey, and opportunities for conservation and further study on the two islands discussed. Continuing volcanic activity and tourism and other human pressures on the Krakatau archipelago, together with the pressing problems of human welfare in Indonesia, give little cause for optimism, and there is need for effective monitoring and control of human disturbances. The island is no longer remote. Formal moves to protect Anak Krakatau, most recently through nomination as a UNESCO Geopark, imply the need to promote tourism and other developments to benefit local economies; such development may further distort interpretation of ecological processes on the island.

15/08/2013 15:30

O-36 Carbon fluxes on Surtsey during 2006–2013 and a comparison with older islands

***Bjarni Diðrik Sigurðsson*[1].**

[1] *Agricultural University of Iceland (Borgarnes, IS).*

Only two studies have been published previously on ecosystem respiration (RE) on Surtsey (Magnússon 1992; Sigurdsson & Magnusson 2010) and no data has been published on carbon uptake. This study reports measurements of RE, net ecosystem exchange (NEE) and gross primary production (GPP) in middle of July during eight years (2006–2013) on 22 permanent plots in different ecosystem types on Surtsey. Further it compares the ecosystem CO_2 fluxes on Surtsey to fluxes on ca. 6000 year old neighbouring islands in 2010.

The results clearly show how ecosystem activity changes during the first steps of primary succession on Surtsey as plants colonize barren areas and communities of both flora and fauna are established. Such development is, however, not quite regular, but fluctuates with annual variation in environmental factors. An extreme drought in summer 2012 was for example clearly displayed in the data.

It came as surprize that RE, NEE and GPP in the ca. 25-year-old vegetated area in the seagull colony on Surtsey was not significantly different from fluxes on two ca. 6000-year-old islands, Álsey and Elliðaey, where succession and soil formation has been on-going for millennia.

References:

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15/08/2013 15:50

O-37 Effects of seabird nitrogen input on biomass and carbon accumulation during 50 years of primary succession on a young volcanic island, Surtsey

Niki Leblans[1,2], *Bjarni D. Sigurðsson*[2], *Borgþór Magnússon*[3], *Ivan Janssens*[2].

[1] *Department of Biology, University of Antwerp (Wilrijk, BE).* [2] *Agricultural University of Iceland (Borgarnes, IS).* [3] *Icelandic Institute of Natural History (Garðabær, IS).*

Primary succession is a slow process in cold climates with a short growing season, and depends usually on seed rain, and/or nitrogen availability and water retaining capacity. Consequently Surtsey, a 50 years old Icelandic volcanic island, is expected to be still in an early phase. However, a seabird colony was established 27 years hence, and might have given the primary succession a kick start.

We measured total ecosystem stocks of biomass, carbon and nitrogen on permanent survey plots both outside and inside the seabird colony. This enabled us to test effects of seabird nitrogen input on biomass and carbon accumulation.

After only 27 years since colonization, the ecosystem shifted from a desert ecosystem (~ 0.01 DW ha^{-1}) to a lush grassland ecosystem (> 0.5 t DW ha^{-1}). The main driver of this drastic change was the N input in the form of bird feces. Firstly, the N accumulation rate outside the seabird colony was very low (1.1 kg ha^{-1} y^{-1}) and agreed closely with the annual atmospheric N deposition rate in Iceland (1.0–2.5 kg ha^{-1} y^{-1}). Inside the colony, the N accumulation rate had increased to 40–65 kg ha^{-1} y^{-1}. Secondly, total ecosystem biomass and carbon stocks showed a strong positive relationship with total ecosystem nitrogen stock (r^2 = 0.88 and 0.98 respectively).

The slow process of biomass and carbon accumulation during primary succession in northern ecosystems can be greatly accelerated by external nutrient inputs.

15/08/2013 16:10

O-38 Accumulation of carbon and nitrogen in different-aged *Leymus arinarius* colonies on Surtsey, Iceland

Guðrún Stefánsdóttir[1], *Bjarni D. Sigurðsson*[1], *Ása L. Aradóttir*[1].

[1] *Agricultural University of Iceland (Borgarnes, IS).*

When Surtsey emerged in 1963–1967 its surface was without any organic carbon (C) and nitrogen (N), but as primary succession took place these elements have accumulated. Now the dominant vegetation, outside the seagull colony, is *Leymus arinarius* (lymegrass) and few other plant species that all are characterised by small aboveground cushions or colonies (hills) and large, extensive root systems. Because of this growth habit, the island still look mostly unvegetated.

In the present study we studied how biomass, C and N accumulated in the top 75 cm of soil, roots and aboveground biomass in limegrass colonies of different age (37, 28, 16, 12, 8, 4 and 2 year old). The average R/S ratio in the limegrass was 42. Total ecosystem C and N stocks increased exponentially as the colonies became older (r^2 = 0.85 and 0.76 for N and C), and the correlation between the N and C stocks was very high (r^2 = 0.99). The exponential increase in the N stock may indicate that root exploration has accumulated N in the growing colonies (hills), as the plants grow in size. This was supported by lower N concentrations between colonies (hills), than within hills. Further, the root biomass of limegrass was more strongly correlated to soil N content (and age) than aboveground biomass.

This strongly supports that it is a lack of N that controls both growth and the dominance of species with extremely high R/S ratios in the first steps of primary succession on Surtsey.

15/08/2013 16:30

O-39 The influence of volcanic tephra on ecosystems

Ólafur Arnalds[1].

[1] *Agricultural University of Iceland (Reykjavík, IS).*

Volcanic eruptions affect a large proportion of Earth's ecosystems, ranging from subtle dust inputs to thick deposits near the volcanoes. In this review, which is published in Advances in Agronomy 121, multiple influences of tephra deposition on land are investigated, using examples of recent volcanic eruptions. Impacts of tephra is depended on the nature of the tephra, including crystallinity, chemical composition, and grain size. The interaction between vegetation height and the deposition depth has a major influence on impacts, while surface roughness and other factors are also important. Low growing Arctic, alpine and desert vegetation is much more sensitive than higher vegetation and forests. Recovery time ranges from few to > 1000 years. Alien species can severely interfere with ecosystem recovery. Erosion processes contribute to volcanic impacts by redistributing tephra, thus reducing tephra thicknesses in some places, but can also cause erosion rates exceeding 100 000 t km^{-2} yr^{-1} with deflation rates of several cm yr^{-1}). Wind erosion of tephra affects ecosystems, agriculture and health, but can provide beneficial dust inputs afar. Thick tephra deposits have pronounced impacts on agriculture and F toxicity is common in volcanic areas. Soils that form in parent materials dominated by volcanic ash are mostly Andisols with the colloidal fraction dominated by short range order minerals and metal-humus complexes. Andisols are often fertile soils with a high capacity to accumulate carbon. There is a need for multidisciplinary long term research on impacts and responses to volcanic eruptions.

15/08/2013 16:50

O-40 Community assembly on nunataks

María Ingimarsdóttir[1, 2], *Jörgen Ripa*[1], *Tancredi Caruso*[3], *Ólöf Birna Magnúsdóttir*[4], *Anders Michelsen*[5], *Katarina Hedlund*[1].

[1] *Lund University (Lund, SE).* [2] *Icelandic Institute of Natural History (Garðabær, IS).* [3] *Freie Universität Berlin (Berlin, DE).* [4] *University of Iceland (Reykjavík, IS).* [5] *University of Copenhagen (Copenhagen, DK).*

Nunataks are ice-free islands within a glacial environment. For the last decades, glaciers have reduced in thickness and consequently nunataks have increased both in number and size. Each nunatak is thus subjected to a primary community assembly. Community assembly takes place everywhere there is an invasion of species to a new or disturbed habitat. The community that develops at each location depends on what species reach the location and are able to establish. Successful establishment depends on both the abiotic environment, e.g. climate and water supplies, and the biotic environment, e.g. food resources.

To study the community assembly of nunataks, we sampled arthropods, identified vegetation, and measured environmental factors along transects within four nunataks (ice-free areas) in Vatnajökull glacier in Iceland, extending from the youngest part of the nunatak to the older parts.

The nunataks are located within the hostile environment of a glacier, where a cold wind normally blows from the upper parts of the glacier down to the lowland. Despite of this, the data indicate a frequent dispersal of organisms to the nunataks, and a community of invertebrates was found on each of the nunataks within a few years from deglaciation. These first colonisers mainly consisted of small, wingless invertebrates that fed on allochthonous material. When plants started to establish, more tropic groups could be added to the community, like herbivores and their predators.

15/08/2013 17:10

O-41 The influence of small topographical variation on plant colonization in early succession

Bryndís Marteinsdóttir[1, 2], *Kristín Svavarsdóttir*[2], *Þóra Ellen Þórhallsdóttir*[2].

[1] *Stockholm University (Stockholm, SE).* [2] *University of Iceland (Reykjavík, IS).*

In early primary succession, plant colonization is often limited by an unfavorable physical environment. Thus, microsites that provide slightly ameliorated conditions may be extremely important for successful establishment.

The objective of this study was to investigate the influence of small topographical variation on plant colonization in early succession on Skeiðarársandur, a 1,000 km² outwash plain in SE-Iceland. The sandy surface is flat with few distinguishing features, except shallow depressions representing flood paths from glacial outbursts and small stones and cushion plants providing small-scale surface relief. We explored if these different micro-topographical features created conditions that ameliorated plant colonization both by quantifying natural seedling germination and survival and experimentally by following the survival of transplanted seedlings.

Seedling survival was low, only 1.4% of germinated seedling survived through their second winter and 11% of transplanted seedlings. Furthermore, neither depressions nor the lee side of cushion plants and stones appeared to ameliorate plant colonization. In fact, survival was sometimes lower in depressions than on nearby flats. In the area, sand accumulates in depressions and behind stones and plants which might negatively influence establishment.

We concluded that colonization patterns of plants in early primary succession on Skeiðarársandur were largely stochastic. However, in better-vegetative areas of Skeiðarársandur depressions often have higher moss and vascular plant cover than nearby flats. As moss cover was negligible in the study area, we suggest that moss may control these vegetation patterns seen later in succession.

15/08/2013 15:30

O-42 Surtsey Nature Reserve

Þórdís Vilhelmína Bragadóttir[1].

[1] *Environment Agency of Iceland (Reykjavík, IS).*

In 1970, there were only five protected sites in Iceland. One of them was Surtsey. In December 2012 number of protected sites had increased to 108. The aim of the protection may vary between sites but the main goal is to preserve these areas for future generations, mainly because of their beauty, education purposes, research values, biosphere and there uniqueness.

Surtsey was declared a nature reserve in 1965 while the volcanic eruption was still in progress. The objective of the protection of Surtsey was to ensure that the development of the island would be kept with the principles of nature itself. Colonization of plants and animals, biotic succession and the shaping of geological formations should be as natural as possible and human disruption minimized. Written permission from the Environment Agency of Iceland is needed to go to the shore in Sursey and dive inside the reserve.

From 1965 the protection was limited to the volcano above sea level. In 2006 the protected area was enlarged and now covers the entire island and the surrounding seas, a total of 65 km^2. In July 2008 was Surtsey placed on the UNESCO World heritage list when it was recognised as a site of unique natural interest and a base for vital research of plant and animal colonisation and of the establishment and development of its ecology. Intensive monitoring and research of the ecosystem and geology of the island with the far-sighted protection of Surtsey in 1965 underpin her presence on the list.

15/08/2013 15:50

O-43 Surtsey as a World Heritage Site

Sigurður Á. Þráinsson[1].

[1] Ministry for the Environment and Natural Resources (Reykjavík, IS).

This short presentation on Surtsey as a World Heritage Site will cover and discuss the process of nomination and the meaning of Surtsey as a World Heritage Site.

The value of the World Heritage Convention and the World Heritage List will be discussed and the importance of World Heritage status for the continuation of the protection of Surtsey considered. Surtsey was inscriped on the WHL on the merits of protection for research and monitoring of geological, geomorphological and ecological processes. The decision to protect the newly formed island, as early as 1965, and to restrict access to scientific expeditions has turned out to be fundamental for the WH listing. As a part of the nomination process the protected area was enlarged to cover all of the volcanic system both the aerial and submerged part and a buffer zone in the waters surrounding the island. The nomination of Surtsey was based on two of the WHL criteria, as an outstanding example representing major stages of earth's history, including the record of life, significant ongoing geological process in the development of landforms, or significant geomorphic or physiographic features and as an outstanding example representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals. Unfortunately only the latter criteria was accepted for the inscription of Surtsey but still it confrims the outstanding universal value of Surtsey which requires protection for the benefit of all humanity.

15/08/2013 16:10

O-44 Geoheritage in Iceland with special reference to Surtsey

***Sigmundur Einarsson*[1]**, *Lovísa Ásbjörnsdóttir*[1], *Kristján Jónasson*[1].

[1] *Icelandic Institute of Natural History (Garðabær, IS).*

For centuries Iceland has been known for geological wonders related to volcanic and geothermal activity. The most spectacular were the geysers, which were the only ones known to Europeans until the discovery of those in the New World. Geysir in Haukadalur (currently dormant) is one of Earth‘s tallest geysers. Additionally, the Icelandic geoheritage contains numerous sites of international scientific importance, including type localities for magnetic events of the geologic time scale, fossil species, rock types and minerals.

The plate boundary in Iceland is characterized by Holocene and Pleistocene volcanic activity. Lava fields, crater rows, shield volcanoes etc. have been formed during the Holocene while hyaloclastite formations express the subglacial Pleistocene volcanic activity. The extensive parallel existence of these two different rock facies is globally unique.

In 1904 Helgi Pjeturss concluded that some of the palagonite (hyaloclastite) mountains were of volcanic origin. At that time the Icelandic *stapi* mountains (tuyas) were still commonly explained as tectonic features *(horstgebirge)*. In 1943 Guðmundur Kjartansson concluded that the *stapi*'s hyaloclastites and the subaerial lava sheet on top were formed in the same eruption. This was based on observations of Hlöðufell and Skriðan in SW-Iceland. His hypothesis was confirmed by the formation of a *stapi* during and after the submarine Surtsey eruption in 1963–1967. This makes Surtsey historically as well as scientifically important and an excellent example of a globally valuable geoheritage site.

15/08/2013 16:30

O-45 Managing sensitive habitats around Laki and Eldgjá in the Vatnajökull National Park.

***Snorri Baldursson*[1].**

[1] *Vatnajökull National Park (Kirkjubæjarklaustur, IS).*

The western region of Vatnajökull National Park (VNP) lies partly within the highly active East Volcanic Zone, which has produced 80% of all eruptive magma in Iceland, during the last millennium. Eruptions typically occur on long fissures and two of those, Eldgjá (934–940) and Laki (1783–1784), are considered among the largest eruptions on Earth in historic times.

The sparse vegetation in these highland areas is dominated by 5–20 cm thick mats of fringe mosses. Similar moss dominated lava and tephra fields are uncommon outside of Iceland, and thus a valuable natural resource. They are also extremely sensitive to trampling and sometimes it takes only a single trail to make a long-lasting impact. Once the moss cover or tephra crust is broken, erosion can follow causing widespread damage.

The image of pristine wilderness is Iceland's main attraction. This image may be in jeopardy as the growing number of visitors has the potential to crowd popular destinations and cause long lasting degradation. In Iceland, mass tourism is a recent phenomenon. Research focusing on the resource, the unique Icelandic nature, and holistic planning and management for tourism, lags far behind. Managers of tourist sites try to keep up by creating infrastructures, such as stairs, viewing platforms and parking lots. However, such infrastructures change the image of the land and hence the tourist's experience. In VNP, we are aware of this dilemma and a few innovative solutions are being developed. The presentation will describe some of these.

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O-46 Katla Geopark

***Steingerður Hreinsdóttir*[1].**

[1] *Katla Geopark (Selfoss, IS).*

Katla Geopark is Iceland´s first geopark. The parks priority is to protect the natural environment while at the same time promote local sustainable development, introduce local culture and place a strong emphasis on geo tourism.

Over 150 volcanic eruptions have been recorded in the area since the 9th century. The eruptions created the landscape and influenced where people settled. Through the centuries, man and nature have affected the region's history. The area is constantly changing due to the volcanic activity.

The Geopark covers about 9% of Iceland, 9542 km^2, and follows the borders of three municipalities, Skaftárhreppur, Mýrdalshreppur and Rangárþing eystra. About 2700 people live within the Geopark. Traditional agriculture has been the main source of employment, especially sheep and dairy farming. Cereal farming has recently increased. The villages of Hvolsvöllur, Vík and Kirkjubæjarklaustur developed as service centres for farmers. In recent years tourism has become increasingly important to the economy of the area.

The sole reason for developing the geopark in this area was as an answer to aging population and that young people were moving away from the area.

The regional development plan of the geopark is therefore to enhance sustainable regional development in the Katla Geopark vicinity and to create employment opportunities for the local population, with the aim of generating conditions in the area that is inviting for young people to move back to.

Abstracts, Posters

P-01 Capelinhos,Azores,a

Victor Hugo Forjaz[1], Zilda Melo França[1].

[1] *Observatorio Vulcanologico e Geotermico dos Açores (S.Miguel, Azores, PT).*

Capelinhos (1957–58) is one of the more studied recent Azores volcanoes. The eruption started off shore, very close to an important lighthouse (Capelinhos), in shallow waters (~100 m) and was followed by technicians and „media" from the begining (27 Sept 1957) until the last explosion (24 Oct 1958). Monthly topographic evolution was followed and daily geological reports were written in an effort to gather knowledge about the most common Azorean volcanoes. Active tectonic structures were also triggered during the 13 months of volcanic activity and marked the start of the Azores volcanic and seismic monitoring.

P-02 Fast coastal processes on volcanic coastlines: the case of Stromboli, Italy.

Claudia Romagnoli[1].

[1] Dip. Scienze Biologiche, Geologiche ed Ambientali, University of Bologna (Bologna, IT).

Very fast coastal processes occur on volcanic coastlines, particularly in response to alternating constructive (eruptive activity) and destructive (erosion or collapse) stages. Studies of historical coastal evolution at Stromboli, in the Aeolian Islands (Italy), indicate that coastal processes develop at high rates there. Stromboli is characterized by persistent, mildly explosive, volcanic activity that, since historical times, concentrates its products mainly on the western flank of the island (in „Sciara del Fuoco"). Small lava deltas, built when lava flows reached the sea during the last main historical eruptions, have been eroded away by wave action within a few weeks or months after formation. Moreover, loose volcaniclastic materials are reworked gravitationally down the steep Sciara del Fuoco scree slope (> 38°) to the sea shore and, from here, drift alongshore in a clockwise direction, due to the most energetic wave climate western approaches. Volcaniclastic sands and gravel thus reach the beaches on the northern and northeastern side of the island. Evolution of coastlines on a 50-years scale has been traced in detail using historical maps and vertical aerial photographs, taken on average at decadal intervals from 1938 to 2003. While cliffed tracts were relatively stable in this time frame, beaches experienced alternating accretion and erosional stages linked, respectively, with contemporary eruptive activity and with sediment redistribution and/or the washing out of sediment to deeper waters. The historical evolution of beaches in the northern part of Stromboli can be thus related to the occurrence of volcanic activity as a natural „replenishment" factor.

P-03 Constraints on primitive magma genesis and magma transfer time at Surtsey Volcano, Iceland, from U-series disequilibrium

Olgeir Sigmarsson[1].

[1] *Institute of Earth Sciences, University of Iceland (Reykjavík, IS).*

Magma transfer time from source to surface can be accessed from short-lived disequilibria in through U-series. Samples reflecting the whole geochemical variations of Surtsey lavas have been analyzed for U-series disequilibria. The U and Th concentrations vary by a factor of 2 with highest values in the first emitted products of Surtla island in 1963 (Th = 1.49 ppm) and lowest values (Th = 0.723 ppm) in the most depleted (primitive) basalts erupted close to the end of Surtsey Fires in 1967. The ratio of Th/U ranges from 2.85 to 3.10 and ($^{230}Th/^{232}Th$) displays a significant range from 1.17 to 1.25. Significant radioactive disequilibrium is found between the radio-nuclides ^{238}U -^{230}Th -^{226}Ra -^{210}Pb. The ($^{230}Th/^{238}U$) disequilibrium spreads from 1.17 to 1.27, ($^{226}Ra/^{230}Th$) range from 1.28 to 1.56 and ($^{210}Pb/^{226}Ra$) at the time of eruption varies from 0.45 to 0.86. No single parental magma composition can be deciphered from these disequilibrium patterns suggesting several mantle melts from a heterogeneous mantle source. These melts were not accumulated in a magma reservoir but most likely rose to surface on a timescale shorter than a decade. These results clearly shows that mantle melting processes and their effects on U-series disequilibria are best recorded in primitive basalts that have not experienced magma chamber processes, which inevitably will smear out the true variability generated by partial melting of heterogeneous mantle lithologies

P-04 Statistical prediction of eruptions in Mount Hekla

Þórir Sigurðsson[1].

[1] *University of Akureyri (Akureyri, IS).*

Hekla is an infamous volcano in southern Iceland which has been active at least since the last Ice Age ended, 10 thousand years ago. It has erupted 18 times during the last 900 years and historical records of the frequency and duration of volcanic activity are available for the majority of these eruptions and volcanologists in the last century identified the lava fields and tephra layers for many of them and measured the volume of the erupted material. In some cases the environmental effects on farmland, grazing and the health of animals and humans are known. In this presentation three linear regression models are specified with the volume as a dependent variable (Y) and either the repose period (X1) before the eruption or the duration (X2) as an independent variable or both. The univariate models are simplistic but the bivariate model gives an opportunity to discuss sophisticated concepts such as multicollinearity, heteroscedasticity and misspecification.The results of the estimated parameters, easily performed in a spreadsheet, turn out to be highly significant and fairly precise and evaluation on the basis of past events behind the historical horizon is supported by geological evidence. Therefore, the models could be useful for predicting the volume of a future eruption. Also, similar models might be applicable to other volcanoes. This problem was originally designed as an exercise in a statistics course for college students but can easily be extended to a multidisciplinary project combining statistical analysis, geology, geophysics, geochemistry, history and medicine.

P-05 A pilot risk assessment for volcanic hazards in Iceland: Vestmannaeyjar

Melissa Anne Pfeffer[1], Sigrún Karlsdóttir[1], Trausti Jónsson[1].

[1] *Icelandic Meteorological Office (Reykjavík, IS).*

An integrated risk assessment of volcanoes in Iceland is being developed. The goals of this project are to minimize loss of life, limit an increase in vulnerability for the future, and minimize economic disruption to and damages in society. An initial risk assessment of volcanic eruptions that may cause extensive damage to property will be presented. Reykjanes and Vestmannaeyjar are pilot regions for this sub-project. The vulnerability of Vestmannaeyjar will be defined as a function of its population, infrastructure, and potential eruption scenarios. Vestmannaeyjar is composed of 15 islands and 30 skerries, of which only Heimaey is permanently inhabited. The vulnerable infrastructure on Heimaey includes buildings, roads, power and water supply, and fisheries. The Vestmannaeyjar volcanic system is 32 km long with the Surtsey, Geirfuglasker, and Heimaey clusters of volcanic edifices. The Heimaey cluster is the largest and is located where people live. The Vestmannaeyjar volcanic system is expected to provide precursory seismic (and potentially other, such as gas) signals days to weeks prior to an eruption. The volcanic hazards in the area are largely a function of interaction of magma with sea water and consist of lava flows, tephra fall, and toxic gases. Eruptions in this system typically last months to years. Based on potential eruption scenarios, we will perform ash and lava flow mapping, analyze the threat to the valuable infrastructure, and define how the risk to infrastructure should be mitigated.

P-06 Early- to mid-Holocene vegetation development in northern Iceland

Sigrún Dögg Eddudóttir[1], Guðrún Gísladóttir[1, 2], Egill Erlendsson[1, 2].

[1] Faculty of Life and Environmental Sciences, University of Iceland (Reykjavík, IS). [2] Institute of Earth Sciences, University of Iceland (Reykjavík, IS).

Iceland is a key site for the study of Holocene vegetation and climate variations due to its location in the North Atlantic. The aim of the project is to reconstruct the history of Holocene vegetation development in Austur-Húnavatnssýsla, northern Iceland. Using pollen and macrofossils, patterns of vegetation change in three locations will be reconstructed, forming a transect from coastal extremes to the highland margin. The palynological and macrofossil data will be combined with a robust regional chronology constructed by combining tephra layers with radiocarbon-dated macrofossils. Available data covering the vegetation history of Iceland are scarce. This study will improve our understanding of how environmental factors have driven vegetation development during the pre-settlement Holocene.

A section of a lacustrine core from the first study site of this project, a lowland site in Svínadalur valley in Húnavatnssýsla, has been analysed. The analysed section of the core covers the period from Younger Dryas to the mid-Holocene. It shows a transition from pioneering vegetation during the cold period of Younger Dryas to the birch forests of the Holocene Thermal Maximum. An initial expansion of birch and gradual closing of vegetation cover was halted by what is probably attributable to the 8,2 ka cooling event. This cooling event has not been demonstrated in the terrestrial biotic palaeorecords in Iceland before. The impact of this event seen in the Svínadalur core, underscores a vulnerability of the early-Holocene terrestrial ecosystem to climatic fluctuations.

P-07 Long-term effects of revegetation on plant succession in Iceland

Járngerður Grétarsdóttir[1], Ása L. Aradóttir[1], H. John B. Birks[2, 3, 4], Vigdis Vandvik[2], Einar Heegaard[5].

[1] Faculty of Environmental Sciences, Agricultural University of Iceland (Borgarnes, IS). [2] Department of Biology, University of Bergen (Bergen, NO). [3] Environmental Change Research Centre, University College London (London, GB). [4] School of Geography and the Environment, University of Oxford (Oxford, GB). [5] Norwegian Forest and Landscape Institute (Fana, NO).

Vast areas of Iceland have a sparse vegetational cover due to active geological processes, extensive retreating glaciers, harsh climate, and vegetation degradation and associated soil erosion. Colonization by biota occurs quite rapidly on some of these areas, but it is slower in other areas.

Efforts have been made to reclaim part of the degraded and eroded land. The purpose of the study presented here was to investigate the long-term effects of different revegetation treatments on plant succession, and to compare it to natural succession on untreated degraded areas. At two localities, vegetation and soil characteristics of five plots in each of eight revegetation treatments (seeded with either perennial or annual grasses and fertilized for various time) that had been applied 20–45 years prior to the study were compared to control plots in adjacent untreated areas.

The areas subjected to revegetation treatments had significantly higher total plant cover (7–100%) than the control plots (≤ 5%), and seeded grasses had less than 10% cover. Floristic composition was in most cases significantly different between treated and untreated plots; with mosses, shrubs, grasses and biological soil crust most abundant on treated land, whereas the control plots had low moss and crust cover and was characterized by species as Arenaria norvegica and Silene uniflora and small tufts of grasses. However, species richness was similar in treated and untreated plots. Our results indicate that revegetation efforts may overcome some of the thresholds that impede succession on eroded land and facilitate colonization of native plants.

P-08 Algal colonisation in the littoral zone in Surtsey

Karl Gunnarsson[1], Svanhildur Egilsdóttir[1].

[1] *Marine Research Institute of Iceland (Reykjavík, IS).*

The littoral zone in Surtsey is extremely unstable being constantly eroded by heavy swell and movement of sand and gravel. The shoreline is therefor constantly changing. Results of observations of littoral algae made in 2009 are presented. The rocky littoral zone was dominated by ephemeral, oportunistic species. Visually two algal zones could be distinguished. In the upper zone of green algae, the most common were species of the genera Ulothrix, Blidingia, Enteromorpha and Urospora and a lower zone brown in appearance there Diatoms, *Ectocarpus fasciculatus*, *Petalonia fascia* and *Alaria esculenta* were most common.

P-09 The lichen funga of Surtsey compared to other islands in the Vestmannaeyjar archipelago

Starri Heiðmarsson[1], *Hörður Kristinsson*[1].

[1] *Icelandic Institute of Natural History (Akureyri, IS).*

Lichen funga of Surtsey has been monitored since its appearance and at present there are 87 species known from the island. On Heimaey, the biggest island in the archipelago, there are only 50 species known. In 2010 two other, uninhabited islands, Elliðaey and Álsey were visited and their lichen funga studied. Comparison of the total lichen funga between different islands is made and similar habitats in different islands are furthermore compared.

P-10 Bryophytes on Surtsey

Gróa Valgerður Ingimundardóttir[1, 2], Henrik Weibull[3], Nils Cronberg[2].

[1] *Icelandic Institute of Natural History (Garðabær, IS).* [2] *Lund University (Lund, SE).* [3] *Naturcentrum AB (Stenungsund, SE).*

The island Surtsey, a UNESCO World Heritage, was formed in a volcanic eruption south of Iceland in 1963–1967 and has since then been protected and monitored by scientists. The first two moss species were found on Surtsey as early as 1967[1] and several new moss species were discovered every year until 1973 when regular sampling ended.

A systematic and particularly intensive inventory was made in 1971 and 1972 respectively; the island was divided into 100 × 100 m quadrats which were searched and sampled for bryophytes each year. Their number had almost doubled between years; with 37 species found in 1971 and 72 species in 1972[2].

In the summer of 2008 bryophytes on the island were revisited. Every other quadrat was searched for bryophytes. The sampling intensity was however considerably lower than before 1973[3]. As expected, the three days of fieldwork revealed increased dispersal of earlier colonists as well as presence of species unrecorded before. However, more thorough investigations are needed to get a clear picture of the status and distribution of the bryophyte species in Surtsey. Due to habitat loss and successional vegetation changes it is to be expected that some bryophyte species from 1972 are declining or even extinct from Surtsey while others continue to thrive and expand.

References:

[1] *Jóhannsson, B. 1968 Surtsey Research Progress Report IV: 61*

[2] *Magnússon, S. and S. Friðriksson, 1974 Surtsey Research Progress Report VII: 45–57*

[3] *Magnússon, S. Personal communication, September 2009.*

P-11 Is the reproductive system in *Honckenya peploides* on Surtsey under change?

Marianne Philipp[1], Henning Adsersen[1].

[1] *Department of Biology, University of Copenhagen (Copenhagen, DK).*

Honckenya peploides arrived to Surtsey in 1967 as the first to colonize barren sandy areas. We sampled populations to study how the dispersal and ecological release influenced the reproductive system. Where *H. peploides* was investigated elsewhere, the populations consisted of female and hermaphroditic individuals in approximately equal proportions. We expected to find hermaphroditic plants to be more frequent in Surtsey as a simpler, mixed mating reproductive system could be favoured at establishment after dispersal. We found, however, that female individuals were dominant in all Surtsey populations and that the hermaphroditic individuals rarely produced capsules. They were functioning as males only, making the reproductive system nearly dioecic. Another expectation was that the ratio between females and hermaphrodites in populations would influence the allocation to male function. We found a tendency towards fewer pollen grains in populations with a high proportion of females. Several of the male functioning plants have, however, pollen grains which did not seem to be well developed and probably not able to germinate. This seemed not to influence the female fecundity since all observed female individuals were covered with capsules, indicating no pollen limitation. Younger and disturbed populations seemed to have highest sex ratio bias. This could be explained by physiological differences between the sexes.

P-12 The effect of long distance dispersal on reproductive system and genetic variation in *Cordia lutea* – a comparison between the coast of Ecuador and the Galápagos Islands

Marianne Philipp[1], Ida Hartvig[2], Henning Adsersen[1], Hafdís Hanna Ægisdóttir[3].

[1] Department of Biology, University of Copenhagen (Copenhagen, DK). [2] Forest & Landscape University of Copenhagen (Frederiksberg, DK). [3] Faculty of Environmental Sciences, Agricultural University of Iceland (Reykjavík, IS).

Species dispersed to isolated localities are believed to possess lower genetic diversity compared to its original region. Furthermore, self-compatibility is supposed to be favoured to ensure sexual reproduction in spite of low density of mates.

The present study investigated the putative heterostylous species *Cordia lutea* Lam. (Boraginaceae), a native, woody plant species found at the Galápagos Islands, western Ecuador and north-western Peru. Heterostyly is a genetic polymorphism often resulting in two types of morphs: The pin morph has long pistil and short stamens and the thrum morph has short pistil and long stamens. Generally, these traits are combined with an incompatibility system preventing selfings and intramorph fertilizations.

We compared the heterostylous system, eight flower traits, three leaf traits and genetic variations (50 polymorphic AFLP makers) between nine populations at the Galapagos Islands and five populations at the coast of Ecuador.

The dispersal from the mainland of Ecuador to the Galápagos Islands has resulted in significant differences in morphological as well as genetic traits. In the reproductive system no changes in response to dispersal were revealed by the present study. We found a continuous variation in the lengths of pistils and stamen which is remarkable and may be explained by different but relaxed selection for reciprocity at the Galapagos Islands and at the coast of Ecuador.

P-13 Effects of vegetation cover on annual, seasonal and diurnal fluctuations in soil temperature and soil water content in Surtsey, Iceland

Bjarni D. Sigurðsson[1], Sigvaldi Árnason[2].

[1] Agricultural University of Iceland (Borgarnes, IS). [2] Icelandic Meteorological Office (Reykjavík, Iceland).

An automatic climate station was installed on Surtsey in May 2009. It measures all basic climatic variables, including global radiation (W/m^2), precipitation (mm), wind speed (m/sec.) and direction, air pressure (hPa), air temperature (°C) and air relative humidity (%). A web-camera was installed which takes one photograph of the island per hour and, finally, sensors to measure soil temperature (°C) and soil volumetric water content (%) were installed in 5 and 15 cm depth in two places with contrasting surface properties: a) an unvegetated black volcanic tephra sand and b) where vegetation had covered the tephra sand. By comparing soil temperature and water contents at those two areas, the effect of vegetation can be evaluated.

The presentation will focus on the effect of vegetation cover on annual, seasonal and diurnal fluctuations in both soil temperature and soil water content. It has been previously shown that water availability can affect vegetation on Surtsey (Sigurdsson 2009), but large diurnal fluctuations in soil temperature could also pose a barrier for many plant and animal species to successfully colonize the island in its early successional stage. It is hypothized that when the first plant colonizers have, however, stabilized the large soil temperature fluctuations this barrier may be lifted.

References:

Bjarni D. Sigurdsson (2009). Ecosystem carbon fluxes of Leymus arenarius and Honckenya pebloides on Surtsey in relation to water availability: a pilot study. Surtsey Research 12, 77–80.

P-14 Nematode generic diversity and density in different habitats in Surtsey

Bjarni D. Sigurðsson[1], Krassimira Ilieva-Makulec[2,3], Brynhildur Bjarnadóttir[4].

[1] Agricultural University of Iceland (Borgarnes, IS). [2] Centre for Ecological Research, PAS (Lomianki, PL). [3] Cardinal St. Wyszynski University in Warsaw (Warsaw, PL). [4] University of Akureyri (Akureyri, IS).

Nematodes play various roles in soil foodwebs. Some species feed on plants, but many others feed on soil bacteria, fungi, or are predators on other soil animals. Thus nematodes take part in the most important soil processes such as the decomposition and nutrient cycling.

We sampled two soil cores in each of all 25 permanent vegetation plots in Surtsey 18 July 2012. The cores were split into surface soil (0–10 cm) and subsoil (10–20 cm), where soil depth allowed, and extracted by Baermann Funnel Method at the soil lab at Möðruvellir, N-Iceland. The nematodes were then shipped to Poland where their genera (species, where possible) and number of individuals was determined.

Barren areas were starkly distinct from the area affected by breeding seagulls from 1985. Within the colony the average nematode density in surface soil was 16.7 ± 7.1SE individuals per cm^2, while only 3.6±2.0 individual were found outside it. Outside the seagull colony the density of nematodes increased with depth, and in the subsoil the density was 97% higher (6.9 ± 3.3), while population density in the subsoil was not significantly different within the seagull colony (7.0 ± 4.3). Altogether 18 genera of nematodes were found within the seagull colony, while 24 genera were found outside it. The trophic group (bacterial, fungal, plant feeders or predators and omnivores) of each genus will be shown, to indicate the functional structure of nematode community in soil foodweb in Surtsey.

P-15 Founder effect in *Empetrum* and *Festuca* species on Surtsey

Agniezka Sutkowska[1], Kesara Anamthawat-Jónsson[2], Borgþór Magnússon[3], Józef Mitka[4].

[1] Agricultural University at Kraków (Kraków, PL). [2] University of Iceland (Reykjavík, IS). [3] Icelandic Institute of Natural History (Gardabær, IS). [4] Jagiellonian University (Kraków, PL).

Inter-simple sequence repeats (ISSR) were used as markers to assess genetic diversity and population structure in two plant species, *Empetrum nigrum* (black crowberry) and *Festuca richardsonii* (arctic fescue), colonizing the island Surtsey since 1993 and 1973, respectively. Based on ISSR analysis, the species differed significantly in their genetic profiles. Although both species were found to be similar in terms of genetic diversity (mean Nei's gene diversity h of 0.2399 and 0.2491, respectively, indicating genetic pauperization in both of them), *E. nigrum* showed high level of polymorphism at the subpopulation level, with only 5.06% ($p = 0.046$) of the genetic variation attributable to the among-population differentiation, whereas *F. richardsonii* is more highly structured with 16.73% ($p < 0.001$) among-population component. Although the two species first appeared at about the same site on the island, i.e. in the seagull colony, they have had different colonization history. The shrub species *Empetrum* may still be in its first generations whereas the grass species *Festuca*, which established much earlier, has expanded rapidly into dense turfs. Furthermore, the differences in the genetic profiles may be attributable to their reproductive biology. Cross-pollinated, dioecious *E. nigrum (spp. nigrum)* retained its broad genetic structure at subpopulation level, nevertheless accompanied by a high gene flow leading to panmixis. On the contrary, cross-pollinated, clonal *F. richardsonii* was genetically differentiated at the subpopulation level, revealing in some cases sign of genetic bottleneck linked with the founder effect.

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