

Title: Secondary mineralization processes in pyroclastic rocks from the island of Surtsey, Iceland

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Research program

Surtsey is a very young volcanic island, formed through a series of submarine eruptions between 1963 and 1967 along the southern extension of the rift areas of south-eastern Iceland.

In 1965, when the eruptions had not yet ended, it was declared natural reserve and for this reason the island is considered a protected area; since its inception it has represented a real geological and biological research laboratory, and will continue to be so.

Various institutions such as the Icelandic Institute of Natural History, the Marine Research Institute of the University of Iceland have conducted extensive research and carried out large number of monitoring projects on the island; in fact Surtsey provided the unique opportunity to monitor a submarine eruption and to study the formation and the development of an island. These projects have been able to retrace the geological history of the island and the colonization of organisms, and also to control changes occurred over time in Surtsey's ecosystem; with regard to geology, in particular, geothermal development, formation and alteration of volcanic materials, subsidence of the island and marine erosion are now monitored. In 2008, given its importance and scientific relevance, Surtsey was named a UNESCO World Heritage Site.

To study its geological features, a first survey was carried out on the island in 1979. The drilling site was located on the south-eastern edge of Surtur, the eastern crater, 58 meters above sea level; the survey reached a total depth of 181 meters and allowed to describe the volcanic structures present above and below sea level, the hydrothermal system and the composition and alteration of the basaltic tephra, as well as providing possibility of monitoring temperatures and composition of fluids since 1980.

A new drilling project called SUSTAIN (Surtsey Underwater volcanic System for Thermophiles, Alteration processes and INnovative Concretes) which also involved DiSTAR (Department of Earth and Environmental Sciences, University of Naples Federico II), dating back to 2017 and partly sponsored by the ICDP (International Continental Scientific Drilling Program), was started to observe and study the hydrothermal, geochemical, geomagnetic and microbiological changes that affected volcanic deposits and minor intrusions since the formation of the volcanic island.

Three perforations were carried out during the summer of 2017, two in a site 5 meters away from 1979's site: a first one, 152 meters deep and a second one 192 meters deep, with the aim of obtaining additional information on deep stratigraphy and underwater structures. In addition, the comparison of these surveys with that of 1979 was carried out with the aim of improving knowledge of geological and biological processes that occurred on the island. A third drill core, 354 meters deep and inclined at 55 °, was carried out to obtain a further vision of the eruptive processes, identifying the presence of a diatrem that extends for at least 100 meters in the seabed below the Surtur crater.

An underground observatory was also installed at 181 meters deep, in one of the vertical wells, to carry out experiments in order to monitor on site the processes of mineralogical and microbial alteration and the interactions between rock, sea and microorganisms.

The study of the two different surveys (1979 and 2017) on the island of Surtsey is considered very important for the study of the mechanisms of submarine and sub-aerial basaltic eruptions, of the deep structures of young islands in shallow rifting environments and of the lithification processes of tephra that allow to an emerging island to resist incessant marine erosion. They also recorded the hydrothermal alteration processes, the rapid evolution of the magnetic properties of the rocks, the different processes of dissolution and alteration of the glass, the development of secondary minerals and their influence on the physical/mechanical properties of the rocks.

Proposal for a PhD position

A position for a PhD student will be required for a candidate who can carry out research in the framework SUSTAIN project. In particular, the doctoral project will focus on the study of secondary mineralization processes (zeolithization, clay minerals formation) in pyroclastites of different volcanic districts, with particular regards to those of the island of Surtsey, Iceland and should be completed within three years.

The project program will include the study a) of the available literature and b) of a selection of samples collected during the two drilling campaigns carried out in Surtsey (1979-2017).

The analytical program will be developed using facilities present at DiSTAR, Federico II University, where the doctoral student will have the opportunity to acquire technical skills related to mineralogical, petrographic and physical methods, including qualitative and quantitative mineralogical analysis (XRPD), chemical analysis (XRF), polarized light optical microscopy (POM), scanning electron microscopy with microanalysis (EDS / WDS), spectroscopic techniques (Raman, FT-IR) and thermal analysis (TGA).

Training courses of the "Doctoral School" will be available for the PhD student at the host University, in order to improve his / her knowledge on different topics.

The work program foresees a period of about 5 months to be carried out in a research facility or university site abroad, to allow the doctoral student to learn different analytical methods and to confront with other scholars, also in order to have the opportunity to further develop your career.

Projects

SUSTAIN project (Surtsey Underwater volcanic System for Thermophiles, Alteration processes and INnovative Concretes, <https://www.icdp-online.org/projects/world/europe/surtsey/details/>) partly sponsored by the ICDP (International Continental Scientific Drilling Program) and in collaboration between the University of Utah, the University of Iceland, the University of Bremen, the University of Bergen and the Federico II University of Naples.