

Historical Notes on Earth Science Research in Iceland by German Expeditions, 1819 – 1970

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Introduction

This article originated as a seminar contribution during a visit to Iceland by Dr. Manfred Osten, General Secretary of the Alexander von Humboldt Stiftung, in 1999. A draft version was published in “Geschichte und Philosophie der Geophysik”, edited by W. Schröder, IAGA IDC History Newsletter no. 42, Bremen 2000, p. 138 – 154.

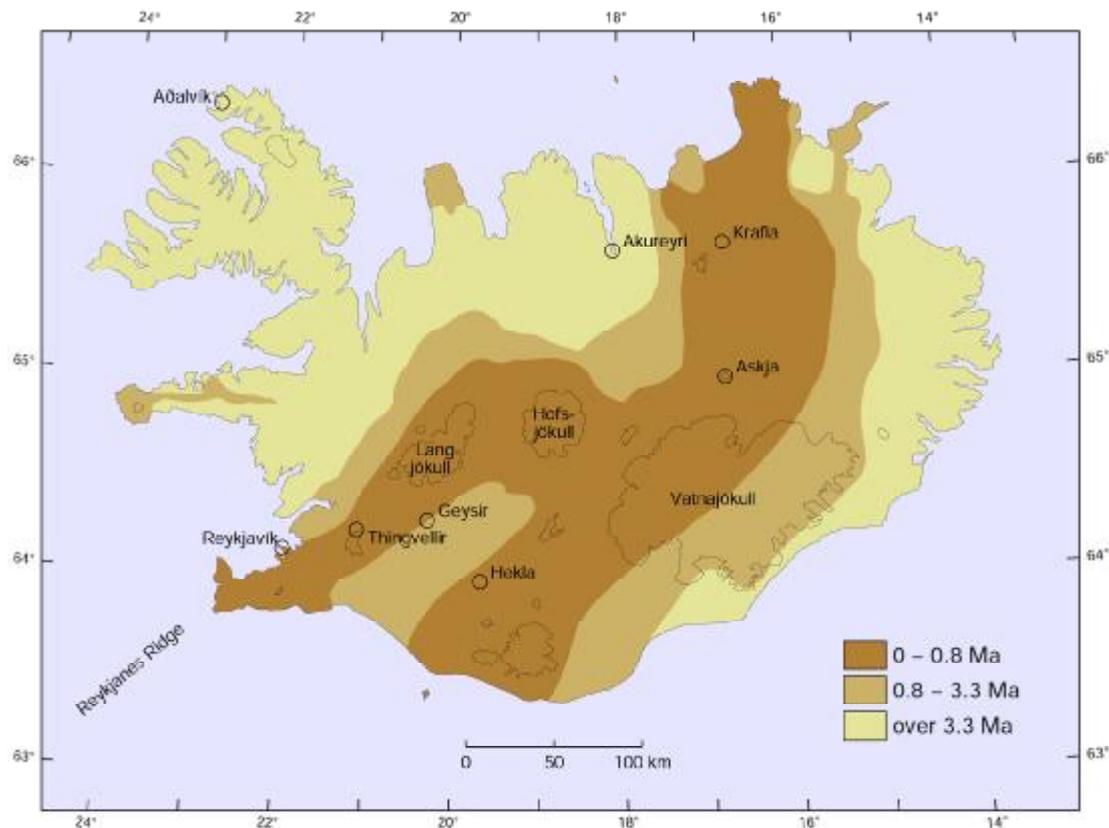


Fig. 1 Index map of Iceland, showing the active volcanic zones, glaciers and some locations mentioned in the text.

Iceland is in many ways an interesting place for geoscientists, as regards processes both in the interior of the Earth, at its surface, and above. Thus, Iceland is a “hot spot” of unusually high heat flow through the crust, believed by many to be caused by a plume of upwelling in the Earth’s mantle. It is also one of the very few places where a divergent (i.e. rifting) boundary between its major tectonic plates is exposed on dry land. These circumstances are manifested directly and indirectly by ongoing volcanic, seismic and geothermal activity, as well as by tectonic structures of which the Thing-

vellir graben is probably the best known. The volcanism has left a well-exposed pile of (mostly subaerial) basalt lavas, intercalated by sediments which contain plant and animal fossils indicating the climate changes during the last 15 million years. Other products of the volcanism include tephra layers, acidic rocks, intrusions of various types, and secondary minerals. The island has the largest glaciers in Europe, accompanied by very active geomorphological processes. Warm and cold currents meet in the ocean around Iceland, and the resultant vertical mixing causes great biological productivity. Similarly, temperate and Arctic air masses interact over the northeastern Atlantic. And finally, Iceland happens to lie in the auroral zone which makes it a good location for studying phenomena in the ionosphere.

In the 18th century, several learned persons were sent to Iceland by the authorities residing in Copenhagen. Their task was to carry out geodetic and hydrographic surveys, assess the island's natural resources and vulnerabilities, and advise on ways to improve the lot of its inhabitants. We may assume that reports from these persons as well as accounts (often quite inaccurate and fanciful) by merchants and others led to visits by scientists from Northern European countries in the late 18th century. The present paper briefly mentions a number of German geologists and geophysicists who carried out geoscience research in Iceland in the period 1819 – 1970, and some of the resulting publications. No complete data base of such expeditions or their published results exists in Iceland, and these results are scattered very widely through the scientific literature. This review is therefore pieced together from various sources, and it may leave out works of importance which have not reached the present author's attention. Lists of some additional publications are available from the author. Most useful have been the extensive accounts of early research by Th. Thoroddsen (1902 – 04), a partial bibliography of foreign literature on Iceland by H. Sigurðsson (1991), a paper by M. Schwarzbach (1983) and the 19-volume "Catalogue of Scientific Papers" of the 19th century published by the Royal Society of London.

It should be noted that there are important aspects of German scientific research related to Iceland which are not given much attention in the present compilation. Among them are laboratory observations on samples of rocks, minerals and geothermal fluids brought from Iceland. However, two early examples of such research will be mentioned here, one being the first German paper on chemical analysis of Icelandic mineral materials, written by M.H. Klaproth (1799), a pioneer in mineralogical chemistry. The other publication on mineral samples concerns the zeolite epistilbite (Rose 1826); this is possibly the only instance of a mineral having been first identified and described in a specimen from Iceland (Fig. 2). It may be remarked in this context that Iceland spar, a transparent variety of calcite exported from a quarry in Eastern Iceland, was of considerable value to segments of German optical science, chemistry and industry in the period 1830 – 1930 at least: see www.raunvis.hi.is/~leo/spar.html

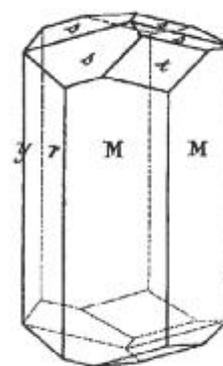


Fig. 2. Drawing by the famous mineralogist G. Rose (1826) of a crystal of epistilbite, in a paper describing this zeolite (hydrated alteration mineral) for the first time. For many decades, epistilbite was only very rarely encountered outside Iceland.

1819 – 1849 Geology, geochemistry

“In der deutschen Wissenschaft hat Islands Naturwelt stets weitgehende Beachtung gefunden” (Spethmann 1930). Among the first people who visited Iceland specifically to study its geology were two Germans, the self-educated mineralogist Johannes Menge in 1819 and Otto Krug von Nidda in 1833. Both travelled widely around the island and wrote papers containing valuable observations (e.g. Menge 1820; Krug von Nidda 1834, 1836) although Thoroddsen (1902 – 04) considers their geological ideas to have been somewhat unrealistic. The year 1819 is also significant because two publications appeared in Germany describing various geological phenomena and rocks from Iceland: one is a book by G. Garlieb (1819), and the other is a paper by E. Vargas de Bedemar (1819), a German scientist in charge of the mineral collection of the Crown Prince of Denmark. As far as I know neither of them visited Iceland, so understandably their accounts are not very accurate. F.A. Thienemann (1824 – 27), a German medical doctor and ornithologist, wrote a book on his travels in Iceland in 1820 – 21 which includes various observations of geological interest.

In late 1845 there was a large eruption in the volcano Hekla, with tephra from its initial phase being carried by winds as far as the Orkneys. This tephra was studied by Ehrenberg (e.g. 1846) who previously had investigated subfossil microfauna brought by the above-mentioned F.A. Thienemann from Iceland. In the summer of 1846, an expedition came from Europe to study Hekla and other geological phenomena, with the generous support of the King of Denmark and Iceland, Christian VIII. It included the famous chemist Robert Bunsen and the geologist Wolfgang Sartorius von Waltershausen. Many important publications resulted from this expedition, regarding the geology of Iceland as well as the mineralogy of basalts, generation of palagonite tuffs, and hydrothermal alteration effects (e.g. Sartorius von Waltershausen 1847, 1853; Bunsen 1847a, 1851; Genth 1848; Rammelsberg 1849). Bunsen (1847a) suggested a mechanism for the eruptions of the large hot spring in Southern Iceland which has given its name Geysir to erupting hot springs everywhere. Bunsen’s paper was for a long time the best known of the various theories of geyser action, and it inspired others to study this phenomenon (see Fig. 3). Another train of developments resulting in part from Bunsen’s Iceland visit, relates to the fact that after this visit he made some of the first-ever laboratory observations on the

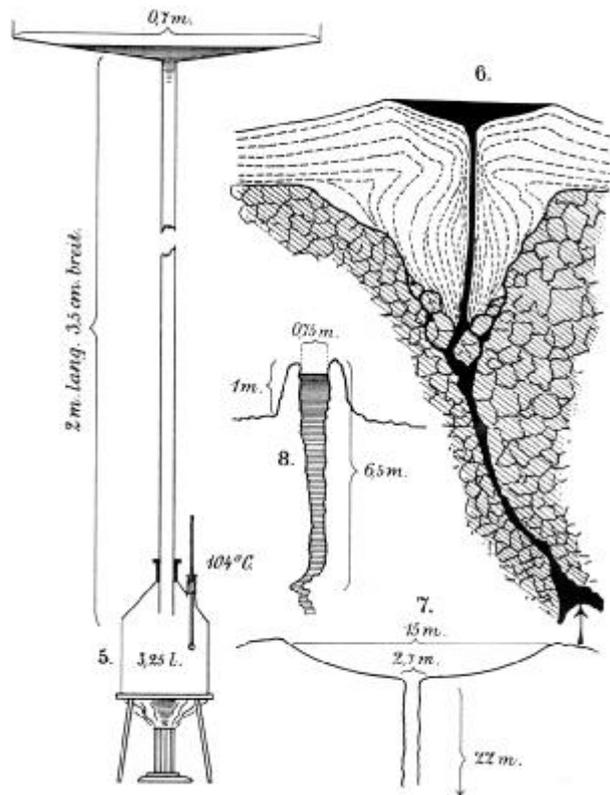


Fig. 3. Testing of one of the many hypotheses of geyser action, inspired by the work of R. Bunsen and others on erupting hot springs in Iceland from Andreae 1893).

color of water; a paper (Bunsen 1849) where he refers to the blueness of Iceland's hot springs and glaciers, prompted among other things far-reaching research by the Irishman J. Tyndall on scattering of light by small particles.

1850 – 1900 Geology, paleontology, mineralogy, geomorphology

Gustav Georg Winkler came to Iceland in 1858 along with the historian Konrad Maurer whose account of their travels has only been published very recently (Maurer 1997). Winkler wrote two books on his observations in Iceland, one on geology (Winkler 1863) but his interpretations were based on outdated concepts such as Neptunism.

The next German geological visitor was the mineralogist Ferdinand Zirkel, who travelled in Iceland in 1860 along with William Th. Preyer, later professor of physiology (Preyer and Zirkel 1862). Zirkel wrote his doctoral thesis on the geology of Iceland (Zirkel 1861), and in his pioneering works on microscopical petrography (Zirkel 1863, etc.) he describes many thin sections of Icelandic igneous rocks (Fig. 4). Zirkel (1875), Gerhard vom Rath and others wrote papers on tephra material from the volcano Askja in Iceland, which fell in Northern Europe in March 1875. Later petrographers such as Harry Rosenbusch, Justus Roth, L. Paul Schirlitz (1882) and Albrecht Penck (1879) also included Icelandic material (at least partly provided by Zirkel) in their papers and books. Penck, by the way, is best known for his later work on landforms and Alpine glaciations.

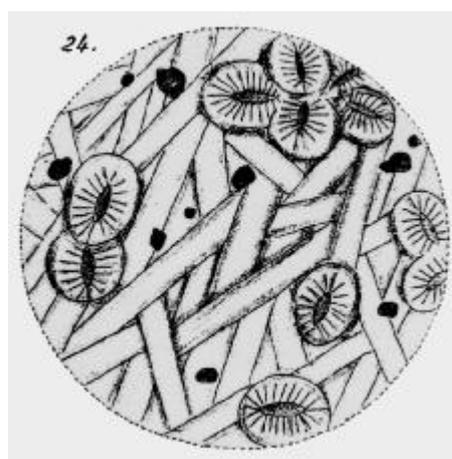


Fig. 4. An illustration by F. Zirkel (1863) showing secondary minerals in a microscope slide from Icelandic basalt. Zirkel was one of the pioneers of microscopical petrography.

Valuable investigations of Miocene-Pliocene plant fossils in Iceland initiated by the Swiss paleontologist Oswald Heer around 1860 (on material collected by Winkler and others) were continued e.g. by Paul Windisch (1885). Konrad Keilhack travelled in Iceland in 1883 with Carl W. Schmidt who studied rhyolites (Schmidt 1885). Keilhack carried out research on geothermal activity and especially on glacial phenomena, which he found helpful for understanding the origin of Quaternary deposits in Northern Germany. Keilhack's varied writings on Iceland include a book (Keilhack 1885), a geological map of the island with explanations (Keilhack 1886a), a description of vegetation around hot springs (Keilhack 1886b) and writings about glacial deposits (e.g. Keilhack 1883) where he introduced the Icelandic term "sandur" into the European literature.

1901 – 1914 Geology, volcanology, glaciers

Several German scientists made notable contributions to the geology of Iceland following their research there in the first decade of the century. In this period Walther von Knebel (who was one of the first geoscientists to study calderas) travelled in Iceland and wrote papers on both volcanic and glacial phenomena (e.g. von Knebel

1906, 1907, see Fig. 5) A book describing his observations was completed by Hans Reck (von Knebel 1912) after von Knebel and the painter Max Rudloff tragically perished at the Askja caldera lake in North Iceland in 1907. Reck himself wrote a book on volcanic eruptions (Reck 1910a) as well as over a dozen papers on volcanic features (e.g. Reck 1910b) and late Quaternary to Recent glacial deposits (e.g. Reck 1911) in Iceland. Karl Schneider (1907) from Bohemia, Karl Sapper (1908, 1909), Hans Spethmann (1909, 1912, 1913, 1930, etc.), Max Trautz (1914), Maurice von Komorowicz (1912) and Ludwig Wunder (1912) also investigated volcanoes and glaciers. Schneider (1913) additionally discussed some geothermal manifestations in Iceland. In geophysics, an expedition arrived to make geomagnetic measurements during the 1910 approach of Halley's Comet (Angenheister and Ansel 1912).

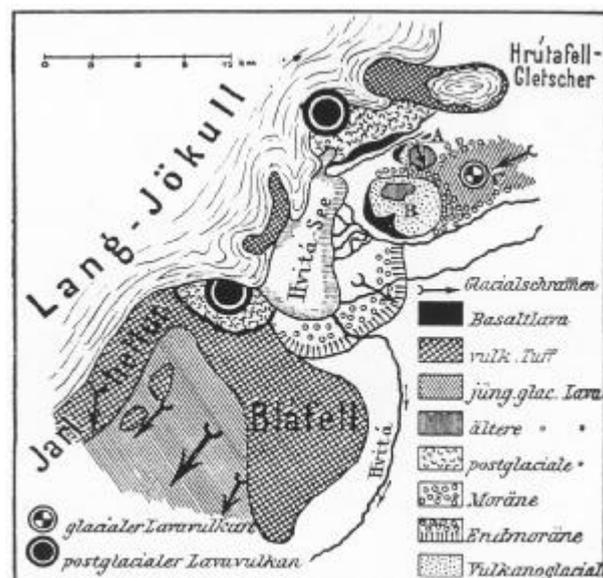


Fig. 1. Kartenskizze vom SO-Randgebiet des Lang-Jökull.

Fig. 5. Map by W. von Knebel (1905) of Quaternary volcanic and glacial formations at the southeastern part of the Langjökull glacier.

Among travellers interested in both geological and geographical aspects of Iceland were Carl Kuchler who published three books and several papers on Iceland (Kuchler 1909, 1911, and others), and Heinrich Erkes who visited Iceland at least eight times to 1926. Erkes wrote over 30 papers and newspaper articles on a wide variety of topics (e.g. Erkes 1909, 1911) and he contributed much descriptive material to the periodical "Mitteilungen der Islandfreunde" which was published in Jena in 1913 – 36.

In 1912, an expedition led by Alfred Wegener travelled from Akureyri in central Northern Iceland to the Vatnajökull glacier (Koch and Wegener 1930), in preparation for their crossing of Greenland in 1912 – 13. Wegener (1914) published a short paper on dust cyclones which he had observed in Iceland, but the island's geology did not come to play a part in his famous concept of continental drift.

1920 – 1940 Glaciers, tectonics

The continuing interest in Iceland's nature and culture in this period is reflected in a two-volume book on "Deutsche Islandforschung 1930", edited by Walter H. Vogt and Hans Spethmann. In the late 1920's and the 1930's several German and Austrian scientists explored Iceland, paying special attention to glaciers and their surroundings. These included Karl Schmid and Helmut Verleger who visited the site of a 1934 volcanic eruption in the Vatnajökull glacier, Emmy M. Todtmann, Ernst Herrmann, Wolfgang Oetting, Walter Iwan, and Paul Woldstedt. Among publications of these scientists are Schmid (1954), Verleger (1934), Todtmann (1932), Oetting (1930), Iwan (1935, 1937), Herrmann (1928 – 29) and Woldstedt (1939). Konrad Keilhack (see above) re-visited Iceland in 1924 in connection with a gold-prospecting project

and wrote further papers, one of them containing the first detailed map of the geology of the Reykjavík area (Keilhack 1925).

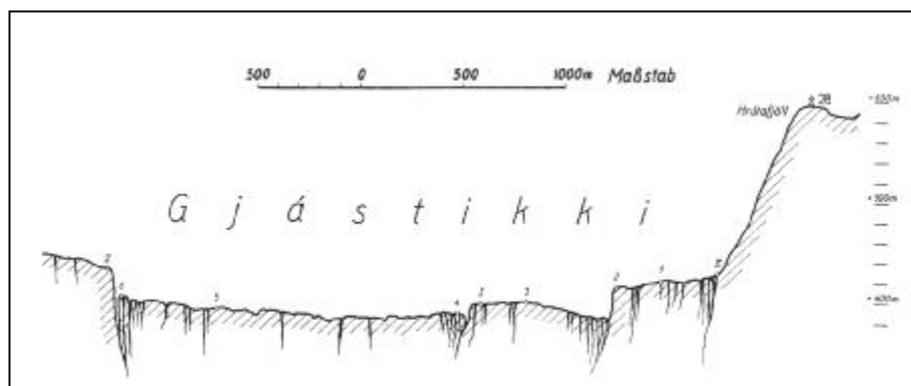


Fig. 6. A detailed cross-section of one of the large tectonic fissure systems in Northeastern Iceland, studied by O. Niemczyk's group in 1938 (adapted from Niemczyk 1943).

A major new development was an expedition in 1938 to study active tectonics of the volcanic zone in Southwestern and Northeastern Iceland. This project was probably inspired by the volcanological research of some of the authors previously mentioned as well as by the work of Danish and Swiss geologists (such as N. Nielsen, R. Sonder and A. Rittmann) in Iceland. It resulted in a book (Niemczyk 1943) which included chapters on tectonic motions in Iceland by Ferdinand Bernauer (who is better known for his work in mineralogy and optics), on precise geodetic measurements across fissure zones (Fig. 6) by Oskar Niemczyk and E. Emschermann, and on gravity observations by E. Ansel and Alfred Schleusener. The geodetic work was also published separately (e.g. Niemczyk and Emschermann 1940), and Bernauer wrote several papers on related topics (e.g. Bernauer 1937, 1939a).

It was intended to continue the tectonics research, but World War II and subsequent changes in Europe intervened. The German group had observed in Iceland important consequences of the process of continental drift by sea floor spreading at mid-ocean ridges (see Bernauer 1939b) but as is well known, the significance of this process was not fully appreciated for the next few decades.

1950 – 1970 Geology, geophysics

Emmy Todtmann continued her work on periglacial phenomena in the 1950's (e.g. Todtmann 1957); otherwise, not much research on Icelandic glaciers and glacial geology seems to have been undertaken by German scientists in the period to 1970.

Martin Schwarzbach's group from Köln wrote several papers on various aspects of Icelandic geology from 1955 to after 1970, largely connected with fossil-bearing interbasaltic sediments (e.g. Schwarzbach 1955, Schwarzbach and Pflug 1957; Strauch 1963; Friedrich 1966, see Fig. 7) as well as geological guide-books (Schwarzbach 1956 and later). Their best known con-



Fig. 7. A well-preserved leaf fossil of about 12 million years age from Northwestern Iceland (drawing from Friedrich 1966).

clusion (Pflug 1959) may have been that pollen in the oldest sediments of Eastern and Northwestern Iceland indicated an Eocene or even older age, i.e. more than 50 million years. However, K-Ar radiometric age determinations published in 1966 – 68 showed that the oldest exposed rocks in Iceland are only about 15 million years old.

Papers by George P.L. Walker of London (and later also by his students and associates) on the stratigraphy, geochemical development, and tectonics of Eastern Iceland began appearing in 1959. Over the next decade this work truly revolutionized all thinking about the island's geology, and paved the way for its understanding in terms of a plate boundary/hot spot environment. One paper on local stratigraphy in Northeastern Iceland appeared from the Köln group (Jux 1960) but otherwise they missed taking part in the revolution. In fact, even Icelandic geologists have been slow at following up Walker's accomplishments, and many parts of Iceland still remain to be mapped in any kind of detail by earth scientists.

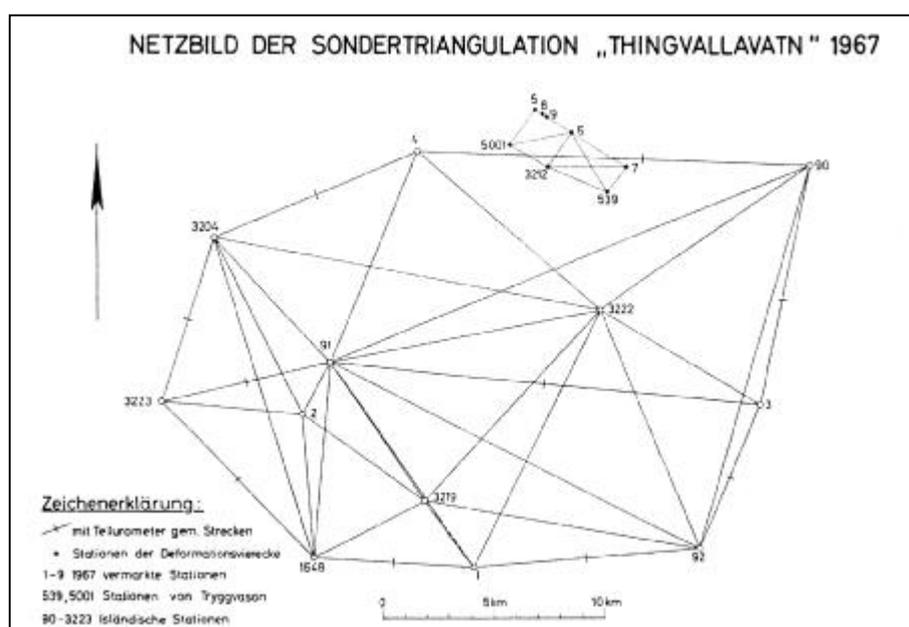


Fig. 8. A precise geodetic triangulation net across the fissure zone at Thingvellir, Southwestern Iceland, set up in 1967 (from Gerke 1967).

The 1938 German geodetic and gravity work across the volcanic zones was resumed (Fig. 8) in 1964 – 65 with much improved equipment (Gerke 1967, Schleusener and Torge 1971). No definite crustal extension had been found by the early 1970's, but during an episode of intense activity in the Krafla volcanic center of Northeastern Iceland in 1975 – 84 it became apparent that the process of spreading in the island is quite intermittent: at each volcanic center, quiescent intervals of the order of centuries may pass between events when several meters of extension take place in a few years.

Towards the end of the 1960's several new earth-science researchers from Germany were beginning work in Iceland, e.g. N. Petersen and his colleagues from München (ground magnetic surveys), K. Schäfer from Karlsruhe (volcanism, tectonics) and H. Noll from Köln (volcanism, stratigraphy).

Notes on meteorology and related studies, to 1938

Already in the late 19th century, European scientists looked to the Northeastern Atlantic Ocean in their efforts to understand the climate of the continent. Aerological expeditions from Germany visited Iceland as early as 1907 (Hildebrandt 1907). Meteorological observations which were made in Iceland continuously from 1845, indicated among other things that the atmospheric pressure was very variable in the Iceland area and that its annual mean there was quite low. It was postulated that the position and intensity of this pressure minimum might influence the European weather (see Drewes 1917; Wiese 1925) directly or through its effect on the Gulf Stream. Others pointed out that due to the large annual pressure variations in the Iceland region, it might be termed a “center of action” for the climate (see Defant 1917). Still other theories involved the presence of the Greenland ice cap and its effect on air masses, or the possibility of occasional large “outbreaks” of cold air from the Arctic which would influence the development of weather systems over the Atlantic. Observations in Iceland were therefore expected to be of value both for short- and long-term forecasting of the weather in Germany.

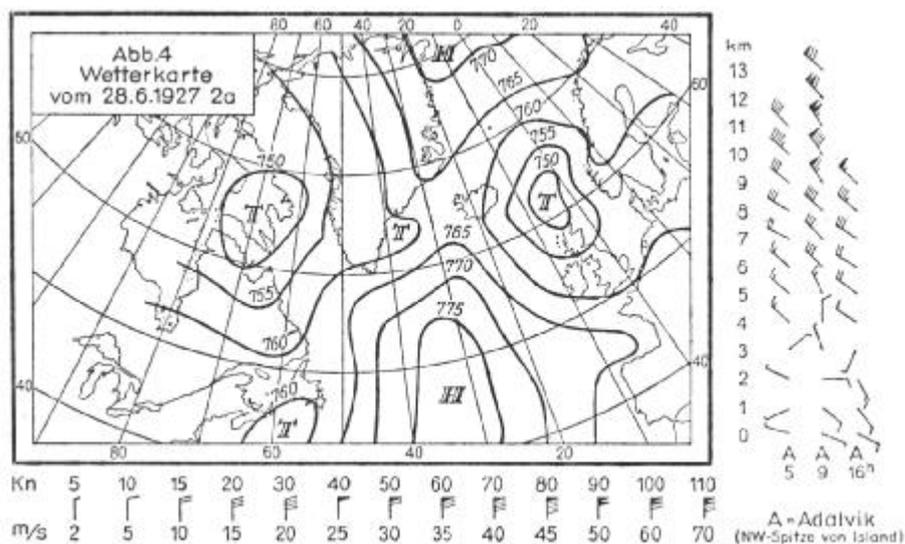


Fig. 9. Very strong northerly winds in the upper troposphere, 9 to 13 km altitude, found by pilot balloon observations in Adalvik, Northwestern Iceland in 1927 (from Georgi 1950).

By the mid-1920's, the weather in the Northeastern Atlantic was also of increasing interest due to the prospect of air transport between the continents by the northern route. This prompted Johannes Georgi, an associate of Alfred Wegener, to study upper atmosphere motions in the exposed location Adalvik in Northwestern Iceland in the summers of 1926 – 27 (see e.g. Dannmeyer and Georgi 1932). During this work, pilot balloon observations revealed occasional very strong winds at altitudes above 5 km (Fig. 9). Georgi (e.g., 1928a,b) ascribed the strong winds to the cold outbreaks just mentioned, but much later it was realized (see Georgi 1950) that his group may have been the first to observe the phenomenon now known as the circumpolar “jet stream”. The expedition to Adalvik also made an interesting series of observations on ultra-violet radiation from the sky, later extended in Northern Iceland by a group from the German University in Prague (Fuchs and Langer 1938).

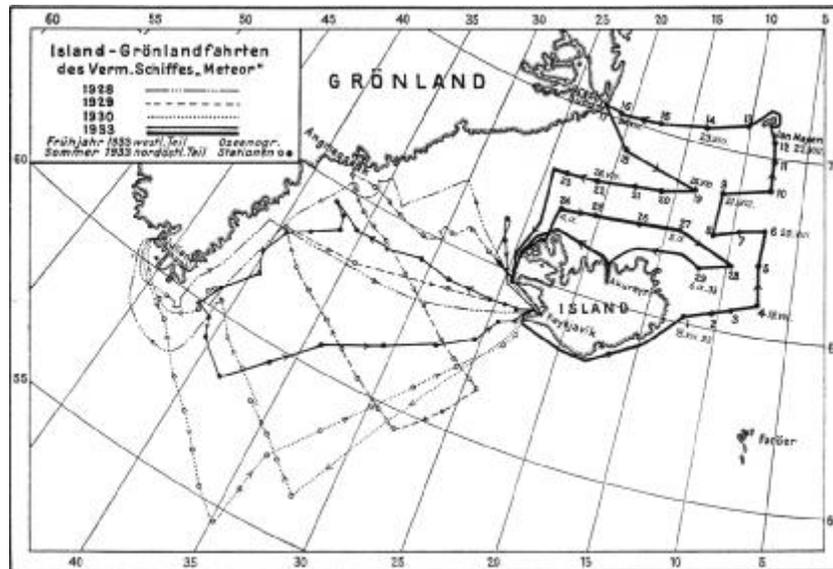


Fig. 10. Tracks of the research ship "Meteor" in the waters around Iceland, 1928 – 33 (Schulz 1934).

At least partially in consequence of Georgi's 1926 – 27 expeditions, the research vessel "Meteor" was sent to carry out meteorological and hydrographic studies in the waters around Iceland in 1928 – 33 (Fig. 10, see Georgi 1932, Schulz 1934). Georgi's results were also followed up by observations from the Greenland ice cap in 1930 – 31, in the last expedition led by Wegener. Some of the research by "Meteor", which was continued in two cruises in 1935 (Defant 1936) had connections with meteorological projects in Iceland during the International Polar Year 1932 – 33.

Concluding remarks

It may be seen from the above that German earth scientists have been active within many fields of research in Iceland and the surrounding region. This account has however been quite limited in its scope, concentrating on scientists who went to Iceland to make observations. Among categories of studies by Germans relevant to Iceland which have not been treated here are e.g. purely geographical descriptions, recording of seismic waves from earthquakes in and around Iceland (beginning in 1896), and processing of meteorological data from that region.

After 1970, German geoscientists have participated in a number of research projects in the Iceland area, sometimes in a leading role. These projects include large explosion-seismic and magnetotelluric studies, geodetic surveys, remote sensing of glaciers and geomorphological phenomena, and deep core drilling into the lava pile in 1978, to name a few of the most conspicuous ones. There have also been several marine geophysical cruises in the area by research ships such as "Meteor" and "Komet", beginning in 1968 over the Iceland-Faeroe Ridge.

Research by Germans in Iceland is only one aspect of the varied contacts between the two countries as regards earth science. Thus, several Icelanders have lived in Germany at some time or another while studying or carrying out research in this field, the first one being Thorvaldur Thoroddsen who stayed in Leipzig in 1884 – 85; they were often supported by German funding agencies like the Alexander von Humboldt Stiftung. Many papers written by Icelandic and other scientists on the geology of

Iceland have appeared in German learned journals (including in 1980 a volume of the “Journal of Geophysics” dedicated to Iceland), and so on.

The population of Iceland itself is small and cannot sustain a high level of funding and manpower for research into the geological history and current manifestations of the varied processes operating in this very active region of the Earth (cf. the Introduction above). The German research effort and its resulting contributions to our knowledge in these fields have been of much value to Iceland and international science.

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