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MARGINAL ZONE OF FLÁJÖKULL (ICELAND). INITIAL RESULTS OF RESEARCH

In the summer of 1997 the study field trip of students and lecturers of the Faculty of Geography and Regional Studies of the University of Warsaw to Iceland was organized. The objective of this trip was to carry out an initial study of the marginal zones of glacier tongues flowing out of the Vatnajökull glacier and to select the area for further, detailed study.

The choice of Vatnajökull was dictated by the unique nature of this glacier. It is located in the zone of Atlantic rift, and occupies a rolling plateau surrounded by mountain peaks and ridges attaining significant altitudes (exceeding 2000 m a.s.l.). The length of the glacier amounts to some 130 km, while its width — to approximately 100 km. It forms the biggest ice cap in Europe. In the north–western part of Vatnajökull the rock bedding is formed both by contemporary lavas and by the aciduous lavas and magma intrusions of at most 0.7 million years of age. The middle part has the bedding of neutral and base lavas of 0.7–3.1 million years of age, while basalts and liparite intrusions older than 3.1 million years appear in the south–eastern part (Johannesson, Saemundsson, 1989).

There are numerous active volcanoes under the ice cap, including, for instance, Bárdarbunga, Kverkfjöll, Esjufjöll, Öraefa or Grímsvötn (Bjornsson, Einarsson, 1991). The eruption of the latter brought about catastrophic changes within the foreground of the Skeidarár glacier (Gudmundsson, Sigurdsson, 1996).

Significant accumulation is observed on Vatnajökull above the snow line, this line being in the zone of our present interest located at the altitude of 1100 m a.s.l. Thus, in particular, the (net) accumulation of firn noted in the years 1951–1952 at the altitude of 1200 m a.s.l. amounted to 238 cm, and in the years 1952–1953 — to 81.8 cm. Average daily ablation measured between July 15th and August 11th of 1953 was 4.05 cm (King, Ives, 1955). It must be noted that the magnitude of accumulation, especially in the areas supplying the glacier tongues flowing out from the main ice mass, depends strictly upon the precipitation and the direction of winds, and so undergoes significant fluctuations. Volcanic dusts deposited on the surface of the ice decrease importantly the albedo (Field, 1975).

Using glaciological criteria Vatnajökull was divided into the central part, located above 1000 m a.s.l., and the marginal part, below this altitude. The central part coincides with the accumulation zone delimited for this glacier. The marginal zone, encompassing the glacier tongues flowing out, is equivalent to the ablation zone (Wójcik, 1976).

Vatnajökull is characterized by high rate of melting and high pace of flow of the glacier tongues originating from it. Ice melting is precipitated by the geothermal heat emitted from the bedding.

Thus, the largest mass of ice in Europe constitutes a glacier of extremal dynamics.

There are several dozens of glacier tongues originating from Vatnajökull. One can relatively easily reach, however, only the ones located within the south–eastern and southern edge area of the ice cap. During the stay in Iceland the participants of the study trip gathered information on five glaciers: Hoffellsjökull, Fláajökull, Skeidarárjökull, Falljökull and Svínafellsjökull.

The glacier of Fláajökull was selected for the more detailed study (Fig. 1). The material gathered in the field, the cartographic data, and the aerial photography made it possible to present the general characterization of the area studied, to elaborate the geomorphological map and to attempt dating of the moraines traced.

Fláajökull is one of the glaciers flowing out from Vatnajökull towards the south–east. It forms a tongue of 15 km of length and 2.5 km of average width. Until the year 1930 the glaciers of Heinabergsjökull and Fláajökull had formed on the coastal plain a well developed glacier foot of Piedmont type. In 1930s, after a strong recession, two separate tongues appeared (Wójcik, 1976). Nowadays the front of Fláajökull is divided into the eastern and western parts. The eastern part attains the level of the abrasion platform of the average altitude of 40 m a.s.l. and is responsible for the formation of the distinct courses of frontal moraines. The western part, on the other hand, hangs over the steep rocky bedding and does not attain the level of the coastal plain (Fig. 1). The field work was carried out within the eastern part of the tongue.

The only map available for the area in question dates from 1945 and its scale is 1:50 000. This map is not sufficiently detailed for carrying out the basic geomorphological mapping. In connection with this a series of photographs were made of the marginal zone, taken from the culminations surrounding the glacier. Schematic outlines of the main relief forms were done, and the approximate courses of frontal moraines were determined, as well as the systems of water outflow from the melting glacier. On this basis two study routes were established in the western and eastern parts of the marginal zone, between ice and the last ridge of frontal moraines. The routes were designed in such a way as to account for all the most characteristic fragments of the zone studied (Fig. 1). All the more important forms were measured and indicated on the field profiles elaborated (Fig. 2). Besides

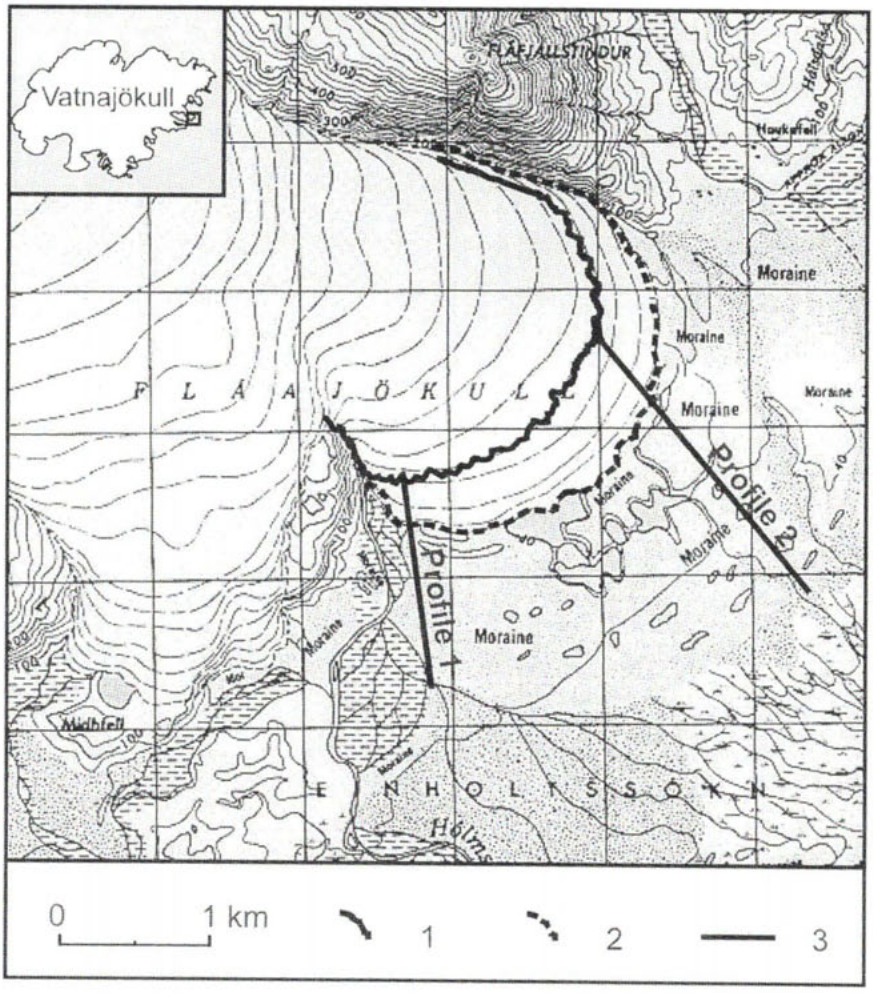

Fig. 1. Map of the front of Fláajökull and of its marginal zone: 1 — reach of the glacier front in 1989, 2 — reach of the glacier front in 1943, 3 — routes of the geomorphological mapping.

this, characteristic geomorphological processes were described and the samples of material were taken from the primary moraine courses.

There are several aerial photographs of the area in question available. The authors of this paper dispose of the photograph taken in 1989. On the basis of the interpretation of this photograph and the material gathered in the field the geomorphological map was elaborated of the marginal zone of Fláajökull (Fig. 3). This map shows the areas taken by the bottom moraine as well as several courses of frontal moraines. Five of them form distinct, easily discriminated ridges. Some are currently present in the form of small preserved fragments, cut through by the valleys of glacier water outflows.

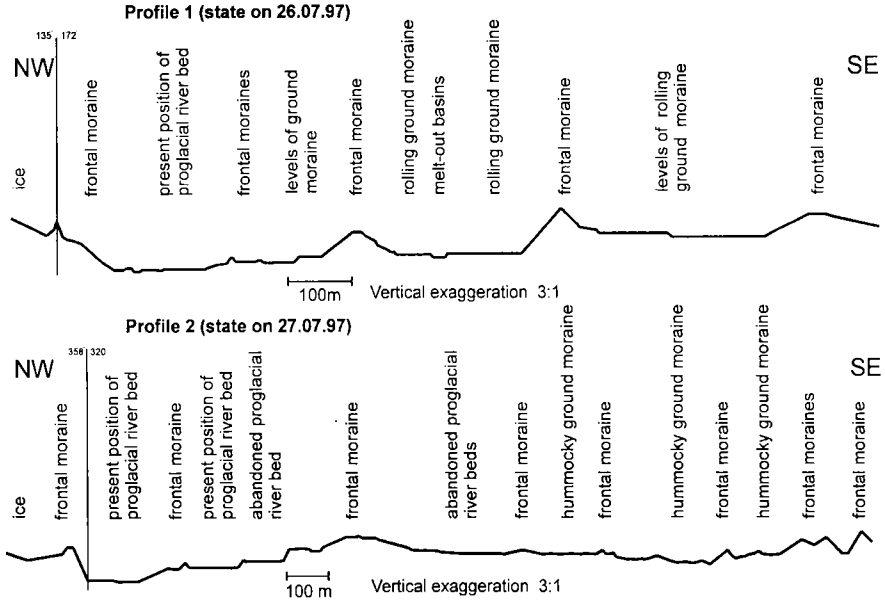

Fig. 2. Profiles elaborated during geomorphological mapping.

The field materials and the aerial photograph made it also possible to precisely determine the beds of proglacial rivers, both active and abandoned. Likewise, the system of river beds on the surface of the outwash occupying the foreground of the zone studied was delineated.

The consecutive stage of in-house work was constituted by the attempt of determining the rate of recession of the glacier studied and of dating the frontal moraines delineated.

A number of distinct periods of transgression during holocene were observed for Vatnajökull. The particularly intensive ones took place during Little Ice Age. It is admitted that in the years 1690–1720 a strong transgression took place. Then, in 1720–1740 there was a period of stagnation or of a limited recession. Strong transgression of the years 1740–1760 marked itself with the maximum reach of some glaciers in the holocene. After a long phase of more or less pronounced recession the years 1850–1870 witnessed another strong transgression of the glaciers. The maximum reaches of many glaciers flowing from Vatnajökull southwards — including also the reach of Fláajökull — are therefore dated 1870. Beginning with 1890 a clear recession is observed lasting until the early 1930s, when a short transgression period occurred. Since that time recession lasting until the present — with short transgression interludes — is being observed (Field, 1975).

The recession of the glaciers flowing from Vatnajökull has both frontal character, like in the cases of Fláajökull and Falljökull, and stretches over

definite areas, like in the cases of such glaciers as Hoffellsjökull or Svínafellsjökull (Field, 1975).

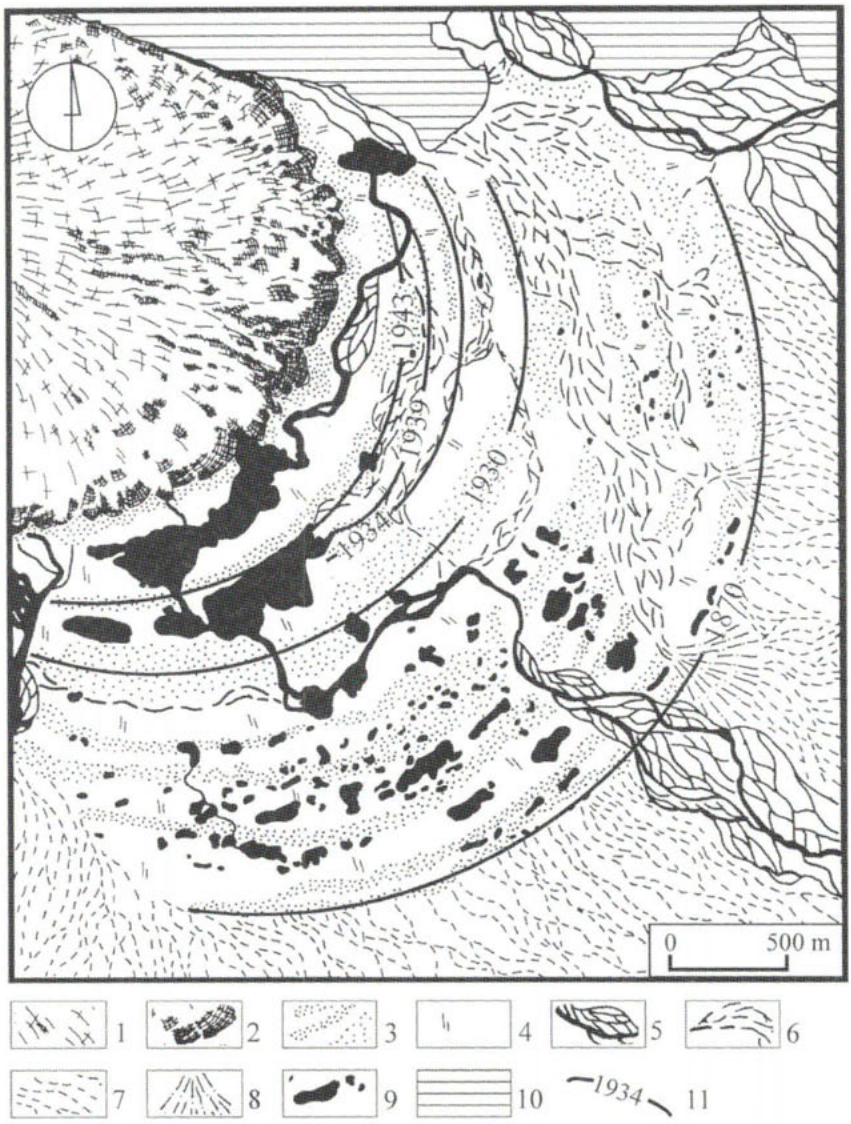

Fig. 3. Geomorphological map elaborated on the basis of the aerial photograph and field mapping: 1 — ice surface, 2 — ice surface covered with moraine material, 3 — frontal moraine, 4 — bottom moraine, 5 — beds of the current proglacial outflows, 6 — abandoned beds of proglacial outflow, 7 — beds of the outwash outflow, 8 — alluvial cone, 9 — postglacial lakes, 10 — outcrops of the rock bedding, 11 — fronal moraine ridges with marked age.

The speed of flow of the glacier tongues depends, in particular, upon the shape of the bedding, as well as on the slopes of the valley, and may attain at the surface of the glacier, in the location of the valley narrowing, even up to 1770 m/year. The respective measurements were carried out on Hoffellsjökull in 1936 (Ahlmann, 1948). Other quantitative data reflect ablation in the frontal zone of this glacier, amounting to 1000 cm/year. The loss of ice mass is, however, bigger due to calving of the glacier to the marginal lake (Ahlmann, 1948).

Separate treatment should be reserved for the occasionally occurring charges of the glaciers. The case is known of 1929, when the violent transgression of the Skeidarárjökull glacier destroyed the newly constructed telephone poles. In the year 1953, out of 27 observed Icelandic glaciers in six cases a transgressive movement of the front was noted, in one case the position of the front did not change, while in the remaining twenty cases recession was observed (Field, 1975).

Between 1930 and 1985 observations of the changes in the reach of the glacier front were conducted on Fláajökull (Field, 1975; Rist, 1987). The table given here presents the results of these observations (Table 1).

Table 1

Changes of the reach of the Fláajökull glacier front in the years 1930–1985, after Field (1975) and Rist (1987)

Time interval	Transgressions and regressions of the front in m		Time interval	Transgressions and regressions of the front in m	
	western part	eastern part		western part	eastern part
1930–1931	–80	–108	1945–1946	–23	–46
1931–1932	–80	–108	1946–1947	–20	–107
1932–1933	–7	+3	1947–1948		–21
1933–1934	–24	–42	1948–1949		–7
1934–1935	–36	–75	1949–1950	↑	–6
1935–1936	–10	–67	1950–1951		+7
1936–1937	–130	–100	1951–1952	stagnation of the front	
1937–1938	–60	+34	1952–1953		–19
1938–1939	–44	–42	1953–1954		–41
1939–1940	–100	–49	1954–1955	↓	–47
1940–1941	–108	–49	1955–1956		–7
1941–1942	–3	–46	1956–1957		–15
1942–1943	–18	–25	1957–1958	} –100	–37
1943–1944	–62	–26	1958–1959		+22
1944–1945	–12	+17	1959–1960		–45
			1960–1964	lack of data	lack of data
			1964–1974	–55	–64/–21
			1973–1985	+27	+7/+12

It can be concluded from the data of Table 1 that between 1930 and 1960 the eastern part of the glacier front of Fláajökull, which had formed distinct walls of frontal moraines, receded by 944 metres. Within this period of time, though, one can clearly distinguish six separate transgressions. Some of them were probably linked with the glacier charges. Since 1964 the rate of recession decreased and the years 1973–1985 are characterized by a very limited advance of the glacier front.

The previously mentioned topographical map of 1:50 000 shows the reach of the Fláajökull glacier determined on the basis of the observations carried out by the US Army in 1943. The aerial photograph shows the situation as of 1989. The two images were overlaid and the difference of the glacier tongue reaches corresponding to the time interval of 46 years could be assessed (Fig. 1). This difference amounts on the average to 500 m.

An attempt was made of correlating the data obtained from the literature and the cartographic material with the geomorphological map elaborated. It was concluded that the moraine ridges located the farthest from the glacier front date back to the maximum transgression of the years 1850–1870. It was then established, on the basis of calculations referring to the data from the table, that the distinct, biggest moraine course, occupying the central part of the marginal zone, corresponds to the position of the glacier front of 1930. A similar situation is observed also on other glaciers, like Skaftafellsjökull and Svínafellsjökull (Thompson, 1988). The subsequent, much less well preserved moraine courses can be attributed, respectively, to the positions of the glacier front of 1934 and 1939. The line of reach depicted on the map of 1943 corresponds to the consecutive moraine ridge. The last, youngest one, is being formed nowadays (Fig. 3).

The results obtained match the datings of the moraines of the Skaftafell and Svínafell glaciers, established with the lichonometric method (Thompson, 1988).

The field material gathered, the maps elaborated and the results here presented are treated by the authors of the paper as the contribution towards the further study of the forms and processes with the use of sedimentological methods.

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