

SPELEOLOGICAL OBSERVATIONS IN THE SVARTISEN MOUNTAINS I.

“Stable” ice-caves in the Østerdalsisen

by

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The *Svartisen Mountains*, Nordland, Norway, bordered by the *Glunfjord* in the north and the *Melfjord* in the south, lie in an area defined by the coordinates 66°30' and 66°50' of northern latitude (hence, much of their area is beyond the polar circle — 66°32,8' of N.l.) and 13°30' and 14°20' of eastern longitude. They are split by the NE-SW-trending *Pikhagona Valley* into two subequal parts. The part lying west of the *Pikhagona Valley* is called *Westerdalsisen*; the eastern part being *Østerdalsisen*. The elevation of the *Svartisen Mountains* varies between 1000 and 1400 m a.s.l., the highest peak is the *Snetid* (1,599 m) on the *Westerdalsisen*. Since the permasnow-line in this part of Norway runs at 900 to 1000 m a.s.l., much of the *Svartisen Mountains*' surface is covered by ice, whose salients such as the *Østerdalsisen* glacier which will be dwelt on in the present paper extend downslope to 200 m elevation a.s.l.

Geologically, the mountains are made up of two main rock types: 1. *Caledonian* intrusive crystalline rocks of acid nature — granites for the most part; 2. *Cambrian-Silurian* sediments, locally including zones of crystalline limestone or dolomite (rare). The western part of the mountains is rather composed of the former rock type, the eastern part of the latter.

The above information on geography and geology has been illustrated on the map-scheme of Fig. 1 plotted on the basis of (6) and (7).

The glacier *Østerdalsisen* s. str. issues from the ice-field of the eastern half of the mountains. With its about 65-km² area, the *Østerdalsisen* can be considered a rather large glacier. Its source is somewhere about the line of the northern polar circle. The glacier borders on the southeast side of the *Kamplitind Peak* in the south and on the westerly slopes of the ridge (1000–1300 m) southwest of Lake *Blakkvatn* in the east (862 m). In the south it strikes against the north slope of the *Burfjeldet* (915 m), so that it changes its direction to the east and west. A few years ago, there was still a lake in the western part of the mountains.

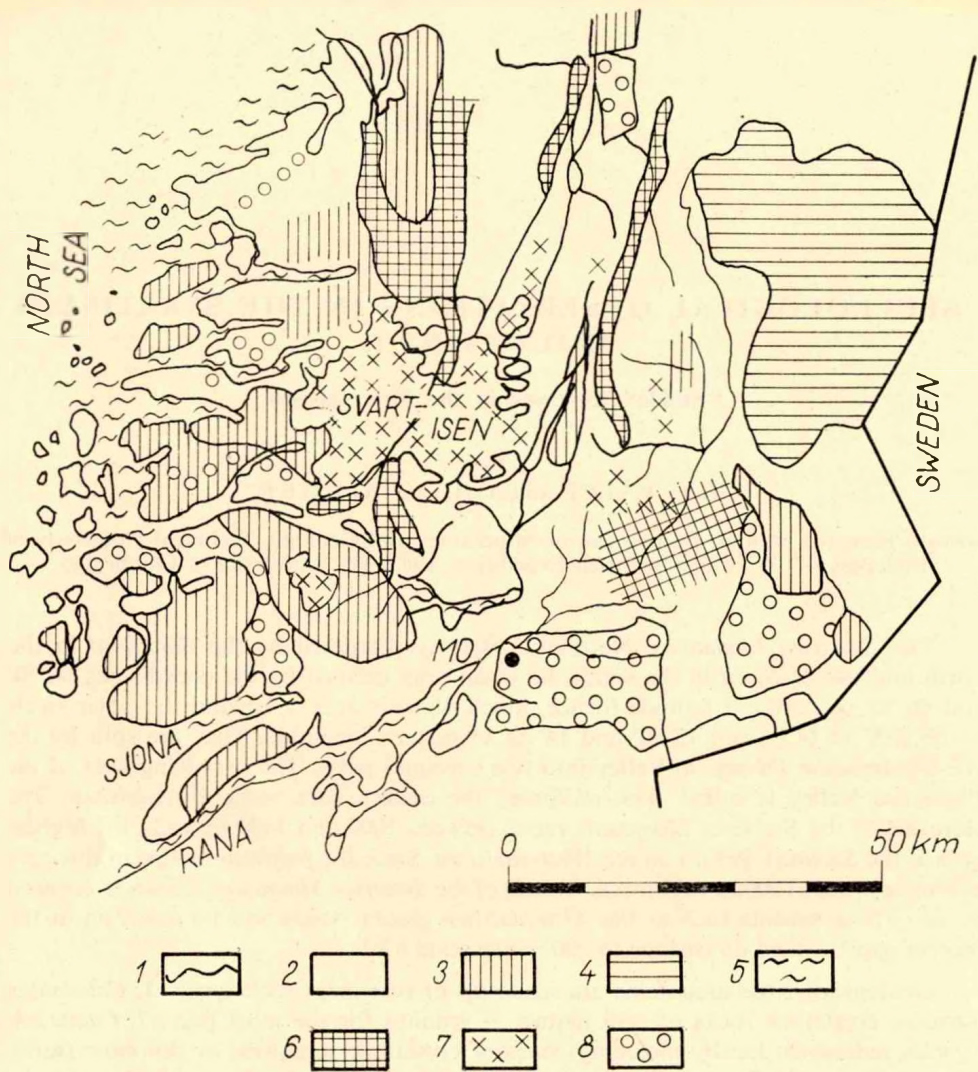


Fig. 1. Geological map-scheme of the Svartisen Mountains

1. Water flow
2. Cambro - Sillurian sedimentary rocks ("Mica schist marble group")
3. Acid rocks, mainly granite
4. Gabbro of uncertain age
5. Water (sea, lake)
6. Cryst. limestone of Cambro - Sillurian age
7. Ice field
8. Gneissic rocks of injection - gneissic character

It emptied the meltwater of the glacier into the *Glommdalen* Valley; the eastern part also included a small meltwater pond, whose stream flowed into Lake *Svartisvatn* (75 m). The number of glacier tongues radiating from the western tip of the glacier is considerably greater than the number of those radiating from the eastern tip. Now the situation has somewhat changed. Various workers (2–4) — *LIESTØL* (5) in the first place — have observed that nowadays the glacier has been markedly receding, owing to which the level of the west-side lake has risen extremely high, threatening with breaking the glacier tongue and crashing down to the *Svartisdal* Valley. To prevent this, a tunnel was driven between the west-side lake and the eastern glacier tip in such a way that the level of the west-side lake could be considerably lowered. The tunnel has been diverting the meltwater collected by the west-side lake into Lake *Svartisvatn* this way. As a result, the drainage of the west-side lake to the *Glommdalen* has been eliminated, the more so, a part of the *Glommdalen*'s brook has changed its direction of flow — owing to the very intensive erosion — so that now it also empties into the west-side glacier lake.

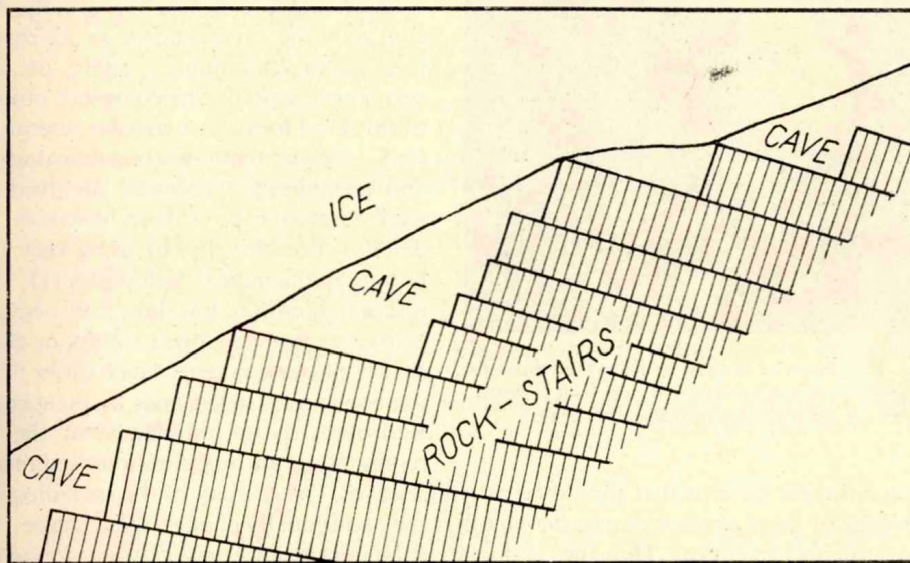


Fig. 2. Typical cross-sections of the ice-caves of the *Osterdalsisen*

During glaciological investigations in this region a rather remarkable phenomenon was observed, for which the peculiar geologic setting of the area has been responsible.

The mountain slope forming the west border of the above-mentioned *Osterdalsisen* glacier is made up of strata with a direction of dip of 44° and an angle of dip of 12° . Owing to this distinct stratification of the rock, the barren slope has been benched with steps 1 to 10 m high. Since the direction of flow of the *Osterdalsisen* is subperpendicular to the edge of the benches, the rather fast-moving ice does not fit tight of the rock surface, leaving triangular spaces unfilled between the benches and the basal face of ice. This is illustrated by the photograph of Fig. 2 and 3.

The resulting ice-caves extend far beneath the ice-flow, their length attains 30 to 60 m. They offer an unusual scenic beauty, as they are illuminated through



Fig. 3. Entrance to a cave in the Østerdalsisen. The arrow on the broken-off ice block points to an anorak (to indicate the scale)

the ice sheet. Since the ice sheet grows gradually thicker as one penetrates deeper into the recesses of the caves, the light will continuously change its colour, displaying all shades from lightblue through dark-blue to dark violet.

On the ice roof of each cave you can see distinct markings left on the flowing ice by the accidents of the edge of the preceding "step". These "profiles" of sliding are eloquent illustrations of the genesis of the caverns being considered.

Classification of the described caverns is rather puzzling.

The individual syntheses of the relevant literature, e. g. (12, 13), usually discuss only the caves known as ice-caves, i. e. caves containing a more or less permanent ice-fill. Speleological objects of this kind have an extensive literature (1, 8—15) and the physicometeorological and geophysical processes involved in their formation have been discussed in detail — occasionally, by using very elaborate mathematical techniques (1). The relevant literature has, however, neglected the caverns developed within, or close to, the glaciers, caverns which differ from the above-mentioned ones by their being walled, partly or completely, by the ice representing an autochthonous sediment.

Hence, it is these caverns that should be called ice-caves. The scarcity of the speleological knowledge of these caves is due to the fact that they continually change their shape and may vanish and re-appear. Thus they cannot even be considered quasi-stationary phenomena. This is the very respect in which the above described caves differ from the common caverns, partly or completely walled by ice.

The above short discussion has aimed — owing to the unfortunately reduced time of on-the-spot observations — merely at raising the problem. The reason for which we have held it necessary to call attention to these formations has been our belief that their thorough examination may help in solving some glaciological problems such as ice movement, plasticity, paths of travelling of meltwater, etc.

Summary

In the Østerdalsisen glacier of Nordland, Norway, the benched structure of the rock and the superimposed ice-flow have given rise to well-defined caverns. They differ from the caves forming within the glaciers, first of all, by their distinct shape. In a discussion of these caves of geologic control the authors draw attention to the necessity of the speleological investigation of caves of this kind — walled partly or completely by ice.

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SPELEOLOGISKE OBSERVASJONER I SVARTISEN

I "Stabile" breis-huler i Østerdalsisen

av

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Sammenfatning

I breen *Østerdalsisen*, tilhørende isfeltet *Svartisen* i det norske fylket Norland, danner det seg ganske godt definerte huler avgrenset av fiellmassens trappeaktige formasjon og breisen. Disse huler skiller seg fra de hulene som dannes i breene, først og fremst på grunn av deres relativt godt definerte form. I forbindelse med beskrivelsen av ishulene som er blitt til tilfeldig gjennom området geologiske utforming, ønsker forfatterne å peke på nødvendigheten av speleologiske undersøkelser av slike og lignende huler helt eller delvis avgrenset av is.

SPELÄOLOGISCHE BEOBACHTUNGEN IM SVARTISEN-GEBIRGE

I. "Stabile" Gletscher-Eishöhlen am Østerdalsisen

von
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Zusammenfassung

Am Gletscher *Østerdalsisen* des Eisfeldes *Svartisen* der norwegischen Provinz Nordland bilden sich durch die treppenförmige Formation der Gesteine und durch das Eis des Gletschers begrenzte, ziemlich gut definierte Hohlräume. Diese Hohlräume unterscheiden sich von den Gletschern ausgebildeten Höhlen vor allem durch, ihre gut definierte Gestalt. In Zusammenhang mit der Bekanntmachung der durch die geologische Formation der Gegend zufällig zustande gekommenen Eishöhlen wollen die Verfasser den Leser auf die Notwendigkeit der speläologischen Untersuchung solcher und ähnlicher — teils oder völlig durch Eis begrenzten — Höhlen aufmerksam machen.

СПЕЛЕОЛОГИЧЕСКИЕ НАБЛЮДЕНИЯ В ГОРАХ СВАРТИСЕН

I. „Стабильные ледниковые пещеры в леднике на Эстердальсисене

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Резюме

В леднике Эстердальсисен ледяного поля Свартисен в норвежской провинции Нордланд образовались довольно хорошо выраженные пустоты, ограниченные уступообразной формацией горных пород и льдом ледника. Эти пустоты отличаются от пещер в ледниках в первую очередь своими относительно четкими формами. При описании ледниковых пещер оформленных геологической формацией района случайно, авторы хотели бы обратить внимание на необходимость спелеологического исследования таких и тому подобных пещер, ограниченных частично или полностью льдом.

SPELEOLOGIAJ ESPLORADOJ EN LA MONTARO SVARTISEN

I. "Stabilaj" glacigrotoj en la glaciario Østerdalsisen

GY. PÁLYI — C. M. AINGLER

Resumo

En la glaciario *Østerdalsisen* de la glacikampo *Svartisen*, situanta en al provinco Nordland de Norvegujo, elformiĝis bone difineblaj kavoj limitaj de la ŝtupareca formaĵo de la ŝtonaĵo kaj de la glacio de la glaciario. Tiuj kavoj malsamas disde la grotoj kreigitaj en la glaciarioj unuavice pro sia relative bone difinebla formo. Konigante la glacigrotojn hazarde elformiĝintajn pepre de la geologia formaĵo de la ĉirkaŭaĵo, la aŭtoro volas atenti pri la neceseco de la speleologia ekzamenado de tiaj kaj similaj grotoj limitaj parte aŭ tute de glacio.