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THE WATER CYCLE IN NORTH-WEST SØRKAPPLAND (SPITSBERGEN)

The characteristics of water circulation has been made on the basis of climatological, hydrological and hydrochemical investigations carried out in the summers of 1983 and 1984 in the north-western part of Sørkappland, Hornsund area (Fig. 1).

On the basis of the spatial distribution of the hydrographic phenomena one can distinguish the following hydrographic areas and zones (Fig. 2):

– the alimentation area, divided into the mountain zone, the wet subslope zone and the wet terrace zone,
– the transit area,
– the accumulation area.

The alimentation area provides the remaining areas with most of the water in summer. The outflow of the waters from melting snow patches and permafrost thawing in the mountains zone takes place during the whole summer. These waters flow mainly through the debris cover. In the wet subslope zone the bog springs and marshes dominate. There are many small lakes drying in the summer in the wet terrace zone. The transit area is dissected by the beds of the rivers carrying waters from the alimentation area. Waters flow through the covers too. The accumulation area stretches along the coast. There are many lakes fed with the water coming from the remaining areas and zones. Most of them are drained through the gorges cut in the old and contemporary beach ridges.

In the north-western Sørkappland, two hydrological periods can be distinguished in the annual cycle of water circulation: the passive one and the active one (Fig. 3).

The passive period includes winter months and lasts from the middle of October till the end of May. Water circulation is held up because of air and ground temperature below 0°C. However, during this period very important processes take place, essential for the later hydrology, namely the accumulation of snow cover and freezing of the ground (Fig. 4).

The active period lasts from the end of May till the middle of October and

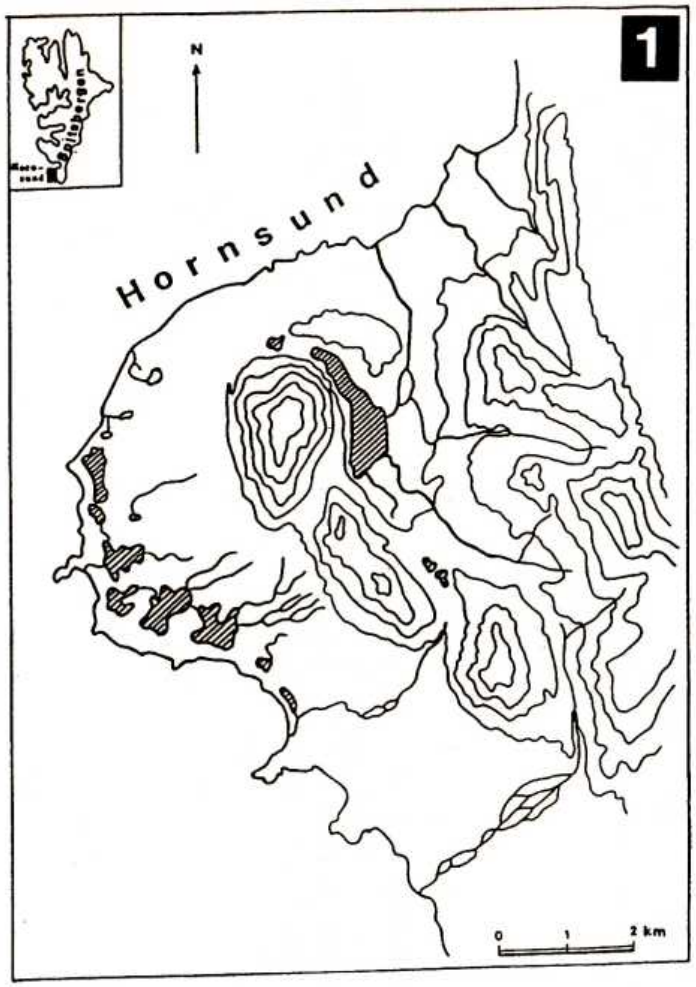
is characterized by intense circulation of water. It includes spring, summer and autumn.

During the spring active period air temperature is above 0°C as well as lasting insolation during the polar day causes ablation of snow cover, melting of the ice in lakes and rivers and local thawing of the ground, due to which water begins running off, mainly on the surface of the ground. The beginning of this process in following years can change from two to three weeks, depending on the weather conditions. In this period outwash activity of meltwater is considerable. Solifluction and cryoplanation become intensive.

In the summer active period the processes begun in the spring are still continuing. It is possible to distinguish two subperiods during summer: the earlier subperiod of intensive snow cover ablation and intensive permafrost thawing and the later subperiod of slow snow patches ablation and slow permafrost thawing. The first one is characterized by low precipitation, increased evaporation, intensive ablation of snow cover on the plains and in the mountains, fast permafrost thawing, big surface and subsurface runoff, and by fast recession of runoff. An amount of runoff depends on the amount of water accumulated in snow cover during the passive winter period preceding the summer season. Dynamics of the runoff depends on the weather conditions during summer, especially on the air temperature, rainfall and foehns phenomena. The next subperiod is characterized by increased precipitation, decreased evaporation, melting of snow patches in the mountains, slow permafrost thawing, low surface and subsurface runoff, slight recession of runoff. This subperiod begins in the third decade of July or at the beginning of August and lasts till the end of summer. The amount of runoff depends mainly on precipitation.

At the beginning of the summer time active period there occurs intensive solifluction which gradually disappears in the end of summer. In this period water is very important for vegetation. Quantity and amount of species depend on the amount of water and its chemical composition. Wetlands, in which water contains a large amount of calcium are occupied by bogs. In the areas where water is enriched in phosphates, calcium and potassium there appear meadow like communities. Water also influences soils. The microbiological processes take place in soils in the summer and stagnating water in the ground causes gley processes.

In the autumn active period runoff gradually disappears, which is caused by air temperature below 0°C. The polar night begins. It can be snowing in this period but the autumn snow cover can melt during warm days. Repeated cycles of freezing and thawing of the ground cause frost segregation forms and patterned ground. Freezing of subsurface waters causes formation of pingos, ice wedges and thufurs. Towards the end of active period surface and subsurface waters as well as the ground freeze.



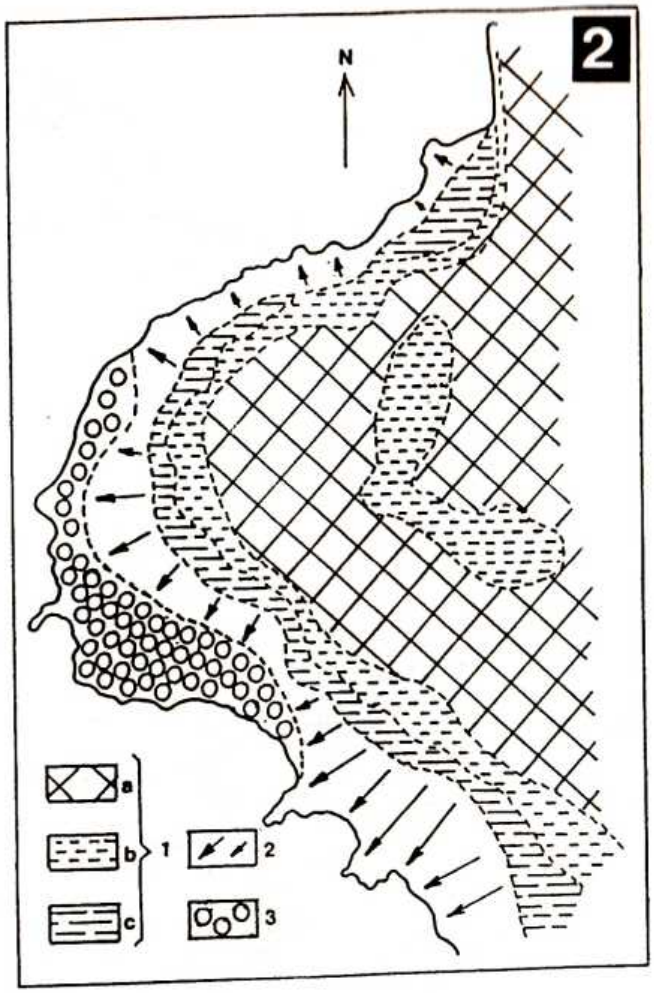


Fig. 1. Location of the study area.

Fig. 2. Hydrographic areas and zones. 1 – area of alimentation, 1a – mountain zone
1b – wet subslope zone, 1c – wet terraces zone, 2 – transit area, 3 – accumulation area

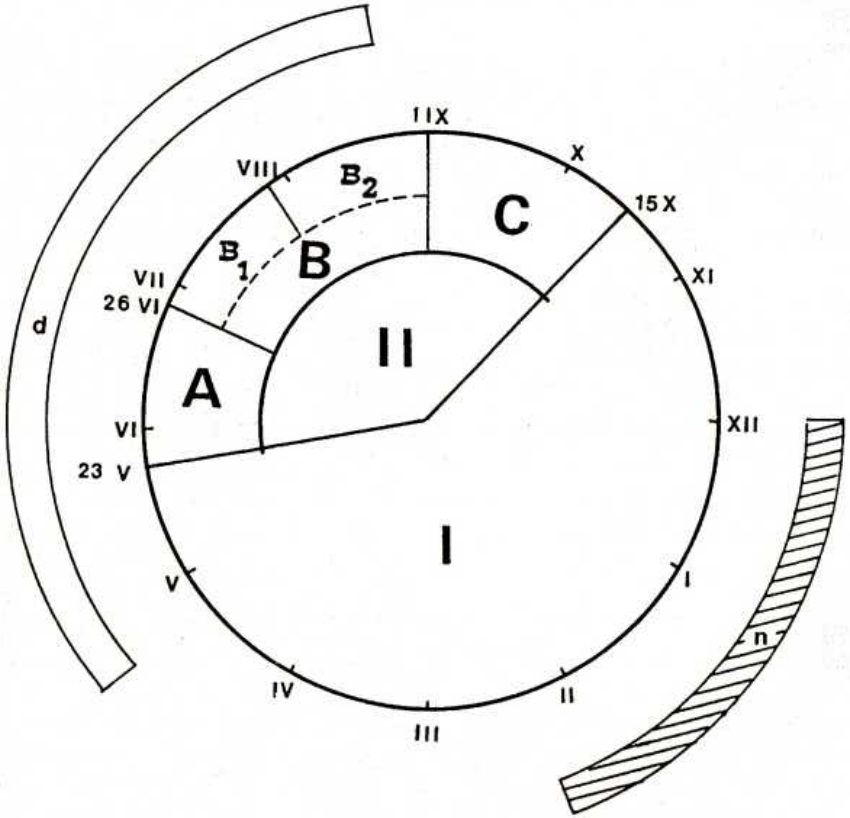


Fig. 3. Hydrological periods and subperiods. I – passive period – winter, II – active period, A – springtime active period, B – summertime active period, B_1 – subperiod of intensive snow cover ablation and intensive permafrost thawing, B_2 – subperiod of slow snow patches ablation and slow permafrost thawing, C – autumn active period, d – polar day, n – polar night

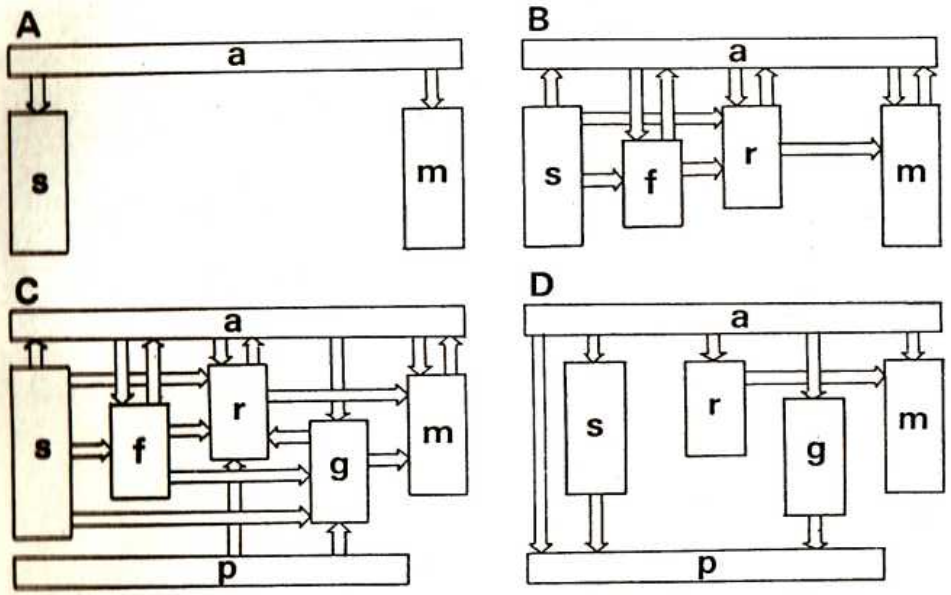


Fig. 4. Water circulation in northwestern part of Sørkappland in passive (A), active springtime (B), active summertime (C) and active autumn (D) periods. a – atmosphere water, s – snow cover, f – surface runoff, g – subsurface runoff, m – fiord and the sea, p – permafrost