NORSK POLARINSTITUTT
MEDDELELSER NR. 98

JEAN-PIERRE PORTMANN

Some superficial deposits within the map sheet Adventdalen, Vestspitsbergen

NORSK POLARINSTITUTT
OSLO 1969

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NORSK POLARINSTITUTT

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Manuscript received December 1967
Printed March 1969

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Introduction

During the summer expedition of Norsk Polarinstitutt in 1961, a few valleys of the southern part of Isfjorden were inspected. The principal aim was to study the superficial deposits concurrently with the elaboration of the Adventdalen sheet of the geological map of Svalbard.[1]

The valleys extend in a sedimentary complex of Mesozoic age. From a morphological point of view, the main features of this area are controlled by sub-horizontal beds of limestones, shales, and sandstones, and by the presence of faults. The latter determine a very specific morphology which can be seen on the south-west side of Arctowskifjellet and Juvdalskampen in the upper part of Adventdalen, and also in the vicinity of Tronfjellet and Slottet in the upper part of Reindalen, these two areas being situated in fact along the same line.

The very strong erosion operates selectively according to the nature of the rocks. The peculiarities are obvious even in minor features of the relief. The valleys show the broad troughlike cross-profile characteristic of glacial erosion. They are filled with clastic sediments of different kinds, derived from glacial and fluvial erosion and from the present marine regression. See Fig. 1.

Description of four exposures

The four exposures described below give an idea of the glacial and post-glacial formations:

1) This was situated in the opening of Todalen on the left bank of the river (Fig. 2). At the bottom lay a boulder clay, 1.5 m thick, surmounted by a deposit incorporating blue clay, then a bed of clay with shells which

[1] Topografisk kart over Svalbard, 1:100 000, Blad C9, Adventdalen (Norges geografiske oppmåling, 1950). Geologisk kart, Svalbard, 1:100 000, Blad C9G, Adventdalen (Norsk Polarinstitutt, 1964).

Fig. 1. *South side of Helvetiafjellet, Adventdalen. – In the foreground cones with blocs.*

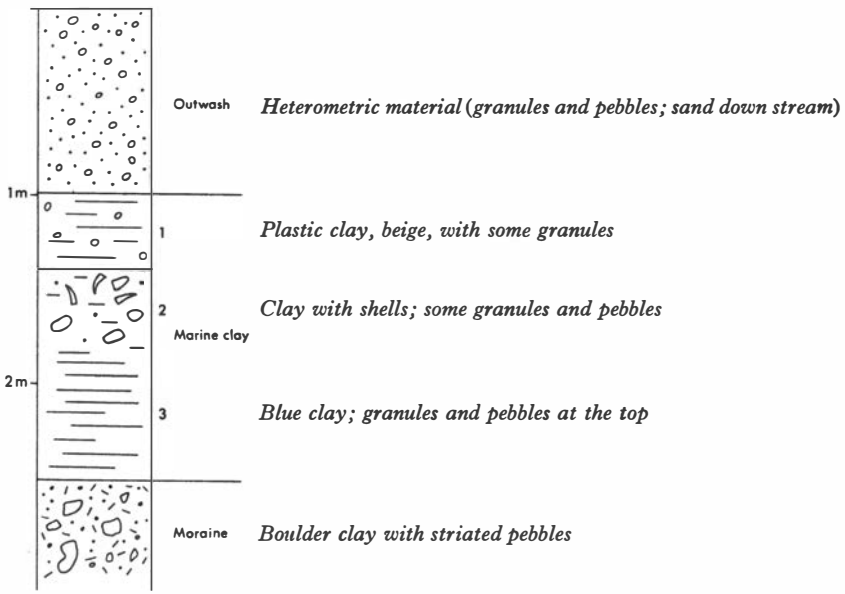

Fig. 2. *Profile from Adventdalen — Todalen.*

were well preserved and concentrated on various levels, and finally a plastic clay with granules. Above the clay complex appeared coarse and heterometric gravels which seemed to be washed material and which extended in the direction of the hut of Store Norske Spitsbergen Kulkompani A/S, where a sand flat appears very sharply in the topography.

2) The second section, 3 m thick, was observed about ten to fourteen metres east of 'Bolterhytta' in Adventdalen in an excavation dug in the river bank. (Fig. 3.) The layers were clearly exposed, but the possibility of disturbance by solifluxion could not be excluded, especially in the presence of frozen ground (Fig. 4).

Down to a depth of 2 m were found alternating clay layers of various facies and of different compactness, composed of lenses of various sizes. Below this, sand was predominant with beds of small pebbles and granules. The upper clayey part of the section included pieces of shells and whole specimens of *Saxicava arctica*. It was, however, impossible to find any definite fossiliferous horizon, although the highest concentration seemed to be 1.5 m from the top. On the surface of the soil there was a non-graded sediment, light in colour and rather hard, with some crystalline rock fragments. The latter were covered with a white film which was often observed in the region, for instance in the neighbourhood of Innre Hiorth-hamn hytte.

Some metres down stream, at a deeper level (280–290 cm), a layer of flat-lying brown leaves with light coloured seeds, probably of *Salix,* was found. It may, however, have been deformed and displaced by cryoturbation.

Not far away, washed material with coarse sand, granules, and small pebbles determined a small flat area, forming a low promontory flanked by two others, less obvious.

Along Bolterdalen, a little above the two huts[1] and close to the small snow patch from which they drew their water supply, the formations described above overlay others which were visible but less distinct owing to thawing.

The correlation of these deposits was assisted by the outcrop of the bedrock at stream level.

[1] The huts are now removed. (Editor's note.)

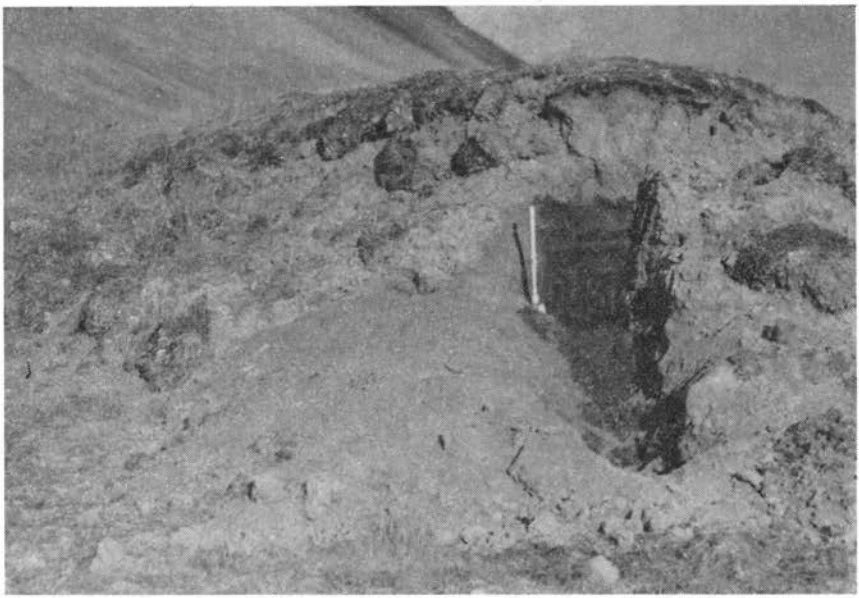

Fig. 3. *Accumulation of washed material, exposure 2, Bolterdalen.*

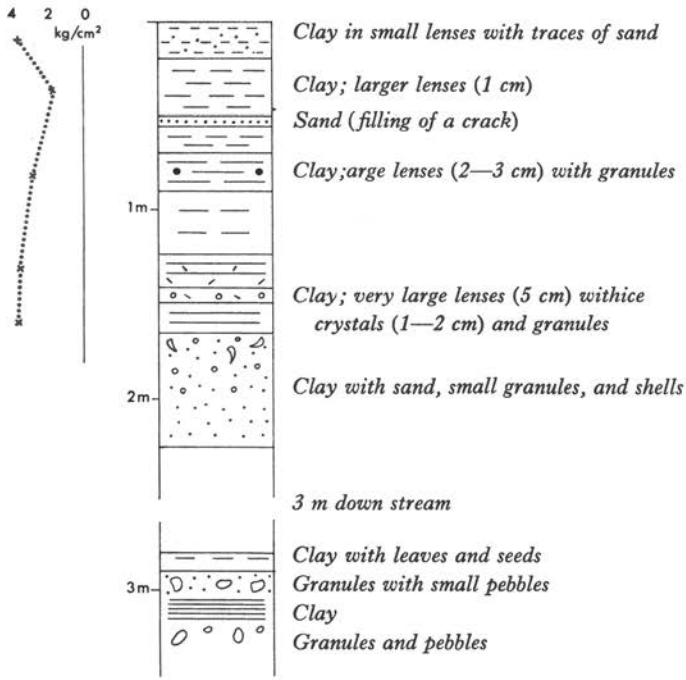

Fig. 4. *Profile from Adventdalen — Bolterdalen. Consistency was determined with the help of a "Soiltest" pocket penetrometer. The resistance to compression is expressed in kg/cm² (compact: 1—2, very compact: 2—4).*

Top:	gravel and alluvial deposits	sand
	beige sand	clay complex
	black sand	moraine (boulder clay with
	washed material	striated pebbles)
Bottom:	bedrock	

3) At Fivelflyane appear small hills about 10 m high. They consist of fine sediments (clay and sand), and are eroded by many well developed gullies. Their lower parts are frozen, and numerous ponds fill the depressions. Their upper parts, as a mollisol, are affected by continuous sliding. On the soil surface, small plates of an ochre sandstone of local origin were found; they seem to originate from Bassen. Just beneath the vegetation cover of these hills was a layer of heterogeneous sand, 1–2 cm thick.

At the bottom of a ravine, a thick sand accumulation was observed to form the base of the sandy, clayey complex mentioned above.

In the lower parts of these hillocks, varved clay was observed, dipping in the direction of the valley, i. e. N 315°E, and at an angle of 40–45°. The contrast between the black layers of clay, 5–10 cm thick, and the silty sand, a few cm thick, was sharp.

Some of the sandy layers were of a brownish colour; and concentrations of coal fragments emphasized the micro-stratification where that occurred. Two zones showed the effects of strong oxidation, at the top of the exposure and in the lower part. At these two levels were concentrations of shells and organic matter.

Fig. 5. *Fivelflyane. First profile.*

Table 1

Nr.	Locality	Diameter i mm				
		20–2	2–0.6	0.6–0.2	0.2–0.6	< 0.6
		%	%	%	%	%
35	Boulder clay with striated pebbles, old; Adventdalen — Todalen (cf. Fig. 2)	53	5	10	8	23
3	Recent moraine, S of glacier on the W side of Bolterdalen	63	13	9	3	12
2	» » upper part of Todalen, E side	53	17	11	8	12
36	Washed material, 'Pynten' between Endalen and Todalen (SNSK hut)	33	31	29	4	3
29	» » , hut on the NE side of Bolterdalen	30	40	24	4	3
56	Raised beach, Lailadalen	57	21	15	3	5
10	Fluvioglacial, W of Innre Hiorth-hamn hytte	53	22	12	3	10
12	» » » » »	38	17	26	5	15
1	Washed moraine, mouth of Bolterdalen, W side	61	10	17	7	5
8	River, Helvetiadalen, 2 km down stream from Tellbreen	50	6	22	14	9
58	» Lailadalen	48	8	9	30	4
5	» Foxfonna	2	1	14	57	25
11	Sand, W of Innre Hiorth-hamn hytte	—	11	14	32	43
7	» upon moraine, mouth of Bolterdalen, W side	2	5	18	50	25
76	De Geerdalen (profile containing whale bone)	5	2	16	26	50
74	»	—	4	4	32	60
77	»	18	11	26	34	10
6	Fivelflyane (æolian sand ?)	—	2	9	19	70
15	Bolterdalen » NE side	—	3	5	30	60
42	Fivelflyane (varved sand)	—	1	19	42	38
21	Profile: Adventdalen—Bolterdalen, near hut on the NE side of Bolterdalen, 125—175 cm	2	0.5	1	5.5	92
25	» —»— —»— —»— c. 300 cm	46	4	3	4	43
31	» —»— —»— —»— sand	—	1	27	51	21
30	» —»— —»— —»— black sand	—	15	23	50	13

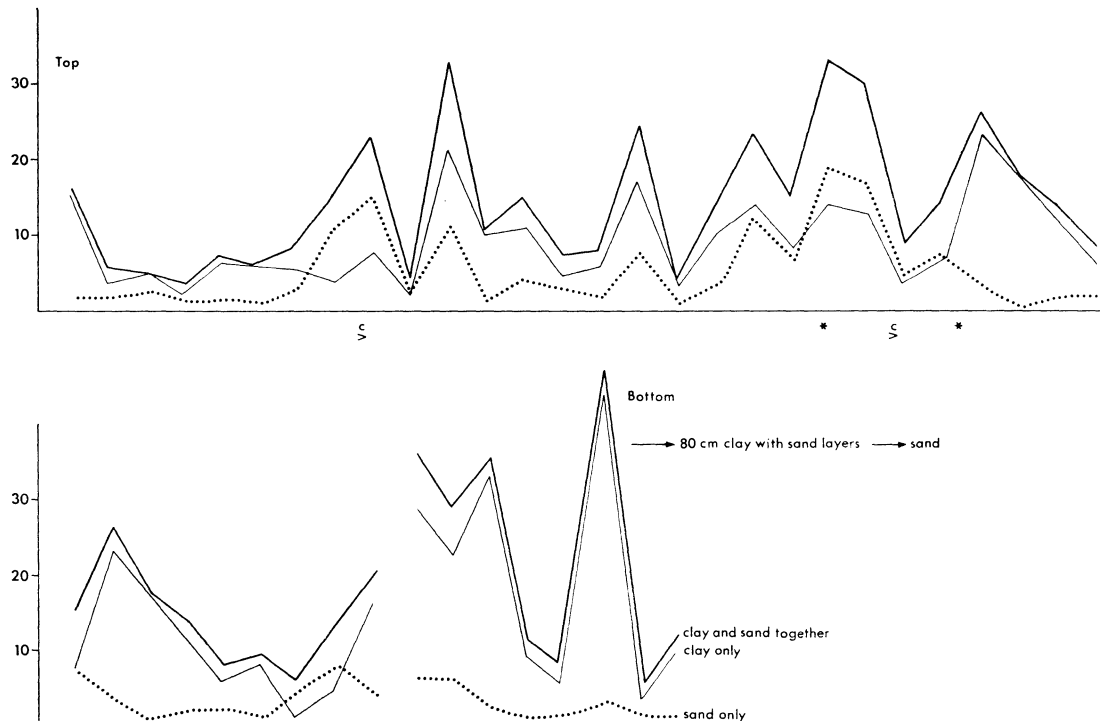

Fig. 6. *Fivelflyane. Second profile. Legend: see Fig. 5.*

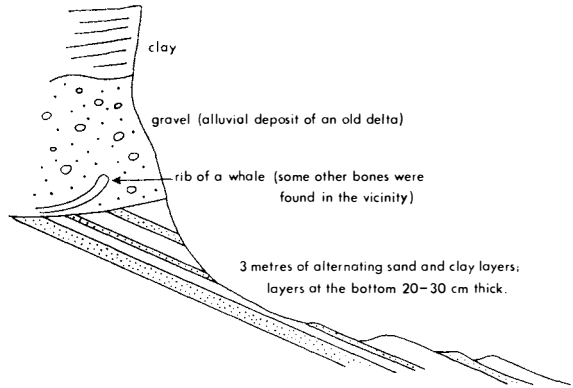

Fig. 7. *Profile containing whale bone, De Geerdalen (30—40 m a.s.l.).*

The coarseness of the sand is shown in Table 1; Figs. 5 and 6 show the variations in thickness of each layer of clay and sand, and also the thickness of the two layers together.

Shells were collected at 3.1 m from the top of the second profile and at the bottoms of exposures 1) and 2).

4) In De Geerdalen, not very far from the sea, on the right side about 30–40 m a.s.l., the profile shown in Fig. 7 was observed.

The lithology of superficial deposits

The mineralogy of the marine clays showed the presence of kaolinite and illite accompanied by a mixed-layer mineral, probably of illite-chlorite.[1] Other studies would be of great interest, especially for the purpose of comparison with the analyses of LANDERGREN (1958) and ROSENQVIST (1960). Heavy minerals are very rare or even absent, in any case in the fractions of less than 200 μ.

The lithological uniformity of the sedimentary series of the region did not allow many analyses. Table 2 gives the results from two exposures: the first one, not very far from 'Bolterhytta' in the bed of the river, and the second in older deposits on the river bank. The lithological composition of the cobbles was different in these two localities.

[1] The author is grateful to Professor J. P. VERNET, Geneva, for this information.

Table 2

	Alluvial deposits	
	Recent	Old
Very fine sandstone, black, with remains of plants	15% in weight	4%
Green sandstones with glauconite	33 » »	58 »
Greyish sandstones with ferriferous spots	31 » »	25 »
Sandstones with grey or black spots and remains of plants ..	18 » »	4 »
Other sandstones.....	2 » »	8 »

Fragments, 1–2 cm in size, from a sample collected in the soil near the 'Bolterhytta' profile (Fig. 4) gave the results shown in Table 3.

Table 3

Fine-grained, greenish sandstones with rounded fragments	51% in weight
Greyish shales in small plates	14 » »
Coarse sandstones with rounded grains of quartz	11 » »
Brownish, splintered, silicified fragments	10 » »
Fine-grained, greyish sandstones	9 » »
Diverse, with some crystalline fragments	5 » »

Morphometry

The flatness of most of the rock fragments belonging to many kinds of stratigraphical units did not permit the use of morphometric indices, which reveal the conditions of genesis of the formations.

The index of flatness was measured according to the formula of CAILLEUX (1952) for two samples only. The fragments, all belonging to the same lithological species, were taken from the bed of Bolterelva and other older alluvial deposits in the vicinity. These two samples came from the same localities as those described on p. 7. See Table 4.

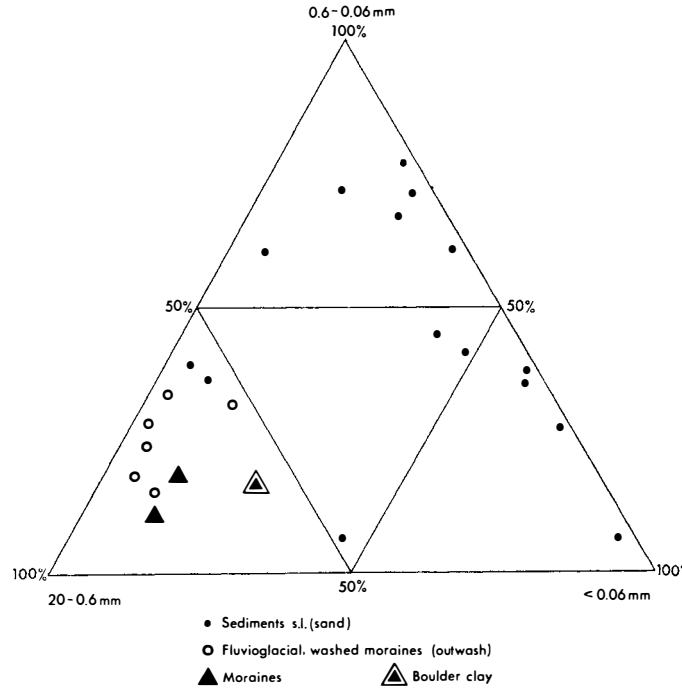

Fig. 8. *Granulometry of some deposits.*

Table 4

Index of flatness $A = \frac{\text{length} + \text{breadth}}{2 \times \text{thickness}}$	Bolterelva (river bed)	Old alluvium (river bank)
	%	%
1 —1.5 (=1.49)	9	22
1.5—2	26	28
2 —2.5	26	22
2.5—3	16	11
3 —3.5	4	3
3.5—4	13	5
4 —4.5	2	1.5
4.5—5	3	6.5
>5	1	1
<2	35	50
Maximum	2—2.5	1.5—2
Median	2.3	2

Fig. 9 gives the morphometric curves of these two samples. They are very similar; the pebbles of the river bed show a very clear secondary maximum for the values between 3 and 4, the median being situated between 2 and 2.5 (about 2.3); for the older alluvium, it is between 1.5 and 2 (about 2).

Geotechnical properties of the deposits

As information about the petrography of the unconsolidated deposits of Svalbard is very sparse, it is appropriate to give some values for the consistency and the plasticity of the clays. These geotechnical characteristics are related to the mineralogy of the clays, their conditions of formation, and the degree of salinity of the water in which they were deposited.

In Scandinavia, a clay is characterized by the amount of water (expressed as a percentage of the dry weight) which must be introduced into a sample by mixing, so that a 60°, 60 g cone will sink 10 mm into the clay. This is termed the 'fineness number', and the value is an expression of the clay's consistency or inversely of its plasticity (MERTZ 1949).

Meagre clay	10–30 (% water on dry weight)	
Silt	30–40	—»—
Fairly rich clay	40–60	—»—
Rich clay	60–80	—»—
Plastic clay	c. 80	—»—

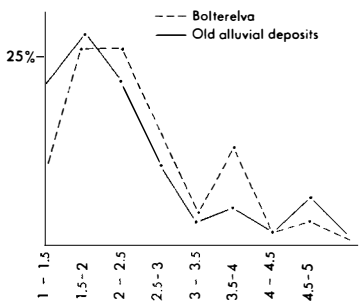

Fig. 9. *Morphometry* (*degree of flatness:* $\frac{length + breadth}{2 \times thickness}$).

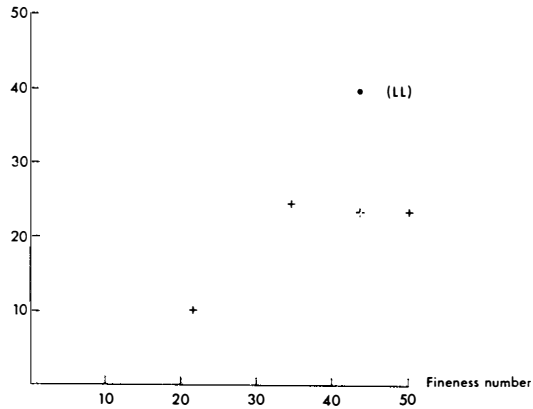

Fig. 10. *Relation between* ATTERBERG's *limits* (*limit of plasticity or limit of liquidity* (*LL*)) *and fineness number.*

Table 5

No.	Locality	'Fineness number'	ATTERBERG's limits of	
			liquidity	plasticity
13	2 km S of Passhytta, weathering of black shales	50	—	22.5
16	Profile 'Bolterhytta' (Fig. 4), 15 cm deep	43	—	—
18	» » 75 » »	22	—	—
33	» Todalen (Fig. 2), 160 cm deep	34	—	24
34	» » 210 » »	43	39	23

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