

CHRISTER PERSSON AND  
BO WÅLLBERG

DRIFT STRATA IN THE VEMAN  
VALLEY, CENTRAL SWEDEN



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## ABSTRACT

Persson, Ch. and Wällberg, B., 1987-12-15: Drift strata in the Veman valley, central Sweden. *Sveriges geologiska undersökning, Ser. C 822*, pp. 1-20. Uppsala 1989.

Drift strata have been investigated in the Veman valley southeast of Vemdalen. Drillings and a seismic survey show that the total thickness of the drift varies between c. 12 and c. 80 m. The stratigraphy is built up of a bottom layer of till up to 60 m thick, overlain by 5 to 25 m of water-laid sediments, in turn overlain by less than a metre of till. The seismic velocity in the lowermost till layer is 2000 to 2200 m/s. Velocity inversions indicate that the till is not hard and homogenous but might be interbedded with water-laid sediments. Analyses of the grain-size and petrographic composition of the water-laid sediments and the uppermost till layer have been carried out. The sediment may be of interstadial age, connected with a late ice oscillation or deposited subglacially. The recent morphology of the valley is probably mainly a result of later fluvial erosion.

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## INTRODUCTION

The investigated part of the Veman valley is situated southeast of Vemdalen from Sersån in the north to the mire Tönningfloarna in the south (Fig. 1). Four areas situated between 385 and 405 m above sea-level have been surveyed and the stratigraphy has been explored by means of drilling and seismic investigations. The field work was carried out in 1982-1984. The main purpose was to study the extension of till-covered sediments and the composition and thickness of the drift in the valley.

## GEOLOGY OF THE AREA

The surrounding mountains are built up of Proterozoic and Cambrian Vemdalen quartzite while the bedrock in the bottom of the valley consists of younger microcline-porphyrific granite, the Rätan granite (Lundegårdh et al. 1985). According to Lundqvist (1969) the Quaternary deposits in the valley are mainly till, often containing layers and lenses of sorted material, and glaciofluvial sediments, forming a sandur. Lundqvist also mentions certain localities, for instance at Vemhån, where till-covered sediments have been observed and says that these deposits probably represent subglacial sedimentation and a transition from till to sandur.

In connection with a survey for ore prospecting, mainly based on air photo interpretation the main part of the drift in the valley was interpreted as glaciofluvial deposits varying in composition and genesis. Test pits at certain places showed that sediments, mainly gravel and coarse sand, occurred under a thin layer of till.

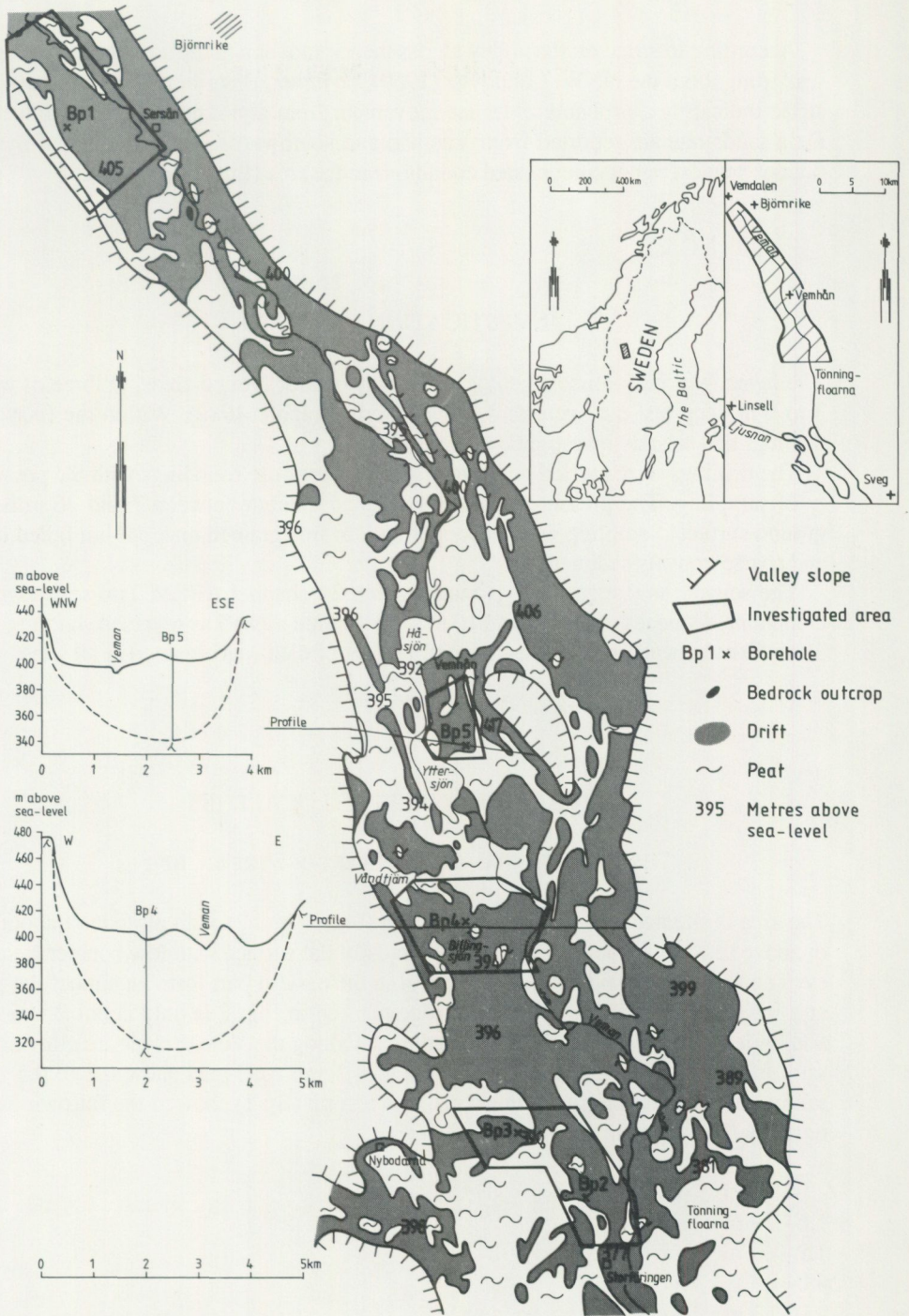


Fig. 1. Sketch map showing the surveyed part of the Veman valley and the localities investigated.

According to striae on the valley slopes the ice movement during the final recession was from about the NNW. Lundqvist (1969), however, describes some localities with striae indicating a probably older ice movement from about the SSE and boulders of Dala sandstone are reported from Vemhån and southwards. The locations of the ice-divides suggest rather complicated conditions in the area (Lundqvist 1969).

### INVESTIGATION METHODS

The investigations include a geological survey of four limited areas, in three of which 3 to 6 m deep test pits were dug (Prospekteringsrapport, 1982). Within the four areas drillings and seismic investigations were made.

The drillings were carried out as motor-driven pressure soundings with the possibility of sampling. The pressure soundings reached a depth between 7 and 26 m below ground surface. Sampling was successful only in fine grained material but failed in till and coarse gravelly sediment.

The seismic investigation was made with a 24-channel ABEM Trio seismograph. Geophone distances of both 5 and 10 m were applied as well as reversed shooting with 30 to 50 m between shot-points. A complete set of data was obtained at all sites.

### DESCRIPTION OF THE LOCALITIES

#### THE AREA WEST AND NORTHWEST OF SERSÅN, BP 1

The area is situated west of the river Veman (Figs. 1 and 2) at an altitude of about 405 m above sea-level. The sandy till forms a mostly flat surface with low boulder frequency. The areas with sand and locally gravel in the eastern part form an almost flat plain at a lower altitude than the till. The ridge marked in Fig. 2 is only about 2.5 m high and built up of gravel and sand. The sediments along the Veman river are alluvial fine sand and silt. In the northern part of the area small road-cuts show 0.2 to 0.5 m of sandy till resting upon sand and gravel. The test pit (Bp 1) showed the following stratigraphy (Prospekteringsrapport, 1982):

- 0–1.6 m Sandy till
- 1.6–1.9 m Sandy gravel
- 1.9–4.0 m Gravelly to sandy till
- 4.0–4.9 m Fine sand
- 4.9–6.0 m Sand with cross bedding
- 6.0–>6.5 m Silt

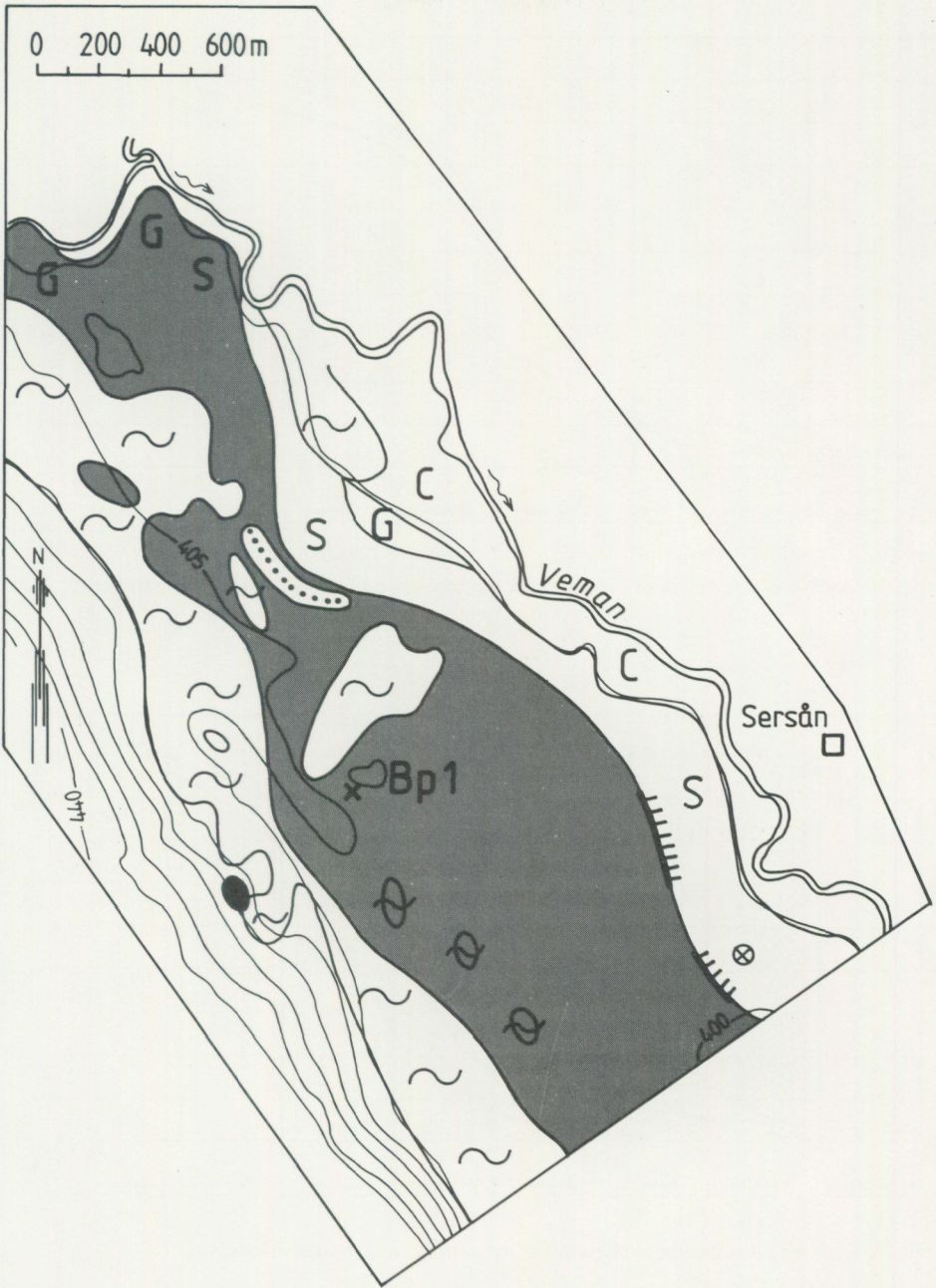


Fig. 2. Map showing the geology of the area around Bp 1. For explanation of symbols see Fig. 11.

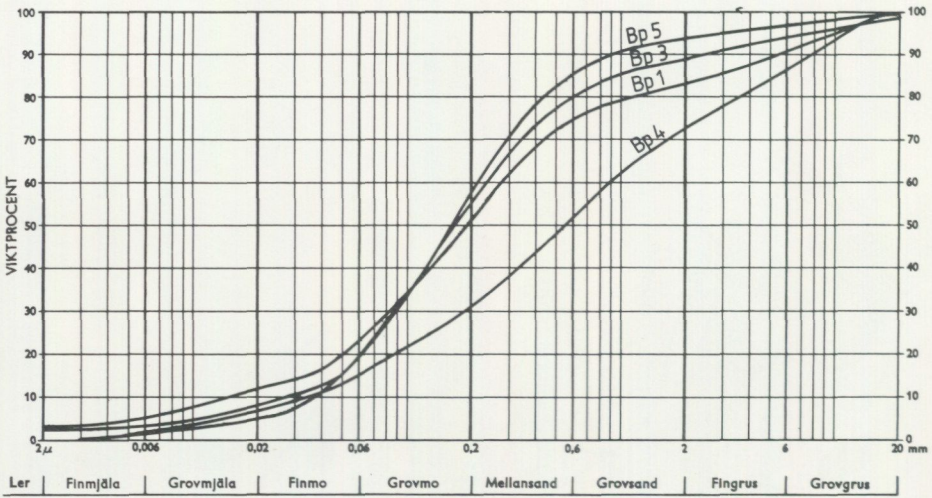


Fig. 3. Grain-size distribution of the matrix in the uppermost till from investigated localities.

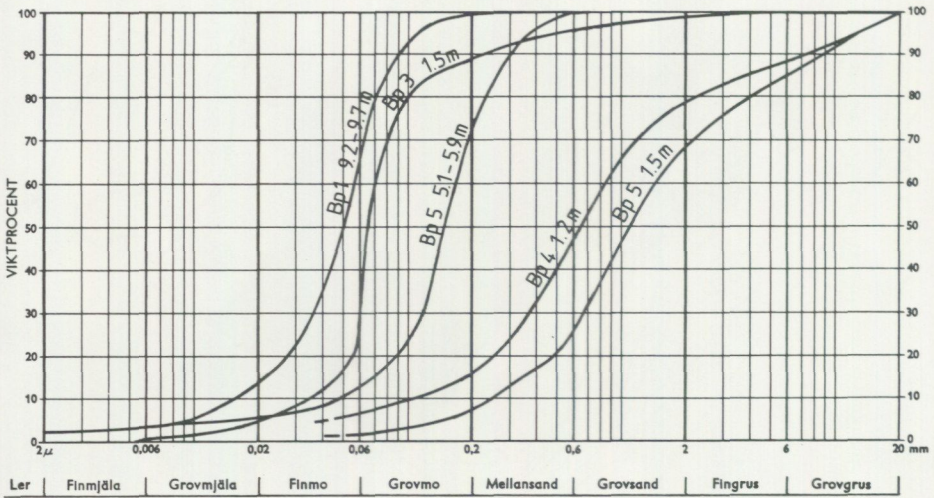


Fig. 4. Grain-size distribution of till covered sediment from investigated localities.

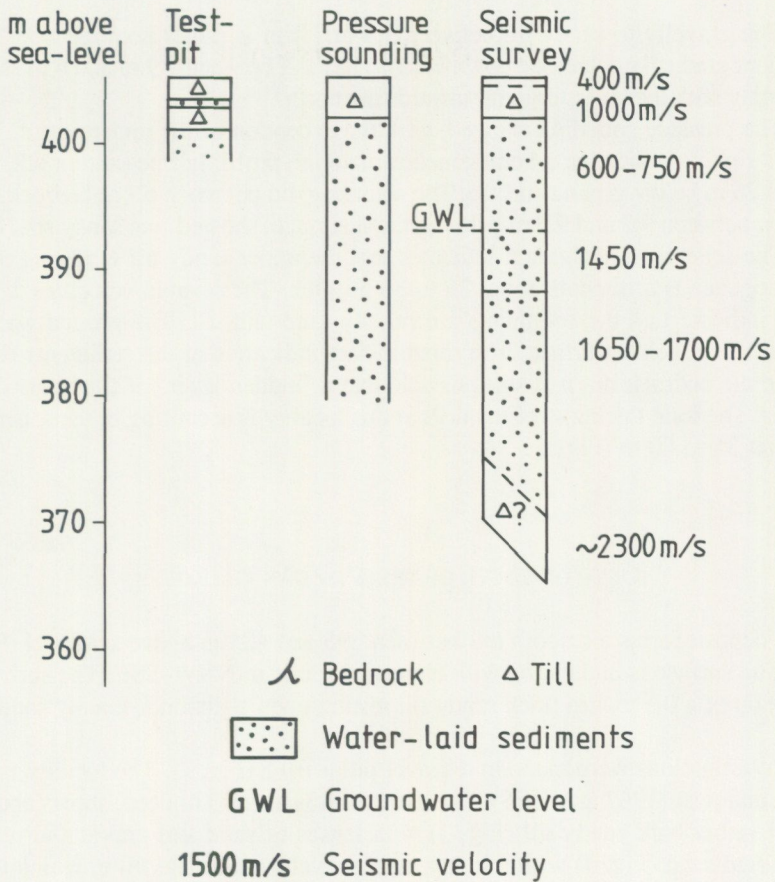


Fig. 5. Drift strata at Bp. 1.

The uppermost sandy till (Fig. 3) is rather hard with low to medium content of stones and a low content of boulders. It contains thin layers of silt and is free of lime. The content of heavy minerals (Bx), that is the percentage of minerals with density exceeding 2.68 is 19.4 The percentage of magnetite is 0.8. An investigation of the petrographic composition of the fine gravel fraction of the till gave the following result:

quartz	64 %
feldspar	3 %
gneiss	5 %
Vemdalen quartzite	8 %
graywacke	2 %
greenstone	13 %
shales	1 %
diabase	4 %

The gravelly to sandy till between 1.9 and 4 m is rather homogeneous. The stone content gradually decreased downwards. The sand between 4.9 m and 6 m shows cross-bedding with the layers dipping towards the north.

The pressure sounding showed, with the exception of the uppermost c. 3 m, continuous sinking indicating a homogeneous material, probably fine sand or silt, down to at least 26 m below ground surface. The sounding did not reach till or bedrock. A sample, taken between 9.2 and 9.7 m below ground surface, showed fine sandy silt (Fig. 4).

The seismic investigation indicates that the upper sandy till is resting upon rather homogeneous sediments about 25 to 30 m thick. The seismic velocities 1 500–1 650 m/s indicate that the sediments are mainly sand and silt. The ground water level is about 12 m below surface. The seismic data indicate that the sediments rest directly upon the bedrock but it is still possible that a "hidden layer" of till forms the bottom-layer. The total thickness of the drift at this locality is according to the seismic investigation 35 to 40 m (Fig. 5).

#### ÖSTMON SOUTH OF THE VEMHÅN VILLAGE, BP 5

The deposit forms a smooth hill between 395 and 405 m above sea-level (Figs. 1 and 6). The surface is undulating with elongated forms in NNW–SSE. The surface layer is built up of a 0.5 to 1 m thick sandy till resting upon sediments, mainly sand and gravel.

Investigations were made in a gravel pit at Bp 5 (Fig. 7). The locality is described by Lundqvist (1967 and 1969). The pit, which is about 3 m deep, shows about 1 to 1.5 m of rather hard sandy till (Fig. 3) with lenses of sand and gravel and resting upon stratified sand (Fig. 4) with thin layers of gravelly sand. The till in which the content of boulders and stones is low, is free of lime. Bx is 17.3 and the percentage of magnetite is 0.7. The petrographic composition of the fine gravel fraction is almost the same in the till as in the underlying gravelly sand.

	till	gravelly sand
quartz	57 %	50 %
feldspar	13 %	18 %
gneiss	1 %	4 %
Vemdalen quartzite	15 %	12 %
greenstone	10 %	11 %
shales	2 %	2 %
diabase	2 %	3 %

The pressure sounding which was made in the bottom of the gravel pit, showed homogeneous and rather loose sediments down to a depth of about 13.5 m. According to the drill cuttings the sediment was mainly sand, which was confirmed by a sample taken between 5.1 and 5.9 m below ground surface (Fig. 4). From 13.5 to 21.5 m the

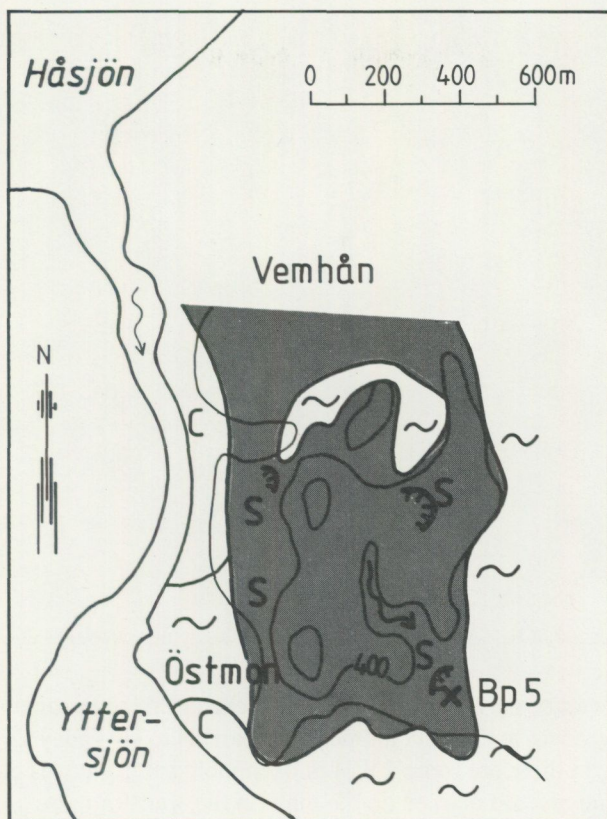


Fig. 6. Map showing the geology of the area around Bp 5. For explanation of symbols see Fig. 11.

sinking was uneven, possibly reflecting varying material containing stones. At 17.5 m there was a thin loose layer, possibly sand. From 21.5 m to 25.5 m the material was very hard with stones, probably till, and at 25.5 m the drilling stopped against a boulder.

The seismic investigation showed sediment to a depth of 17 to 24 m below surface. The groundwater level was at a depth of about 6 m. The seismic velocity 2200 m/s below the sediments most probably reflects till which, at this locality, is between 35 and 47 m thick and rests upon the bedrock. According to the seismic data the total thickness of the drift is about 60 m (Fig. 8).

#### THE AREA NORTHWEST OF BILLINGSJÖN, BP 4

This area is situated at an altitude of 390 to 410 m above sea-level and is dominated by sandy till forming a smoothly undulating surface with low boulder frequency (Fig. 1



Fig. 7. The gravel pit 500 m ESE of Östmon shows c. 1 m of sandy till covering mainly stratified sand.

and 9). The area west of the lakes Sandtjärnarna is characterized by hummocky moraine with melt-water grooves at different altitudes and parallel to the valley slope. In the area north of Billingsjön there are some 2 to 4 m deep melt-water grooves cut down in the till, and the two largest are marked on the map. In the walls of these grooves there is sand and in the bottom sand and gravel. The area with sand northeast of Billingsjön gives the impression of a glaciofluvial delta with kettles and small hills of sand. Northeast of the sand area there is a marked ridge of gravel. About 600 m northwest of Billingsjön there are two small road-cuts showing about 1 m of hard sandy till (Fig. 3) covering gravelly sand with stones and boulders (Fig. 4). The till has medium boulder and stone content and the main part of the boulders are rounded. It has no lime content, Bx is 19.1 and the percentage of magnetite is 1.1. The gravelly sand beneath the till is more than 1.5 m thick. The fine gravel fraction of the till and the gravelly sand does not show any significant petrographic compositional difference.

	till	gravelly sand
quartz	43 %	55 %
feldspar	22 %	26 %
gneiss	18 %	8 %
Vemdalen quartzite	12 %	9 %
greenstone	1 %	—
shales	—	—
diabase	4 %	2 %

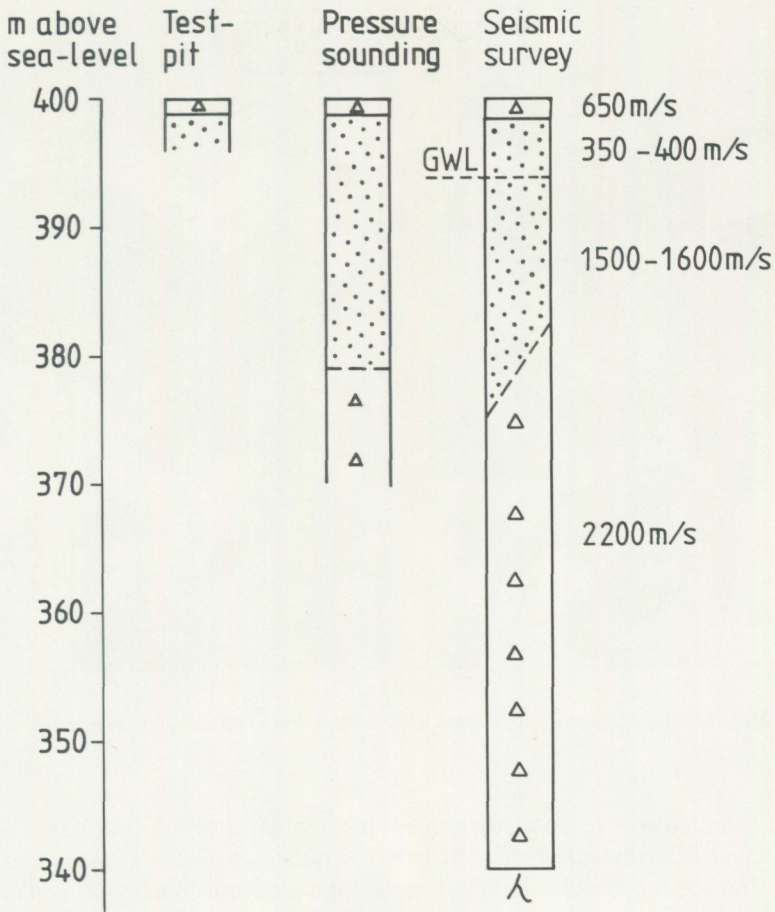


Fig. 8. Drift strata at Bp 5.

South of the lake Stor-Våndtjärnen an old gravel pit shows about 0.5 m sandy till covering gravel and sand c. 4 m thick, probably resting upon till.

The investigations were made at point Bp 4. The test pit showed (Prospekteringsrapport, 1982) 0.5 m of sand covering 2 m of sandy till with lenses of mainly gravel and sand and resting upon more than 1 m of coarse gravel with stones and boulders.

The pressure sounding showed coarse material with stones and boulders down to 4.5 m below ground surface and between 4.5 and 5.5 m presumably gravel. From 5.5 m and down to 8.5 m the uneven sinking in hard material probably indicates till. Between 8.5 and 9.5 m there was a sediment layer and from 9.5 m to 16.5 m the sounding showed both hard material with stones and layers of loose material. This might indicate complex strata with till or coarse sediment and fine-grained sediment. From 16.5 m to 19 m the sounding indicated till.

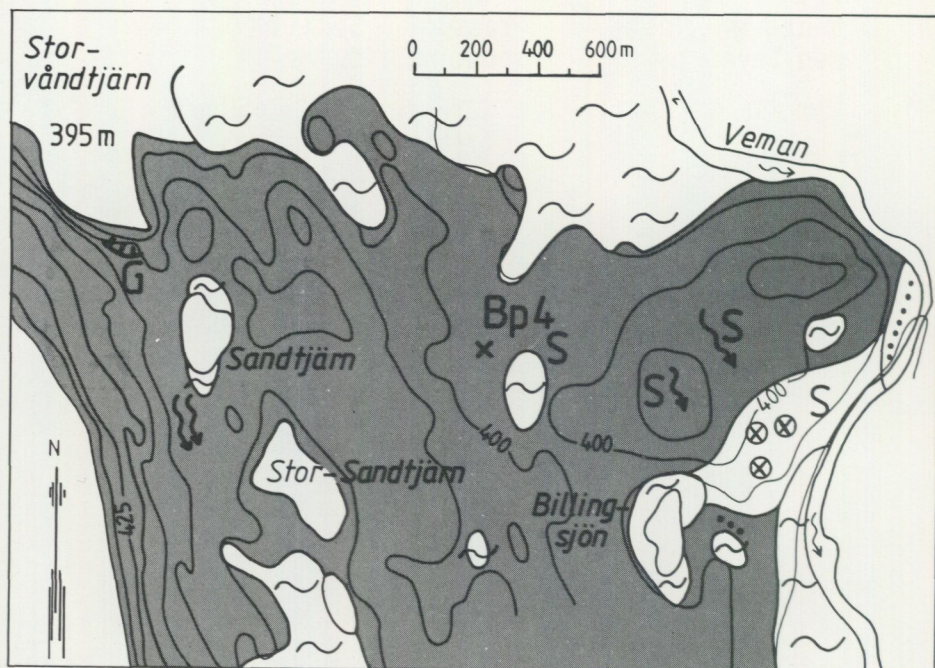


Fig. 9. Map showing the geology of the area around Bp 4. For explanation of symbols see Fig. 11.

The seismic investigation indicates a superficial layer of till, 6 to 10 m thick, with a thin layer of sediment about 2 m below surface, where the groundwater level is found. The seismic velocity 2000 m/s in the formation immediately below the groundwater level indicates till. A velocity inversion where the seismic velocity drops to 1600 m/s indicates that the till 0.5 m below the groundwater level is underlaid by sediment, the thickness of which is calculated to be between 7 and 10 m. From about 18 m below surface and downwards the seismic velocity 2200 m/s indicates till. A second velocity inversion suggests that also this layer of till might be interbedded with a sediment layer in the upper part. The thickness of this sediment layer cannot be calculated but is estimated at a few metres. The total thickness of the drift as indicated by the seismic survey is between 75 and 80 m (Fig. 10).

#### THE AREA NORTH AND NORTHWEST OF STORFÄRINGEN, BP 2 AND BP 3

The area (Figs. 1 and 11) which is situated 380 to 395 m above sea-level, is rather flat or smoothly undulating and dominated by sandy till which, according to a number of small pits, is at least 1 to 2 m thick. Within the southern part there are a number of 3 to 4 m high ridges with drumlin shape and orientated mainly in NNW-SSE. Around

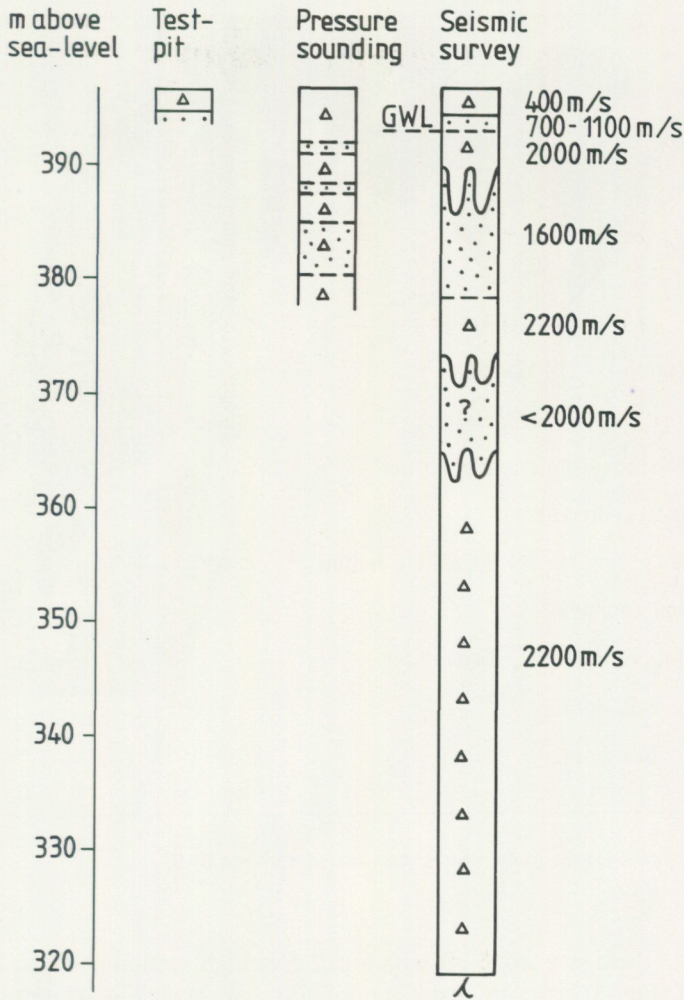


Fig. 10. Drift strata at Bp 4.

Bp 3 the morphology is alternately flat and hilly. 2.4 km north of Storfäringen there is a limited area with either outcropping bedrock or, more likely, a piling up of large boulders. The alluvial sediments along the Veman river are silt.

Three sections show till covering sand and gravel. 200 m west of Veman there is a small pit in gravel which is partly covered by 0.5 to 1 m of till. Along the road 2.3 km NNW of Storfäringen there is a 3 m high section in a small hill. The section shows about 0.5 m of silty to fine sandy till upon gravel, gravelly sand and sand. In the bottom of the small gravel pit on the opposite side of the road the gravel seems to cover sandy till.

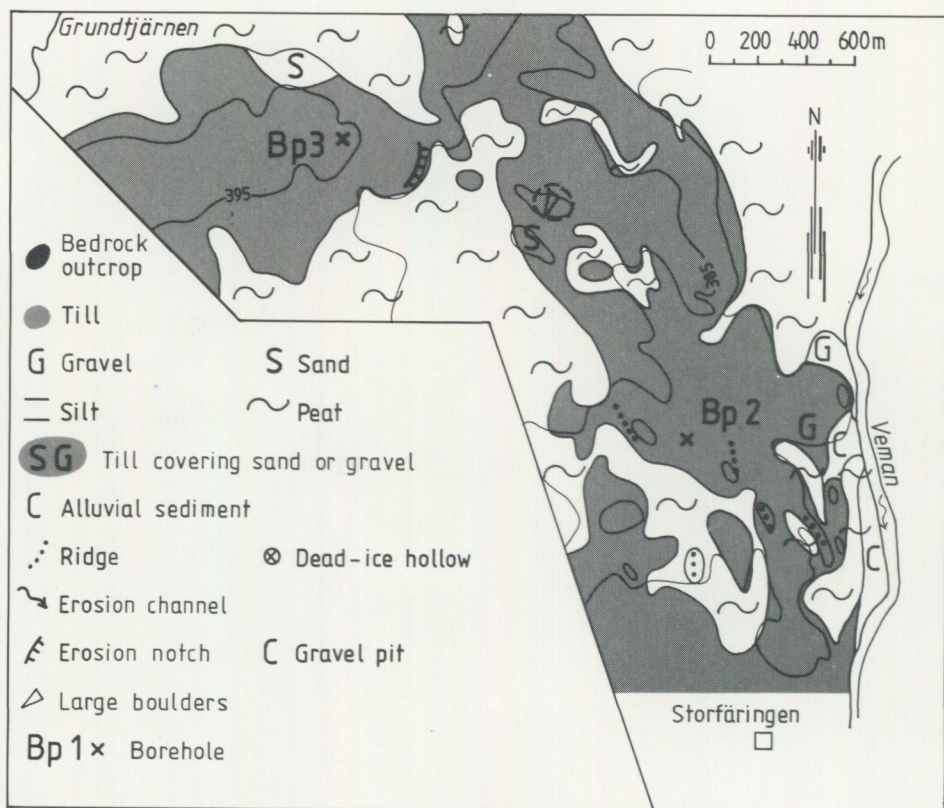


Fig. 11. Map showing the geology of the area around Bp 2 and Bp 3.

At Bp 3 there is a small pit with a c. 2.5 m high section showing 0.5 to 1 m of sandy till (Fig. 3) covering about 2 m of silty fine sand (Fig. 4) with thin layers of sand which in the uppermost part are disturbed and folded (Fig. 12). The till has a rather low content of boulders and stones. It has no lime content, Bx is 14.3 and the percentage of magnetite is 0.6. In the silty fine sand Bx is 13.5 and the percentage of magnetite is 0.5.

A pressure sounding in the bottom of the pit showed 2.5 m of homogeneous and rather loose material, probably silty fine sand. From 2.5 m down to 7 m the sinking was very uneven due to hard material with stones and boulders interpreted as till. The sounding was stopped 7 m below the ground surface.

The seismic velocities 650–800 m/s and 2 000 m/s probably reflect till over and under the groundwater level. According to seismic data the till is a little more than 20 m thick and rests upon the bedrock. The total thickness of the drift is thus about 25 m (Fig. 13). The seismic velocities about 4 000 m/s and 5 500 m/s might reflect fractured rock and hard rock, respectively.



Fig. 12. The gravel pit at Bp 3 shows 0.5 to 1 m of sandy till covering c. 2 m of silty fine sand.

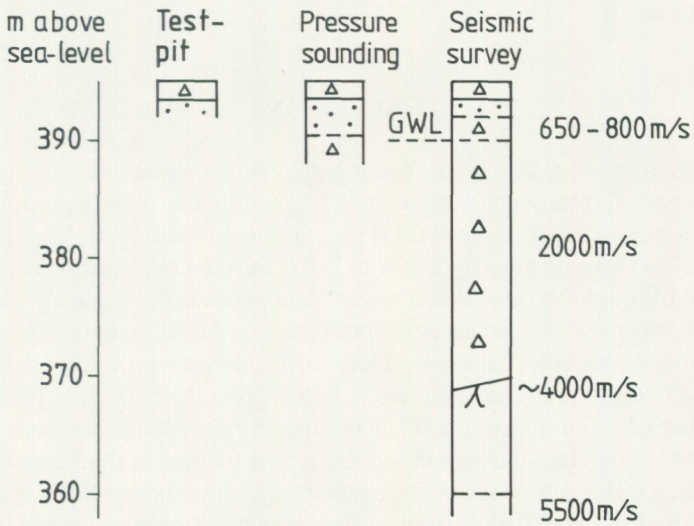


Fig. 13. Drift strata at Bp 3.

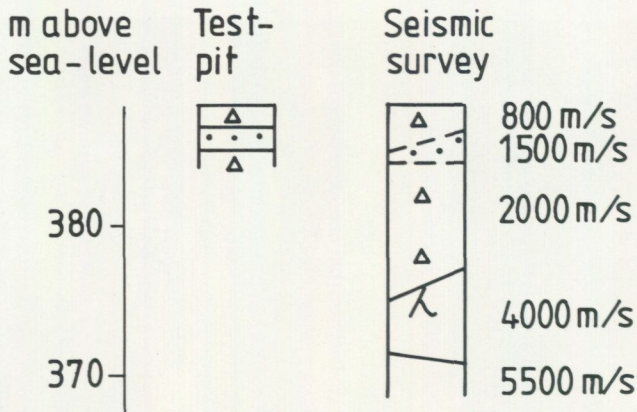


Fig. 14. Drift strata at Bp 2.

At Bp 2, 1.3 km NNW of Storfäringen a test pit showed about 1.5 m of sandy till with a high content of rounded stones and resting upon 1.3 m of sandy gravel. From 2.9 m to at least 3.2 m below surface there was sandy till (Prospekteringsrapport, 1982).

According to the seismic velocities the strata is mainly built up of till with a thin layer of sediment about 2 m below the surface. The till rests upon the bedrock and the total thickness of the drift is according to the seismic investigation about 12 m (Fig. 14). As at Bp 3 two different seismic velocities, 4 000 and 5 500 m/s, were obtained from the bedrock.

### CONCLUSIONS

The investigations show that the drift stratigraphy in the Veman valley is built up of a bottom layer of till resting upon the bedrock and overlain by mainly glaciofluvial sand which is covered by a thin layer of till (Fig. 15). The lowermost till layer is at most c. 60 m thick. The seismic velocity 2 000 to 2 200 m/s and the signs of velocity inversions in the till might indicate that it is not homogeneous but probably locally interbedded with water-laid sediments. Attempts to sample this till have failed and its grain-size and petrographic composition is unknown. The covering glaciofluvial sediments, mainly sand but also gravel and silt, are c. 5 to c. 25 m thick. In Bp 1 the sediment is fine sand and silt. The uppermost till is sandy and rather hard. In places it contains layers of sorted material. Analyses of the fine gravel fraction in Bp 5 does not indicate any significant difference in the petrographic composition between the uppermost till and the underlying glaciofluvial sediment. In places the uppermost till bed is lacking.

As neither the composition nor the age of the lowermost till is known it must be left out of the discussion.

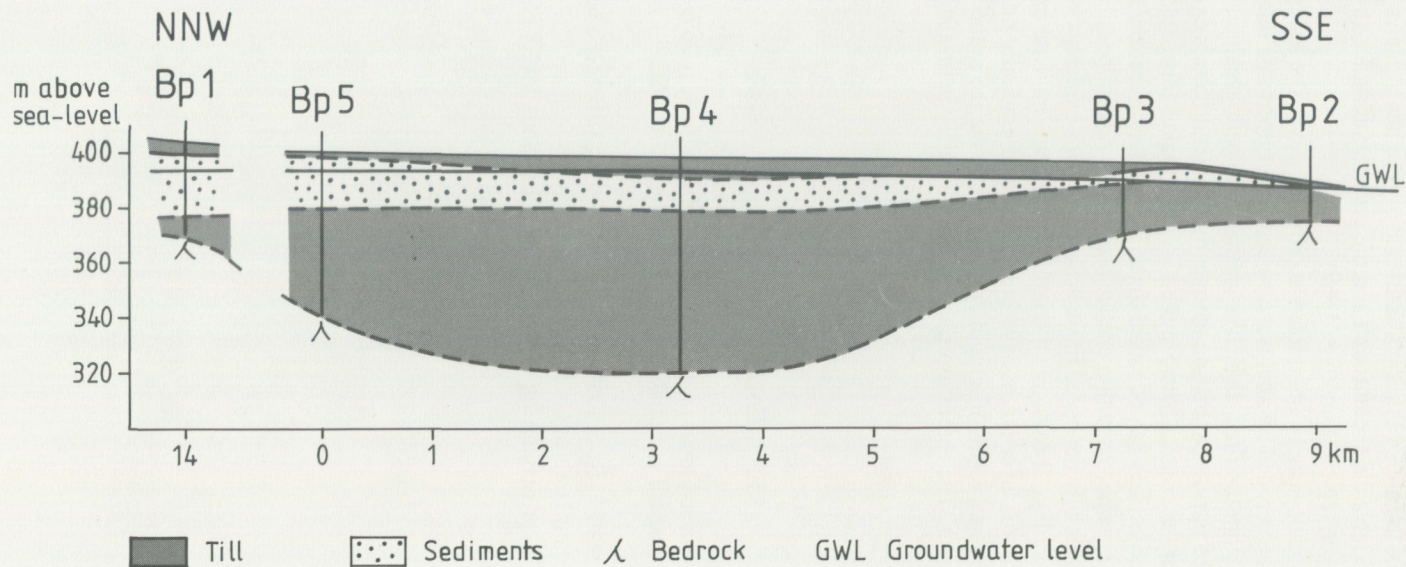


Fig. 15. Schematic section showing the drift strata in the investigated part of the Veman valley.

During the final stage of the glaciation the ice movement was from the NNW at least in the northwestern part of the area. In the area southeast of Vemhån striae indicating a movement from the SSE have also been found and the corresponding ice-divide was probably situated in the Sveg region (Lundqvist 1969).

The drift stratigraphy in the valley can be interpreted in different ways. The sediment layer is interstadial and has been eroded by an advancing ice. The uppermost thin till cover is then the only deposit from the final stage. The similarity in petrographic composition of the sediment and the uppermost till and the fact that no disturbances except in Bp 3, have been observed at the contact between the two units makes this explanation less plausible. The same objections can be raised to the interpretation that the sediments and the covering till are connected with a late ice oscillation. A third possibility is that the sediments were subglacially deposited in shallow water. This explanation demands an ice damming of the valley. The composition of the sediments indicate rather stable conditions. The covering till layer might have been deposited gradually during the ice retreat or in a short time as a result of a rapid drainage when the ice in the valley settled down on the sediment. The recent morphology of the valley is probably a result of later fluvial erosion.

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