

# THE DISTRIBUTION OF SOME METALS IN DIFFERENT TILL FRACTIONS

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*Abstract.* Till samples have been divided into several fractions by different methods, and in each fraction the content of Cu, Pb and Zn has been determined in a tape machine. The results indicate that not only the finest fraction but also coarser fractions may be used for prospecting purposes.

## INTRODUCTION

Geochemical investigations in till are an important ore-prospecting method in glaciated areas. By tracing ore boulders in till, several mineralizations have been localized directly (Grip, 1953), but it is often also necessary to make geochemical investigations in the fine fractions of the till.

Since the tape machine was constructed (Danielsson, 1957; Danielsson, Lundgren and Sundkvist, 1959) in our company, soil samples have been analysed routinely on a direct-reading spectrograph, equipped with a tape machine. When using the tape method for analysis, the samples must be in powder form and have a defined particle-size distribution. Till samples are therefore sieved before the analysis. Only the finest fraction of the till,  $< 60 \mu$ , has been analysed. The sieved sample is continuously fed to an adhesive tape, which is passed through the spark gap. The sparks pass through the tape and vaporize and excite the sample.

Till is composed of an unsorted, heterogeneous mixture of particles of different sizes, from large boulders to clay particles. In the coarser fractions, rock fragments predominate; the sand and silt fractions contain a mixture of rock and monomineralic particles. The clay fraction ( $< 2 \mu$ ) is composed mostly of clay minerals, oxides and colloidal materials. The metal content of the clay is dependent on postglacial cation exchange and may not represent the composition of the coarser fractions of the till. As the analysed fraction,  $< 60 \mu$ , is a mixture of both silt and clay, the clay

proportion of the till seems to influence the result of the chemical analysis (cf. Shilts, 1971).

In most ore-prospecting projects associated with glaciated areas, the geochemical investigations are supposed to give a complementary picture of the ore boulder trains transported by the ice. Thus the primary anomalies caused by clastic rock and mineral fragments in the sand fractions may be of more interest than those dependent on secondary, hydromorphic dispersions in the finest fraction.

The present report gives some of the results of investigations of different till fractions undertaken to determine whether any other fraction than  $< 60 \mu$  could be analysed in the tape machine and, if so, whether the results obtained were more representative.

In analysing different particle-size fractions, using the same analytical working curves, the results obtained are not to be considered as real contents but only as apparent contents.

## PREPARATION OF THE TILL SAMPLES

Before the till samples were analysed in the tape machine, they were prepared by sieving and grinding.

(a) *Sieving.* The whole sample (weighing about 2000 g) was dry-sieved on a sieve with a 2-mm opening. This sieved sample was divided into two parts in a sample-splitter. One part was dry-sieved and the other part was wet-sieved in distilled water. The sieves used were made of nylon to prevent metallic contamination, and the following openings were used: 1 000  $\mu$ , 600  $\mu$ , 400  $\mu$ , 200  $\mu$ , 100  $\mu$ , and 56  $\mu$ . Thus the samples were divided into the following fractions: 2000–1000  $\mu$ , A 1000–600  $\mu$ , B 600–400  $\mu$ , C 400–200  $\mu$ , D 200–100  $\mu$ , E 100–56  $\mu$  and F  $< 56 \mu$ .

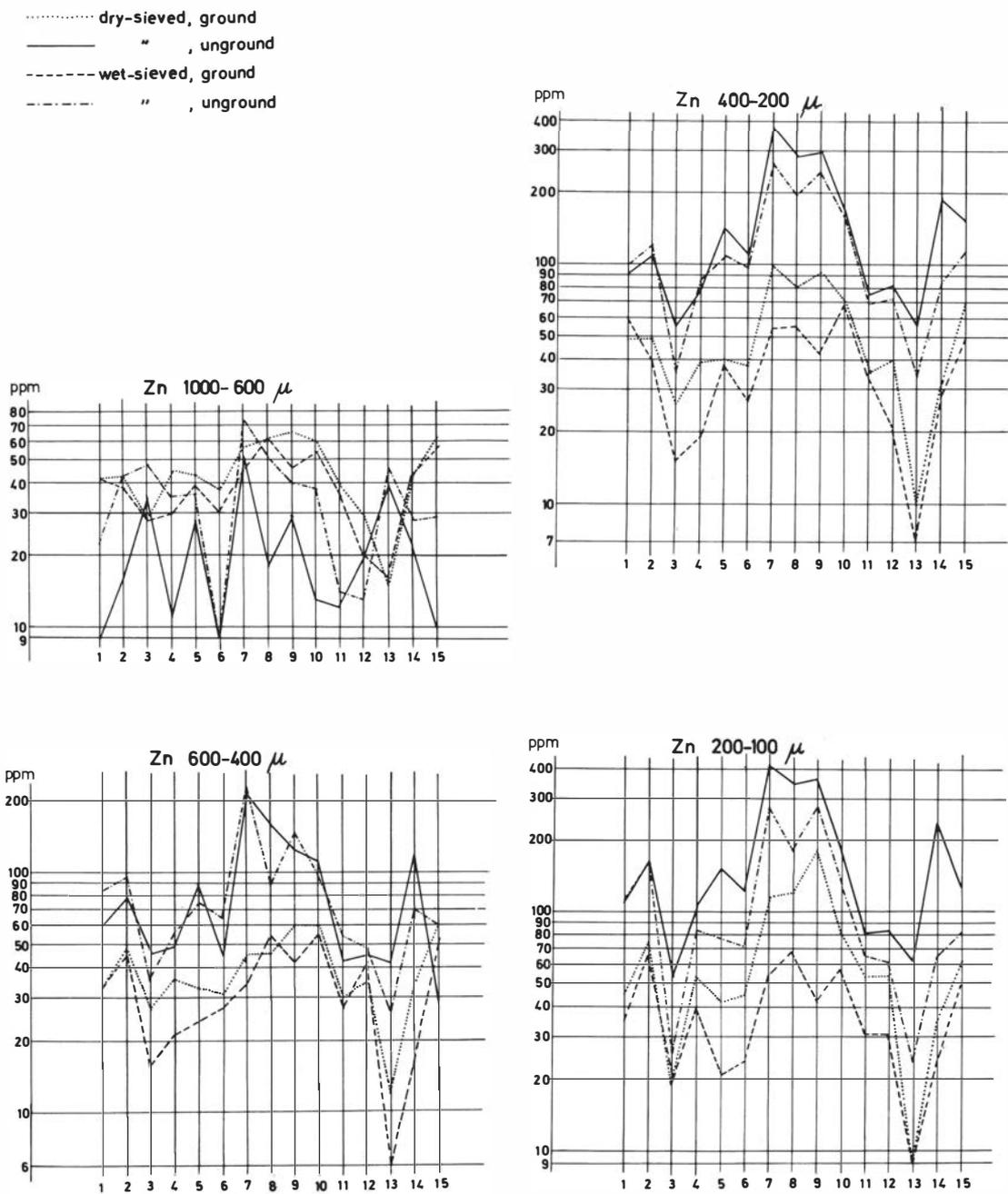


Fig. 1. The apparent Zn content of 15 till samples prepared by sieving and grinding, as described in the text.

(b) *Grinding.* After sieving, each fraction was divided into two parts, one of which was then ground into powder. Thus after dry- and wet-sieving and grinding, the original sample was divided into 28 different parts.

RESULTS

After preparation as described above, a large number of samples were run in the tape machine. Some examples are given below. Fig. 1 shows the apparent Zn content of 15 till samples after sieving and grinding and analysis by the tape method. The coarsest fraction, 2000–100  $\mu$ , is excluded, because the unground grains did not attach to the tape properly.

In the next fraction, 1000–600  $\mu$ , the picture is quite uniform, but in the somewhat finer fractions, especially 400–200  $\mu$  and 200–100  $\mu$ , there is a clear tendency for the dry-sieved, unground samples to yield the highest Zn values. The lowest apparent Zn content in these fractions appears in the wet-sieved and ground samples.

In the finest fractions, < 56  $\mu$ , the maximum value appears mostly in the wet-sieved, ground samples.

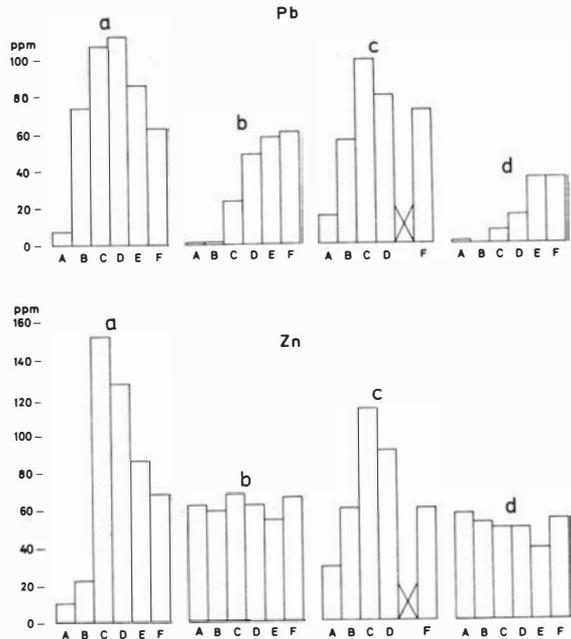
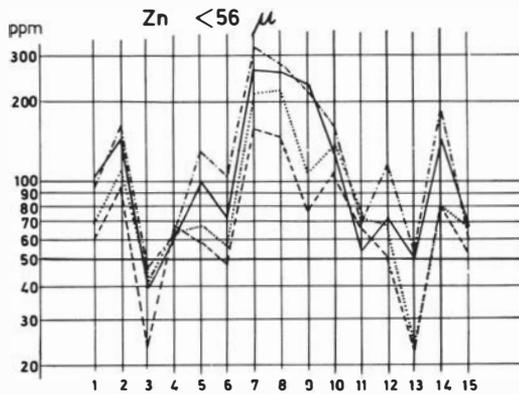
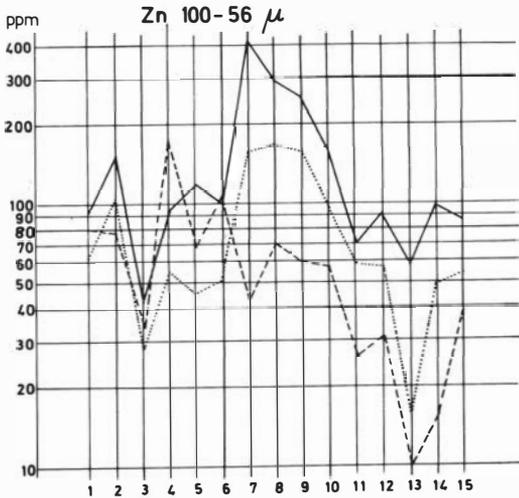


Fig. 2. Upper diagram: The apparent Pb content of different fractions in one till sample. Lower diagram: The apparent Zn content of different fractions in one till sample. a = dry-sieved, unground; b = dry-sieved, ground; c = wet-sieved, unground; d = wet-sieved, ground; A = 1000–600  $\mu$ ; B = 600–400  $\mu$ ; C = 400–200  $\mu$ ; D = 200–100  $\mu$ ; E = 100–56  $\mu$ ; F = < 56  $\mu$ .

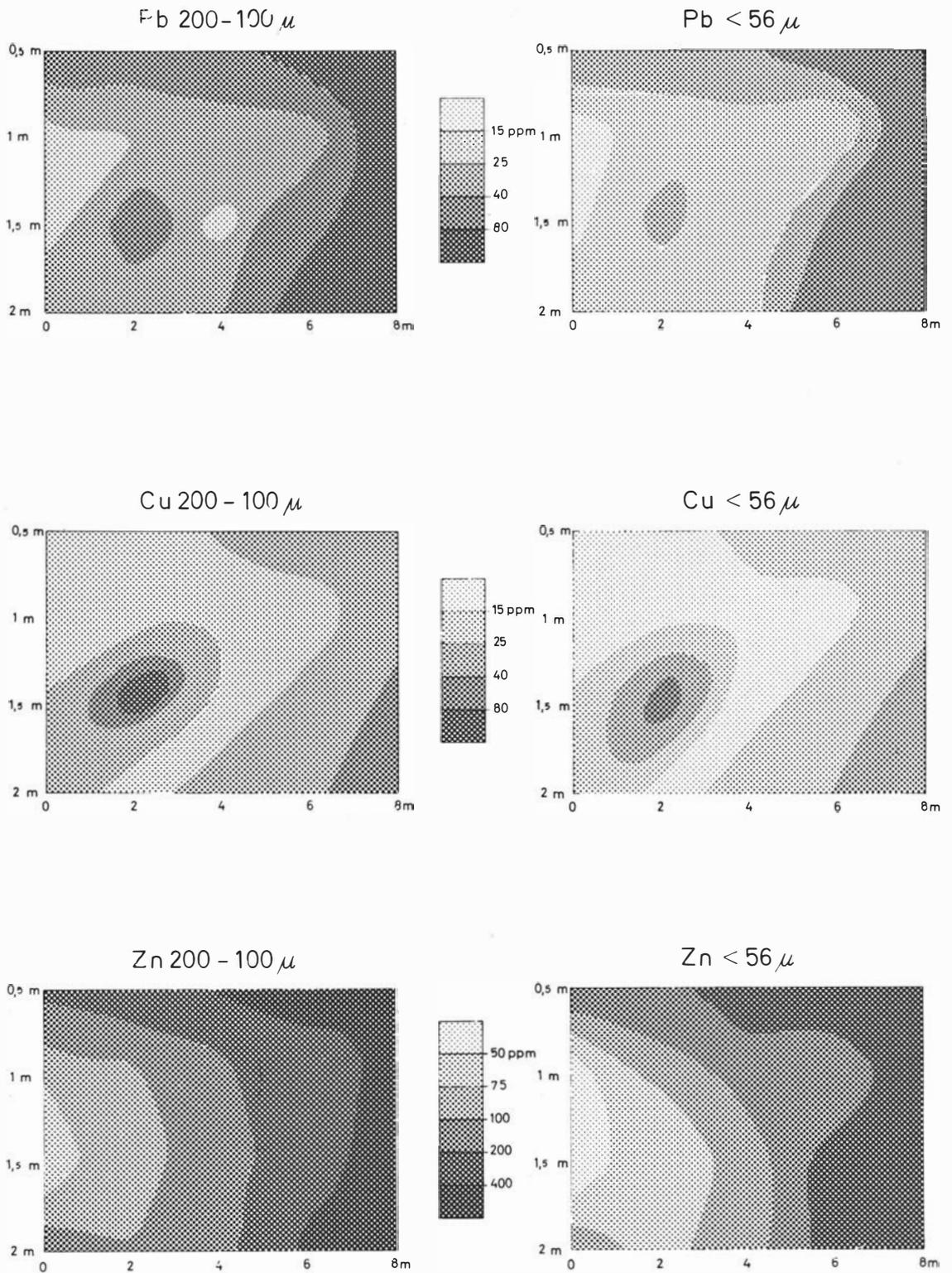


Fig. 3. The apparent distribution of Pb, Cu and Zn in a section of a boulder train in basal till. The two fractions, 200–100  $\mu$  and < 56  $\mu$ , are dry-sieved and unground.

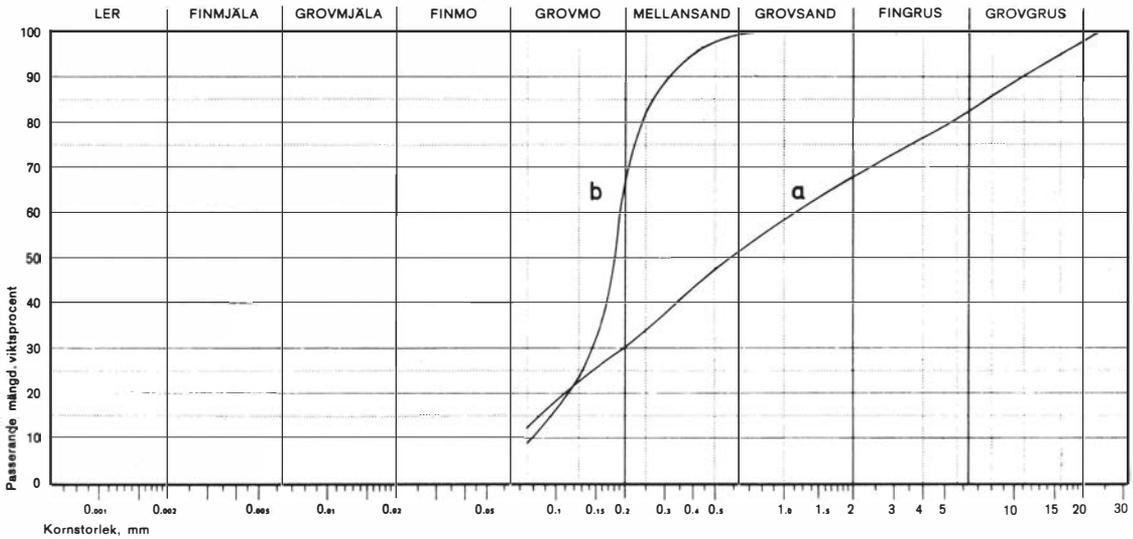


Fig. 4. Grain-size distribution in (a) till and (b) fine sand sampled above the mineralization shown in Figs. 5 and 6.

The upper diagram in Fig. 2 shows the apparent Pb content in one till sample after sieving and grinding. The tendencies are the same as in the previous example. The highest Pb values appear in the dry-sieved, unground cluster, especially in the 200–100 μ fraction. The lowest Pb values are represented in the wet-sieved and ground cluster.

The lower diagram in Fig. 2 shows another till sample, analysed for Zn. The same features appear in this diagram with the maximum value in the same fraction as in the upper diagram. Another characteristic feature in both diagrams is the high apparent metal content in the unground, wet-sieved, < 56-μ fraction. The high apparent metal content in this fraction is probably due to the wet-sieving method. The easily soluble metal

ions covering coarser particles have been dissolved in water during the sieving and have then been concentrated by evaporation in the finest fraction, < 56 μ.

The next example is taken from an investigation made in connection with a small boulder train situated in central Sweden. The ore boulders contain Pb, Cu and Zn and are deposited in basal till. The till is about 15 m thick. Several ore boulders could be seen, both on the surface of the till and in the walls of the pit, which was 2 m deep. The mother lode is assumed to be situated about 3 km to the north against the direction of the ice movement, where there are magnetic indications. Fig. 3 shows the distribution of metals in two dry-sieved fractions in a 2-m-deep cross-section of the uppermost part of the till layer. The pit was dug at right angles to the

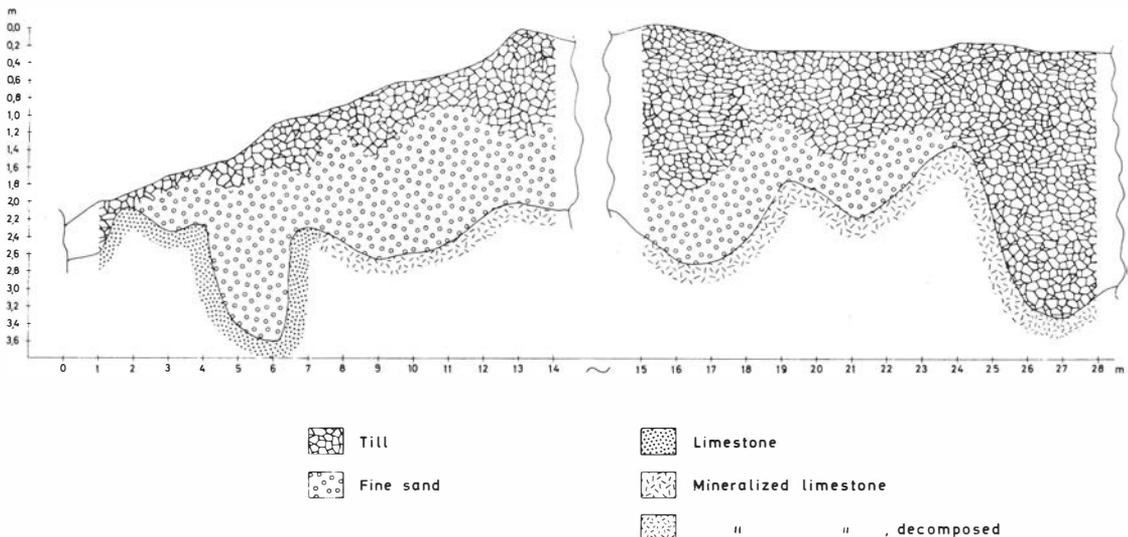
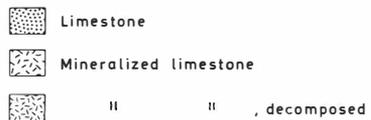
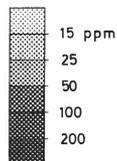
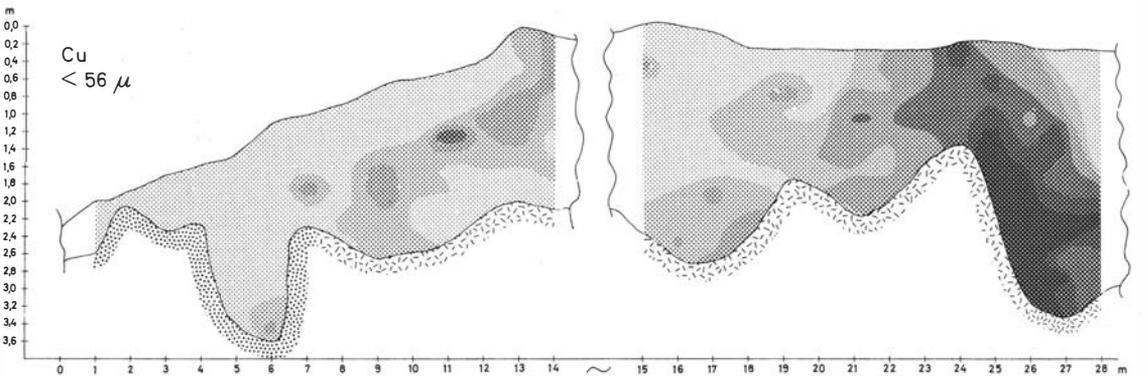
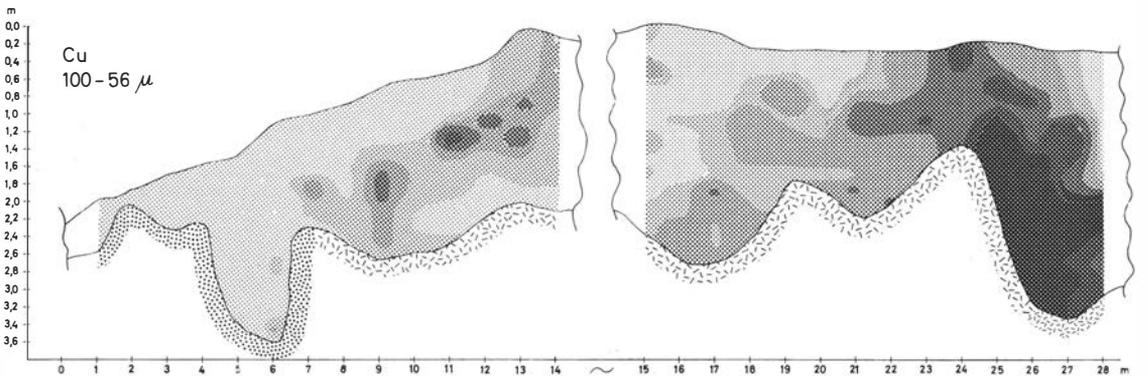
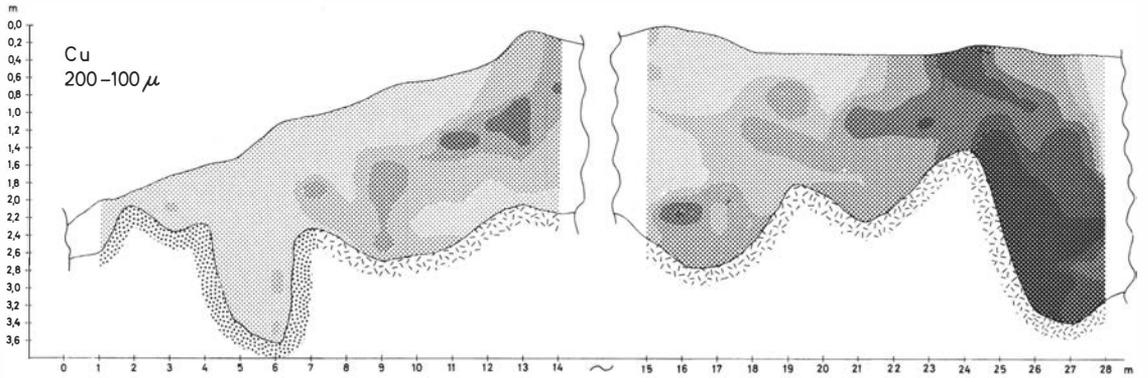
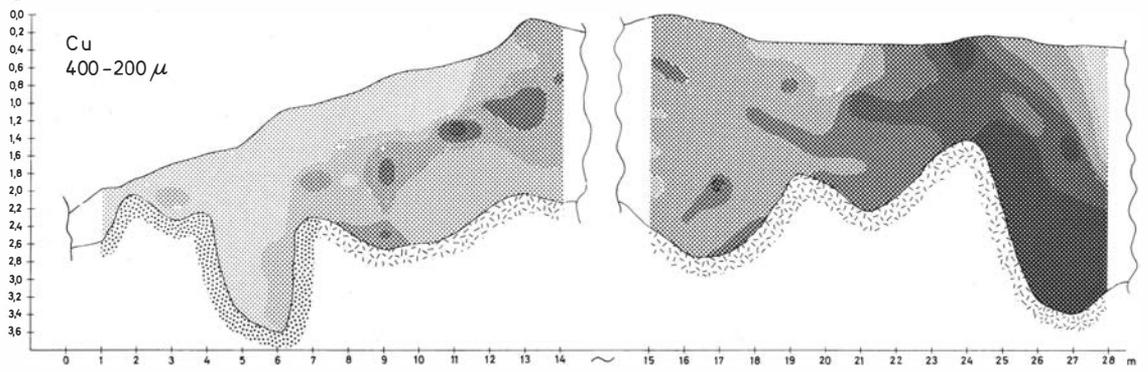


Fig. 5. Section through drift on a partly mineralized limestone.



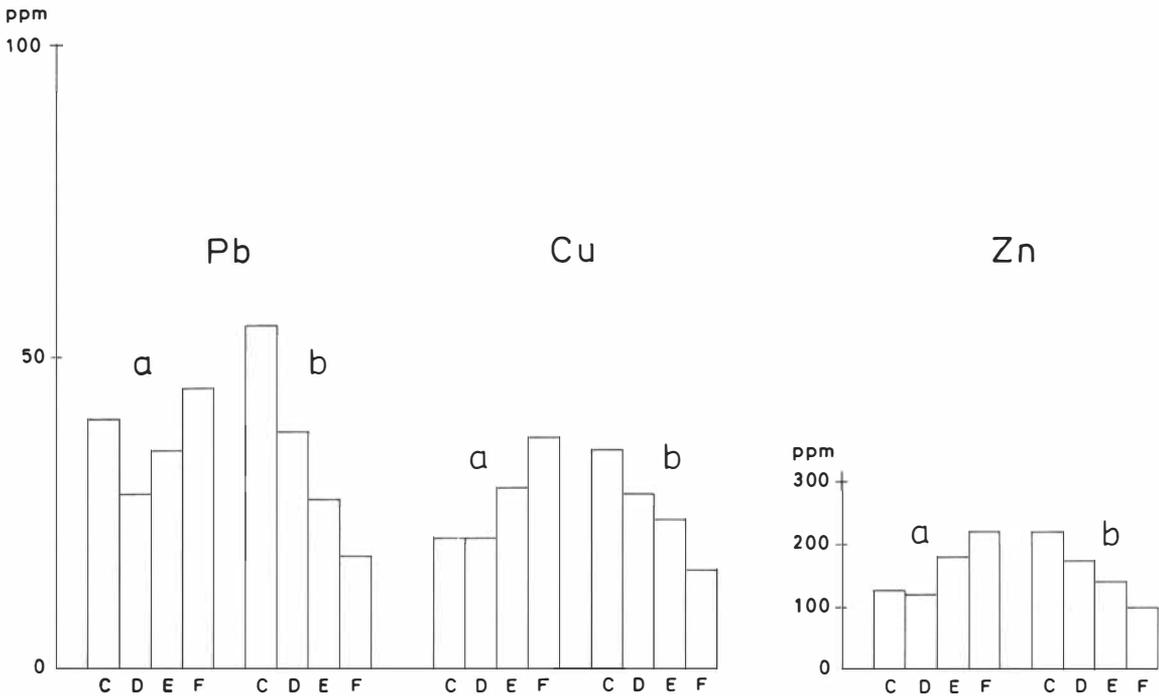


Fig. 7. The apparent and real Pb, Cu and Zn contents of one till sample of the dry-sieved, unground fractions C, D, E and F (see Fig. 2). The values in diagrams *a* have been determined by chemical analysis and in diagrams *b* by the tape method.

ice-movement direction and the right-hand side of the cross-section of the pit is situated in the centre of the boulder train. The horizontal distance between the samples taken was 2 m and the vertical distance 0.5 m. As can be seen from the diagrams, the apparent metal content distributions in the two fractions (200–100  $\mu$  and < 56  $\mu$ ) are similar. The only difference is the level of the values. Pb, Cu and Zn reach higher values in the 200–100- $\mu$  fraction than in the < 56 $\mu$  fraction.

The next examples shows the distribution of Cu in a drift just above a mineralization. This prospecting project, situated in central Sweden, followed the discovery of ore boulders consisting of limestone with impregnations of Cu, Pb and Zn sulphides. The mother lode was found by digging and carrying out geochemical investigations. A pit, dug at right angles to the strike and also roughly at right angles to the ice-movement direction, was sampled horizontally at 1-m intervals and vertically at 0.2-m intervals. The drift is composed partly of fine sand and partly of till (Figs. 4 and 5). The area is situated close to glaciofluvial deposits and below the highest shore-line. As can be

seen from Fig. 6, the highest apparent Cu values appear in the till to the right of the pit, while the lowest values appear in the fine sand to the left. This distribution is similar in all the four fractions shown, though, as in the previous examples, the highest values appear in coarser fractions.

Apparently the underlying bedrock does not influence the sediment lying upon it to any great extent. Though the Cu content of the impregnated limestones was rather high, the Cu content of the samples taken at the bottom of the pit on the surface of the impregnation is quite low in the fine sand. This fact indicates that there has been no diffusion from the mineralized bedrock into the sediment (cf. Kauranne, 1959, and Dreimanis, 1960).

The results reported above have indicated that the finest fractions (< 56  $\mu$ ) give the lowest apparent metal values when the samples are only dry-sieved and run by the tape technique (cf. Hyvärinen, 1967, and Kauranne, 1967). As a complementary investigation, the real metal content in the different fractions of some samples has been determined by chemical analysis. Fig. 7 shows

Fig. 6. The apparent distribution of Cu in four, dry-sieved, unground fractions of drift on a partly mineralized limestone.

one of these determinations. Compared to the sample analysed by the tape method, the result is exactly the opposite. Thus the highest real metal content appears in the  $< 56 \mu$  fraction.

### CONCLUSIONS

As the investigations are not yet complete, no definitive conclusion can be drawn from the results obtained. The systematic difference between the results obtained by the chemical and spectrographic methods may be due to different ways of defining the proportions. At present it can only be established that for practical prospecting purposes the finest fraction ( $< 56 \mu$ ) is not the most suitable, if the tape method is used. On the contrary, it seems to be more convenient to use a somewhat coarser fraction,  $400\text{--}200 \mu$  or  $200\text{--}100 \mu$ , as the total variation will be wider.

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