Armor Coats, Inverse Grading, and Streambed Scour in Selected Streams of Southern Ontario and Western New York

by

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ABSTRACT

Surface size analyses of Twenty and Sixteen Mile Creeks, the Grand and Genesee Rivers and Cazenovia Creek show three distinct types of bed-surface sediment: 1) a "continuous" armor coat which has a mean size of -6.5 phi and coarser, 2) a "discontinuous" armor coat which has a mean size of approximately -6.0 phi and 3) a bed with no armor coat which has a mean surface size of -5.0 phi and finer. The continuous armor coat completely covers and protects the subsurface from the flow. The discontinuous armor coat is composed of intermittently-spaced surface clasts, which provide the subsurface with only limited protection from the flow. The bed with no armor coat allows complete exposure of the subsurface to the flow.

The subsurface beneath the continuous armor coats of Twenty and Sixteen Mile Creeks is possibly modified by a "vertical winnowing" process when the armor coat is penetrated. This process results in a well-developed inversely graded sediment sequence.

Vertical winnowing is reduced beneath the discontinuous armor coats of the Grand and Genesee Rivers. The reduction of vertical winnowing results in a more poorly-developed inverse grading than that found in Twenty and Sixteen Mile Creeks. The streambed of Cazenovia Creek normally is not armored resulting in a homogeneous subsurface which shows no modification by vertical winnowing. This streambed forms during waning or moderate flows, suggesting it does not represent the maximum competence of the stream.

Each population of grains in the subsurface layers of Twenty and Sixteen Mile Creeks has been modified by vertical winnowing and does not represent a mode of transport. Each population in the subsurface layers beneath a discontinuous armor coat may partially reflect a transport mode. These layers are still inversely graded suggesting that each population is affected to some degree by vertical winnowing. The populations for sediment beneath a surface which is not armored are probably indicative of transport modes because such sediment has not been modified by vertical winnowing.

Bed photographs taken in each of the five streams before and after the 1982-83 snow-melt show that the probability of movement for the surface clasts is a

function of grain size. The greatest probability of of clast movement and scour depth of this study were recorded on Cazenovia Creek in areas where no armor coat is present. The scour depth in the armored beds of Twenty and Sixteen Mile Creeks is related to the probability of movement for a given mean surface size.

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INTRODUCTION

Present Study

The purpose of this research was to study the relation between the armor coat, subsurface sediment and streambed scour. The relation between the armor coat and subsurface sediment was studied by comparing size distributions of the surface and subsurface sediment in five different streams. The relation between the armor coat and streambed scour was studied by comparing surface clast movement with the data obtained from scour gauges. This surface clast movement is measured by comparing streambed photographs taken before and after the 1982-83 snow-melt. The average bottom shear stress is calculated for the maximum instantaneous flow of this melt at three stations on Twenty Mile Creek. The average bottom shear stress at each of these stations was calculated and compared to the size distribution of the transported clasts at each station.

Location of Study Areas

The streams of this study are Twenty Mile Creek at Jordan, Ontario, Sixteen Mile Creek located approximately 5 km west of St. Catharines, Ontario, the Grand River at Brantford, Ontario, Cazenovia Creek at Ebenezer, New York, and the Genesee River at

Portageville, New York (figure 1). The positions of scour gauges and photographs on each stream are given in figures 2 to 6.

PHYSIOGRAPHY and BEDROCK GEOLOGY

Twenty and Sixteen Mile Creeks

Twenty Mile Creek originates approximately 7 km south of Hamilton, Ontario, and flows east parallel with the Niagara Escarpment. At the Balls' Falls Conservation Area, Twenty Mile Creek turns northward, and flows over the Lockport, Irondequoit and Whirlpool water-falls. Between Balls' Falls and Highway 8, Twenty Mile Creek cuts a steep, narrow gorge through the Niagara Escarpment. Downstream of Highway 8, the creek has developed open meanders with a lower bank height and a wider cross-section than in the gorge. Twenty Mile Creek then empties into a drowned lagoon near Lake Ontario.

Sixteen Mile Creek originates approximately 4 km south of Smithville, Ontario, and flows east parallel to Twenty Mile Creek. Sixteen Mile Creek eventually turns northward, and cuts a smaller gorge than that of Twenty Mile Creek. Near the Canadian National Railway, Sixteen Mile Creek empties into a drowned lagoon similar to that of Twenty Mile Creek.

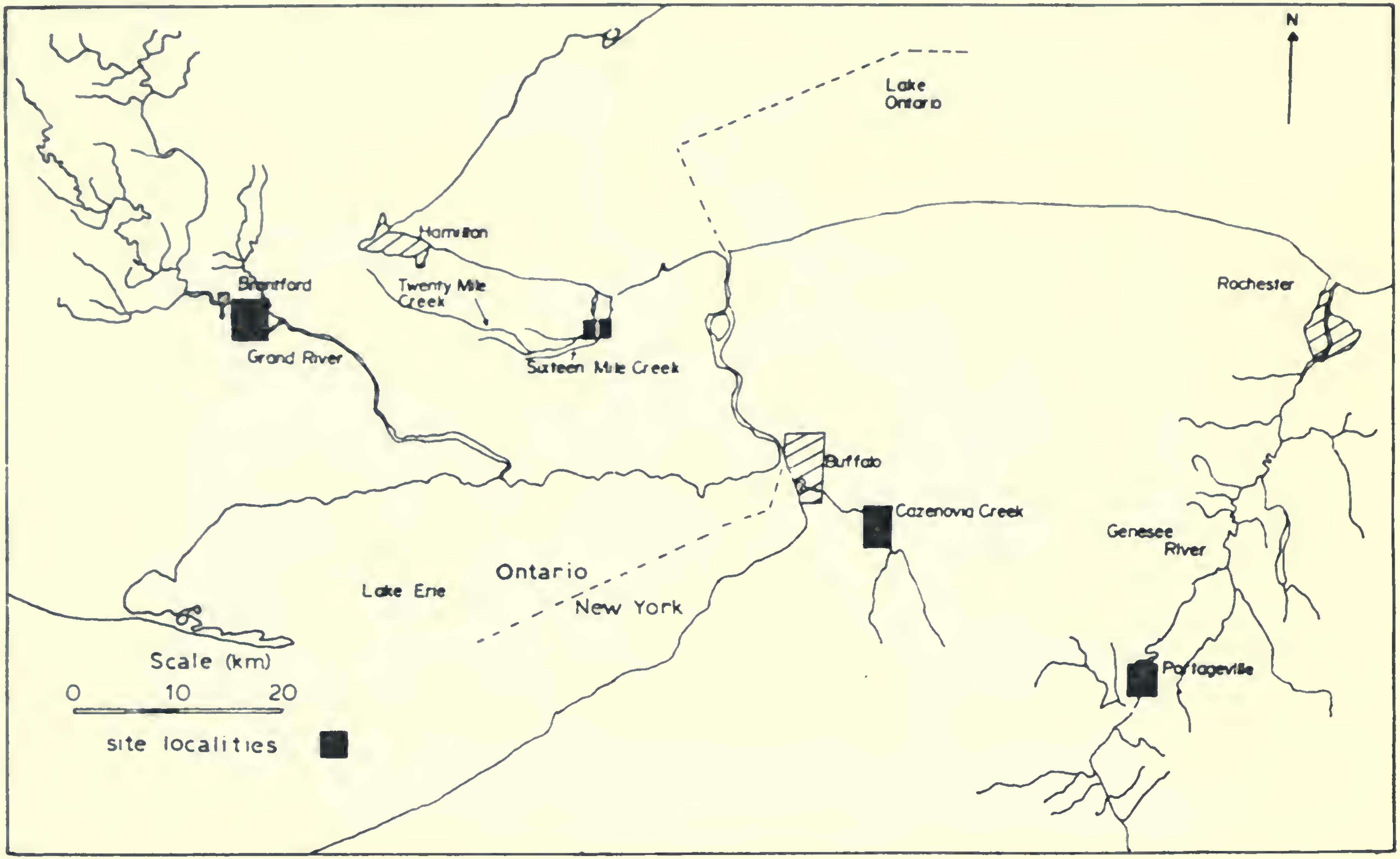

Figure 1. Study Locations

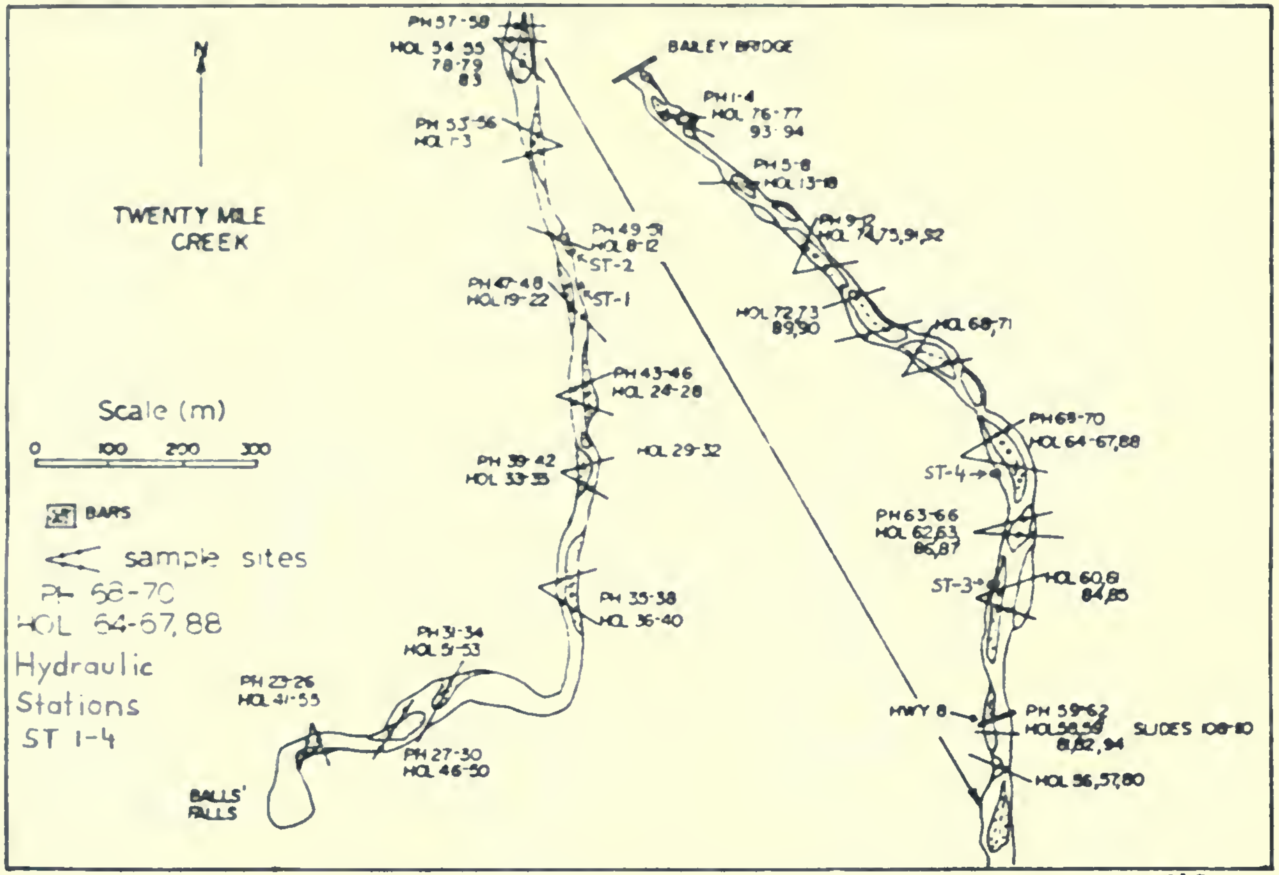

Figure 2. Scour gauges and photograph locations for Twenty Mile Creek. HOL=Scour Gauge on Twenty Mile Creek, PH=Photograph. (The base map was provided by J.J. Flint, Brock University).

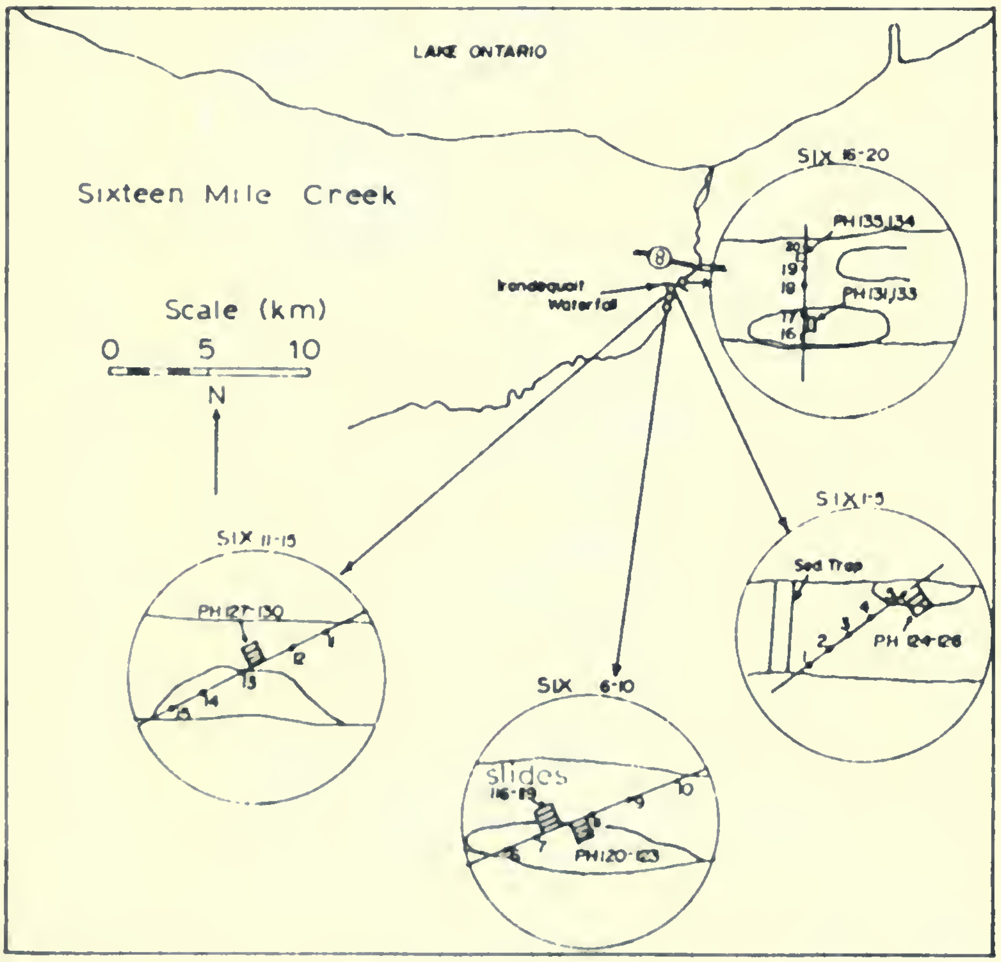

Figure 3. Scour gauges and photograph locations for Sixteen Mile Creek. Six=Scour gauge on Sixteen Mile Creek, PH=Photograph. (Base map after Rickard and Fisher 1970).

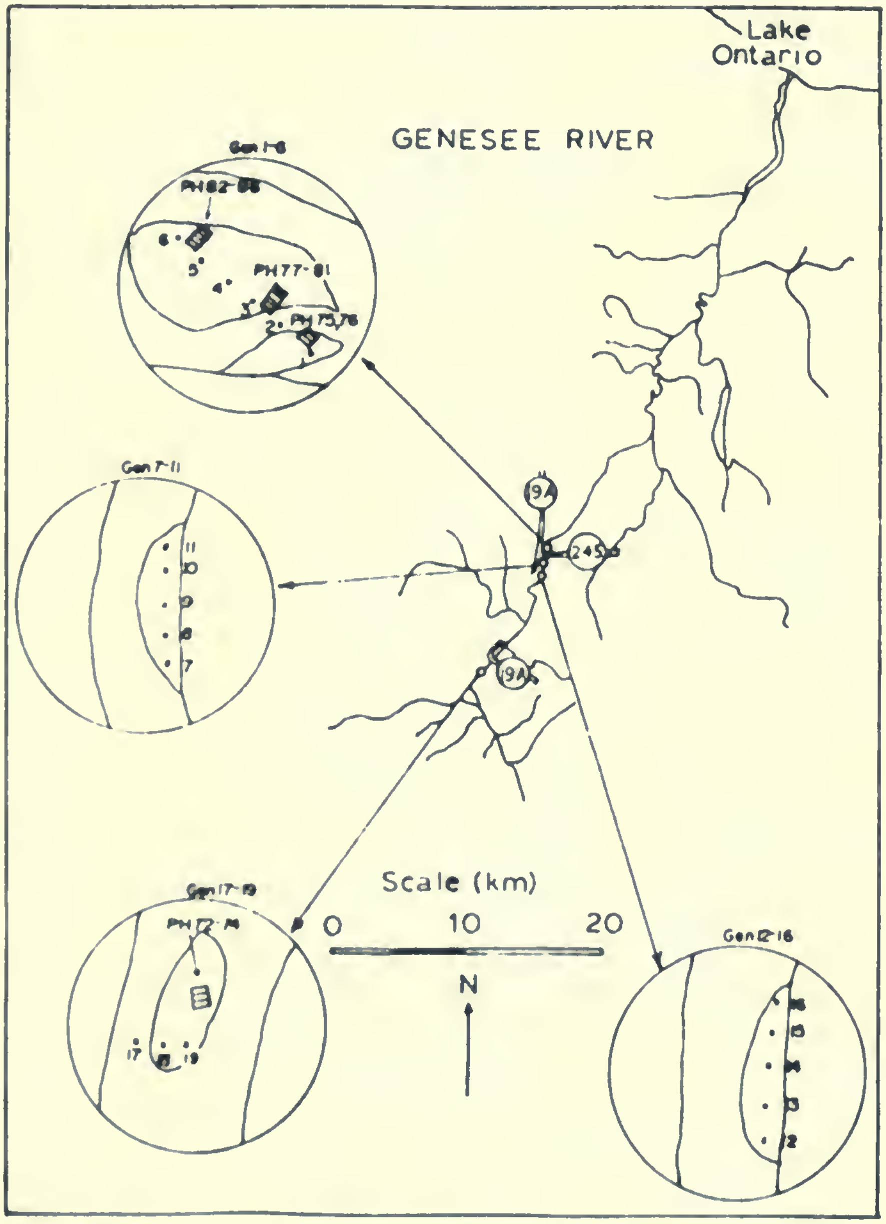

Figure 4. Scour gauges and photograph locations for the Genesee River. GEN=Scour gauge on the Genesee River, PH=Photograph. (Base map is the Physical Map of New York State, United States Coast and Geodetic Survey).

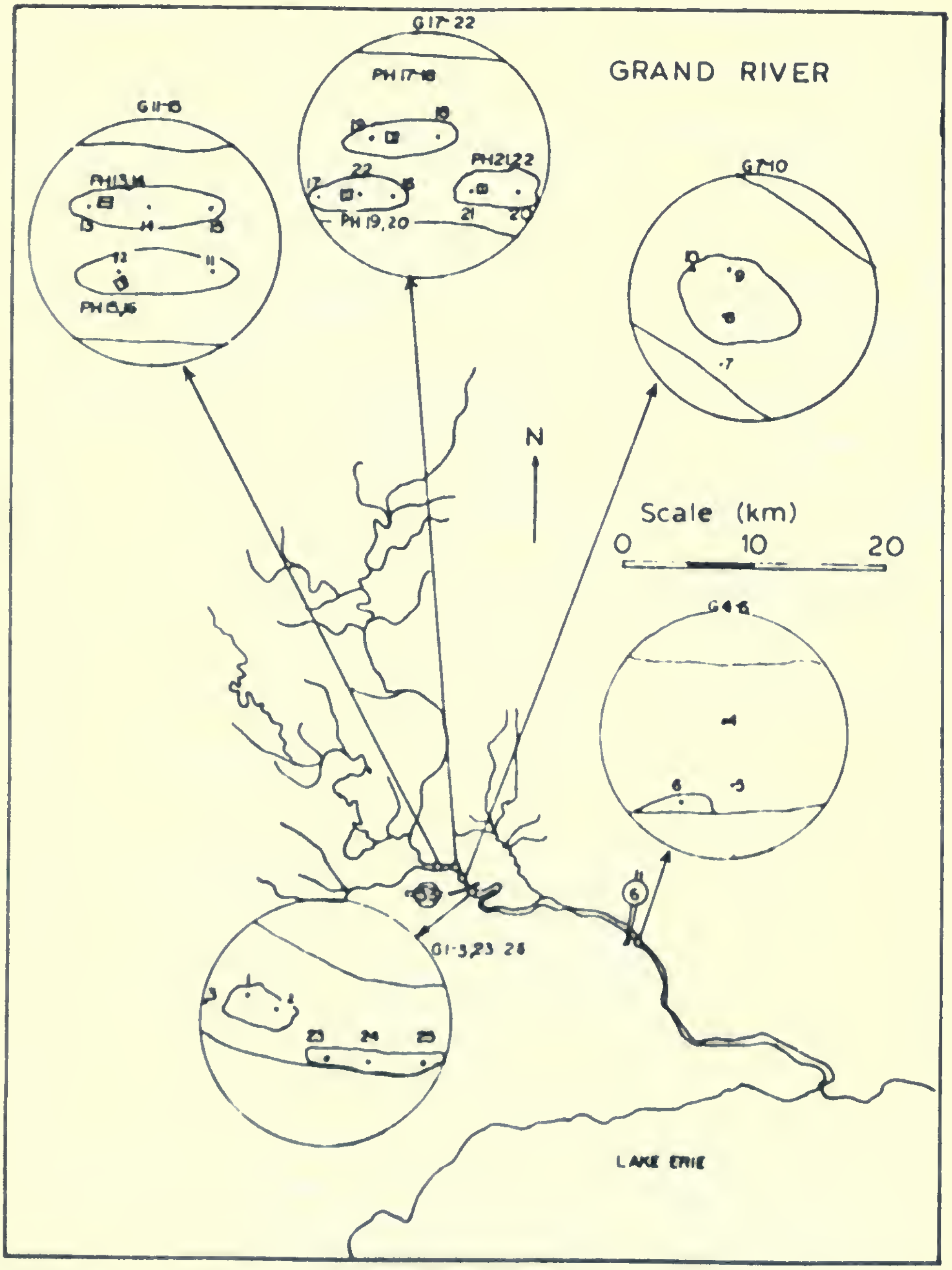

Figure 5. Scour gauges and photograph locations for the Grand River. G=Scour gauge on the Grand River, PH= Photograph. (Base map is the Physical Map of New York State. United States Coast and Geodetic Survey).

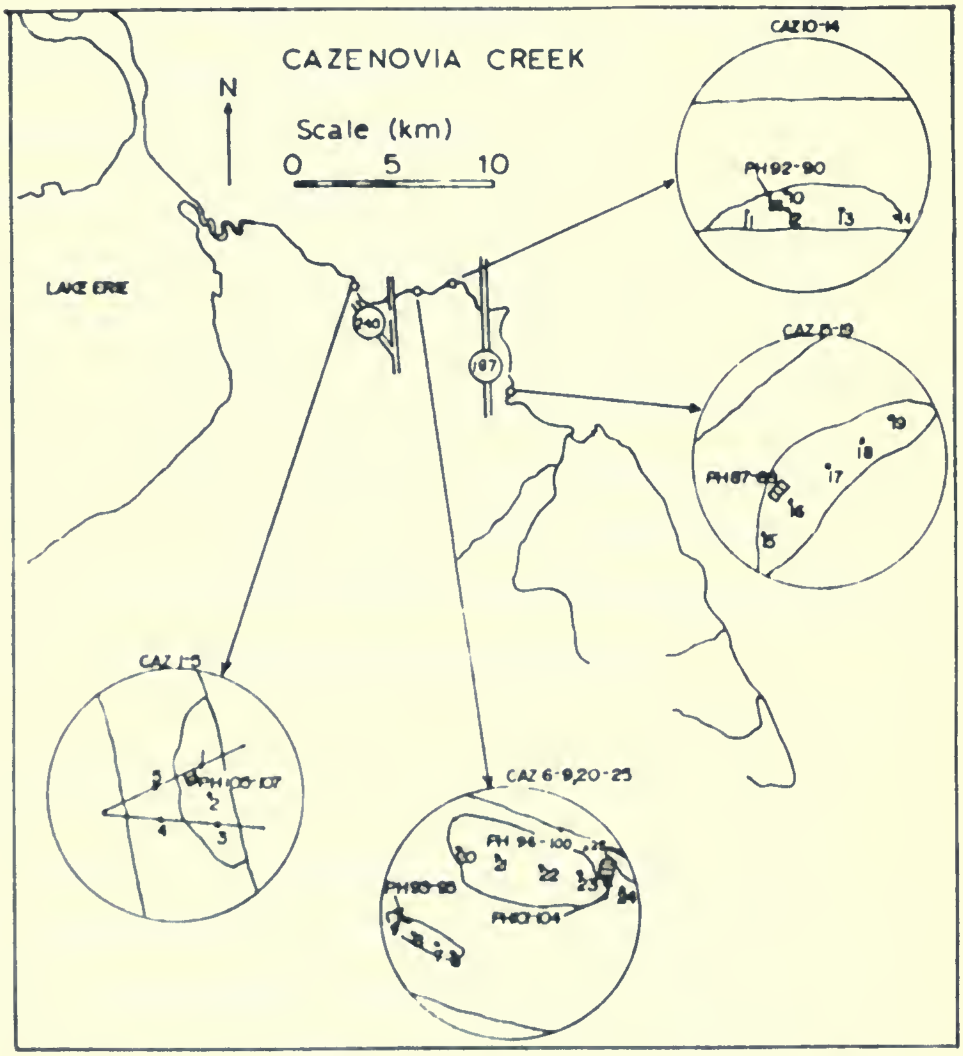

Figure 6. Scour gauges and photograph locations for Cazenovia Creek. CAZ=Scour gauge on Cazenovia Creek, PH=Photograph. (Base map is after Rickard and Fisher 1970).

The sediment in Twenty and Sixteen Mile Creeks is derived mainly from the Niagara Escarpment (Fisher 1978). The dominant lithologies present in both creeks are the dolostones from the Lockport Dolostone (34 m thick); the limestones and shales of the Clinton Group (36 m thick) and the sandstones and shale of the Cataract Group (approximately 35 m thick). Sediment is also derived from the Queenston Shale. Approximately 31 m of this lithology is exposed in the Niagara Peninsula. The stratigraphy of the Niagara Escarpment is outlined by Sanford and others (1972). Downstream from Highway 8, both creeks cut through glacial Lake Iroquois sediment and the Halton Till (Feenstra 1972). In addition, minor amounts of sediment downstream of Highway 8 on Twenty Mile Creek are derived from previous stream terraces.

The Grand River

The Grand River originates in central southern Ontario, approximately 40 km south of Georgian Bay. It flows south, and empties into Lake Erie at Dunnville, Ontario. In the study area at Brantford, Ontario, the dominant bedrock formation is the Salina Dolostone which is approximately 92 m thick (Sanford 1969). Sediment is partially derived from this lithology but the main sources of stream sediment are glaciofluvial outwash gravels, the Wentworth, Port Stanley, Catfish,

and Canning Tills, the sediments of proglacial Lakes Warren and Whittlesey and the sand and gravel from the fluvial deposits comprising the modern flood plain (Cowan 1972).

The Genesee River

The Genesee River originates approximately 28 km south of Wellsville, New York, along the New York-Pennsylvania border, and flows across New York State before emptying into Lake Ontario at Rochester, New York. The Genesee River flows through the Glaciated Southern New York Subprovince and the Lake Ontario Plain (Muller and others 1976). Several dams are present on the Genesee River for both flood control and hydro-electric power.

The sediment in the study area at Portageville, New York is mainly shale with some sandstone derived from the Java Group which ranges in thickness from 30 to 60 m and the West Falls Group which ranges in thickness from 120 to 190 m (Rickard and Fisher 1970). Sediment is also derived from a moderately stony till of Port Huron age, previous fluvial terraces and glaciolacustrine clay (Muller and others 1976).

Cazenovia Creek

Cazenovia Creek originates in Erie County approximately 32 km south of East Aurora, New York. It flows to the northwest, and empties into the Buffalo River at Buffalo, New York.

The sediment in the study area is mainly shale with minor amounts of siltstone and limestone derived from the Hamilton Group which ranges in thickness from 60 to 150 m,the Genesee Group which ranges in thickness from 3 to 45 m, the Sonyea Group which ranges in thickness from 15 to 60 m, and the West Falls Group which ranges in thickness from 120 to 290 m (Rickard and Fisher 1970). In addition, a minor amount of sediment is derived from the Kent, Lavery and Hiram Tills and the deposits of proglacial Lakes Warren and Whittlesey. The glacial history of this area was described by Calkin and others (1980).

PREVIOUS WORK

Streambed Armoring

When a sediment mixture is exposed to a flow, the finest particles on the surface are entrained leaving the coarsest grains behind as a lag deposit. This lag is called an "armor coat" or "pavement" (Parker and Klingeman 1982) because it is a coarse surface layer

that protects the finer subsurface from the flow. Therefore, armor sediment is the end product of the selective removal of small particles from a bed surface.

Gessler (1965), Little and Mayer (1976), Gard and others (1977) , Parker and Klingeman (1982), Parker and others (1982), Parker, Klingeman and McLean (1982), Raudkivi and Ettema (1982) have simulated the armoring process in flume experiments using a known sediment distribution which was then exposed to a given flow.

Gessler (1965) indicated that the size distribution of the armor coat is determined by stochastic turbulence. He calculated the probability of each grain size remaining stationary. He also describes four methods by which this probability could be determined using an experimental starting sediment mixture, the eroded sediment and the resulting armor coat. Gessler showed that the probability of a given grain remaining stationary is a function of how often the critical shear stress of the grain is not exceeded by the bottom instantaneous shear stress.

Little and Mayer (1976) also describe the armoring process as stochastic and as the result of a distribution of turbulence acting on a given size

distribution. Based on flume experiments, they relate the ratio of the mean diameter (mm) of the starting experimental sediment and the mean diameter (mm) of the resulting armor coat to shear velocity. They show that as the shear velocity over an experimental size distribution is increased, the armor sediment coarsens. This coarsening continues until the flow reaches a shear velocity that is capable of entraining the coarsest sediment in the flume destroying the armor coat. Just before this destruction occurs, all of the fines are removed and therefore, the armor coat is composed of the largest size present in the original distribution. This size represents the largest clast capable of armoring the surface for a given size distribution. This suggests that the shear velocity controls the largest size present in a given armor coat for a given size distribution.

Gessler (1965), Little and Mayer (1975), Garde and others (1977), Parker and others (1982) and Raudkivi and Ettema (1982) further indicate that an armor coat forms fairly quickly after the initial sediment mixture is exposed to the flow. Further coarsening of the armor is a slow process (Garde and others 1977). However, results given by Parker and Klingeman (1982) show that when a clast of the armor coat is mobilized, the exposed subsurface grains are

also transported. In flume experiments by Parker, Klingeman and McLean (1982), small cobbles and granules were transported together, and were observed to interchange positions with particles of the armor coat.

Parker and others (1982) conducted flume experiments where sediment was continually fed in and transported over a bed which was already armored. Fines from the feed were deposited in openings left by grains of the armor coat which were entrained. This fine sediment then became immobile if another armor clast was deposited above it. Although the exact size range of these fines was not given, these experiments show that fine material in transport may be deposited in the openings left by entrained clasts of the armor coat.

Interpretation of Size Distribution Curves

A given sand-size distribution may be composed of three populations (Tanner 1964, Visher 1969, Middleton 1976, Sagoe and Visher 1977 and Bridge 1981). Each population is represented on a cumulative curve as a straight-line segment, and has been shown by Middleton (1976) to be indicative of sediment moved by a different transport mode. Three transport modes are associated with a given size distribution: 1) the

coarsest grains are transported by traction, 2) the intermediate grains by intermittent suspension, and 3) the finest grains by suspension. The "breaks" or changes of slope in the cumulative curve are interpreted as points where the sediment is changing from one transport mode to another. However, Visher (1969) and Sagoe and Visher (1977) indicate that these "breaks" represent a truncation of one subpopulation and the beginning of another, while Spencer (1964), Tanner (1964) and Middleton and Southard (1977) suggest that "breaks" represent the overlap of one subpopulation with another.

Middleton (1976) and Bridge (1981) point out that individual grains of a given size may travel in more than one transport mode depending on the fluctuating shear stress. This suggests that "break" positions may be variable and perhaps, may reflect overlapping of populations. One important implication of the coarse/intermediate "break" as noted by Middleton (1976) and Bridge (1981) is that it defines the largest particle size that can be transported by intermittent suspension. Bridge (1981) indicates that the intermediate/fine "break" defines the largest size which can be held in suspension by the maximum fluctuation of bed shear velocity. He also states that armoring and grain packing change the behavior of particles. An armor coat protects the subsurface,

making it inaccessible to the flow except when a surface armor clast is mobilized. Tight packing of small particles between larger clasts and imbrication will cause grains to remain immobile at much higher shear stresses than would be necessary if they were lying separately on the bed. In addition, bed load measurements for sizes coarser than -5.0 phi are difficult to obtain in the field. Consequently, the transport modes for these sizes are not well-known. Therefore, cumulative distributions of the armor coat may not show the same populations and "breaks" as sand-size sediment.

Causes of Inverse Grading in Streams

Inverse grading as described by Maude and Whitmore (1956), Segre' and Silberberg (1961), and Naylor (1980) is explained in terms of processes which apply only to debris flows and therefore, may not apply to the stream environment.

Middleton (1970) proposed a mechanism called kinetic sieving. In this process, fine particles pass through the interstices between large grains which are agitated. In the stream environment this agitation may be caused by a bottom shear stress which is very close to, but not greater than the critical value for movement of a clast on the bed-surface. The

fine particles may filter down between the vibrating coarser grains, and accumulate as the bottom-most sediments. This mechanism for inverse grading has been demonstrated only for sand-size sediment (Naylor 1980).

Bagnold (1954) found that a dispersive pressure occurs on grains that are present in a fluid undergoing shear. He found that this pressure increases with the size of the grains which are present in the fluid. It is postulated that if a mixed distribution of clasts is transported, the largest clasts would move to the area of least shearing. This area is the surface of the sediment in transport. The dispersive pressure theory has been suggested as the cause of some inverse grading in streams (Scott and Gravlee 1968 and Leopold and others 1964).

Milhouse (1973) described a mechanism called "vertical winnowing" in a stream with a gravel bottom. Parker and Klingeman (1982) described this process as involving the removal of surface clasts, which causes a "gap" in the armor coat. Therefore, the first layer beneath the armor coat is exposed to the flow when a clast of the armor coat is entrained. Small particles in the gap may be partially protected by flow separation (Middleton and Southard 1977)

caused by the surrounding immobile armor clasts. Because of the fluctuating nature of turbulence, it is possible to have simultaneous deposition of clasts with different sizes into the gap during a turbulence low. These clasts would remain immobile if they are large enough to withstand future turbulent eddies that enter the gap.

The clasts deposited into the bottom of the gap may have a lower probability of being further eroded. Of these clasts, only the finest particles would be winnowed out. As the bed is rebuilt by continued deposition, the probability of erosion for all sizes deposited in the gap may increase because the bed is getting closer to the main flow. The next layer deposited is winnowed of larger sizes than the one below. Once the subsurface is fully rebuilt, the probability of erosion on the bed may be high enough to prevent further deposition of any clasts which are finer than those of the armor coat. Once a clast of the armor coat is permanently in place, vertical winnowing of the subsurface is terminated. This process would occur only during high flows because it requires penetration of the armored surface.

Vertical winnowing requires that the bed shear stress increases from the bottom to the top of the subsurface as it is rebuilt. Fenton and Abbott (1977)

conducted flume experiments relating particle exposure to incipient particle motion. The bed of their flume was composed of 2.5 mm particles that were glued in place. A test grain of this same size was placed over a hole which was drilled through the bottom of the flume. A threaded rod was slowly screwed upwards through this hole, pushing the test grain towards the top of the bed. When this test grain was entrained, the level of the top of the rod was measured to an arbitrary point. The top of the rod was used to determine how far the particle was protruding into the flow. This procedure was repeated twenty times for a given flow to determine the minimum protrusion necessary to entrain the particle. The critical shear stress of the test grain decreased thirty-fold from the bottom to the top of the bed-surface. Although only a single size was used, this study shows that the shear stress acting on a given grain increases as the grain is moved closer to the main flow.

Scour

Studies of scour and fill are normally conducted for rivers that transport just sand and gravel. Most of these works are undertaken by engineers who are concerned with undercutting of obstacles such as spur dikes, levees and bridge pillars (Garde and others

1961). Ashmore and Parker (1983) modelled scouring in a flume, and obtained results suggesting that scour tends to be greatest in well-sorted sand for a given flow. The flume study of scour around spur dikes by Garde and others (1961) shows that the maximum scour depth depends on the Froude number and the size of the bed sediment. These experiments pertain only to uniform sand-size material. Therefore, it is doubtful that these data apply to streams with an armor coat. Baumann (1962) studied scour in a mountain stream consisting of boulders, and found that maximum scour occurred when discharges were rising. Scott (1969) and Leopold and others (1964) indicated that scour usually occurs during rising stages, and fill normally occurs during receding flows. However, they also note that a large debris load introduced during rising stages may cause deposition instead of scour.

Scour Below an Armor Coat

Scour in the subsurface beneath an armor coat requires that the armor is penetrated. This means that the critical shear stress of armor coat clasts must be exceeded by the instantaneous shear stress on the bed. Penetration of the armor coat and subsequent scour of the subsurface should be related to the distribution of bottom shear stress.

Because the movement of surface clasts can be influenced by imbrication, packing (Bridge 1981), and exposure to the flow (Einstein 1950, Fenton and Abbot 1977, Andrews 1983), it is apparent that scour depth may be dependent on these same factors. In addition, scour depth can be influenced by the size and packing of the subsurface material, and by the size of the surface clasts surrounding the scour pit. Large clasts in the subsurface and packing of small clasts can also prevent excessive scour of subsurface grains.

Raudkivi and Ettema (1982) conducted experiments in a flume with a bed composed of 5.35 mm particles surrounded by 1.9 mm grains. They indicate that the scour of this bed is caused by the winnowing of the 1.9 mm grains, and is not related to the transport of the 5.35 mm grains. Therefore, scour of a discontinuous armor coat may be related to the removal of the fine grains rather than the transport of large clasts on the bed.

METHODS

Field Methods Using Streambed Photographs

The use of streambed photographs to measure sediment movement in this study was suggested by

Jean-Jacques Flint of Brock University.

A metal rectangle with dimensions 0.76 by 1.37 m was made by welding iron rods. This rectangle was placed on the streambed and provided the scale for all photographs. A number was placed in a corner, and the area within the rectangle was photographed. Metal pegs were put into both banks of the stream, and a tape measure was tied to each peg. The distance from one peg to the corner of the photograph was recorded on a rough field map of the local stream area. The long side of the rectangle was always parallel with the tape, therefore only one point was needed to locate each photograph. This measurement was used the following year to photograph the same bed area. For the Grand and Genesee Rivers, where the tape could not reach across, the photograph position was determined by triangulation.

A total of 204 photographs were taken of the bed in all five streams from the top of a stepladder. This method minimized the amount of distortion in each photograph.

Photographs of each site were taken before and after the 1982-83 snow-melt. By comparing the two photographs, it was possible to measure the movement of armor coat clasts during the 1982-83 melt. Clasts

of the armor coat photographed before this melt were not sieved in the field for fear of disturbing the bed and causing unnatural clast movement. Clasts photographed after the snow-melt were sieved in the field, and their sizes were recorded on an overlay for size analysis. Clasts of the armor coat within the rectangle and lying 50 percent within the border were sieved. If more than 50 percent of the clast was either lying outside the area or buried in the subsurface it was excluded. The smallest size sieved was -5.0 phi. Clasts were sieved in the field using a half-phi interval. This field sieving measures the intermediate clast diameter. Only the number frequency of each size was recorded. These frequencies were converted to weights using an exponential relation between phi size and weight based 2771 weighed particles. The correlation coefficient for this relation is -0.996. Most of the data used for this relation was obtained on Twenty Mile Creek by J. J. Flint and B. Edgar in 1980. The regression was calculated using a Fortran program written by J.J.Flint.

The sizes of armor coat clasts not sieved in the field were estimated directly from photographs. This estimate was obtained by comparing the clasts which were not sieved with those which were already sieved in the field. Photographs were printed so as to make

the rectangle identical for each photograph. This was necessary to accurately determine grain size. The size analysis estimated from photographs was not compared with the size analysis from sieving the same areas in the field. Therefore, it is not known if these two methods are comparable.

The sieved clasts in each photograph were labelled to record whether or not the clasts moved or remained stationary. It should be noted that occasional difficulties arose with this method. In the case where a large clast moved in and completely covered the space previously occupied by a smaller clast, it was difficult to determine if the smaller clast has been moved out unless the larger clast was lifted. This was not done during field work. Similarly, in the case where the area was once occupied by a very large clast and was later occupied by a smaller clast, it was sometimes difficult to determine if the smaller clast was actually moved into the area or was merely uncovered. In both cases the clasts of questionable origin were excluded from the size analysis. It is emphasized that these cases did not occur often. When 100 percent of the clasts in both the "before and after" photographs were different, it is not known if the clasts presently occupying the area were actually moved in or were

uncovered. If these clasts were moved in, they either replaced or completely covered the previous clasts. Therefore, photographs with 100 percent movement are of little use.

The percent probability of movement for a given size was determined from each photograph by the following method: if three clasts of -7.0 phi were initially present on the bed, and one of these clasts was transported out of the area, then the percent probability of movement for grains of -7.0 phi is 33.33 percent. Therefore, each grain size is represented by a single probability value for each photograph. This method is similar to that used by Gessler (1965).

Scour Gauges and Sampling

The United States Army Corps of Engineers in Los Angeles (1972) has measured maximum streambed scour by using scour gauges which consist of auger drilled pits filled with painted gravel. Similar gauges were installed for this study.

Scour gauges consist of a hand-dug pit in the streambed. Pits were dug as deep as possible, and ranged from approximately 45 to 82 cm deep. The excavated pit was approximately 30 cm in diameter. An aluminum casing of approximately 14 cm in diameter was

placed into the pit, and excavated material was placed around the outside of the casing. Blue-painted, 6 mm gravel was placed into the casing which was then slowly pulled out allowing the gravel to fill any open spaces in the subsurface. The elevation of the blue gravel with respect to a peg on the bank was obtained using a surveying level. The original clasts of the armor coat were then replaced. In the summer following the 1982-83 snow-melt, each pit was relocated and carefully re-excavated to the new surface of the blue gravel. This new elevation was surveyed with respect to the same peg installed the previous year. The scour depth was determined by subtracting the new elevation of gravel from the old one. The location of each scour gauge was determined in the same manner as that of the photographs.

It should be noted that excavation of the bed disturbs the packing of subsurface grains, and can result in excessive local scour. This is most important on Twenty and Sixteen Mile Creeks, where subsurface packing is greatest. This fact was realized before excavation began and therefore, the diameter of the excavated pit was kept constant. Also the excavated material was replaced in the same order in which it was removed, and packed down with a shovel. It is recognized however, that this

"artificial" packing cannot reinstate the subsurface to its original condition and therefore, excessive scour may have occurred.

Samples of the subsurface below the armor coat were obtained when the scour gauges were excavated. The armor coat was removed, and a sample was taken each time a different subsurface layer was encountered. Thickness and depth of each sediment layer were also recorded. Clasts greater than -6.0 phi encountered in the subsurface were not included in the subsurface size analysis because removal of these sizes required re-excavation resulting in a pit larger than 30 cm in diameter. Therefore, subsurface sampling is biased toward sizes smaller than -6.0 phi. A total of 216 samples were used for subsurface size analysis. Approximately 120 of these samples came from Twenty Mile Creek.

Laboratory Methods

Subsurface samples from all five creeks and surface samples from Cazenovia Creek were brought back to the laboratory for size analysis. The total weight of each sample varied from 2.0 to 3.5 kg. The samples were wet sieved using a -1.0 and +4.0 phi mesh. The fraction coarser than +4.0 phi was then oven dried for 48 hours, and allowed to cool down to

room temperature before sieving. Sizes from -6.0 to -3.0 phi were sieved by a half-phi interval, and the remainder of the sample was sieved by a quarter-phi interval. Occasionally samples were split to obtain a workable portion. Samples were shaken for 15 minutes before weighing. The silt-clay fraction was collected during wet sieving, and then oven dried for 2 to 3 days. This fraction was then allowed to cool to room temperature before weighing. The dry silt and clay weight was added as a single unit to the total sample weight. It was not further analyzed because in most samples the silt-clay portion accounted for less than 5 percent of the total sample weight. The mean, standard deviation, skewness, and kurtosis for each sample were calculated using the method of moments outlined by Folk (1968).

DISCUSSION

Size Distributions for the Armor Coat in Different Streams

It has been noted by Gessler (1965) and Parker and Klingeman (1982) that an armor coat will form if the stream sediment contains a mixture of coarse and fine sediment. The flume study by Little and Mayer (1976) shows that increasing the shear velocity causes an increase in the size of the armor coat. Therefore, the two main parameters which cause an

armor coat are: 1) size distribution which is ultimately controlled by the sediment source, and 2) shear velocity or shear stress which is controlled by flow velocity.

The coarsest size distributions for the armor coats on bars of all five creeks are plotted in figure 7. This figure indicates that Twenty Mile Creek has the coarsest armor coat of the creeks in this study. Sixteen Mile Creek is next, followed by the Grand and Genesee Rivers, while Cazenovia Creek has the finest surface sediment.

The average size of the surface sediment on Twenty Mile Creek changes from -9.0 phi upstream near Balls' Falls to +3.0 phi near the lagoon on Lake Ontario, a distance of about 5 km (Flint and Maddalena 1984). This large size decrease over such a short distance is caused by rapid changes in the stream width and slope.

Size distributions of the armor coat for the channel and nearby bars are shown from the base of Balls' Falls (figure 8) to a site 2.5 km downstream (figure 9) on Twenty Mile Creek. The size distribution of the armor coat in the channel is coarser than that of nearby bars in both figures. This reflects the higher flow velocity in the channel for a

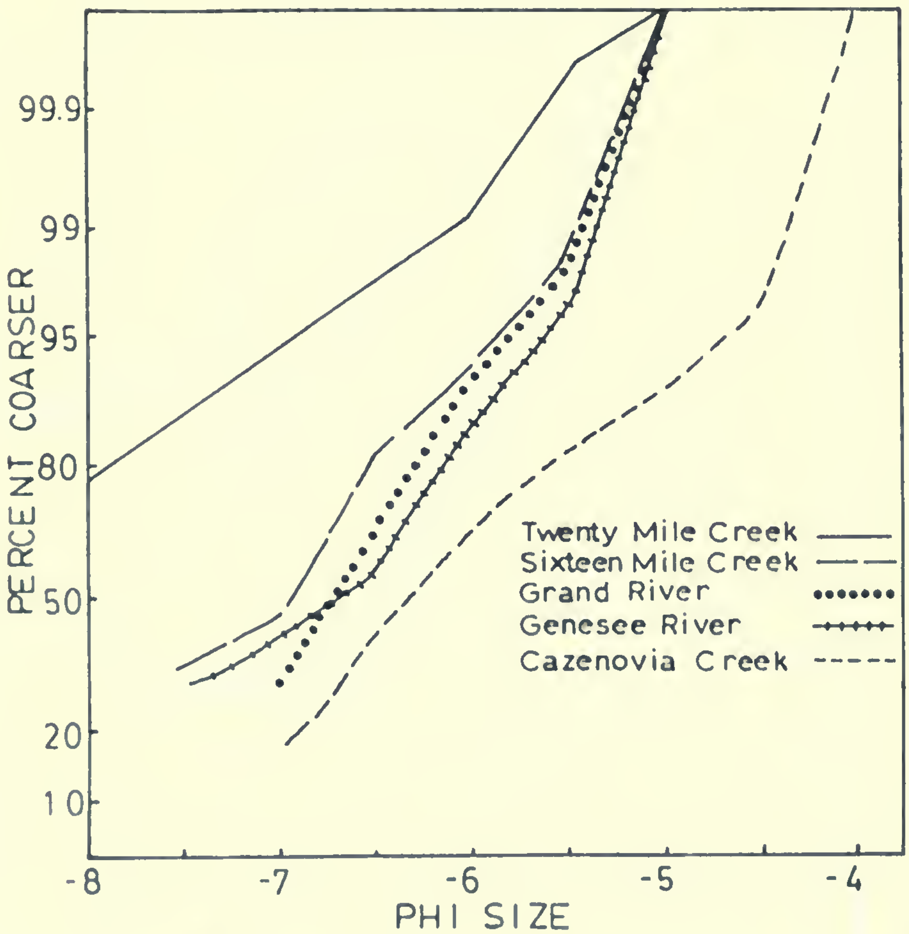

Figure 7. Armor coat size distributions for the coarsest bars present on Twenty and Sixteen Mile Creeks, the Grand and Genesee Rivers and Cazenovia Creek.

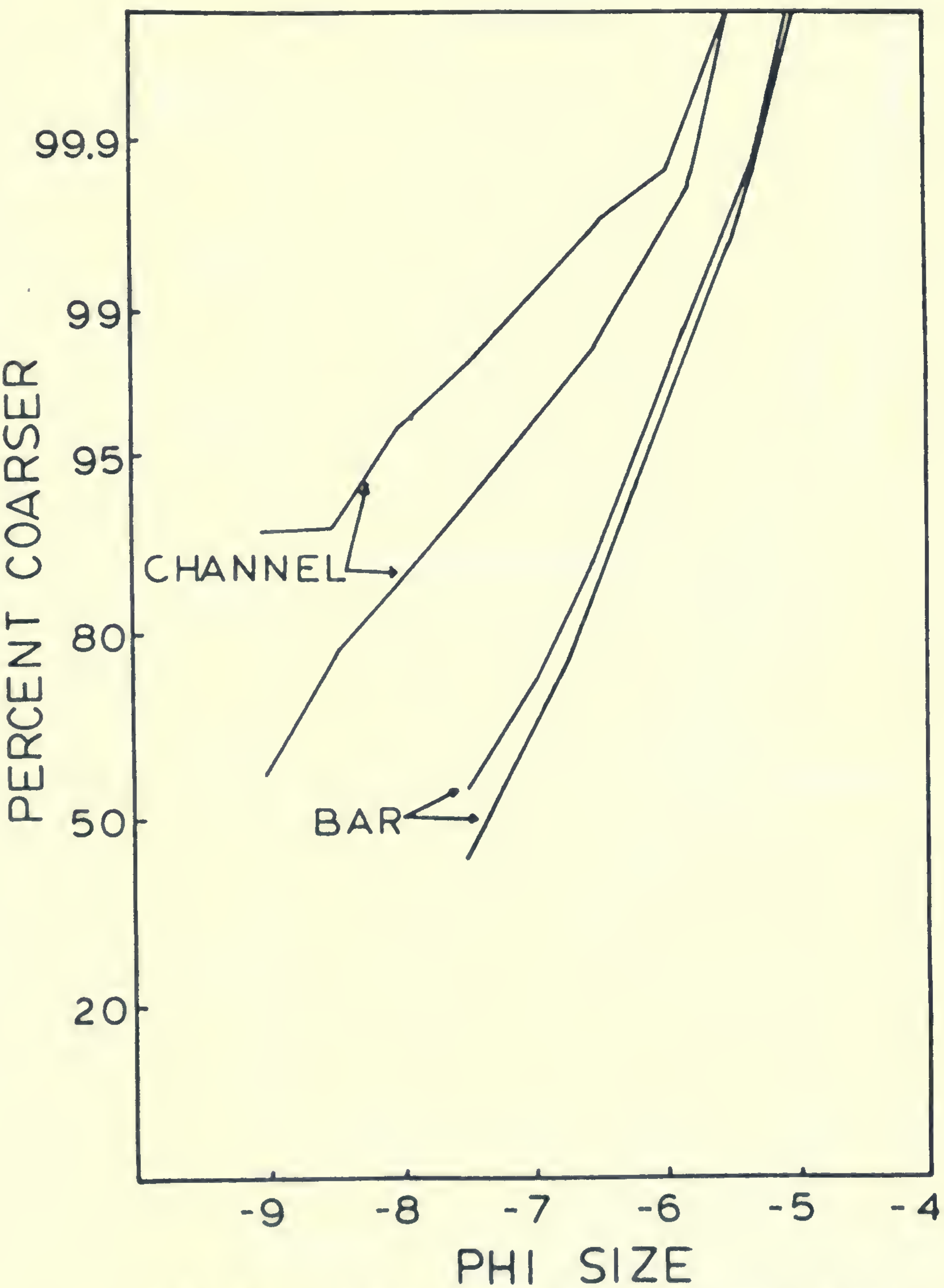

Figure 8. Armor coat size distributions for the channel and a nearby bar at the base of Balls' Falls on Twenty Mile Creek. Dataare derived from photographs 27, 28,29 and 30.

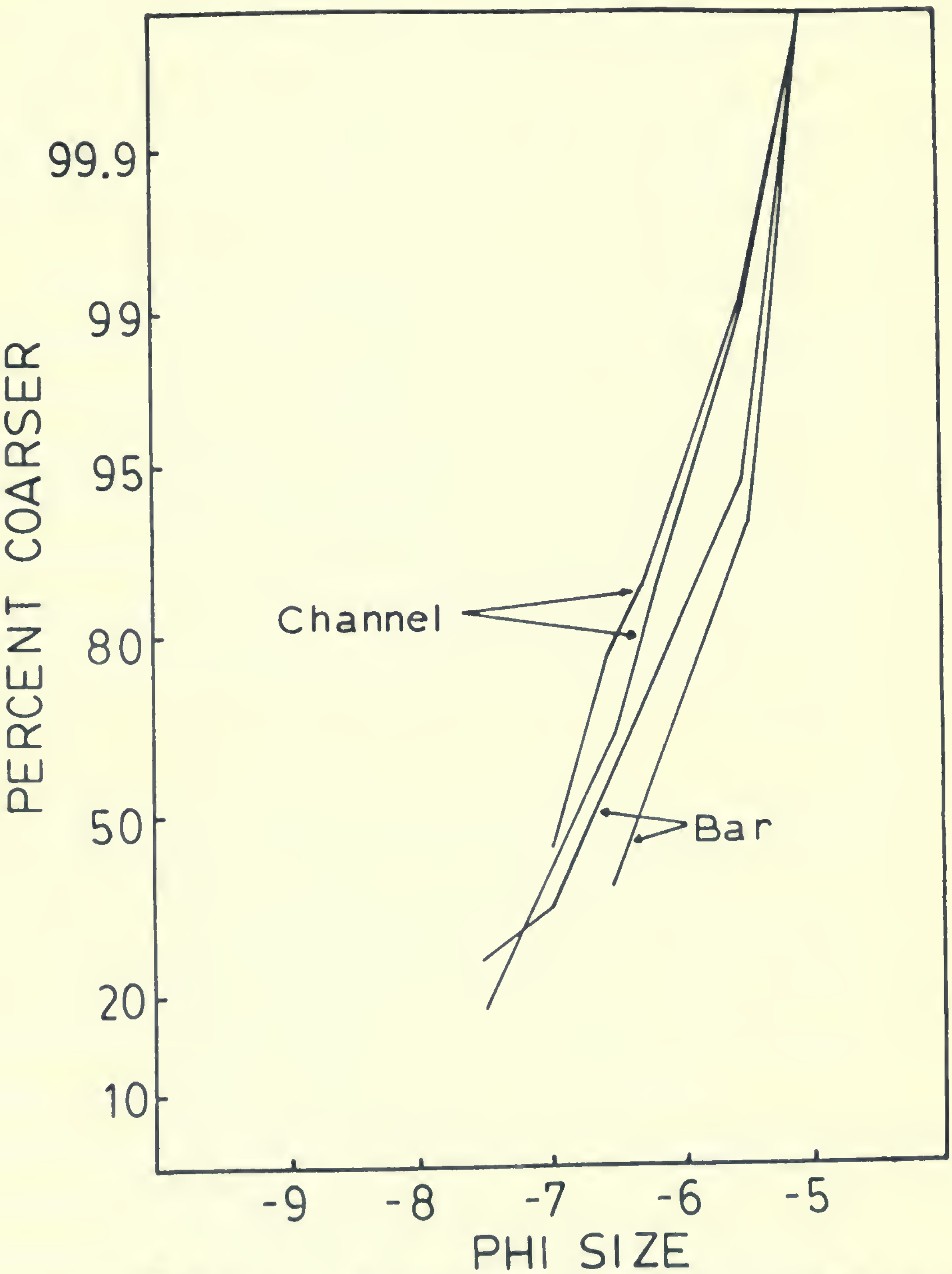

Figure 9. Armor coat size distributions for the channel and a nearby bar 2.5 kilometers downstream of Balls' Falls. Data are derived from photographs 1,2,3 and 4.

given flow. In addition, the size difference between the channel and bars is much greater in figure 8 than in figure 9. This suggests that the velocity difference between the channel and bars is probably higher in the gorge than downstream of Highway 8.

Figure 10 shows the distributions of armor sediment for the three environments at site number PH 68-70 in figure 2. The data indicate that the armor sediment is coarsest in the main channel, next coarsest is the bed of the back channel, while the armor coat of the bar is finest. The three sediment sizes for the armor coat suggest that each of these beds was deposited by a different bottom shear stress.

Sixteen Mile Creek is approximately 3 km east of Twenty Mile Creek, and also erodes through the escarpment. Therefore, both creeks have essentially the same source of sediment. However, the clast size distribution of the armor coat is different for both creeks. In figure 11, cumulative armor coat distributions are plotted for bars in the gorges of both Twenty and Sixteen Mile Creeks. The distributions for Sixteen Mile Creek are noticeably finer than those of Twenty Mile Creek. Annual discharge and perhaps flow velocity are highest on Twenty Mile Creek which has the larger lag deposit.

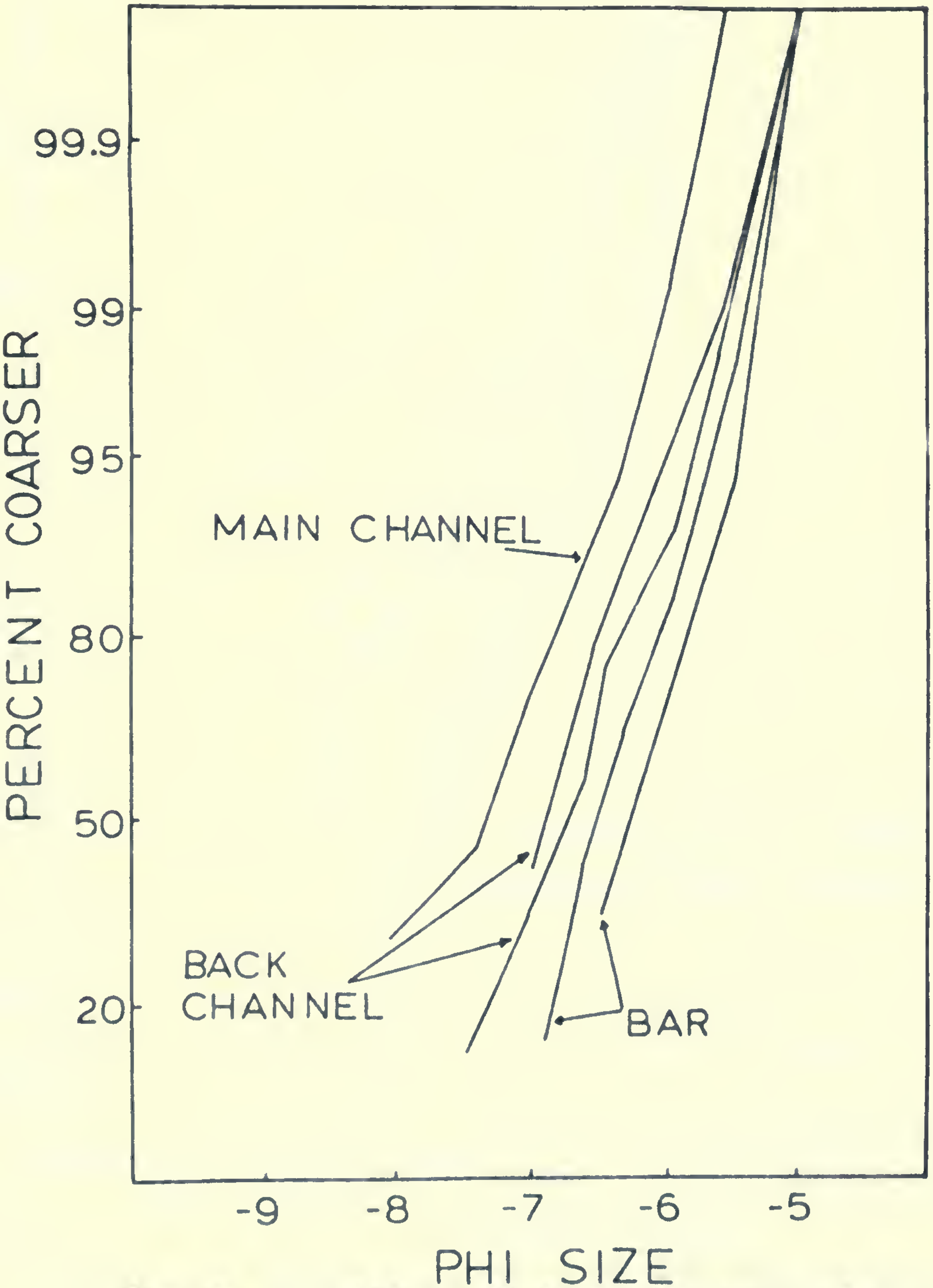

Figure 10. Armor coat size distributions for the main channel, back channel and bar downstream of Highway 8 on Twenty Mile Creek (site location PH 68-70 in figure 2).

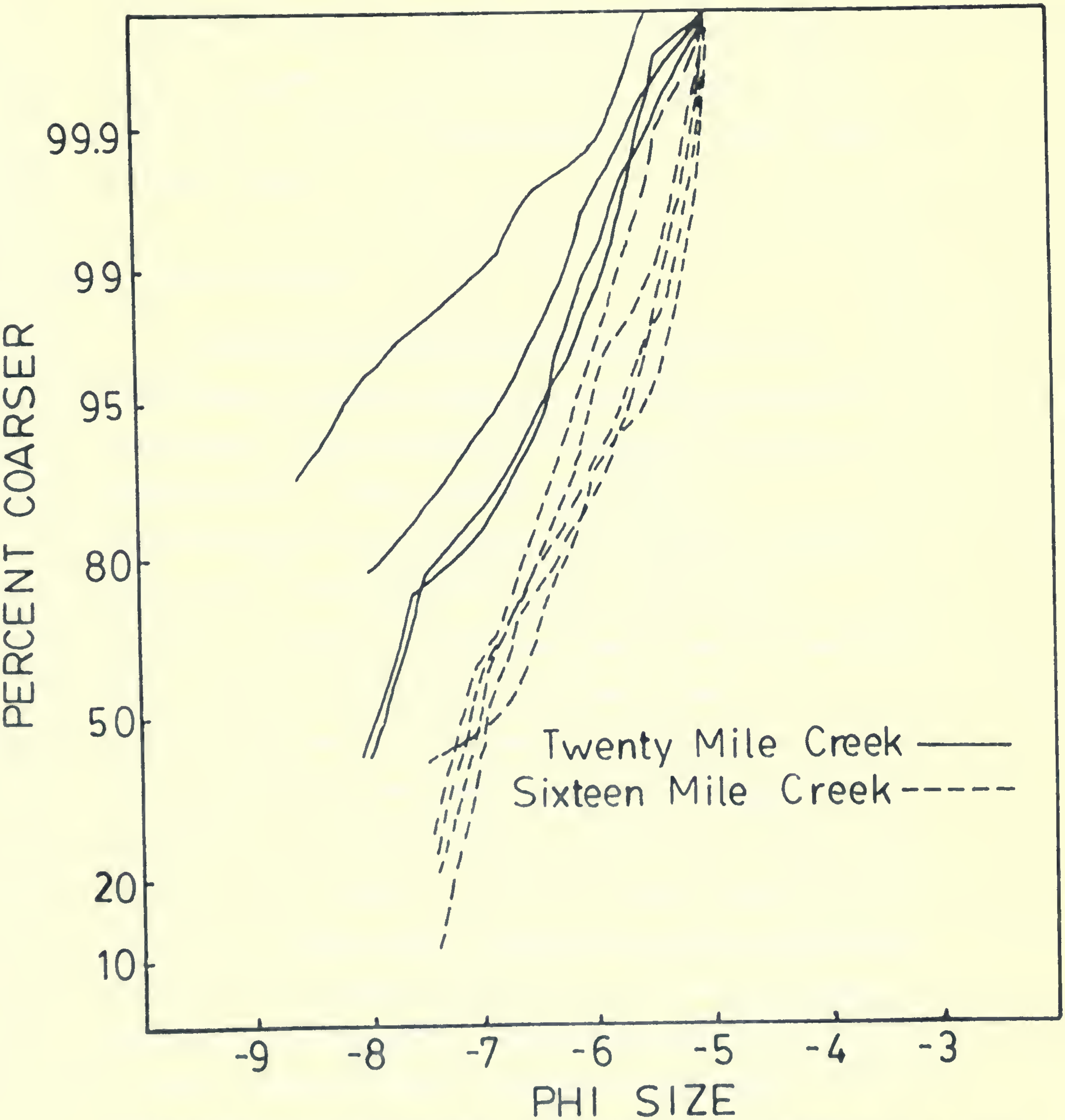

Figure 11. Armor coat size distributions for the channel in the gorges of Twenty and Sixteen Mile Creeks.

This comparison of Twenty and Sixteen Mile creeks possibly confirms the results of Little and Mayer (1976) suggesting that streams with the same source and higher shear velocities also have a larger armor sediment size.

Inverse Grading

Representative size distributions for the subsurface material on bars and in the channel of Twenty Mile Creek are shown in figures 12 and 13 respectively. These figures show that a well-developed inverse grading is present below the armor coat on Twenty Mile Creek. This grading normally consists of three sublayers: the top-sublayer lies directly beneath the armor coat, the middle-sublayer is below the top, and the bottom-sublayer lies deepest. Although sublayer thickness is variable the top-sublayer is about 3 to 4 cm thick, the middle is about 15 cm and the bottom is about 25 cm thick. The downward increase in standard deviation and decrease in kurtosis values in figures 12 and 13 indicate that sorting decreases from the top to the bottom-sublayer. A comparison of size distributions for the three sublayers indicates that the smallest proportion of coarse material is in the bottom-sublayer. The data indicate that the inverse grading is present in all environments along the

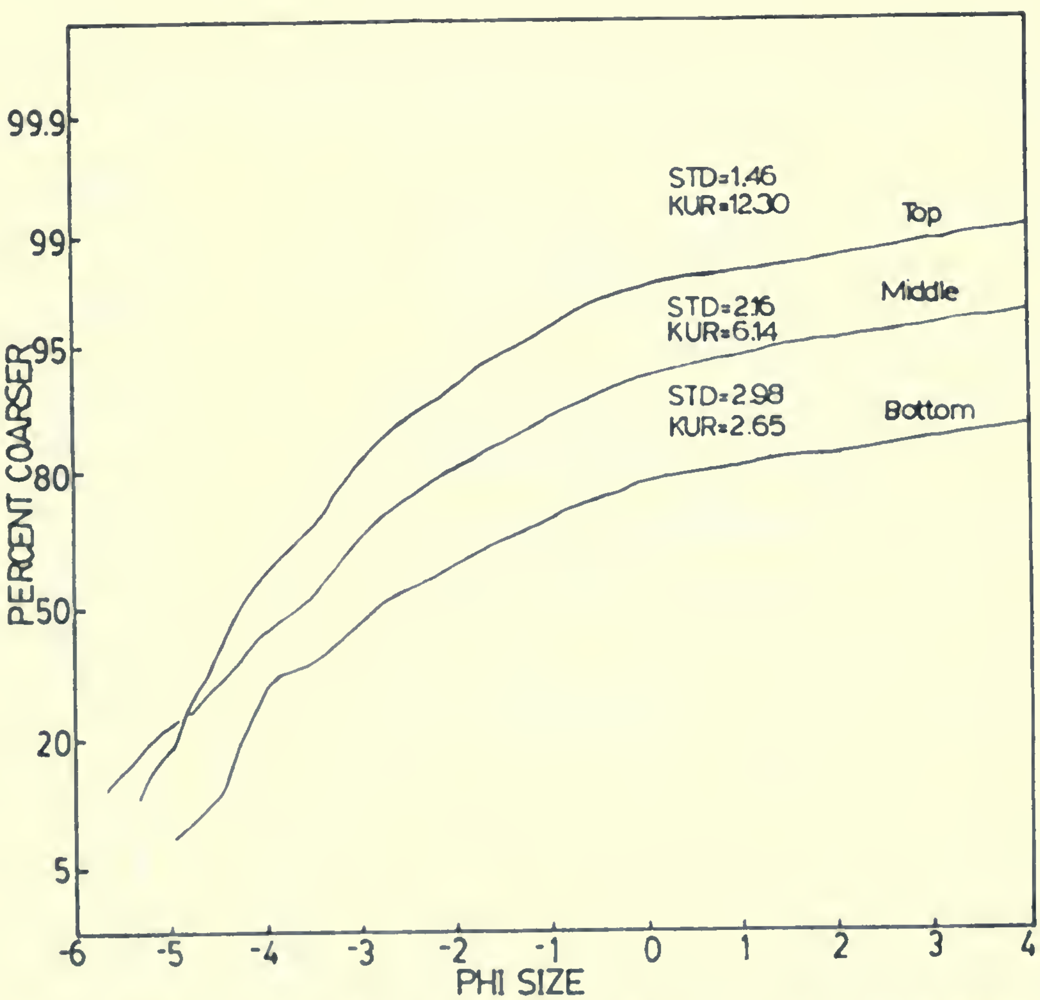

Figure 12. Size distributions for subsurface samples from bars on Twenty Mile Creek. STD= Standard Deviation, KUR=Kurtosis. Sample HOL 19.

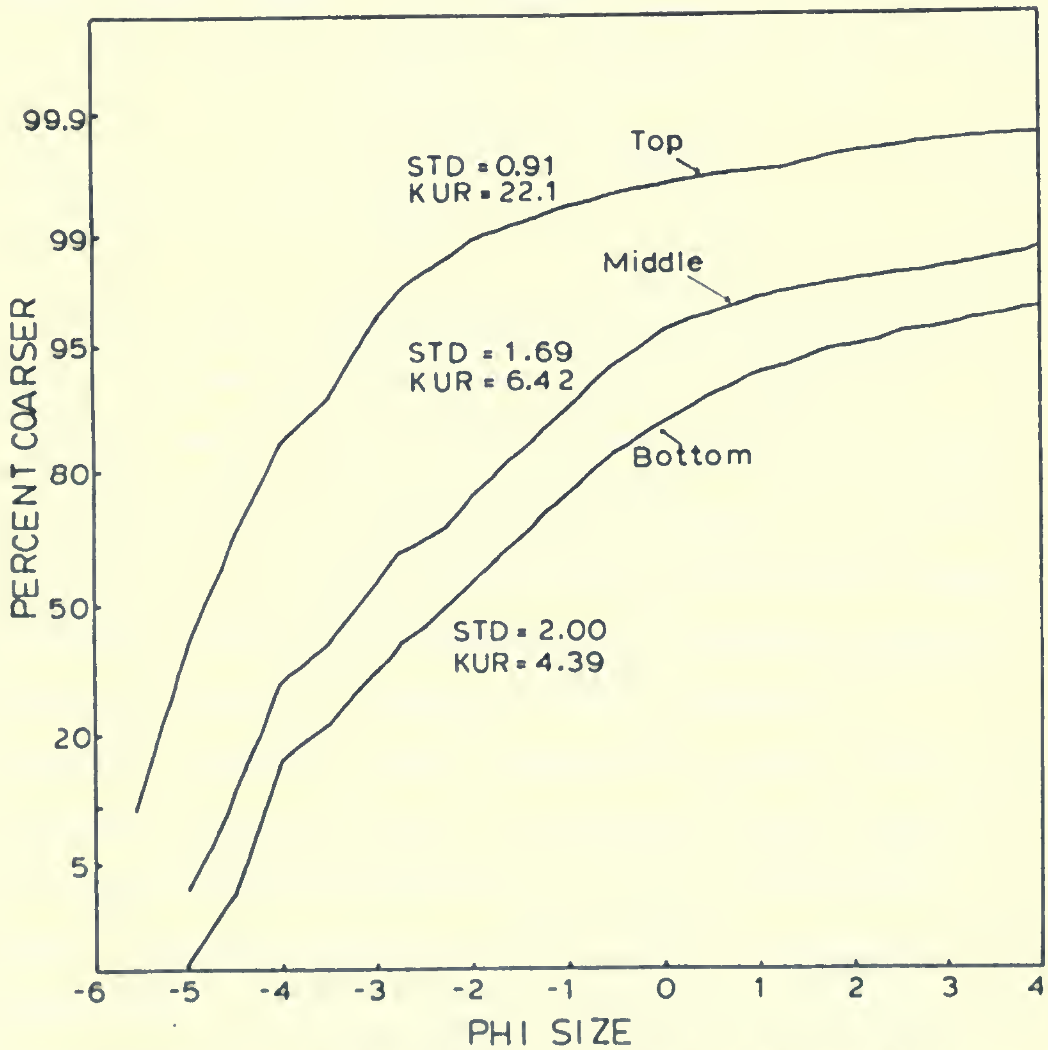

Figure 13. Size distributions for subsurface samples from the channel of Twenty Mile Creek. STD=Standard Deviation, KUR=Kurtosis. Sample HOL 46.

stream.

Size distributions for the subsurface layers on a bar and in the channel of Sixteen Mile Creek are shown in figures 14 and 15 respectively. It is evident that inverse grading is also well-developed on Sixteen Mile Creek. The sublayer sequence and sorting are very similar to those of Twenty Mile Creek.

The Cause of Inverse Grading on Twenty and Sixteen Mile Creeks

A pertinent observation on inverse grading was made during summer field work for J. J. Flint in 1982. Red cement bricks were placed on the creek bed at a designated site upstream in the gorge of Twenty Mile Creek. After the spring flood bricks were found scattered over the bed downstream from their original starting position. However, bricks were also discovered beneath larger clasts of the armor coat. At times they were partially or entirely buried within the top-sublayer, and other times they were lying loose. Cement bricks were also found at greater depths after very high flows (J.J. Flint, personal communication). The presence of these bricks beneath the armor coat indicates that the armor sediment is penetrated at high flow, and that deposition of fine clasts occurs in the gaps left by entrained armor

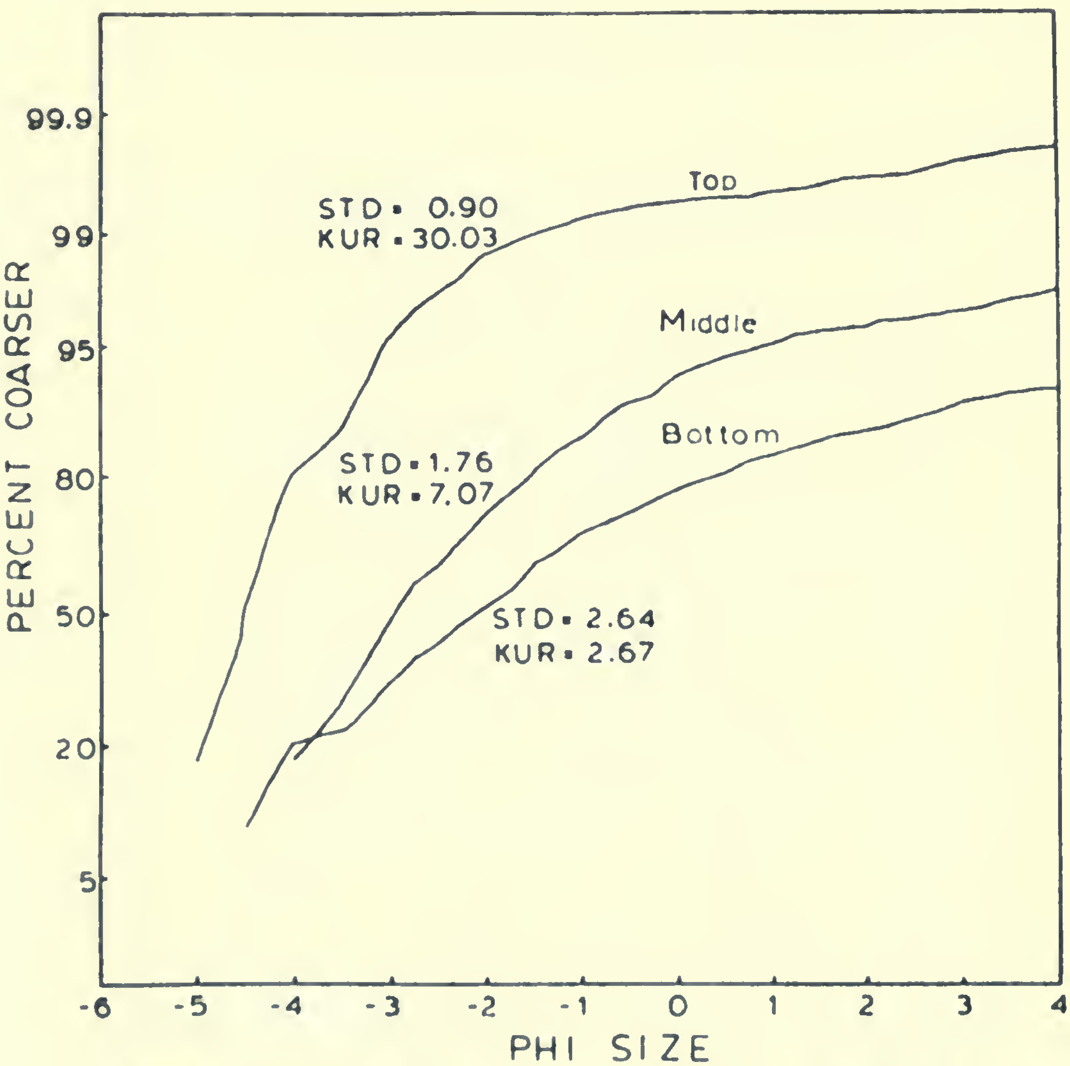

Figure 14. Size distributions for subsurface samples from the channel of Sixteen Mile Creek. STD= Standard Deviation, KUR=Kurtosis. Sample SIX-9.

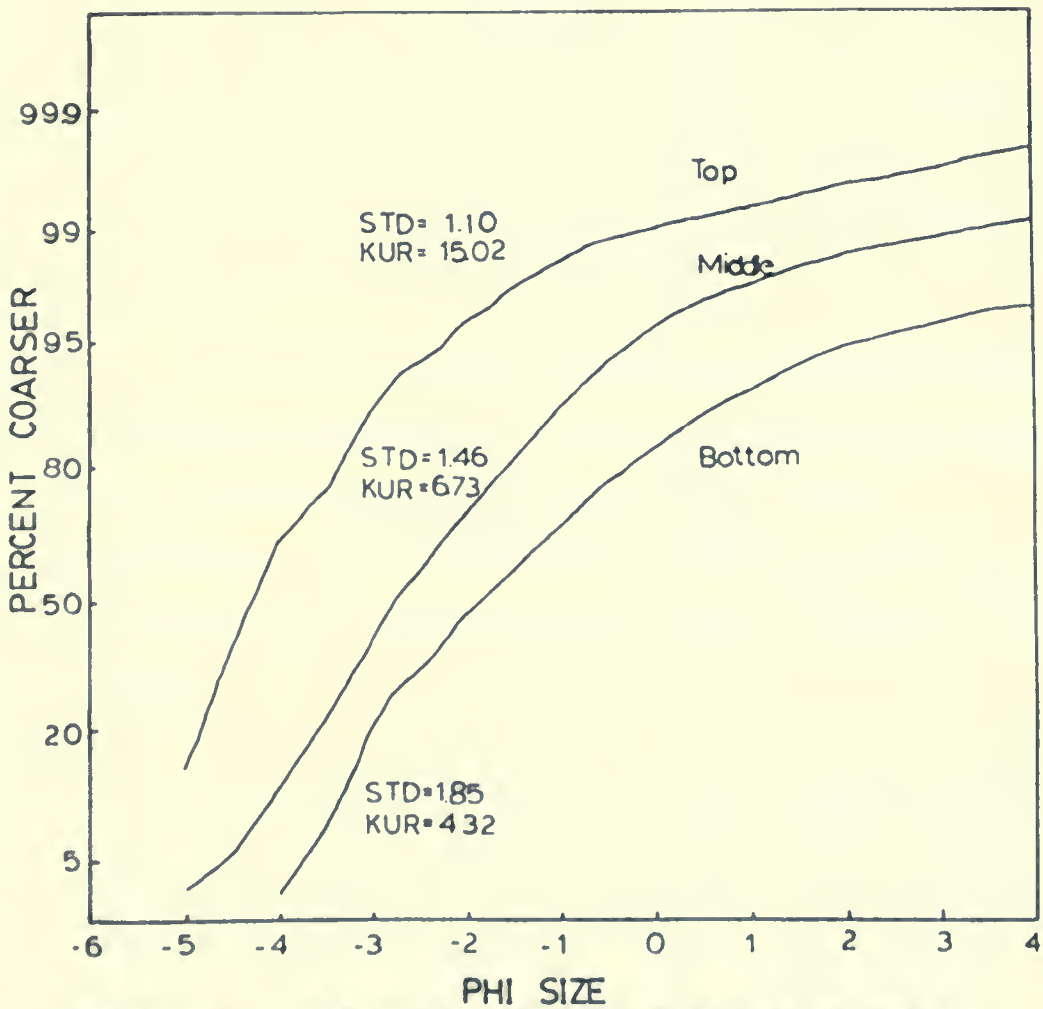

Figure 15. Size distributions for subsurface samples from the channel of Sixteen Mile Creek. Sample SIX-11, STD=Standard Deviation, KUR=Kurtosis.

clasts. This phenomenon was observed by Parker and others (1982) during flume experiments.

Bagnold's (1954) dispersive pressure theory for inverse grading is based on experiments that have not been verified by other authors, and cannot be applied to sediment with a mixture of sizes (Middleton and Southard 1977, Naylor 1980). In addition, the size distributions of sediments affected by dispersive pressure was not given in Bagnold's (1954) study. Therefore, it is impossible to determine whether or not the dispersive pressure theory is responsible for the inverse grading of this study.

The kinetic sieving model for inverse grading proposed by Middleton (1970) has been demonstrated only for sand-size sediment (Naylor 1980). Therefore, it is difficult to determine whether or not this process occurs for the coarser sediment of this study.

Studies by Spencer (1963) and McLaren (1981) show that a given size distribution may be altered when subjected to different amounts of winnowing. A series of distributions may represent different amounts of mixing between the coarse and fine populations. Each sublayer of the inverse grading in this study represents sediment exposed to a different degree of vertical winnowing. The downward decrease

in sorting suggested in figures 12 to 15 reflects the amount of vertical winnowing undergone by each sublayer.

The distributions for the bar sublayers (figure 12 and 14) seem to converge near the coarse end of the size scale, indicating that they are fairly similar in the proportion of sizes from -4.0 to -5.5 phi. Distributions for the channel sublayers appear to remain separate in this size range (figures 13 and 15). This implies that the distibutions for the channel sublayers probably converge over a coarser size range than do those for bars. Therefore, channel sublayers are winnowed of more fines than the sublayers of bars.

Population Analysis

To analyze the sediment distributions of Twenty Mile Creek in detail, straight-line segments were drawn for all distributions. These are numbered 1, 2 and 3 in figures 16 and 17. These segments separate each distribution into three populations, each characterized by a different length and slope. The terminology of Sagoe and Visher (1977) is used; therefore, the populations 1, 2 and 3 are called the traction, saltation and suspension populations. It must be noted that these terms are used by Sagoe and

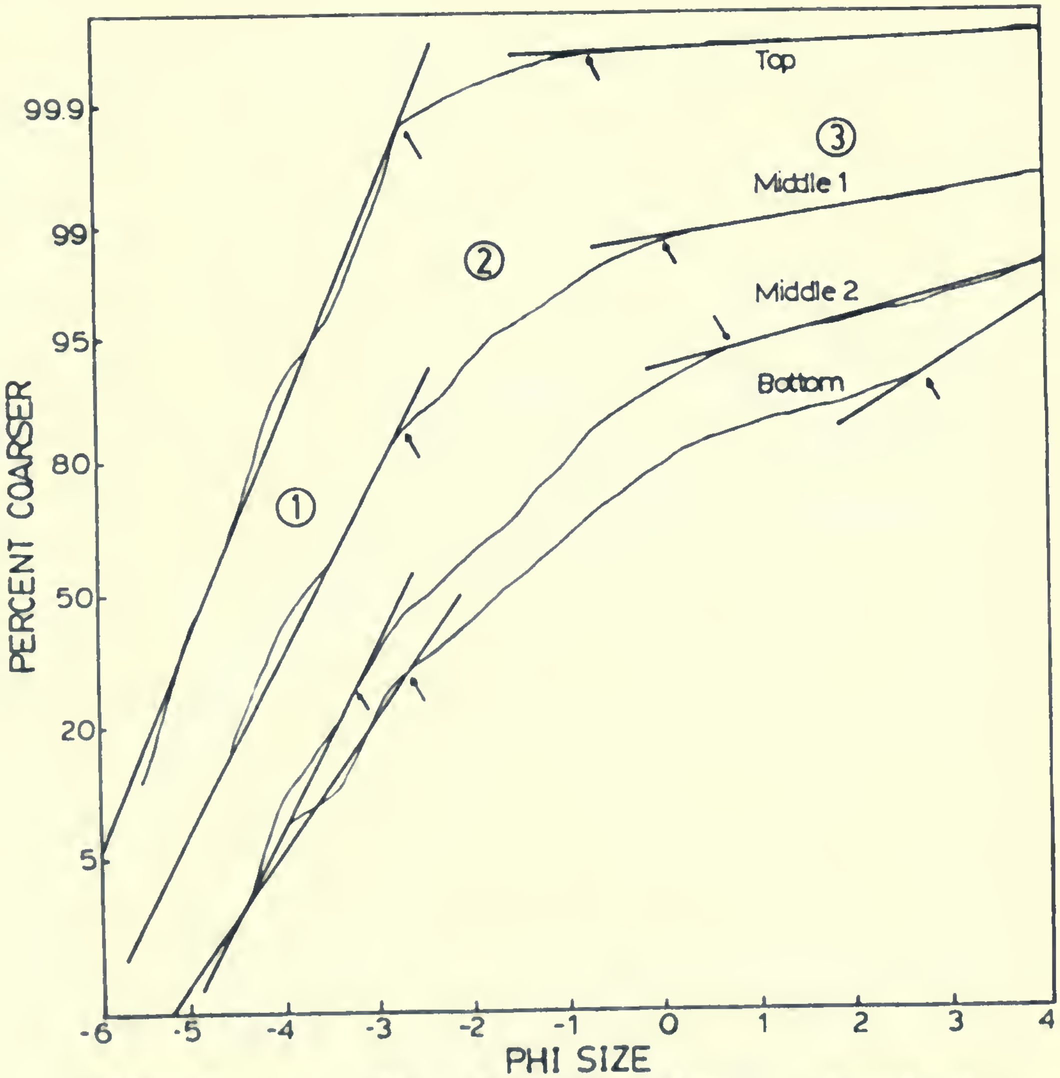

Figure 16. Size distributions for the channel sublayers in the gorge of Twenty Mile Creek. Arrows indicate "breaks" between populations. Sample HOL-35.

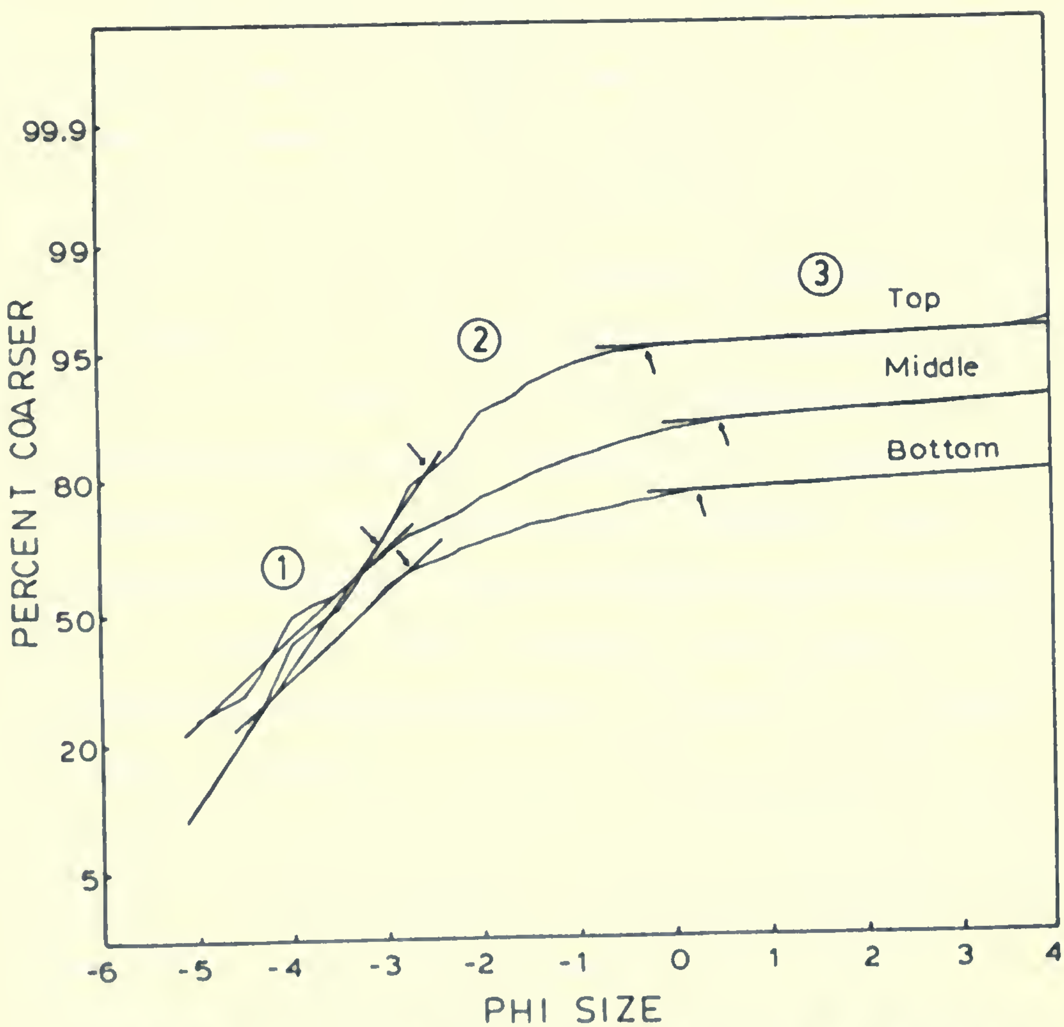

Figure 17. Size distributions for bar sublayers in the gorge of Twenty Mile Creek. Arrows show "breaks". Sample HOL-41.

Visher (1977) for describing sand and gravel distributions, and may not have the same genetic meaning for the coarser distributions observed in this study.

The Traction Population

The traction population is composed of sizes ranging from -6.0 to approximately -2.75 phi. The "break" between the traction (population 1) and the next population appears to remain fairly constant at some sites (left arrows in figure 16) and is variable at others (left arrows in figure 17) from the top to the bottom-sublayer. The grains defining the population 1 may not be winnowed from any of the sublayers if their critical shear stress is not exceeded by the turbulent eddy that enters the gap made in the armor coat. Therefore, the fairly constant "break" may suggest that the largest size winnowed from each sublayer is similar. Fluctuation of the "break" may be due to variable grain removal which may be caused by the packing of subsurface grains. Therefore, the variable "break" suggests that winnowing is not uniform from one sublayer to the next.

Population 1 comprises a larger percentage of the top-sublayer than any other sublayer (figure 16). The

percentage or proportion of this population decreases significantly toward the bottom-sublayer. This is mainly because the greatest winnowing of sediment finer than about -2.75 phi occurs for the top-sublayer and decreases toward the bottom-sublayer.

The Saltation Population

The next population of the cumulative distribution is the saltation population. The straight-line segments of the saltation population (population 2) have not been included in figure 16 so that the increase in range of this population is more evident. Population 2 normally cannot be shown by just one straight-line segment and therefore, may be described as a mixture of population 1 and population 3. The size-range of population 2 increases downward from the top to the bottom-sublayer (figure 16). This size-range increase occurs toward the fine sizes. Therefore, as the size-range for population 2 increases a given particle may be considered to be part of a different population depending on the sublayer in which it is present. For example in figure 16, a particle size of -0.5 phi is part of population 3 in the top-sublayer, but changes to population 2 of the middle and bottom-sublayers. This trend was found to occur for most of the subsurface samples on Twenty and Sixteen Mile Creeks. This

suggests that mixing of populations 1 and 3 occurs at a decreasing size from the top to the bottom-sublayer.

In figure 16, the population 2 comprises 0.1 percent of the top-sublayer, and increases to 55 percent in the bottom-sublayer. This suggests that population 2 also increases in percent of the total distribution from the top to the bottom-sublayer.

The range of sizes for population 2 increases from the top to the bottom-sublayer, and reflects the amount of mixing in each sublayer. In figure 16, the greatest mixing between the coarse and fine populations occurs in the bottom-sublayer. Therefore, as the subsurface sediment is winnowed, the mixing between populations 1 and 3 is decreased.

The Suspension Population

The suspension population (population 1) consists of two parts for the samples of this study: 1) a sand and 2) a silt-clay fraction. Only the sand of population 1 is plotted because silt and clay comprises less than 5 percent of the total weight for most samples. The sand fraction is poorly sorted as indicated by the almost horizontal line segments in figures 16 and 17. Also evident from these figures is

the fact that the percentage of silt and clay is smallest in the top and increases toward the bottom-sublayer. This trend is consistent in all the samples of this study, and also reflects the amount of winnowing that each sublayer has undergone.

Downstream Change in the Armor Coat and the Sublayers of Twenty Mile Creek

Figures 18 and 19 show the channel armor coat distributions in the gorge and downstream of Highway 8 respectively. Figures 20 and 21 show the distributions of the top-sublayer in the gorge and downstream of Highway 8 respectively. Although the armor coat shows a well-defined downstream size decrease, there appears to be no similar decrease for the top-sublayer. By comparing figures 20 and 21 it is evident that the coarse and fine fractions overlap, suggesting that the top-sublayer of the channel both in the gorge and downstream of Highway 8 have approximately equal percentages of these size fractions. However, some distributions in the gorge have a higher proportion of sizes ranging from -5.5 to -1.0 phi than do those downstream of Highway 8. This may indicate that winnowing of the top-sublayer is greater in the gorge than downstream of Highway 8.

Figures 22 and 23 show size distributions of the

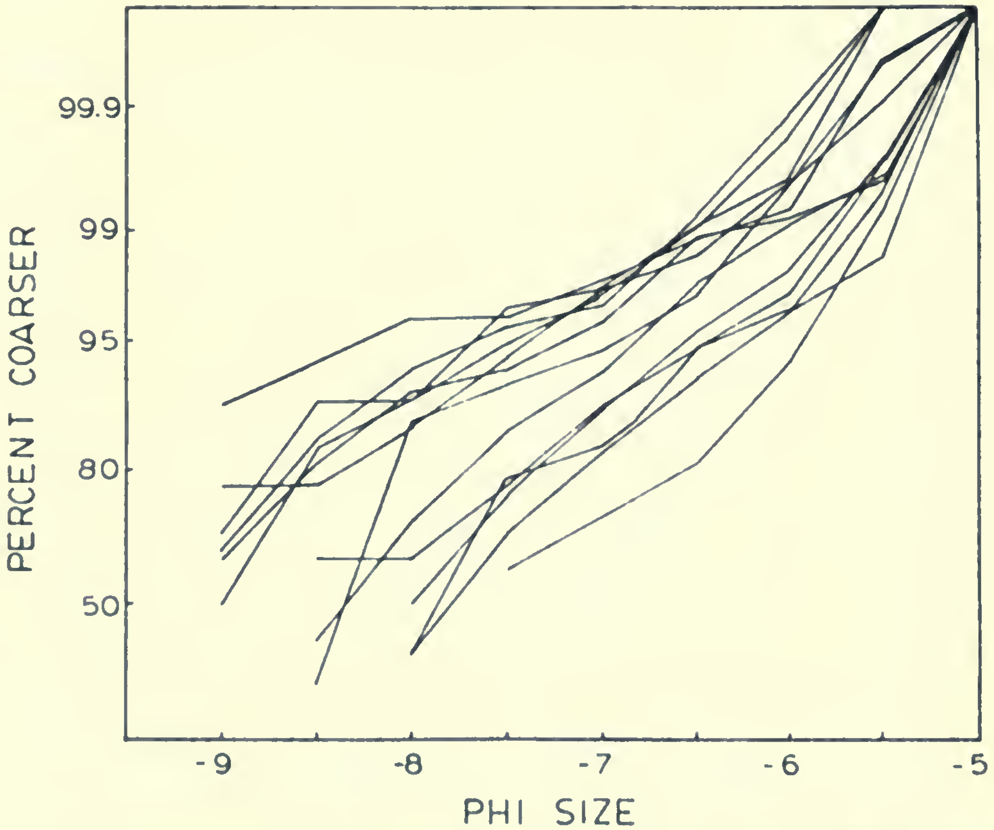

Figure 18. Size distributions for the channel armor coat in the gorge of Twenty Mile Creek.

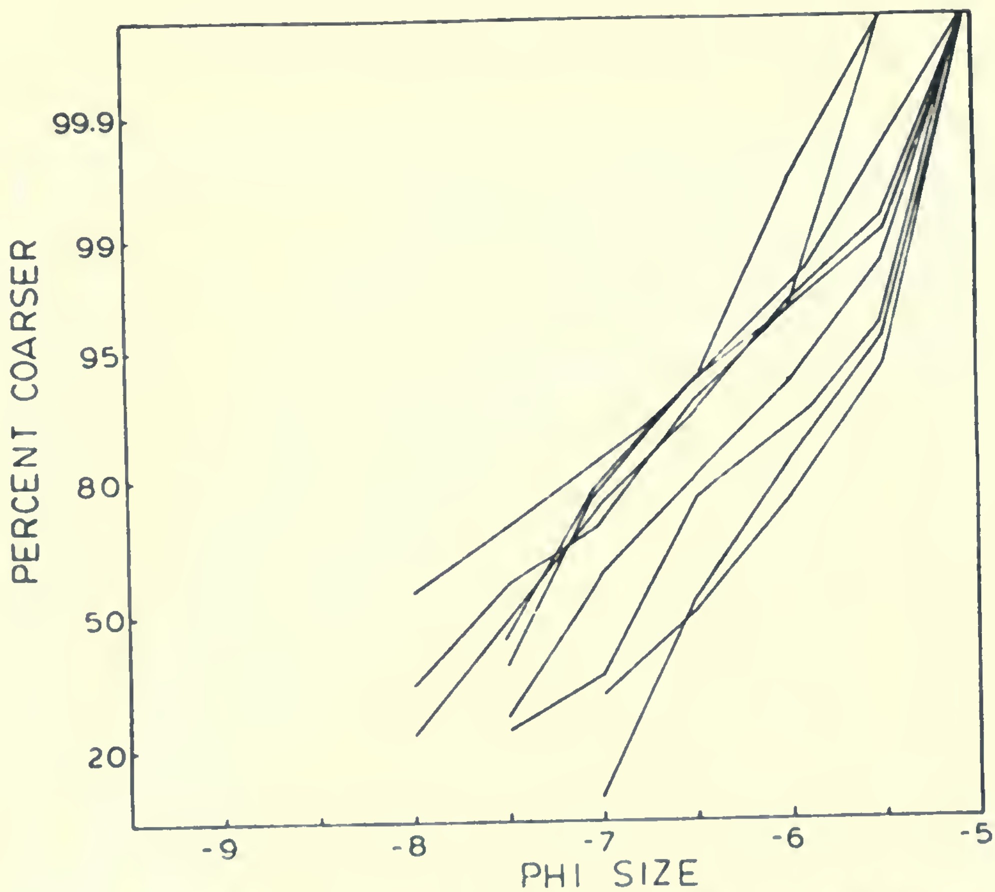

Figure 19. Size distributions for the armor coat in the channel downstream of Highway 8 for Twenty Mile Creek.

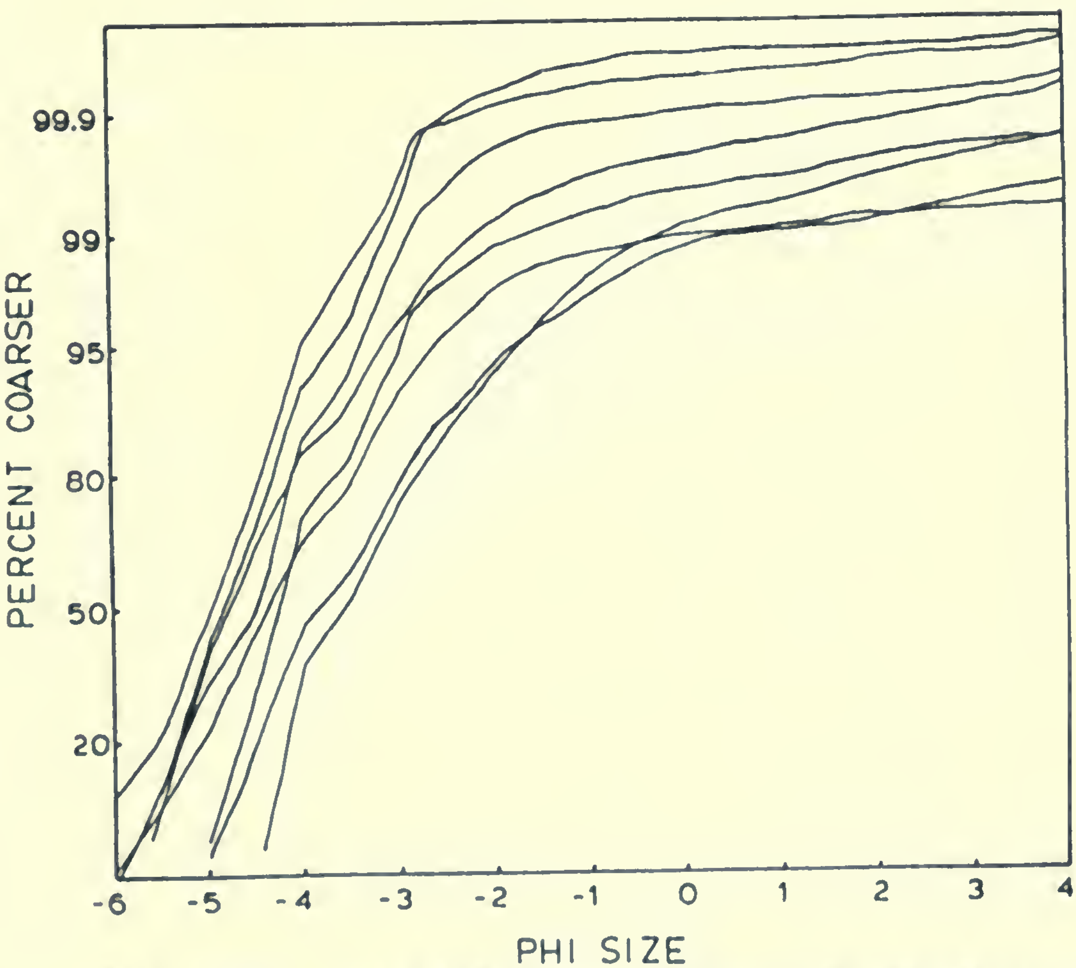

Figure 20. Size distributions for the channel top-sublayer in the gorge of Twenty Mile Creek.

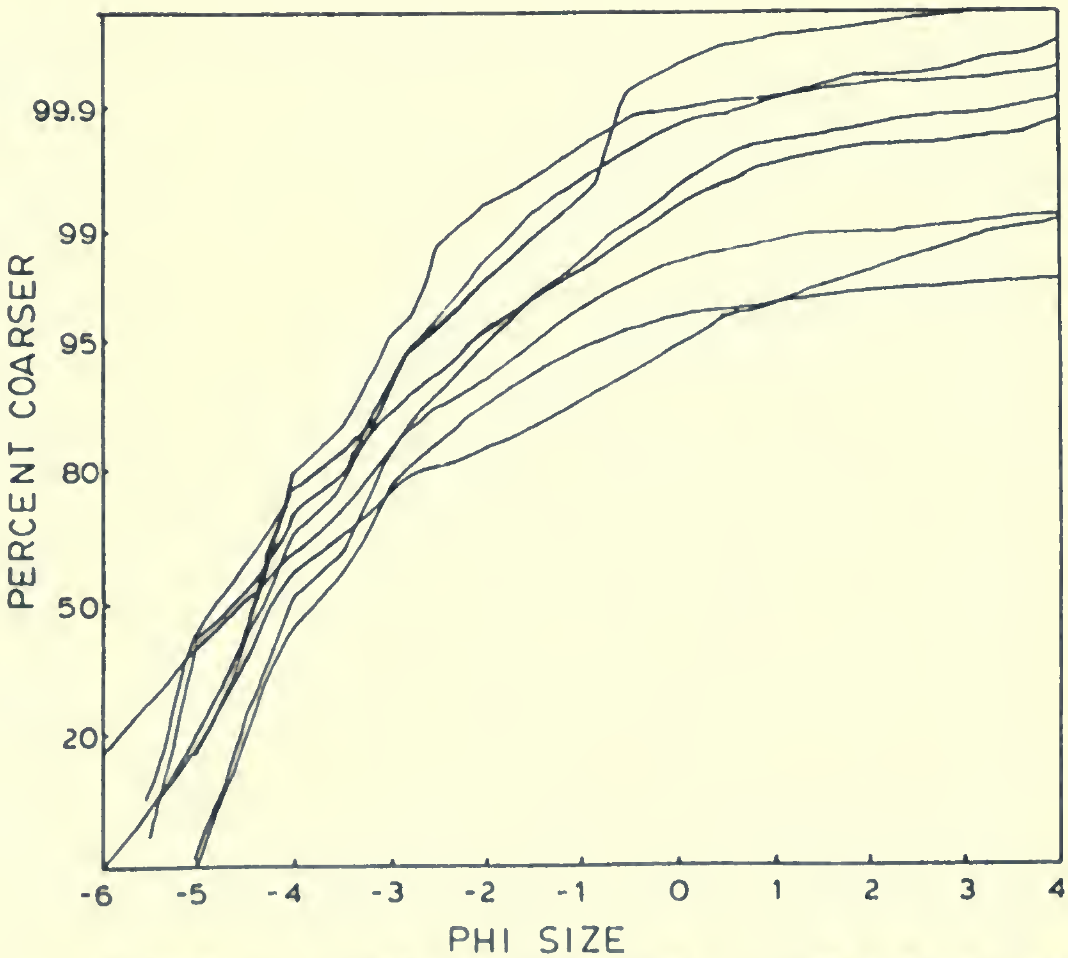

Figure 21. Size distributions for the channel top-sublayer downstream of Highway 8 on Twenty Mile Creek.

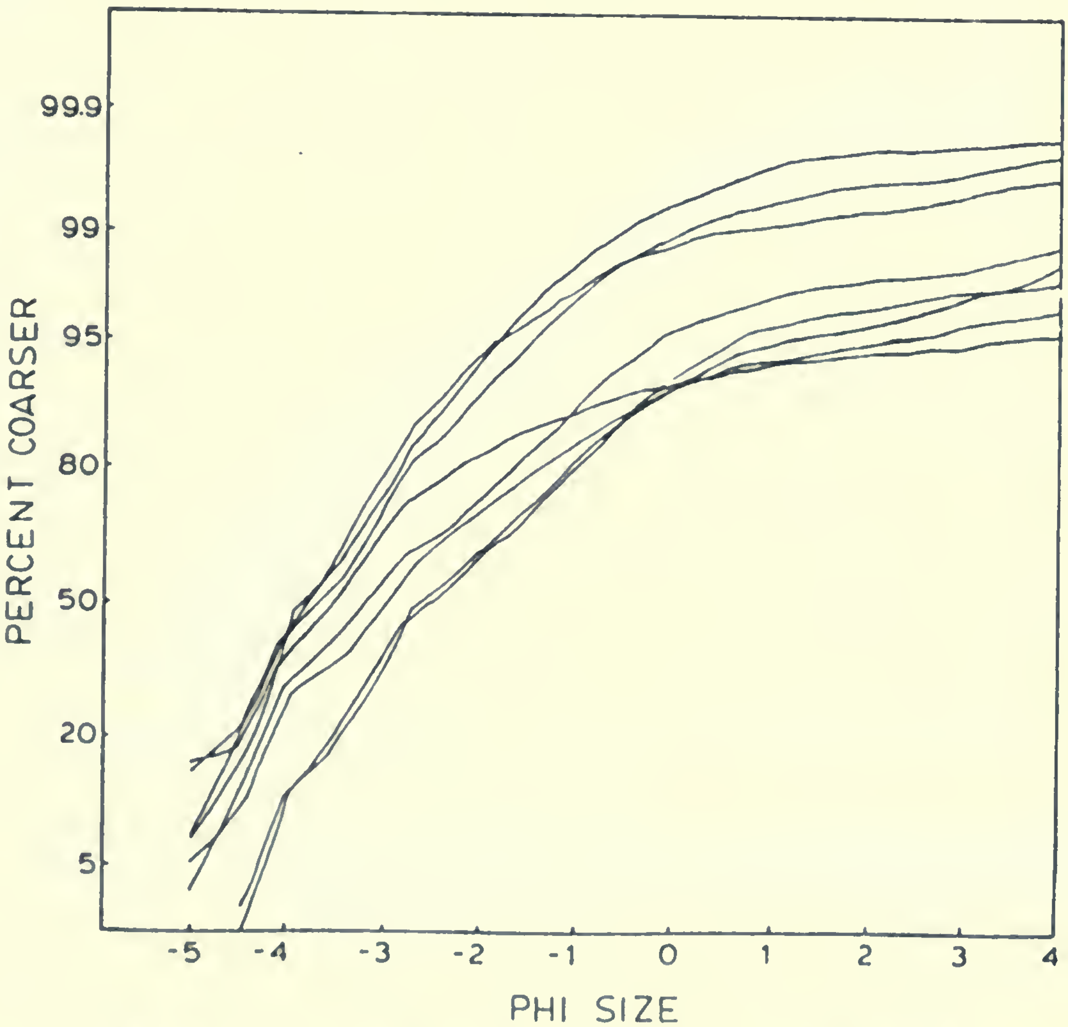

Figure 22. Size distributions for the channel middle-sublayer in the gorge of Twenty Mile Creek.

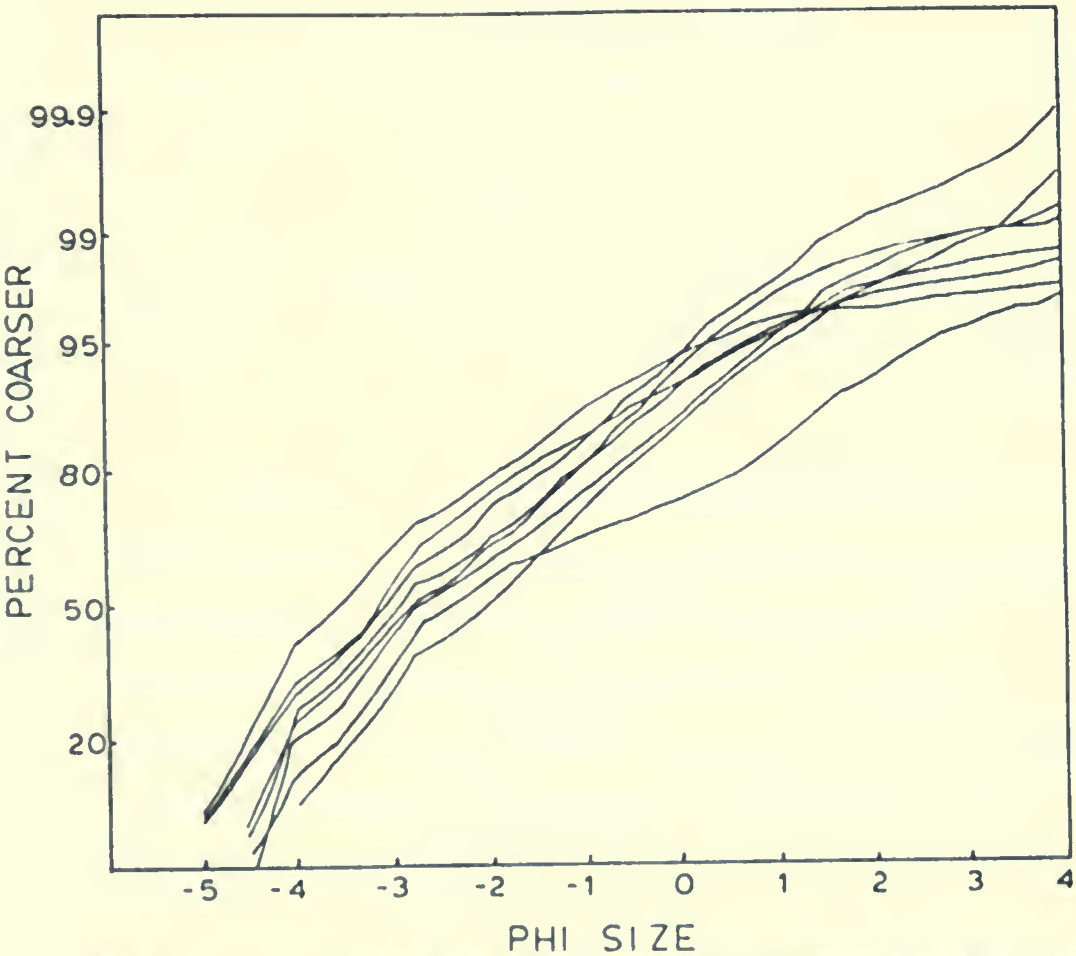

Figure 23. Size distributions for the middle-sublayer in the channel downstream of Highway 8 on Twenty Mile Creek.

middle-sublayer for the channel in the gorge and downstream of Highway 8 respectively. The same trend is present for the middle as is evident for the top-sublayer.

Size distributions of the channel bottom-sublayer in the gorge and downstream of Highway 8 are shown in figures 24 and 25 respectively. Distributions for these figures overlap almost completely suggesting that the bottom-sublayer is similar both in the gorge and downstream of Highway 8.

Figures 26 and 27 show the populations of the top-sublayer in the gorge and downstream of Highway 8 respectively. The size-range of population 2 increases significantly downstream of Highway 8 (figure 27). This suggests that mixing of populations 1 and 3 is greater downstream of Highway 8 than upstream in the gorge.

Line segments representing the middle-sublayer in the gorge and downstream of Highway 8 are shown in figures 28 and 29 respectively. Comparison of these figures shows that the size-range of population 2 increases slightly downstream. This indicates that the amount of mixing between populations 1 and 3 for the middle-sublayer also increases downstream.

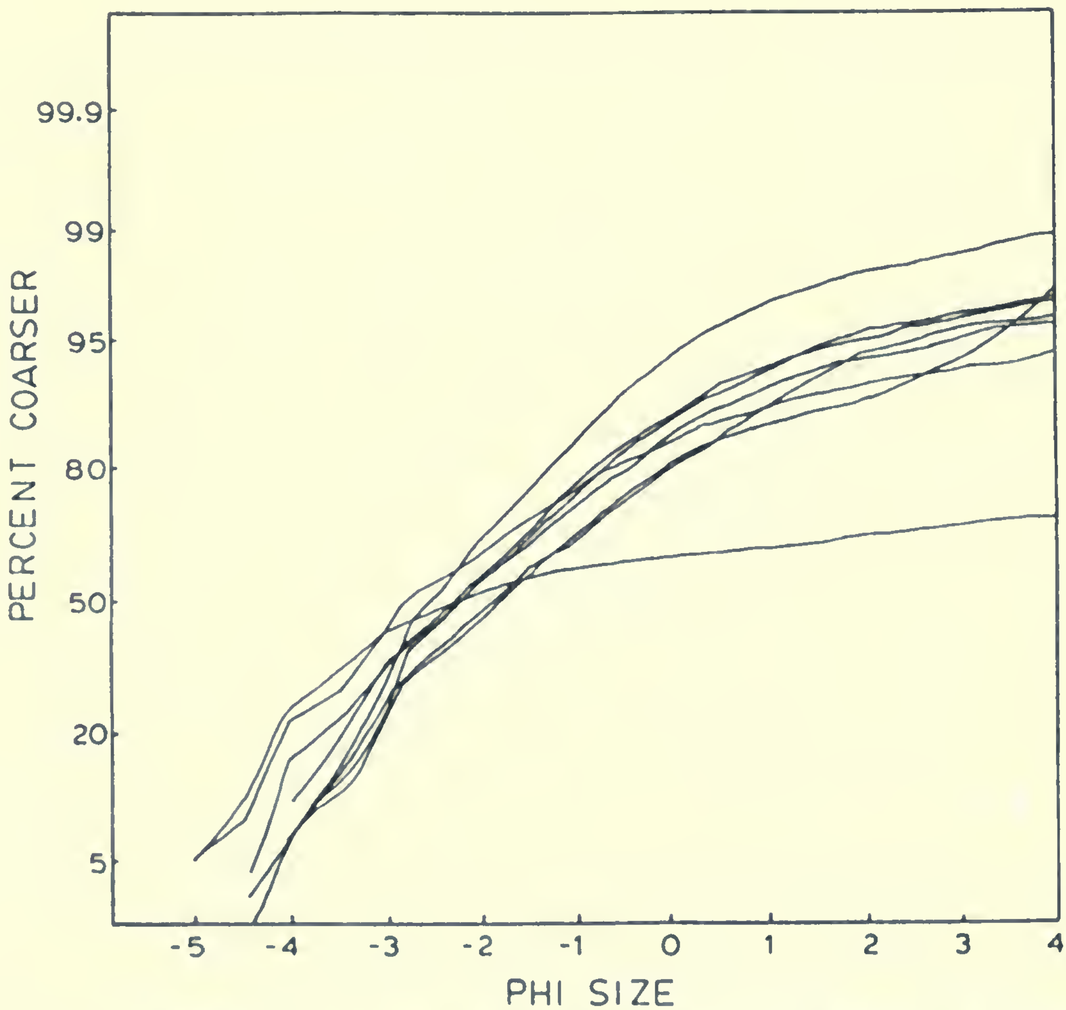

Figure 24. Size distributions for the bottom channel-sublayer in the gorge of Twenty Mile Creek.

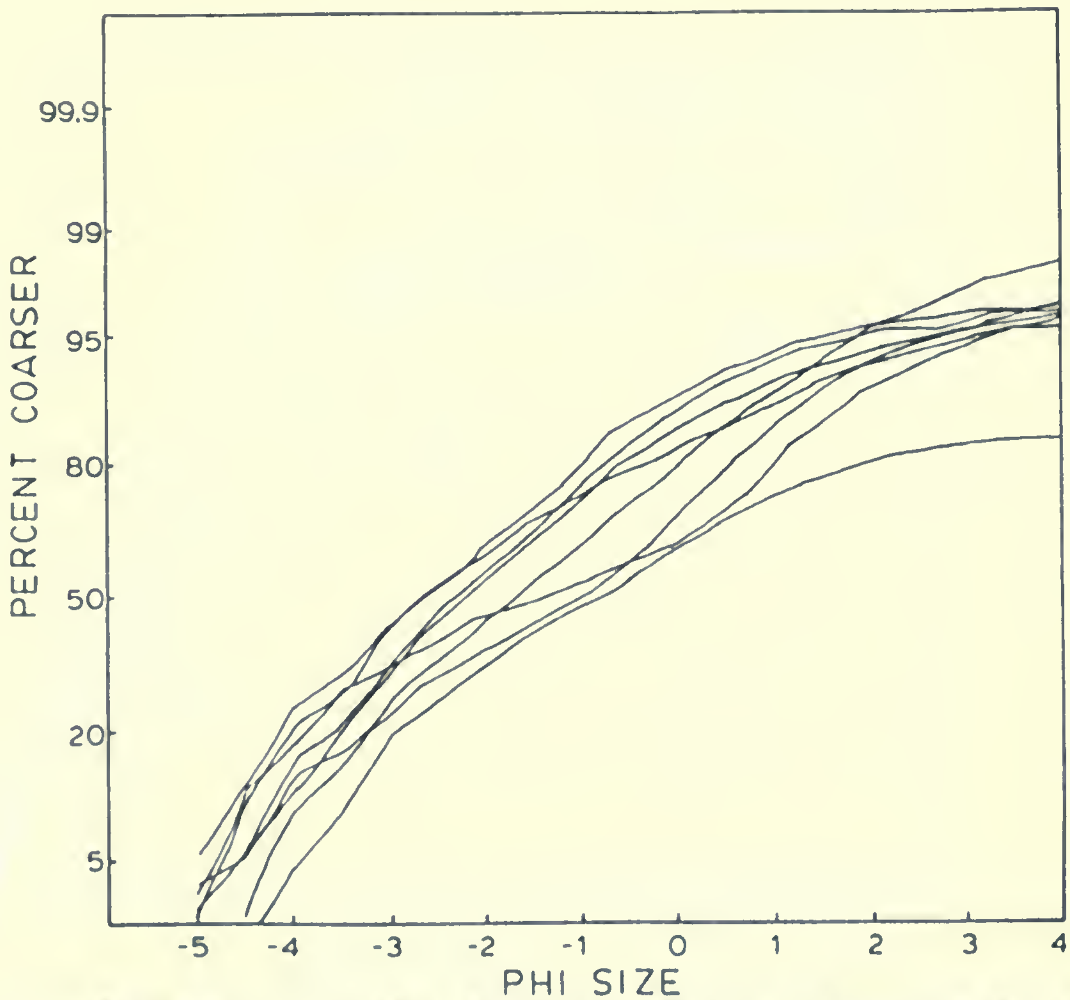

Figure 25. Size distributions for the bottom-sublayer in the channel downstream of Highway 8 on Twenty Mile Creek.

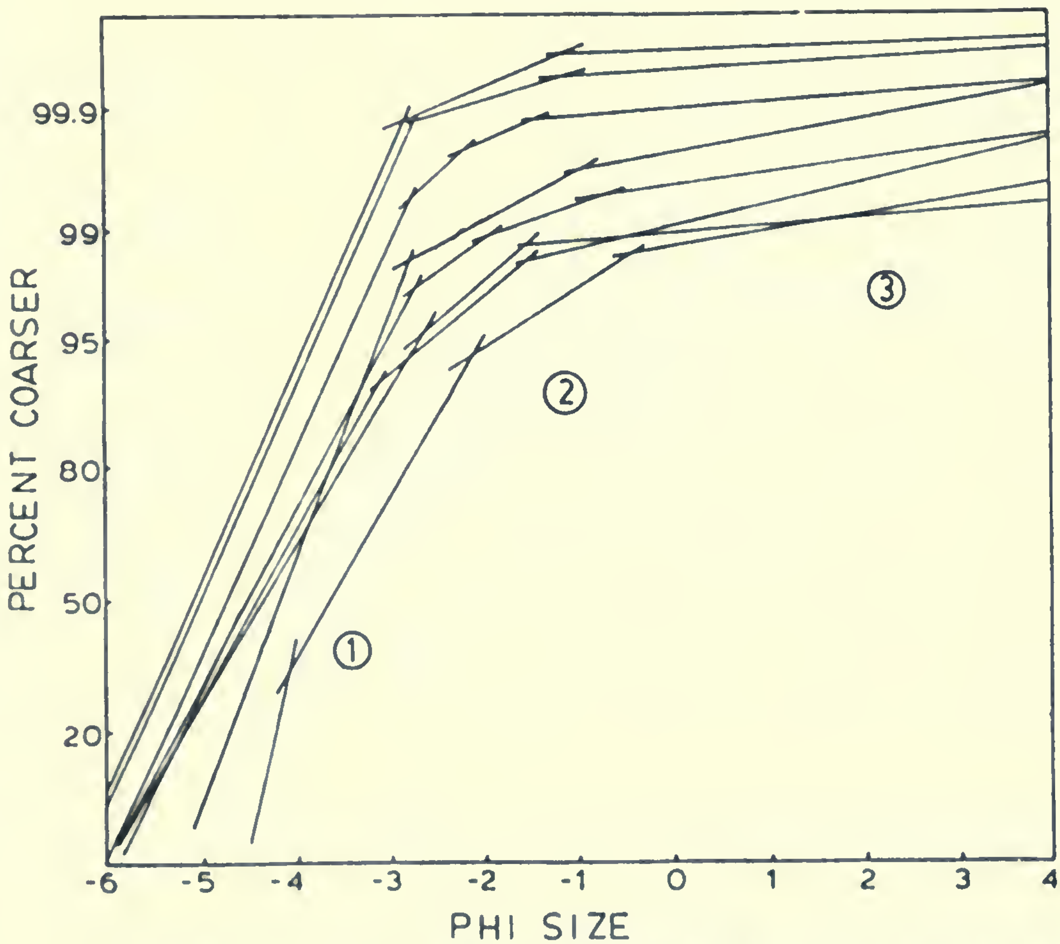

Figure 26. Straight-line segments for the channel top-sublayer in the gorge of Twenty Mile Creek.

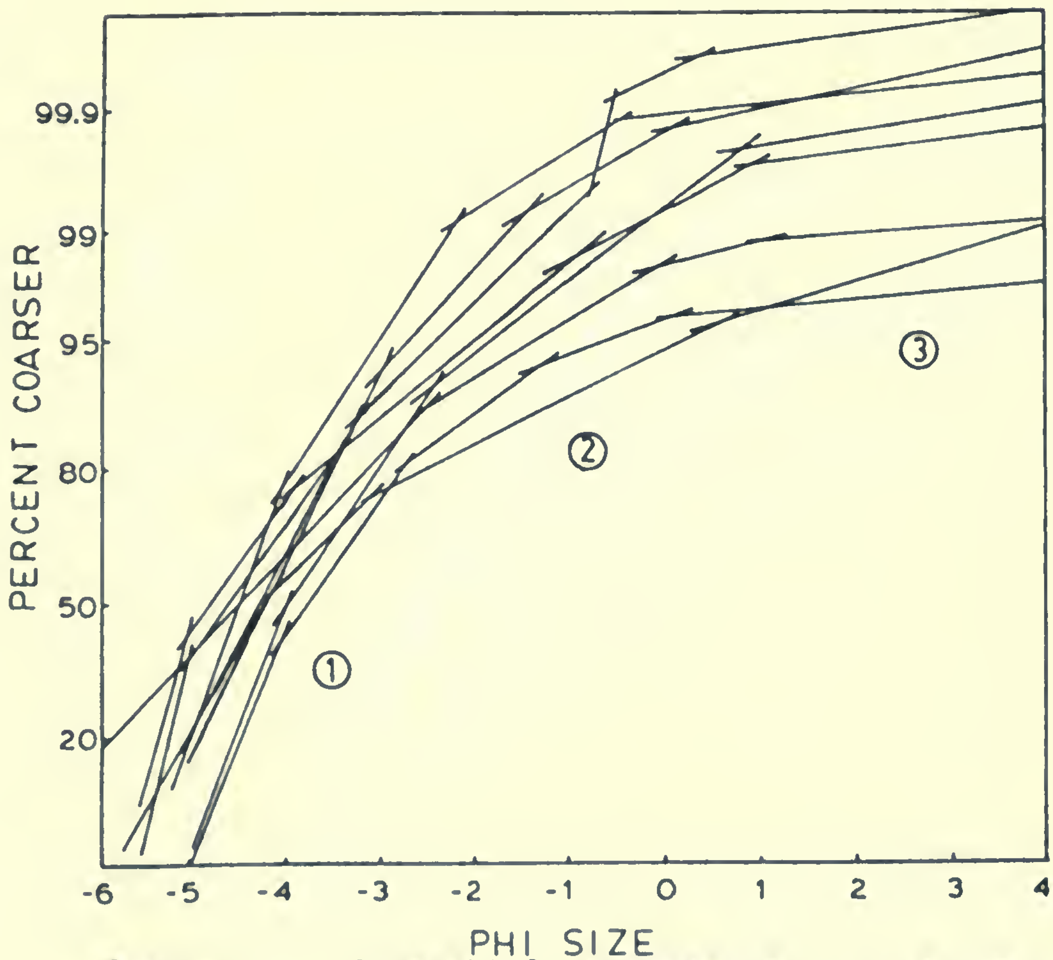

Figure 27. Straight-line segments for the channel top-sublayer downstream of Highway 8 on Twenty Mile Creek.

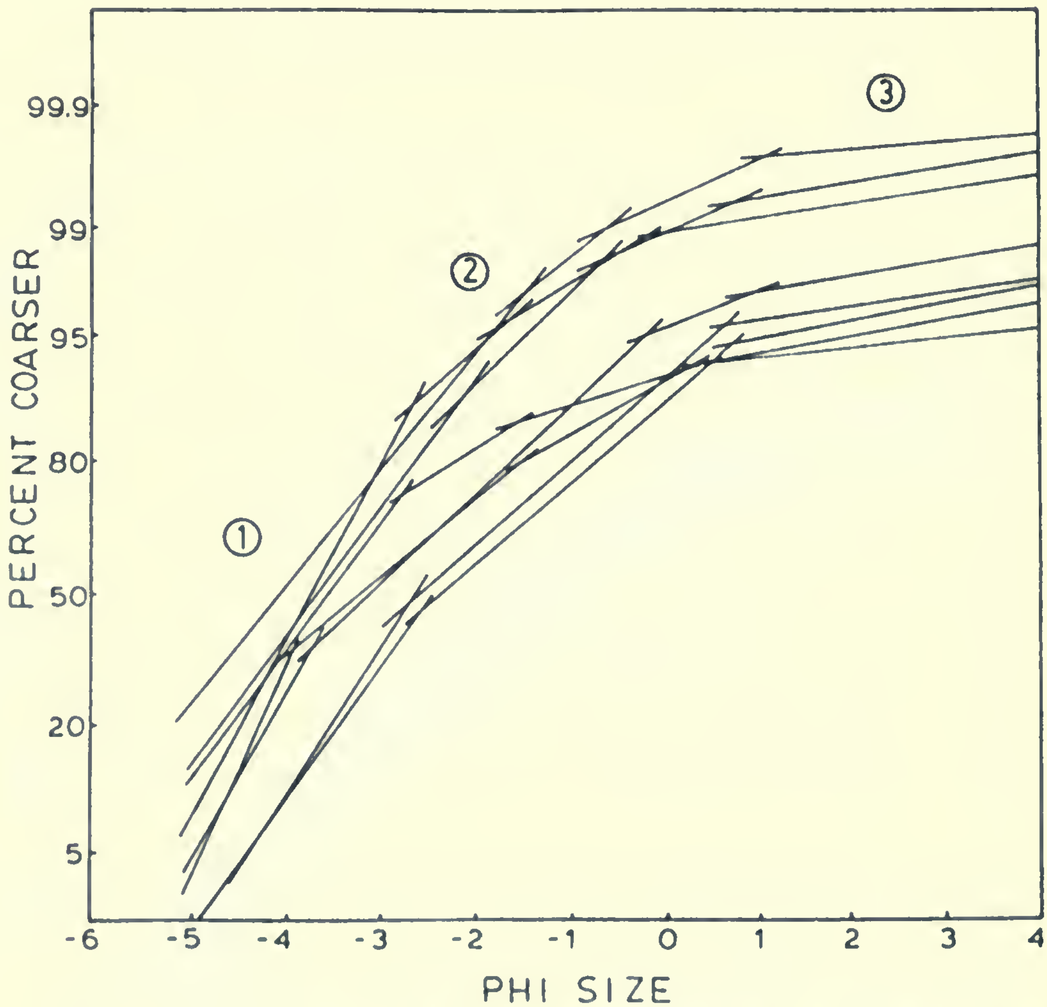

Figure 28. Straight-line segments for the channel middle-sublayer in the gorge of Twenty Mile Creek.

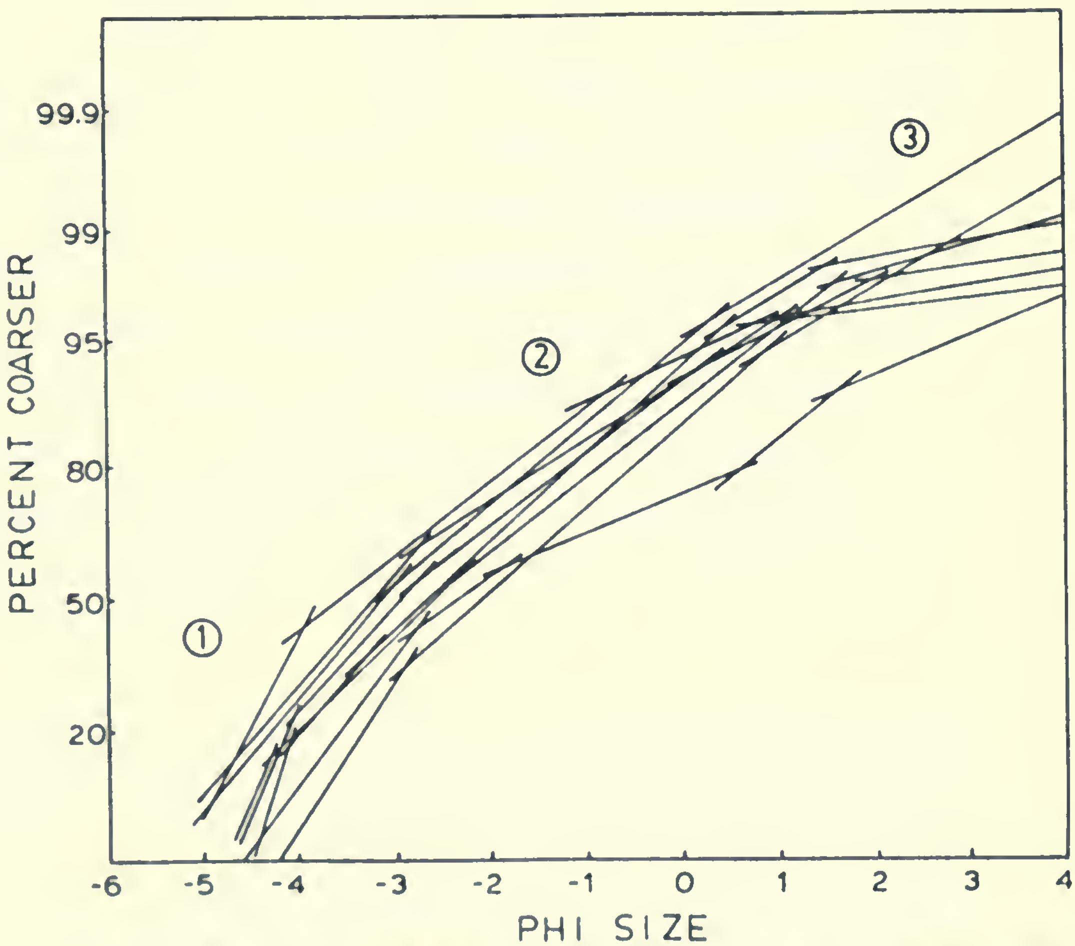

Figure 29. Straight-line segments for the middle-sublayer in the channel downstream of of Highway 8 on Twenty Mile Creek.

Line segments for the distributions of the bottom-sublayer in the gorge and downstream of Highway 8 are shown in figures 30 and 31 respectively. Again, it is evident that the size-range of population 2 increases slightly downstream. These same trends are present for all sublayers in the bars of Twenty Mile Creek.

By comparing figures 26 and 31, a summary can be made to describe the relation between the size of the armor coat and the sublayer populations in Twenty Mile Creek. All three subsurface layers show a downstream increase in the size-range of population 2. This reflects a downstream increase in mixing of populations 1 and 3. A downcurrent reduction in winnowing may be responsible for the downstream increase in population mixing for each sublayer in Twenty Mile Creek.

Armor Coat and Subsediment for Twenty and Sixteen Mile Creeks, the Grand and Genesee Rivers and Cazenovia Creek

As a result of discussions with J.J. Flint, three terms were obtained to describe the bed surfaces of the streams in this study: a "continuous" armor coat; a "discontinuous" armor coat; and no armor coat. The armored surfaces for Twenty and Sixteen Mile Creeks are mainly "continuous" because in these creeks surface clasts

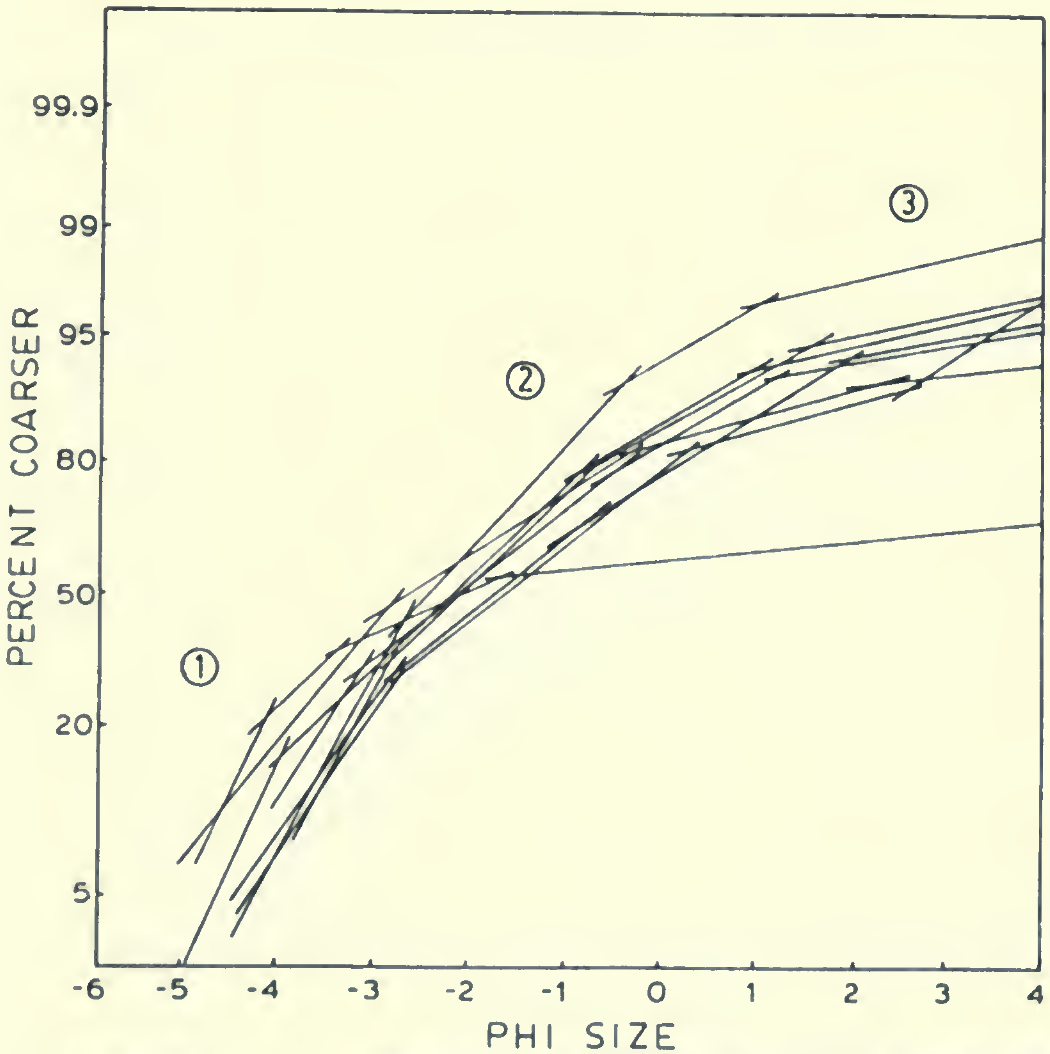

Figure 30. Straight-line segments for the channel bottom-sublayer in the gorge of Twenty Mile Creek.

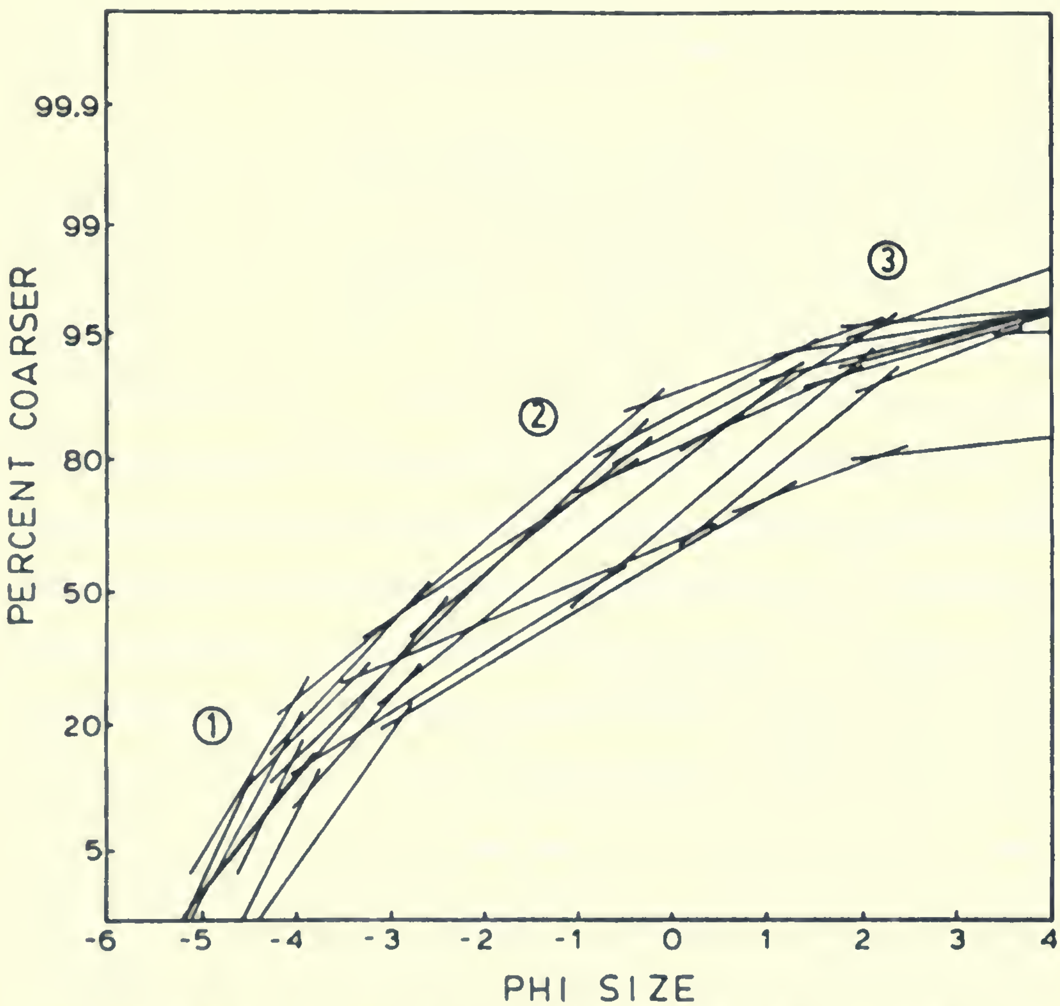

Figure 31. Straight-line segments for the bottom-sublayer in the channel downstream of Highway 8 on Twenty Mile Creek.

completely cover the finer subsurface. The armor coats for the Grand and Genesee Rivers are mainly "discontinuous" because they are composed of intermittently spaced coarse clasts which do not entirely cover the subsurface. Cazenovia Creek normally has no armor coat and therefore, the subsurface is completely exposed.

Cazenovia Creek exhibits another important aspect of armor coat formation. Although this creek normally has the finest surface sediment, a discontinuous armor coat is present in two areas. The clast sizes in both of these areas range from -7.0 to -4.0 phi. In the first area the discontinuous armor coat has formed because of the contribution of clasts from limestones and shales which outcrop in a steep bedrock gorge about 1 km upstream. In this area the discontinuous armor coat is formed mainly because of the contibution of clasts from this limestone. In the second area, the discontinuous armor coat has formed on a bar which is located on the inner bank of a channel bend partially protected from the main flow by a bedrock outcrop. The formation of this surface appears to be caused by a decrease in the main flow resulting in the deposition of clasts that are normally transported further downstream. Scour gauges in fine bars of the channel were completely washed away during the 1982-83 snow-melt. These bars must form during flow recession, and are not indicative of the maximum shear stress in the channel.

Therefore, Cazenovia Creek is an example of a stream with a maximum shear stress high enough to form an armor coat, but has sediment that is normally too fine for an armored surface to occur.

Continuous armor coats such as those of Twenty and Sixteen Mile Creeks have subsurface sediment that is inversely graded (figures 32 and 33 respectively). Even though the size of the armor surface changes significantly between Twenty and Sixteen Mile Creek, the inverse grading is similar because vertical winnowing is active in both creeks.

Size distributions for the discontinuous armor coat and the subsurface material of the Grand River are shown in figure 34, while those of the Genesee River are shown in figures 35 and 36, and those of Cazenovia Creek are shown in figures 37 and 38. Sublayer thickness for the Grand and Genesee Rivers and Cazenovia Creeks ranges from 14 to 70 cm. Inverse grading is present but is not always well-developed. In figures 34, 35 and 38, the armor coat is discontinuous, resulting in a similar inverse grading to that of Twenty and Sixteen Mile Creeks. However, in figure 35 the bottom-sublayer appears to be coarser than the other sublayers. The grading of sediments shown in this figure can be explained by aggradation. The present armor coat is coarser than the bottom-sublayer. Therefore, the bottom-sublayer must have been formed under lower flow

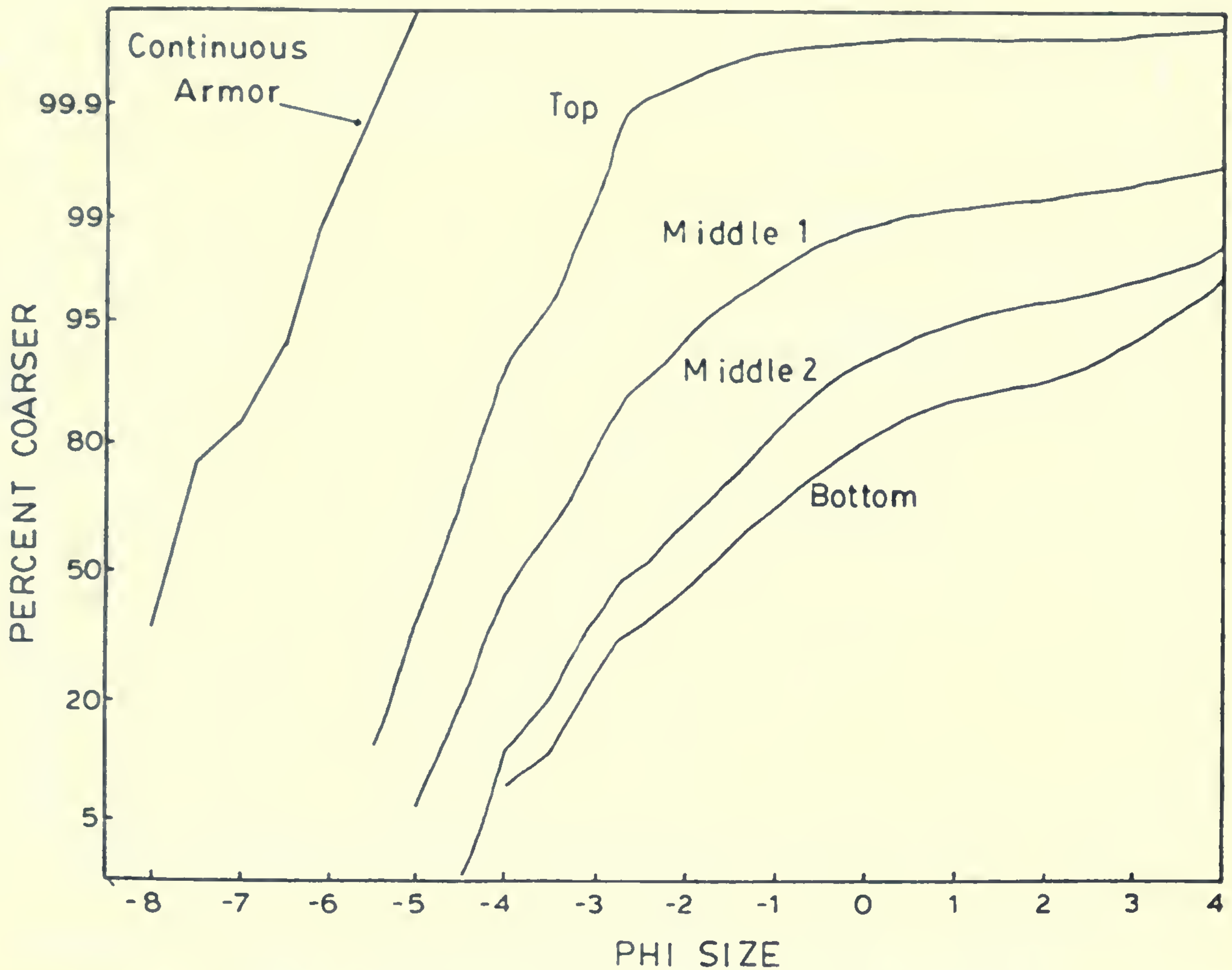

Figure 32. Size distributions for the continuous armor coat and sublayers in the gorge of Twenty Mile Creek. Sample HOL 35. Armor coat distribution is derived from photograph 41.

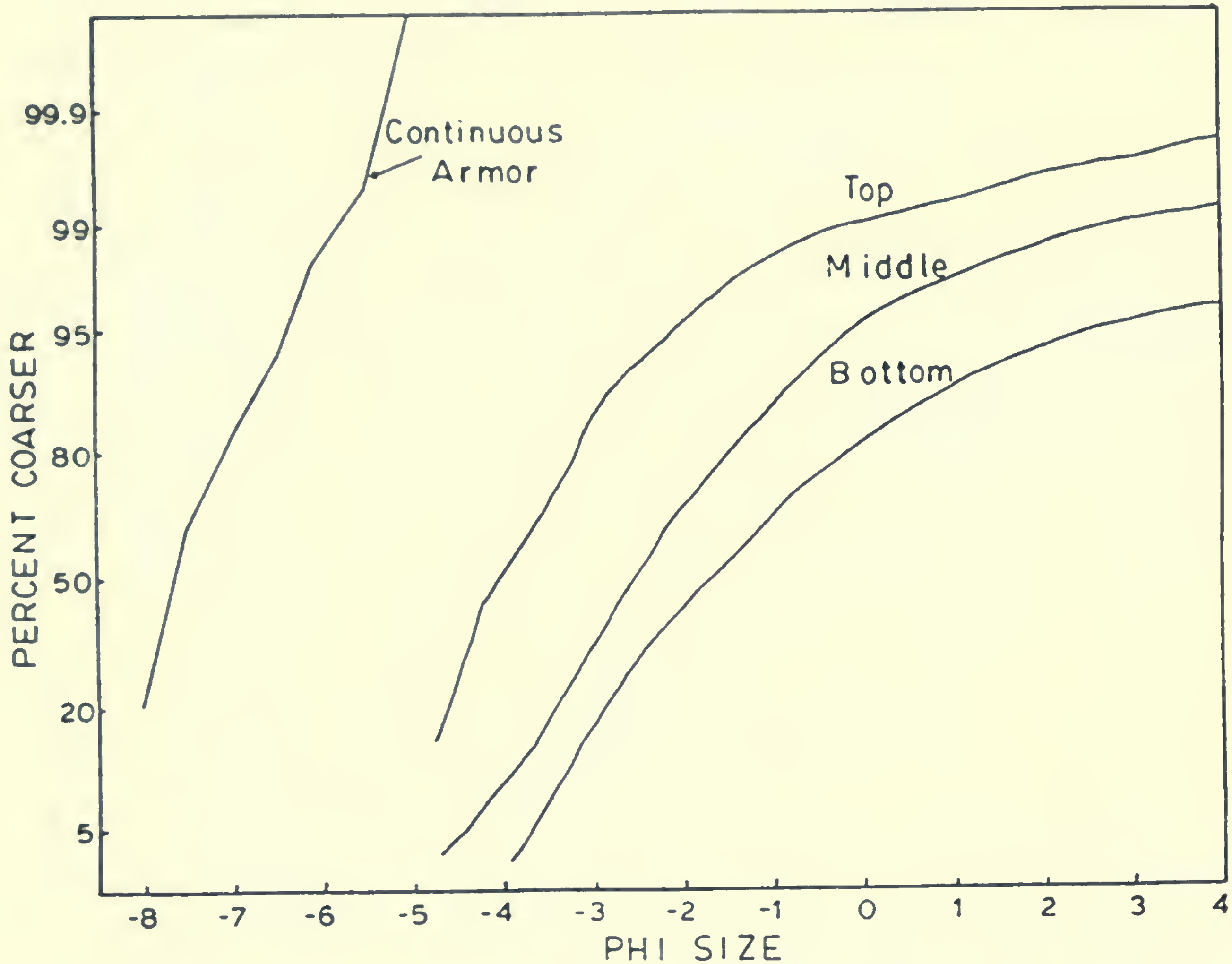

Figure 33. Size distributions for the continuous armor coat and sublayers of the channel in the gorge of Sixteen Mile Creek. Sample SIX-11. Armor coat distribution is derived from photograph 130.

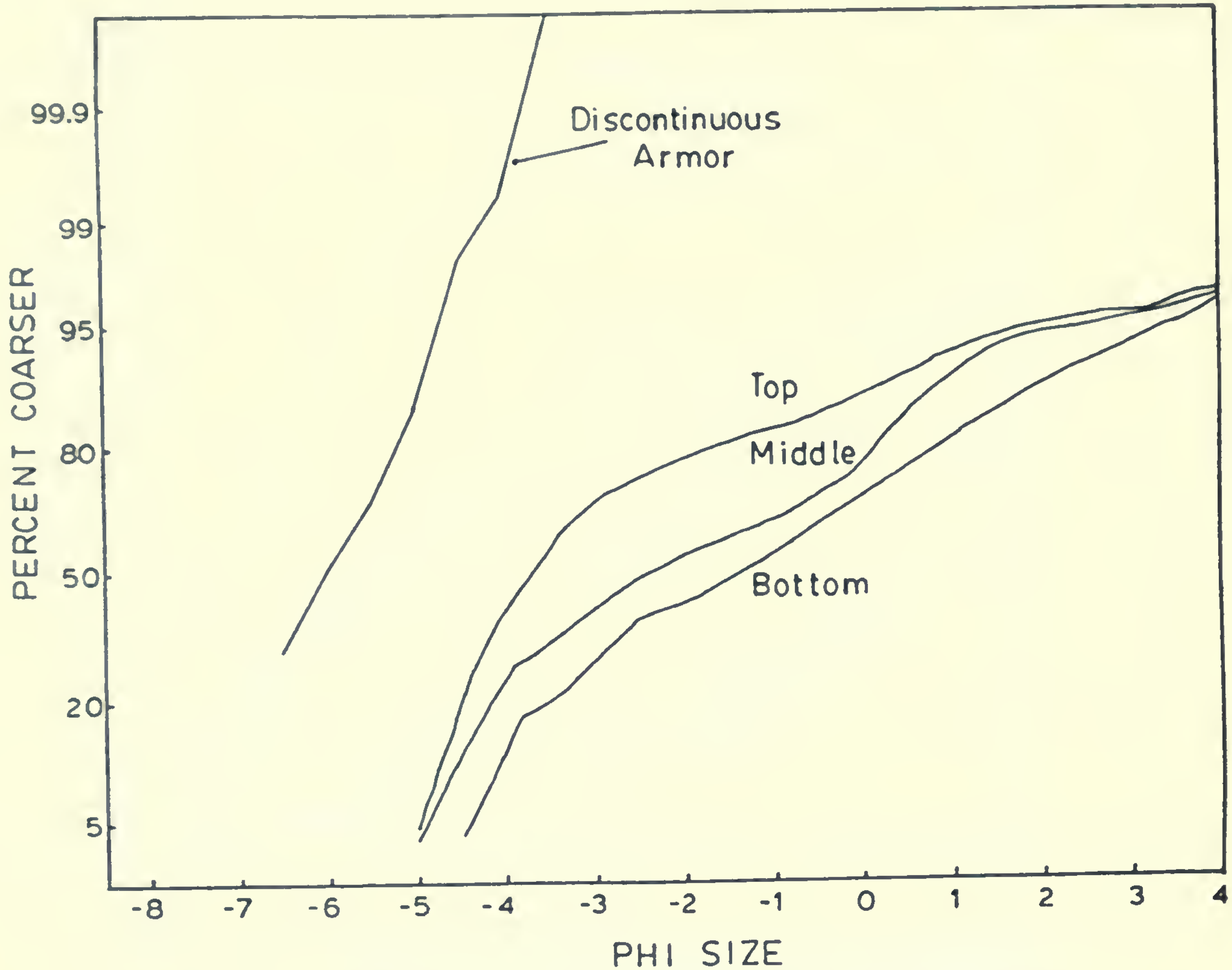

Figure 34. Size distributions for the discontinuous armor coat and sublayers for bar G-17 on the Grand River. Armor coat distribution is derived from sieving the area near photograph 20.

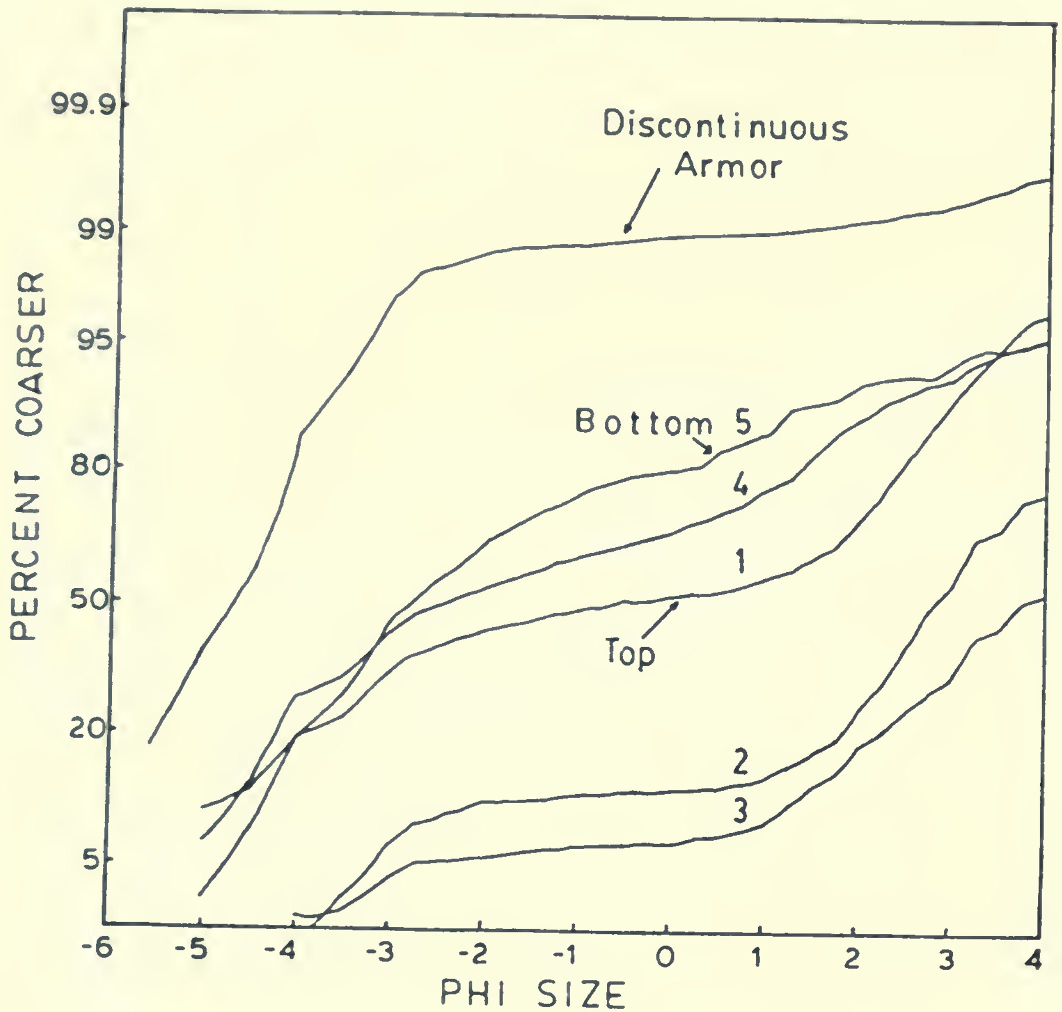

Figure 35. Size distributions for the discontinuous armor coat and sublayers of bar sample Gen-6 on the Genesee River. Numbers on distributions indicate the sequence of sublayers.

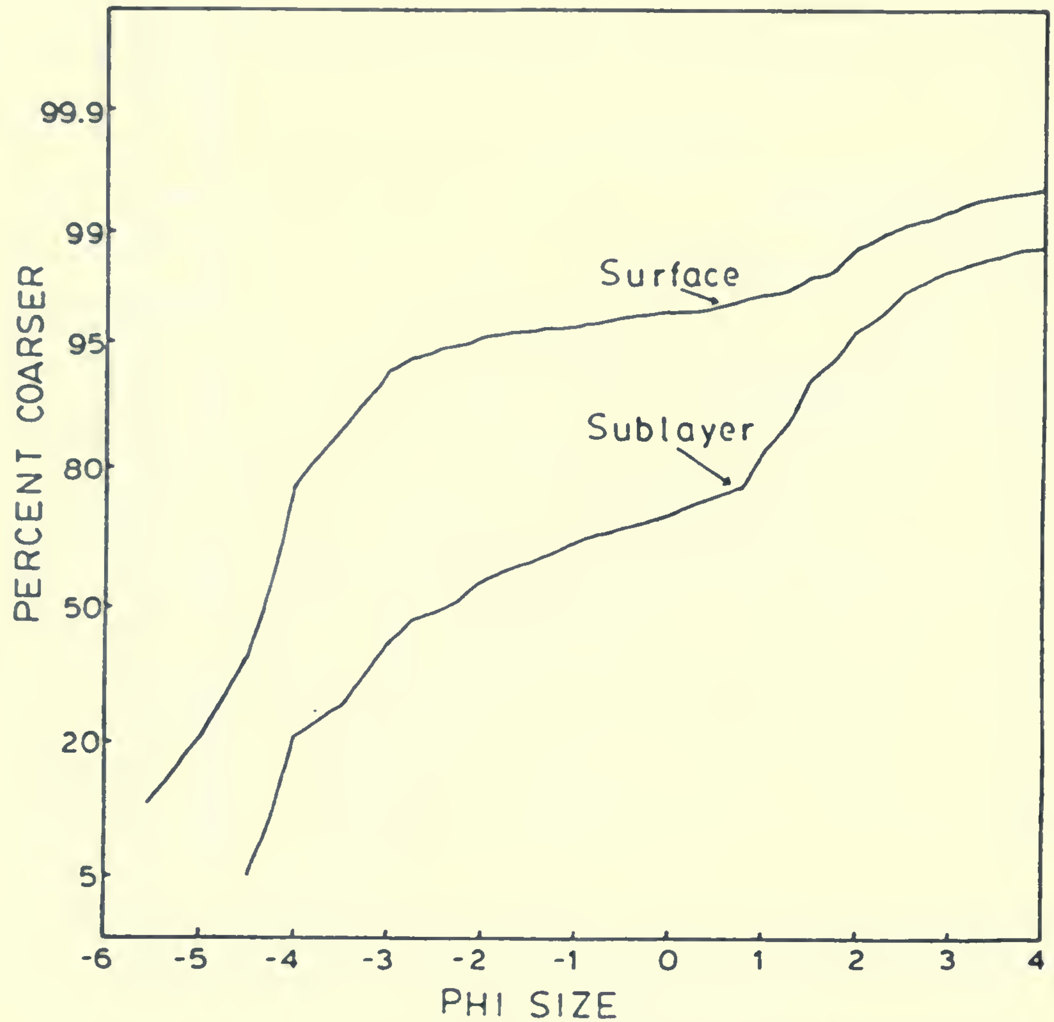

Figure 36. Size distributions for the surface and sublayer of bar Gen-16 on the Genesee River.

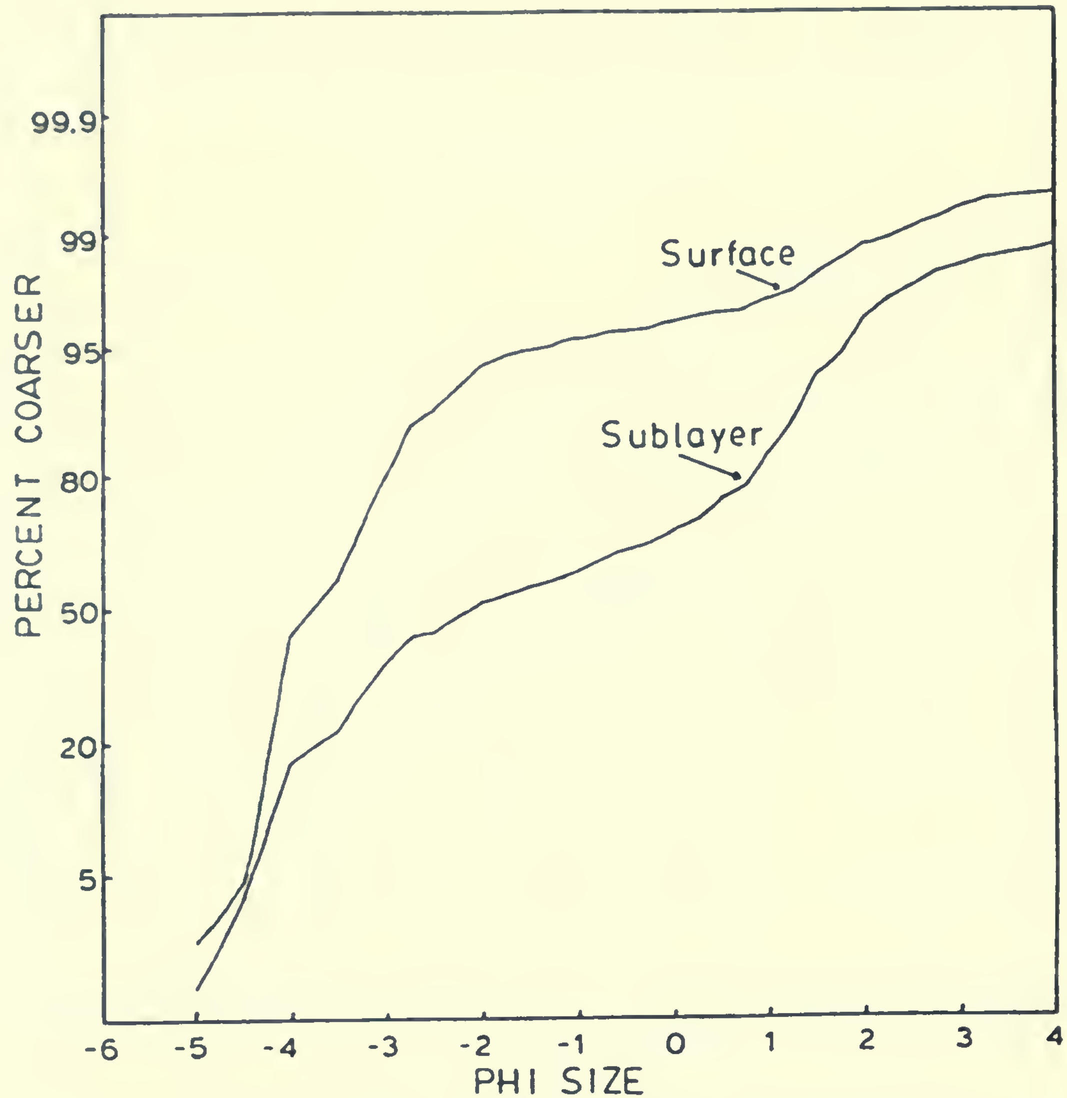

Figure 37. Size distributions for the surface and sublayer for bar Caz-19 on Cazenovia Creek.

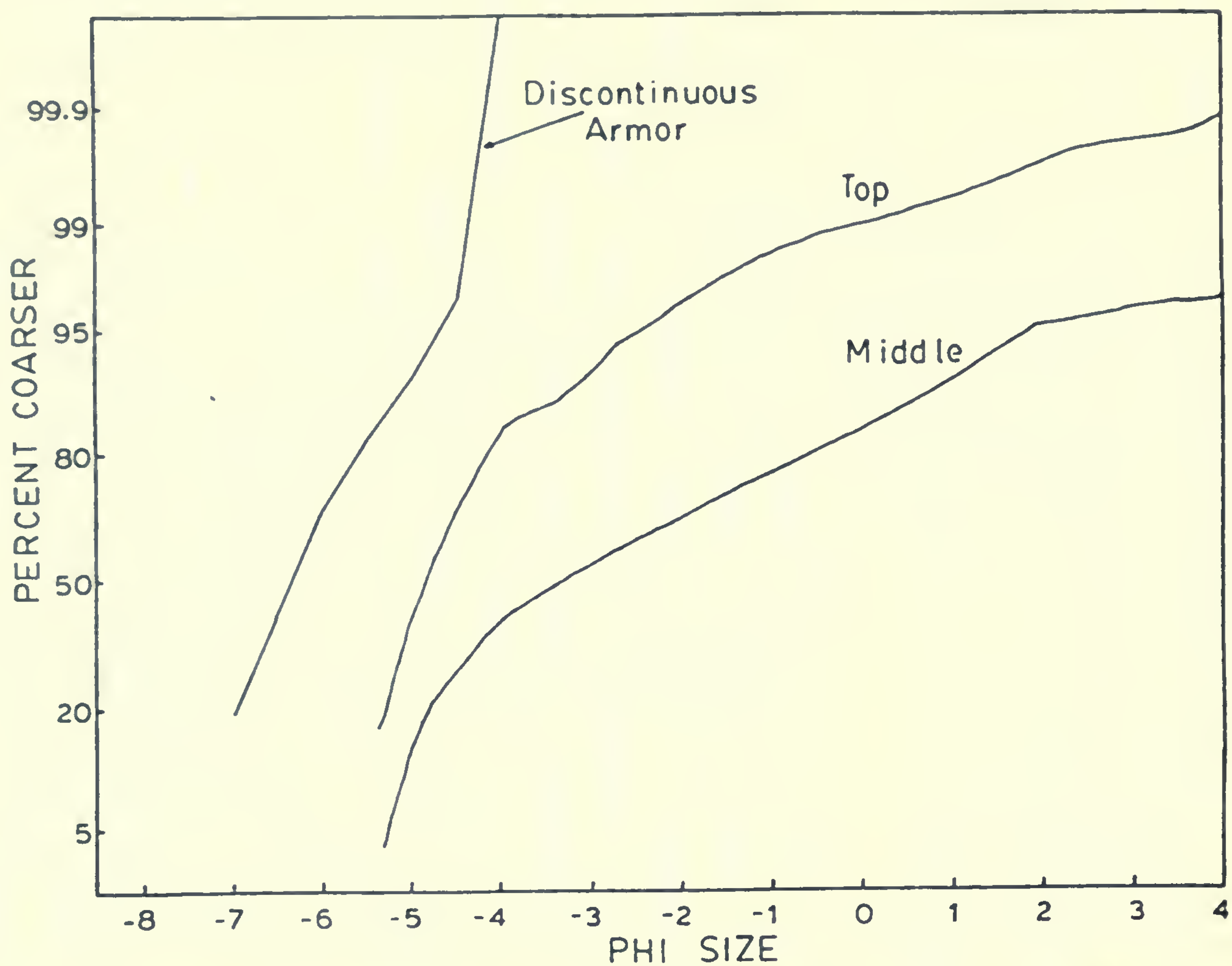

Figure 38. Size distributions for the discontinuous armor coat and sublayers of sample Caz-25 on Cazenovia Creek at Mill Street. Armor coat distribution is derived from sieving an area near photograph 96.

conditions than the present armor coat but under higher flow conditions than the other sublayers. The bottom-sublayer may represent a previous armored streambed over which sediment was later deposited as the stream aggraded. The coarse fraction of the bottom-sublayer also appears to be similar to that of the top-sublayer and sublayer 4 in figure 35, suggesting that they differ only in the amount of fines removed.

Several areas on the Genesee River have a fine bed-surface which is not armored. The fine surfaces on the Genesee River and Cazenovia Creek are shown in figures 36 and 37 respectively. The nature of the subsurface layer in both figures indicates that this sediment is deposited instantaneously and is not later modified by vertical winnowing. Deposition of this sublayer may occur during a low turbulent fluctuation as the flow recedes. Complete removal of scour gauges during the 1982-83 snow-melt shows that this subsurface is completely replaced during high flow. Subsequently, the surface of the sediment which replaces the original deposit is winnowed by waning and moderate flows. This suggests that the fine bed-surfaces on the Genesee River and Cazenovia Creek do not represent maximum flow conditions.

Size distributions of the top-sublayer for Sixteen Mile Creek are plotted in figure 39. Comparison of these distributions with those of figure 20 for Twenty Mile Creek

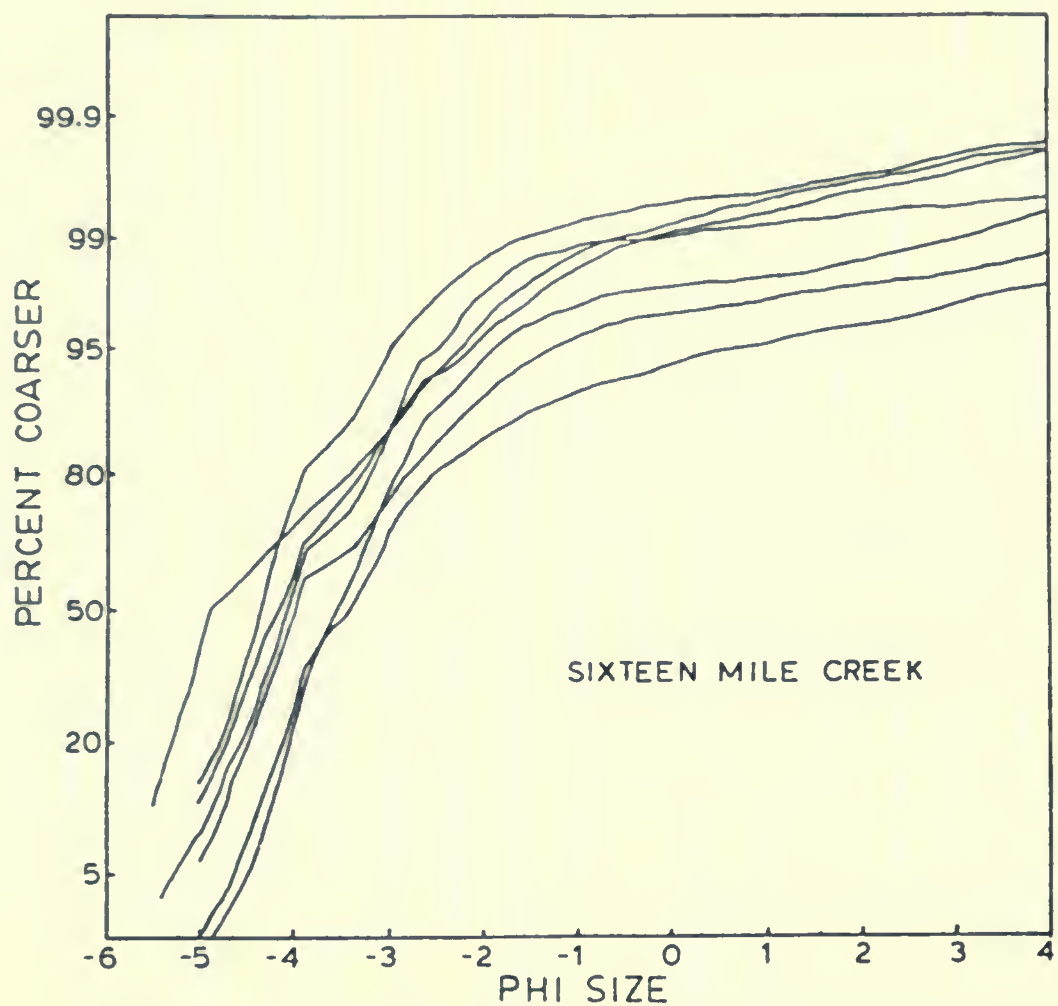

Figure 39. Size distributions for the top-sublayer in the gorge of Sixteen Mile Creek.

shows that the top-sublayer of Twenty Mile Creek is winnowed of more fines than that of Sixteen Mile Creek. This suggests that vertical winnowing is more intense on Twenty Mile Creek than on Sixteen Mile Creek. Size distributions for the top-sublayer of the Grand River are plotted in figure 40. Comparison of these distributions with those in figure 39 shows that the top-sublayer of Sixteen Mile Creek is winnowed of more fines than that of the Grand River. Distributions for the top-sublayer sampled in the Genesee River (figure 41) and Cazenovia Creek (figure 42) show some striking similarities. The distribution with the largest percentage of coarse material in each figure represents the sublayer that occurs beneath a discontinuous armor coat in each creek. The distributions with the smallest percentage of coarse material in each figure represent the top-sublayers beneath a surface that is not armored. This large difference between distributions in each figure occurs because the top-sublayer forms under different flow conditions. The finest distributions in both figures represent the top-sublayer deposited during moderate and receding flows, and is not later modified by vertical winnowing. The coarsest distributions in both figures represent the top-sublayer which is partially modified by vertical winnowing. This partial modification may occur when the discontinuous armor coat is penetrated during high flow. A comparison of the middle and bottom-sublayers between all

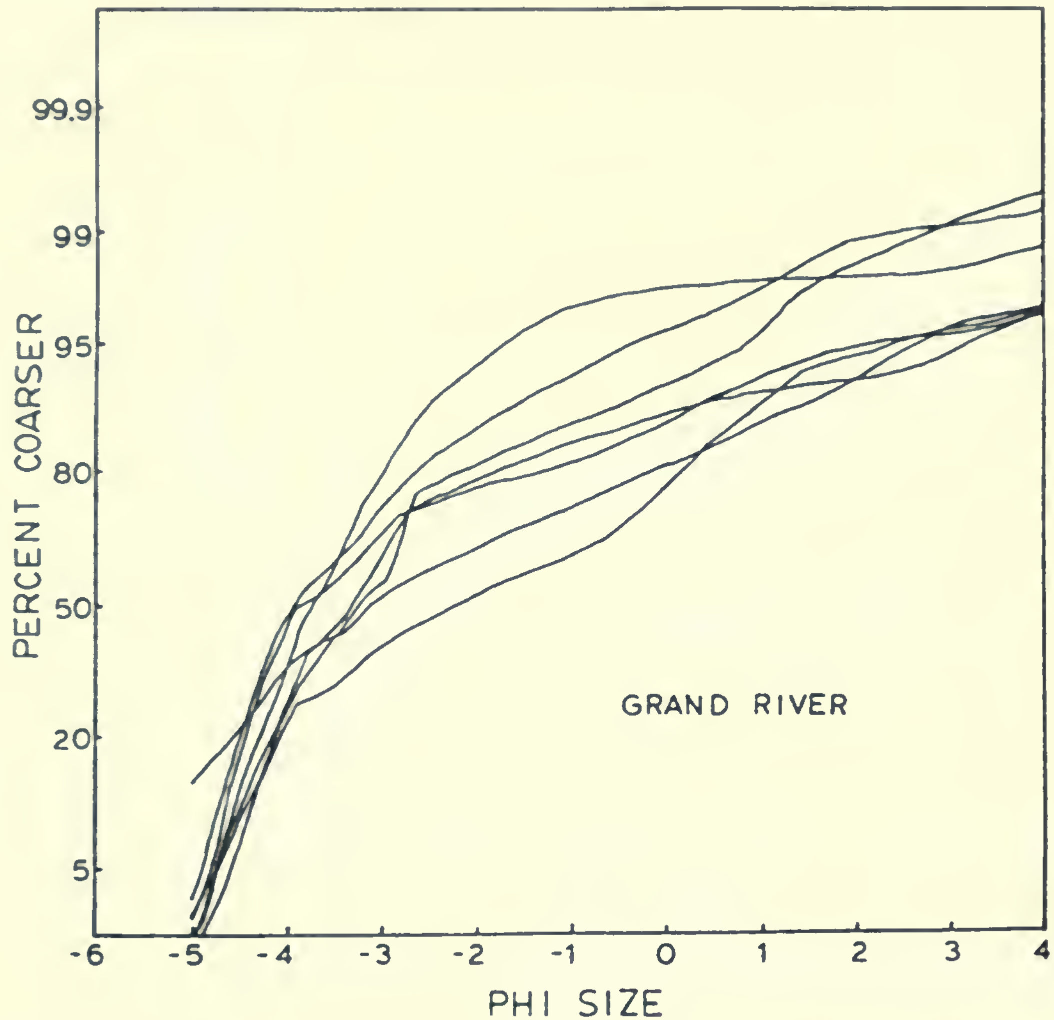

Figure 40. Size distributions for the top-sublayer of bars on the Grand River.

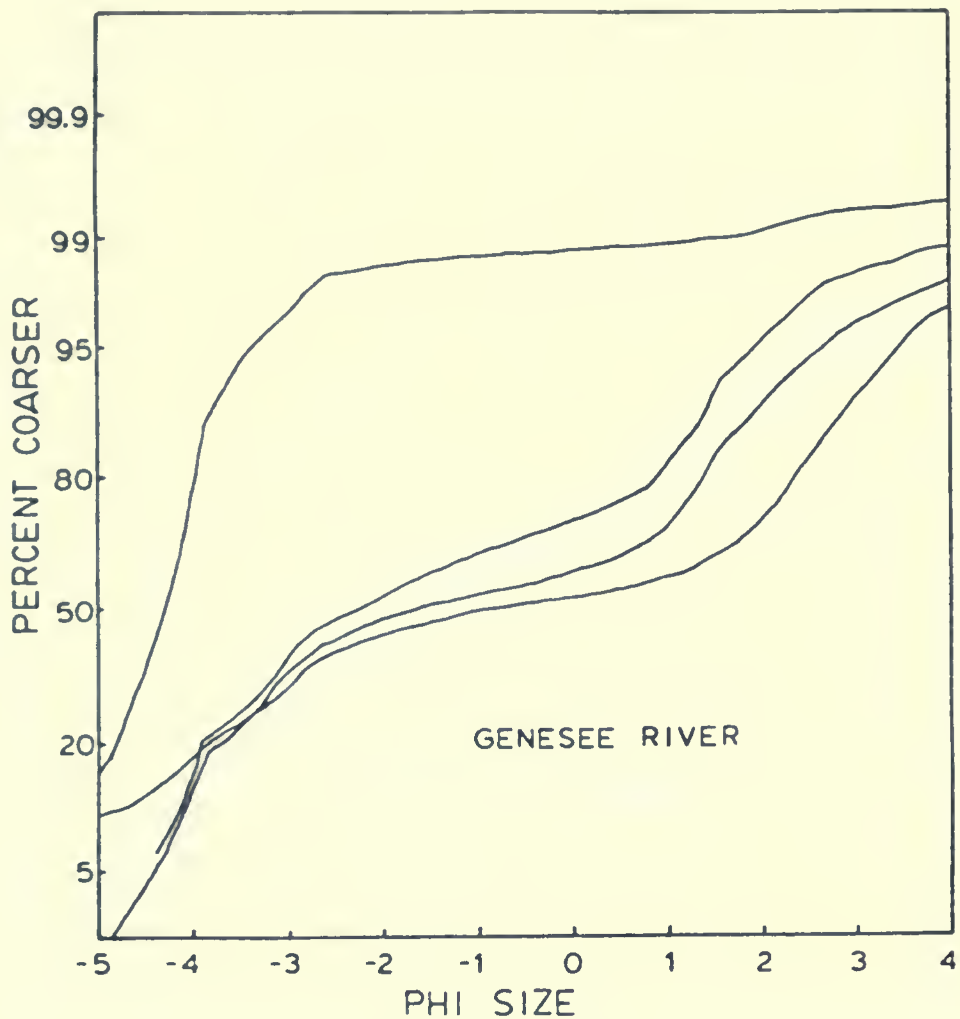

Figure 41. Size distributions for the top-sublayer of bars on the Genesee River.

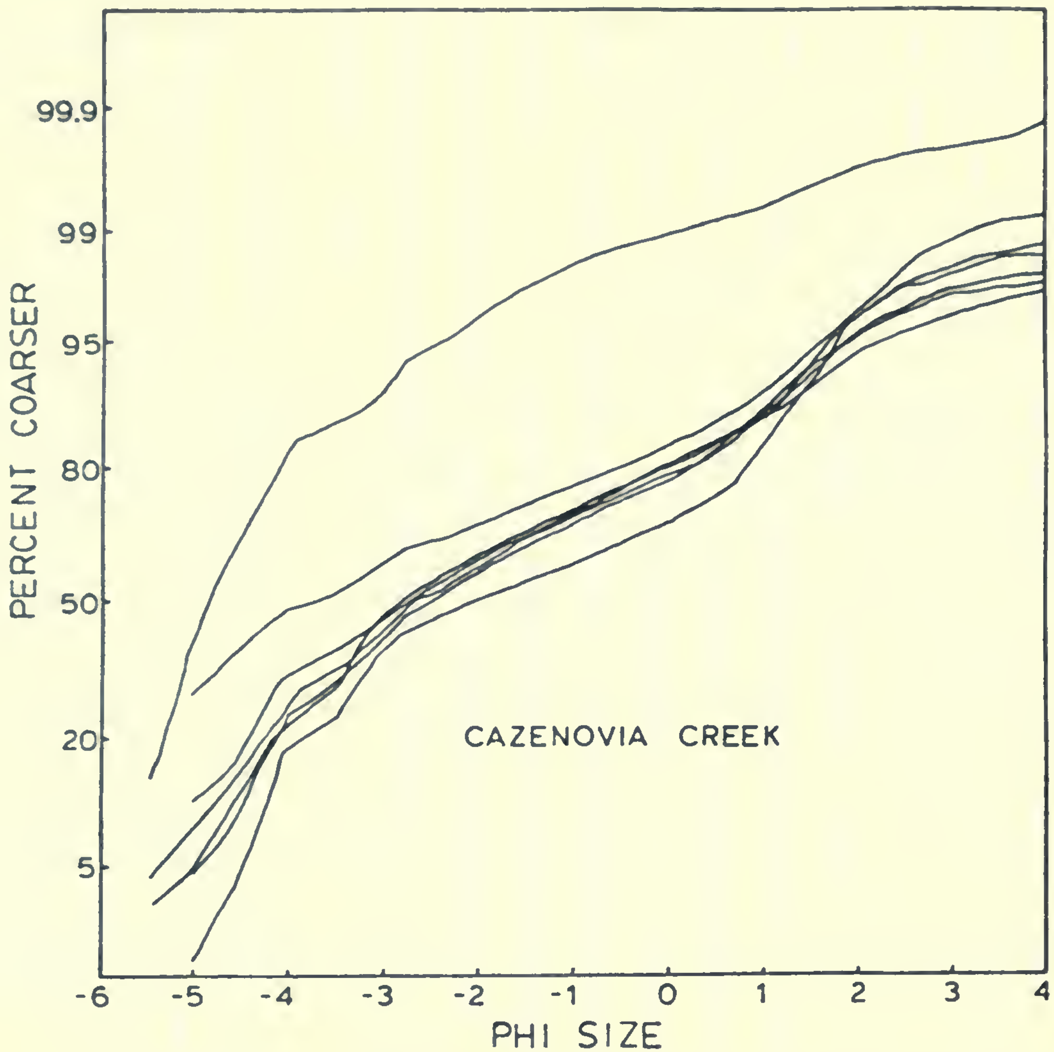

Figure 42. Size distributions for the top-sublayer of bars on Cazenovia Creek.

the streams is not possible because of insufficient data for the Grand and Genesee Rivers and the absence of these sublayers for most areas of Cazenovia Creek.

Figure 43 a to c summarizes the relation between the surface and subsurface sediment in this study. The sublayers beneath a continuous armor coat are subjected to the most vertical winnowing and therefore, show the greatest differences between one another (figure 43 a). The sublayers beneath discontinuous armor sediment are subjected to less vertical winnowing than those below a continuous armor coat. Inverse grading still occurs but the difference between sublayers is markedly decreased (figure 43 b). An unsorted, homogeneous subsurface occurs below a surface layer that is not armored because the sediments have not been modified by vertical winnowing (figure 43 c).

In addition, figure 44 may represent a method by which streambed armoring can be measured. It indicates that the mean size of the armor coat is related to the mean size of the top-sublayer. Three distinct fields are evident: 1) the first field represents the coarsest top-sublayer beneath a continuous armor coat, 2) the second field represents the next coarsest top-sublayer below a discontinuous armor coat, and 3) the third field represents the finest top-sublayer beneath a surface which is not armored. These results suggest that in at least the five

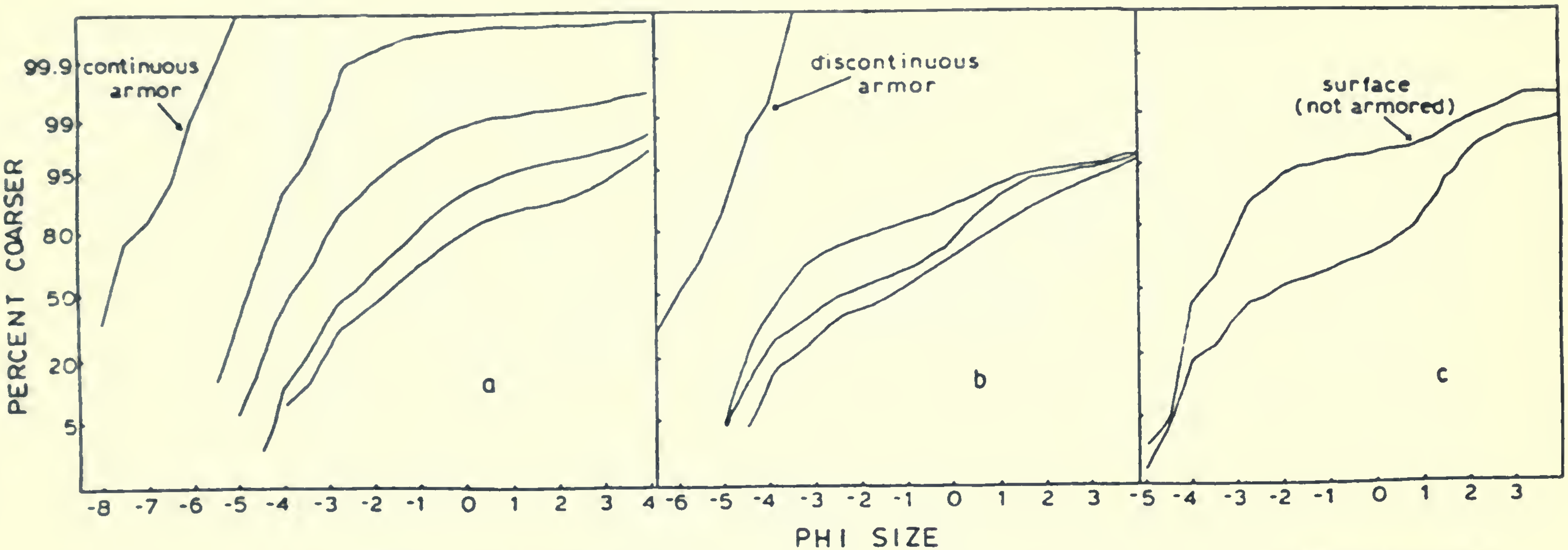

Figure 43. A comparison of sublayers beneath a)a continuous armor coat b)a discontinuous armor coat, and c)no armor coat.

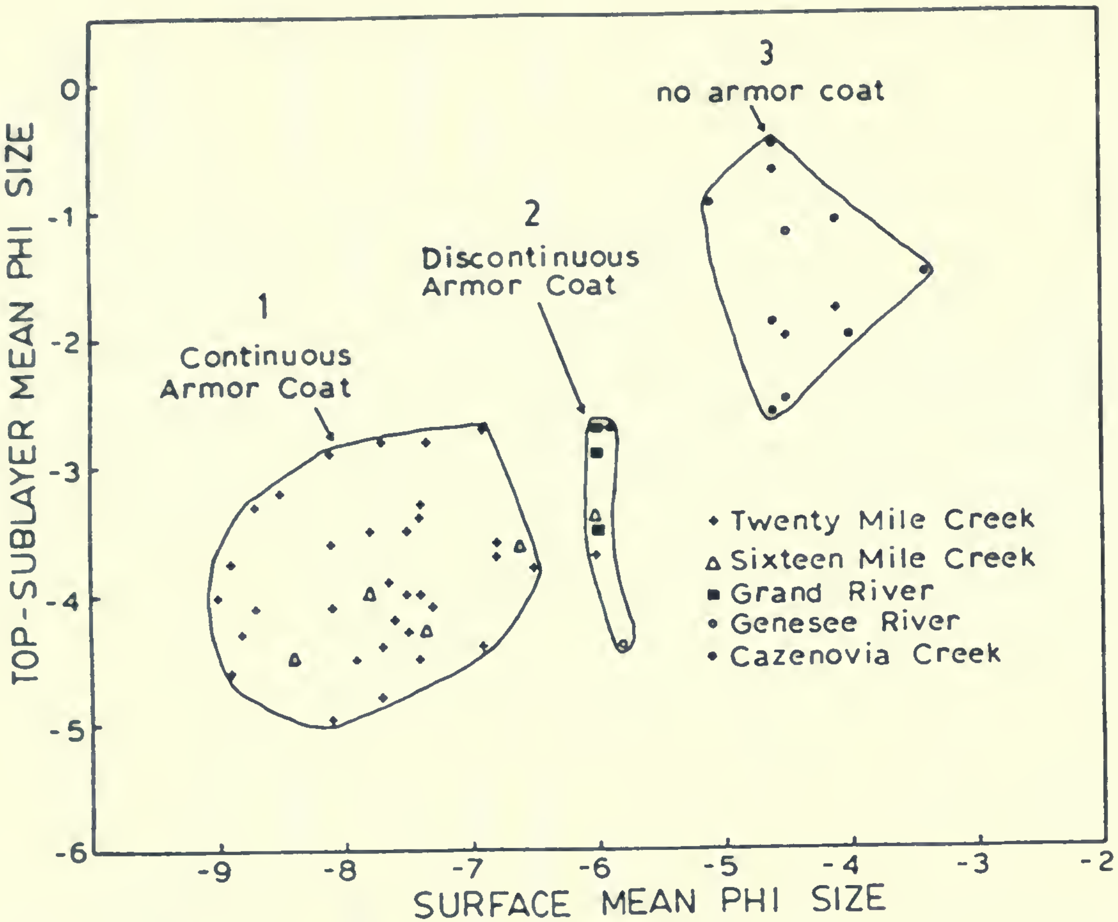

Figure 44. Mean phi size of the armor coat versus mean phi size of the corresponding top sublayer.

rivers studied, a continuous armor coat has a mean size of -6.5 phi and coarser. A discontinuous armor coat has a mean size of approximately -6.0 phi, and a surface with no armor coat has a mean size of -5.0 phi and finer.

Figures 45 to 49 show straight-line segments for the top-sublayers of bars on Twenty and Sixteen Mile Creeks, the Grand and Genesee Rivers, and Cazenovia Creek respectively. Comparison of each consecutive figure shows that the size-range of population 2 expands from one stream to the next. This suggests that the least mixing of populations for the top-sublayer occurs in Twenty Mile Creek, next is Sixteen Mile Creek, followed by the Grand River, and the greatest mixing occurred in the Genesee River and Cazenovia Creek. However, the sizes comprising population 1 in the sublayers of each stream are also related to the source of sediment for each stream. This is suggested by Middleton and Southard (1977) who indicate that the sizes which constitute the traction population are partially dependent on the source area.

It must be noted that the populations of sublayers beneath a continuous armor coat are not indicative of transport modes because they are modified by vertical winnowing. However, vertical winnowing is significantly reduced for the subsurface beneath a discontinuous armor coat. Therefore, populations for this subsurface sediment may be indicative of transport modes, but are modified by

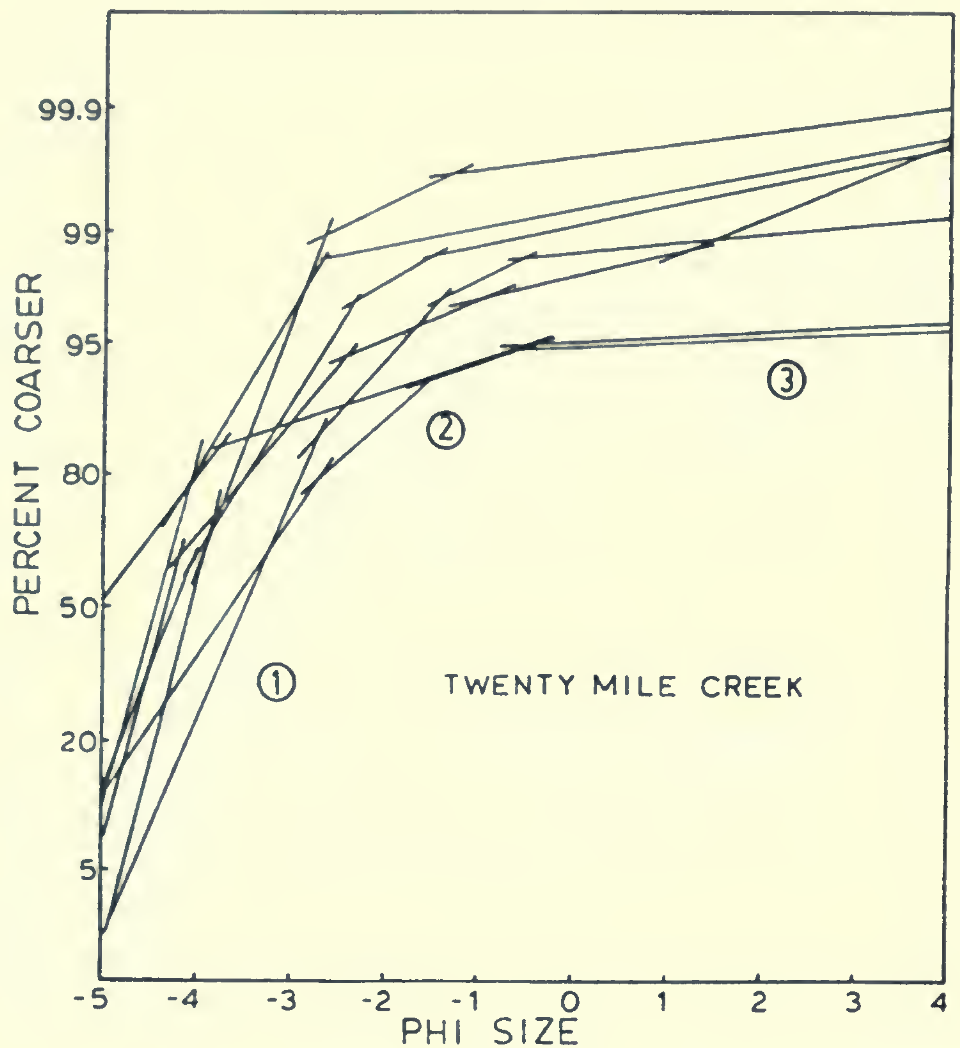

Figure 45. Straight-line segments for the top-sublayer of bars in the gorge of Twenty Mile Creek.

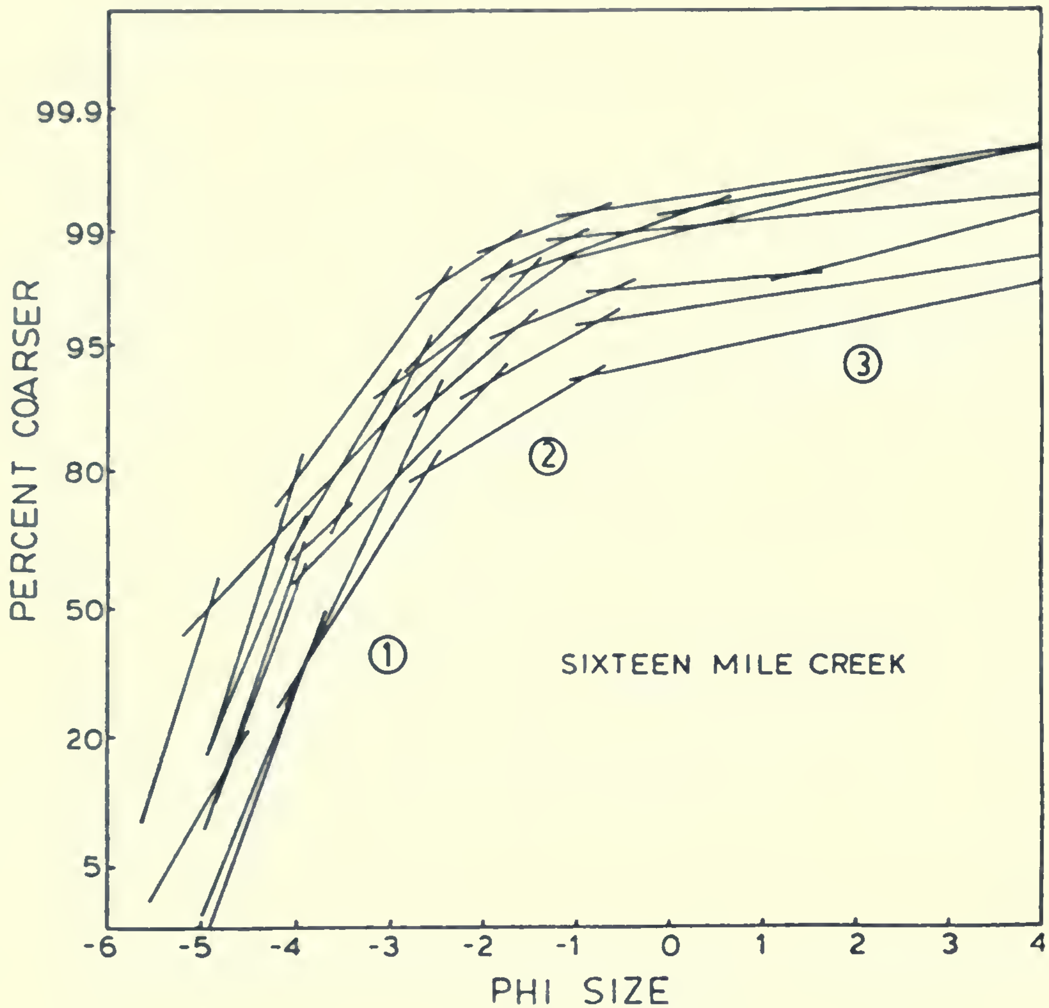

Figure 46. Straight-line segments for the top-sublayer in the gorge of Sixteen Mile Creek.

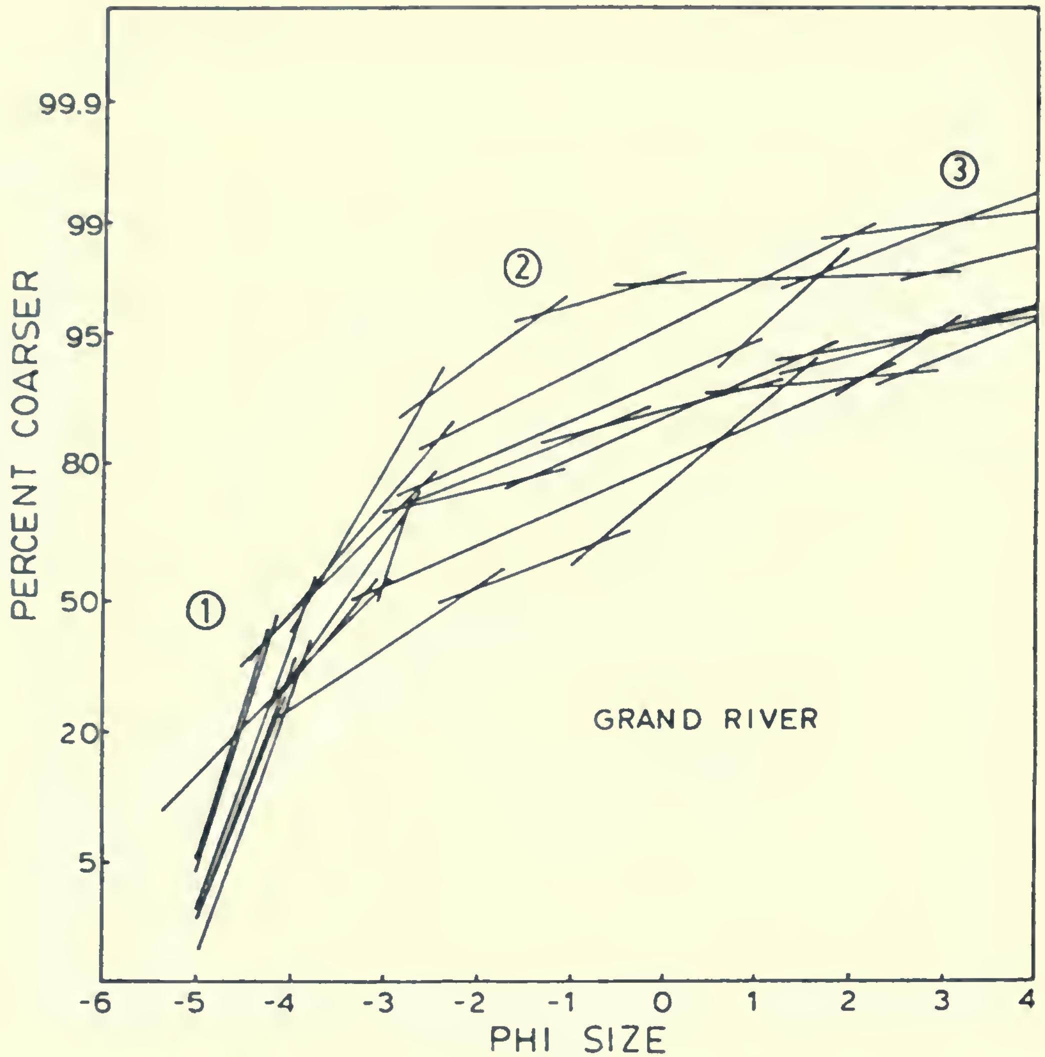

Figure 47. Straight-line segments for the top-sublayer of bars on the Grand River.

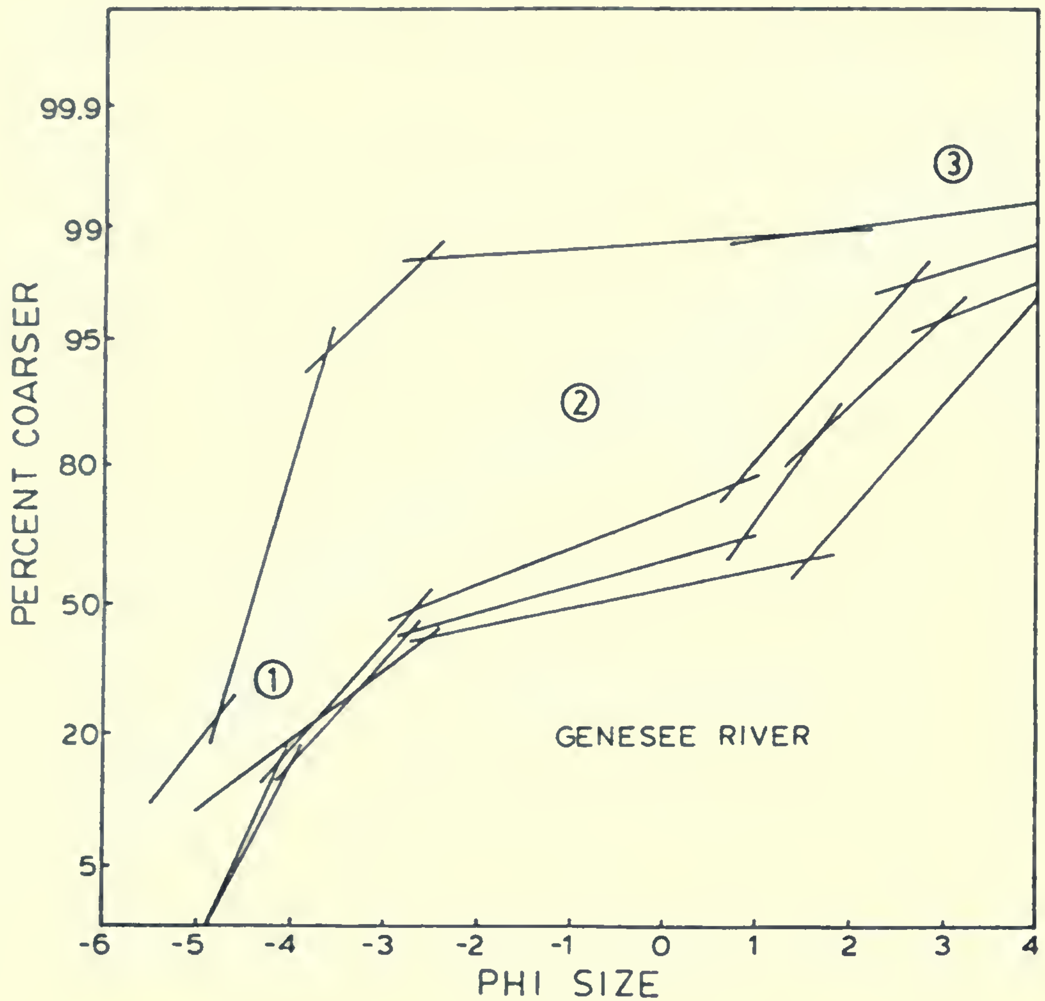

Figure 48. Straight-line segments for the top-sublayer of bars on the Genesee River.

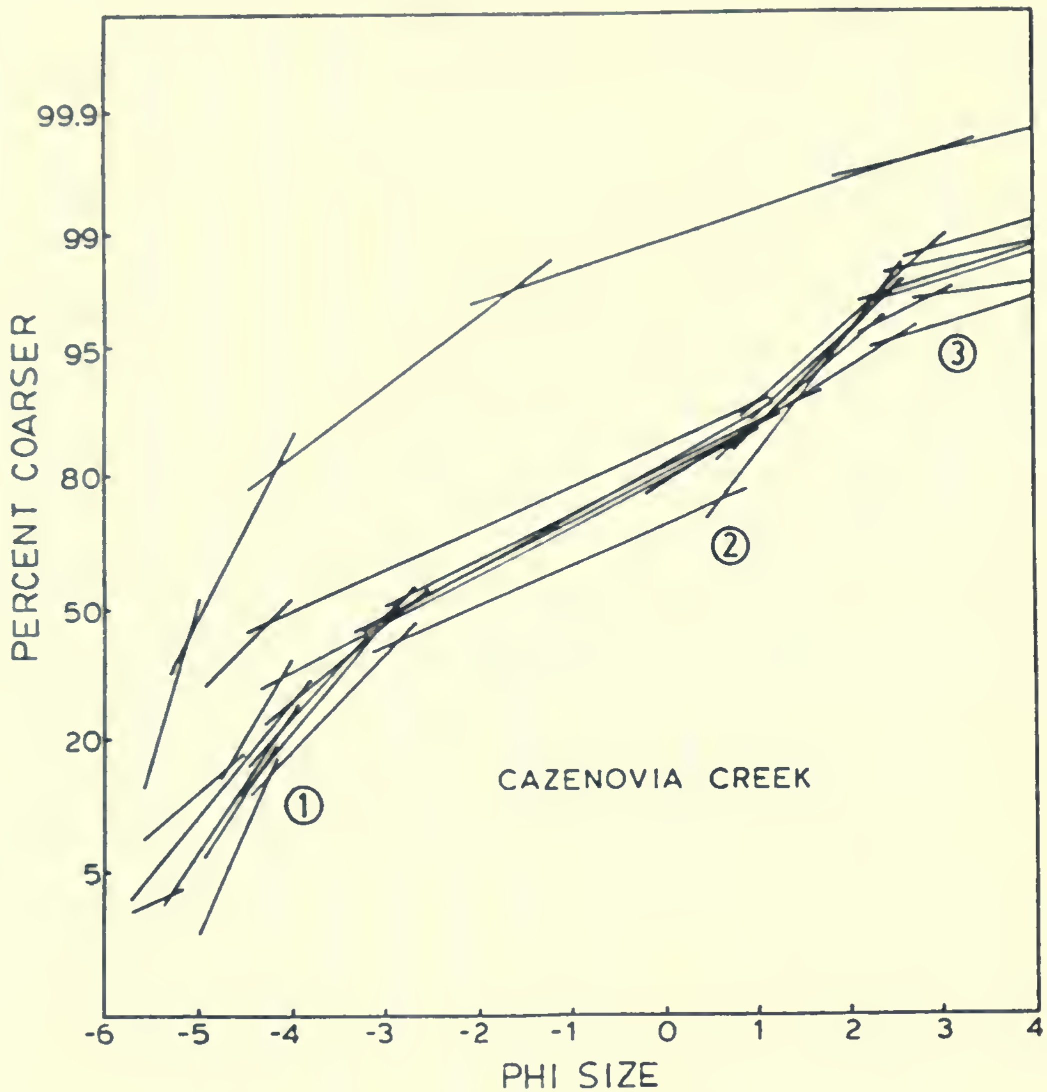

Figure 49. Straight-line segments for the top-sublayer of bars on Cazenovia Creek.

vertical winnowing. The populations for the sediment beneath a surface which is not armored are probably indicative of transport modes because they show no modification by vertical winnowing.

STREAMBED PHOTOGRAPHS

Probability of Motion

Probability of movement for given size sediment was determined using photographs. It is calculated by dividing the number of grains of a given size moved between the 1982 and 1983 photographs by the total number of grains of this size initially present in the 1982 photographs.

Figures 50 and 51 show the percent probability of movement versus phi size for photographed areas of Twenty Mile Creek in the channel and on bars respectively. Each graph represents a different photograph. Although some scatter is present, a good relation exists between percent probability of movement and size. In all sampled areas of Twenty Mile Creek, the coarsest sizes have the lowest, and finest sizes have the highest probability of movement.

Figures 52, 53 and 54a and b show the percent probability of motion for a given size in the photographed areas of Sixteen Mile Creek, the Genesee and Grand Rivers and Cazenovia Creek respectively. All the streams show the same linear relation between probability of movement and

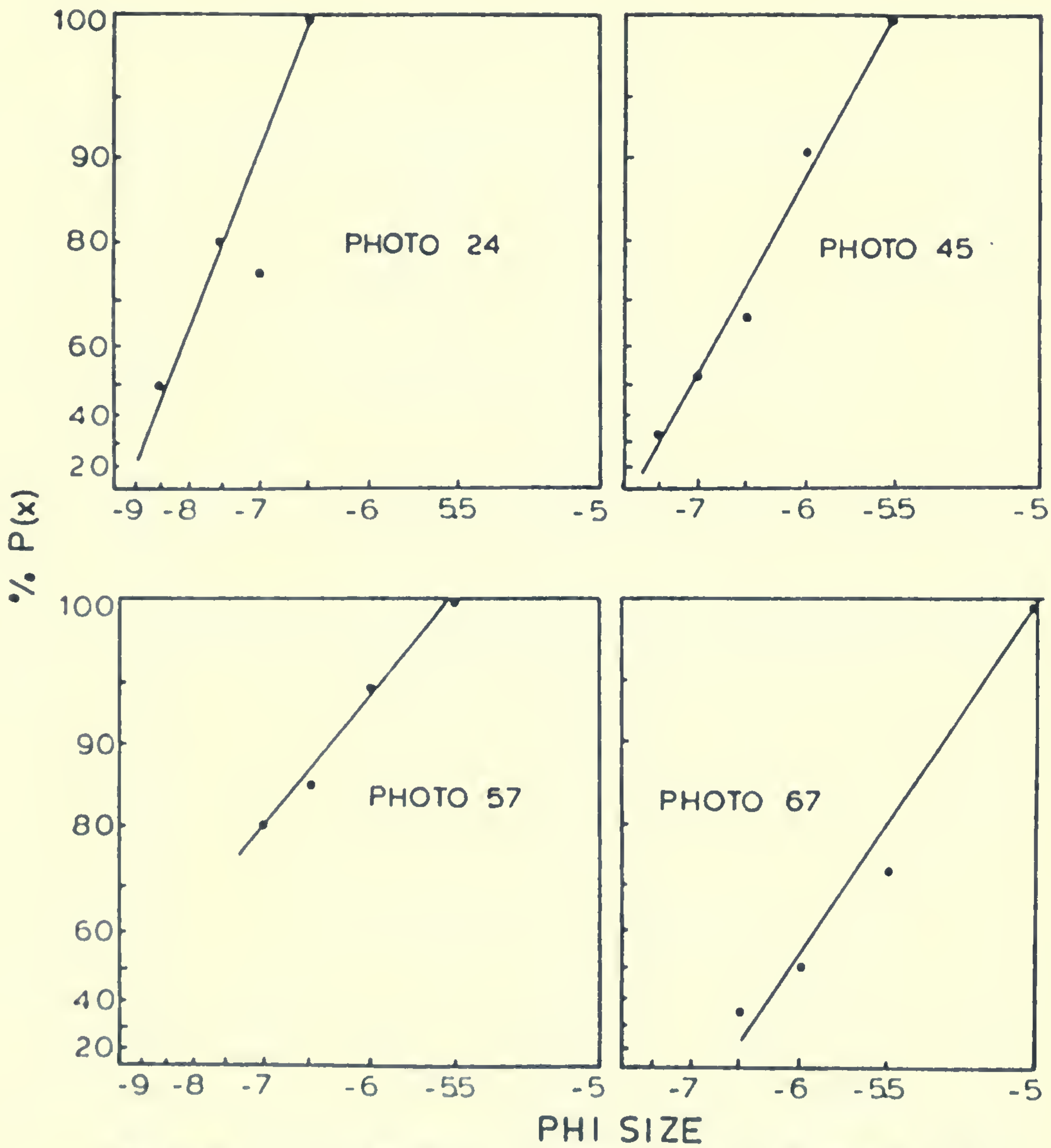

Figure 50. Percent probability of movement with phi size for several photographed areas in the channel of Twenty Mile Creek.

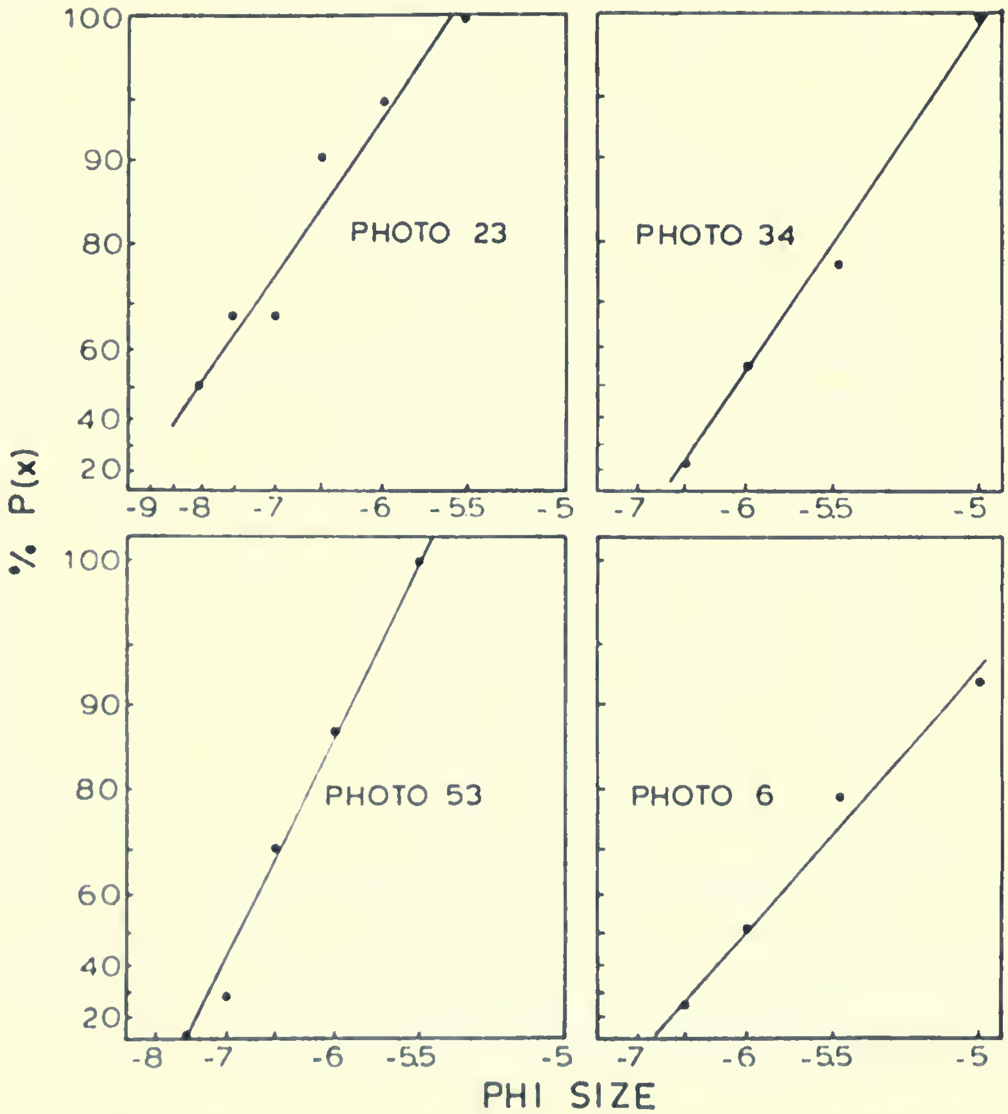

Figure 51. Percent probability of movement with phi size for several photographed areas on bars of Twenty Mile Creek.

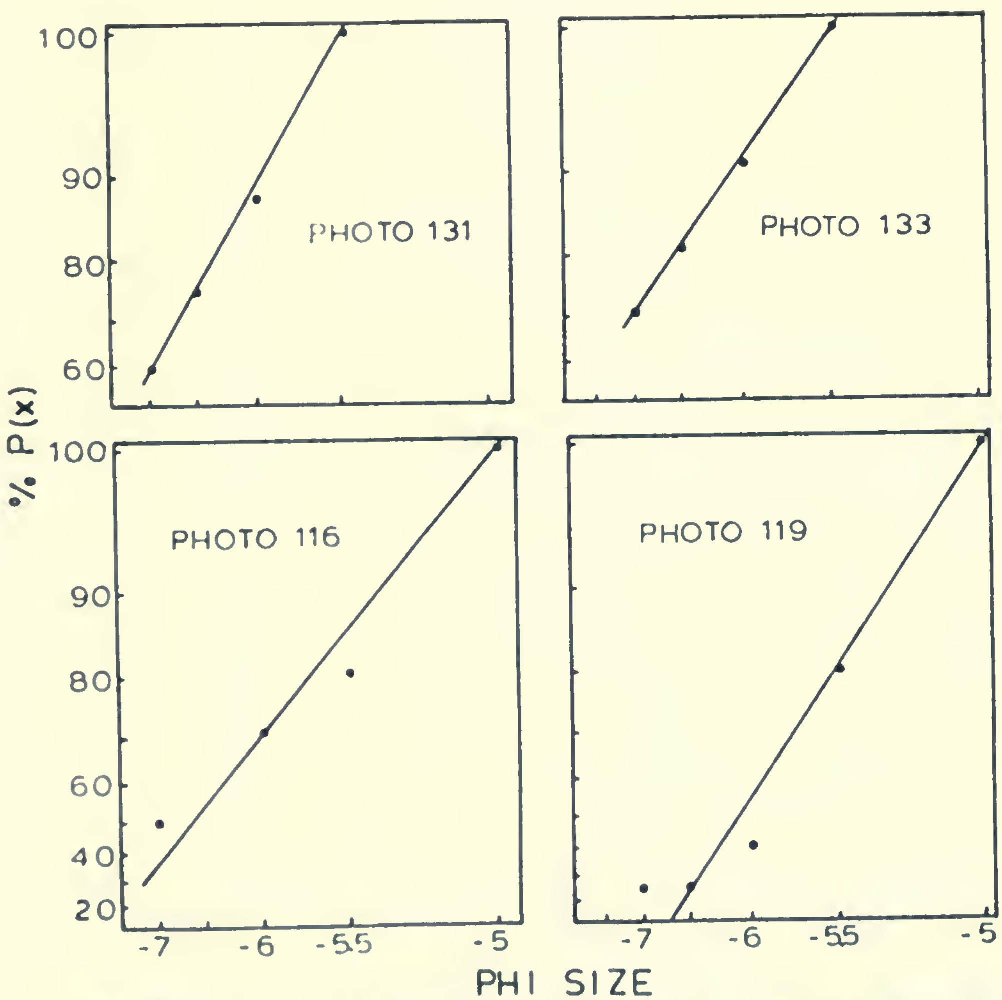

Figure 52. Percent probability of movement with phi size for several photographed areas on Sixteen Mile Creek.

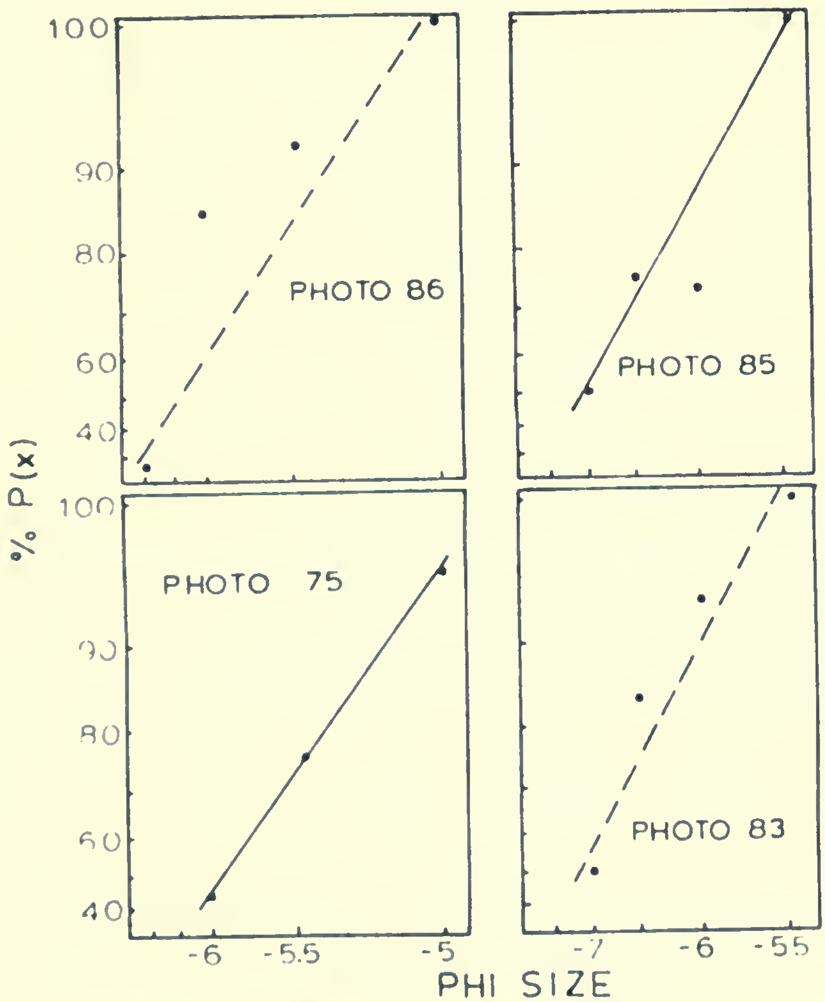

Figure 53. Percent probability of movement with phi size of several photographed areas on the Genesee River.

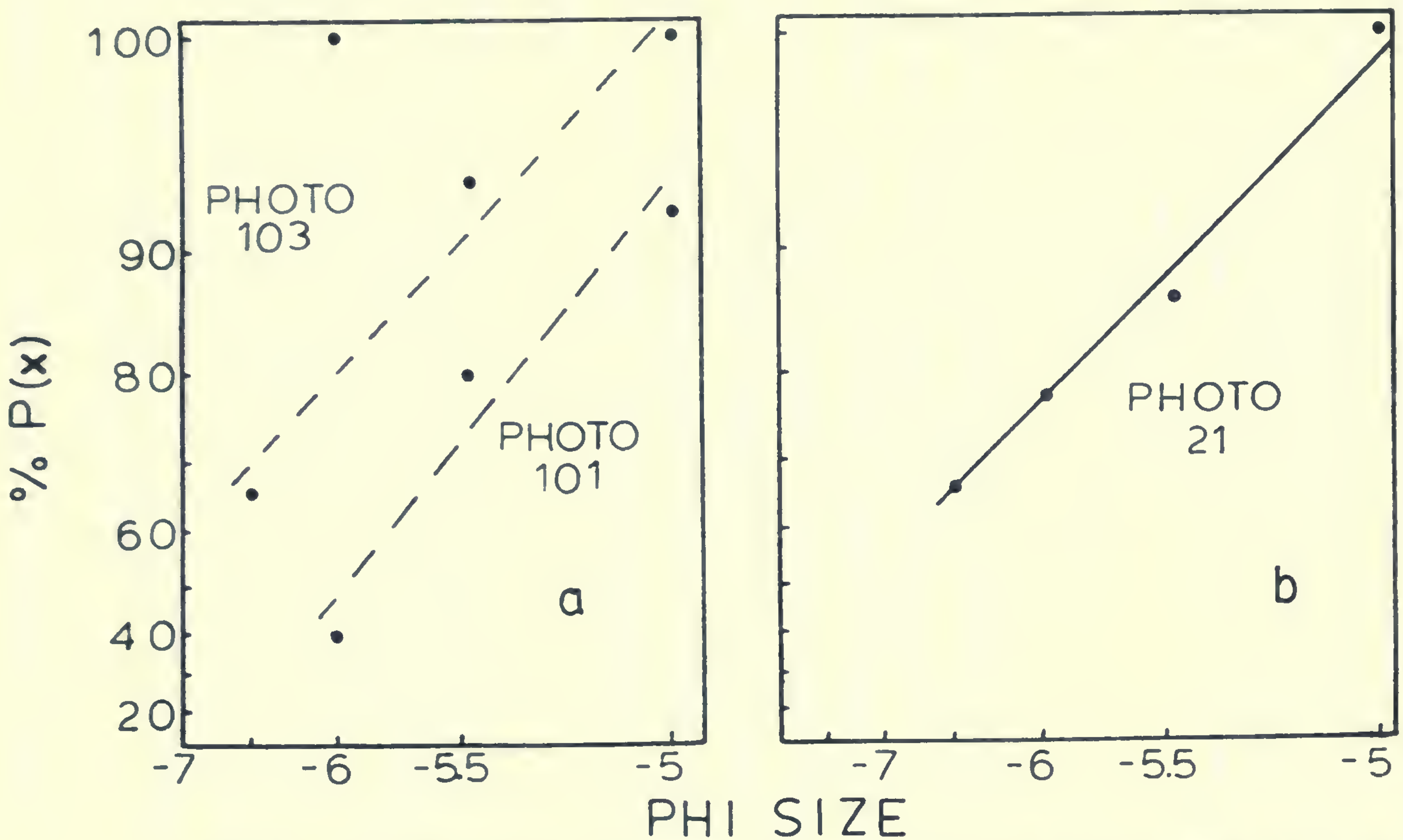

Figure 54. Percent probability of movement versus phi size for two photographed areas on Cazenovia Creek (a) and one for the Grand River (b). Photograph numbers are indicated.

size observed on Twenty Mile Creek. However, because most photographs of Cazenovia Creek showed 100 percent movement, only two photographs were used for determining probability of movement. Only 20 photographs were taken on the Grand River because summer flooding prevented access to the bed. Only one of these photographs was used to determine probability of movement. The others showed either no clast movement or 100 percent movement.

Local Streambed Equilibrium

Size analysis from photographs was also used to measure the weight of sediment moved in and out of a given photographed area. If the total weight of sediment moved into a local bed area is greater than the total weight moved out, then the bed is aggrading. If the reverse is true, then the bed is degrading, and if sediment weight moved in and out is equal, then the streambed is in equilibrium.

Figure 55 a and b show the total weight moved in versus the total weight moved out of the photographed areas on Twenty Mile Creek in the gorge and downstream of Highway 8 respectively. It is evident that the total weight moved into most areas on Twenty Mile Creek is greater than the weight moved out suggesting that the bed has aggraded slightly during the 1982-83 snow-melt.

Figure 56 a to d shows the total weight moved in

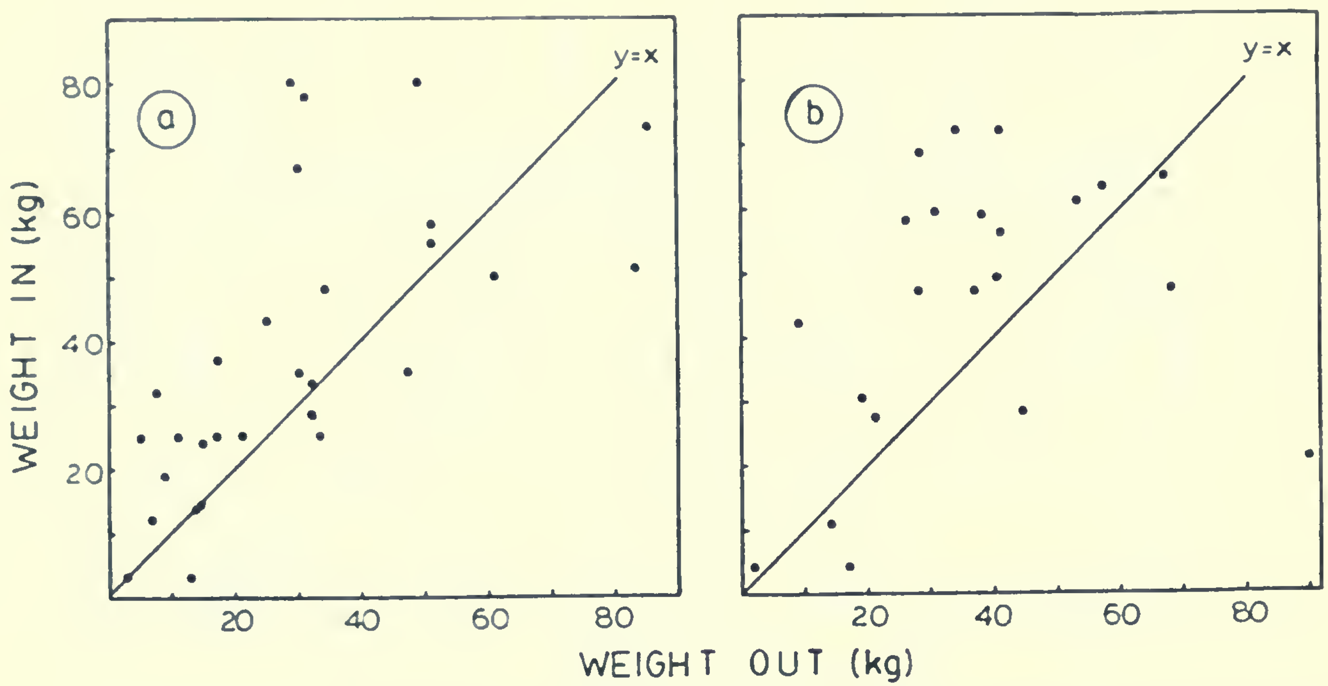

Figure 55. Total sediment weight moved in versus total sediment weight moved out for each photographed area on Twenty Mile Creek in the gorge (a) and downstream of Highway 8 (b).

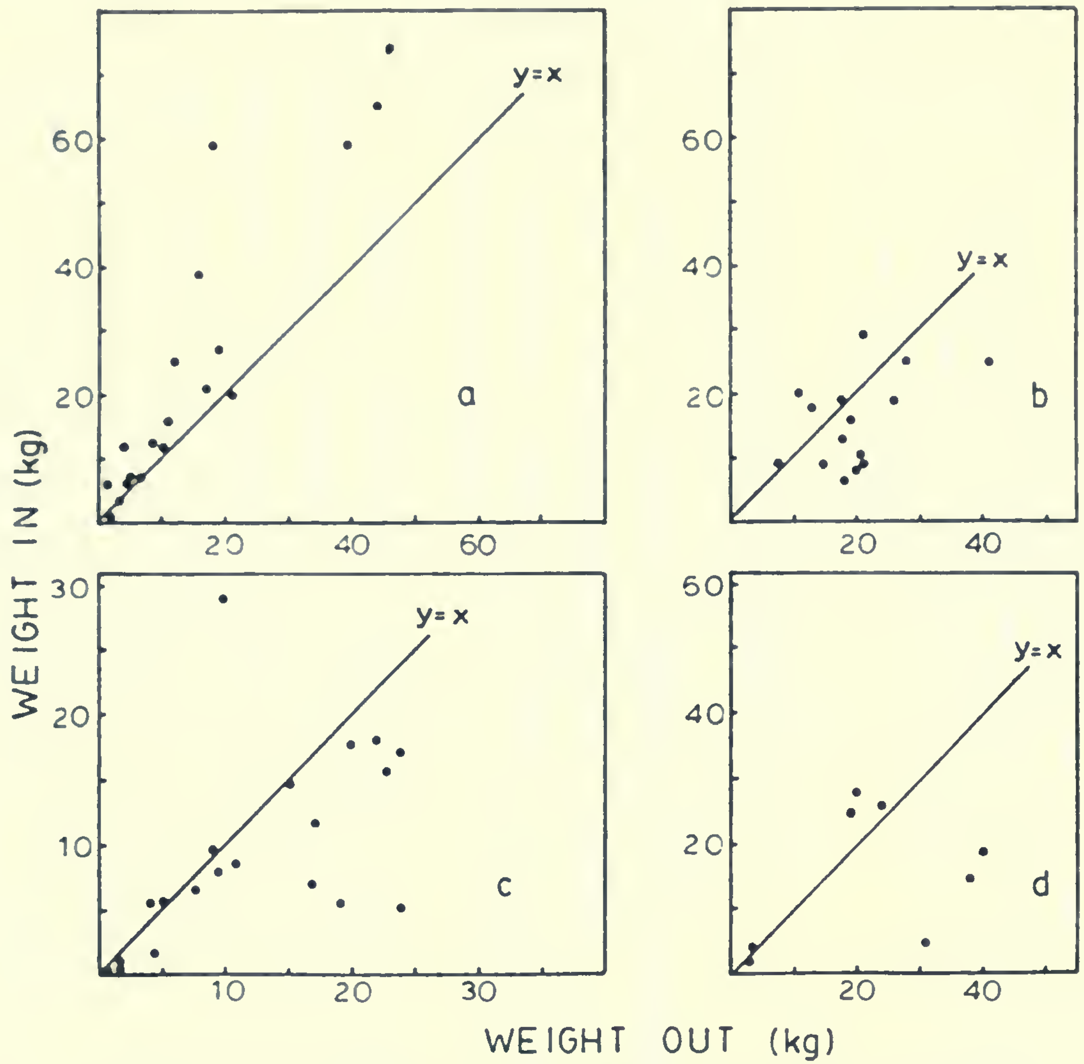

Figure 56. Total sediment weight moved in versus total sediment weight moved out of each photographed area on a)Sixteen Mile Creek, b)the Genesee River, c) Cazenovia Creek and d)the Grand River.

versus the total weight moved out of photographed areas on Sixteen Mile Creek, the Genesee River, Cazenovia Creek and the Grand River respectively . These figures show that during the 1982-83 snow-melt degradation predominated for the unarmored bed of Cazenovia Creek and the discontinuous and unarmored beds of the Genesee River, while aggradation was more common for the continuous armor coats of Twenty and Sixteen Mile Creeks.

Scour and Probability of Movement

Probability of motion determined from photographs may be related to local bed scour. This relation is determined by comparing data from a scour gauge to that obtained from the nearest photograph.

Figures 57 and 58 show scour depth versus percent probability of movement for a given photographed area on Twenty Mile Creek with mean sizes ranging from -6.0 to -8.0 phi. Figure 59 shows similar data for Sixteen Mile Creek. In all three figures, two trends are present: one for the channel and one for bars. Although there is some scatter, the relation between probability of movement for a given mean bed size and scour depth is quite good.

Clasts of -5.0 phi and smaller were not included in figures 57 to 59. Clasts of these sizes may be transported during flows when the armor coat is not penetrated and should not be related to scour.

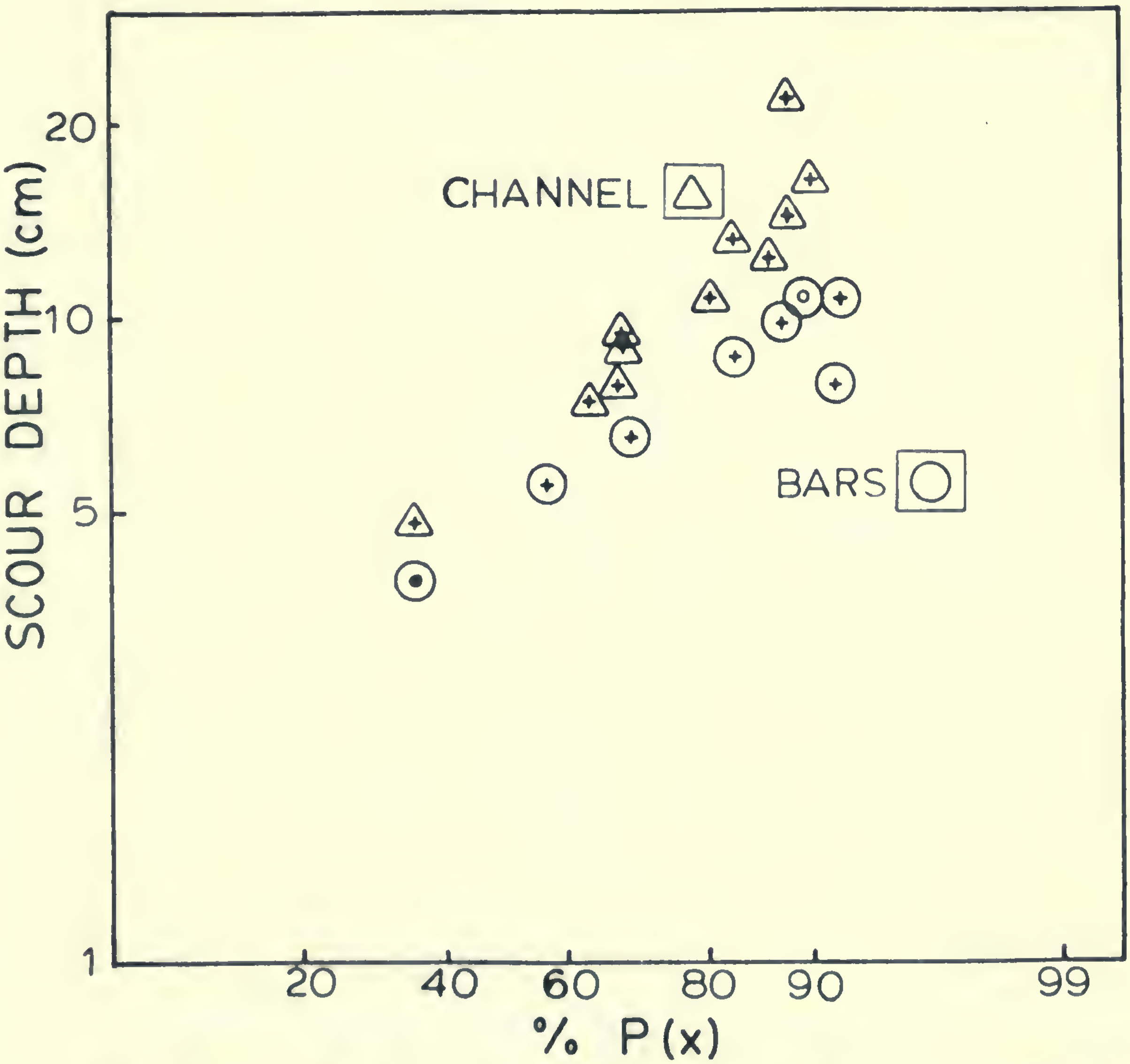

Figure 57. Percent probability of movement for photographed areas whose mean size is -7.5 phi (•), -7.0 phi (+), and -8.0 phi (o) versus scour depth for the 1982-83 snow-melt. Data are shown for Twenty Mile Creek, and do not include clasts of -5.0 phi and smaller.

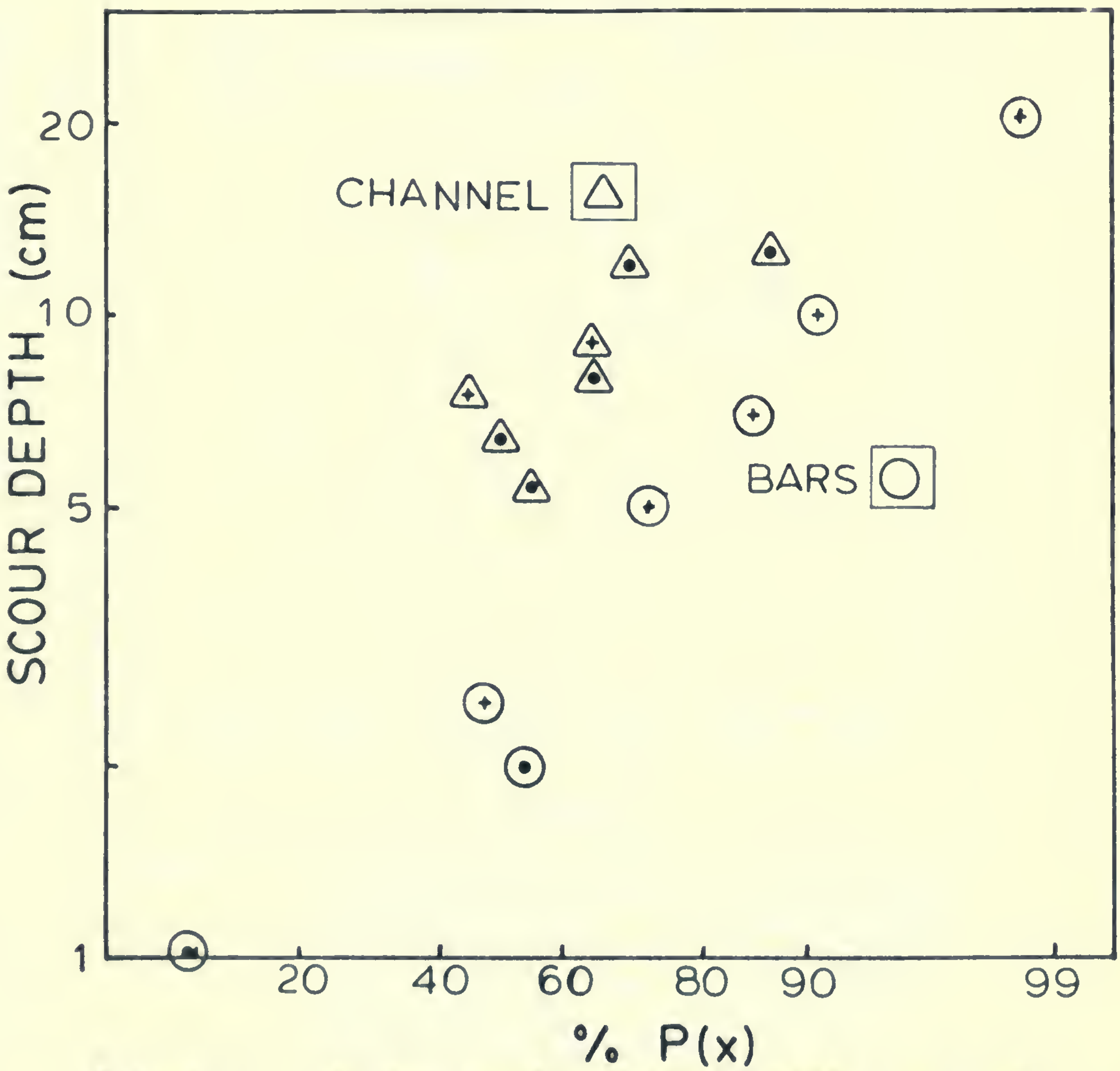

Figure 58. Percent probability of movement for the photographed areas whose mean size is -6.5 phi (+) and -6.0 phi (•) versus scour depth for the 1982-83 snow-melt. Data are shown for Twenty Mile Creek and do not include clasts of -5.0 phi and smaller.

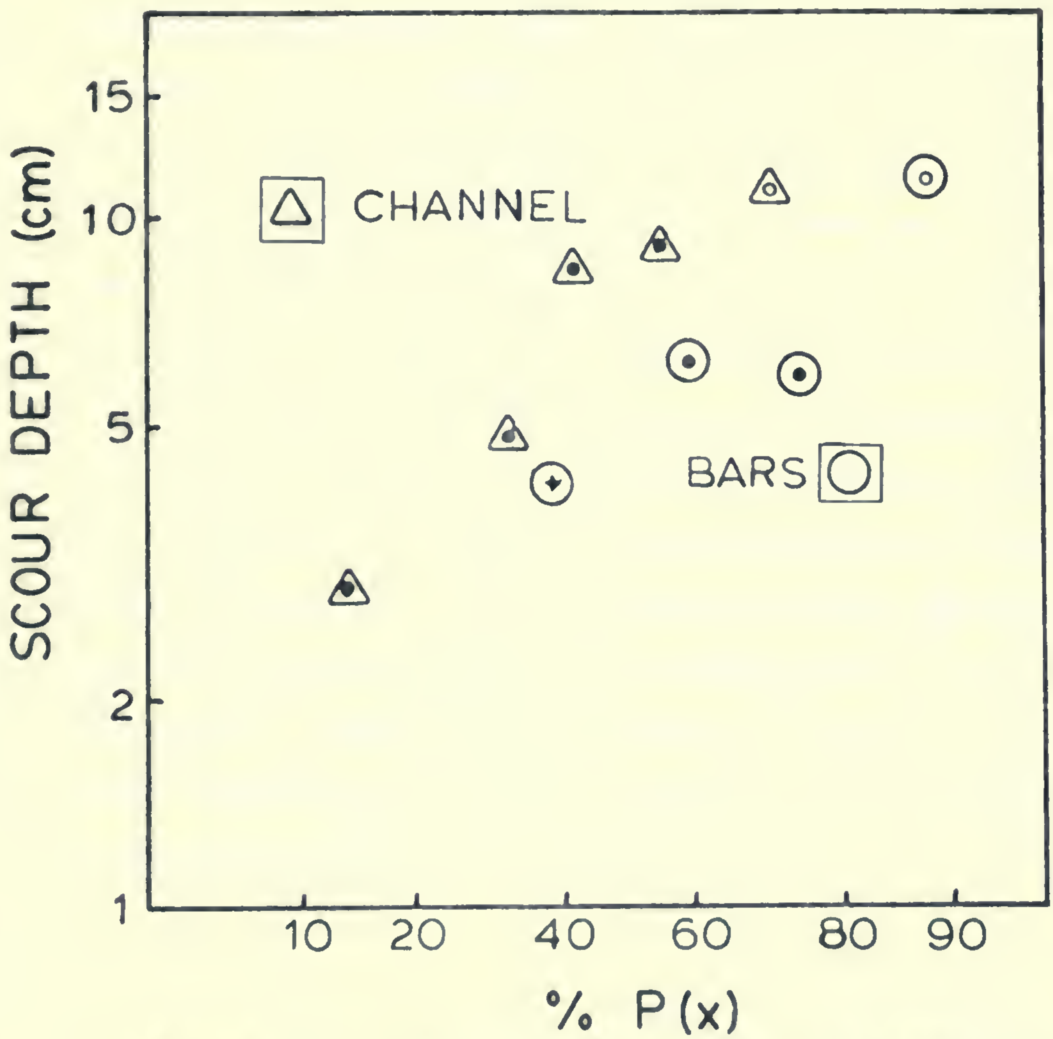

Figure 59. Percent probability of movement for photographed areas whose mean size is -7.0 phi (o), -6.5 phi (+) and -6.0 phi (•) versus scour depth. Data were collected on Sixteen Mile Creek and do not include clasts of -5.0 phi and smaller.

Scour beneath the discontinuous armor coats of the Grand and Genesee Rivers may be caused by the winnowing of fines surrounding the large isolated surface clasts (Raudkivi and Ettema 1982). Scour of these beds should be related to the probability of movement of the fine surface grains. This is also true for the unarmored bed of Cazenovia Creek. The probability of movement for the surface clasts finer than -5.0 phi was not calculated for the creeks in this study. However, bed surfaces with clasts having 100 percent movement are related to scour depth. Each histogram in figure 60 represents a different scour depth that occured in a bed area with a different mean surface size. All the surface clasts in these areas had 100 percent probability of movement for the 1982-83 snow-melt. These histograms show that the greatest scour measured in this study occured in a streambed having a mean size between -5.5 and -4.0 phi.

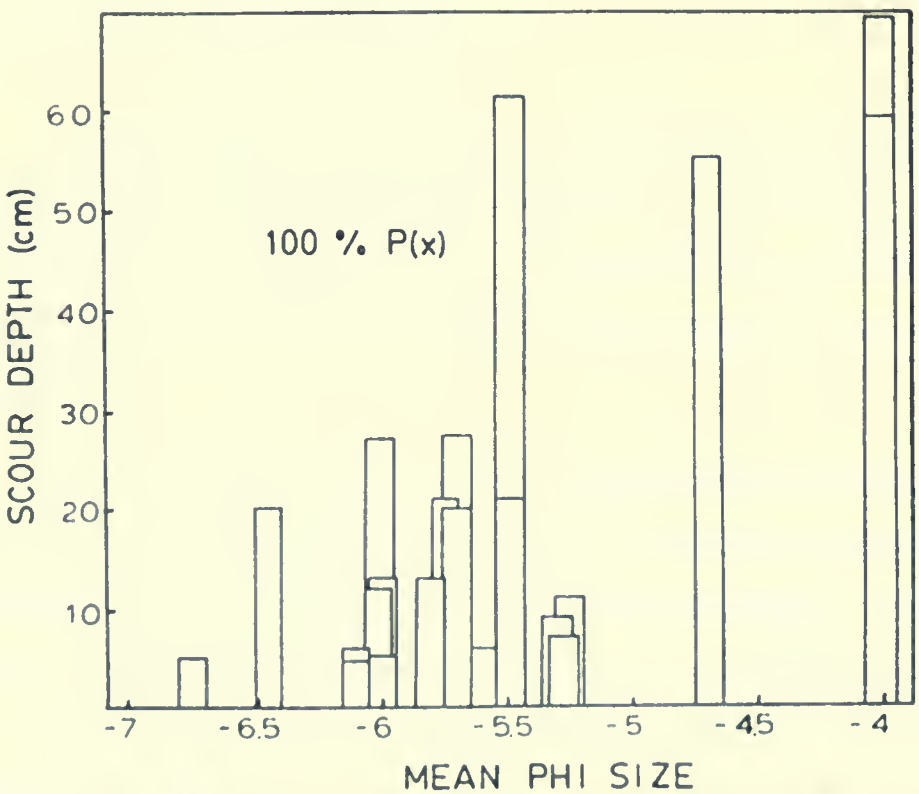

Figure 60. Histograms representing scour depths for a given mean size of surface sediment. Probability of movement for these surfaces was 100 percent for the 1982-83 snow-melt. The data shown are from all creeks.

HYDROLOGY

The drainage area of Twenty Mile Creek is 293 square km with an average discharge of 2.8 cubic meters per second (cms) based on 19 years of records (Sangal and Kallio 1977). The recurrence curve for Twenty Mile Creek is shown in figure 61. This curve was constructed using data from Environment Canada (1982).

Construction of a similar recurrence curve for Sixteen Mile Creek is not possible because of insufficient data. Therefore, a comparison of the hydraulics of Sixteen Mile Creek with the other streams of this study is not possible.

The drainage area of the Grand River at Brantford, Ontario is 5,210 square km with an average discharge of 55 cms based on 47 years of records (Environment Canada 1982). The recurrence curve for the Grand River is shown in figure 62. The data for this curve was obtained from Environment Canada (1982).

The drainage area for the Genesee River at Portageville, New York is 2,542 square km with an average discharge of 29 cms based on 62 years of record (United States Geological Survey 1976). The recurrence curve for the Genesee River is shown in figure 63. This curve was obtained from the United States Army Corps of Engineers, Buffalo, New York. The dam at Portageville, New York was

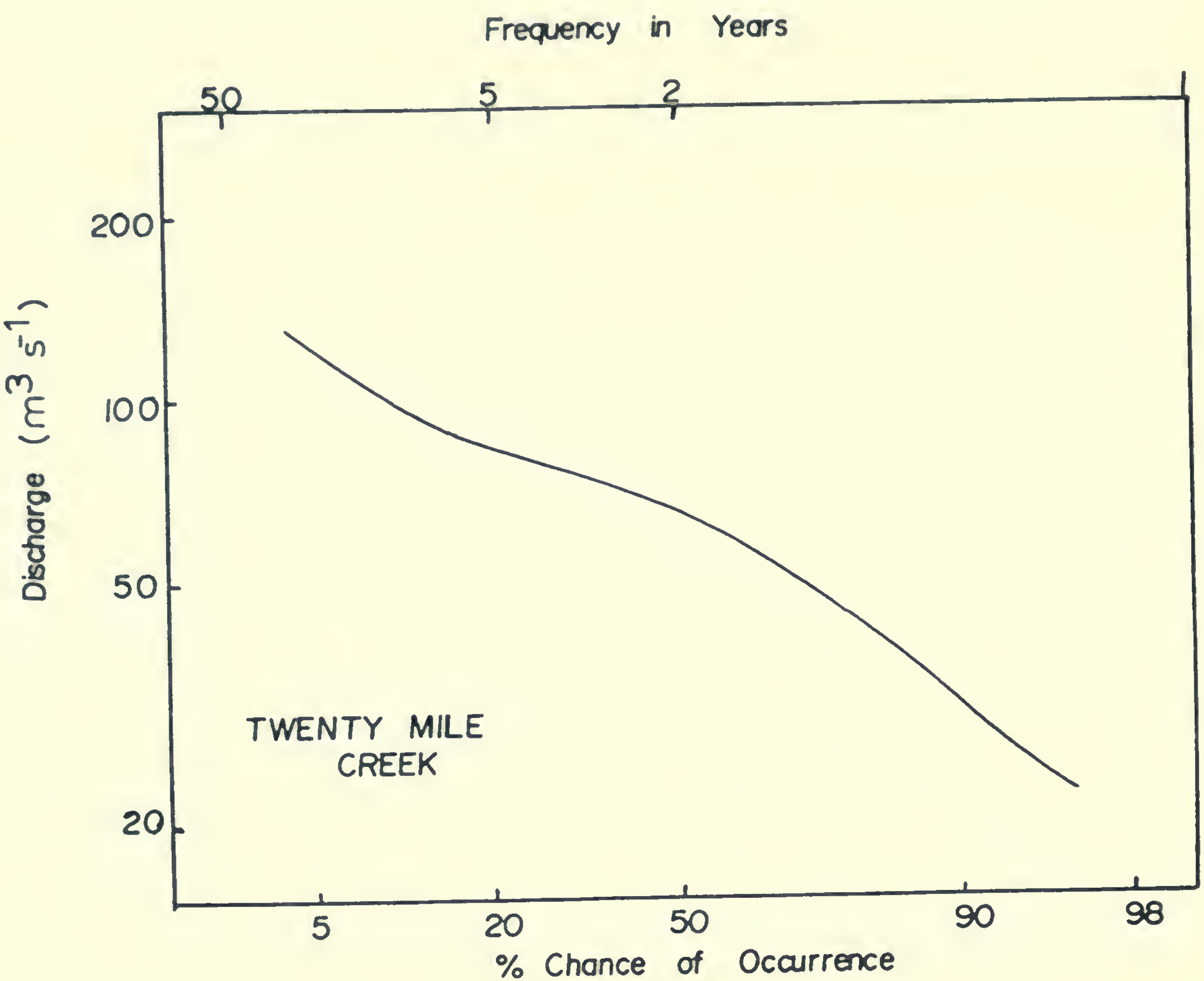

Figure 61. Recurrence Curve for Twenty Mile Creek.

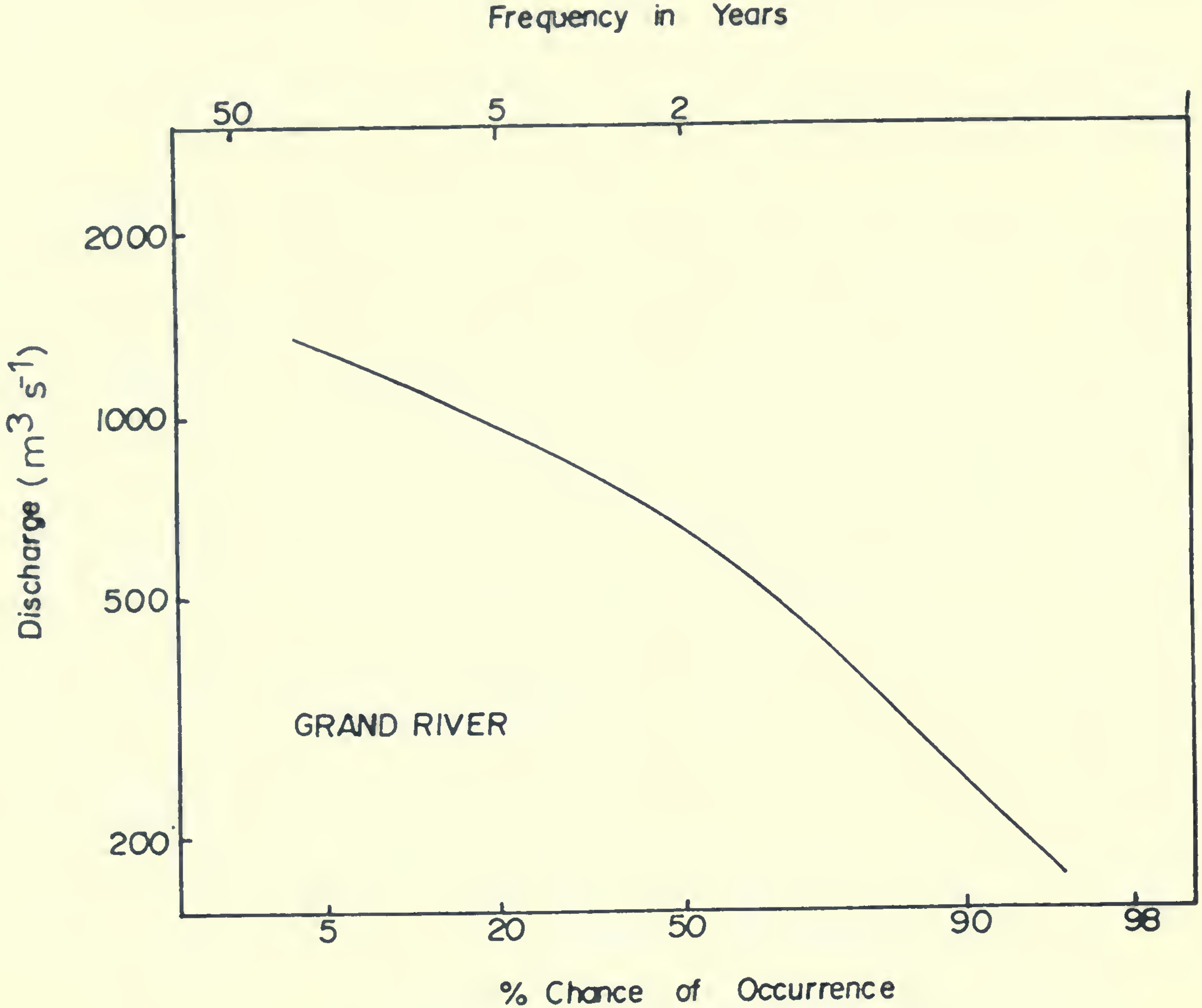

Figure 62. Recurrence curve for the Grand River.

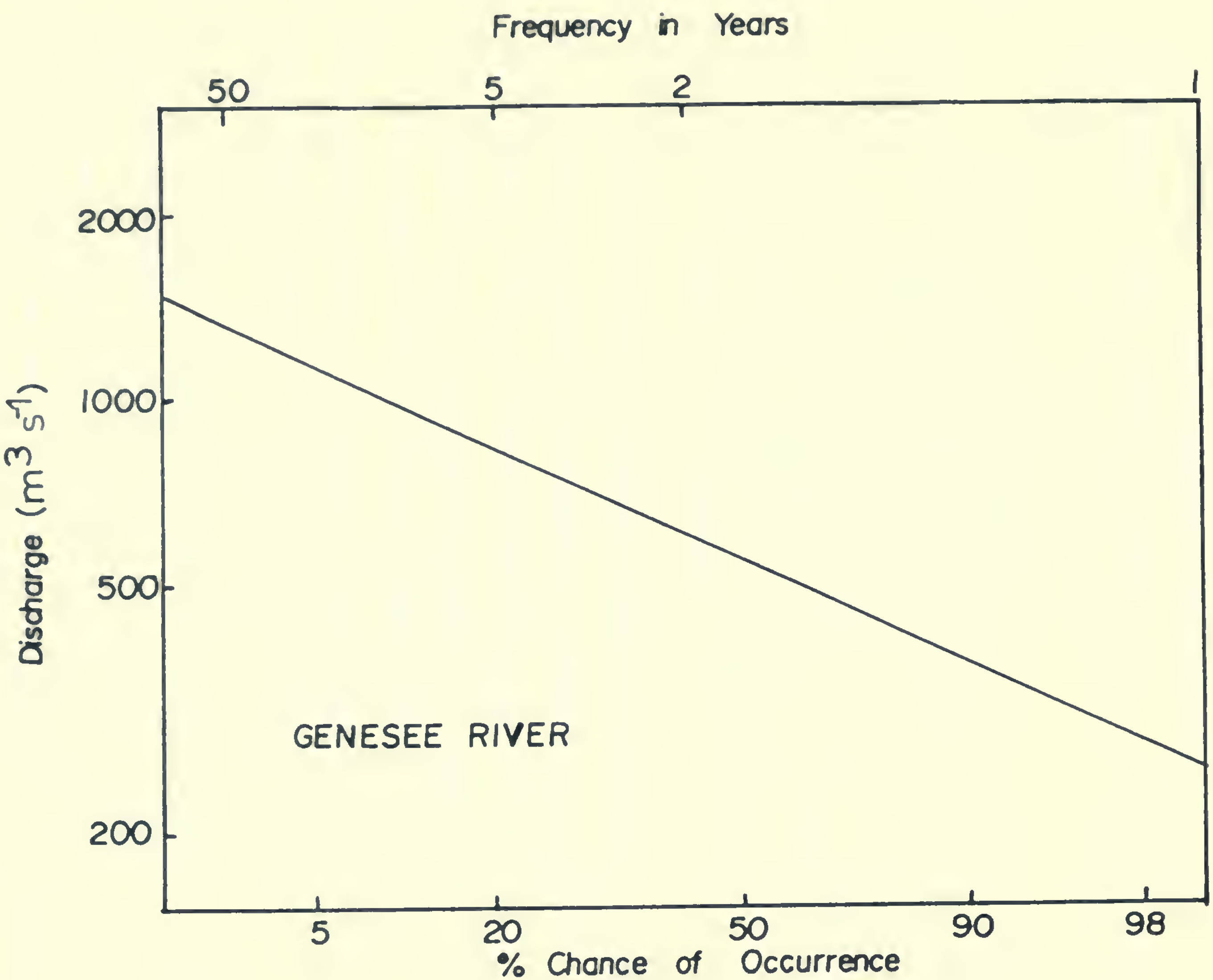

Figure 63. Recurrence line for the Genesee River (line obtained from the United States Army Corps of Engineers, Buffalo, New York).

built and has been maintained by the United States Army Corps of Engineers since 1946 (United States Geological Survey 1976). Consequently, the high flows of the recurrence curve after this date may have been affected by the dam.

Cazenovia Creek at Ebenezer, New York has a drainage area of 347 square km with an average discharge of 6.1 cms based on 30 years of records (United States Geological Survey 1976). The recurrence curve for Cazenovia Creek is shown in figure 64. The data for this curve was obtained from the United States Geological Survey (1965).

Because modest and more frequent floods are considered to do more work than infrequent catastrophic flows (Leopold and others 1964, p.71) the mean annual discharge with a recurrence of 2.33 years may be used to compare the streams in this study. Thus the mean annual flood is 66 cms for Twenty Mile Creek, 680 cms for the Grand River, 620 cms for the Genesee River and 190 cms for Cazenovia Creek.

Hourly discharge data for Twenty Mile Creek and the Grand River were obtained from Environment Canada. Data for the Genesee River and Cazenovia Creek was obtained from the United States Geological Survey. The maximum instantaneous flow was 44.1 cms on Twenty Mile Creek, 360.0 cms on the Grand River, 60.6 cms on the Genesee River and 17.1 cms on Cazenovia Creek. As determined from the recurrence curves these flows occur approximately once every 1.6 years on

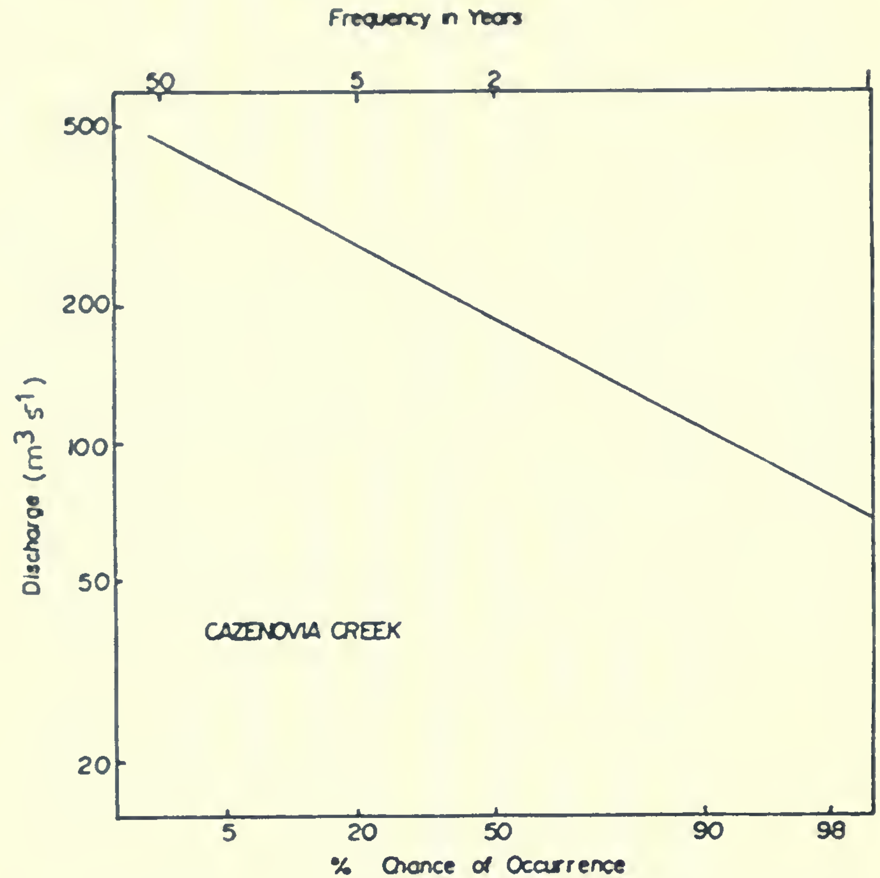

Figure 64. Recurrence line for Cazenovia Creek.

Twenty Mile Creek, every 1.6 years on the Grand River and every year on the Genesee River and Cazenovia Creek respectively. Therefore, the sediment transport measured during the 1982-83 snow-melt represents a very frequent event that occurs during flows which are well below the mean annual flood for each stream.

Hydraulic Data for Twenty Mile Creek

Two sites were selected on Twenty Mile Creek. The upper site is located in the gorge approximately 280 m upstream of Highway 8. The lower site is approximately 65 m downstream of Highway 8. At each of these sites, two stations were designated from which water-surface elevation could be measured for a given discharge. Water-surface slope was then calculated between the two stations at each site. Figure 65 shows the relation between the dimensionless water-surface slope and discharge for both sites. This figure indicates that for a given discharge, the water-surface slope at the upper site is greater than that of the lower one.

The cross-sectional area at each station was also determined using a surveying level. These data were then used to calculate the hydraulic radius for a known discharge. Based on these relations the bottom shear stress was calculated for the maximum instantaneous flow of the 1982-83 snow-melt using the DuBoys equation:

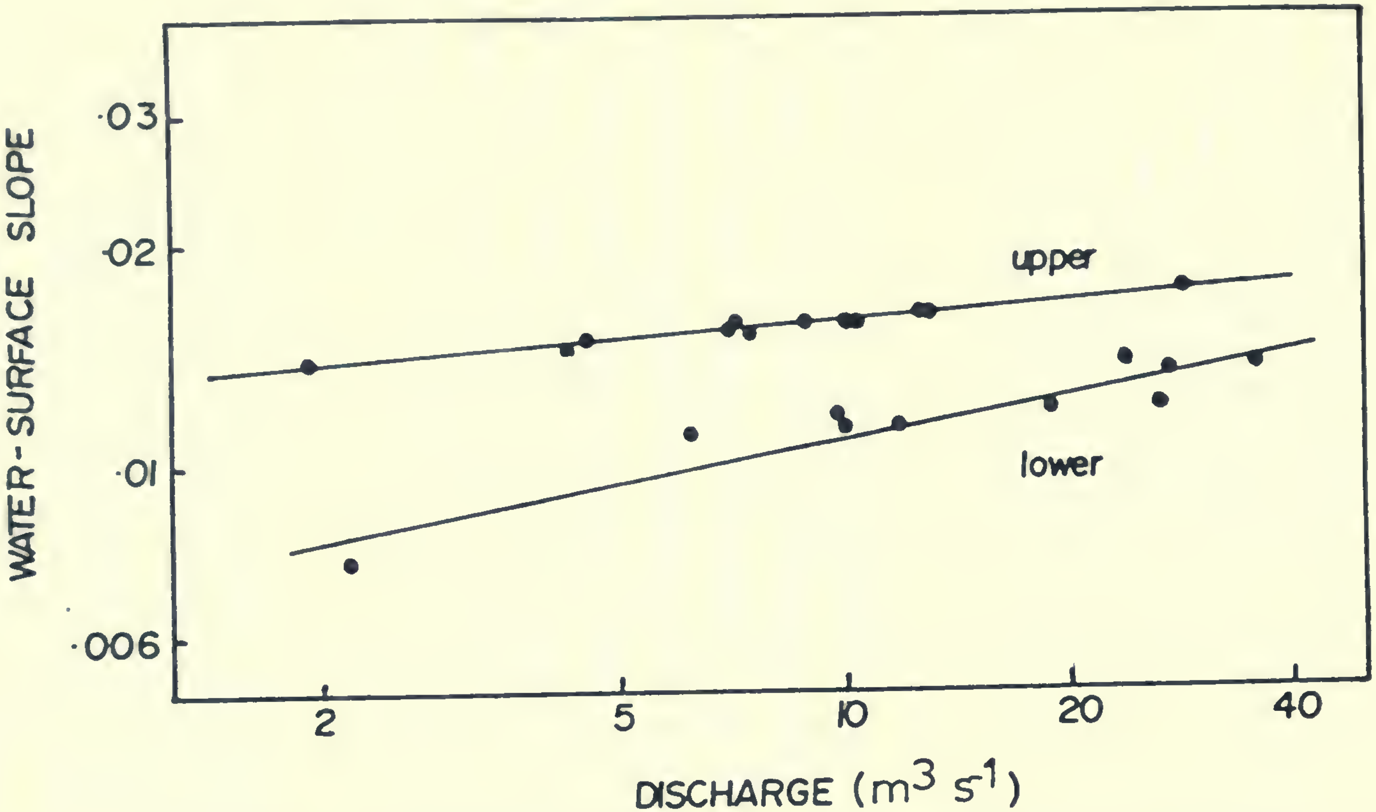

Figure 65. Dimensionless water-surface slope versus discharge for the two sites on Twenty Mile Creek.

$$T = Y R S$$

where T is the average bottom shear stress, Y is the specific weight of the water, R is the hydraulic radius, and S is the dimensionless water-surface slope. Figure 66 shows the average bottom shear stress versus discharge at three stations. A streambed photograph was not taken at Station 3 . Therefore, this station is not shown. It is evident that the average bottom shear stress decreases between the stations in the gorge and the one downstream of Highway 8.

Figure 67 shows the size distributions of the surface clasts transported on the bed at three of the four stations on Twenty Mile Creek. Each distribution was determined from the nearest streambed photograph in each area. The average bottom shear stress for the maximum 1982-83 flow at each station is shown beneath each distribution. It is evident that the transported size distribution coarsens as the average bottom shear stress increases between the hydraulic stations.

Figure 68 is a comparison of Baker and Ritter's (1975) line with the shear stress of the largest transported clasts at the three stations on Twenty Mile Creek. All the points corresponding to the largest clasts moved in photographs 48 (-7.5 phi), 50 (-7.0 phi) and 68 (-6.0 phi) plot below Baker and Ritter's line and suggests that the shear stress in all the areas was high enough to mobilize

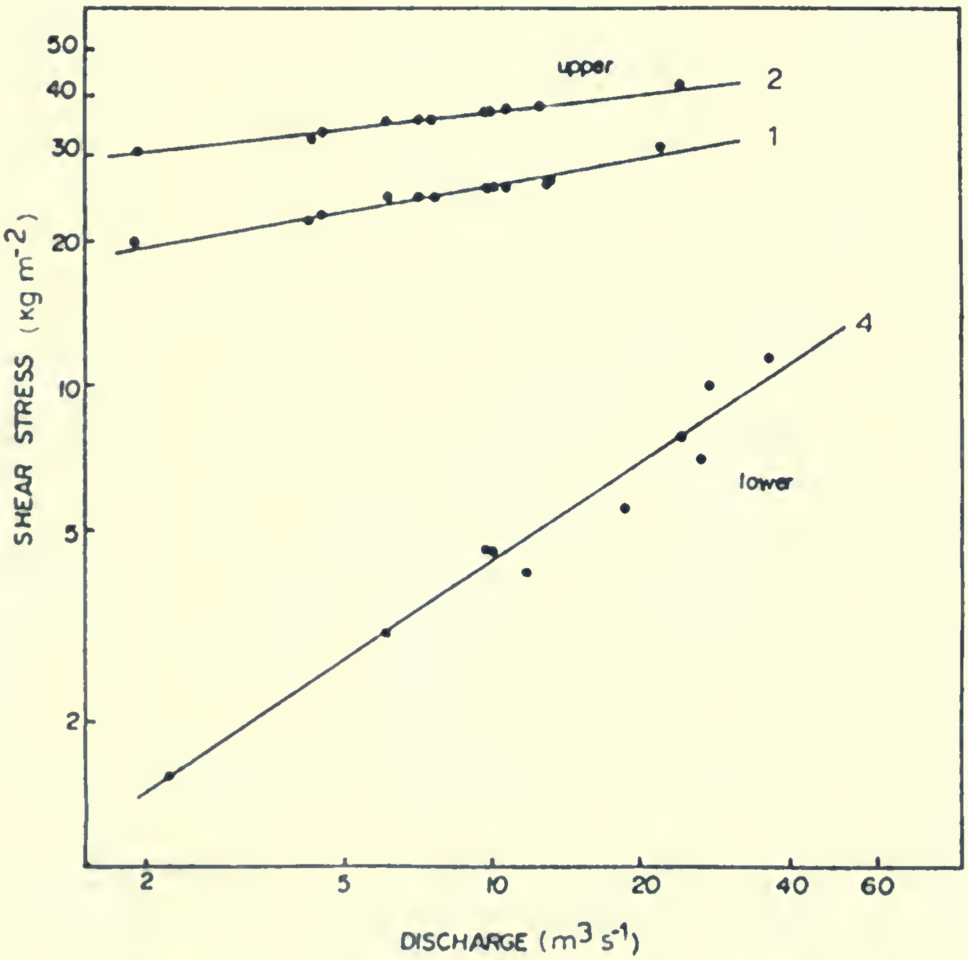

Figure 66. Average bottom shear stress versus discharge for upper and lower stations. Station 1 is located approximately 298 meters upstream of Highway 8. Station 2 is approximately 272 meters upstream of Highway 8, and station 4 is approximately 158 meters downstream of Highway 8.

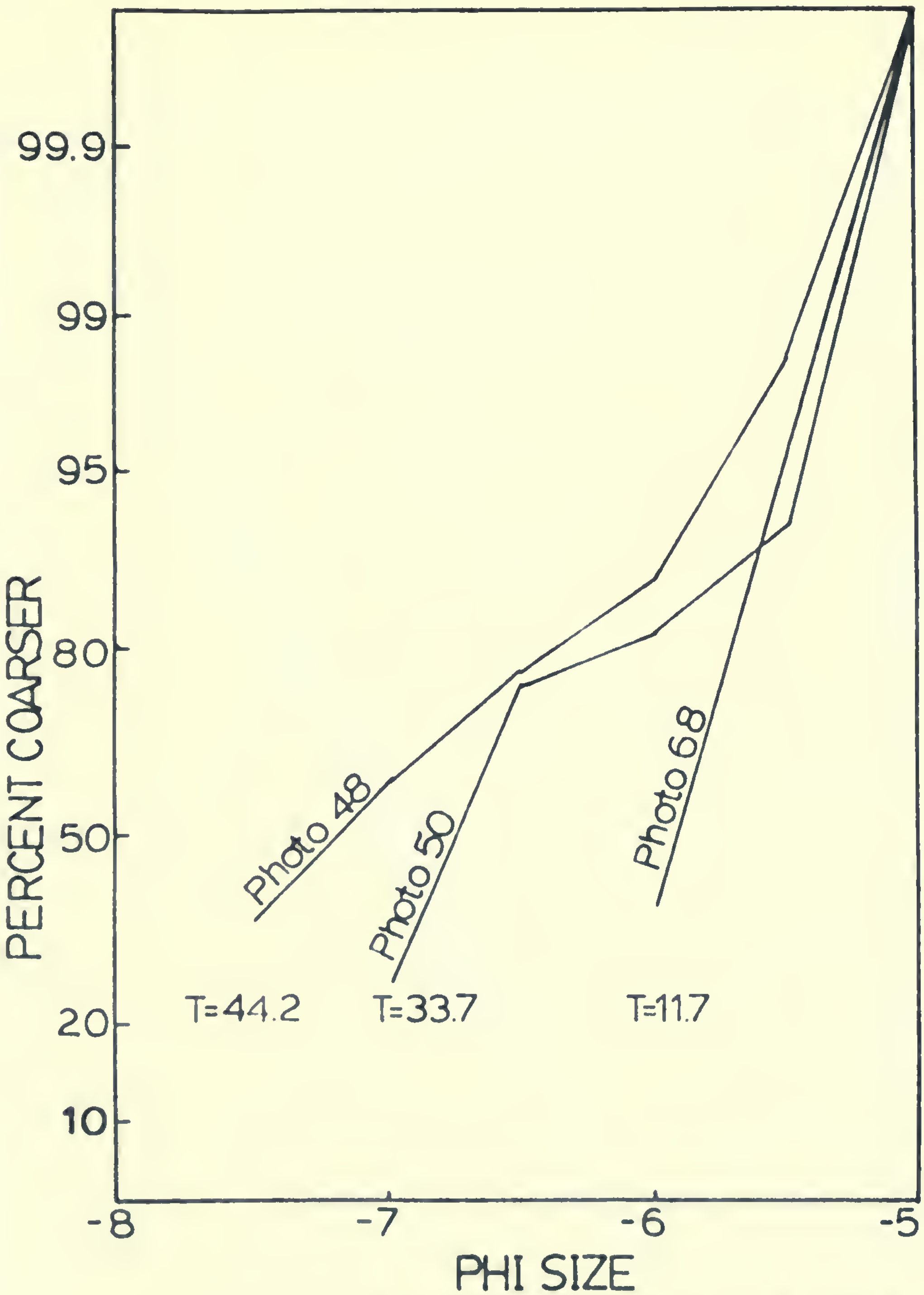

Figure 67. Size distributions for the transported clasts of the armor coat at 3 of the 4 stations on Twenty Mile Creek during the 1982-83 snow-melt. The average bottom shear stress(T) at each station is in kgm^{-2}. The average bottom shear stress is calculated for the maximum flow of the 1982-83 melt.

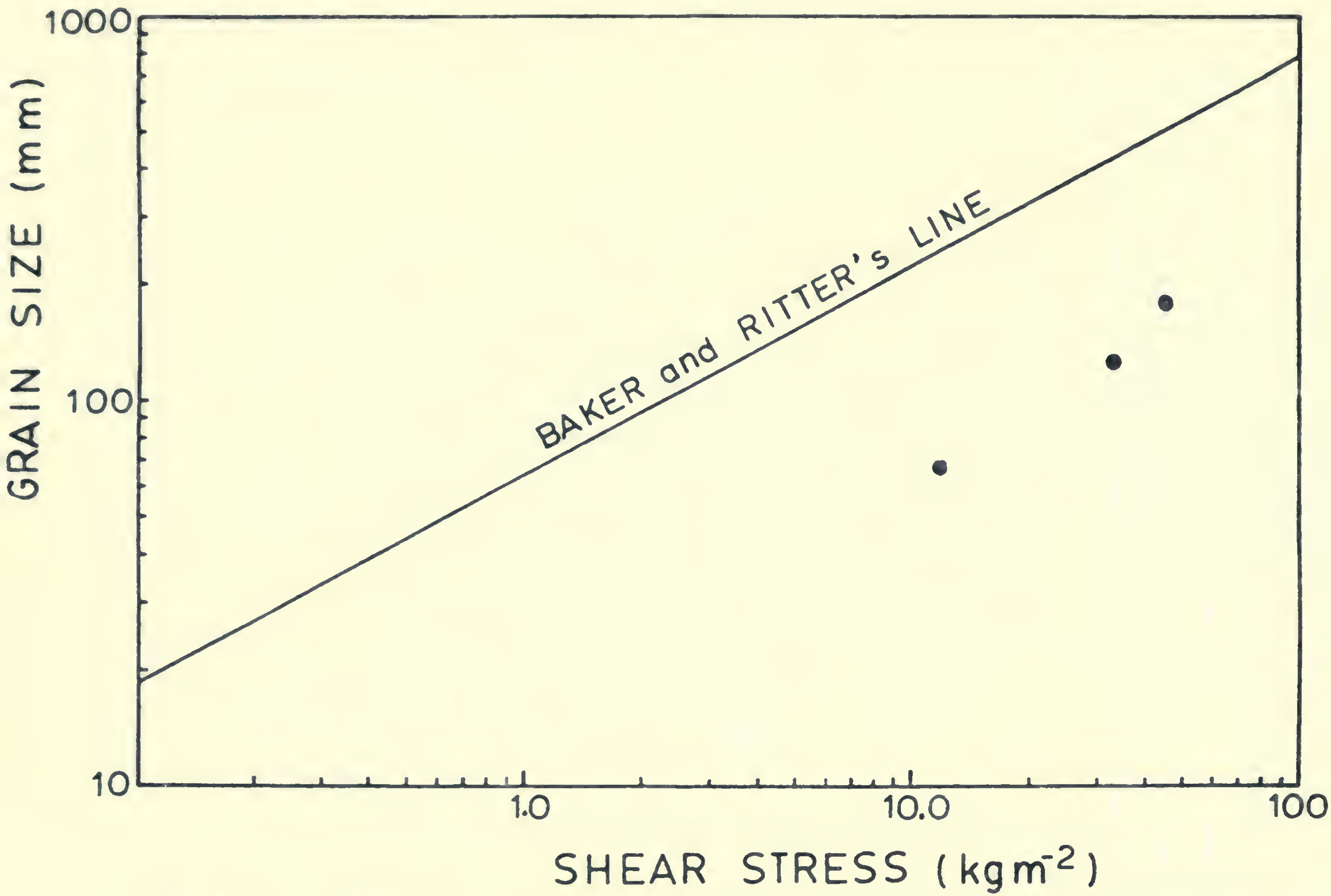

Figure 68. Comparison of the shear stress for the largest transported clasts at three stations on Twenty Mile Creek with Baker and Ritter's (1975) line.

clasts larger than these sizes. A clast of -8.0 phi is present in photograph 48, clasts of -8.9, -8.5, -8.0 and -7.5 phi are present in photograph 50 and clasts of -7.0 and -6.5 phi are present in photograph 68. It is possible that clast packing and variable clast exposure to the flow may be the factors that prevented these sizes from being moved.

SUMMARY and CONCLUSIONS

It has been determined that the size distribution of the streambed armor coats in this study depends on two factors, 1) the nature of the source area, and 2) the flow competence of the stream. Both factors combine to determine the maximum size capable of armoring the streambed.

Comparison of the armor coat distributions of Twenty and Sixteen Mile Creeks suggests that the surface size difference between creeks with the same source must be due to differences in flow and perhaps, bottom shear stress.

Three types of streambed surfaces were categorized in this study: 1) a "continuous" armor coat, 2) a "discontinous" armor coat and 3) a bed-surface which is not armored. The continuous armor coats of Twenty and Sixteen Mile Creeks have a mean size of -6.5 phi and coarser. This armor sediment completely covers and protects the subsurface except at high flow. The discontinuous armor coats of this study have a mean size of approximately -6.0 phi. The large surface clasts of this armor coat are irregularly spaced causing the subsurface to be partially exposed to the flow. The bed of Cazenovia Creek is normally not armored and the subsurface is completely exposed.

The three types of streambeds differ in the amount of winnowing that occurs in the subsurface. Beneath a

continuous armor coat the subsurface is inversely graded, and is possibly formed by a vertical winnowing process. This mechanism requires the penetration of the armor coat, erosion of the subsurface, and winnowing of the sediment which rebuilds the streambed during high flow.

The sublayers beneath the discontinuous armor coats of the Grand and Genesee Rivers are more similar to one another than are those of Twenty and Sixteen Mile Creeks. The limited amount of vertical winnowing beneath a discontinuous armor coat is resposible for this similarity between the sublayers.

The bed of Cazenovia Creek usually has no armor coat resulting in a homogeneous subsurface which shows no signs of vertical winnowing. This suggests that the unarmored surface sediment is not deposited during high flow, and does not represent the maximum flow conditions of the stream.

Populations for a given sublayer beneath a continuous armor coat do not represent transport modes because they are modified by vertical winnowing. Vertical winnowing is greatly reduced in sediment beneath a discontinous armor coat and therefore, populations for these sublayers may be indicative of different transport modes. The subsurface of a bed which has no armor coat is not modified by vertical winnowing and therefore, the populations for this sediment probably represent transport modes.

Photographic analysis of the five streambeds before and after the 1982-83 snow-melt shows that degradation predominated on the discontinuous and unarmored beds of the Genesee River and Cazenovia Creek, while aggradation occurred on the continuous armor coats of Twenty and Sixteen Mile Creeks.

Photographic data also show that the probability of movement is a function of size. This relation is best defined on Twenty and Sixteen Mile Creeks, and the Genesee River, but is not well-developed for the Grand River and Cazenovia Creek because of insufficient data. However, 100 percent probability of movement occurs most often for the unarmored bed of Cazenovia Creek.

The data obtained from scour gauges show that the depth of scour is greatest in a streambed which has no armor coat. Scour depth beneath a continuous armor coat is a function of the probability of movement for a given mean surface size.

Hydraulic calculations relating the average bottom shear stress to the sediment transported on Twenty Mile Creek show that the competence decreases between stations in the gorge and the one downstream of Highway 8.

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APPENDIX I

List of sediment weights (gm) by size fraction used for subsurface size analysis

Twenty Mile Creek

Phi Interval Used

[illegible] [illegible] [illegible] -5.05 -4.50 -4.00 -3.50 -3.00 -2.75 -2.50
-2.25 -2.00 -1.75 -1.50 -1.25 -1.00 -0.75 -0.50 -0.25 0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
2.75 3.00 3.25 3.50 3.75 4.00 4.25

SAMPLE HOL10 BOT THICKNESS = 21 cm BAR

0.000	0.000	217.666	546.666	477.196	340.656	150.636	295.586	152.166	38.254	69.826	68.006	39.301	44.479
32.400	28.437	28.251	22.696	14.486	16.454	13.448	10.522	10.869	12.685	12.854	16.781	9.846	14.322
8.296	10.660	9.587	8.319	11.229	2.919	7.872	3.004	63.441					

SAMPLE HOL10 MID THICKNESS = 20 cm BAR

0.000	0.000	228.367	249.727	340.837	457.377	211.257	427.757	205.727	72.987	115.337	118.[illegible]77	72.037	76.297
64.287	53.927	55.207	43.850	27.399	29.952	23.232	16.652	14.536	14.627	11.840	13.296	7.329	10.136
6.259	8.306	7.375	7.015	9.250	3.004	6.824	3.237	73.908					

SAMPLE HOL10 TOP THICKNESS = 4 cm BAR

0.000	0.000	108.903	223.983	836.243	709.513	204.373	396.693	99.043	28.553	26.616	26.625	8.014	8.403
5.834	3.846	3.378	2.642	1.538	1.707	1.502	1.021	1.174	1.123	0.990	1.248	0.686	0.945
0.522	0.761	0.787	0.667	0.907	0.313	0.761	0.376	6.703					

SAMPLE HOL19 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	534.612	633.632	530.452	282.552	356.502	114.082	58.172	59.992	54.922	27.263	30.657
20.724	18.399	16.728	11.844	7.333	7.522	5.471	3.805	3.658	3.357	2.886	3.397	1.898	2.430
1.436	2.144	1.909	1.954	2.727	1.008	2.299	1.201	22.923					

SAMPLE HOL19 MID THICKNESS = 20 cm BAR

0.000	0.000	0.000	464.711	190.031	265.541	190.751	249.761	102.641	45.700	63.691	60.501	38.594	42.486
33.736	28.082	30.675	22.372	14.714	15.479	12.084	8.615	7.665	7.497	5.797	7.142	3.779	5.281
3.268	4.271	4.156	3.078	5.491	1.909	4.240	2.194	63.644					

SAMPLE HOL19 MID THICKNESS = 23 cm BAR

0.000	0.000	0.000	114.112	73.922	304.192	58.572	166.532	81.082	34.522	49.698	51.963	35.135	44.324
38.834	32.449	35.434	29.119	18.629	20.497	15.733	11.544	11.158	11.741	8.893	10.355	5.279	6.703
4.479	6.210	6.376	7.120	13.497	4.387	11.647	4.321	194.553					

SAMPLE HOL22 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	424.003	334.343	360.133	178.373	200.443	54.243	16.118	19.187	14.553	4.871	3.961
2.293	1.857	1.984	1.444	0.880	0.933	0.674	0.436	0.568	0.572	0.517	0.607	0.305	0.406
0.214	0.281	0.283	0.227	0.292	0.104	0.231	0.111	9.364					

SAMPLE HOL34 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	235.853	522.713	824.553	155.533	119.013	17.434	6.563	2.525	3.068	1.646	1.102
0.931	0.998	0.769	0.755	0.570	0.934	0.799	0.695	0.843	0.899	0.813	1.110	0.630	0.854
0.563	0.753	0.681	0.637	0.762	0.235	0.560	0.329	3.482					

SAMPLE HOL46 BOT THICKNESS = 38 cm MCH

0.000	0.000	0.000	36.880	47.750	333.960	160.570	292.520	192.080	83.470	131.940	175.090	111.050	151.090
127.280	115.690	125.520	78.740	53.964	59.889	46.624	33.424	27.971	24.458	18.744	20.619	10.510	12.983
6.689	8.062	6.402	6.166	9.419	3.209	8.431	4.830	84.880					

SAMPLE HOL46 MID THICKNESS = 12 cm MCH

0.000	0.000	0.000	94.343	195.163	508.663	219.223	397.873	185.973	69.643	110.883	142.663	97.333	108.763
84.803	69.093	67.933	47.317	23.242	26.501	19.447	11.947	9.187	7.790	5.657	5.927	3.099	3.834
2.083	2.963	2.[illegible]85	2.647	3.461	1.331	3.357	2.344	34.806					

SAMPLE HOL46 TOP THICKNESS = 4 cm MCH

0.000	0.000	270.723	841.453	777.403	578.313	168.573	165.113	40.503	11.987	13.018	10.817	4.760	4.749
3.404	2.423	2.289	1.721	1.034	1.121	0.822	0.622	0.596	0.549	0.568	0.835	0.520	0.720
0.494	0.578	0.567	0.522	0.640	0.205	0.568	0.273	3.206					

SAMPLE HOL61 BOT THICKNESS = 17 cm MCH

0.000	0.000	0.000	0.000	0.000	172.611	137.521	383.591	194.461	64.771	112.121	146.711	96.141	120.241
110.611	95.721	112.301	90.405	55.038	62.433	47.996	33.992	28.377	22.777	17.321	16.942	8.230	9.459
4.952	6.067	4.719	4.121	4.382	1.694	2.884	1.269	35.660					

SAMPLE HOL68 TOP THICKNESS = 4 cm BCH

0.000	0.000	0.000	398.514	309.274	619.260	120.694	246.444	83.504	27.364	33.784	39.049	23.962	27.803
24.600	19.913	22.419	18.580	11.495	11.973	8.887	5.777	5.142	4.101	3.395	4.050	2.192	2.829
1.522	2.026	1.866	1.784	2.045	0.710	1.610	0.917	26.530					

SAMPLE HOL68 MID THICKNESS = 33 cm BCH

0.000	0.000	0.000	166.661	143.451	503.851	240.011	386.371	213.821	81.411	124.101	139.151	85.391	108.491
89.091	76.011	78.971	54.230	32.010	29.450	17.794	10.198	7.287	5.076	3.280	3.470	1.620	2.084
1.178	1.522	1.401	1.457	1.942	0.607	1.894	0.911	21.027					

SAMPLE HOL68 BOT THICKNESS = 15 cm BCH

0.000	0.000	0.000	0.000	59.934	193.524	106.924	245.964	147.494	57.394	121.134	102.614	137.624	184.414
171.674	148.894	103.454	126.934	91.201	97.215	71.533	47.220	34.528	30.267	22.053	21.206	9.691	10.990
5.710	6.616	5.566	5.131	6.421	2.572	4.831	2.849	122.758					

SAMPLE HOL69 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.009	346.132	203.892	888.284	234.422	429.592	141.912	51.572	71.282	80.102	39.928	48.462
[illegible]	[illegible]	28.482	23.850	14.901	16.902	13.809	11.347	10.484	10.442	9.374	11.258	6.279	9.071
5.745	7.674	6.679	7.101	8.963	3.513	6.063	2.677	62.893					

SAMPLE HOL69 MID THICKNESS = 59 cm BAR

0.000	0.000	0.000	0.000	52.636	228.216	135.816	301.946	161.106	59.886	106.276	135.796	81.646	99.846
86.486	67.676	83.946	61.490	44.040	51.635	47.189	40.671	38.837	44.377	39.710	47.719	25.196	35.813
33.149	28.007	27.263	20.820	44.301	7.171	27.239	8.731	234.247					

SAMPLE HOL70 TOP THICKNESS = 4 cm MCH

0.000	0.000	339.163	850.303	477.153	420.073	150.293	224.273	81.113	29.634	40.664	39.872	22.698	22.402
15.715	12.339	11.077	9.010	5.325	5.524	3.639	2.271	1.914	1.338	0.953	0.955	0.434	0.544
0.309	0.361	0.379	0.365	0.401	0.193	0.457	0.278	3.575					

SAMPLE HOL70 MID THICKNESS = 27 cm MCH

0.000	0.000	0.000	0.000	117.464	366.224	144.694	394.004	186.774	70.534	119.214	138.654	89.884	109.734
97.284	86.044	102.994	79.478	54.439	59.307	43.762	28.714	21.497	17.085	11.650	10.463	4.491	4.6[illegible]3
2.356	2.900	2.333	2.126	2.401	0.783	2.044	1.037	21.773					

SAMPLE HOL70 BOT THICKNESS = 22 cm MCH

0.000	0.000	0.000	0.000	50.723	171.383	108.723	270.703	133.813	70.003	99.183	1[illegible]5.683	83.263	113.693
117.403	99.313	131.723	105.159	74.897	89.980	76.108	60.735	53.746	49.361	39.980	42.212	19.555	24.327
12.264	13.747	10.861	9.550	9.457	3.397	5.465	2.002	41.476					

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SAMPLE HOL12  TOP THICKNESS =  4 cm MCH
    0.000     0.000     0.000   151.583   463.193   782.063   197.893   223.163    59.833    11.237    10.399     5.661     2.091     2.396
    1.265     0.769     0.791     0.528     0.465     0.452     0.362     0.278     0.332     0.301     0.252     0.280     0.140     0.183
    0.113     0.124     0.142     0.110     0.168     0.058     0.162     0.082     1.027

SAMPLE HOL12  MID THICKNESS =  7 cm MCH
    0.000     0.000     0.000   537.448   266.128   751.768   338.928   675.796   266.108    97.288   126.328   112.398    62.748    61.938
   43.139    29.511    26.064    16.537     8.442     7.553     5.037     3.211     2.785     2.496     1.910     2.051     1.041     1.247
    0.653     0.907     0.935     0.795     1.237     0.379     1.127     0.638     8.171

SAMPLE HOL12  BOT THICKNESS = 21 cm MCH
    0.000     0.000     0.000    59.160    70.090   152.260    78.490    95.760    44.580    14.808    21.317    26.577    13.664    15.748
   12.455    12.093    10.302     9.481     6.177     6.945     5.830     4.677     5.195     5.961     6.611    11.022     6.185     8.592
    4.969     6.748     6.188     7.288     9.622     2.916     8.903     3.453   323.860

SAMPLE HOL15  TOP THICKNESS =  4 cm BAR
    0.000     0.000   108.664    88.724   353.984   433.824   182.674   346.944   160.974    66.704    99.784   120.424    78.794    95.334
   85.534    68.014    82.914    53.988    34.890    38.212    31.794    23.786    21.827    21.379    17.927    20.060     9.984    12.955
    6.952     8.261     5.983     6.170     7.824     2.072     6.386     2.415    61.674

SAMPLE HOL15  MID THICKNESS = 36 cm BAR
    0.000     0.000   548.226   207.166   353.846   554.016   134.886   265.866    94.766    35.626    63.236    68.386    46.566    57.763
   51.075    42.778    52.333    42.609    27.884    32.710    26.444    20.163    17.438    17.062    13.514    14.054     6.937     8.560
    4.973     6.039     5.358     4.996     6.824     2.636     4.949     2.340    51.360

SAMPLE HOL15  BOT THICKNESS = 17 cm BAR
    0.000     0.000   260.064   309.264   235.694   255.084   176.774   348.584   136.694    61.824    92.434   113.074    77.044    96.474
   81.674    67.594    82.004    62.723    41.163    44.563    34.144    23.247    17.926    15.258    10.929    11.425     5.226     6.544
    3.820     4.601     4.110     3.740     5.655     1.658     4.532     1.922   113.564

SAMPLE HOL22  MID THICKNESS = 29 cm MCH
    0.000     0.000     0.000   140.243   135.413   659.033   202.893   316.233   135.283    49.773    64.503    60.113    26.933    25.257
   16.033    10.081     8.354     5.318     2.662     2.611     1.721     1.037     0.981     0.714     0.593     0.667     0.275     0.121
    0.068     0.088     0.112     0.095     0.176     0.060     0.228     0.141     3.214

SAMPLE HOL22  BOT THICKNESS = 18 cm MCH
    0.000     0.000     0.000     0.000    42.788   139.508   181.818   445.828   247.758   100.978   152.958   177.678   108.148   127.928
   98.378    79.128    84.838    59.657    35.583    35.757    25.739    16.808    13.262    11.821     8.533     8.705     4.166     4.719
    2.413     3.360     2.580     2.605     3.013     1.198     2.539     1.402    24.108

SAMPLE HOL34  MID THICKNESS = 18 cm BAR
    0.000     0.000   357.733   232.783   172.963   483.063   155.723   259.873   122.703    44.183    72.403    88.363    57.133    71.213
   61.563    53.623    63.663    53.472    35.561    41.806    33.389    25.498    21.588    20.113    15.094    16.675     8.085    10.149
    5.407     6.574     6.207     5.801     7.002     3.179     5.526     3.358    69.553

SAMPLE HOL34  BOT THICKNESS = 41 cm BAR
    0.000     0.000     0.000   301.686   338.976   348.896    51.226   237.126    96.766    37.746    51.186    54.526    28.910    36.286
   29.071    24.429    25.484    21.040    14.066    15.650    13.478    10.046    10.880    11.831    10.077    11.858     6.243     8.595
    5.275     6.613     6.176     5.803     8.993     2.538     7.992     3.096   112.140

SAMPLE HOL35  TOP THICKNESS =  4 cm MCH
    0.000     0.000   359.746   830.776   793.246   612.136   113.336    87.036    12.338     0.951     1.124     0.317     0.295     0.155
    0.060     0.149     0.103     0.039     0.046     0.026     0.026     0.012     0.011     0.012     0.009     0.013     0.012     0.007
    0.006     0.007     0.014     0.010     0.026     0.014     0.031     0.024     0.475

SAMPLE HOL35  MID THICKNESS = 14 cm MCH
    0.000     0.000     0.000   144.066   284.456   555.596   294.406   401.646   129.746    43.257    62.072    56.728    26.646    26.176
    0.796    13.358    12.326     8.631     4.191     3.755     2.461     1.565     1.614     1.523     1.128     1.373     0.688     0.958
    0.528     0.709     0.807     0.761     1.181     0.422     1.072     0.079     8.408

SAMPLE HOL35  MID THICKNESS = 21 cm MCH
    0.000     0.000     0.000     0.000    36.855   193.425   159.775   293.465   152.845    60.295   106.905   121.055    74.775    94.275
   76.665    70.445    70.765    51.814    30.158    31.134    22.265    14.307    11.252     9.481     6.467     6.187     2.906     3.242
    1.692     2.149     1.917     1.908     2.538     0.844     2.569     1.628    27.661

SAMPLE HOL35  BOT THICKNESS =  7 cm MCH
    0.000     0.000     0.000     0.000     0.000    89.561    36.803   143.133    75.923    29.308    56.439    69.433    43.255    56.910
   52.878    45.663    51.192    43.027    27.382    29.996    23.846    16.485    13.496    11.794     8.470     8.160     3.793     4.243
    2.169     2.451     2.117     1.782     2.344     0.737     1.973     1.102    20.499

SAMPLE HOL36  TOP THICKNESS =  4 cm BAR
    0.000     0.000     0.000   237.953   815.983  1277.793   406.093   433.493    89.813    18.758    25.301    16.524     8.208     8.176
    5.021     3.908     3.354     2.251     1.499     1.574     1.302     1.022     1.268     1.550     1.630     1.129     1.286     1.811
    1.157     1.438     1.410     1.313     1.670     0.759     1.117     1.641     9.950

SAMPLE HOL36  MID THICKNESS = 13 cm BAR
    0.000     0.000    94.458   165.068   733.408   750.978   354.528   448.848   162.308    47.069    65.278    60.544    31.220    34.544
   25.680    20.380    20.462    15.395     9.674    10.265     7.874     5.670     6.107     7.010     6.401     8.651     5.260     7.753
    5.141     6.859     5.835     5.799     7.564     3.003     5.121     2.359    59.031

SAMPLE HOL36  MID THICKNESS = 13 cm BAR
    0.000     0.000     0.000   147.457    56.537   297.707   171.767   353.157   143.137    47.257    84.337    92.217    49.613    52.352
   42.044    32.167    33.283    24.826    14.945    15.583    12.087     8.566     7.690     8.467     6.968     8.141     4.502     6.438
    3.886     4.964     5.102     4.848     7.038     2.027     5.897     2.896    87.527

SAMPLE HOL36  MID THICKNESS = 11 cm BAR
    0.000     0.000     0.000   156.656   312.506   423.716   263.346   486.156   204.436    66.506   103.016   102.246    55.566    59.813
   44.352    36.211    36.447    26.433    16.403    18.278    14.337    10.640    10.244    10.652     8.768    10.368     5.535     7.455
    4.602     6.023     5.208     5.754     8.444     2.097     8.122     3.562    35.417

SAMPLE HOL36  BOT THICKNESS = 29 cm BAR
    0.000     0.000    88.112    40.802   191.782   480.172   162.972   218.822   145.292    51.742    68.922    82.062    47.742    56.292
   44.052    39.952    46.442    37.779    25.149    29.600    25.057    19.205    19.034    20.197    16.360    19.533    10.514    13.400
    8.001    11.739    11.419    11.779    16.651     5.270    14.651     6.925    57.515

SAMPLE HOL37  TOP THICKNESS =  4 cm MCH
    0.000   263.712 [illegible]  709.003   694.112   447.522    81.812    27.947     8.258     0.210     0.632     0.332     0.150     0.271
    0.049     0.028     0.113     0.078     0.066     0.061     0.050     0.040     0.059     0.047     0.042     0.045     0.026     0.034
    0.027     0.031     0.038     0.027     0.052     0.020     0.047     0.029     0.476

SAMPLE HOL37  MID THICKNESS = 38 cm MCH
    0.000     0.000     0.000   114.464   132.654   369.904   149.784   357.444   187.134    56.134   103.244   102.584    66.704    75.534
   63.114    52.594    54.454    41.490    26.740    28.177    21.369    14.686    12.061    13.823     9.452    10.552     5.380     7.540
    4.264     5.479     5.015     4.942     7.817     2.411     7.535     3.188    73.996

SAMPLE HOL54  TOP THICKNESS =  4 cm MCH
    0.000     0.000     0.000   509.363   627.573   543.163   114.423   152.083    47.913    10.335    25.340    28.064    16.764    17.436
   11.662     8.715     8.751     5.796     3.432     3.621     2.758     2.033     1.871     1.650     1.387     1.646     0.821     1.115
    0.595     0.725     0.706     0.577     0.698     0.223     0.515     0.309     4.688

NUMBER OF SAMPLES     23
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SAMPLE HOL26 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	168.018	269.088	348.588	133.048	129.838	36.558	9.992	14.345	12.434	6.370	6.614
5.195	4.686	3.687	3.156	2.001	2.189	1.914	1.416	1.516	1.624	1.484	1.908	1.070	1.564
0.901	1.253	1.165	1.039	1.327	0.424	1.014	0.509	2.092					

SAMPLE HOL26 MID THICKNESS = 18 cm BAR

0.000	0.000	198.986	309.016	318.356	410.336	152.916	326.596	183.356	66.496	102.306	115.716	77.926	86.306
72.136	60.126	63.826	49.759	32.712	35.478	29.339	21.585	18.996	19.192	13.885	16.772	8.220	12.036
6.384	8.947	7.559	7.698	9.930	2.980	9.207	4.906	89.408					

SAMPLE HOL26 TIL THICKNESS = 20 cm BAR

0.000	0.000	0.000	174.646	232.626	428.376	125.026	228.226	86.076	32.581	49.257	51.924	30.625	34.733
24.506	21.572	22.707	18.183	12.261	14.034	12.256	10.372	8.789	9.816	7.340	9.557	4.798	6.739
4.073	5.511	4.650	5.184	6.955	2.435	6.471	2.938	108.890					

SAMPLE HOL28 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	0.000	83.630	367.210	150.580	296.070	101.070	27.663	45.425	40.739	17.409	15.715
10.644	6.645	5.903	4.349	1.898	1.970	1.383	0.900	0.763	0.644	0.501	0.542	0.264	0.360
0.202	0.243	0.281	0.236	0.329	0.123	0.319	0.159	1.859					

SAMPLE HOL28 MID THICKNESS = 20 cm MCH

0.000	0.000	0.000	0.000	59.060	161.970	149.320	411.730	192.160	59.440	108.560	126.760	81.930	102.070
85.250	70.820	76.130	61.587	32.877	38.547	25.885	17.849	13.911	9.361	7.707	6.727	3.304	3.870
2.053	2.586	2.346	2.391	2.893	1.189	2.839	1.540	41.185					

SAMPLE HOL28 TIL THICKNESS = 14 cm MCH

0.000	0.000	0.000	0.000	0.000	189.955	91.635	369.675	167.305	65.585	110.055	120.165	77.395	99.005
85.885	80.365	89.505	53.079	37.743	42.844	33.981	24.712	20.756	19.754	13.719	14.641	6.891	8.835
4.272	5.194	4.659	4.268	4.853	1.610	4.122	1.916	58.762					

SAMPLE HOL48 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	100.821	957.651	1287.741	461.611	526.531	76.531	10.498	9.337	6.972	1.405	2.025
1.498	0.897	1.122	0.904	0.472	0.541	0.412	0.343	0.379	0.391	0.414	0.549	0.342	0.527
0.300	0.413	0.428	0.398	0.482	0.176	0.433	0.247	2.915					

SAMPLE HOL48 MID THICKNESS = 21 cm BAR

0.000	0.000	0.000	123.791	228.891	880.701	426.981	690.131	214.211	72.601	81.351	61.021	24.871	19.979
11.879	6.701	4.859	3.072	1.951	1.909	1.500	1.153	1.158	1.235	1.156	1.635	0.981	1.400
0.862	1.126	1.200	1.186	1.507	0.693	1.515	0.901	9.140					

SAMPLE HOL48 BOT THICKNESS = 14 cm BAR

0.000	0.000	0.000	0.000	25.232	311.732	171.672	381.542	217.902	76.922	130.742	141.252	78.402	84.242
64.462	49.862	45.452	30.257	20.500	21.759	17.862	13.869	13.031	14.055	11.816	15.228	8.339	13.240
7.659	9.939	8.677	6.640	10.662	3.708	6.492	2.855	49.567					

SAMPLE HOL54 MID THICKNESS = 16 cm MCH

0.000	0.000	0.000	0.000	46.725	323.095	148.805	294.825	206.415	56.015	112.215	152.775	98.775	127.415
106.245	91.145	95.345	63.797	46.029	46.486	35.899	25.470	20.651	19.376	13.881	15.928	7.600	9.797
4.829	6.335	5.020	4.525	5.044	1.927	3.637	1.660	54.645					

SAMPLE HOL54 BOT THICKNESS = 11 cm MCH

0.000	0.000	0.000	0.000	46.989	75.869	109.449	208.309	120.059	49.899	75.019	106.529	66.449	88.129
72.769	67.239	77.669	58.845	45.356	53.045	46.363	36.593	32.074	32.201	24.875	28.143	13.136	16.539
8.175	8.675	6.630	5.127	5.825	1.796	4.098	1.727	65.578					

SAMPLE HOL58 TOP THICKNESS = 4 cm MCH

0.000	0.000	216.476	332.386	492.656	755.986	199.706	314.826	86.016	24.494	40.724	53.160	38.508	56.155
51.437	47.075	46.185	40.599	25.334	27.968	21.895	16.456	15.162	12.808	11.571	12.704	8.003	7.757
3.864	5.293	4.214	3.528	4.224	1.453	2.755	1.540	21.957					

SAMPLE HOL67 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	188.980	235.080	439.620	145.860	294.190	133.790	66.000	83.420	95.320	56.630	67.120
51.427	38.132	34.130	24.706	13.799	15.422	13.545	11.438	11.299	10.850	9.837	11.797	6.520	9.243
6.561	8.077	7.133	6.988	9.312	2.839	6.536	2.561	74.157					

SAMPLE HOL70 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	92.713	205.163	611.183	295.713	429.033	205.953	68.853	98.763	119.483	80.903	92.553
77.303	58.253	62.783	43.153	27.573	28.489	19.658	13.227	10.245	8.891	6.129	6.390	3.100	4.425
2.467	3.136	3.007	2.618	4.314	1.566	3.117	1.817	52.353					

SAMPLE HOL70 MID THICKNESS = 58 cm BAR

0.000	0.000	0.000	193.640	159.870	422.630	179.170	275.100	130.020	54.380	88.470	96.950	65.190	84.870
83.090	83.120	102.600	82.136	64.714	76.267	62.823	45.168	34.948	30.243	19.119	18.560	8.227	10.651
5.500	6.750	6.143	5.696	7.695	3.189	6.013	3.284	120.620					

SAMPLE HOL84 MID THICKNESS = 40 cm BAR

0.000	0.000	0.000	121.987	374.987	393.497	116.477	251.937	123.027	50.317	66.847	141.697	49.187	63.957
56.937	55.547	65.257	47.772	36.945	44.529	39.514	30.661	26.274	24.299	17.984	18.893	9.460	12.200
6.951	9.364	7.938	8.111	11.621	3.770	10.822	4.914	178.986					

SAMPLE HOL86 BOT THICKNESS = 43 cm BAR

0.000	0.000	122.455	421.465	195.835	304.595	122.185	253.965	134.655	49.965	78.395	96.345	64.795	76.805
72.055	64.335	76.015	64.001	46.592	56.651	48.735	37.930	33.000	31.314	25.211	27.354	14.212	19.014
12.580	13.639	13.118	11.433	14.603	4.044	10.849	2.938	122.761					

SAMPLE HOL87 MID THICKNESS = 35 cm BAR

0.000	0.000	0.000	147.713	230.843	426.043	117.373	325.703	114.313	42.627	82.933	99.083	67.933	82.843
75.563	69.903	77.493	46.967	32.961	37.194	29.013	20.235	18.516	16.892	12.315	13.540	6.754	8.216
4.464	5.678	4.529	4.347	5.603	2.398	3.708	2.163	50.966					

SAMPLE HOL88 BOT THICKNESS = 3 cm BAR

0.000	0.000	0.000	0.000	0.000	126.133	35.273	135.853	84.223	32.279	56.833	71.993	45.018	59.523
59.223	53.363	68.713	37.713	45.125	59.761	53.063	41.013	37.532	35.102	26.008	29.678	15.604	22.546
15.539	22.189	23.960	24.333	43.093	8.802	33.267	11.986	389.264					

SAMPLE HOL89 MID THICKNESS = 14 cm BAR

0.000	0.000	497.299	220.069	162.139	358.559	125.069	258.619	137.469	43.799	71.869	72.629	43.043	46.939
36.911	30.011	31.454	23.363	14.947	16.646	13.441	10.665	10.595	11.838	11.246	14.677	8.052	10.997
6.715	8.971	8.449	8.169	11.239	3.069	8.693	3.601	177.609					

NUMBER OF SAMPLES 20

SAMPLE HOL61 BOT THICKNESS = 13 cm MCH

0.000	0.000	0.000	0.000	219.239	400.479	187.829	348.609	176.839	71.689	109.829	130.769	76.469	91.449
87.999	77.809	90.359	71.630	50.315	54.133	41.739	28.405	23.256	20.901	15.099	14.980	6.866	7.759
3.962	4.870	3.206	2.907	2.962	0.851	2.355	0.863	37.538					

SAMPLE HOL62 TOP THICKNESS = 4 cm MCH

0.000	0.000	429.070	527.440	302.310	329.050	194.810	270.470	109.010	35.110	52.880	50.250	24.460	28.690
23.010	20.460	17.890	12.230	7.110	7.240	4.920	3.170	2.630	2.070	1.490	1.530	0.770	0.918
0.578	0.638	0.748	0.688	1.128	0.378	1.048	0.678	18.310					

SAMPLE HOL62 MID THICKNESS = 28 cm MCH

0.000	0.000	0.000	161.419	377.509	525.069	246.909	343.709	156.499	66.239	90.519	99.529	61.719	71.449
59.199	51.899	54.049	43.449	28.709	28.759	21.099	13.939	10.729	9.879	6.529	6.499	3.059	4.099
2.419	2.669	2.379	2.559	3.329	1.169	3.649	1.679	62.050					

SAMPLE HOL62 BOT THICKNESS = 15 cm MCH

0.000	0.000	0.000	114.279	151.269	293.259	143.939	273.539	141.259	61.009	96.789	131.659	78.929	99.999
92.709	87.479	99.719	52.083	34.433	37.481	28.656	21.057	19.084	16.245	12.519	12.700	6.154	6.606
3.742	4.185	3.597	2.984	3.381	1.256	2.104	1.059	78.969					

SAMPLE HOL63 TOP THICKNESS = 4 cm BCH

0.000	0.000	0.000	0.000	215.829	309.319	111.639	146.049	76.609	22.596	33.904	38.339	22.355	29.041
24.947	26.133	29.002	24.005	16.630	18.157	13.543	9.278	7.366	6.050	4.685	4.950	2.477	3.295
1.827	2.646	2.707	2.690	3.993	1.193	3.344	2.103	53.395					

SAMPLE HOL63 MID THICKNESS = 38 cm FCH

0.000	0.000	0.000	109.368	141.548	296.049	79.528	161.568	87.978	27.088	45.858	48.708	31.558	38.658
33.843	34.298	37.638	20.196	14.978	17.014	14.411	11.471	10.193	10.495	7.855	9.289	4.722	6.916
4.277	6.025	6.398	6.928	11.279	2.807	9.399	3.735	455.214					

SAMPLE HOL63 BOT THICKNESS = 14 cm BCH

0.000	0.000	0.000	150.822	153.542	214.542	101.392	267.992	114.462	50.792	62.412	79.112	50.242	65.982
60.662	61.962	72.122	66.264	46.555	55.394	45.849	33.262	27.929	24.359	17.428	18.772	8.410	10.488
5.641	6.957	6.660	6.427	7.677	2.355	5.624	2.503	105.358					

SAMPLE HOL64 TOP THICKNESS = 4 cm BCH

0.000	0.000	0.000	336.677	63.077	450.007	181.757	294.497	87.397	34.768	48.721	50.104	25.036	26.331
20.521	12.961	10.700	8.153	3.963	3.763	2.625	1.987	1.930	1.606	1.961	2.765	1.760	2.911
1.791	2.573	2.328	2.131	2.851	0.851	2.214	1.107	20.650					

SAMPLE HOL64 BOT THICKNESS = 30 cm BCH

0.000	0.000	0.000	60.069	124.549	413.739	163.139	204.719	106.579	50.559	67.699	93.489	61.637	81.569
74.047	71.539	81.759	63.909	40.302	42.648	29.395	18.357	15.185	11.331	9.116	10.974	6.331	9.275
5.963	9.301	9.991	9.675	16.729	3.342	15.193	8.325	166.530					

SAMPLE HOL64 MID THICKNESS = 29 cm BCH

0.000	0.000	0.000	33.772	78.219	277.829	172.529	331.619	151.829	67.479	110.869	151.219	95.119	123.269
119.449	194.347	120.739	91.374	54.206	53.305	35.399	23.879	20.264	17.363	17.462	23.820	14.358	21.866
14.589	18.541	15.716	13.946	20.218	5.292	15.393	7.049	176.434					

SAMPLE HOL66 TOP THICKNESS = 4 cm MCH

0.000	0.000	124.679	455.339	461.339	729.259	245.339	354.549	110.729	37.631	36.972	26.400	11.279	10.766
0.070	3.124	2.561	1.711	0.870	0.803	0.599	0.425	0.374	0.304	0.235	0.237	0.101	0.141
0.081	0.091	0.096	0.087	0.138	0.048	0.151	0.080	0.533					

SAMPLE HOL66 MID THICKNESS = 32 cm MCH

0.000	0.000	0.000	171.901	222.121	377.391	153.311	393.301	207.341	72.601	111.081	104.921	62.891	67.141
53.211	48.375	46.267	37.549	25.358	31.074	28.635	21.500	20.840	18.828	14.511	13.166	6.061	6.479
3.557	3.845	4.036	2.862	4.229	1.157	3.293	1.351	44.395					

SAMPLE HOL66 BOT THICKNESS = 12 cm MCH

0.000	0.000	0.000	53.213	170.371	202.121	152.271	338.071	131.661	61.281	88.061	102.801	69.291	76.891
59.471	52.211	51.771	47.181	34.049	39.890	37.059	32.802	31.421	30.188	25.458	29.702	13.880	18.167
10.049	11.149	9.817	7.802	9.202	3.192	4.885	2.619	93.595					

SAMPLE HOL67 MID THICKNESS = 22 cm BAB

0.000	0.000	0.000	0.000	180.295	129.295	46.516	84.375	34.824	16.637	26.951	36.709	27.392	41.762
41.949	44.395	63.560	66.440	54.439	68.855	61.709	50.038	39.708	40.277	26.292	27.097	11.167	14.327
6.519	7.776	7.127	6.487	8.022	3.116	6.958	4.438	164.860					

SAMPLE HOL67 MID THICKNESS = 37 cm BAB

0.000	0.000	0.000	561.237	101.767	256.997	107.207	186.197	90.397	31.007	52.347	59.777	34.171	40.354
37.327	37.618	44.333	41.351	39.839	35.190	29.243	22.510	21.947	25.495	24.669	34.009	18.112	30.599
18.476	28.153	27.470	27.498	43.238	13.424	30.285	17.277	202.640					

SAMPLE HOL67 BOT THICKNESS = 22 cm BAB

0.000	0.000	0.000	0.000	180.295	129.155	46.516	84.375	34.824	16.637	26.951	36.709	27.392	41.762
41.949	44.395	63.560	66.440	54.439	68.855	61.709	50.038	39.708	40.277	26.292	27.097	11.167	14.327
6.519	7.776	7.127	6.437	8.022	3.116	6.958	4.438	164.860					

SAMPLE HOL72 TOP THICKNESS = 4 cm BCH

0.000	0.000	0.000	0.000	280.971	189.921	104.031	196.621	79.911	25.655	39.875	42.134	25.123	30.797
25.589	24.947	27.106	24.273	17.998	21.862	20.276	18.746	19.772	23.384	24.463	35.834	21.077	54.335
31.366	47.066	39.903	41.077	56.073	24.362	35.936	17.358	337.860					

SAMPLE HOL73 MID THICKNESS = 18 cm BCH

0.000	0.000	0.000	0.000	232.185	245.445	83.155	125.575	95.745	42.835	69.365	85.545	53.435	70.275
56.625	51.675	66.115	22.702	43.348	54.138	47.644	38.074	39.824	47.978	45.922	61.726	31.644	43.108
25.244	26.602	26.798	21.285	28.646	11.743	17.990	9.354	358.989					

SAMPLE HOL72 BOT THICKNESS = 31 cm BCH

0.000	0.000	0.000	0.000	0.000	43.853	33.628	24.877	17.780	14.480	9.287	16.159	17.253	17.560
24.736	20.565	39.517	31.282	25.298	34.968	31.494	29.775	31.448	40.574	39.187	57.022	32.206	47.572
28.214	33.171	31.339	26.471	36.822	9.817	26.176	11.430	520.860					

SAMPLE HOL73 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	543.987	651.937	1106.587	199.837	298.627	78.037	30.234	35.233	30.898	14.610	14.458
10.172	5.904	5.278	0.735	0.425	0.360	0.251	0.154	0.094	0.063	0.059	0.050	0.025	0.033
0.023	0.021	0.030	0.029	0.049	0.021	0.049	0.032	0.169					

SAMPLE HOL41 BOT THICKNESS = 12 cm BAR

0.000	0.000	0.000	87.167	274.817	139.177	140.627	180.997	53.999	21.421	32.796	34.641	16.843	21.252
18.332	16.172	17.222	12.720	8.796	9.435	7.728	5.623	5.009	4.675	3.589	4.088	2.073	2.950
1.898	2.928	3.149	3.836	6.298	3.395	6.875	4.671	271.300					

SAMPLE HOL41 MID THICKNESS = 33 cm BAR

0.000	0.000	121.839	466.599	118.509	410.709	136.729	229.199	103.589	39.882	60.319	62.639	39.263	47.543
35.903	31.330	32.937	24.311	15.211	15.751	12.254	8.706	7.022	6.233	4.535	5.102	2.497	3.434
2.014	2.634	2.841	2.456	5.509	2.368	6.390	4.681	212.040					

SAMPLE HOL41 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	224.032	217.802	369.822	174.252	343.172	162.002	57.842	72.772	72.472	33.181	30.451
20.673	14.217	10.509	6.223	3.528	2.951	2.067	1.427	1.172	1.041	0.822	0.957	0.476	0.701
0.410	0.614	0.819	0.963	2.218	1.175	3.419	2.332	71.080					

SAMPLE HOL42 TOP THICKNESS = 4 cm MCH

0.000	0.000	118.875	838.435	481.435	1080.455	188.595	153.965	20.949	6.010	3.234	1.562	1.171	0.594
0.290	0.201	0.211	0.166	0.126	0.120	0.105	0.067	0.073	0.076	0.067	0.070	0.054	0.047
0.033	0.051	0.064	0.083	0.141	0.052	0.188	0.103	1.070					

SAMPLE HOL42 MID THICKNESS = 38 cm MCH

0.000	0.000	0.000	404.103	35.029	474.193	268.123	423.203	190.993	60.593	85.093	72.163	40.128	43.713
31.910	26.683	27.676	20.677	15.031	16.073	13.236	10.048	8.648	8.122	6.469	7.292	3.673	5.100
3.069	3.600	3.075	3.149	5.302	1.742	5.313	3.776	110.910					

SAMPLE HOL51 TOP THICKNESS = 4 cm BAR

0.000	0.000	0.000	63.081	101.061	703.001	402.851	862.351	290.441	81.491	96.501	79.421	32.821	28.677
18.029	10.430	8.599	5.347	2.835	2.685	1.898	1.244	1.066	0.963	0.763	0.968	0.563	0.799
0.609	0.869	0.977	1.326	1.989	0.891	2.105	1.257	20.836					

SAMPLE HOL51 MID THICKNESS = 7 cm BAR

0.000	0.000	0.000	71.933	65.748	120.633	77.093	306.323	187.203	109.168	29.680	142.493	86.985	91.411
76.253	58.121	53.337	41.393	25.212	26.287	19.132	14.781	12.734	16.193	15.079	18.807	9.257	12.596
7.401	9.697	11.105	9.495	14.619	5.592	10.847	8.380	125.280					

SAMPLE HOL51 MID THICKNESS = 29 cm BAR

0.000	0.000	105.153	39.697	30.327	219.403	114.013	365.113	203.343	99.963	129.943	149.113	83.953	92.823
73.933	57.613	55.623	40.218	23.597	23.593	16.776	12.008	10.173	8.798	6.442	7.798	3.842	5.333
3.014	3.773	4.365	4.046	7.599	2.984	9.541	8.293	114.110					

SAMPLE HOL51 BOT THICKNESS = 10 cm BAR

0.000	0.000	0.000	0.000	0.000	287.370	147.230	340.210	157.280	74.640	126.660	150.330	74.570	117.370
99.730	87.400	93.480	66.036	44.790	48.170	38.757	28.747	24.306	22.965	18.546	22.452	12.068	17.317
9.939	12.906	11.375	10.175	16.374	4.308	14.930	6.671	186.786					

SAMPLE HOL56 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	701.750	818.350	872.600	242.870	243.480	58.680	13.740	20.040	13.950	6.220	5.160
3.950	2.720	2.120	1.760	0.740	0.910	0.590	0.310	0.300	0.170	0.090	0.070	0.030	0.051
0.022	0.033	0.015	0.031	0.022	0.031	0.013	0.012	0.011					

SAMPLE HOL56 MID THICKNESS = 38 cm MCH

0.000	0.000	0.000	69.364	23.884	119.044	139.454	253.184	144.234	45.156	89.574	125.714	83.314	115.934
111.524	102.154	123.604	74.416	55.234	60.400	46.749	34.327	25.403	23.946	15.860	17.988	8.227	10.368
5.631	6.189	5.794	5.392	7.450	3.273	6.776	3.577	8.160					

SAMPLE HOL56 BOT THICKNESS = 10 cm MCH

0.000	0.000	0.000	109.327	62.067	315.007	107.457	326.467	153.837	53.047	90.967	93.717	61.977	78.187
69.977	62.777	71.007	46.133	34.093	38.660	32.851	24.890	21.249	18.395	15.349	16.752	8.704	11.465
6.355	8.349	6.964	7.161	9.920	3.048	11.311	3.882	135.635					

SAMPLE HOL58 MID THICKNESS = 22 cm MCH

0.000	0.000	0.000	798.940	450.880	459.802	246.810	258.870	100.650	46.859	79.890	90.950	65.397	77.400
70.570	64.135	73.320	63.549	38.176	39.264	29.289	20.959	16.675	11.392	9.462	8.745	4.318	4.966
2.984	3.232	3.587	2.980	4.742	1.567	4.462	2.289	139.400					

SAMPLE HOL58 BOT THICKNESS = 16 cm MCH

0.000	0.000	0.000	0.000	0.000	174.440	123.250	275.230	56.910	64.862	84.963	92.488	69.271	72.617
67.727	63.966	71.273	59.296	36.902	39.099	29.758	23.048	18.670	19.538	13.920	15.520	7.125	8.918
4.786	5.463	5.840	4.462	5.440	1.825	3.802	1.913	67.325					

SAMPLE HOL61 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	116.793	315.593	558.246	256.193	381.825	142.153	43.373	63.590	62.837	29.881	30.779
23.620	17.992	17.633	13.101	7.238	6.670	4.816	3.183	3.576	3.103	2.656	2.539	1.391	1.680
0.919	1.098	1.164	0.932	1.195	0.464	0.807	0.521	50.035					

SAMPLE HOL61 BOT THICKNESS = 15 cm MCH

0.000	0.000	0.000	0.000	107.175	254.265	86.435	292.745	161.565	87.745	97.175	143.785	90.765	125.475
108.105	97.075	105.315	77.469	51.930	52.659	53.176	26.698	20.084	19.374	13.929	14.581	7.353	9.909
5.250	7.071	5.863	4.579	6.783	2.048	5.403	2.949	71.528					

NUMBER OF SAMPLES 21

SAMPLE HOL73 MID THICKNESS = 32 cm MCH

0.000	0.000	0.000	0.000	200.230	394.960	158.360	353.200	144.680	63.350	99.540	120.450	74.860	99.880
86.850	80.060	99.070	84.718	60.413	72.415	60.692	49.065	40.987	37.181	27.618	25.953	11.236	12.139
6.005	6.045	4.047	3.863	4.006	1.219	2.624	1.335	20.072					

SAMPLE HOL73 BOT THICKNESS = 23 cm MCH

0.000	0.000	0.000	0.000	30.775	66.868	83.378	209.408	115.708	46.858	79.948	95.328	64.428	86.068
77.988	73.368	91.388	83.379	61.942	79.426	72.875	61.805	57.743	54.733	44.106	46.591	21.184	26.629
13.883	15.893	11.683	9.838	10.138	2.798	6.125	2.587	355.086					

SAMPLE HOL74 TOP THICKNESS = 3 cm MCH

0.000	0.000	117.830	534.340	767.950	1153.150	260.690	202.200	43.300	73.370	13.170	8.710	3.740	3.460
2.920	2.370	2.130	0.520	0.340	0.510	0.310	0.220	0.200	0.170	0.130	0.140	0.070	0.090
0.050	0.050	0.080	0.080	0.120	0.050	0.150	0.060	1.290					

SAMPLE HOL74 MID THICKNESS = 28 cm MCH

0.000	0.000	0.000	45.077	106.928	195.238	132.798	357.058	181.728	60.938	95.098	99.228	64.588	61.028
50.508	46.118	49.018	40.175	31.937	43.241	46.057	48.151	52.239	57.236	54.177	65.561	32.515	37.758
19.592	22.088	16.883	13.444	14.842	5.213	9.157	4.628	62.572					

SAMPLE HOL74 BOT THICKNESS = 33 cm MCH

0.000	0.000	0.000	0.000	55.056	167.026	95.756	175.496	85.406	39.946	58.386	62.016	37.456	42.086
34.689	33.472	36.943	41.920	34.225	43.202	50.383	50.339	65.575	76.539	70.715	76.534	34.915	46.396
30.195	26.301	20.407	11.808	16.111	3.917	7.729	2.931	81.065					

SAMPLE HOL75 TOP THICKNESS = 4 cm DAB

0.000	0.000	0.000	203.966	383.766	496.146	255.726	319.256	133.836	56.396	70.226	74.456	40.816	42.066
32.856	27.956	27.126	22.366	13.419	14.795	13.343	9.500	8.436	8.326	7.464	9.152	5.115	7.627
4.814	6.126	5.611	5.751	8.171	2.530	7.396	2.749	34.149					

SAMPLE HOL75 MID THICKNESS = 35 cm DAB

0.000	0.000	0.000	581.775	245.655	303.215	117.037	245.625	110.485	46.242	64.735	65.405	40.744	47.854
36.012	33.989	37.155	23.316	17.709	20.141	19.779	18.042	18.306	19.397	16.706	19.877	10.595	14.883
9.231	11.759	10.371	10.928	14.427	5.629	11.841	5.789	132.980					

SAMPLE HOL75 BOT THICKNESS = 18 cm DAB

0.000	0.000	155.630	151.910	263.190	354.070	147.950	209.120	114.500	39.478	65.030	69.030	43.340	48.080
40.040	36.058	38.444	31.727	20.081	23.296	20.712	16.183	15.599	15.608	14.154	16.752	9.384	13.613
8.440	13.364	11.083	11.509	16.415	4.989	12.047	5.766	130.976					

SAMPLE HOL76 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	136.540	483.300	687.870	273.590	492.120	138.040	47.108	60.320	55.465	28.345	23.718
17.726	11.514	10.561	8.052	4.611	4.411	2.925	1.693	1.145	0.862	0.538	0.514	0.201	0.226
0.124	0.152	0.203	0.178	0.344	0.117	0.323	0.127	1.990					

SAMPLE HOL76 MID THICKNESS = 28 cm MCH

0.000	0.000	0.000	208.009	171.129	332.989	183.979	346.339	178.019	69.779	114.559	121.949	70.989	88.469
69.959	66.369	71.839	57.913	40.214	45.435	35.611	25.011	19.719	16.729	11.997	12.648	5.161	5.252
2.528	2.775	2.263	1.776	2.597	0.931	2.043	1.668	2.657					

SAMPLE HOL76 BOT THICKNESS = 39 cm MCH

0.000	0.000	0.000	94.012	40.682	198.012	75.022	186.632	106.982	51.132	75.192	97.942	61.672	84.802
80.352	[illegible]	102.062	129.858	111.970	140.315	128.560	101.133	84.590	86.712	61.128	69.804	29.627	34.999
17.422	16.131	15.603	11.716	13.721	3.693	11.545	4.867	93.655					

SAMPLE HOL80 TOP THICKNESS = 4 cm DAB

0.000	0.000	0.000	147.788	525.988	591.298	112.098	195.448	90.388	30.535	53.843	72.738	54.896	65.998
62.388	54.269	58.278	43.934	26.004	25.538	18.464	12.197	10.025	9.470	7.351	8.648	4.662	6.174
3.805	5.383	5.053	5.287	8.147	2.508	8.078	3.773	141.950					

SAMPLE HOL80 MID THICKNESS = 58 cm DAB

0.000	0.000	0.000	162.723	120.883	321.283	122.303	403.553	160.343	70.183	114.973	123.163	77.843	87.193
73.343	60.293	57.043	43.122	27.811	27.370	20.762	13.773	10.416	9.847	7.020	8.470	4.093	5.861
3.605	4.966	5.539	6.012	8.926	3.000	9.832	5.768	168.459					

SAMPLE HOL84 TOP THICKNESS = 4 cm DAB

0.000	308.775	306.265	806.505	266.505	504.545	105.945	85.935	40.679	11.806	22.927	27.087	14.084	19.773
17.027	16.475	18.099	16.009	10.816	12.381	9.495	6.626	5.552	3.490	3.055	3.128	1.671	2.317
1.539	1.961	2.265	2.172	3.527	1.242	3.173	2.288	56.840					

SAMPLE HOL84 BOT THICKNESS = 20 cm DAB

0.000	0.000	0.000	0.000	0.000	129.291	73.721	213.231	111.721	48.564	88.463	107.900	70.898	87.476
72.519	73.690	79.107	69.622	43.642	49.333	39.858	30.480	26.189	22.664	17.875	20.280	10.254	13.192
8.303	11.014	12.627	11.858	17.826	5.243	12.385	6.778	369.512					

SAMPLE HOL87 TOP THICKNESS = 4 cm DAB

0.000	0.000	713.473	460.543	291.493	379.953	94.713	188.953	69.613	27.807	32.141	34.541	20.529	21.064
16.872	15.401	13.419	10.009	6.205	6.369	4.276	2.891	2.335	1.957	1.486	1.617	0.788	0.999
0.583	0.687	0.675	0.607	0.947	0.484	0.862	0.474	12.634					

SAMPLE HOL87 BOT THICKNESS = 15 cm DAB

0.000	0.000	0.000	0.000	0.000	11.459	10.019	52.229	28.249	14.989	19.679	21.649	15.449	21.379
20.319	21.449	26.809	23.969	17.889	21.669	18.259	20.869	11.069	9.299	6.509	6.479	2.769	3.081
1.481	1.971	1.501	1.471	1.861	0.691	1.461	0.891	33.151					

SAMPLE HOL88 TOP THICKNESS = 4 cm DAB

0.000	0.000	313.160	912.829	427.470	703.690	135.040	178.590	35.876	5.460	8.448	7.046	2.850	3.805
2.843	2.229	1.879	1.383	0.916	0.987	0.816	0.624	0.710	0.700	0.835	1.525	1.130	1.927
1.487	2.357	2.414	2.437	2.811	1.244	1.764	0.824	12.061					

SAMPLE HOL88 MID THICKNESS = 40 cm DAB

0.000	0.000	0.000	0.000	407.290	264.820	217.810	316.510	168.870	66.342	84.251	106.421	67.779	84.155
68.999	55.224	58.077	46.370	26.791	26.447	18.862	13.013	11.497	14.076	12.279	17.451	9.014	14.434
10.125	12.912	15.211	12.680	17.670	5.194	12.990	5.782	115.836					

SAMPLE HOL93 TOP THICKNESS = 4 cm DAB

0.000	0.000	0.000	0.000	787.057	911.867	393.107	511.177	170.437	55.420	71.467	68.337	35.752	36.045
26.636	20.004	19.146	12.879	7.296	6.653	3.963	2.276	1.673	1.227	1.697	0.963	0.502	0.615
0.365	0.512	0.615	0.676	1.148	0.508	1.598	0.715	19.520					

SAMPLE HOL93 MID THICKNESS = 42 cm DAB

0.000	0.000	313.038	211.470	382.730	562.664	210.908	339.108	139.348	46.212	64.938	68.288	39.105	44.023
33.066	29.964	30.962	21.357	14.999	14.374	9.601	6.134	4.718	4.279	3.270	3.453	2.019	3.103
1.664	2.302	2.543	2.517	3.034	1.812	3.139	1.637	82.695					

Sixteen Mile Creek

SAMPLE SIX 1 TOP THICKNESS = 2 cm MCH

0.000	0.000	0.000	70.763	210.833	608.693	224.753	497.993	183.003	51.103	72.093	71.393	36.973	39.083
27.066	23.250	21.869	16.222	11.012	12.273	9.736	7.491	7.100	7.342	6.104	8.176	4.586	6.997
4.464	5.815	5.301	5.415	6.833	2.077	5.226	2.216	56.081					

SAMPLE SIX 1 MID THICKNESS = 17 cm MCH

0.000	0.000	0.000	93.354	274.684	537.154	244.594	335.174	158.144	48.144	74.104	79.074	46.454	52.024
41.104	34.731	38.019	28.045	20.682	24.047	20.340	15.973	15.259	15.190	11.950	14.307	6.776	9.802
5.045	6.782	5.524	5.719	8.155	2.347	7.443	3.748	144.169					

SAMPLE SIX 1 TIL THICKNESS = 25 cm MCH

0.000	0.000	0.000	53.295	117.265	204.495	78.565	151.105	69.085	29.065	40.335	48.275	28.803	33.556
28.645	26.284	29.468	23.912	19.602	23.076	22.377	19.884	22.105	26.314	23.155	31.054	16.425	21.474
12.332	15.907	13.880	14.673	21.480	5.882	18.800	7.548	448.690					

SAMPLE SIX 5 TOP THICKNESS = 2 cm BAR

0.000	0.000	0.000	45.141	122.741	635.962	462.721	536.391	189.441	46.989	54.356	50.870	22.373	16.546
8.675	6.259	4.896	3.171	2.037	2.202	2.107	1.739	2.096	2.373	2.495	3.691	2.282	3.420
2.031	3.042	2.912	2.710	3.233	1.378	2.219	1.100	16.387					

SAMPLE SIX 5 MID THICKNESS = 22 cm BAR

0.000	0.000	0.000	276.715	52.795	369.905	153.785	299.165	136.055	42.116	84.295	83.655	55.145	60.895
54.655	45.345	52.095	39.980	31.969	40.139	36.055	30.189	30.302	29.917	26.465	32.079	17.750	23.622
13.931	17.675	15.441	13.199	19.702	4.378	14.418	5.194	131.060					

SAMPLE SIX 5 TIL THICKNESS = 27 cm BAR

0.000	0.000	0.000	0.000	27.386	48.766	18.666	46.462	24.493	9.486	18.811	24.985	14.666	20.405
17.895	18.701	22.633	11.858	9.213	13.196	14.505	13.898	16.391	20.768	23.140	31.687	18.585	26.432
17.115	21.663	18.233	18.262	28.821	7.880	19.638	6.712	539.244					

SAMPLE SIX 6 TOP THICKNESS = 2 cm BAR

0.000	0.000	0.000	107.141	72.531	49.821	24.481	11.941	3.991	1.184	1.812	1.398	1.168	0.889
1.263	1.861	2.764	3.603	3.265	3.544	2.480	5.069	5.157	8.401	12.499	12.529	7.292	20.088
10.073	13.052	11.312	10.436	15.756	4.797	11.476	5.731	144.196					

SAMPLE SIX 6 MID THICKNESS = 58 cm BAR

0.000	0.000	0.000	32.107	89.087	141.717	16.697	75.227	40.727	11.43?	22.043	20.564	12.926	17.007
13.939	12.978	15.721	13.164	11.922	14.710	14.894	13.973	18.747	31.080	34.270	48.324	26.547	38.756
22.214	28.583	22.363	19.798	29.296	8.264	19.292	8.478	271.886					

SAMPLE SIX 6 BOT THICKNESS = 8 cm BAR

0.000	0.000	0.000	0.000	0.000	0.000	10.571	19.811	8.891	2.960	5.410	7.031	5.108	6.618
5.589	5.381	6.019	5.264	4.072	4.841	4.353	3.712	3.850	5.185	5.170	7.826	4.714	7.264
4.674	6.525	6.112	5.709	9.392	2.892	8.578	3.617	260.487					

SAMPLE SIX 9 TOP THICKNESS = 4 cm MCH

0.000	0.000	0.000	396.123	762.573	657.453	165.943	176.033	38.333	9.031	15.255	13.102	5.021	4.346
2.656	1.640	1.488	1.144	0.656	0.669	0.497	0.420	0.497	0.497	1.554	0.699	0.469	0.499
0.381	0.556	0.569	0.481	0.738	0.247	0.660	0.314	4.689					

SAMPLE SIX 9 MID THICKNESS = 26 cm MCH

0.000	0.000	0.000	0.000	0.000	287.231	166.481	312.981	150.871	59.291	91.341	93.081	57.981	64.431
47.971	39.381	40.621	28.832	17.653	18.484	14.059	9.414	7.977	7.772	5.140	6.376	2.828	4.015
2.110	2.667	2.682	2.509	3.934	1.432	3.932	1.849	39.643					

SAMPLE SIX 9 BOT THICKNESS = 27 cm MCH

0.000	0.000	0.000	0.000	131.924	173.194	32.344	152.284	87.224	35.894	65.554	73.494	44.429	53.844
56.494	43.904	50.104	39.981	29.872	33.381	30.026	22.791	20.447	22.179	16.741	19.428	9.859	14.241
8.091	10.021	9.931	9.581	14.123	5.276	9.745	4.734	125.146					

SAMPLE SIX17 TOP THICKNESS = 2 cm MCH

0.000	0.000	0.000	149.473	407.013	628.713	146.253	260.223	153.413	36.023	70.273	62.153	27.673	25.253
15.393	11.928	9.346	6.773	3.786	4.012	3.311	2.656	2.838	2.918	2.781	3.547	1.921	2.975
1.668	2.362	2.125	2.227	2.910	1.007	2.110	1.186	30.128					

SAMPLE SIX17 MID THICKNESS = 11 cm MCH

0.000	0.000	0.000	103.702	126.892	336.142	88.412	386.072	184.832	65.372	110.602	126.772	71.592	87.312
67.442	56.942	61.682	42.675	30.552	35.263	28.635	22.532	21.805	22.961	17.119	21.550	10.363	14.383
7.536	8.763	6.891	6.462	7.412	2.895	5.058	2.628	97.976					

SAMPLE SIX17 TIL THICKNESS = 63 cm MCH

0.000	0.000	0.000	0.000	53.631	208.641	88.481	210.531	110.901	44.091	71.481	86.491	58.021	65.121
57.621	54.001	59.271	47.499	34.419	40.905	36.303	30.940	30.577	33.889	27.197	32.234	16.982	23.132
14.123	17.876	15.469	15.842	21.919	8.584	14.492	7.156	454.382					

SAMPLE SIX18 TOP THICKNESS = 2 cm BCH

0.000	0.000	103.853	170.313	450.063	1100.963	289.233	460.593	152.433	28.903	48.983	31.783	14.513	11.448
5.763	4.020	2.985	1.906	1.084	1.127	0.806	0.714	0.761	0.863	0.867	1.268	0.699	1.035
0.569	0.753	0.759	0.638	0.931	-0.031	0.685	0.367	15.308					

SAMPLE SIX18 MID THICKNESS = 18 cm BCH

0.000	0.000	0.000	52.883	68.493	579.223	203.183	461.403	214.503	75.683	122.653	135.253	80.073	87.273
66.673	55.743	53.783	38.145	25.489	28.193	23.501	18.005	15.713	15.862	11.901	14.093	6.573	8.358
4.677	5.245	4.180	3.880	4.527	1.603	3.633	1.554	27.712					

SAMPLE SIX18 TIL THICKNESS = 35 cm BCH

0.000	0.000	0.000	0.000	22.681	263.591	134.231	175.911	93.021	29.511	41.771	52.481	30.981	36.681
20.641	26.961	27.631	21.490	14.934	16.998	14.866	12.176	11.748	13.051	10.624	13.471	7.024	10.027
5.718	7.617	5.688	5.338	7.738	2.113	6.206	2.750	216.345					

SAMPLE SIX20 TOP THICKNESS = 3 cm MCH

0.000	0.000	253.435	853.885	266.015	246.675	144.215	203.275	100.185	31.025	40.895	35.095	16.365	15.725
9.085	6.705	4.695	3.105	1.942	1.877	1.538	1.193	1.158	1.159	1.075	1.286	0.693	0.940
0.461	0.602	0.574	0.489	0.701	0.239	0.517	0.275	4.413					

SAMPLE SIX20 MID THICKNESS = 30 cm MCH

0.000	0.000	0.000	53.879	58.319	113.029	98.199	175.669	121.949	48.409	75.909	89.379	53.639	53.029
39.083	21.433	20.897	20.417	11.375	12.003	8.756	6.115	2.000	4.863	3.726	4.290	2.060	2.626
1.300	1.719	1.544	1.458	1.897	0.612	1.273	0.613	14.889					

SAMPLE SIX11 TOP THICKNESS = 3 cm MCH

0.000	0.000	0.000	426.091	719.741	731.381	291.101	367.361	105.821	23.851	44.061	42.761	19.291	22.501
13.631	10.231	8.431	5.086	3.028	3.009	2.425	1.900	1.747	1.920	1.861	2.114	1.104	1.270
0.817	0.805	0.988	0.699	1.051	0.342	0.967	0.235	6.990					

SAMPLE SIX11 TOP THICKNESS = 3 cm MCH

0.000	0.000	0.000	426.091	719.741	731.381	291.101	367.361	105.821	23.851	44.061	42.761	19.291	22.501
13.631	10.231	8.431	5.006	3.028	3.009	2.425	1.900	1.747	1.920	1.861	2.114	1.104	1.270
0.817	0.805	0.988	0.699	1.051	0.342	0.967	0.235	6.990					

SAMPLE SIX11 MID THICKNESS = 6 cm MCH

0.000	0.000	0.000	71.322	47.972	157.482	105.912	372.612	247.962	111.952	142.142	163.212	91.802	108.780
83.282	66.732	64.532	39.504	24.930	23.794	15.923	10.194	7.703	7.110	5.325	5.427	2.507	3.205
1.665	2.042	1.666	1.520	2.377	1.114	2.611	0.920	17.340					

SAMPLE SIX11 BOT THICKNESS = 39 cm MCH

0.000	0.000	0.000	0.000	0.000	76.212	92.563	312.472	187.732	86.772	141.972	183.312	106.252	134.552
123.682	110.762	116.332	87.391	64.844	74.556	60.060	44.700	36.937	35.976	26.098	26.038	12.347	15.765
7.869	9.393	8.414	7.800	9.932	3.104	8.709	2.766	71.503					

Grand River

SAMPLE CA22S TIL THICKNESS = 45 cm BLM

0.000	0.000	0.000	58.145	41.455	143.305	48.385	119.385	49.905	24.175	36.307	46.489	28.202	33.881	
29.681	30.144	34.186	26.225	22.577	29.700	28.109	25.436	26.325	31.264	27.721	32.012	16.541	24.710	
14.641	15.764	15.578	13.263	20.582	7.928	12.359	3.414	421.790						

SAMPLE GND 2 TOP THICKNESS = 18 cm BAR

0.000	0.000	0.000	384.096	245.256	372.826	172.516	311.666	137.836	54.326	69.536	74.706	54.466	63.976
55.526	54.016	60.116	58.914	46.669	59.258	57.063	49.364	42.963	42.445	30.467	40.604	26.690	43.943
25.571	25.641	18.463	14.489	13.547	5.349	6.057	1.972	95.280					

SAMPLE GND 2 BOT THICKNESS = 33 cm BAR

0.000	0.000	0.000	0.000	45.545	95.445	46.445	63.705	43.725	10.545	17.505	21.505	13.715	16.935
14.335	14.455	17.165	16.186	13.283	18.343	19.351	18.581	17.922	21.524	17.913	24.111	15.881	26.711
15.108	15.825	10.537	7.134	9.112	2.985	4.565	1.365	1039.071					

SAMPLE GND 4 TOP THICKNESS = 22 cm MCH

0.000	0.000	0.000	88.595	477.175	646.145	208.755	315.345	127.555	47.035	61.105	63.045	35.375	36.735
28.495	22.075	22.455	16.799	11.322	13.119	11.846	10.039	11.180	12.904	9.151	9.583	4.661	4.406
1.614	1.764	1.534	1.062	1.364	0.517	1.029	0.271	16.253					

SAMPLE GND 4 MID THICKNESS = 19 cm MCH

0.000	0.000	0.000	80.656	52.256	331.456	125.866	276.446	143.796	51.656	90.896	107.266	68.456	81.326
65.766	68.316	73.186	57.210	45.766	56.886	51.895	44.429	41.631	43.411	27.453	27.509	11.492	10.647
3.986	4.186	2.758	2.100	2.178	0.890	1.746	0.519	26.992					

SAMPLE GND 4 BOT THICKNESS = 10 cm MCH

0.000	0.000	0.000	0.000	66.999	302.319	118.709	223.779	114.949	45.689	83.899	106.799	61.739	86.089
72.729	77.129	88.109	77.524	71.606	100.209	111.187	118.408	135.356	154.670	109.549	107.106	49.303	40.080
13.176	10.807	8.099	5.456	6.050	1.980	3.218	0.823	42.992					

SAMPLE GND 8 TOP THICKNESS = 15 cm BAR

0.000	0.000	0.000	102.516	342.786	656.956	298.346	365.306	545.536	69.096	74.016	74.816	40.126	42.486
36.626	35.106	37.796	31.315	26.701	34.820	34.533	31.898	33.982	37.354	26.649	27.738	9.726	11.310
5.394	6.318	5.831	4.207	4.989	1.841	3.190	0.738	17.690					

SAMPLE GND 8 BOT THICKNESS = 39 cm BAR

0.000	0.000	87.612	68.272	291.982	195.612	333.112	188.012	183.802	60.112	105.962	110.062	67.552	79.592
68.052	63.952	69.632	55.344	49.702	71.023	76.969	81.187	94.022	115.191	89.680	92.519	38.418	46.272
22.716	22.868	17.606	11.880	12.875	3.387	5.646	1.128	21.752					

SAMPLE GND14 MOD THICKNESS = 62 cm BAR

0.000	0.000	0.000	339.785	229.165	459.205	125.625	236.555	68.365	36.375	38.012	44.159	24.886	30.662
27.544	31.226	37.460	49.674	44.221	73.084	90.473	111.478	145.321	205.585	179.794	228.044	122.789	165.714
94.071	94.029	71.964	47.336	53.927	14.668	22.429	6.046	76.512					

SAMPLE GND15 ONE THICKNESS = 35 cm BAR

0.000	0.000	0.000	94.876	231.326	515.946	149.036	257.026	108.126	49.039	69.016	73.586	45.216	52.466
49.263	49.096	59.266	51.979	51.333	77.761	92.583	113.961	135.413	163.680	131.716	150.908	63.514	74.329
29.947	26.989	16.924	10.087	8.916	2.290	4.388	1.204	24.852					

SAMPLE GND15 BOT THICKNESS = 19 cm BAR

0.000	0.000	0.000	0.000	0.000	10.361	21.649	74.016	59.186	25.836	43.196	58.296	46.419	60.076
63.246	71.116	103.036	88.692	90.566	131.735	156.567	171.840	191.405	223.457	183.828	218.349	116.604	147.478
85.141	96.920	68.339	41.277	35.331	8.183	14.033	3.058	53.828					

SAMPLE GND17 TOP THICKNESS = 2 cm BAR

0.000	0.000	0.000	103.525	700.345	865.495	211.635	430.665	114.555	37.425	56.745	50.185	33.505	41.975
37.075	40.145	49.715	46.294	42.221	57.542	53.216	44.526	38.548	36.521	45.131	24.217	9.756	11.741
5.668	8.222	8.124	6.118	12.515	5.205	10.881	3.300	126.242					

SAMPLE GND17 MID THICKNESS = 35 cm BAR

0.000	0.000	0.000	131.985	297.525	521.925	186.515	405.665	161.865	78.185	92.255	110.855	73.315	90.305
82.555	88.905	114.545	150.954	133.125	173.057	155.200	122.581	100.727	89.744	53.510	51.509	18.884	21.105
11.000	12.961	12.840	13.186	19.830	6.316	16.110	5.474	121.331					

SAMPLE GND17 BOT THICKNESS = 14 cm BAR

0.000	0.000	0.000	0.000	94.094	225.154	116.574	253.444	142.344	41.954	69.644	83.714	54.444	71.344
65.994	69.134	85.874	74.025	68.623	91.441	88.666	80.367	76.610	77.793	57.103	64.983	28.559	41.643
23.245	27.684	27.265	25.544	34.658	12.783	24.847	8.112	85.416					

SAMPLE GND18 TOP THICKNESS = 15 cm BAR

0.000	0.000	0.000	67.490	379.810	916.150	385.740	521.000	150.330	65.410	63.690	57.490	29.253	24.781
13.894	10.022	7.986	4.800	3.145	3.427	2.725	1.959	1.905	1.260	0.972	1.027	0.570	1.295
1.170	2.585	3.606	3.404	5.267	2.021	3.518	1.343	25.734					

SAMPLE GND18 BOT THICKNESS = 25 cm BAR

0.000	0.000	790.719	1012.939	709.739	552.169	152.969	202.369	51.579	14.372	15.363	12.958	4.389	3.870
2.034	1.633	1.373	0.952	0.676	0.744	0.600	0.557	0.584	0.678	0.787	1.104	0.636	1.176
0.881	1.505	1.062	1.847	2.564	0.927	1.901	0.488	18.261					

SAMPLE GND18 BOT THICKNESS = 11 cm BAR

0.000	0.000	0.000	116.761	500.341	985.391	375.211	763.681	334.931	123.591	148.731	132.691	69.701	59.551
39.471	26.671	21.901	12.835	8.257	7.924	5.617	4.012	3.107	2.251	1.574	1.419	0.733	1.544
1.786	3.429	5.168	5.143	8.020	2.467	4.954	1.141	25.396					

SAMPLE GND20 TOP THICKNESS = 20 cm BAR

0.000	0.000	0.000	62.686	248.916	861.016	293.126	580.666	216.956	65.916	75.316	64.776	36.816	43.096
35.452	36.196	38.946	33.759	24.843	29.054	22.614	16.793	12.907	12.588	8.651	8.736	4.727	9.574
10.555	17.558	21.017	17.309	37.912	10.379	15.471	5.786	118.780					

SAMPLE GND20 BOT THICKNESS = 25 cm BAR

0.000	0.000	0.000	168.505	556.985	1048.575	303.805	594.205	272.305	101.425	112.315	115.625	61.325	58.855
41.260	35.875	34.715	28.010	21.078	26.113	24.045	20.180	18.382	19.143	14.092	14.347	6.316	8.931
6.002	9.795	10.086	8.834	16.169	6.245	7.376	2.792	35.498					

SAMPLE GND20 BOT THICKNESS = 7 cm BAR

0.000	0.000	0.000	0.000	61.642	190.822	107.322	256.922	130.052	53.382	68.122	72.772	44.222	48.442
40.312	41.162	44.842	39.875	31.667	41.934	43.106	40.303	39.550	42.411	31.101	29.246	11.618	15.999
9.243	13.083	12.637	11.002	15.249	4.063	9.185	2.787	29.952					

NUMBER OF SAMPLES 20

Genesee River

SAMPLE GEN 6 ARM THICKNESS = 2 cm BAR

0.000	0.000	415.594	820.594	673.594	908.834	234.334	152.644	28.934	3.937	6.567	5.506	2.054	2.046
0.944	0.970	1.236	0.946	0.819	0.984	0.978	1.014	1.275	1.304	1.502	1.931	1.023	1.386
1.118	1.931	2.195	2.244	2.873	1.039	2.431	0.588	10.933					

SAMPLE GEN 6 FST THICKNESS = 4 cm BAR

0.000	0.000	0.000	308.442	77.732	240.405	144.322	296.502	121.652	59.202	74.602	77.062	46.872	50.962
38.842	35.222	37.022	30.668	25.055	30.644	32.349	32.677	40.493	65.908	70.140	104.884	65.948	223.086
179.198	213.423	138.793	100.897	99.478	35.401	48.922	12.073	108.635					

SAMPLE GEN 6 SEC THICKNESS = 6 cm BAR

0.000	0.000	0.000	0.000	0.000	36.532	36.622	73.442	36.712	13.632	14.132	16.442	7.392	6.092
4.779	4.251	4.746	4.271	4.019	5.562	6.303	7.635	11.316	17.561	27.035	55.129	44.137	116.514
120.573	204.185	192.055	144.983	260.543	52.816	140.090	26.579	525.722					

SAMPLE GEN 6 THD THICKNESS = 18 cm BAR

0.000	0.000	0.000	0.000	0.000	26.340	11.190	16.970	8.320	0.318	3.492	3.899	2.494	2.118
1.614	1.170	1.809	1.846	1.720	2.627	3.120	4.226	6.014	10.909	17.733	33.638	23.342	46.672
39.051	52.651	48.240	43.335	114.549	31.802	86.914	18.509	585.945					

SAMPLE GEN 6 FTH THICKNESS = 33 cm BAR

0.000	0.000	0.000	146.274	137.034	335.504	93.934	249.484	102.714	45.724	60.244	61.834	38.524	48.734
36.054	33.044	39.104	33.761	29.430	42.353	43.169	42.531	47.018	60.550	61.888	94.677	49.924	60.210
26.702	26.433	21.159	18.164	25.911	9.726	18.426	5.761	98.682					

SAMPLE GEN 6 FIF THICKNESS = 15 cm BAR

0.000	0.000	0.000	79.234	120.464	318.364	227.634	430.304	198.804	85.164	108.834	114.644	70.694	72.464
58.444	51.574	52.634	35.358	26.966	33.238	30.507	26.992	30.096	40.333	37.107	46.598	23.007	28.660
14.867	14.065	10.692	9.373	12.892	6.050	9.918	3.533	119.570					

SAMPLE GEN 7 ARM THICKNESS = 2 cm BAR

0.000	0.000	369.981	664.151	809.241	1248.731	209.951	77.611	9.071	1.951	4.306	4.057	1.542	1.809
0.917	0.940	0.895	1.020	0.756	1.153	1.186	1.401	2.589	4.298	5.161	6.363	4.051	7.472
4.877	5.319	3.810	2.457	2.377	0.772	1.529	0.672	15.986					

SAMPLE GEN 7 FST THICKNESS = 10 cm BAR

0.000	0.000	0.000	72.791	118.221	453.681	239.691	390.441	149.971	56.551	87.011	90.991	50.191	57.931
43.031	35.921	38.541	48.263	39.003	54.280	69.011	85.321	120.677	178.251	212.413	255.089	102.132	112.188
62.872	60.310	40.378	24.819	27.683	9.536	19.110	6.331	70.639					

SAMPLE GEN 7 SEC THICKNESS = 5 cm BAR

0.000	0.000	0.000	0.000	116.273	66.673	30.458	55.073	28.417	9.302	14.513	13.344	7.200	9.500
6.289	6.556	7.772	7.253	5.794	7.031	7.539	9.209	11.867	16.724	18.550	24.740	12.102	19.297
13.412	18.214	25.979	39.008	114.139	37.034	84.558	20.231	216.754					

SAMPLE GEN 7 BOT THICKNESS = 42 cm BAR

0.000	0.000	0.000	0.000	68.894	453.934	123.714	264.234	142.134	53.384	77.804	84.334	55.734	59.934
47.724	44.664	56.204	40.924	38.719	56.834	65.636	75.750	87.997	103.117	96.133	101.482	44.831	56.234
21.652	18.997	12.756	7.747	8.639	2.958	5.844	1.536	17.668					

SAMPLE GEN16 ARM THICKNESS = 1 cm BAR

0.000	0.000	436.516	273.106	587.606	1279.326	297.896	225.026	35.376	13.226	16.111	10.118	7.163	8.002
6.182	5.108	3.598	5.174	3.971	5.661	6.120	6.232	7.461	9.481	7.086	12.189	8.645	13.484
7.472	6.927	3.608	3.024	2.678	1.070	1.878	0.731	16.099					

SAMPLE GEN16 MID THICKNESS = 70 cm BAR

0.000	0.000	0.000	0.000	148.084	483.924	179.974	394.814	160.314	64.074	104.714	119.284	69.384	73.404
61.934	51.604	60.064	48.602	37.249	52.679	62.207	68.872	96.898	133.380	126.092	125.835	51.756	59.344
26.653	23.215	13.970	7.777	7.472	2.446	5.270	2.146	36.304					

SAMPLE GEN18 ARM THICKNESS = 2 cm BAR

0.000	0.000	317.495	336.725	864.635	1298.205	190.405	80.785	15.135	2.956	3.524	3.451	0.449	0.866
0.658	0.843	0.983	0.701	0.633	0.647	0.631	0.712	1.121	1.686	2.353	3.808	1.976	2.925
1.148	1.128	0.925	0.697	0.840	0.357	0.920	0.549	19.736					

SAMPLE GEN18 FST THICKNESS = 8 cm BAR

0.000	0.000	122.594	302.494	169.964	624.004	222.734	389.864	285.994	80.674	88.574	94.294	57.544	65.404
56.034	40.684	40.114	27.152	19.303	22.352	20.398	19.490	26.970	53.992	86.245	145.054	72.505	78.980
37.191	30.907	21.379	16.214	18.075	5.891	12.058	5.177	66.270					

SAMPLE GEN18 SEC THICKNESS = 42 cm BAR

0.000	0.000	0.000	0.000	254.136	546.966	157.826	250.426	107.746	33.616	51.261	49.088	32.964	38.324
30.585	26.615	29.194	25.297	17.831	22.598	21.899	19.946	24.882	37.591	52.557	83.893	44.638	50.503
25.213	21.791	17.364	15.878	24.748	8.542	18.287	7.278	264.175					

SAMPLE GEN18 TIL THICKNESS = 15 cm BAR

0.000	0.000	115.361	101.961	31.381	139.711	103.901	209.731	69.791	31.661	41.291	48.231	32.811	33.761
28.789	26.108	28.571	23.412	16.644	20.123	17.667	14.843	14.099	15.780	13.853	17.970	8.622	12.961
6.941	7.787	8.149	8.280	15.751	5.739	15.514	4.519	461.304					

NUMBER OF SAMPLES 16

Cazenovia Creek

SAMPLE CAZ 1 ARM THICKNESS = 1 cm BAR

0.000	0.000	111.700	866.990	840.130	596.740	191.500	162.240	27.840	6.323	9.813	8.338	4.884	6.432
5.036	5.478	5.553	5.403	4.907	6.759	7.079	6.676	7.098	8.238	6.727	9.026	4.643	6.323
3.026	3.147	2.579	1.824	1.764	0.503	0.895	0.423	7.588					

SAMPLE CAZ 1 MID THICKNESS = 33 cm BAR

0.000	0.000	0.000	866.440	317.070	292.660	118.770	244.390	119.130	47.641	80.350	80.970	51.707	61.020
52.620	48.590	59.900	52.998	45.793	57.213	58.643	54.356	57.133	61.807	47.729	60.417	30.179	43.093
30.868	21.388	13.685	8.394	6.674	2.189	2.488	1.087	22.152					

SAMPLE CAZ 1 TIL THICKNESS = 41 cm BAR

0.000	0.000	0.000	0.000	0.000	7.662	15.562	24.322	22.012	9.109	13.514	18.542	13.458	16.081
16.109	14.990	17.490	16.796	13.633	19.696	20.197	20.313	21.761	25.664	22.055	27.336	15.814	23.887
16.448	21.655	21.397	21.865	16.456	11.441	23.207	8.802	50.000					

SAMPLE CAZ 3 ARM THICKNESS = 1 cm MCM

0.000	0.000	159.935	856.775	327.985	460.815	112.925	119.905	15.205	3.112	2.984	4.612	1.622	2.273
2.463	2.097	2.272	2.431	2.080	2.805	2.850	2.836	3.135	3.392	3.254	3.628	1.751	2.143
1.108	1.132	0.844	0.654	0.644	0.203	0.393	0.093	4.100					

SAMPLE CAZ 3 MOD THICKNESS = 29 cm MCM

0.000	0.000	0.000	143.292	192.622	333.572	143.112	308.662	125.812	48.532	77.342	85.302	48.292	60.152
48.392	44.802	53.012	100.428	81.860	110.241	115.154	115.808	121.921	148.291	119.829	132.298	63.959	87.722
40.710	38.812	26.634	14.740	13.216	3.784	5.827	1.738	29.440					

SAMPLE CAZ 6 ARM THICKNESS = 1 cm BAR

0.000	0.000	0.000	214.342	528.892	858.222	177.722	232.092	66.312	19.907	26.880	19.640	10.292	10.096
7.524	5.541	4.908	4.298	3.071	3.974	3.555	3.189	3.574	3.503	3.106	3.180	1.231	1.252
0.455	0.464	0.428	0.330	0.443	0.181	0.349	0.130	4.190					

SAMPLE CAZ 6 BOT THICKNESS = 30 cm BAR

0.000	0.000	0.000	115.870	135.500	428.400	141.860	332.210	173.100	86.510	110.640	139.030	77.280	97.130
83.330	76.860	88.860	74.476	58.632	71.341	66.585	61.595	60.390	74.433	64.269	79.130	31.749	37.663
16.264	14.063	9.711	6.218	6.319	1.953	4.035	1.006	63.054					

SAMPLE CAZ 9 ARM THICKNESS = 1 cm BAR

0.000	0.000	352.483	617.663	421.033	530.723	57.653	72.953	27.679	6.871	6.961	8.066	3.878	4.507
2.812	2.294	1.337	1.358	0.876	0.976	0.804	0.686	0.733	0.815	0.952	1.176	0.637	0.861
0.473	0.562	0.570	0.534	0.772	0.331	0.719	0.227	5.448					

SAMPLE CAZ 9 BOT THICKNESS = 54 cm BAR

0.000	0.000	0.000	177.198	101.138	297.018	95.348	168.188	102.028	59.888	63.208	80.278	48.738	55.808
46.058	44.438	52.308	39.203	32.037	40.231	40.662	37.425	41.329	51.533	49.920	59.693	28.214	32.527
13.572	9.128	5.421	3.551	3.857	1.201	2.751	0.823	26.313					

SAMPLE CAZ10 ARM THICKNESS = 1 cm BAR

0.000	0.000	446.784	694.204	470.334	433.504	53.824	56.654	17.608	3.586	5.581	4.802	2.899	4.208
2.818	2.836	2.962	2.216	1.893	2.146	1.975	1.933	2.327	2.927	4.457	13.216	12.618	42.435
39.079	51.059	39.616	26.395	28.967	9.561	15.128	3.589	54.510					

SAMPLE CAZ10 MID THICKNESS = 14 cm BAR

0.000	0.000	0.000	143.119	188.119	46.909	35.929	73.069	35.499	16.605	25.847	29.966	17.652	20.310
16.477	15.178	17.757	14.573	9.703	10.585	11.577	12.393	18.998	31.376	59.742	158.449	139.414	425.256
239.071	219.324	150.590	97.147	94.155	30.333	37.885	10.771	90.365					

SAMPLE CAZ10 BOT THICKNESS = 52 cm BAR

0.000	0.000	239.039	170.249	42.759	113.019	34.019	85.469	45.139	15.844	26.517	32.667	15.140	21.160
18.024	17.260	19.293	15.708	14.616	19.576	21.096	20.696	24.782	34.227	35.605	54.500	31.777	51.416
31.112	34.868	70.882	23.238	30.411	12.292	21.104	6.409	238.330					

SAMPLE CAZ14 ARM THICKNESS = 1 cm BAR

0.000	386.592	1125.140	664.932	706.672	379.302	50.482	122.452	23.652	6.662	8.802	6.202	2.922	2.672
1.812	1.942	1.742	0.993	0.769	0.846	0.698	0.658	0.644	0.677	0.755	1.392	1.039	2.077
1.331	1.525	1.125	0.661	0.833	0.248	0.491	0.127	4.491					

SAMPLE CAZ14 MID THICKNESS = 19 cm BAR

0.000	0.000	0.000	0.000	103.422	235.792	100.522	229.862	145.762	58.742	80.392	105.252	64.572	82.272
69.962	61.072	65.632	51.418	40.632	49.243	42.632	35.629	34.383	44.005	49.295	93.532	71.968	102.449
52.437	48.441	31.787	20.486	20.232	7.320	10.439	3.585	97.076					

SAMPLE CAZ14 BOT THICKNESS = 29 cm BAR

0.000	0.000	0.000	86.461	47.821	256.171	139.071	331.681	168.201	68.841	105.651	127.841	62.001	79.851
64.411	54.651	58.221	45.322	31.138	39.451	35.819	30.942	32.906	45.232	49.909	91.665	71.696	104.126
55.229	48.241	34.406	22.535	28.622	8.936	16.032	4.292	174.852					

SAMPLE CAZ15 ARM THICKNESS = 1 cm BAR

0.000	0.000	177.285	373.665	536.795	875.385	216.465	446.245	88.075	25.001	25.576	22.961	9.646	9.539
6.925	5.782	6.393	4.968	3.623	3.996	3.406	2.752	2.858	2.547	2.456	3.020	1.470	2.236
1.186	1.316	1.309	1.156	1.563	0.787	1.201	0.017	8.517					

SAMPLE CAZ15 MID THICKNESS = 21 cm BAR

0.000	0.000	120.365	144.515	212.695	329.075	157.695	322.005	167.035	50.075	94.425	109.835	67.925	86.495
71.885	71.485	79.765	61.823	51.240	63.412	59.960	55.010	55.150	62.920	54.942	64.558	30.272	37.533
18.406	15.245	10.826	6.906	9.013	3.292	4.810	1.336	57.124					

SAMPLE CAZ19 ARM THICKNESS = 1 cm BAR

0.000	0.000	0.000	47.159	84.759	942.299	375.219	574.339	182.919	52.659	64.589	45.279	15.759	14.439
8.239	6.829	7.072	5.522	4.218	5.564	5.644	5.561	6.710	9.591	9.603	13.441	6.388	8.620
4.214	4.307	3.129	2.297	2.304	0.757	1.605	0.857	10.464					

SAMPLE CAZ19 MOD THICKNESS = 40 cm BAR

0.000	0.000	0.000	25.651	97.491	344.451	141.351	394.051	148.321	54.121	94.721	100.821	56.911	72.341
55.701	55.891	61.321	61.818	50.319	73.444	81.605	89.192	102.900	131.826	119.933	130.707	51.535	50.752
19.057	15.709	10.317	6.059	5.723	1.815	3.158	1.377	32.655					

SAMPLE CAZ22 ARM THICKNESS = 1 cm BAR

0.000	0.000	1112.664	345.644	386.934	462.184	146.444	230.684	120.214	36.557	57.134	47.804	25.355	24.888
17.103	11.873	10.500	5.798	3.890	4.212	3.440	3.009	3.131	2.741	2.530	3.169	1.487	2.001
1.000	0.999	0.884	0.689	0.835	0.300	0.691	0.323	5.029					

SAMPLE CAZ22 MID THICKNESS = 76 cm BAR

0.000	0.000	61.308	35.288	159.638	288.748	142.198	320.768	156.778	60.668	108.078	122.078	76.248	84.448
71.208	66.938	73.848	55.033	44.829	54.525	50.475	45.217	44.694	54.026	46.061	57.755	37.772	35.307
16.248	15.923	12.624	9.038	10.149	3.729	6.513	2.021	66.205					

SAMPLE CAZ22 BOT THICKNESS = 9 cm BAR

0.000	0.000	0.000	43.867	106.367	144.897	74.747	163.957	61.257	24.457	40.857	49.737	27.497	35.877
28.665	26.668	28.079	21.977	16.587	20.442	19.293	17.184	17.035	20.507	18.450	21.818	10.293	13.053
5.911	5.800	4.293	3.326	3.614	1.444	2.275	0.784	32.011					

SAMPLE CAZ23 ARM THICKNESS = 1 cm BCH

0.000	0.000	495.385	1259.805	427.425	437.265	65.225	144.925	59.275	17.626	30.001	30.459	15.519	14.529
[illegible]	7.221	[illegible]	[illegible]	[illegible]	3.741	3.119	2.843	2.878	2.851	2.577	3.006	1.390	1.995
0.945	0.884	0.788	[illegible]	0.763	0.296	0.634	0.152	4.369					

SAMPLE CAZ23 MID THICKNESS = 21 cm BCH

0.000	0.000	111.954	405.124	295.624	257.544	144.154	226.974	117.504	42.014	75.564	94.094	55.944	68.134
61.674	58.824	72.394	55.565	47.610	58.574	56.787	50.545	45.756	50.442	39.387	39.311	15.709	19.177
9.064	8.502	6.478	5.020	6.097	2.472	4.833	1.212	91.918					

NUMBER OF SAMPLES 24

APPENDIX II

List of number frequencies determined from photographs and armor sediment sieved in the field. Scour depths are also included.

PHOTO NO. 1 SCOUR DEPTH 20.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	1	9	19	25	21
FREQ.OUT	0	0	0	0	0	1	8	19	25	21
FREQ.AFTER	0	0	0	0	1	2	12	35	24	10
FREQ.IN	0	0	0	0	1	2	11	35	24	10

PHOTO NO. 2 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	2	4	13	28	25
FREQ.OUT	0	0	0	0	0	2	4	13	28	25
FREQ.AFTER	0	0	0	0	0	7	16	21	23	9
FREQ.IN	0	0	0	0	0	7	16	21	23	9

PHOTO NO. 3 SCOUR DEPTH 27.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	4	19	42	51
FREQ.OUT	0	0	0	0	0	0	4	19	42	51
FREQ.AFTER	0	0	0	0	0	0	9	22	43	22
FREQ.IN	0	0	0	0	0	0	9	22	43	22

PHOTO NO. 4 SCOUR DEPTH 21.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	10	37	59
FREQ.OUT	0	0	0	0	0	0	0	10	37	59
FREQ.AFTER	0	0	0	0	1	1	8	22	36	43
FREQ.IN	0	0	0	0	1	1	8	22	36	43

PHOTO NO. 5 SCOUR DEPTH 5.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	5	21	13	29	12
FREQ.OUT	0	0	0	0	0	2	17	2	29	12
FREQ.AFTER	0	0	0	0	1	2	13	29	12	8
FREQ.IN	0	0	0	0	0	0	9	24	11	8

PHOTO NO. 6 SCOUR DEPTH 2.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	3	4	3	21	28	26
FREQ.OUT	0	0	0	0	0	0	2	11	22	24
FREQ.AFTER	0	0	0	0	3	4	7	22	25	4
FREQ.IN	0	0	0	0	0	0	1	12	19	2

PHOTO NO. 7 SCOUR DEPTH 7.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	7	13	21	29	19
FREQ.OUT	0	0	0	0	0	2	11	20	29	19
FREQ.AFTER	0	0	0	0	3	6	12	26	22	15
FREQ.IN	0	0	0	0	1	1	10	25	22	15

PHOTO NO. 8 SCOUR DEPTH 14.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	3	8	13	19	16	14
FREQ.OUT	0	0	0	0	1	6	12	10	16	14
FREQ.AFTER	0	0	0	1	3	8	8	27	24	12
FREQ.IN	0	0	0	0	1	6	7	26	24	12

PHOTO NO. 9 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	2	11	14	7	22	42
FREQ.OUT	0	0	0	0	1	7	12	6	22	42
FREQ.AFTER	0	0	0	1	1	6	21	12	31	0
FREQ.IN	0	0	0	0	0	2	19	11	31	8

PHOTO NO. 10 SCOUR DEPTH 10.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	2	3	6	13	12	15	19
FREQ.OUT	0	0	0	0	2	4	9	11	15	19
FREQ.AFTER	0	0	0	3	5	5	15	11	26	6
FREQ.IN	0	0	0	1	2	3	14	11	26	6

PHOTO NO. 11 SCOUR DEPTH 7.7 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	3	9	9	13	2	0
FREQ.OUT	0	0	0	0	2	7	9	13	2	0
FREQ.AFTER	0	0	0	0	2	10	15	14	17	4
FREQ.IN	0	0	0	0	0	8	14	14	17	4

PHOTO NO. 12 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	2	3	13	11	17	0
FREQ.OUT	0	0	0	0	2	2	12	10	17	0
FREQ.AFTER	0	0	0	1	1	6	14	18	14	1
FREQ.IN	0	0	0	0	1	5	13	17	14	1

PHOTO NO. 23 SCOUR DEPTH 5.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	1	8	8	14	13	0
FREQ.OUT	0	0	0	1	1	5	8	14	13	0
FREQ.AFTER	0	0	0	0	2	10	7	12	16	7
FREQ.IN	0	0	0	0	2	7	7	12	16	7

PHOTO NO. 24 SCOUR DEPTH 5.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	0	0	1	3	10	12	24	2
FREQ.OUT	0	0	0	0	1	3	10	12	24	2
FREQ.AFTER	0	1	0	0	3	6	9	8	15	2
FREQ.IN	0	0	0	0	3	6	9	8	15	2

PHOTO NO. 25 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	1	1	1	1	7	5	3	0
FREQ.OUT	0	0	0	0	0	0	7	5	3	0
FREQ.AFTER	0	1	1	1	1	2	5	4	0	0
FREQ.IN	0	0	0	0	0	0	1	3	0	0

PHOTO NO. 26 SCOUR DEPTH 2.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	1	0	2	2	5	6	4	0
FREQ.OUT	0	0	0	0	0	0	2	4	4	0
FREQ.AFTER	0	0	0	0	3	4	5	5	2	3
FREQ.IN	0	0	0	0	1	2	2	3	2	3

PHOTO NO. 27 SCOUR DEPTH 9.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	0	1	2	3	3	6	8	2
FREQ.OUT	0	0	0	0	2	2	3	6	8	2
FREQ.AFTER	0	2	0	1	1	1	3	1	5	0
FREQ.IN	0	1	0	0	1	0	3	1	5	0

PHOTO NO. 28 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	2	1	3	1	6	5	11	0
FREQ.OUT	0	0	1	0	2	1	6	5	11	0
FREQ.AFTER	0	1	1	1	3	2	8	9	9	0
FREQ.IN	0	0	0	0	2	2	8	9	9	0

PHOTO NO. 29 SCOUR DEPTH 16.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	4	6	6	11	24	12
FREQ.OUT	0	0	0	0	2	5	4	11	24	12
FREQ.AFTER	0	0	0	0	3	5	9	19	9	7
FREQ.IN	0	0	0	0	1	4	7	19	9	7

PHOTO NO. 30 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	4	4	10	31	7
FREQ.OUT	0	0	0	0	1	1	2	9	31	7
FREQ.AFTER	0	0	0	0	5	5	11	21	15	7
FREQ.IN	0	0	0	0	4	2	8	21	15	7

PHOTO NO. 31 SCOUR DEPTH 12.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	5	3	5	4	19	20
FREQ.OUT	0	0	0	0	2	3	3	4	19	20
FREQ.AFTER	0	0	0	0	4	2	7	11	6	14
FREQ.IN	0	0	0	0	1	2	5	11	6	14

PHOTO NO. 32 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	3	3	2	6	8	18	19
FREQ.OUT	0	0	0	1	3	1	5	3	14	19
FREQ.AFTER	0	0	0	2	2	1	14	14	28	14
FREQ.IN	0	0	0	0	2	0	13	9	24	13

PHOTO NO. 33 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	0	2	5	5	10	13	26
FREQ.OUT	0	0	0	0	0	2	0	5	11	26
FREQ.AFTER	0	0	1	0	2	4	9	11	10	6
FREQ.IN	0	0	0	0	0	1	4	6	8	6

PHOTO NO. 34 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	8	13	16	9	17
FREQ.OUT	0	0	0	0	0	0	3	9	7	17
FREQ.AFTER	0	0	0	0	1	10	17	15	13	13
FREQ.IN	0	0	0	0	0	2	7	8	11	13

PHOTO NO. 35 SCOUR DEPTH 8.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	3	4	8	12	33	32
FREQ.OUT	0	0	0	0	0	1	1	7	31	32
FREQ.AFTER	0	0	0	1	3	4	13	23	20	10
FREQ.IN	0	0	0	0	1	1	6	18	18	10

PHOTO NO. 36 SCOUR DEPTH 14.2 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	3	1	9	22	28	36
FREQ.OUT	0	0	0	0	0	0	5	15	25	35
FREQ.AFTER	0	0	0	1	3	3	7	20	35	4
FREQ.IN	0	0	0	0	0	2	3	13	32	3

PHOTO NO. 37 SCOUR DEPTH 10.7 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	5	3	7	23	35	10
FREQ.OUT	0	0	0	0	2	3	7	23	35	10
FREQ.AFTER	0	0	1	0	6	4	11	18	14	1
FREQ.IN	0	0	1	0	3	4	11	18	14	1

PHOTO NO. 38 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	0	2	4	6	5	23	12
FREQ.OUT	0	0	0	0	0	4	5	5	23	12
FREQ.AFTER	0	0	1	0	5	5	10	11	19	2
FREQ.IN	0	0	0	0	3	5	9	11	19	2

PHOTO NO. 39 SCOUR DEPTH 6.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	0	1	0	5	14	10	17	16
FREQ.OUT	0	0	0	0	0	0	1	8	15	16
FREQ.AFTER	0	1	0	1	0	5	19	13	25	14
FREQ.IN	0	0	0	0	0	0	6	11	23	14

PHOTO NO. 40 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	0	6	11	6	26	21
FREQ.OUT	0	0	0	0	0	5	3	3	24	19
FREQ.AFTER	0	0	0	1	0	4	14	16	23	17
FREQ.IN	0	0	0	0	0	3	6	13	21	15

PHOTO NO. 41 SCOUR DEPTH 13.2 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	2	6	2	12	10	23	7
FREQ.OUT	0	0	0	0	2	1	10	10	23	7
FREQ.AFTER	0	0	0	2	6	3	12	19	11	2
FREQ.IN	0	0	0	0	2	2	10	19	11	2

PHOTO NO. 42 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	1	0	0	2	0	3	6	8	28	5
FREQ.OUT	0	0	0	0	0	3	6	8	28	5
FREQ.AFTER	1	0	1	1	2	5	12	7	12	0
FREQ.IN	0	0	0	0	2	5	12	7	12	0

PHOTO NO. 43 SCOUR DEPTH 3.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	1	4	9	12	22	9
FREQ.OUT	0	0	0	0	0	0	0	0	18	2
FREQ.AFTER	0	0	0	1	1	4	10	19	10	5
FREQ.IN	0	0	0	0	0	0	0	4	6	3

PHOTO NO. 44 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	1	2	4	8	8	9	23
FREQ.OUT	0	0	0	0	0	1	1	0	1	23
FREQ.AFTER	0	0	1	1	2	4	9	14	23	8
FREQ.IN	0	0	0	0	0	1	1	6	15	8

PHOTO NO. 45 SCOUR DEPTH 9.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	5	1	2	6	12	6	4
FREQ.OUT	0	0	0	0	1	1	4	11	6	4
FREQ.AFTER	0	0	1	5	1	3	13	10	4	1
FREQ.IN	0	0	0	0	1	2	11	9	4	1

PHOTO NO. 46 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	2	3	4	6	7	12	5
FREQ.OUT	0	0	0	0	1	2	0	6	12	5
FREQ.AFTER	0	0	0	2	3	6	12	8	15	3
FREQ.IN	0	0	0	0	1	4	6	7	15	3

PHOTO NO. 47 SCOUR DEPTH 22.2 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	2	4	4	9	11	27	4
FREQ.OUT	0	0	0	0	2	1	9	11	27	4
FREQ.AFTER	0	0	0	2	4	6	7	11	18	3
FREQ.IN	0	0	0	0	2	3	7	11	18	3

PHOTO NO. 48 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	5	5	6	9	22	9
FREQ.OUT	0	0	0	0	1	2	4	7	22	9
FREQ.AFTER	0	0	0	1	6	3	10	21	19	4
FREQ.IN	0	0	0	0	2	0	8	19	19	4

PHOTO NO. 49 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	2	3	4	7	7	7	11
FREQ.OUT	0	0	0	0	0	4	6	6	6	11
FREQ.AFTER	0	0	1	2	3	5	7	9	5	0
FREQ.IN	0	0	0	0	0	5	6	8	4	0

PHOTO NO. 50 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	1	1	1	3	8	3	11	22
FREQ.OUT	0	0	0	0	0	1	6	2	10	22
FREQ.AFTER	0	1	1	1	2	2	8	9	6	0
FREQ.IN	0	0	0	0	1	0	6	8	5	0

PHOTO NO. 51 SCOUR DEPTH 9.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	2	3	5	7	8	17
FREQ.OUT	0	0	0	0	0	1	3	6	7	16
FREQ.AFTER	0	0	0	1	1	3	5	1	7	2
FREQ.IN	0	0	0	0	0	2	3	0	6	1

PHOTO NO. 52 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	5	6	6	14	23	13
FREQ.OUT	0	0	0	0	1	2	1	11	23	13
FREQ.AFTER	0	0	1	0	5	5	12	6	4	3
FREQ.IN	0	0	0	0	1	1	7	3	4	3

PHOTO NO. 53 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	8	7	7	8	11	1
FREQ.OUT	0	0	0	0	1	2	5	7	11	1
FREQ.AFTER	0	0	0	1	8	5	9	7	3	0
FREQ.IN	0	0	0	0	1	0	7	6	3	0

PHOTO NO. 54 SCOUR DEPTH 10.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	1	3	6	4	4	10	4
FREQ.OUT	0	0	1	1	1	5	4	4	10	4
FREQ.AFTER	0	0	1	1	3	3	12	5	5	3
FREQ.IN	0	0	0	1	1	2	12	5	5	3

PHOTO NO. 55 SCOUR DEPTH 4.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	3	2	1	4	1	0	0
FREQ.OUT	0	0	0	0	0	1	2	1	0	0
FREQ.AFTER	0	0	0	3	4	1	4	3	0	0
FREQ.IN	0	0	0	0	2	1	2	3	0	0

PHOTO NO. 56 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	1	0	1	1	1	2	4	5	0	0
FREQ.OUT	0	0	0	0	0	2	3	5	0	0
FREQ.AFTER	1	0	1	1	2	2	2	3	7	1
FREQ.IN	0	0	0	0	1	2	1	3	7	1

PHOTO NO. 57 SCOUR DEPTH 9.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	5	7	18	24	40
FREQ.OUT	0	0	0	0	0	4	6	17	24	40
FREQ.AFTER	0	0	0	0	2	4	21	20	25	8
FREQ.IN	0	0	0	0	0	3	20	19	25	8

PHOTO NO. 58 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	4	11	10	20	50
FREQ.OUT	0	0	0	0	0	3	10	10	18	49
FREQ.AFTER	0	0	0	0	4	2	16	15	16	5
FREQ.IN	0	0	0	0	2	1	15	14	14	4

PHOTO NO. 59 SCOUR DEPTH 8.6 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	0	4	3	6	10	18	0
FREQ.OUT	0	0	0	0	2	1	4	10	18	0
FREQ.AFTER	0	0	1	0	4	7	14	15	14	2
FREQ.IN	0	0	0	0	2	5	12	15	14	2

PHOTO NO. 60 SCOUR DEPTH 7.4 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	0	4	9	9	13	10	4
FREQ.OUT	0	0	0	0	1	2	7	10	9	4
FREQ.AFTER	0	0	1	0	5	9	10	11	3	0
FREQ.IN	0	0	0	0	2	2	8	7	3	0

PHOTO NO. 61 SCOUR DEPTH 16.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	5	2	3	5	10	0
FREQ.OUT	0	0	0	0	2	1	2	4	10	0
FREQ.AFTER	0	0	0	1	7	4	7	8	5	0
FREQ.IN	0	0	0	0	4	3	6	7	5	0

PHOTO NO. 62 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	1	0	4	3	1	0	4	9	11
FREQ.OUT	0	0	0	2	2	0	0	4	9	11
FREQ.AFTER	0	1	0	2	1	2	7	9	11	2
FREQ.IN	0	0	0	0	0	1	7	9	11	2

PHOTO NO. 63 SCOUR DEPTH 7.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	4	10	10	13	12	3
FREQ.OUT	0	0	0	0	0	1	7	8	6	3
FREQ.AFTER	0	0	0	0	5	11	9	21	32	4
FREQ.IN	0	0	0	0	0	2	6	16	26	4

PHOTO NO. 64 SCOUR DEPTH 7.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	3	2	5	11	14	18	21
FREQ.OUT	0	0	0	1	0	1	5	12	17	21
FREQ.AFTER	0	0	0	2	4	8	14	15	15	1
FREQ.IN	0	0	0	0	2	4	8	13	14	1

PHOTO NO. 65 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	1	0	6	10	14	21	30
FREQ.OUT	0	0	0	0	0	2	2	7	21	30
FREQ.AFTER	0	0	0	1	0	5	15	20	30	6
FREQ.IN	0	0	0	0	0	1	7	13	30	6

PHOTO NO. 66 SCOUR DEPTH 15.4 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	4	9	13	31	50
FREQ.OUT	0	0	0	0	0	1	6	12	31	50
FREQ.AFTER	0	0	0	0	0	7	11	26	30	7
FREQ.IN	0	0	0	0	0	4	8	25	30	7

PHOTO NO. 67 SCOUR DEPTH 5.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	1	14	10	25	27
FREQ.OUT	0	0	0	0	1	0	5	5	18	27
FREQ.AFTER	0	0	0	0	1	4	20	27	42	8
FREQ.IN	0	0	0	0	1	3	11	22	35	8

PHOTO NO. 68 SCOUR DEPTH 5.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	6	14	11	32	6
FREQ.OUT	0	0	0	0	0	0	0	6	29	6
FREQ.AFTER	0	0	0	0	0	9	24	27	21	9
FREQ.IN	0	0	0	0	0	3	10	22	18	9

PHOTO NO. 69 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	3	13	24	51	21
FREQ.OUT	0	0	0	0	0	2	2	2	20	11
FREQ.AFTER	0	0	0	0	0	1	12	24	37	13
FREQ.IN	0	0	0	0	0	0	1	2	7	3

PHOTO NO. 70 SCOUR DEPTH 1.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	4	21	28	26
FREQ.OUT	0	0	0	0	0	0	0	2	3	5
FREQ.AFTER	0	0	0	0	0	0	6	20	27	25
FREQ.IN	0	0	0	0	0	0	2	1	2	4

PHOTO NO. 116 SCOUR DEPTH 6.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	6	5	7	21	42
FREQ.OUT	0	0	0	0	0	3	0	5	17	42
FREQ.AFTER	0	0	0	0	2	3	10	16	30	40
FREQ.IN	0	0	0	0	0	0	4	14	26	40

PHOTO NO. 117 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	6	4	6	24	18
FREQ.OUT	0	0	0	0	0	2	1	4	23	18
FREQ.AFTER	0	0	0	0	1	5	8	12	21	16
FREQ.IN	0	0	0	0	0	1	5	10	20	16

PHOTO NO. 118 SCOUR DEPTH 2.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	2	0	2	2	1	10	14	12	15
FREQ.OUT	0	0	0	0	0	0	1	2	2	12
FREQ.AFTER	0	2	0	2	2	2	10	13	20	10
FREQ.IN	0	0	0	0	0	0	1	1	7	4

PHOTO NO. 119 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	3	4	8	10	15	13
FREQ.OUT	0	0	0	0	0	1	2	4	12	13
FREQ.AFTER	0	0	0	0	3	5	8	23	28	18
FREQ.IN	0	0	0	0	0	2	2	17	25	18

PHOTO NO. 120 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	2	1	2	6	17	12	24
FREQ.OUT	0	0	0	0	0	0	3	15	12	24
FREQ.AFTER	0	0	0	2	2	3	10	20	14	13
FREQ.IN	0	0	0	0	1	1	7	18	14	13

PHOTO NO. 121 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	5	5	10	10	17
FREQ.OUT	0	0	0	0	0	0	3	6	8	15
FREQ.AFTER	0	0	0	0	0	5	4	15	23	5
FREQ.IN	0	0	0	0	0	0	2	11	21	3

PHOTO NO. 122 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	1	0	2	5	10	13	13	18
FREQ.OUT	0	0	0	0	0	0	0	5	7	16
FREQ.AFTER	0	0	1	0	2	5	11	14	12	10
FREQ.IN	0	0	0	0	0	0	1	6	6	8

PHOTO NO. 123 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	6	8	24	26
FREQ.OUT	0	0	0	0	0	0	0	0	19	25
FREQ.AFTER	0	0	0	0	1	0	6	12	22	36
FREQ.IN	0	0	0	0	0	0	0	4	17	35

PHOTO NO. 124 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	1	10	15	20
FREQ.OUT	0	0	0	0	0	0	0	0	3	17
FREQ.AFTER	0	0	0	0	0	0	3	10	20	24
FREQ.IN	0	0	0	0	0	0	2	0	8	21

PHOTO NO. 125 SCOUR DEPTH 8.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	4	5	10	26	16
FREQ.OUT	0	0	0	0	0	0	1	4	14	14
FREQ.AFTER	0	0	0	0	1	4	5	12	23	12
FREQ.IN	0	0	0	0	0	0	1	6	11	10

PHOTO NO. 126 SCOUR DEPTH 4.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	1	9	13	18	44
FREQ.OUT	0	0	0	0	0	0	2	6	6	31
FREQ.AFTER	0	0	0	0	2	1	10	18	19	31
FREQ.IN	0	0	0	0	0	0	3	11	7	18

PHOTO NO. 127 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	3	11	7	7	0
FREQ.OUT	0	0	0	0	0	0	9	7	7	0
FREQ.AFTER	0	0	0	0	1	6	26	20	10	1
FREQ.IN	0	0	0	0	0	3	24	20	10	1

PHOTO NO. 128 SCOUR DEPTH 5.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	10	8	8	6	7
FREQ.OUT	0	0	0	0	0	6	6	7	6	7
FREQ.AFTER	0	0	0	0	1	9	19	22	11	12
FREQ.IN	0	0	0	0	0	5	17	21	11	12

PHOTO NO. 129 SCOUR DEPTH 11.5 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	7	12	11	26	13
FREQ.OUT	0	0	0	0	0	5	10	10	26	13
FREQ.AFTER	0	0	0	0	2	11	18	22	9	7
FREQ.IN	0	0	0	0	0	9	16	21	9	7

PHOTO NO. 130 SCOUR DEPTH 11.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	2	2	0	8	7	9	5
FREQ.OUT	0	0	0	1	0	0	6	4	9	5
FREQ.AFTER	0	0	0	1	4	6	8	13	7	9
FREQ.IN	0	0	0	0	2	6	6	10	7	9

PHOTO NO. 131 SCOUR DEPTH 4.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	4	7	20	28	25
FREQ.OUT	0	0	0	0	0	1	1	4	16	11
FREQ.AFTER	0	0	0	0	0	4	8	24	33	24
FREQ.IN	0	0	0	0	0	1	2	8	21	10

PHOTO NO. 133 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	2	15	15	21	20
FREQ.OUT	0	0	0	0	0	0	0	1	6	8
FREQ.AFTER	0	0	0	0	2	2	17	15	19	16
FREQ.IN	0	0	0	0	0	0	0	1	4	4

PHOTO NO. 134 SCOUR DEPTH 9.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	2	0	1	2	4	11	16	14
FREQ.OUT	0	0	0	0	0	0	2	0	3	9
FREQ.AFTER	0	0	2	0	1	3	5	16	18	9
FREQ.IN	0	0	0	0	0	1	3	5	5	4

PHOTO NO. 135 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	7	5	11	15	20
FREQ.OUT	0	0	0	0	0	3	0	6	13	17
FREQ.AFTER	0	0	0	0	2	6	11	16	32	19
FREQ.IN	0	0	0	0	0	2	5	11	30	16

Grand River

PHOTO NO. 15 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	1	1	10	49	99
FREQ.OUT	0	0	0	0	0	0	1	0	4	5
FREQ.AFTER	0	0	0	0	0	1	1	10	47	99
FREQ.IN	0	0	0	0	0	0	1	0	2	5

PHOTO NO. 16 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	3	22	62	50
FREQ.OUT	0	0	0	0	0	0	1	3	2	6
FREQ.AFTER	0	0	0	0	0	0	3	22	62	50
FREQ.IN	0	0	0	0	0	0	1	3	2	7

PHOTO NO. 17 SCOUR DEPTH 61.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	5	8	22	72
FREQ.OUT	0	0	0	0	0	0	5	8	22	72
FREQ.AFTER	0	0	0	0	0	1	5	15	39	38
FREQ.IN	0	0	0	0	0	1	5	15	39	38

PHOTO NO. 18 SCOUR DEPTH 51.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	2	20	26	86
FREQ.OUT	0	0	0	0	0	0	2	20	26	86
FREQ.AFTER	0	0	0	0	0	0	4	18	40	66
FREQ.IN	0	0	0	0	0	0	4	18	40	66

PHOTO NO. 19 SCOUR DEPTH 4.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	7	30	45	75
FREQ.OUT	0	0	0	0	0	0	7	30	45	75
FREQ.AFTER	0	0	0	0	0	1	4	8	6	4
FREQ.IN	0	0	0	0	0	1	4	8	6	4

PHOTO NO. 20 SCOUR DEPTH 13.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	8	14	37	110
FREQ.OUT	0	0	0	0	0	0	8	14	37	110
FREQ.AFTER	0	0	0	0	0	0	1	4	6	9
FREQ.IN	0	0	0	0	0	0	1	4	6	9

PHOTO NO. 21 SCOUR DEPTH 9.7 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	3	18	22	82
FREQ.OUT	0	0	0	0	0	0	2	14	19	82
FREQ.AFTER	0	0	0	0	0	0	6	18	43	49
FREQ.IN	0	0	0	0	0	0	5	15	39	49

PHOTO NO. 22 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	5	32	74	86
FREQ.OUT	0	0	0	0	0	0	5	29	72	86
FREQ.AFTER	0	0	0	0	0	0	1	14	50	52
FREQ.IN	0	0	0	0	0	0	1	11	48	52

Area near photograph [illegible]6 on Cazenovia Creek

PHI SIZE	-7.0	-6.49	-5.98	-5.46	-5.05	-4.5	-4.0
FREQ	2	6	[illegible]	[illegible]7	54	[illegible]	141

Area near photograph [illegible] on the Grand River

PHI SIZE	[illegible].49	[illegible].98	[illegible].4[illegible]	[illegible].05	[illegible].5	[illegible].0
Freq.	1	21	64	74	123	297

PHOTO NO. 72 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	11	17	32	46
FREQ.OUT	0	0	0	0	0	0	0	6	29	39
FREQ.AFTER	0	0	0	0	0	1	15	23	21	22
FREQ.IN	0	0	0	0	0	1	4	12	18	15

PHOTO NO. 73 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	3	11	19	25	37
FREQ.OUT	0	0	0	0	0	2	4	13	25	37
FREQ.AFTER	0	0	0	0	0	2	15	16	24	3
FREQ.IN	0	0	0	0	0	1	8	10	24	3

PHOTO NO. 74 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	3	9	10	24	50
FREQ.OUT	0	0	0	0	0	0	4	2	19	50
FREQ.AFTER	0	0	0	0	0	3	11	19	25	10
FREQ.IN	0	0	0	0	0	0	6	11	20	10

PHOTO NO. 75 SCOUR DEPTH 0.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	7	64	127
FREQ.OUT	0	0	0	0	0	0	0	3	49	122
FREQ.AFTER	0	0	0	0	0	0	0	6	29	50
FREQ.IN	0	0	0	0	0	0	0	2	14	45

PHOTO NO. 76 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	2	33	70
FREQ.OUT	0	0	0	0	0	0	0	1	18	58
FREQ.AFTER	0	0	0	0	0	0	0	1	31	104
FREQ.IN	0	0	0	0	0	0	0	0	16	92

PHOTO NO. 77 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	1	45	96
FREQ.OUT	0	0	0	0	0	0	0	1	45	96
FREQ.AFTER	0	0	0	0	0	0	0	2	21	68
FREQ.IN	0	0	0	0	0	0	0	2	21	68

PHOTO NO. 78 SCOUR DEPTH 21.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	1	4	68	97
FREQ.OUT	0	0	0	0	0	0	0	4	68	97
FREQ.AFTER	0	0	0	0	0	0	1	2	14	65
FREQ.IN	0	0	0	0	0	0	0	2	14	65

PHOTO NO. 79 SCOUR DEPTH 20.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	13	50	82
FREQ.OUT	0	0	0	0	0	0	0	13	50	82
FREQ.AFTER	0	0	0	0	0	0	0	3	25	69
FREQ.IN	0	0	0	0	0	0	0	3	25	69

PHOTO NO. 80 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	12	54	87
FREQ.OUT	0	0	0	0	0	0	0	12	54	87
FREQ.AFTER	0	0	0	0	0	0	0	4	25	46
FREQ.IN	0	0	0	0	0	0	0	4	25	46

PHOTO NO. 81 SCOUR DEPTH 27.4 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	9	56	74
FREQ.OUT	0	0	0	0	0	0	0	9	56	74
FREQ.AFTER	0	0	0	0	0	0	1	4	37	92
FREQ.IN	0	0	0	0	0	0	1	4	37	92

PHOTO NO. 82 SCOUR DEPTH 6.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	2	13	50	69
FREQ.OUT	0	0	0	0	0	0	0	9	50	69
FREQ.AFTER	0	0	0	0	0	0	2	17	32	18
FREQ.IN	0	0	0	0	0	0	0	13	32	18

PHOTO NO. 83 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	3	5	14	29	52
FREQ.OUT	0	0	0	0	1	2	4	13	29	52
FREQ.AFTER	0	0	0	0	0	2	6	16	19	32
FREQ.IN	0	0	0	0	0	1	5	15	19	32

PHOTO NO. 84 SCOUR DEPTH 20.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	3	19	24	69
FREQ.OUT	0	0	0	0	0	0	2	19	24	69
FREQ.AFTER	0	0	0	0	0	0	7	26	29	18
FREQ.IN	0	0	0	0	0	0	6	26	29	18

PHOTO NO. 85 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	2	98	15	26	50
FREQ.OUT	0	0	0	0	0	1	96	11	26	50
FREQ.AFTER	0	0	0	0	1	1	5	22	26	20
FREQ.IN	0	0	0	0	0	0	3	18	26	20

PHOTO NO. 86 SCOUR DEPTH 5.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	3	8	17	27	57
FREQ.OUT	0	0	0	0	0	0	2	14	25	57
FREQ.AFTER	0	0	0	0	0	3	8	20	36	27
FREQ.IN	0	0	0	0	0	0	2	17	34	27

PHOTO NO. 107 SCOUR DEPTH 55.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	4	18	59
FREQ.OUT	0	0	0	0	0	0	0	4	18	59
FREQ.AFTER	0	0	0	0	0	0	0	4	22	35
FREQ.IN	0	0	0	0	0	0	0	4	22	35

PHOTO NO. 87 SCOUR DEPTH 11.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	0	1	66
FREQ.OUT	0	0	0	0	0	0	0	0	1	66
FREQ.AFTER	0	0	0	0	0	0	0	1	3	9
FREQ.IN	0	0	0	0	0	0	0	1	3	9

PHOTO NO. 88 SCOUR DEPTH 9.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	0	5	51
FREQ.OUT	0	0	0	0	0	0	0	0	5	51
FREQ.AFTER	0	0	0	0	0	0	3	0	7	8
FREQ.IN	0	0	0	0	0	0	3	0	7	8

PHOTO NO. 89 SCOUR DEPTH 7.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	0	5	69
FREQ.OUT	0	0	0	0	0	0	0	0	5	69
FREQ.AFTER	0	0	0	0	0	0	3	1	2	8
FREQ.IN	0	0	0	0	0	0	3	1	2	8

PHOTO NO. 90 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	4	12	36	62
FREQ.OUT	0	0	0	0	0	0	4	12	36	62
FREQ.AFTER	0	0	0	0	0	0	2	12	39	34
FREQ.IN	0	0	0	0	0	0	2	12	39	34

PHOTO NO. 91 SCOUR DEPTH 5.1 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	4	14	37	58
FREQ.OUT	0	0	0	0	0	0	4	14	37	58
FREQ.AFTER	0	0	0	0	0	0	2	12	30	19
FREQ.IN	0	0	0	0	0	0	2	12	30	19

PHOTO NO. 92 SCOUR DEPTH 3.7 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	4	15	44	48
FREQ.OUT	0	0	0	0	0	0	4	15	44	48
FREQ.AFTER	0	0	0	0	0	0	1	15	29	47
FREQ.IN	0	0	0	0	0	0	1	15	29	47

PHOTO NO. 93 SCOUR DEPTH 55.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	0	0	13
FREQ.OUT	0	0	0	0	0	0	0	0	0	13
FREQ.AFTER	0	0	0	0	0	0	0	0	0	5
FREQ.IN	0	0	0	0	0	0	0	0	0	5

PHOTO NO. 94 SCOUR DEPTH 59.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	0	1	17
FREQ.OUT	0	0	0	0	0	0	0	0	1	17
FREQ.AFTER	0	0	0	0	0	0	0	0	0	4
FREQ.IN	0	0	0	0	0	0	0	0	0	4

PHOTO NO. 95 SCOUR DEPTH 68.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	0	0	37
FREQ.OUT	0	0	0	0	0	0	0	0	0	37
FREQ.AFTER	0	0	0	0	0	0	0	0	0	6
FREQ.IN	0	0	0	0	0	0	0	0	0	6

PHOTO NO. 96 SCOUR DEPTH 11.6 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	1	13	21	48
FREQ.OUT	0	0	0	0	0	0	1	13	21	48
FREQ.AFTER	0	0	0	0	1	1	4	5	10	6
FREQ.IN	0	0	0	0	0	1	4	5	10	6

PHOTO NO. 97 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	2	12	24	57
FREQ.OUT	0	0	0	0	0	0	2	12	24	57
FREQ.AFTER	0	0	0	0	0	1	3	2	6	16
FREQ.IN	0	0	0	0	0	1	3	2	6	16

PHOTO NO. 98 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	5	8	20	63
FREQ.OUT	0	0	0	0	0	0	5	8	20	63
FREQ.AFTER	0	0	0	0	0	0	1	3	10	12
FREQ.IN	0	0	0	0	0	0	1	3	10	12

PHOTO NO. 99 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	7	11	29	41
FREQ.OUT	0	0	0	0	0	0	7	11	29	41
FREQ.AFTER	0	0	0	0	0	0	0	6	9	7
FREQ.IN	0	0	0	0	0	0	0	6	9	7

PHOTO NO. 100 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	3	8	31	51
FREQ.OUT	0	0	0	0	0	0	3	8	31	51
FREQ.AFTER	0	0	0	0	0	0	1	7	9	7
FREQ.IN	0	0	0	0	0	0	1	7	9	7

PHOTO NO. 101 SCOUR DEPTH 8.3 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	1	5	10	30	52
FREQ.OUT	0	0	0	0	0	0	0	4	24	48
FREQ.AFTER	0	0	0	0	0	1	7	8	21	40
FREQ.IN	0	0	0	0	0	0	1	6	15	36

PHOTO NO. 102 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	1	4	7	27	37
FREQ.OUT	0	0	0	0	0	1	4	7	26	37
FREQ.AFTER	0	0	0	0	1	1	4	12	24	25
FREQ.IN	0	0	0	0	0	0	4	12	23	25

PHOTO NO. 103 SCOUR DEPTH 8.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	2	2	3	4	18	36
FREQ.OUT	0	0	0	0	0	0	2	4	17	36
FREQ.AFTER	0	0	0	0	2	4	6	16	23	14
FREQ.IN	0	0	0	0	0	2	5	16	22	14

PHOTO NO. 104 SCOUR DEPTH 0.0 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	1	0	4	11	24	36
FREQ.OUT	0	0	0	0	1	0	4	11	24	36
FREQ.AFTER	0	0	0	0	1	4	6	7	16	9
FREQ.IN	0	0	0	0	1	4	6	7	16	9

PHOTO NO. 105 SCOUR DEPTH 5.9 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	5	26	67
FREQ.OUT	0	0	0	0	0	0	0	5	26	67
FREQ.AFTER	0	0	0	0	0	0	0	3	22	49
FREQ.IN	0	0	0	0	0	0	0	3	22	49

PHOTO NO. 106 SCOUR DEPTH 30.8 CM.

PHI SIZE	-9.49	-8.99	-8.49	-8.00	-7.50	-7.00	-6.49	-5.98	-5.46	-5.05
FREQ.BEFORE	0	0	0	0	0	0	0	1	21	68
FREQ.OUT	0	0	0	0	0	0	0	0	19	68
FREQ.AFTER	0	0	0	0	0	0	1	3	26	30
FREQ.IN	0	0	0	0	0	0	0	1	26	30

APPENDIX III

Photographs taken before and after the spring flood of 1982 for all 5 streams of this study are included in 2 photo albums.

APPENDIX IV

Hydraulic Data for Twenty Mile Creek

The average bottom shear stress is calculated using the Duboys equation:

$$T = Y R S$$

where T = Average Bottom Shear Stress (kg/sq.m)
Y = Specific Weight of Water (1000.000 kg/cu.m) (after Baker and Ritter 1975)
R = Hydraulic Radius (m)
S = Dimensionless Water-Surface Slope

Station 1

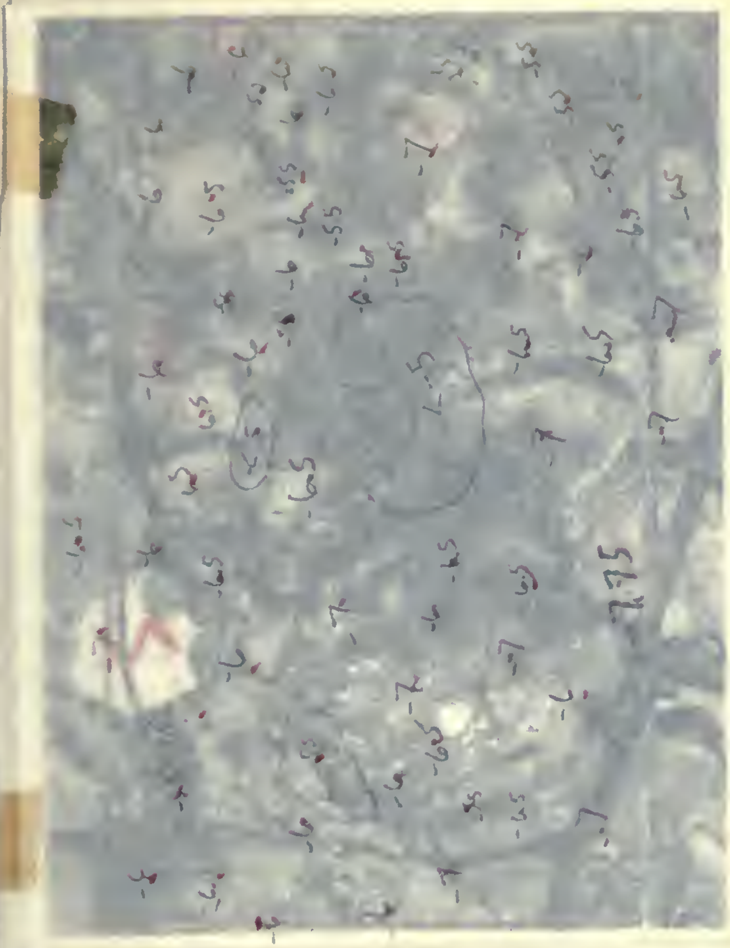
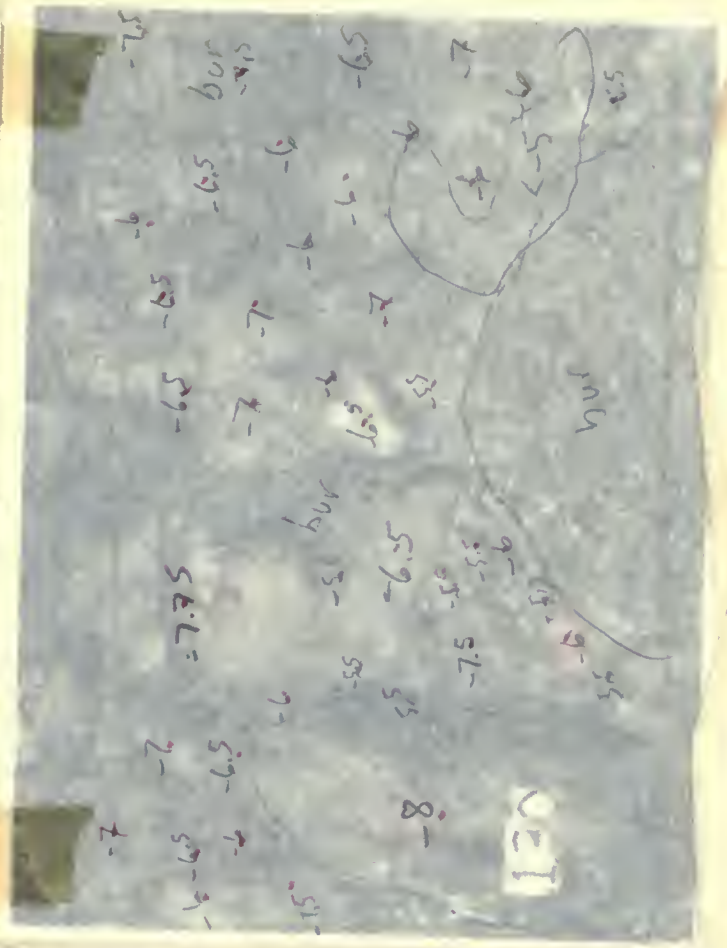
DISCHARGE (CMS)	DIMENSIONLESS SLOPE (M/M)	HYDRAULIC RADIUS (M)	AVERAGE BOTTOM SHEAR STRESS (KG/SQ.M)
24.3	0.0175	1.7780	31.12
6.1	0.0158	1.5608	24.66
9.8	0.0159	1.6263	25.86
1.9	0.0145	1.3836	20.06
10.0	0.0159	1.6467	26.18
13.0	0.0161	1.6934	27.26
13.1	0.0161	1.6967	27.32
10.8	0.0159	1.6589	26.38
7.1	0.0155	1.5843	24.56
4.5	0.0150	1.5140	22.71
7.6	0.0153	1.5926	24.37
4.3	0.0146	1.5049	21.97

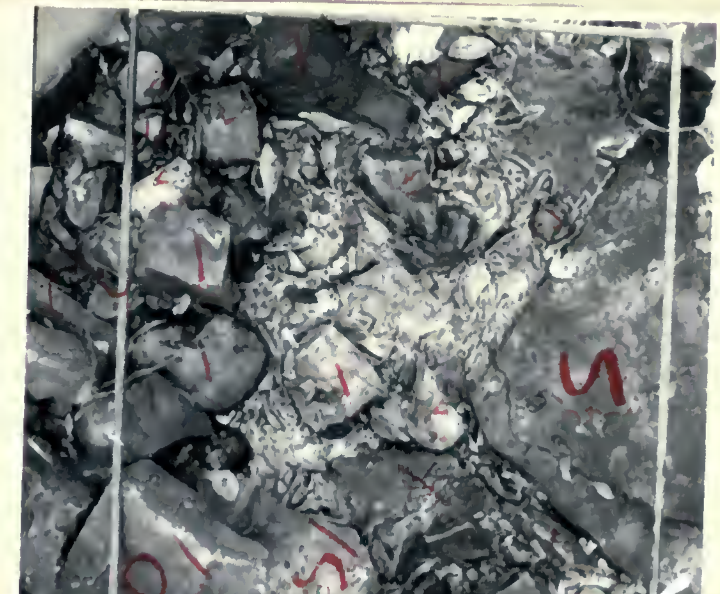
Station 2

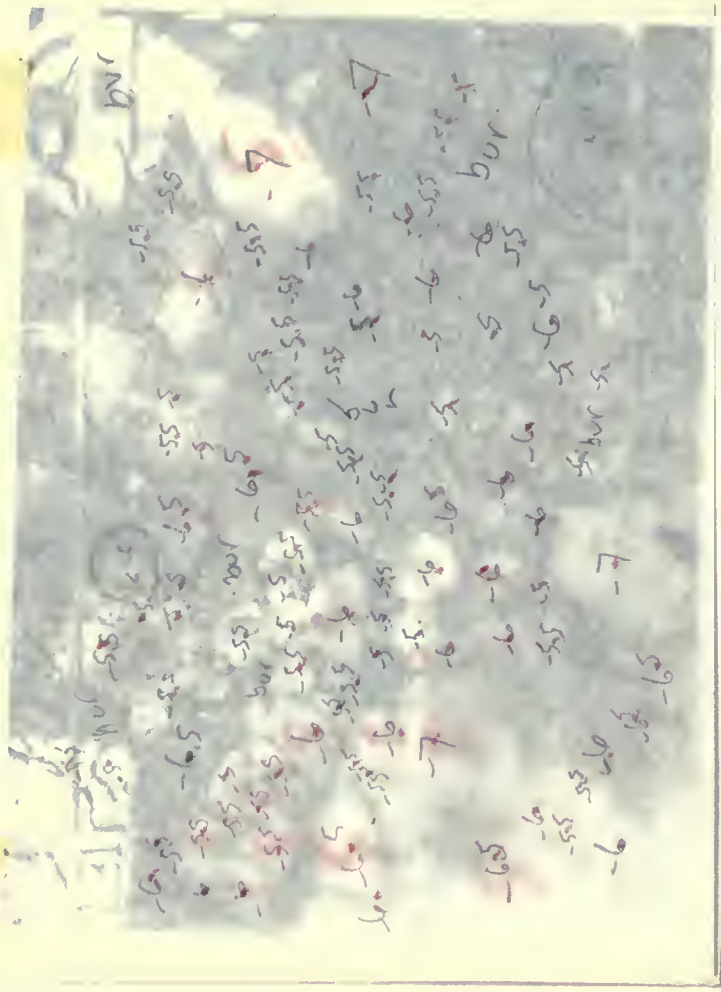
DISCHARGE (CMS)	DIMENSIONLESS SLOPE (M/M)	HYDRAULIC RADIUS (M)	AVERAGE BOTTOM SHEAR STRESS (KG/SQ.M.)
24.3	0.0175	2.4005	42.01
6.1	0.0158	2.2522	35.58
9.8	0.0159	2.3088	36.71
1.9	0.0145	2.1304	30.89
10.0	0.0159	2.3265	36.99
13.0	0.0161	2.3628	38.04
13.1	0.0161	2.3645	38.07
10.8	0.0159	2.3359	37.14
7.1	0.0155	2.2821	35.37
4.5	0.0150	2.2311	33.47
7.6	0.0153	2.2928	35.08
4.3	0.0146	2.2335	32.61
Station 4			
24.3	0.0136	0.5739	7.81
27.1	0.0120	0.5880	7.06
18.7	0.0118	0.4749	5.60
11.6	0.0113	0.3785	4.28
6.1	0.0110	0.2873	3.16
9.8	0.0116	0.3971	4.61
10.0	0.0114	0.4017	4.58
27.4	0.0134	0.7653	10.26
36.9	0.0135	0.8438	11.39
2.3	0.0075	0.2093	1.57

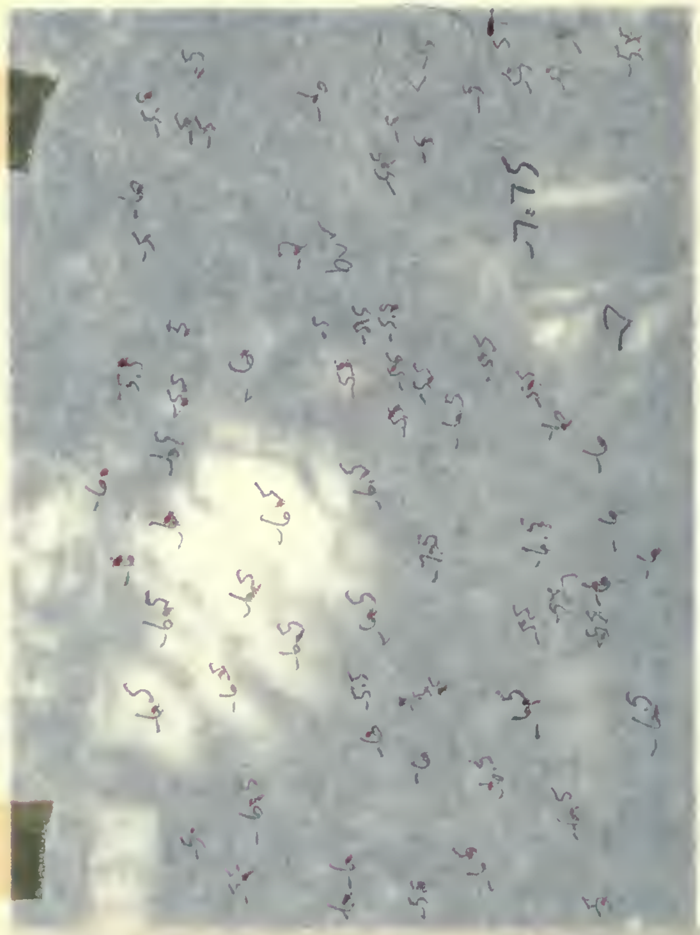
Photographs of Sixteen Mile Creek

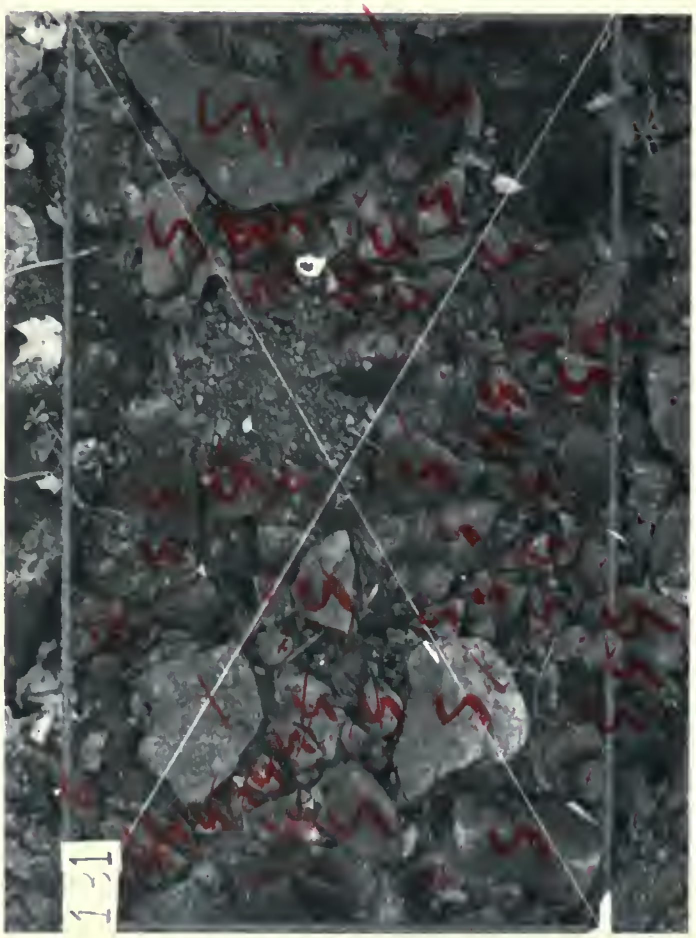
continued

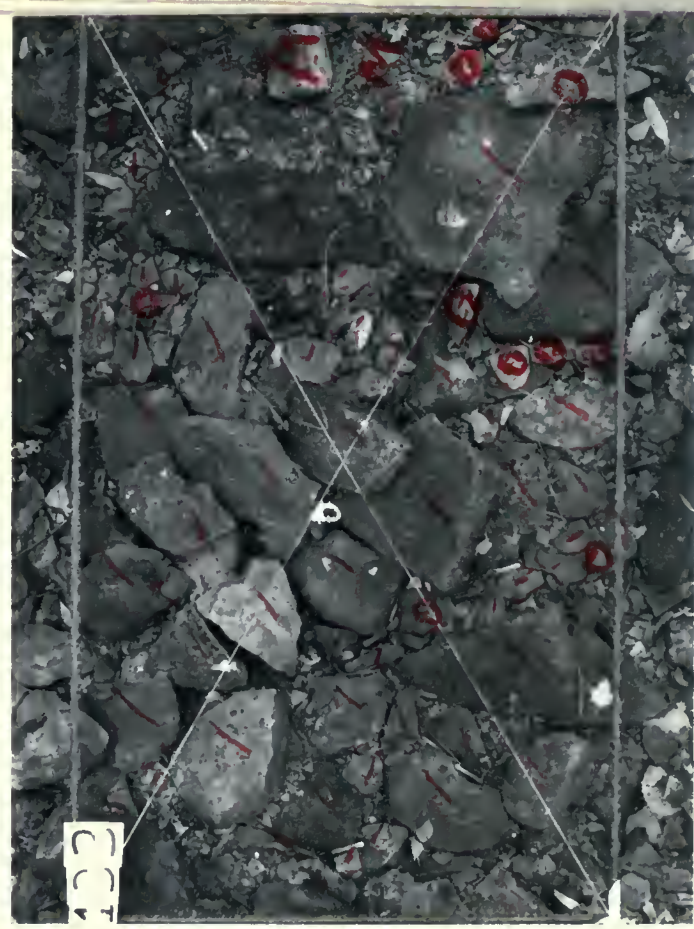



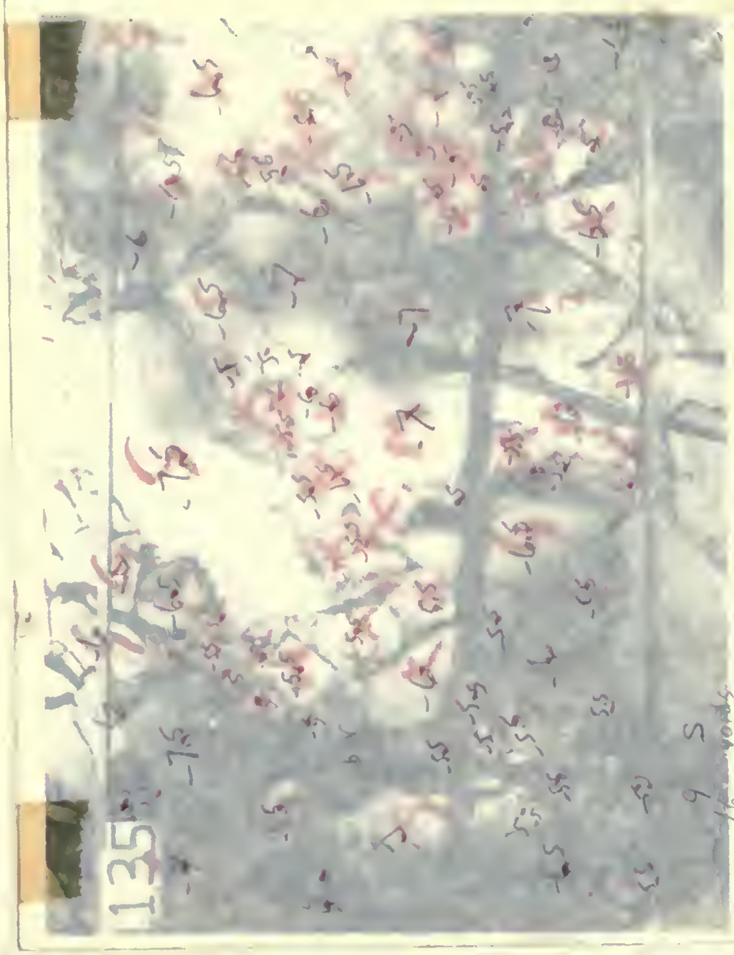


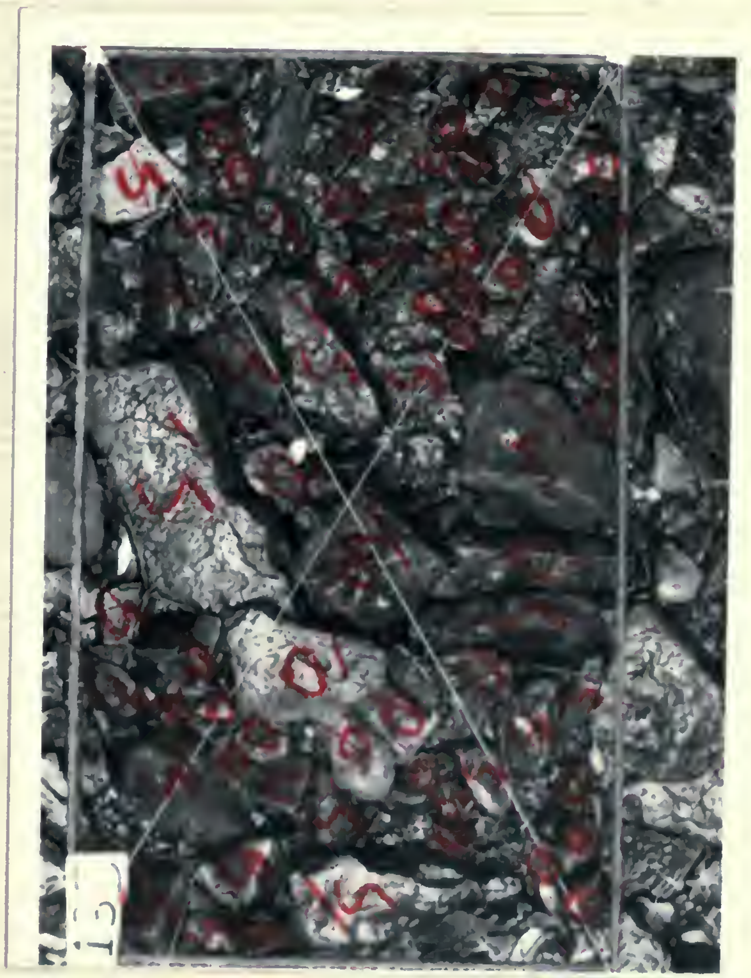




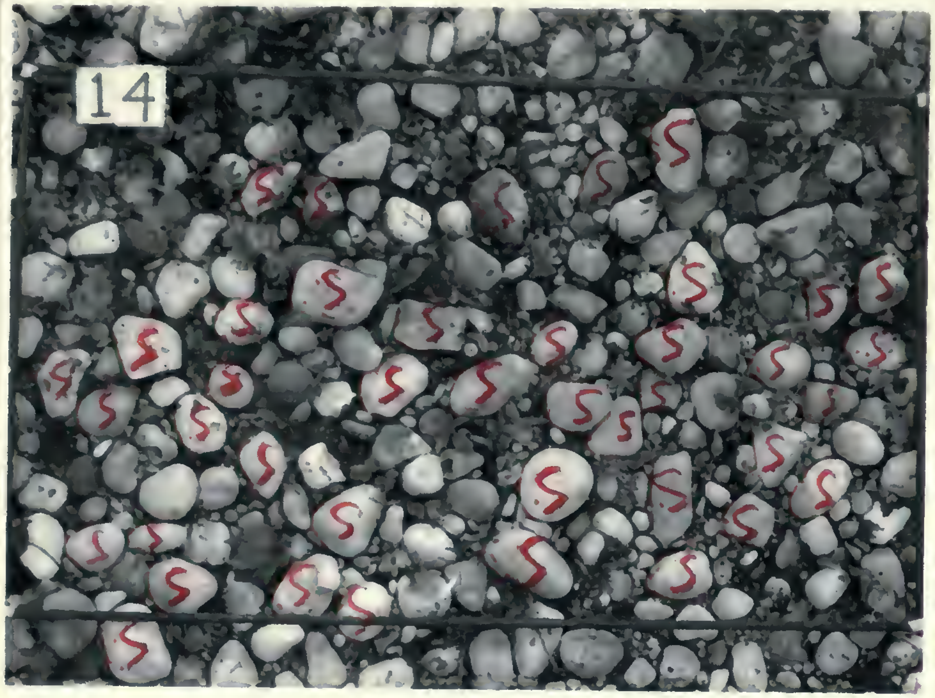








Photographs of the Grand River Before (left side) and After (right side) the 1982-83 Snow-melt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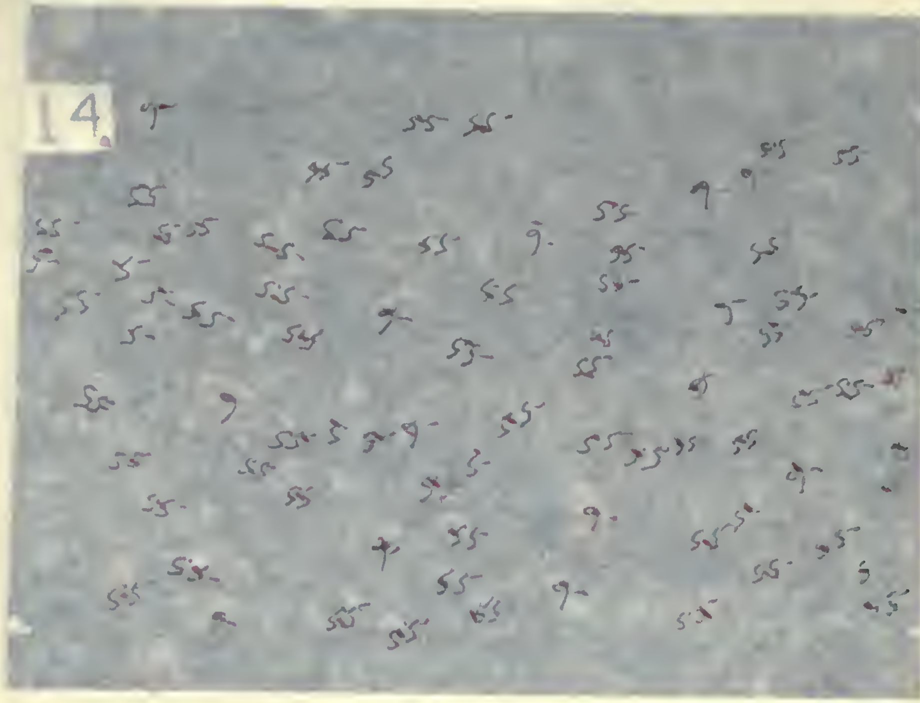
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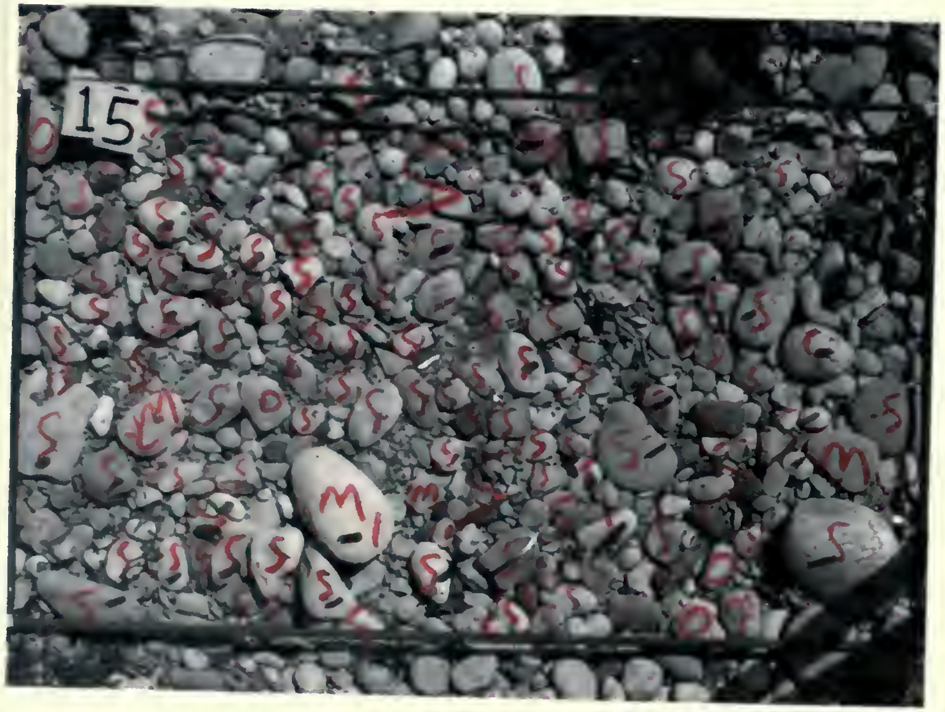
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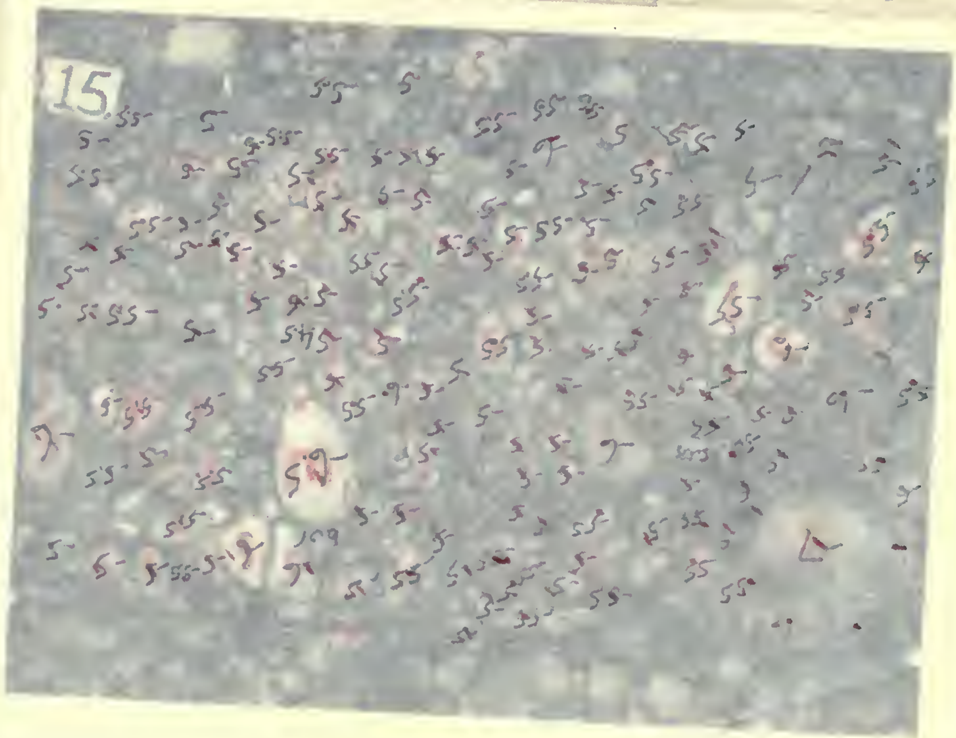
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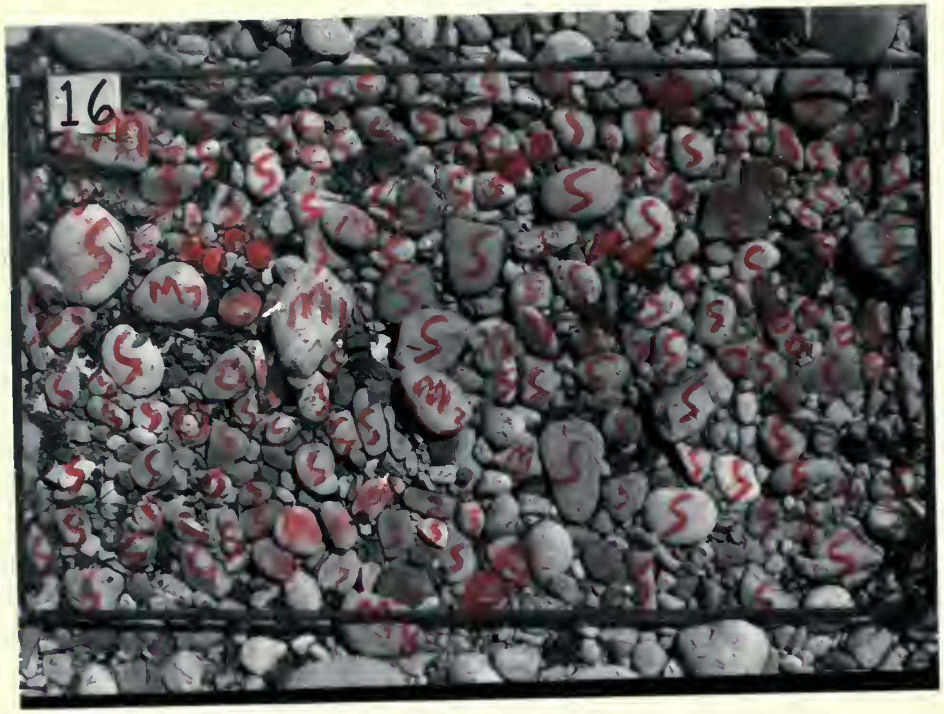

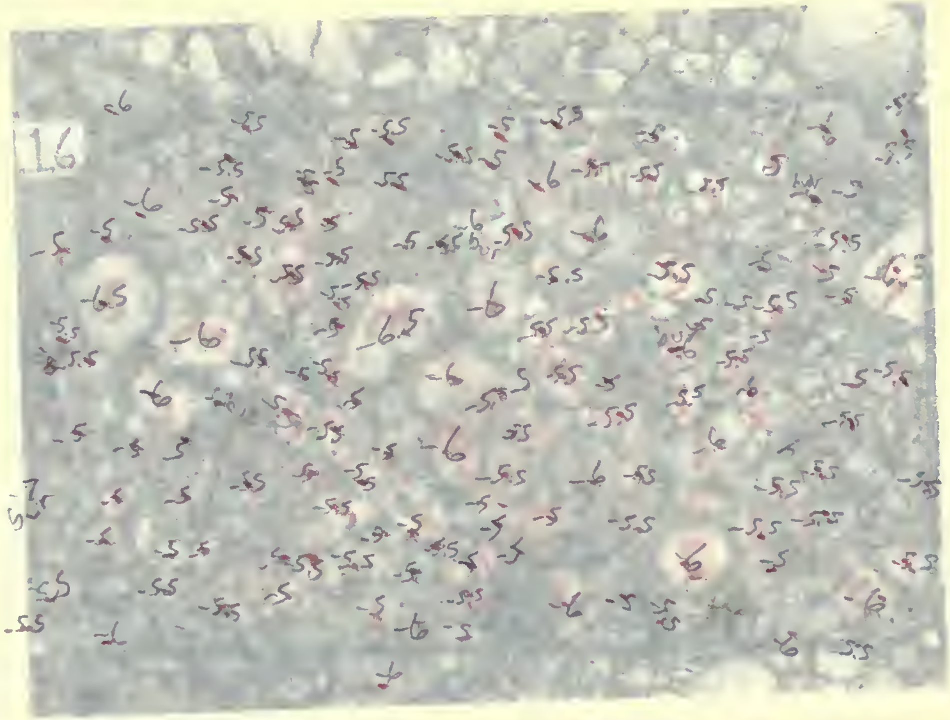

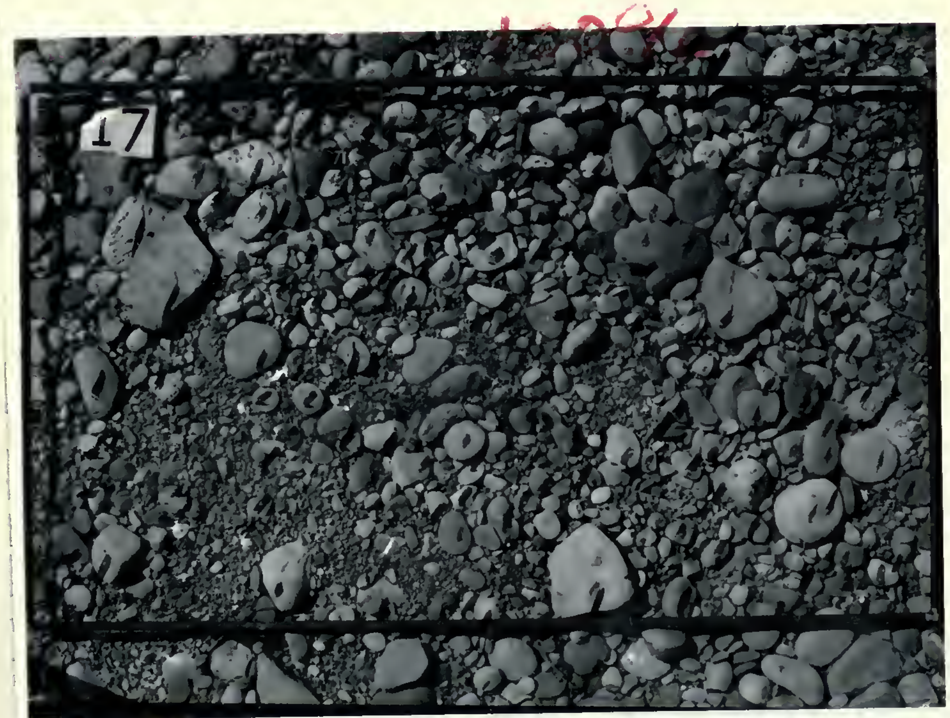

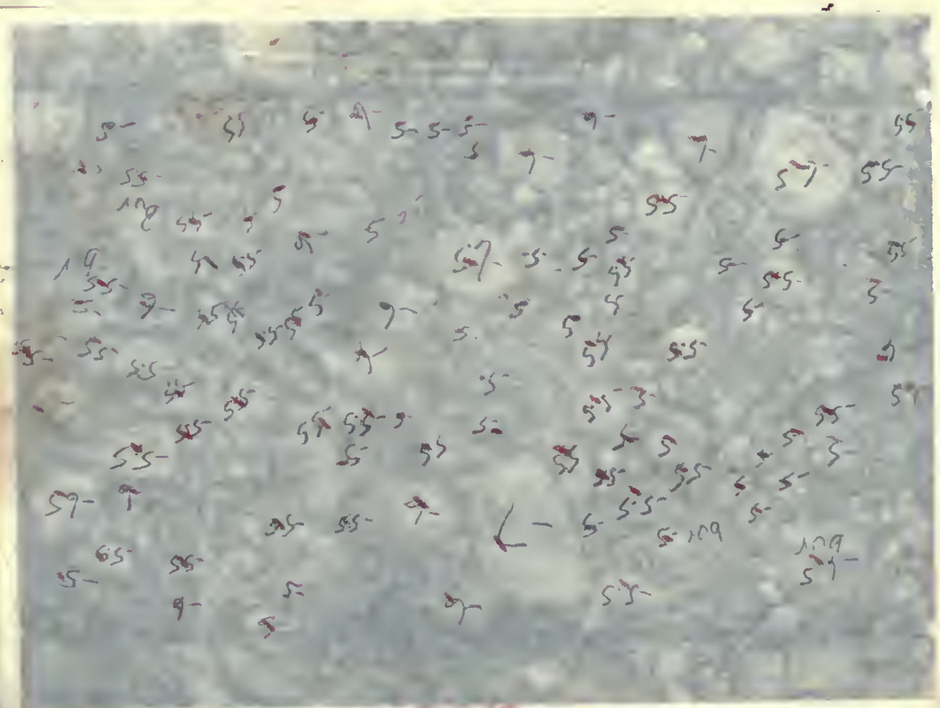

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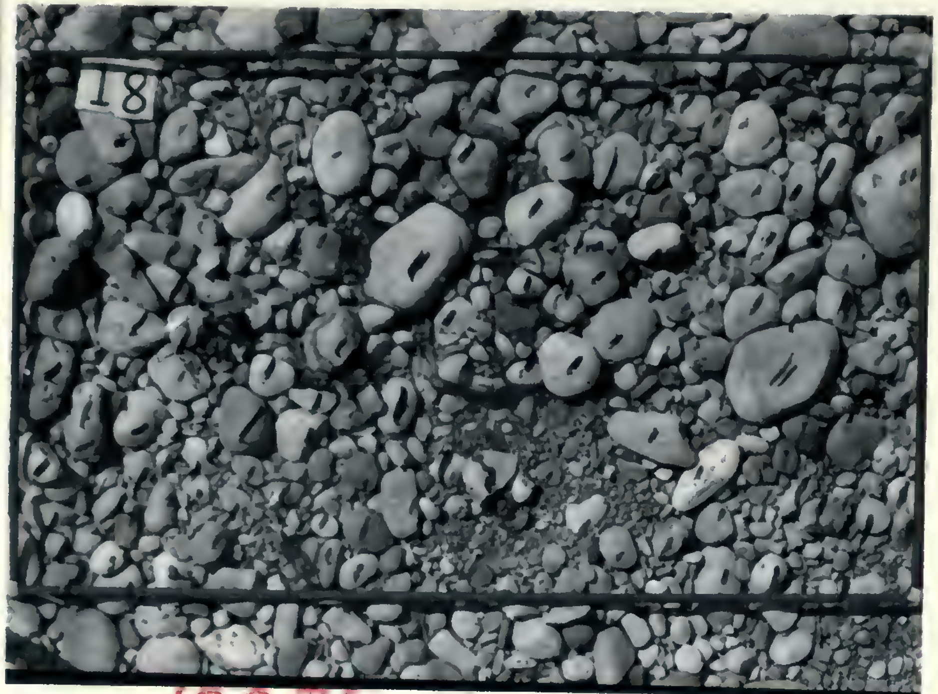

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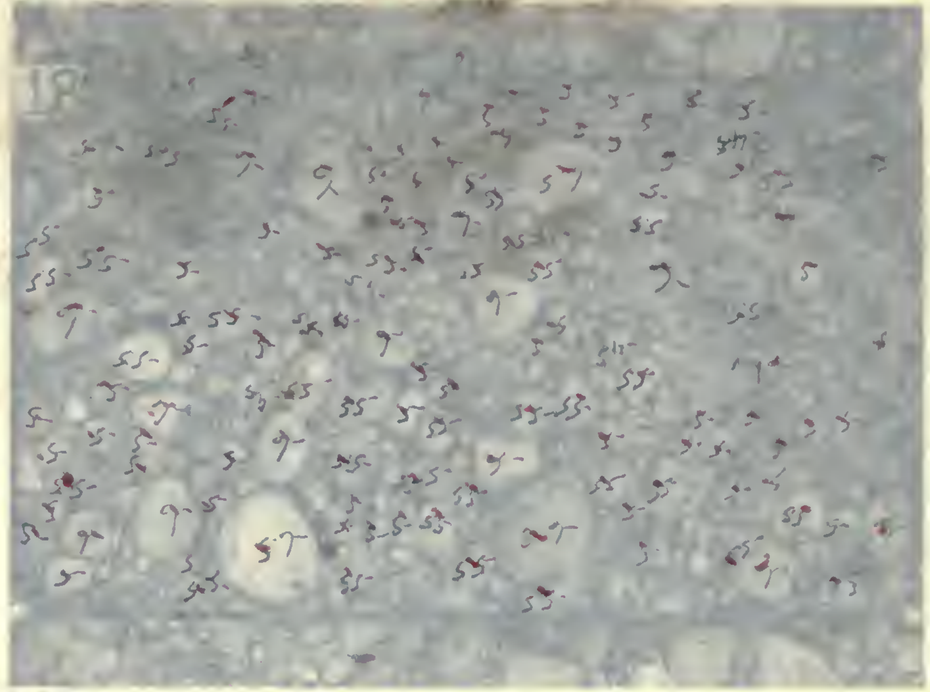

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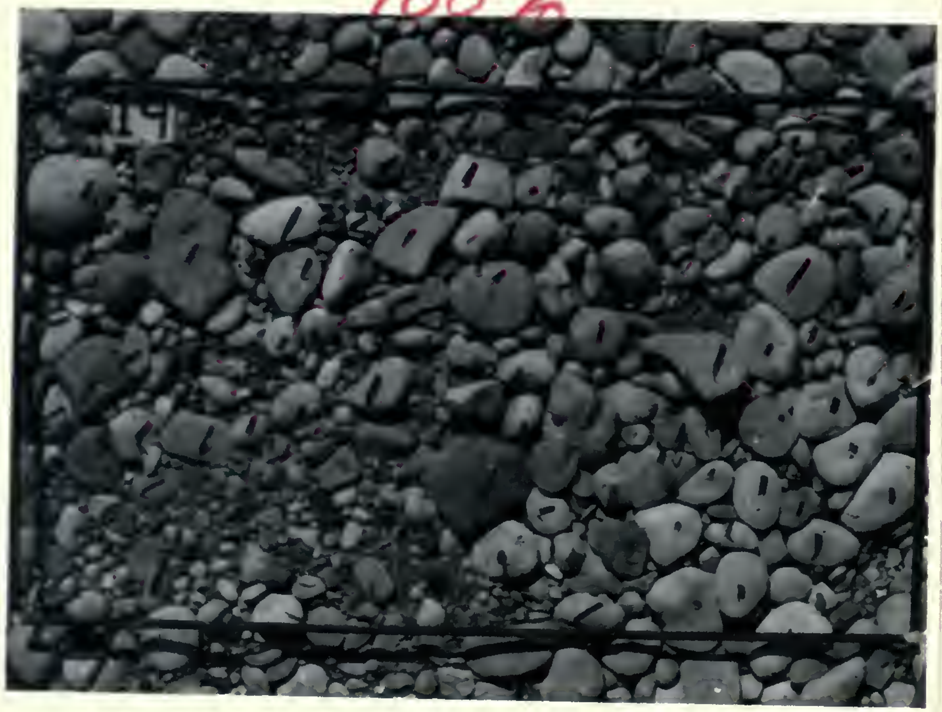

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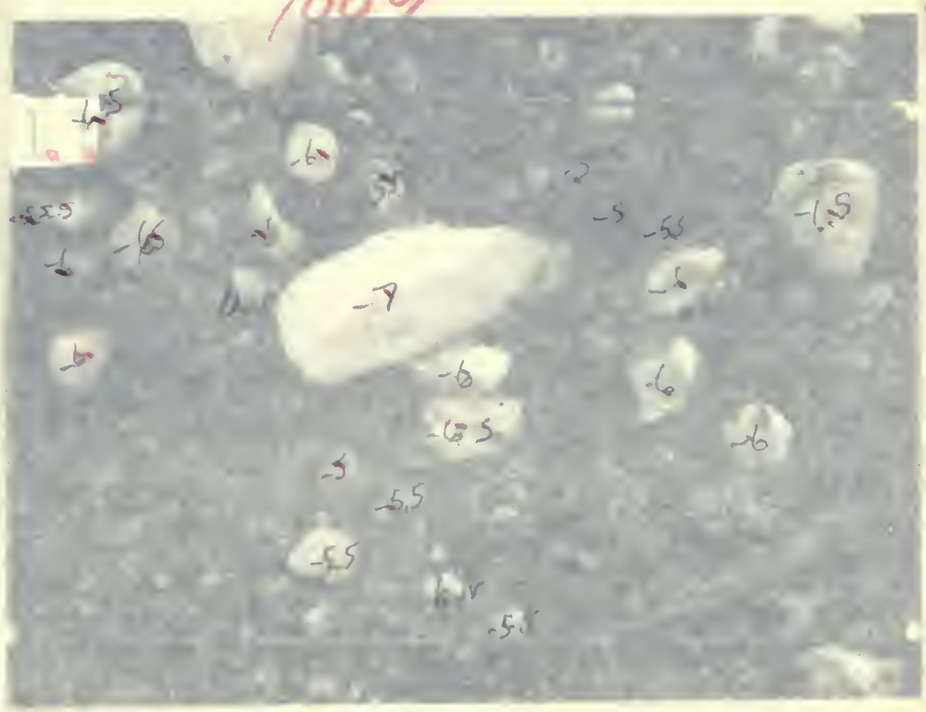

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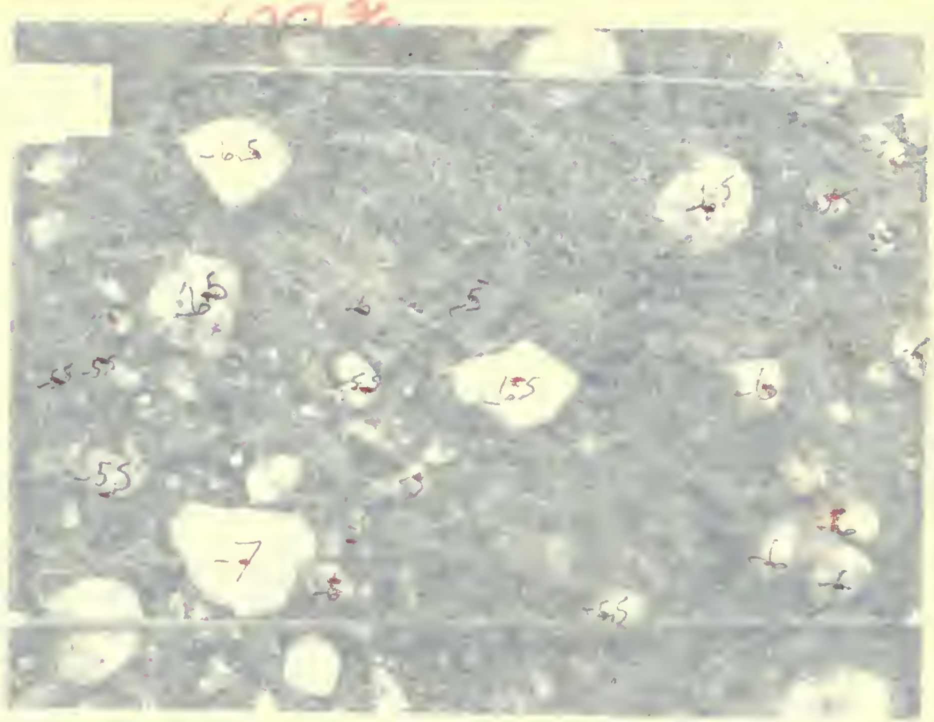

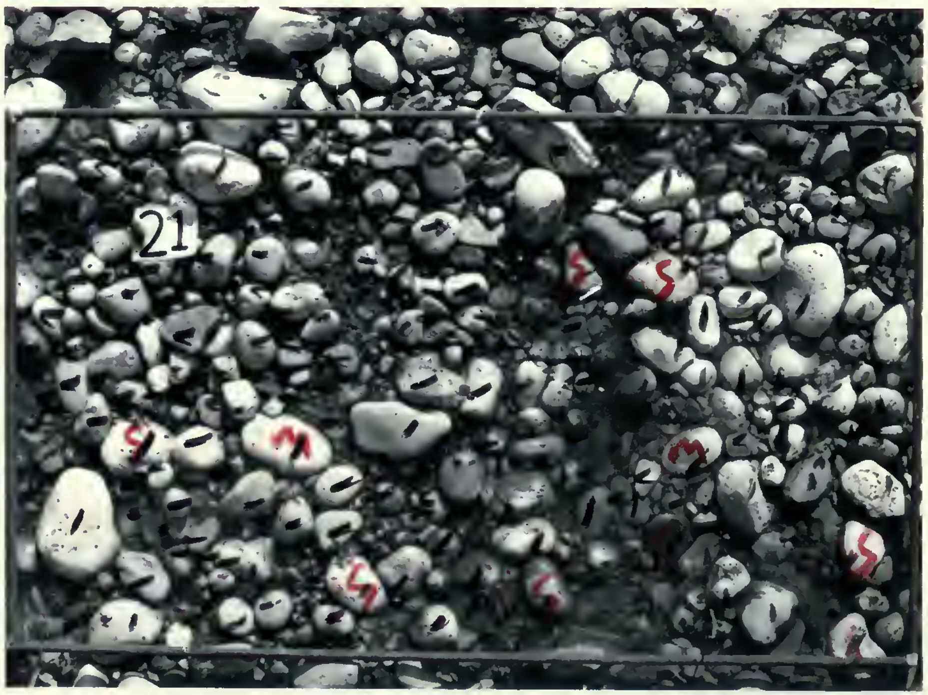

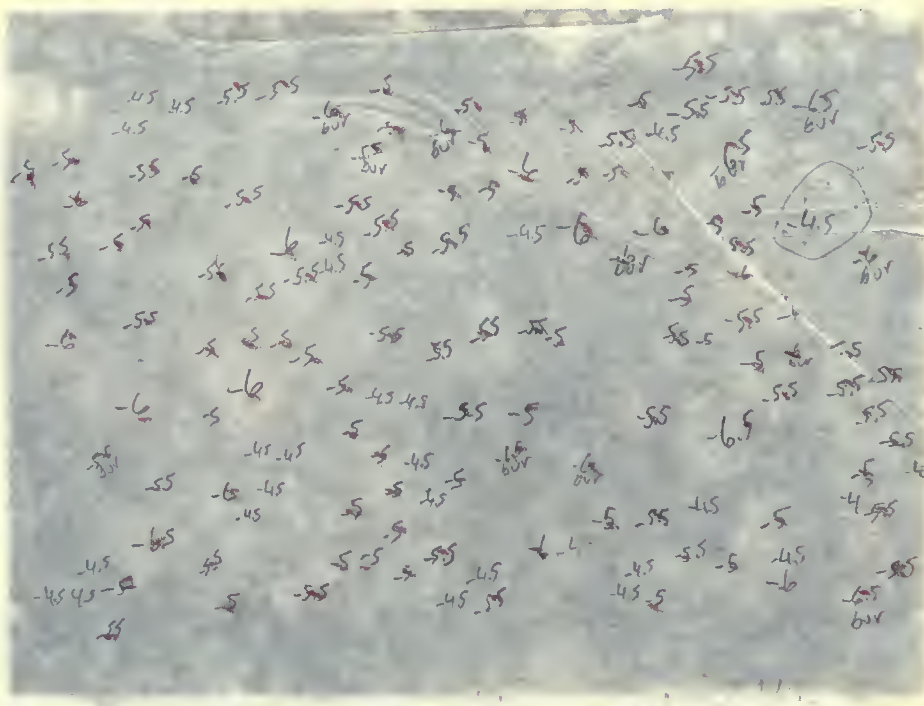

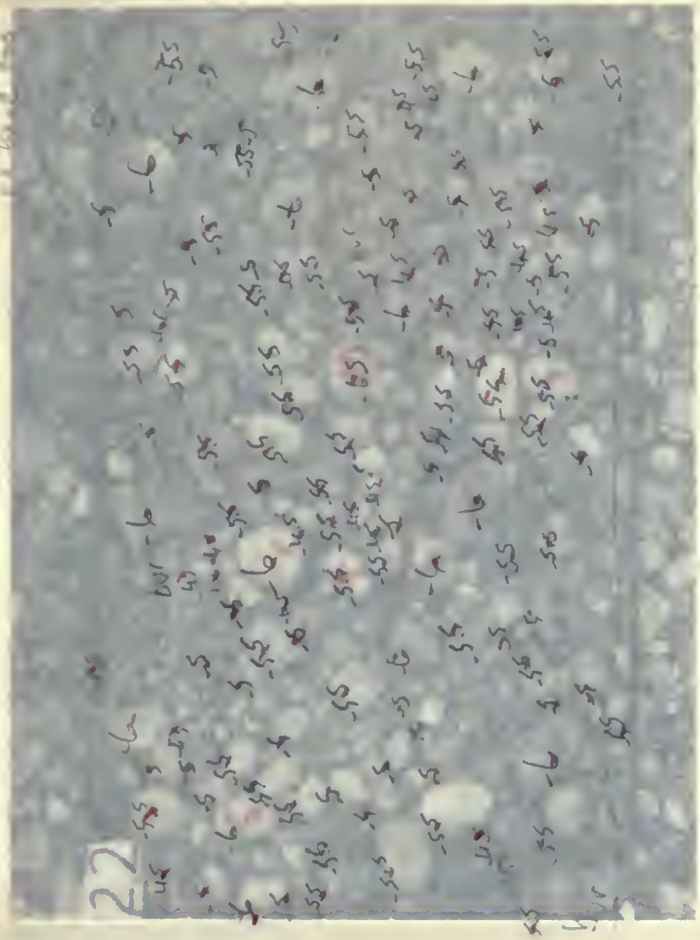
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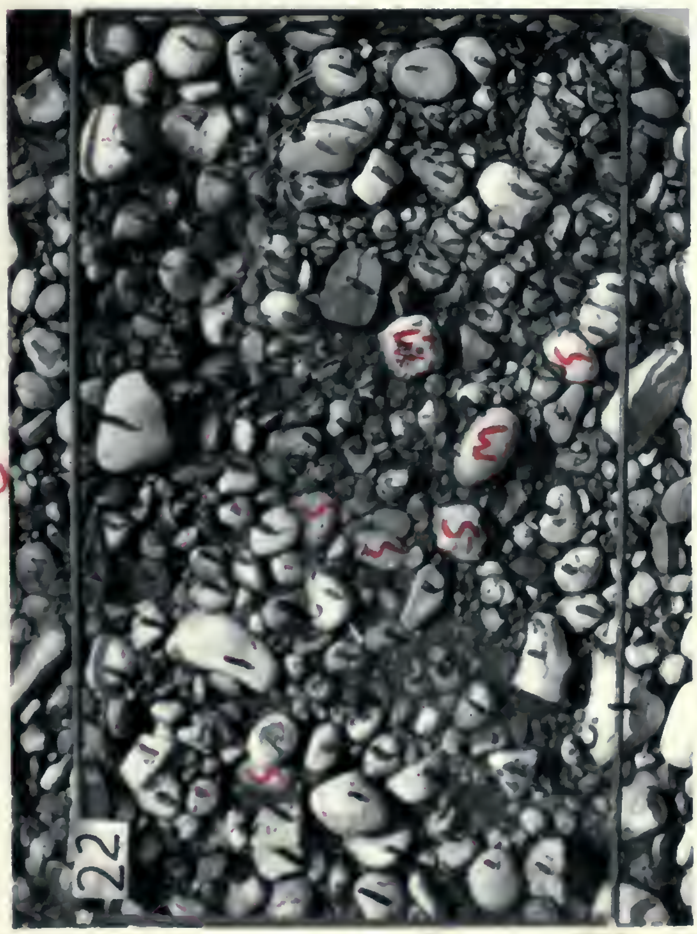
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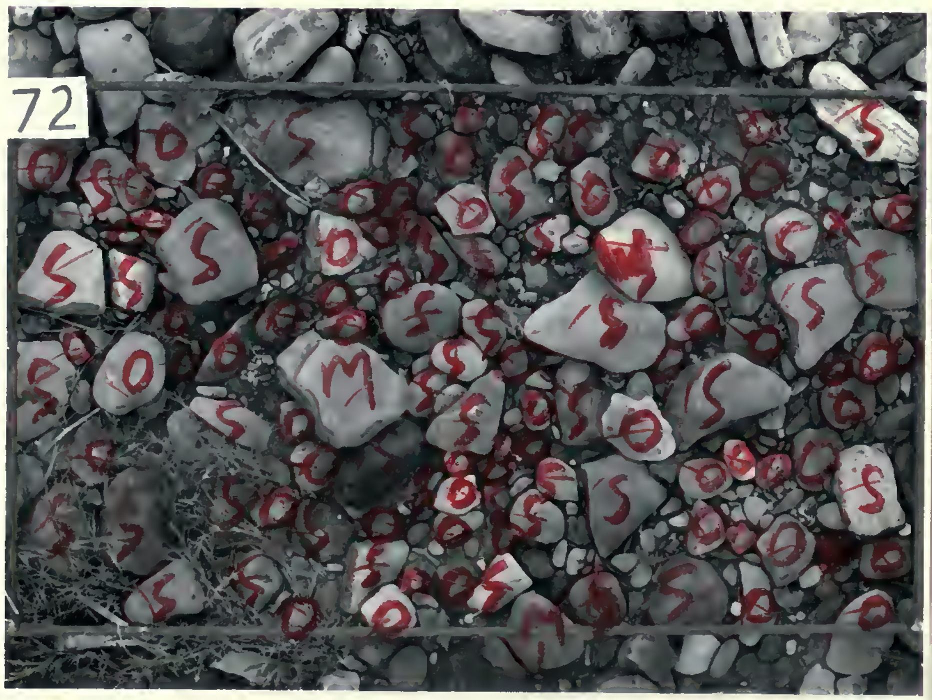
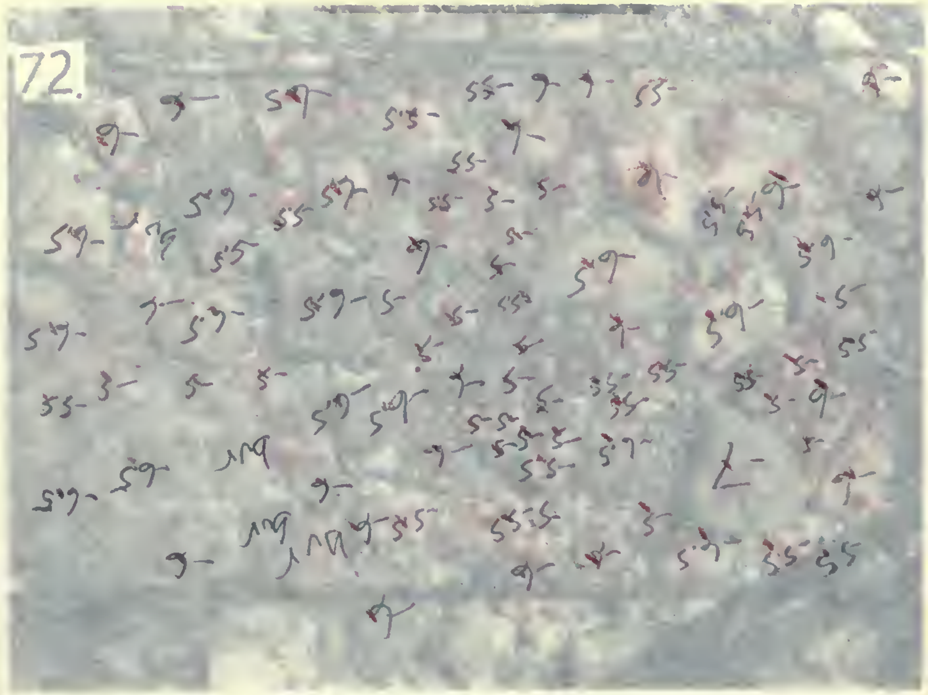
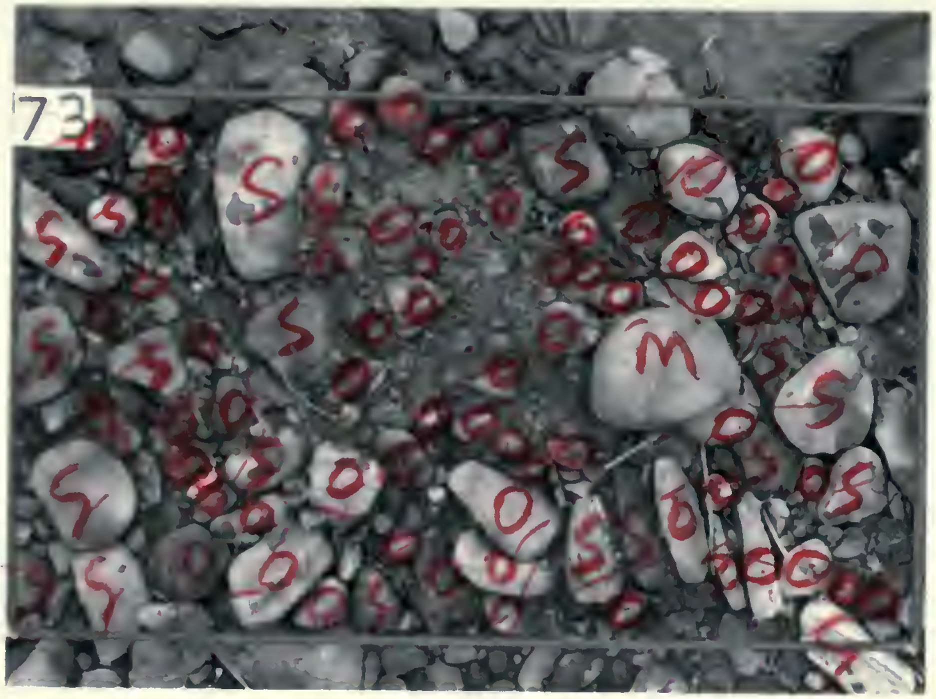
Photographs of the Genesee River

Before (left side) and After (right side)

the 1982-83 Snow-melt



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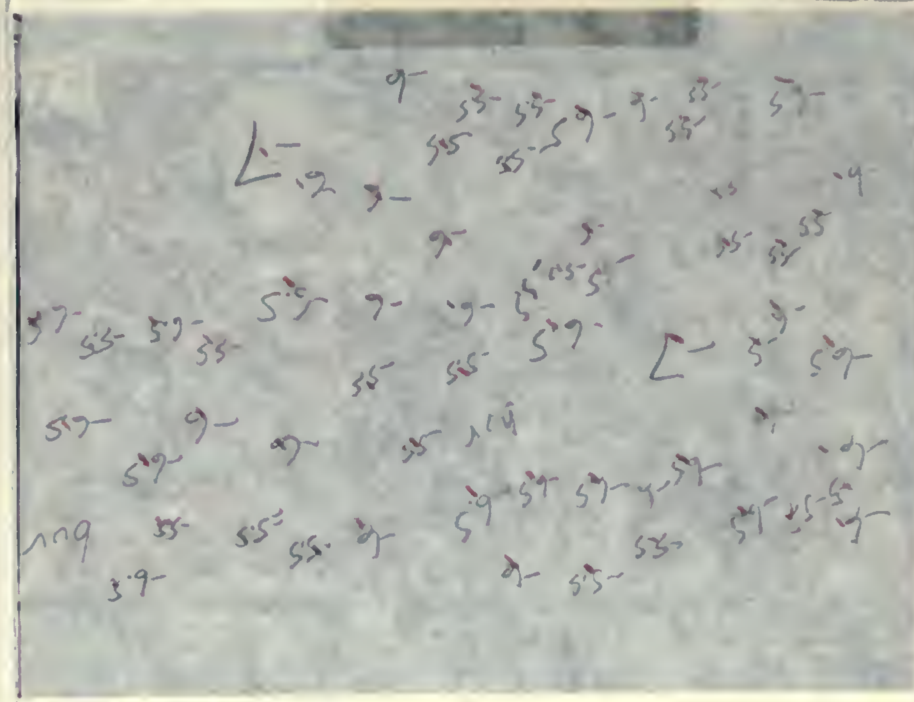

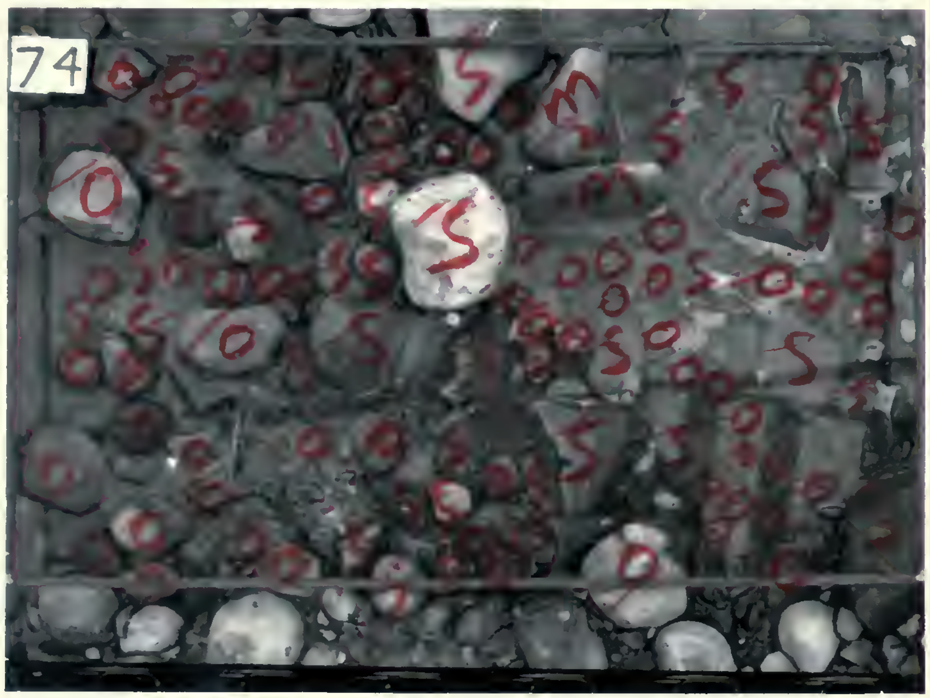
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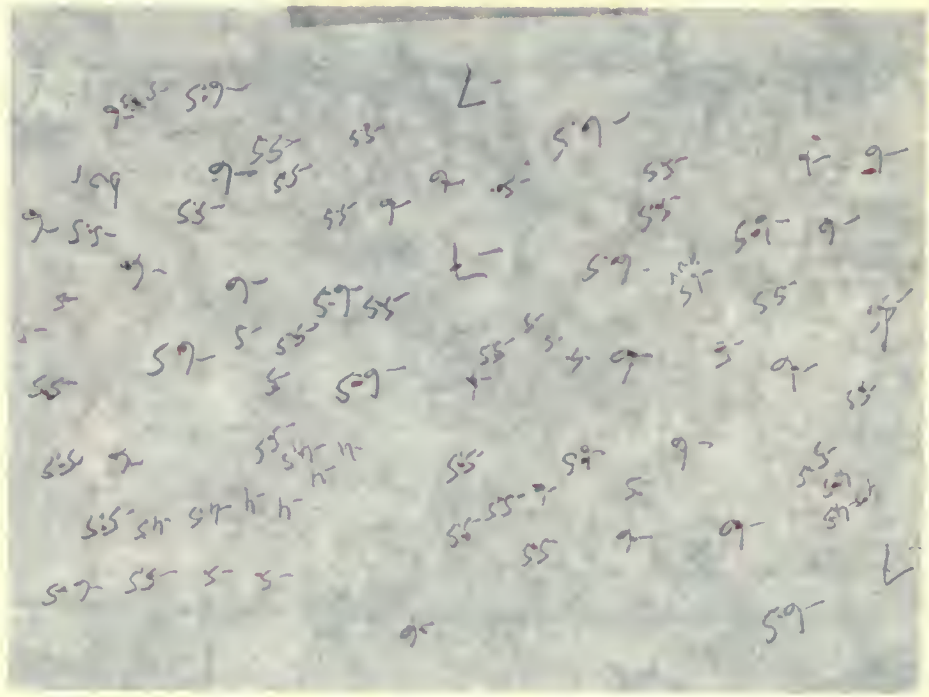

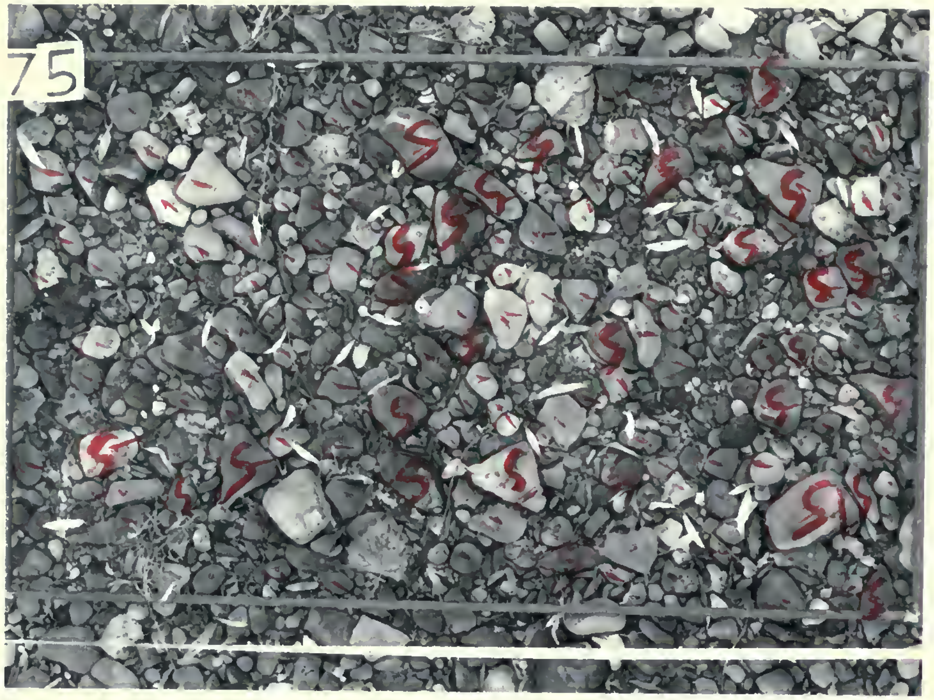
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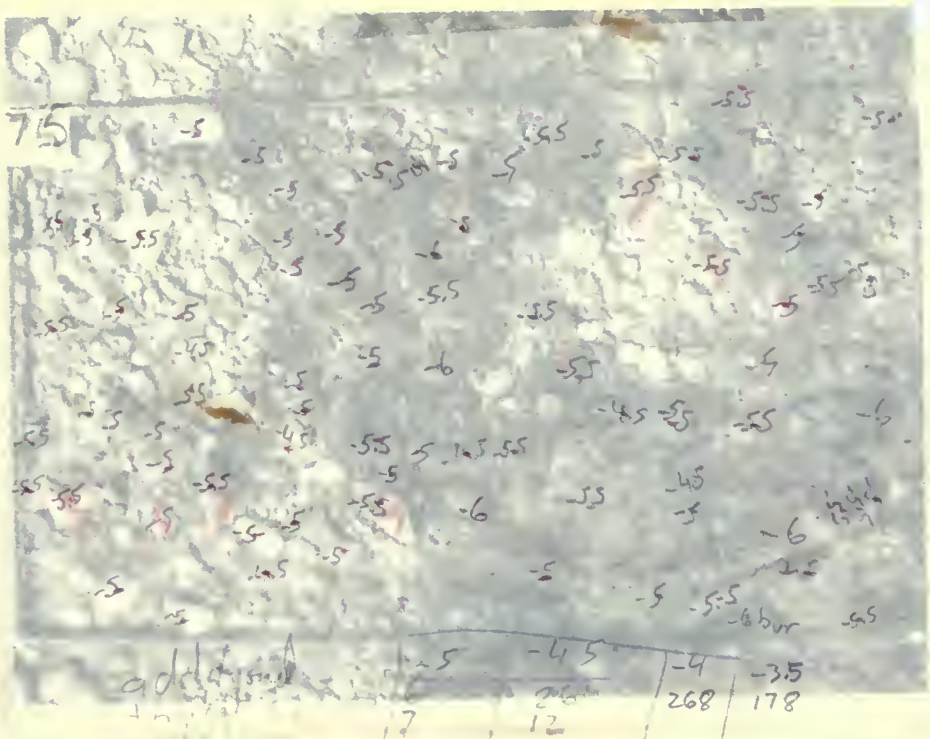
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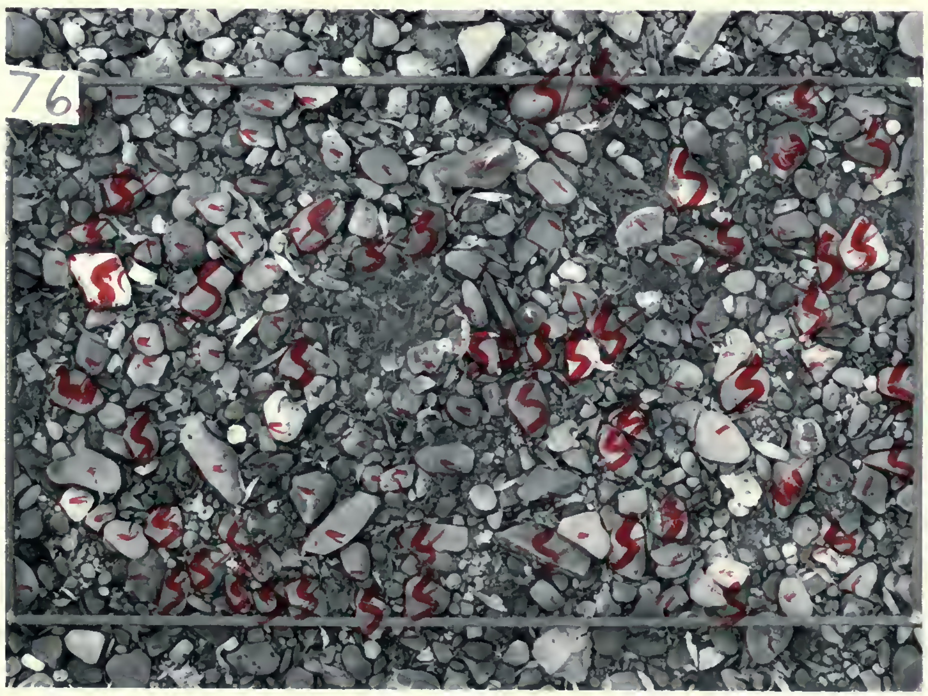
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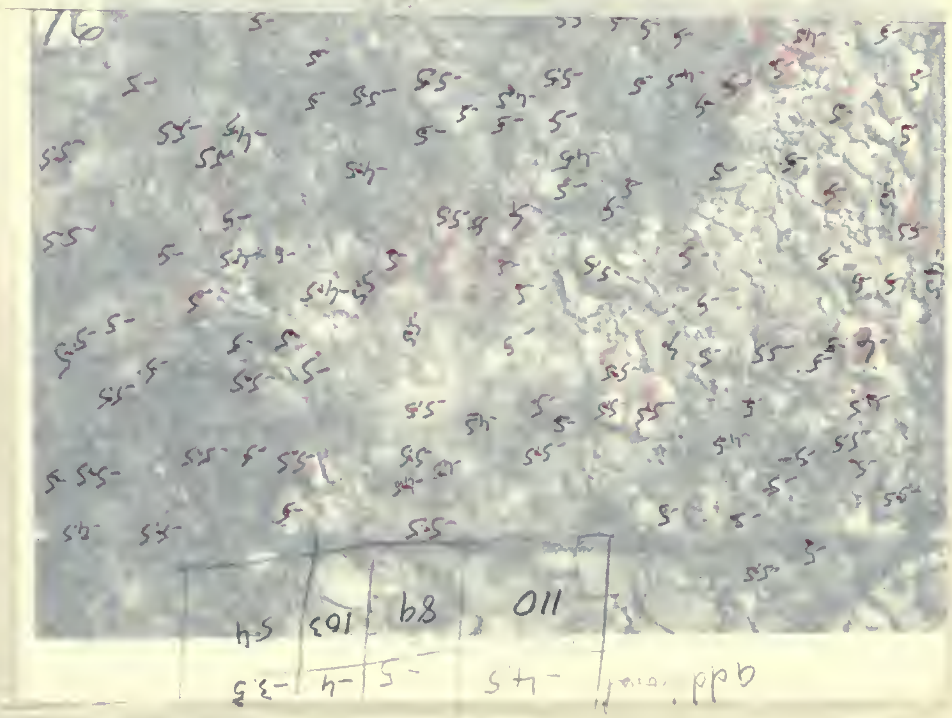
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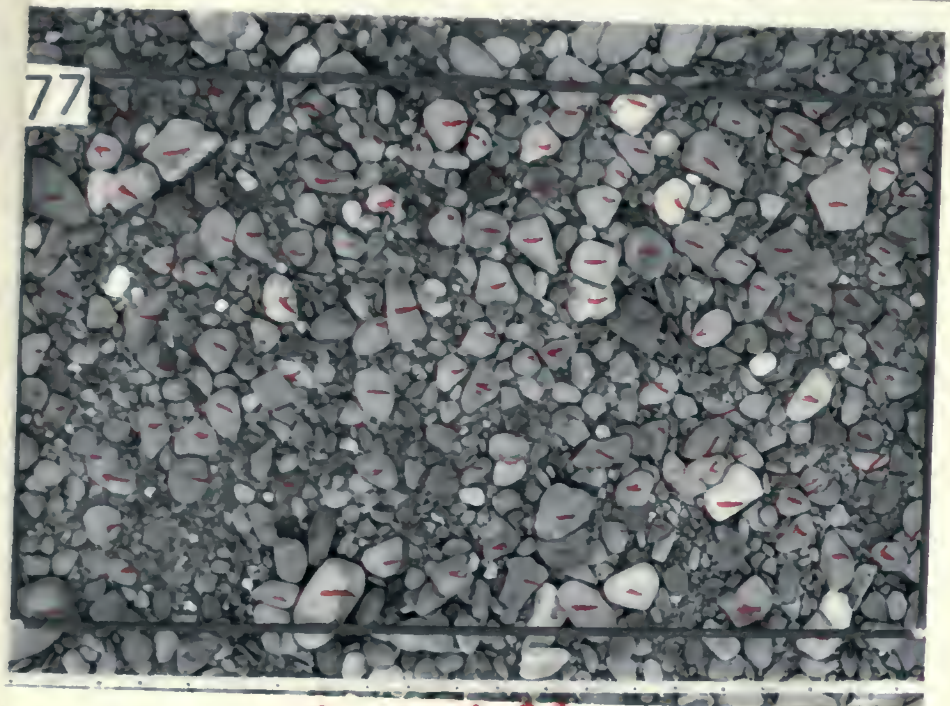

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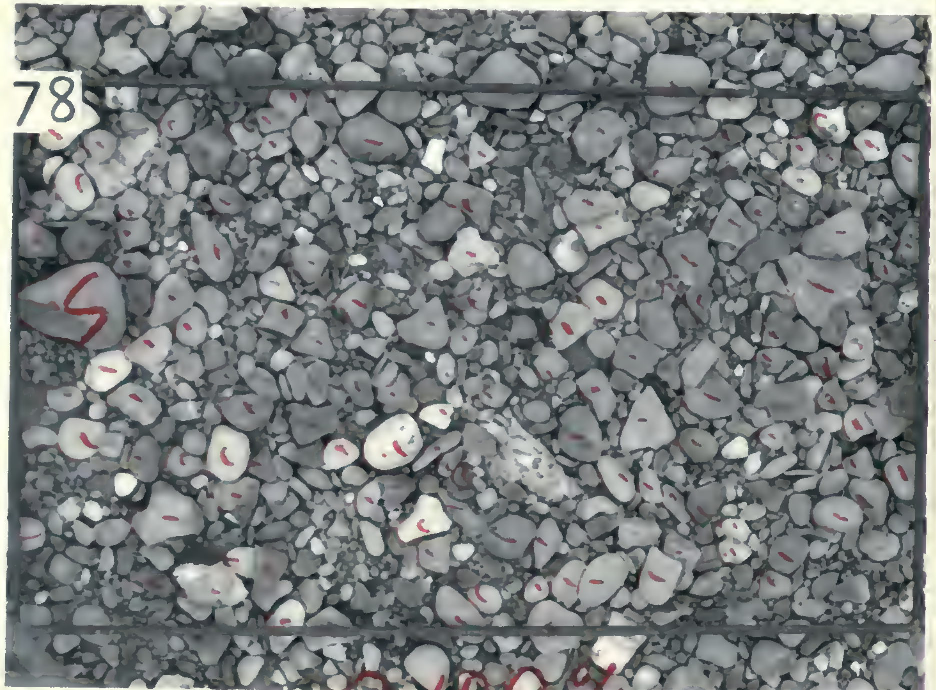

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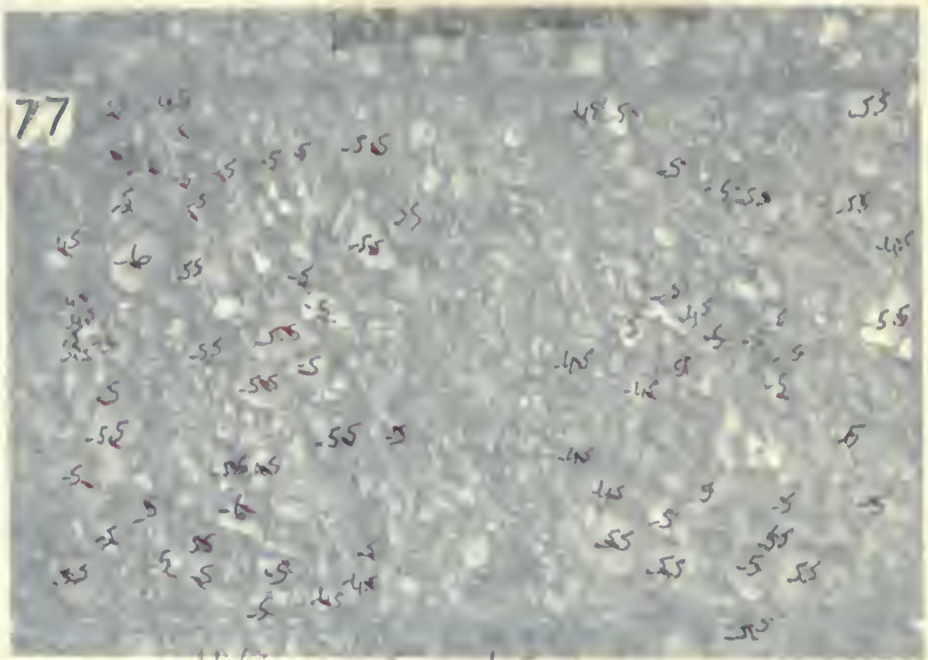
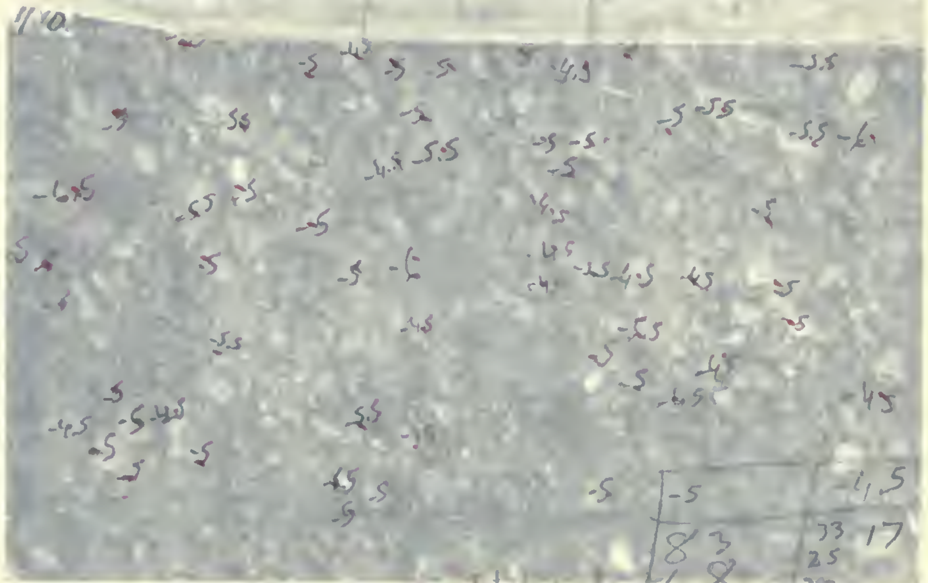


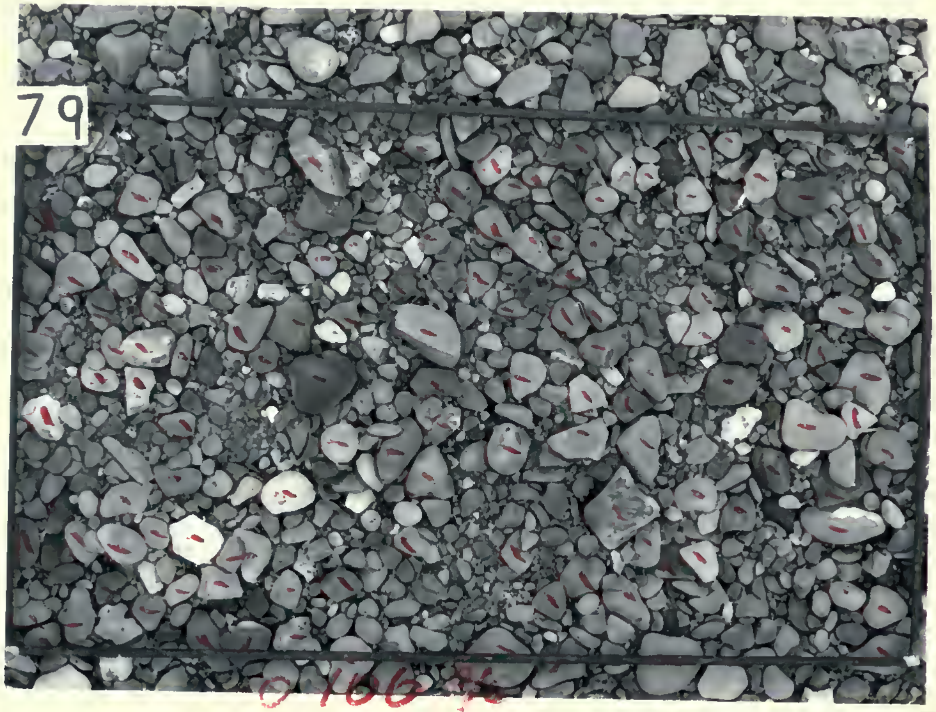
additional	-5	-4.5
	5 6 7 10	21 25 26 33

<-4.5 not collected for this photo



-5	-4.5
8 3 6 8	33 25 20 23 17

1-4.5 ... X 100% additional <4.5 in bag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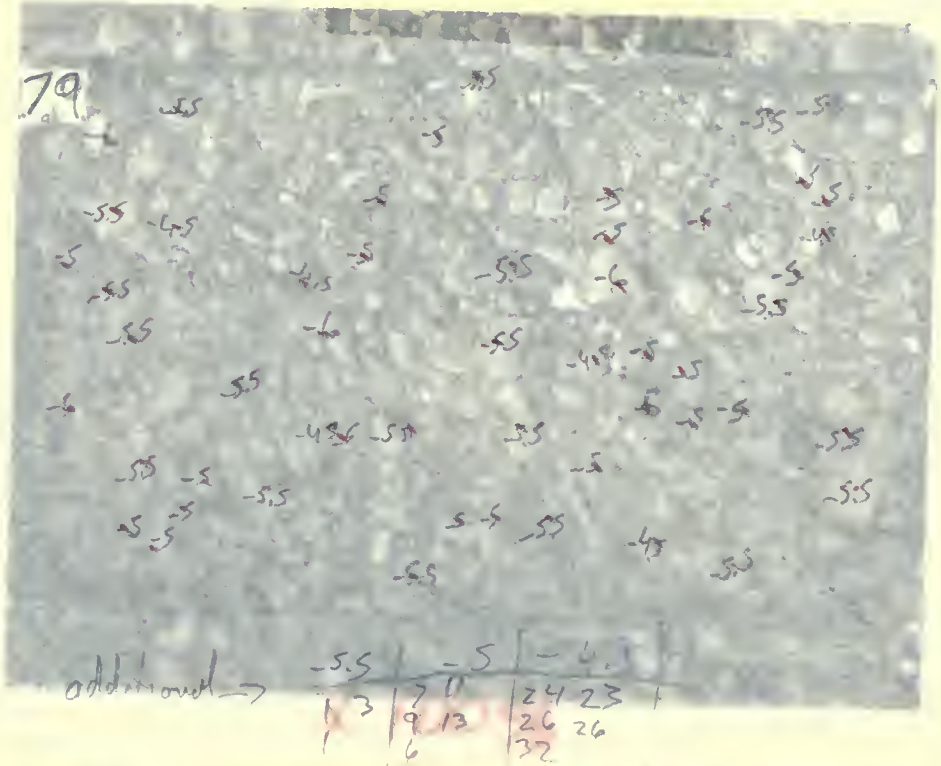
0 100 %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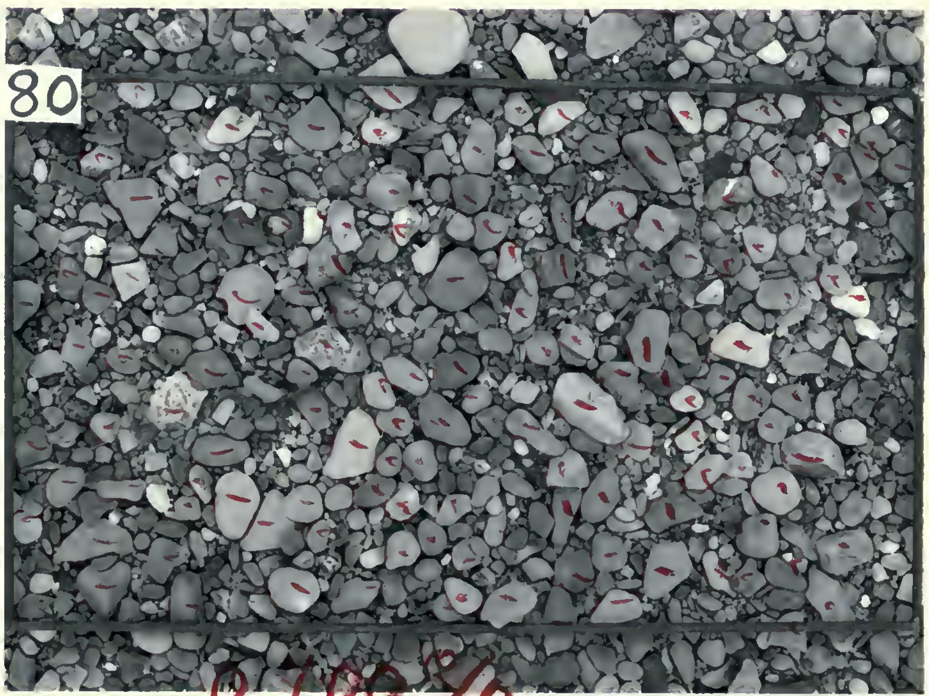
additional →
-5.5 | -5 | -4.5
1 3 | 7 11 | 24 23
1 | 9 13 | 26 26
 | 6 | 32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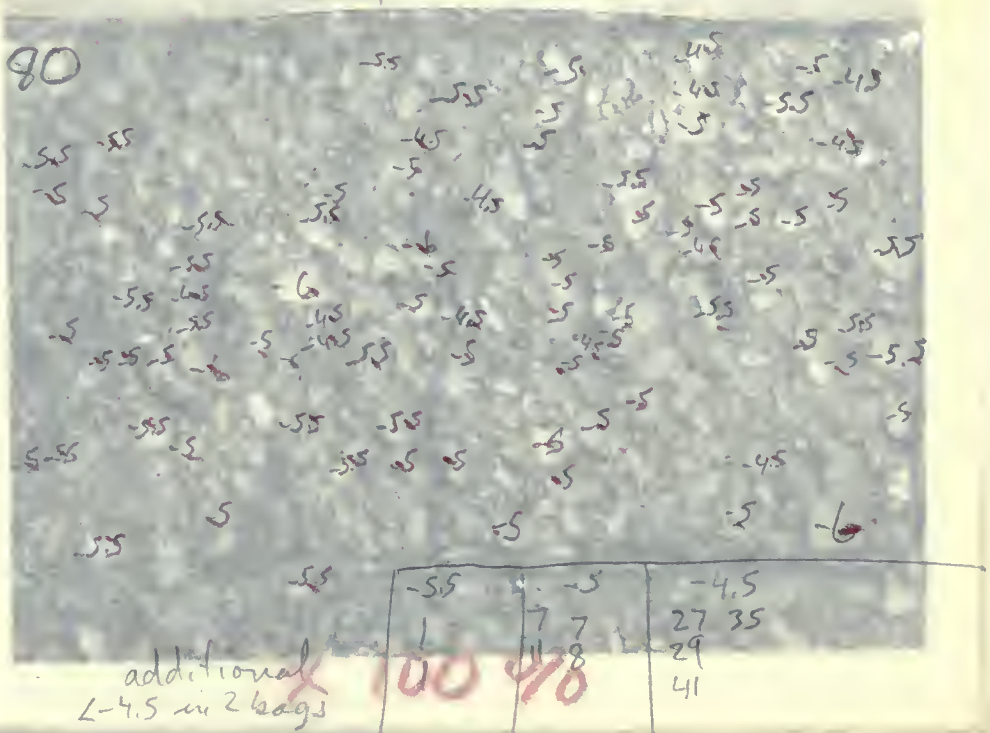
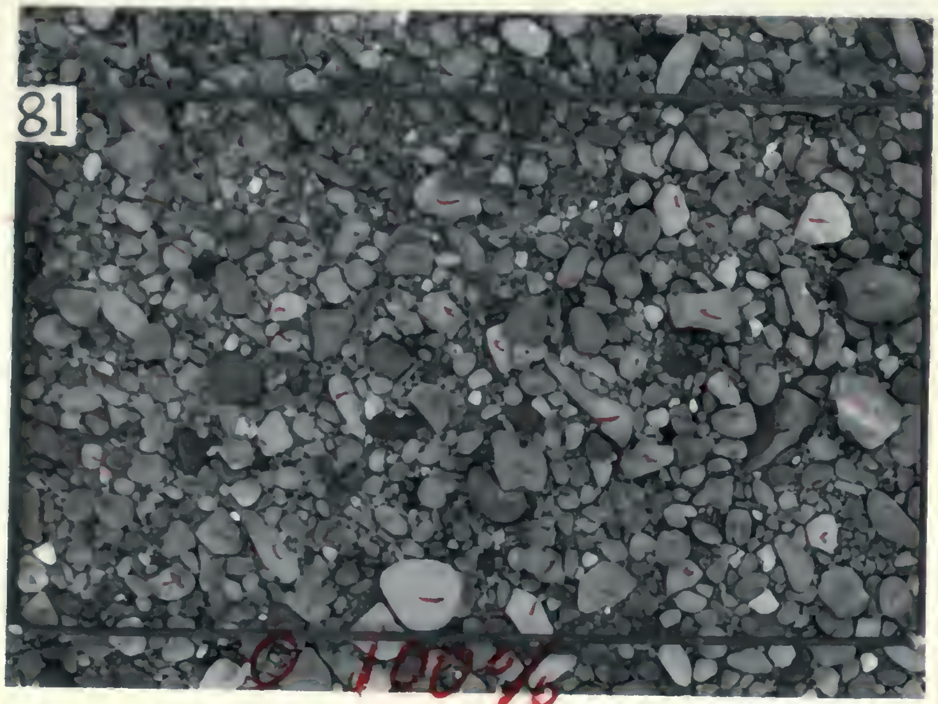
0 100 %


80
-5.5 | -5 | -4.5
1 | 7 7 | 27 35
 | 11 8 | 29
 | | 41
additional
<-4.5 in 2 bags
100 %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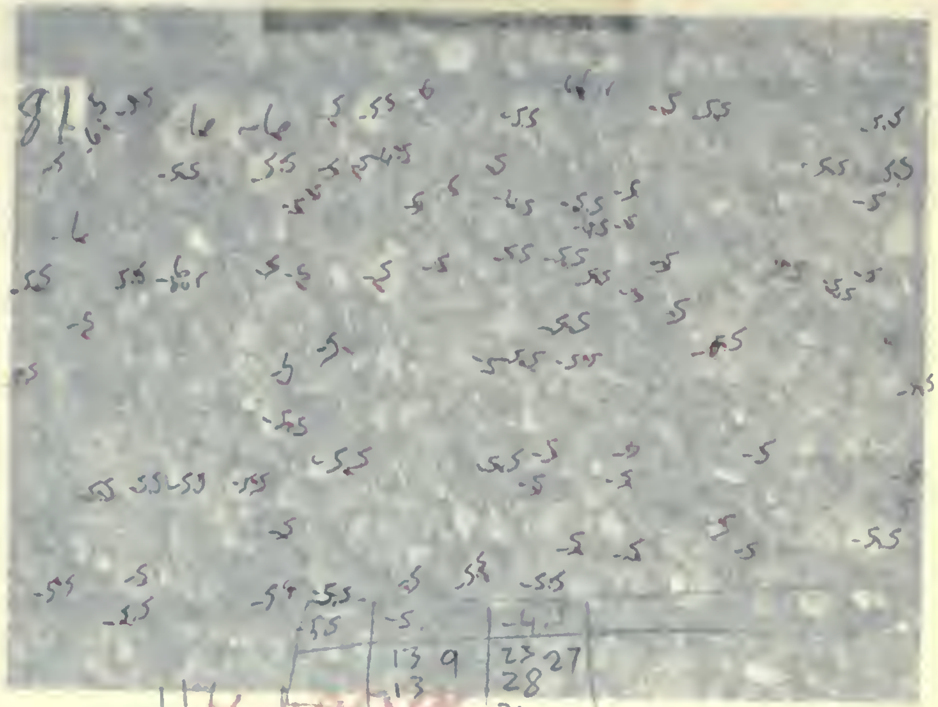
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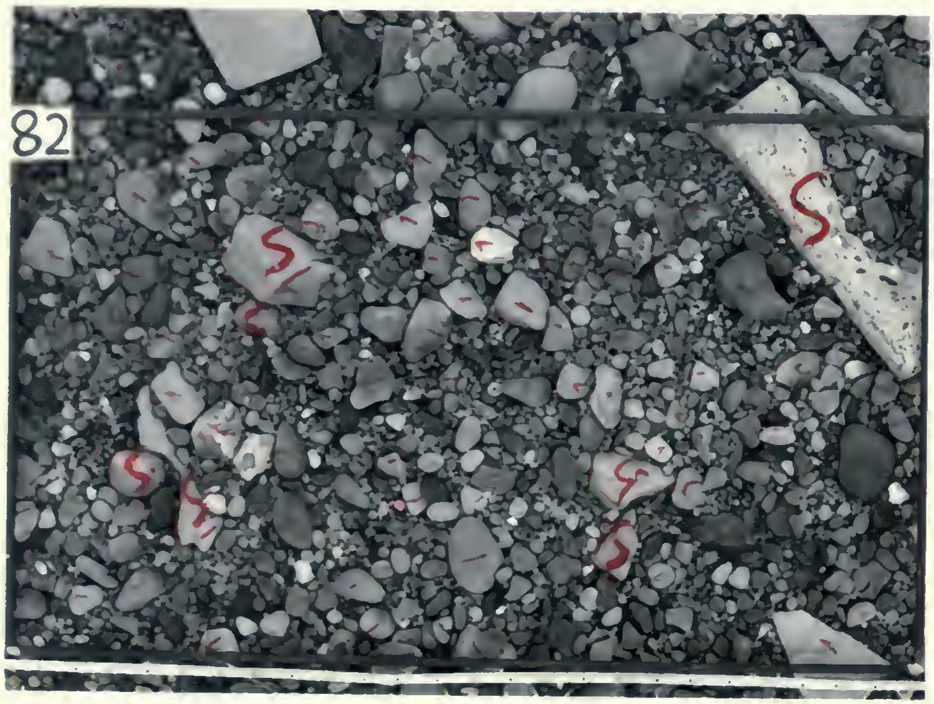
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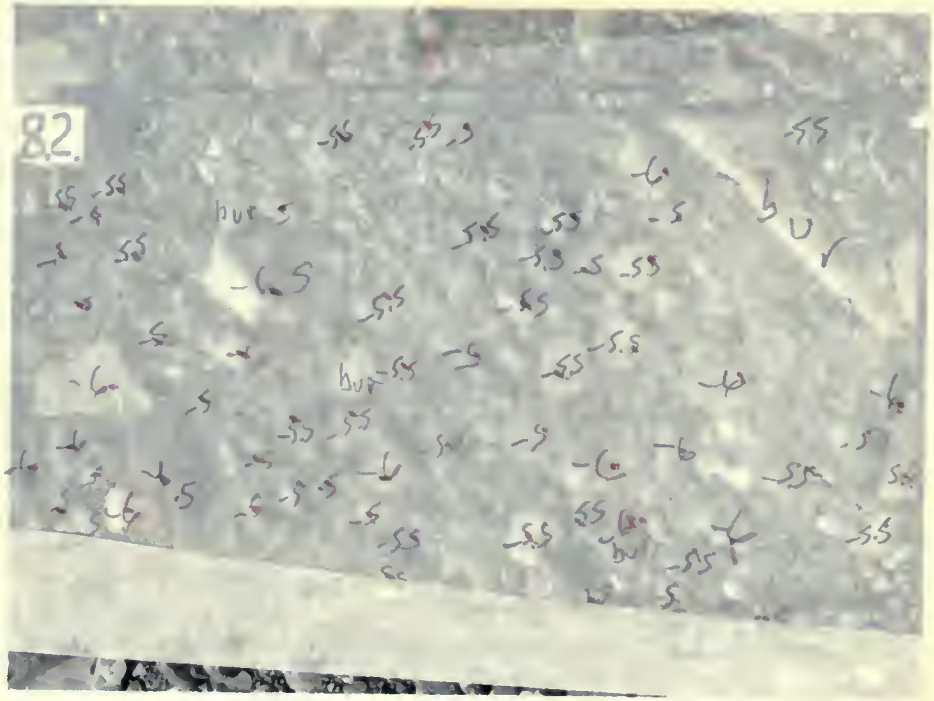
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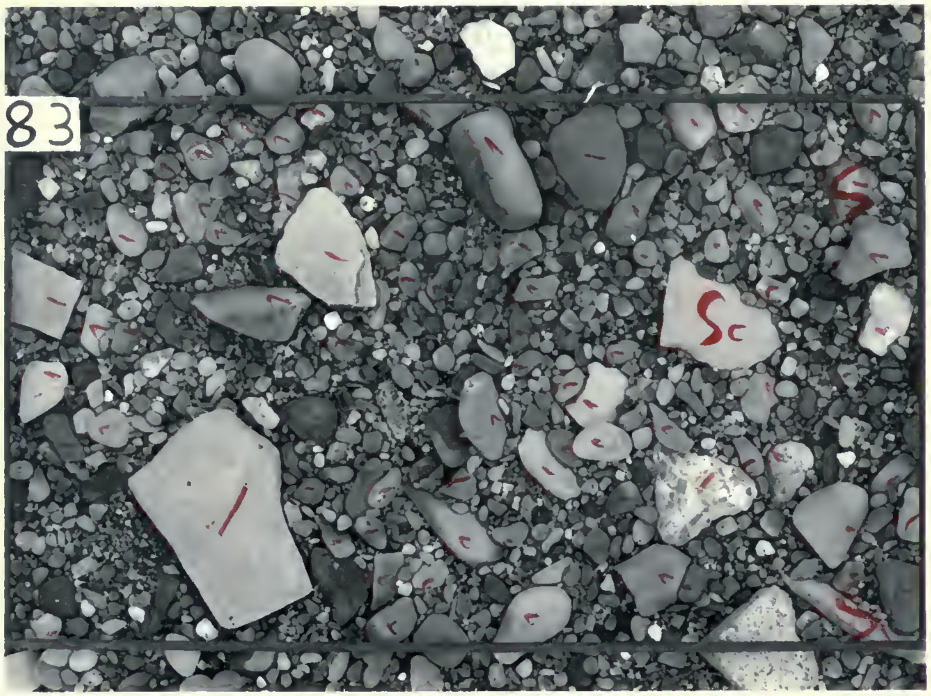
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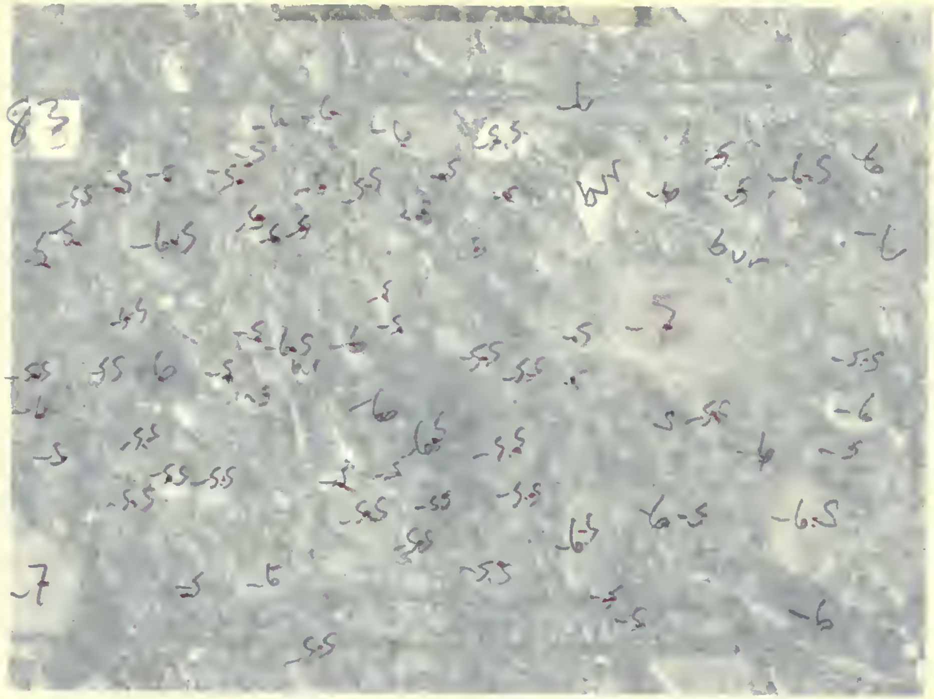
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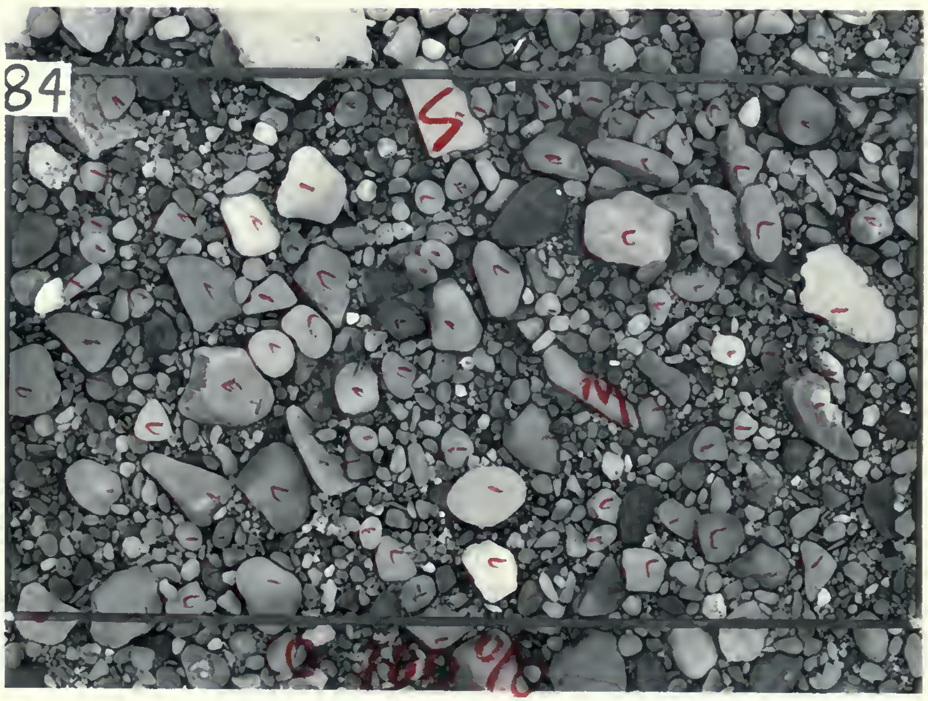
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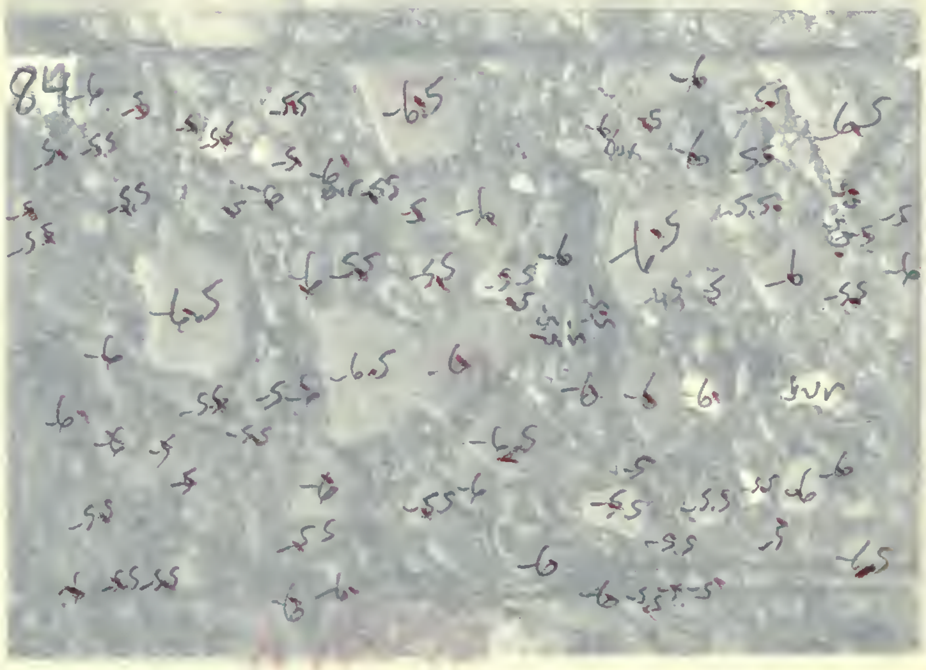
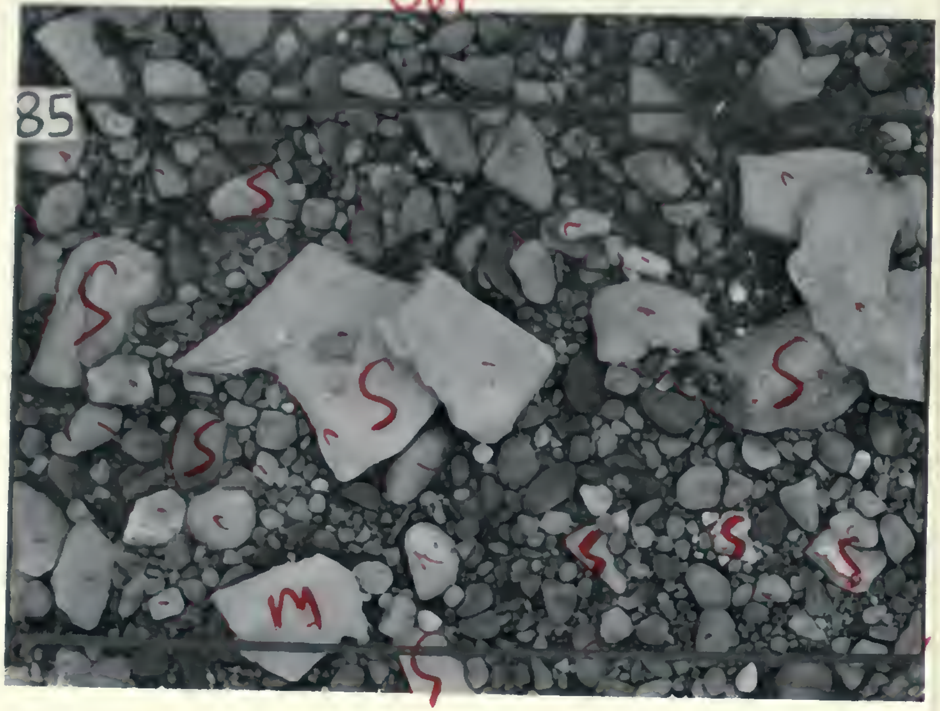
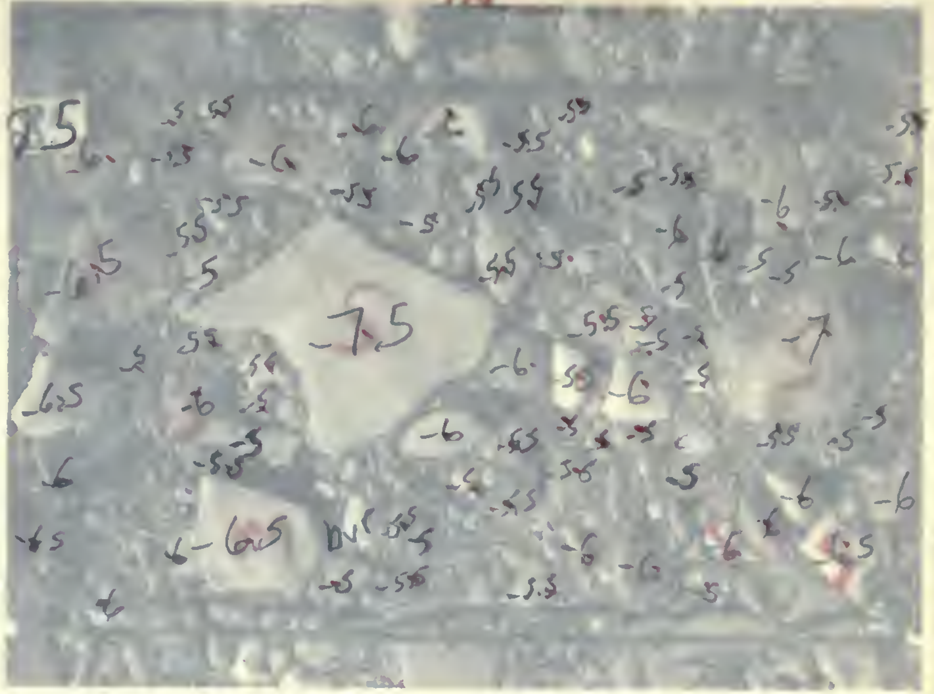
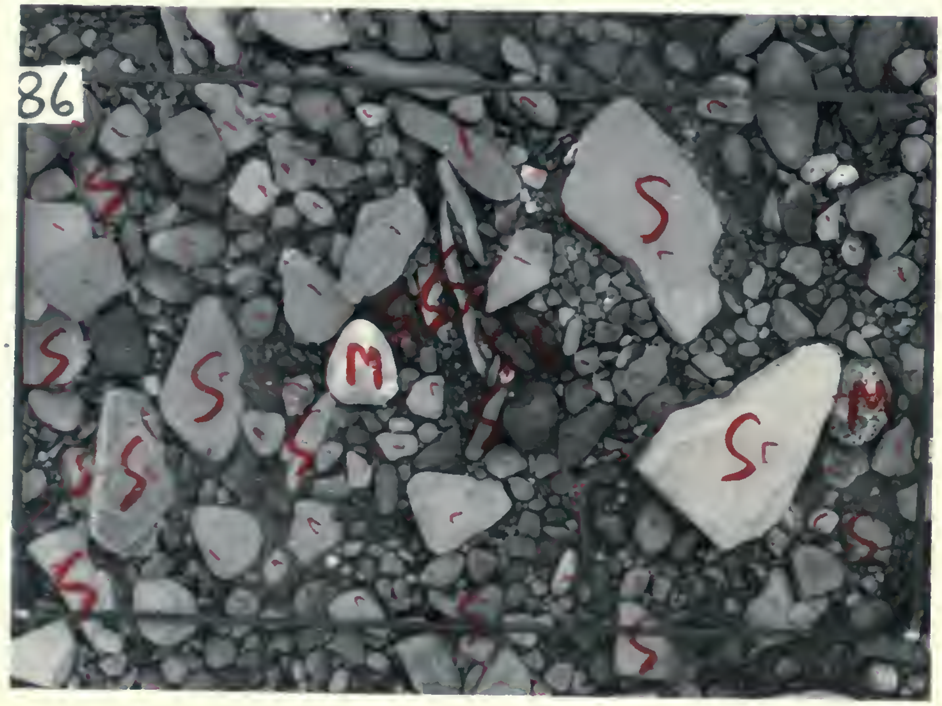

84

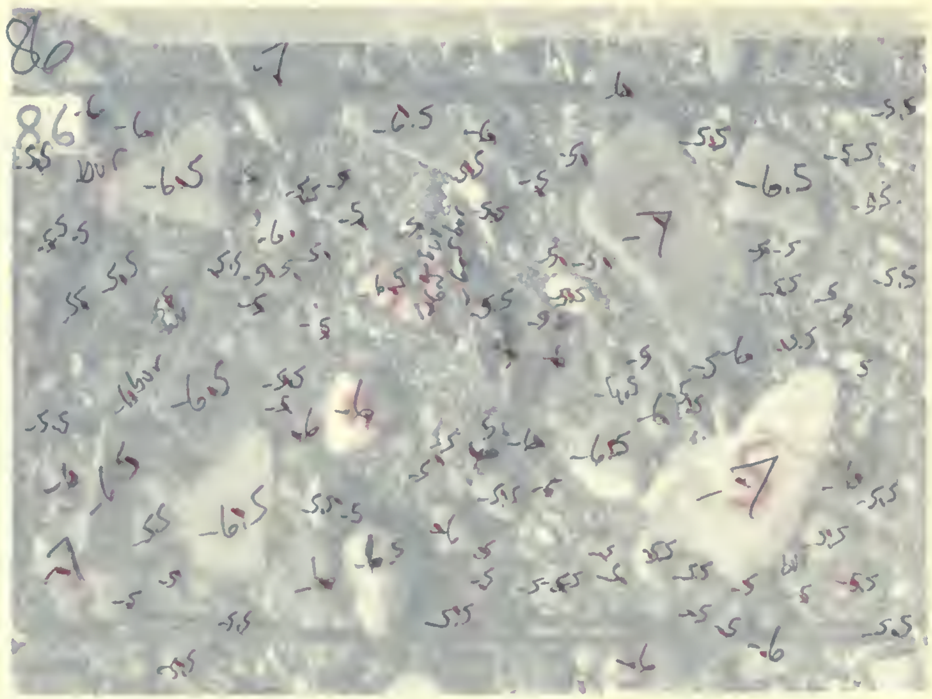
Out



IN



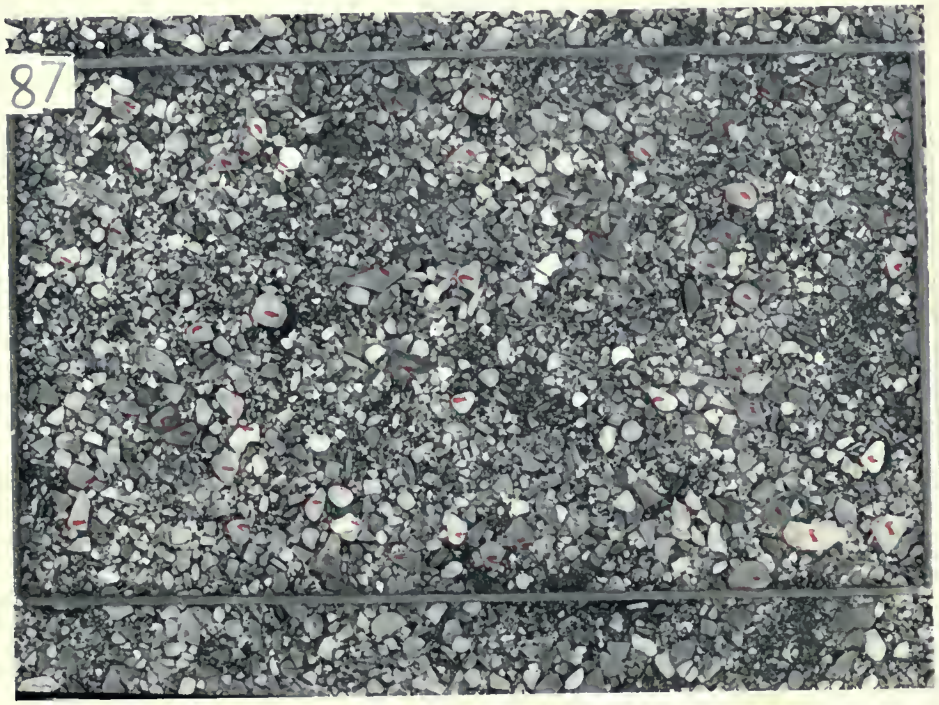


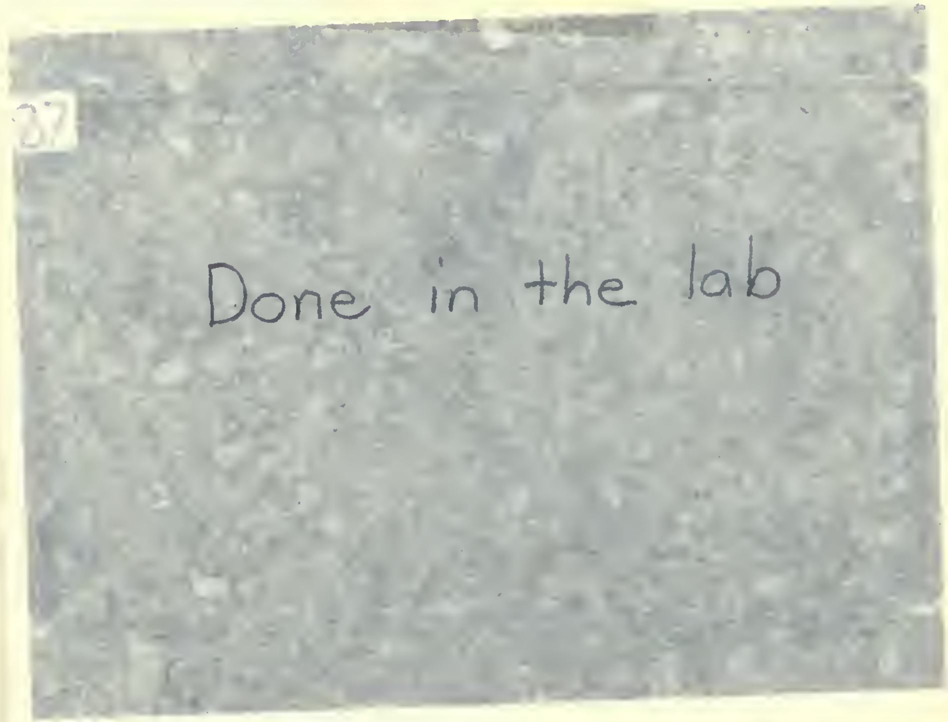


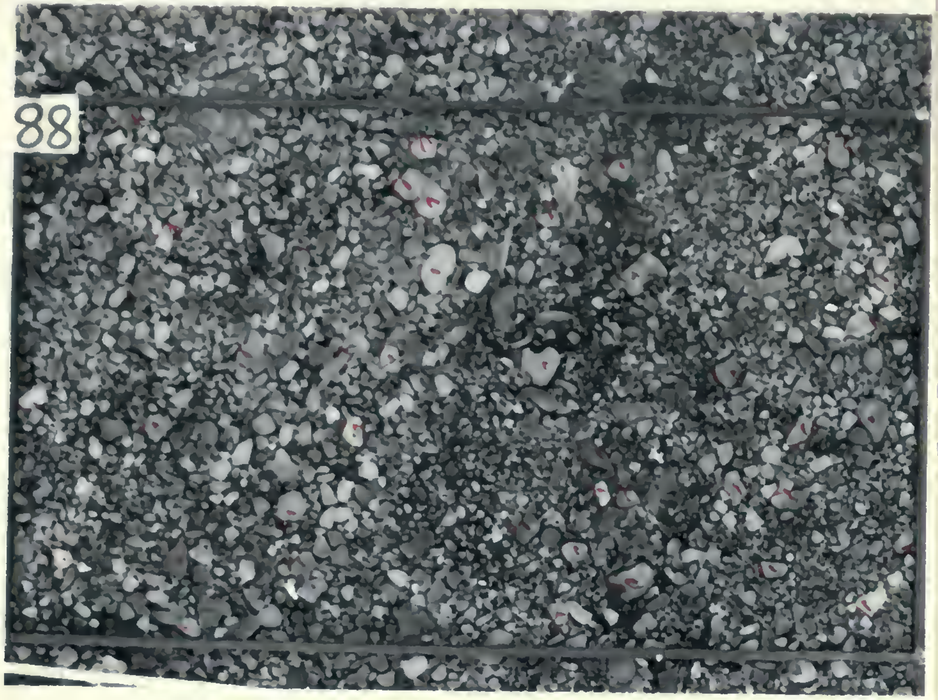
Photographs of Cazenovia Creek

Before (left side) and After (right side)

the 1982-83 Snow-melt



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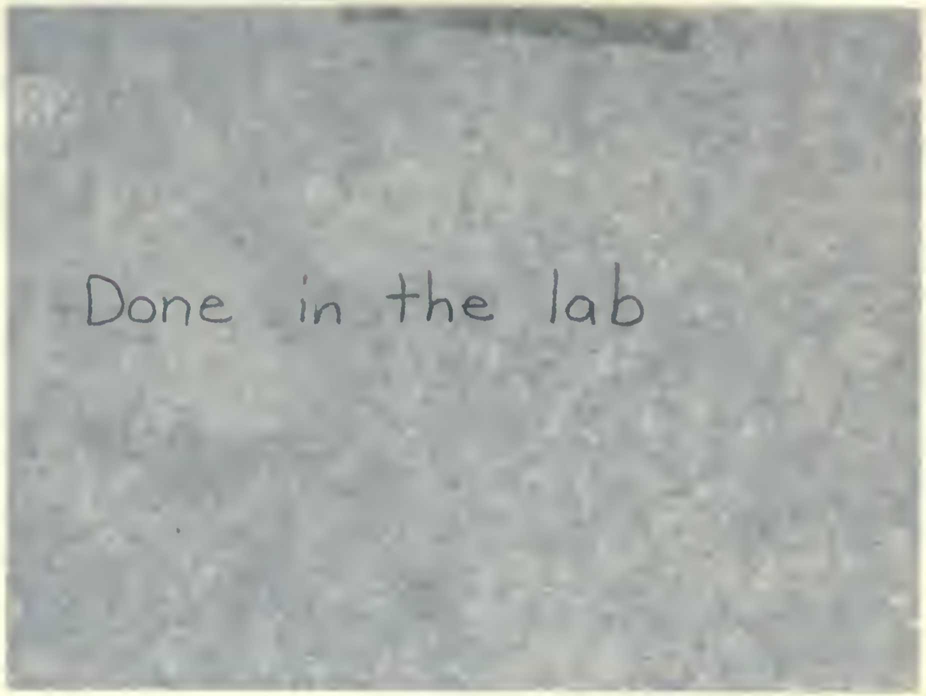
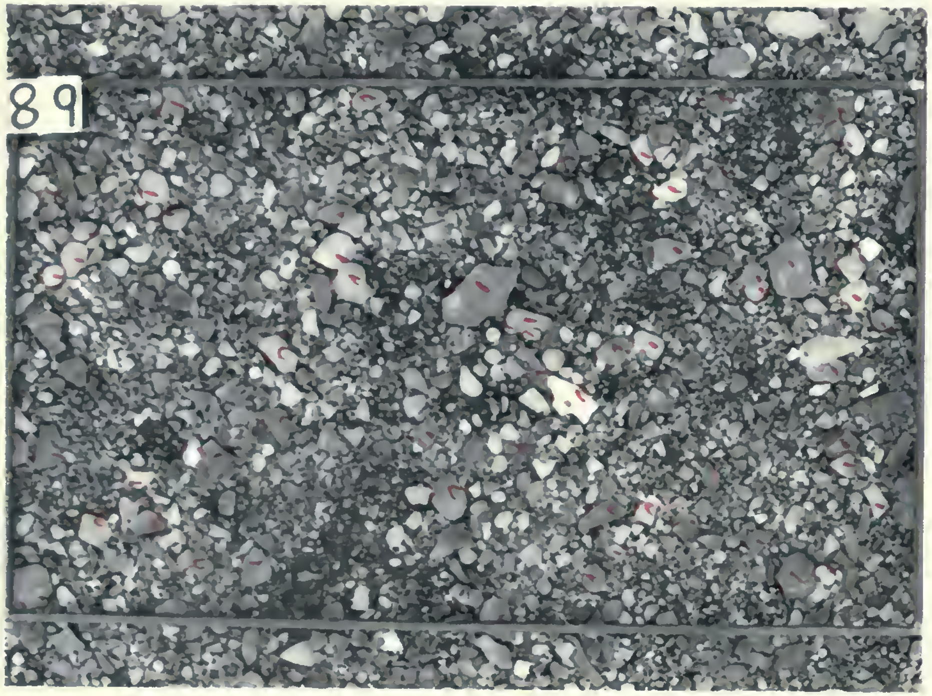

Done in the lab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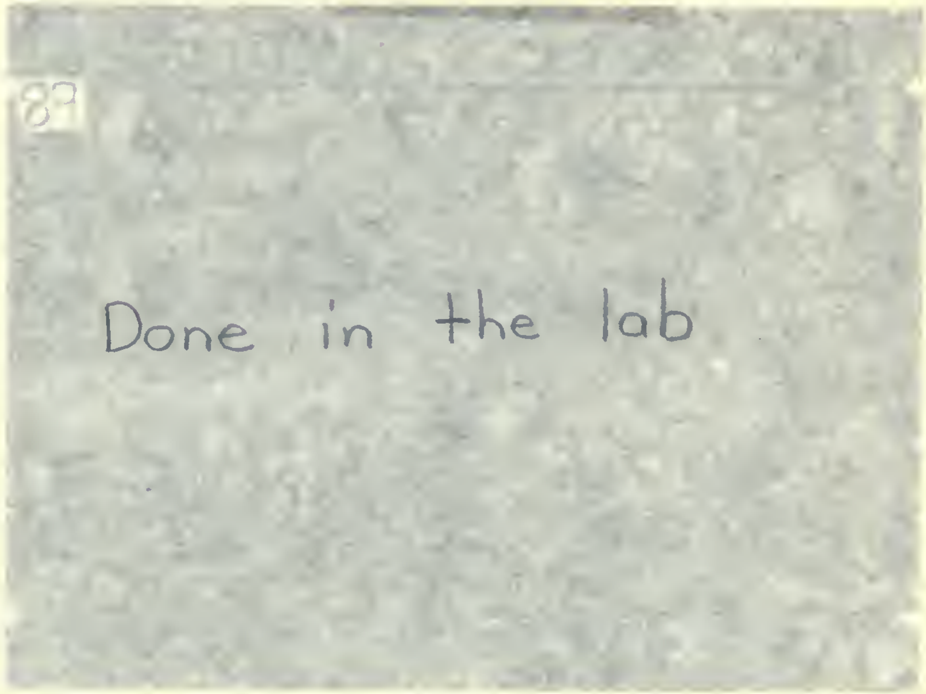
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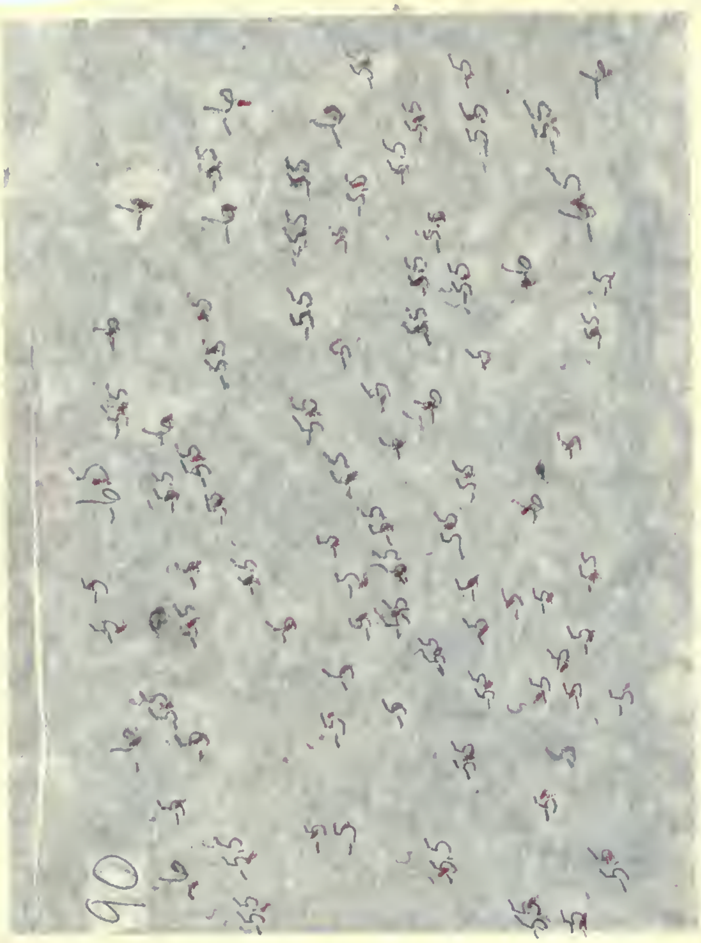

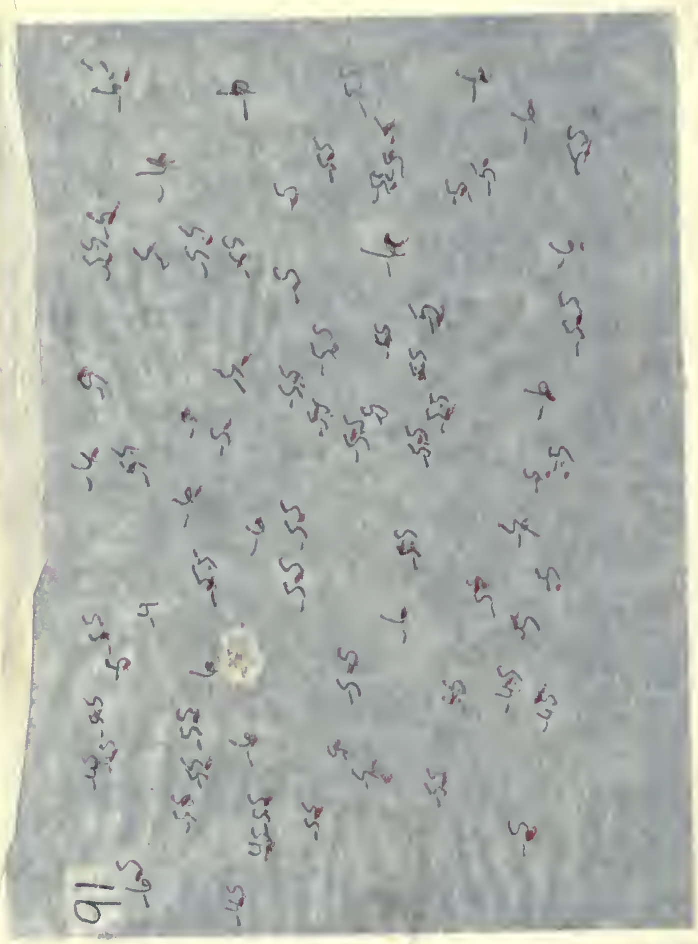

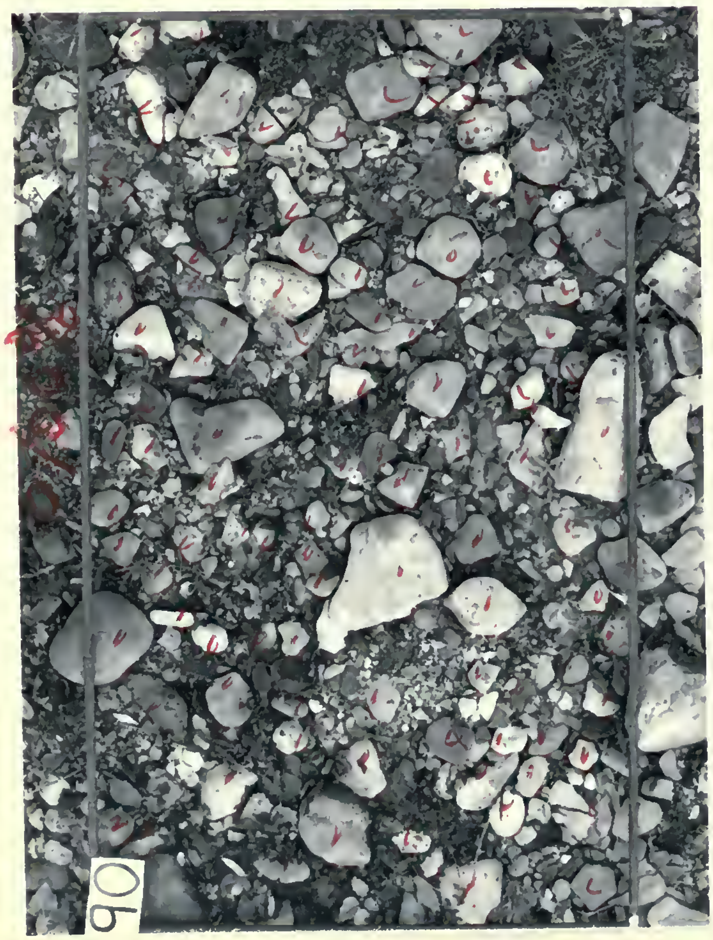

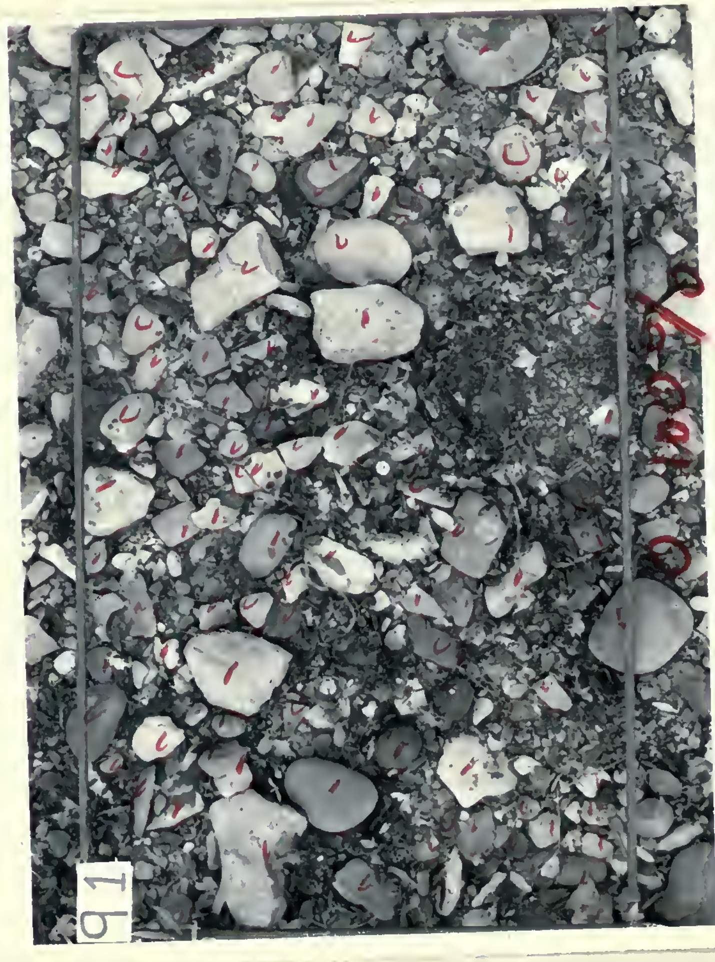

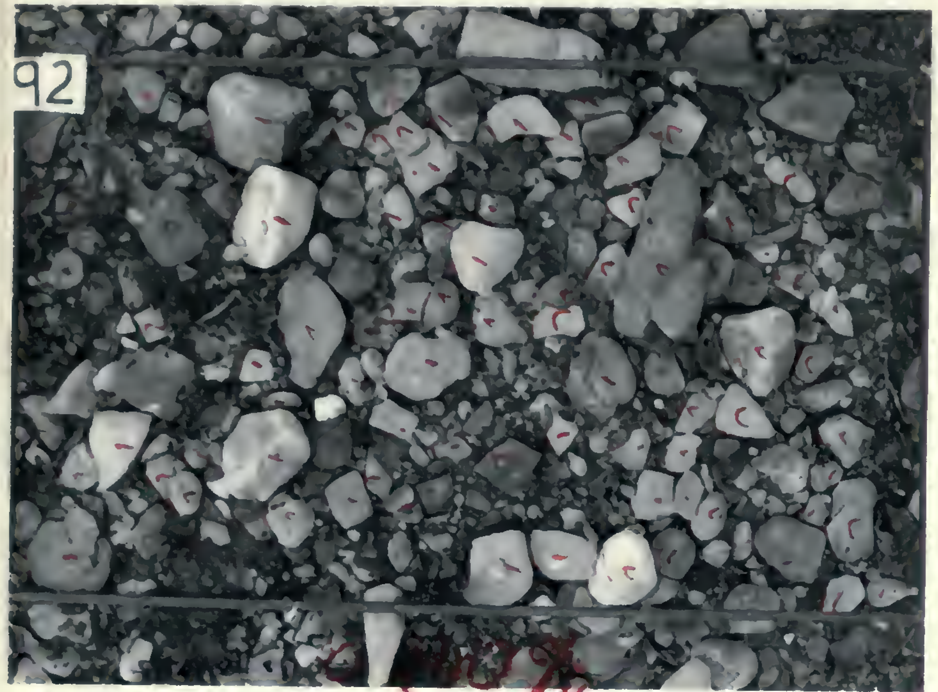

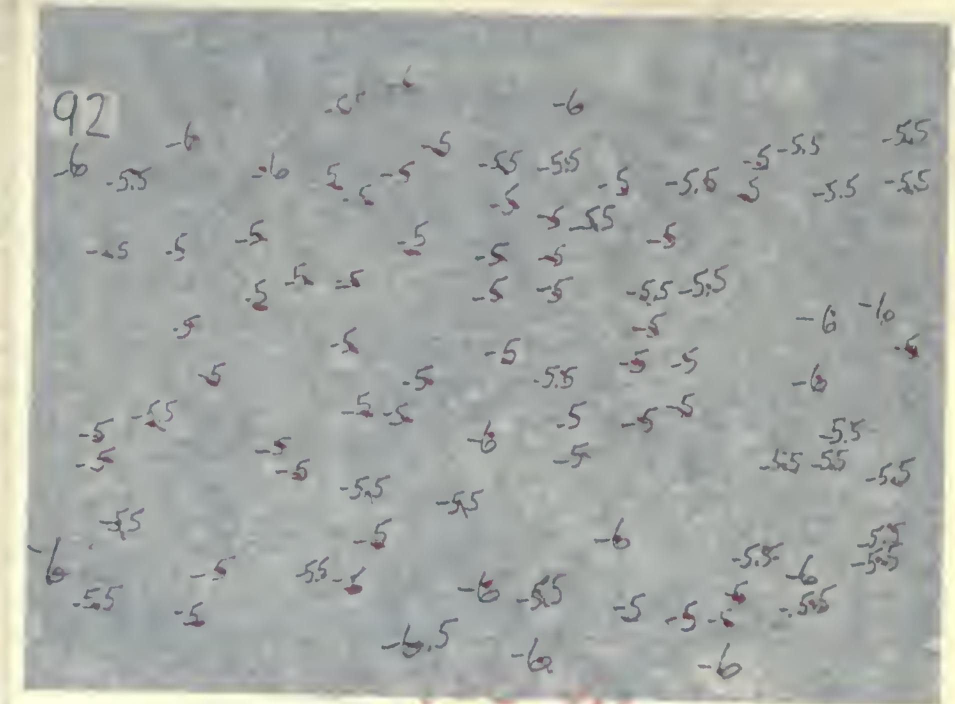

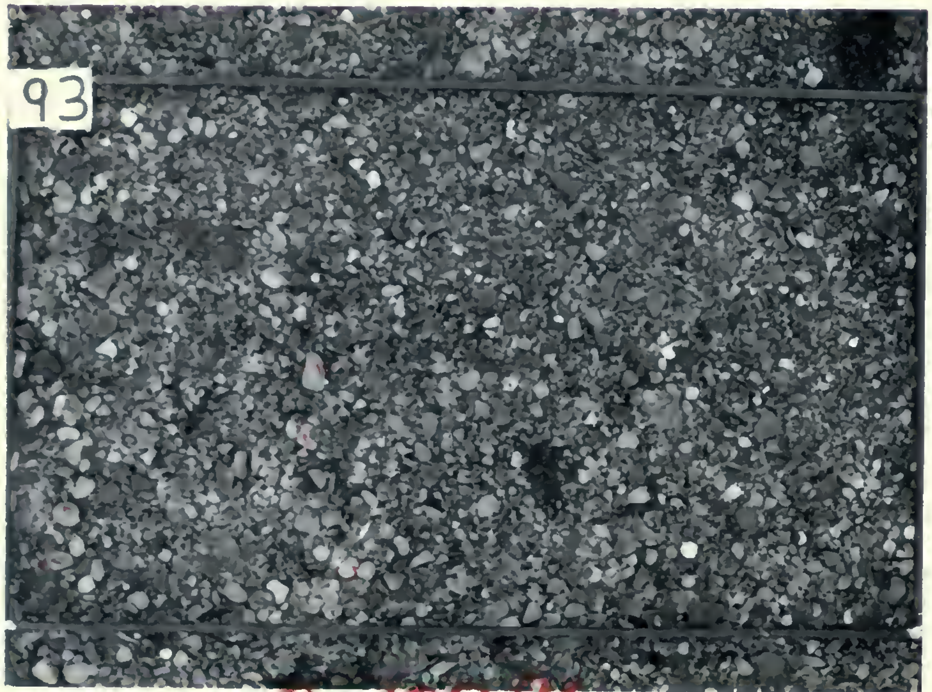

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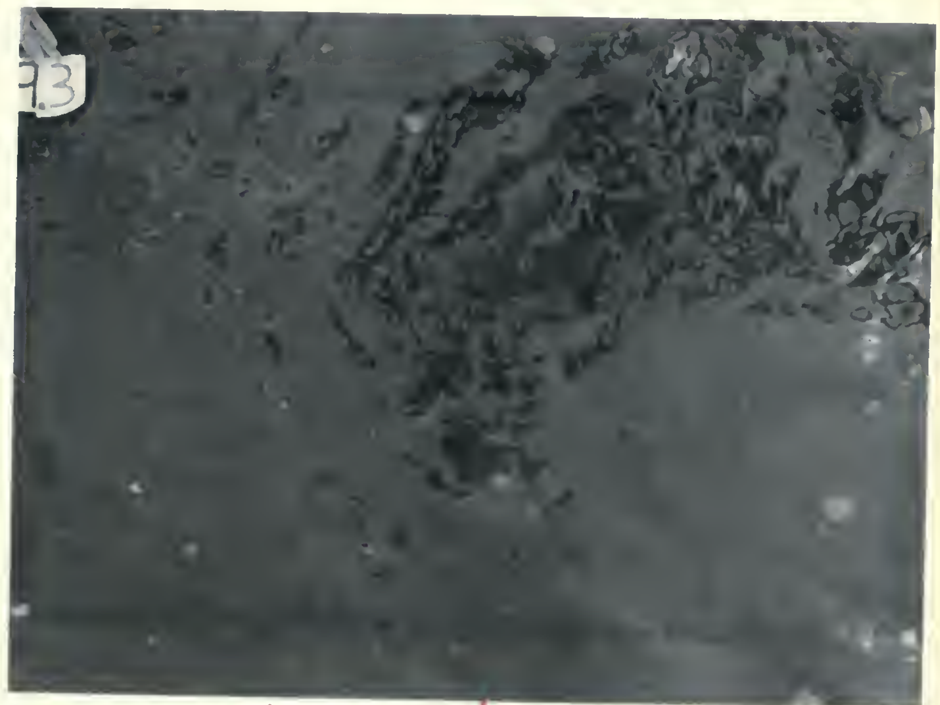
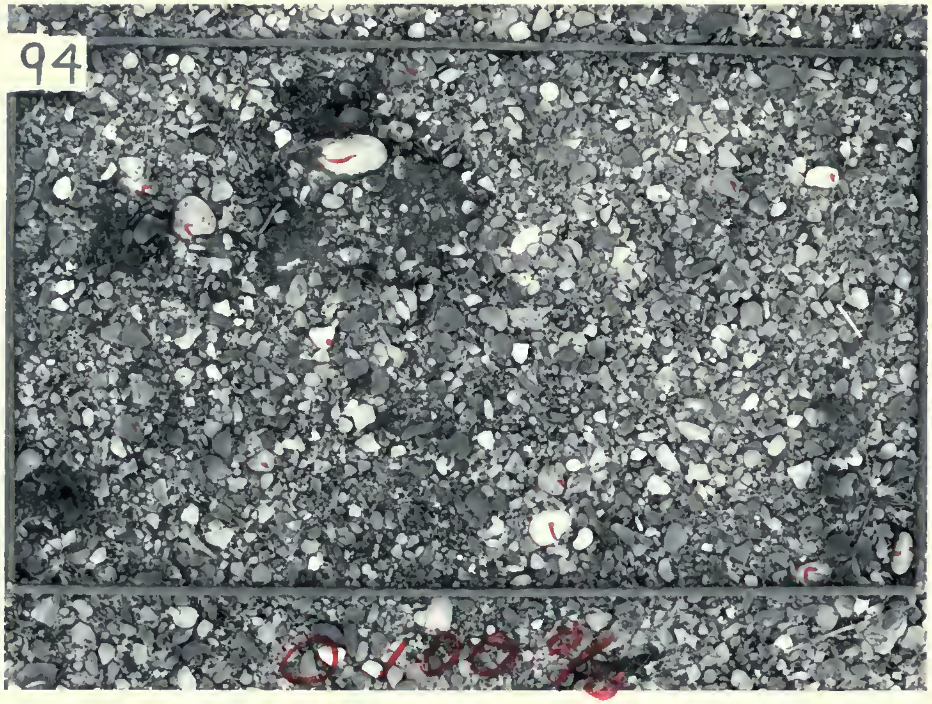
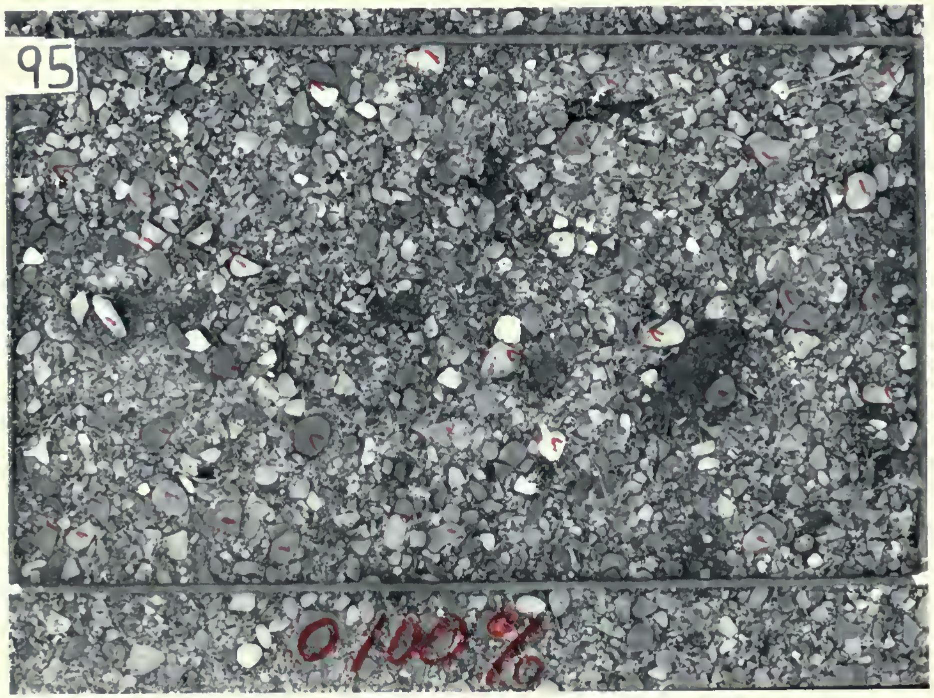
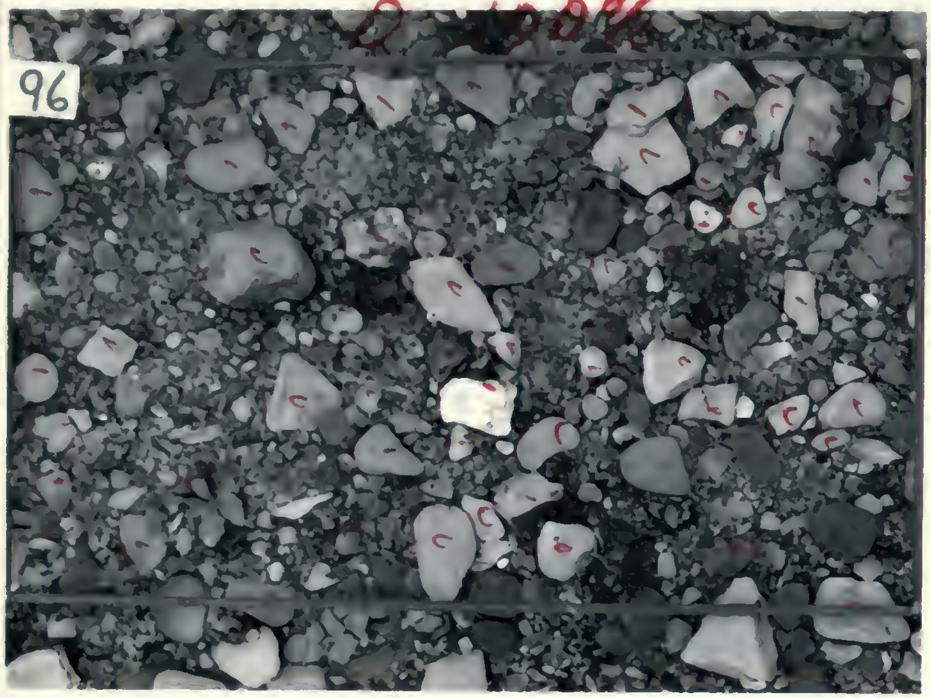


only bedrock



Only Bedrock visible

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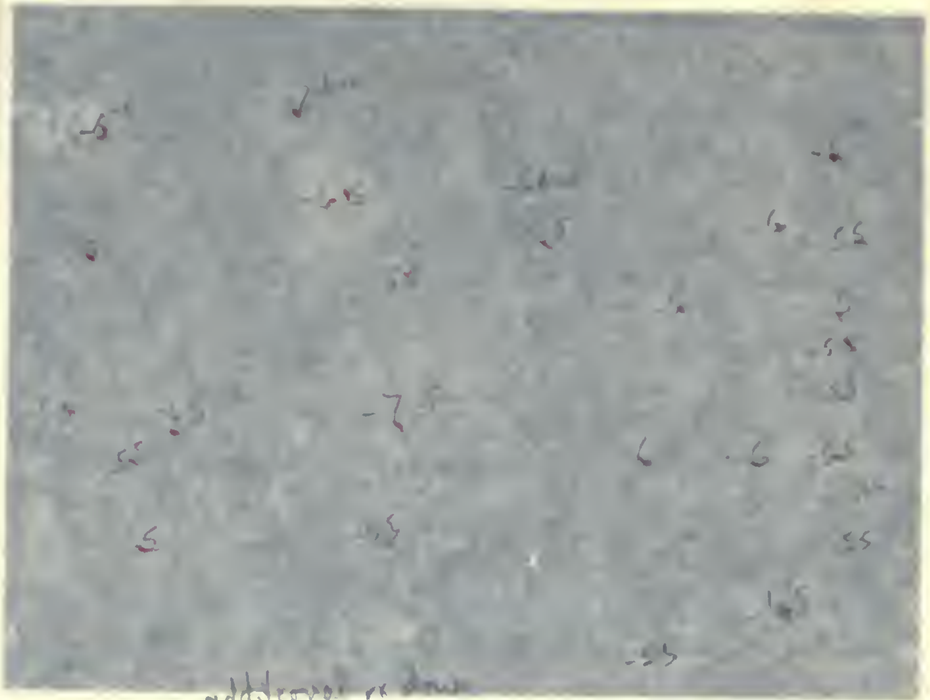

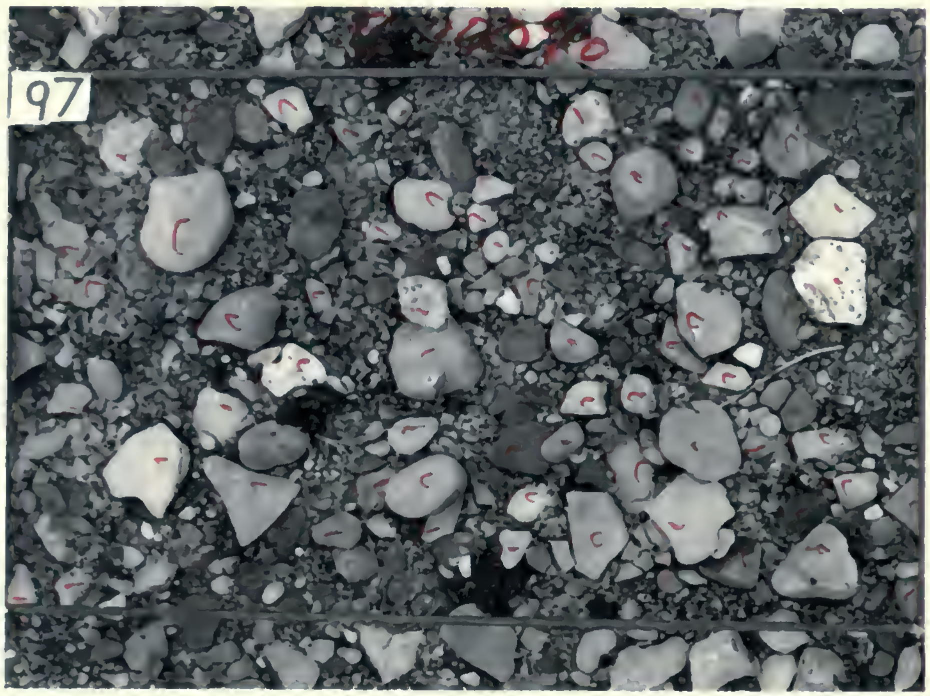
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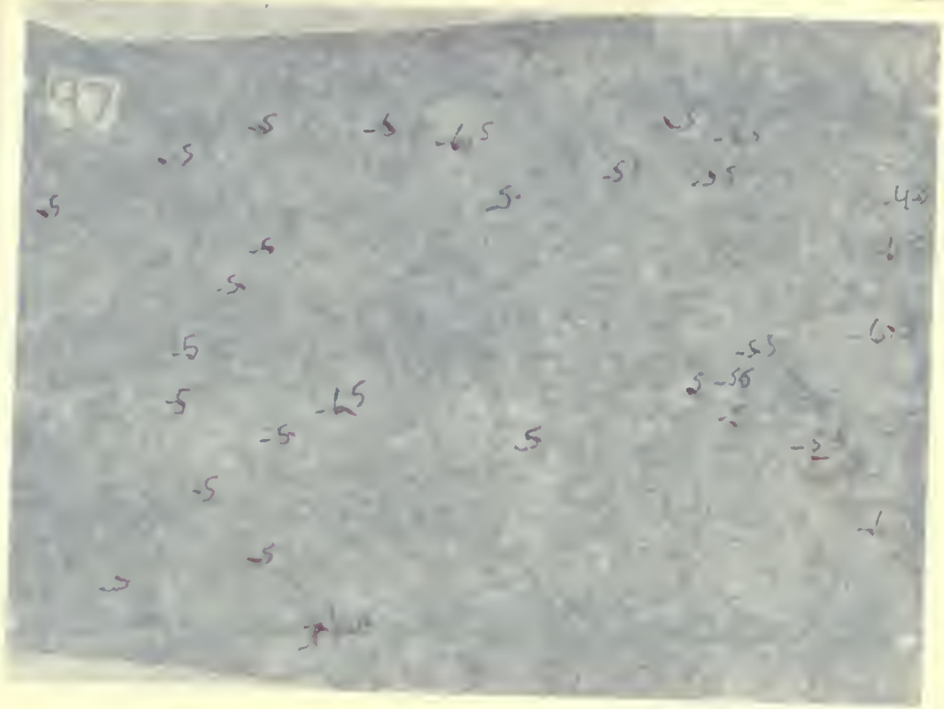

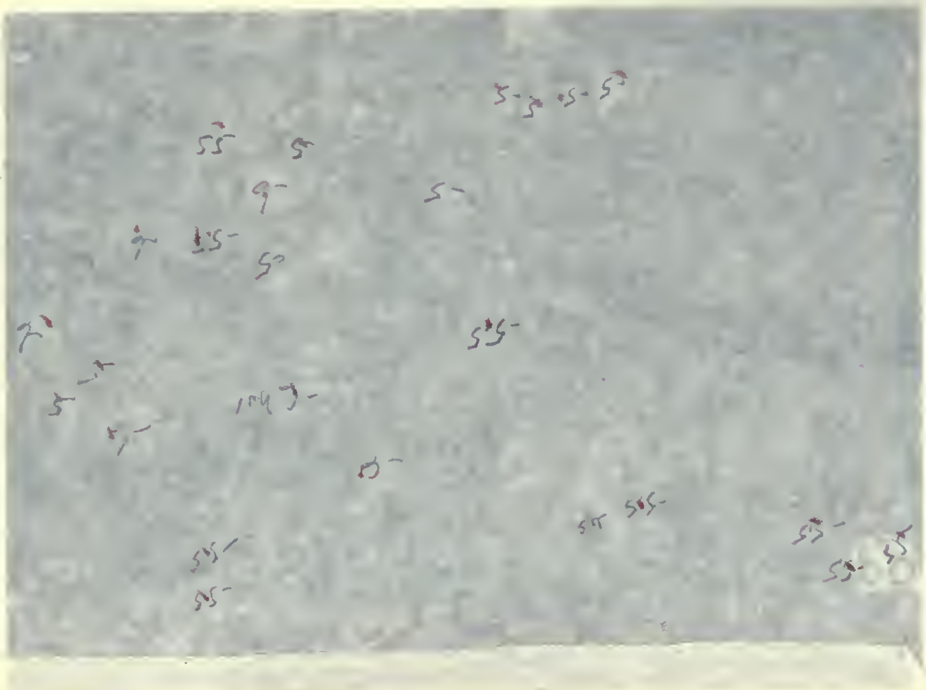

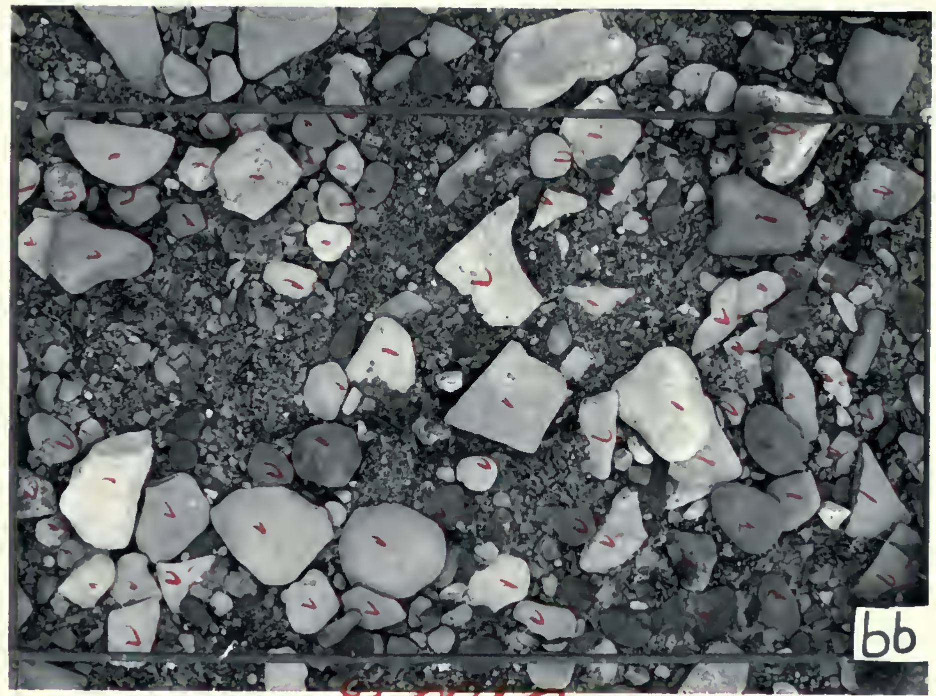
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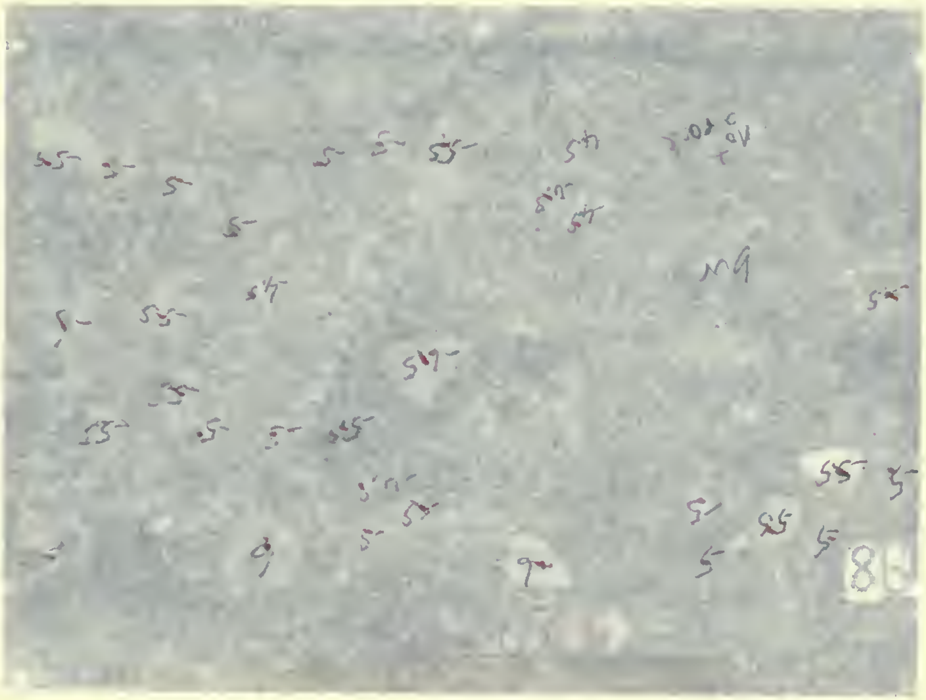

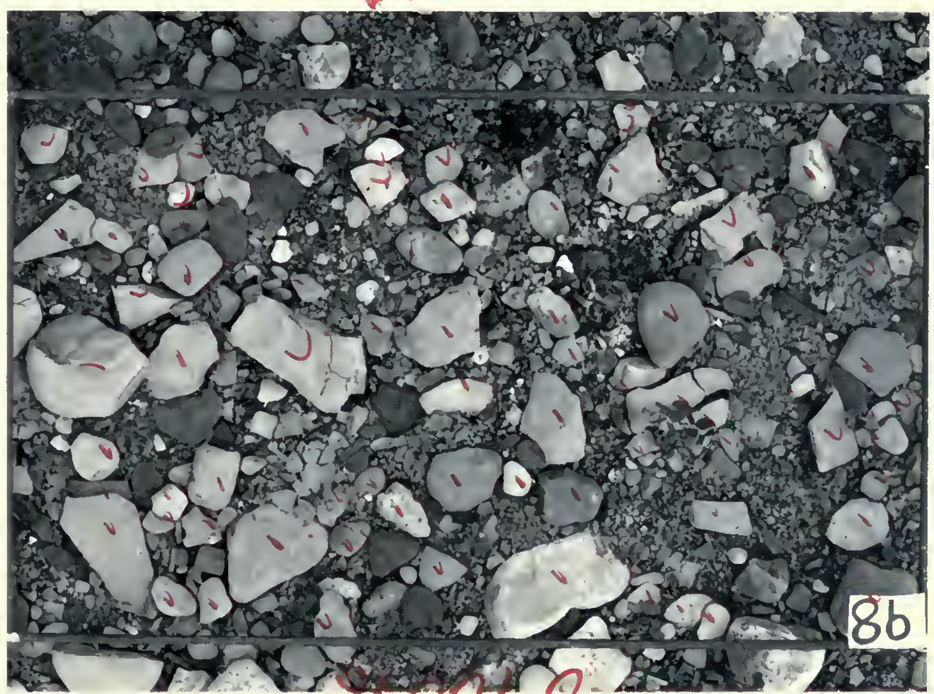
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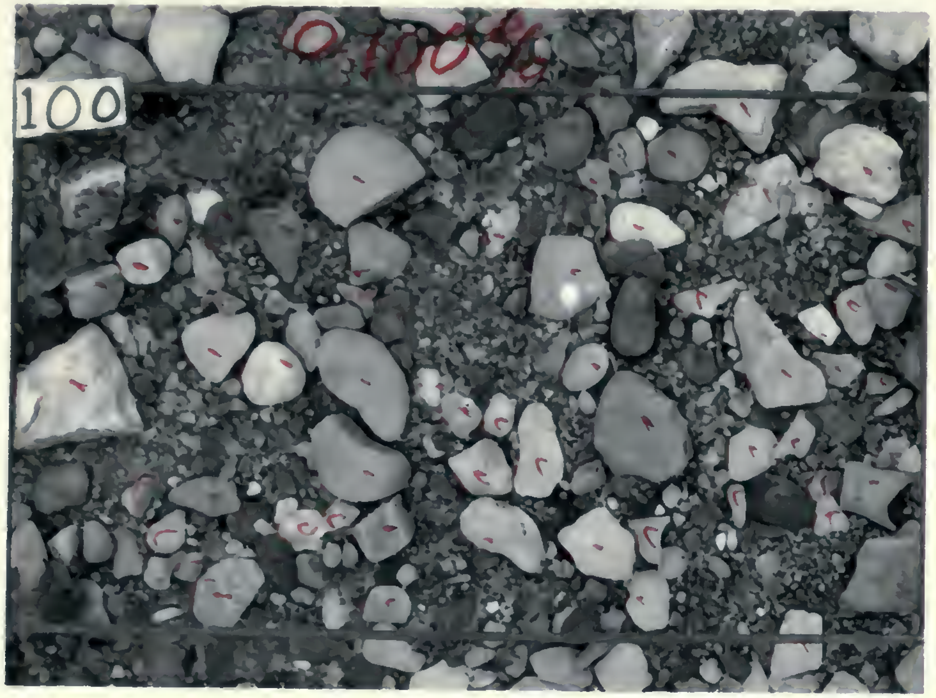
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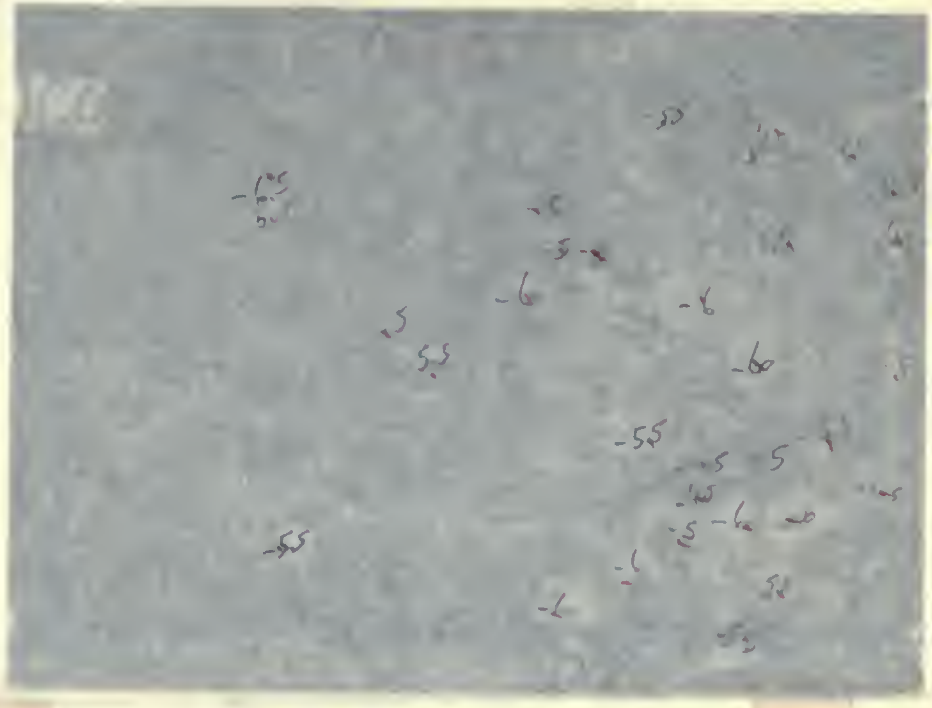

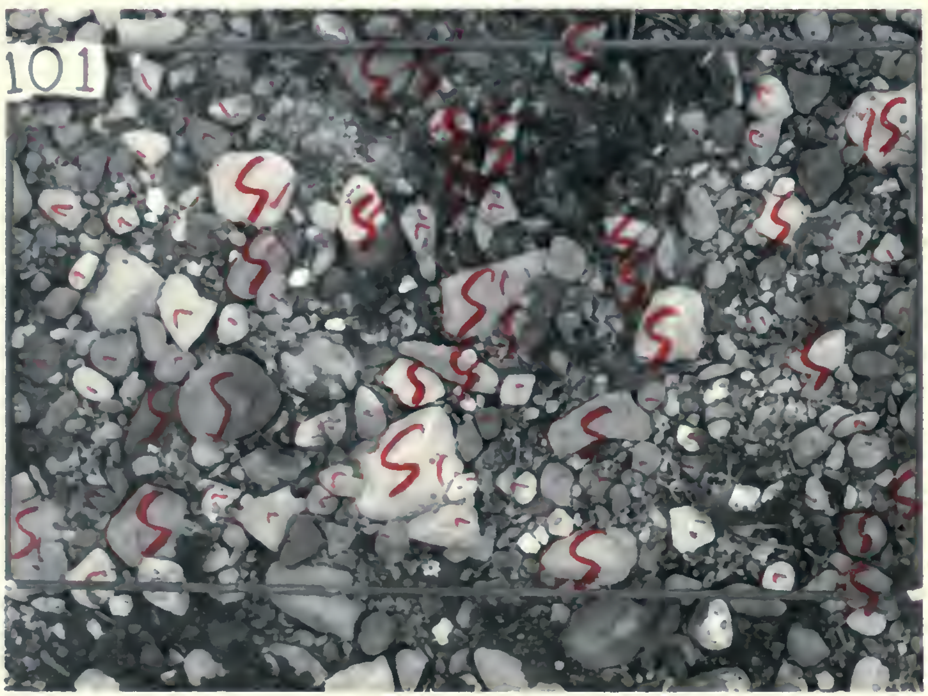
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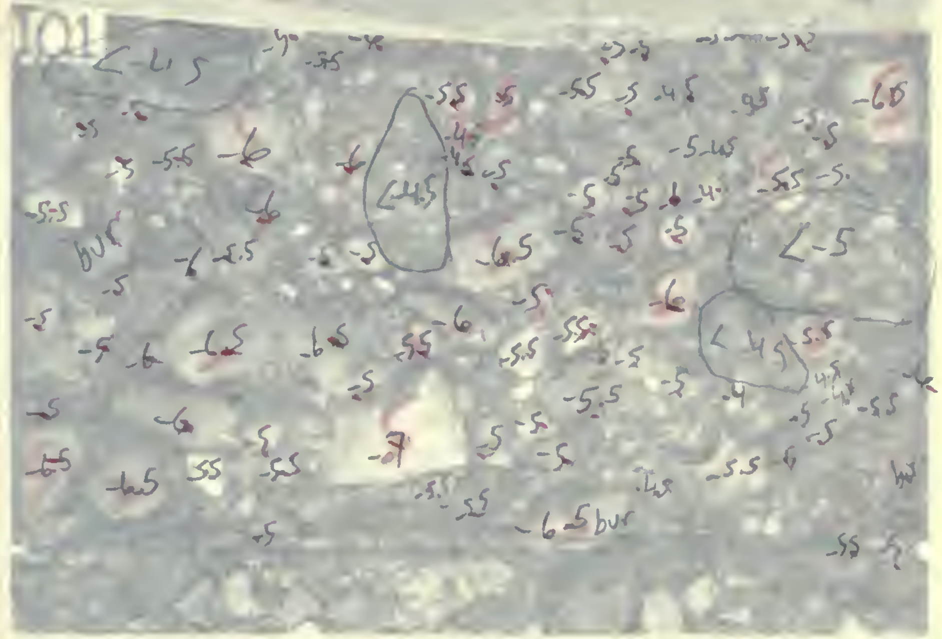
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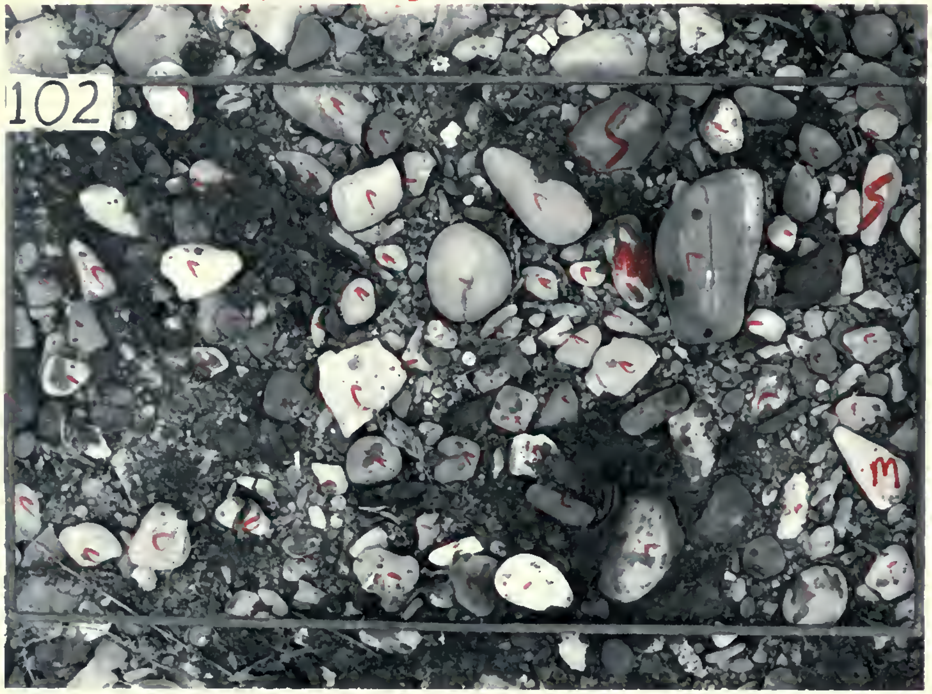
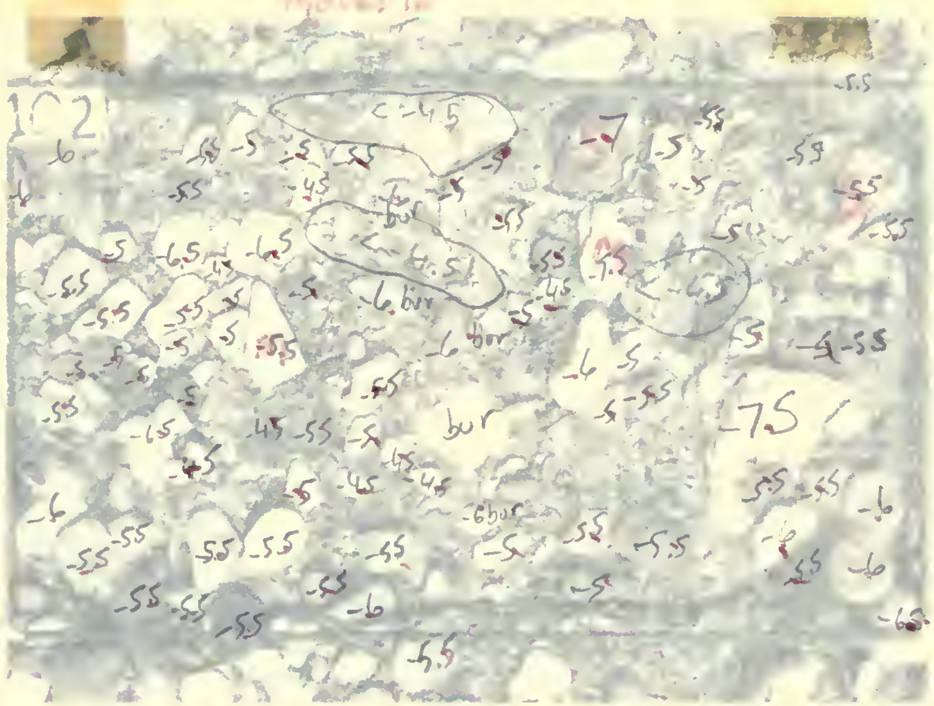
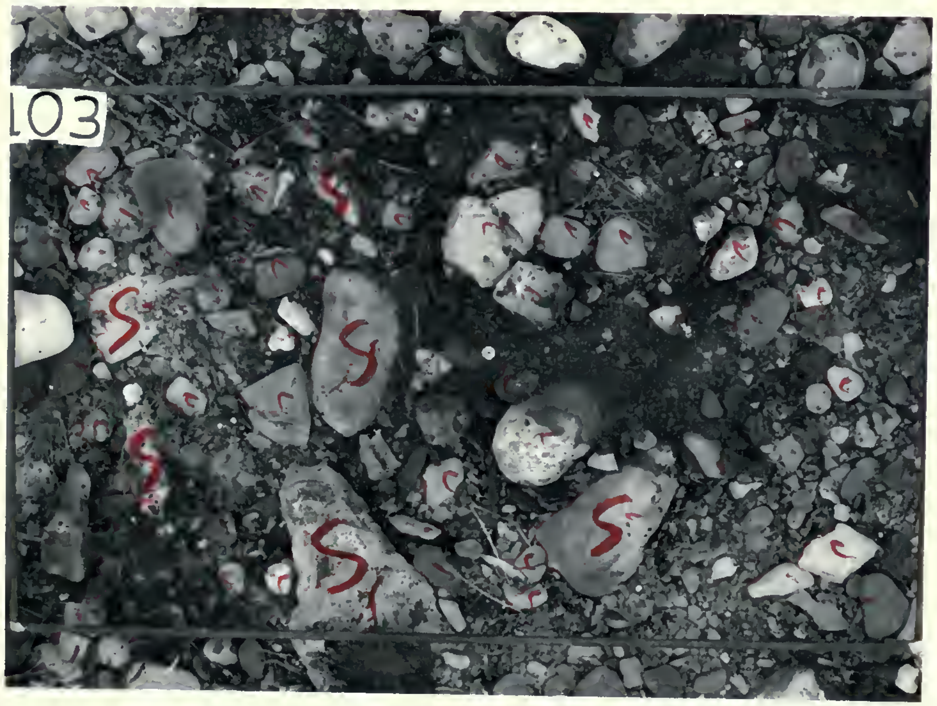
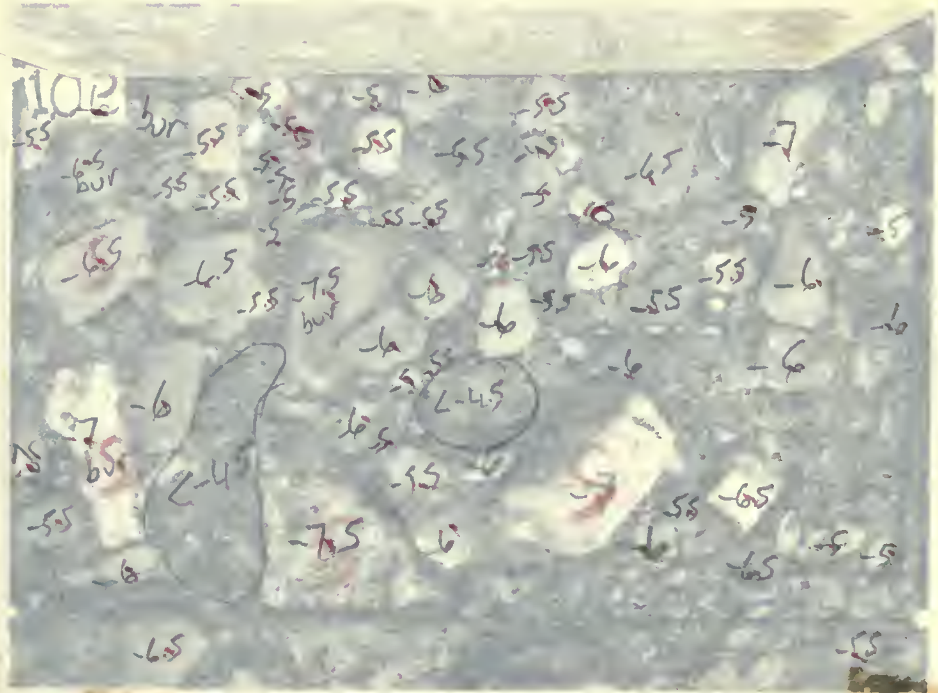
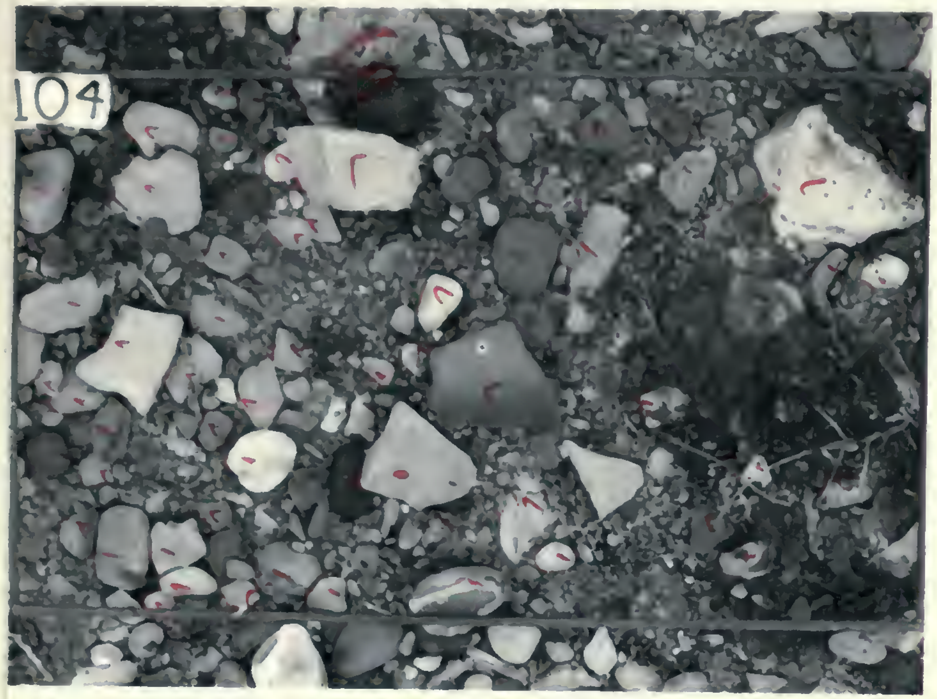
MOVED OUT







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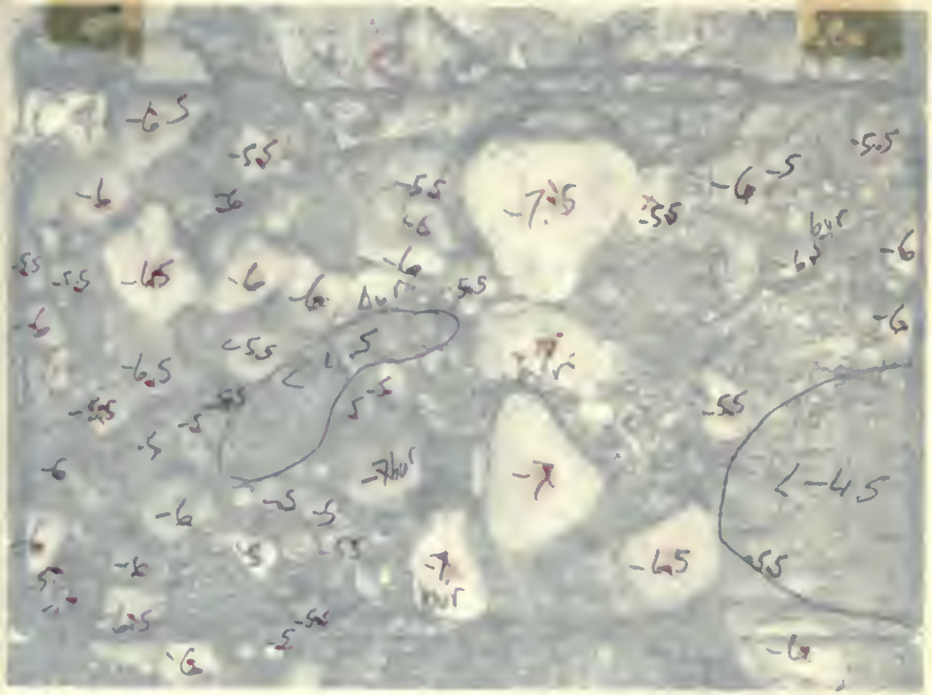

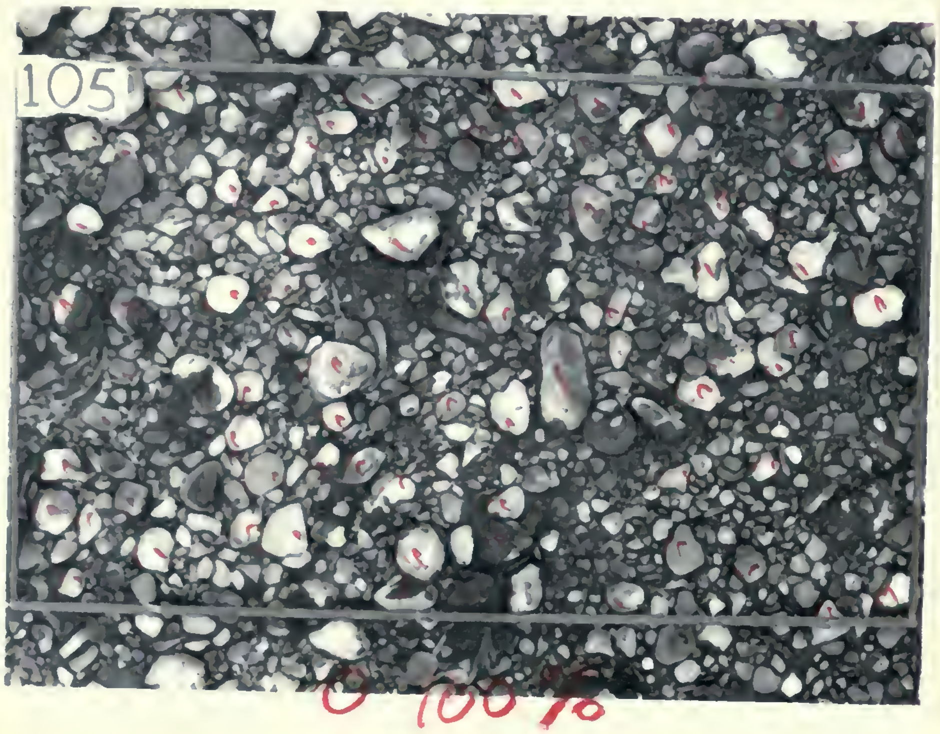
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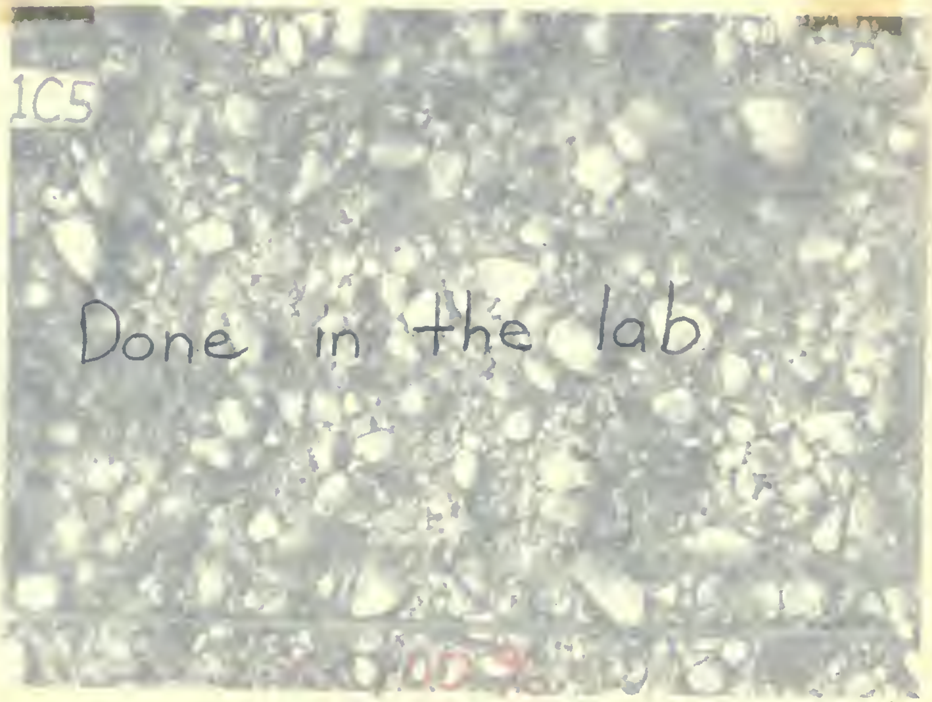
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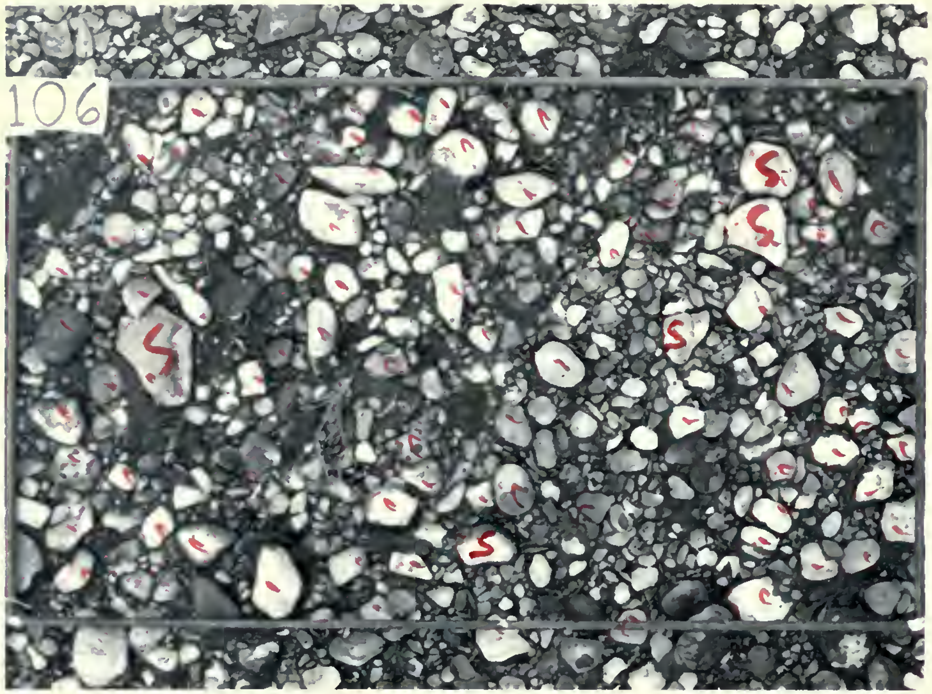
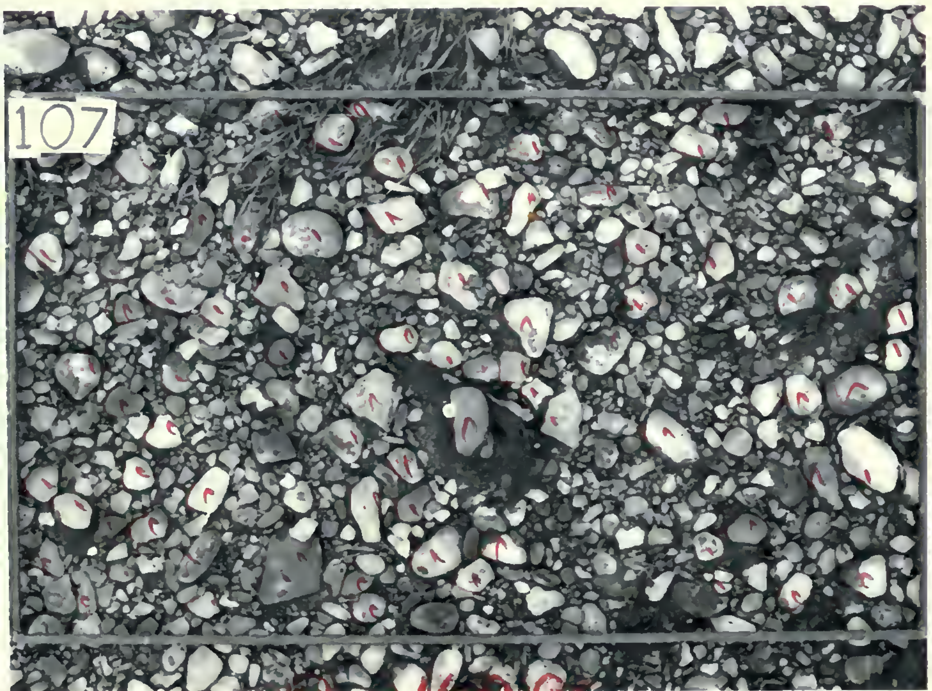
Done in the lab





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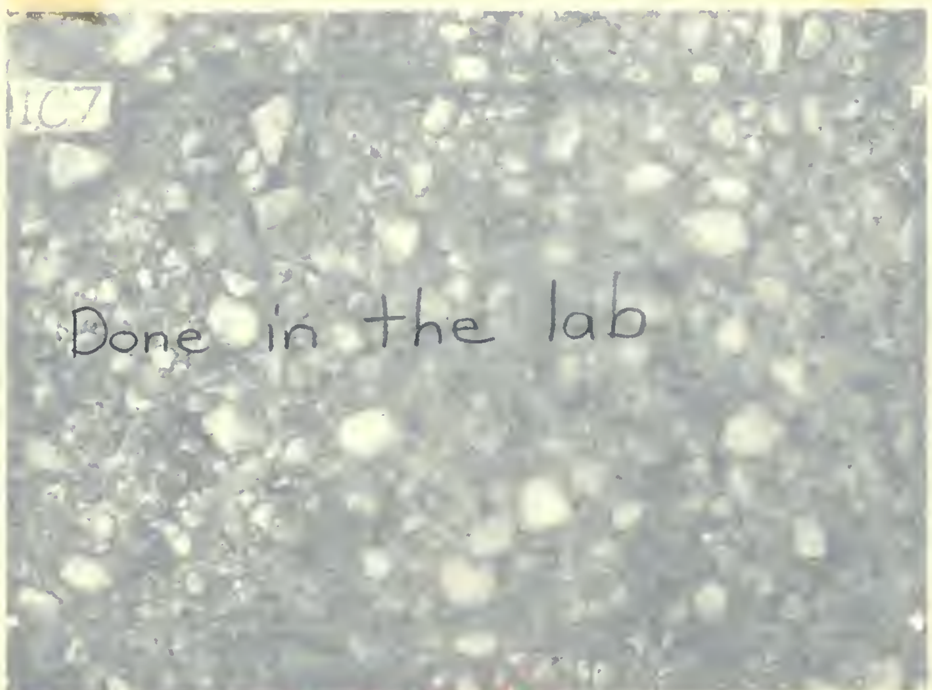


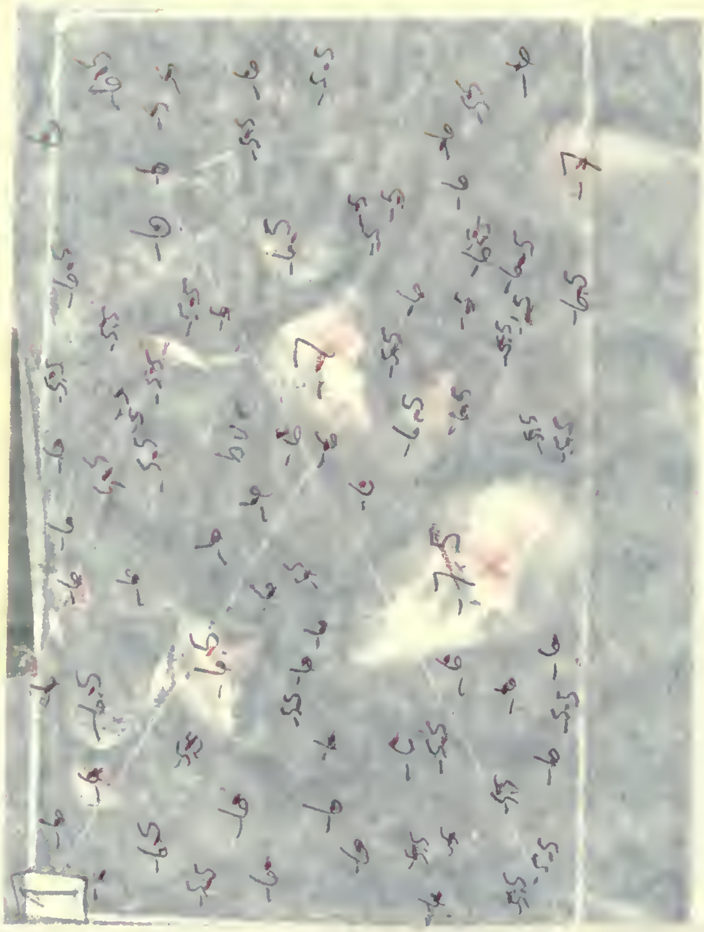
The method of taking streambed photographs. Compliments of Jim Yaki.

Photographs of Twenty Mile Creek

Before and After the 1982-83

Snow-melt

Photograph Before (left side)	Photograph After (right side)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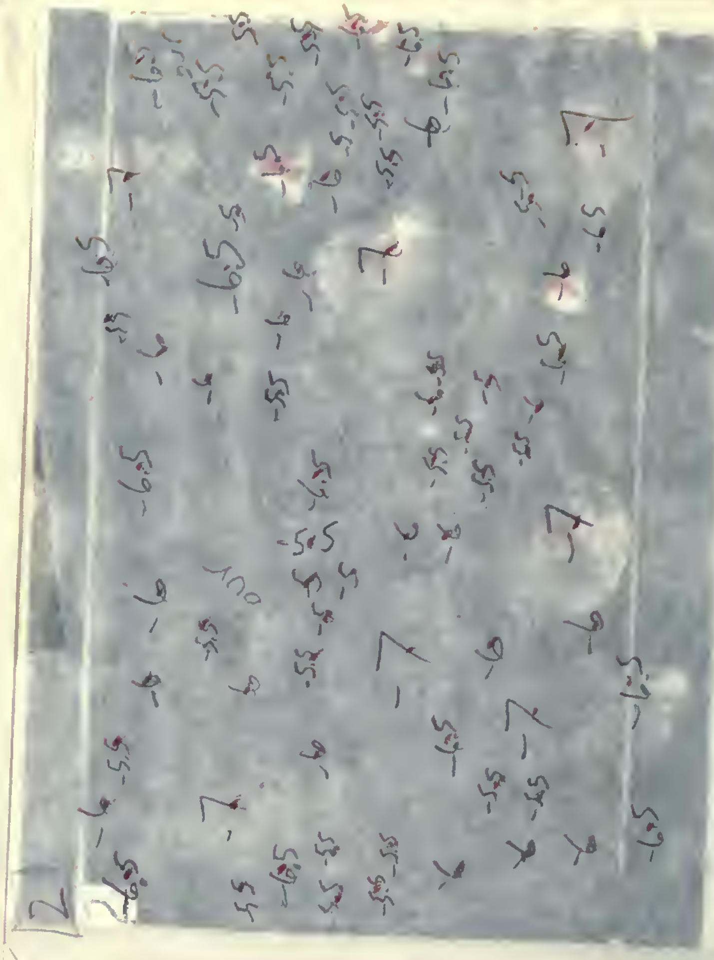
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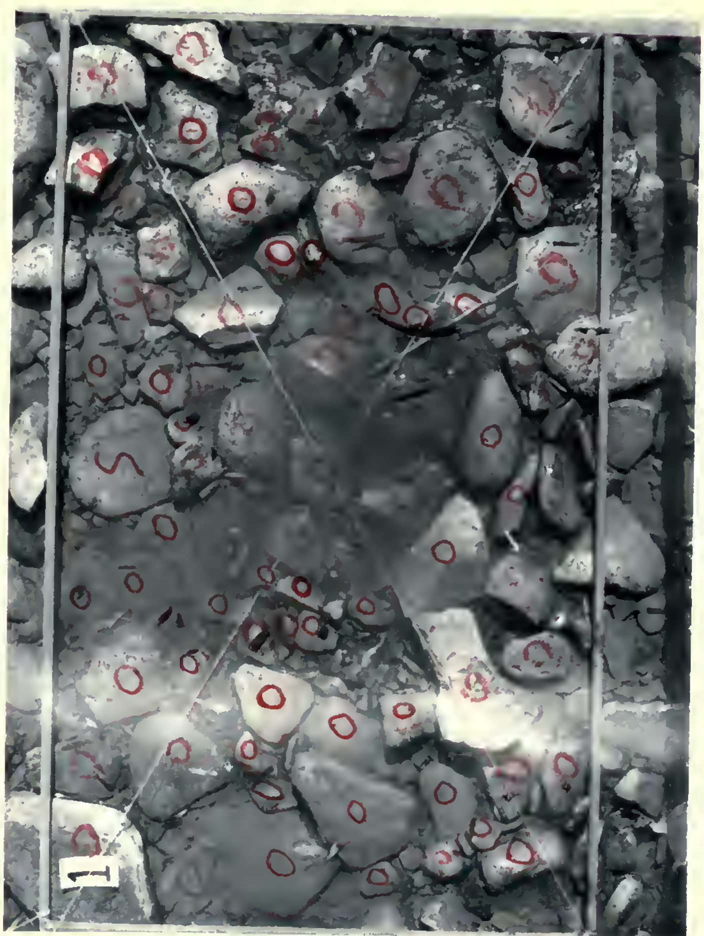
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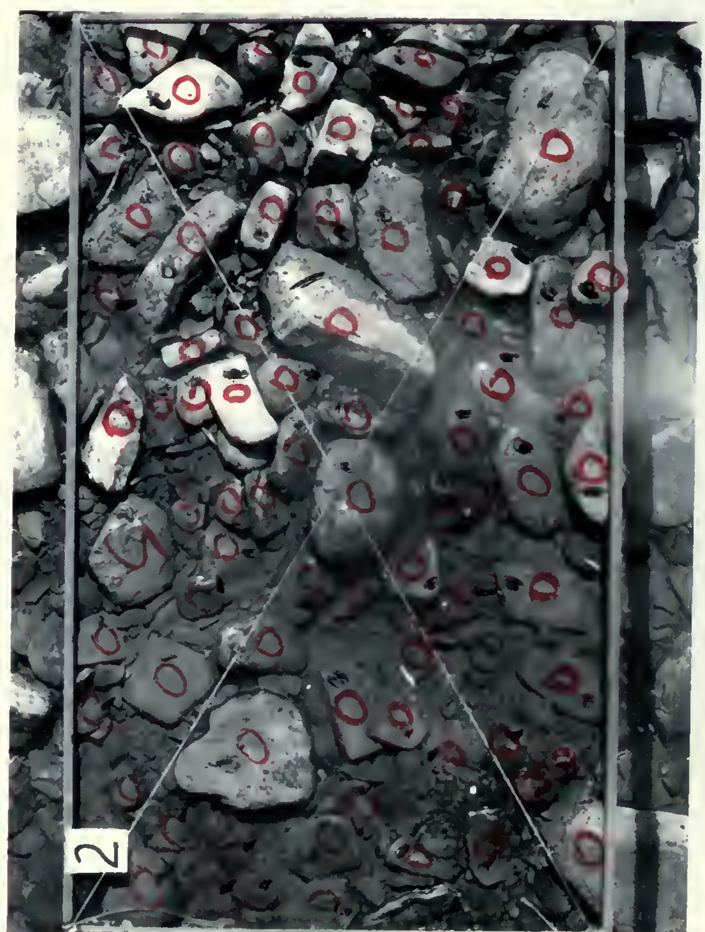
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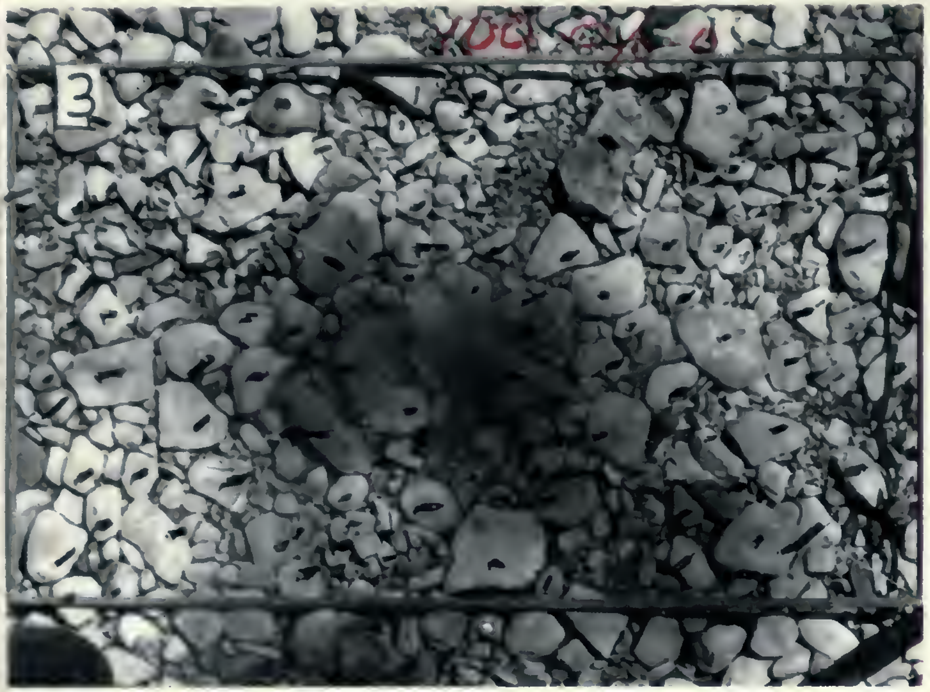
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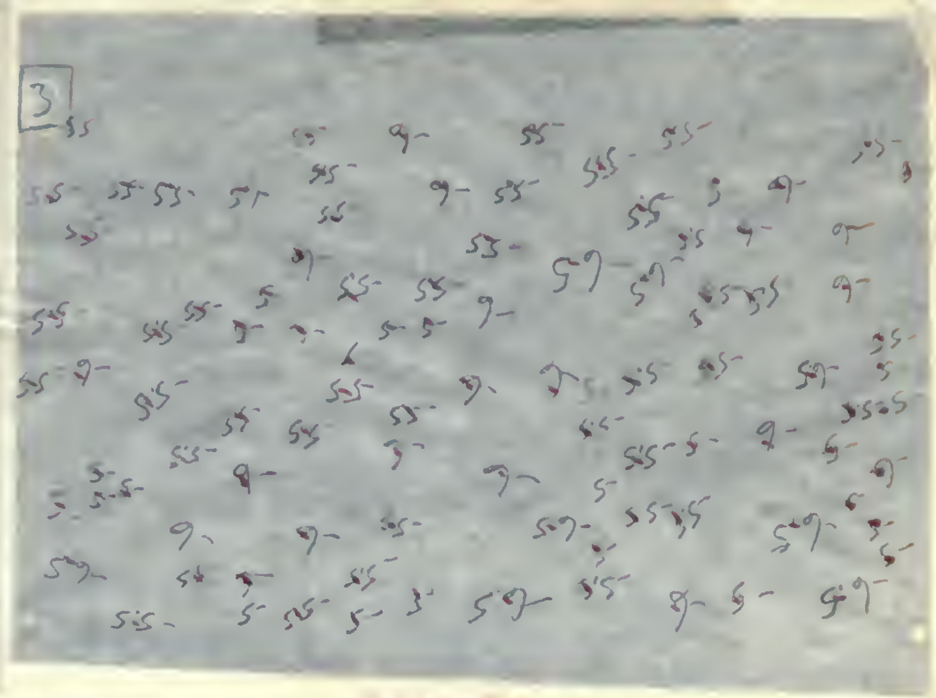
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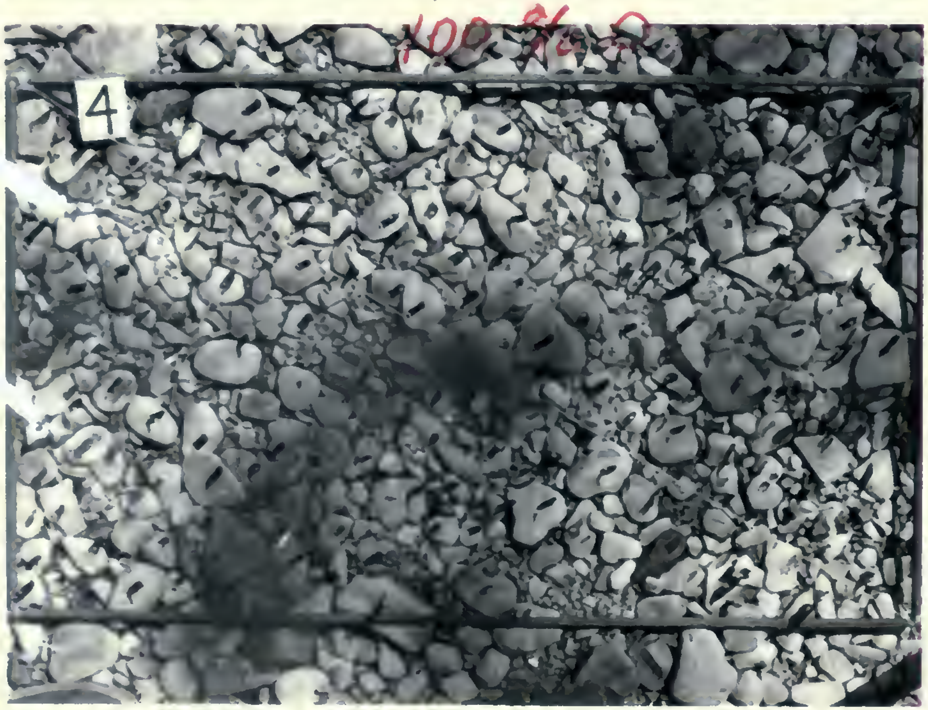
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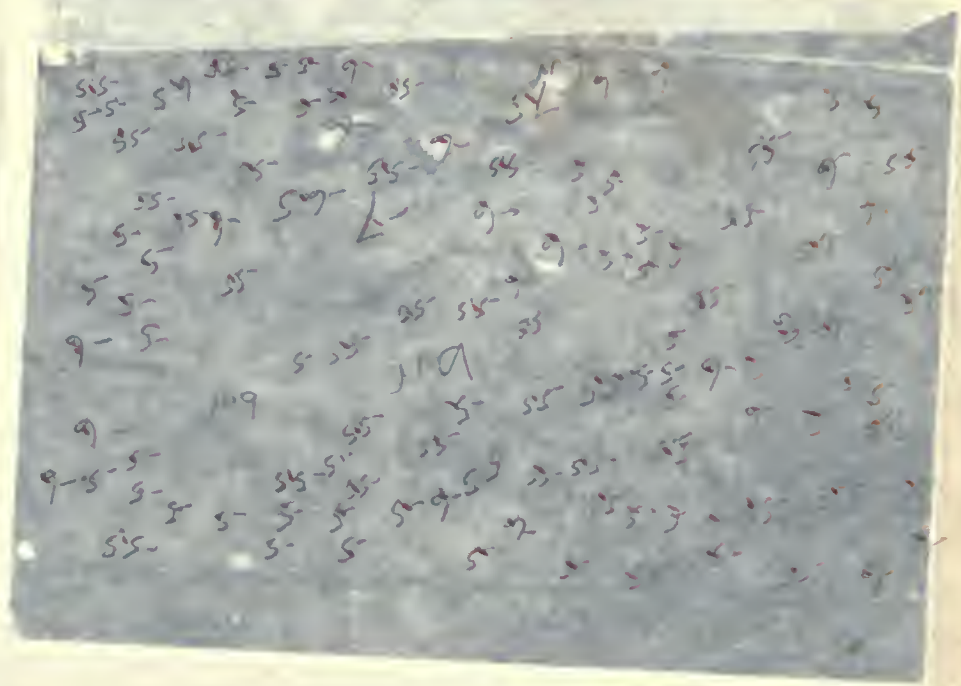

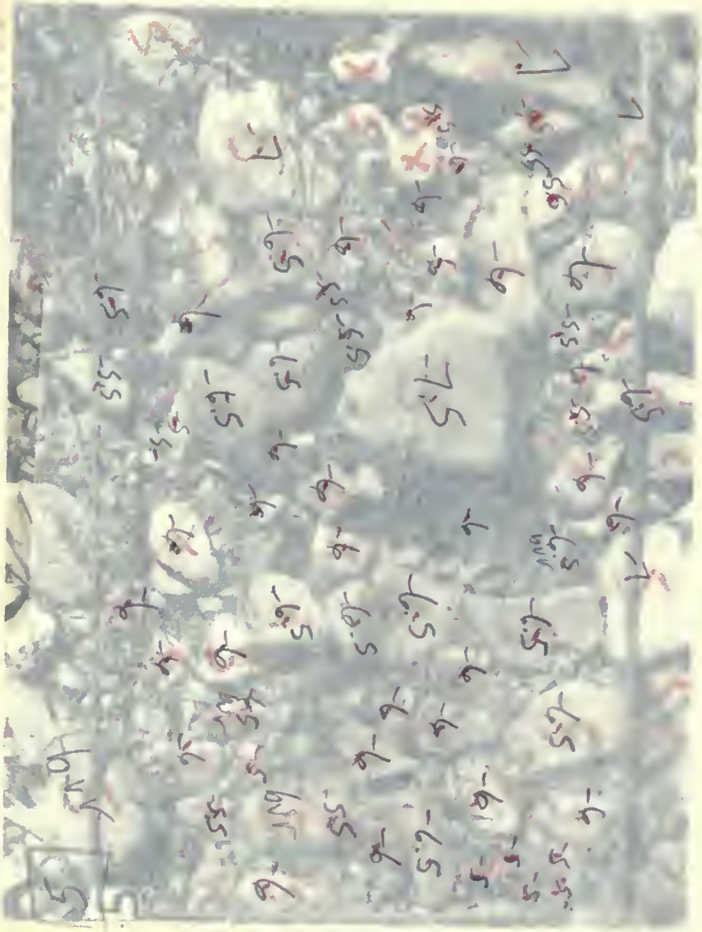
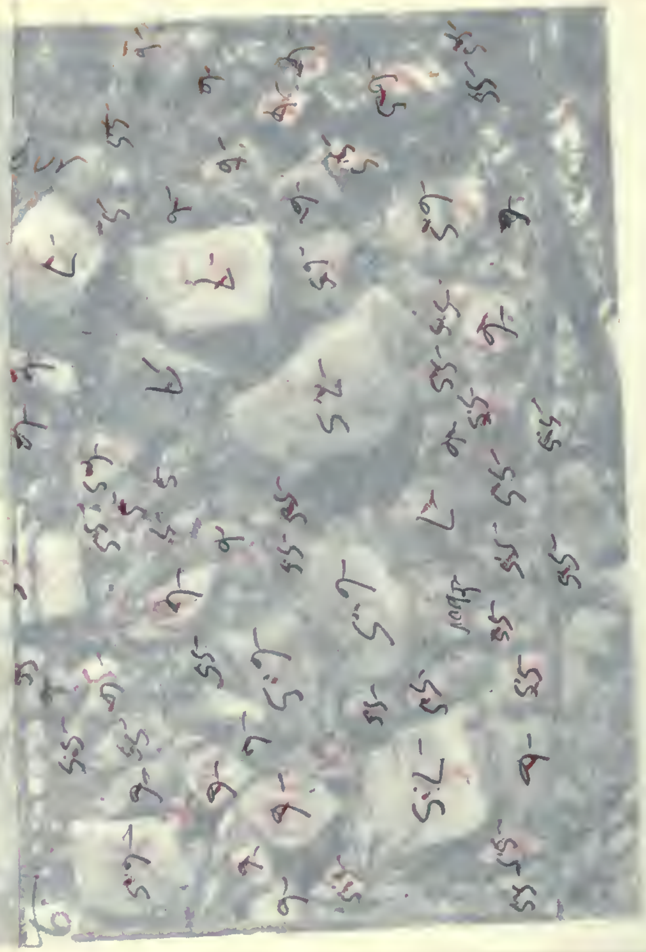
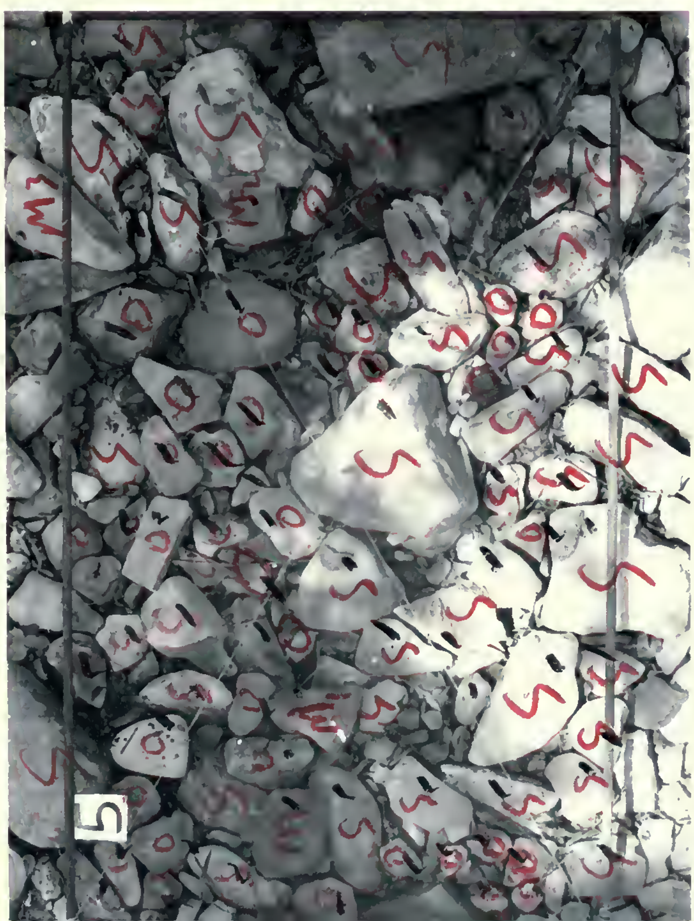
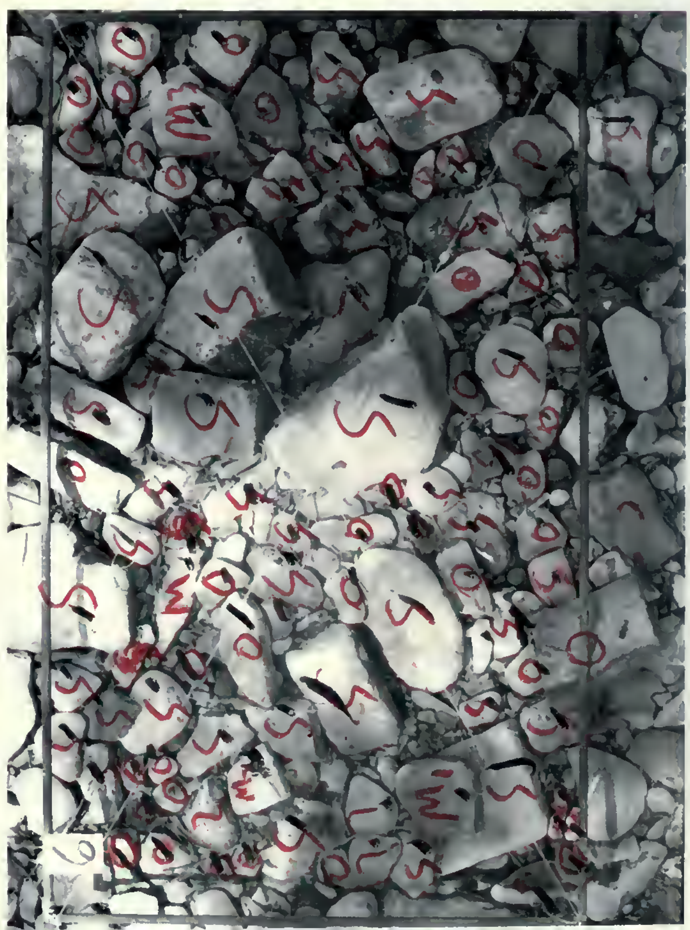

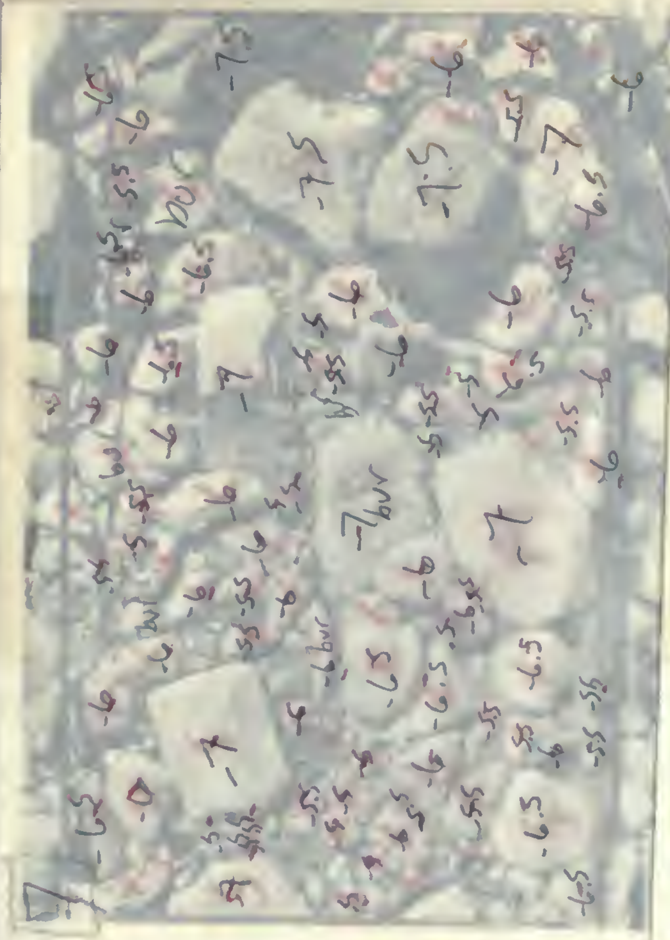

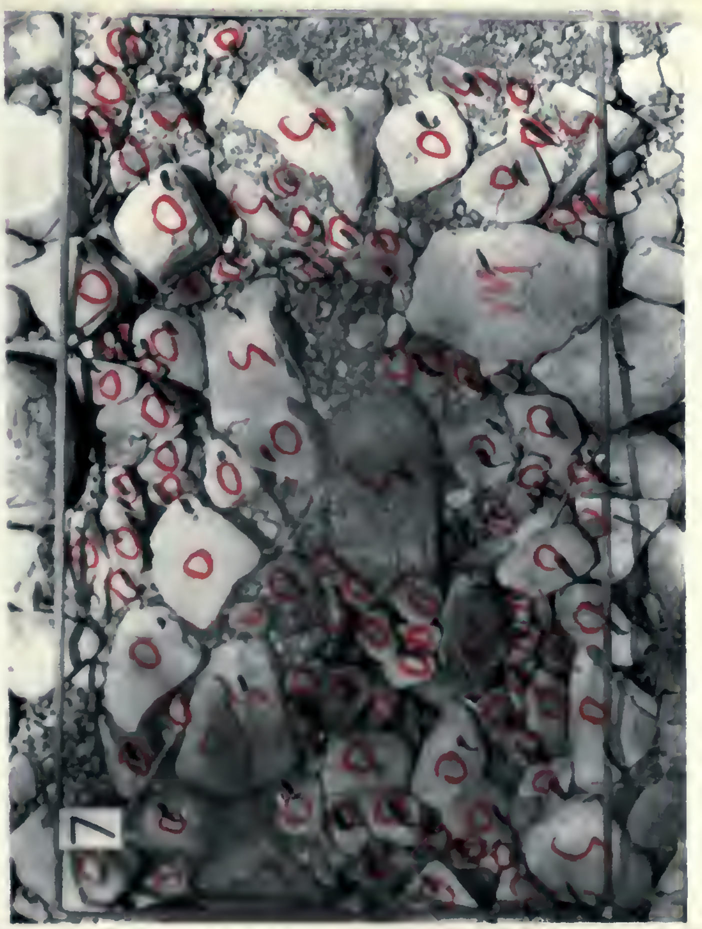

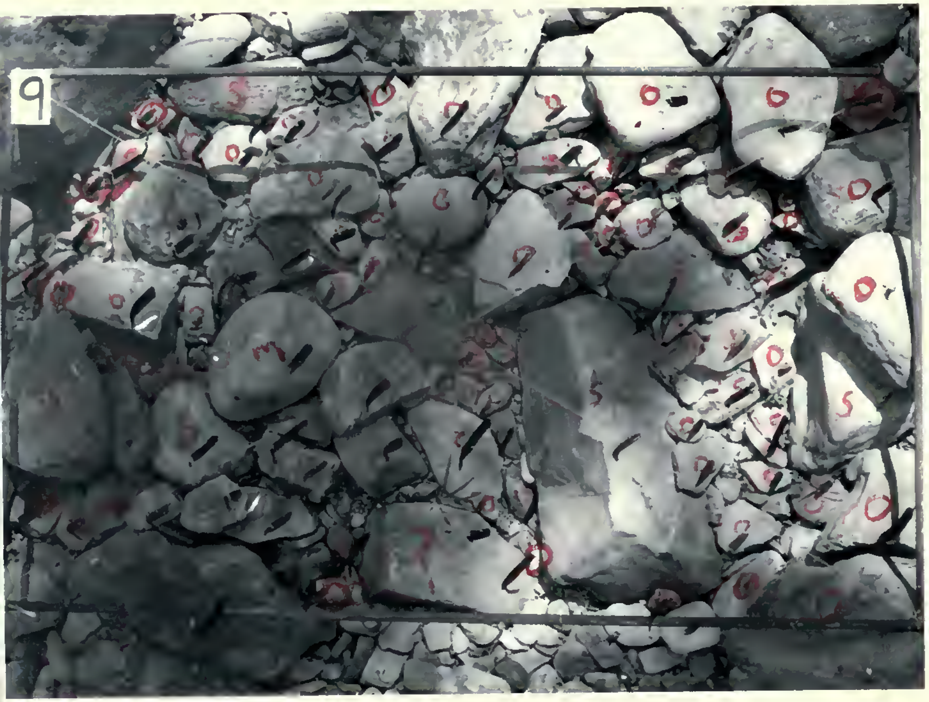
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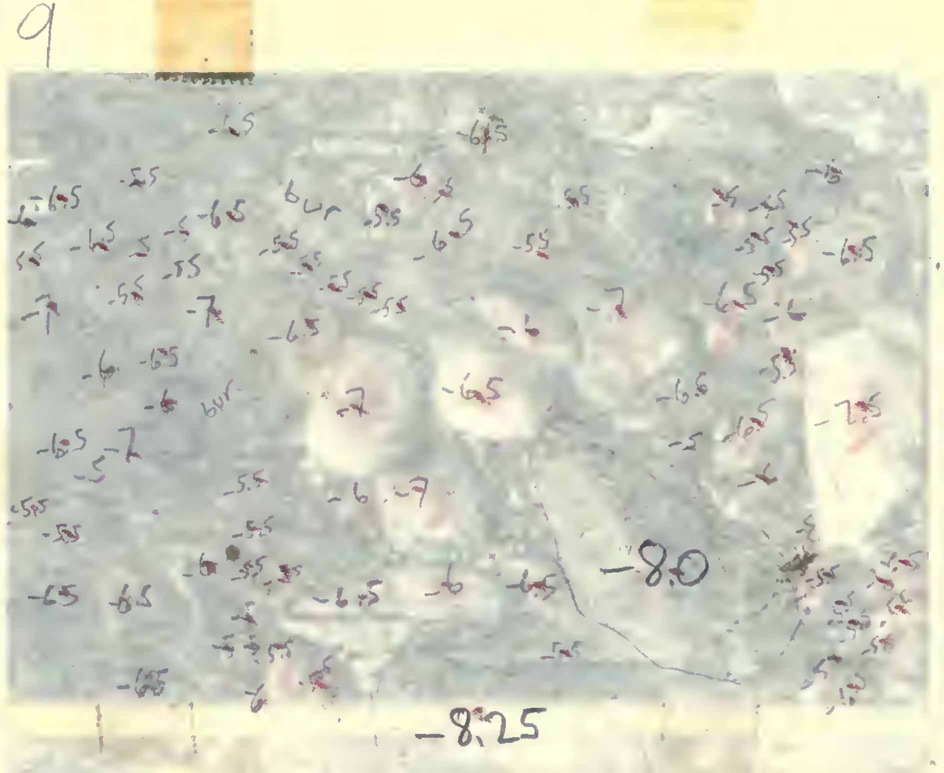
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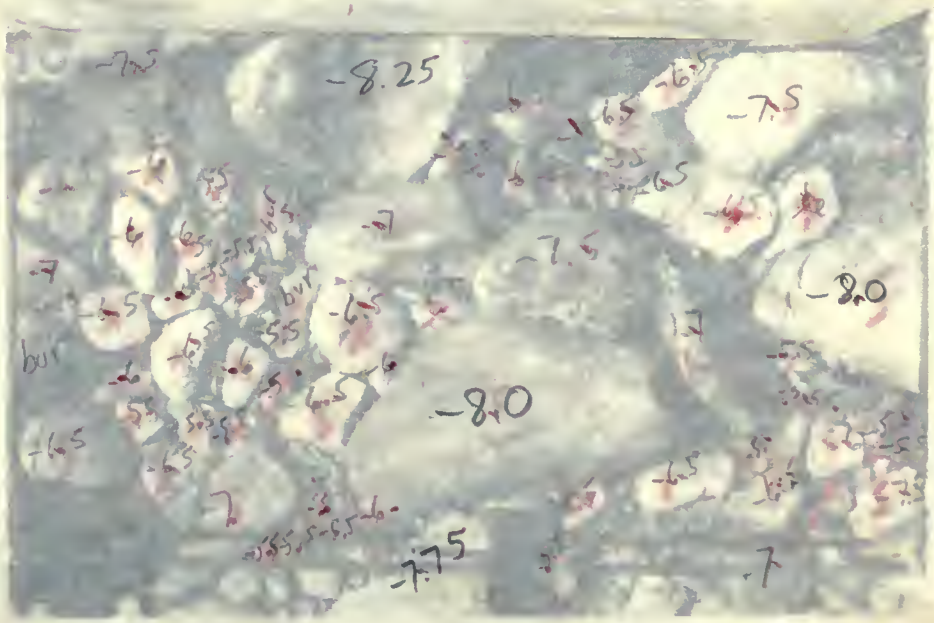
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-8.0
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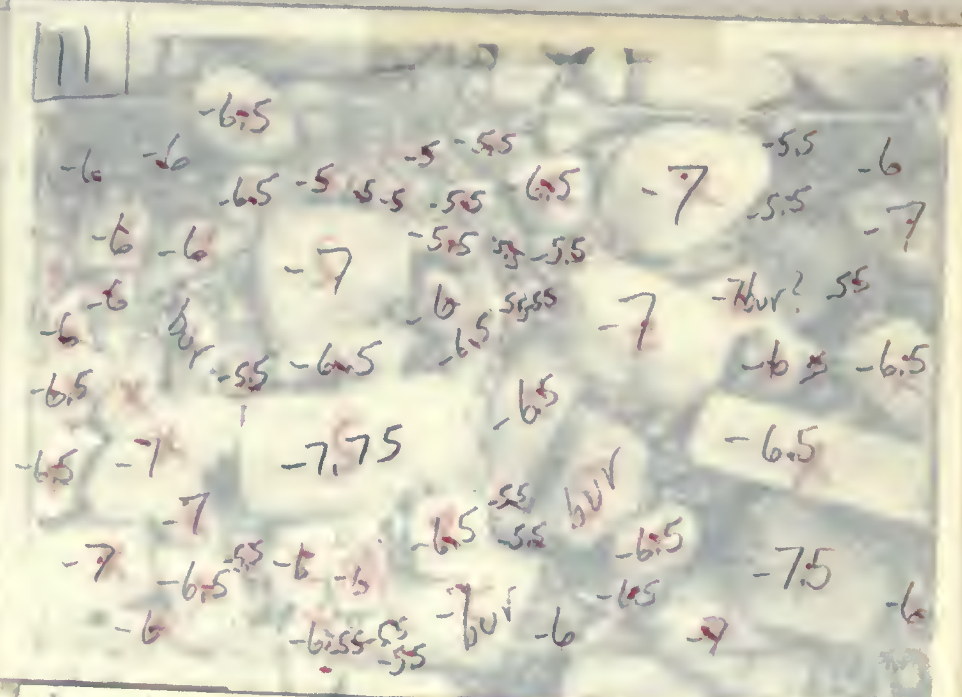
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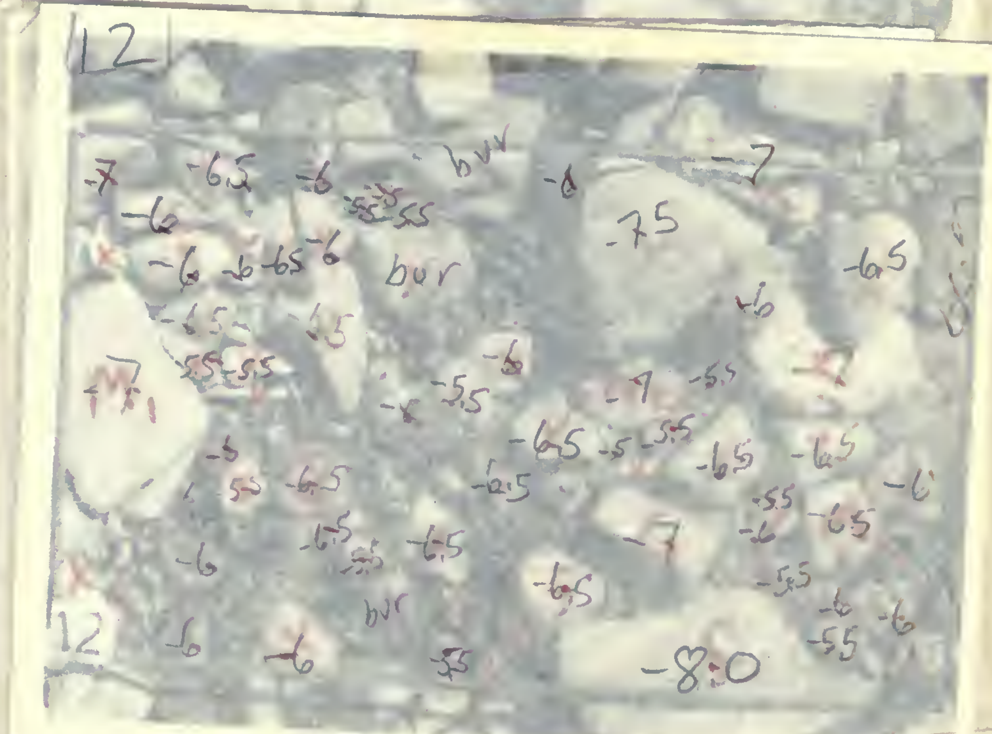
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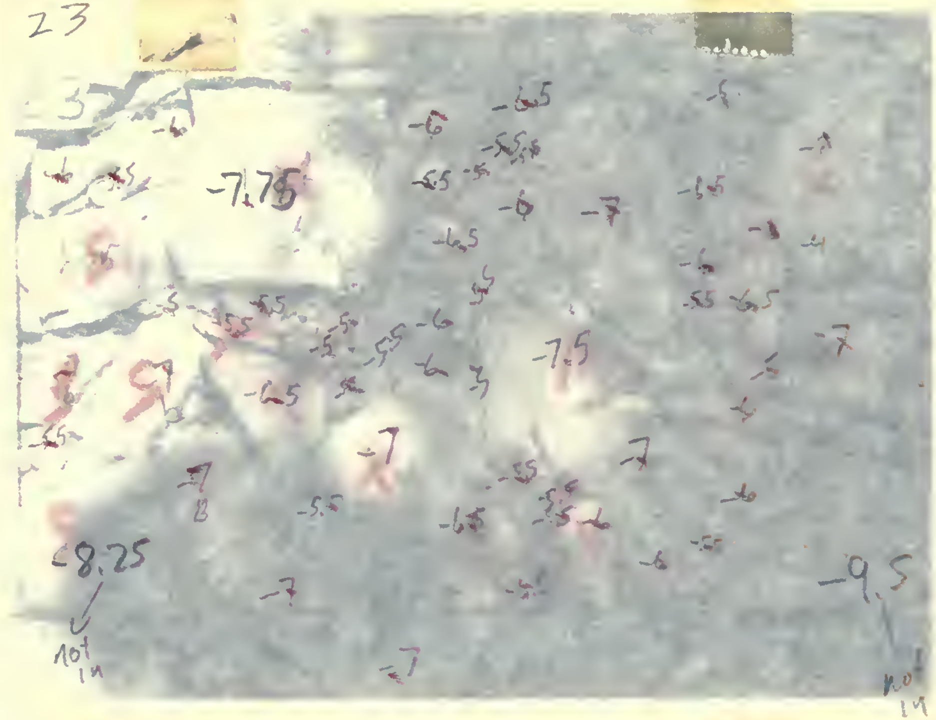
m2

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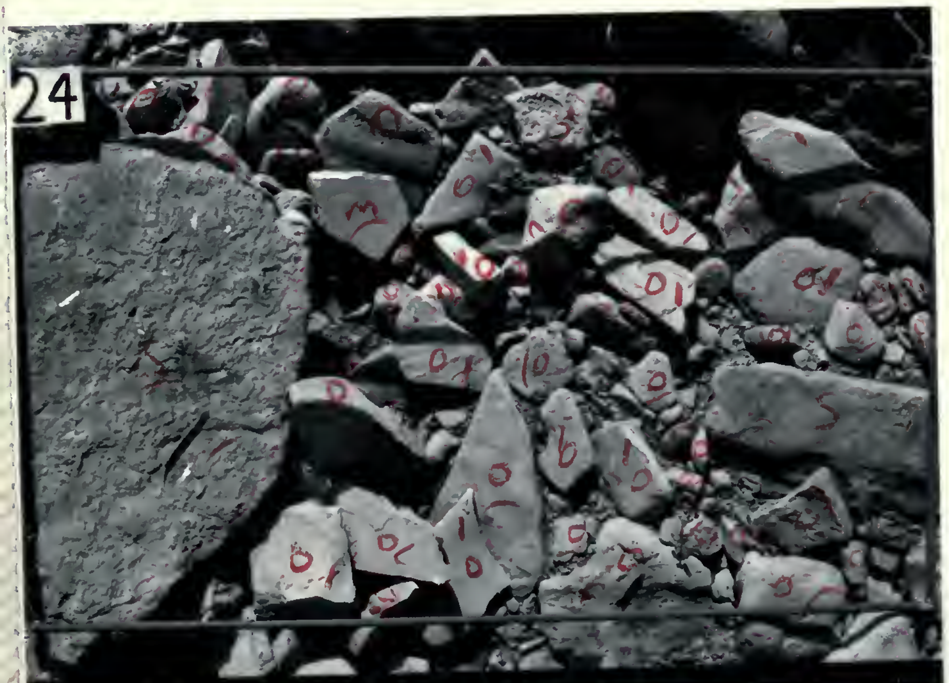
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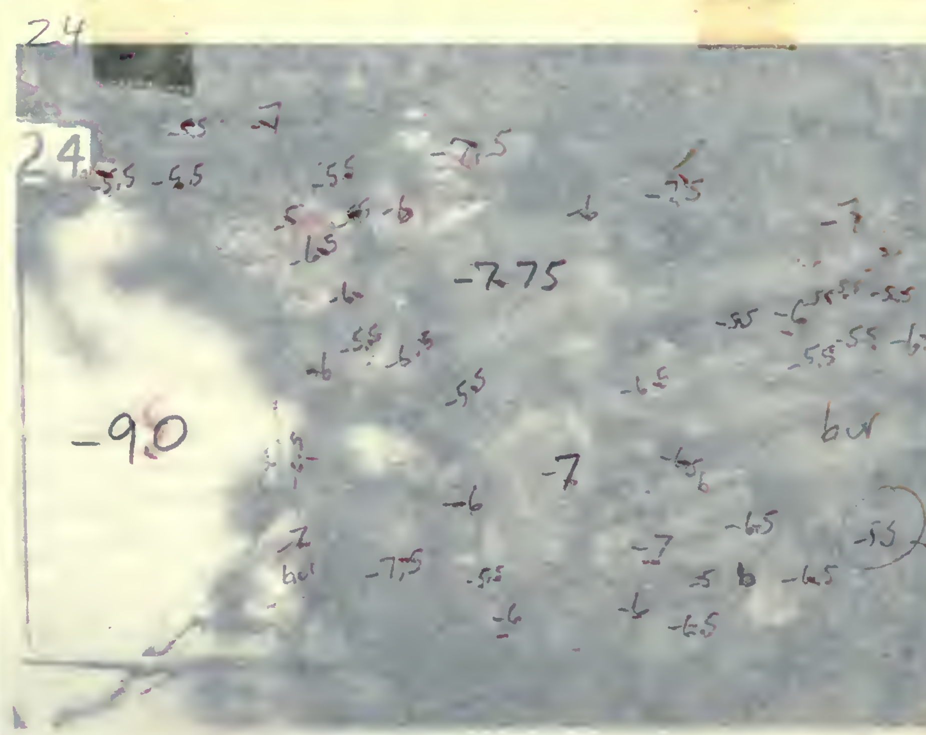
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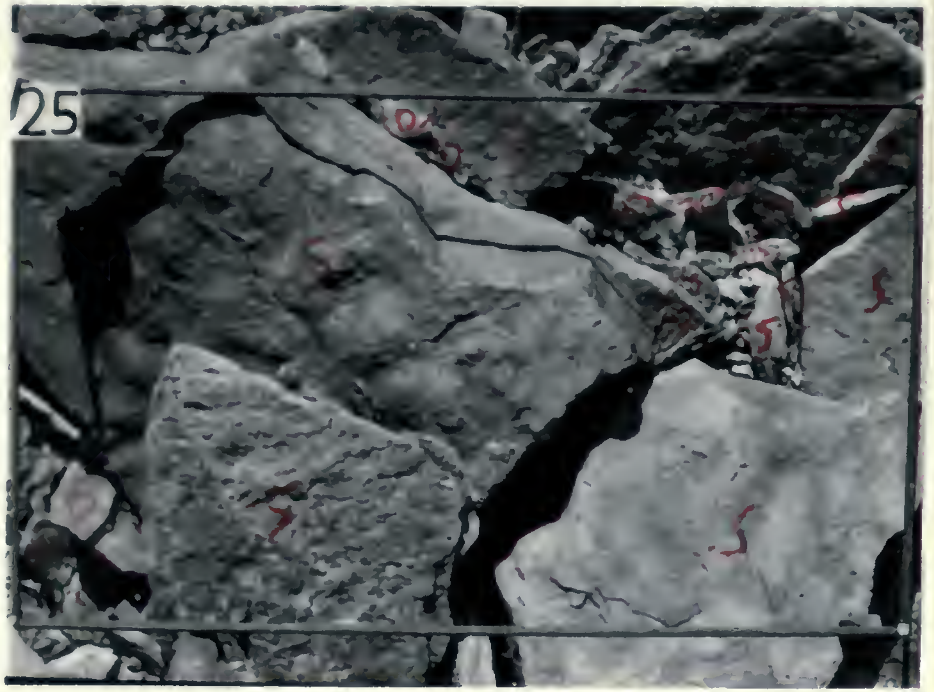
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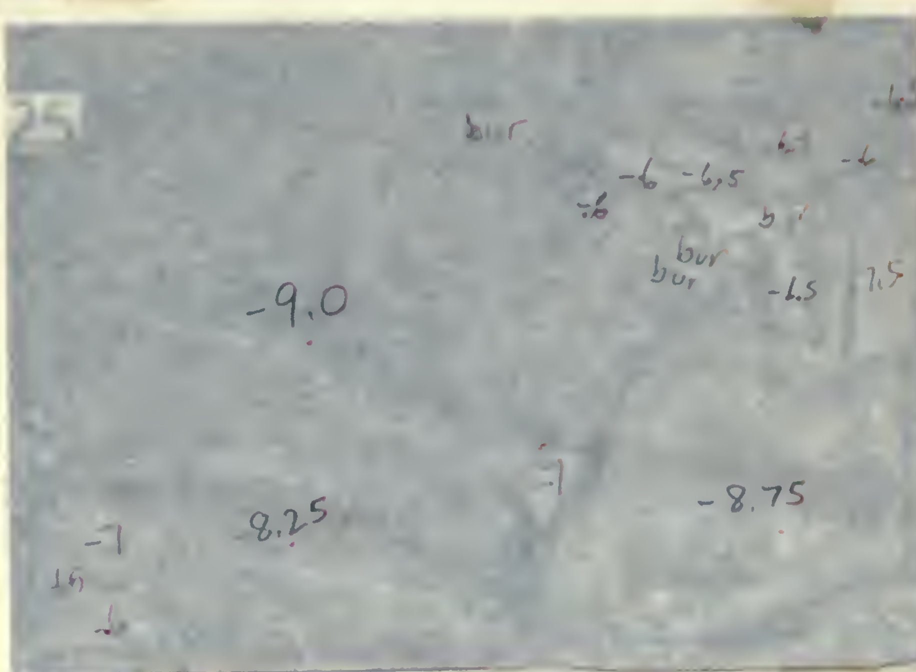
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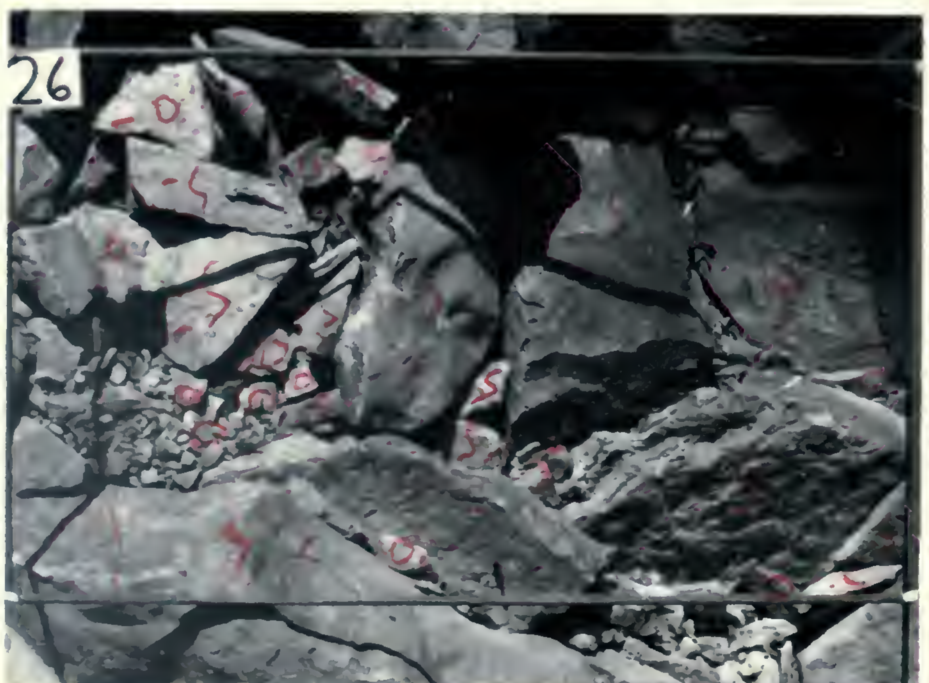
bur
-9.0
8.25
-8.75
-6
-6.5
bur
bur
-6.5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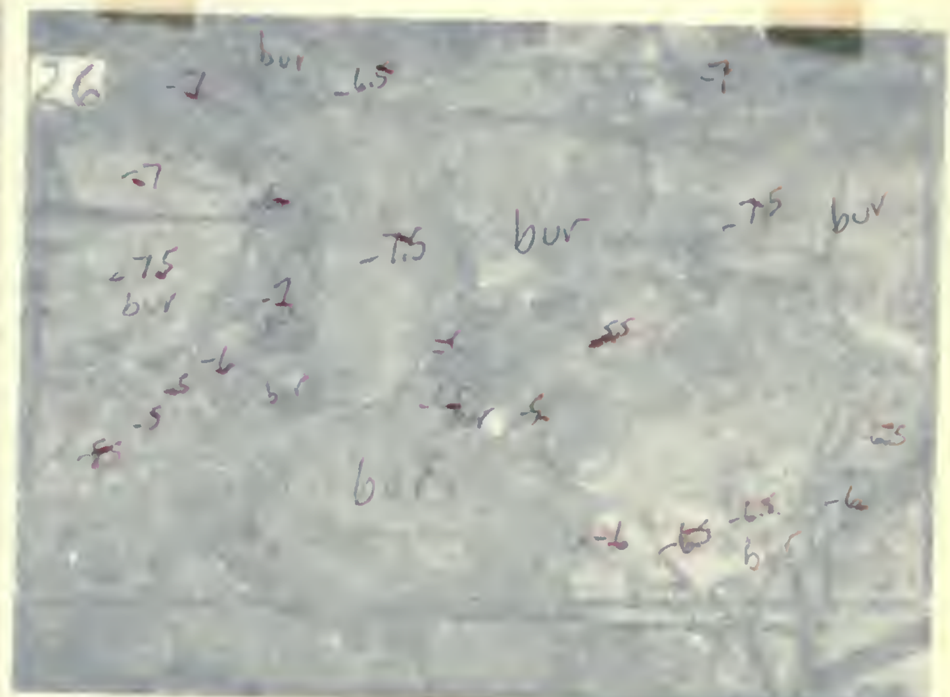
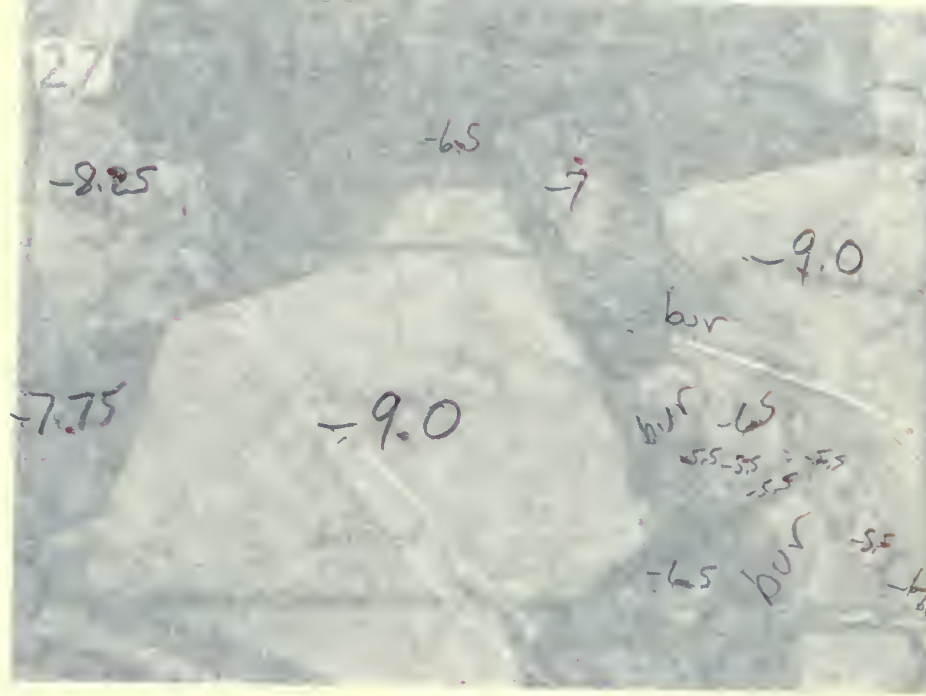
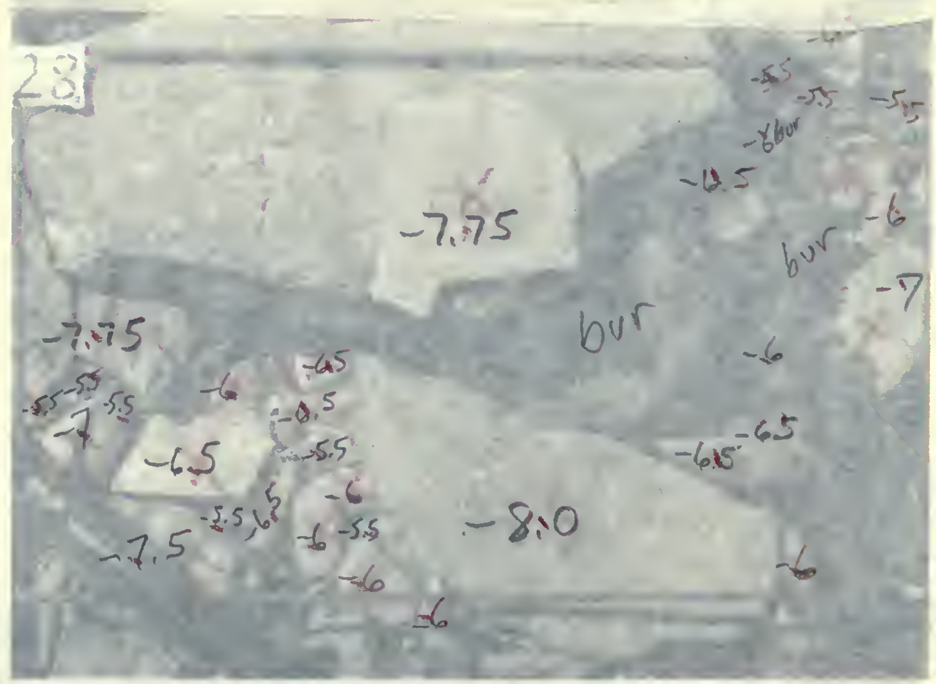

26
bur
-6.5
-7.5
bur
-7.5
bur
-7.5
bur
bur


27


-8.25
-6.5
-7
-9.0
bur
-7.75
-9.0
bur -6.5
-6.5
bur

moved ↑ 5.5m


28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-6


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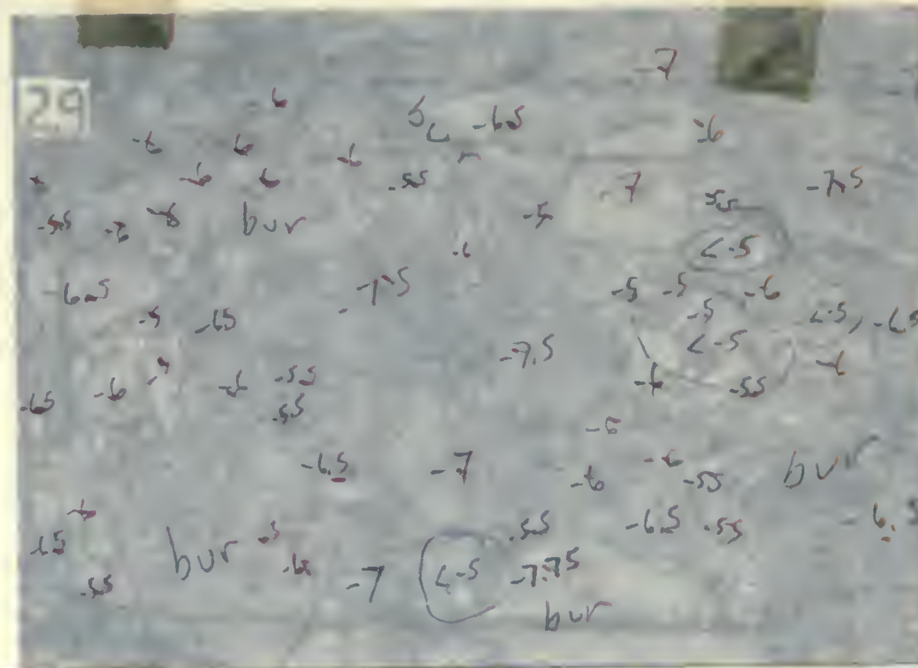
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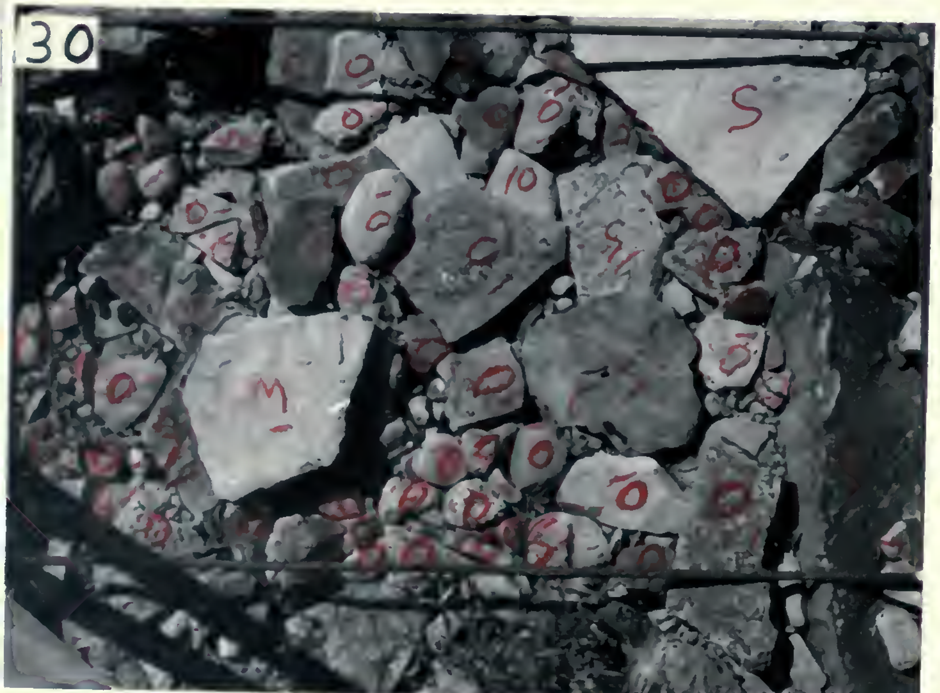
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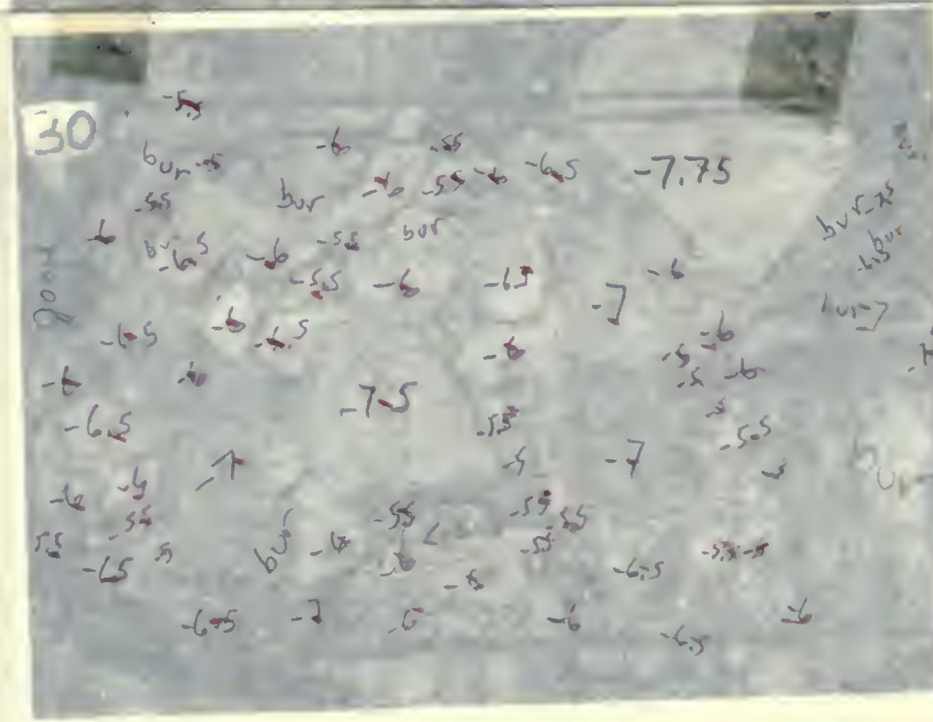
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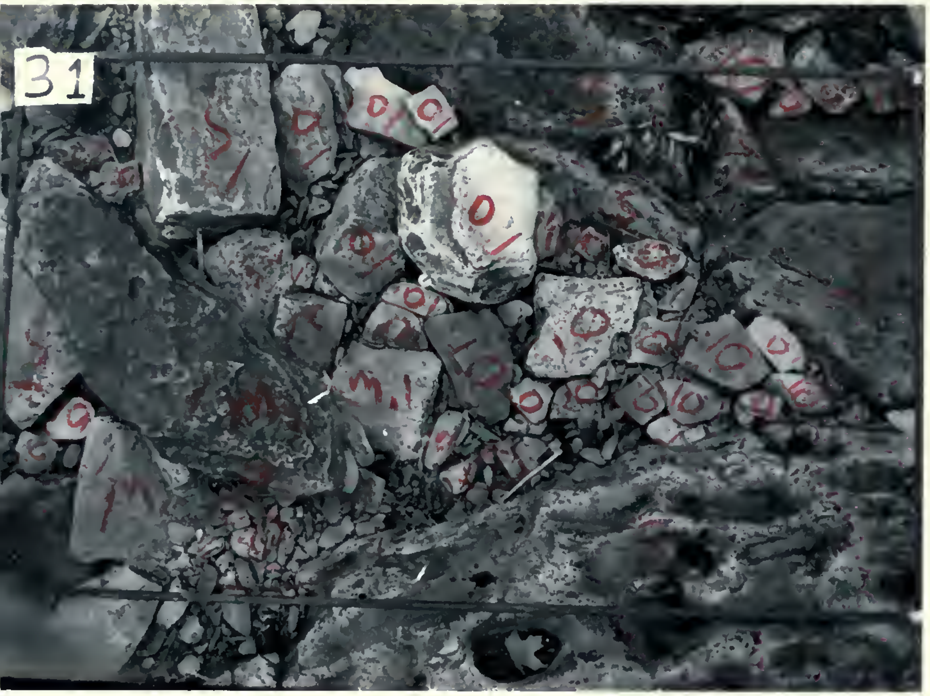
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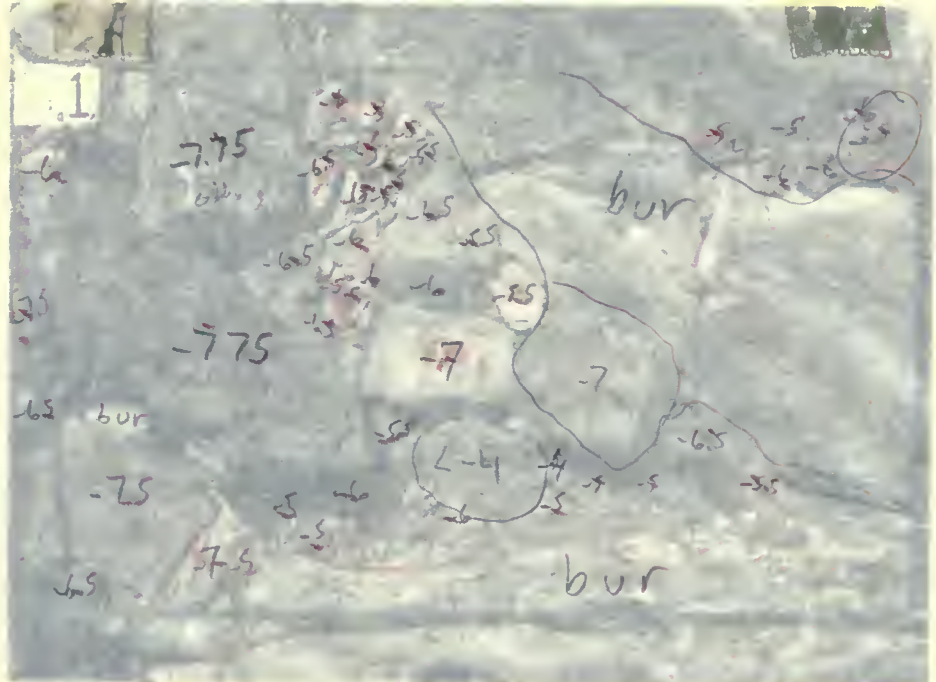
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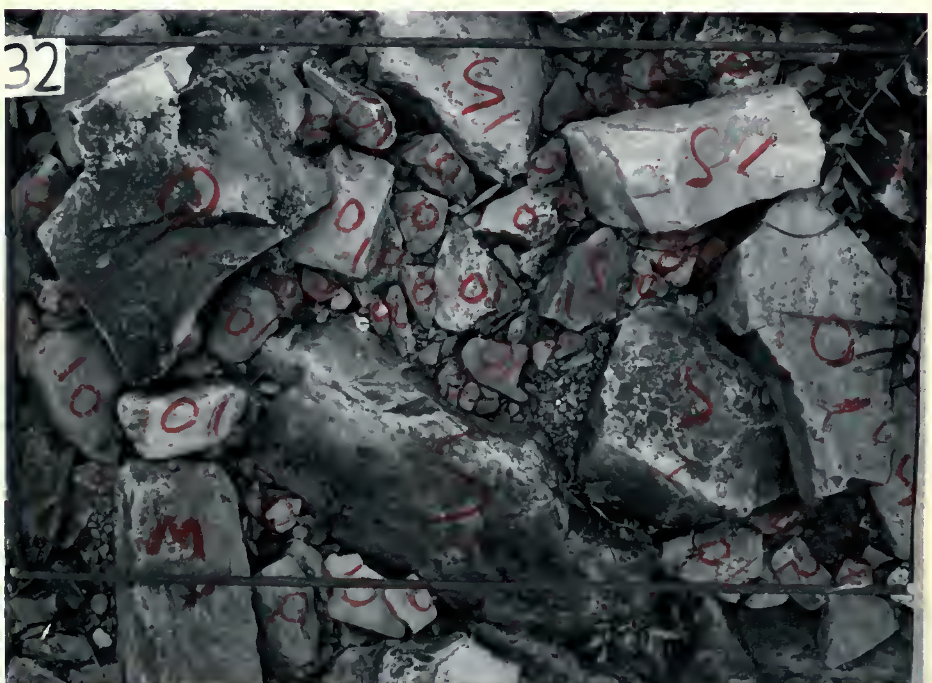
-7.75
-7.75
-7
-7
bur
bur
-7.5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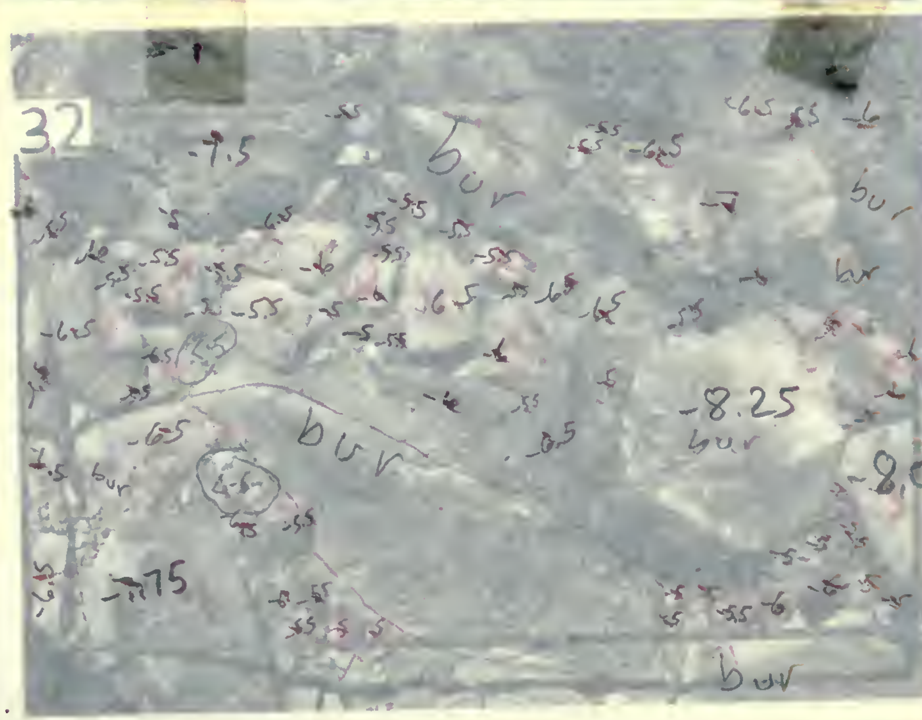
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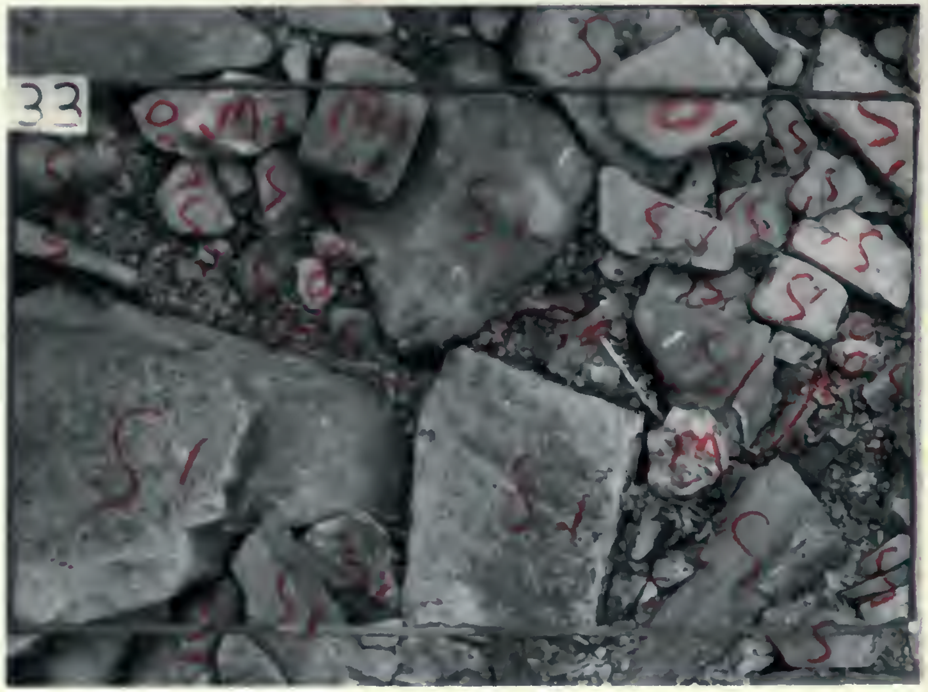
bur
bur
-8.25
bur
-8.00
-7.75
bur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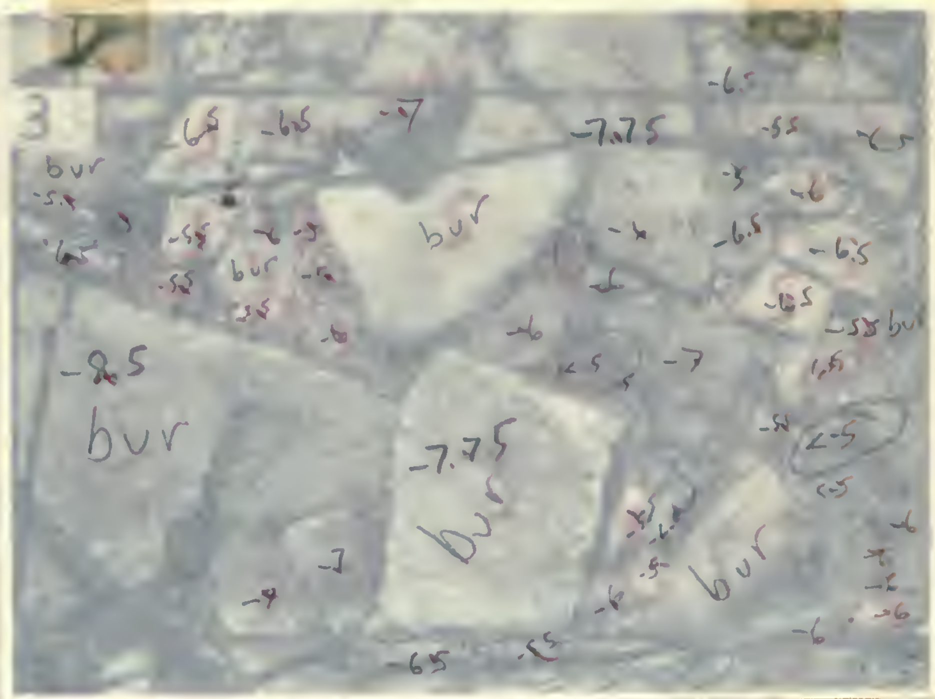

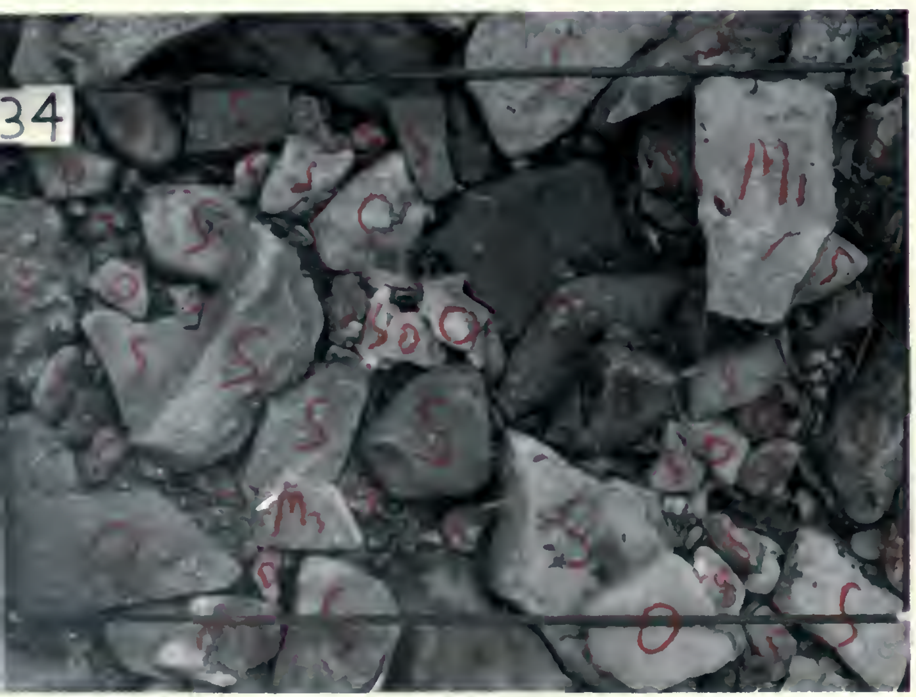
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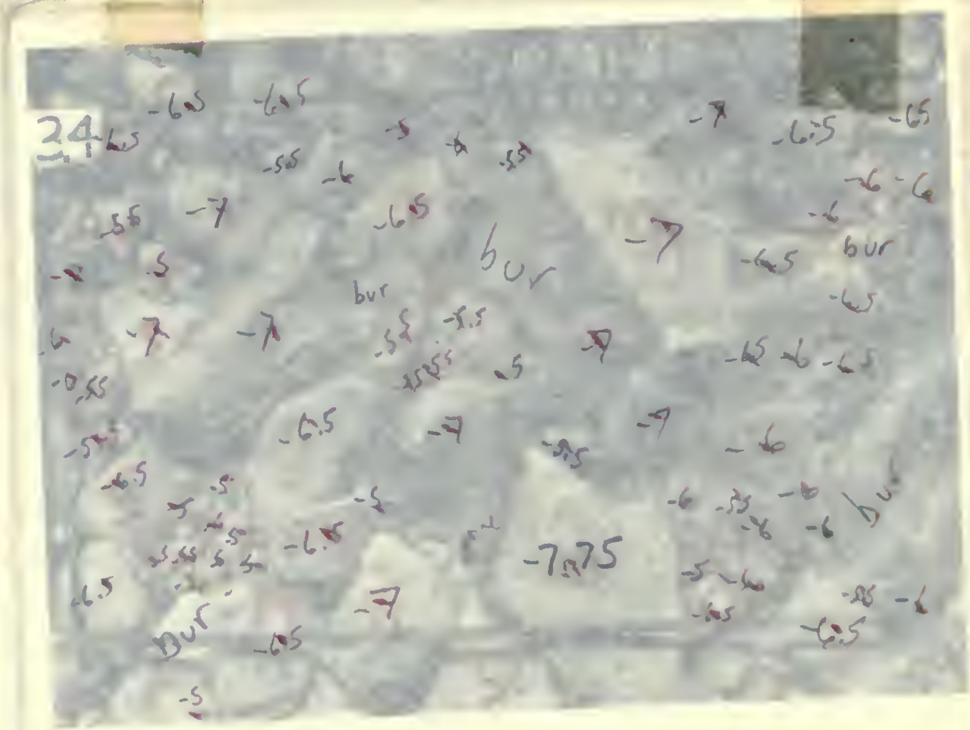
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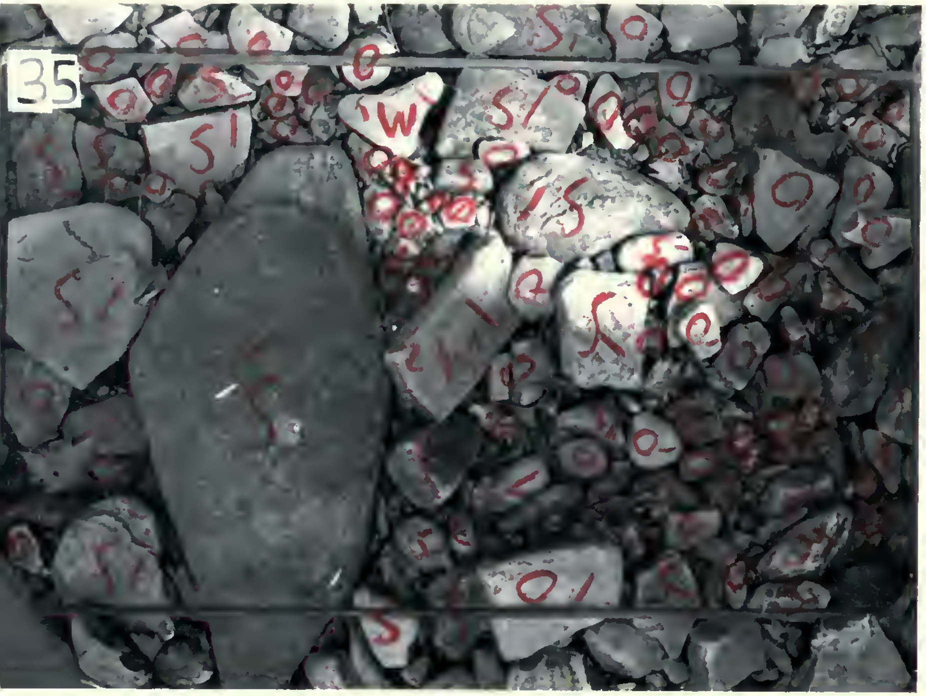
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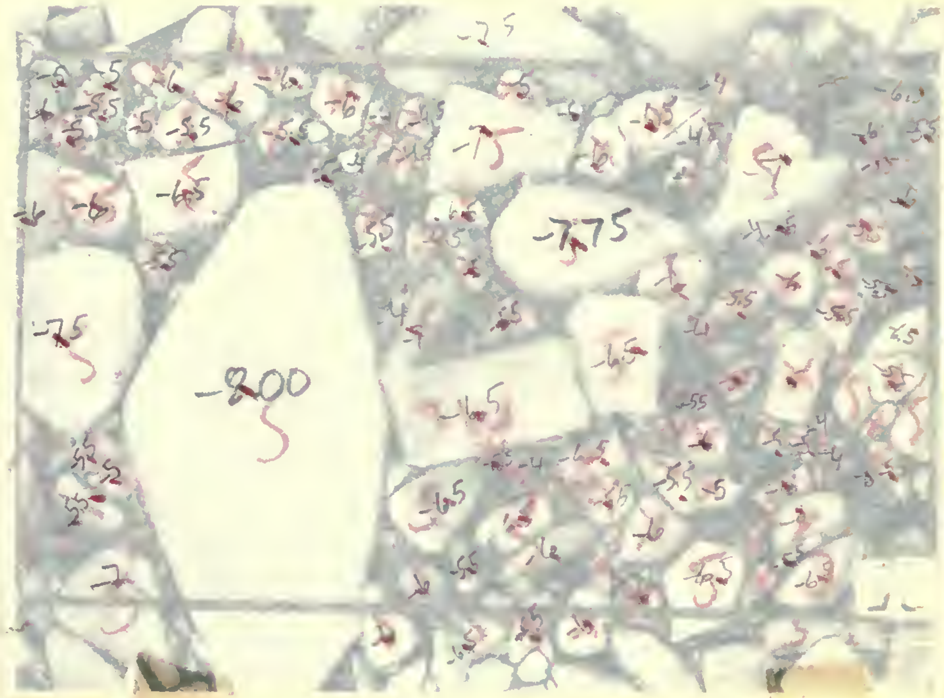

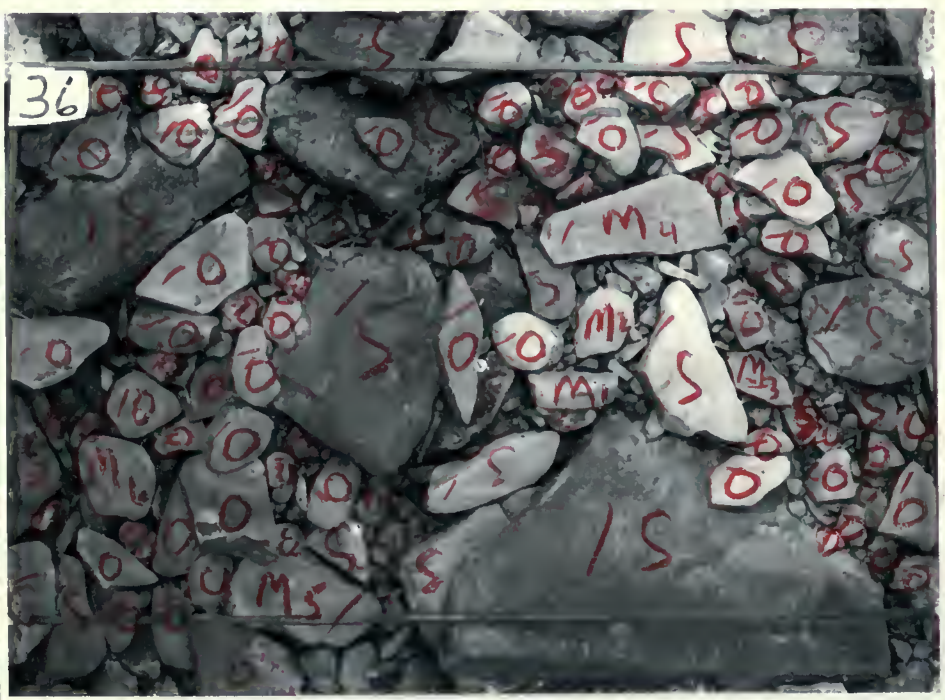
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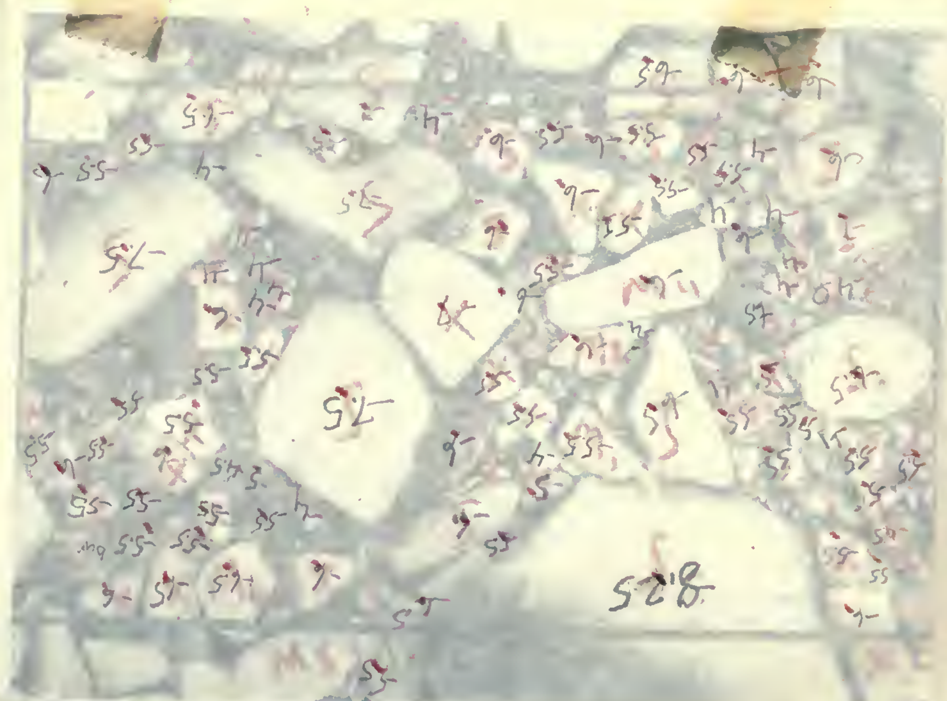

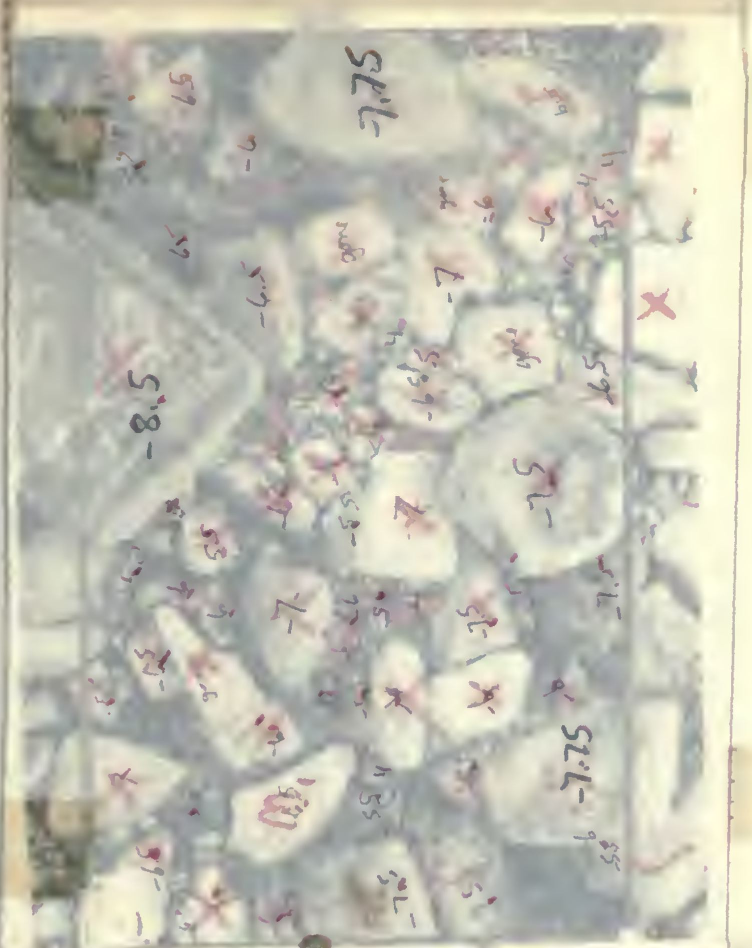

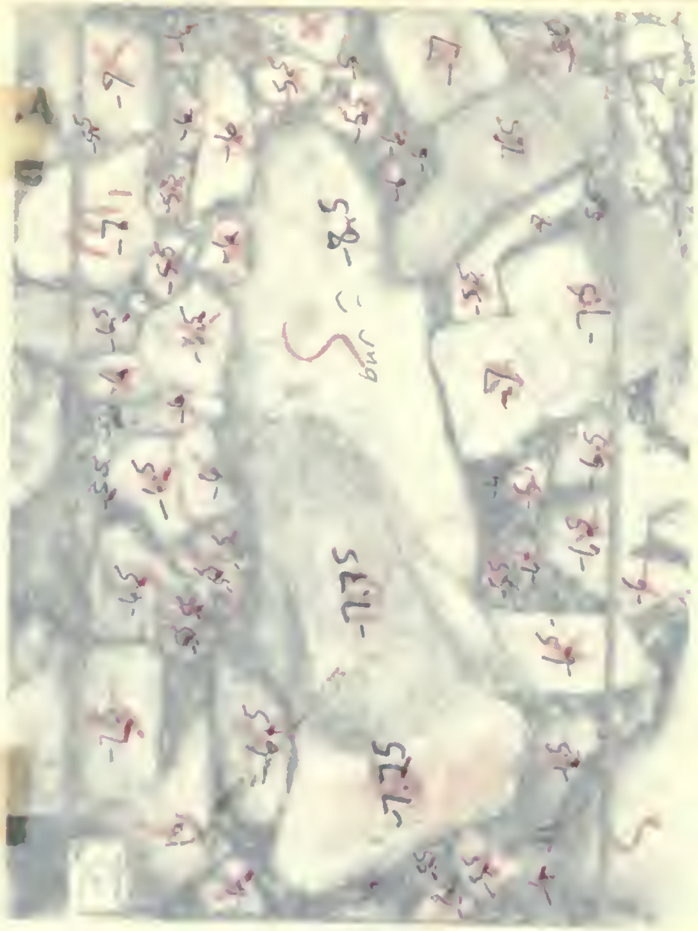

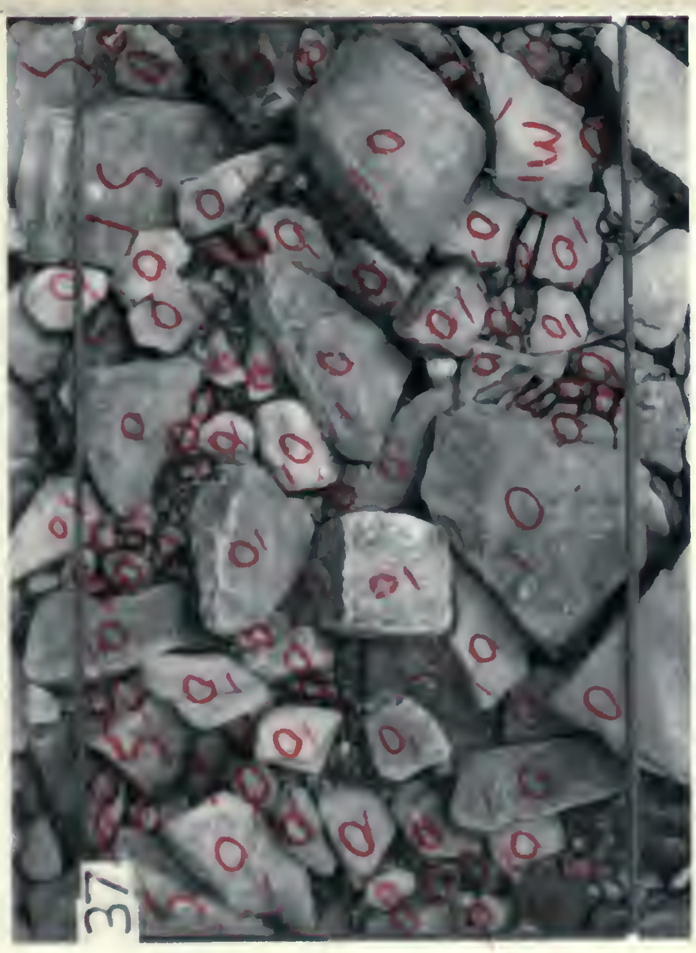


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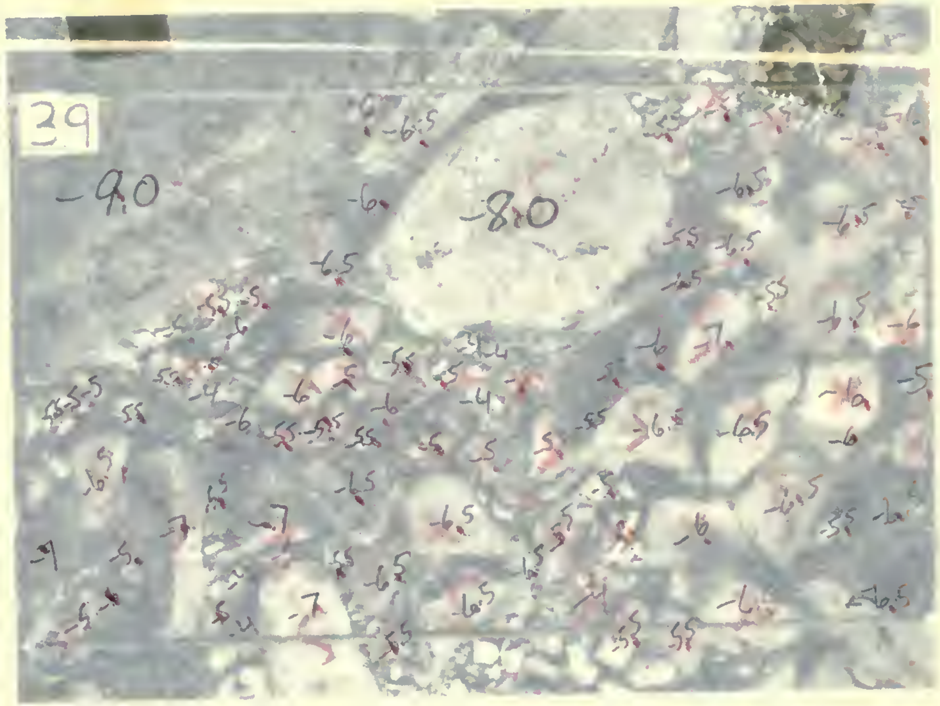
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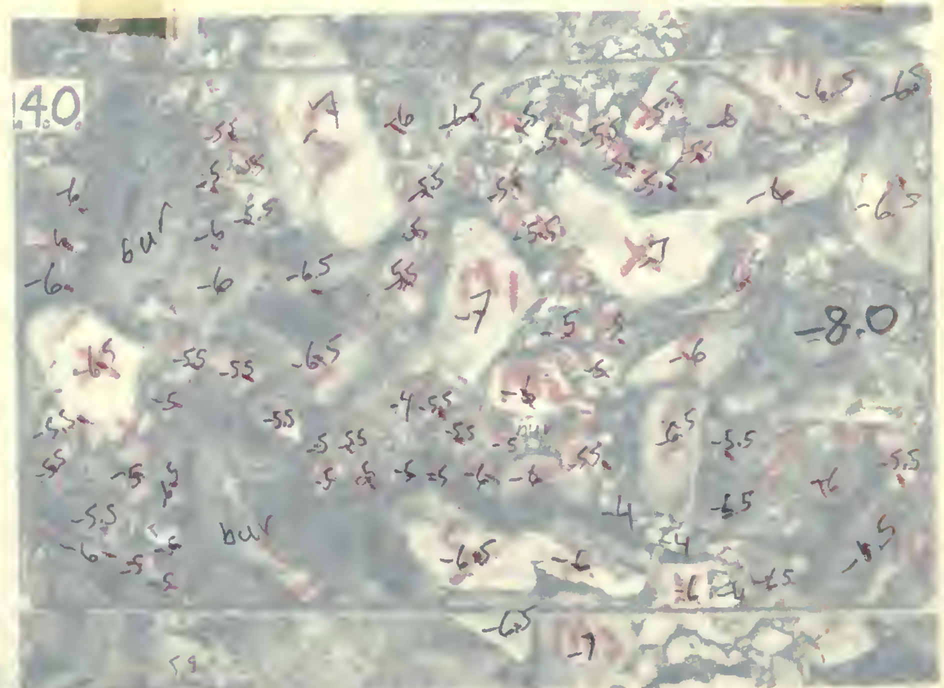
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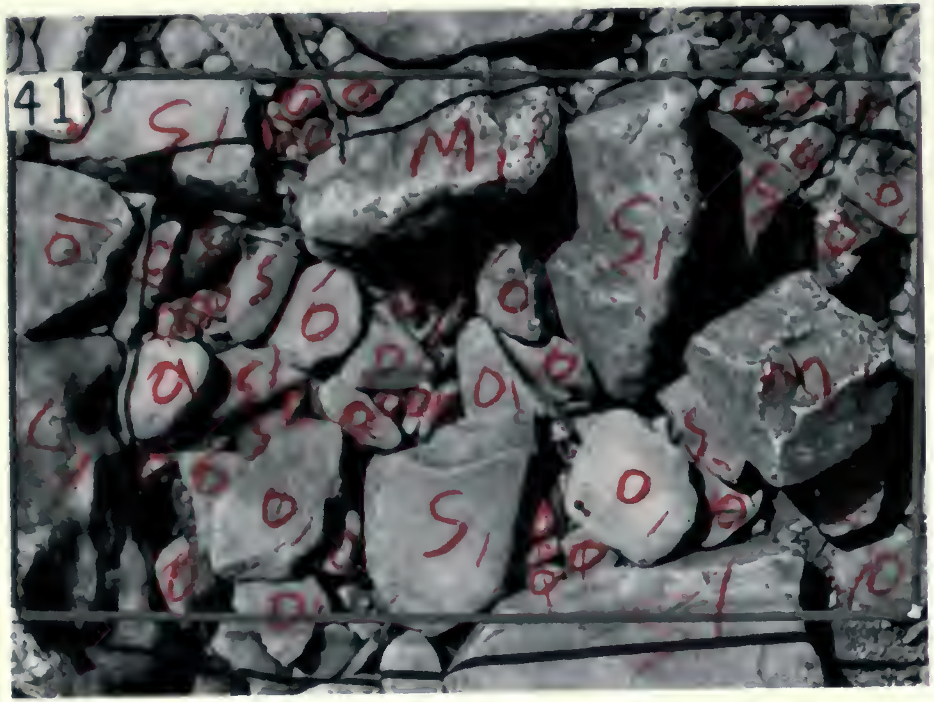
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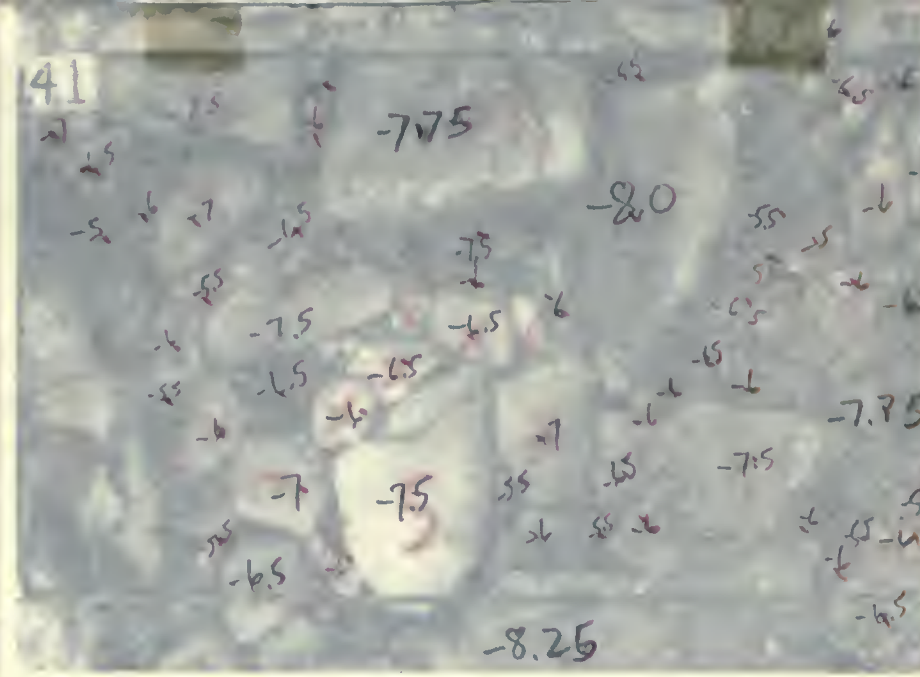
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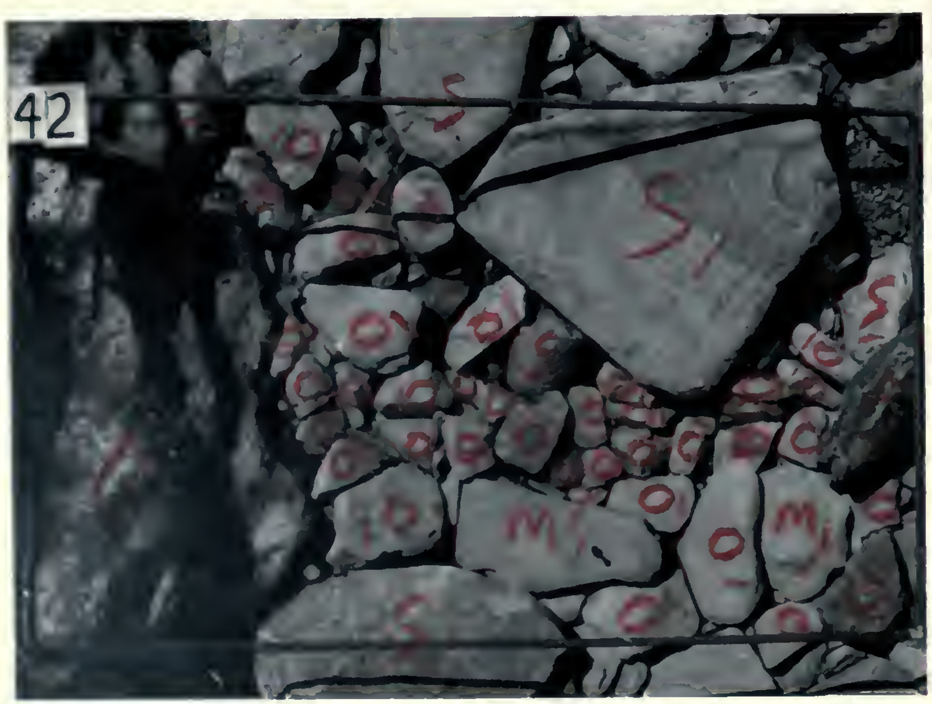
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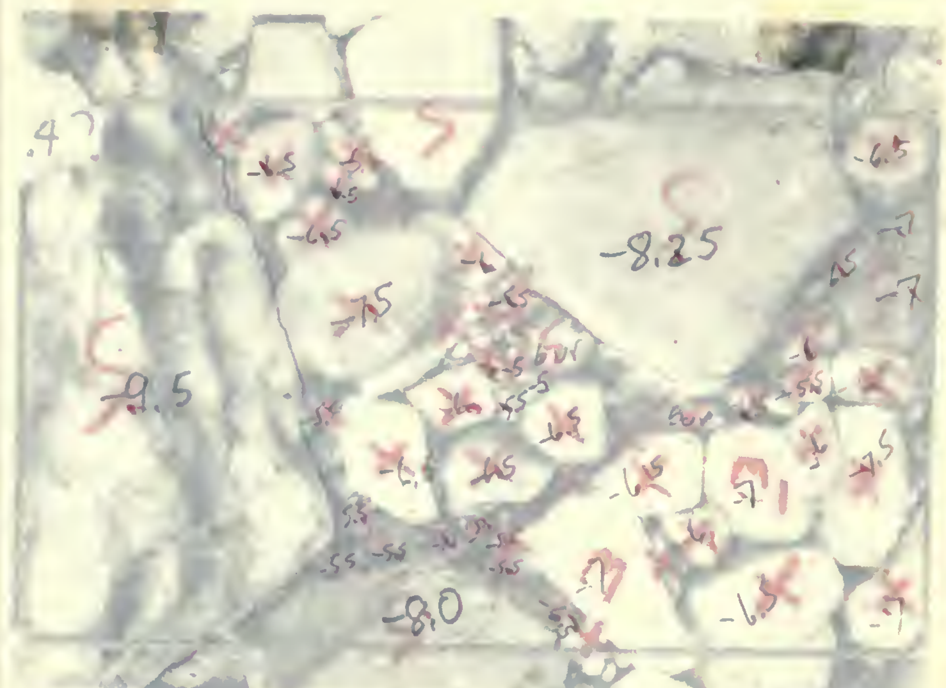

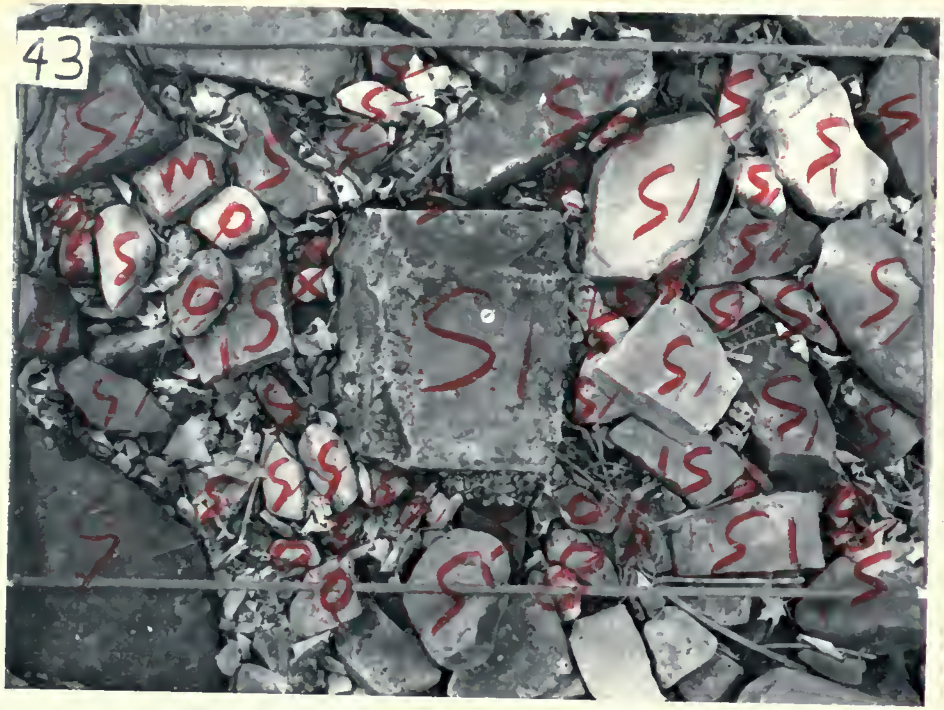
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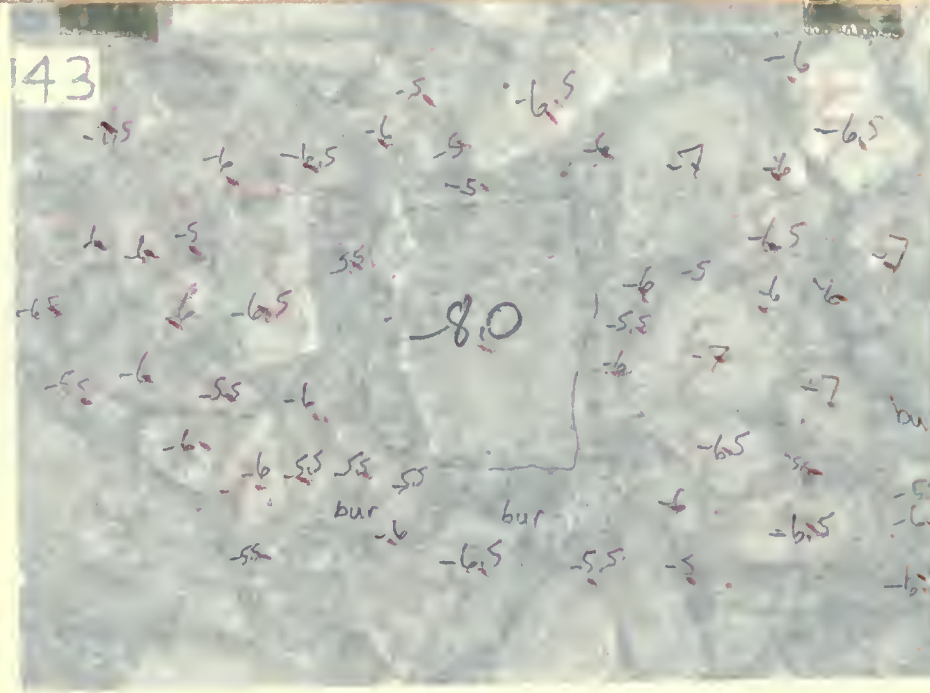
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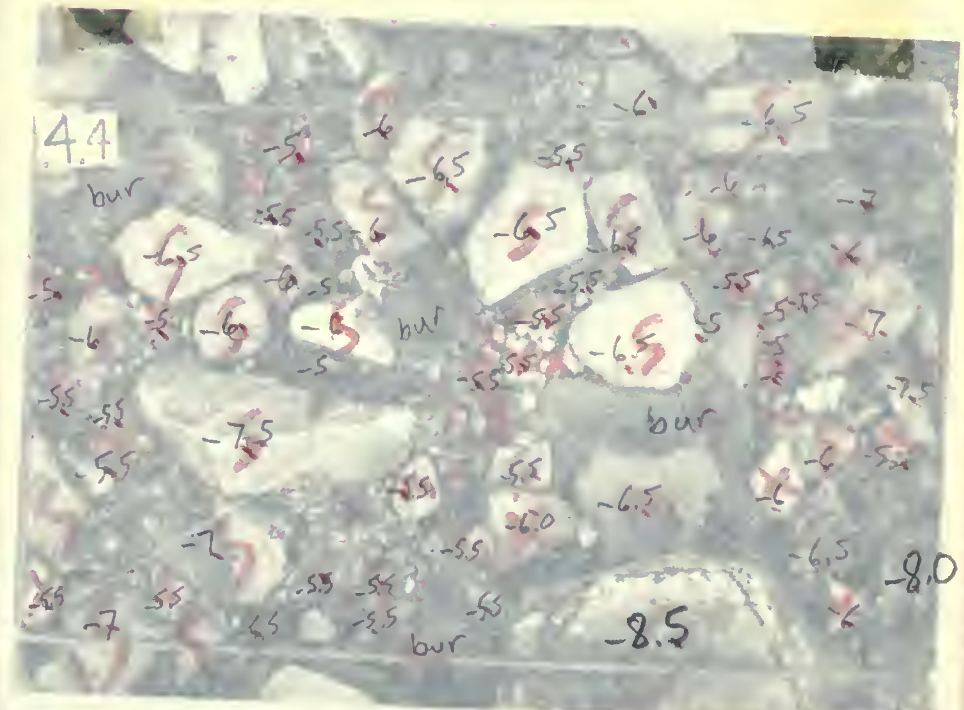
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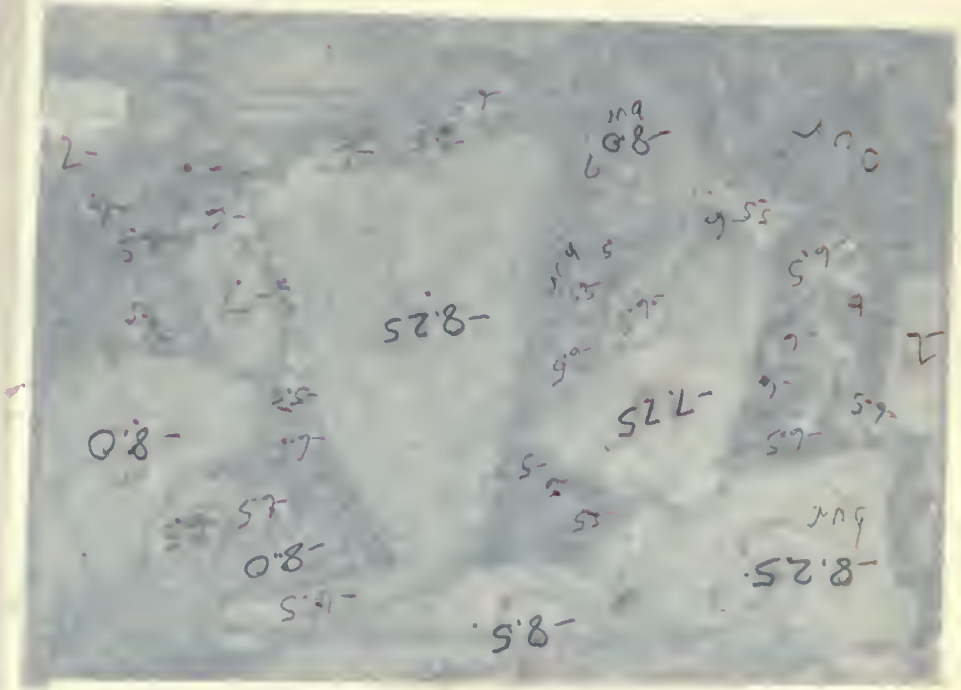


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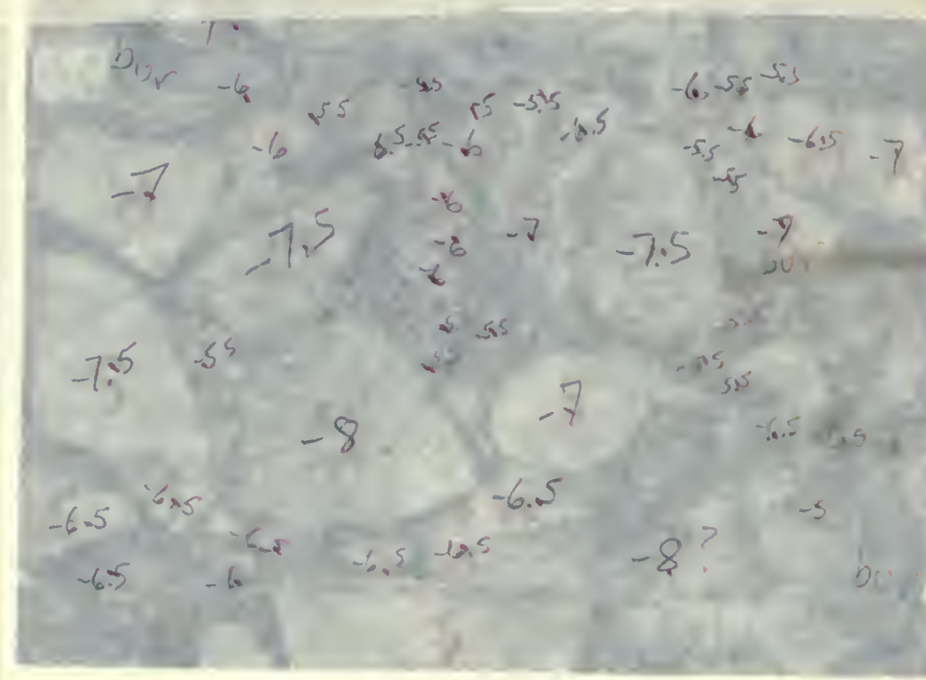

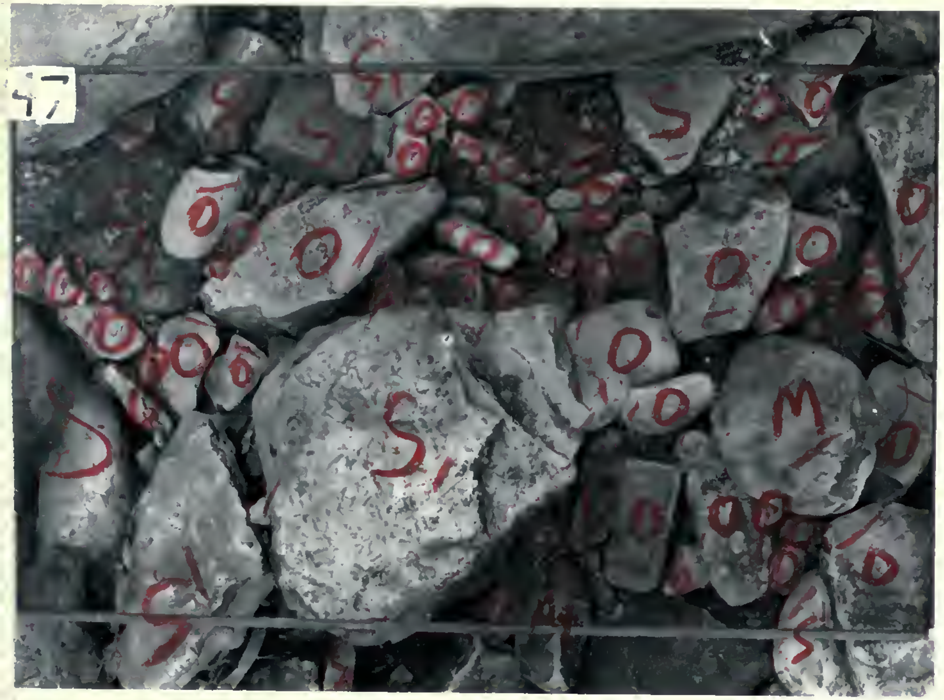

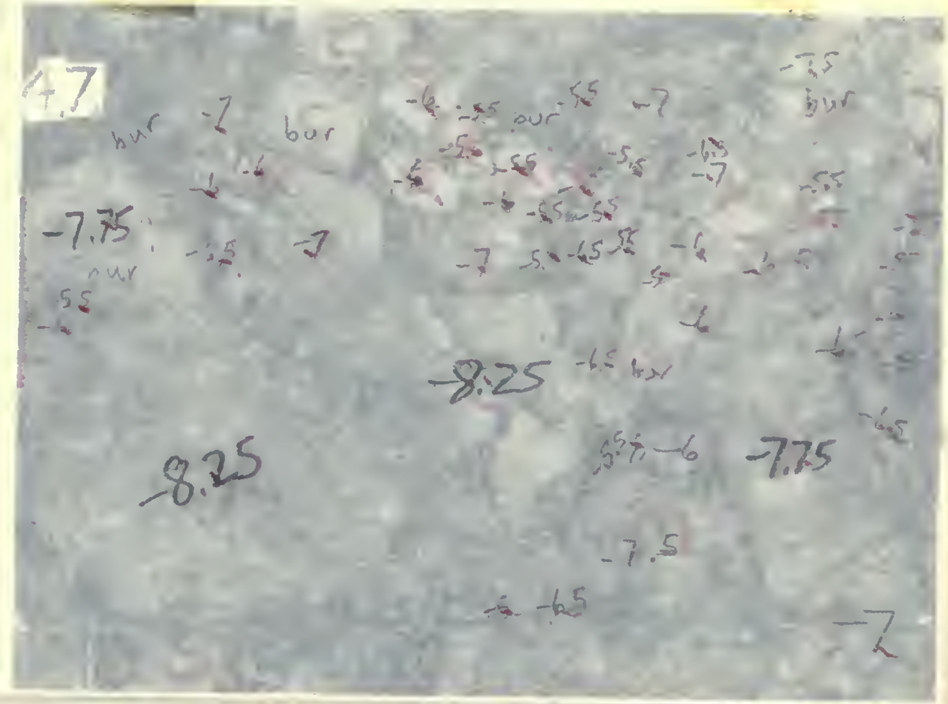

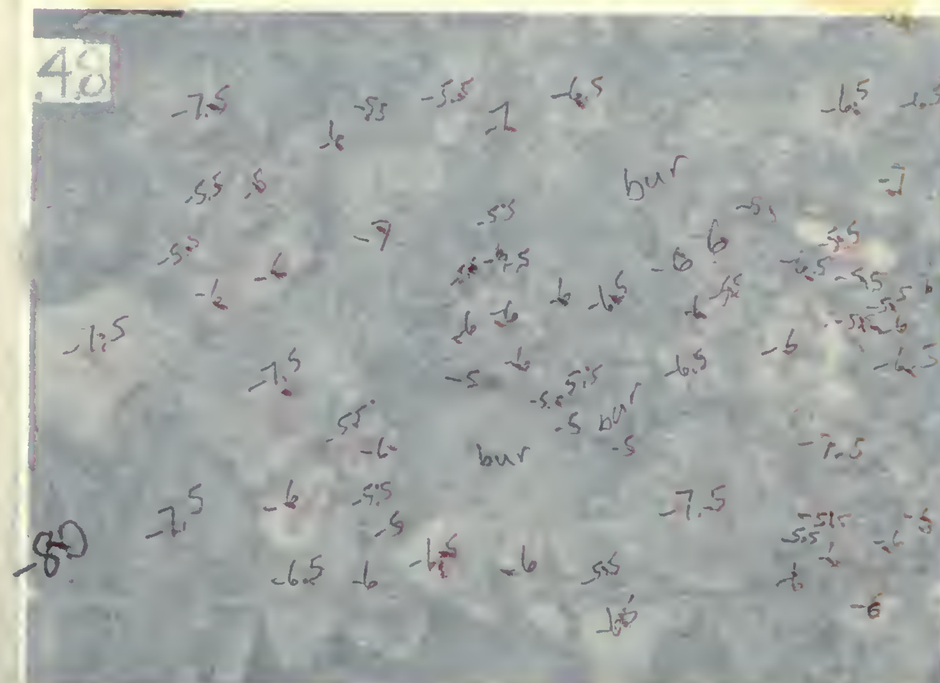

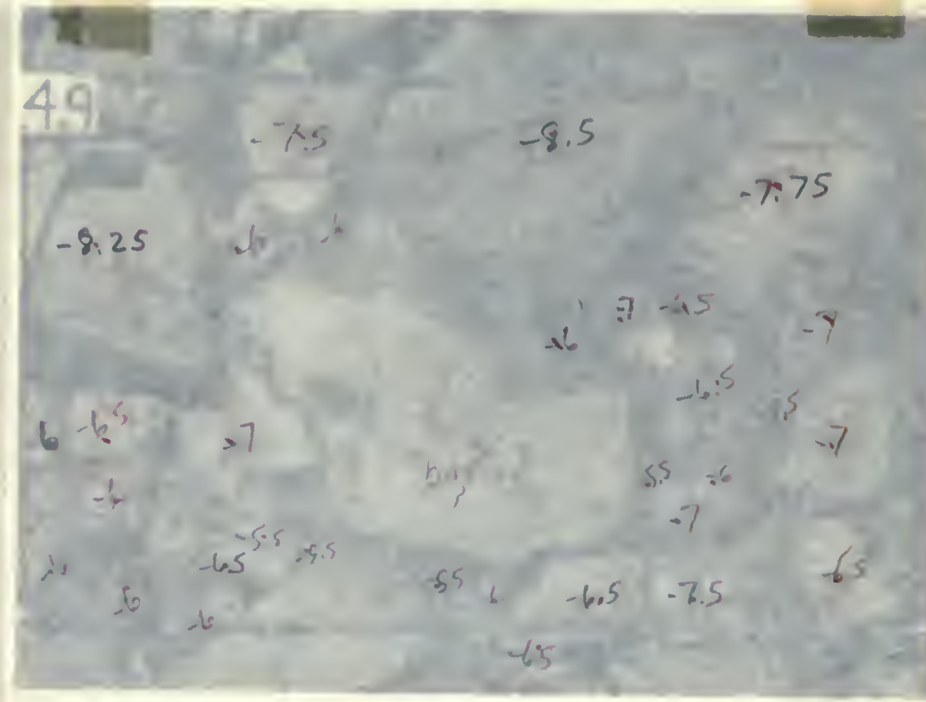
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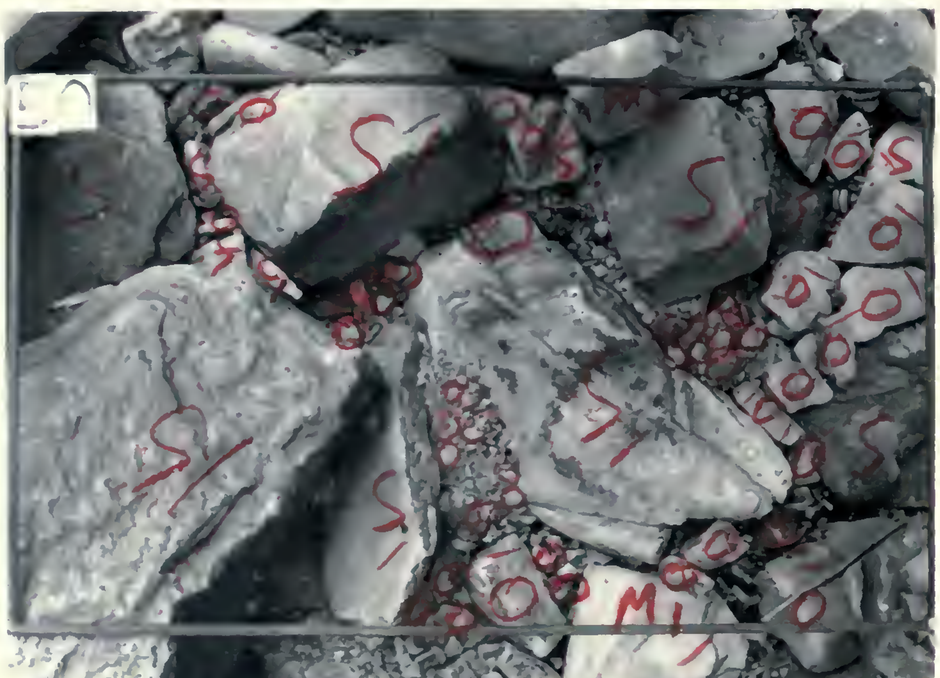
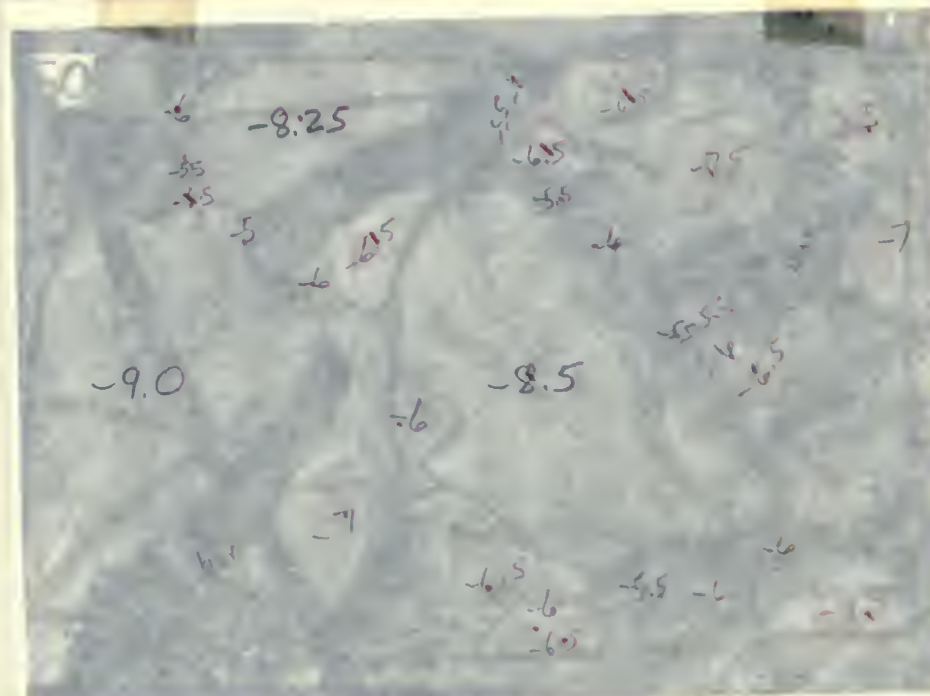
-8.5
-7.75
-8.25
-7.5

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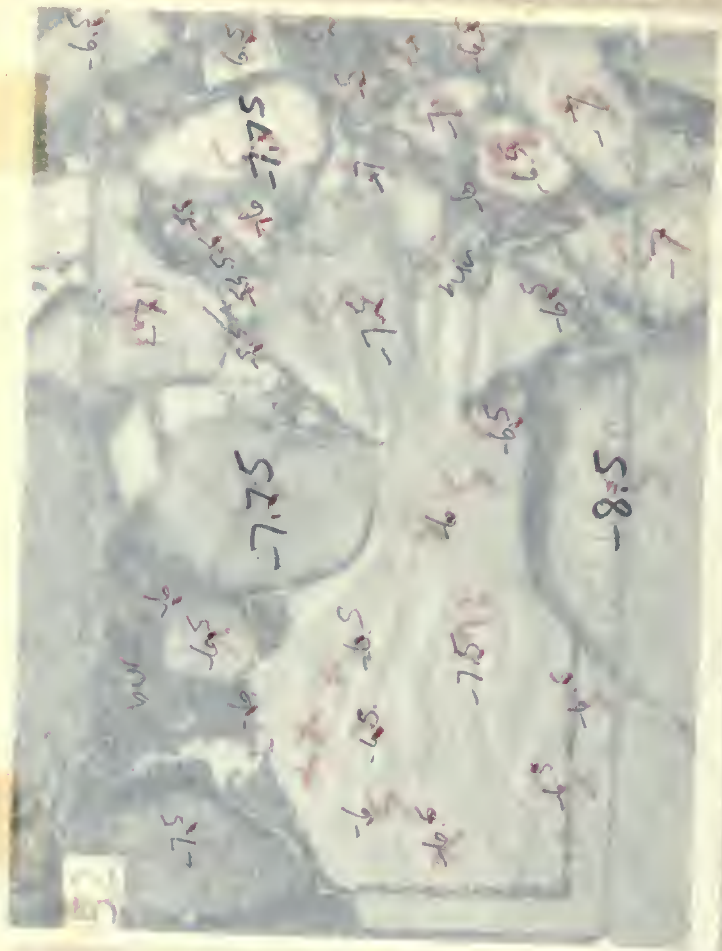

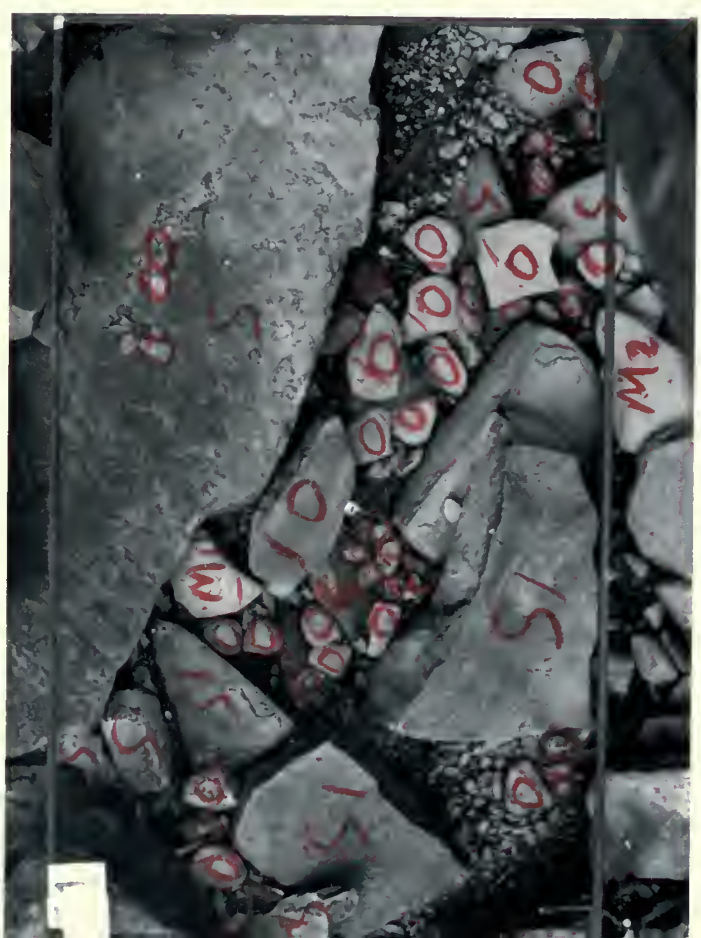

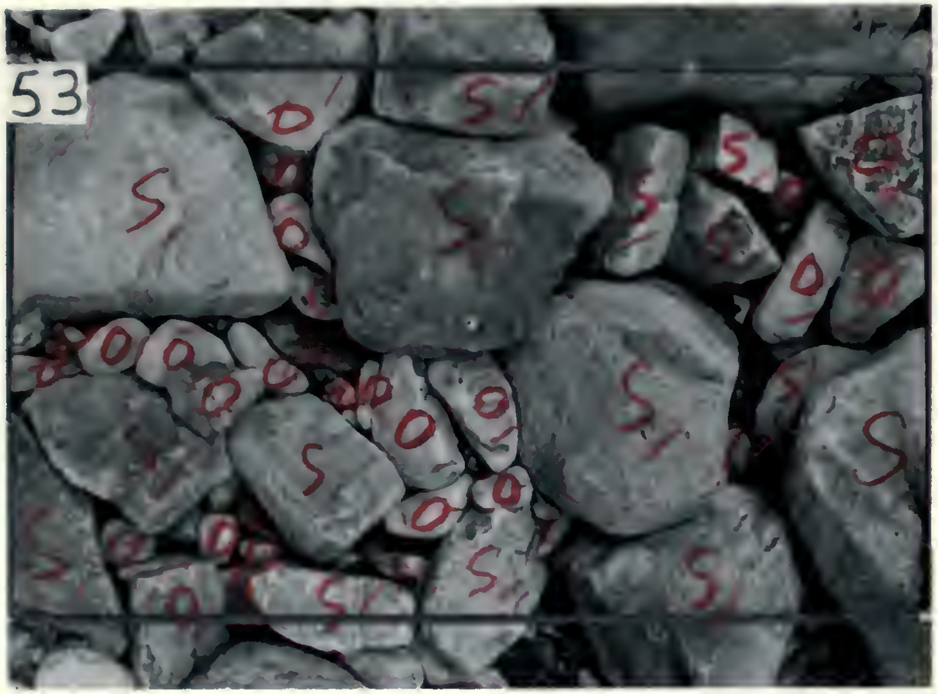
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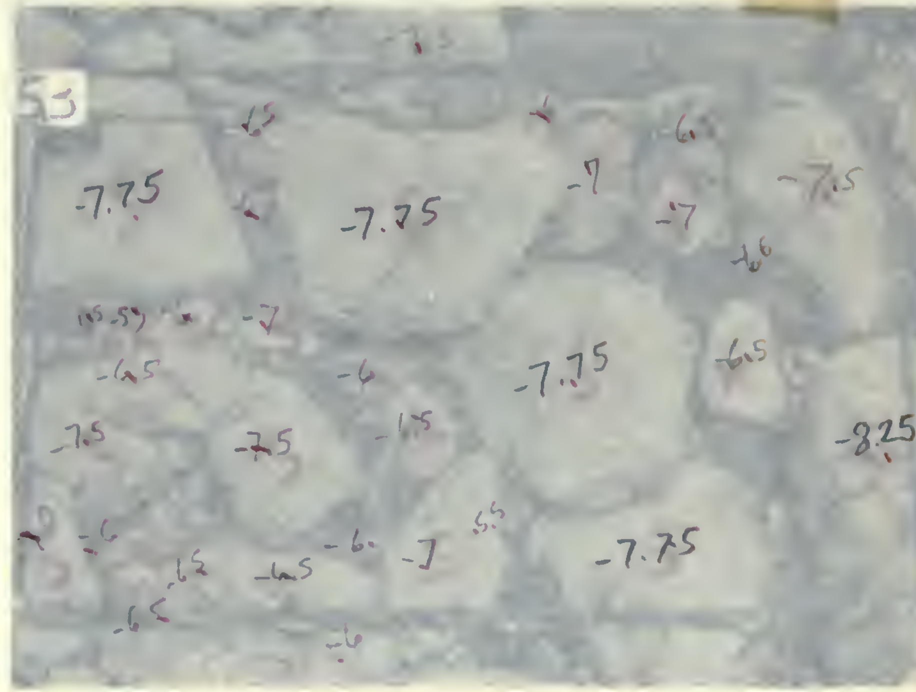
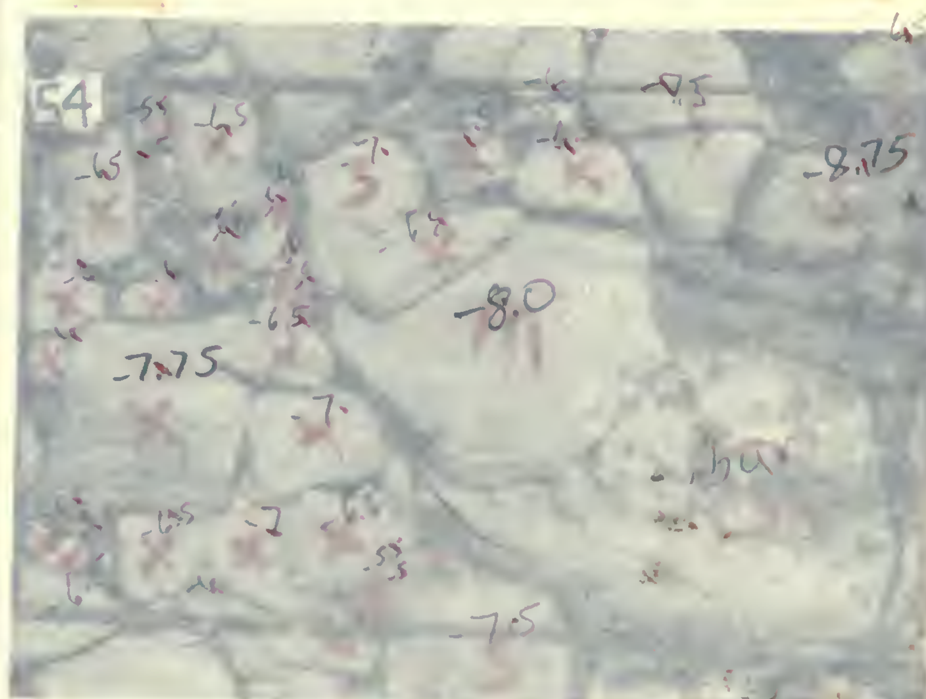

-7.75
-7.75
-7.75
-7.75
-8.25


flipped over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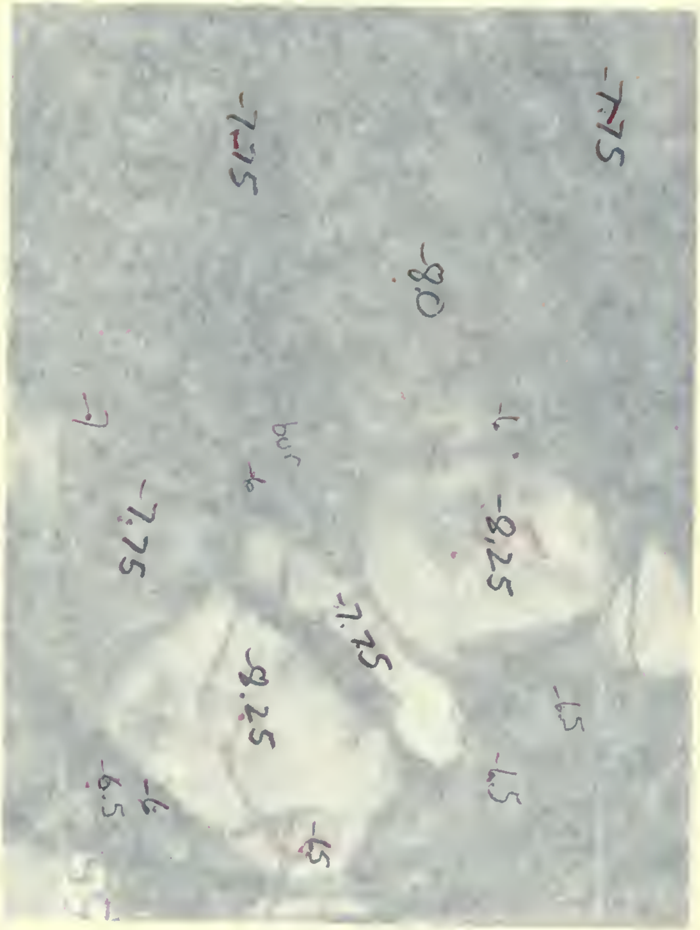

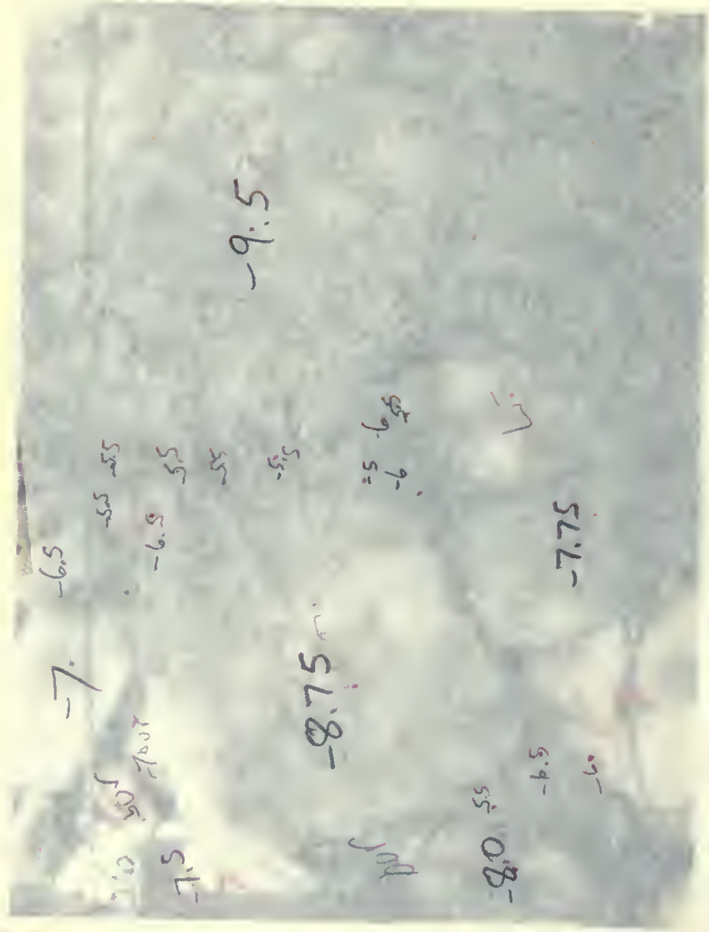

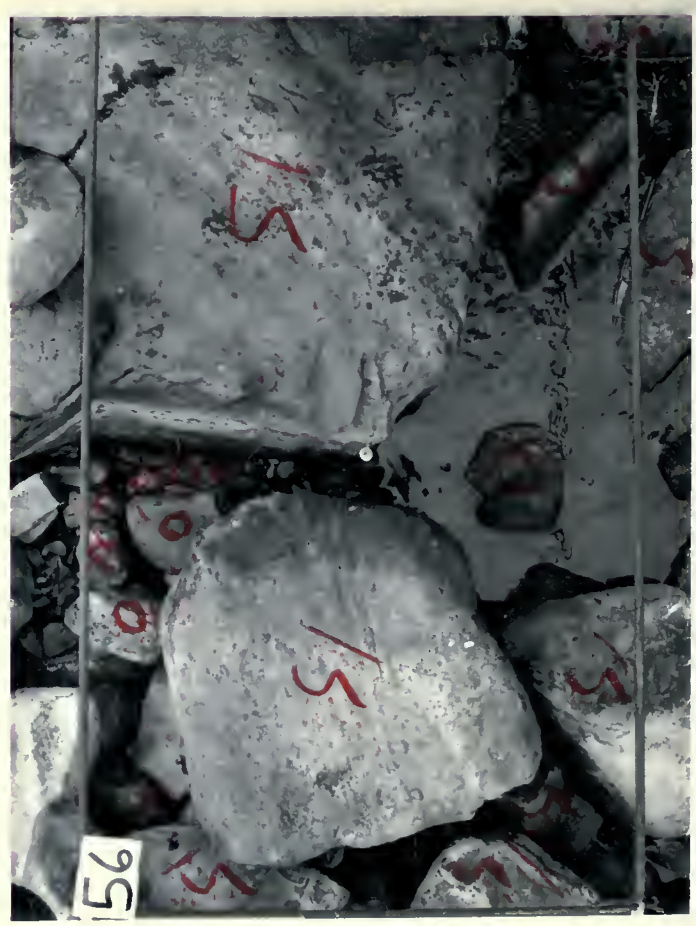

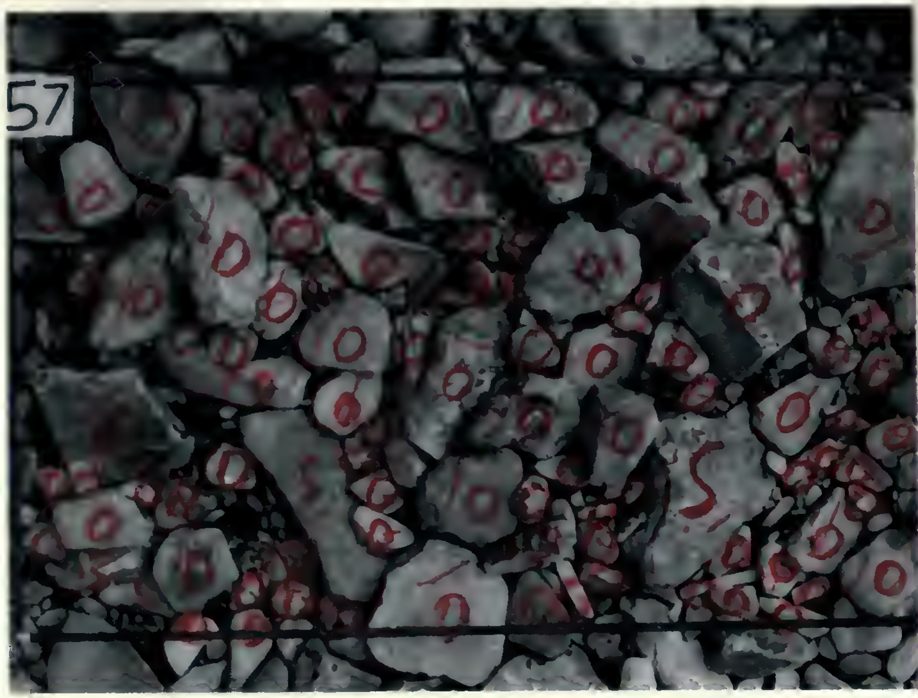
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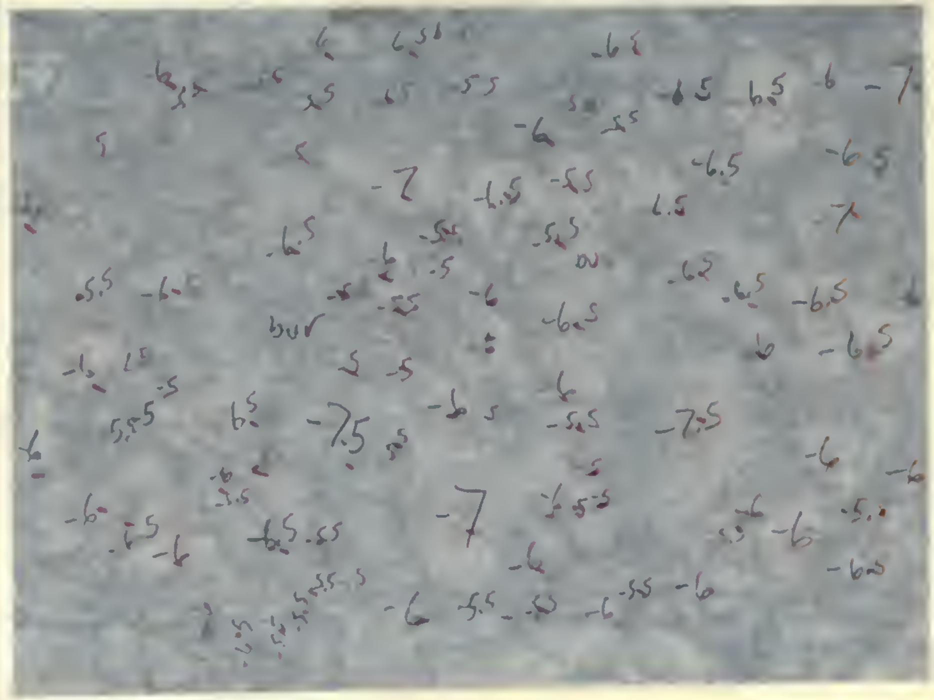

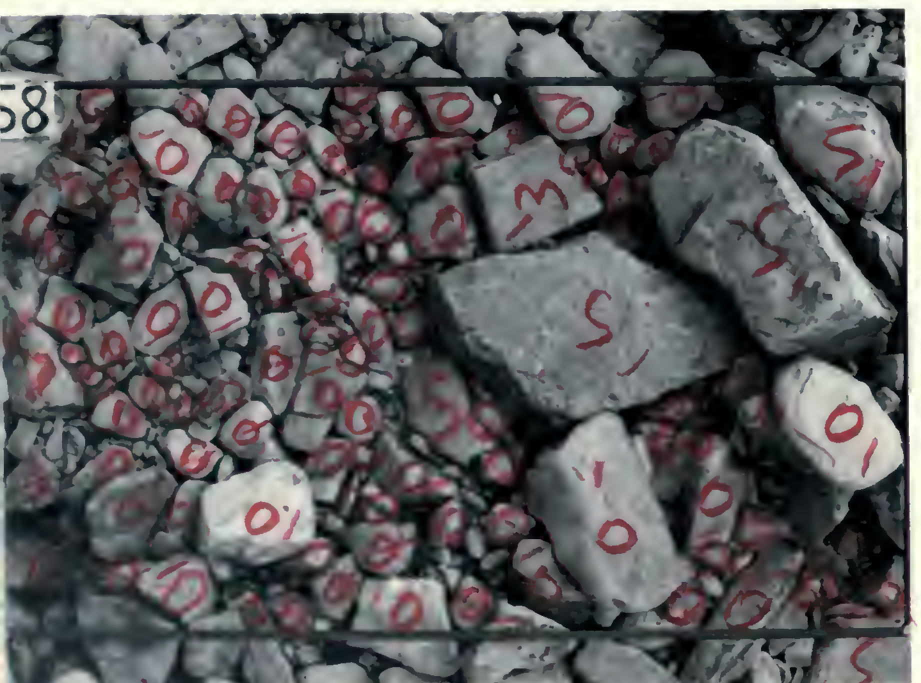
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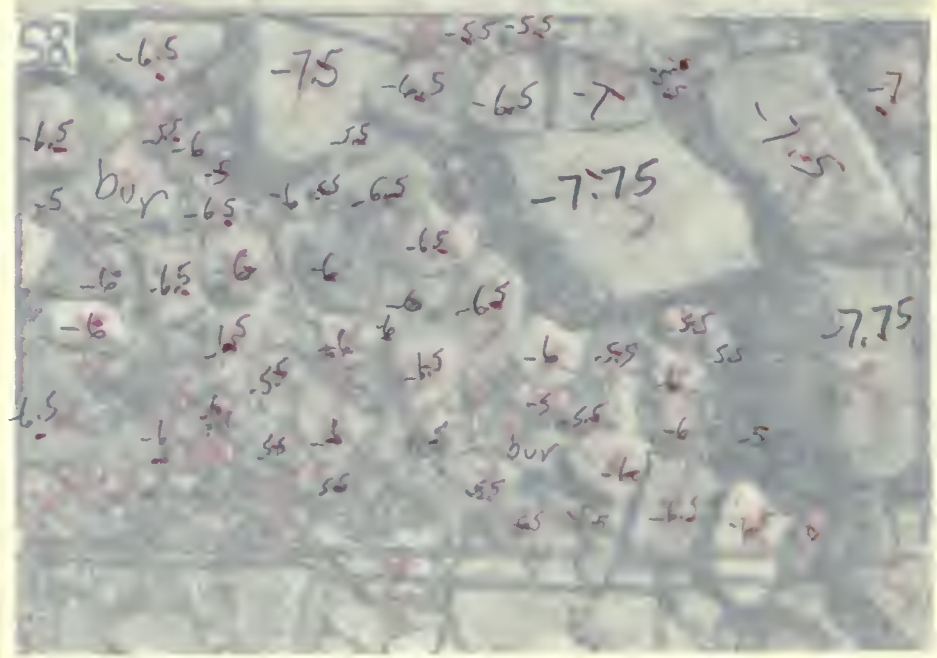
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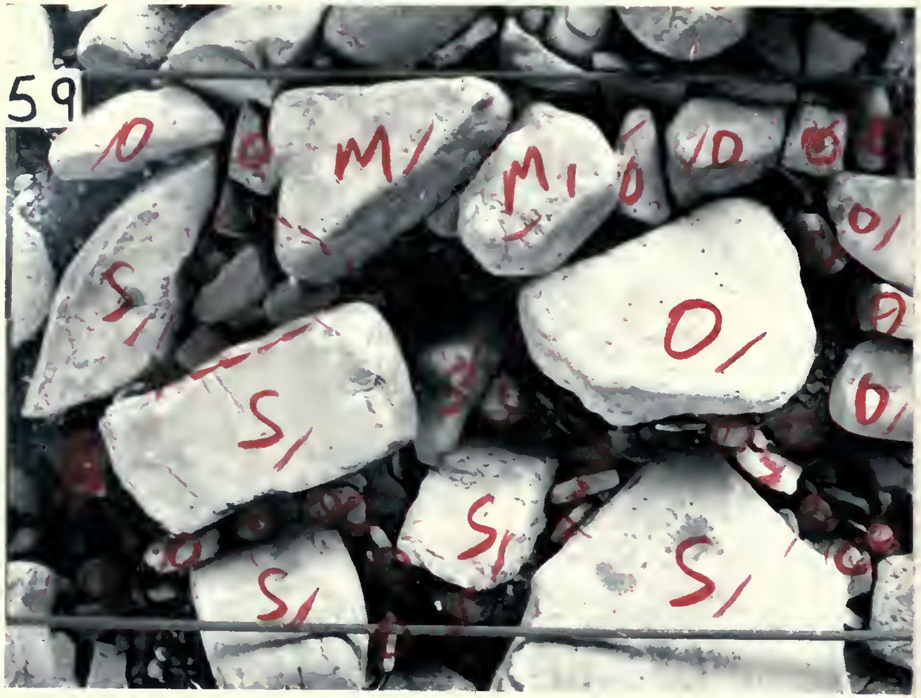
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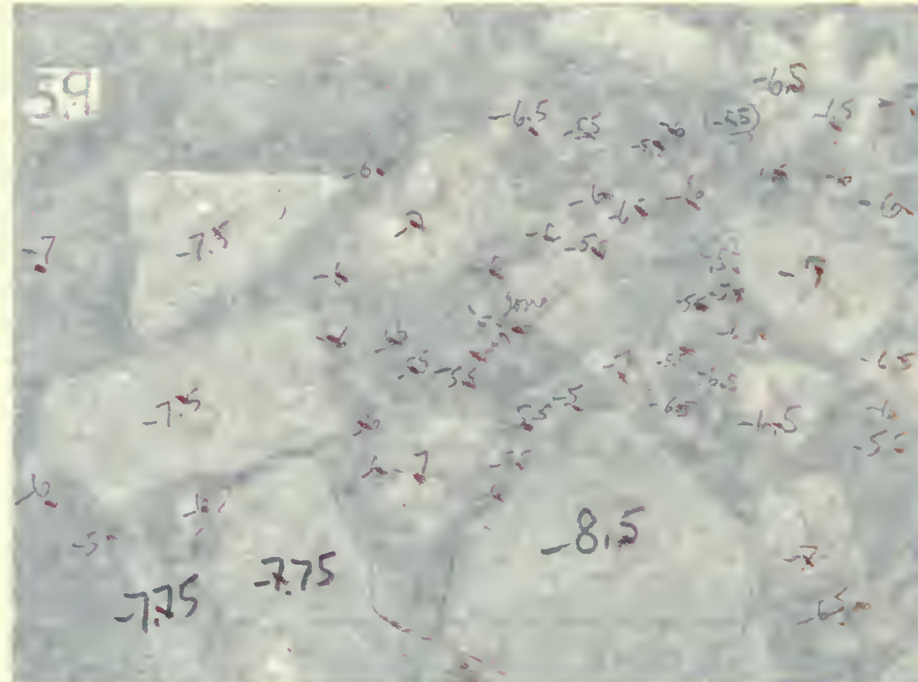
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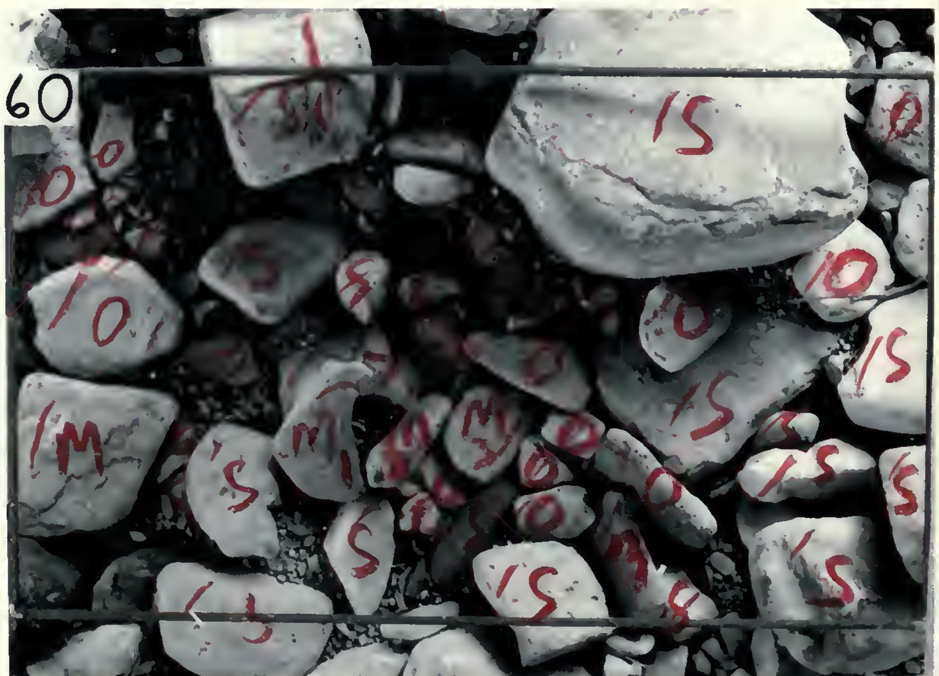
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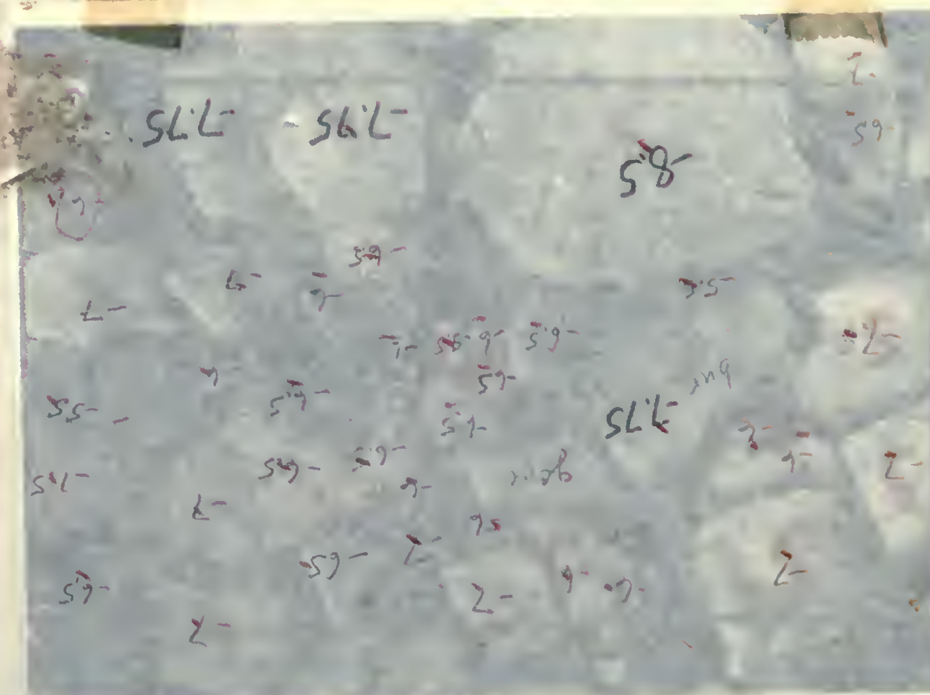

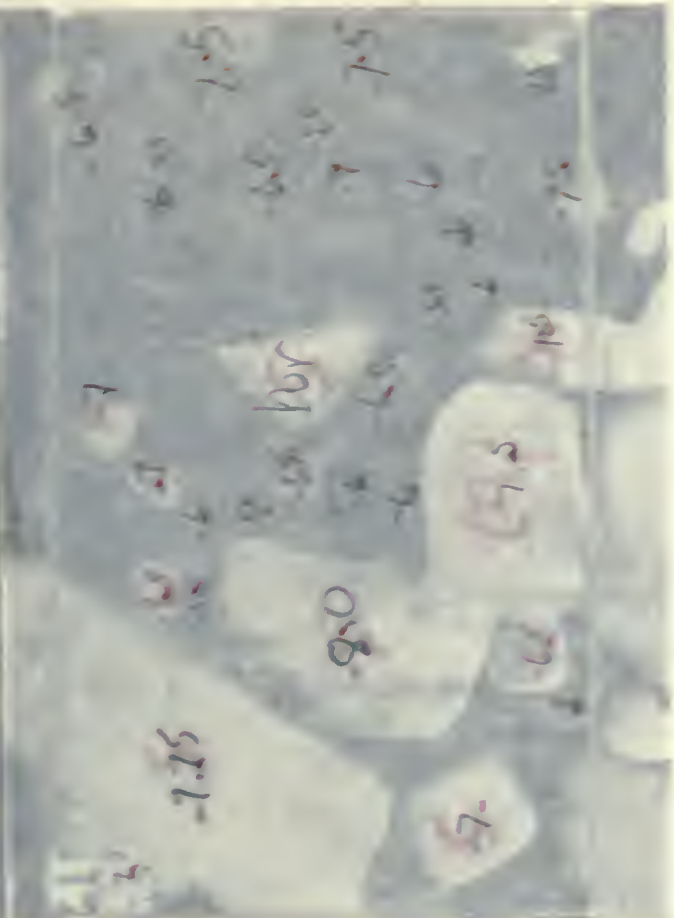
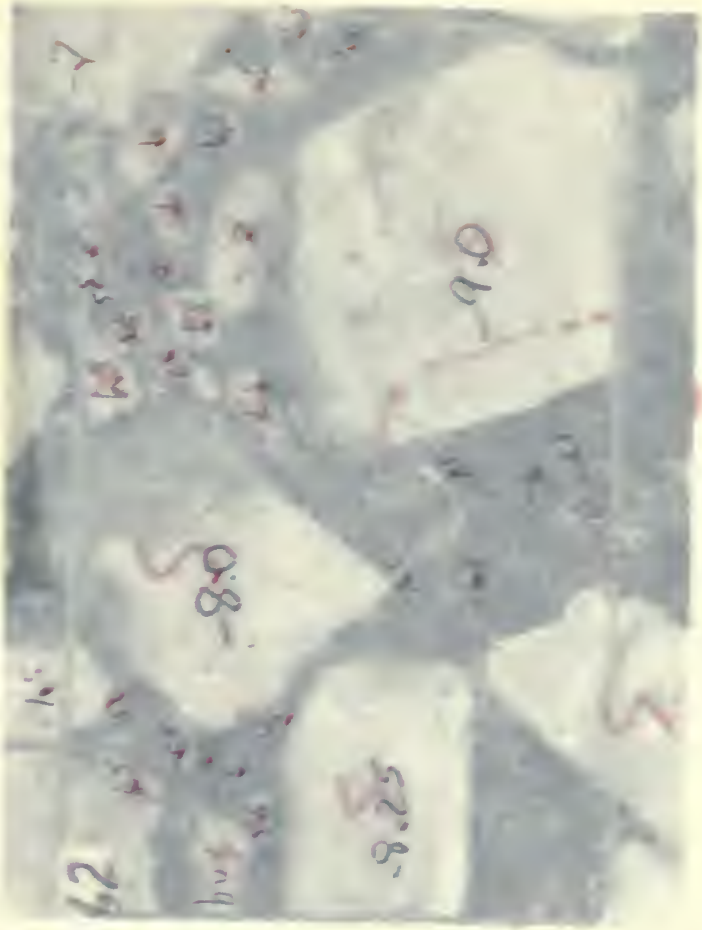

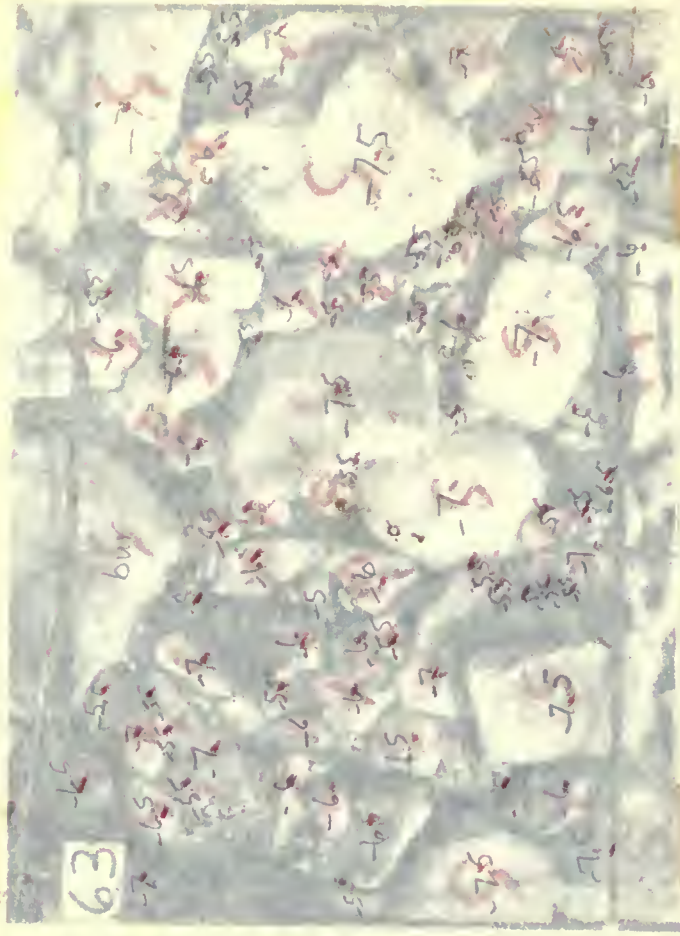

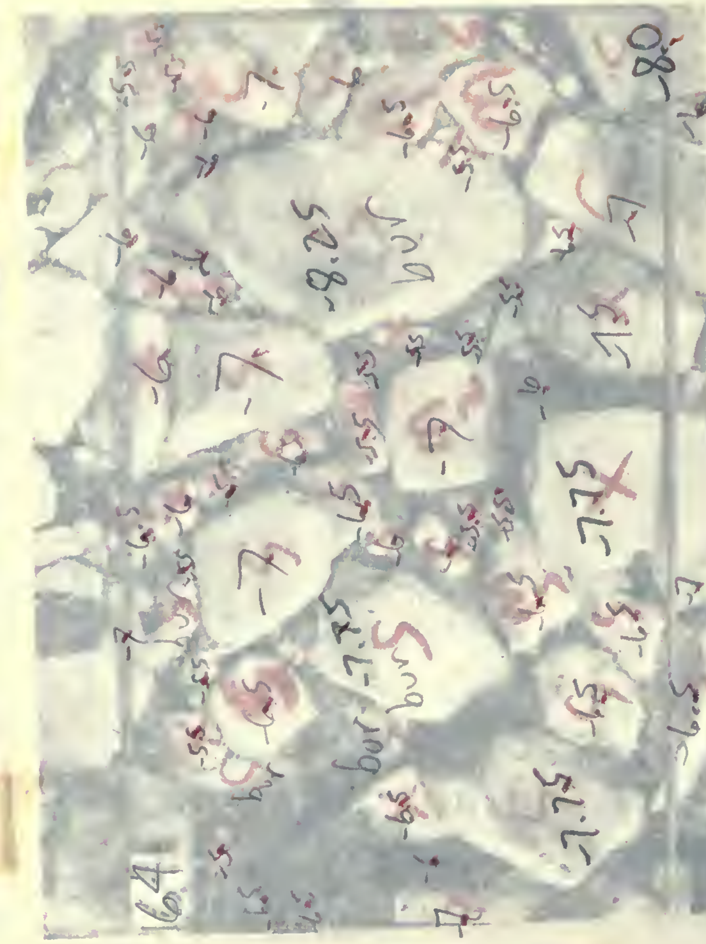

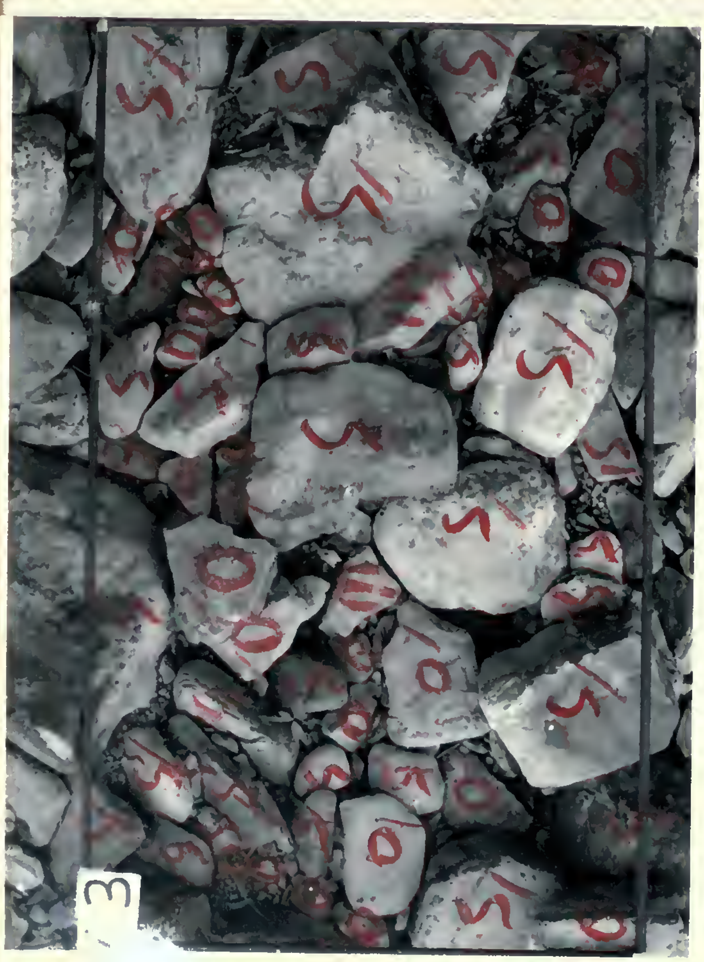

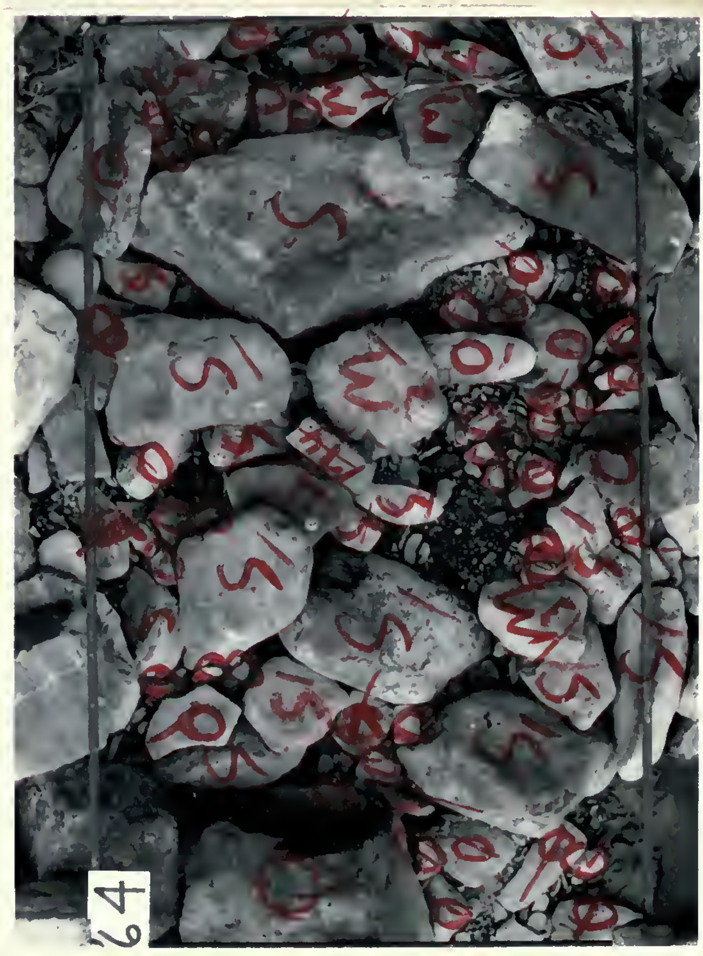

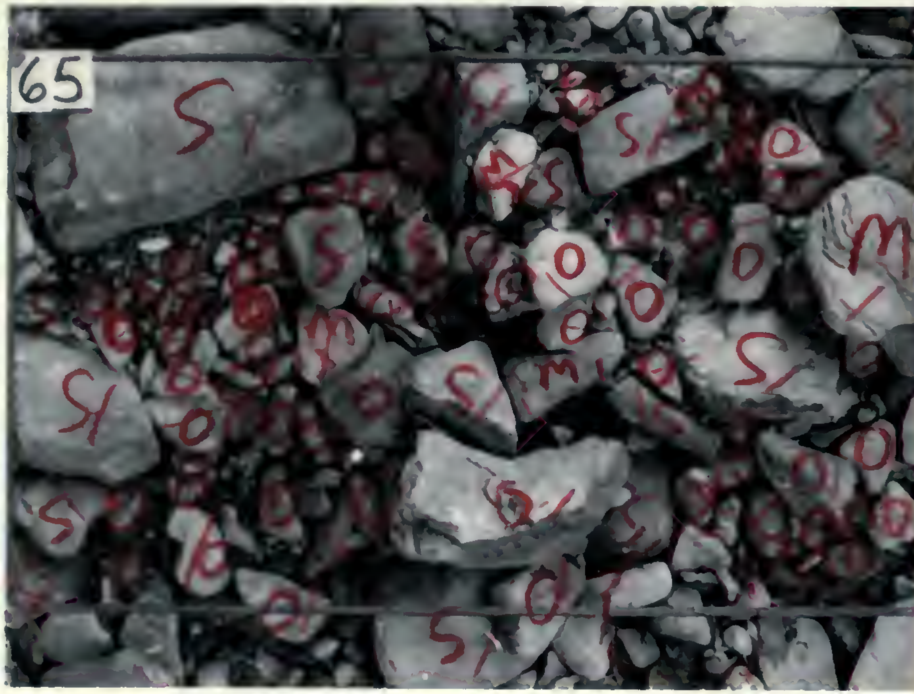
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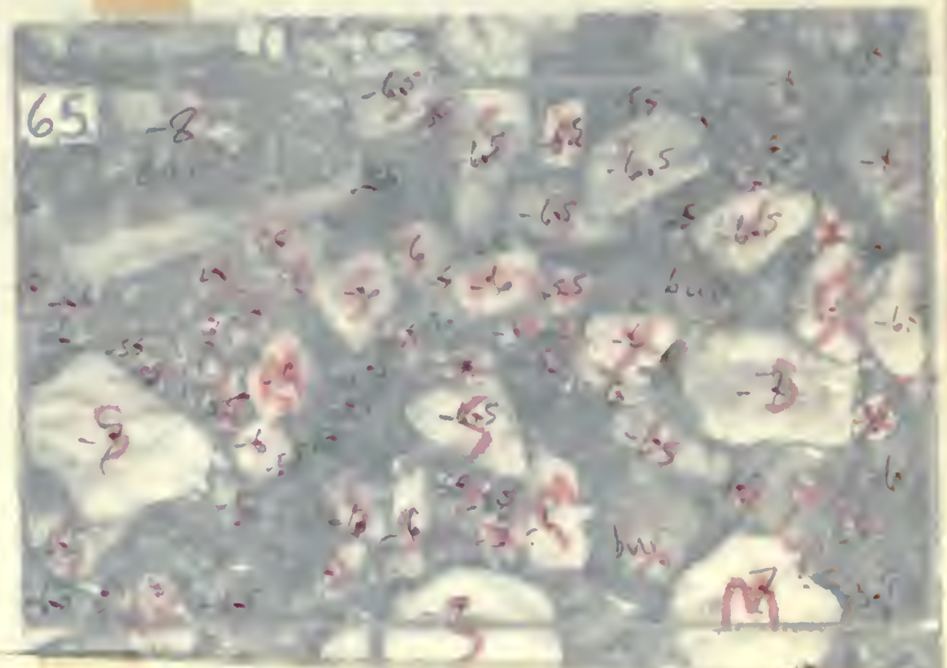
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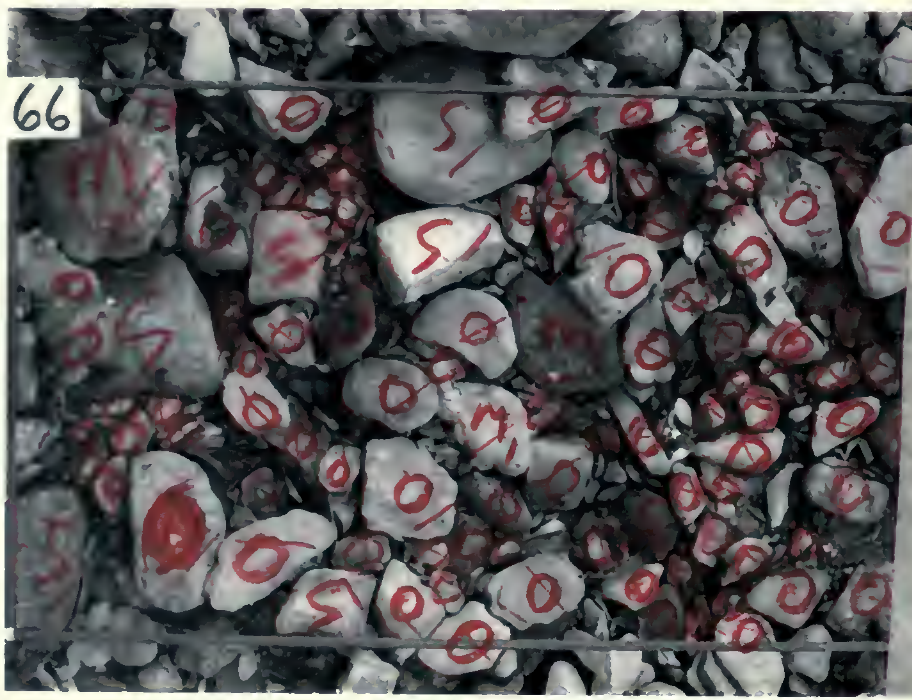
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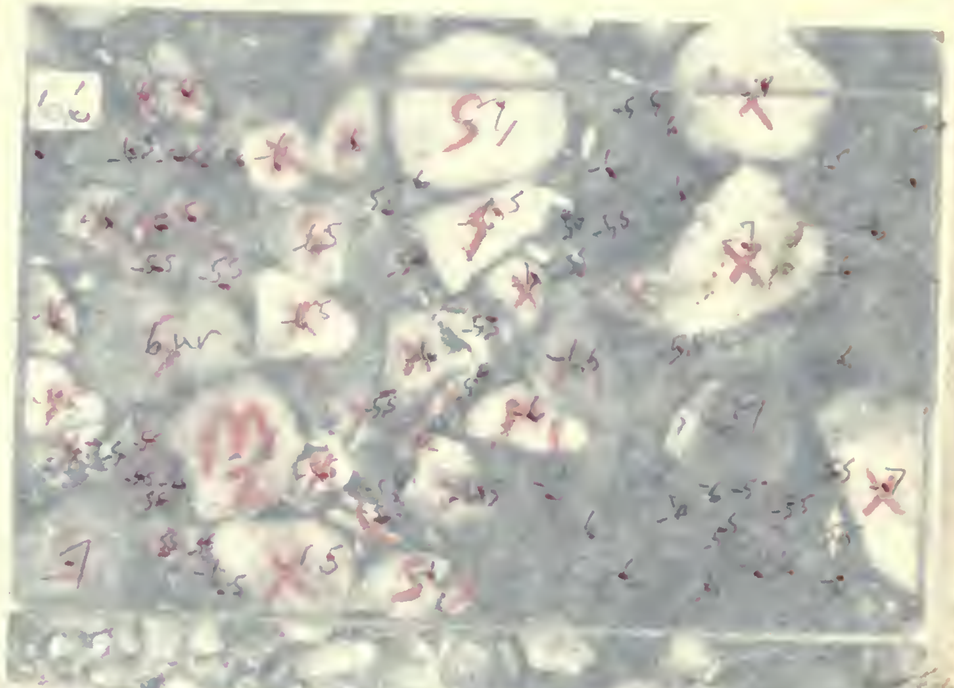
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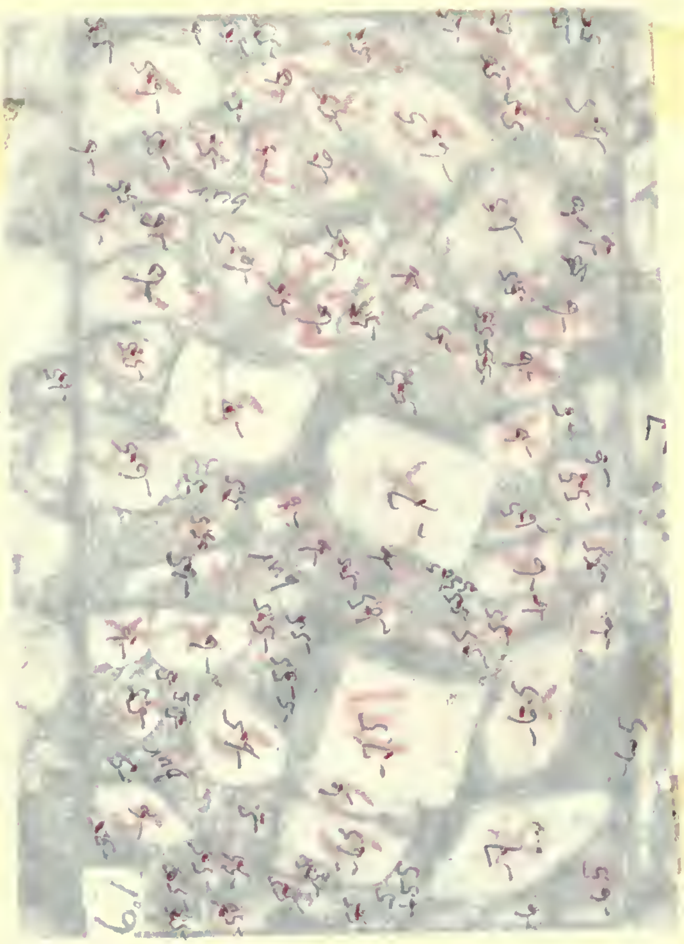

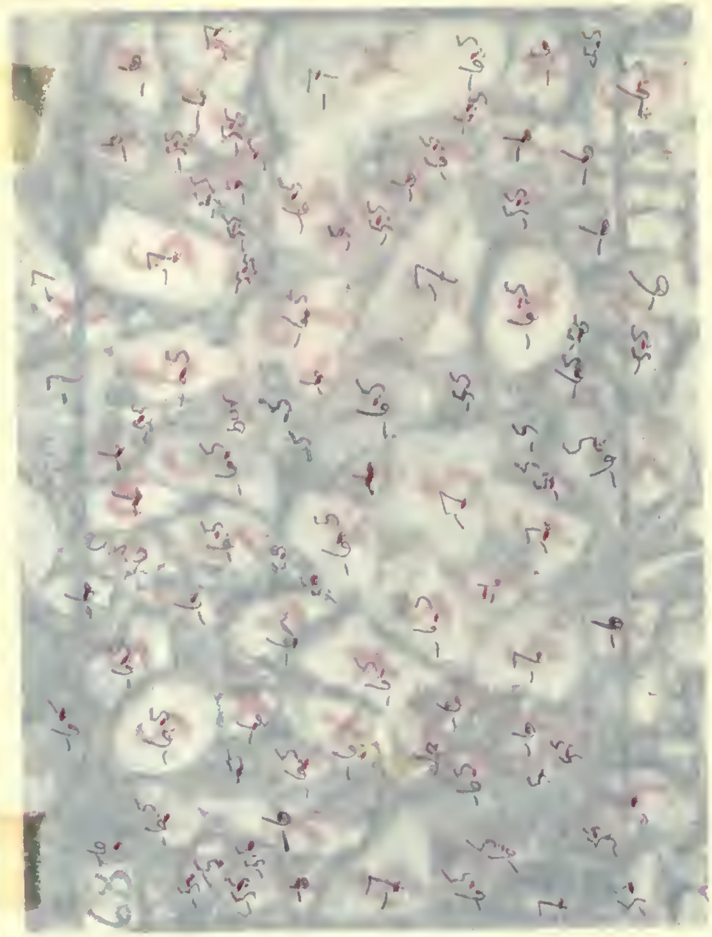

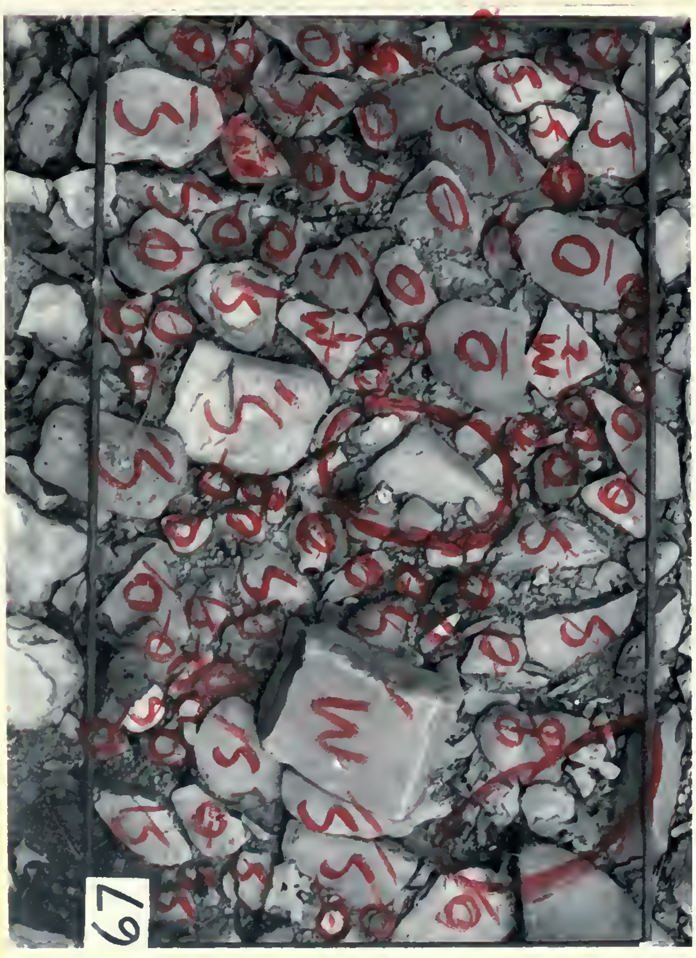
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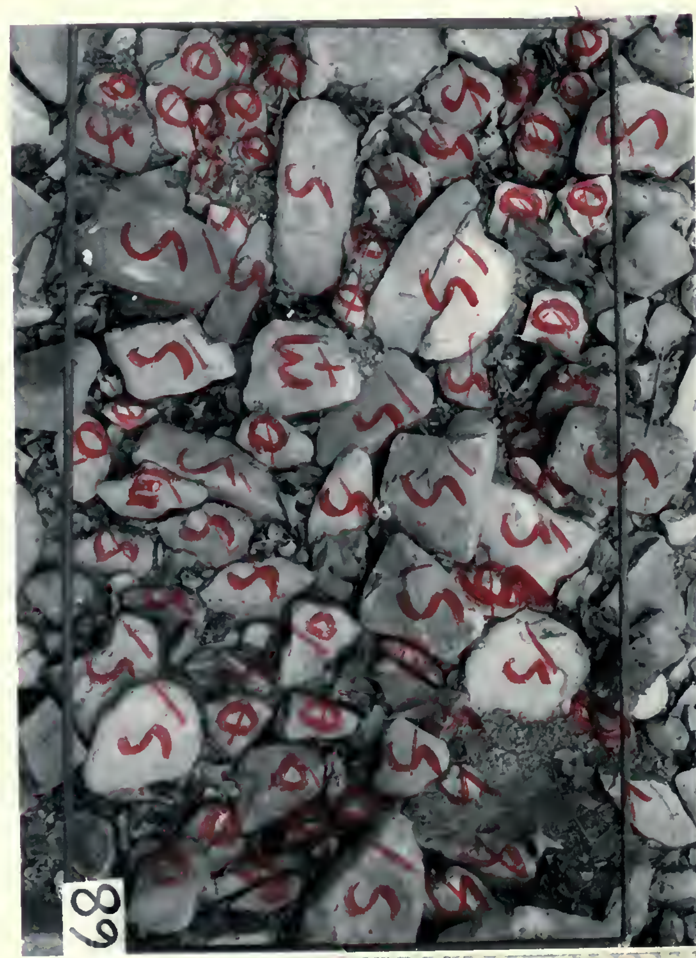
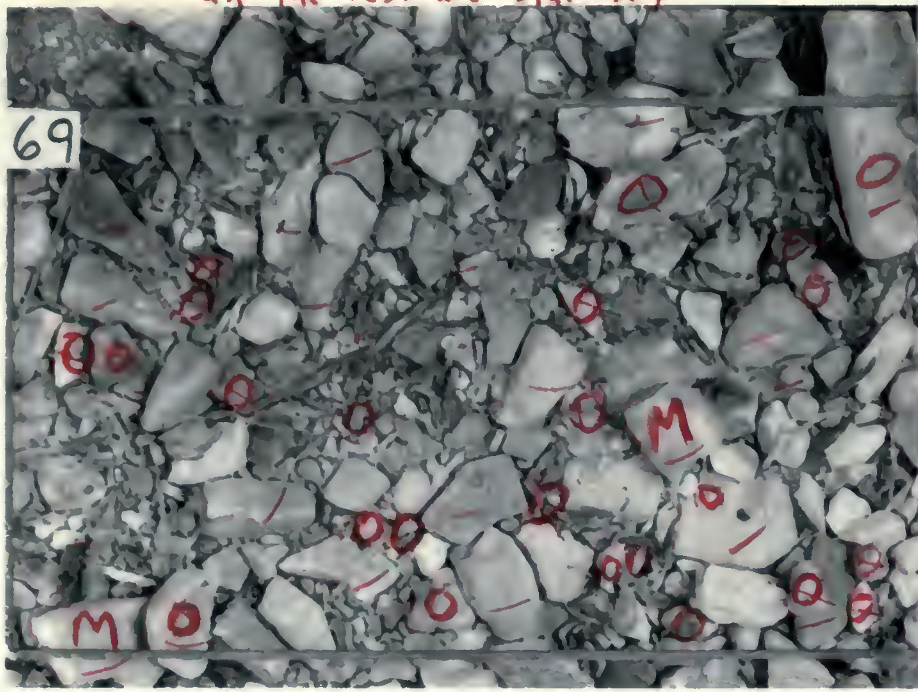
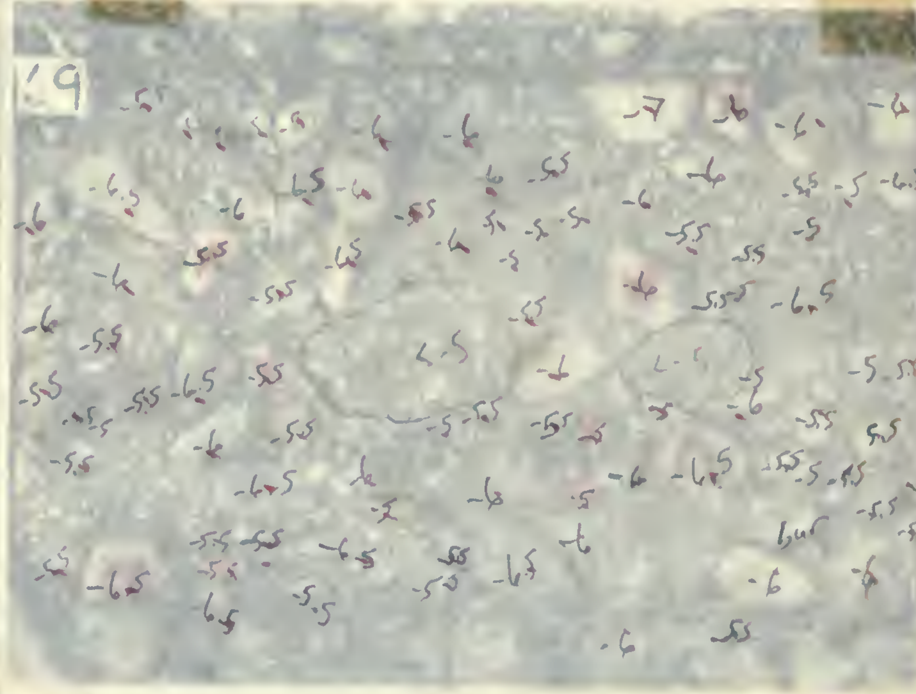
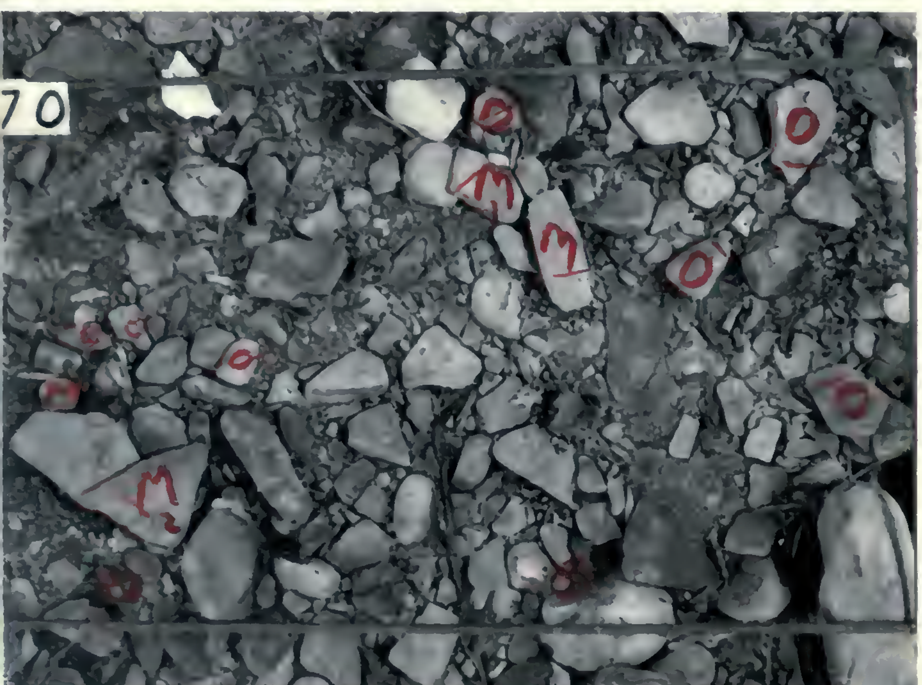
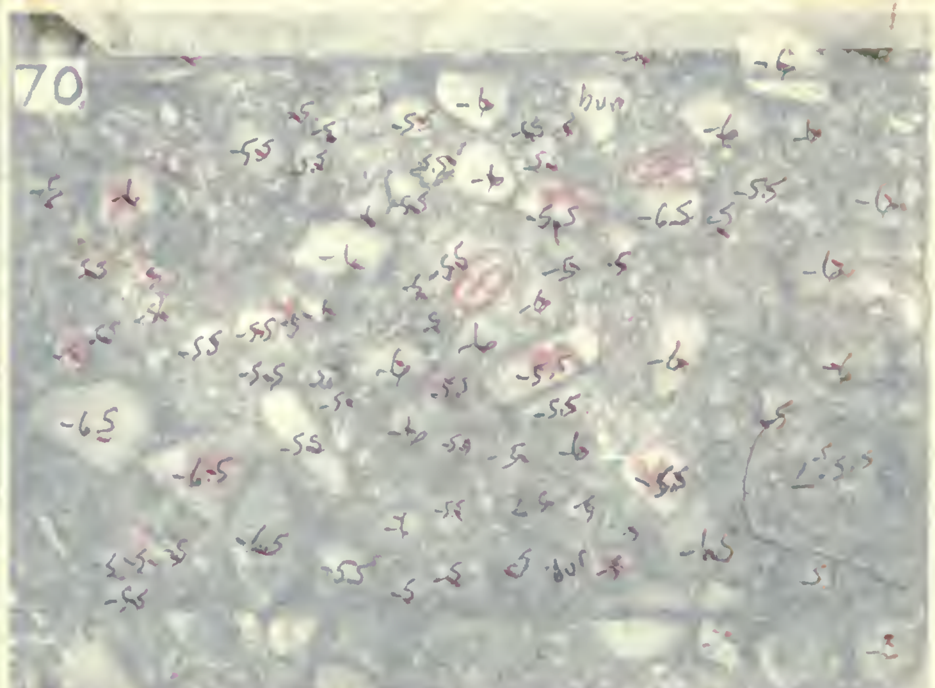

68

all the rest are stationary

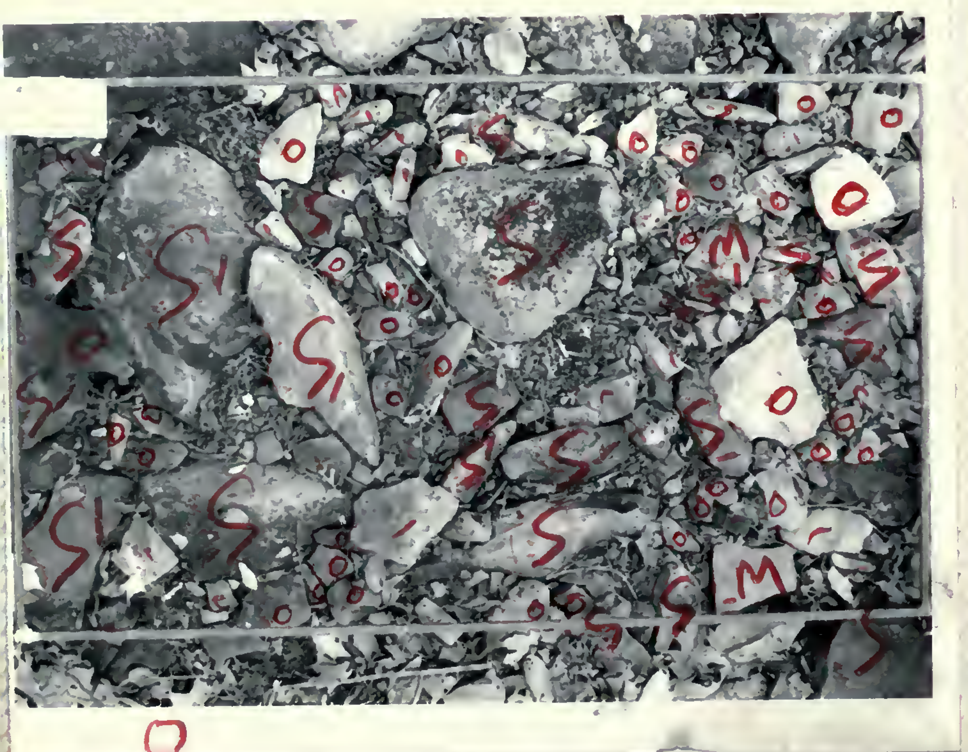


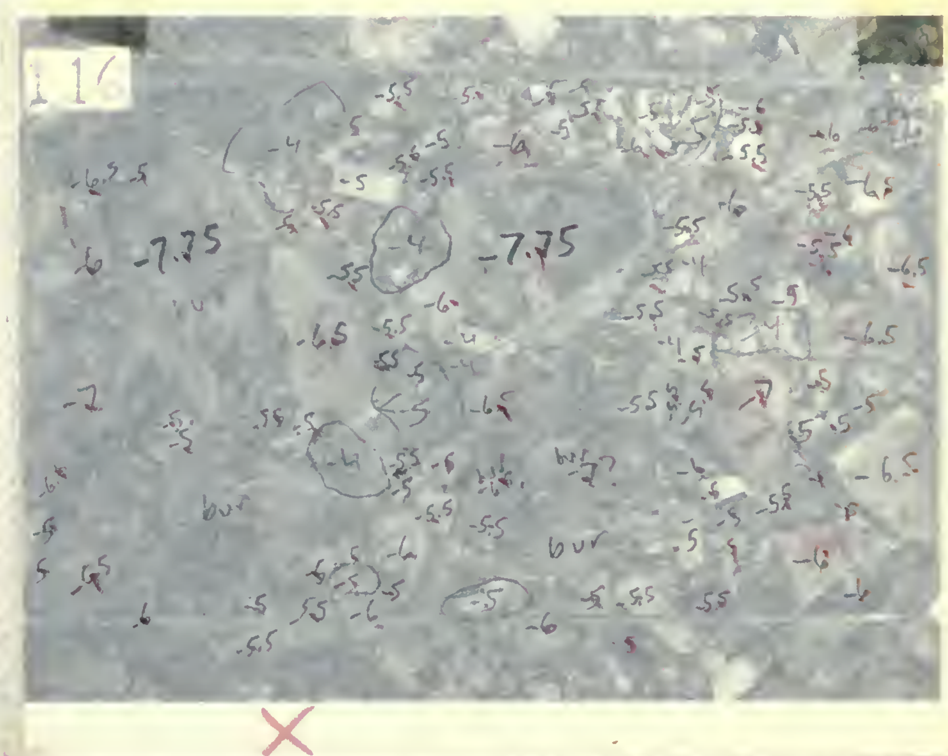




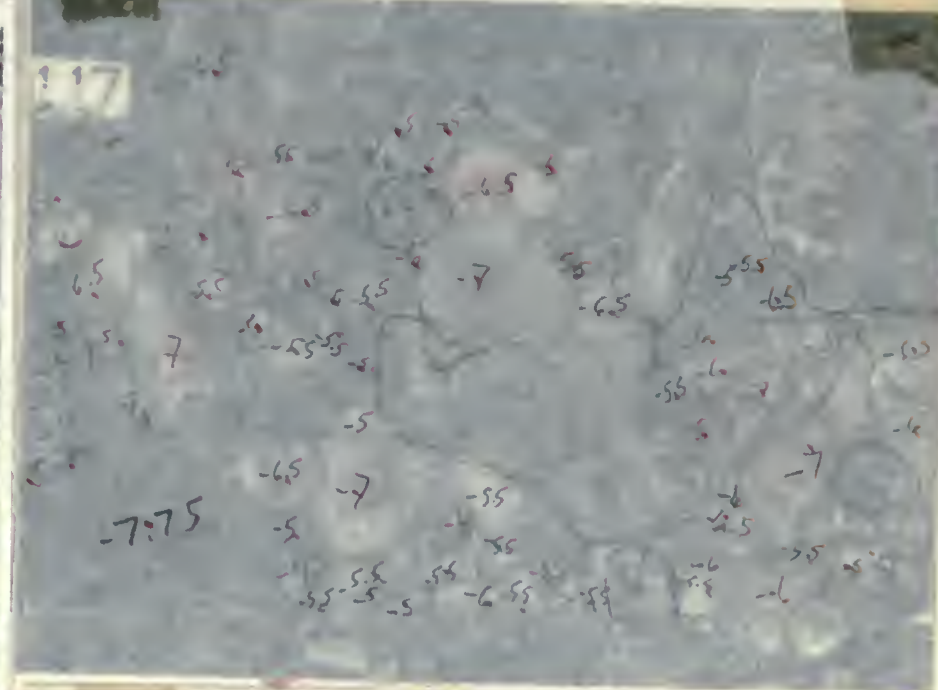


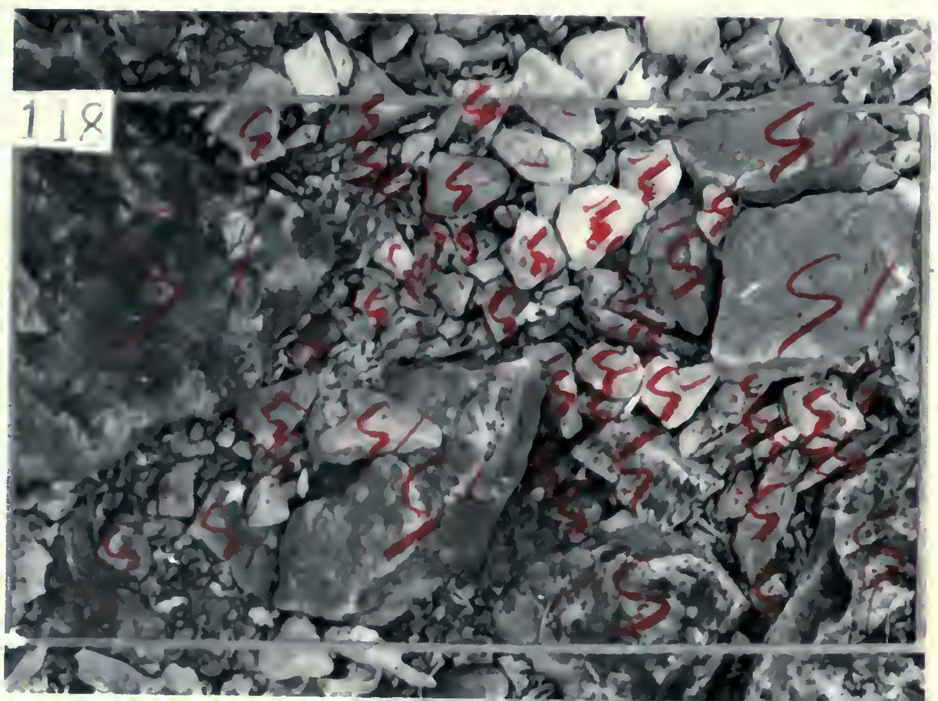
Photographs of Sixteen Mile Creek
Before (left side) and After (right side)
the 1982-83 Snow-melt






117


117
-7.75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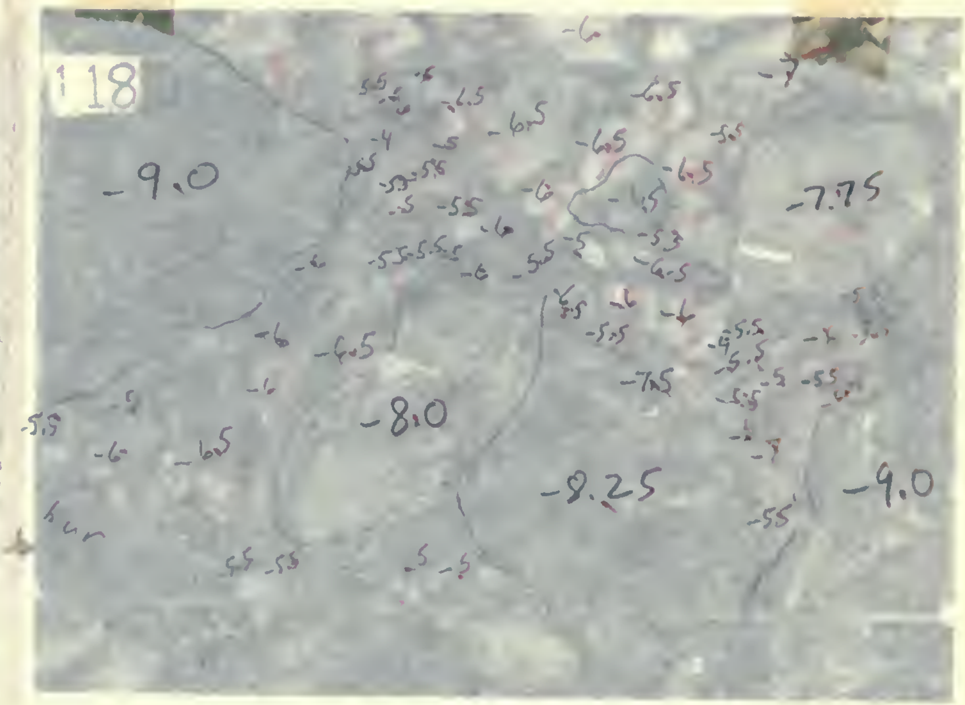
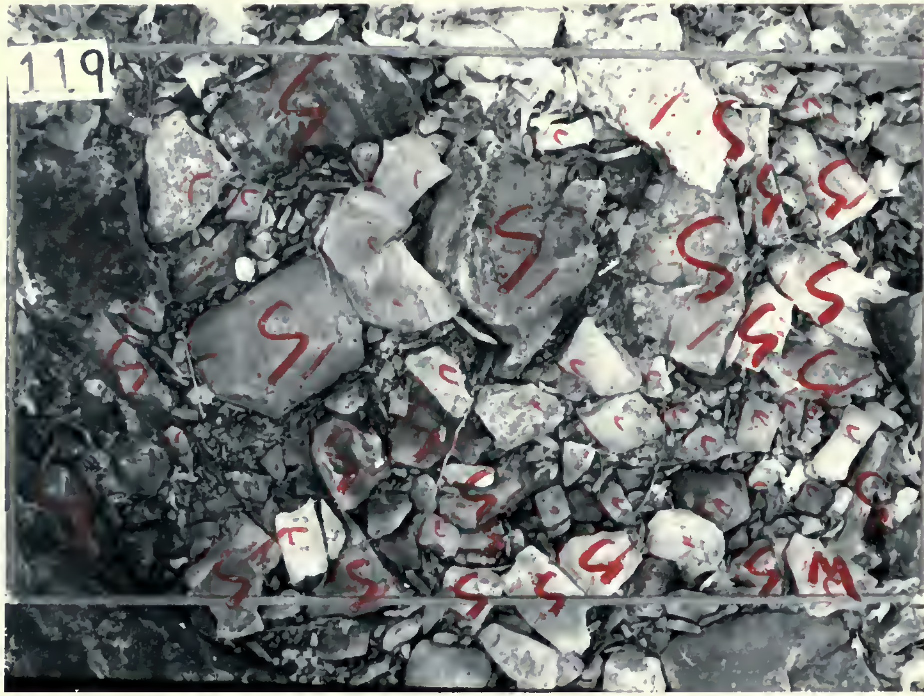

118
-9.0
-7.75
-8.0
-8.25
-9.0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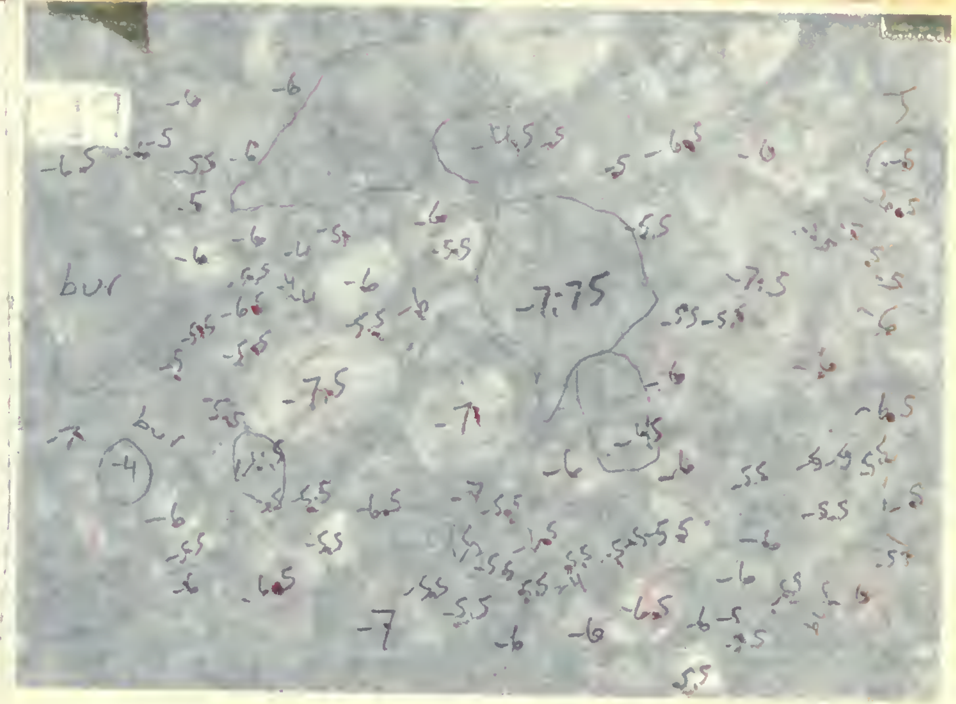

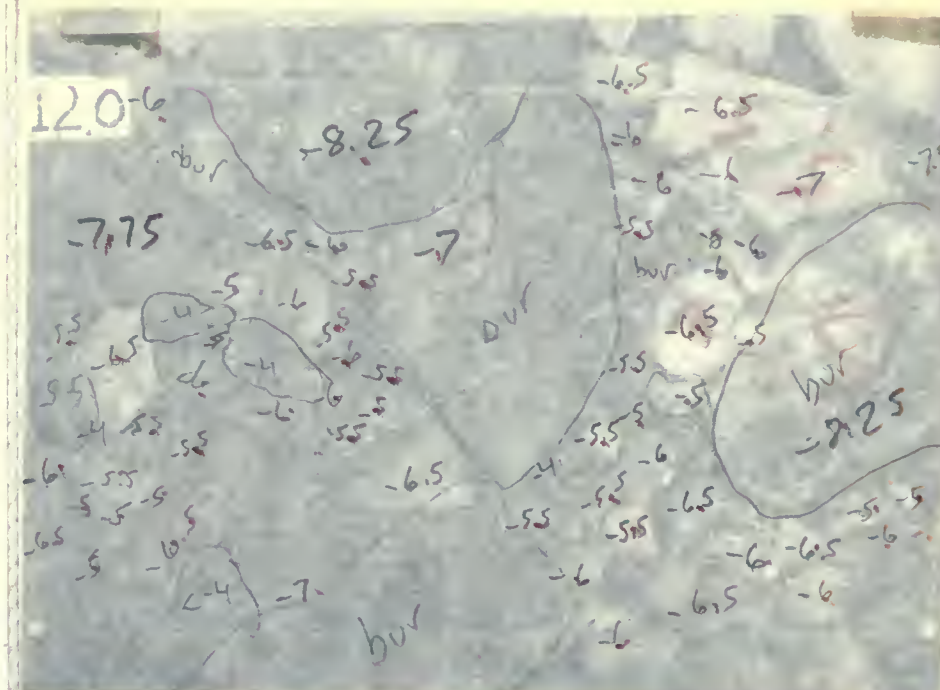
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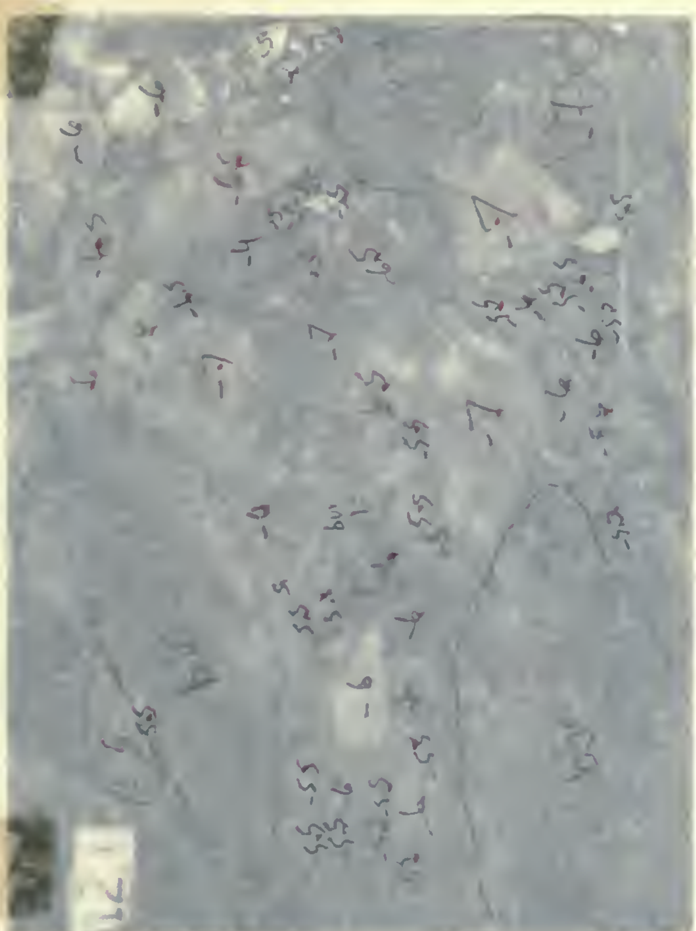

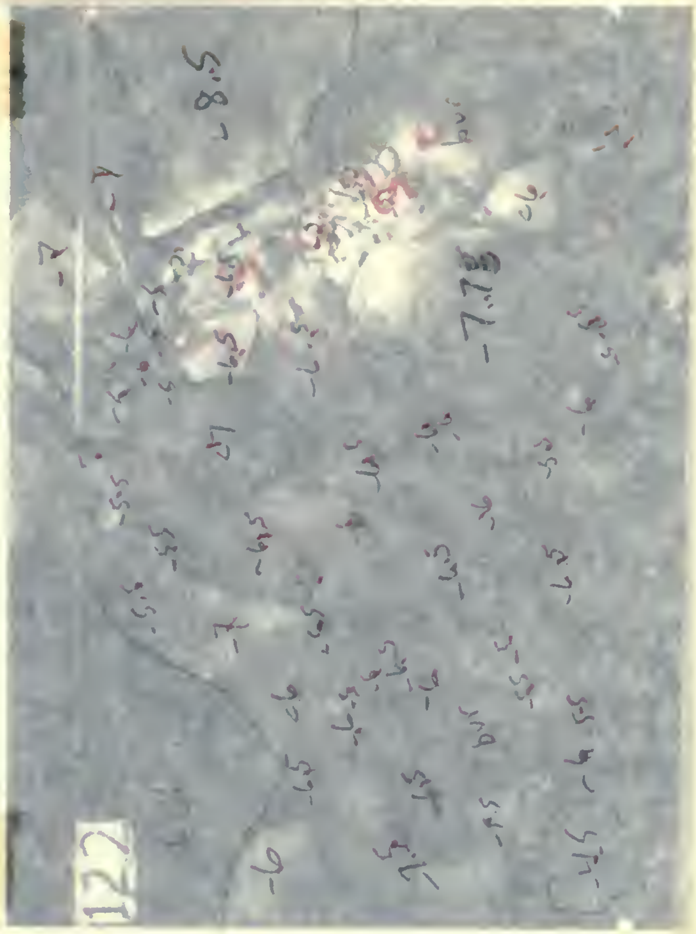

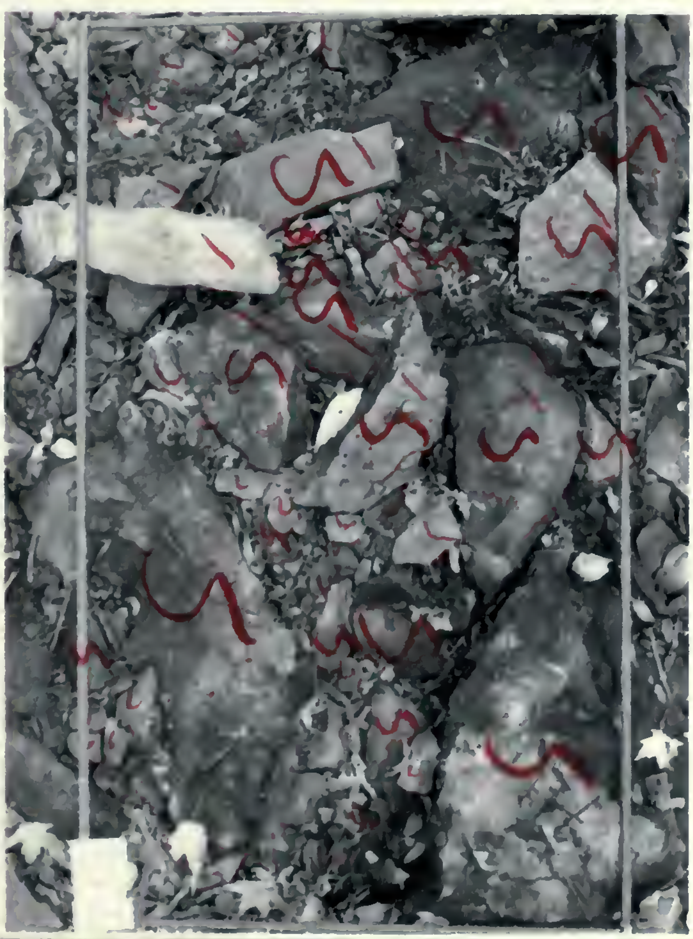

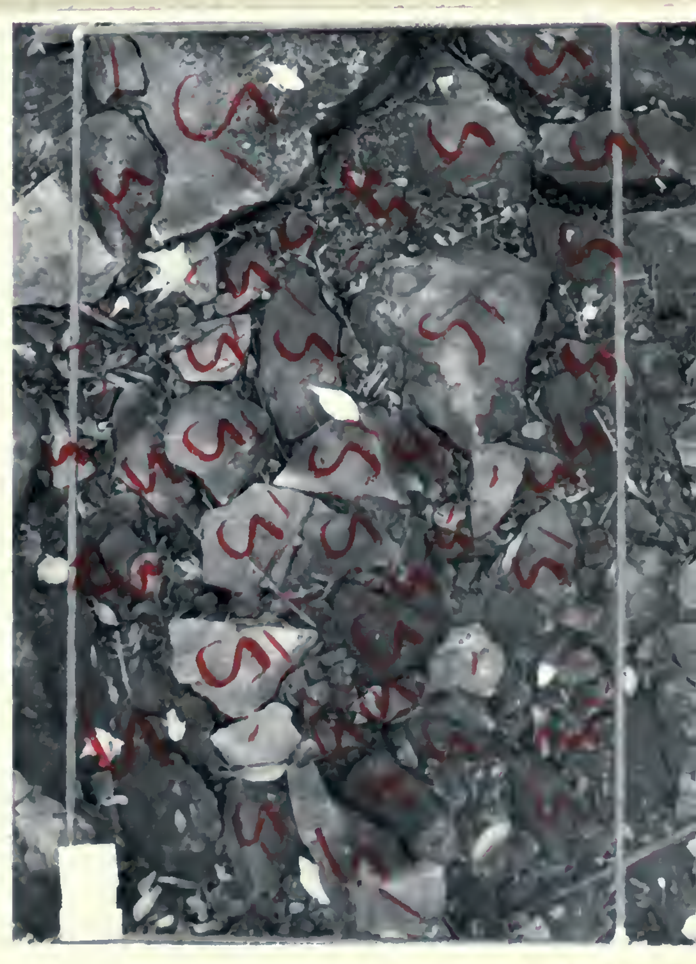

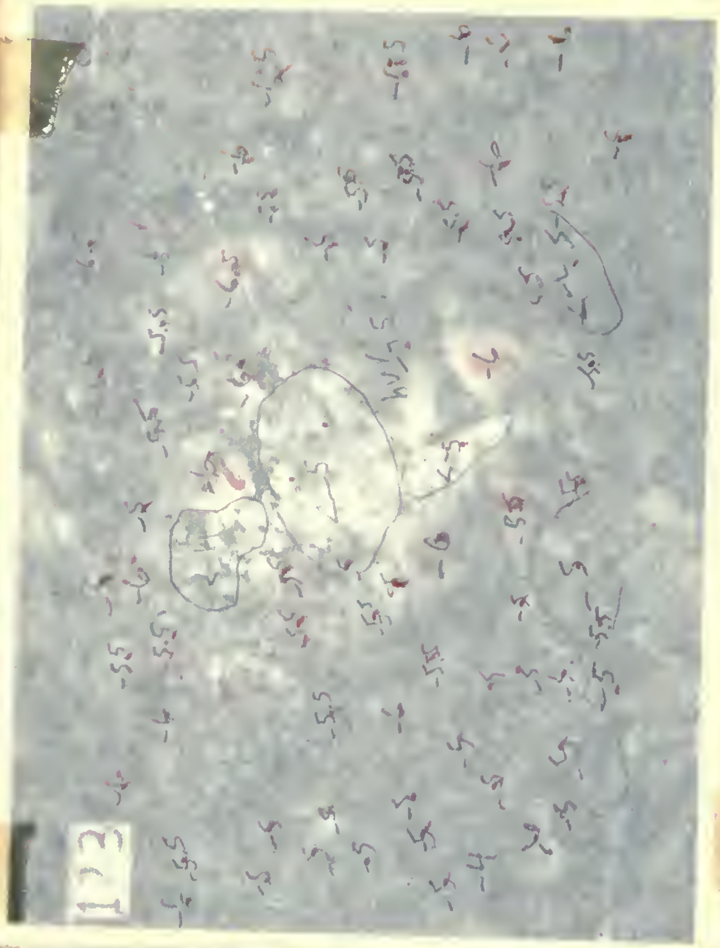

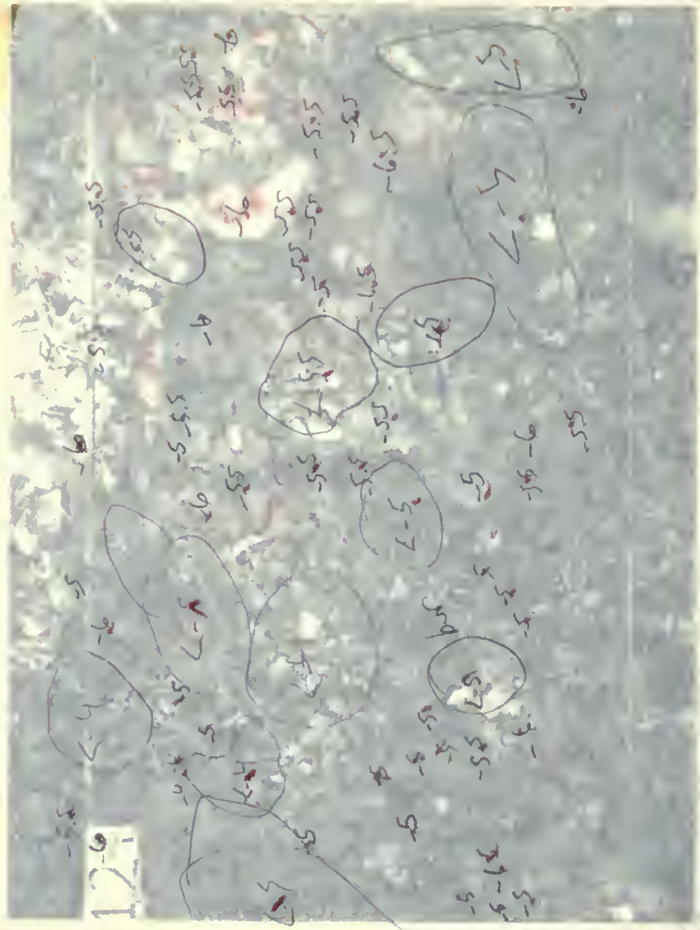

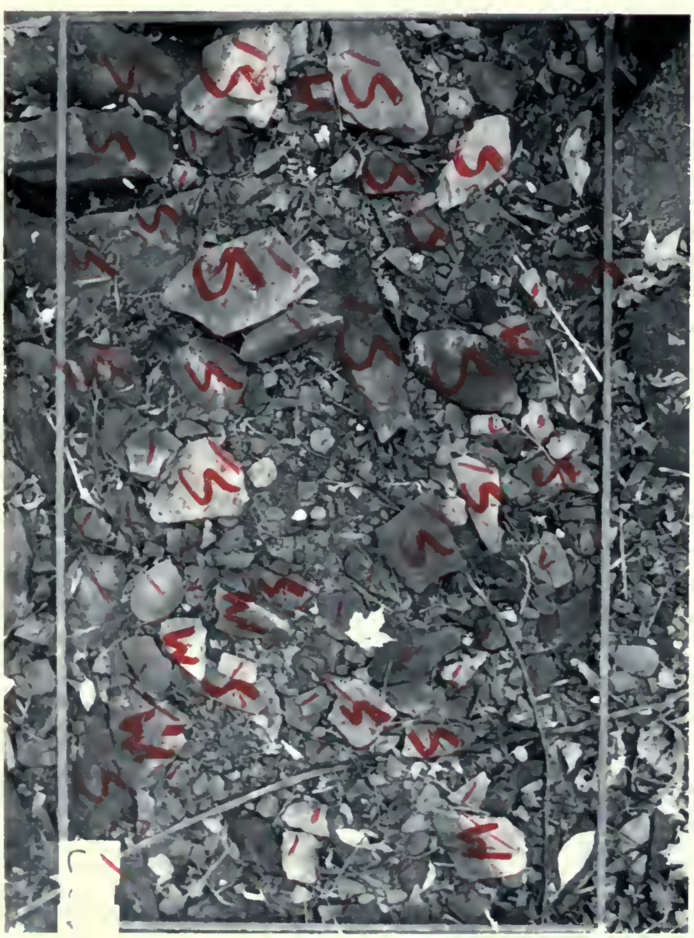

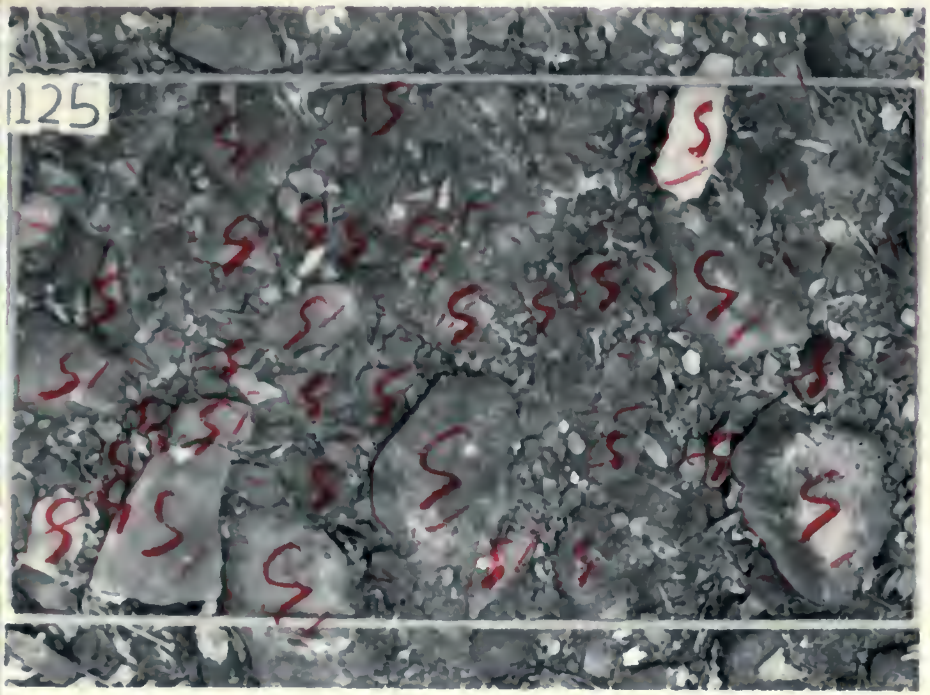
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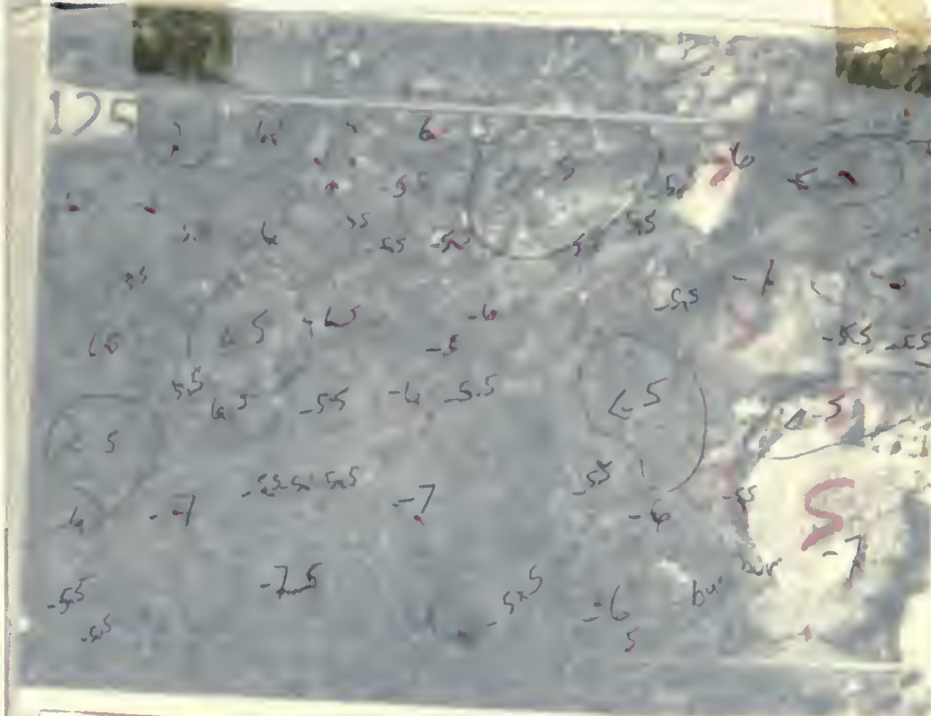

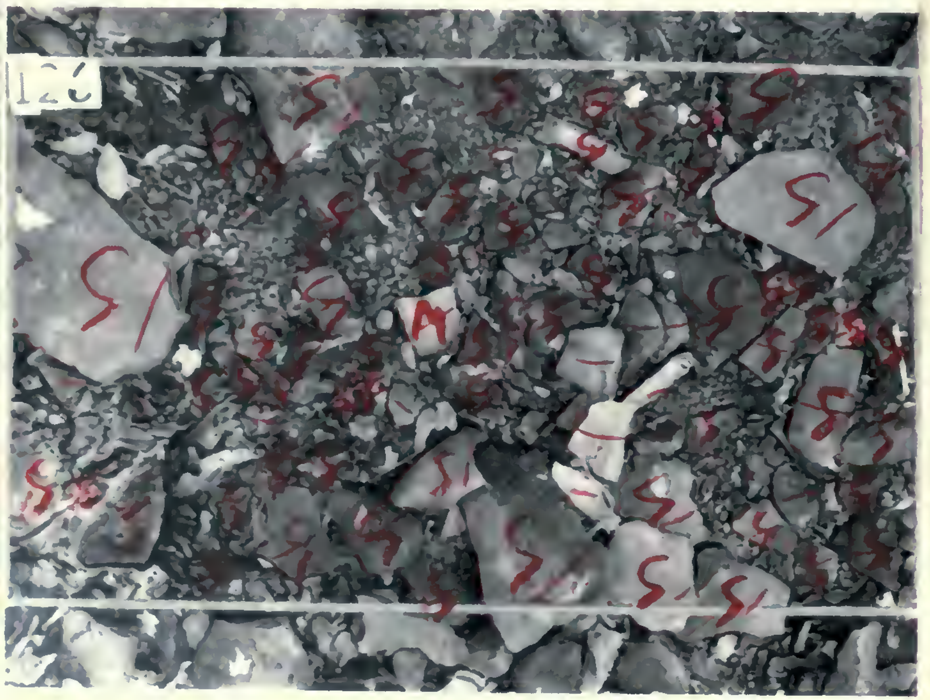

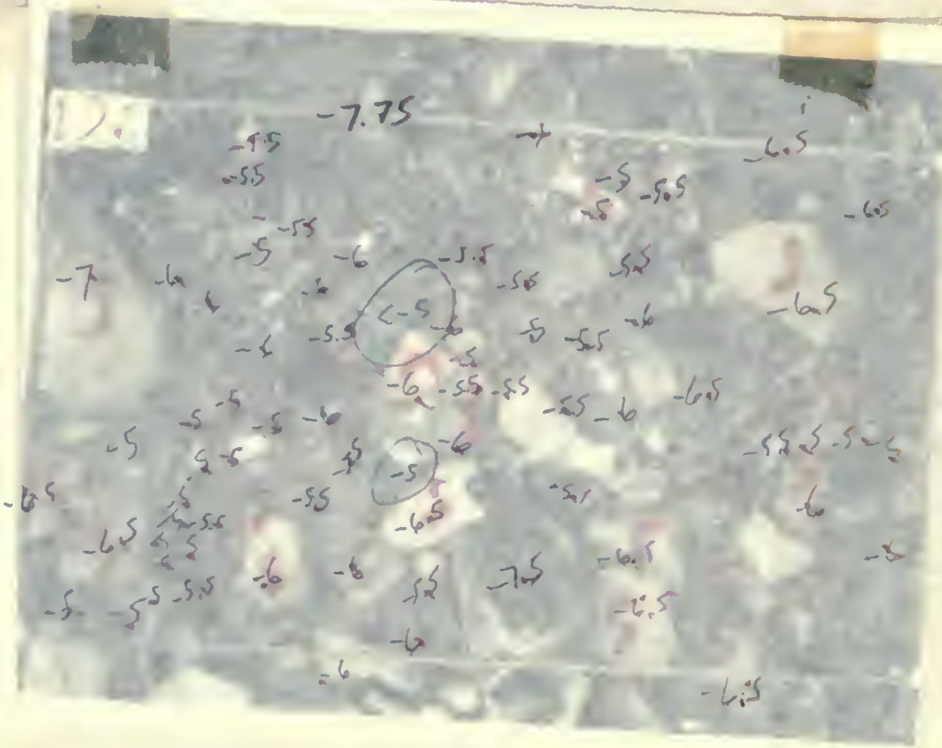

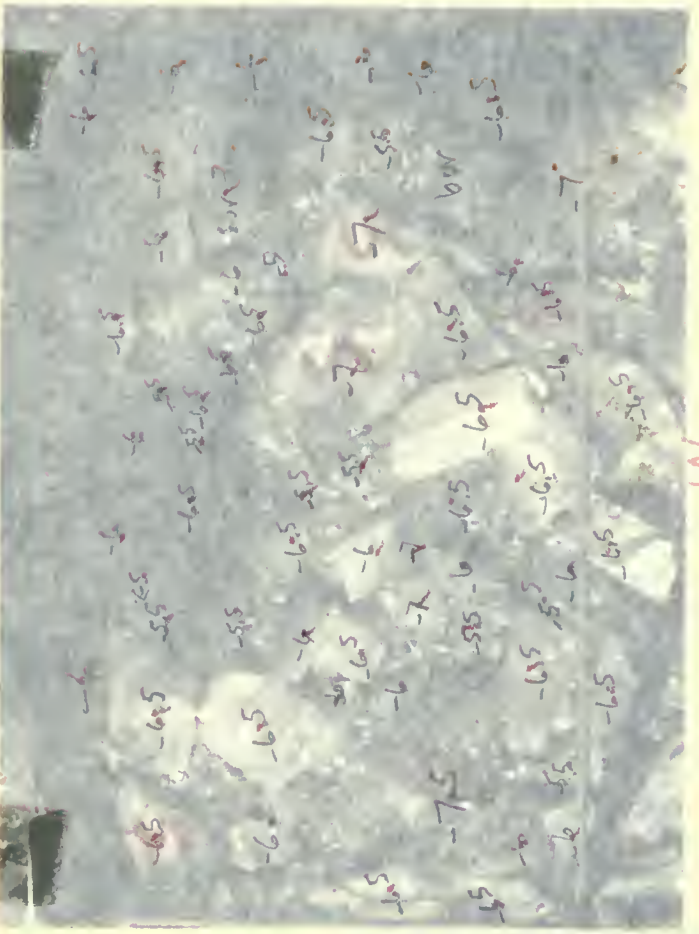
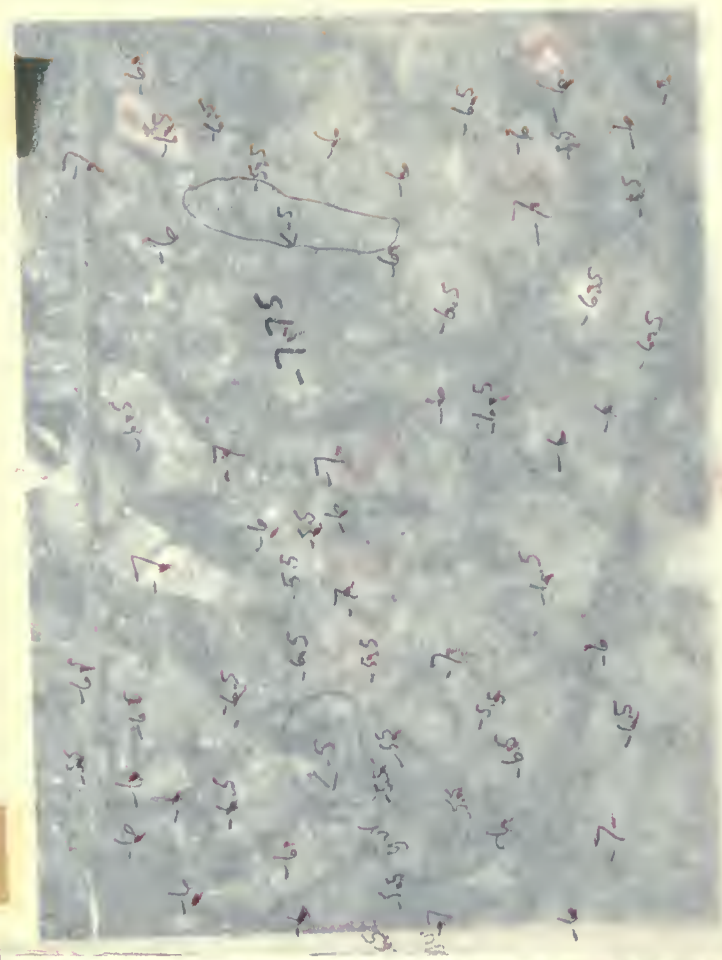

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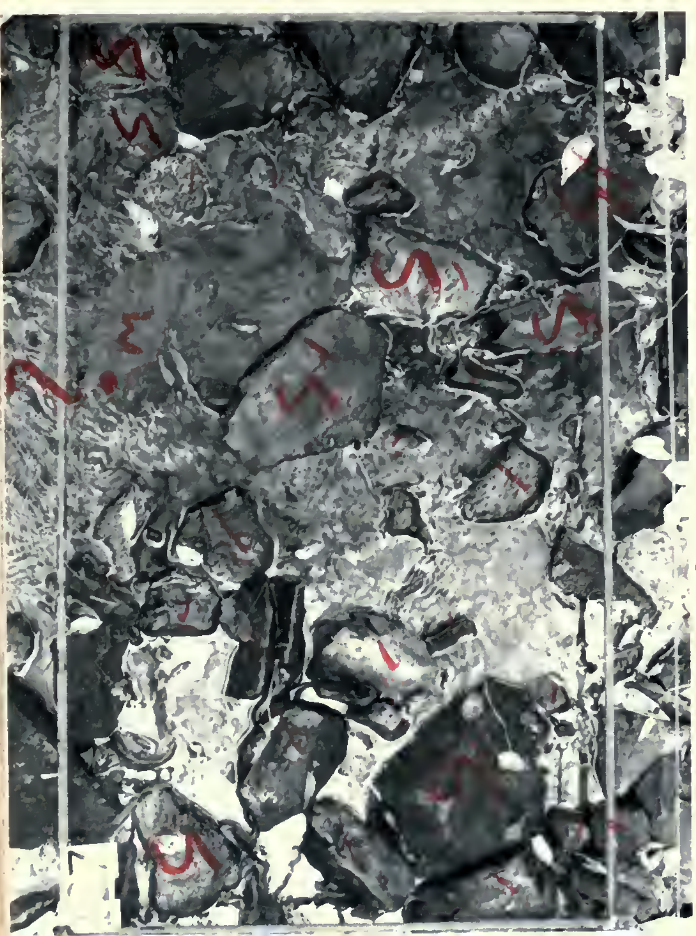
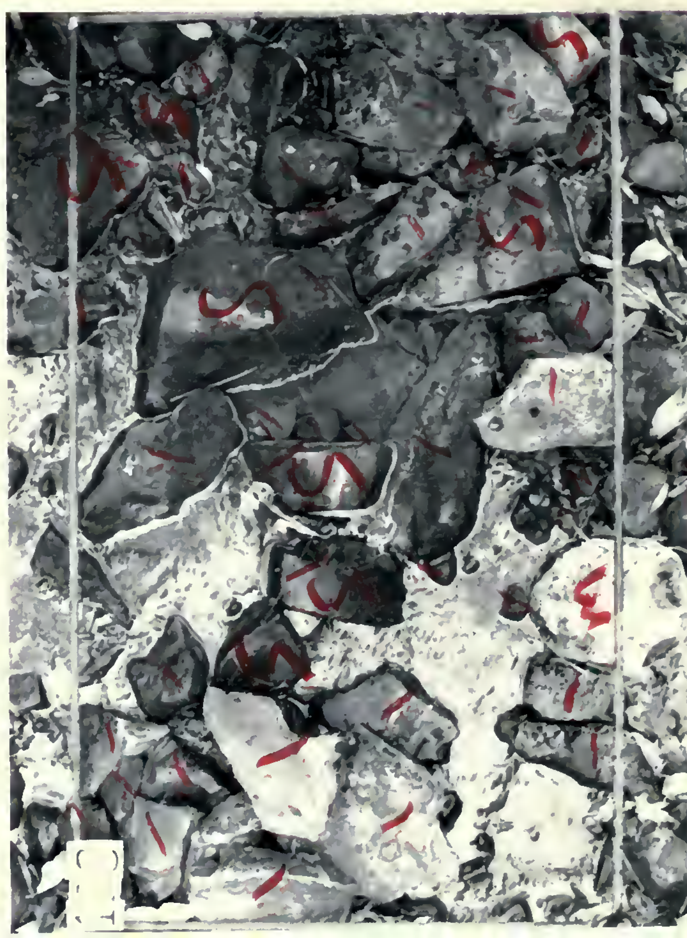

OUT