FIELD VERIFICATION PROGRAM

MONITORING CRUISE ON 26 JUNE, 1985

CONTRIBUTION # 49

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TABLE OF CONTENTS

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LIST OF FIGURES

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1.0 INTRODUCTION

Through the Disposal Area Monitoring System program (DAMOS), the New England Division of the Corps of Engineers has been supporting a joint EPA-COE project at the CLIS disposal site since March 1982. A description of the Field Verification Program (FVP), the baseline surveys and subsequent disposal site selection have been presented in DAMOS contributions #23 and #46. The FVP site at the northeast corner of the CLIS open water disposal area (41° 9.39'N, 72° 51.75'W) was characterized by a flat, gently sloping topography prior to disposal, typical of the central Long Island Sound mud bottom. The disposal site was considered to be very homogeneous in all parameters measured, characteristic of the natural sediments in the region. These conclusions were based on results from sediment chemistry, diver observations and the REMOTS® camera. Suspended sediment measurements indicated that the potential impact on the FVP site from other proposed disposal operations in the southwest corner of the CLIS disposal area would be negligible.

The most recent DAMOS cruise at this site was conducted on 26 June, 1985. This cruise consisted solely of REMOTS® sediment profile photography.

2.0 REMOTS®

The purpose of this REMOTS® survey is to monitor potential change in the sedimentary characteristics of the dredged material mound, to document the process of successional recovery of the FVP disposal site, and to monitor changes in the ambient fauna and sediments adjacent to the FVP site. This survey was conducted approximately 2 years after the disposal operation (25 months).

2.1 Methods

On 26 June, 21 stations were occupied at, or adjacent to, the FVP site. These stations correspond to the station locations which have been monitored since the June, 1984 FVP REMOTS® survey. The twelve central stations are considered to be located on the main dredged material mound or mound flanks based on REMOTS® and bathymetric surveys conducted immediately after the FVP disposal operation (Fig. 2-1). The surrounding nine stations are classified as edge and ambient stations. Three REMOTS® images were scheduled to be taken at all stations. However, only two of the three images taken at stations 300S and 250W provided useful information. Eighteen REMOTS® images were obtained from the CLIS-REFERENCE site. For the first time, near-bottom dissolved oxygen measurements were made at the CLIS-REF station. This was done by mounting a digital YSI dissolved oxygen (d.o.) meter in a water-tight housing on the REMOTS® system. A "slave" digital readout was mounted at the top of the REMOTS® optical window so that each photograph was accompanied by a d.o. reading. The polarigraphic electrode was mounted on the camera prism, near the top of the window; this probe was lowered to the bottom as the prism descended into the seafloor. As a result, d.o. measurements were made within a few centimeters of the sediment surface. However, the probe membrane did not come into contact with the bottom sediments.

Methods of image interpretation are described in our earlier FVP reports and are not repeated here.

2.2 Results

The distribution and thickness (cm) of dredged material observed in REMOTS® images is shown in fig. 2-1. This distribution is comparable to that observed in earlier surveys. Some stations that are located on the mound and flank perimeter show no apparent dredged material layer. This may be caused by the complete mixing of the Black Rock material into the ambient bottom and/or the loss of high reflectance of the buried pre-disposal surface (datum of reference).

Although laterally continuous disposal layers were not observed in some replicates, most of the FVP stations show the presence of reduced sediment at, or near, the sediment-water interface. We interpret this material to represent locally eroded Black Rock sediment which has recently been redistributed over the site as far as 1000E and 1000W (fig. 2-1). This is the first FVP post-disposal survey in which relatively widespread erosion of Black Rock sediment has been observed.

All stations show an apparent grain-size major mode of $\geq$ 4 phi (silt-clay), with subordinate fractions of 3 and 2 phi (very fine to fine sand). A layer of fine sand (3-2 phi) continues to be observed at station CTR. It is difficult to discern whether the fine sand mode or the silt-clay mode dominate in some CTR station replicates. The coarser grain-size at station CTR has been observed since our January, 1984 REMOTS® survey and we have interpreted it as being a lag deposit resulting from current washing of the mound apex.

The frequency distributions of boundary roughness values for the dredged material mound stations, edge and ambient stations, and the CLIS-REF site are shown in fig. 2-2. The frequency distributions are similar for all three areas, with the major mode for small-scale topographic relief being 0.4 cm. Boundary roughness values have not changed since the December, 1984 survey. The justification for continuing to make these measurements is based on earlier observations that much of this small scale roughness (at least in fine-grained sediments) is related to biogenic topography. Seasonal changes in rates of bioturbation can result in changes in such roughness. Qualitative changes in the type of biogenic reworking can also cause changes in boundary roughness. In addition, biologically or physically induced surface erosion or depositional events can change boundary roughness. The background roughness data which we have been accumulating at the FVP and CLIS-REF sites may prove useful in the future should these sites experience an unusual change in any of the above processes.

A layer of floccular material, interpreted to represent sedimented detritus associated with a decaying Spring plankton bloom, was described in our March, 1985 report (DAMOS contribution # 47). This layer is no longer observed in any station replicates.

Figure 2-3 shows the average depth of the apparent RPD for each station. The average RPD depth is 2.45 cm at mound stations and 2.90 cm at edge and ambient stations. The CLIS-REF station has a mean RPD depth of 4.35 cm. The average RPD value for the mound stations is not significantly different from the average value for edge and ambient stations ($p = .0942$; Mann-Whitney U-test). However, the mound, edge, and ambient station mean RPD depths are significantly shallower than those measured at the CLIS-REF station ($p < .001$; Mann-Whitney U-test). Further, the average mound, edge and ambient station RPD depths are significantly shallower than those recorded at these stations in our March, 1985 REMOTS® survey ($p < .001$; Mann-Whitney U-test). The CLIS-REF station, however, is not signficantly different in its average RPD depth between the March and June surveys ($p = .125$).

Figure 2-4 shows the frequency distributions of mean RPD depths for mound stations, edge and ambient stations, and the CLIS-REF area. Mound and edge and ambient stations have apparent RPD distributions centered on 3 cm, while the CLIS-REF station has a distribution centered on 4 to 5 cm.

The mapped distribution of successional stages is shown in figure 2-5. Forty-three percent of the mound station replicates exhibit stage III seres compared with 31% for edge and ambient stations and 61% for the CLIS-REF station. Relative to both the March 1985 and December 1984 surveys, the number of CLIS-REF stations that show Stage III seres has decreased. In earlier surveys, over 80% of the CLIS-REF station replicates showed stage III seres to be present. Should the autumn 1985 REMOTS® survey show a continued decrease in the number of stage III seres at the CLIS-REF station, additional sampling may be required to resolve the scale and cause(s) of this phenomenon.

The mapped distribution of REMOTS® organism-sediment indices is shown in fig. 2-6. The indices exhibit a broad range of values (3 to 11) reflecting the patchy mosaic associated with recolonization of the deposit (fig. 2-7). The frequency distribution of organism-sediment indices at station CLIS-REF is right-skewed and bimodal with a major mode at 11 and a minor mode at 7. The indices at the CLIS-REF station are significantly higher than those on, or near, the FVP site ($p < .001$; Mann-Whitney U-test). Past REMOTS® surveys have documented an apparent convergence in the organism-sediment index of the FVP site with that of the CLIS-REF station. This convergence has apparently been reversed; our June 1985 survey shows an index distribution resembling that measured in August 1983 (fig. 2-8).

The cause (or causes) for the apparent "retrograde" conditions at the FVP site, as well as the CLIS-REF station, is (are) unknown. However, 95 % of the REMOTS® images at edge and ambient stations show the presence of reducing sediment at, or near, the sediment surface. Over 77% of the mound station replicates also show this feature (fig. 2-9). We interpret this as a manifestation of recent distrubance of the disposal site with local redistribution of reduced Black Rock sediment. This localzed erosion could be caused either by natural physical forces or trawling activity. This phenomenon may also be responsible for the unusually shallow apparent redox depths recorded for ,the FVP site. None of the CLIS-REF station images show this reducing sediment at, or near the sediment surface and redox depths appear to be normal for this station.

The decrease in the number of Stage III seres at the CLIS-REF station is unknown. Near-bottom dissolved oxygen values were high (6.7 - 7.4 ml/l). It is possible that the intensity of bottom sampling at this site since 1982 has compromised this station as a reference site.

2.3 Summary and Conclusions

This REMOTS® survey was done 25 months after disposal of Black Rock Harbor dredged materials at the FVP site. The areal distribution of the main mass of deposited material is comparable to that described in earlier reports. However, the appearance of patches of black reducing sediment near the sediment surface at most of the FVP mound, edge, and ambient stations suggests that some local erosion and redistribution of Black Rock material has taken place in the recent past. Sediment grain-size remains unchanged, with the major mode being silt-clay. A lag or scour deposit of fine-sand and shell material is present at station CTR.

Small scale boundary roughness is uniform throughout the survey site and has remained constant since the beginning of 1984 (ca. 4 to 8 millimeters over a horizontal distance of 15 cm.).

The apparent depth of the RPD (depth to which bioturbation and molecular diffusion supply oxygenated seawater to buried sediment) at the mound and edge and ambient stations is anomalously shallow, averaging less than three centimeters in depth. This is probably related to the observation that local erosion and redistribution of sediment appear to have taken place at the FVP site. The CLIS-REF station has a mean RPD depth greater than 4 cm.

Forty-three percent of the mound station replicates show the presence of Stage III infauna compared with 31% for edge and ambient stations, and 61% for the CLIS-REF station. Relative to past surveys, the number of replicates which show the presence of Stage III infauna has decreased at the CLIS-REF site. In the past, over 80% of these replicates have shown Stage III seres. The reason for this change is unknown but one should consider the possibility that the large volume of benthic sampling done at the CLIS-REF site (located with precision navigation) has, in itself, disturbed this area to the extent that it can no longer be considered a valid "reference" site.

The organism-sediment indices (formerly called benthic indices) at the FVP site are anomalously low. Until this sampling period, FVP indices were converging rapidly with the CLIS-REF station. The index frequency distribution from this survey resembles that plotted for the FVP site in August 1983. Again, this anomaly is due mainly to the very shallow RPD depths measured over the FVP site in June, 1985.

We have documented, for the first time, processes acting on the mound (apparent erosion) which have affected off mound stations. The total areal extent of this "far-field" effect is unknown but recently deposited lenses and clasts of black reducing sediment can be seen at, or near, the sediment surface in some replicates from 1000E and 1000W. This phenomenon is not observed at the CLIS-REF site. For this reason, we believe that the aforementioned black sediment represents eroded and redeposited Black Rock Harbor mud.

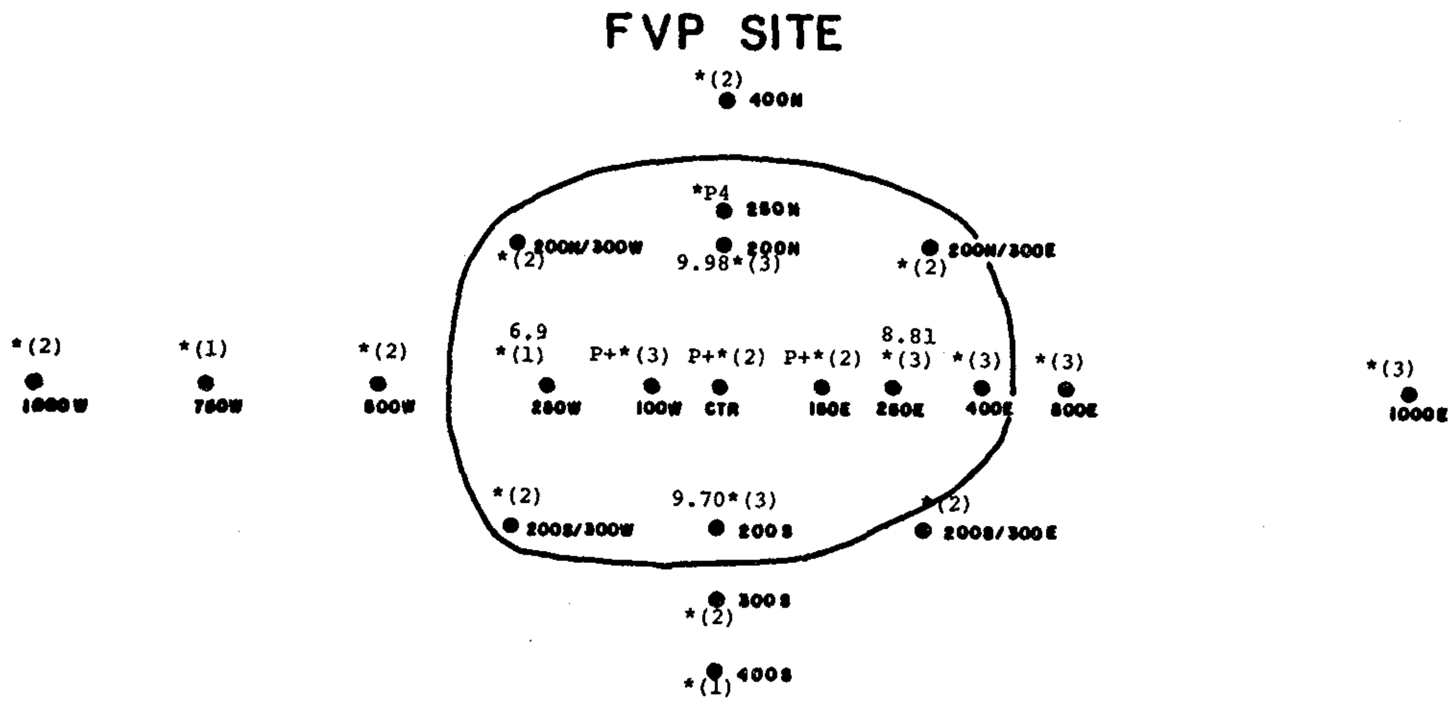

Figure 2-1. The apparent distribution and thickness (cm) of dredged material, averaged by station, at the FVP site in June, 1985. The solid line encloses the twelve stations considered to be on the main dredged material mound or flanks as defined by REMOTS® and bathymetric surveys conducted immediately after the disposal operation. Starred stations, # of replicates in (), show the presence of reducing sediment near the sediment-water interface.

P+ = dredged material thicker than REMOTS® window penetration.

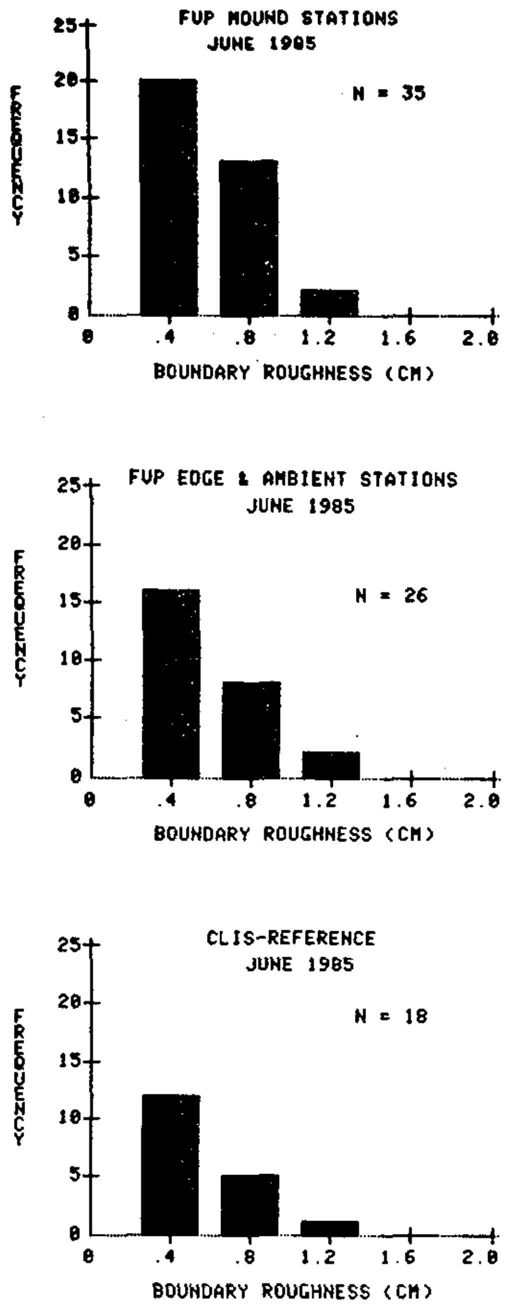

Figure 2-2.

The frequency distributions of boundary roughness values for dredged material mound stations, edge, and ambient stations, and the CLIS-REF site.

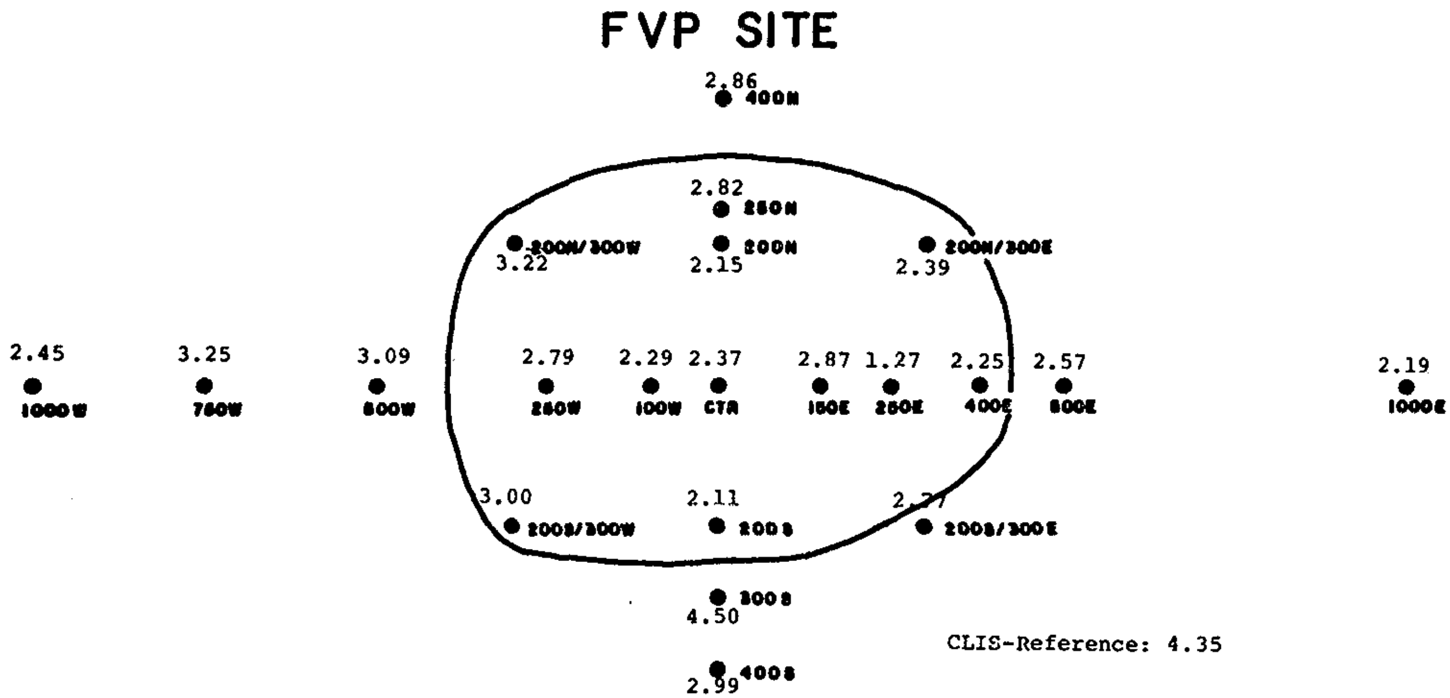

Figure 2-3. The mapped average apparent RPD depth values (cm) at each station.

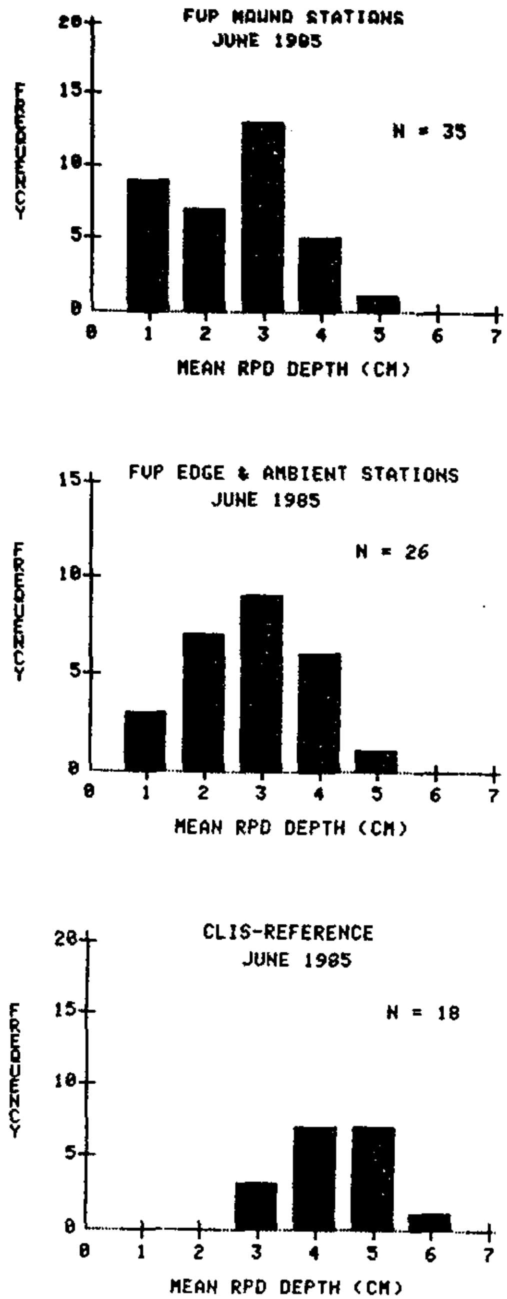

Figure 2-4.

The frequency distributions of mean apparent RPD depths for mound, edge and ambient, and CLIS-REF stations.

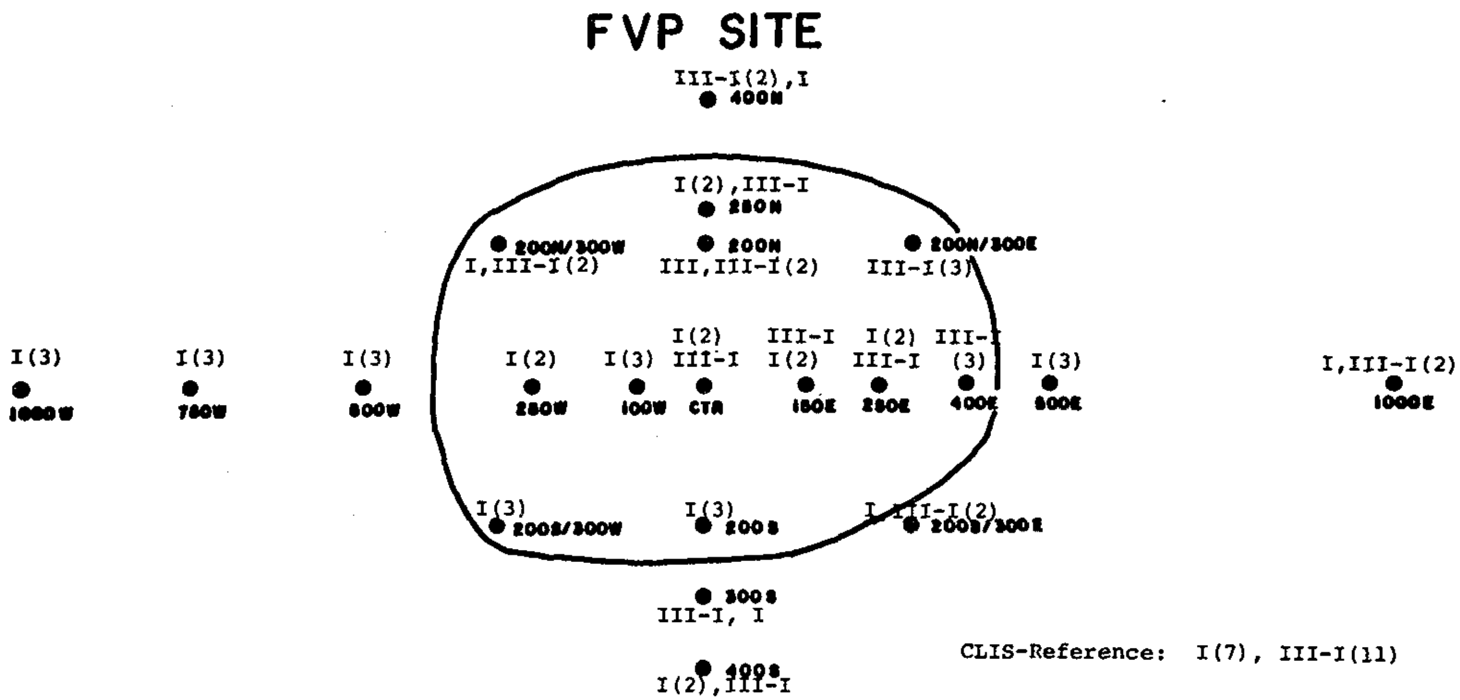

Figure 2-5. The mapped distribution of successional stages for all replicates in the June survey.

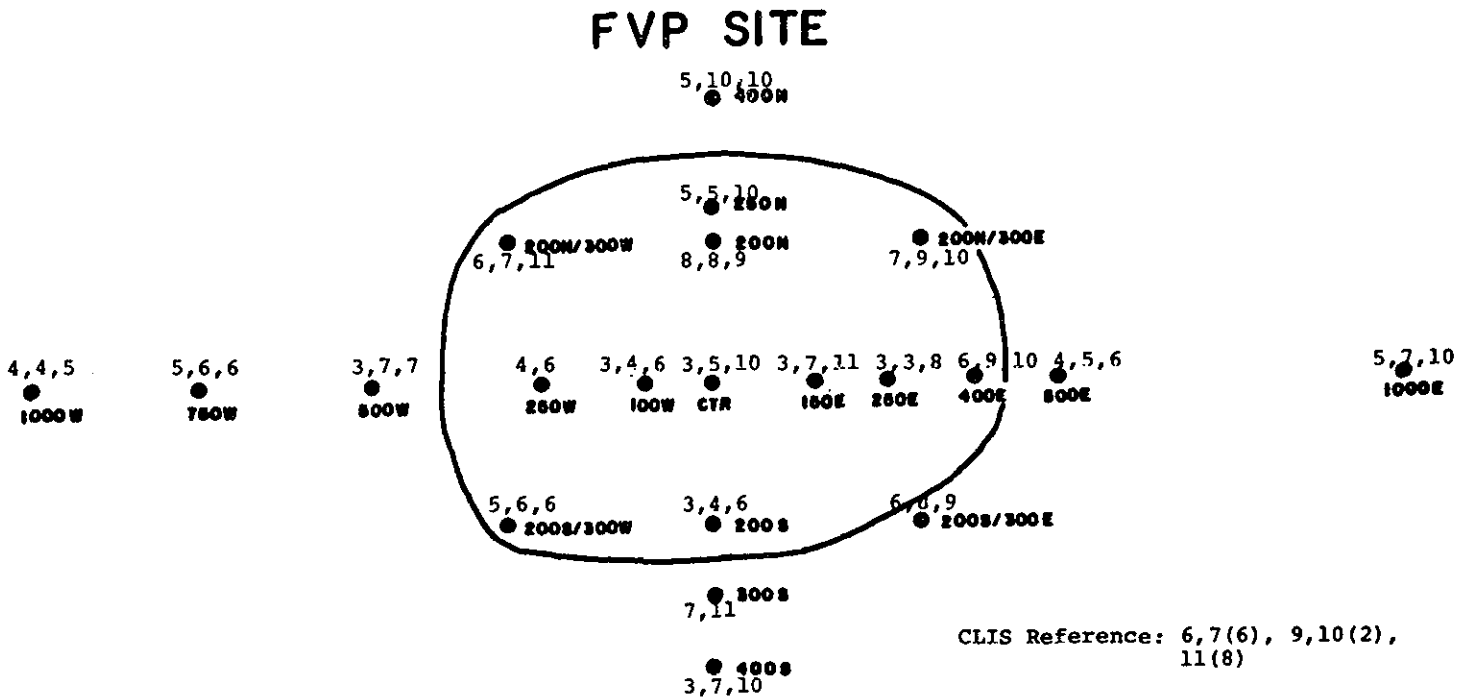

Figure 2-6. The mapped distribution of organism-sediment indices for all replicates in the June survey.

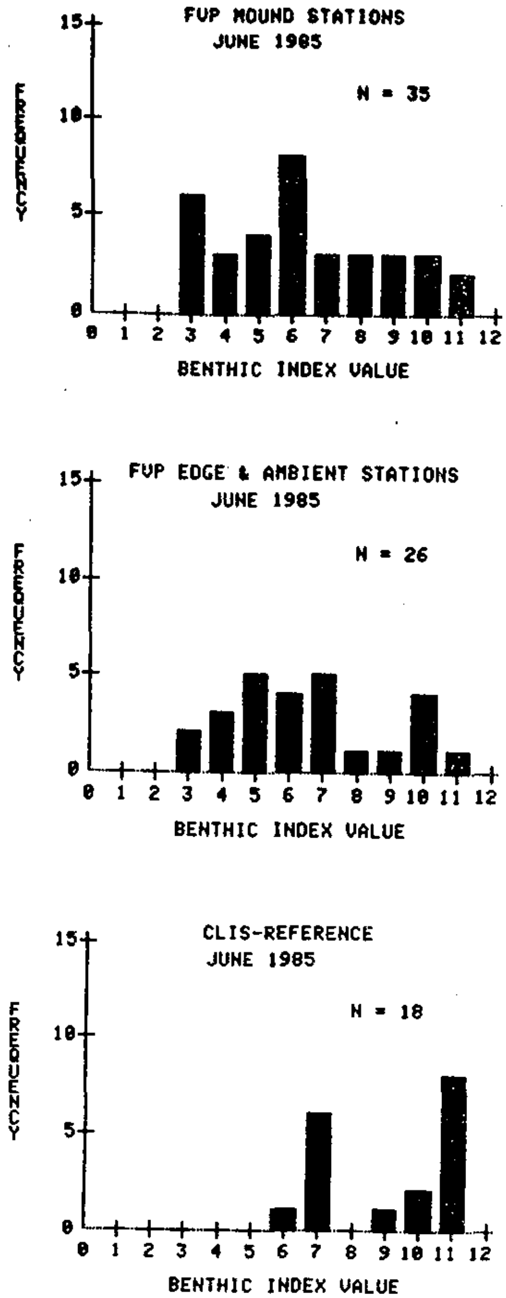

Figure 2-7. Organism-sediment index frequency distributions for the mound, edge and ambient, and CLIS-REF stations.

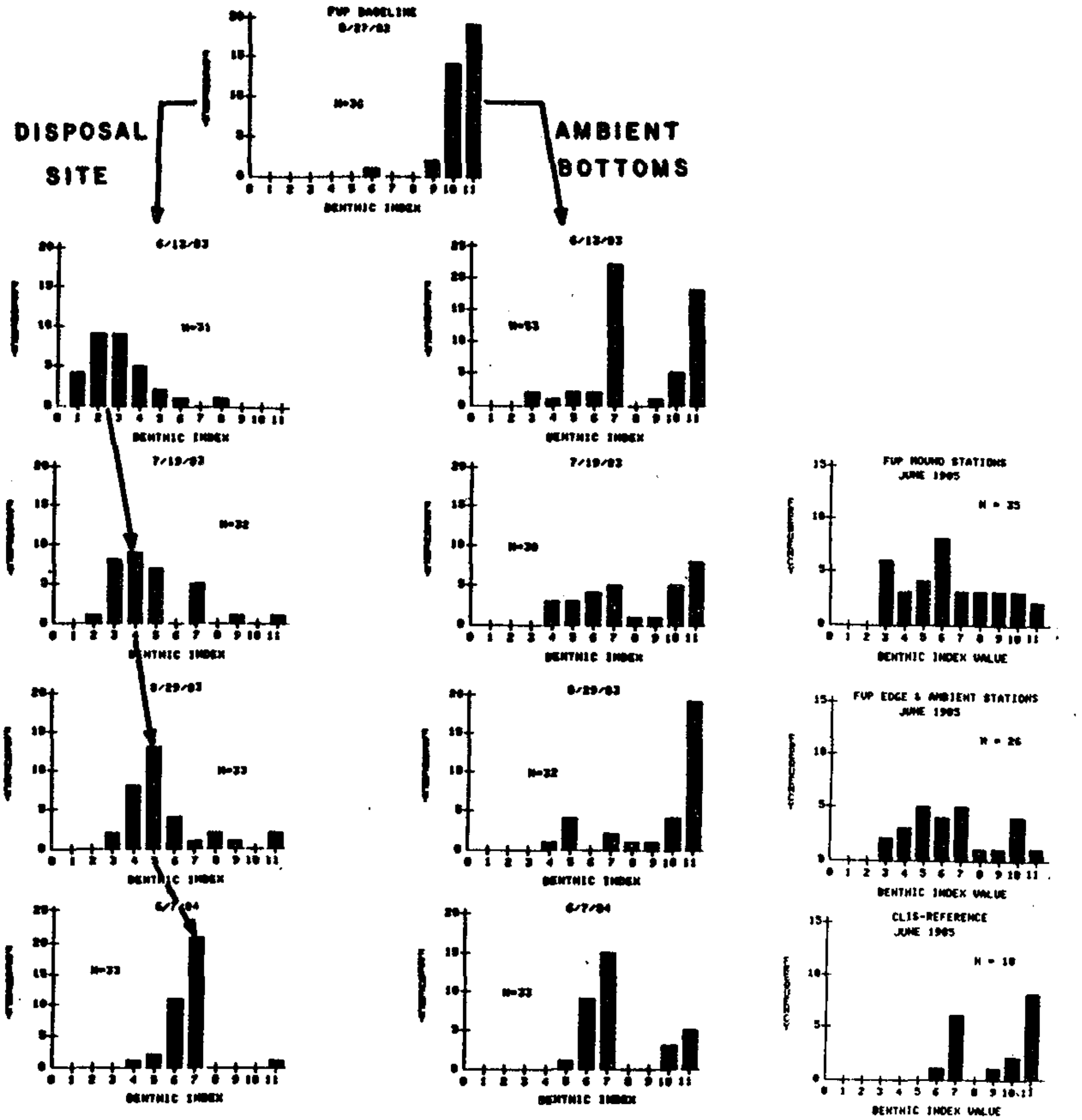

Figure 2-8. Index frequency distributions for the FVP site as measured in 1982, 1983, and the present survey. Note that the June 1985 index frequency distribution for stations on or adjacent to the disposal site (mound, edge, and ambient) is similar to that recorded in August, 1983.

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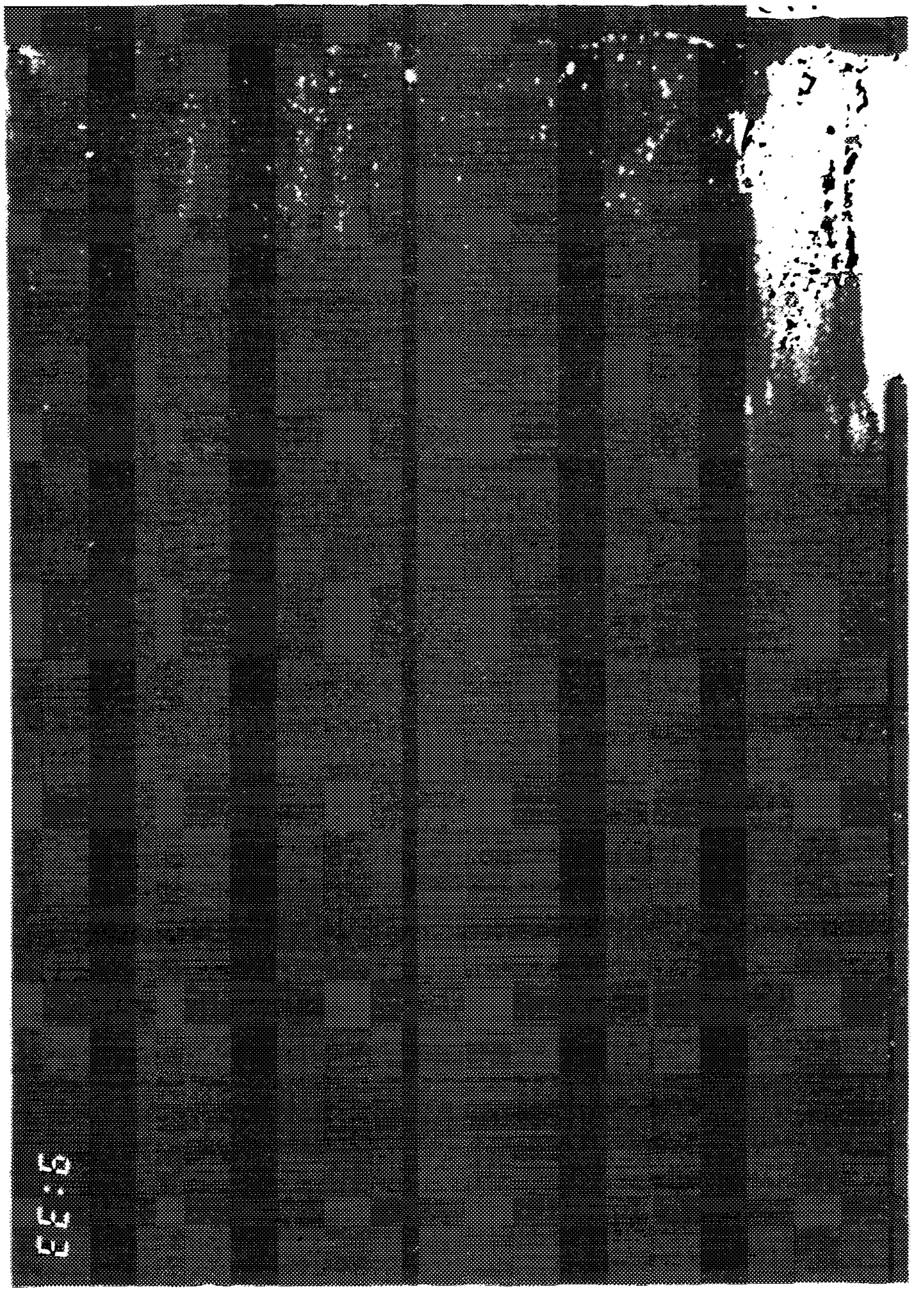

Figure 2-9.A

REMOTS® images showing the appearance of dark reducing sediment near the sediment surface. This feature suggests that local erosion and redistribution of Black Rock sediment has taken place.

A= Sta. 100W, B= Sta. 250W, C= Sta. 400N, D= Sta. 1000E.

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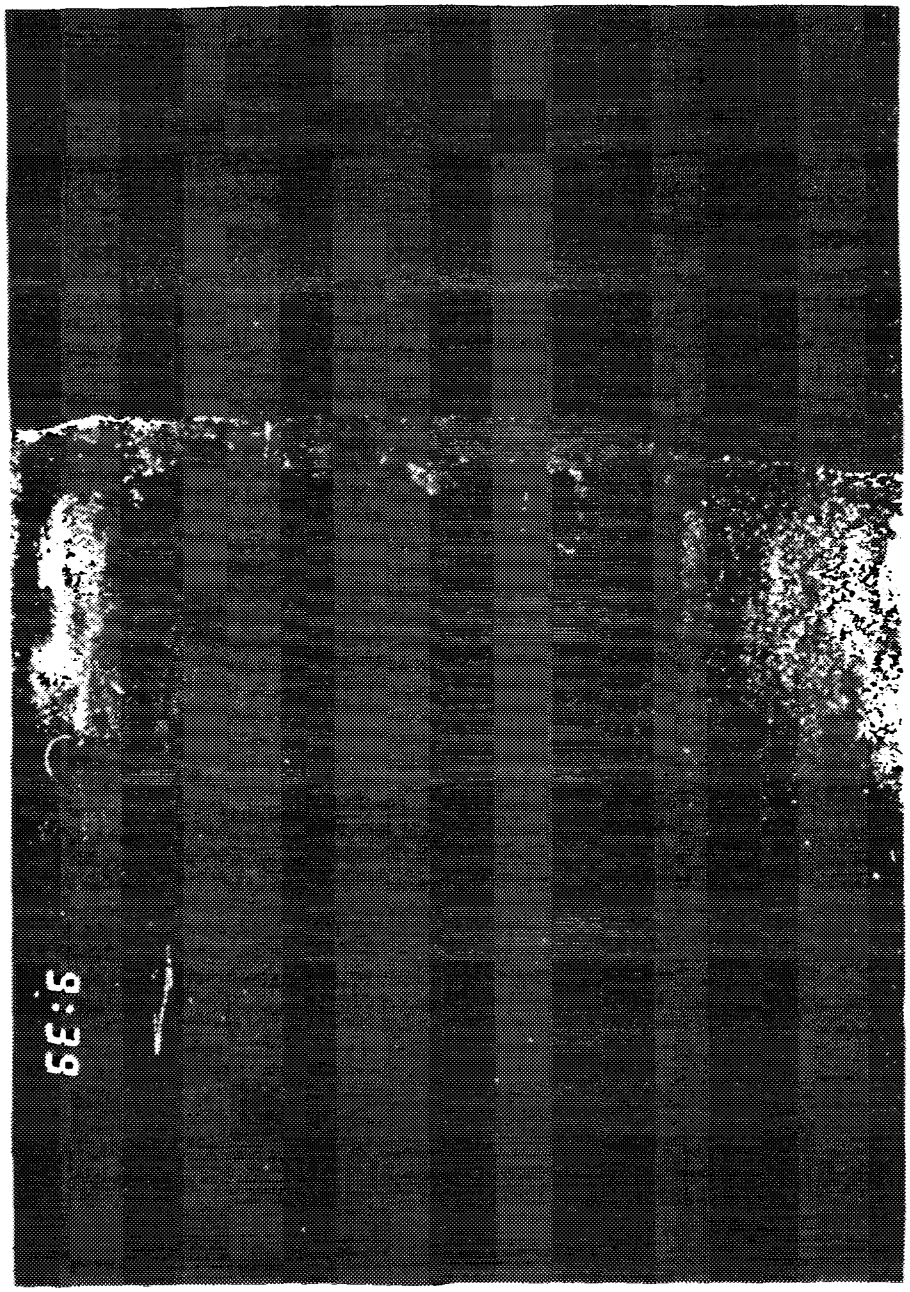

Figure 2-9.B

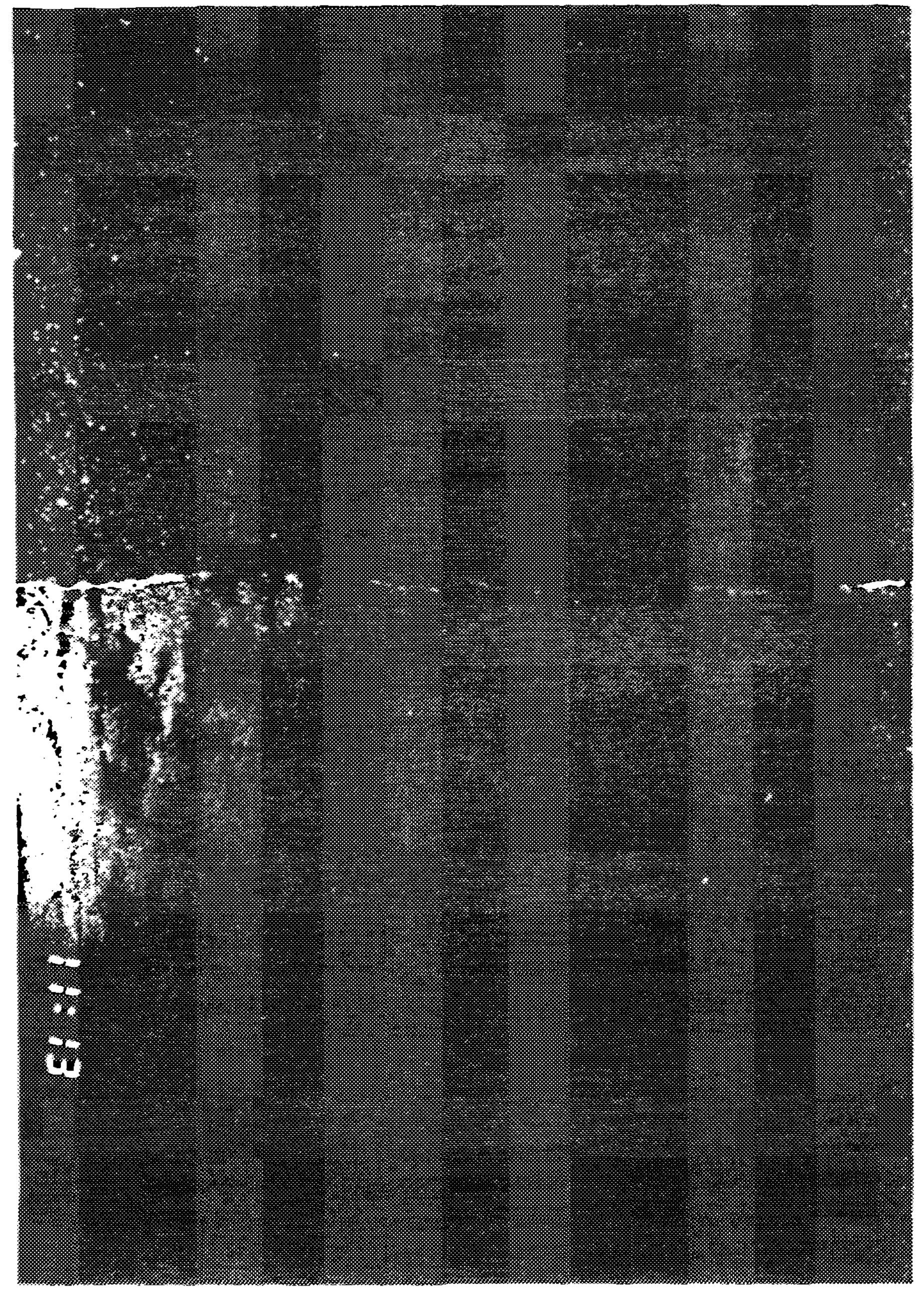

Figure 2-9.C

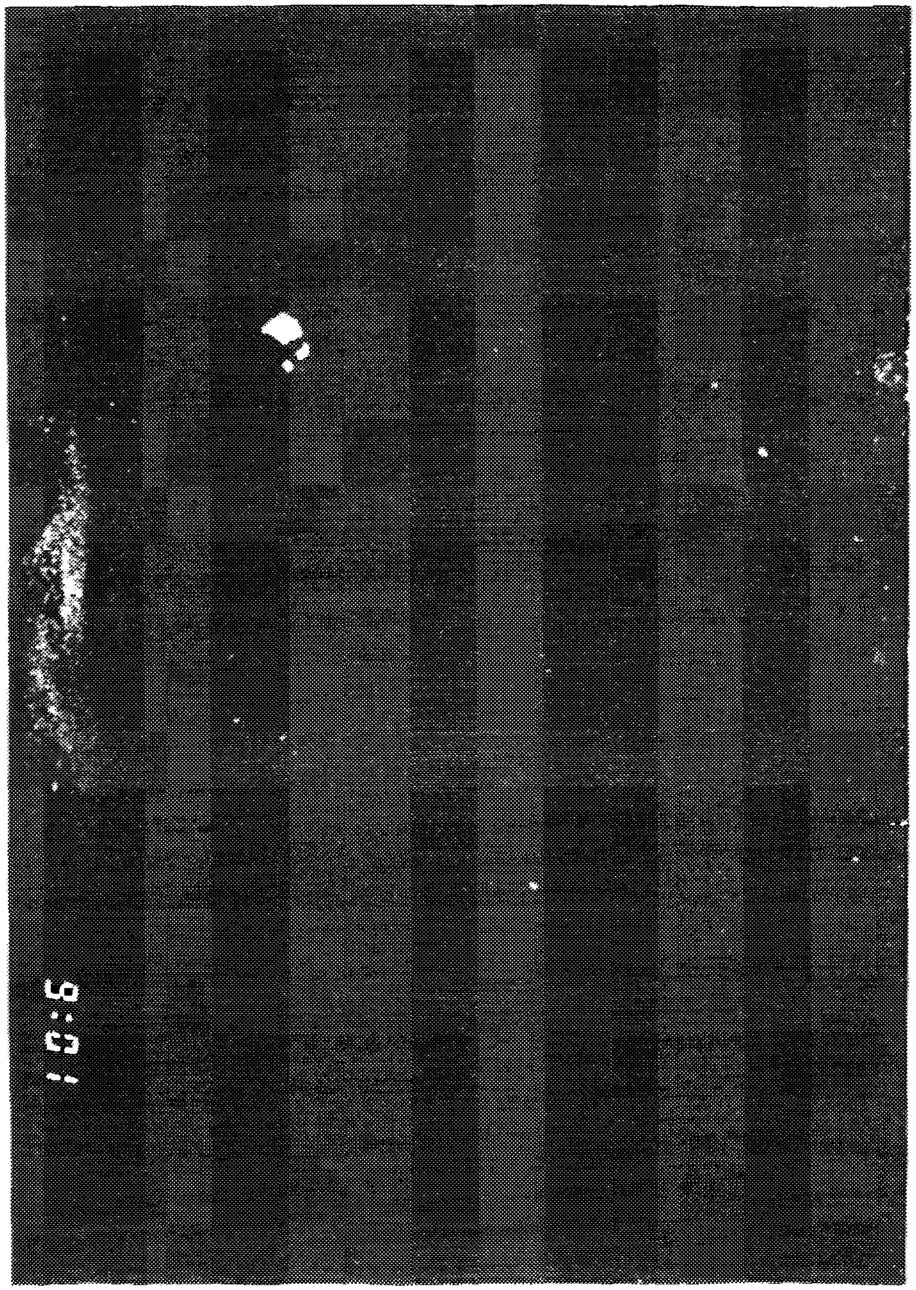

Figure 2-9.D