TROV OPERATIONS IN GEORGIAN BAY, JULY 1976

- WITH UNDERWATER PHOTOGRAPHS

by

R.G. Sandilands and P.G. Sly

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Introduction

An area in Georgian Bay, east of Tobermory, was surveyed between 1968 and 1971 (Sly 1969a, 1969b, 1970). Data obtained included echo-sounding and seismic records, surface sediment samples, some cores and underwater photographs of the sediment surface. Part of this data was used to identify and to characterise the form and occurrence of the surficial sediments. The purpose of the TROV operations in 1976, was to visually inspect and verify these sediment characteristics, to inspect selected anomalous areas and features, and to field test the equipment.

Equipment

TROV is a tethered remotely operated vehicle built by McElhanney Offshore Surveying and Engineering Limited, Vancouver. During this study, the vehicle was maneuvered by the use of four D.C. motors (18 lb. thrust each) and was provided with a self-contained power supply from lead acid batteries. It carries a low light level television camera and a manipulating arm. All functions are surface controlled, through an umbilical line. TROV was used briefly in Lake Ontario in 1975 (Roe et al, 1975).

In addition, an EG&G model 205 camera (35 mm) and model 206 strobe were attached to TROV (Figure 1). These were used to obtain a permanent and detailed photographic record of interesting features and to

supplement the videotape records from the television camera. Kodak (R) High Speed Ektachrome reversal film (ASA 160) was used in the 35 mm camera. It was developed in the field using a Kodak (R) E-4 processing kit to check camera operation and exposure. The camera was triggered by opening the claw on the end of the manipulating arm, which in turn activated a magnetic reed switch. As in previous years, operations and support were provided from the contract vessel, M.V. LAC ERIE.

Results

Two dives were conducted prior to the field survey to test the equipment and a total of twelve dives were conducted in the survey area (Figure 2). A brief summary of each dive follows, and selected prints from slides of some dives are included in Appendix A.

Dive 3 - July 1976.

Location: Dunks Bay, one mile east of Tobermory

Dive Duration: 2 hours

Maximum Depth: 18 m

Weather: Wind WSW 25-30 knots
Sea 3-4 feet, 1 foot in shelter of the bay
Overcast and rain

Data: The visibility was good but there was some particulate material in the water column. The bottom was flat and probably a silty clay

Problems: Some difficulty was encountered in an attempted traverse across the bay, caused by a cross current and the slow reaction of the magnetic compass.

Dive 4 - July 20, 1976

Location and weather was the same as dive 3.

Dive Duration: 1 hour

Maximum Depth: 10 m

Data: The dive was conducted in shallow water to check buoyancy control and to observe a submerged portion of a boulder beach. Visibility was good over the boulder and bedrock bottom.

Problems: TROV was underpowered and lacked sufficient drive to move itself to the dive site on the surface, against the wind and waves. It had to be towed to the site by a small boat. The dive was aborted early due to an override condition, probably caused by the low voltage of the power supply. Grimsby floats were attached to the tether line at ≃ 30 m intervals. In shallow water, slack line between these floats would sink and snag on the rough bottom.

Dive 5 - July 21, 1976

Location: Approximately 1/2 mile east of Middle Island and 1 mile south of Flowerpot Island in Georgian Bay.

Dive Duration: 2 hours

Maximum Depth: 60 m

Weather: Wind SE 10-12 knots
Sea 1-2 feet

Data: The dive site was on a portion of the submerged escarpment slope and base. Photos 1, 2 and 3 show the progressive fining of sediment types from bedrock and boulders, rippled marked sands, to smooth surfaced mud.

Problems: TROV did not have enough power either to pull the long umbilical and/or to counter the water currents. It had to be positioned with the small boat and then could be maneuvered locally.

Dive 6 - July 21, 1976

Location: Close to dive site 5, but slightly further east in deeper water.

Dive Duration: 1/2 hour

Maximum Depth: 90 m

Data: Photo 4 shows a bottom of recent mud with numerous marks and depressions.

Dive 7 - July 22, 1976

Location: 45^{o} 18.8' N 81^{o} 26.5' W

Dive Duration: 1 hour

Maximum Depth: 140 m

Weather: Wind 15-20 knots

Sea 2-3 feet

Data: TROV was suspended just above the bottom and the ship was allowed to drift in a SE to NW direction.

Photos 5 and 6 show a generally flat bottom but with small irregular depressions. These may correspond to irregularities on the top of the sub-surface unit, (see photos in dive 9) or may be caused by sediment dewatering. Photo 5 shows lineations and scouring probably caused by bottom currents. When TROV was retrieved, there was some reddish brown clay on its runners, probably from the sub-surface unit.

Problems: The drifting, suspended system worked well for a 'make-shift' traverse, but it needed a lower position of the light source on TROV.

Dive 8 - July 22, 1976

Location: 45° 20.5' N 81° 27.7' W

5 statute miles ENE of Bears Rump Island

Dive Duration: 1 1/4 hours

Maximum Depth: 125 m

Weather: Wind 15-20 knots

Sea 2-3 feet

Data: Trov was again suspended and drifting SE to NW. TROV was also placed on the bottom to observe one location over a period of time. Photo 7 shows this site, a flat surface of mud with a number of pin hole depressions. The large oval depressions

and the shallow, irregular depression adjacent to it are typical of this bottom sediment type at this depth, and may be related to sediment dewatering. Two apparent directions of lineations suggest the possibility of scouring during conditions of high current. False lineations, at the top of the picture, are caused by a 'school' of crustaceans (Mysis) swimming into the current.

Dive 9 - July 23, 1976

Location: 45° 19' 81° 29.5'

3 1/2 statute miles east of Bears Rump Island

Dive Duration: 1 hour

Maximum Depth: 60 m

Weather: Wind 5-10 knots

Sea 1-1 1/2 feet

Data: A pair of old downhill skiis were attached to TROV's runners, with approximately 50 cm forward extension, to reduce its tendency to sink into the mud. Photos 8, 9 and 10 show a till or galciolacustrine sub-surface with minimal but varying thicknesses of overlying recent mud. Scouring is visible in photo 9. Photo 10 shows a glaciolacustrine surface with an apparently hardened surface more resistant to erosion, that may indicate previous subaerial exposure.

Dive 10 - July 23, 1976

Location: 43° 20.1' N 81° 30.6 W

2 1/2 statute miles ENE of Bears Rump Island

Dive Duration: 1 1/4 hours

Maximum Depth: 52 m

Weather: Wind 5 knots

Sea calm

Data: This is an area previously identified as being covered by recent muds. The echo sounder showed approximately one metre of mud over a harder reflector, probably till. The sediment was easily disturbed and there was a large quantity of particulate material in the water column. Photo 11 shows a flat bottom of recent mud with an extensive covering of micro relief structures consisting of pin hole depressions and small "hills", possibly caused by burrowing worms (Oligochaeta).

Dive 11 - July 24, 1976

Location: Approximately 1/4 mile SW of Flowerpot Island

Dive Duration: 2 hours

Maximum Depth: 20 m

Weather: Wind NE 15-25 knots

Sea 2-3 feet, except in shelter of the island

Data: TROV was 'flown' over the bottom and at various mid-water depths. Television images were obtained in ambient light alone, and lake bed images could be seen with TROV as much as 20 feet above the bottom. Photos 12 and 13 show the limestone bedrock with extensive solution pitting.

Dive 12 - July 26, 1976

Location: East of Dunks Bay and Northwest of Driftwood Cove, about 1/4 mile offshore

Dive Duration: 1 1/2 hours

Maximum Depth: 105 m

Weather: Wind 15-20 knots SW
Sea 2-3 feet

Data: TROV was suspended from a second line off the ship's bow; then the ship and TROV were allowed to drift into deeper water. Photos 14, 15 and 16 show the change from coarse material, nearshore, to that of finer, offshore. The lineations and smoothing of micro relief in photo 16 suggest the scouring of the bottom during periods of high current activity.

Dive 13 - July 26, 1976

Location: Approximately 1 mile north of Driftwood Cove

Dive Duration: 2 hours

Maximum Depth: 110 m

Weather: Wind SW 15-20 knots

Sea 2-3 feet

Data: Photo 17 to 20 show a flat bottom of recent mud with an extensive covering of pin hole depressions and burrow hills. The mud surface is typically 'fluffy' and easily disturbed. The bottom current was estimated to be about 1/2 knot, by observing the movement of particulate material on the television, when TROV was stationary on the bottom.

Dive 14 - July 27, 1976

Location: Dunks Bay

Weather: Wind 15-20 knots

Sea 1-3 feet

Dive Duration: 5 minutes

Problems: A faulty 'O' ring seal allowed water to enter the electronics compartment on TROV. The flood warning light activated and TROV was recovered, but not before approximately 3 inches of water had entered the compartment. A complete repair of water damage was not possible in the field. The program was terminated.

Conclusions

The lack of sufficient propulsion prevented TROV from being used effectively in a search or traverse survey. It could only be used as

a pan and tilt platform for the television camera, with limited, local maneuverability. However, subsequent modifications to the propulsion, ballasting and power supply systems of TROV, should allow greater success with this type of survey.

During the 1976 operations, a temporary trigger, using a magnetic reed switch on the manipulator arm, was used to activate the 35 mm camera. This resulted in a time lag of 3-5 seconds between the time a photo was required and the camera triggered. There is a requirement to have instantaneous control of the 35 mm camera and the triggering should be provided by a separate system. This should be independent of other systems and TROV operation, to allow the observer to take a picture without interrupting the pilot.

The limited operational ability of TROV did not prevent the observation of a number of bottom types, nor the identification of numerous bottom features and surface marks, as seen in the photos (Appendix A). The photos also show the effects of water currents and bioturbation on fine-grained sediments. The possibility of these activities must be recognized in any work using sediment cores; such as determining contaminant loadings and dates for sedimentation rates.

Acknowledgements

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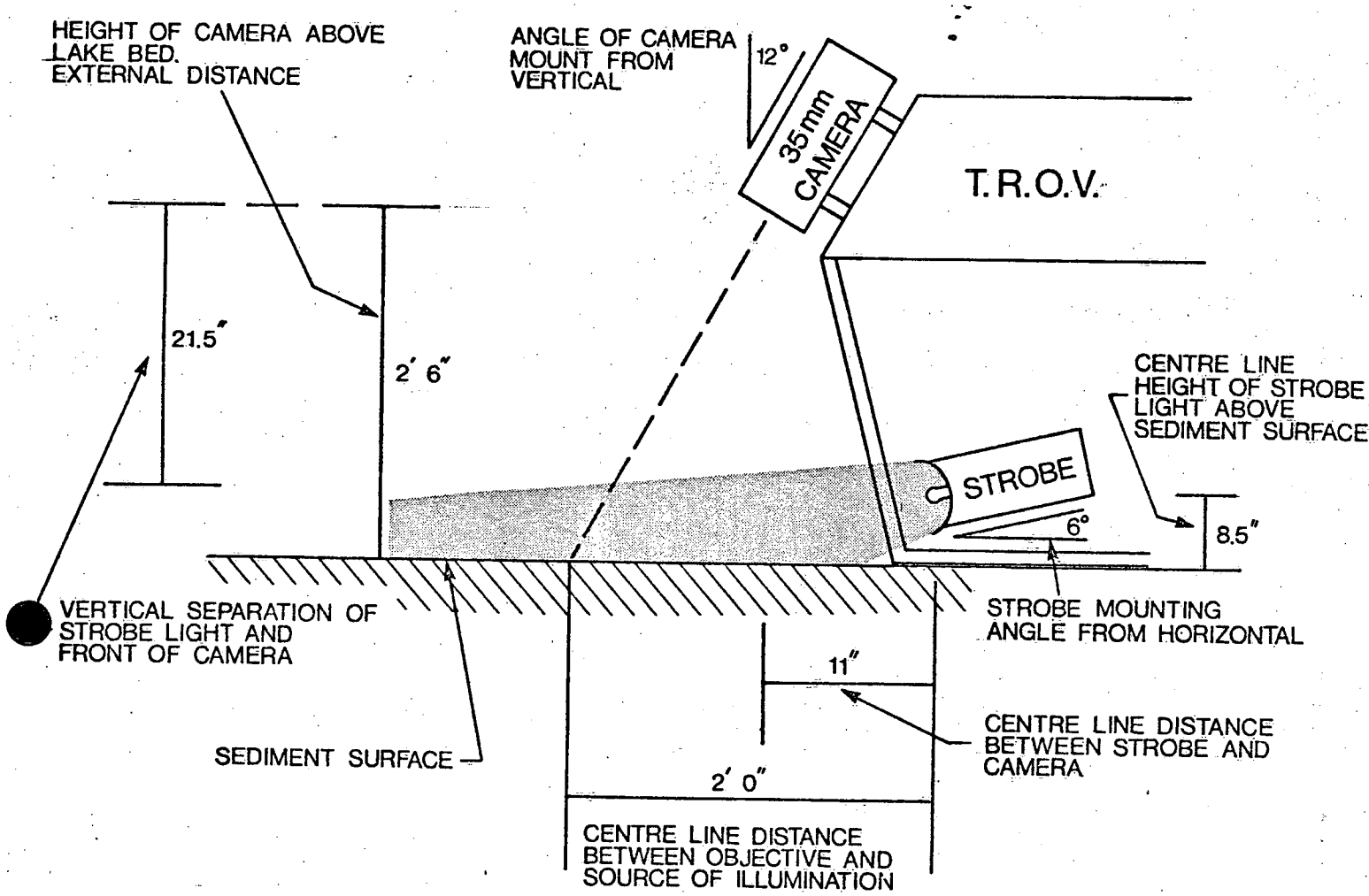
FIGURE 1 CAMERA SET-UP ON T.R.O.V.

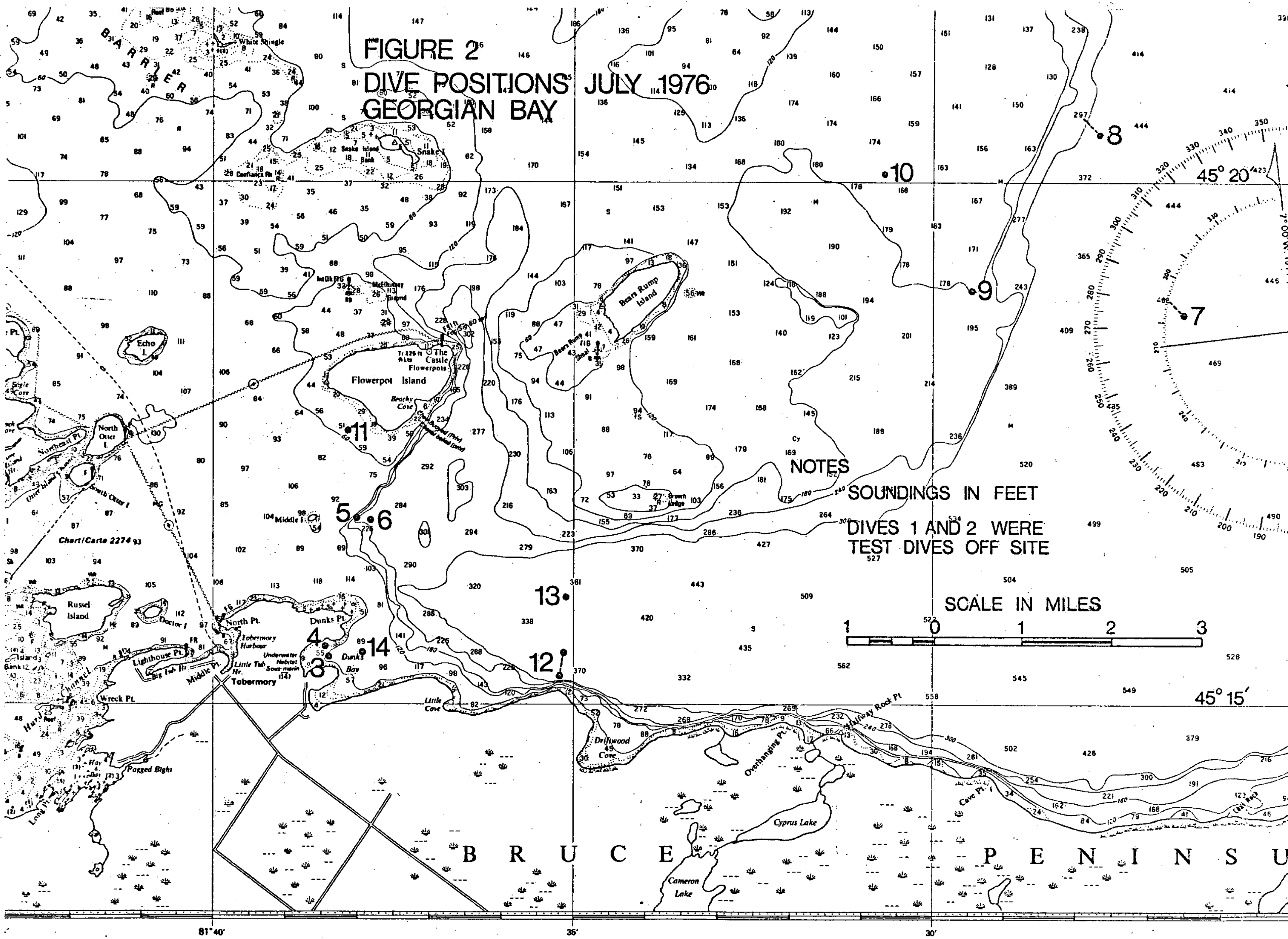


Camera : EG&G model 205
Lens : 35 mm focal length, f4.5, water corrected
Aperture setting : f22
Shutter speed : 1/50 second
Focal distance setting : 3 feet
Depth of field at settings : 2'2" to 4'9"

Strobe : EG&G model 206
50 watt/second
Xenon flash duration - 1/1000 second

Film : Kodak High Speed Ektachrome 135-36
Film speed : ASA 160
E-4 processing kit

FIGURE 2
DIVE POSITIONS JULY 1976 GEORGIAN BAY



NOTES

SOUNDINGS IN FEET

DIVES 1 AND 2 WERE TEST DIVES OFF SITE

SCALE IN MILES

1 0 1 2 3

Appendix A

Selected prints of lake bottom views in Georgian Bay.

A test in air with this camera arrangement (Figure 1) gave a slide covering an area approximately 60 x 100 cm.

The following photographs have been prepared from 35 mm colour positive slides and, as a result, have lost some definition and contrast. The original slides provide more readily observable features and should be used in preference to the prints for the examination of field evidence. Information in dark areas has been lost in transformation from slides to prints.

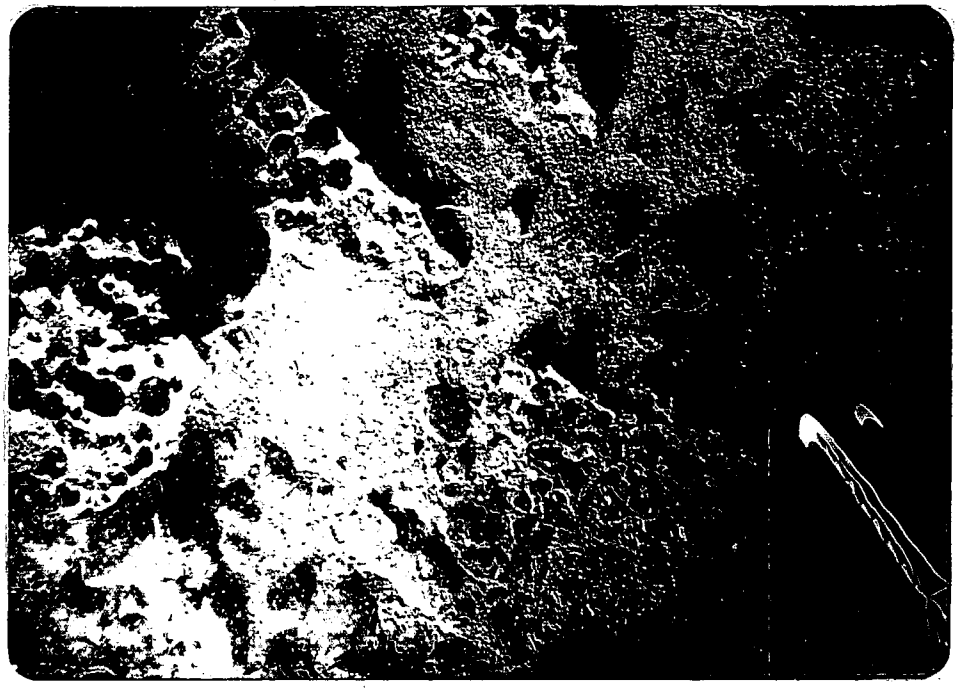
Photo 1: Dive 5

- pitted limestone bedrock and boulders
- possibly some Fe-Mn coating on limestone and some Fe-Mn nodules (dark oval pebbles)
- object in lower right is the jaw of the manipulator arm
- sculpin in upper right corner

Photo 2: Dive 5

- slightly undulating surface, possible sand ripples
- Pin hole depressions (burrow holes?)

1



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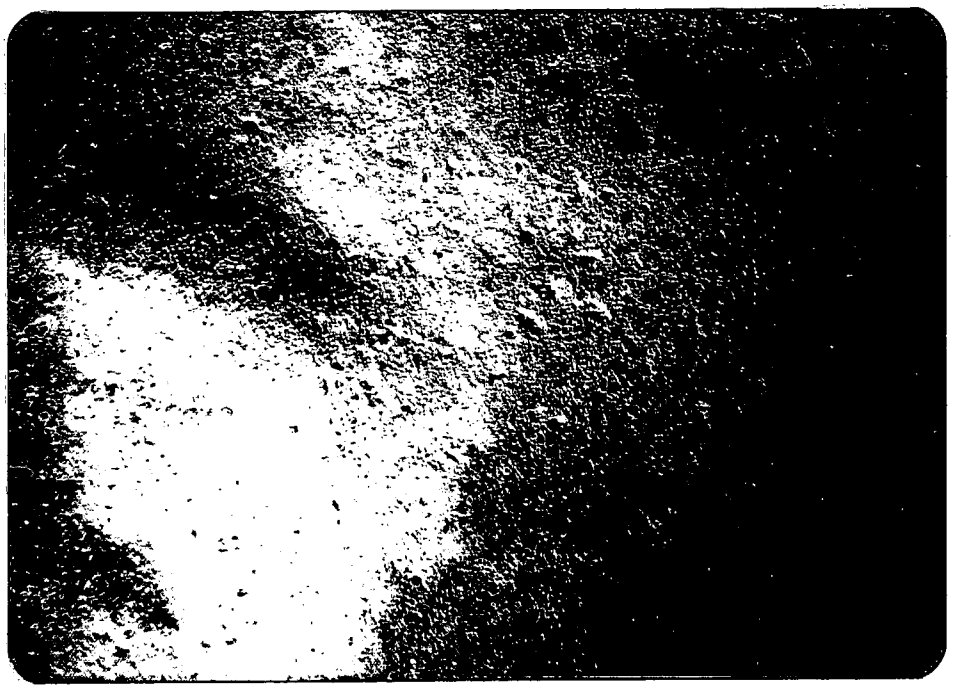

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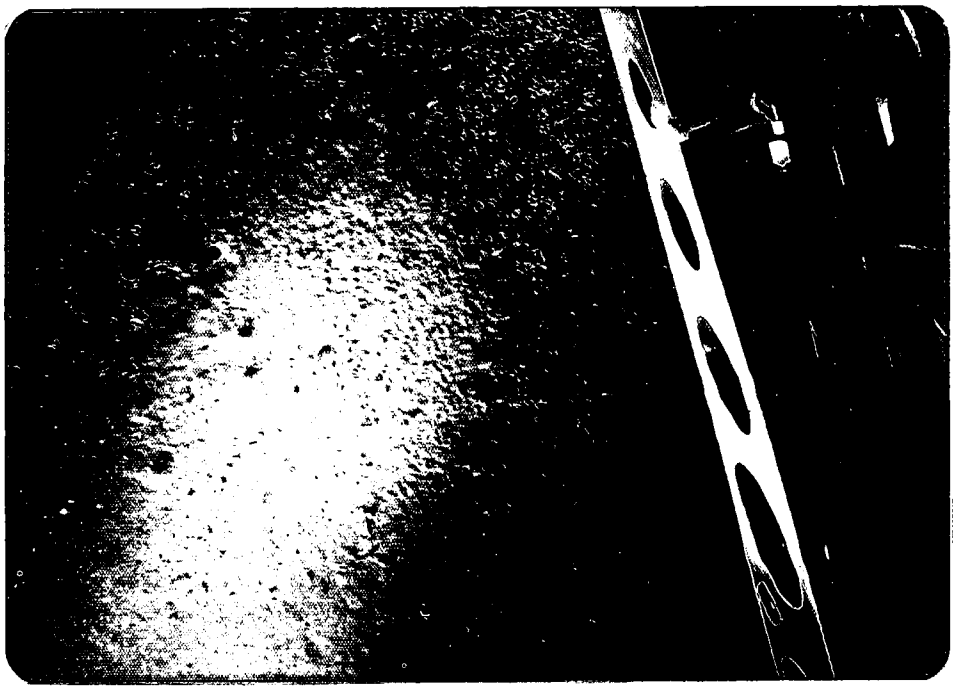

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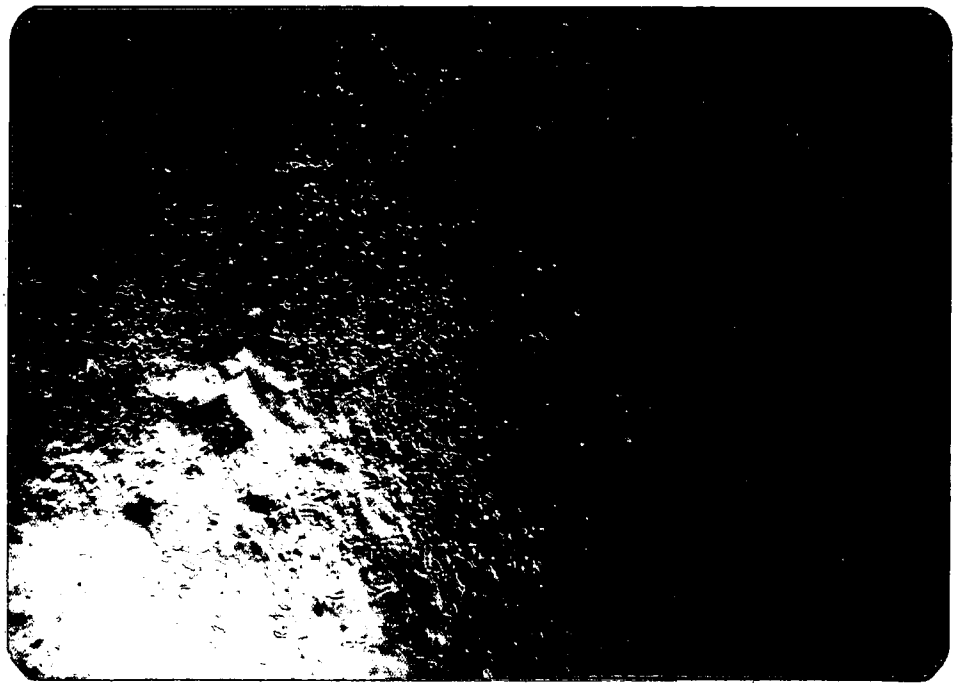


Photo 3: Dive 5

- Flat surface of mud
- Numerous pin hole depressions (burrow holes?)
- 20-30 nearly transparent, small crustaceans (Mysis) swimming just above the bottom and apparently into the current, estimated to be 2-3 cm in length
- surface micro relief appears to be slightly disturbed or washed out, probably from bottom currents

Photo 4: Dive 6

- Mud with irregular surface, slightly disturbed or washed out features
- Some pin hole depressions, some mounds and some bottom tracks
- Some of the mounds and adjoining tracks may be small molluscs
- Five-ten crustaceans (Mysis)

Photo 5: Dive 7

- Mud; smooth surface and lineations suggest possible scouring during periods of high current
- Some shallow, irregularly shaped depressions, may be caused by sediment dewatering
- Some small mounds, may be molluscs
- There is a raised object casting a shadow at the lower centre; it may be a buried mollusc with an extended siphon tube?

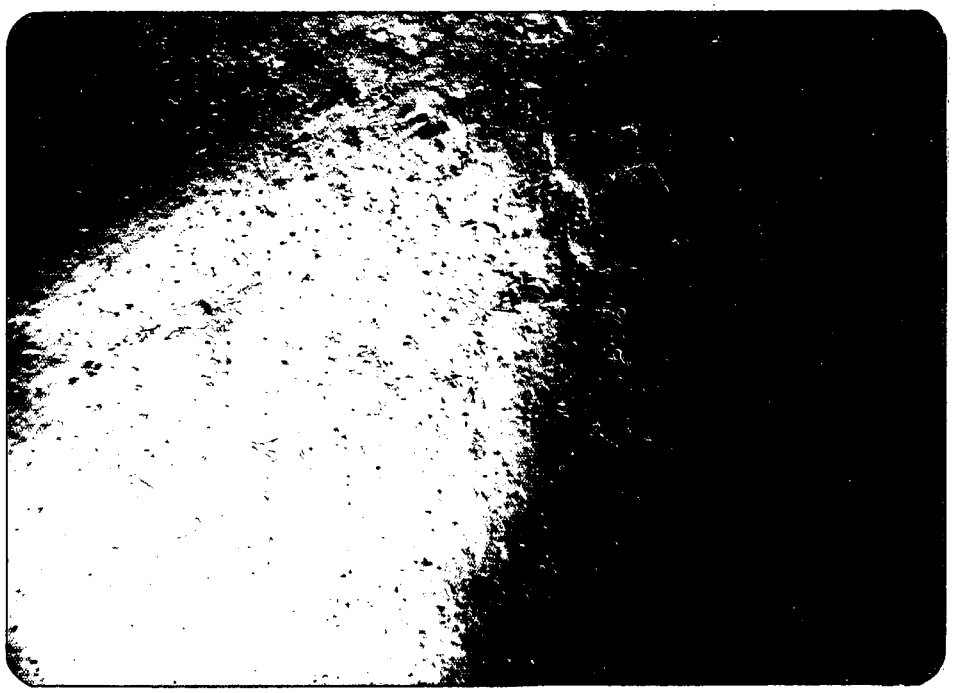
Photo 6: Dive 7

- Similar to photo 5
- The lighter coloured fragments are pieces of sub-surface sediment that has fallen off TROV
- The disturbance around the largest fragment (lower right), shows how easily the surface mud is disturbed.

5

6

7



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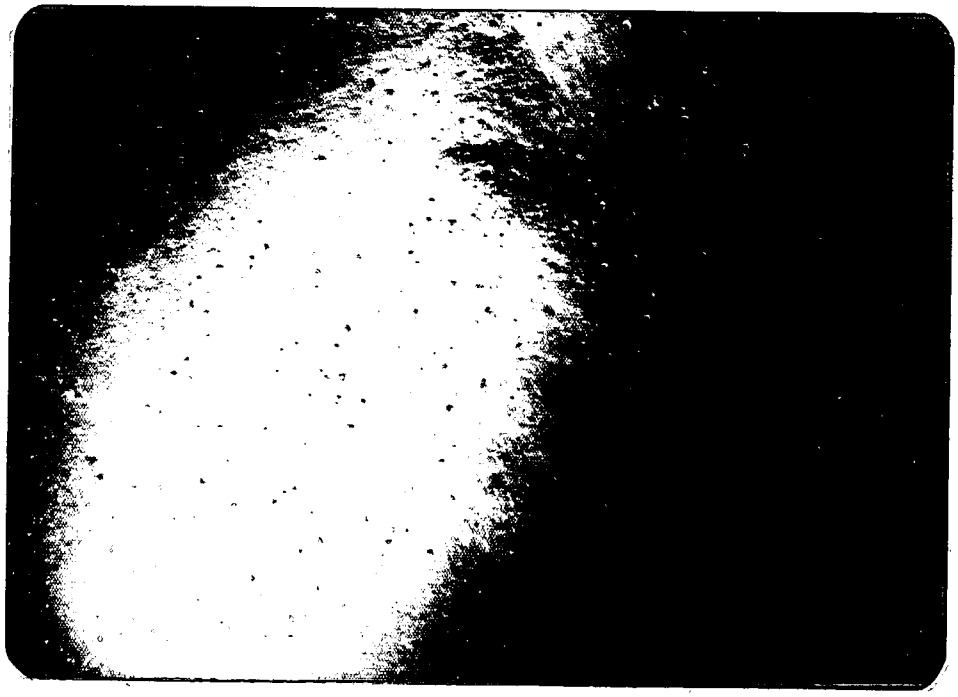


Photo 7: Dive 8

- Mud
- Number of pin hole depressions (burrow holes)
- Ten-fifteen crustaceans (Mysis)
- Lineation suggests scouring
- Single large depression is typical of this bottom sediment at this depth

Photo 8: Dive 9

- Generally flat bottom of mud with some slight irregularities corresponding to sub-surface layer
- pin hole depressions

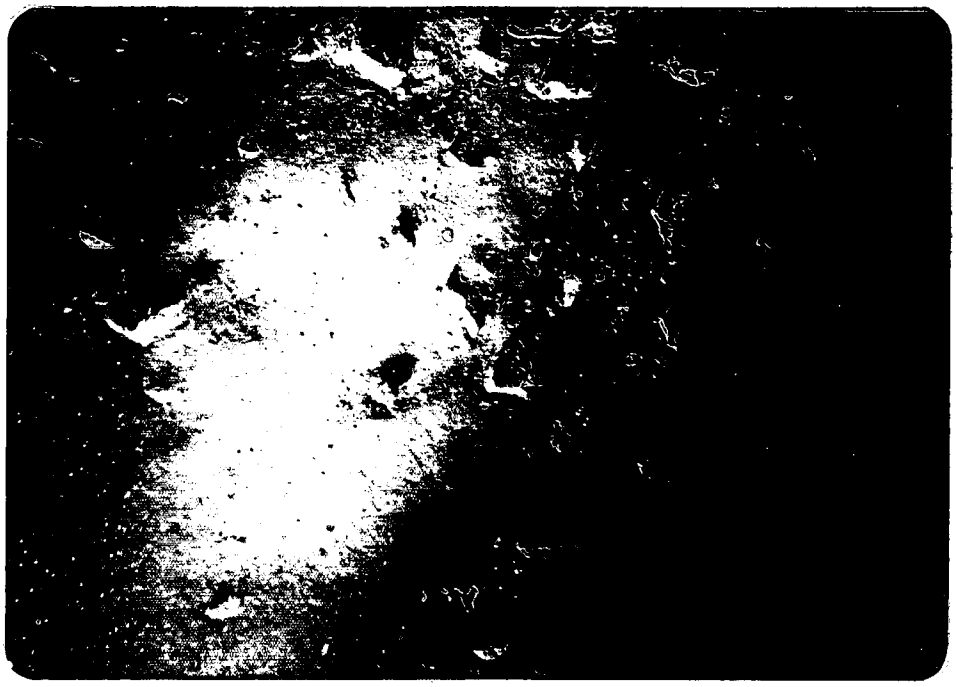
Photo 9: Dive 9

- Irregularly shaped fragments of glaciolacustrine surface exposed through a thin layer of recent mud
- Some scouring is visible around some fragments
- A few pin hole depressions

Photo 10: Dive 9

- Irregular surface of glaciolacustrine clay
- The surface is probably hardened from subaerial exposure and is more resistant to erosion
- The surface is undercut by scouring, and it then fractures into irregularly shaped fragments

9



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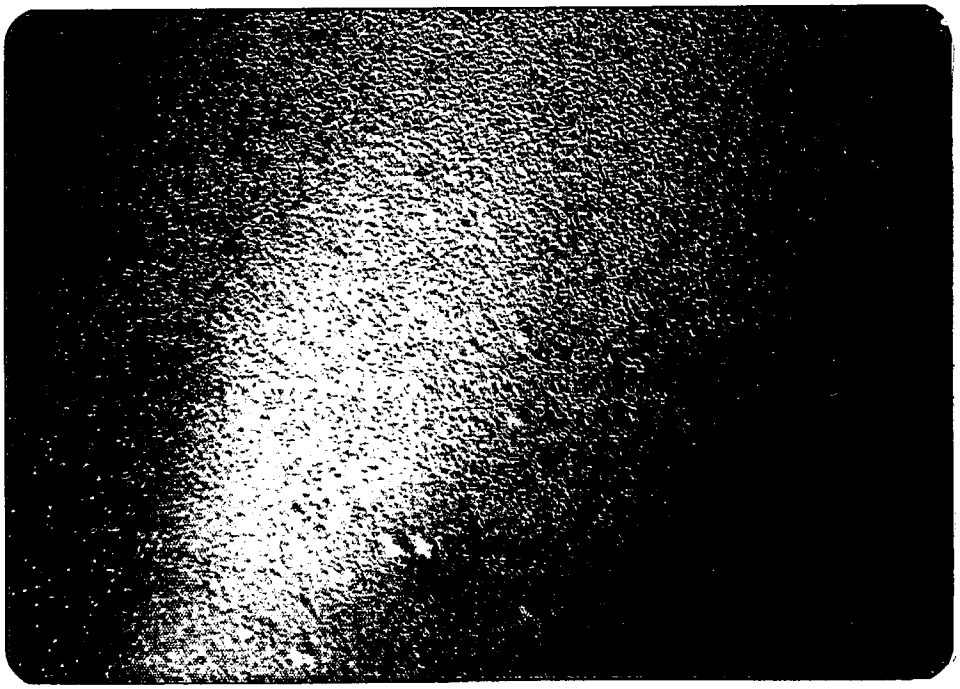

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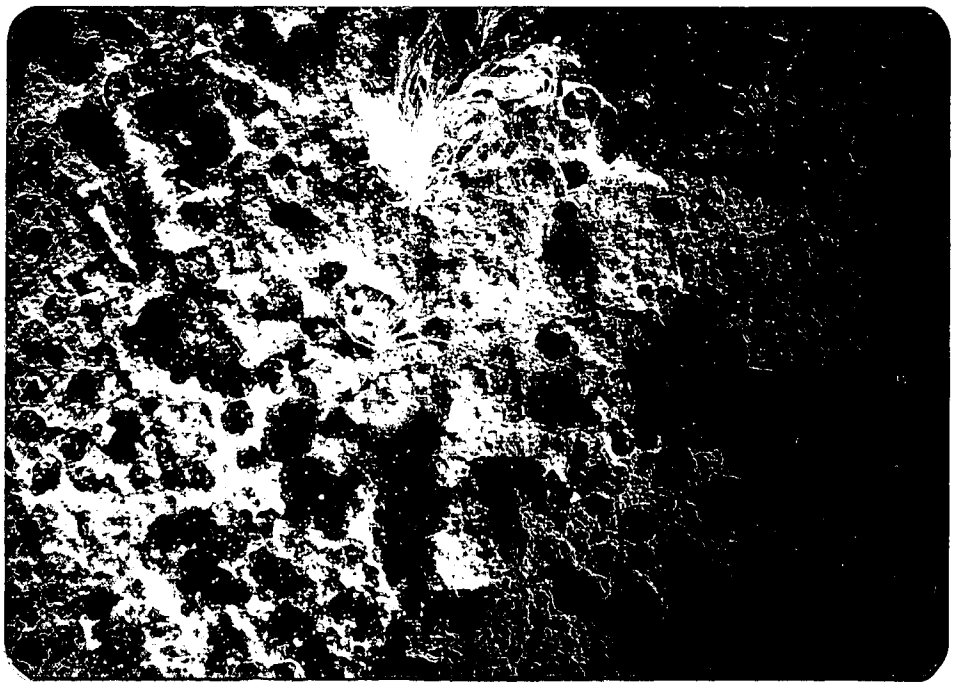


Photo 11: Dive 10

- Recent mud; typically fluffy or flocculated sediment surface
- Extensive covering of micro features, pin hole depressions and some burrow hills
- Small sculpins near bottom center

Photo 12: Dive 11

- Pitted limestone bedrock surface
- Thin surface growth on rocks
- Hydras in upper center

Photo 13: Dive 11

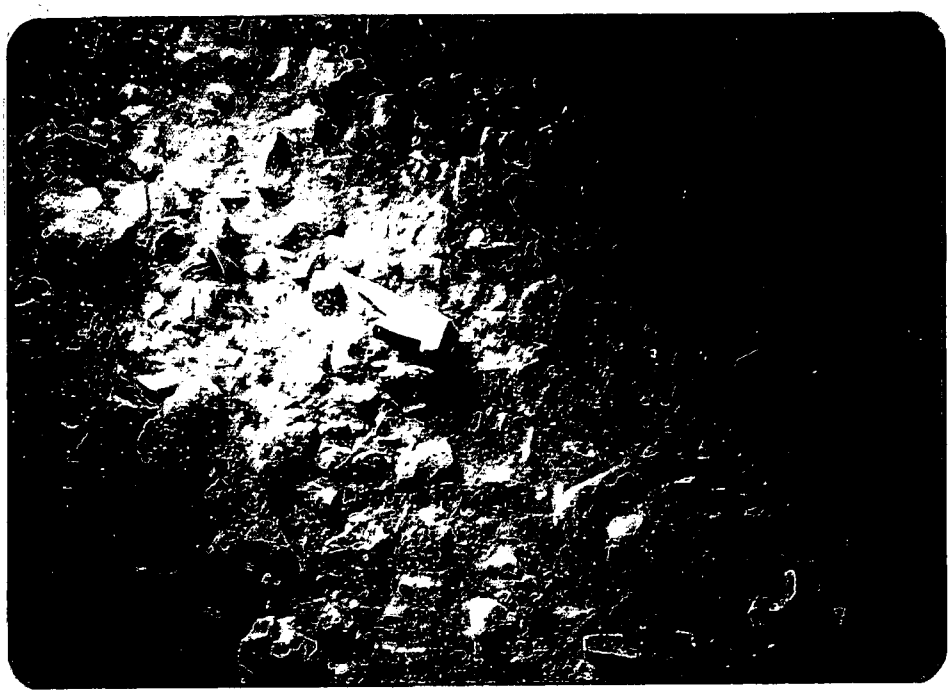
- Pitted limestone with surface growth
- Crayfish

Photo 14: Dive 12

- Rock fragments near base of escarpment with thin covering of mud
- Three sculpins and a couple crustaceans
- Slide was printed from wrong side, so that light source is in upper left corner

13

14



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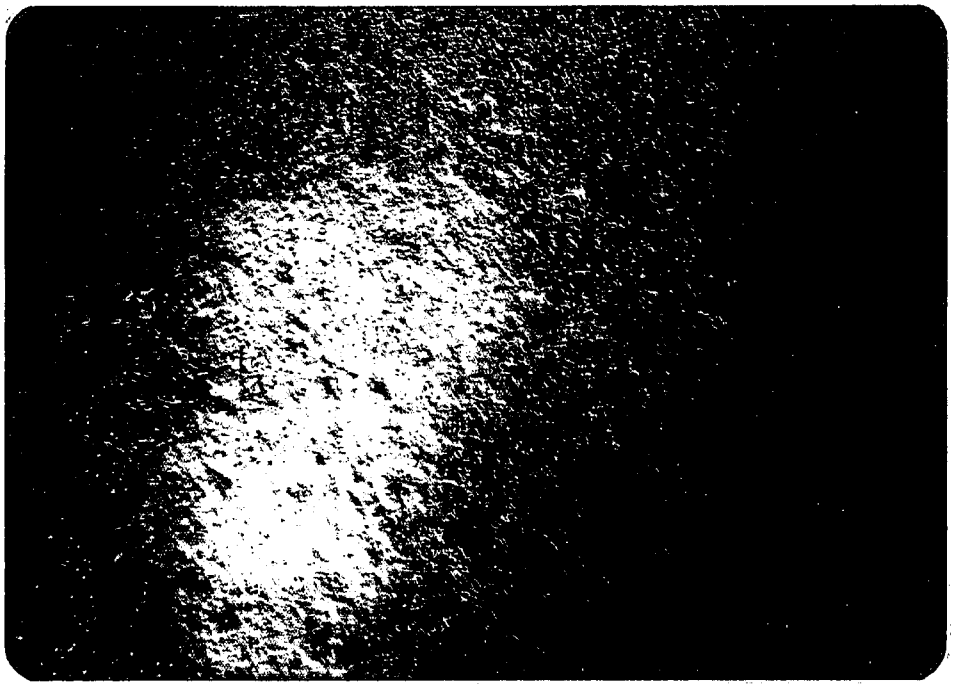

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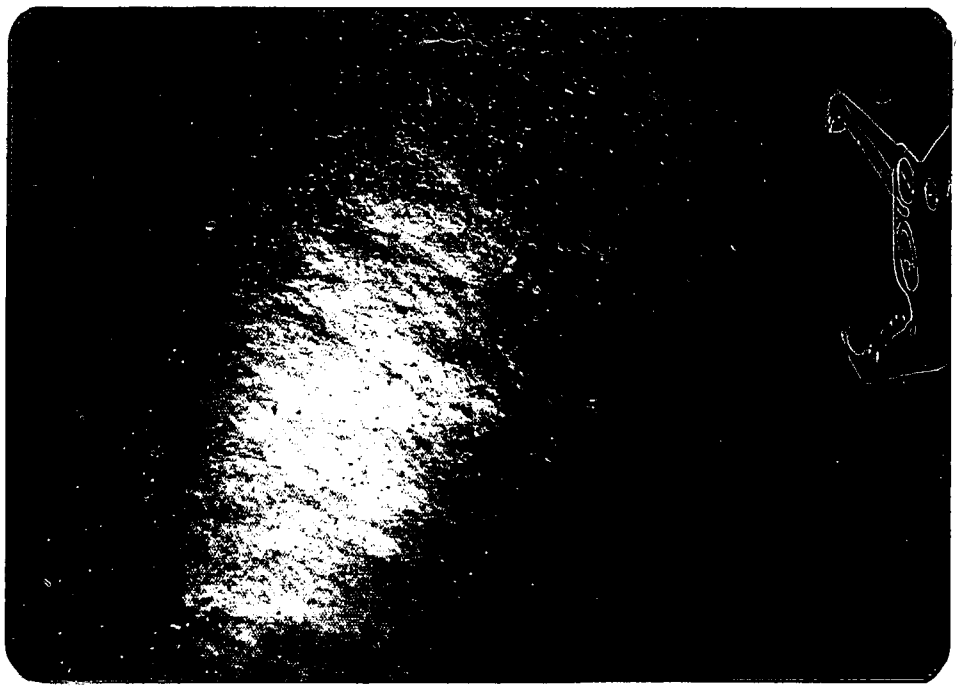


Photo 15: Dive 12

- Mud, irregular surface
- Numerous marks and depressions that appear to be slightly washed out from scouring
- Five-ten crustaceans

Photo 16: Dive 12

- Mud, further offshore than photos 14 and 15
- Lineation and smoothing of micro relief suggests scouring during periods of high current
- Some small crustaceans

Photo 17: Dive 13

- Recent mud, typically fluffy surface
- Micro relief of pin hole depressions and burrow hills suggests no current scour recently
- The narrow curving marks are fin marks from sculpin in lower left
- A cloud of easily disturbed sediment occurs after sculpin's tail strokes the bottom
- The fresh, irregular depression in right center and the washed out micro relief around it, could have been caused by fish movement also
- In upper center, a 'worm-like' object sticking out of the bottom and casting a shadow

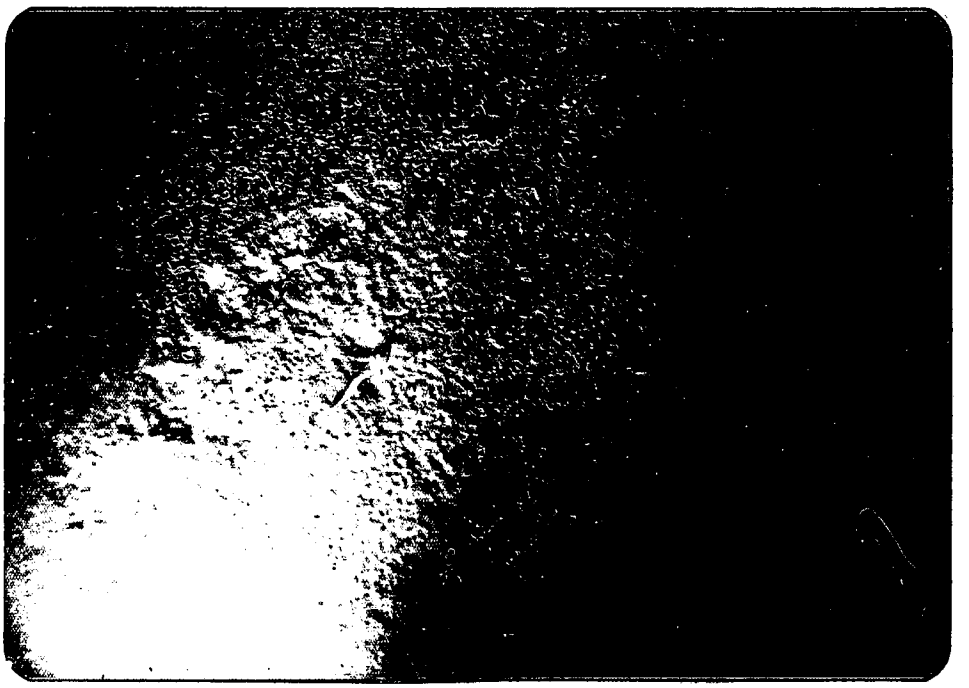
Photo 18: Dive 13

- Similar to 17, recent mud and micro relief
- Sculpin
- The small oval depressions may have been caused by the sculpin resting on the bottom

17

18

19



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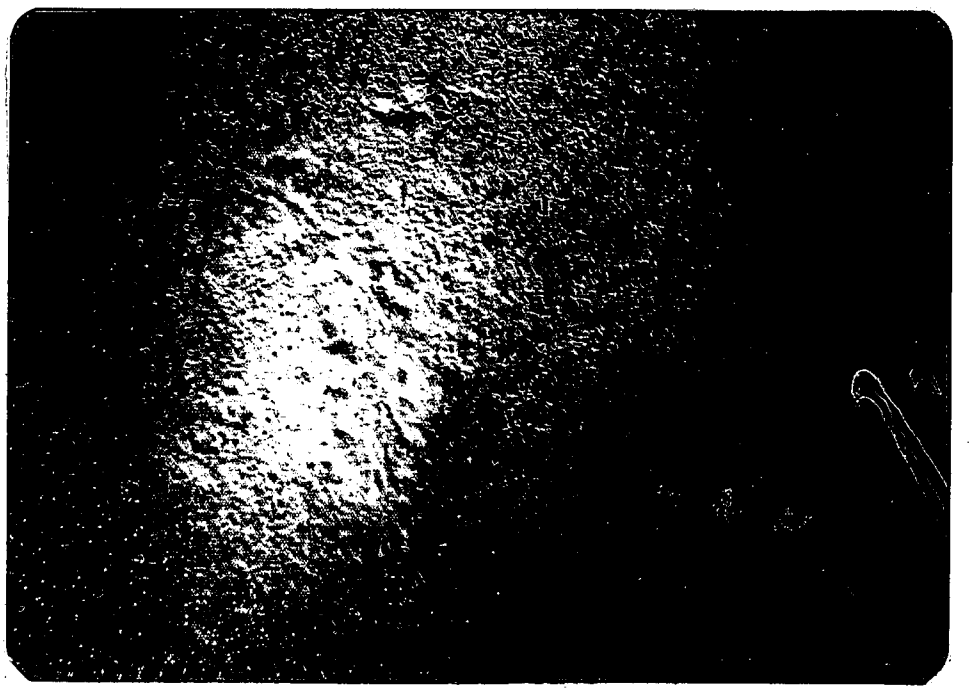

Photo 19: Dive 13

- Similar recent mud
- A large track of varying depth across the photo
- Sculpin

Photo 20: Dive 13

- Similar recent mud
- A shallow sinuous track with side marks; may have been caused by a fish moving close to the bottom