A SHALLOW SEISMIC SURVEY ON THE INTERTIDAL FLATS AT PANGNIRTUNG, BAFFIN ISLAND, NORTHWEST TERRITORIES

Project 790034

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Abstract

A hammer seismic survey was conducted along selected lines across the intertidal flats at Pangnirtung, Baffin Island, in an attempt to delineate the bedrock surface beneath the sediments. The results indicate that bedrock drops off steeply from shore where the flats are narrow, whereas it forms a supporting platform beneath the extensive flats at the mouth of the Duval River. Approximately 30 m of sediment lie above this bedrock platform. There is some evidence of boulders or groups of boulders buried in these sediments, but the density of these cannot be estimated.

Résumé

Une étude sismique au marteau a été entreprise le long de cheminements choisis en travers de l'estran à Pangnirtung (île de Baffin) en vue de tracer la surface du socle rocheux sous les sédiments. Les résultats indiquent que le socle plonge abruptement à partir du rivage, là où l'estran est étroit; d'autre part, il forme une plate-forme de soutènement sous la vaste étendue d'estran à l'embouchure de la rivière Duval. Environ 30 m de sédiments recouvrent cette plate-forme. Des gros blocs ou des groupes de gros blocs sembleraient exister sous les sédiments mais il est impossible d'estimer leur densité.

Introduction

A hammer seismic survey was conducted along two lines across the intertidal flats at Pangnirtung, Baffin Island, in July 1982, as the first stage in a co-operative research program between the Geological Survey of Canada and the Department of Geography at Queen's University. The objective of this program is to evaluate the origin and development of the intertidal flats, especially with respect to tidal processes, the action of sea ice, and the changes in sea level which have occurred through the Holocene Epoch. The geophysical results presented here define the bedrock topography and set the stage for the recovery of cores through the sediments to be used in stratigraphic and paleo-environmental study.

Intertidal flats are found all around the shores of Pangnirtung Fiord. They are generally less than 200 m wide except at the mouth of the Duval River at Pangnirtung where they reach a maximum width of 600 m (Fig. 32.1). The intertidal surface is characterized by the presence of large boulders and a prominent boulder barricade near the outer edge. Biological and sedimentary environments of the intertidal flats were described by Aitken and Gilbert (1981), Gilbert and Aitken (1981), and McCann et al. (1981).

Survey Operations

The seismic source used in this survey was a 7.3 kg sledge hammer striking a steel plate firmly set on the ground surface. Where standing water did not drain from the surface of the flats, the hammer was used directly on the top of boulders. The data were recorded on a Nimbus 1210F 12-channel engineering seismograph and stored on cassette tape in the field using the Nimbus G742S digital tape recorder. In the office, the tape recorder was linked to an Apple II microcomputer and the records were transferred to floppy disk to allow further interpretation and display through the computer (Hunter et al., 1980).

The intertidal flats did present some operational difficulties. It was only possible to work during low tide, and even then there were large pools of standing water especially near the boulder barricade at the end of line 2. The geophones (4.5 Hz) were in waterproof marsh cases, but the records deteriorated rapidly when the goephone/cable connections got wet. These connections had to be made temporarily waterproof with a covering of silica caulking compound before useable data could be collected in this environment.

In order to map the detailed structure of the bedrock surface beneath the tidal flats, the "optimum offset" shallow reflection technique (Hunter et al., 1982) was used. This method involves recording an initial expanded spread shot, from which an optimum offset between source and receiver is chosen. This offset is one at which the bedrock reflection can be observed without interference from either shallower events or surface waves. Using the individual channel "memory hold" feature of the Nimbus 1210F, records of common offset data can be produced. Periodically, other expanded spread reflection and/or refraction records are shot to provide velocity information.

Results

The "optimum offset" sections along lines 1 and 2 are shown in Figures 32.2 and 32.3 respectively. These records were obtained with one or two hammer blows per trace, a 3 m spacing between traces, and a 150 Hz low-cut filter setting on the instrument. The water-saturated sediments were an excellent transmitter of high frequencies, and even with this relatively low filter setting, the predominant energy on these records is in the 300-500 Hz range. This, along with negligible interference from either ground roll or a ground-coupled air wave, made it possible to map bedrock reflections from depths of less than 30 m.

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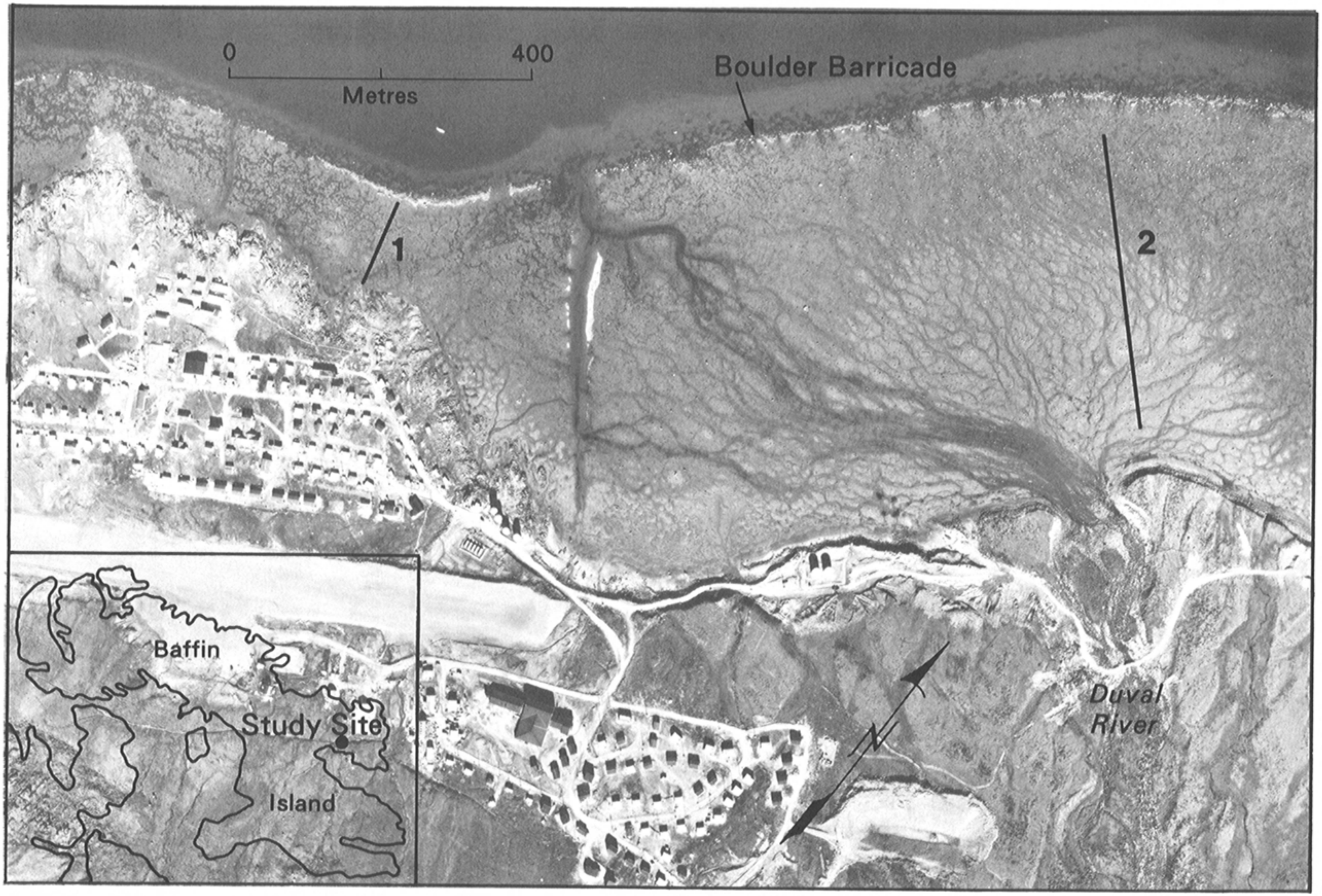

Figure 32.1. *Portion of air photograph A24493-54 taken on August 20, 1976, showing the intertidal flats and seismic lines 1 and 2 in the vicinity of Duval River and the Hamlet of Pangnirtung, Baffin Island.*

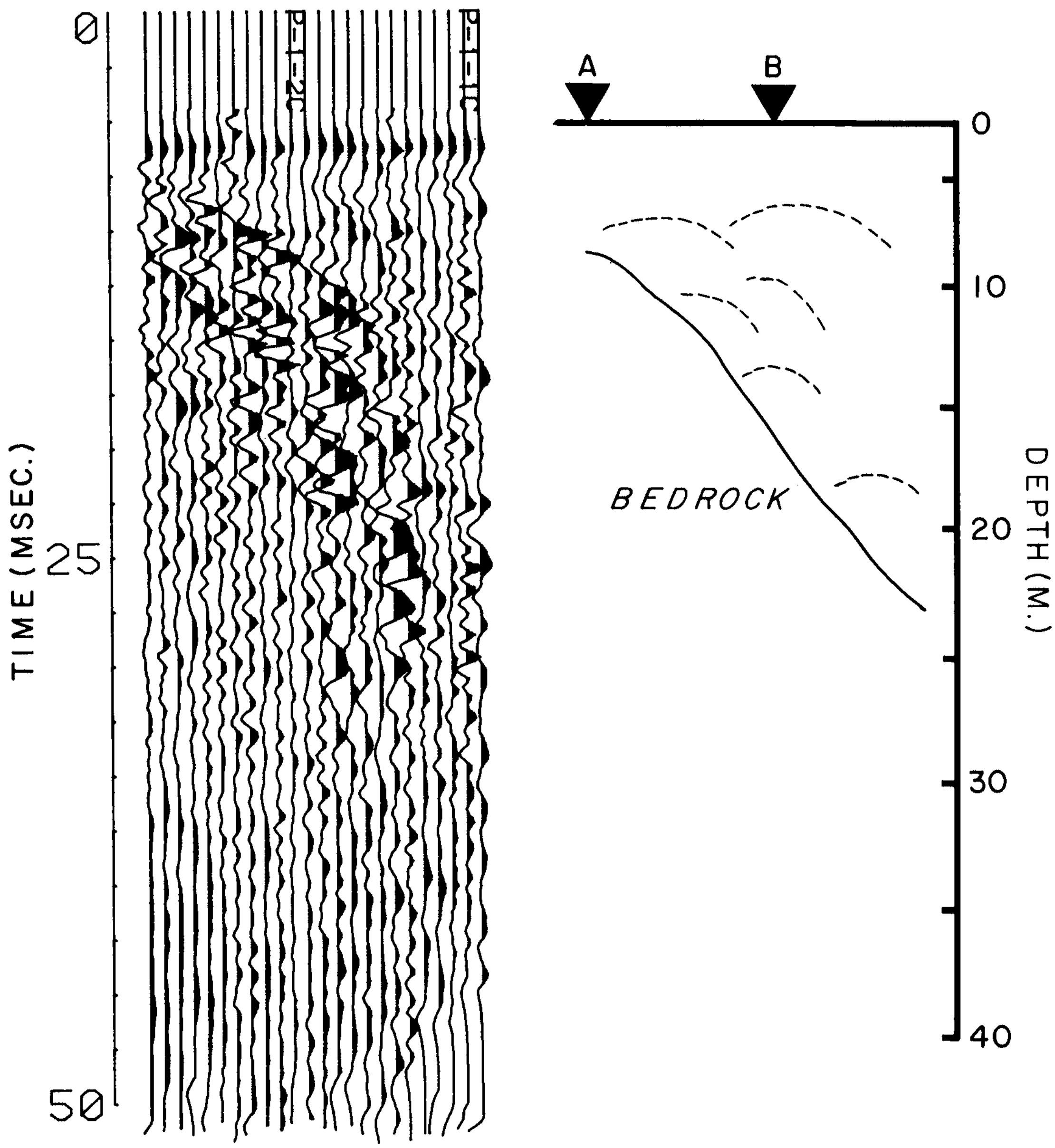

Figure 32.2. *Common offset section along line 1 from shore (at left) towards the boulder barricade. The offset between source and receiver was 9 m along this line. There is a 3 m spacing between traces, and the total length of the section is 70 m. An automatic gain control with a sampling window of 8 ms has been applied to these records.*

At the right of the figure is a schematic interpretation of the section with a non-linear depth scale that has been calculated assuming an average velocity of 1700 m/sec above bedrock. The arrows above this interpreted section mark the positions where expanded spread reflection and refraction records were shot perpendicular to the line. The dashed curved lines represent possible diffraction events.

Reversed expanded reflection and refraction spreads were shot perpendicular to these optimum offset sections at the positions (A to E) indicated in Figures 32.2 and 32.3, and were used to obtain the interpreted sections shown along with the data. The refraction data indicated consistent velocities of 1700 m/sec for the surface layer, and from this information the time scale of the optimum offset sections has been converted to a non-linear depth scale. It is evident from the reversed spreads that there is considerable variability in elevation of the bedrock surface perpendicular to the sections presented here (i.e. approximately parallel to the shoreline). For example, the refraction data from E (Fig. 32.4) indicate that there is an elevation change of 6 or 7 m along the spread length of 80 m. Thus, the bedrock profiles along lines 1 and 2 can only be considered to represent bedrock topography beneath the flats in a most general sense.

Along line 1 where the intertidal flats are quite narrow (130 m wide), bedrock drops off steeply from shore. Under the boulder barricade the wedge of sediments is more than 20 m thick.

The picture is quite different, however, beneath line 2 across the wide zone of the flats. Here a bedrock plateau exists beneath the centre of the intertidal zone, and there is a broad bedrock high (a knob? or ridge?) shoreward of the

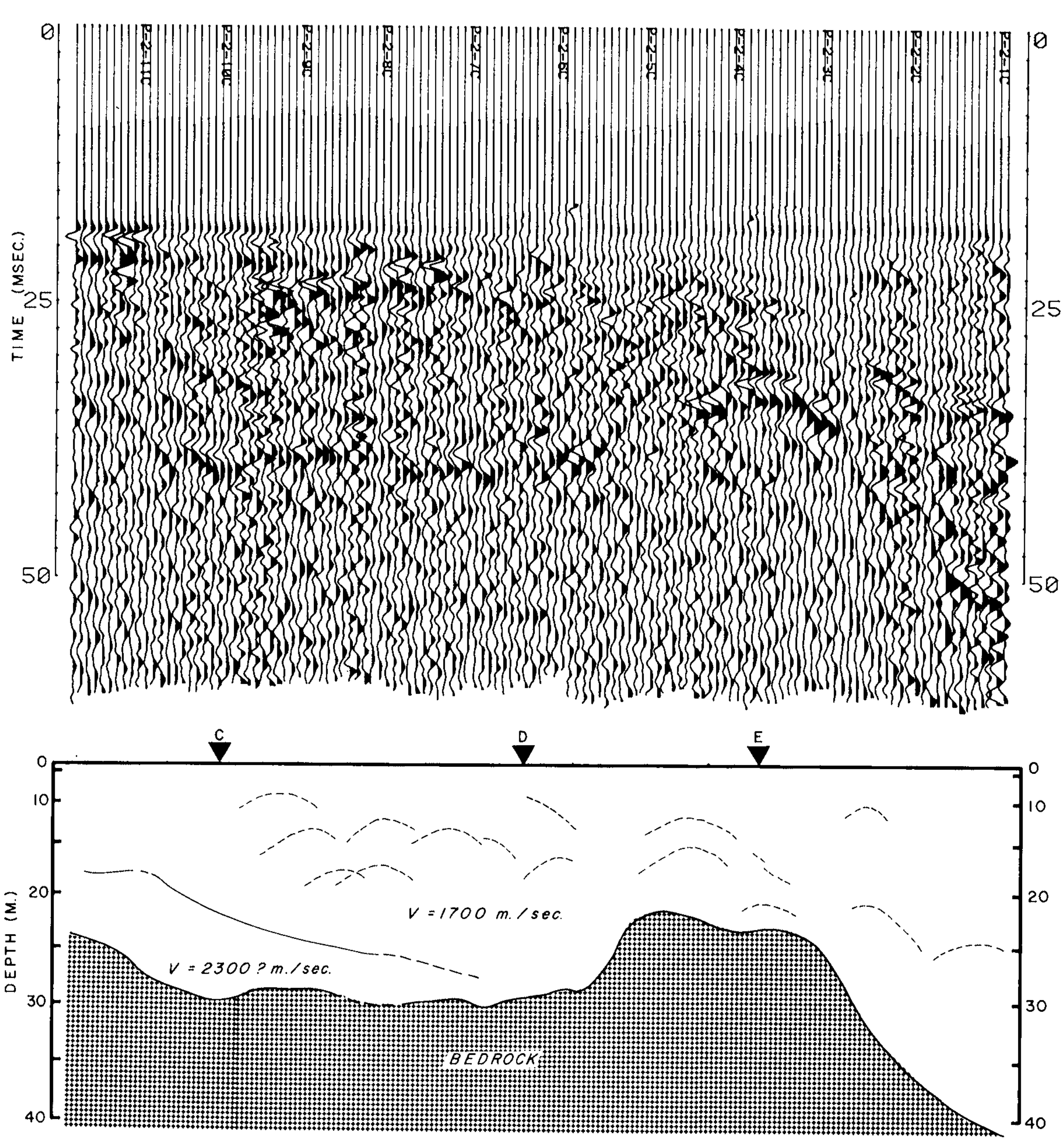

Figure 32.3. *Common offset section along line 2 from shore (at left) towards the boulder barricade. The offset in this case was 30 m and the total length of the section is 390 m. Otherwise the comments accompanying Figure 32.2 apply also to this figure.*

steep drop-off into the fiord. Under the boulder barricade at the end of line 2, the sediment thickness is estimated to be of the order of 50-60 m. At the shoreward end of this profile there is some evidence of stratification in the sediments above bedrock (see Fig. 32.3). This is tentatively interpreted as the top of a wedge of coarser sediments from Duval River, deposited perhaps during a period of lower sea level. For example, evidence presented by Dyke (1979) indicated sea level at Pangnirtung Fiord was some 10 m below present about 3000 years B.P. It is also possible that the shallow reflection comes from a permafrost zone in the sediments, but this is considered unlikely in view of the warm surface water temperatures in this region of the fiord which may exceed 6°C during the open water season (Gilbert, 1978). The velocity of 2300 m/sec that is given for this layer is based on a single reflection record. It would, however, support either of the interpretations suggested above.

One question that it was hoped the seismic data might address was whether the boulders are confined to the surface of the intertidal flats or are scattered throughout the sediments. On the records obtained in this survey there is considerable energy return from within the sedimentary layer (though this has been disguised somewhat in the sections presented here by the automatic gain control that has been applied to the data). On the interpreted sections are indicated possible diffraction events which may be caused by buried boulders, or groups of boulders.

SUMMARY

The results of the hammer seismic survey conducted on the intertidal flats at Pangnirtung in 1982 indicate that bedrock drops off steeply from shore where the flats are narrow, whereas it forms a supporting platform beneath the

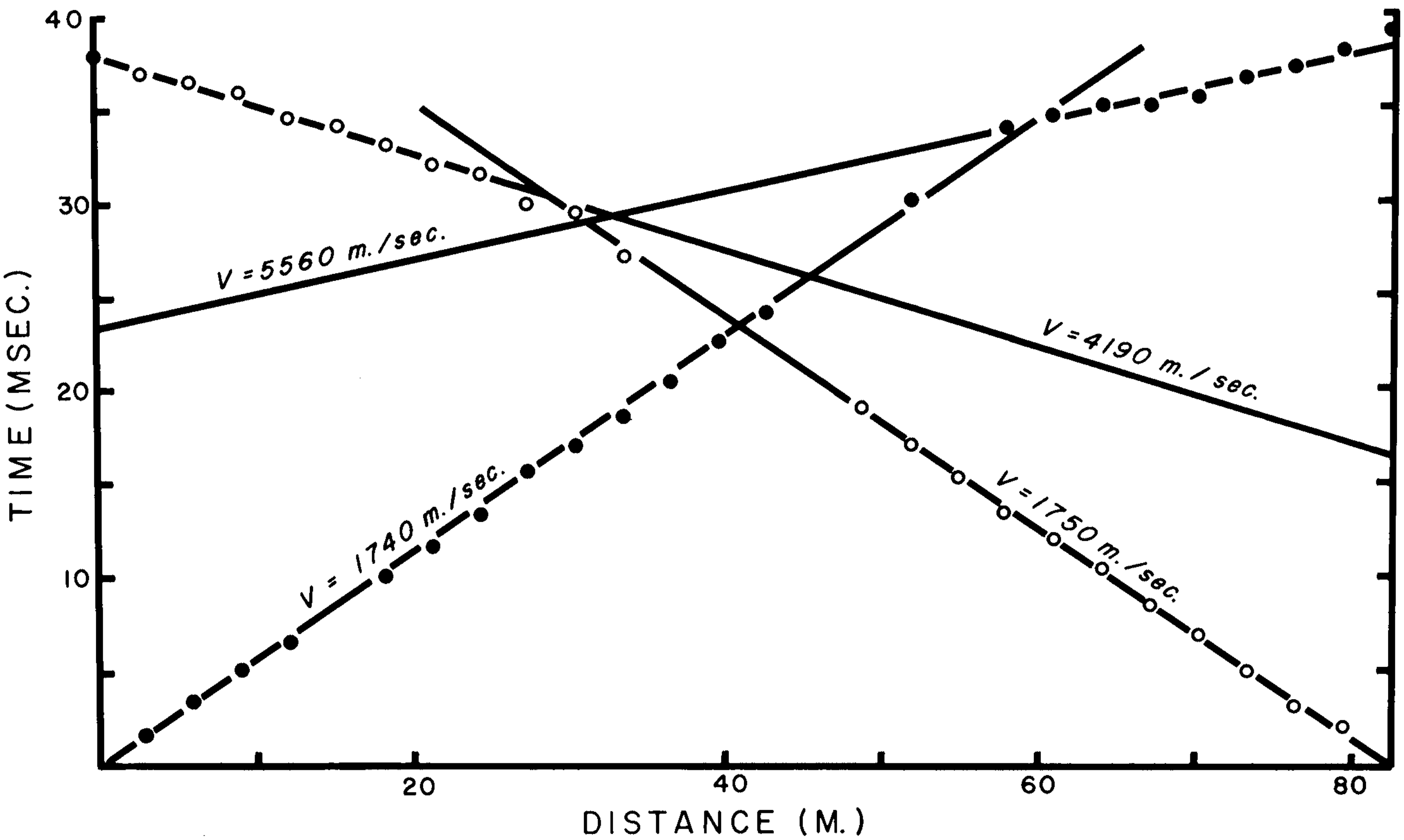

Figure 32.4. *Reversed refraction profile shot perpendicular to line 2 at the position marked E in Figure 32.3. Interpreting this as a case of a uniform overburden (v = 1745 m/sec) above a dipping bedrock (v = 4770 m/sec) the depth to bedrock varies from 22 m at the left end of the profile to 15 m at the right end.*

extensive flats at the outlet of the Duval River. Approximately 30 m of sediment lie above this bedrock platform along most of the survey line. A bedrock high (a knob? or ridge?) was mapped at approximately 150-200 m inside the boulder barricade shoreward of the steep drop-off into the fiord. There is evidence of considerable topography on the bedrock surface perpendicular to the survey lines, so the bedrock profiles presented here can only be considered to be representative ones in a most general sense. It is thought that there are boulders or groups of boulders buried in the sediments, but the density of these in comaprison to those observed on the surface of the flats cannot be estimated.

Acknowledgments

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