A Profiling Method for Measuring Erosion and Accretion of Intertidal Rock Surfaces

Thomas F. Donn and Mark R. Boardman

Department of Geology
Miami University
Oxford, Ohio 45056, USA

ABSTRACT


A rock surface profiling device for use in the intertidal zone is described. Rates of rock erosion and details of erosion patterns may be determined with this system.

ADDITIONAL INDEX WORDS: Erosion rate, intertidal.

INTRODUCTION

A method for determining the rate of rock erosion or accretion utilizes periodic surface contouring. A surface profiler, designed for studying intertidal rock erosion along the coasts of Andros Island, Bahamas, has provided a combination of precision, durability, and environmental adaptation which is unavailable with other devices.

While many methods for determining rates of rock erosion exist, only a few of these include direct measurement of the rock surface. As part of a study on erosion of beachrock in Barbados, McLEAN (1964) compared two contours which were drawn one year apart to obtain a direct measure of rock erosion rate. EVANS (1970) described a method of determining erosion rates which uses a drawing table to produce a single contour of the rock surface. This method, however, only has a precision of 5 mm and measures a very limited surface area.

The surface profiler described here allows a surface area of approximately 2600 cm$^2$ to be contoured, while maintaining a precision of 0.1 mm (Figure 1). This system measures distances to the rock surface from a permanent level above the rock. The grid of measurements is then used to produce a contour of the surface. A rate of erosion or accretion may be determined by comparing an initial surface contour to a subsequent contour.

DESCRIPTION

The entire apparatus is constructed with rigid, durable, and non-corrodible materials so that general field conditions and seawater will not limit its capabilities. The four main components of the system include the measuring frame, corner support rods, cross-beam, and measuring rod (Figure 2).

The measuring frame is made with four pieces of aluminum channel which are welded at the corners. McLEAN (1964) compared two contours which were drawn one year apart to obtain a direct measure of rock erosion rate. EVANS (1970) described a method of determining erosion rates which uses a drawing table to produce a single contour of the rock surface. This method, however, only has a precision of 5 mm and measures a very limited surface area.

The surface profiler described here allows a surface area of approximately 2600 cm$^2$ to be contoured, while maintaining a precision of 0.1 mm (Figure 1). This system measures distances to the rock surface from a permanent level above the rock. The grid of measurements is then used to produce a contour of the surface. A rate of erosion or accretion may be determined by comparing an initial surface contour to a subsequent contour.

Corner support rods consist of 0.5 inch diameter stainless steel all thread. These are permanently anchored into the substrate by cementing them into holes created with a gasoline-powered coring device (J.K Smit and Sons, model 10 GSC). We found that holes 5 cm in diameter and 20-25 cm deep are sufficient to ensure firm anchoring of the rods using quick-setting hydraulic cement (Thoro Water Plug®). To ensure proper alignment and spacing, rods should...
be cemented in place while attached to the measuring frame. Two stainless steel nuts are used on each rod to support the frame. Tightening the two nuts against each other and applying thread-locking fluid prevents them from rotating and thus assures that the frame can be returned to the exact position for subsequent measurements. These rods and permanently locked support nuts are the only parts of the system which remain at each site. The rods protrude approximately 25 cm above the surface.

The cross-beam consists of one piece of aluminum channel with stainless steel supports welded to the base of each end. Two metal pegs (0.6 cm diameter) project from the underside of each support and position the cross-beam on the measuring frame. Pinch clamps are used to keep the cross-beam in firm contact with the frame while a row of measurements is made. Notches in the upper and lower sections of the cross-beam control the vertical positioning of the measuring rod along each row of measurements.

The measuring rod consists of a stainless steel rod which has been flattened on one side along which a plastic scale is affixed. The bottom end of the rod is rounded to prevent wear and resulting loss of precision.

**OPERATION**

The measuring frame is lowered over the support rods until it is in firm contact with the basal nuts. Once in position, additional nuts may be turned down against the top of the measuring frame, holding it tightly against the basal nuts. These top nuts are especially necessary on inclined and inverted surfaces. To position the cross-beam on the measuring frame, the operator sets the pegs of the cross-beam into holes along the side of the frame. The two pegs on each support assure correct positioning on the frame and prevent oblique traverses. Pinch clamps must be placed on each end of the cross-beam to hold it firmly against the measuring frame (Figure 1).

Profiling may now begin by placing the measuring rod into the first pair of notches on the cross-beam and lowering it until the rounded end reaches...
Figure 2. Diagram of surface profiler. For explanation, see text.

The surface profiler can be used to measure erosion or accretion on hard substrates in virtually any supratidal and intertidal marine environment. This system may also be used in a submarine environment, however, modifications in site preparation and data recording would be necessary.

Statistical and graphical analysis of data provide a method for evaluating surface morphology. Computer-generated contour maps may be used to visualize topography (Figure 3). Changes of the rock surface are determined by calculating the difference between initial and subsequent data sets.
Figure 3. Contour map produced from data collected using this surface profiler. Contour values are the distances (in centimeters) to the rock surface from the top of the cross-beam. This map was produced using the GCONTOUR procedure of SAS/GRAPH.

Figure 4. Contour map of differences between initial and subsequent measurements. This type of map shows areas of greater or lesser erosion.