On more fragile samples, such as frog or toad urinary bladder, where we have been examining the relative permeabilities of the granular and mitochondria-rich cells before and after stimulation by vasopressin, the required flow rates generate shear forces that cause the tissue to degenerate rapidly. This problem can be eliminated if a second micropipette (tip diameter, approximately 5 to 10 μm) is introduced to provide substantial flow only in the immediate vicinity of the sampling micropipette tip.

The results presented here reflect a few of the possible applications of scanning micropipette molecule microscopy to problems in biology and medicine. Even in a nonscanning mode, the rapid time response and small volume sampled could be used to great advantage in studies of preparations such as isolated tubules or capillaries. Furthermore, for many applications, a high-grade mass spectrometer is not necessary, since the conversion of HDO to HD reduces the necessary resolving capability of the mass spectrometer substantially. A modified leak detector might suffice for many applications.

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References and Notes

1. The micropipettes are plugged by being dipped into a solution of the plug material in a volatile solvent. Internal overpressure is used to oppose capillarity and thus to regulate the length of the slug of solution drawn into the tip and hence the thickness of the polymer plug that remains after the solvent evaporates. Further details of micropipette construction and the rest of the instrument are given in J. A. Jarrell and J. G. King, in preparation.
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5. The peak in Fig. 2b is wider than that in Fig. 2a. This is most likely the result of greater diffusional broadening since both the pressure head (about 10 cm of water) and hole diameter used to generate Fig. 2b were smaller than those used for Fig. 2a, resulting in a lower emergent fluid velocity. Many other factors may be involved, however. The low solubility of helium in water relative to the high "solubility" of water in water causes the micropipette plug to act as a "low-impedance" probe for dissolved helium in which depletion of the surrounding solution is significant. For water the micropipette acts as a "high-impedance" probe. Moreover, the microcirculation of the unlabeled water in the upper half-chamber can affect the concentration profile of emerging labeled water.
6. Cellulose acetate plugs, although approximately 20 to 100 times more permeable than dimethyl siloxane-polycarbonate plugs, are less permeable by at least a factor of 10 than might be expected on the basis of literature values. A possible explanation is that the permeability of cellulose acetate is known to be a function of its degree of hydration. Clearly, the vacuum side of the plug is not fully hydrated. Also, there seems to be some variability of cellulose acetate permeability from plug to plug. This is not easy to quantify in view of the limited accuracy to which plug dimensions can be measured.
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Diatoms as Hydrographic Tracers: Example from Bering Sea Sediments

Abstract. *Variations in the distribution of diatom species in surface sediments mirror distinct hydrographic regimes on the Bering shelf. Spring salinity fronts divide the water column into four zones with different vertical structures and different productivity patterns. Four assemblages of diatoms can be distinguished in sediments underlying the zones.*

The PROBES (Processes and Resources of the Bering Sea) project is a multidisciplinary study designed to investigate the relations between hydrography, productivity, and food-web structure in the southeast Bering Sea. Fieldwork over several years (*1*) has determined the basic hydrography and productivity of the area. The work has included hydrographic and nutrient measurements, analyses of plankton and chlorophyll, and counts of birds and fish.

In May 1979, during Leg 2 of the PROBES study, a series of bottom-grab samples were taken along the station track line (Fig. 1A). I examined the nu-

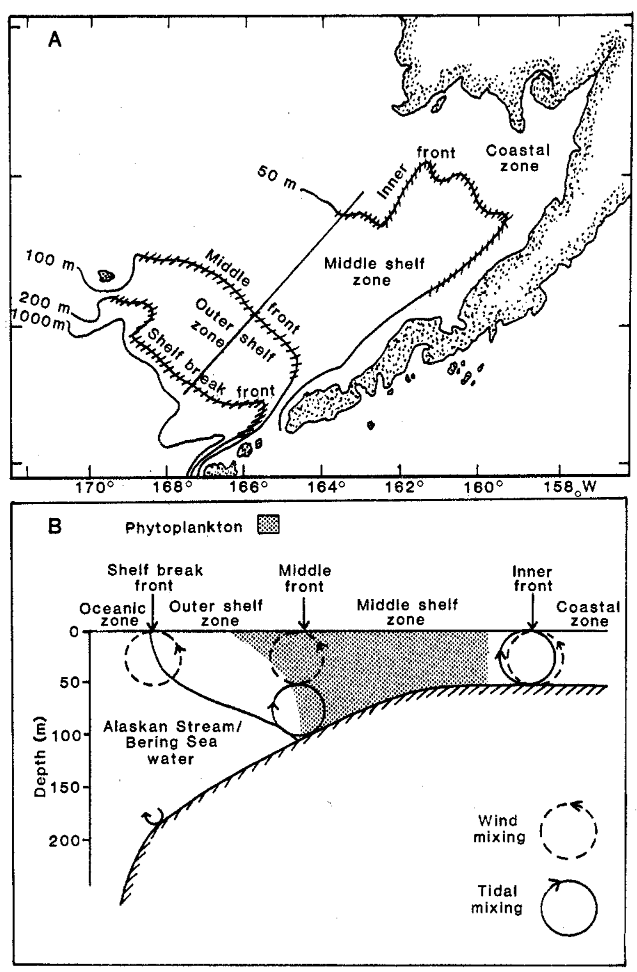

Fig. 1. Map of the region of the Bering shelf studied by PROBES, showing interpreted fronts and zones (*1*). (A) Horizontal distribution of the fronts. The straight line indicates the transect of Leg 2. (B) Schematic diagram of vertical structure and productivity in the area.

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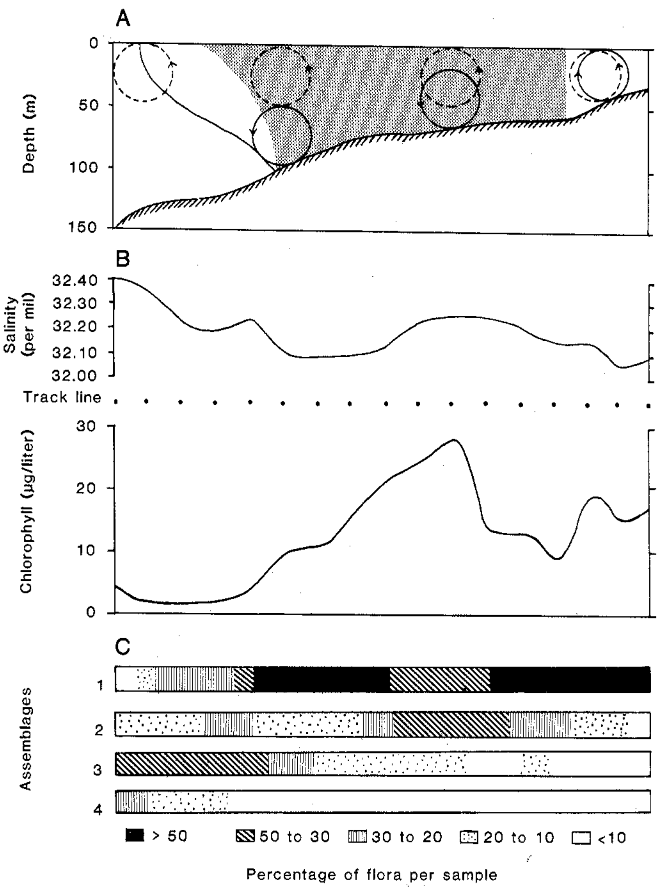

Fig. 2. Distribution of diatom assemblages along the transect of Leg 2 compared with salinity and the concentration of chlorophyll. (A) Schematic diagram of the vertical structure (*1*). (B) Salinity and the concentration of chlorophyll at 10 m during May 1979 (*1*). Trackline stations are shown as a series of dots. (C) Distribution of the four assemblages.

merical distribution of diatom species in the samples in connection with a regional study of diatoms in Bering Sea sediments (*2*). The variations in the abundance of different species in the samples are consistent with the hydrographic and productivity patterns found by PROBES (*1*) and suggest that the distribution of fossil diatom species in older sediments may be used to draw conclusions about paleohydrographic regimes.

Three fronts, largely defined by differences in salinity, divide the shelf into distinct zones (Fig. 1). The outer front lies along the shelf break (at the 200-m isobath) and appears to be permanent (*3*). It separates warmer, more saline waters of the Alaskan Stream and Bering Basin from cooler, low-salinity shelf water, which is affected by variable river discharge and the formation of sea ice. The middle front (at the 100-m isobath) and the inner front (at the 50-m isobath) are probably seasonal phenomena, forming during the spring melt of sea ice and dissipating the following winter (*4, 5*). In the outer shelf zone, between the shelf break front and the middle front (Fig. 1B), the low-salinity shelf water overrides the denser oceanic water, with relatively little vertical exchange (*1, 4*). In the middle shelf zone, between the seasonal fronts, the thermocline is occasionally disturbed by wind and tidal vertical mixing in spring. This results in higher nutrient concentrations, leading to a spring bloom of phytoplankton; chlorophyll persists below the surface until fall (*1*). The timing and intensity of the spring bloom appear to be affected by the presence of ice, in that high productivity is associated with the undersurface of the ice and the ice margin (*6*). The PROBES workers (*1*) distinguished a different food web in each of these zones and believe that these webs are based on different feeding strategies of the zooplankton. These strategies, in turn, are probably influenced by different phytoplankton inhabiting the zones.

Four different assemblages (defined by factor analysis) occur in sediments along the Leg 2 transect. Assemblage 1 (Fig. 2) is most abundant in the coastal and middle shelf zones. The characteristic species of this assemblage are members of the genera *Melosira* [*M. sulcata* and *M. sol* (?)] and *Delphineis* (*D. surirella* and *D. sachalinensis*). With the exception of the latter species, these are common, widely distributed forms which, although primarily benthic, have also been found among the plankton (*7*). I have found this assemblage to be typical of all shallow waters of the Alaskan continental shelf, extending into the Chukchi Sea (*2*). It is particularly common in such areas as Norton Sound and Bristol Bay, where there is significant river input. Assemblage 1 thus appears to be a good marker for low-salinity, river-derived water generally shallower than 100 m (approximately the maximum depth of light penetration).

Assemblage 2 is most abundant in the region of the spring chlorophyll maximum (Fig. 2, B and C). Two of the species in this assemblage (*Nitzschia oceanica* and *N. cylindrus*) are commonly found living in large numbers in the sea ice (*8, 9*), while the third (*Thalassiosira nordenskiöldii*) is common in early spring blooms of phytoplankton in northern latitudes (*7, 10*). Monospecific mats of *T. nordenskiöldii* have been reported in ice leads and at the margin of melting ice (*11*). This assemblage reaches its greatest regional abundance in the Chukchi Sea and Anadyr Bay (*2*)—areas of prolonged ice cover. Assemblage 2 would thus appear to be a marker of the spring bloom associated with melting of the ice cover.

Assemblage 3 is most common in the outer shelf zone (Fig. 2, A and C). In spring this is an area of moderate salinity and low concentrations of chlorophyll. The PROBES researchers reported a chlorophyll maximum in this zone in summer (July through September) and suggested that the bloom in this outer shelf zone occurs later in the season than that of the middle shelf. Species characteristic of this assemblage are *Thalassionema nitzschioides*, a cosmopolitan oceanic species, and *Biddulphia aurita*, a neritic species often found in spring blooms in northern latitudes (*7*). *Thalassionema nitzschioides* is present in most pelagic sediments but shows an abundance maximum in equatorial regions of upwelling (*12*), with secondary maxima along the Antarctic convergence and the Kuroshio-Oyashio convergence (*12, 13*). This implies that the species, although eurythermal and euryhaline, prefers somewhat warmer, more saline oceanic waters, where it may be the dominant species in a bloom. Assemblage 3 may be taken as an indicator of late spring and summer productivity in the outer shelf zone, where shelf and oceanic waters are incompletely mixed.

Assemblage 4 has its maximum abundance basinward of this transect, and appears here only in samples from the oceanic zone (Fig. 2, A and C). It is sharply limited by the shelf break front and disappears completely landward of the middle front. The dominant species in this assemblage, *Denticulopsis seminae* (*14*), is a widespread pelagic subarctic species that is common in all deepwater sediments north of the subarctic front in the Pacific (13, 15). In a regional study (2), I found it to be the dominant species in sediments below the Alaskan Stream and Bering Basin waters, with a sharp cutoff at the continental slope. Assemblage 4 is thus a marker of oceanic waters of higher temperature and salinity than those of the Bering shelf—in particular, the Alaskan Stream and derived waters.

The most abundant diatom species in the sediments are not necessarily those that are most abundant among the plankton (15). This difference stems in part from the effect of differential predation by herbivores and in part from the diverse susceptibilities of diatom valves to dissolution. Two of the most common genera of the plankton (*Rhizosolenia* and *Chaetoceros*) are rarely found in the sediments (15), probably because of their slight silicification. The assemblages of diatoms in the sediment are thus not representative of the living plankton.

Nevertheless, the assemblages in the sediment appear to be consistent with hydrographic and productivity patterns. This lends support to the hypothesis that diatoms in the sediments can be used to reconstruct details of hydrographic circulation and that fossil diatoms in older sediments may serve as guides to paleohydrography and paleoproductivity. In addition, shifts in the relative abundance of benthic, shallow-water species and pelagic species in cores from the outer continental shelf that contain a record of glacial events may indicate fluctuations in sea level that were due to changes in ice volume. The distribution of Assemblage 2 (ice-dwelling species) may also be used, to a first approximation, to estimate the extent and duration of sea ice during glacial intervals.

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A Three-Band Hand-Held Radiometer for Field Use

Abstract. *A self-contained, hand-held radiometer designed for field use has been constructed and tested. The 4.5-kilogram device, consisting of a strap-supported electronics module and a hand-held probe containing three sensors, is powered by flashlight and transistor radio batteries, uses two silicon and one lead sulfide detector, has three liquid-crystal displays, features sample-and-hold radiometric sampling, and is spectrally configured to Landsat-D's thematic mapper bands TM3 (0.63 to 0.69 micrometer), TM4 (0.76 to 0.90 micrometer), and TM5 (1.55 to 1.75 micrometers). The device was designed to collect ground-truth data for the thematic mapper and to facilitate ground-based, remote-sensing studies of natural materials in situ. Prototype instruments were extensively tested under laboratory and field conditions, with satisfactory results.*

The applications of remotely sensed data for environmental monitoring have increased substantially since the launch of Landsat-1 in 1972. This new technology has been extended into many disciplines to study various resource questions, and Landsat data have been used in most remote-sensing research to date. However, ground-based remote-sensing studies are needed to better understand the basic relations between natural materials in situ and reflectance or radiance as a function of wavelength. Landsat multispectral scanner imagery is not the best method to use in more fundamental remote-sensing research on natural materials. Considerable difficulties are encountered in sampling ground areas of ~ 0.4 ha, measuring atmospheric variability, compensating for sun angle effects, accounting for instrument responses, and determining the interactions between such sources of variation.

Ground-based spectrometers have been used by several research groups in an attempt to collect spectral reflectance data for natural materials in situ (1). These efforts have largely been successful but have also demonstrated some of the limitations of spectrometers: their cumbersomeness, the high cost of maintaining and operating them, and their lack of portability. Spectrometers do provide basic information about natural materials and their reflectances as a function of wavelength. This information is not only important per se but has provided the experimental basis for the development of hand-held radiometers.

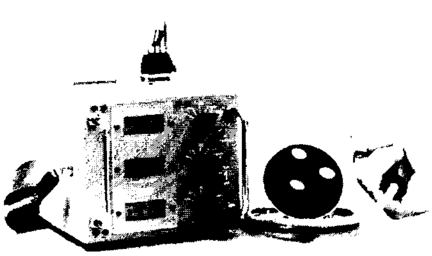

Fig. 1. Hand-held, three-band digital radiometer.

Hand-held radiometers have discrete wave bands and can be carried and operated by one person. Their spectral range is set by placing a filter in the path of each detector. For example, the three-band device described here has two silicon detectors (sensitivity range, ~ 0.4 to 1.1 μm) and one lead sulfide detector (sensitivity range, ~ 1.1 to 3.0 μm). With 0.63- to 0.69-μm and 0.76- to 0.90-μm interference filters placed over the aperture of the silicon channels and a 1.55- to 1.75-μm filter placed over the aperture of the lead sulfide channel, the device responds to the same spectral bands as thematic mapper bands TM3, TM4, and TM5. This device was primarily intended to support Landsat-D's thematic mapper.

A spectral region with a bandwidth of at least 0.04 μm is sensitive to a single property of surfaces with vegetation (2, 3). Only Collins (4) has indicated that "fine structure" spectral information (< 0.04 μm) may exist for plant canopies. Collins used spectral data collect-