FIGURE 2. GIRDWOOD BAR. AERIAL VIEW(VERTICAL) TAKEN NEAR LOW TIDE, JUNE 29, 1973.

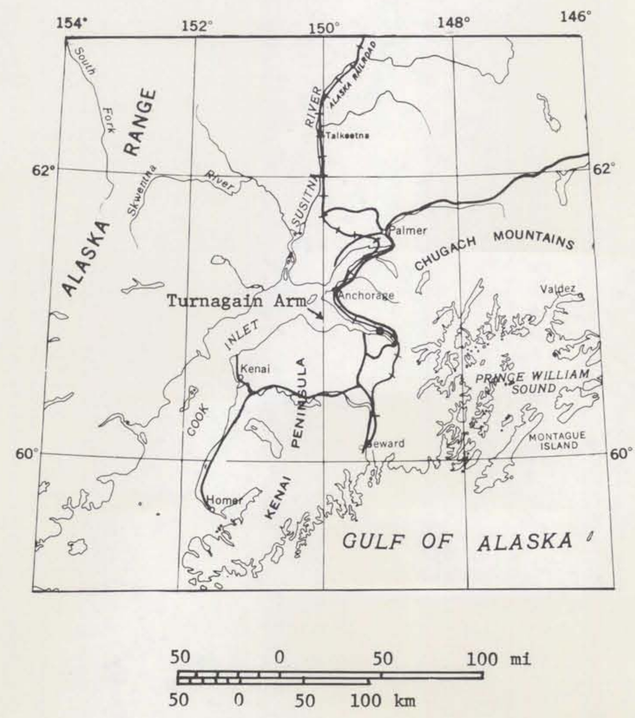

Figure 1. INDEX MAP OF THE COOK INLET REGION SHOWING THE LOCATION OF TURNAGAIN ARM. THE BLACK DOT INDICATES THE SITE OF GIRDWOOD BAR.

Table 1.--Summary of semiquantitative spectrographic analyses of 226 samples from Girdwood Bar. Elements Ag, As, Au, Bi, Cd, Mo, Nb, Sb, Sn, W, and Zn were not detected or were below the limits of detection. Analyses by J. Abrams, R. B. Carten, R. W. Leinz, and D. Siems, 1973.

Element	Mean	Standard Deviation
B	13.3	4.9
Ba	773.6	194.9
Be	1.0	1.9
Ca	1.2	0.3
Co	9.6	1.9
Cr	88.9	41.0
Cu	18.5	9.4
Fe	2.4	0.6
Hg	0.02	0.2
La	29.5	10.5
Mg	1.2	0.3
Mn	503.1	172.8
Ni	24.0	6.3
Pb	10.7	3.4
Sc	12.8	3.2
Sr	223.5	55.6
Ti	0.3	0.1
V	110.9	29.9
Y	19.1	6.2
Zr	149.3	92.9

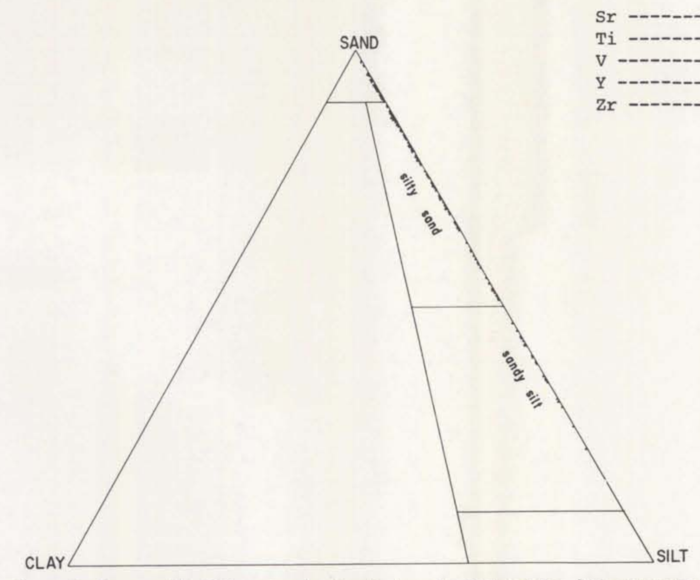

Figure 3. Ternary plot of 151 analysed sediments from the Girdwood Bar. (Size categories after Folk, 1954)

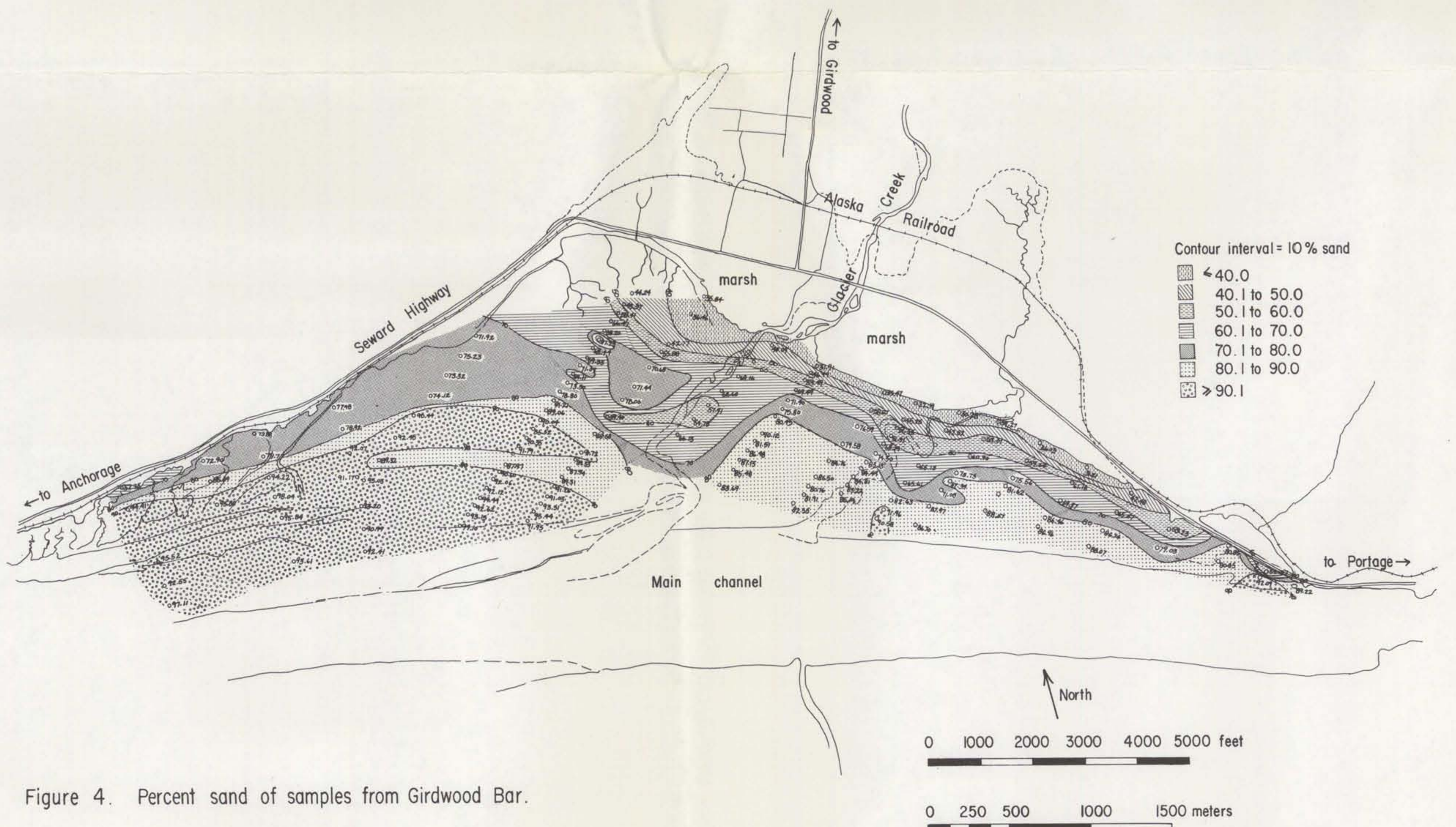

Figure 4. Percent sand of samples from Girdwood Bar.

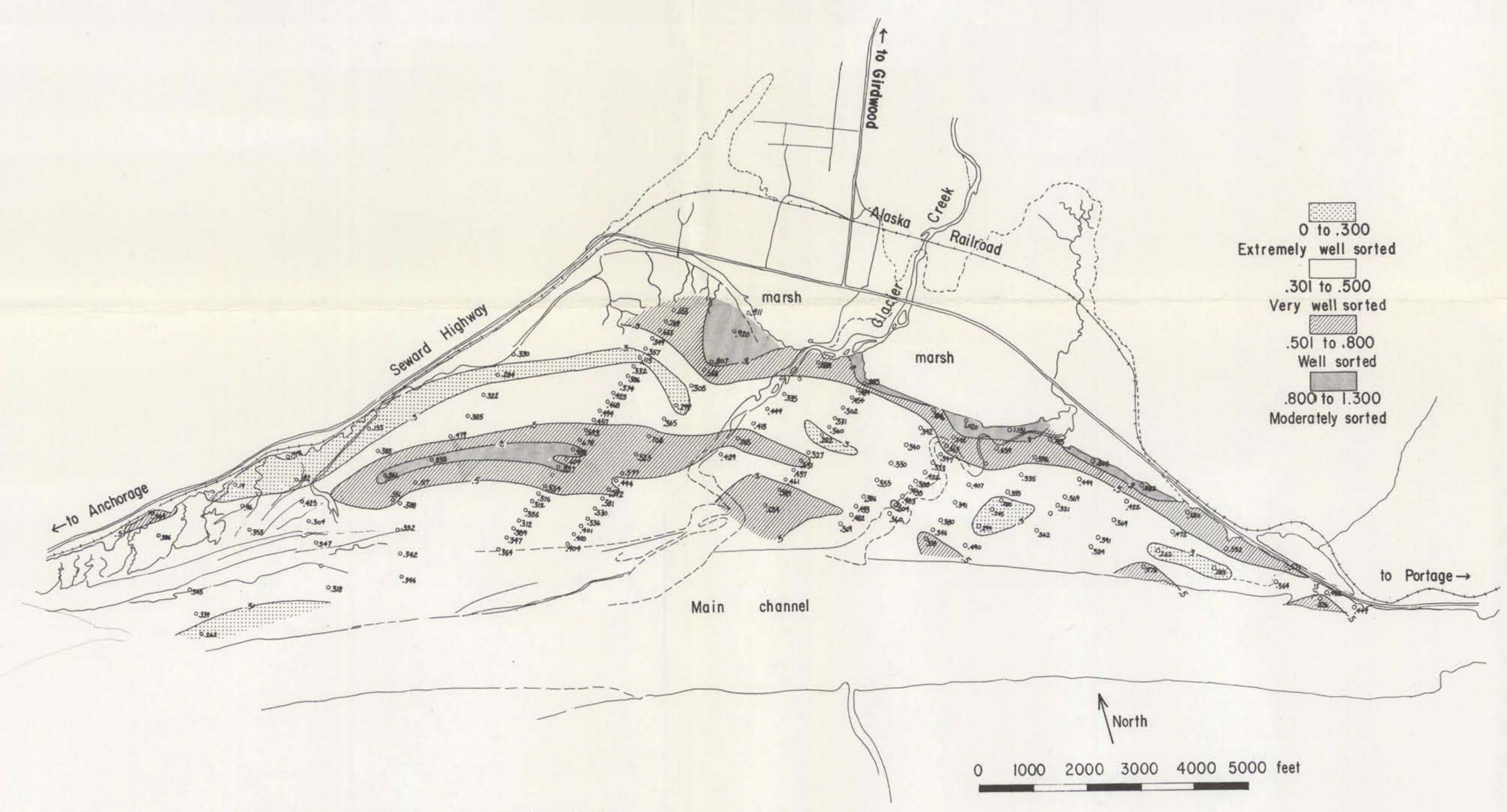

Figure 5. Standard deviations of samples from Girdwood Bar.

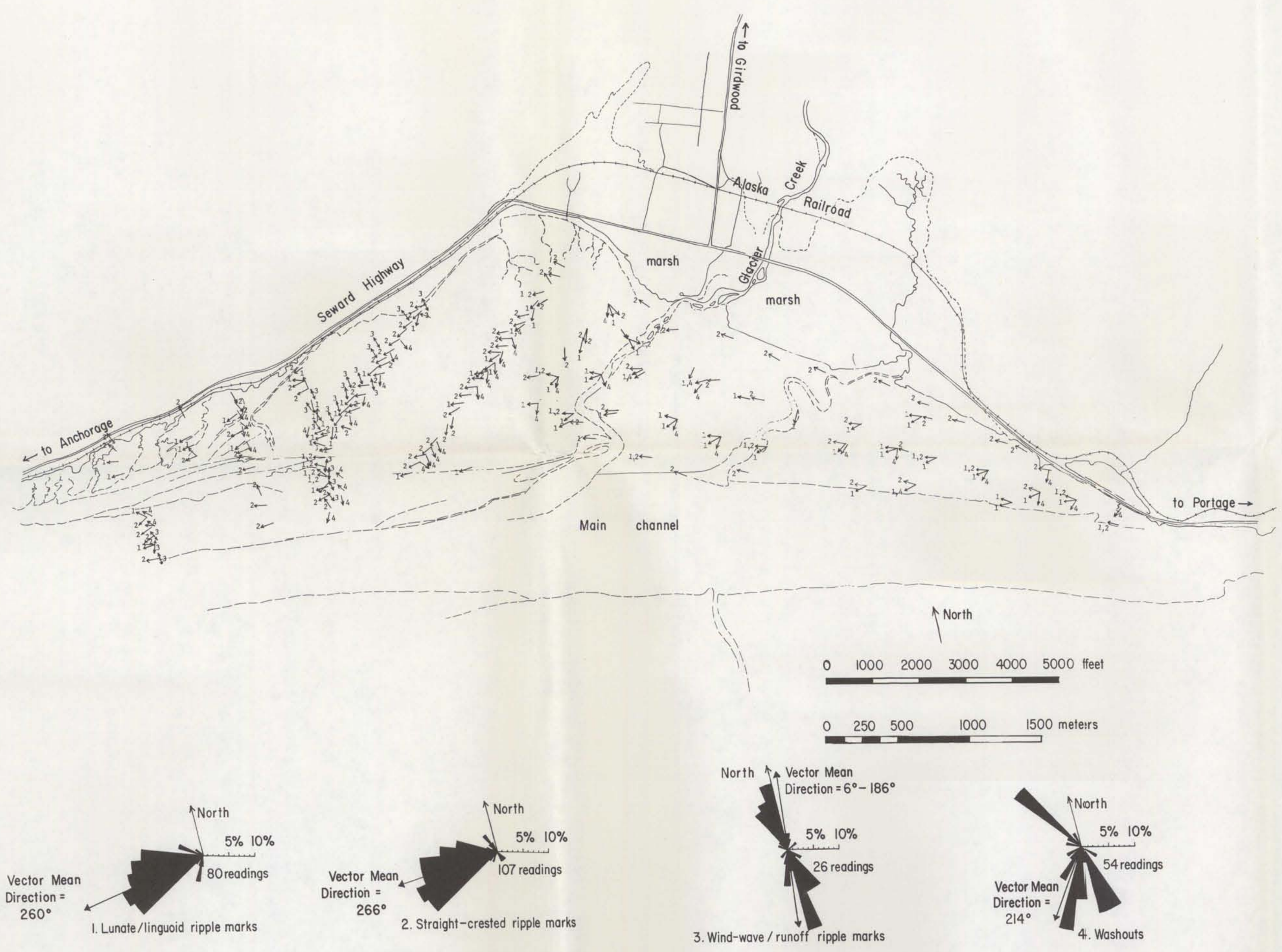

Figure 6. Surface bedform orientations on the Girdwood Bar.

SEDIMENTOLOGICAL MAPS OF THE GIRDWOOD BAR, TURNAGAIN ARM, ALASKA, FOR JULY-AUGUST 1973

Susan Bartsch-Winkler, A. T. Ovenshine, and Daniel E. Lawson

Turnagain Arm, a fiordlike marine embayment at the northeast end of Cook Inlet south of Anchorage, Alaska, approximately 72 km long, 20 km wide at the mouth and 2 km wide at the head (fig. 1), is noted for a tidal range of about 10 m and frequent tidal bores. As the result of an abundant supply of sediment and high tidal energy, extensive areas of intertidal silt and sand bars have developed in the embayment. This map presents data on the texture, surface bedforms, and minor-element geochemistry of one intertidal sand bar attached to the shoreline on the north side of the Arm near the village of Girdwood, herein informally termed the Girdwood Bar.

Girdwood Bar is situated in a reentrant of the shoreline at the mouth of Glacier Creek on the northeast side of Turnagain Arm. To the north and east the Chugach Mountains rise to heights of 1,200 m and more (elevation) within 2 km of the shoreline. Bedrock of the mountains is metagraywacke, metasiltstone, and argillite of the Valdez(?) Group (Clark, 1972). Glacier Creek, which flows southwestward through Glacier Valley and the village of Girdwood, crosses Girdwood Bar near its midpoint, carrying sediment derived from Valdez(?) Group bedrock and from the unconsolidated deposits that underlie the lower part of Glacier Valley (Zenone, 1974).

Preliminary reconnaissance investigations of the mineralogy of the sediment in Turnagain Arm, not including samples from Girdwood Bar, indicate that the major components are quartz, feldspar, and rock fragments. Important minor components are heavy minerals, micas, chlorite, pumice, and coal. Probable sources of the mineral and rock fragments are (1) bedrock and unconsolidated deposits of the Chugach Mountains, and (2) volcanic, plutonic, sedimentary, and metamorphic terranes of the west side of Cook Inlet (A. T. Ovenshine, oral commun., 1973).

Aerial photographs

The black-and-white vertical aerial photographs (fig. 2) used in mapping and sampling Girdwood Bar were taken near low tide on June 29, 1973. Low tide at about the time of photographing was -0.98 m (elevation) at Anchorage, the nearest tidal station.

Sampling and laboratory procedures

Samples were obtained by pace and compass traverse during a 3-week period in July and August 1973. Two 80 cm^3 grab samples of surface sediment were taken at each sample station. One was analyzed for metal content by six-step semiquantitative spectrographic methods supplemented by atomic absorption analysis for gold and mercury-vapor-detector analysis for mercury (Ward and others, 1963, 1969; Vaughn and McCarthy, 1964). The other was sealed to minimize drying and mailed to Menlo Park, Calif., for later textural analysis.

Steps in the textural analysis were: (1) drying at 60°C, (2) weighing, (3) wet-sieving to remove the fraction less than 44 μ, (4) drying, (5) weighing to determine the percent finer than 44 μ, (6) dry-sieving at half-phi intervals, and (7) weighing sieve fractions to an accuracy of 1 mg. Analysis of the fine fraction was accomplished by the use of a hydrophotometer and methods described by Jordan, Fryer, and Hemmen (1971). A computer program was used to calculate the statistical parameters presented in this report.

Sediment types

The sediment of Girdwood Bar is a mixture of sand and silt with virtually no admixture of clay or gravel. An average sample contains approximately 75 percent sand, 25 percent silt, and less than a percent gravel and clay.

Plot of analyses of individual samples on a ternary (fig. 3) of three end-member textural types--sand (62.5 μ to 200 mm), silt (3.9 to 62.5 μ), and clay (less than 3.9 μ) shows the majority of the samples to be composed of silty sand and sand.

Percent sand

The sediments of Girdwood Bar generally coarsen from the shoreward edge at the margin of the salt marsh to the seaward edge at the margin of the main channel. The coarsest component of bar sediment in the summer of 1973 was sand. A progressive textural change is clearly shown by the map of percent sand (fig. 4), most traverses exhibiting a systematic increase in percent sand from about 35 percent at the shore edge to about 90 percent at the channel margin.

Sand in appreciable quantities (greater than 90 percent) makes up more of the area of the bar west of Glacier Creek than east of it. We do not believe this to be caused by dispersal of sand from Glacier Creek for the principal effect of the creek on sediment texture appears to be a seaward extension, approximately 350 m, of the zone of finer sediment (fig. 4). Rather, we interpret the larger areal extent of sandy sediment west of Glacier Creek to be the result of higher ebb-flow velocities developed during falling water.

Standard deviation

By the distribution of standard deviations of the samples shown in figure 5, most of the samples from Girdwood Bar are in the sorting range well sorted to very well sorted. The nearshore zone of fine sediment at the marsh edge is well to moderately sorted. A band of extremely well sorted sediment occurs about midway across the bar, more or less parallel to the shoreline, flanked by bands of less well sorted material. This distribution may be a function of water depth, as the better sorted material, being lower in topographic position, is subjected to longer periods of current action during ebb and flood tides. Farther offshore, an elongate "ridge" extends the length of the bar west of Glacier Creek and is marked by less well sorted sediment.

Surface bedforms

Sedimentary structures formed during the falling tide are ubiquitous on the surface of Girdwood Bar. We recognize four main types of surface bedforms: (1) isolated lunate and liguoid ripples, approximately 10 X 10 cm with amplitudes to 5 cm; (2) straight-crested ripples that have wave lengths of 8 to 15 cm and amplitudes of 3 to 5 cm; (3) small, symmetrical ripples that have wave lengths of 3 to 5 cm and amplitudes of 1 to 3 cm; (4) microchannels that measure to 75 cm long, 15 cm wide, and 4 cm deep.

The orientations of these surface bedforms are shown in figure 6. The summary diagram for symmetrical ripples is a bipolar plot that shows only the colinear direction of current flow. The diagrams for the other bedforms show the unidirectional current flow. The orientations of the lunate and linguoid ripples and the straight-crested ripples differ in vector mean direction (Pincus, 1956) by only 6°. The directions (260°, 266°) are undoubtedly the mean ebb current directions across the Girdwood Bar.

Some of the surface bedforms reflect the gentle topography of the bar. Both the symmetrical ripples and the microchannels are late-stage runoff features, and their orientation is therefore determined by bar slope. The orientation of the symmetrical ripples is determined mainly by bar slope but is influenced by wind and ebb current directions. Although the mean slope of Girdwood Bar is to the southwest, the summary diagram of microchannel orientation shows additional sloping in south and northwest directions. These orientations reflect local drainage into subsidiary tidal channels on parts of the bar west of Glacier Creek.

Geochemistry

The geochemical studies were undertaken with the hope of recognizing the sediment contribution of Glacier Creek (lode and placer deposits occur within the watershed (Park, 1933)) and in order to provide environmental baseline data (table 1). Each sample was analyzed for 30 elements by the six-step semiquantitative spectrographic method. Ca, Fe, Mg, and Ti are reported as percentages; all other elements in parts per million. Each sample was analyzed for gold by the atomic absorption method and for mercury by the mercury-vapor-detector method. Semiquantitative spectrographic analyses were done by D. Siems and J. Abrams, atomic absorption analyses by R. W. Leinz, mercury-vapor-detector analyses by R. B. Carten. Preliminary inspection of the data reveal no systematic variations that can be correlated with location, topography, or texture; we therefore conclude tentatively that a statistically homogeneous population was sampled.

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