Attachment K

Sagavanirktok River Sediment Load, 1980

By Peter W. Barnes and Thomas Reiss

Sediments found in the Beaufort Sea marine environment come from 3 sources: upland erosion delivered to the sea by rivers, coastal erosion of the frozen tundra bluffs, and erosion or resuspension of seabed sediments by waves, currents and ice. In order to assess a sediment budget for the continental shelf of the Beaufort Sea the magnitude of input from the 3 sources must be assessed. Arnborg et al. (1967) have the only set of data for an arctic Alaska river sediment input, and that is only for one year. Coastal erosion and bluff retreat have been discussed by Lewellen (1970, 1977), Hopkins and Hartz (1978), Cannon (1979), Cannon and Rawlinson (1979, 1980), Reimnitz et al. (1977), and the input from this source can be estimated. There is no data on the amount of sediment introduced to the shelf by seabed erosion although data do exist on areas where modern sediments are very thin or absent (Reimnitz et al., 1972; Dinter,1982). In this report we add a small set of data on sediment input from the west channel of the Sagavanirktok River (Fig. 1) during the summer of 1980 to assess if significant quantities were being carried in summer and to assess the variability of input.

METHODS

River discharge and sediment load were determined in the following manner. The profile of the river bed was measured at the constriction in channel where the Sagavanirktok River bridge has been built (Fig. 2). A staff gauge was used to determine the river level within that cross section. Water samples and current measurements were taken in the deepest section of the channel (Fig. 2). Currents were estimated by determining the 10-m time of transit for a current cross placed at mid-depth to travel 10 m. Suspended sediments were collected daily by lowering a weighted bottle through the water column at such a rate as to just fill when the river bed was reached (Rodolfo, 1964). Water samples were homogenized by shaking vigorously and then filtered through a pre-weighed 0.4 micron filter. The sediment concentration was determined by reweighing the filter on an electrobalance. Precipitation data is compared from the weather station at Galbraith (Fig. 1). The techniques used are adequate to roughly characterize the discharge and suspended load of the west channel of the Sagavanirktok . However, the methods are not rigorous by stream-gauging standards and should not be used as rigorous estimates of the sediment load and water discharge of the Sagavanirktok River.

OBSERVATIONS

The discharge and sediment load of the river were computed using the velocity measurements and the cross sectional area from the river stage. The suspended load used a simple application of the observed sediment concentration to the computed discharge. The suspended sediment concentrations increased with increasing discharge (Fig. 3). As increasing discharge is normally accompanied by higher velocities, larger sediment loads are to be expected due to more water passing downstream and at higher

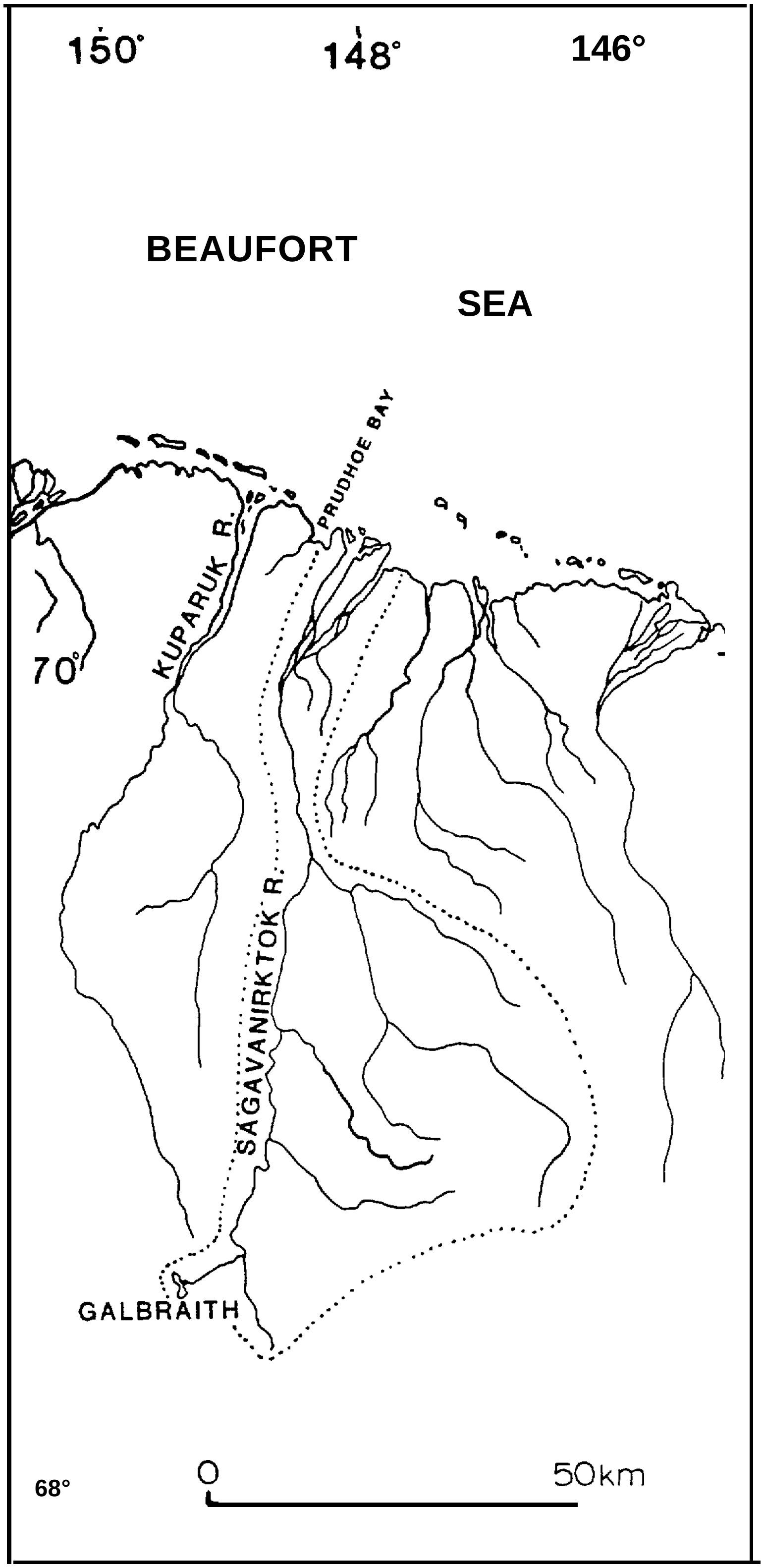

Figure 1. Location map. The dotted line encloses the drainage area of the **Sagavanirktok** River.

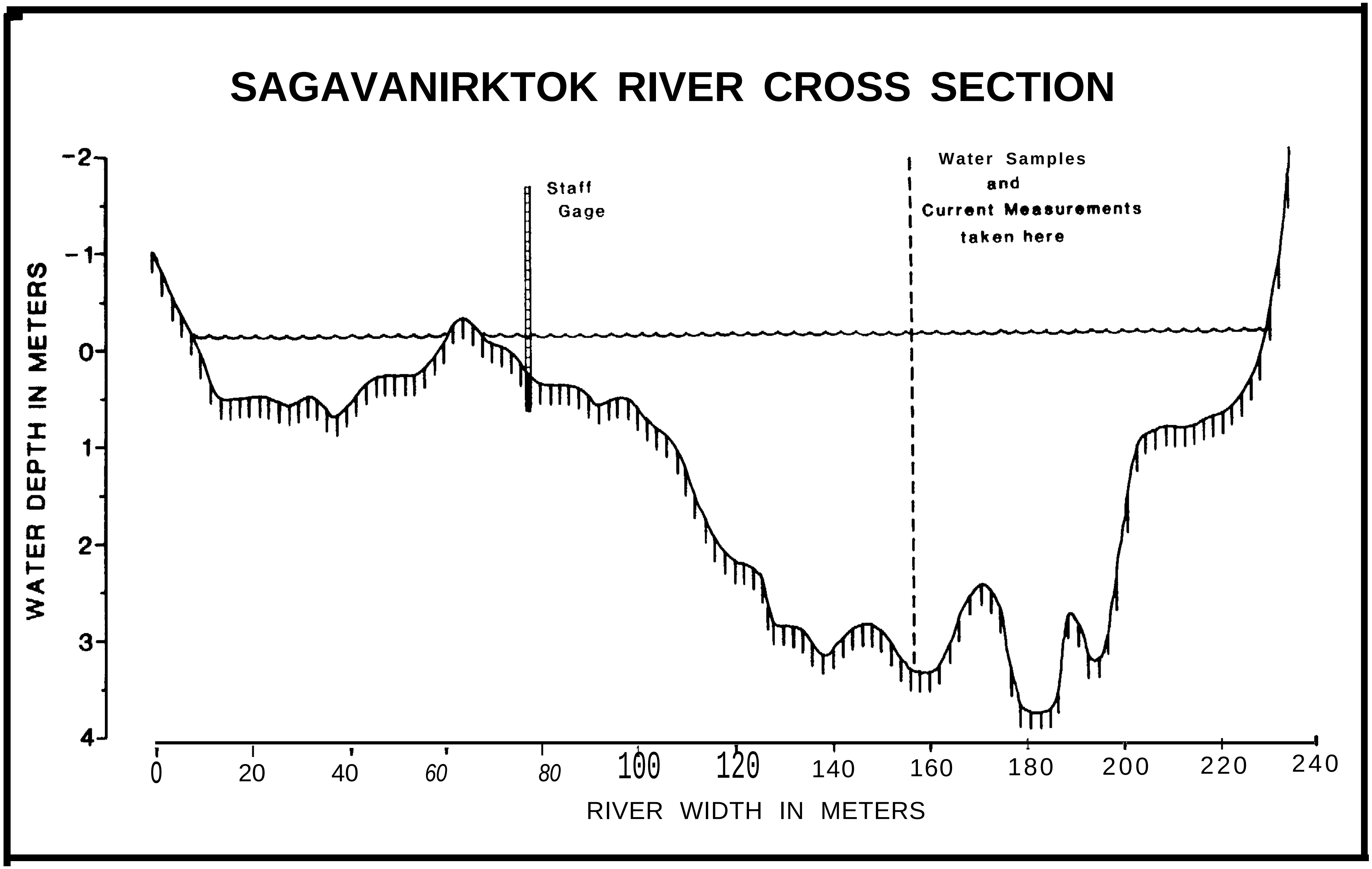

Figure 2. Cross section of the west channel of the Sagavanirktok River where the daily suspended sediment load samples were collected.

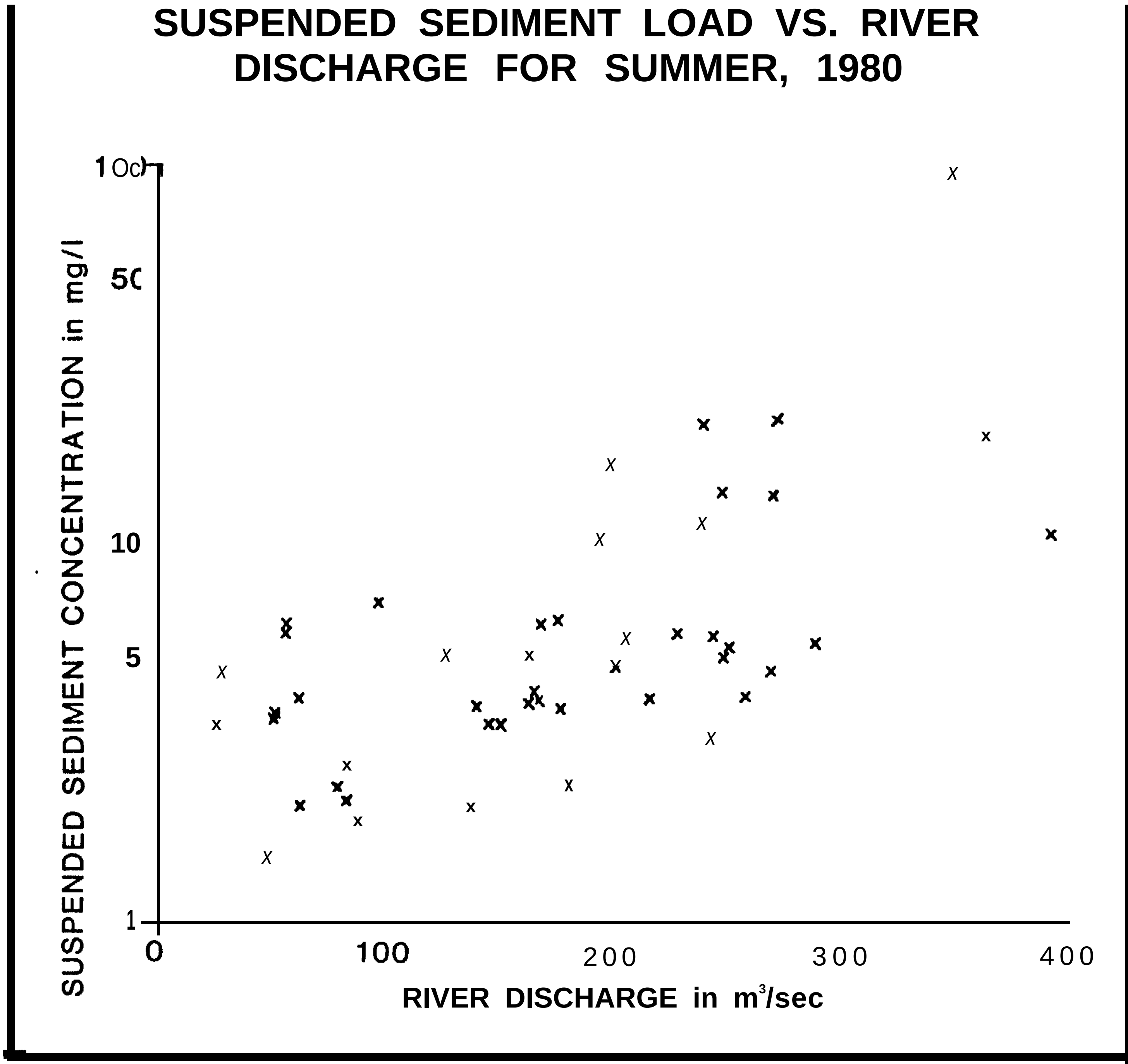

Figure 3. Suspended sediment concentration versus river discharge for the west channel of the Sagavanirktok River in 1980. Increased discharge results in greater suspended sediment concentration.

velocities, the capacity of the stream to carry more sediments is increased (Leopold et al., 1964).

The river discharge is related to upland precipitation but lags the precipitation at Galbraith by about 2 days as shown in Figure 4. This suggests that the discharge is not related to local input as much as the runoff from rains in the foothills and streams of the Brooks Range. The river discharge is also related to the sediment load carried by this branch of the river. With increased discharge, river velocity increases and the sediment load increases (Figs. 4 and 5).

Total load and discharge relative to drainage area

The total suspended discharge of the west channel of the Sagavanirktok River between the 19th of July and the 11th of September was 8.8 x 103m tonnes. This was carried by a water discharge of .815 x $10^9 m^3$ during the same period. The total discharge of the Sagavanirktok River would include the flow through the east channel about 10 km to the east of our study site. Estimates of the relative discharge in the two channels suggest that about half the flow uses each channel at the low flow stages we sampled.

TABLE I

River	Drainage Area km^2	Discharge m^3	Sediment load metric tonnes
Colville (Arnborg et al., 1967)	50,000	16 x 10^9	5800.0 x 10^3
Kuparuk (WRD, 1981) .	8,107	'.30 x 10^9	no data
Sagavanirktok (this study)	15,800	[a].815 x 10^9	8.8 x 10^3

[a]for 19 July to 11 September 1980

Discharge ranged from a low of 29 $m3sec^{-1}$ in late July to a high of 393 m^3sec^{-1} in late August. We would expect flood values during breakup in early June to show much higher values from studies of other arctic streams (Arnborg et al., 1966, 1967; USGS, 1981). Sediment load during the low flow part of the season ranged from a low of 7 tonnes/day to over 2800 tonnes/day in early August. Thus the flow varied by about an order of magnitude, while the sediment load varied by about 2 orders of magnitude.

DISCUSSION

The trend of flow through the low flow part of the river discharge season appears related to precipitation as noted above and did not show a seasonal pattern during our observations. The sediment load appears to decrease slightly through the season. The peak discharge occurs in late August (Fig. 4) while the high sediment loads occurr early in the month (Fig. 5).

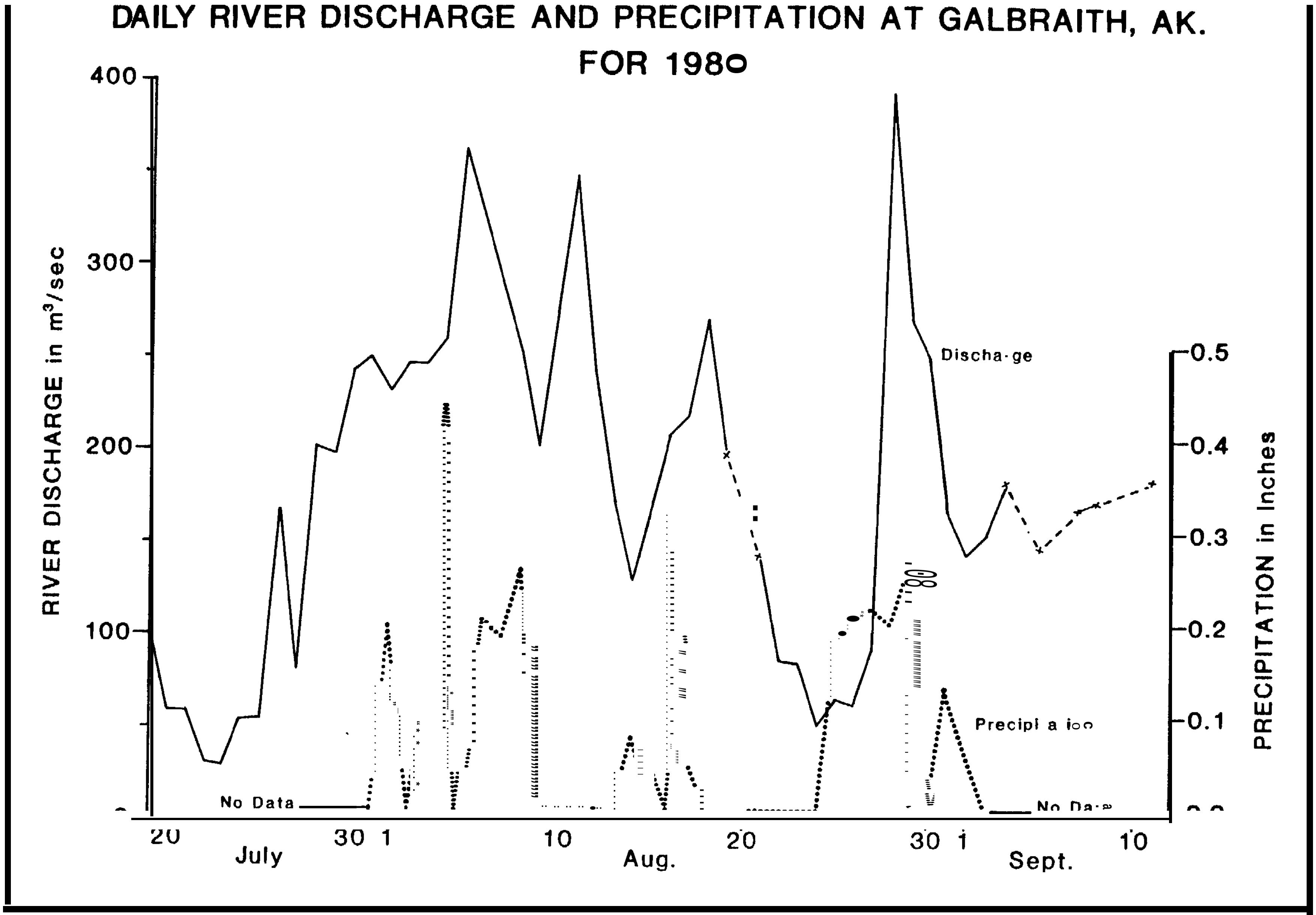

Figure 4. Daily river discharge and pre=ipita=ion at Galbraith in 198o.

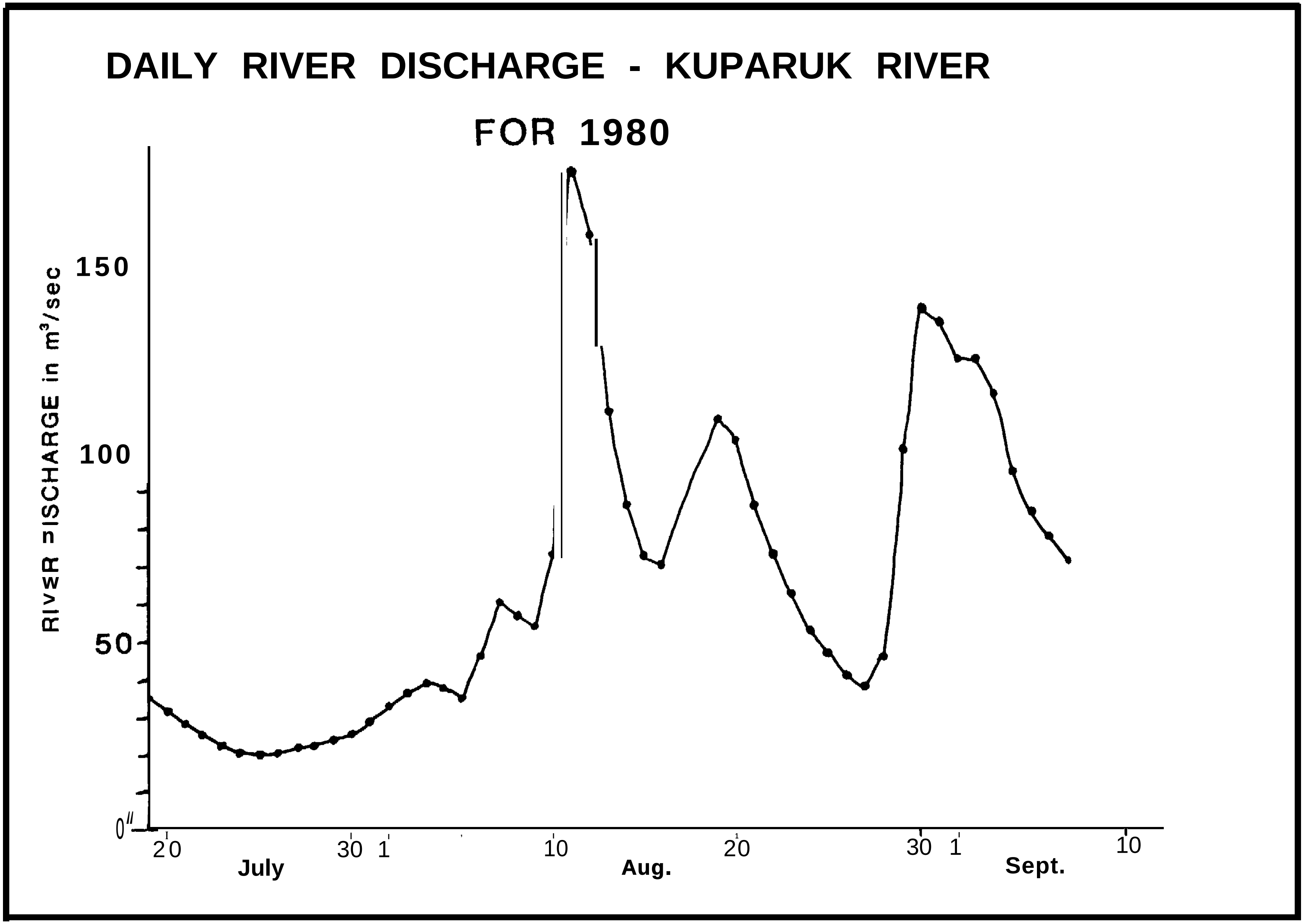

Figure 5. Daily suspended sediment load and river velocity on the west channel of the Sagavanirktok River from July to September, 1980.

Comparison with the river discharge characteristics of the Kuparuk River just 30 km to the west of the Sagavanirktok (Fig. 1) indicates a river about half the size of the Sagavanirktok with a discharge about 1/3 of what we measured in only one channel of the Sagavanirktok (Table 1, Fig. 6). The Sagavanirktok River drains from well inside the Brooks Range while the Kuparuk drains terrane in the lower foothills and the coastal plain. The differences in the discharge profiles of the two rivers suggests that the quantity and timing of sediment input to the Beaufort Sea could be very different, depending on stream type, source of sediments, and regional precipitation patterns.

The low amount of sediment input during the open-water season by the Sagavanirktok River (Table I) indicates that the amount of fine-grained sediments brought to the ocean for transport and redeposition during this period is small. The large quantities of sediments are brought to the delta front during and immediately following the June floods which can carry up to 80% of the discharge of arctic rivers (Arnborg et al., 1967; Carson, 1977). During the remainder of the stream-flow period the amount of sediment brought to the delta front apparently decreases (Fig. 5) although it is higher during times of high discharge. This suggests that much of the suspended sediment observed during the summer and fall on the inner shelf is resuspended rather than newly introduced river sediments.

CONCLUSIONS AND SUMMARY

1) Discharge of the western channel at the Sagavanirktok River during summer follows the precipitation pattern in the Brooks Range. The Sagavanirktok River discharge variabilities are different than the Kuparuk River whose headwaters are confined to the foothills and the coastal plain and which presumably has a different precipitation pattern.

2) The sediment load of the west channel is very modest during the summer months. In comparison to the yearly sediment load of the Colville River, which has three times the drainage area, the Sagavanirktok carried 3 orders of magnitude less sediment during the summer.

3) The sediment supply brought to the ocean during the open-water season is only a small fraction of the seasonal influx of sediments which are apparently primarily introduced during the early stages of river flow.

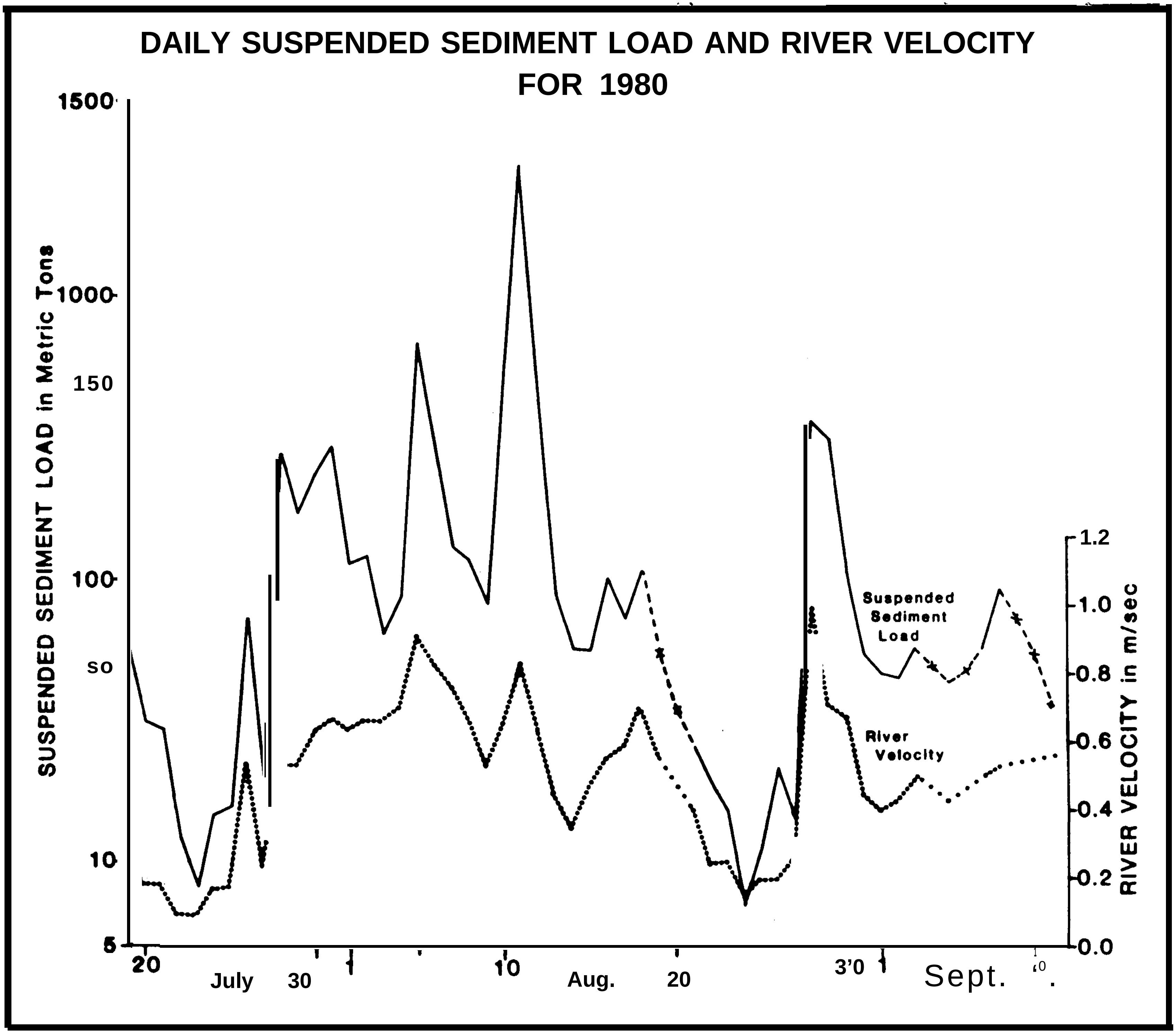

Figure 6. Daily river discharge for the Kuparuk River in 1980 (from WRD, 1981). Compare with discharge curve for Sagavanirktok in Figure 4.

REFERENCES

Arnborg, L., Walker, H. J., and Pieppo, J., 1966, Water discharge in the Colville River, 1962: Geografiska Annaler, v. 48, p. 195-210.

Arnborg, L., Walker, H.J., and Pieppo, J., 1967, Suspended load in the Colville River, Alaska, 1962: Geografiska Annaler, v. 49, p. 131-144.

Cannon, J.P., 1980, The environmental geology and geomorphology of the barrier island-lagoon system along the Beaufort Sea coastal plain from Prudhoe Bay to the Colville river in: National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaskan Outer Continental Shelf, Quarterly Reports of Principal Investigators, April to December 1979, v. 2, p. 380-421.

Cannon, J.P. , and Rawlinson, S.E., 1981, The environmental geology and geomorphology of the barrier-island-lagoon system along the Beaufort Sea coastal plain from Prudhoe Bay to the Colville River in: National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaskan Outer Continental Shelf, Annual Report of Principal Investigators for year ending March 1980, v. 5, p. 619-634.

Carson, R.F., 1977, Effects of seasonality and variability of streamflow on nearshore coastal area in: National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaskan Outer Continental Shelf, Annual Report of Principal Investigators for year ending March 1977, v 14, p. 96-250.

Dinter, D.A., 1982, Holocene marine sedimentation on the middle and outer continental shelf of the Beaufort Sea north of Alaska: U.S. Geological Survey Map I 1182-B, 5 p., 2 map sheets (in press).

Hopkins, D.M., and Hartz, R.W., 1978, Coastal morphology, coastal erosion and barrier islands of the Beaufort Sea, Alaska: U.S. Geological Survey Open-File Report 78-1063, 54 p.

Leopold, L.B. , Wolman, M.G., and Miller, J.P. , 1964, Fluvial processes in geomorphlogy, W.H. Freeman and Company, San Francisco, California.

Lewellen, R.I., 1970, Permafrost erosion along the Beaufort Sea coast, published by the author, Denver, Colorado, 25 p.

Lewellen, R.I., 1977, A study of Beaufort Sea coastal erosion, northern Alaska in: National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaskan Outer Continental Shelf, Annual Report of Principal Investigators for year ending March, 1977, v. 15, p. 491-528.

Reimnitz, Erk, Wolf, S.C, and Rodeick, C.A., 1972, Preliminary interpretation of seismic profiles in the Prudhoe Bay area, Beaufort Sea, Alaska: U*SO Geological Survey Open-File Report 548.

Reimnitz, Erk, Barnes, P. W., Melchior, J. , 1977, Changes in barrier island morphology - 1949-1975, Cross Island, Beaufort Sea, Alaska part F in: National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaskan Outer Continental Shelf, Principal Investigators Reports for year ending April 1977, 16 p.

Rodolfo, K.A., 1970, Annual suspended sediment supply to the California continental borderland by the southern California watershed: Journal of Sedimentary Petrology, v. 40, n. 2, p. 666-671.

Wiseman, W.J., Coleman, J.M., Gregory, A., Hsu, S.A., Short, A.D., Suhayda, JoN., Walters, COD., Jr., and Wright, L.D., 1973, Alaskan Arctic coastal processes and morphology: Technical Report No. 149, Coastal Studies Institute, Louisiana State University, Baton Rouge, Louisiana, 171 p.