DEPARTMENT OF THE INTERIOR
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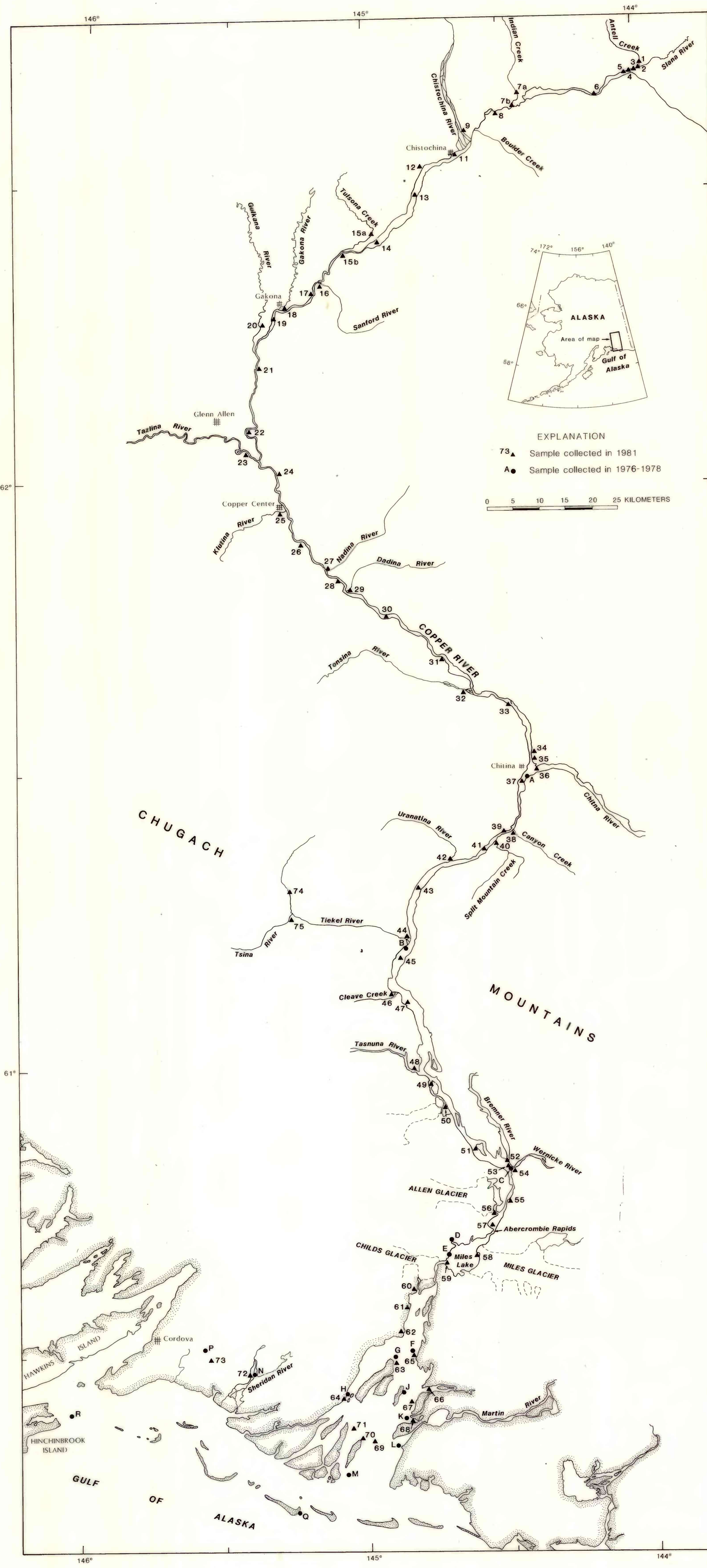

Figure 1. Sample locations in the Copper River system, Alaska.

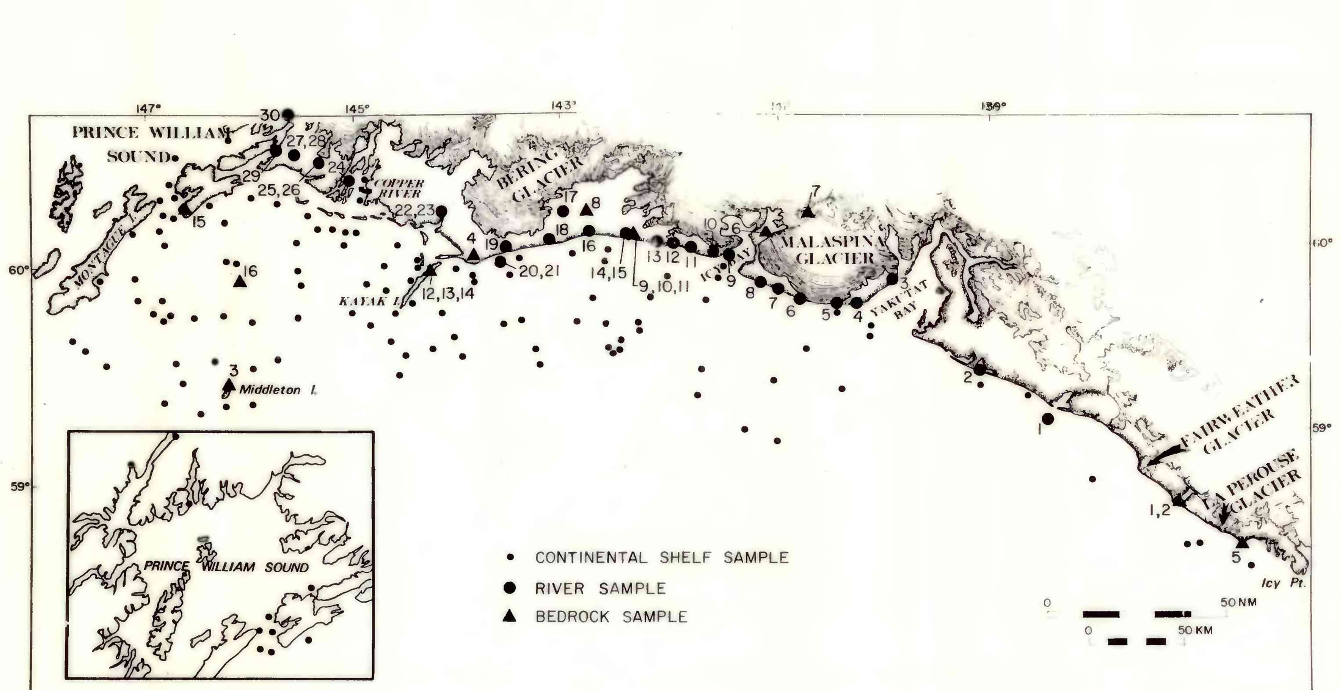

Figure 2. Sample locations on the Gulf of Alaska continental shelf. Numbers refer to samples discussed in Molnia and Hein, 1982.

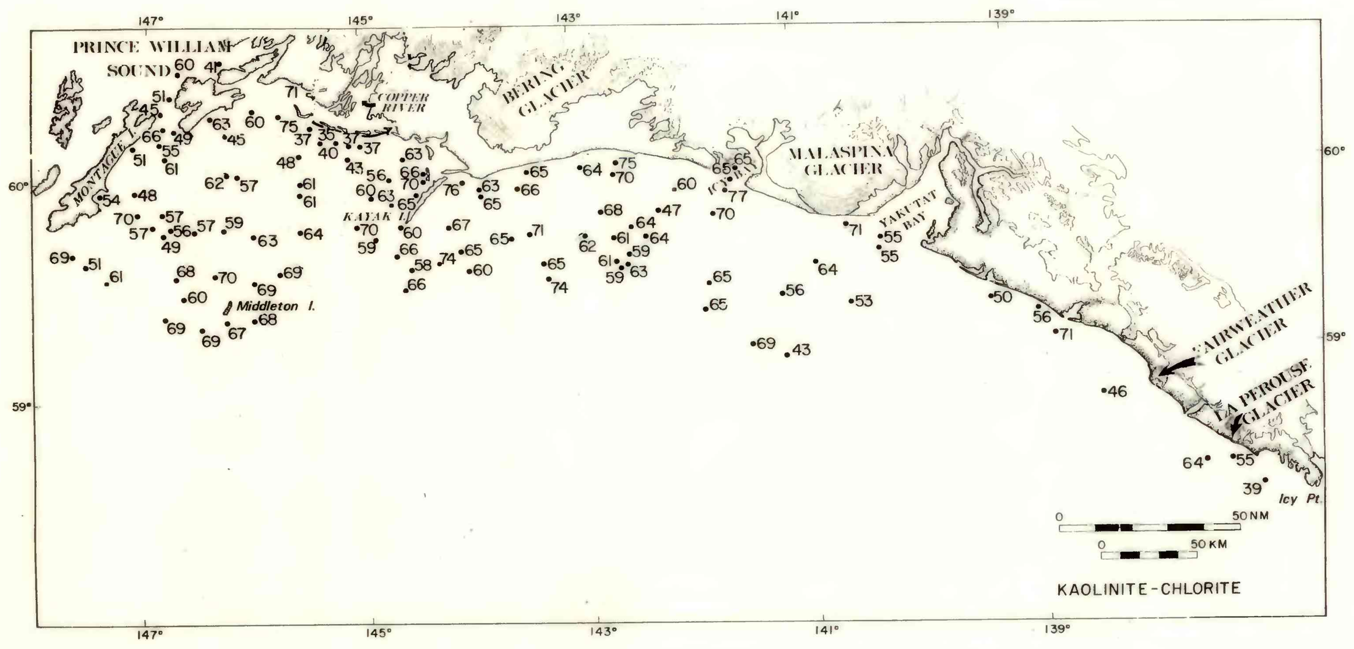

Figure 3. Distribution of kaolinite plus chlorite in Gulf of Alaska continental shelf sediments (from Molnia and Hein, 1982).

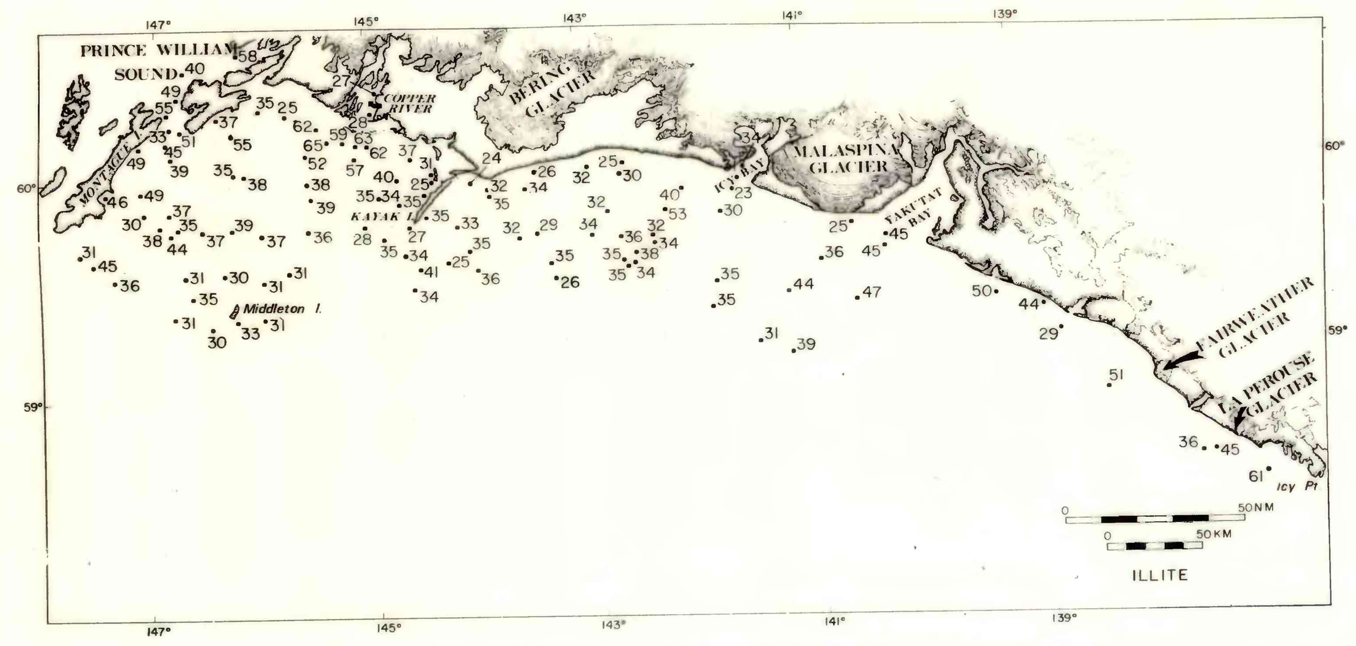

Figure 4. Distribution of illite in Gulf of Alaska continental shelf sediments (from Molnia and Hein, 1982).

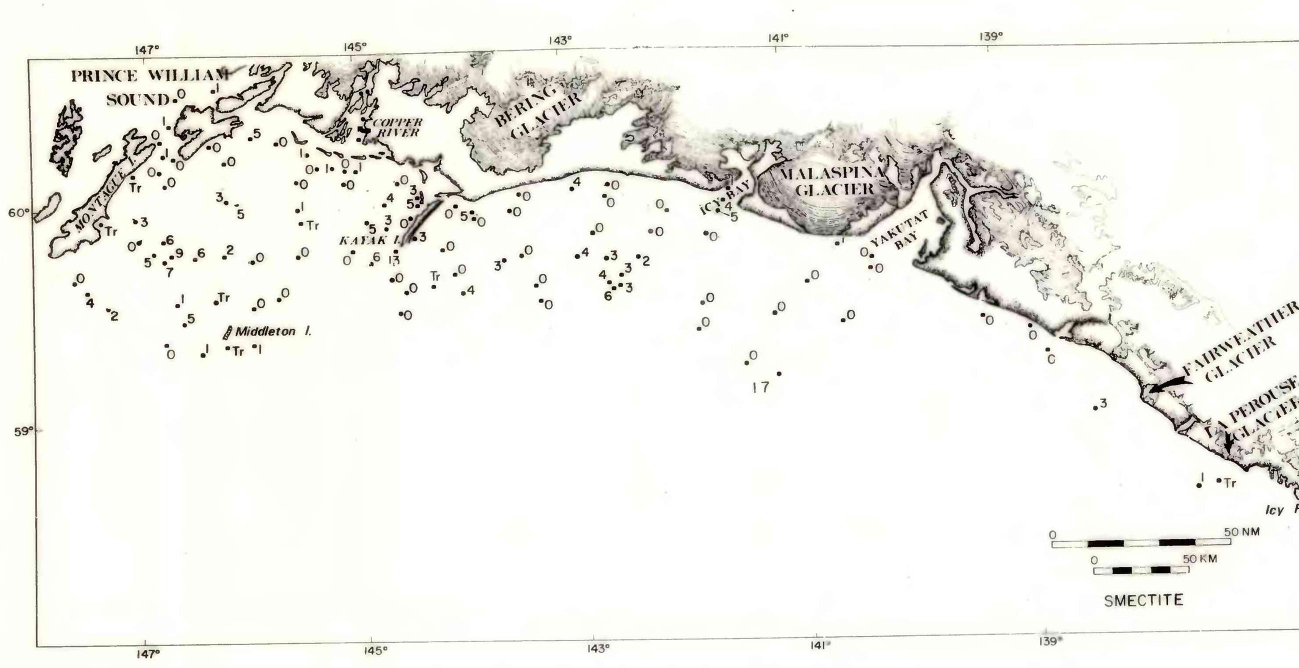

Figure 5. Distribution of smectite in Gulf of Alaska continental shelf sediments (from Molnia and Hein, 1982).

Table 1. Copper River Clay Mineralogy, 1976-1978. K+C= kaolinite plus chlorite; I=illite; S=smectite

Sample	Year	Location	Suspended Sediment			Bottom Sediment		
			% K+C	%I	%S	%K+C	%I	%S
A	1976	Chitina R	62	36	2		no sample	
B	"	Tiekel R		no sample		71	27	2
C	"	Wernicke R	75	23	2	48	52	0
D	"	Abercrombie Cr	100	0	0		no sample	
E	"	Miles Lake		no sample		63	34	3
E	1977	"	41	54	5		no sample	
E	1978	"	53	47	Tr		no sample	
F	1976	Copper R delta	41	56	3		no sample	
G	"	"	44	53	3		no sample	
H	"	"		no sample		50	44	6
H	1977	"	53	42	5		no sample	
H	1978	"	48	52	Tr		no sample	
J	1976	"		no sample		61	39	0
K	"	"	73	27	Tr		no sample	
L	"	"		no sample		69	31	0
M	"	"		no sample		68	32	0
N	1977	Sheridan R	70	29	1		no sample	
N	1978	"	70	30	0		no sample	
P	1977	Scott R	65	35	0		no sample	
P	1978	"	68	32	0		no sample	
Q	1976	Grass Island		no sample		51	49	0
R	"	Strawberry Channel		no sample		51	49	0
Average			62	37	2	59	40	1
Stan. Dev.			16.9	15.4	1.8	9.2	9.2	2.1

COMPARISON OF MULTIPLE-YEAR ANALYSES OF CLAY MINERALOGY OF THE COPPER RIVER SYSTEM AND THE GULF OF ALASKA

By

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Summary

In the summer of 1981, a systematic series of suspended- and bottom-sediment samples were collected at 75 sites from the Copper River and its tributaries. Copper River samples were taken from the rivers' headwaters to its mouth. Samples were also taken from each tributary river near its confluence with the Copper River, and in Miles Lake and the Copper River estuary. Figure 1 shows the location of all the samples collected in the Copper River system. Figure 2 shows the locations of all offshore samples used for comparison. Figures 3, 4, and 5 show the distribution of kaolinite plus chlorite, illite, and smectite, respectively, on the continental shelf; these data are not separated by the year in which the sample was taken. The continental shelf samples are discussed by Molnia and Hein (1982). The Copper River data are tabulated in Tables 1 and 2 by year in which the samples were collected.

Kaolinite plus chlorite, illite, and smectite contents were determined for each sample, after the method described by Hein et al. (1976). In brief, the procedure is as follows: Carbonate was removed with Morgan's solution (sodium acetate plus glacial acetic acid diluted with distilled water), and organic matter was removed with 30 percent hydrogen peroxide. The clay-size fraction (<0.002 mm) was isolated by centrifugation, and each sample Mg-saturated and glycolated. An X-ray diffractogram was made after glycolation. Clay mineral percentages were calculated form peak areas. Kaolinite is a minor component of the samples analyzed and is included with chlorite.

Limited sampling of both suspended and bottom sediment in the Copper River system during the summers of 1976, 1977, and 1978 showed that significant yearly variations in clay-mineralogy occur within the river system. This reflects variations in sediment supply from different source terranes (Molnia and Hein, 1982). The clay-mineral suites of samples collected in 1981 are compared not only to each other but also to those of samples collected in 1976-1978 from offshore of the Copper River drainage.

Average percentages of clay minerals from the 1976-1978 samples (Table 1) are comparable to those in the 1981 samples (Table 2). The mineralogy of the suspended and bottom samples are, for the samples collected in 1981, similar with a few exceptions. The 1981 data show that, even though any individual sample can vary widely in its clay-mineral composition, the average clay mineralogy from any stretch of the Copper River system varies little from the headwaters to the mouth (Table 2). The clay-mineral suites are quickly homogenized downstream from any tributary stream that contributes a significantly different percentage of a given clay mineral. The average clay mineral percentages from both bottom- and suspended sediment of the Copper River system are essentially identical to the shelf-wide averages determined from samples collected in 1976-1978 (Figures 3, 4, and 5). Shelf-wide clay-mineral averages (standard deviations in parenthesis) are as follows: kaolinite plus chlorite, 59.5 (10.9); illite, 37.5 (10.7); smectite, 1 (2.7).

The Copper River flows through Miles Lake (Figure 1), a glacially scoured basin, which acts as a partial sediment settling basin. Molnia and Hein (1982) noticed a change in the clay mineralogy north of Miles Lake, where illite-rich sediment is introduced to the Copper River somewhere between the Bremner and Wernicke Rivers and the lake (Figure 1). This mineralogic change appears even more prominently in the 1981 data, where over 90% of the clay minerals in Samples 53 and 54 are illite.

The greatest differences, however, occur for smectite, where it is more abundant in the bottom sediment; only 10 of the 75 samples taken in 1981 show smectite values higher in the suspended sediment fraction. A large influx of smectite (68 percent) occurs at the Sanford River (Sample 16, Table 2), but samples taken in the Copper River south of the Sanford River contain less than 10 percent smectite. High percentages of smectite also occur in samples between the Nadina and Chitina Rivers. Statistical comparison using the Student's t test shows the smectite contents from both the series of samples north of the Chitina and those south of Canyon Creek are significantly different, at a 95% confidence level, from the smectite contents between the Nadina and Chitina Rivers. Again, the introduction of smectite is localized and becomes rapidly homogenized where, south of Canyon Creek, the Copper River shows a characteristically low smectite content.

In conclusion, the clay mineralogy of the Copper River system is dominated by chlorite (with minor kaolinite), illite ranks second in abundance, and smectite is a minor constituent. Clay minerals have a longer residence in the bottom sediment, which may represent a longer-term average composition of what has been introduced into the system. Although siginificant variablility in clay-mineral percentages occurs near mouths of Copper River tributaries, the average clay-mineral composition along the Copper River's main channel and of the Alaskan continental shelf shows the Copper River to be very efficient at mixing the various clay minerals.

References

Hein, J.R., Scholl, D.W., and Gutmacher, C.E., 1976, Neogene clay minerals of the far NW Pacific and southern Bering Sea, in Bailey, S.W., ed., International Clay Conference, Mexico City, 1975, Proceedings: Wilmette, Ill., Applied Publishing Ltd., p. 71-80.

Molnia, B.F. and Hein, J.R., 1982, Clay mineralogy of glacially dominated, subarctic continental shelf--northeastern Gulf of Alaska: Journal of Sedimentary Petrology, v. 52, no. 2, p. 515-527.

Table 2. Copper River Mineralogy, 1981. K+C=kaolinite plus chlorite; I=illite; S=smectite. "Glacier" means sample was taken from a subglacial meltwater stream.

Sample	River	Suspended Sediment			Bottom Sediment		
		%K+C	%I	%S	%K+C	%I	%S
1	Antell	68	32	0	63	33	0
2	Slana	38	62	0	34	66	0
3	"	40	57	3	29	71	0
4	"	34	58	8	29	60	11
5	"	23	63	14	29	67	4
6	"		Tr clay in suspension		65	31	3
7a	Indian		Tr clay in suspension		31	32	36
7b	"	27	65	8	36	37	26
9	Chistochina	57	43	0	47	53	0
11*	Copper	39	52	9	36	42	22
12	"	49	47	4	49	46	5
13	"	43	50	7	52	45	3
14	"	44	47	9	54	32	14
15**	Tulsona	49	47	4	46	41	13
16	Sanford	13	19	68	24	19	57
17	Copper	47	46	7	38	36	26
18	Gakona	55	37	8	51	41	9
19	Copper	53	41	6	42	42	16
20	Gulkana		no sample		51	26	23
21	Copper	33	63	4	60	40	0
22	"	49	42	9	60	40	0
23	Tazlina	68	32	0	52	30	18
24	"	47	45	8	54	37	9
25	Klutina		Tr clay in suspension		63	37	0
26	Copper	53	39	8	55	44	1
27	Nadina	40	9	51	24	13	63
28	Copper	46	32	22	43	23	34
29	Dadina	19	0	81	27	10	63
30	Copper	36	24	40	43	23	34
31	"	51	40	9	50	39	11
32	Tonsina		Tr clay in suspension		58	35	7
33	Copper	47	34	19	46	29	26
34	"	66	25	8	52	22	25
35	"	54	38	8	44	35	21
36	Chitina	43	57	0	68	32	0
37	Copper	59	33	8	48	32	20
38	Canyon	80	20	0	69	31	0
39	Copper	48	42	10	49	40	11
40	Split Mt	70	30	0	54	46	0
41	Copper	51	41	8	53	32	15
42	Urantina		Tr clay in suspension		52	48	0
43	Copper	55	38	7	65	27	8
44	Tiekel	57	43	0	52	48	0
45	Copper	53	40	7	60	27	13
46	Cleave	45	55	0	31	69	0
47	Copper	61	39	0	71	29	0
48	Tasnuna	90	10	0	73	27	0
49	Copper	66	30	4	67	26	8
50	"	82	18	0	64	36	0
51	"	59	36	5	72	28	0
52	Bremner		no sample		29	71	0
53	Copper	9	91	0		no sample	
54	Wernicke	5	95	0	6	94	0
55	Copper	53	41	6	71	29	0
56	Allen Glacier	6[illegible]	3[illegible]	0	72	28	0
57	Copper	54	46	0	55	40	5
58	Miles Glacier	26	74	0	34	66	0
59	Miles Lake	56	41	3	55	36	9
60	Copper R delta	78	22	0	71	29	0
61	"	52	48	0	51	44	5
62	"	77	23	0	66	34	0
63	"	48	48	4	32	68	0
64	"	45	50	5	63	32	5
65	"	47	49	4	49	40	11
66	"	66	34	0	70	30	0
67	"	48	52	0	74	26	0
68	"	73	27	0	60	40	0
69	"	72	28	0		no sample	
70	"	43	57	0	73	27	0
71	"	49	51	0		no sample	
72	Sheridan	72	28	0		no sample	
73	Scott	66	34	0	71	29	0
74	Tiekel	61	39	0	60	40	0
75	Tsina		Tr clay in suspension		66	34	0

*No sample 10 was taken **Suspended sediment sample was taken at 15a, bottom sediment at 15b on Figure 1

Average values (standard deviations in parenthesis)

Sample series	Suspended Sediment			Bottom Sediment		
	K+C	I	S	K+C	I	S
1-7b	39 (15.6)	56 (11.9)	6 (5.5)	38 (16.1)	50 (17.3)	11 (14.6)
8-15	44 (9.4)	50 (7.1)	6 (3.3)	46 (7.2)	42 (6.7)	12 (9.8)
17-26	51 (9.8)	43 (9.2)	6 (3.0)	53 (7.9)	37 (7.9)	10 (10.0)
27-37	46 (13.1)	29 (16.0)	25 (25.4)	46 (12.5)	27 (9.3)	28 (20.4)
38-45	59 (11.6)	36 (8.4)	5 (4.4)	58 (7.1)	37 (9.2)	6 (6.6)
46-51	67 (16.4)	31 (16.0)	2 (2.4)	63 (16.0)	36 (16.6)	1 (3.3)
52-55	22 (26.6)	76 (30.1)	2 (3.5)	35 (33.0)	65 (33.0)	0
56-59	51 (18.1)	48 (18.4)	0.75 (1.5)	54 (15.6)	43 (16.4)	4 (4.4)
60-71	58 (13.7)	41 (12.9)	1 (2.0)	61 (13.4)	37 (12.5)	2 (4.0)
All	49 (17.6)	42 (18.0)	8 (14.7)	49 (15.4)	38 (16.4)	11 (15.0)