UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

MINERALOGICAL AND SEDIMENTOLOGICAL DATA COLLECTED ON THE SHELF AND UPPER SLOPE ADJACENT TO THE RUSSIAN RIVER, NORTHERN CALIFORNIA

by

James V. Gardner and David H. Klise[1]

OPEN-FILE REPORT

83-517

[1] Menlo Park, CA 94025

MINERALOGICAL AND SEDIMENTOLOGICAL DATA COLLECTED ON THE SHELF AND UPPER SLOPE ADJACENT TO THE RUSSIAN RIVER, NORTHERN CALIFORNIA

This report documents textural and mineralogical analyses of surface sediment from the shelf and upper slope of the continental margin west of the Russian River, Northern California (Fig. 1). The samples were collected on cruises V1-80, L1-81,and L13-81. Fifty-six sampling stations were occupied (Fig. 2 and Table 1) and sediment samples were collected using gravity, piston trigger-weight, van Veen and box corers. The surface samples are representative of the upper 10 cm of the sediment section. Navigation during all cruises was by Miniranger and provided nominal position accuracy of +/- 50 m.

METHODS

Core samples and subsamples taken aboard ship were sealed to minimize dehydration and were stored at 3°C until the analytical phase began. Sample were first treated with 30% H2O2 to remove organic material, then placed in a 10-ml solution of 30% H2O2 and 50-ml of H2O and allowed to stand for 24 hr or until oxidation ceased. Excess liquid and salt were removed by repeated washes with distilled water. Following this treatment, the samples were separated into gravel, sand, silt, and clay using wet-sieves and/or centrifuge techniques.

Grain-size analyses were made by first determining the dry-weight percent of the gravel, sand, silt, and clay size fractions. The size distributions of sand fraction (-1.0 to 4.0 phi) were then determined using a 2-m Rapid Sediment Analyser (RSA) (Thiede, et al., 1976). The size distribution of the silt and clay fractions (<4.0 phi) were determined using a calibrated hydrophotometer (Jordan, 1977; Jordan, et al., 1971). Replicate analyses and calibration tests show that the RSA has a precision of +/- 5% and an accuracy of +/- 5%, and that the hydrophotometer has a precision of +/- 10% and an accuracy of +/- 2%.

The grain-size data were used to calculate sediment textural parameters by the graphic method of Folk (1974). The textural parameters include percent sand, percent silt, percent clay, median, mode, graphic mean, inclusive graphic standard deviation, and inclusive graphic skewness. The values of these textural parameters for the surface samples are given in Table 2.

Petrographic analyses were performed on the silt fraction of 33 surface sediment samples and on samples collected from the Russian, Gualala, and Garcia Rivers (see Fig. 1 for locations of rivers). Grain mounts were made from the 44 to 63 micron size fraction (4.0 to 4.5 phi) and the minerals and rock fragments were identified using a polarizing light microscope. The optical properties of the minerals were easily obtained because the size of the silt fraction is near the thickness of standard petrographic thin sections.

Quartz was distinguished from feldspars by its optical relief, uniaxial positive sign, and lack of cleavage. Varieties of plagioclase and potash feldspars were not differentiated. Rock fragments were classified by characteristics outlined in Table 3. Some rock fragments have relatively severe effects of weathering or have fine aphanitic textures so that identification is uncertain. Consequently, the rock fragment groupings were combined into classes of plutonic, metamorphic, volcanic, and sedimentary rock fragments. Thirty-five classes of minerals and rock fragments were counted and the data are shown in Table 4.

Clay mineralogy was determined on samples from bottom sediment from offshore and from the Russian River. The slide preparation and X-ray diffraction techniques are similar to the methods described by Hein, et al., (1976). The analyses for clay mineralogy was performed on a Picker X-ray diffractometer after Mg-saturation, glycolation , and heating to 550 degrees C. Diffraction patterns were run from 3 to 14 degrees 2-theta at a speed of 1 degree/min. Glycolated samples were scanned from 24 to 26 degrees 2-theta at 1/4 degree per min.

Smectite, illite, chlorite, kaolinite, and vermiculite were identified in the samples. Discrete vermiculite was verified in several samples by treatment with barium saturation. However, the peak produced by this treatment was so variable that barium saturation was not routinely used. The relative amounts of clay minerals in the samples was calculated using the techniques of Biscaye (1965). An internal standard of talc was used in the clay analyses so that samples could be compared. Replicate analyses gave a precision of less than +/- 3% for each clay mineral present. The clay mineralogy data are given in Table 5.

Figures 3 through 19 are plots of the distributions of the various textural and mineralogical parameters calculated from the raw data. A distinct mineral assemblage was found, composed of fragments of tremolite-actinolite, blue-green hornblende, glaucophane, chrysotile and jadeite with minor amounts of garnet, lawsonite, stilpnomelene, pumpellyite, sillimanite, prehnite, and omphacite. Because of the close association of this assemblage with the widespread outcrops onshore of the Franciscan complex, this assemblage is referred to as the Franciscan Mineral Assemblage (Fig. 15). No discussion of the interpretations of the data are included here. An extensive interpretation of these data can be found in Klise (1983).

REFERENCES CITED

Biscaye, P. E., 1965. Mineralogy and sedimentation of Recent deep-sea clay in the Atlantic Ocean and adjacent seas and oceans. Geol. Soc. Amer. Bull., v.76, p. 803-832.

Folk, R. L., 1974. Petrology of sedimentary rocks. Hemphill Publ. Co., Austin, Tx., 182p

Hein, J. R., Scholl, D. W., and Gutmacher, C. E., 1976. Neogene clay minerals of the far NW Pacific and southern Bering Sea: Sedimentation and diagenesis. in Bailey, S. W., (ed.), Proc. Intl Clay Conf., 1975, Mexico City, Applied Publ. Ltd., Wilmette, Ill., p. 71-80.

Jordan, C. F., 1977. Reply: Size analysis of silt and clay by hydrophotometer. J. Sed. Petrology, v. 47, p. 931-933.

Jordan, C. F., Fryer, G. E., and Hemmen, E. H., 1971. Size analysis of silt and clay by hydrophotometer. J. Sed. Petrology, v. 41, p. 489-496.

Klise, D. H., 1983. Modern sedimentation on the California continental margin adjacent to the Russian River. M.S. Thesis, San Jose State Univ., San Jose, Calif., 134p.

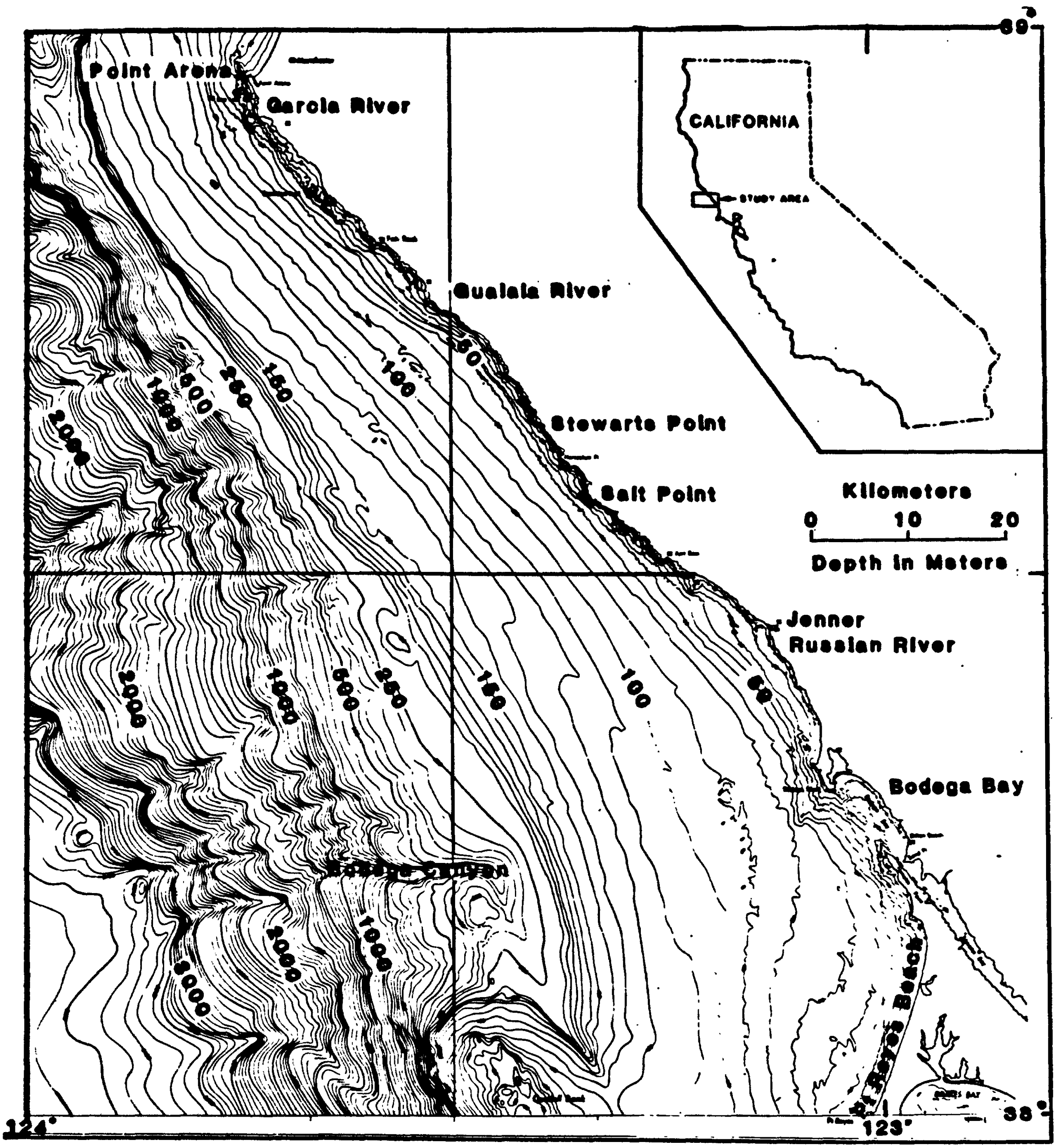

Figure 1. Detailed bathymetric map and location of study area (modified from NOS 1370N-18B map).

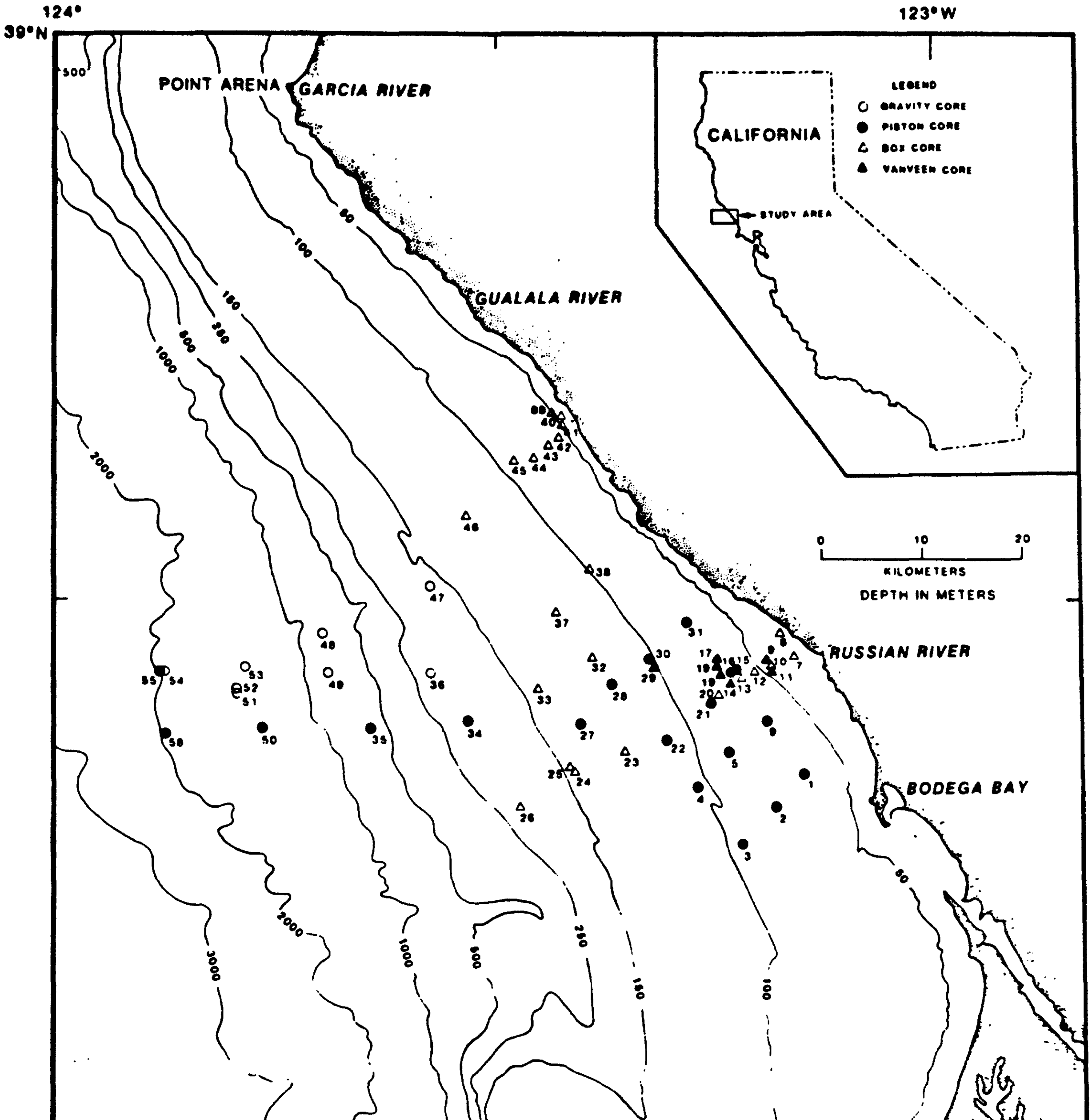

Figure 2. Location of study area and offshore sample sites. Map numbers and symbols refer to the sediment cores listed in Appendix 1.

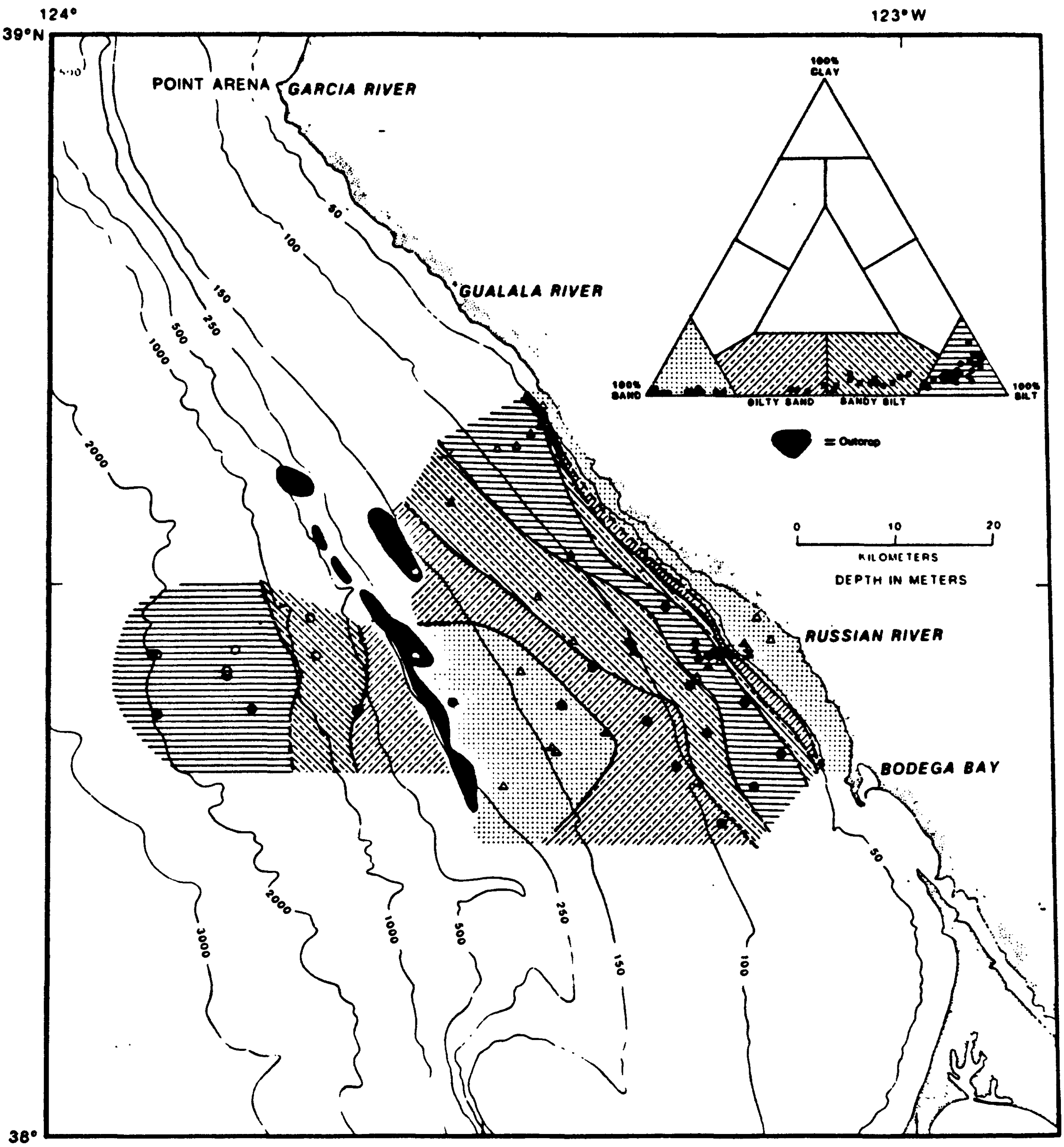

Figure 3. The texture of surficial sediment on the continental margin.

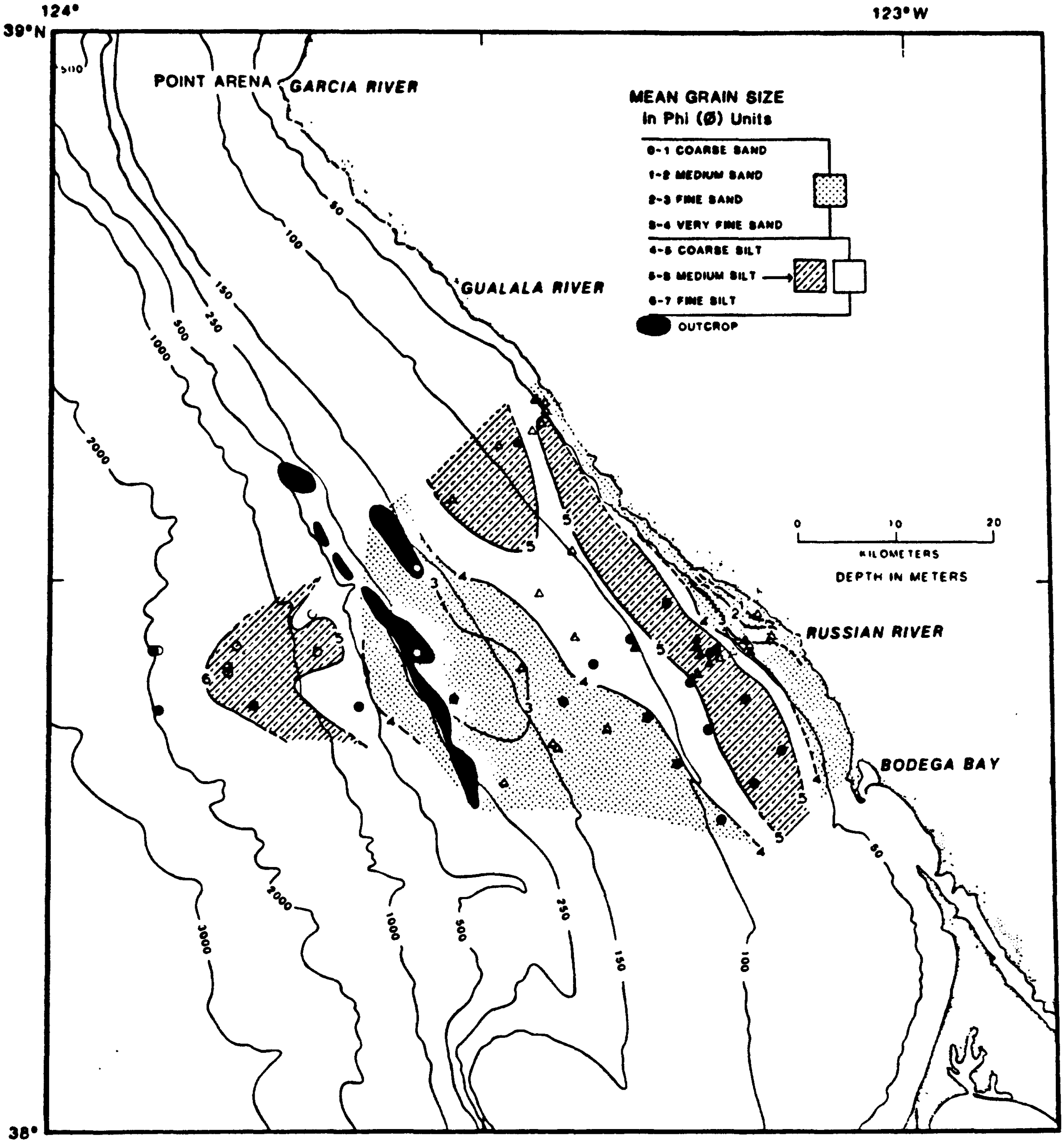

Figure 4. Distribution of mean grain-size for surface sediment.

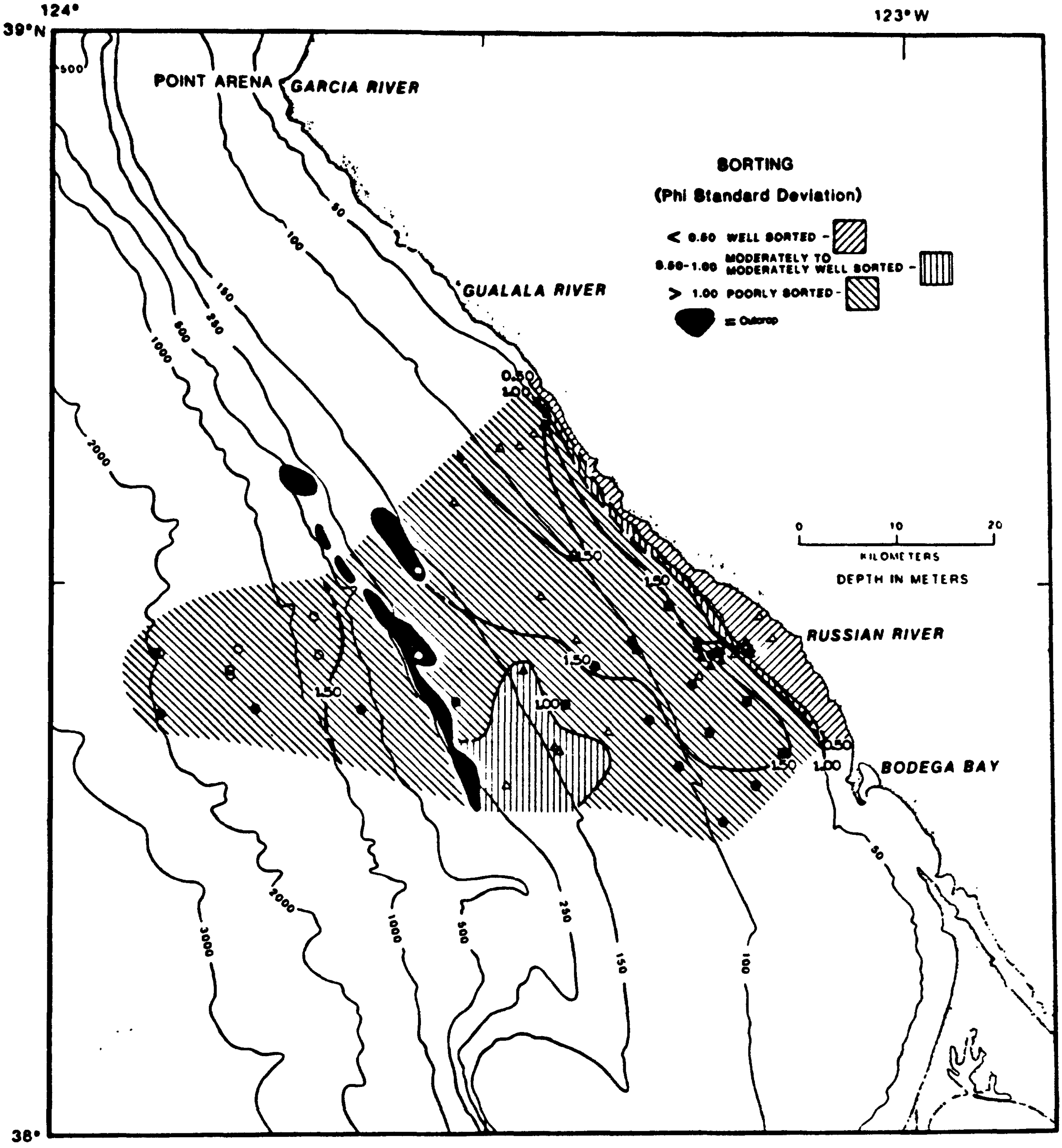

Figure 5. Distribution of sorting values for surface sediment.

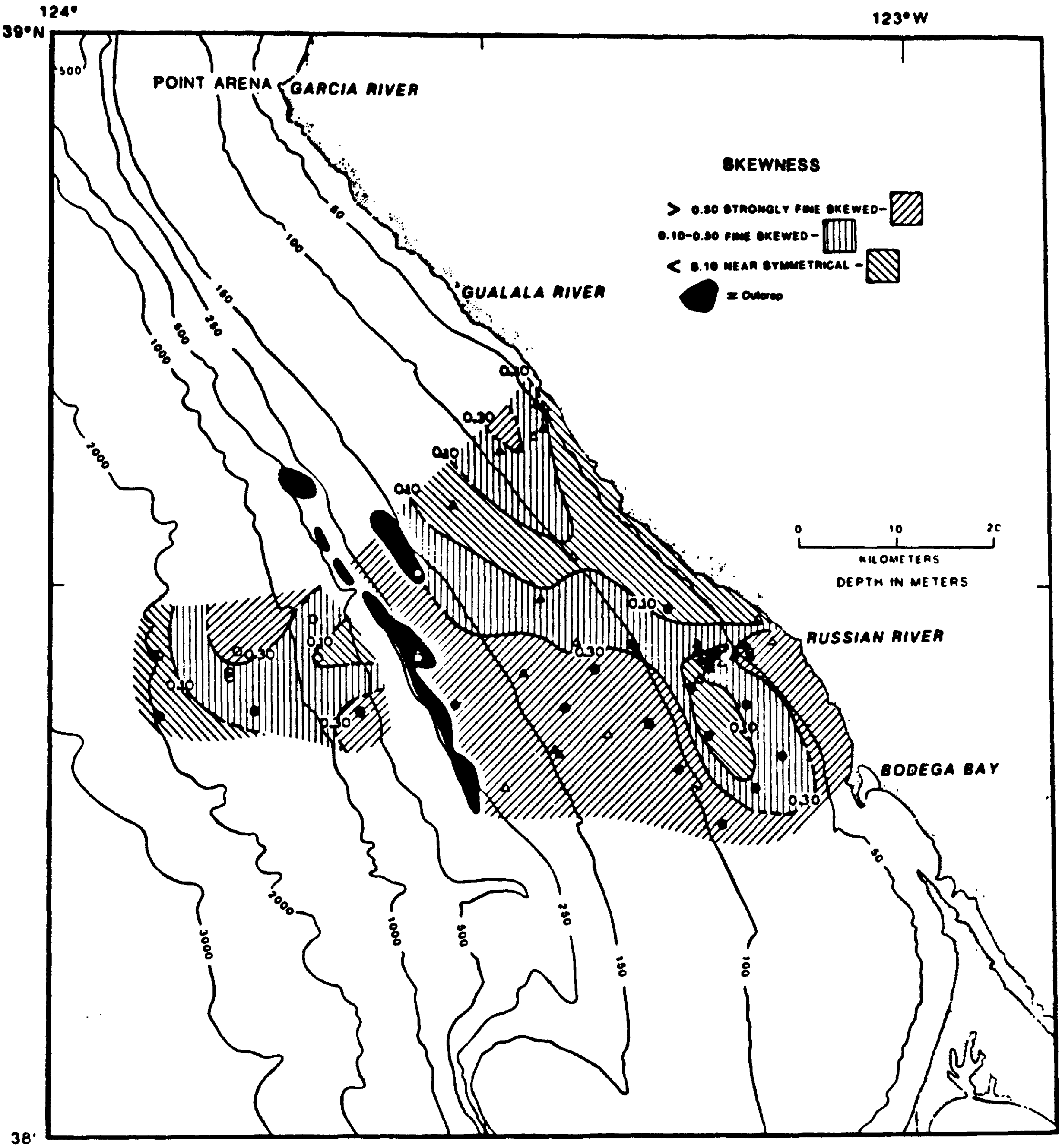

Figure 6. Distribution of skewness values for surface sediment.

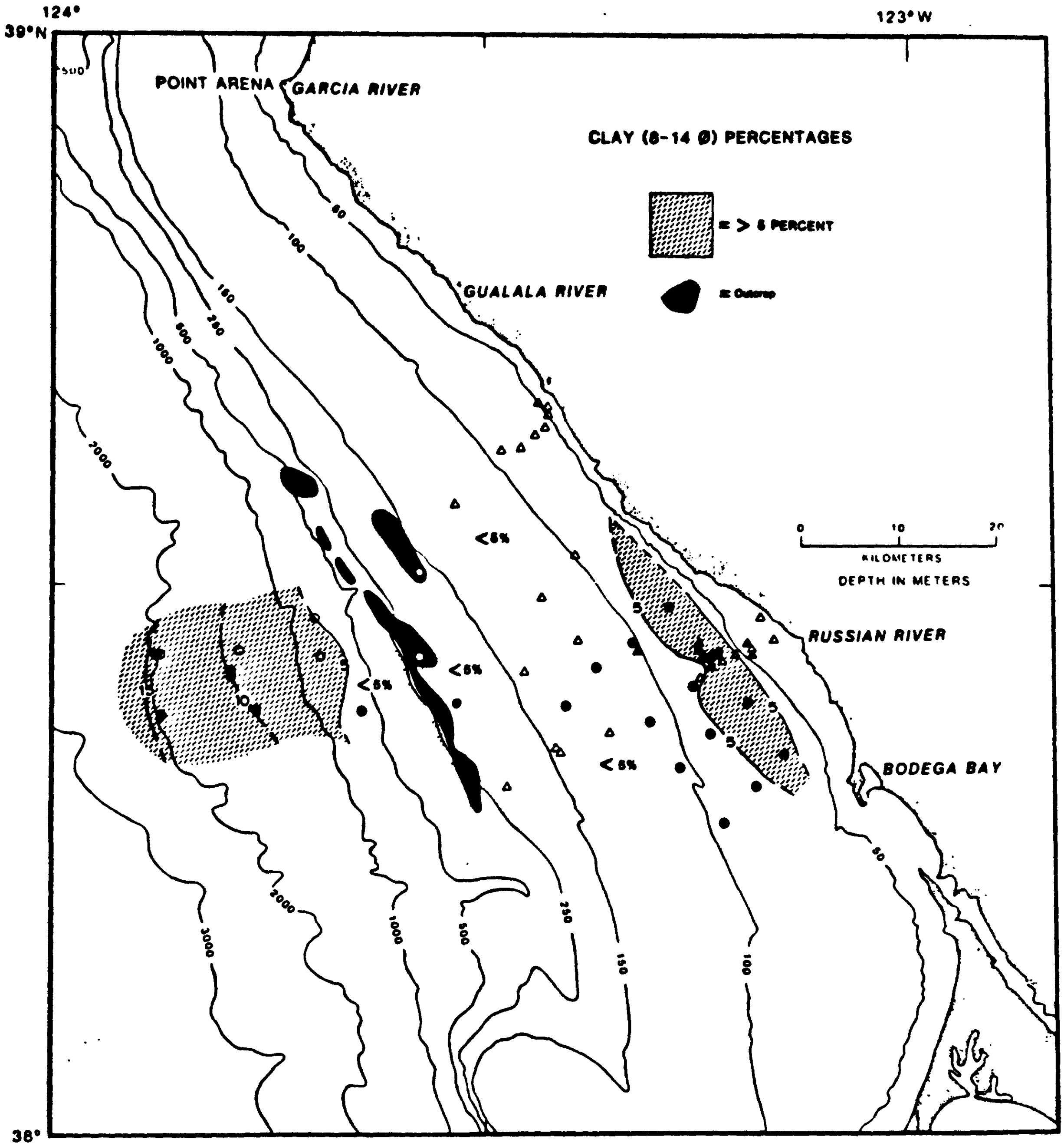

Figure 7. Distribution of percentage of clay fraction in offshore samples.

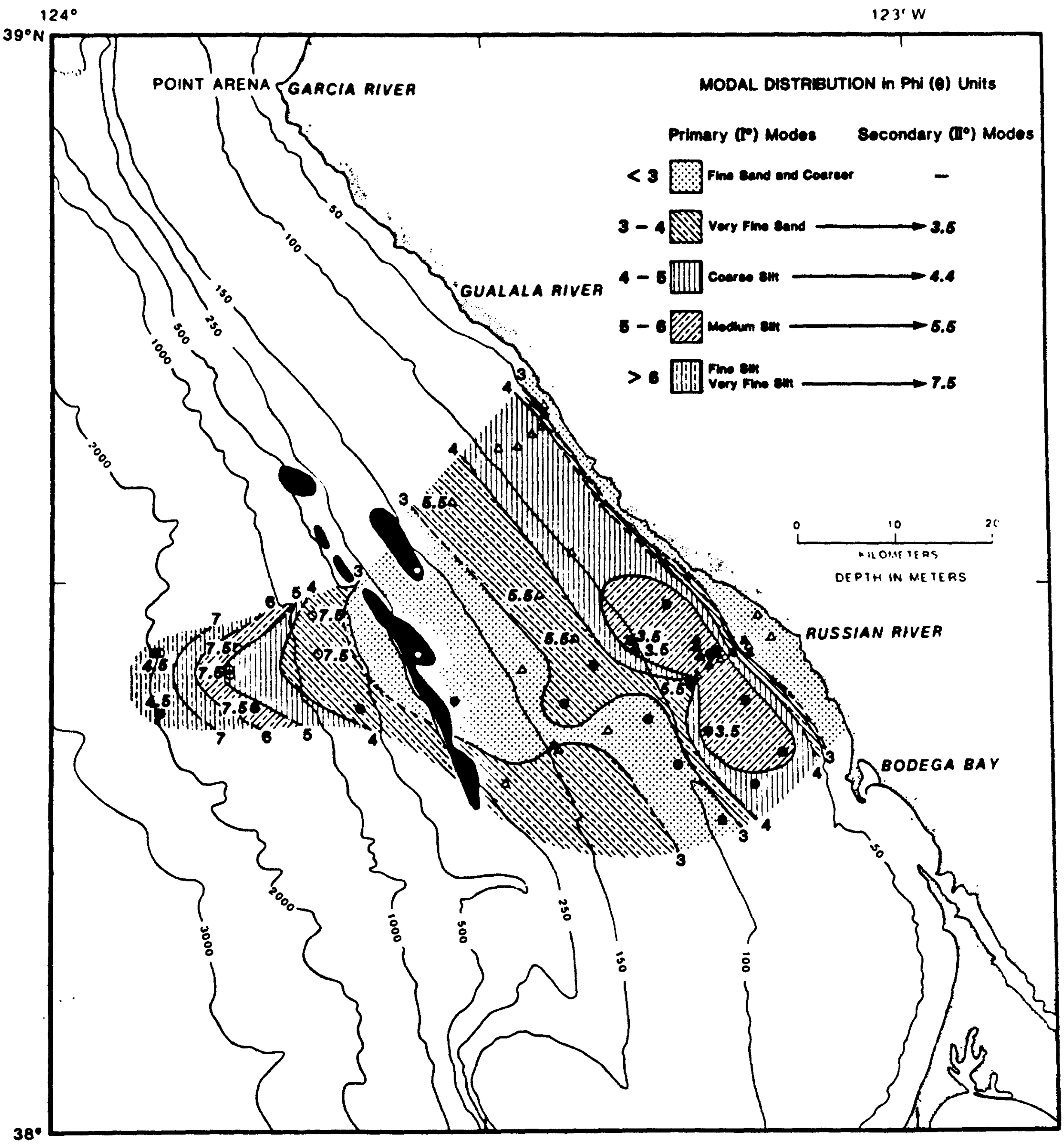

Figure 8. Distribution of modes in Phi (ϕ) units. Italicized values represent the secondary mode of samples that are bimodal.

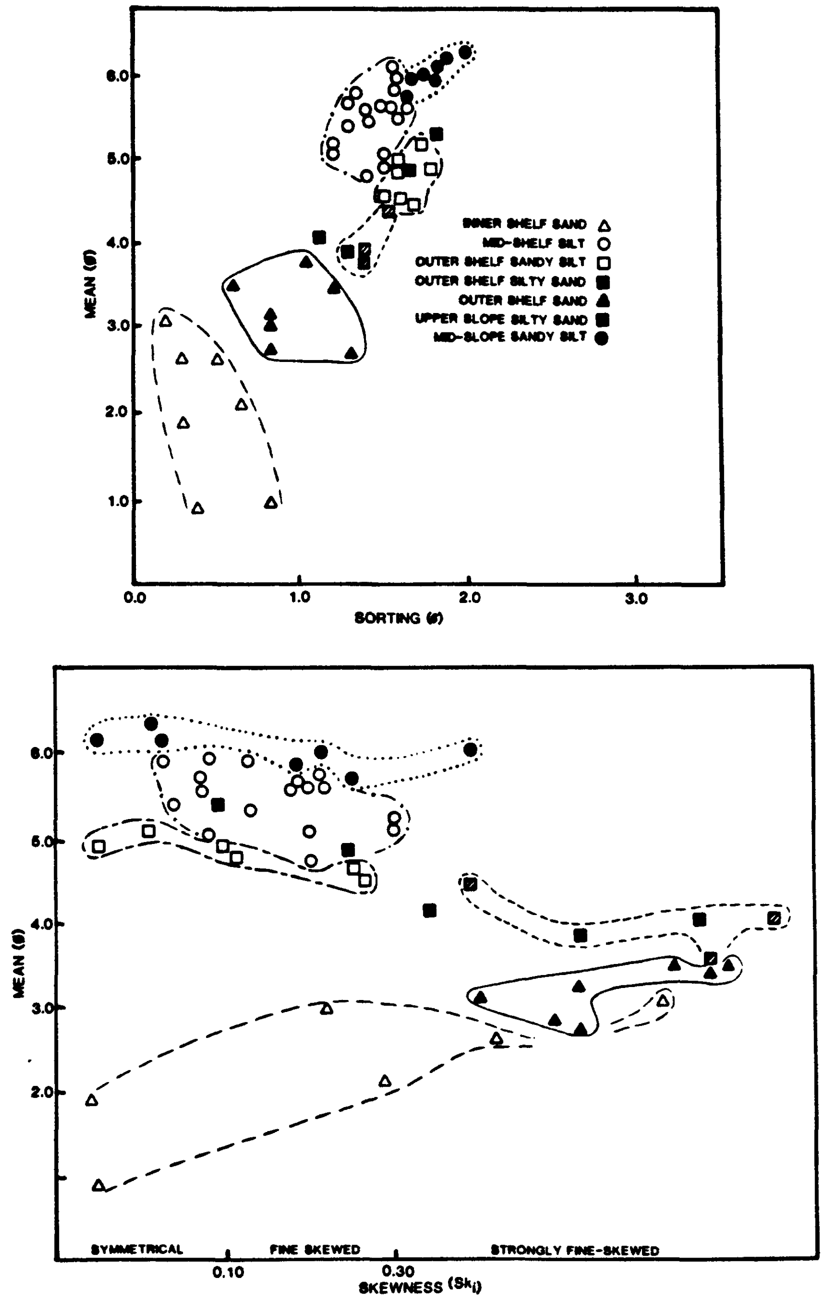

Figure 9. Plots of mean grain size vs. sorting (A) and skewness (B). Circled areas represent samples from the same geographical province.

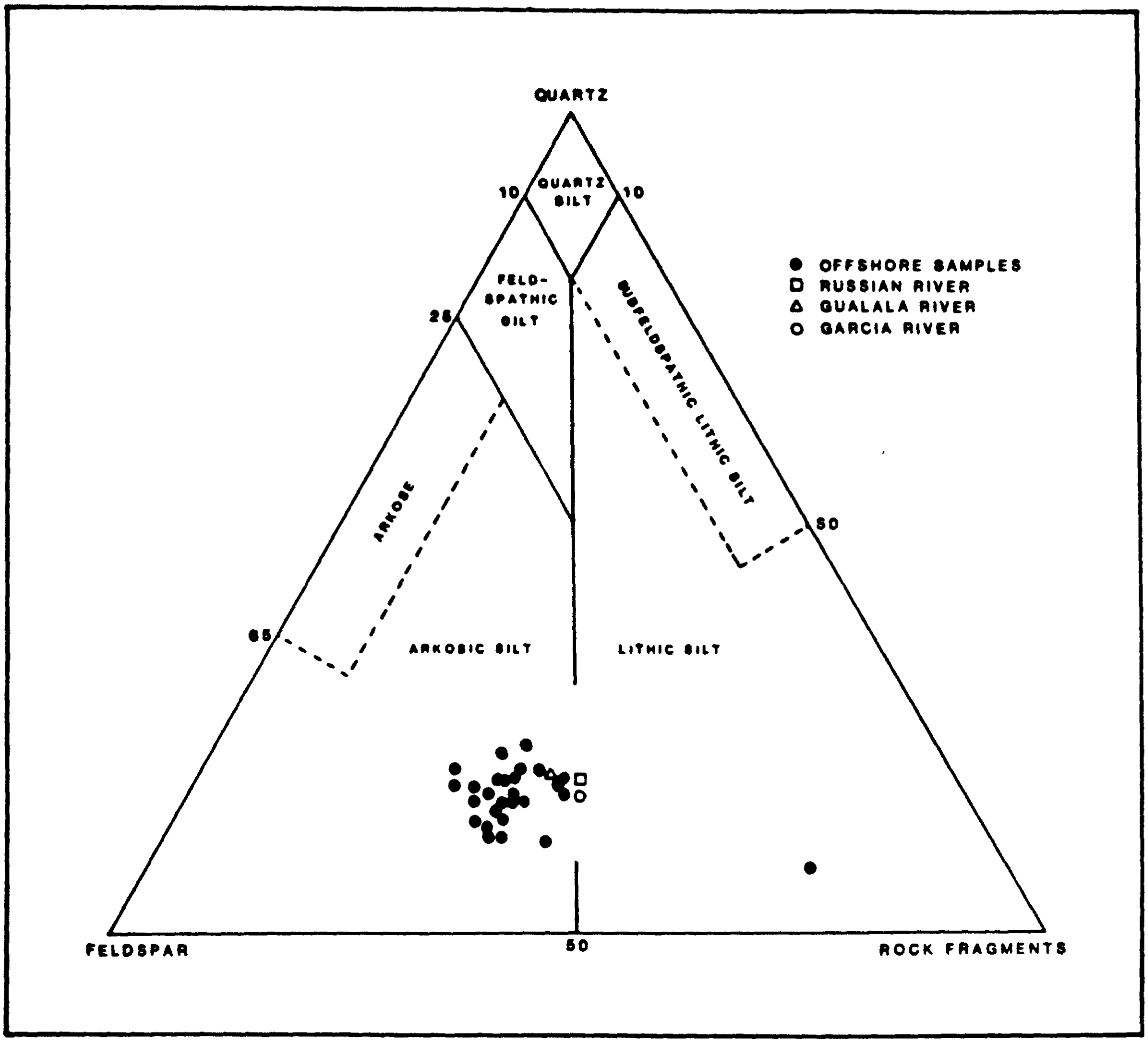

Figure 10 . QFR ternary diagram. Note that all offshore samples excluding one, are more feldspathic than the Russian River.

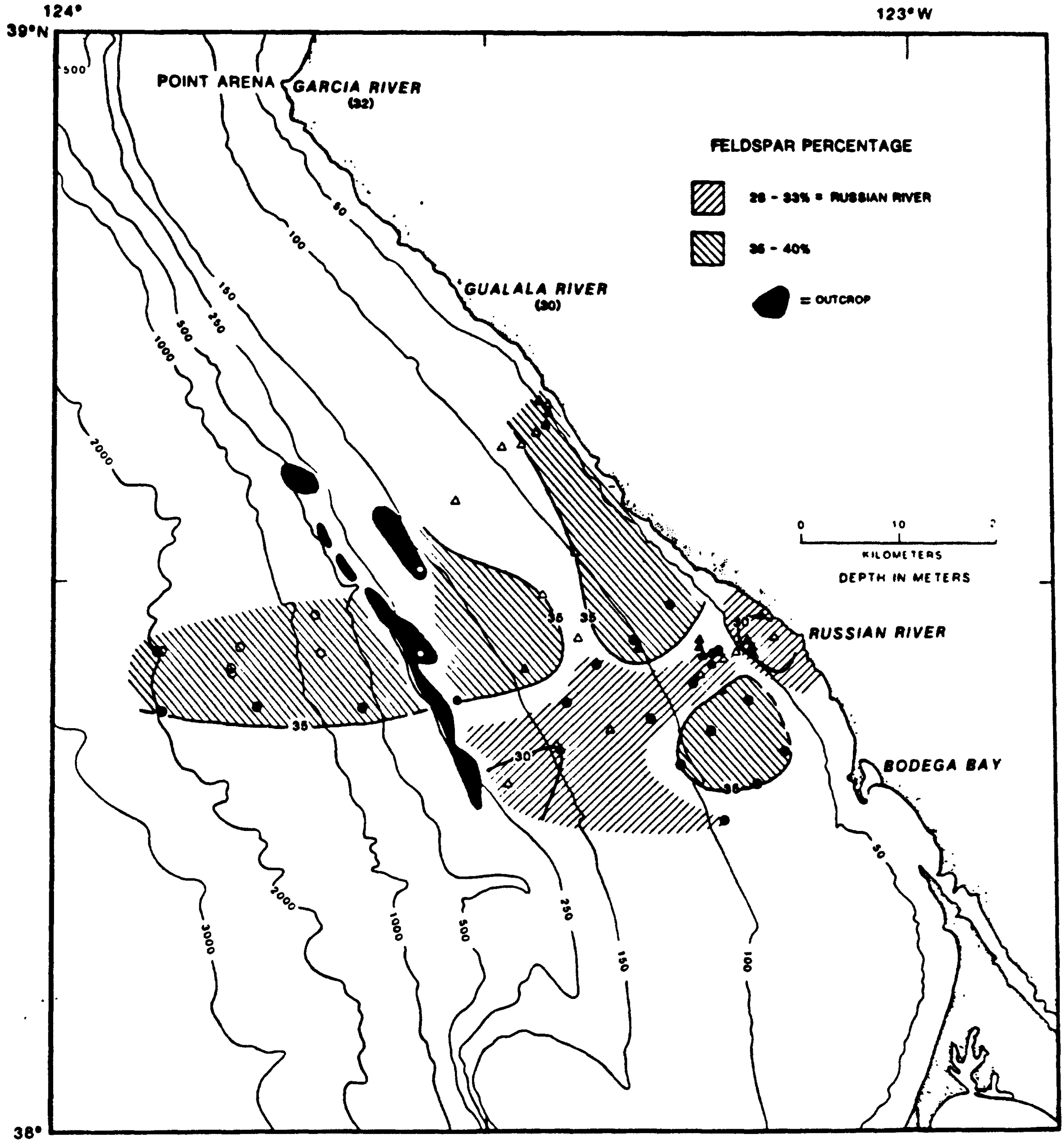

Figure 11 . Distribution of feldspar across the continental margin.

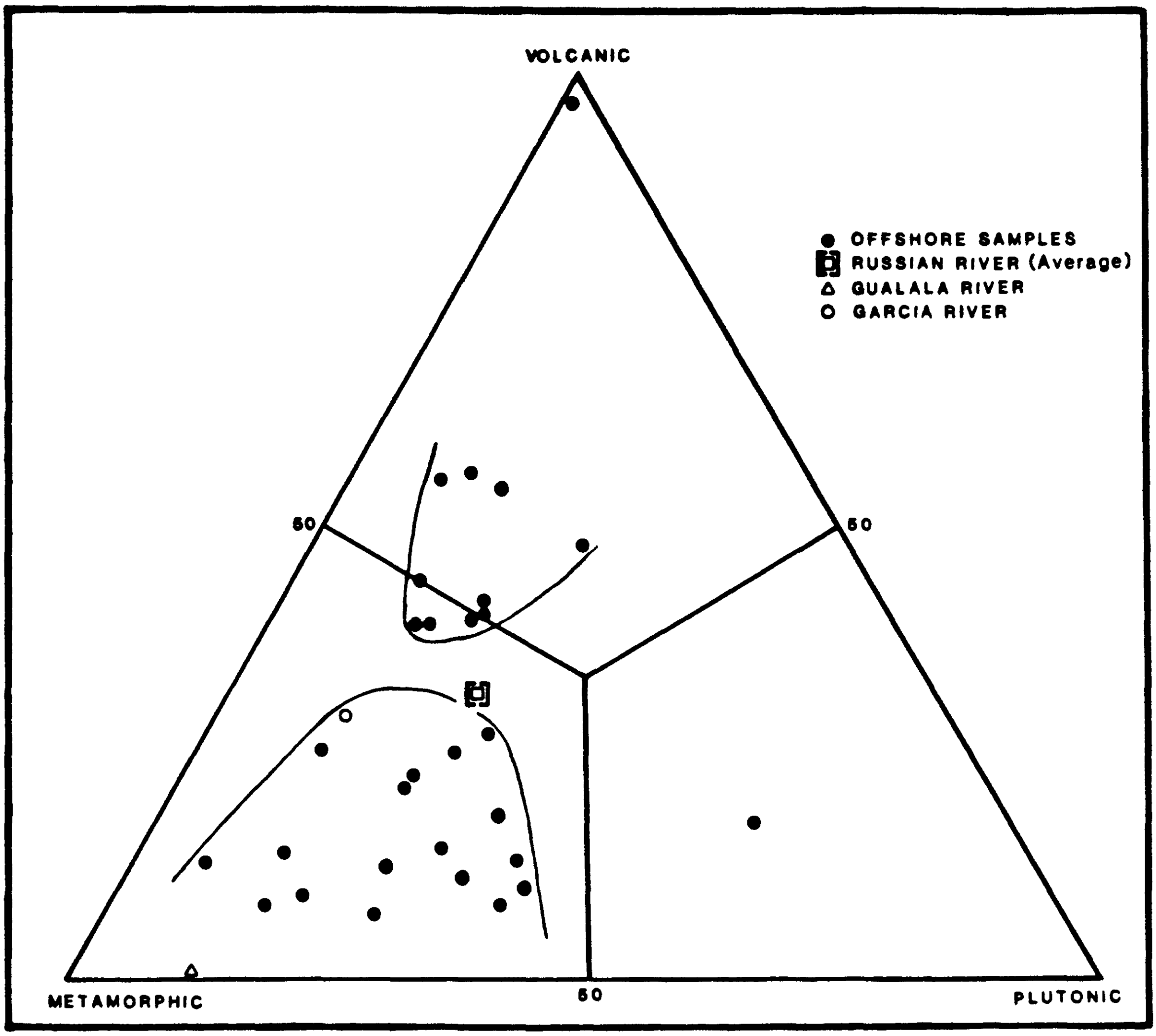

Figure 12. Ternary diagram comparing diagnostic rock fragment components.

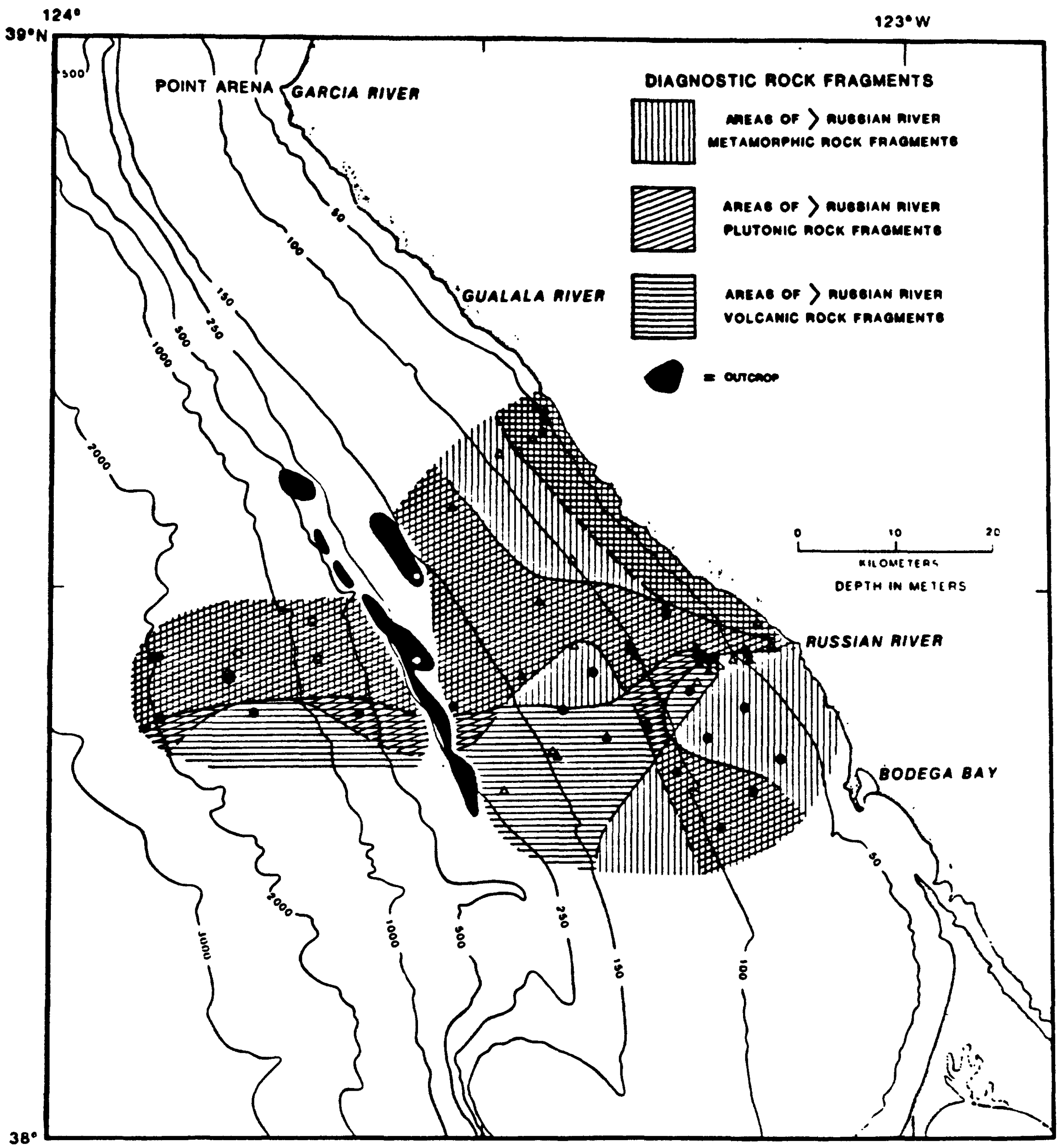

Figure 13. Offshore areas where each of the diagnostic rock fragments occur in amounts greater than that of the Russian River.

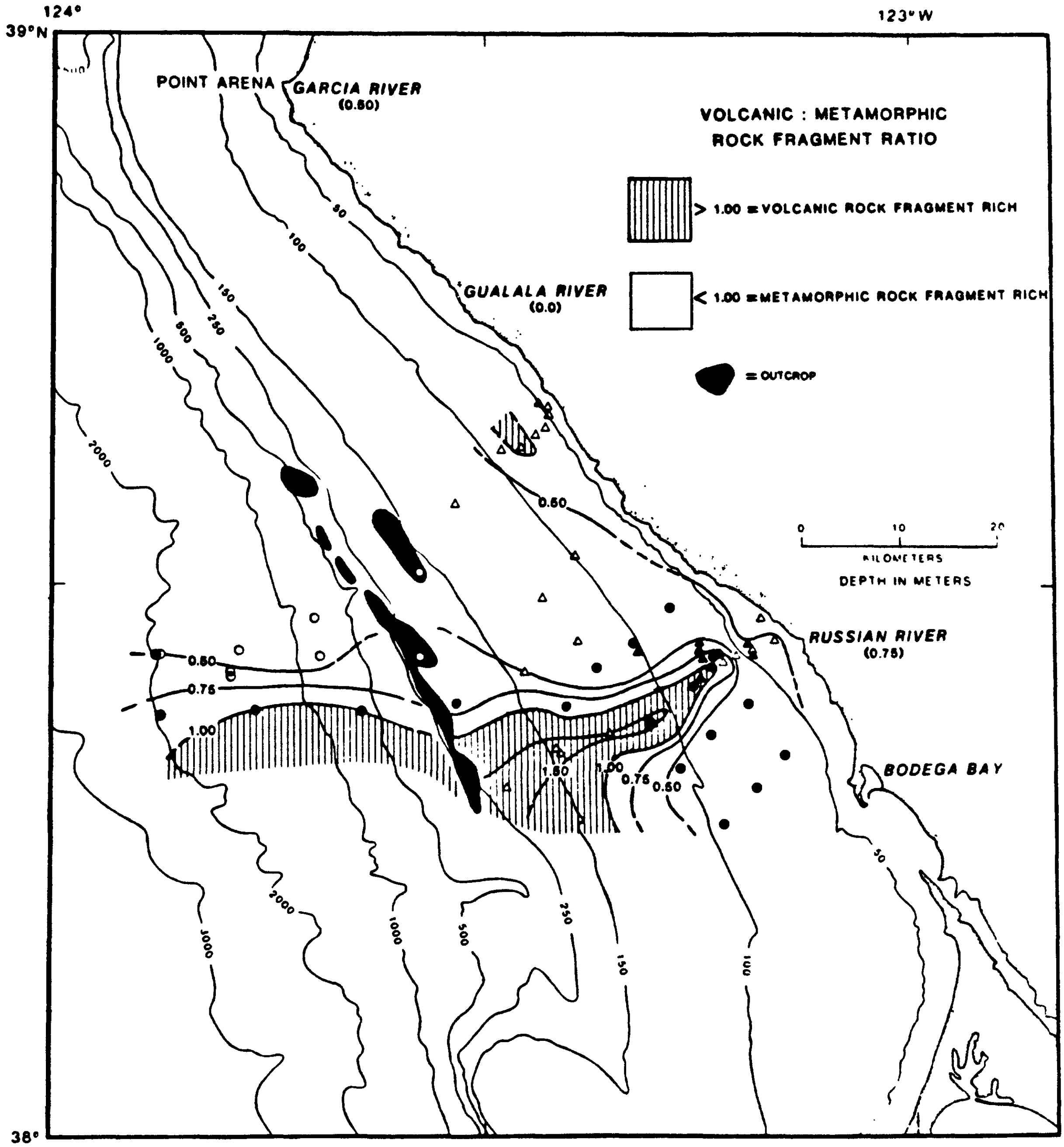

Figure 14. Relative abundance of volcanic to metamorphic rock fragments offshore.

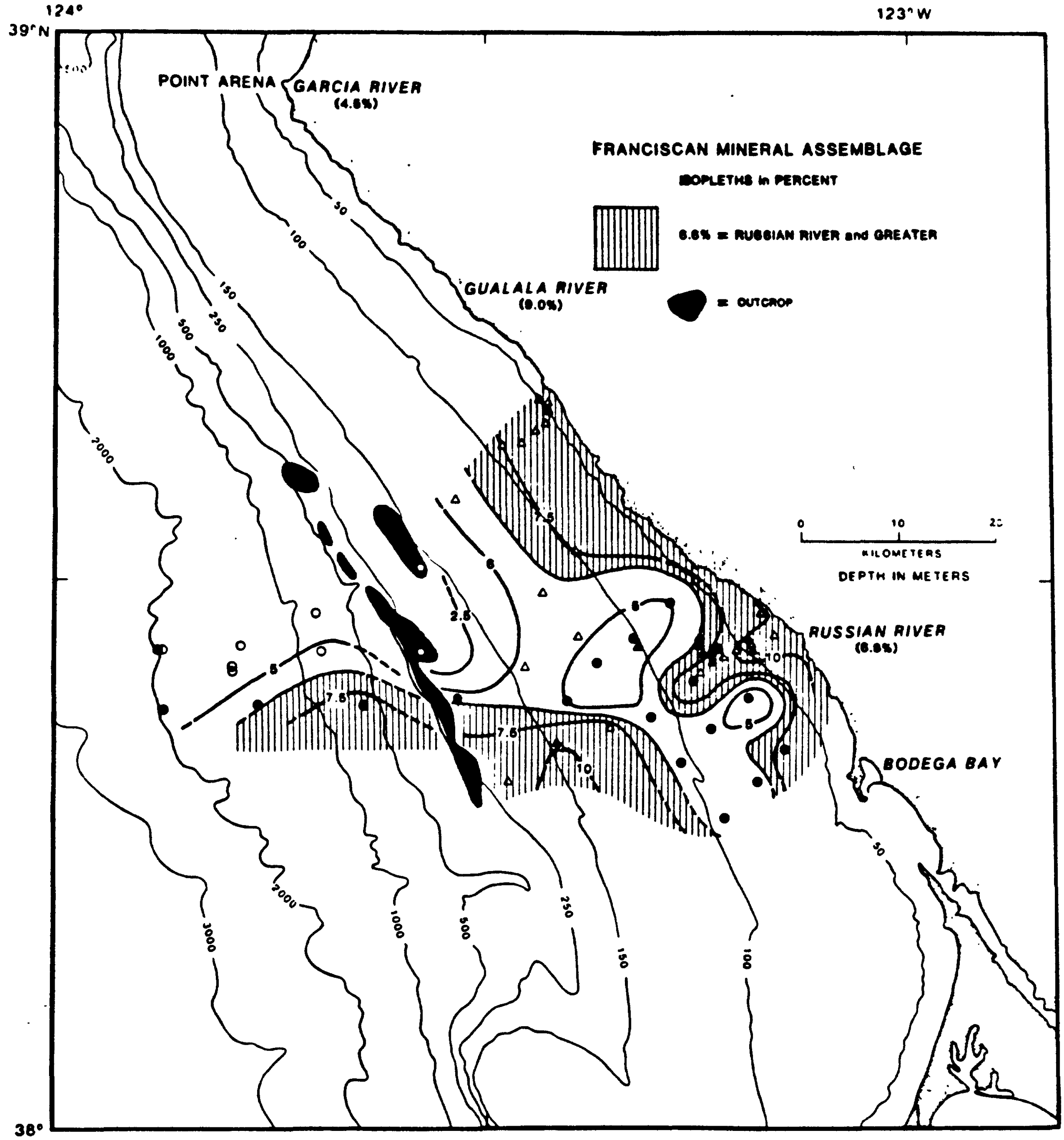

Figure 15. Distribution of Franciscan Mineral Assemblage (FMA) across the continental margin.

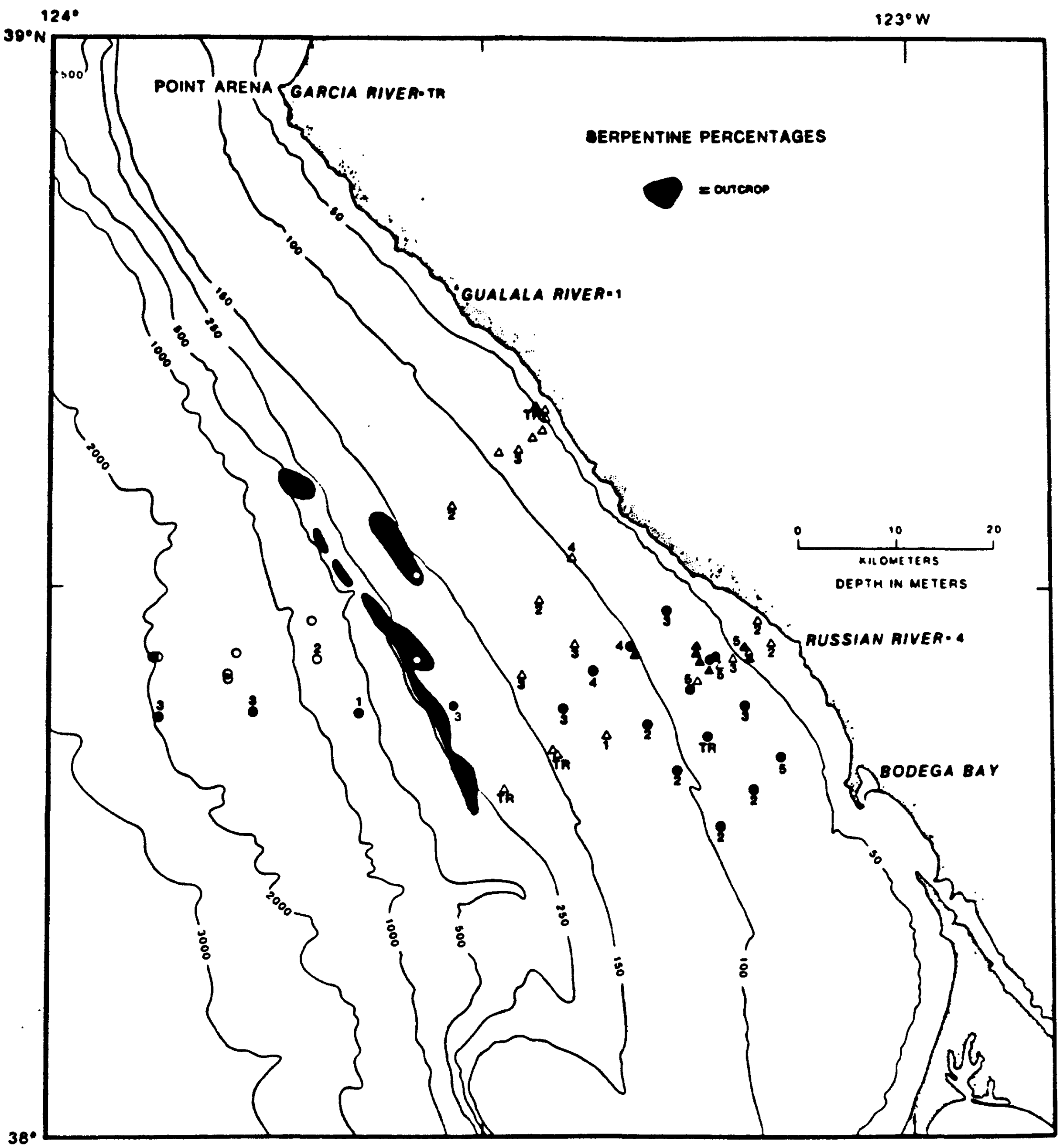

Figure 16. Serpentine percentages for the various river and offshore samples.

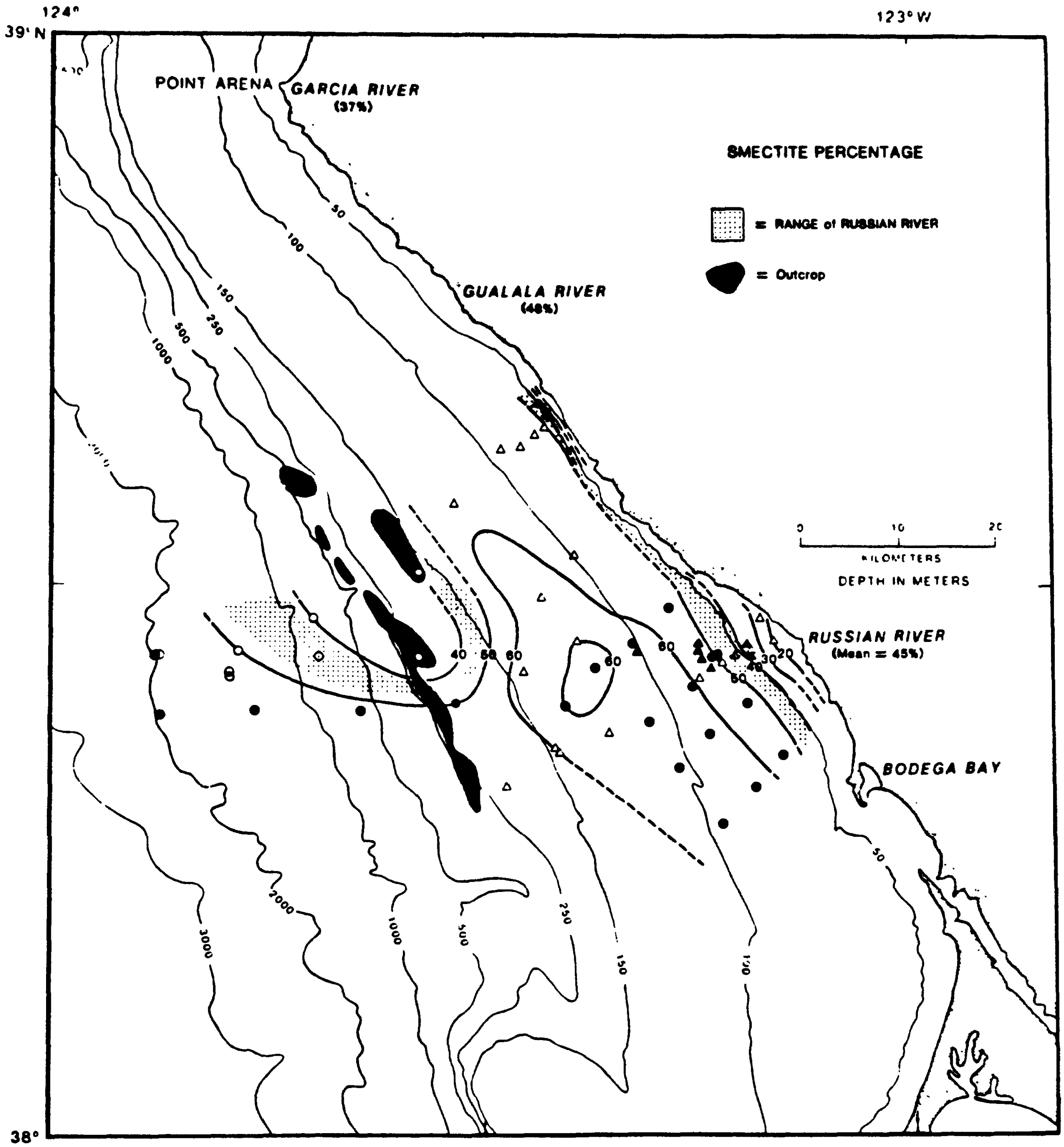

Figure 17. Smectite abundance in the fine fraction (<2μm) of river and offshore samples.

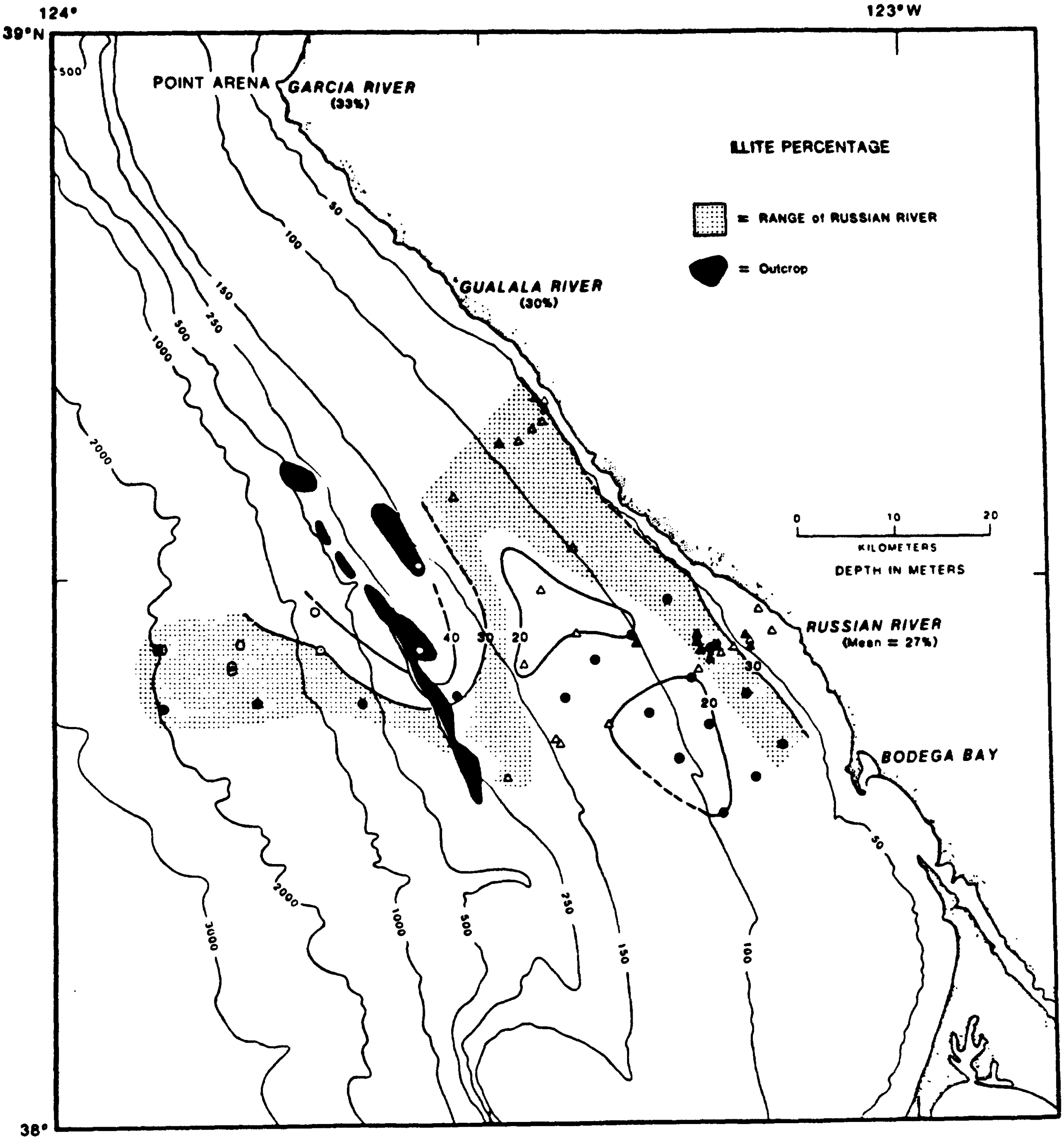

Figure 18. Illite abundance in the fine fraction (<2μm) of river and offshore samples.

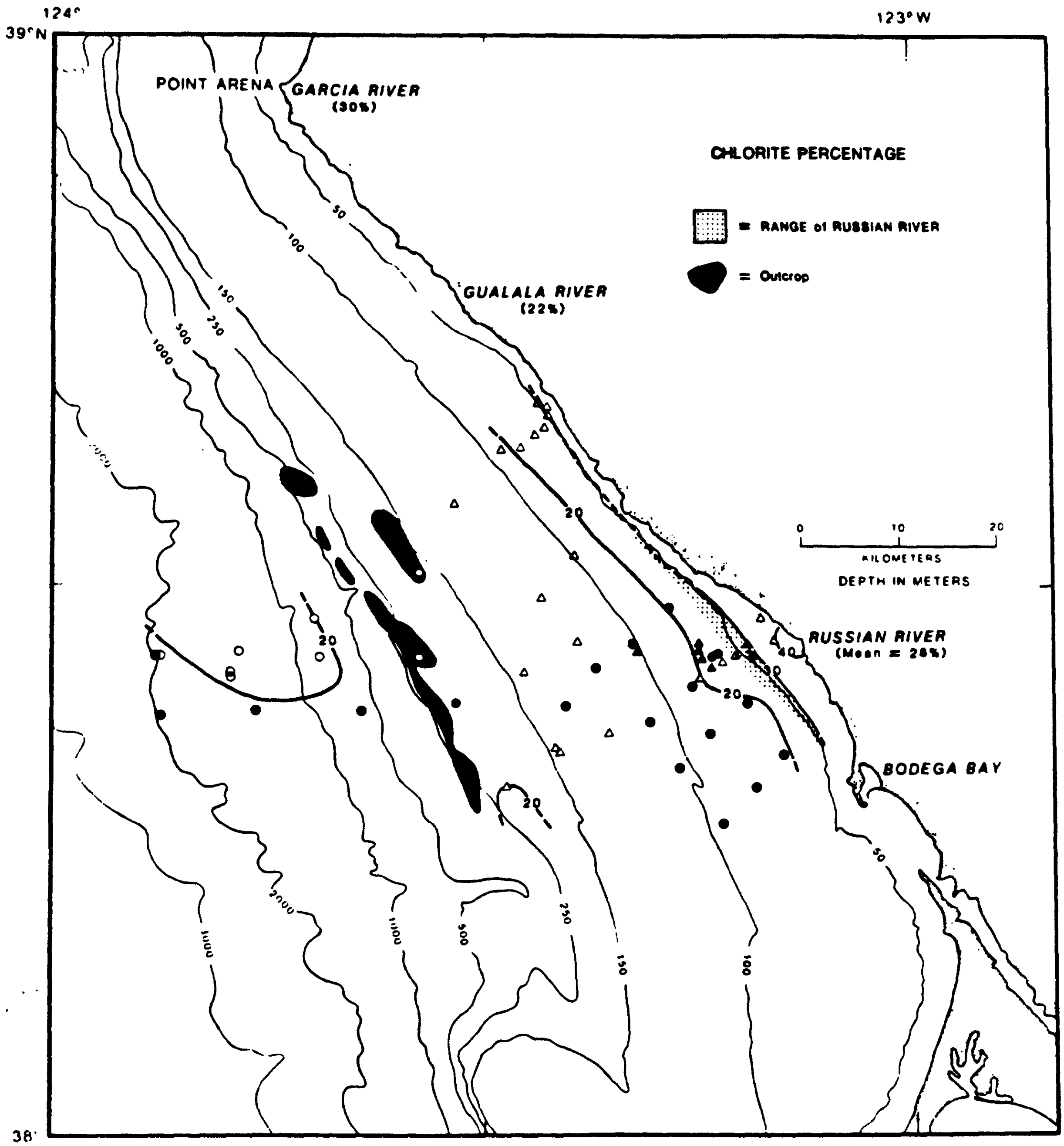

Figure 19. Chlorite abundance in the fine fraction (<2μm) of river and offshore samples.

Table 1. MAP NUMBERS AND SAMPLE LOCATION

MAP #	SAMPLE NO.	LATITUDE	LONGITUDE
1	V1-80-G11	38° 20.79'N	-123° 09.06'W
2	V1-80-G12	19.79'N	11.07'W
3	V1-80-G13	17.07'N	13.39'W
4	V1-80-G14	20.03'N	16.47'W
5	V1-80-G10	21.90'N	14.22'W
6	V1-80-G4	23.76'N	11.67'W
7	L1-81-Bx15	27.13'N	10.00'W
8	L1-81-Bx16	28.38'N	10.76'W
9	REX-2-9-VV1	26.61'N	10.95'W
10	L1-81-Bx17	26.75'N	11.35'W
11	REX-1-4-VV1	26.50'N	11.10'W
12	L1-81-Bx19	26.21'N	12.66'W
13	L1-81-Bx20	25.82'N	13.35'W
14	REX-1-1-VV1	26.50'N	14.80'W
15	V1-80-G5	26.20'N	13.70'W
16	V1-80-G6	26.05'N	13.99'W
17	REX-2-5A-VV1	26.71'N	14.76'W
18	REX-2-4-VV1	27.31'W	15.91'W
19	REX-2-8-VV1	26.65'N	14.63'W
20	L1-81-Bx21	24.96'N	15.10'W
21	V1-80-G9	24.55'N	16.65'W
22	V1-80-G16	22.63'N	18.64'W
23	L1-81-Bx14	21.96'N	21.38'W
24	L1-81-Bx12	20.90'N	24.60'W
25	L1-81-Bx13	21.08'N	24.97'W
26	L1-81-Bx11	10.06'N	28.43'W
27	V1-80-G18	23.53'N	24.30'W
28	V1-80-G17	25.52'N	22.11'W
29	REX-1-3-VV1	26.40'N	19.20'W
30	V1-80-G8	26.89'N	19.73'W
31	V1-80-G7	28.98'N	17.14'W
32	L1-81-Bx29	27.03'N	23.69'W
33	L1-81-Bx30	25.22'N	27.26'W
34	V1-80-G20	23.56'N	31.98'W
35	V1-80-G21	23.19'N	38.59'W
36	V1-80-5(Tw5)	26.09'N	34.59'N
37	L1-81-Bx28	29.43'N	26.03'W
38	L1-81-Bx27	31.67'N	23.76'W
39	L1-81-Bx23	40.06'N	26.36'W
40	L1-81-Bx22	39.80'N	25.75'W
41	L1-81-Bx10	38.60'N	26.10'W
42	L1-81-Bx9	38.77'N	25.85'W
43	L1-81-Bx8	38.28'N	26.48'W
44	L1-81-Bx6	37.63'N	27.47'W
45	L1-81-Bx3	37.26'N	29.00'W
46	L1-81-Bx7	34.37'N	32.06'W
47	V1-80-P6	30.50'N	34.67'W
48	V1-80-P7 (Tw7)	28.21'N	41.74'W

MAP #	SAMPLE NO.	LATITUDE		LONGITUDE	
49	V1-80-P4 (Tw4)	38°	26.13'N	-123°	41.50'W
50	V1-80-G22		23.24'N		45.89'W
51	V1-80-P2		25.92'N		46.12'W
52	V1-80-P3		25.51'N		47.42'W
53	V1-80-Tw8		27.74'N		47.69'W
54	V1-80-P1 (Tw1)		25.50'N		52.70'W
55	V1-80-G1		26.70'N		52.24'W
56	V1-80-G23		22.95'N		52.56'W

Table 2. GRAPHICAL STATISTICS FROM GRAIN SIZE ANALYSIS

SAMPLE NO.	MAP INDEX NUMBER	MEDIAN (Ø)	MEAN (Ø)	SORTING (σ)	SKEWNESS (S_{ki})	KURTOSIS (Kg)	SAND (%)	SILT (%)	CLAY (%)
80-G11	1	5.45	5.64	1.53	0.20	1.07	8.2	85.8	6.0
80-G12	2	5.21	5.40	1.33	0.12	1.20	14.3	81.6	4.1
80-G13	3	5.44	3.90	1.32	0.52	0.86	54.8	43.7	1.5
80-G14	4	3.25	3.90	1.41	0.75	0.80	58.4	39.4	2.2
80-G10	5	5.04	4.89	1.63	-0.05	0.75	35.1	61.1	3.8
80-G4	6	5.90	5.92	1.61	0.13	1.24	8.6	83.9	7.5
81-BX15	7	2.58	2.68	0.54	0.42	1.95	93.8	5.9	0.3
81-BX16	8	0.92	0.90	0.43	-0.05	1.25	99.2	0.7	0.1
REX-2-9	9	2.87	2.87	0.32	0.22	1.00	97.4	2.5	0.1
REX-1-4	11	2.94	3.09	0.25	0.62	0.74	96.8	2.9	0.3
81-BX20	13	5.50	5.75	1.35	0.21	1.07	7.7	87.2	5.1
REX 1-1	14	5.53	5.69	1.49	0.18	1.38	10.8	83.0	6.2
80-G5	15	5.89	5.86	1.61	0.02	1.11	12.2	81.6	6.2
80-G6	16	6.04	5.60	1.61	1.30	1.31	6.1	86.4	7.5
REX-2-5	17	5.50	5.65	1.64	0.19	1.22	13.2	79.7	7.1
REX-2-4	18	5.47	5.61	1.53	0.18	1.13	12.6	81.3	6.1
REX-2-8	19	5.43	5.53	1.50	0.05	1.08	13.1	81.6	5.3
81-BX21	20	5.41	5.41	1.55	0.04	1.10	17.4	77.4	5.2
80-G9	21	4.86	4.91	1.82	0.10	0.69	41.1	53.9	5.0
80-G16	22	3.34	3.99	1.39	0.66	0.84	57.3	40.8	1.9
81-BX14	23	3.03	3.37	1.03	0.68	1.77	78.4	20.7	0.9
81-BX12	24	3.03	3.20	0.83	0.51	2.64	85.8	13.1	1.1
81-BX13	25	3.01	3.06	0.81	0.40	2.47	87.0	11.8	1.2
81-BX11	26	3.36	3.52	0.60	0.68	2.21	85.3	13.5	1.2
80-G18	27	3.03	3.49	1.25	0.63	2.33	80.0	18.7	1.3
80-G17	28	4.03	4.42	1.56	0.39	0.78	49.7	47.7	2.6
REX-1-3	29	4.70	4.65	1.52	0.64	0.80	32.8	64.0	3.2
80-G8	30	4.79	4.70	1.65	0.39	0.70	35.1	62.1	2.8

SAMPLE NO.	MAP INDEX NUMBER	MEDIAN (Ø)	MEAN (Ø)	SORTING (σ)	SKEWNESS (S_{ki})	KURTOSIS (Kg)	SAND (%)	SILT (%)	CLAY (%)
80-G7	31	5.60	5.66	1.61	0.07	1.06	15.1	78.8	6.1
81-BX29	32	4.30	4.56	1.65	0.26	0.28	45.3	51.4	3.3
81-BX30	33	2.66	2.80	0.85	0.49	1.76	88.5	10.6	0.9
80-G20	34	2.41	2.70	1.29	0.52	1.66	84.3	14.3	1.4
80-G21	35	4.06	4.16	1.12	0.34	1.26	46.6	51.3	2.1
81-BX28	37	4.72	4.77	1.6.	0.11	0.73	36.0	60.2	3.8
81-BX27	38	4.93	4.96	1.49	0.08	1.06	22.7	73.6	3.7
81-BX23	39	2.09	2.14	0.68	0.29	2.67	94.7	4.7	0.6
81-BX22	40	1.90	1.89	0.33	-0.04	1.28	98.9	1.0	0.1
81-BX10	41	1.00	0.96	0.86	-0.25	1.64	*86.5	0.9	0.1
81-BX9	42	4.90	5.09	1.58	0.20	1.01	22.0	74.6	3.4
81-BX8	43	4.61	4.78	1.42	0.20	1.34	21.7	75.9	2.4
81-BX6	44	4.83	5.12	1.24	0.30	1.17	14.8	82.6	2.6
81-BX3	45	4.95	5.25	1.24	0.30	1.13	12.1	84.4	3.5
81-BX7	46	5.20	5.17	1.70	0.01	0.69	29.5	66.2	4.3
80-TW7	48	4.51	4.83	1.64	0.24	1.02	38.8	56.9	4.3
80-TW4	49	5.36	5.32	1.86	0.09	0.82	24.5	68.5	7.0
80-G22	50	5.83	5.89	1.81	0.18	1.20	7.6	82.1	10.3
80-P2	51	5.23	5.70	1.61	0.25	1.25	8.3	83.2	8.5
80-P3	52	5.93	5.96	1.72	0.21	1.03	1.8	87.3	10.9
80-TW8	53	5.72	5.96	1.59	0.39	1.04	3.1	87.7	9.2
80-TW1	54	6.59	6.24	1.74	-0.05	1.20	0.8	87.2	12.0
80-G1	55	6.71	6.38	2.03	0.01	1.03	2.4	81.5	16.1
80-G23	56	6.54	6.24	1.85	0.02	1.08	1.0	85.7	13.3

* plus gravel

Table 3. Criteria used to classify various rock fragments.

Rock Fragment Category	Identification Characteristics
Volcanic Rock Fragments	Feldspar laths, palagonite, glassy texture.
Metamorphic Rock Fragments	Schistose or gneissose structure; radiating crystal groups, inclusions of metamorphic minerals.
Sedimentary Rock Fragments	Fine-grained aggregates either altered or unaltered. Altered types are yellow/green in color under plain light, yellow to black mottled between crossed nicols; unaltered types are clear to slightly yellow/brown under plain light, gray to black (salt and pepper) between crossed nicols.
Chert	Similar to unaltered sedimentary rock fragments except aggregates are coarser grained mosaic with "salt and pepper" texture between crossed nicols.
Plutonic Rock Fragments	Similar to chert but much coarser-grained and polymineralic (i.e., 3-5 individual minerals).
Other Rock Fragments	Highly altered by weathering. Dark yellow/green color under plain light, nearly opaque between crossed nicols.

Table 4. PERCENTAGES OF MINERAL COMPONENTS

COMPONENTS	SAMPLE NO.	V1-80 G11	V1-80 G12	V1-80 G13	V1-80 G14	V1-80 G10	V1-80 G4	L1-81 BX15	L1-81 BX16	L1-81 BX17	L1-81 BX19	L1-81 BX21	L1-81 BX21
	MAP NO.	1	2	3	4	5	6	7	8	10	12	13	20
Quartz		12	11	11	9	9	12	13	12	10	13	15	12
Feldspar		36	35	33	35	39	40	29	30	29	34	29	31
Green Hornblende		*TR	2	2	TR	1	1	-	1	1	-	TR	1
Brown Hornblende		-	-	1	1	TR	TR	-	-	TR	-	-	-
Tremolite		2	TR	1	TR	TR	1	TR	1	1	1	1	1
Glaucophane		1	TR	TR	TR	TR	TR	2	1	1	2	TR	1
Epidote		2	2	3	3	2	4	4	2	4	2	1	3
Orthopyroxene		TR	-	TR	TR	TR	-	1	TR	1	2	TR	1
Clinopyroxene		TR	TR	TR	TR	1	TR	1	TR	TR	-	1	1
Serpentine		5	2	2	2	TR	3	2	2	5	3	5	2
Glauconite		1	1	4	2	TR	-	-	-	-	-	-	-
Biotite		4	6	4	6	4	3	TR	4	2	3	4	2
Muscovite		-	2	1	1	TR	1	TR	1	1	1	TR	2
Chlorite		2	3	4	5	3	3	1	3	4	6	6	6
Brittle Mica		-	-	-	-	TR	1	TR	TR	2	2	2	3
Glass		1	1	TR	4	3	-	2	1	2	2	4	1
Isotropic		-	4	5	1	3	-	-	-	-	-	-	-
Sphene		1	1	1	1	1	1	2	1	1	1	-	1
Zircon		-	-	1	1	TR	-	2	1	1	TR	TR	-
Lawsonite		TR	1	-	1	1	-	1	TR	1	2	1	1
Garnet		TR	-	TR	TR	TR	-	TR	1	2	-	-	-
Carbonate		-	-	-	TR	-	-	-	2	-	-	-	-
Zeolite		1	-	3	1	1	TR	TR	2	1	2	2	3
Chromite		1	TR	TR	-	-	TR	TR	1	TR	-	-	-
Volcanic Rock Frags.		1	1	1	1	TR	-	3	2	2	2	4	4
Metamorphic Rock Frags.		6	4	4	5	5	6	8	3	5	4	4	4
Altered Sed. Rock Frags.		6	4	4	5	5	5	4	5	3	3	2	3
Unaltered Sed. Rock Frags.		5	5	4	2	6	7	3	4	4	2	2	4
Chert		6	4	3	3	4	3	3	4	3	3	2	3
Plutonic Rock Frags.		TR	4	3	3	1	1	3	7	2	1	2	2
Unknown Rock Frags.		TR	1	TR	1	TR	1	1	1	1	TR	2	TR
Fecal Pellets		TR	-	TR	1	1	1	2	1	2	2	1	1
Opaques		TR	1	1	1	1	TR	1	2	2	TR	2	1
Unknowns		TR	1	1	1	1	1	1	2	1	1	1	1
Others		3	1	3	3	2	2	9	4	7	6	7	5
Totals		96	97	100	99	94	91	98	101	101	100	100	100

*TR=Trace (<0.5%)

COMPONENTS	SAMPLE NO. / MAP NO.	V1-80 G16 22	L1-81 BX14 23	L1-81 BX13 25	L1-81 BX11 26	V1-80 G18 27	V1-81 G17 28	V1-80 G8 30	V1-80 G7 31	L1-81 BX29 32	L1-80 BX30 33	V1-80 G20 34	V1-80 G21 35
Quartz		13	14	14	13	11	12	11	16	11	13	14	12
Feldspar		32	32	30	28	32	32	37	37	34	37	35	37
Green Hornblende		-	1	1	2	1	-	TR	-	TR	2	1	2
Brown Hornblende		-	1	1	1	TR	TR	-	-	1	1	1	1
Tremolite		TR	1	3	2	1	1	-	2	2	TR	TR	1
Glaucophane		1	2	1	TR	TR	-	1	1	TR	TR	1	2
Epidote		2	2	3	3	2	3	1	2	2	2	4	3
Orthopyroxene		1	1	1	1	TR	TR	TR	1	-	1	1	1
Clinopyroxene		1	1	2	2	4	2	TR	1	1	1	1	2
Serpentine		2	1	-	2	3	4	4	3	3	3	3	1
Glauconite		1	TR	1	2	-	TR	TR	TR	2	1	1	1
Biotite		1	2	1	3	2	6	3	2	7	1	1	2
Muscovite		1	1	1	0	TR	-	2	TR	1	TR	1	1
Chlorite		4	3	5	4	3	7	7	1	2	3	1	4
Brittle Mica		2	2	2	1	2	-	2	-	TR	1	2	1
Glass		3	2	1	2	1	1	2	1	3	1	-	1
Isotropic		-	-	-	-	-	5	-	-	2	-	-	-
Sphene		1	1	1	2	1	TR	1	1	2	1	1	TR
Zircon		-	1	1	-	TR	1	TR	1	1	TR	TR	1
Lawsonite		-	1	TR	TR	-	-	-	-	TR	1	1	-
Garnet		TR	1	1	-	TR	-	-	-	TR	-	TR	-
Carbonate		-	-	-	-	TR	-	-	-	-	-	-	TR
Zeolite		2	1	1	1	1	2	-	1	1	1	TR	3
Chromite		-	-	-	-	-	-	-	-	1	-	TR	-
Volcanic Rock Frags.		7	6	5	7	5	TR	5	1	1	2	3	4
Metamorphic Rock Frags.		4	4	3	4	4	4	3	7	5	4	5	4
Altered Sed. Rock Frag.		3	6	7	5	5	5	1	4	5	5	7	6
Unaltered Sed. Rock Frag.		4	4	1	5	4	6	4	5	5	3	2	2
Chert		4	2	1	2	3	2	3	4	2	3	4	2
Plutonic Rock Frags.		4	1	1	2	2	1	4	5	2	2	3	2
Unknown Rock Frags.		1	1	1	1	TR	2	1	1	1	1	1	1
Fecal Pellets		2	1	1	2	1	1	1	1	1	1	TR	1
Opaques		1	2	2	2	1	1	TR	TR	1	1	1	1
Unknowns		2	1	2	2	1	1	1	1	1	1	2	2
Others		4	2	4	3	6	3	4	2	2	4	3	4
Totals		103	101	99	101	96	102	100	101	102	97	100	104

COMPONENTS / SAMPLE NO. / MAP NO.	V1-80 P5 36	L1-81 BX28 37	L1-81 BX27 38	L1-81 BX22 40	L1-81 BX6 44	L1-81 BX7 46	V1-80 TW-4 49	V1-80 G22 50	V1-80 G23 56	Russian River	Gualala River	Garcia River
Quartz	5	10	10	12	9	8	13	12	8	14	13	13
Feldspar	14	35	35	36	35	34	38	37	35	30	30	32
Green Hornblende	TR	1	-	-	TR	1	2	1	1	1	-	TR
Brown Hornblende	-	-	-	1	-	-	TR	TR	-	TR	-	-
Tremolite	-	1	3	2	2	2	1	1	TR	1	1	TR
Glaucophane	-	TR	TR	-	TR	TR	-	1	-	1	2	1
Epidote	TR	3	2	2	2	4	3	1	2	2	5	2
Orthopyroxene	-	TR	1	TR	TR	TR	1	TR	-	1	-	-
Clinopyroyene	-	TR	1	1	TR	1	2	1	1	1	TR	-
Serpentine	-	2	4	TR	3	2	2	3	3	3	1	TR
Glauconite	-	TR	TR	-	1	1	TR	1	TR	-	-	-
Biotite	2	8	6	8	6	9	4	1	3	3	4	2
Muscovite	-	1	TR	1	1	2	1	1	2	2	1	1
Chlorite	2	4	2	1	4	3	2	4	3	4	2	4
Brittle Mica	2	-	TR	-	-	-	-	TR	1	TR	-	-
Glass	-	1	2	-	1	2	TR	3	4	1	1	2
Isotropic	-	1	1	-	-	1	-	-	-	-	-	-
Sphene	-	1	TR	-	TR	1	1	-	TR	1	2	2
Zircon	-	TR	-	TR	TR	TR	-	-	-	TR	-	TR
Lawsonite	-	1	TR	2	TR	TR	TR	1	-	TR	1	-
Garnet	-	TR	TR	-	-	-	-	-	-	TR	-	TR
Carbonate	1	TR	-	5	-	-	TR	1	TR	TR	-	-
Zeolite	-	TR	1	1	2	1	1	2	2	TR	1	2
Chromite	-	TR	-	-	-	1	-	-	-	1	1	TR
Volcanic Rock Frags.	44	1	1	5	6	TR	1	4	5	6	-	5
Metamorphic Rock Frags.	1	4	5	8	8	5	3	4	6	8	7	10
Altered Sed. Rock Frags.	-	7	4	2	2	8	9	7	6	5	11	7
Unaltered Sed. Rock Frags.	-	6	9	3	2	4	1	5	5	3	3	2
Chert	1	2	3	4	4	TR	3	2	3	3	4	4
Plutonic Rock Frags.	TR	2	1	1	2	2	2	1	2	4	1	2
Unknown Rock Frags.	-	1	1	2	2	1	1	1	1	1	TR	1
Fecal Pellets	-	1	1	-	TR	1	1	1	1	2	1	1
Opaques	2	1	1	TR	TR	1	2	1	TR	1	1	1
Unknowns	TR	1	1	1	1	1	1	2	1	2	1	2
Others	25	2	3	3	4	2	2	3	3	2	5	2
Totals	99	97	99	101	99	98	97	102	98	100	99	98

Table 5. **Clay Mineral Percentages**

Sample	Map Index Numbers	% Smectite	% Illite	% Kaolinite & Chlorite
80-G11	1	57	26	17
80-G12	2	64	21	15
80-G13	3	62	20	18
80-G14	4	65	18	17
80-G10	5	62	20	18
80-G4	6	56	25	19
81-BX15	7	20	39	41
81-BX16	8	26	37	37
81-BX17	10	38	33	29
81-BX19	12	45	30	25
81-BX20	13	48	28	24
80-G5	15	51	28	21
80-G6	16	52	25	23
81-BX21	20	58	22	20
80-G9	21	63	20	17
80-G16	22	69	16	15
81-BX14	23	63	20	17
81-BX12	24	60	22	18
81-BX13	25	59	24	17
81-BX11	26	55	25	20
80-G18	27	60	24	16
80-G17	28	58	27	15
80-G8	30	63	20	17
80-G7	31	55	25	20
81-BX29	32	60	20	20
81-BX30	33	64	19	17
80-G20	34	50	31	19
80-G21	35	54	29	17
80-P5	36	30	57	13
81-BX28	37	67	16	17
81-BX27	38	55	26	19
81-BX23	39	47	29	24
81-BX22	40	18	43	39
81-BX10	41	47	28	25
81-BX9	42	51	22	23
81-BX10	43	53	24	23
81-BX6	44	55	25	20
81-BX3	45	56	23	21
81-BX7	46	57	25	18
80-TW7	48	65	17	18
80-TW4	49	46	30	24
80-G22	50	53	28	19
80-TW2	51	56	25	19
80-TW3	52	59	22	18
80-TW8	53	50	26	24
80-TW1	54	56	23	21
80-G23	56	58	26	16

Sample	Date Collected	% Smectite	% Illite	% Kaolinite & Chlorite
Russian River	(01/18/80)	45	26	29
Russian River	(04/01/80)	41	27	32
Russian River	(05/29/80)	41	32	27
Russian River	(07/23/80)	42	33	25
Russian River	(10/16/80)	47	25	28
Russian River	(12/03/80)	44	25	31
Russian River	(02/14/81)	48	25	27
Russian River	(03/25/81)	48	24	28
Gualala River	(04/10/81)	48	30	22
Garcia River	(06/06/81)	36	35	29