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Variations in titanium and chromium concentrations in magnetite separates from beach and offshore sediments, San Francisco and San Mateo Counties, California--Part A

by

Gretchen Luepke

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Introduction

Heavy minerals have traditionally been used as tracers for sediment transport studies, and nonopaque heavy-mineral studies have been conducted on beaches and offshore sediments on the continental shelf between the Golden Gate Bridge and Santa Cruz, California (Hutton, 1959; Sayles, 1965; Lee and others, 1971a, 1971b). Although longshore transport is known to occur generally in a southerly direction (Yancey and Lee, 1972), detailed transport patterns and sediment budget for this region remains inexact. With the establishment of the Monterey Bay National Marine Sanctuary (MBNMS), a need exists to find ways to measure the transport of sediment offshore this segment of the California coast (Dingler and others, 1985). Figure 1 shows the study area, which includes the northernmost part of the MBNMS.

While the nonopaque heavy-mineral assemblages in this region have been extensively studied (Yancey and Lee, 1972), the opaque minerals have not. Magnetite, ilmenite, and chromian spinel--the most common opaque minerals previously identified in beach sands in this region (Hutton, 1959, p. 20-21)--lack detailed studies. Variations in titanium percentages in magnetite separates seen in black sand concentrates in an earlier study north of Santa Cruz (Luepke and Consul, 1987) suggested the possible use of magnetite as a natural sediment tracer for sediment budget studies. This report presents the initial results of a geochemical study of magnetite in samples from beaches between San Francisco and Monterey Bay.

Methods

Figure 1 shows the location of the samples collected for this study. Black-sand concentrates were collected from beaches at Ocean Beach (3 samples), Daly City (2 samples), Pillar Point (1 sample), and Waddell Creek (2 samples). Magnetite was also extracted from subsamples of 13 vibracores taken offshore between Ocean Beach and Daly City. These vibracores, taken for the Southwest Ocean Outfall Project (SWOOP), were obtained through Willy Tsai of the San Francisco Clean Water Project. The cores are part of a detailed sedimentological study in progress; latitudes and longitudes for the cores are given in Table 2.

Beach samples were collected in the back beach in regions of highest black-sand concentration. After washing in demineralized water and drying in air, magnetite in the samples was separated with a Carpco separator set at 0 ampere with the magnetic drum set at 45 rpm. Magnetite from the vibracores was separated from the heavy-mineral concentrates with a large hand magnet. All samples were analyzed by energy dispersive X-ray fluorescence spectrometry (EDXRF) at the Branch of Geochemistry laboratories in Menlo Park.

Results

Beach samples (Table 1) show elemental titanium values ranging from 2 to 6.7 weight percent, and elemental chromium values from 5.9 to 9.9 weight percent. The 27 offshore samples (Table 2) average 5.3 percent titanium and 10,500 ppm chromium.

Discussion

The titanium values from the beach samples in the present study are similar to earlier titanium values obtained from a different set of samples that were analyzed with inductively coupled plasma-atomic emission spectrometry (ICP-AES) methods (Luepke and Consul, 1987; see Table 1). The titanium values for both the beach and offshore samples are within the same order of magnitude. This is not true of the chromium values, which are approximately 5 times higher, on average, in the beach samples. The reason for this disparity is not clear at this time, but may relate to different sediment sources. The relatively low standard deviations among the Ti and Cr values in these closely-spaced offshore samples show that analysis of all available samples will not be required to yield accurate values for this region.

It is unknown at present whether the titanium within the magnetic fraction of these samples represents titanomagnetite or magnetite-ilmenite intergrowths, but there is a good chance these detrital magnetite grains are polymineralic. Magnetites from California source rocks have not been studied in detail, but Yancey and Lee (1972) have identified source rocks, including granitic rocks, metamorphic rocks, and Cenozoic volcanic rocks, in the central California coast region. Detrital magnetite grains carry unique petrographic and chemical fingerprints based on source rock (Grigsby, 1990), so the potential exists for differentiating sources among the detrital magnetites in this region.

In this study I tried to ascertain if significant differences in the geochemistry of magnetite could be detected with EDXRF spectrometry. This method is quick, involves no sample destruction, and has a relative error of ±5 percent. Microsplits for 40-element ICP-AES analysis have been obtained from all the samples in this study and, together with additional samples from beaches south of the present study area, will better indicate whether trace-element geochemistry is a viable tool for sediment transport studies in the Monterey Bay region.

References

Dingler, J. R., Laband, B. L., and Anima, R. A., 1985, Geomorphology framework report, Monterey Bay: U. S. Army Corps of Engineers Coast of California Storm and Tidal Waves Study CCSTWS 85-2, various pagination.

Grigsby, J. D., 1990, Detrital magnetite as a provenance indicator: Journal of Sedimentary Petrology, v. 60, no. 6, p. 940-951.

Hutton, C. O., 1959, Mineralogy of beach sands between Halfmoon and Monterey bays, California: California Division of Mines Special Report 59, 32 p.

Lee, J., Glogoczowski, M., Yancey, T., and Wilde, Pat, 1971a, Recent sediments of the central California continental shelf, Pillar Point to Pigeon Point--Part B, Mineralogical data: University of California Berkeley Hydraulic Engineering Lab. Technical Report HEL-2-30, 63 p.

Lee, J., Yancey, T., Glogoczowski, M., and Wilde, Pat, 1971b, Recent sediments of the central California continental shelf, Pigeon Point to Sand Hill Bluffs--Part B, Mineralogical data: University of California Berkeley Hydraulic Engineering Lab. Technical Report HEL-2-31, p. 56 p.

Luepke, Gretchen and Consul, J.J.,1987, Titanium analysis of black sands from six beaches, San Francisco and San Mateo counties, California: U. S. Geological Survey Open-File Report 87-483, 4 p.

Sayles, F., 1965, Coastal sedimentation--Point San Pedro to Miramontes Point, California: University of California Berkeley Hydraulic Engineering Lab. Technical Report HEL-2-15, 105 p.

Yancey, T. E., and Lee, J. W., 1972, Major heavy minerals assemblages and heavy mineral provinces of the central California coast region: Geological Society of America Bulletin, v. 83, no. 7, p. 2099-2104.

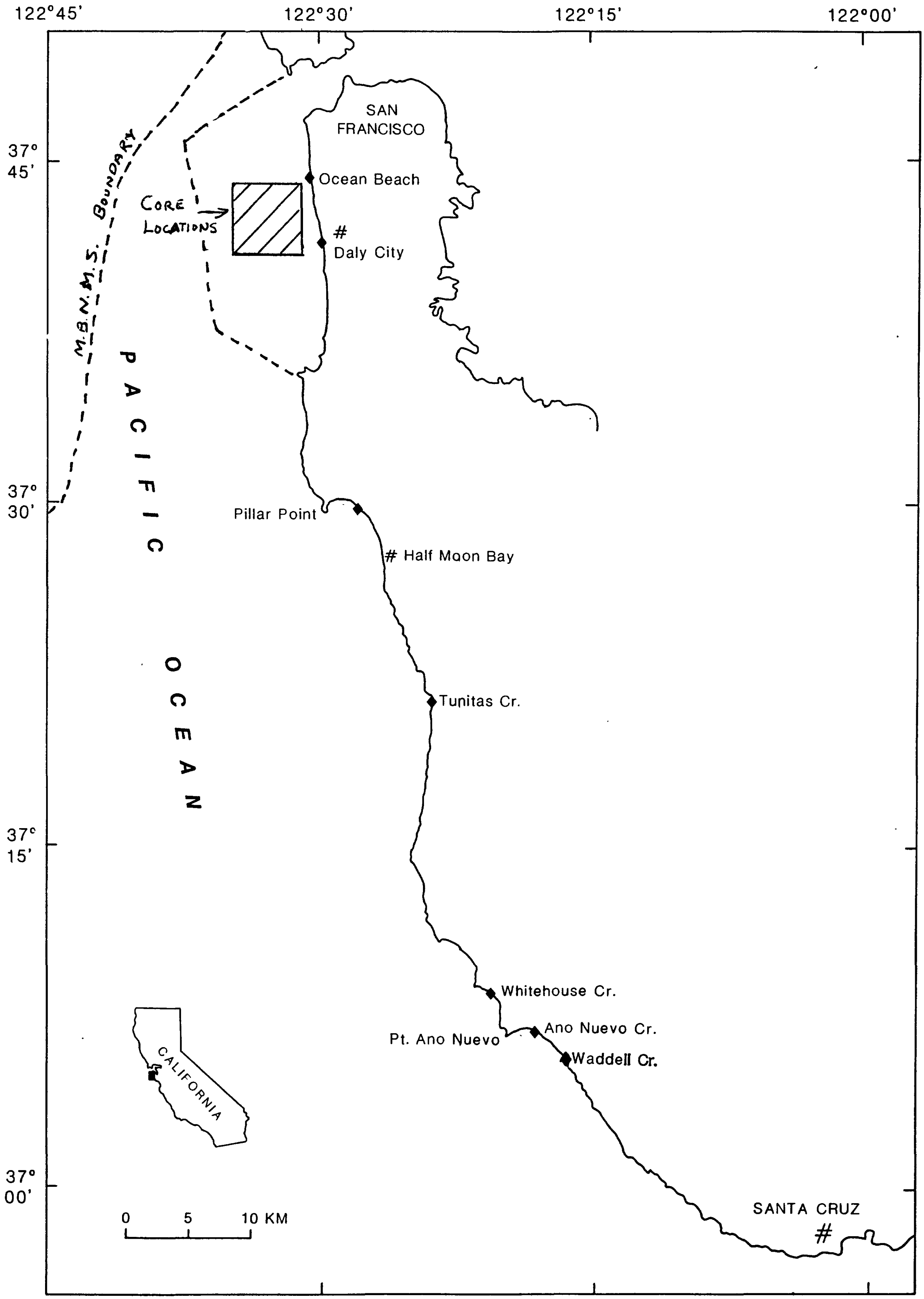

Figure 1. Index map of coastline from San Francisco to Santa Cruz, California, showing beach and offshore sampling areas

Table 1. Percentages of titanium and chromium in black-sand concentrates from beaches. Data in second group of samples from Luepke and Consul, 1987 for comparison. Analyst: Jerry Consul

Sample Location	Latitude	Longitude	%Ti	% Cr
Ocean Beach	37 44' 00"	122 30' 12"	2.4	5.9
Ocean Beach	37 44' 30"	122 30' 18"	3.2	9.3
Ocean Beach	37 43' 30"	"	2.7	6.7
Daly City	37 43' 18"	"	3.2	8.0
Daly City	37 40' 00"	122 29' 30"	2.0	7.3
Pillar Point	37 30' 00"	122 28' 00"	6.7	9.9
Waddell Creek	37 05' 36"	122 16' 18"	5.8	7.1
Waddell Creek	"	"	6.7	8.0
Ocean Beach	37 44' 00"	122 30' 12"	2.8	(not analyzed)
Daly City	37 43' 18"	122 30' 18"	1.5	"
Pillar Point	37 29' 48"	122 28' 54"	6.3	"
Tunitas Creek	37 22' 00"	122 24' 00'	3.7	"
Whitehouse Creek	37 08' 42"	122 20' 42"	3.9	"
Whitehouse Creek	"	"	5.2	"
Ano Nuevo Creek	37 07' 00"	122 18' 00"	5.5	"

Table 2. Percentages of titanium and chromium in offshore samples. Analyst: Bi-Shia King

Sample No.	Latitude	Longitude	%Ti	Cr-ppm
3V-1	37 42' 34"	122 31' 46"	6.9	12,600
3V-2	"	"	5.4	10,400
4V-1	37 43' 00"	122 32' 05"	4.7	9,500
4V-2	"	"	4.3	8,000
5V	37 43' 56"	122 32' 21"	6.5	11,300
6V-1	37 41' 54"	122 32' 52"	4.7	9,400
6V-2	"	"	4.5	10,300
7V-1	37 42' 30"	122 33' 16"	5.0	9,950
7V-2	"	"	6.0	11,600
7V-3	"	"	4.9	10,600
8V-1	37 43' 05"	122 33' 42"	5.4	10,500
8V-2	"	"	4.8	10,700
9V-1	37 41' 22"	122 34' 13"	5.0	11,700
9V-2	"	"	5.0	11,000
10V-1	37 41' 57"	122 34' 36"	5.3	11,700
10V-2	"	"	5.2	11,300
10V-3	"	"	5.3	11,600
11V-1	37 42' 31"	122 34' 59"	6.2	13,500
11V-2	"	"	5.1	11,100
11V-3	"	"	4.7	9,900
12V-1	37 41' 40"	122 35' 15"	5.3	12,600
12V-2	"	"	4.7	10,200
12V-3	"	"	4.9	11,700
13V	37 42' 57"	122 31' 05"	5.5	6,600
14V	37 43' 41"	122 31' 32"	5.4	10,400
16V-1	37 43' 29"	122 30' 53"	5.5	10,400
16V-2	"	"	5.8	4,950
		Average	5.3	10,500
		St. dev.	0.6	1,780