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ABUNDANCES OF MAJOR ELEMENTS AND SEDIMENTARY COMPONENTS IN MIOCENE AND EARLY PLIOCENE CUTTINGS FROM A WELL IN THE SOUTH ELWOOD OIL FIELD AREA, OFFSHORE SANTA BARBARA-VENTURA BASIN, SOUTHERN CALIFORNIA

by

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ABSTRACT

Cuttings analyzed from a well in the South Elwood field area include all intervals in a complete sequence of the Monterey Formation as well as the uppermost part of the Rincon Shale and lowermost part of the Sisquoc Formation. Also analyzed were selected intervals in overlying parts of the Sisquoc Formation.

Based on these chemical analyses of 213 cuttings samples, abundances of sedimentary components in the well average as follows:

Formation	No. Samples	Detritus	Silica	Carbonate minerals	Apatite	Organic matter
Sisquoc Fm	54	59	32	5	0.1	3.1
Monterey Fm	124	38	33	21	1.2	7.5
Rincon Shale	35	49	19	27	0.2	4.2

INTRODUCTION

The Monterey Formation in the south central coastal basins of California (Figure 1) has received considerable attention in recent years. Because of the formation's heterogeneity, however, meaningful compositional comparison of different Monterey sections has been difficult. Analysis of cuttings has proven to be an efficient approach to this problem (Isaacs and others, 1986, 1990; Isaacs, 1987). Cuttings are thus being analyzed from a number of wells in the south central coastal basins, as part of a regional study of the Monterey Formation.

This report presents data from a well in the South Elwood offshore oil field area (Figure 1), in which cuttings were collected in 10-foot intervals. In this well, the Monterey Formation (as defined by the operator) extends from well depths of 4070 to 5310 feet. Within this depth range and down to 5660 feet in the underlying Rincon Shale, splits of cuttings from each 10-foot interval were analyzed, providing a complete compositional sequence of the Monterey Formation and uppermost Rincon Shale in this area. Splits of cuttings from each 10-foot interval were also analyzed in overlying strata of the Sisquoc Formation up to depths of 3850 feet, as well as cuttings from selected 10-foot intervals in the Sisquoc up to depths of 3050 feet.

METHODS

Sample Preparation

Bulk cuttings were washed by personnel at Arco Oil and Gas Company prior to receipt at the U.S. Geological Survey. After receipt, samples were split with a riffle splitter and submitted for grinding and analysis by the U.S. Geological Survey Branch of Geochemistry. Like samples reported by Isaacs and others (1990) and in contrast to samples reported by Isaacs and others (1989a, 1989b) and Isaacs and Tomson (1990), all analyses reported here were made on powder fractions containing adsorbed water (H_2O^-). Amounts of H_2O^- probably range from about 1 wt% to as much as 5 wt% in clay-rich samples (Isaacs, 1980, appendix A).

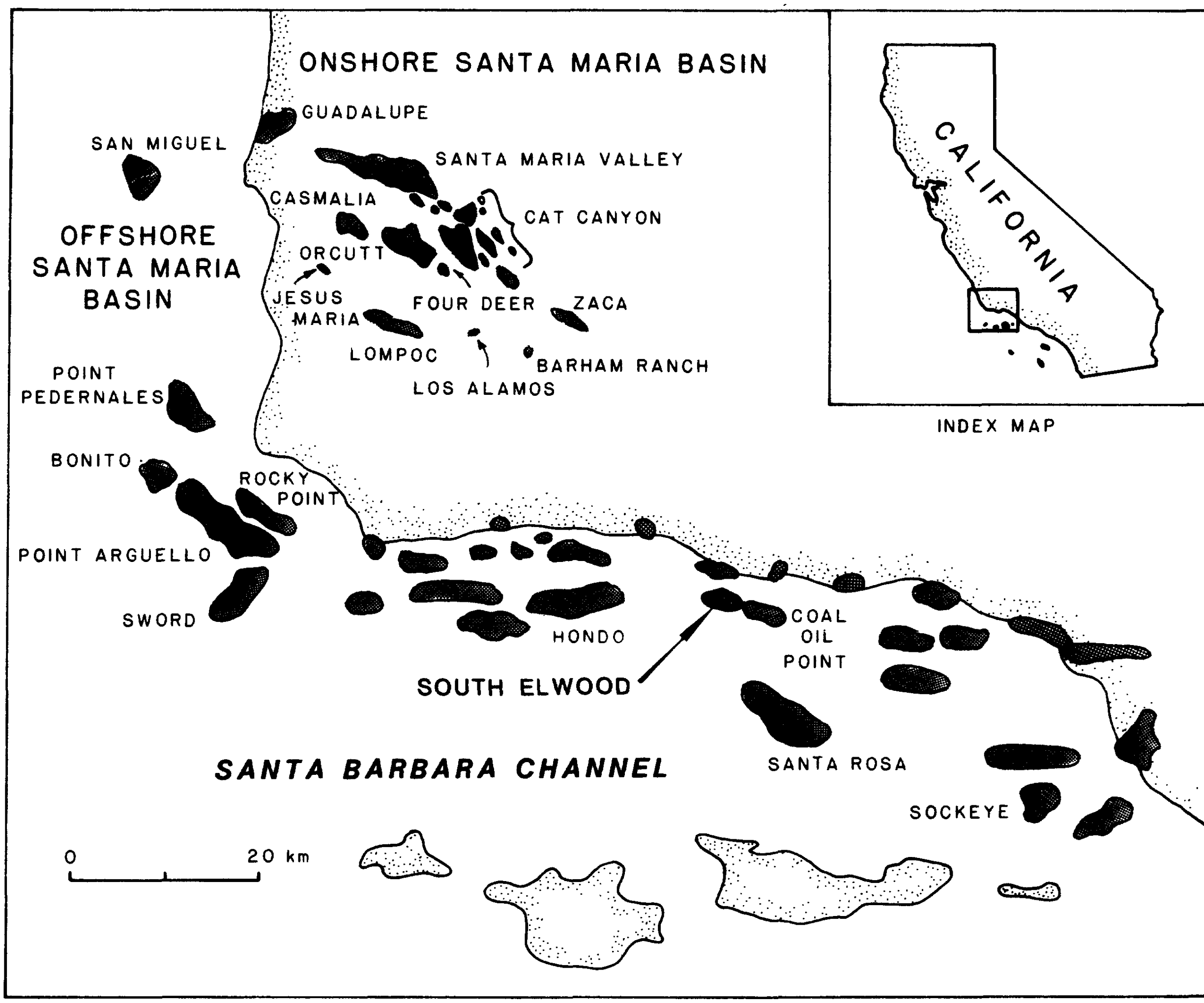

Figure 1. Location map showing position of the South Elwood oil field and other oil and gas fields in the Santa Maria and Santa Barbara-Ventura areas, California. Labeled fields have significant production or potential from Monterey Formation fractured reservoirs. Adapted from California Division of Oil and Gas (1974) and Williams (1985).

Analytical Techniques - Major Elements

Samples were analyzed for major elements by X-ray fluorescence spectroscopy, using methods described by Taggart and Wahlberg (1980a, 1980b) and Taggart and others (1981, 1987). Identical methods were used on samples reported by Isaacs and others (1989a, 1989b; 1990) and Isaacs and Tomson (1990). For this analysis, 0.8 g of samples (ground to <100 mesh) was weighed into a tared platinum-gold (95:5) crucible and ignited for 45 minutes at 920°C, after which it was reweighed to determine loss on ignition (LOI). An 8 g charge of lithium tetraborate was then added to the crucible, physically mixed with the sample, and then fused at 1130°C for 40 minutes (Taggart and Wahlberg, 1980a) after which it was cast in a platinum-gold mold (Taggart and Wahlberg, 1980b) and allowed to cool. The disc was then presented to a Phillips PW1600 simultaneous X-ray spectrometer using an on-line Digital Equipment Corporation PDP 11/04 computer to perform a de Jongh matrix correction program (Taggart and others, 1981, 1987).

Analytical Techniques - Carbon

Carbon was measured by methods described by Jackson and others (1987). Identical methods were used on samples reported by Isaacs and others (1989a, 1990) and Isaacs and Tomson (1990). Total carbon abundance was measured by dry combustion with a LECO CR12 automated carbon analyzer (Jackson and others, 1987). Carbonate carbon was measured by automated coulometric titration of perchloric acid-evolved CO2 (Huffman, 1977; Engleman and others, 1985; Jackson and others, 1987). Organic carbon was then determined by difference between total carbon and carbonate carbon.

Determination of Sedimentary Components

The major sedimentary components in the Monterey Formation are termed silica (representing both biogenic and diagenetic silica, including opal-A, opal-CT, and diagenetic quartz), detritus (detrital quartz and aluminosilicate minerals, mainly consisting of mixed layer illite-smectite clay along with minor feldspar and quartz), carbonate minerals (calcite and dolomite), apatite, and organic matter. Abundances of silica and detritus were estimated from elemental abundances of SiO_2 and Al_2O_3 by constants developed for the Monterey Formation in adjacent onshore areas (Table 1). Resulting values are for the most part reliable for Monterey strata but probably underestimate the amount of aluminosilicate material where mica or chlorite is abundant; values also may underestimate detrital quartz (and thus overestimate biogenous and diagenetic silica) in highly terrigenous samples. Abundances of silica and detritus for non-Monterey strata should therefore be regarded as approximations.

Abundances of calcite, dolomite, and apatite were estimated from abundances of CaO, MgO, and P2O5 after adjustment of these values for average abundances in the aluminosilicate fraction (Table 1). Because abundance values were not confirmed by X-ray diffraction analysis, they are preliminary estimates only. Abundances of organic matter were estimated from the abundances of total organic carbon (Table 1).

This method of component determination probably underestimates dolomite relative to calcite inasmuch as dolomite in the Monterey Formation tends to have CaO in excess of the ideal values used here and may also have significant Fe (Murata and others, 1972). Moreover, a previous report noted that bulk X-ray diffraction analysis showed no detectable calcite in a number of samples estimated by these conversion parameters (Table 1) as having minor (5-10%) calcite (Isaacs and others, 1989b). However, Isaacs and others (1989a) compared the abundances of carbonate carbon represented by dolomite + calcite as estimated above (0.13 x dolomite + 0.12 x calcite) with the analytical determination of carbonate carbon. In that study, the average difference between each pair of calculated and measured values was 0.13 wt% carbonate carbon (about 1 wt% carbonate minerals), and the maximum difference was 0.30 wt% carbonate carbon (about 2.5 wt% carbonate minerals). These comparisons show that the <u>total</u> abundance of carbonate minerals is reliably estimated from major oxide analyses by the methods used here (see also Figure 2).

Another inaccuracy in the determination of sedimentary components is reflected by the presence of some negative numbers for calcite, dolomite, and apatite. Although clearly incorrect, these negative values are highly reproducible, as noted by Isaacs and others (1989a, 1989b) and thus seem likely to reflect errors in the conversion parameters (Table 1). The inaccuracy is probably due to partitioning slightly too much CaO, MgO and P_2O_5 into the aluminosilicate fraction.

Because all samples were analyzed for organic carbon in the South Elwood well, abundances of major sedimentary components (silica, detritus, calcite, dolomite, apatite, and organic matter) were all normalized to sum to 100% on an organic-matter-bearing basis.

Reproducibility of Analyses of Cuttings

Previous reports (Isaacs and others, 1989a, 1989b) showed that the reproducibility of analytical results is excellent. The relative standard deviation is generally less than 2% of major oxide values (av 1.1%) for blind duplicate powder splits analyzed by the techniques used here. Reproducibility of the abundance of sedimentary components based on major oxide analyses is also excellent, with average standard deviations of 0.5 wt% detritus, 0.4 wt% silica, 0.1 wt% dolomite, 0.2 wt% calcite, and 0.01 wt% apatite. Reproducibility of carbon analyses (total carbon, carbonate carbon, and organic carbon) was not tested for the techniques used here on blind duplicate powder splits, only on duplicate splits of bulk (unpowdered) cuttings (see below).

Because some cuttings samples included individual pieces that were large (2-5 g) relative to sample size (10-15 g), some bias and (or) variability may have been introduced into analytical results by splitting. A previous report studied the additional variability introduced by the inhomogeneous character of cuttings, and showed that this variability results in larger average relative standard deviations - in the range 1-2.6% (av 2.0%) - of major oxides analyzed among blind duplicate splits of the same cuttings materials (Isaacs and others, 1989a). In that study, the average relative standard deviation for organic carbon was 3.5%, and for carbonate carbon 2.9%. Average standard deviations of sedimentary components in blind duplicate bulk (unpowdered) cuttings were 0.7 wt% detritus, 0.7 wt% silica, 0.5 wt% dolomite, 0.1 wt% calcite, 0.01 wt% apatite, and 0.1 wt% organic matter. This reproducibility is so excellent that variation due to analytical methods is negligible for practical purposes.

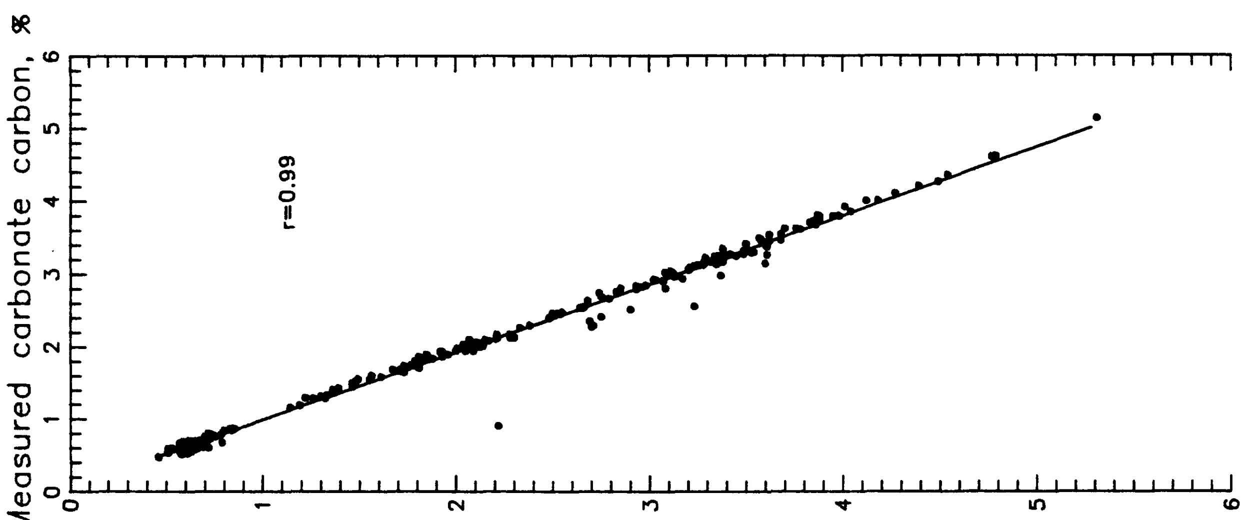

Figure 2. Measured values of carbonate carbon versus values estimated from oxide analyses in the South Elwood well. The correlation was calculated by least-squares linear regression; "r" is the correlation coefficient.

Table 1. Formulas used to convert elemental abundances to approximate mineral abundances. Formulas for detritus and silica contents and average abundance of major elements in detritus are derived from the evaluation in Isaacs (1980, appendix B) for the Monterey Formation in the western Santa Barbara coastal area. CaO and P2O5 abundances in apatite are based on published references (see Isaacs, 1980, p. 228), and calculations for calcite and dolomite are based on their molecular formulas. See text for comments on the calcite–dolomite partition.

Quantity	Explanation	Formula
Detritus	Equals aluminosilicates + detrital quartz	Al2O3 x 5.6
Aluminosilicates	Based on Al2O3 content	Al2O3 x 4.2
Detrital quartz	Based on a proportion of aluminosilicates	Aluminosilicates ÷ 3
Silica (biogenic and diagenetic)	Based on Si02 content adjusted for amounts in detritus	SiO2 – (3.5 x Al2O3)
Apatite	Based on P2O5 content adjusted for 0.7% P2O5 in aluminosilicates and assuming 42.4% P2O5 in apatite	{P2O5 – (0.032 x Al2O3)} ÷ 0.424
Dolomite	Based on MgO content adjusted for 2.6% MgO in aluminosilicates and assuming 21.9% MgO in dolomite	{MgO – (0.11 x Al2O3)} ÷ 0.219
Calcite	Based on CaO content adjusted for 1.9% Cao in aluminosilicates, 55.5% CaO in apatite, and 30.4% in dolomite, and assuming 56.0% CaO in calcite	{CaO – [(0.08 x Al2O3) – (0.555 x apatite) – (0.304 x dolomite)]} ÷ 0.56
Organic matter	Based on organic carbon content	Organic carbon x 1.5

Table 2. Elemental abundances in bulk cuttings from the South Elwood field well (in weight %). Each sample represents a 10-foot interval; the given depth (in ft) is the mid-point of the interval. "LOI" is loss on ignition at 925°C. Total Fe is reported as Fe_2O_3. Analysts: C. Gent and E. Brandt (carbon), J. Taggart and A. Bartel (oxides and LOI).

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
3055	61.9	11.3	4.54	2.29	2.93	1.95	1.81	0.55	0.36	0.03	10.5	1.88	0.67
3065	62.4	11.3	4.55	2.26	2.67	2.01	1.83	0.57	0.38	0.02	9.93	1.55	0.60
3075	63.0	11.1	4.61	2.21	2.53	1.97	1.77	0.56	0.34	0.02	9.66	1.51	0.61
3085	63.1	11.4	4.74	2.21	2.25	1.97	1.81	0.56	0.35	0.02	10.0	1.47	0.52
3095	62.9	11.5	4.91	2.20	2.11	1.96	1.80	0.57	0.34	0.02	9.88	1.34	0.51
3105	63.3	11.2	4.81	2.20	2.33	1.88	1.73	0.56	0.32	0.02	9.96	1.29	0.58
3115	62.9	11.2	4.78	2.21	2.27	1.86	1.78	0.56	0.34	0.02	10.1	1.36	0.56
3125	63.3	11.3	4.77	2.23	2.32	1.97	1.76	0.56	0.38	0.03	9.38	1.25	0.55
3135	63.9	11.2	4.76	2.38	2.34	2.00	1.72	0.56	0.39	0.02	9.47	1.16	0.62
3175	63.3	11.4	4.85	2.41	2.19	1.90	1.76	0.56	0.37	0.03	9.43	1.21	0.59
3215	64.1	11.0	4.89	2.31	1.96	1.91	1.75	0.53	0.36	0.03	10.2	1.31	0.62
3255	62.4	11.3	4.75	2.42	2.41	2.17	1.77	0.54	0.36	0.03	9.85	1.42	0.71
3295	63.0	10.7	4.74	2.31	2.64	1.98	1.68	0.52	0.31	0.03	10.4	1.69	0.77
3335	63.1	11.2	4.65	2.25	2.40	2.15	1.73	0.54	0.31	0.03	9.75	1.34	0.69
3375	63.2	10.8	4.71	2.17	2.46	1.96	1.63	0.50	0.33	0.03	10.4	1.50	0.69
3415	65.2	9.72	4.10	2.26	2.85	1.90	1.51	0.47	0.32	0.02	9.86	1.29	0.87
3455	65.9	9.33	3.88	2.13	2.75	1.70	1.50	0.44	0.31	<0.02	10.0	1.52	0.84
3465	67.1	9.08	3.74	2.12	2.67	1.63	1.45	0.42	0.31	<0.02	9.44	1.46	0.80
3475	68.4	8.33	3.51	1.86	2.72	1.61	1.36	0.39	0.37	<0.02	9.46	1.55	0.78
3485	68.4	8.51	3.52	1.89	2.69	1.64	1.38	0.41	0.32	<0.02	9.28	1.47	0.76
3495	69.2	8.38	3.49	1.80	2.83	1.50	1.35	0.40	0.33	<0.02	9.07	1.41	0.75
3505	69.6	8.31	3.46	1.64	2.68	1.55	1.32	0.40	0.33	<0.02	9.04	1.36	0.69
3515	68.5	8.59	3.59	1.73	2.75	1.69	1.38	0.41	0.34	<0.02	9.03	1.41	0.73
3525	66.2	9.10	3.70	1.63	2.79	1.89	1.46	0.44	0.41	<0.02	9.90	1.49	0.68
3535	67.5	8.71	3.69	1.67	3.03	1.70	1.39	0.42	0.41	<0.02	9.71	1.49	0.73
3575	67.5	9.17	3.70	1.59	2.59	1.80	1.50	0.44	0.43	<0.02	9.83	1.77	0.55
3615	63.9	10.4	4.22	2.14	2.73	1.73	1.69	0.49	0.39	0.02	10.3	2.01	0.74
3655	67.5	9.41	4.06	1.73	2.09	1.78	1.51	0.44	0.34	0.02	9.55	1.73	0.58

Table 2. continued

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
3695	65.2	10.1	4.24	1.77	2.20	1.78	1.63	0.47	0.39	0.02	11.2	2.46	0.53
3735	63.9	9.85	4.24	2.12	3.02	1.74	1.57	0.46	0.34	0.02	11.0	1.90	0.86
3775	65.1	10.6	4.23	2.00	2.53	1.95	1.68	0.51	0.37	0.02	10.1	1.48	0.66
3815	64.3	10.6	4.28	2.08	2.83	2.00	1.67	0.51	0.39	0.02	10.1	1.50	0.77
3855	66.3	10.2	4.17	1.93	2.30	1.81	1.65	0.49	0.36	0.02	9.68	1.50	0.63
3865	64.8	10.7	4.37	1.98	2.14	1.94	1.73	0.51	0.40	0.02	10.0	1.68	0.59
3875	64.8	10.4	4.12	1.84	2.66	1.96	1.71	0.49	0.42	0.02	10.5	1.83	0.64
3885	66.2	10.2	4.12	1.88	2.40	1.90	1.68	0.48	0.39	0.02	8.79	1.67	0.61
3895	64.9	10.1	4.06	1.94	2.59	1.89	1.64	0.48	0.39	0.02	9.98	1.67	0.69
3905	67.0	10.2	4.14	1.93	2.37	1.68	1.62	0.48	0.34	0.02	10.4	1.68	0.62
3915	56.8	8.61	3.38	1.55	1.82	1.68	1.38	0.40	0.31	< 0.02	22.5	7.51	0.47
3925	59.5	8.38	3.28	1.86	2.32	1.61	1.32	0.40	0.30	< 0.02	19.1	5.79	0.70
3935	61.9	8.62	3.41	1.71	1.94	1.64	1.38	0.42	0.31	< 0.02	16.8	5.00	0.58
3945	61.6	8.54	3.55	1.95	2.45	1.48	1.37	0.41	0.31	< 0.02	16.3	4.84	0.76
3955	66.4	8.64	3.61	1.92	2.41	1.51	1.37	0.41	0.29	< 0.02	11.9	2.53	0.75
3965	66.3	9.50	3.94	1.91	2.11	1.66	1.49	0.46	0.31	< 0.02	10.8	1.95	0.66
3975	64.9	10.1	4.22	2.07	2.17	1.69	1.60	0.48	0.30	0.02	10.5	1.81	0.69
3985	65.3	9.96	4.05	2.00	2.23	1.70	1.58	0.48	0.30	< 0.02	10.3	1.79	0.69
3995	68.1	9.13	3.65	1.74	2.21	1.54	1.41	0.44	0.30	< 0.02	9.44	1.46	0.66
4005	65.5	9.80	4.10	1.93	2.19	1.60	1.53	0.47	0.32	< 0.02	10.2	1.83	0.68
4015	65.3	9.93	4.06	1.81	2.39	1.71	1.55	0.47	0.34	< 0.02	10.3	1.80	0.66
4025	65.5	9.98	4.04	1.78	2.41	1.68	1.55	0.48	0.33	< 0.02	10.3	1.86	0.66
4035	65.5	9.54	3.95	1.94	2.71	1.60	1.49	0.46	0.32	< 0.02	10.0	1.85	0.80
4045	62.3	9.38	4.12	2.84	3.59	1.55	1.44	0.45	0.30	0.02	11.4	1.86	1.29
4055	61.5	8.71	3.96	3.14	4.11	1.40	1.38	0.42	0.30	< 0.02	12.2	2.15	1.49
4065	61.1	8.84	4.02	3.14	4.23	1.49	1.45	0.43	0.31	0.02	12.1	2.44	1.52
4075	58.3	8.97	4.16	3.65	5.33	1.57	1.52	0.45	0.33	0.03	13.5	2.86	1.89
4085	59.0	9.14	4.20	3.17	4.71	1.63	1.58	0.46	0.37	0.02	13.0	3.02	1.60
4095	58.4	9.88	4.48	2.83	4.39	1.76	1.75	0.49	0.35	0.03	12.9	3.11	1.38
4105	58.9	9.87	4.53	2.75	4.37	1.73	1.78	0.49	0.34	0.03	12.8	3.27	1.32
4115	56.4	9.11	4.28	3.30	5.66	1.66	1.65	0.46	0.33	0.03	13.7	3.22	1.82

Table 2. continued

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
4125	55.0	9.49	4.40	3.50	5.85	1.76	1.73	0.48	0.34	0.03	13.9	3.44	1.93
4135	55.3	9.75	4.54	3.39	5.59	1.72	1.78	0.50	0.34	0.03	13.8	3.45	1.84
4145	53.5	9.67	4.78	3.82	6.07	1.79	1.75	0.49	0.33	0.04	14.0	3.41	2.10
4155	55.3	10.8	4.99	2.99	4.45	2.00	1.95	0.56	0.36	0.04	13.7	3.51	1.42
4165	53.2	10.5	5.10	3.57	5.44	1.86	1.92	0.53	0.35	0.05	14.2	3.65	1.86
4175	53.2	10.8	5.05	3.44	5.12	1.96	1.97	0.56	0.37	0.04	14.7	4.09	1.68
4185	52.0	10.5	4.97	3.83	5.69	1.84	1.93	0.54	0.37	0.04	14.8	4.06	1.93
4195	53.6	10.7	4.82	3.39	4.96	1.86	1.93	0.55	0.39	0.04	14.9	4.17	1.58
4205	53.4	10.6	4.76	3.68	5.22	1.89	1.83	0.54	0.37	0.04	13.6	3.91	1.74
4215	56.6	11.0	4.89	2.85	3.90	2.04	1.93	0.55	0.38	0.03	13.1	4.20	1.18
4225	60.7	10.2	4.49	2.27	2.96	1.81	1.83	0.51	0.36	0.02	12.3	4.00	0.84
4235	60.6	10.7	4.66	2.03	2.66	1.77	1.92	0.54	0.38	0.02	13.0	4.48	0.63
4245	57.5	9.93	4.34	2.97	4.26	1.81	1.81	0.50	0.35	0.03	12.9	4.07	1.35
4255	58.7	10.5	4.58	2.92	4.00	1.94	1.83	0.53	0.35	0.03	12.6	3.07	1.28
4265	52.8	10.2	4.53	3.99	5.87	1.72	1.83	0.51	0.36	0.04	13.7	3.36	2.03
4275	54.7	10.3	4.61	3.58	5.10	1.70	1.89	0.53	0.35	0.04	12.9	3.70	1.73
4285	52.6	10.2	4.50	3.98	5.80	1.70	1.87	0.53	0.37	0.04	14.2	3.83	1.98
4295	54.3	10.7	4.84	3.28	4.61	1.71	1.96	0.55	0.38	0.04	14.1	4.60	1.55
4305	57.5	9.94	4.27	2.61	3.87	1.71	1.84	0.51	0.44	0.03	14.1	4.98	1.15
4315	56.5	10.3	4.47	2.89	4.35	1.67	1.84	0.52	0.45	0.03	14.2	4.79	1.31
4325	54.3	9.93	4.35	3.54	5.44	1.65	1.83	0.51	0.40	0.04	13.9	4.14	1.80
4335	50.5	8.46	4.23	4.75	7.63	1.51	1.54	0.43	0.34	0.05	16.2	4.09	2.74
4345	51.9	9.61	4.43	3.86	6.18	1.63	1.77	0.50	0.43	0.04	15.0	4.62	2.06
4355	54.9	10.6	4.59	2.91	4.67	1.63	1.93	0.55	0.49	0.03	14.3	5.01	1.40
4365	47.0	8.24	3.79	5.01	8.93	1.38	1.51	0.43	0.44	0.03	18.4	5.14	3.02
4375	50.8	7.38	3.42	4.26	8.88	1.16	1.37	0.39	0.45	0.02	17.4	5.18	2.80
4385	54.1	6.79	3.24	3.91	8.42	1.15	1.26	0.35	0.39	< 0.02	16.3	4.74	2.63
4395	57.6	7.02	3.23	3.21	7.04	1.21	1.29	0.36	0.41	< 0.02	14.5	4.61	2.09
4405	56.2	9.24	4.20	3.18	5.47	1.58	1.61	0.46	0.42	0.03	13.6	3.95	1.68
4415	55.7	9.48	4.21	3.33	5.67	1.62	1.64	0.47	0.42	0.03	14.1	3.79	1.74
4425	59.4	6.64	3.12	3.42	6.57	1.18	1.20	0.35	0.40	< 0.02	13.9	4.24	2.05

Table 2. continued

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
4435	56.8	8.57	3.79	3.52	6.27	1.51	1.50	0.43	0.47	0.02	13.7	3.47	1.94
4445	56.3	7.30	3.48	3.35	7.19	1.23	1.34	0.38	0.55	< 0.02	15.2	4.90	2.08
4455	59.3	7.20	3.39	3.14	6.15	1.19	1.32	0.37	0.54	< 0.02	13.9	4.56	1.83
4465	62.7	7.05	3.19	2.59	4.88	1.22	1.28	0.36	0.48	< 0.02	12.5	4.24	1.44
4475	63.5	6.48	2.94	2.69	4.85	1.18	1.19	0.33	0.37	< 0.02	11.7	3.90	1.54
4485	57.5	7.10	3.28	3.42	6.70	1.25	1.29	0.37	0.52	< 0.02	13.9	4.38	2.06
4495	64.2	5.87	2.68	3.06	5.49	1.06	1.03	0.30	0.38	< 0.02	12.0	3.81	1.72
4505	64.5	5.06	2.32	3.31	5.85	0.99	0.89	0.25	0.34	< 0.02	12.5	3.59	1.97
4515	64.2	5.54	2.58	3.25	5.72	1.05	0.97	0.28	0.39	< 0.02	12.2	3.56	1.86
4525	61.2	5.82	2.80	3.53	6.17	1.04	1.0	0.29	0.42	< 0.02	13.4	3.94	2.04
4535	57.2	7.24	3.41	3.81	6.60	1.16	1.25	0.37	0.49	< 0.02	14.0	4.06	2.17
4545	64.3	4.63	2.14	3.67	6.57	0.88	0.83	0.24	0.42	< 0.02	12.8	4.72	0.90
4555	62.0	4.67	2.19	4.00	7.18	0.85	0.84	0.24	0.46	< 0.02	13.6	3.30	2.46
4565	62.0	4.60	2.18	4.02	7.31	0.79	0.83	0.23	0.48	< 0.02	13.5	3.34	2.46
4575	62.9	4.37	2.04	4.07	7.25	0.78	0.77	0.22	0.44	< 0.02	13.8	3.22	2.45
4585	58.5	6.13	2.88	4.08	7.13	1.00	1.09	0.31	0.38	< 0.02	14.4	3.66	2.39
4595	60.9	4.62	2.14	4.39	7.62	0.82	0.79	0.24	0.34	< 0.02	14.2	3.19	2.69
4605	65.8	3.67	1.69	3.98	6.89	0.67	0.63	0.18	0.29	< 0.02	12.9	2.77	2.42
4615	62.8	3.29	1.45	4.88	8.41	0.73	0.54	0.16	0.27	< 0.02	14.7	2.67	3.04
4625	68.4	3.68	1.69	3.48	6.02	0.63	0.61	0.18	0.28	< 0.02	12.0	3.02	2.08
4635	65.7	3.49	1.54	3.68	6.58	0.73	0.60	0.18	0.37	< 0.02	13.9	3.82	2.26
4645	58.8	3.19	1.57	5.15	9.34	0.60	0.53	0.16	0.44	< 0.02	17.5	4.10	3.24
4655	58.1	4.11	1.89	4.71	8.71	0.82	0.70	0.20	0.59	< 0.02	16.8	4.22	2.92
4665	53.4	4.23	1.79	5.50	10.3	0.73	0.67	0.20	0.70	< 0.02	18.6	4.43	3.49
4675	52.4	4.25	1.94	5.64	10.8	0.66	0.72	0.21	0.73	< 0.02	19.4	4.36	3.62
4685	54.8	4.24	1.99	3.21	12.5	0.69	0.73	0.22	0.85	< 0.02	17.7	4.37	3.22
4695	50.5	4.27	1.91	4.24	13.7	0.70	0.73	0.22	0.78	< 0.02	19.4	4.40	3.79
4705	48.6	4.24	1.83	3.38	15.7	0.70	0.73	0.21	0.88	< 0.02	20.8	4.97	3.92
4715	53.4	4.83	2.16	2.84	12.6	0.71	0.83	0.25	1.06	< 0.02	18.2	5.45	2.99
4725	52.5	6.14	2.69	2.09	12.9	1.02	1.03	0.31	1.05	< 0.02	16.7	4.30	2.83
4735	58.1	3.89	1.84	2.66	11.8	0.70	0.65	0.20	0.73	< 0.02	16.1	4.04	2.92

Table 2. continued

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
4745	52.1	4.02	1.88	4.45	13.1	0.68	0.66	0.20	0.72	< 0.02	18.6	3.93	3.72
4755	53.3	4.47	2.24	2.52	13.5	0.80	0.75	0.22	0.95	< 0.02	17.1	4.58	3.14
4765	50.9	4.44	2.24	3.04	14.3	0.76	0.73	0.22	0.94	< 0.02	18.6	4.58	3.44
4775	53.1	4.53	2.18	1.79	14.6	0.78	0.75	0.23	1.02	< 0.02	17.6	4.89	3.11
4785	51.4	5.64	2.71	1.41	13.3	1.0	0.91	0.29	1.66	< 0.02	18.0	6.06	2.53
4795	49.9	5.18	2.41	1.98	14.8	0.92	0.82	0.27	1.72	< 0.02	18.1	5.76	3.01
4805	45.3	5.27	2.43	1.62	17.6	0.93	0.86	0.27	1.29	< 0.02	20.7	5.74	3.62
4815	46.4	6.40	3.05	2.29	14.2	1.18	0.94	0.33	2.19	< 0.02	18.3	6.29	2.79
4825	40.6	5.67	2.76	1.56	19.0	0.95	0.92	0.30	2.19	< 0.02	21.6	6.7	3.61
4835	44.6	4.83	2.26	1.53	18.0	0.79	0.81	0.25	1.32	< 0.02	21.2	6.3	3.70
4845	53.8	3.45	1.58	1.02	15.5	0.51	0.60	0.17	0.87	< 0.02	19.2	5.87	3.17
4855	55.6	7.89	3.35	1.92	9.62	1.47	1.28	0.39	0.67	< 0.02	14.4	3.65	2.11
4865	52.3	6.40	2.64	1.69	13.3	1.11	1.04	0.31	0.76	< 0.02	17.1	4.42	2.82
4875	58.7	4.20	1.96	1.22	11.8	0.61	0.72	0.21	0.92	< 0.02	16.6	5.60	2.43
4885	57.9	4.49	1.93	1.19	11.4	0.64	0.77	0.23	1.02	< 0.02	17.0	6.25	2.29
4895	57.6	5.04	2.20	1.10	9.46	0.81	0.87	0.26	1.69	< 0.02	17.3	8.20	1.66
4905	57.1	5.01	2.16	1.23	10.2	0.78	0.85	0.27	1.56	< 0.02	17.0	7.30	1.89
4915	60.0	4.97	2.08	1.05	7.40	0.80	0.83	0.26	1.45	< 0.02	17.6	8.8	1.28
4925	56.1	4.90	2.13	1.59	9.89	0.76	0.81	0.25	2.23	< 0.02	17.3	8.12	1.71
4935	52.5	5.95	2.60	1.94	12.2	1.18	0.96	0.30	1.38	< 0.02	16.5	5.56	2.53
4945	47.3	5.79	2.53	2.19	13.4	0.96	0.96	0.30	2.76	< 0.02	20.0	8.3	2.47
4955	45.0	6.15	2.78	1.53	14.9	0.95	1.07	0.31	2.32	< 0.02	20.1	7.6	2.75
4965	46.9	4.86	2.19	2.15	16.3	0.82	0.82	0.24	1.50	< 0.02	20.5	6.15	3.46
4975	53.3	3.36	1.57	2.82	14.4	0.60	0.57	0.16	0.82	< 0.02	18.9	4.99	3.53
4985	50.0	4.48	2.13	2.09	14.8	0.69	0.79	0.23	1.16	< 0.02	19.6	6.15	3.23
4995	43.4	4.92	2.40	1.90	18.1	0.83	0.86	0.25	1.35	< 0.02	21.0	6.4	3.79
5005	40.7	4.77	2.36	2.86	19.1	0.64	0.78	0.23	1.09	< 0.02	22.8	5.8	4.35
5015	35.9	5.05	2.60	2.32	21.0	0.67	0.84	0.26	1.17	< 0.02	25.4	7.1	4.60
5025	46.3	4.00	2.09	1.60	17.7	0.57	0.68	0.20	1.11	< 0.02	21.5	6.3	3.74
5035	46.6	3.78	1.97	2.32	17.1	0.60	0.64	0.19	0.96	< 0.02	21.7	5.83	3.85
5045	48.8	4.23	2.24	1.43	16.1	0.73	0.71	0.21	0.74	< 0.02	22.6	6.21	3.40

Table 2. continued

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
5055	58.0	7.23	3.23	2.06	8.66	1.42	1.15	0.35	0.54	< 0.02	13.4	3.24	2.00
5065	54.3	8.11	3.54	1.90	9.83	1.35	1.28	0.39	0.58	< 0.02	14.8	3.85	2.17
5075	34.8	4.94	2.44	4.62	20.2	0.72	0.85	0.25	1.14	< 0.02	25.8	5.6	5.13
5085	45.4	4.68	2.42	3.12	16.2	0.76	0.80	0.24	0.62	< 0.02	21.8	5.93	4.00
5095	51.7	3.96	2.41	1.53	15.1	0.67	0.65	0.19	0.44	< 0.02	19.4	5.56	3.32
5105	55.9	3.91	2.50	1.93	12.0	0.72	0.63	0.19	0.40	< 0.02	17.2	5.56	2.84
5115	52.9	5.93	4.28	1.41	9.11	0.85	0.95	0.32	0.37	< 0.02	18.5	8.2	2.00
5125	44.7	5.51	3.96	1.29	14.8	0.84	0.89	0.29	0.39	< 0.02	21.5	8.5	3.13
5135	56.9	4.59	3.39	0.96	10.2	0.84	0.73	0.24	0.41	< 0.02	16.0	6.76	2.12
5145	59.8	4.45	3.10	0.92	9.42	0.82	0.68	0.22	0.38	< 0.02	15.3	6.40	1.94
5155	56.0	4.57	3.28	0.85	10.6	0.73	0.72	0.23	0.46	< 0.02	17.0	7.48	2.13
5165	60.7	3.70	2.49	1.17	10.1	0.54	0.58	0.18	0.46	< 0.02	15.6	6.15	2.12
5175	65.5	4.79	2.68	1.19	7.50	0.88	0.74	0.23	0.36	< 0.02	12.1	4.25	1.64
5185	62.6	4.82	3.05	1.32	8.79	0.85	0.75	0.24	0.38	< 0.02	13.2	4.52	1.94
5195	54.4	6.03	3.19	1.68	12.0	1.11	0.92	0.30	0.49	0.02	15.4	4.30	2.66
5205	47.9	4.95	2.56	1.32	15.2	0.88	0.81	0.25	0.61	< 0.02	20.7	6.9	3.23
5215	48.7	5.13	2.87	1.50	14.3	0.80	0.85	0.25	0.77	< 0.02	20.0	6.70	3.05
5225	47.3	5.92	3.15	2.08	14.1	0.91	0.98	0.30	0.81	< 0.02	19.7	6.39	3.12
5235	54.4	5.66	3.12	1.55	11.4	0.98	0.91	0.30	0.42	< 0.02	16.7	5.54	2.54
5245	55.8	3.80	2.10	3.79	11.8	0.63	0.60	0.19	0.31	0.02	17.0	4.10	3.41
5255	54.9	4.32	2.34	2.90	12.5	0.72	0.71	0.22	0.39	< 0.02	16.7	4.05	3.24
5265	46.7	4.81	2.74	4.01	15.2	0.81	0.79	0.25	0.41	< 0.02	19.7	4.14	4.10
5275	44.2	6.01	3.11	3.40	14.9	1.03	0.96	0.30	0.61	< 0.02	19.6	4.59	3.79
5285	44.1	6.69	3.38	3.25	14.8	1.17	1.08	0.34	0.54	0.02	19.3	4.75	3.67
5295	45.4	7.00	3.53	3.22	14.1	1.25	1.11	0.36	0.55	0.02	18.6	4.49	3.53
5305	47.9	6.60	3.38	2.54	13.9	1.10	0.98	0.33	0.50	0.03	17.8	4.63	3.24
5315	43.0	6.14	2.99	3.69	17.1	1.07	0.88	0.31	0.48	0.03	20.5	3.65	4.26
5325	43.1	6.43	3.18	3.64	16.7	1.09	0.93	0.33	0.50	0.03	19.9	3.55	4.20
5335	41.2	6.00	3.05	4.32	17.5	0.95	0.84	0.29	0.53	0.04	21.0	3.34	4.61
5345	44.0	6.62	3.24	3.48	16.0	1.10	0.91	0.30	0.54	0.04	19.8	3.57	4.00
5355	49.5	8.20	3.55	3.03	11.7	1.43	1.24	0.38	0.47	0.03	16.0	3.28	2.90

Table 2. continued

Depth	SiO2	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	LOI	Organic Carbon	Carbonate Carbon
5365	55.2	9.27	4.22	3.34	7.52	1.62	1.45	0.43	0.42	0.04	13.1	2.29	2.12
5375	46.0	7.77	4.03	5.06	12.2	1.30	1.25	0.36	0.34	0.07	18.4	2.52	3.80
5385	50.5	7.80	3.87	4.55	10.9	1.27	1.22	0.35	0.37	0.06	16.8	2.35	3.34
5395	49.9	8.14	4.03	4.02	11.0	1.22	1.34	0.38	0.33	0.05	16.6	2.67	3.11
5405	49.4	8.37	4.12	3.78	11.3	1.22	1.35	0.41	0.40	0.05	16.5	2.83	3.08
5415	47.5	8.63	4.83	4.20	11.6	1.15	1.41	0.44	0.41	0.06	16.9	2.68	3.25
5425	49.4	8.75	4.81	3.90	10.7	1.29	1.45	0.42	0.37	0.06	16.3	2.46	2.96
5435	50.3	8.88	4.88	3.80	10.7	1.30	1.46	0.43	0.36	0.06	15.7	2.40	2.90
5445	48.4	7.79	4.44	3.74	12.3	1.09	1.28	0.36	0.35	0.05	17.4	2.57	3.31
5455	48.0	8.26	4.72	3.68	12.8	1.07	1.30	0.38	0.33	0.06	17.6	2.47	3.29
5465	47.7	8.03	4.49	3.66	13.2	0.99	1.31	0.38	0.34	0.05	18.0	2.52	3.37
5475	48.4	8.43	4.56	3.54	12.3	1.11	1.31	0.38	0.33	0.05	17.2	2.46	3.16
5485	46.9	7.90	4.62	3.83	13.1	1.0	1.29	0.37	0.34	0.06	18.1	2.51	3.46
5495	48.0	7.93	4.74	3.63	12.8	1.01	1.30	0.38	0.35	0.06	17.5	2.54	3.30
5505	48.7	8.25	4.25	3.94	11.7	1.21	1.33	0.40	0.32	0.06	17.0	2.56	3.25
5515	48.4	8.05	4.53	3.90	12.2	1.11	1.31	0.39	0.32	0.06	17.1	2.61	3.27
5525	48.4	8.11	4.32	4.09	11.6	1.26	1.33	0.39	0.37	0.06	16.9	2.58	3.27
5535	49.2	8.08	4.32	3.92	11.5	1.19	1.34	0.39	0.39	0.06	16.6	2.74	3.16
5545	49.7	8.25	4.36	3.81	11.2	1.27	1.36	0.40	0.34	0.06	16.4	2.61	3.10
5555	49.2	9.12	4.88	3.57	11.1	1.36	1.47	0.43	0.37	0.06	15.8	2.57	2.80
5565	48.6	9.08	4.74	3.65	11.4	1.47	1.46	0.43	0.37	0.06	16.2	2.59	2.93
5575	49.3	8.93	4.92	3.84	11.6	1.34	1.46	0.43	0.36	0.07	16.2	2.96	2.56
5585	47.7	9.48	4.84	3.74	10.2	1.59	1.52	0.46	0.43	0.06	17.9	4.00	2.51
5595	48.8	11.1	5.22	4.11	9.05	1.85	1.44	0.46	0.31	0.08	15.8	2.79	2.27
5605	48.7	11.2	5.18	4.21	8.94	1.89	1.49	0.49	0.30	0.08	15.6	2.63	2.29
5615	51.1	9.92	5.43	3.85	9.04	1.66	1.44	0.47	0.32	0.08	14.4	2.36	2.35
5625	50.5	9.92	5.42	3.91	9.27	1.67	1.43	0.46	0.35	0.08	14.5	2.44	2.41
5635	47.7	9.04	5.00	4.58	10.9	1.38	1.36	0.44	0.30	0.09	16.9	2.44	2.98
5645	47.4	8.92	5.52	5.04	11.4	1.50	1.34	0.44	0.26	0.13	16.7	2.22	3.26
5655	46.1	8.77	5.65	5.09	10.8	1.63	1.36	0.45	0.28	0.12	16.1	1.98	3.14

Table 3. Abundances of sedimentary components and other derived parameters in bulk cuttings from the South Elwood field well (in weight %). The quantity "sum" represents the sum of detritus + silica + apatite + dolomite + calcite + organic matter derived from data in Table 2 using formulas in Table 1; this sum is consistently less than 100% due to the presence of H2O–. Values listed in columns 2 through 7 have been normalized to sum to 100%. See text for comments on negative numbers and problems with the calcite–dolomite partition.

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
3055	67	24	0.0	5.1	1.1	3.0	94.3	0.79	0.26
3065	68	24	0.0	5.0	0.6	2.5	93.7	0.81	0.27
3075	66	26	0.0	4.8	0.6	2.4	93.6	0.83	0.28
3085	68	25	0.0	4.7	0.1	2.4	93.6	0.84	0.27
3095	69	24	–0.1	4.6	–0.1	2.2	93.1	0.85	0.26
3105	67	26	–0.1	4.7	0.3	2.1	93.3	0.84	0.28
3115	67	25	0.0	4.8	0.1	2.2	93.0	0.84	0.27
3125	68	25	0.0	4.8	0.0	2.0	93.5	0.84	0.27
3135	67	26	0.1	5.6	–0.4	1.8	94.1	0.83	0.28
3175	68	25	0.0	5.6	–0.6	1.9	93.8	0.83	0.27
3215	66	27	0.0	5.4	–0.9	2.1	93.4	0.86	0.29
3255	68	24	0.0	5.8	–0.2	2.3	93.4	0.82	0.27
3295	64	27	–0.1	5.5	0.5	2.7	93.6	0.82	0.30
3335	67	26	–0.1	5.0	0.3	2.2	93.4	0.83	0.28
3375	65	27	0.0	4.8	0.5	2.4	93.0	0.84	0.30
3415	58	33	0.0	5.8	0.8	2.1	93.7	0.83	0.36
3455	56	35	0.0	5.4	0.9	2.4	93.7	0.85	0.39
3465	54	38	0.0	5.4	0.7	2.3	94.2	0.86	0.41
3475	50	42	0.3	4.6	1.2	2.5	93.9	0.88	0.46
3485	51	41	0.1	4.6	1.2	2.3	94.1	0.88	0.45
3495	50	42	0.2	4.2	1.6	2.2	94.6	0.88	0.46
3505	49	43	0.2	3.5	1.8	2.2	94.2	0.89	0.47
3515	51	41	0.2	3.8	1.7	2.3	94.0	0.88	0.44
3525	55	37	0.3	3.1	2.0	2.4	92.5	0.88	0.40
3535	52	40	0.3	3.5	2.2	2.4	93.7	0.87	0.43
3575	55	38	0.3	2.8	1.7	2.8	93.9	0.89	0.41
3615	62	29	0.1	4.8	0.8	3.2	94.2	0.84	0.32
3655	56	37	0.1	3.4	0.6	2.8	93.7	0.90	0.40

Table 3. continued

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
3695	60	32	0.2	3.2	0.7	3.9	94.0	0.89	0.35
3735	59	31	0.1	5.1	1.5	3.0	93.6	0.83	0.35
3775	63	30	0.1	4.0	0.9	2.4	94.3	0.86	0.32
3815	63	29	0.1	4.4	1.2	2.4	94.3	0.84	0.31
3855	61	32	0.1	3.9	0.6	2.4	94.3	0.88	0.35
3865	64	29	0.1	3.9	0.2	2.7	93.8	0.88	0.31
3875	62	30	0.2	3.4	1.4	2.9	94.1	0.86	0.33
3885	60	32	0.2	3.7	0.8	2.6	94.5	0.88	0.35
3895	60	32	0.2	4.0	1.0	2.7	93.5	0.86	0.34
3905	60	33	0.0	3.9	0.8	2.6	95.4	0.88	0.35
3915	54	30	0.1	3.1	0.5	12.6	89.4	0.89	0.36
3925	52	33	0.1	4.7	0.6	9.6	90.7	0.86	0.39
3935	53	35	0.1	3.8	0.3	8.2	91.3	0.89	0.40
3945	52	34	0.1	5.0	0.6	7.9	92.1	0.86	0.40
3955	52	39	0.0	4.7	0.7	4.1	93.4	0.88	0.43
3965	57	35	0.0	4.2	0.3	3.1	93.4	0.89	0.38
3975	61	32	-0.1	4.7	0.1	2.9	93.3	0.87	0.34
3985	60	33	0.0	4.4	0.4	2.9	93.3	0.87	0.35
3995	55	39	0.0	3.6	0.9	2.3	93.6	0.90	0.41
4005	59	34	0.0	4.2	0.4	2.9	93.1	0.88	0.36
4015	60	33	0.1	3.5	1.1	2.9	93.2	0.88	0.35
4025	60	33	0.0	3.3	1.2	3.0	93.6	0.88	0.35
4035	57	34	0.0	4.3	1.3	3.0	93.6	0.86	0.38
4045	56	31	0.0	8.8	0.6	3.0	93.6	0.77	0.36
4055	52	33	0.1	10.6	0.7	3.4	93.7	0.75	0.39
4065	53	32	0.1	10.5	0.9	3.9	94.1	0.74	0.38
4075	53	28	0.1	12.8	1.6	4.5	95.2	0.66	0.35
4085	54	29	0.2	10.5	1.7	4.8	94.3	0.70	0.35
4095	59	25	0.1	8.5	2.2	5.0	93.9	0.70	0.30
4105	59	26	0.1	8.1	2.3	5.2	94.4	0.71	0.31
4115	54	26	0.1	11.2	3.2	5.1	94.0	0.64	0.32

Table 3. continued

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
4125	56	23	0.1	11.9	3.1	5.5	94.3	0.61	0.29
4135	58	22	0.1	11.2	2.9	5.5	94.4	0.61	0.28
4145	58	21	0.1	13.4	2.7	5.4	94.1	0.56	0.27
4155	65	19	0.0	8.8	2.0	5.6	93.4	0.63	0.22
4165	63	18	0.0	11.7	2.3	5.8	94.0	0.55	0.22
4175	64	16	0.1	10.9	2.1	6.5	94.3	0.56	0.20
4185	62	16	0.1	12.9	2.1	6.5	94.4	0.52	0.21
4195	64	17	0.1	10.7	1.8	6.6	94.3	0.58	0.21
4205	63	17	0.1	12.1	1.6	6.2	94.6	0.56	0.22
4215	65	19	0.1	7.9	1.3	6.6	94.8	0.67	0.23
4225	61	26	0.1	5.6	1.0	6.4	94.3	0.80	0.30
4235	63	24	0.1	4.1	1.1	7.1	94.8	0.82	0.28
4245	59	24	0.1	9.1	1.5	6.5	94.6	0.69	0.29
4255	62	23	0.0	8.5	1.3	4.9	94.7	0.70	0.27
4265	61	18	0.1	13.9	1.9	5.3	94.3	0.53	0.23
4275	61	20	0.1	11.8	1.6	5.9	94.6	0.59	0.24
4285	60	18	0.1	13.8	1.8	6.1	94.6	0.53	0.23
4295	63	18	0.1	10.1	1.5	7.3	94.8	0.60	0.22
4305	59	24	0.3	7.3	1.5	7.9	94.5	0.73	0.29
4315	61	21	0.3	8.4	1.7	7.5	95.3	0.68	0.26
4325	59	21	0.2	11.8	2.1	6.6	94.8	0.60	0.26
4335	50	22	0.2	18.4	2.9	6.5	94.8	0.51	0.31
4345	57	19	0.3	13.5	2.6	7.3	94.5	0.55	0.25
4355	62	19	0.4	8.4	2.3	7.9	95.1	0.64	0.23
4365	48	19	0.4	19.7	4.4	8.1	95.4	0.44	0.28
4375	43	26	0.5	16.4	6.0	8.1	96.1	0.54	0.38
4385	40	32	0.4	15.0	6.1	7.4	96.1	0.60	0.44
4395	41	34	0.5	11.6	5.3	7.2	95.9	0.67	0.46
4405	55	25	0.3	10.5	3.0	6.3	94.5	0.65	0.32
4415	56	24	0.3	11.0	3.0	6.0	94.8	0.63	0.30
4425	39	38	0.5	12.8	3.8	6.6	96.1	0.69	0.49

Table 3. continued

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
4435	50	28	0.5	12.3	3.3	5.5	95.4	0.64	0.36
4445	43	32	0.8	12.1	4.9	7.6	96.1	0.65	0.43
4455	42	35	0.8	11.2	3.5	7.1	96.1	0.71	0.46
4465	41	40	0.6	8.7	2.7	6.7	95.4	0.78	0.49
4475	38	43	0.4	9.5	2.6	6.2	94.8	0.78	0.53
4485	42	34	0.7	12.6	3.9	6.9	95.4	0.67	0.45
4495	34	45	0.5	11.5	2.6	5.9	96.3	0.76	0.57
4505	30	49	0.4	13.1	2.6	5.6	96.0	0.76	0.62
4515	32	47	0.5	12.5	2.5	5.6	96.1	0.76	0.59
4525	34	43	0.6	13.8	2.6	6.2	95.6	0.72	0.56
4535	42	33	0.6	14.4	2.8	6.4	95.5	0.66	0.44
4545	26	49	0.6	14.6	2.6	7.2	98.8	0.74	0.65
4555	27	47	0.8	16.5	2.9	5.1	96.2	0.71	0.64
4565	27	48	0.8	16.6	3.0	5.2	96.4	0.71	0.64
4575	25	49	0.7	16.9	2.8	5.0	96.7	0.71	0.66
4585	36	39	0.5	16.2	3.1	5.7	95.8	0.67	0.52
4595	27	46	0.5	18.4	3.0	5.0	96.4	0.68	0.63
4605B	21	55	0.4	16.9	2.6	4.3	96.9	0.74	0.72
4615	19	52	0.4	21.1	3.0	4.1	97.7	0.68	0.74
4625	21	57	0.4	14.4	2.3	4.7	97.3	0.77	0.73
4635	20	55	0.6	15.5	2.6	5.9	96.9	0.75	0.73
4645	18	49	0.8	22.4	3.6	6.3	97.9	0.65	0.73
4655	24	45	1.1	20.1	3.4	6.5	96.9	0.66	0.66
4665	24	40	1.4	23.6	4.1	6.8	97.2	0.59	0.62
4675	24	39	1.4	24.3	4.6	6.7	97.4	0.57	0.61
4685	24	41	1.7	12.8	13.6	6.7	97.7	0.61	0.63
4695	24	36	1.6	17.6	13.3	6.7	97.8	0.54	0.60
4705	24	34	1.8	13.5	18.8	7.6	98.5	0.52	0.59
4715	27	37	2.2	10.7	14.2	8.3	98.4	0.60	0.57
4725	35	32	2.1	6.7	17.2	6.7	97.0	0.57	0.47
4735	22	46	1.5	10.5	13.9	6.2	97.5	0.65	0.67

Table 3. continued

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
4745	23	39	1.4	18.7	11.8	6.0	97.6	0.56	0.63
4755	26	39	2.0	9.5	17.0	7.1	97.3	0.59	0.60
4765	26	36	1.9	12.0	17.2	7.1	97.3	0.55	0.59
4775	26	38	2.1	6.0	20.6	7.5	98.1	0.59	0.59
4785	33	33	3.6	3.7	18.1	9.4	97.0	0.60	0.50
4795	30	32	3.7	6.6	19.0	8.8	98.1	0.56	0.52
4805	30	27	2.7	4.9	26.0	8.8	97.8	0.47	0.48
4815	37	25	4.8	7.5	16.4	9.7	97.1	0.51	0.40
4825	33	21	4.9	4.4	26.7	10.3	97.7	0.41	0.40
4835	28	28	2.8	4.7	26.9	9.7	97.8	0.47	0.51
4845	20	42	1.8	3.0	24.2	8.9	98.4	0.61	0.68
4855	46	29	1.0	5.0	13.0	5.7	95.9	0.62	0.39
4865	37	31	1.3	4.6	19.6	6.8	97.3	0.56	0.45
4875	24	45	1.9	3.5	17.1	8.6	98.0	0.69	0.65
4885	26	43	2.1	3.2	16.3	9.6	97.9	0.69	0.63
4895	29	41	3.7	2.5	11.5	12.6	97.8	0.74	0.59
4905	29	41	3.4	3.2	12.9	11.2	97.5	0.72	0.59
4915	29	44	3.1	2.4	8.5	13.6	97.2	0.80	0.60
4925	28	40	5.0	4.9	9.7	12.5	97.8	0.73	0.59
4935	34	33	2.9	6.1	15.4	8.6	97.0	0.60	0.49
4945	33	28	6.2	7.2	13.5	12.7	98.3	0.57	0.45
4955	36	24	5.2	4.0	19.3	11.8	96.9	0.51	0.41
4965	28	30	3.2	7.5	21.7	9.4	98.1	0.51	0.52
4975	19	42	1.7	11.4	17.8	7.6	98.2	0.59	0.69
4985B	26	35	2.5	7.5	19.9	9.4	97.8	0.56	0.58
4995	28	27	2.9	6.3	26.0	9.8	97.8	0.45	0.49
5005	27	25	2.3	10.9	26.0	8.9	97.7	0.40	0.47
5015	29	19	2.4	8.3	30.8	10.9	97.6	0.32	0.39
5025	23	33	2.4	5.4	26.5	9.7	97.6	0.51	0.59
5035	22	34	2.0	8.9	24.0	9.0	97.3	0.51	0.61
5045	24	35	1.5	4.5	25.0	9.6	97.2	0.54	0.59

Table 3. continued

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
5055	43	34	0.8	6.1	11.1	5.1	95.1	0.67	0.45
5065	48	27	0.8	4.8	13.8	6.0	95.6	0.59	0.36
5075	28	18	2.4	19.1	23.6	8.6	97.5	0.30	0.39
5085	27	30	1.1	12.2	21.2	9.1	97.8	0.47	0.53
5095	23	39	0.8	5.1	23.7	8.6	97.0	0.58	0.63
5105	23	44	0.7	7.1	17.1	8.6	96.5	0.64	0.66
5115	35	34	0.4	3.7	13.9	13.0	94.7	0.66	0.49
5125	32	26	0.5	3.2	24.4	13.3	96.1	0.49	0.45
5135	27	43	0.7	2.2	16.6	10.7	95.2	0.70	0.61
5145	26	46	0.6	2.1	15.2	10.0	95.8	0.73	0.64
5155	27	42	0.8	1.7	17.4	11.7	95.8	0.69	0.61
5165	21	49	0.8	3.6	15.3	9.5	96.8	0.72	0.70
5175	28	51	0.5	3.2	11.0	6.6	96.0	0.78	0.64
5185	28	48	0.6	3.8	13.0	7.1	96.2	0.74	0.63
5195	35	35	0.7	4.8	18.0	6.7	96.2	0.60	0.50
5205	29	32	1.1	3.7	24.3	10.7	96.7	0.53	0.52
5215	30	32	1.5	4.4	21.9	10.4	96.3	0.55	0.52
5225	34	28	1.5	6.8	20.0	9.9	96.6	0.51	0.44
5235	33	36	0.6	4.4	17.4	8.6	96.1	0.62	0.52
5245	22	44	0.5	15.8	12.0	6.3	97.5	0.61	0.67
5255	25	41	0.6	11.4	15.6	6.3	96.8	0.60	0.62
5265	28	31	0.6	16.4	17.8	6.4	96.7	0.47	0.53
5275	35	24	1.0	13.1	18.9	7.2	95.2	0.43	0.41
5285	39	22	0.8	12.0	19.2	7.4	96.0	0.41	0.36
5295	41	22	0.8	11.6	18.0	7.0	96.1	0.42	0.35
5305	38	26	0.7	8.6	19.4	7.2	96.4	0.48	0.40
5315	35	22	0.7	14.1	22.1	5.6	97.3	0.38	0.38
5325	37	21	0.7	13.8	21.6	5.5	97.0	0.37	0.36
5335	35	21	0.8	17.3	21.2	5.2	96.8	0.35	0.38
5345	38	22	0.8	13.0	20.7	5.5	96.6	0.39	0.36
5355	48	22	0.5	10.1	14.6	5.1	95.8	0.47	0.31

Table 3. continued

Depth	Detritus	Silica	Apatite	Dolomite	Calcite	Organic Matter	Sum	Silica/ Silica+Carb	Silica/ Silica+Detritus
5365	55	24	0.3	11.1	6.4	3.6	95.1	0.58	0.30
5375	46	20	0.2	20.1	10.5	4.0	95.6	0.39	0.30
5385	45	24	0.3	17.5	9.2	3.7	96.5	0.47	0.35
5395	47	22	0.2	14.9	11.0	4.2	96.0	0.46	0.32
5405	49	21	0.3	13.6	12.0	4.4	96.2	0.45	0.30
5415	50	18	0.3	15.5	11.6	4.2	95.9	0.40	0.26
5425	51	20	0.2	14.1	10.9	3.9	95.5	0.44	0.28
5435	52	20	0.2	13.4	11.1	3.7	96.3	0.45	0.28
5445	46	22	0.2	13.8	14.1	4.0	95.5	0.44	0.33
5455	48	20	0.2	13.1	15.2	3.8	96.5	0.41	0.29
5465	47	20	0.2	13.1	15.9	3.9	96.6	0.41	0.30
5475	49	20	0.1	12.4	14.7	3.8	96.0	0.42	0.29
5485	46	20	0.2	14.1	15.4	3.9	95.7	0.41	0.30
5495	46	21	0.2	13.1	15.3	4.0	95.9	0.43	0.31
5505	48	21	0.1	14.4	12.6	4.0	95.9	0.43	0.30
5515	47	21	0.2	14.3	13.5	4.1	96.1	0.43	0.31
5525	48	21	0.3	15.3	11.9	4.1	95.5	0.44	0.31
5535	47	22	0.3	14.4	12.0	4.3	96.0	0.45	0.32
5545	48	22	0.2	13.8	11.9	4.1	95.8	0.46	0.31
5555	53	18	0.2	12.2	12.5	4.0	96.1	0.42	0.25
5565	53	17	0.2	12.6	12.8	4.0	96.1	0.41	0.25
5575	51	18	0.2	13.3	12.4	4.5	97.9	0.42	0.27
5585	55	15	0.3	12.8	10.3	6.2	96.1	0.40	0.21
5595	64	10	-0.1	13.6	7.8	4.3	96.9	0.32	0.14
5605	65	10	-0.1	14.1	7.4	4.1	96.7	0.31	0.13
5615	58	17	0.0	13.1	8.2	3.7	96.0	0.44	0.23
5625	58	16	0.1	13.4	8.4	3.8	96.0	0.43	0.22
5635	53	17	0.0	17.1	9.6	3.8	96.0	0.39	0.24
5645	51	17	-0.1	19.1	9.4	3.4	97.0	0.37	0.24
5655	52	16	0.0	20.0	8.3	3.2	94.1	0.37	0.24

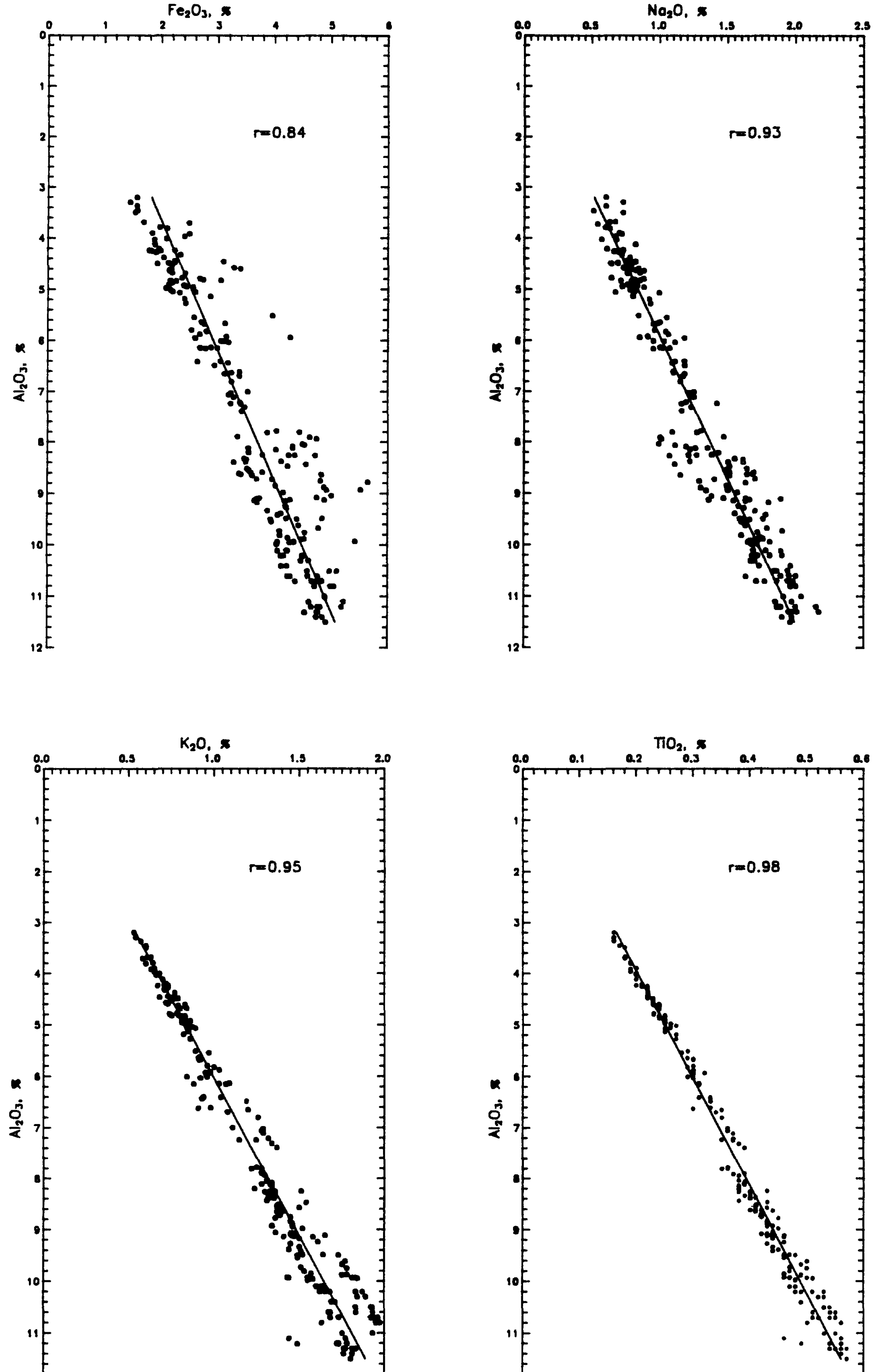

Figure 3. Al_2O_3 versus other major oxides in bulk cuttings from the South Elwood well. Correlations were calculated by least-squares linear regression; "r" is the correlation coefficient.

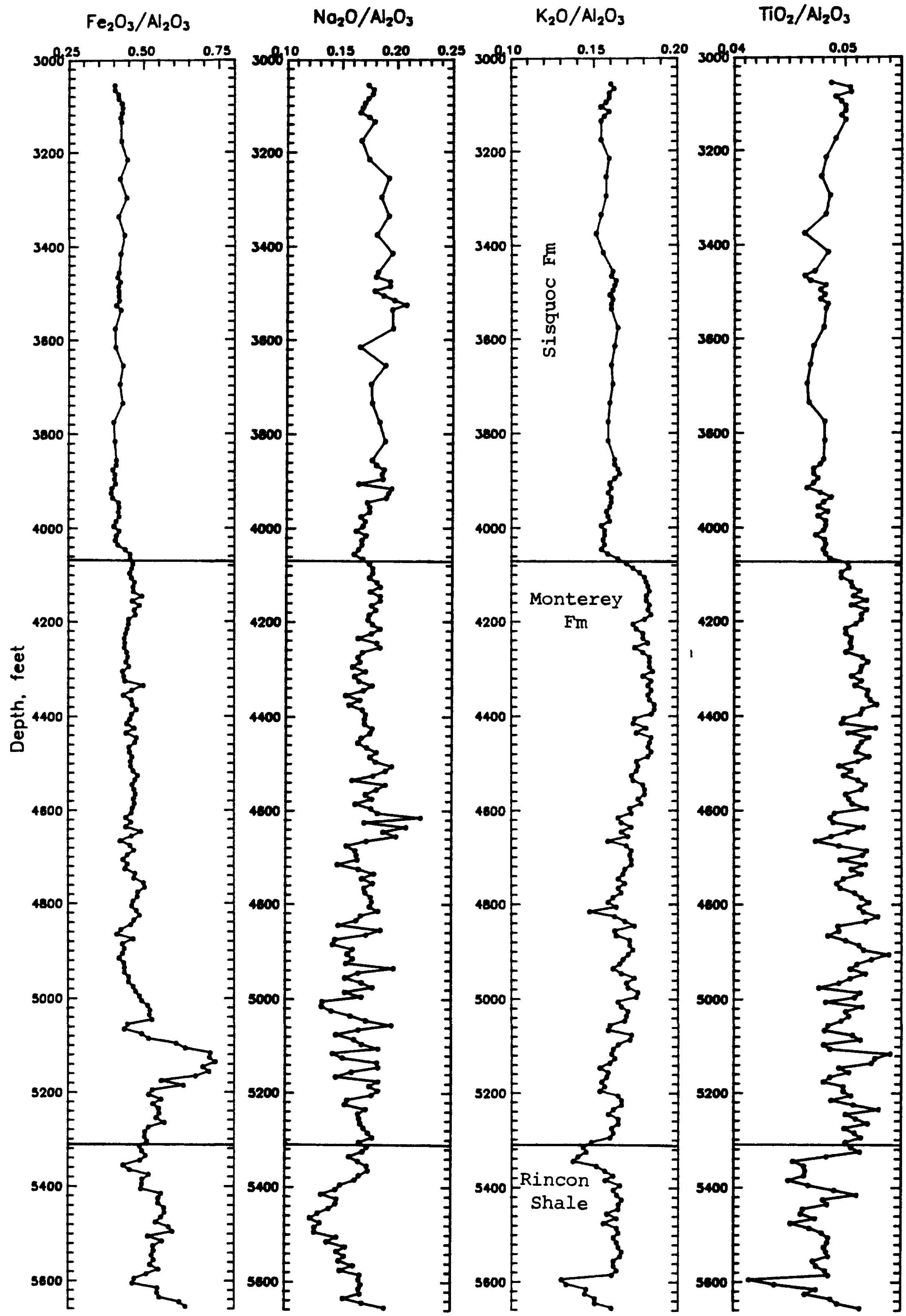

Figure 4. Oxide ratios versus depth in bulk cuttings from the South Elwood well.

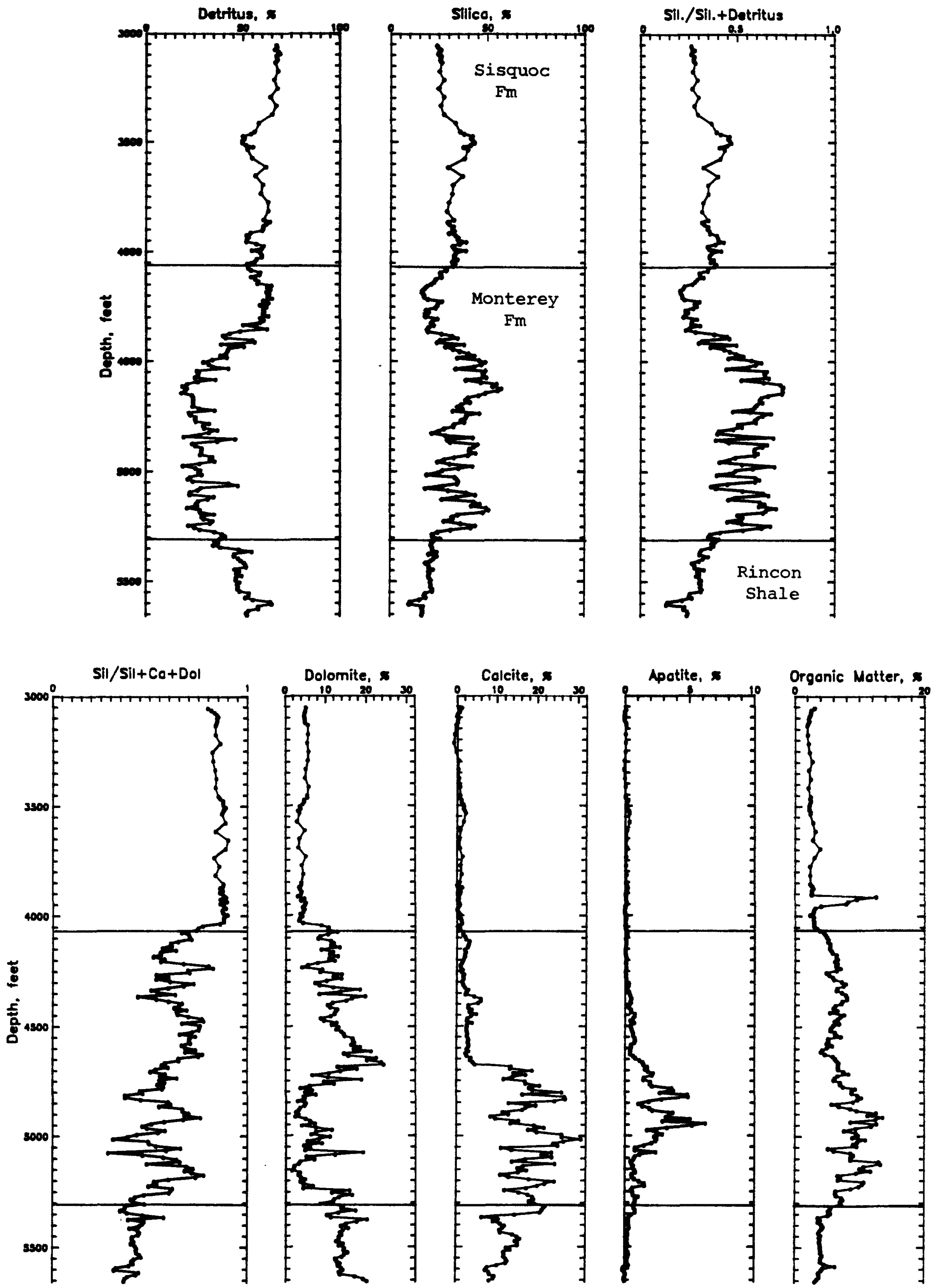

Figure 5. Summary of sedimentary components and selected parameters vs. depth in bulk cuttings from the South Elwood well.

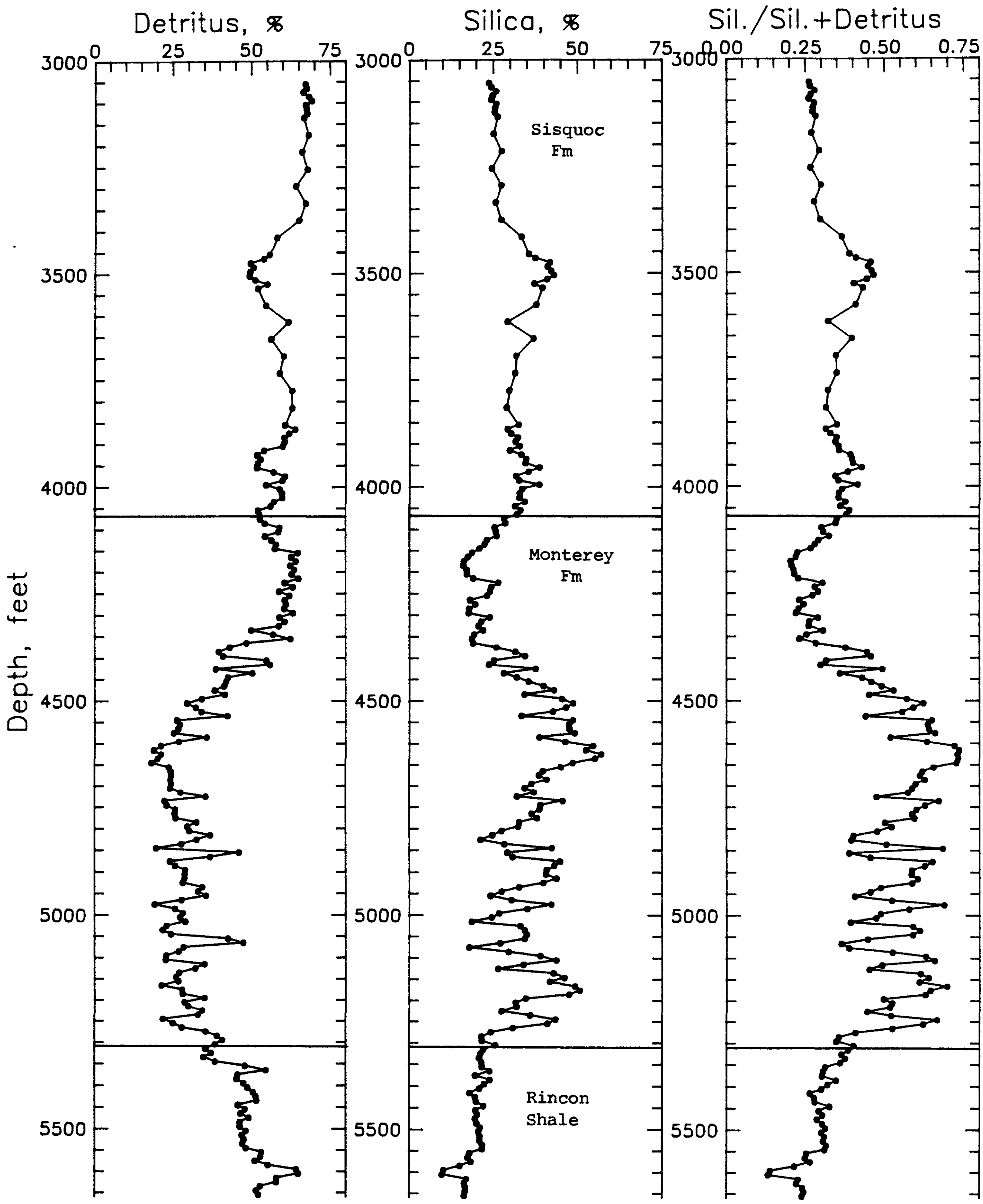

Figure 6. Detritus, silica, and silica/(silica + detritus) vs. depth in the South Elwood well.

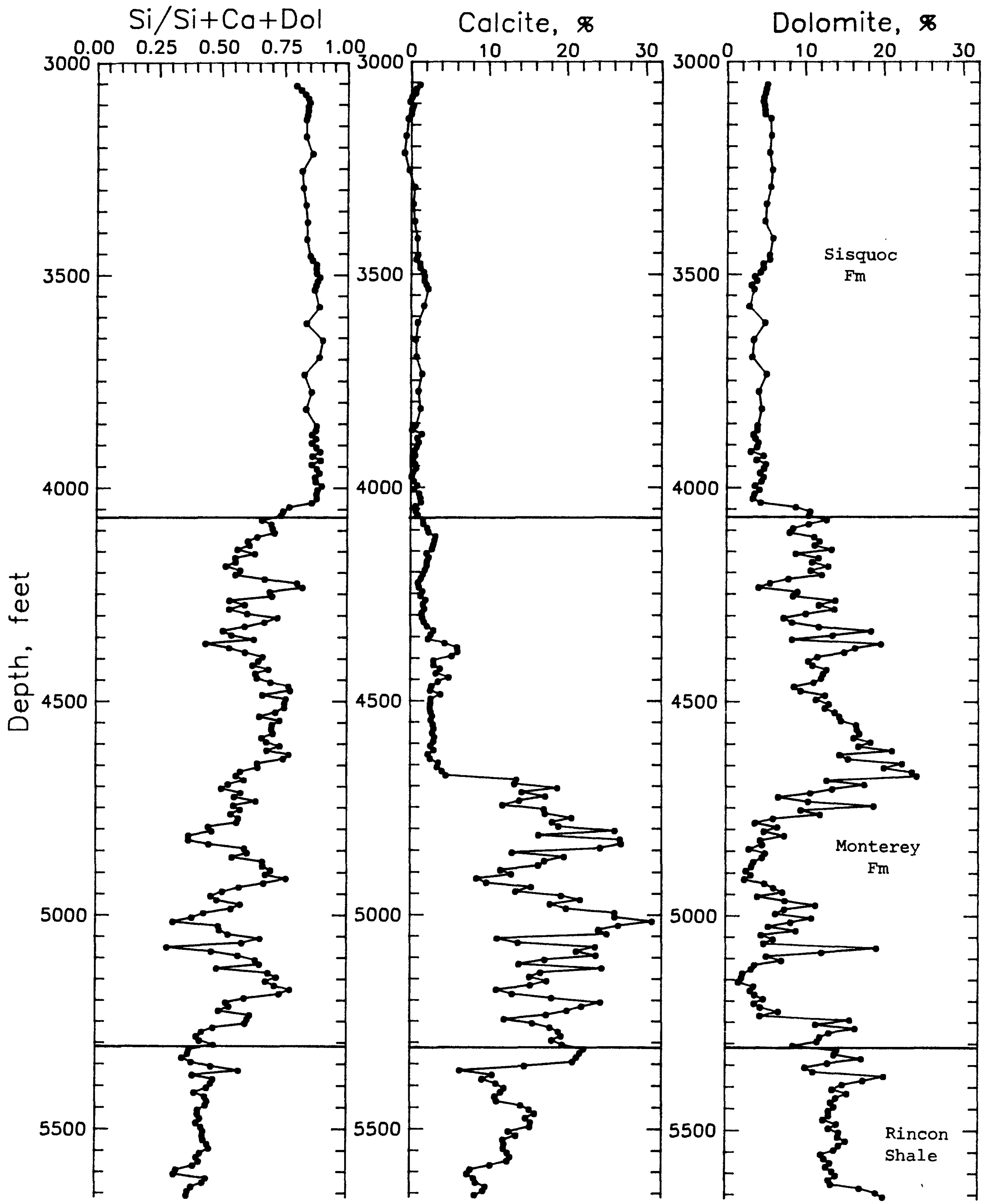

Figure 7. Silica/(silica + carbonates), calcite, and dolomite vs. depth in the South Elwood well.

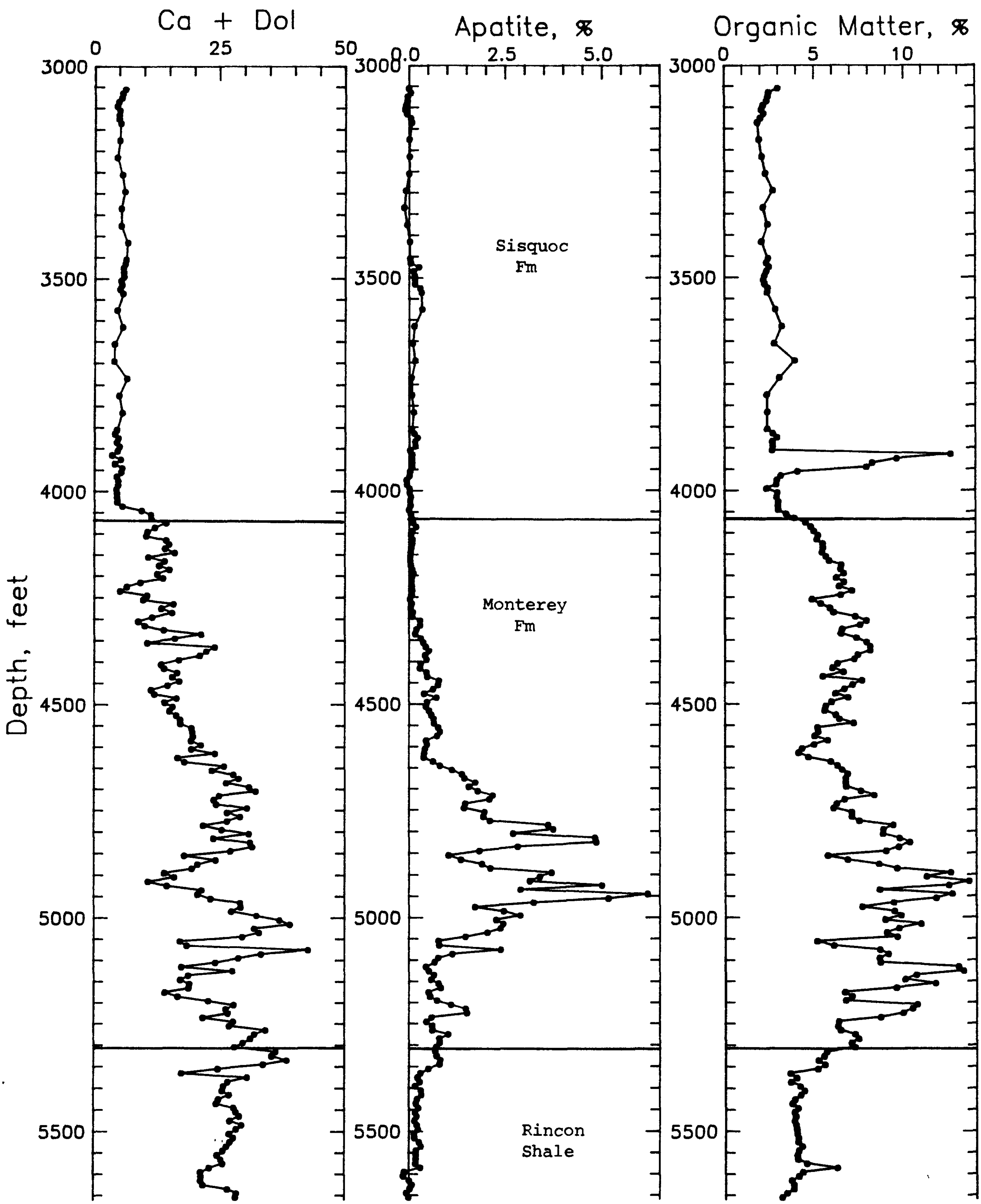

Figure 8. Carbonates, apatite, and organic matter vs. depth in the South Elwood well.

RESULTS

The abundances of major oxides, organic carbon, and carbonate carbon in cuttings samples from the South Elwood well are presented in Table 2, and the abundances of major sedimentary components and values of other derived parameters in Table 3. Figure 3 shows the abundances of oxides that are present mainly in the detritus fraction (Fe_2O_3, Na_2O, K_2O, and TiO_2) graphed against Al_2O_3, and Figure 4 shows the ratios of these oxides to Al_2O_3 graphed against depth. Figures 5-8 show the abundances of major sedimentary components and values of other derived parameters graphed against depth. In these tables and figures, the depth is given as the mid-point of the 10-foot interval analyzed; for example, the sample listed at 3055 feet represents the interval 3050-3060 feet.

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