9-23-37W

15-093-21250

Western Atlas International
A Litton/Dresser Company

CORE LABORATORIES

5/20/93

CORE ANALYSIS RESULTS

for

Amoco Production Company

Shankle 2-9
Hugoton Field
Kearny County, Kansas
57122-7769

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Western Atlas International
A Litton/Dresser Company

CORE LABORATORIES

May 20, 1993

Mr. Marty Williams
Amoco Production Company
P.O. Box 800
Denver, CO 80201

Subject:

Core Analysis Project
Shankle 2-9
Kearny County, Kansas
File Number: 57122-7769

Dear Mr. Williams:

Core Laboratories was requested to analyze core material obtained from the subject well. The following tests were performed and the results are presented in graphical and tabular formats within this report:

1. Plug Type Core Analysis (CMS-300)
   (Porosity, Permeability and Grain Density)

Please note additional quality control section and procedure letter that is also included in this report. Thank you for the opportunity to perform this study for Amoco. Should you have any questions pertaining to these test results or if we may be of further assistance, please contact us at (307) 265-2731.

Very truly yours,

David A. Foster
Core Laboratories

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle
Location : Sec.9 T23S R37W
Co,State : Kearny, Kansas

Field : Hugoton
Formation :
Coring Fluid :
Elevation :

File No.: 57122-7769
Date : 22-Mar-1993
API No. :
Analysts: DF SS

C O R E   A N A L Y S I S   R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
1	2470.3	0.160	9.4	2.74	
2	2471.3	3.87	5.6	2.77	frac
3	2492.6	0.062	14.2	2.72	
4	2508.1	0.816	11.7	2.83	lams
5	2510.5	0.326	11.6	2.80	lams
6	2515.3	0.425	15.8	2.70	chipped plug
7	2515.7	0.212	12.9	2.73	
8	2516.7	0.490	14.3	2.73	
9	2518.5	0.492	17.2	2.73	
10	2519.4	0.271	16.8	2.73	
11	2521.8	2.16	18.8	2.73	frac
12	2522.5	0.285	17.6	2.72	
13	2537.6	3.48	14.9	2.75	
14	2538.7	2.40	16.6	2.77	
15	2540.9	13.5	18.2	2.71	
16	2541.6	5.35	15.9	2.72	
17	2542.3	0.036	9.0	2.76	
18	2543.4	0.090	8.7	2.76	
19	2544.8	0.266	11.7	2.74	
20	2545.8	2.29	16.8	2.72	
21	2546.6	0.665	10.4	2.74	
22	2547.7	1.92	16.9	2.71	
23	2548.4	2.95	17.3	2.70	
24	2549.6	1.16	16.7	2.70	
25	2550.5	0.940	16.0	2.71	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

C O R E   A N A L Y S I S   R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
26	2551.5	0.056	7.6	2.75	
27	2553.4	0.028	8.0	2.84	
28	2554.5	0.350	10.5	2.86	
29	2555.5	0.025	8.1	2.87	
30	2556.5	0.079	8.0	2.88	
31	2565.5	0.008	10.2	2.78	
32	2574.5	0.056	13.7	2.74	
33	2589.5	3.02	13.3	2.72	
34	2590.5	3.50	13.4	2.73	
35	2593.5	1.12	13.0	2.79	
36	2595.5	0.230	10.7	2.83	
37	2596.5	0.593	12.5	2.81	
38	2597.5	0.593	12.6	2.84	
39	2598.4	0.106	9.0	2.86	
40	2599.5	0.187	9.7	2.86	
41	2601.1	0.059	8.3	2.87	
42	2602.4	8.09	16.7	2.70	frac
43	2603.5	4.13	16.3	2.67	
44	2604.6	2.82	16.8	2.70	
45	2605.6	1.18	16.1	2.69	
46	2607.5	10.0	19.3	2.69	fractured during cleaning
47	2610.2	0.016	9.9	2.72	salt
48	2624.9	0.025	11.6	2.76	
49	2627.1	0.236	14.5	2.73	
50	2634.5	0.958	16.0	2.72	frac
51	2635.5	0.314	12.2	2.72	
52	2638.8	0.206	10.0	2.74	
53	2657.4	0.068	10.8	2.77	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

C O R E   A N A L Y S I S   R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
54	2663.5	2.04	15.1	2.73	frac
55	2677.1	3.29	16.4	2.72	
56	2678.6	5.29	17.7	2.71	
57	2679.4	3.60	18.7	2.71	frac
58	2680.5	0.776	15.2	2.71	
59	2682.5	0.905	17.6	2.84	
60	2683.2	2.32	23.4	2.84	
61	2684.4	0.860	18.0	2.84	
62	2685.6	2.52	21.4	2.84	
63	2686.5	3.89	22.0	2.85	
64	2687.3	0.493	13.2	2.86	
65	2688.3	6.21	16.1	2.84	
66	2689.5	1.91	15.4	2.86	
67	2690.8	6.25	17.4	2.85	
68	2691.6	2.16	17.7	2.85	
69	2692.7	7.78	26.1	2.84	
70	2693.5	1.13	18.2	2.86	
71	2694.6	0.784	15.7	2.86	
72	2695.8	3.85	19.3	2.82	
73	2696.5	1.51	16.4	2.82	
74	2697.6	0.450	12.2	2.81	
75	2698.3	0.424	12.5	2.84	
76	2699.5	0.390	14.7	2.80	
77	2700.5	0.228	12.8	2.79	
78	2701.5	0.059	9.4	2.77	
79	2702.5	0.240	11.1	2.75	
80	2703.4	0.115	9.9	2.74	
81	2704.5	0.091	9.6	2.73	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

C O R E A N A L Y S I S R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
82	2705.8	0.095	9.5	2.73	
83	2706.6	0.185	10.7	2.74	
84	2707.6	0.093	9.8	2.77	
85	2708.8	0.327	11.4	2.72	
86	2709.5	0.542	12.4	2.74	
87	2710.3	0.381	11.9	2.74	
88	2711.7	0.277	11.4	2.73	
89	2712.7	0.235	10.9	2.75	
90	2713.5	0.034	7.8	2.76	
91	2714.5	12.1	23.3	2.82	
92	2716.5	0.025	7.9	2.76	
93	2717.5	1.19	16.0	2.80	
94	2718.5	3.95	22.9	2.84	
95	2719.4	2.25	20.9	2.82	
96	2720.5	0.112	17.9	2.81	
97	2721.5	0.152	13.4	2.78	
98	2722.5	0.322	14.5	2.73	
99	2723.5	0.532	15.2	2.73	
100	2725.5	13.4	19.5	2.70	
101	2726.5	16.9	19.2	2.71	
102	2727.5	4.00	18.0	2.71	
103	2728.5	7.17	19.0	2.70	
104	2730.5	4.82	16.6	2.71	frac
105	2731.5	0.057	12.4	2.71	
106	2733.3	0.003	8.8	2.75	
107	2742.2	0.009	9.0	2.73	
108	2755.5	0.008	5.7	2.71	
109	2756.4	0.031	7.0	2.68	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

C O R E   A N A L Y S I S   R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
110	2758.1	0.387	15.4	2.72	
111	2759.5	0.109	12.8	2.71	
112	2760.4	1.68	18.1	2.71	
113	2763.6	0.907	12.1	2.70	
114	2764.6	0.076	9.7	2.74	
115	2766.4	0.039	6.7	2.76	
116	2767.5	0.039	7.1	2.73	
117	2769.8	0.198	8.7	2.72	
118	2770.6	9.88	25.6	2.78	
119	2771.4	8.18	24.0	2.77	
120	2773.5	10.6	28.5	2.79	
121	2774.1	6.19	21.8	2.77	
122	2782.4	0.005	9.2	2.73	
123	2785.4	0.036	10.3	2.70	
124	2790.8	0.728	15.4	2.68	
125	2791.5	1.30	15.8	2.69	
126	2793.5	3.54	17.7	2.70	
127	2796.5	1.77	17.7	2.70	
128	2806.6	0.007	5.4	2.72	
129	2807.7	0.086	7.7	2.72	
130	2808.3	0.001	2.6	2.71	
131	2809.0	0.003	8.0	2.79	Chipped
132	2810.8	0.004	4.9	2.72	
133	2811.3	0.006	5.5	2.72	
134	2812.4	0.024	4.0	2.72	
135	2813.8	0.091	9.3	2.71	
136	2816.2	0.070	7.7	2.73	
137	2816.9	0.005	4.9	2.73	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

CORE ANALYSIS RESULTS

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
138	2820.1	0.030	8.4	2.71	
139	2822.7	0.011	5.2	2.71	
140	2823.5	0.001	2.9	2.71	
141	2824.5	0.003	3.5	2.72	
142	2825.7		5.8	2.70	Frac
143	2841.3		11.2	2.69	Frac
144	2844.8	0.064	10.2	2.71	
145	2846.3	0.130	13.2	2.71	
146	2852.6	0.006	6.3	2.71	
147	2854.8	0.003	2.4	2.79	
148	2856.1	0.003	2.6	2.68	
149	2856.8	0.005	5.7	2.73	
150	2885.5	0.109	14.2	2.73	
151	2887.8	0.020	13.2	2.75	
152	2895.2	0.035	13.4	2.73	
153	2908.3				
154	2917.5	0.615	17.2	2.73	
155	2924.3	0.003	4.1	2.79	
156	2924.8	0.004	4.2	2.78	
157	2925.6	0.109	7.4	2.82	
158	2926.4	0.036	9.1	2.85	
159	2935.2	5.97	21.2	2.84	Chipped
160	2936.5	2.66	20.1	2.83	
161	2938.0	24.1	21.8	2.79	
162	2938.5	0.731	12.9	2.78	
163	2939.2	6.18	13.7	2.76	
164	2939.8	1.12	13.2	2.76	
165	2940.3	1.25	13.2	2.77	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

C O R E   A N A L Y S I S   R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
166	2942.2	1.67	13.3	2.73	
167	2943.8	0.253	10.5	2.72	
168	2945.7	0.012	6.4	2.77	
169	2974.5	0.012	6.7	2.77	
170	2975.6	0.002	5.2	2.75	
171	2976.8	1.30	17.7	2.81	
172	2977.8	0.052	8.4	2.78	
173	2982.3	0.034	12.3	2.76	
174	3004.6	8.68	7.5	2.74	Frac
175	3005.7	0.007	5.4	2.71	
176	3006.5	0.004	3.8	2.72	
177	3007.5	0.002	3.7	2.69	Chipped, Frac
178	3048.3	<.001	3.1	2.72	
179	3057.3	<.001	3.6	2.70	
180	3068.5	0.002	4.5	2.71	
181	3074.6	<.001	2.1	2.71	
182	3077.3	0.005	8.2	2.71	
183	3096.0	0.001	7.0	2.71	
184	3097.3	0.024	6.9	2.71	
185	3098.0	0.017	6.5	2.71	
186	3099.8	0.004	5.2	2.73	Chipped
187	3100.8	0.066	9.8	2.74	
188	3101.3	0.171	12.7	2.73	
189	3102.2	0.279	12.7	2.74	
190	3102.8	0.188	12.4	2.74	
191	3105.2	3.55	19.0	2.75	Chipped, Frac
192	3107.9	0.314	10.9	2.74	
193	3108.4	0.103	10.3	2.73	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

C O R E   A N A L Y S I S   R E S U L T S

(HYDROSTATIC CONFINEMENT)

SAMPLE NUMBER	DEPTH ft	NOB (800 psi) Kair md	POROSITY (HELIUM) %	GRAIN DENSITY gm/cc	DESCRIPTION
194	3108.8	0.886	9.7	2.71	Frac
195	3113.5	0.002	4.1	2.69	
196	3115.4	0.001	3.3	2.70	
197	3116.8	0.008	3.4	2.69	
198	3129.3		4.2	2.70	Frac
199	3130.3	0.018	6.1	2.71	
200	3133.8	0.003	5.3	2.72	
201	3135.4	0.026	6.7	2.70	
202	3136.1	0.157	9.9	2.72	
203	3136.8	0.004	4.9	2.72	
204	3138.8	<.001	3.4	2.69	
205	3152.6	<.001	1.1	2.71	
206	3157.8	0.001	3.3	2.68	
207	3158.8	<.001	2.8	2.71	
208	3160.5	<.001	3.2	2.70	
209	3162.3	<.001	3.0	2.71	
210	3165.3	0.052	8.7	2.72	
211	3166.4	0.157	11.8	2.71	
212	3167.7	0.010	6.5	2.72	
213	3169.1	0.026	6.2	2.72	
214	3171.0	0.028	5.9	2.71	Lam
215	3172.0	0.030	4.7	2.76	
216	3173.3	0.002	3.4	2.71	
217	3174.5	0.016	5.7	2.72	
218	3175.4	0.039	5.9	2.71	
219	3176.8	0.014	4.9	2.72	
220	3182.7	0.177	8.1	2.76	

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation : NOT SPECIFIED

File No.: 57122-7769
Date : 22-Mar-1993

TABLE I

SUMMARY OF CORE DATA

ZONE AND CUTOFF DATA

ZONE:

Identification --------	Not Specified
Top Depth ----------------	2470.0 ft
Bottom Depth -------------	3190.0 ft
Number of Samples --------	219

DATA TYPE:

Porosity --------------	(HELIUM)
Permeability ----------	Kair (800 psi)

CUTOFFS:

Porosity (Minimum) -------	0.0 %
Porosity (Maximum) -------	100.0 %
Permeability (Minimum) ---	0.0000 md
Permeability (Maximum) ---	100000. md
Water Saturation (Maximum)	
Oil Saturation (Minimum) -	
Grain Density (Minimum) --	2.00 gm/cc
Grain Density (Maximum) --	3.00 gm/cc
Lithology Excluded -------	NONE

CHARACTERISTICS REMAINING AFTER CUTOFFS

ZONE:

Number of Samples -----	219
Thickness Represented -	219.0 ft

POROSITY:

Storage Capacity ------	2524.9 ϕ-ft
Arithmetic Average ----	11.5 %
Minimum ---------------	1.1 %
Maximum ---------------	28.5 %
Median ----------------	11.2 %
Standard Deviation ----	±5.6 %

GRAIN DENSITY:

Arithmetic Average ----	2.75 gm/cc
Minimum ---------------	2.67 gm/cc
Maximum ---------------	2.88 gm/cc
Median ----------------	2.73 gm/cc
Standard Deviation ----	±0.05 gm/cc

PERMEABILITY:

Flow Capacity ---------	318.6 md-ft
Arithmetic Average ----	1.48 md
Geometric Average -----	0.142 md
Harmonic Average ------	0.007 md
Minimum ---------------	0.001 md
Maximum ---------------	24.1 md
Median ----------------	0.186 md
Standard Dev. (Geom) --	$K\cdot10^{\pm1.180}$ md

HETEROGENEITY (Permeability):

Dykstra-Parsons Var. --	0.954
Lorenz Coefficient ----	0.669

AVERAGE SATURATIONS (Pore Volume):

Oil -------------------	
Water -----------------	

** Permeabilities less than 0.001 or greater than 3000 md exceed current CMS capabilities. Values exceeding **
** limits are assigned permeabilities of 0.0005 and 3500 md respectively for statistical and graphical purposes. **

CORE LABORATORIES

Company : Amoco Production Company
Well : No. 2-9 Shankle

Field : Hugoton
Formation :

File No.: 57122-7769
Date : 22-Mar-1993

ANALYTICAL PROCEDURES AND QUALITY ASSURANCE

HANDLING & CLEANING

Core Transportation	: Motor Freight
Solvent	: Toluene/CO_2
Extraction Equipment	: CO_2/Toluene Core Cleaner
Extraction Time	: 10-12 Hours
Drying Equipment	: Dry Oven
Drying Time	: 16 Hours
Drying Temperature	: 140 F

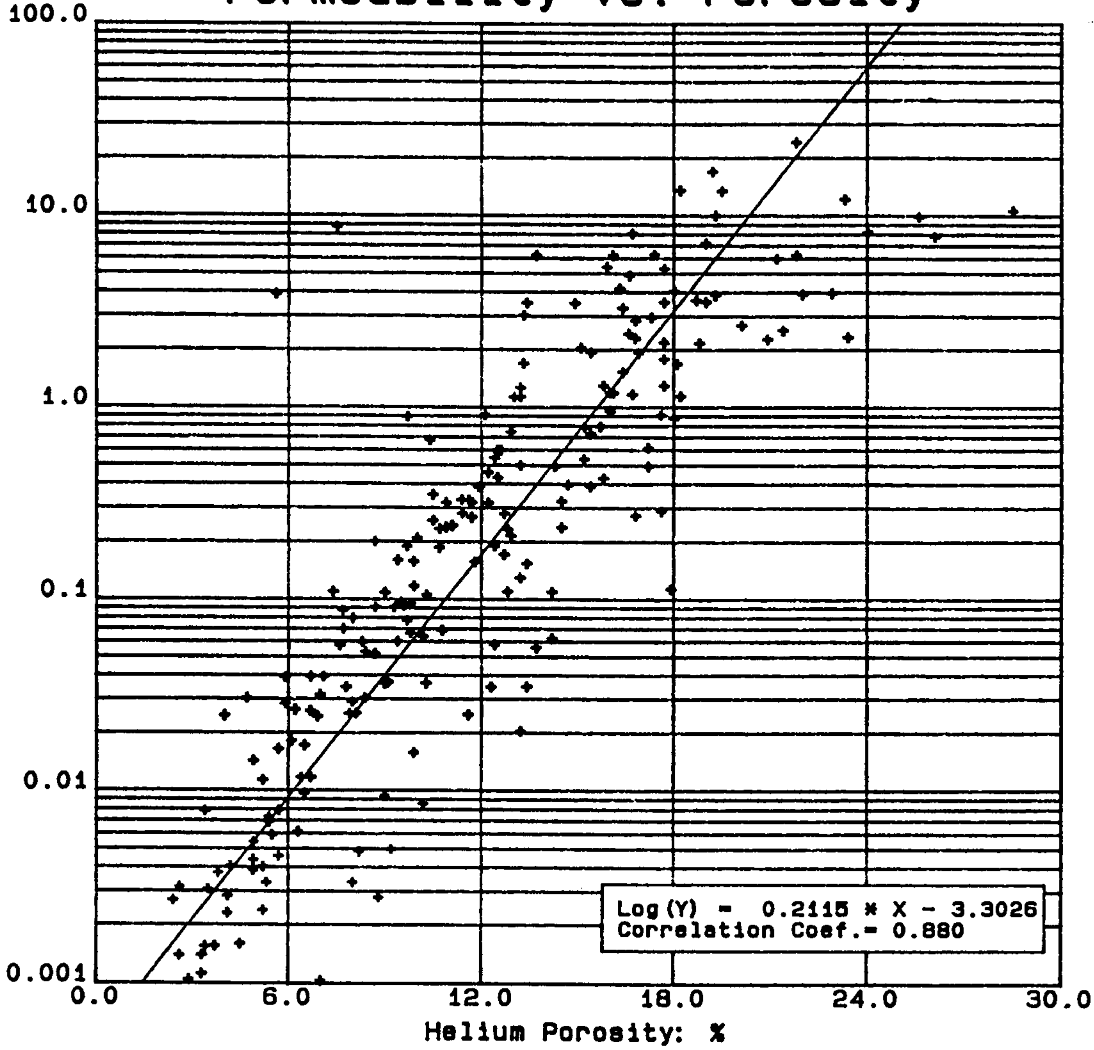
ANALYSIS

Grain volume measured by Boyle's Law in a matrix cup using He
Permeabilities measured on 1.5 in. diameter drilled plugs

REMARKS

Samples were drilled by Amoco and shipped to Core Lab. Humidity oven was not requested. Samples were put into core cleaner and then dried at low temperature. Many samples were retrimmed to obtain right cylinders. CMS-300 was used in perm-only mode, Kl was not requested. Samples 142,143,153, and 198 were either already fractured or they broke during sample preparation. Hence, some data may be missing.

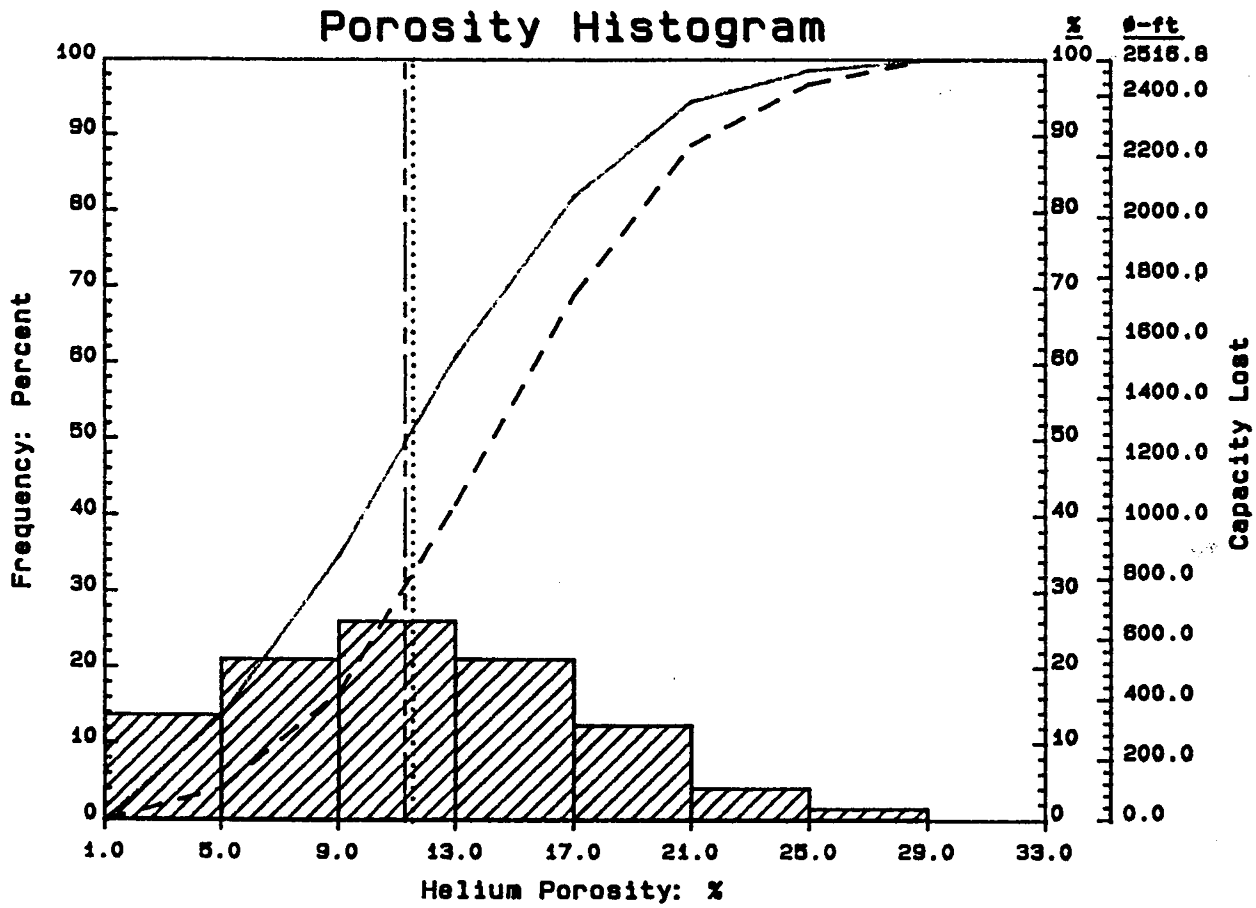
Permeability vs. Porosity



Amoco Production Company
No. 2-9 Shankle
Hugoton Field
Kearny County, Kansas
(2759.5-3182.7 feet)

Core Laboratories 22-Mar-1993

- LEGEND -
Not Specified



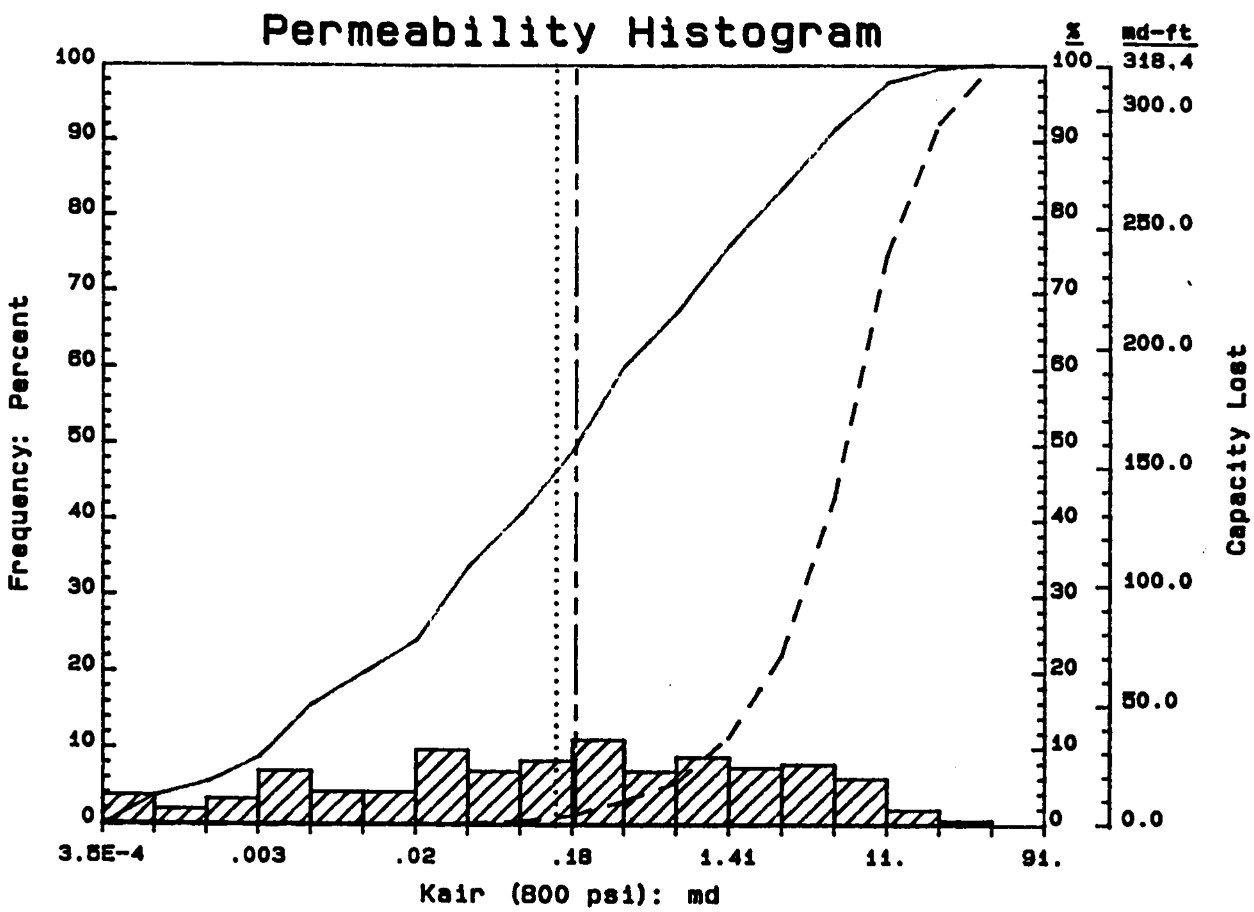
Amoco Production Company
No. 2-9 Shankle
Hugoton Field
Kearny County, Kansas
(2759.5-3182.7 feet)

Core Laboratories 22-Mar-1993

- LEGEND -

Median Value (11.3)
Arith. Average (11.5)
Cumulative Frequency
Cumulative Capacity Lost

218 Samples



Amoco Production Company
No. 2-9 Shankle
Hugoton Field
Kearny County, Kansas
(2759.5-3182.7 feet)

Core Laboratories 22-Mar-1993

- LEGEND -

Median Value (0.187)
Geom. Average (0.142)
Cumulative Frequency
Cumulative Capacity Lost

215 Samples

Western Atlas International

CORE LABORATORIES

Mr. Marty Williams
Amoco Production Co.
P.O. Box 800
Denver, CO 80201

May 4, 1993

Dear Mr. Williams:

I am including with this letter some quality control information that I did on the Shankle 2-9 well. I wanted to show you some of the checks and balances that we performed and explain how we were running your cores. Comparisons, like the ones shown, will be done on the work that we do for you.

The bulk ratio graphs are a ratio of the Archimedes bulk and the calipered bulk. I use this primarily to detect measurement errors that would effect the porosity. We exclusively use the Archimedes method except where large vugs are present. A ratio of 1.000 would indicate a perfect right cylinder. As you can see, the ratios are, for the most part, somewhat less than 1. Those with great deviation from the others, along with some other random samples were checked and/or measured again.

Some of the plugs that have been sent to us so far have been somewhat "corkscrewed". This would account for the bulk ratios of some of the samples not being very close to 1.000.

As per your instructions, the samples were put into the core cleaner, at low temperature, to remove extraneous mud and clays and then put into a dry oven.
We are running these samples in the "Perm Only" mode in the CMS-300. The grain volumes are measured in a separate device using a helium auto-porosimeter. This is how we routinely measure core samples. Since the CMS-300 requires near perfect right cylinders for accurate porosity measurements, I feel that the method we are using is the best for this job.
Although right cylinders are also important to permeability measurements, the error introduced in permeability would be very small compared to measuring porosity using the CMS-300.

On the CMS vs Steady State Perm. graph, note how well the two permeabilities track one another. The CMS uses various pressures in a pressure decay setting to measure permeability (Unsteady-State), it also takes in account the gas slippage factor. A standard pressure, (Steady State) reflecting historical data, the Klinkenberg permeability, and it's slip factor are used to calculate k(air).
The steady state permeameter uses a constant pressure. Subsequently, the permeability comparison should be close, be not necessarily the same.

I have spoken to Butch Oliver and have expressed my concerns about the samples. He said he would try different techniques to avoid the "corkscrew" effect.

We are using the letter dated 3/27/1992 by L.R. Smith of the Amoco Research Center for our CMS requirements. With the exception that we are measuring the grain volume separately and then subtracting this value from the Archimedes bulk to obtain the pore volume.
I believe that the methods we are using to measure these core samples, (for Kair, Porosity(ambient) and grain density), will give you very accurate results.
However, please do not hesitate to check with your research center to see if we are in compliance with their standards for running these cores.

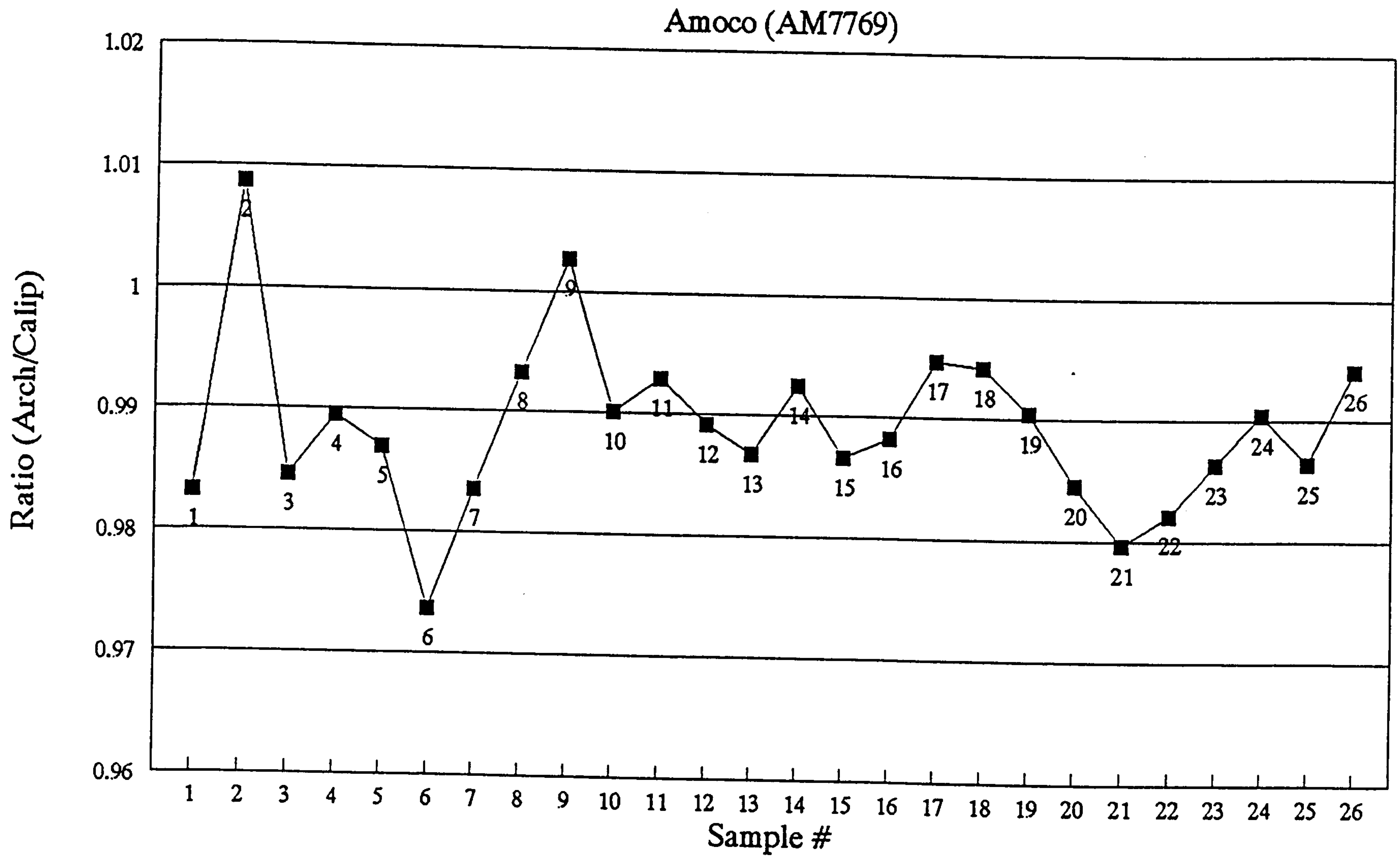
Sincerely;

David Foster

David Foster
Core Laboratories

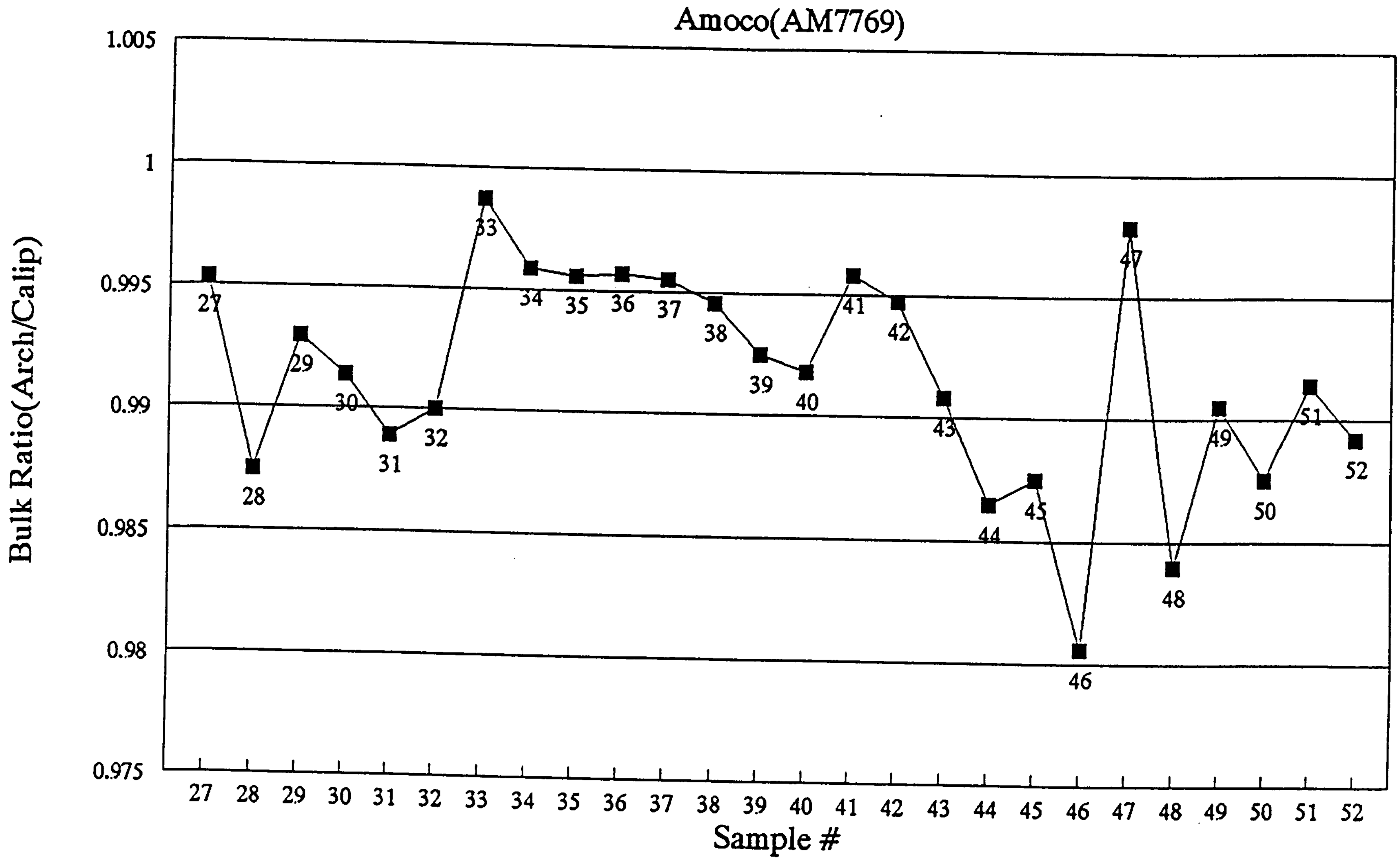
cc:Cortez Mays
Midland

Bulk Ratio



Amoco (AM7769)
Ratio (Arch/Calip)
1.02
1.01
1
0.99
0.98
0.97
0.96
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Sample #

Bulk Ratio



Amoco(AM7769)
Bulk Ratio(Arch/Calip)
1.005
1
0.995
0.99
0.985
0.98
0.975
27
28
29
30
31
32
33
34
35
36
37
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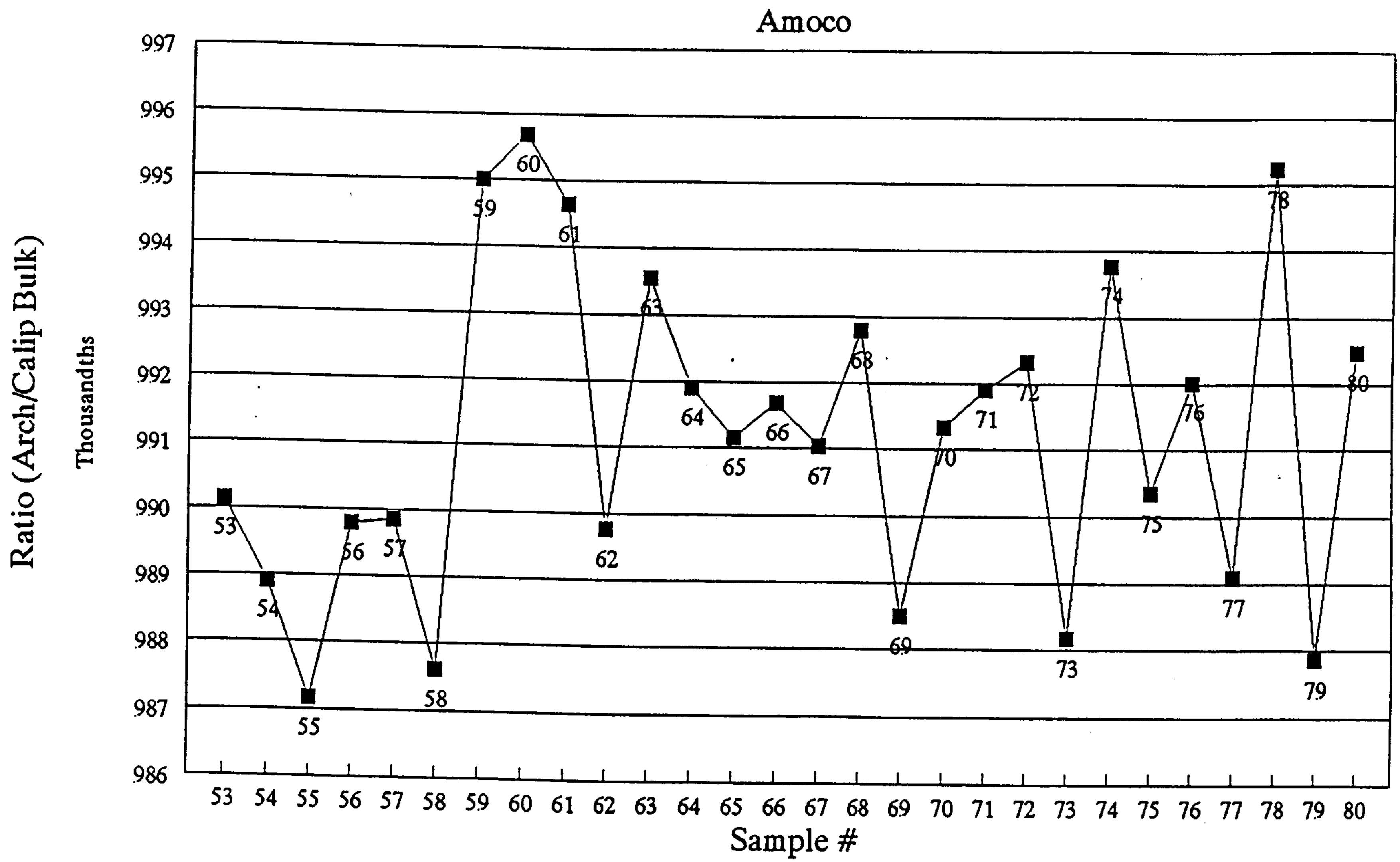
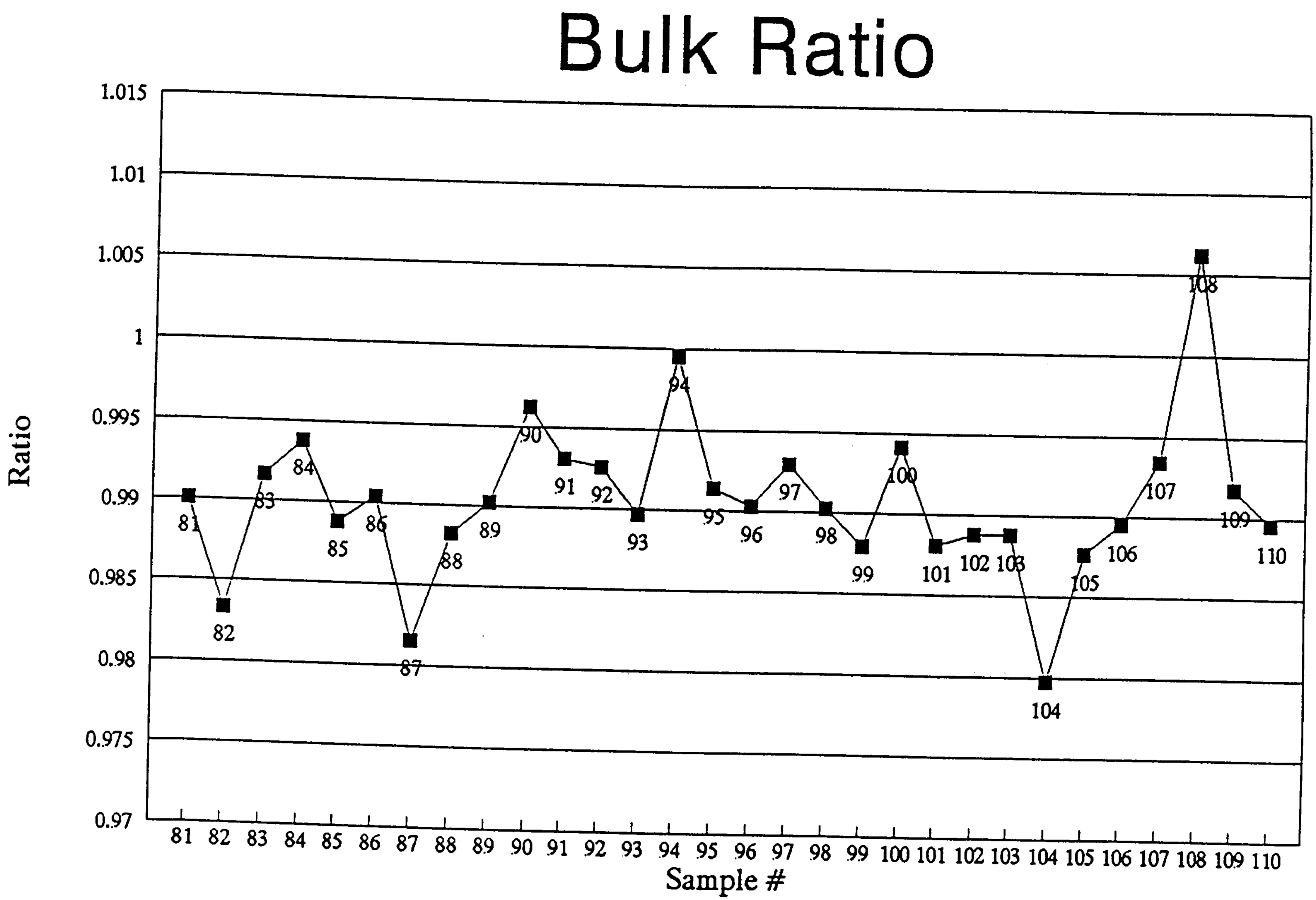
40
41
42
43
44
45
46
47
48
49
50
51
52
Sample #

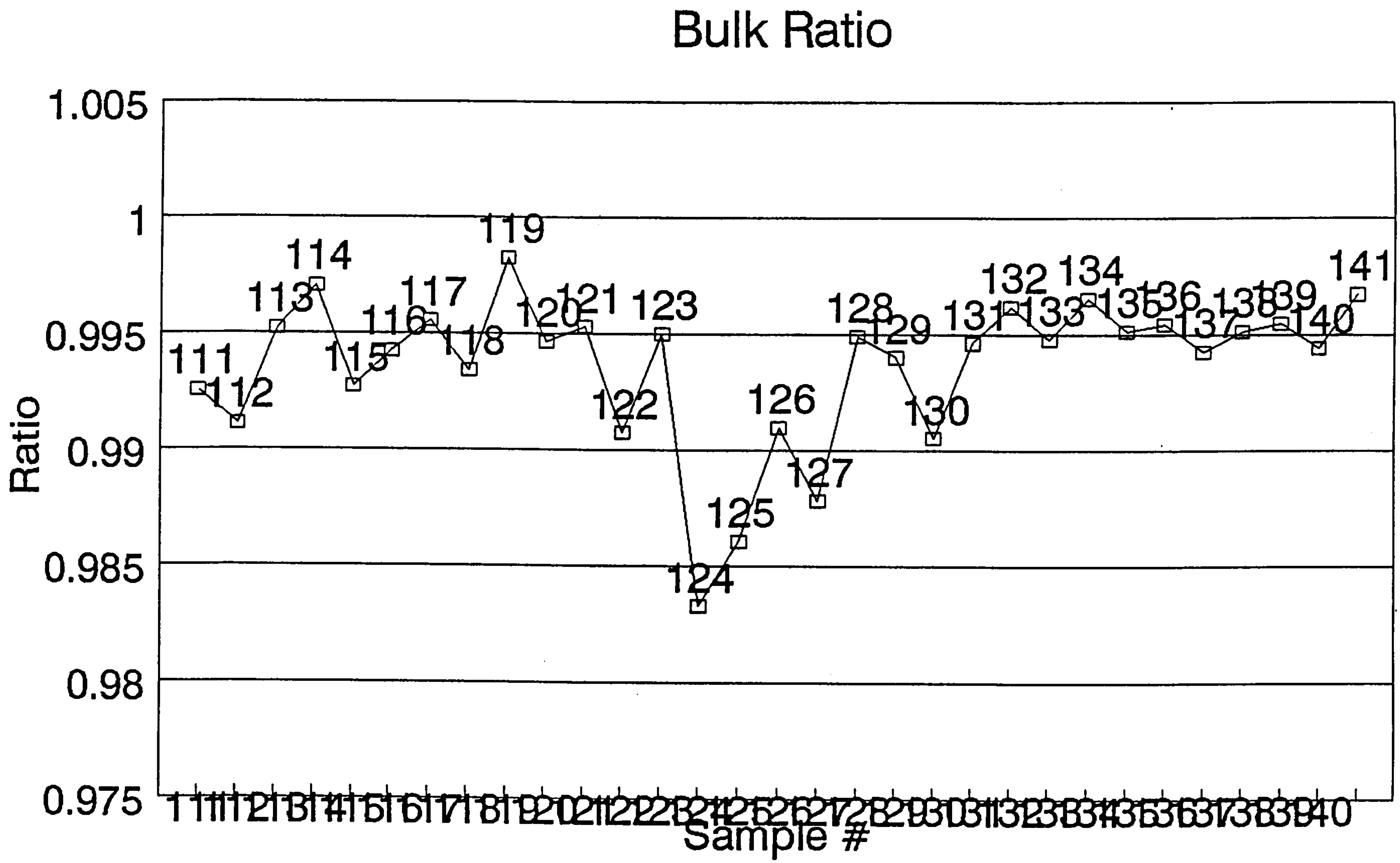
Bulk Ratio



Amoco
Ratio (Arch/Calip Bulk)
Thousandths
997
996
995
994
993
992
991
990
989
988
987
986
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
Sample #



Bulk Ratio
Ratio
1.015
1.01
1.005
1
0.995
0.99
0.985
0.98
0.975
0.97
Sample #
81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110


Bulk Ratio
Ratio
Sample #
1.005
1
0.995
0.99
0.985
0.98
0.975
111
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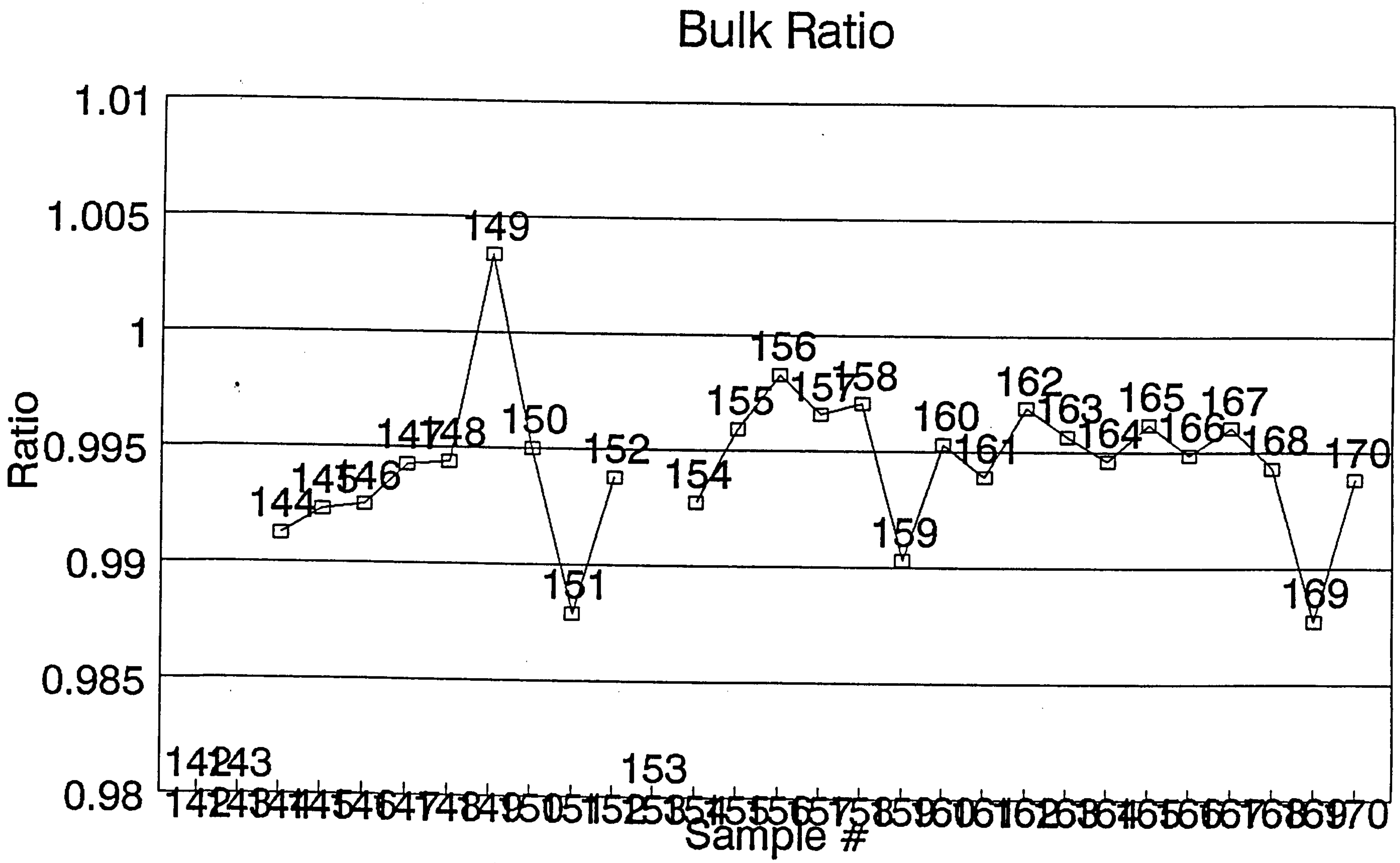
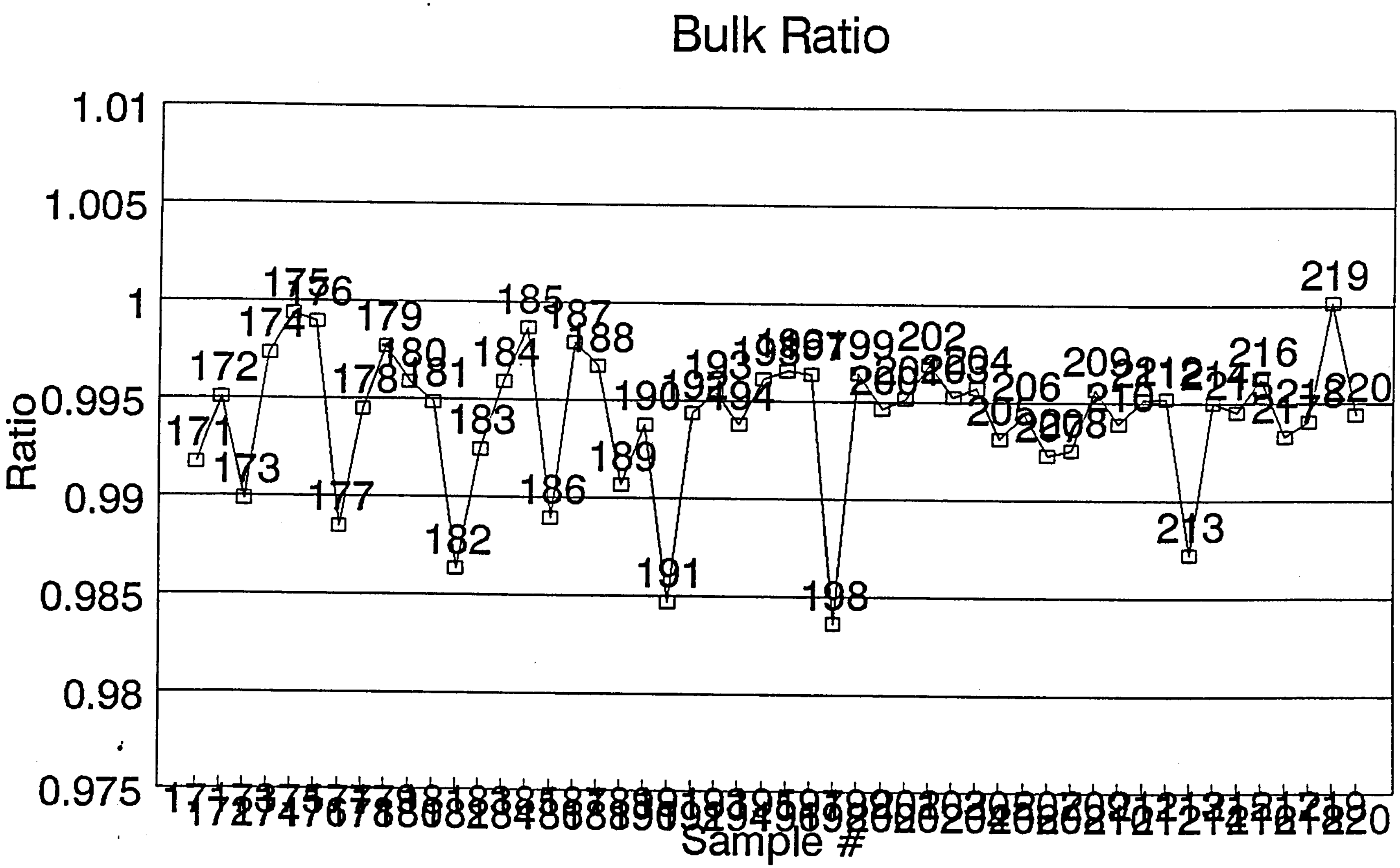


Bulk Ratio
Ratio
Sample #
1.01
1.005
1
0.995
0.99
0.985
0.98


Bulk Ratio
Ratio
Sample #
1.01
1.005
1
0.995
0.99
0.985
0.98
0.975
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Amoco 2-9 Shankle