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A STATISTICAL ANALYSIS OF LOW GRADE URANIUM BACTERIAL LEACH DATA FROM RIO ALGOM MINES LIMITED, ELLIOT LAKE, ONTARIO

by

F. J. Kelly

EXTRACTION METALLURGY DIVISION

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A STATISTICAL ANALYSIS OF LOW-GRADE URANIUM BACTERIAL LEACH DATA FROM RIO ALGOM MINES LIMITED, ELLIOT LAKE, ONTARIO

by

F. J. Kelly*

SUMMARY

A detailed statistical analysis was conducted of data from bacterial-leach test work done on low-grade uranium ore by the research staff of Rio Algom Mines Limited. The effects of ammonia levels (0.05 and 0.1 g/l) and pH (2.2, 3.0, 4.0) of the leach solution and wash frequency (weekly, twice weekly, daily) on the extraction of U_3O_8 from the trays of heaped ore were tested during a 40-week period.

Due mainly to the experimental error in this work being greater than many observations after test conditions had been varied, the results of the statistical analysis are of limited value in that they are useful only in indicating general trends and the relative importance of the variables examined. The most important trends and effects indicated by the relevant correlation coefficients are that uranium extraction: increases with increasing ammonium concentration and continues to increase with time, decreases with increasing solution pH and continues to decrease with time, increases with increasing wash frequency at the start of the leach period but steadily decreases with time. The interaction between ammonia concentration and solution pH is not significant. The interaction between ammonia concentration and wash frequency is highly significant and beneficial at the start of the leach period but steadily decreases with time. The interaction between solution pH and wash frequency is insignificant at the start of the leach period but becomes significantly detrimental to uranium extraction with time.

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CONCLUSIONS AND RECOMMENDATIONS

Because of the problems introduced by the experimental error the only significant statistics obtainable from the test observations were the correlation coefficients. The conclusions that can be made on the basis of the correlation coefficients are listed below.

1. Cumulative U_3O_8 extraction shows a significant positive correlation with increasing ammonia concentration in the leach solution in the range of 0.05 to 0.1 g/l.
2. Cumulative U_3O_8 extraction shows an insignificant correlation with increasing pH of solution i.e. reduced acidity in the range of 2.2 to 4.0, except during the last four weeks of the test when it becomes negatively significant.
3. Cumulative U_3O_8 extraction shows a significant positive correlation with increasing wash frequency in the range of weekly, twice weekly, daily, during the first four weeks of the leach period. The effect of this variable increases negatively with the length of the leach period. With U_3O_8 extraction based on successive four-week leach periods this variable shows significant negative correlation with extraction during the last 24 weeks of the test period.
4. Cumulative U_3O_8 extraction shows an insignificant correlation with the interaction between ammonia concentration and solution pH.

5. Cumulative U_3O_8 extraction shows a significant positive correlation with the interaction between ammonia concentration and wash frequency during the first 16 weeks of the test. The effect of this variable is to decrease extraction with the length of the leach period.
6. Cumulative U_3O_8 extraction shows, an insignificant correlation with the interaction between solution pH and wash frequency over the first 12 weeks of the test period, a negative correlation over the next 16 weeks, and a significant negative correlation over the last 8 weeks. Based on the U_3O_8 extraction of successive four-week leach periods this variable shows a highly significant negative correlation with extraction during the last 24 weeks of the test period.

The statistical analyses of these data indicate that bacterial leach process and/or future test work to extract uranium from heaped low-grade ore, under the same conditions as used in this test series, should maintain the concentration of ammonia in the leach solution in excess of 0.1 g/l while keeping the solution pH below a value of 2.2 if possible. At the start of the leach period the ore should be washed: daily during the first four week period, then twice a week over the next four weeks, and only once a week for the remainder of the leach period.

PROCEDURE

In July 1971, Mr. J.W. Fisher, Research Superintendent, Rio Algom Mines Limited, Elliot Lake, Ontario, requested that the Mines Branch conduct a statistical analysis on the results of a designed bacterial-leach experiment done by the company's R. & D. staff.

The experiment was designed around three independent variables: ammonia concentration (A) of the leach solution at two levels 0.05 and 0.1 g/l, pH (P) of the leach solution at three levels 2.2, 3.0, 4.0, and wash frequency (W) at three levels 7, 2, and 1 times per week. The experiment was carried out during a 40-week period. The data includes the results obtained from twenty-one samples. Each sample tray contained 10 kg of 1.5 to 1.0-inch ore. Based on the calculated heads, the mean U_3O_8 content of the 21 trays was 0.082 ± 0.010%. The leach solution was sampled every four weeks and analysed for U_3O_8 content. During the test period the temperature was thermostatically controlled at 70°F and the relative humidity was maintained at 100% saturation. One of the tests was replicated three times to provide an estimate of experimental error. The data are reproduced in the Appendix. Table 1, Appendix contains the cumulative U_3O_8 extracted (weight in mg and %) up to the end of each four-week period and Table 2 the amount extracted during each successive four-week period.

The correlations between the dependent variable (U_3O_8 extraction) and the independent variables (ammonia concentration, pH, and wash frequency) were tested by calculating the relevant correlation coefficients. Also, first-order linear regression equations relating the dependent and independent variables were calculated[1]. The regression analysis calculations produced approximately seventy-five empirical models for statistical assessment. The calculated correlation coefficients for the cumulative extraction of U_3O_8 are given in Table 1. Those based on the extraction of U_3O_8 over successive four-week periods are given in Table 2. Those values that are statistically significant at a confidence level of 95% are indicated by an asterisk(*). The calculated percentage of variation in the cumulative and non-cumulative extraction of U_3O_8 due to experimental error at the end of each successive four-week period as well as that based on the entire 40-week period are given in Table 3.

A verbal explanation of the detailed findings, along with the computer listings with suitable notations of the results, were presented to Mr. J.W. Fisher of the company's research staff by the author at a meeting held at the Mines Branch, 28 October, 1971. The detailed results have been communicated to the company, so only a summary of the results is given in this report.

RESULTS

The calculated correlation coefficients (Tables 1 and 2) range in values between minus 0.812 and plus 0.757. These values are not everywhere significant at a confidence level of 95% ($\leq$ minus 0.45 and $\geq$ plus 0.45). However, the coefficient values do indicate the relative effect that each of the independent variables has on the dependent variable with respect to time. The effect is beneficial when all are positive (e.g., ammonia) and detrimental when all are negative (e.g. pH). When these values range from positive to negative the effect is beneficial down to the crossover point and from thereon is detrimental (e.g. wash frequency). The opposite is true when the range is from negative to positive.

The only variable that shows a significant continuous positive effect is ammonia concentration (Tables 1, 2). The effect of the interaction between ammonia and pH (Tables 1, 2) is insignificant. The interaction between ammonia and wash frequency has a positive and significant effect on U_3O_8 extraction during the first 16 weeks of the test (Table 1). During the last 24 weeks the correlation coefficients show a steady decrease in value. However, when compared on a successive four-week leach period (Table 2) the effect is significantly positive for only the first 8 weeks and is significantly detrimental to U_3O_8 extraction during 12 of the last 16 weeks of the test.

The difference in the correlation coefficient values between Tables 1 and 2 for each of the independent variables is due to the masking effect caused by the accumulation of values for the dependent variable after each four-week test period (Table 1). This simply means that part of the variance in the dependent variable caused by the variation of the independent variables during the previous four-week test periods is carried over to the next four-week period. As a result rapid changes in the variance of the dependent variable are smoothed out over succeeding periods.

The effect of pH on U_3O_8 extraction is insignificant during the first 36 weeks of the test but becomes significant and reduces extraction during the last 4 weeks (Tables 1, 2). The effect of the interaction between pH and wash frequency is not significant. Table 2 shows, however, that during the last 24 weeks of the test the effect is significantly detrimental to U_3O_8 extraction. The effect of wash frequency is significantly beneficial during the first 4 weeks but significantly detrimental during the last 24 weeks of the test (Table 2).

The masking effect caused by the accumulation of U_3O_8 extraction values is clearly demonstrated in the cumulative experimental error calculation (Table 3). The error increases during the first 16 weeks and then becomes relatively constant during the last 26 weeks. The column of non-cumulative error values shows

that the largest error resulting from experimental techniques occurred during the 12 weeks after the first 4 weeks of the test. The pooled estimate of the experimental error for the 40-week test period accounts for 7.7% of the variation for the non-cumulative data and 9.5% of the variation for the cumulative data.

Because of the experimental error the first-order regression equations developed from the data failed to produce significant fits to the data. They can not therefore be used to predict the effects of experimental conditions not actually tested. In essence, the regression equations do not provide any additional information to that supplied by the correlation coefficients. Because none of these equations are of any statistical value, they are not reproduced in this report.

ACKNOWLEDGEMENTS

The contributions of Mr. D. Fraser of the Hydrometallurgy Section who assisted with the mathematical computations associated with this report are gratefully acknowledged.

REFERENCES

1. Draper, N. R., and Smith, H., "Applied Regression Analyses", Wiley, 1967.

TABLE: 1 RIO ALGOM R&D BACTERIAL LEACH DATA OF J.FISHER

CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES AND CUMULATIVE EXTRACTION OF U3O8

TEST PERIOD (WEEKS)	INDEPENDENT VARIABLES A NH4OH (G/L)	P PH	W WASH FREQUENCY	AP INTERACT	AW INTERACT	PW INTERACT
4	0.540*	-0.334	0.489*	0.237	0.757*	0.276
8	0.501*	-0.363	0.443	0.170	0.698*	0.224
12	0.504*	-0.393	0.358	0.154	0.622*	0.126
16	0.518*	-0.383	0.292	0.171	0.563*	0.060
20	0.546*	-0.388	0.152	0.198	0.443	-0.075
24	0.605*	-0.408	-0.001	0.243	0.307	-0.214
28	0.616*	-0.417	-0.107	0.255	0.211	-0.312
32	0.626*	-0.408	-0.199	0.275	0.124	-0.391
36	0.624*	-0.426	-0.285	0.270	0.042	-0.468*
40	0.621*	-0.463*	-0.348	0.242	-0.014	-0.526*

TABLE: 2 RIO ALGOM R&D BACTERIAL LEACH DATA OF J.FISHER

CORRELATION COEFFICIENTS BETWEEN INDEPENDENT VARIABLES AND EXTRACTION OF U3O8 OVER SUCCESSIVE FOUR WEEK LEACH PERIODS

TEST PERIOD	INDEPENDENT VARIABLES A NH4OH (G/L)	P PH	W WASH FREQUENCY	AP INTERACT	AW INTERACT	PW INTERACT
1	0.540*	-0.334	0.489*	0.237	0.757*	0.276
2	0.413	-0.372	0.352	0.073	0.570*	0.142
3	0.449*	-0.420	0.100	0.093	0.354	-0.139
4	0.510*	-0.292	-0.028	0.222	0.236	-0.225
5	0.434	-0.241	-0.523*	0.232	-0.269	-0.631*
6	0.547*	-0.303	-0.527*	0.291	-0.294	-0.600*
7	0.450*	-0.308	-0.733*	0.232	-0.471*	-0.809*
8	0.470*	-0.214	-0.693*	0.307	-0.456*	-0.739*
9	0.439	-0.413	-0.738*	0.161	-0.474*	-0.812*
10	0.342	-0.512*	-0.612*	-0.043	-0.373	-0.684*

* INDICATES STATISTICAL SIGNIFICANCE AT 95% CONFIDENCE LEVEL

TABLE: 3 RIO ALGOM R&D BACTERIAL LEACH DATA OF J.FISHER

PERCENTAGE OF VARIATION IN U3O8 EXTRACTION DUE TO EXPERIMENTAL ERROR

TEST PERIOD	CUMULATIVE ERROR	NON CUMULATIVE ERROR
4	2.366	2.366
8	6.713	13.767
12	8.781	13.713
16	10.325	16.120
20	11.548	7.924
24	10.886	2.393
28	11.340	6.952
32	11.623	6.373
36	11.065	5.034
40	10.568	2.780

AVERAGE EXPERIMENTAL NON CUMULATIVE ERROR VARIATION = 7.742%

AVERAGE EXPERIMENTAL CUMULATIVE ERROR VARIATION = 9.522%

A P P E N D I X

TABLE: 1 CONVERSION OF BACTERIAL LEACHING DATA TO PERCENT

TRAY	CUMULATIVE URANIUM OXIDE (MG. TO END OF WEEK)					VARIABLE LEVELS		
	(4)	(8)	(12)	(16)	(20)	A	P	W
1	264.5	583.8	960.8	1307.3	1639.5	0.05	2.2	7.0
% =	3.0745	6.7859	11.1681	15.1957	19.0571			
2	200.5	517.3	908.6	1255.6	1667.6	0.05	2.2	2.0
% =	2.0082	5.1813	9.1007	12.5762	16.7029			
3	233.1	462.4	734.7	1013.1	1309.5	0.05	2.2	1.0
% =	2.7126	5.3809	8.5497	11.7894	15.2386			
4	201.1	389.5	598.3	821.5	1028.1	0.05	3.0	7.0
% =	3.4175	6.6191	10.1674	13.9604	17.4713			
5	132.7	329.1	567.6	802.8	1079.7	0.05	3.0	2.0
% =	2.0601	5.1091	8.8116	12.4629	16.7616			
6	152.1	380.8	684.2	1013.2	1340.9	0.05	3.0	1.0
% =	1.6974	4.2498	7.6357	11.3074	14.9646			
7	188.9	384.7	614.5	859.4	1098.7	0.05	4.0	7.0
% =	2.0929	4.2622	6.8082	9.5215	12.1727			
29	222.3	504.1	786.3	1064.3	1319.2	0.05	4.0	7.0
% =	2.6899	6.0997	9.5143	12.8781	15.9624			
30	241.4	555.2	876.9	1195.6	1494.9	0.05	4.0	7.0
% =	2.9978	6.8948	10.8898	14.8476	18.5644			
36	216.5	479.5	794.0	1111.4	1396.3	0.05	4.0	7.0
% =	2.5401	5.6257	9.3155	13.0394	16.3820			
8	109.2	283.6	536.1	776.5	1076.3	0.05	4.0	2.0
% =	1.6760	4.3527	8.2281	11.9177	16.5191			
9	166.0	428.1	739.7	1082.0	1431.4	0.05	4.0	1.0
% =	1.9861	5.1219	8.8500	12.9454	17.1257			
10	464.2	934.6	1412.7	1850.0	2244.2	0.10	2.2	7.0
% =	5.7902	11.6577	17.6213	23.0760	27.9930			
11	285.4	626.2	1011.1	1371.5	1780.1	0.10	2.2	2.0
% =	3.2328	7.0932	11.4531	15.5354	20.1638			
12	236.3	522.4	818.7	1135.1	1442.6	0.10	2.2	1.0
% =	3.1552	6.9754	10.9317	15.1565	19.2624			
13	369.4	680.4	1028.8	1355.7	1631.8	0.10	3.0	7.0
% =	4.3134	7.9448	12.0129	15.8300	19.0540			
14	281.6	613.9	1020.8	1389.9	1809.0	0.10	3.0	2.0
% =	3.1449	6.8561	11.4004	15.5225	20.2030			
15	196.3	430.7	754.5	1101.9	1456.9	0.10	3.0	1.0
% =	2.1228	4.6575	8.1591	11.9158	15.7547			
16	304.8	620.0	936.3	1258.1	1567.0	0.10	4.0	7.0
% =	3.4451	7.0078	10.5829	14.2202	17.7116			
17	215.9	462.3	778.7	1095.2	1484.7	0.10	4.0	2.0
% =	2.5825	5.5299	9.3146	13.1005	17.7596			
18	204.8	421.2	689.6	988.7	1297.9	0.10	4.0	1.0
% =	3.0192	6.2095	10.1663	14.5757	19.1340			

VARIABLES: A=AMMONIA CONC(G/L) P=PH W=WASH FREQUENCY(NO PER WEEK)

TABLE: 1 (CONTINUED)

TRAY	CUMULATIVE URANIUM OXIDE (MG. TO END OF WEEK) (24)	(28)	(32)	(36)	(40)	TAILS	HEADS
1	1985.7	2276.5	2580.1	2859.9	3128.1	5475.0	8603.1
% =	23.0812	26.4614	29.9904	33.2427	36.3601	63.6399	
2	2050.7	2409.1	2761.7	3105.3	3433.9	6550.0	9983.9
% =	20.5401	24.1298	27.6615	31.1031	34.3944	65.6056	
3	1597.4	1873.3	2153.9	2457.7	2768.3	5825.0	8593.3
% =	18.5889	21.7995	25.0649	28.6002	32.2146	67.7854	
4	1211.8	1386.0	1562.5	1720.4	1884.5	4000.0	5884.5
% =	20.5931	23.5534	26.5528	29.2361	32.0248	67.9752	
5	1305.5	1508.9	1698.9	1899.1	2091.5	4350.0	6441.5
% =	20.2670	23.4247	26.3743	29.4823	32.4691	67.5309	
6	1686.4	2027.1	2393.2	2769.2	3140.5	5820.0	8960.5
% =	18.8204	22.6226	26.7083	30.9045	35.0483	64.9517	
7	1327.6	1518.4	1721.9	1910.3	2110.9	6915.0	9025.9
% =	14.7088	16.8227	19.0773	21.1546	23.3871	76.6129	
29	1565.6	1770.1	1989.7	2159.1	2339.4	5925.0	8264.4
% =	18.9439	21.4184	24.0756	26.1253	28.3070	71.6930	
30	1767.7	2006.2	2267.7	2499.9	2727.5	5325.0	8052.5
% =	21.9522	24.9140	28.1614	31.0450	33.8715	66.1285	
36	1657.4	1899.5	2138.9	2358.4	2583.4	5940.0	8523.4
% =	19.4453	22.2857	25.0944	27.6697	30.3095	69.6905	
8	1328.6	1546.5	1758.4	1950.1	2140.5	4375.0	6515.5
% =	20.3914	23.7357	26.9880	29.9302	32.8524	67.1476	
9	1767.6	2108.5	2468.6	2789.3	3143.2	5215.0	8358.2
% =	21.1481	25.2267	29.5351	33.3720	37.6062	62.3938	
10	2608.2	2902.5	3198.6	3496.8	3792.0	4225.0	8017.0
% =	32.5334	36.2043	39.8977	43.6173	47.2995	52.7005	
11	2132.0	2459.0	2783.3	3106.4	3453.2	5375.0	8828.2
% =	24.1499	27.8539	31.5274	35.1872	39.1156	60.8844	
12	1929.0	2239.3	2575.5	2920.8	3289.2	4200.0	7489.2
% =	25.7571	29.9004	34.3895	39.0002	43.9192	56.0808	
13	1914.3	2157.2	2403.0	2631.0	2864.1	5700.0	8564.1
% =	22.3526	25.1889	28.0590	30.7213	33.4431	66.5569	
14	2183.3	2531.7	2879.1	3194.9	3529.1	5425.0	8954.1
% =	24.3832	28.2742	32.1540	35.6809	39.4132	60.5868	
15	1822.1	2161.0	2532.6	2885.5	3272.4	5975.0	9247.4
% =	19.7039	23.3687	27.3872	31.2034	35.3872	64.6128	
16	1873.5	2145.7	2430.7	2696.1	2972.3	5875.0	8847.3
% =	21.1760	24.2526	27.4739	30.4737	33.5956	66.4044	
17	1835.6	2136.8	2462.9	2746.6	3045.0	5315.0	8360.0
% =	21.9569	25.5598	29.4605	32.8541	36.4234	63.5766	
18	1676.6	1971.4	2287.8	2590.2	2748.2	4035.0	6783.2
% =	24.7169	29.0630	33.7274	38.1855	40.5148	59.4852	

TABLE: 2 CONVERSION OF BACTERIAL LEACHING DATA TO PERCENT

TRAY	URANIUM OXIDE (MG. TO END OF WEEK)					VARIABLE LEVELS		
	(4)	(8)	(12)	(16)	(20)	A	P	W
1	264.5	319.3	377.0	346.5	332.2	0.05	2.2	7.0
% =	3.0745	3.7115	4.3821	4.0276	3.8614			
2	200.5	316.8	391.3	347.0	412.0	0.05	2.2	2.0
% =	2.0082	3.1731	3.9193	3.4756	4.1266			
3	233.1	229.3	272.3	278.4	296.4	0.05	2.2	1.0
% =	2.7126	2.6684	3.1687	3.2397	3.4492			
4	201.1	188.4	208.8	223.2	206.6	0.05	3.0	7.0
% =	3.4175	3.2016	3.5483	3.7930	3.5109			
5	132.7	196.4	238.5	235.2	276.9	0.05	3.0	2.0
% =	2.0601	3.0490	3.7026	3.6513	4.2987			
6	152.1	228.7	303.4	329.0	327.7	0.05	3.0	1.0
% =	1.6974	2.5523	3.3860	3.6717	3.6572			
7	188.9	195.8	229.8	244.9	239.3	0.05	4.0	7.0
% =	2.0929	2.1693	2.5460	2.7133	2.6513			
29	222.3	281.8	282.2	278.0	254.9	0.05	4.0	7.0
% =	2.6899	3.4098	3.4146	3.3638	3.0843			
30	241.4	313.8	321.7	318.7	299.3	0.05	4.0	7.0
% =	2.9978	3.8969	3.9950	3.9578	3.7169			
36	216.5	263.0	314.5	317.4	284.9	0.05	4.0	7.0
% =	2.5401	3.0856	3.6898	3.7239	3.3426			
8	109.2	174.4	252.5	240.4	299.8	0.05	4.0	2.0
% =	1.6760	2.6767	3.8754	3.6897	4.6013			
9	166.0	262.1	311.6	342.3	349.4	0.05	4.0	1.0
% =	1.9861	3.1358	3.7281	4.0954	4.1803			
10	464.2	470.4	478.1	437.3	394.2	0.10	2.2	7.0
% =	5.7902	5.8675	5.9636	5.4547	4.9171			
11	285.4	340.8	384.9	360.4	408.6	0.10	2.2	2.0
% =	3.2328	3.8604	4.3599	4.0824	4.6283			
12	236.3	286.1	296.3	316.4	307.5	0.10	2.2	1.0
% =	3.1552	3.8202	3.9564	4.2248	4.1059			
13	369.4	311.0	348.4	326.9	276.1	0.10	3.0	7.0
% =	4.3134	3.6314	4.0681	3.8171	3.2239			
14	281.6	332.3	406.9	369.1	419.1	0.10	3.0	2.0
% =	3.1449	3.7111	4.5443	4.1221	4.6805			
15	196.3	234.4	323.8	347.4	355.0	0.10	3.0	1.0
% =	2.1228	2.5348	3.5015	3.7567	3.8389			
16	304.8	315.2	316.3	321.8	308.9	0.10	4.0	7.0
% =	3.4451	3.5627	3.5751	3.6373	3.4915			
17	215.9	246.4	316.4	316.5	389.5	0.10	4.0	2.0
% =	2.5825	2.9474	3.7847	3.7859	4.6591			
18	204.8	216.4	268.4	299.1	309.2	0.10	4.0	1.0
% =	3.0192	3.1902	3.9568	4.4094	4.5583			

VARIABLES: A=AMMONIA CONC(G/L) P=PH W=WASH FREQUENCY(NO PER WEEK)

TABLE: 2 (CONTINUED)

TRAY	URANIUM OXIDE (MG. TO END OF WEEK) (24)	(28)	(32)	(36)	(40)	TAILS	HEADS
1	346.2	290.8	303.6	279.8	268.2	5475.0	8603.1
% =	4.0241	3.3802	3.5290	3.2523	3.1175	63.6399	
2	383.1	358.4	352.6	343.6	328.6	6550.0	9983.9
% =	3.8372	3.5898	3.5317	3.4415	3.2913	65.6056	
3	287.9	275.9	280.6	303.8	310.6	5825.0	8593.3
% =	3.3503	3.2106	3.2653	3.5353	3.6144	67.7854	
4	183.7	174.2	176.5	157.9	164.1	4000.0	5884.5
% =	3.1218	2.9603	2.9994	2.6833	2.7887	67.9752	
5	225.8	203.4	190.0	200.2	192.4	4350.0	6441.5
% =	3.5054	3.1576	2.9496	3.1080	2.9869	67.5309	
6	345.5	340.7	366.1	376.0	371.3	5820.0	8960.5
% =	3.8558	3.8022	4.0857	4.1962	4.1437	64.9517	
7	228.9	190.8	203.5	188.4	200.6	6915.0	9025.9
% =	2.5360	2.1139	2.2546	2.0873	2.2225	76.6129	
29	246.4	204.5	219.6	169.4	180.3	5925.0	8264.4
% =	2.9815	2.4745	2.6572	2.0498	2.1816	71.6930	
30	272.8	238.5	261.5	232.2	227.6	5325.0	8052.5
% =	3.3878	2.9618	3.2474	2.8836	2.8265	66.1285	
36	261.1	242.1	239.4	219.5	225.0	5940.0	8523.4
% =	3.0633	2.8404	2.8087	2.5753	2.6398	69.6905	
8	252.3	217.9	211.9	191.7	190.4	4375.0	6515.5
% =	3.8723	3.3443	3.2522	2.9422	2.9223	67.1476	
9	336.2	340.9	360.1	320.7	353.9	5215.0	8358.2
% =	4.0224	4.0786	4.3083	3.8370	4.2342	62.3938	
10	364.0	294.3	296.1	298.2	295.2	4225.0	8017.0
% =	4.5404	3.6709	3.6934	3.7196	3.6822	52.7005	
11	351.9	327.0	324.3	323.1	346.8	5375.0	8828.2
% =	3.9861	3.7040	3.6735	3.6599	3.9283	60.8844	
12	486.4	310.3	336.2	345.3	368.4	4200.0	7489.2
% =	6.4947	4.1433	4.4891	4.6106	4.9191	56.0808	
13	282.5	242.9	245.8	228.0	233.1	5700.0	8564.1
% =	3.2987	2.8363	2.8701	2.6623	2.7218	66.5569	
14	374.3	348.4	347.4	315.8	334.2	5425.0	8954.1
% =	4.1802	3.8910	3.8798	3.5269	3.7324	60.5868	
15	365.2	338.9	371.6	352.9	386.9	5975.0	9247.4
% =	3.9492	3.6648	4.0184	3.8162	4.1839	64.6128	
16	306.5	272.2	285.0	265.4	276.2	5875.0	8847.3
% =	3.4643	3.0766	3.2213	2.9998	3.1219	66.4044	
17	350.9	301.2	326.1	283.7	298.4	5315.0	8360.0
% =	4.1974	3.6029	3.9007	3.3935	3.5694	63.5766	
18	378.7	294.8	316.4	302.4	158.0	4035.0	6783.2
% =	5.5829	4.3460	4.6645	4.4581	2.3293	59.4852	