GCA data

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Contents

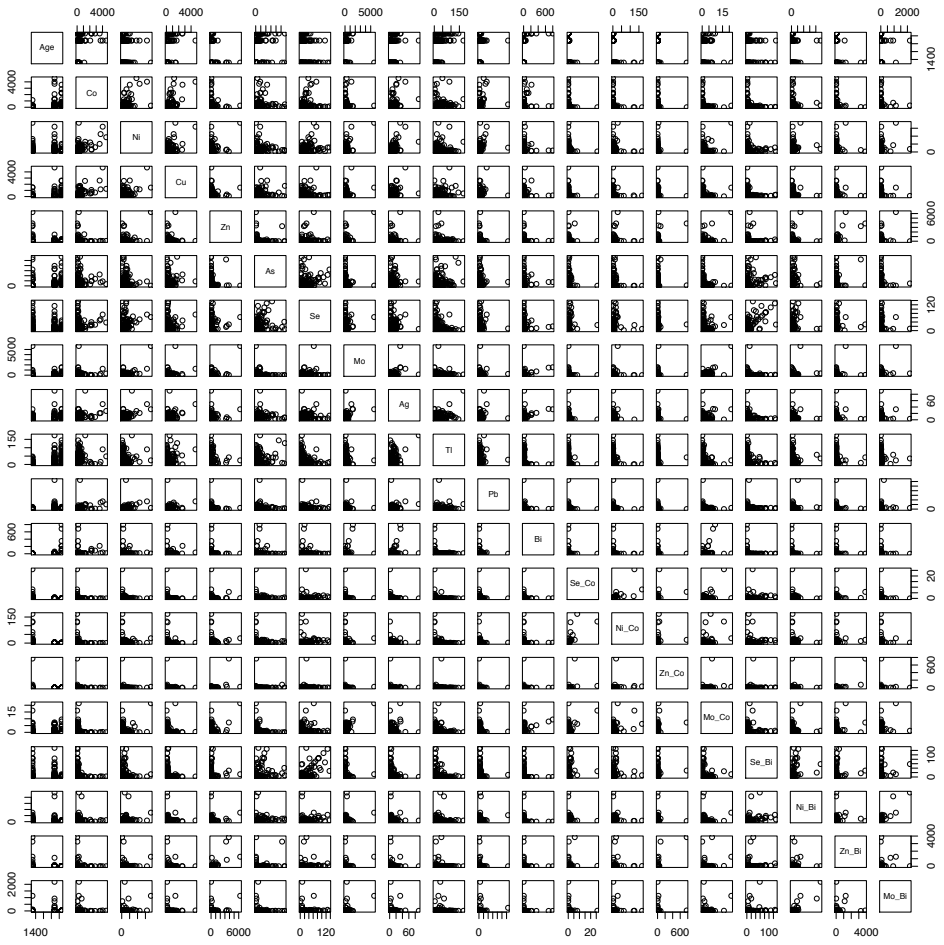

Figure 1: Scatter plot of all variables.

1 Data

I plot the data in Fig. 1 and 2.

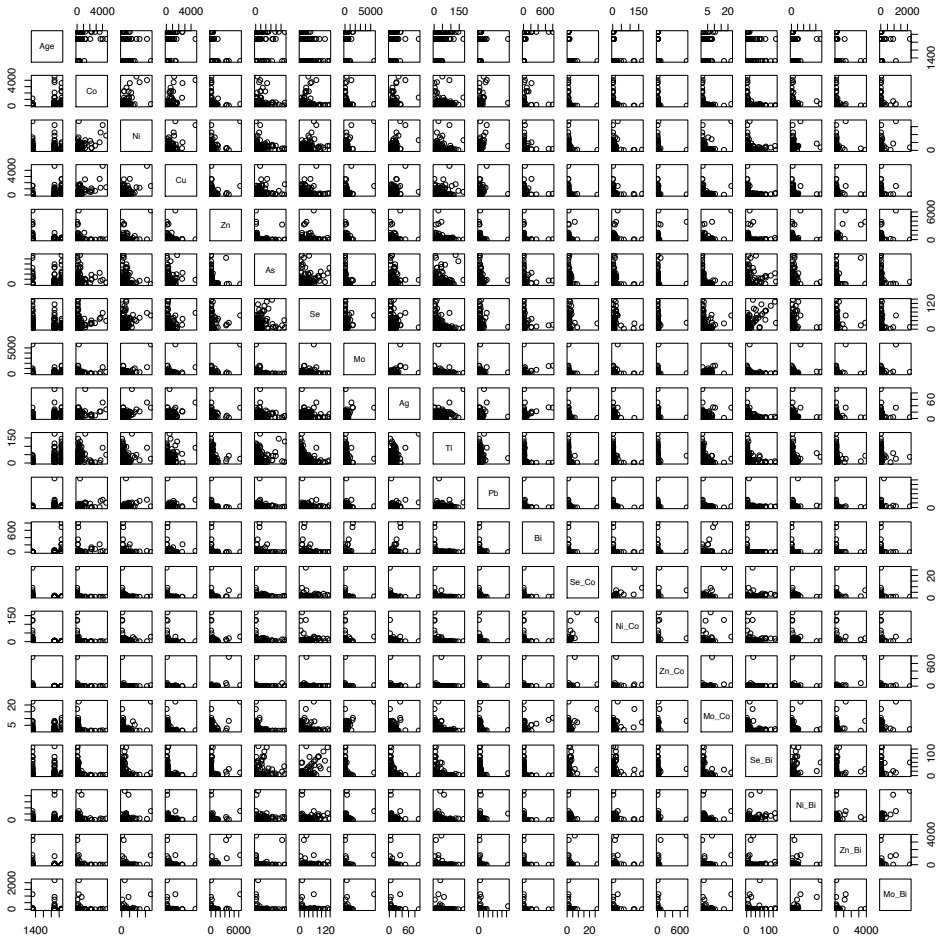

Figure 2: Scatter plot of all variables (+1) — log 10 scales.

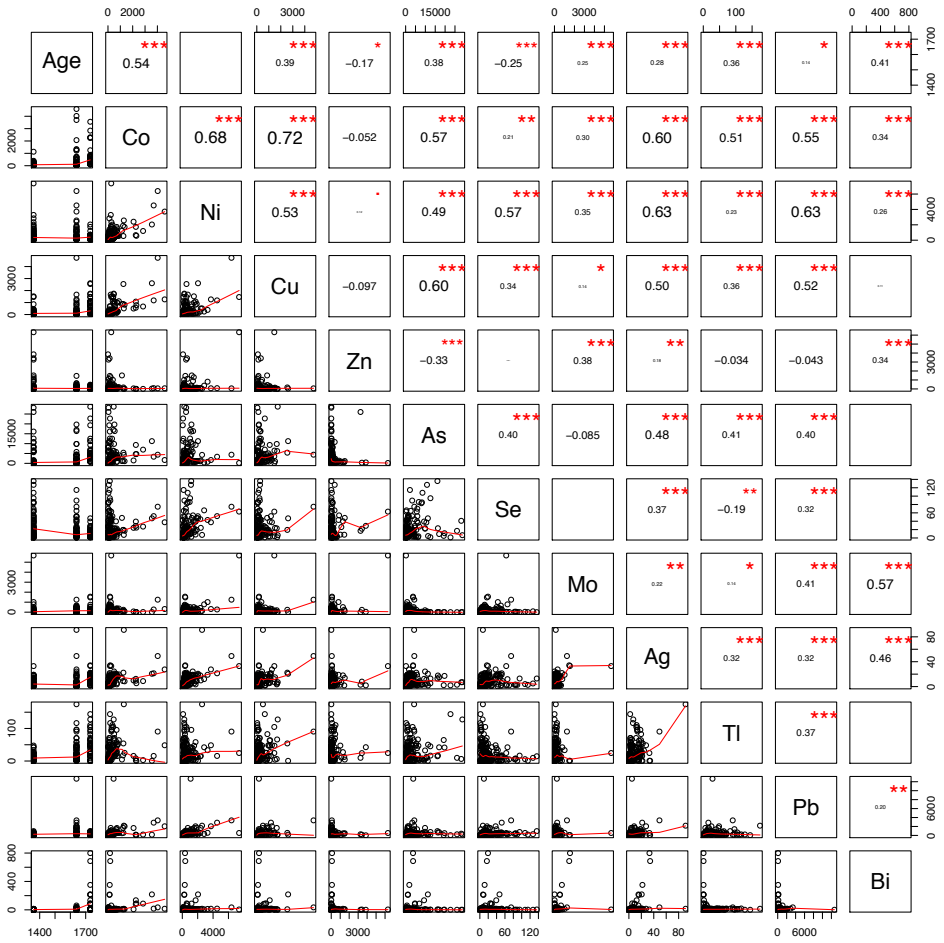

Figure 3: Spearman correlations of main variables (+1) — log 10 scales.

2 Correlations

I show the data with correlations in Fig. 3 – 4. Also shown are smoothed trends.

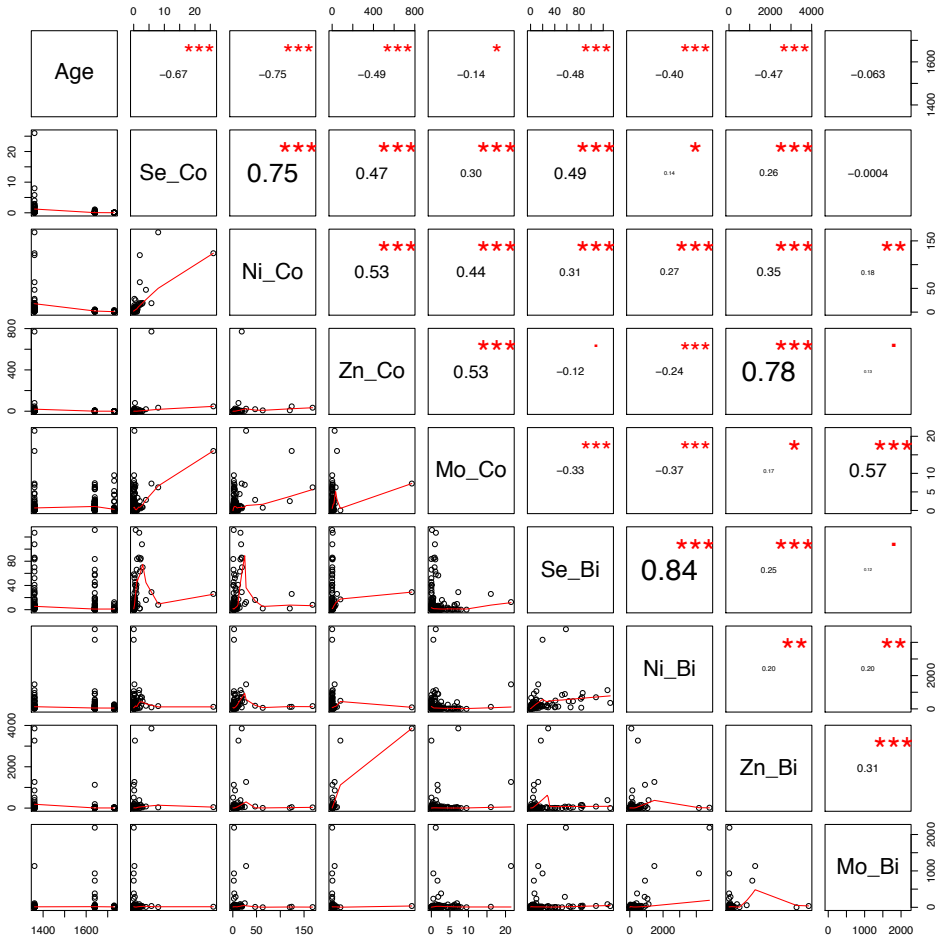

Figure 4: Spearman correlations of ratio variables (+1) — log 10 scales.

I show the Spearman correlations of each variable with `Age` below. This is a non-parametric measure, which means that using the logged data would give the same result. For each I show the correlation, the significance, and the sample size.

The CORR Procedure

Spearman Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	Co	Ni	Cu	Zn	As	Se	Mo	Ag	Tl	Pb	Bi
Age	0.54140	0.00943	0.39375	-0.16633	0.37540	-0.24914	0.24955	0.28389	0.35966	0.14187	0.40885
Age	<.0001	0.8904	<.0001	0.0144	<.0001	0.0002	0.0002	<.0001	<.0001	0.0381	<.0001
	216	216	216	216	216	216	216	211	216	214	216

The CORR Procedure

Spearman Correlation Coefficients, N = 216
Prob > |r| under H0: Rho=0

	Se_Co	Ni_Co	Zn_Co	Mo_Co	Se_Bi	Ni_Bi	Zn_Bi	Mo_Bi
Age	-0.66702	-0.75275	-0.48966	-0.14217	-0.47688	-0.40362	-0.46517	-0.06345
Age	<.0001	<.0001	<.0001	0.0368	<.0001	<.0001	<.0001	0.3534

3 Regressions

I calculate simple linear regressions of the logged data versus age. For each I show the r-squared and the parameters estimates (intercept and slope).

The REG Procedure
Model: MODEL1
Dependent Variable: L_Co

Root MSE	0.48634	R-Square	0.2062	
Dependent Mean	2.18112	Adj R-Sq	0.2024	
Coeff Var	22.29753			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-0.73542	0.39726	-1.85	0.0655
Age	Age	1	0.00183	0.00024845	7.37	<.0001

The REG Procedure
Model: MODEL2
Dependent Variable: L_Ni

Root MSE	0.41710	R-Square	0.0139	
Dependent Mean	2.55789	Adj R-Sq	0.0092	
Coeff Var	16.30634			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	3.14105	0.34070	9.22	<.0001
Age	Age	1	-0.00036601	0.00021308	-1.72	0.0873

The REG Procedure
Model: MODEL3
Dependent Variable: L_Cu

Root MSE	0.46937	R-Square	0.1103	
Dependent Mean	2.16047	Adj R-Sq	0.1060	
Coeff Var	21.72556			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	0.21579	0.38340	0.56	0.5742
Age	Age	1	0.00122	0.00023978	5.09	<.0001

The REG Procedure
Model: MODEL4
Dependent Variable: L_Zn

Root MSE	0.73071	R-Square	0.0774	
Dependent Mean	1.69032	Adj R-Sq	0.0730	
Coeff Var	43.22916			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	4.18080	0.59687	7.00	<.0001
Age	Age	1	-0.00156	0.00037329	-4.19	<.0001

The REG Procedure
Model: MODEL5
Dependent Variable: L_As

Root MSE	0.62405	R-Square	0.0662	
Dependent Mean	3.02085	Adj R-Sq	0.0617	
Coeff Var	20.65803			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	1.06580	0.50974	2.09	0.0378
Age	Age	1	0.00123	0.00031880	3.85	0.0002

The REG Procedure
Model: MODEL6
Dependent Variable: L_Se

Root MSE	0.37702	R-Square	0.1579	
Dependent Mean	1.09288	Adj R-Sq	0.1539	
Coeff Var	34.49750			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	3.01407	0.30796	9.79	<.0001
Age	Age	1	-0.00121	0.00019260	-6.26	<.0001

The REG Procedure
Model: MODEL7
Dependent Variable: L_Mo

Root MSE	0.74325	R-Square	0.0554	
Dependent Mean	1.82954	Adj R-Sq	0.0509	
Coeff Var	40.62495			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-0.28926	0.60711	-0.48	0.6342
Age	Age	1	0.00133	0.00037969	3.50	0.0006

The REG Procedure
Model: MODEL8
Dependent Variable: L_Ag

Root MSE	0.38525	R-Square	0.0169	
Dependent Mean	0.76177	Adj R-Sq	0.0122	
Coeff Var	50.57268			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	0.16730	0.31468	0.53	0.5955
Age	Age	1	0.00037311	0.00019680	1.90	0.0594

The REG Procedure
Model: MODEL9
Dependent Variable: L_Tl

Root MSE	0.49183	R-Square	0.0817	
Dependent Mean	1.12062	Adj R-Sq	0.0773	
Coeff Var	43.88923			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-0.60594	0.40174	-1.51	0.1330
Age	Age	1	0.00108	0.00025125	4.31	<.0001

The REG Procedure
Model: MODEL10
Dependent Variable: L_Pb

Root MSE	0.43120	R-Square	0.0654	
Dependent Mean	2.48296	Adj R-Sq	0.0609	
Coeff Var	17.36648			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	1.14090	0.35222	3.24	0.0014
Age	Age	1	0.00084233	0.00022028	3.82	0.0002

The REG Procedure
Model: MODEL11
Dependent Variable: L_Bi

Root MSE	0.46300	R-Square	0.1578	
Dependent Mean	0.89587	Adj R-Sq	0.1537	
Coeff Var	51.68177			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-1.46196	0.37820	-3.87	0.0001
Age	Age	1	0.00148	0.00023653	6.26	<.0001

The REG Procedure
Model: MODEL12
Dependent Variable: L_Se_Co

Root MSE	0.13493	R-Square	0.2625	
Dependent Mean	0.07895	Adj R-Sq	0.2589	
Coeff Var	170.89017			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	1.02608	0.11021	9.31	<.0001
Age	Age	1	-0.00059445	0.00006893	-8.62	<.0001

The REG Procedure
Model: MODEL13
Dependent Variable: L_Ni_Co

Root MSE	0.19799	R-Square	0.5640	
Dependent Mean	0.56829	Adj R-Sq	0.5619	
Coeff Var	34.83928			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	3.21801	0.16172	19.90	<.0001
Age	Age	1	-0.00166	0.00010114	-16.44	<.0001

The REG Procedure
Model: MODEL14
Dependent Variable: L_Zn_Co

Root MSE	0.33246	R-Square	0.2474	
Dependent Mean	0.28271	Adj R-Sq	0.2438	
Coeff Var	117.59645			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	2.52554	0.27156	9.30	<.0001
Age	Age	1	-0.00141	0.00016984	-8.29	<.0001

The REG Procedure
Model: MODEL15
Dependent Variable: L_Mo_Co

Root MSE	0.26160	R-Square	0.0045	
Dependent Mean	0.28774	Adj R-Sq	-0.0002	
Coeff Var	90.91794			

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	0.49504	0.21369	2.32	0.0215
Age	Age	1	-0.00013011	0.00013364	-0.97	0.3314

The REG Procedure

Model: MODEL16
Dependent Variable: L_Se_Bi

Root MSE	0.45080	R-Square	0.2594
Dependent Mean	0.57952	Adj R-Sq	0.2559
Coeff Var	77.78838		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	3.71913	0.36823	10.10	<.0001
Age	Age	1	-0.00197	0.00023029	-8.56	<.0001

The REG Procedure
Model: MODEL17
Dependent Variable: L_Ni_Bi

Root MSE	0.55292	R-Square	0.1898
Dependent Mean	1.81151	Adj R-Sq	0.1859
Coeff Var	30.52260		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	4.96001	0.45164	10.98	<.0001
Age	Age	1	-0.00198	0.00028246	-7.00	<.0001

The REG Procedure
Model: MODEL18
Dependent Variable: L_Zn_Bi

Root MSE	0.55594	R-Square	0.3137
Dependent Mean	1.02384	Adj R-Sq	0.3104
Coeff Var	54.29953		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	5.44602	0.45411	11.99	<.0001
Age	Age	1	-0.00278	0.00028400	-9.77	<.0001

The REG Procedure
Model: MODEL19
Dependent Variable: L_Mo_Bi

Root MSE	0.57001	R-Square	0.0016
Dependent Mean	1.12442	Adj R-Sq	-0.0032
Coeff Var	50.69329		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	1.39227	0.46560	2.99	0.0031
Age	Age	1	-0.00016811	0.00029119	-0.58	0.5643

4 AOVs

I calculate analyses of variance of the logged data to compare mean values for each level of age. For each I show the F tests (see `Pr > F`) and predicted means (see `LSMEAN`). I compare all pairs of means after adjusting the P values for multiplicity using Tukey's method. These are shown as 3x3 matrices containing adjusted P values.

Where the F test is significant the comparisons of pairs of means indicate the source(s) of the significance. If the F test is not significant, the comparisons of pairs of means are not of interest. For example, for `L_Co` the F test is significant, and the 3 pairs of means all differ signifiantly. However,for `L_Ni` the F test is not significant which means that the the 3 ages do not differ significantly.

I examine the distribution of residual using QQ-plots (not shown). All variables met the assumptions of ANOVA except `Se_Co`, `Ni_Co`, `Zn_Co`, and `Mo_Co`.

```
The GLM Procedure

Dependent Variable: L_Co
Source                      DF     Type III SS     Mean Square    F Value    Pr > F
Age                          2     22.21613578     11.10806789      45.14    <.0001
The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer
                             LSMEAN
Age          L_Co LSMEAN     Number
1360.000      1.71917958          1
1640.000      2.14535608          2
1730.000      2.66091901          3

      Least Squares Means for effect Age
     Pr > |t| for H0: LSMean(i)=LSMean(j)

           Dependent Variable: L_Co

i/j              1             2             3
   1                       <.0001        <.0001
   2        <.0001                       <.0001
   3        <.0001        <.0001
```

```
The GLM Procedure

Dependent Variable: L_Ni
Source                      DF     Type III SS     Mean Square    F Value    Pr > F
Age                          2      0.35233453      0.17616726       0.95    0.3902
The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer
                             LSMEAN
Age          L_Ni LSMEAN     Number
1360.000      2.58979222          1
1640.000      2.50380251          2
1730.000      2.57780807          3

      Least Squares Means for effect Age
     Pr > |t| for H0: LSMean(i)=LSMean(j)
```

Dependent Variable: L_Ni

i/j	1	2	3
1		0.4456	0.9894
2	0.4456		0.5886
3	0.9894	0.5886	

The GLM Procedure

Dependent Variable: L_Cu

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	11.80124112	5.90062056	28.47	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Cu LSMEAN	LSMEAN Number
1360.000	1.92077948	1
1640.000	2.08502147	2
1730.000	2.57800305	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Cu

i/j	1	2	3
1		0.0734	<.0001
2	0.0734		<.0001
3	<.0001	<.0001	

The GLM Procedure

Dependent Variable: L_Zn

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	7.69424593	3.84712297	7.15	0.0010

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Zn LSMEAN	LSMEAN Number
1360.000	2.00279019	1
1640.000	1.57751146	2
1730.000	1.55182909	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Zn

i/j	1	2	3
1		0.0014	0.0067

2	0.0014		0.9780
3	0.0067	0.9780	

The GLM Procedure

Dependent Variable: L_As

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	19.85381604	9.92690802	25.26	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_As LSMEAN	LSMEAN Number
1360.000	2.70794716	1
1640.000	2.88843916	2
1730.000	3.54761886	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_As

i/j	1	2	3
1		0.1870	<.0001
2	0.1870		<.0001
3	<.0001	<.0001	

The GLM Procedure

Dependent Variable: L_Se

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	4.69532650	2.34766325	15.76	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Se LSMEAN	LSMEAN Number
1360.000	1.33540159	1
1640.000	0.99098221	2
1730.000	1.01418817	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Se

i/j	1	2	3
1		<.0001	0.0001
2	<.0001		0.9366
3	0.0001	0.9366	

The GLM Procedure

Dependent Variable: L_Mo

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	11.27089359	5.63544680	10.13	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Mo LSMEAN	LSMEAN Number
1360.000	1.41104253	1
1640.000	1.94285453	2
1730.000	1.91455360	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Mo

i/j	1	2	3
1		<.0001	0.0025
2	<.0001		0.9743
3	0.0025	0.9743	

The GLM Procedure

Dependent Variable: L_Ag

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	8.21179207	4.10589603	36.59	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Ag LSMEAN	LSMEAN Number
1360.000	0.76494665	1
1640.000	0.61795157	2
1730.000	1.11785552	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Ag

i/j	1	2	3
1		0.0276	<.0001
2	0.0276		<.0001
3	<.0001	<.0001	

The GLM Procedure

Dependent Variable: L_Tl

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	7.20565179	3.60282590	14.85	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Tl LSMEAN	LSMEAN Number
1360.000	0.84909218	1
1640.000	1.10990826	2
1730.000	1.38486309	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Tl

i/j	1	2	3
1		0.0041	<.0001
2	0.0041		0.0045
3	<.0001	0.0045	

The GLM Procedure

Dependent Variable: L_Pb

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	8.31373297	4.15686648	20.77	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Pb LSMEAN	LSMEAN Number
1360.000	2.14931947	1
1640.000	2.62335706	2
1730.000	2.40698722	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Pb

i/j	1	2	3
1		<.0001	0.0130
2	<.0001		0.0166
3	0.0130	0.0166	

The GLM Procedure

Dependent Variable: L_Bi

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	10.39421417	5.19710708	24.96	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Bi LSMEAN	LSMEAN Number

```
1360.000      0.55662760           1
1640.000      0.91496754           2
1730.000      1.19291417           3

      Least Squares Means for effect Age
     Pr > |t| for H0: LSMean(i)=LSMean(j)

           Dependent Variable: L_Bi

i/j             1            2            3
   1                     <.0001       <.0001
   2        <.0001                    0.0017
   3        <.0001       0.0017
```

```
The GLM Procedure

Dependent Variable: L_Se_Co
Source                      DF     Type III SS     Mean Square    F Value    Pr > F
Age                          2      1.76409148      0.88204574      42.06    <.0001
The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer
                 L_Se_Co      LSMEAN
Age               LSMEAN      Number
1360.000      0.23998226           1
1640.000      0.04409320           2
1730.000      0.01107362           3

      Least Squares Means for effect Age
     Pr > |t| for H0: LSMean(i)=LSMean(j)

         Dependent Variable: L_Se_Co

i/j             1            2            3
   1                     <.0001       <.0001
   2        <.0001                    0.3928
   3        <.0001       0.3928
```

```
The GLM Procedure

Dependent Variable: L_Ni_Co
Source                      DF     Type III SS     Mean Square    F Value    Pr > F
Age                          2     13.37614853      6.68807426     119.43    <.0001
The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer
                 L_Ni_Co      LSMEAN
Age               LSMEAN      Number
1360.000      0.98153398           1
1640.000      0.52289161           2
1730.000      0.27974899           3

      Least Squares Means for effect Age
```

```
     Pr > |t| for H0: LSMean(i)=LSMean(j)

         Dependent Variable: L_Ni_Co

i/j              1             2             3
   1                       <.0001        <.0001
   2        <.0001                       <.0001
   3        <.0001        <.0001
```

```
The GLM Procedure

Dependent Variable: L_Zn_Co
Source                      DF     Type III SS     Mean Square    F Value    Pr > F
Age                          2      8.91345916      4.45672958      39.01    <.0001
The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer
                 L_Zn_Co      LSMEAN
Age               LSMEAN      Number
1360.000      0.63253596           1
1640.000      0.21792896           2
1730.000      0.08835161           3

      Least Squares Means for effect Age
     Pr > |t| for H0: LSMean(i)=LSMean(j)

         Dependent Variable: L_Zn_Co

i/j              1             2             3
   1                       <.0001        <.0001
   2        <.0001                       0.0739
   3        <.0001        0.0739
```

```
The GLM Procedure

Dependent Variable: L_Mo_Co
Source                      DF     Type III SS     Mean Square    F Value    Pr > F
Age                          2      0.56488482      0.28244241       4.22    0.0160
The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer
                 L_Mo_Co      LSMEAN
Age               LSMEAN      Number
1360.000      0.30461604           1
1640.000      0.32233515           2
1730.000      0.19298899           3

      Least Squares Means for effect Age
     Pr > |t| for H0: LSMean(i)=LSMean(j)

         Dependent Variable: L_Mo_Co

i/j              1             2             3
```

1		0.9084	0.0808
2	0.9084		0.0127
3	0.0808	0.0127	

The GLM Procedure

Dependent Variable: L_Se_Bi

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	14.17343289	7.08671645	34.78	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Se_Bi LSMEAN	LSMEAN Number
1360.000	1.00682002	1
1640.000	0.47968011	2
1730.000	0.32476774	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Se_Bi

i/j	1	2	3
1		<.0001	<.0001
2	<.0001		0.1229
3	<.0001	0.1229	

The GLM Procedure

Dependent Variable: L_Ni_Bi

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	13.93333289	6.96666645	22.61	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Ni_Bi LSMEAN	LSMEAN Number
1360.000	2.22504503	1
1640.000	1.72598713	2
1730.000	1.52841199	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Ni_Bi

i/j	1	2	3
1		<.0001	<.0001
2	<.0001		0.1052
3	<.0001	0.1052	

The GLM Procedure

Dependent Variable: L_Zn_Bi

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	29.06649145	14.53324573	47.29	<.0001

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Zn_Bi LSMEAN	LSMEAN Number
1360.000	1.64950653	1
1640.000	0.85276928	2
1730.000	0.72259738	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Zn_Bi

i/j	1	2	3
1		<.0001	<.0001
2	<.0001		0.3714
3	<.0001	0.3714	

The GLM Procedure

Dependent Variable: L_Mo_Bi

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	2	2.04301480	1.02150740	3.21	0.0423

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

Age	L_Mo_Bi LSMEAN	LSMEAN Number
1360.000	1.07038707	1
1640.000	1.19485589	2
1730.000	0.95331621	3

Least Squares Means for effect Age
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: L_Mo_Bi

i/j	1	2	3
1		0.3714	0.5533
2	0.3714		0.0394
3	0.5533	0.0394	

I separately analyse some ratios using the Kruskal-Wallis test. This is a non-parametric equivalent to ANOVA. The significance of the Kruskal-Wallis test is given by `Pr > Chi-Square`. For these you would quote the chi-square statistic and the P value.

Where significant, I compare pairs of ages using the Wilcoxon test and use Monte Carlo approximation to estimate the P value. The significance of the Wilcoxon test is given by the estmate under `Monte Carlo Estimates for the Exact Test` and then `Two-Sided Pr >= |S - Mean|`. For these you would quote the Wilcoxon `S` statistic and the P value.

L_Se_Co:

```
The NPAR1WAY Procedure
   Kruskal-Wallis Test
Chi-Square         95.7145
DF                       2
Pr > Chi-Square     <.0001
```

Comparing pairs:

```
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         6863.0000

Normal Approximation
Z                        7.1948
One-Sided Pr >  Z        <.0001
Two-Sided Pr > |Z|       <.0001

t Approximation
One-Sided Pr >  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr >= S
Estimate                          0.0000
99% Lower Conf Limit              0.0000
99% Upper Conf Limit           4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                          0.0000
99% Lower Conf Limit              0.0000
99% Upper Conf Limit           4.604E-04

Number of Samples                   10000
Initial Seed                    962995001
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         1198.0000

Normal Approximation
Z                       -7.8250
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001
```

```
t Approximation
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
Estimate                        0.0000
99% Lower Conf Limit            0.0000
99% Upper Conf Limit         4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                        0.0000
99% Lower Conf Limit            0.0000
99% Upper Conf Limit         4.604E-04

Number of Samples                10000
Initial Seed                963095001
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)          2055.0000

Normal Approximation
Z                       -6.2510
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001

t Approximation
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
Estimate                        0.0000
99% Lower Conf Limit            0.0000
99% Upper Conf Limit         4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                        0.0000
99% Lower Conf Limit            0.0000
99% Upper Conf Limit         4.604E-04

Number of Samples                10000
Initial Seed                963176001
```

L_Ni_Co:

```
The NPAR1WAY Procedure
    Kruskal-Wallis Test
Chi-Square         122.1552
DF                        2
Pr > Chi-Square      <.0001
```

Comparing pairs:

```
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         7071.0000

Normal Approximation
Z                        7.8876
One-Sided Pr >  Z        <.0001
Two-Sided Pr > |Z|       <.0001

t Approximation
One-Sided Pr >  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr >= S
Estimate                      0.0000
99% Lower Conf Limit          0.0000
99% Upper Conf Limit         4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                      0.0000
99% Lower Conf Limit          0.0000
99% Upper Conf Limit         4.604E-04

Number of Samples               10000
Initial Seed                964958001
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         1168.0000

Normal Approximation
Z                       -8.0295
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001

t Approximation
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
```

```
Estimate                          0.0000
99% Lower Conf Limit              0.0000
99% Upper Conf Limit           4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                          0.0000
99% Lower Conf Limit              0.0000
99% Upper Conf Limit           4.604E-04

Number of Samples                 10000
Initial Seed                  965048001
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)           1525.0000

Normal Approximation
Z                         -8.2343
One-Sided Pr <  Z          <.0001
Two-Sided Pr > |Z|         <.0001

t Approximation
One-Sided Pr <  Z          <.0001
Two-Sided Pr > |Z|         <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
Estimate                          0.0000
99% Lower Conf Limit              0.0000
99% Upper Conf Limit           4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                          0.0000
99% Lower Conf Limit              0.0000
99% Upper Conf Limit           4.604E-04

Number of Samples                 10000
Initial Seed                  965108001
```

L_Zn_Co:

```
The NPAR1WAY Procedure
   Kruskal-Wallis Test
Chi-Square         52.9918
DF                       2
Pr > Chi-Square     <.0001
```

Comparing pairs:

```
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         6390.0000

Normal Approximation
Z                        5.6192
One-Sided Pr >  Z        <.0001
Two-Sided Pr > |Z|       <.0001

t Approximation
One-Sided Pr >  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr >= S
Estimate                    0.0000
99% Lower Conf Limit        0.0000
99% Upper Conf Limit     4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                    0.0000
99% Lower Conf Limit        0.0000
99% Upper Conf Limit     4.604E-04

Number of Samples             10000
Initial Seed              966811001
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         1377.0000

Normal Approximation
Z                       -6.6043
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001

t Approximation
One-Sided Pr <  Z        <.0001
Two-Sided Pr > |Z|       <.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
```

```
Estimate                         0.0000
99% Lower Conf Limit             0.0000
99% Upper Conf Limit          4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                         0.0000
99% Lower Conf Limit             0.0000
99% Upper Conf Limit          4.604E-04

Number of Samples                10000
Initial Seed                 966901001
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)          2866.0000

Normal Approximation
Z                        -3.2163
One-Sided Pr <  Z         0.0006
Two-Sided Pr > |Z|        0.0013

t Approximation
One-Sided Pr <  Z         0.0008
Two-Sided Pr > |Z|        0.0016
Z includes a continuity correction of 0.5.
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
Estimate                     6.000E-04
99% Lower Conf Limit             0.0000
99% Upper Conf Limit             0.0012

Two-Sided Pr >= |S - Mean|
Estimate                         0.0015
99% Lower Conf Limit          5.031E-04
99% Upper Conf Limit             0.0025

Number of Samples                10000
Initial Seed                 966971001
```

L_Mo_Co:

```
The NPAR1WAY Procedure
   Kruskal-Wallis Test
Chi-Square         16.2509
DF                       2
Pr > Chi-Square     0.0003
```

Comparing pairs:

```
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         4274.0000

Normal Approximation
Z                       -1.4256
One-Sided Pr <  Z        0.0770
Two-Sided Pr > |Z|       0.1540

t Approximation
One-Sided Pr <  Z        0.0779
Two-Sided Pr > |Z|       0.1558
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1640 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
Estimate                        0.0787
99% Lower Conf Limit            0.0718
99% Upper Conf Limit            0.0856

Two-Sided Pr >= |S - Mean|
Estimate                        0.1537
99% Lower Conf Limit            0.1444
99% Upper Conf Limit            0.1630

Number of Samples               10000
Initial Seed                968764001
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         1990.0000

Normal Approximation
Z                       -2.4242
One-Sided Pr <  Z        0.0077
Two-Sided Pr > |Z|       0.0153

t Approximation
One-Sided Pr <  Z        0.0086
Two-Sided Pr > |Z|       0.0171
Z includes a continuity correction of 0.5.
------------- Comparing age 1360 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
```

```
Estimate                       0.0080
99% Lower Conf Limit           0.0057
99% Upper Conf Limit           0.0103

Two-Sided Pr >= |S - Mean|
Estimate                       0.0146
99% Lower Conf Limit           0.0115
99% Upper Conf Limit           0.0177

Number of Samples               10000
Initial Seed                968844001
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
   Wilcoxon Two-Sample Test
Statistic (S)         2660.0000

Normal Approximation
Z                      -3.9871
One-Sided Pr <  Z       <.0001
Two-Sided Pr > |Z|      <.0001

t Approximation
One-Sided Pr <  Z       <.0001
Two-Sided Pr > |Z|      0.0001
Z includes a continuity correction of 0.5.
------------- Comparing age 1640 vs 1730 -------------
The NPAR1WAY Procedure
Monte Carlo Estimates for the Exact Test
One-Sided Pr <= S
Estimate                       0.0000
99% Lower Conf Limit           0.0000
99% Upper Conf Limit         4.604E-04

Two-Sided Pr >= |S - Mean|
Estimate                     1.000E-04
99% Lower Conf Limit           0.0000
99% Upper Conf Limit         3.576E-04

Number of Samples               10000
Initial Seed                968904001
```