**Supplementary Information** for “Paleosols and weathering leading up to Snowball Earth” by Gregory J. Retallack, Department of Earth Sciences, University of Oregon, Eugene, Oregon 97403. for Australian Journal of Earth Sciences.

**Table S1.** Major element chemical composition (wt %) from XRF of Tonian samples from central Australia.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pedo-type or level (m) | Spec-imen | SiO2 | TiO2 | Al2O3 | Fe2O3 | FeO | CaO | MgO | Na2O | K2O | MnO | P2O5 | SrO | BaO | LOI | Total | g/cc |
| Alkynge | R5169 | 34.00 | 0.37 | 8.13 | 3.57 | 0.39 | 21.66 | 5.04 | 0.12 | 4.58 | 0.08 | 0.067 | <0.01 | 0.04 | 21.8 | 99.46 | 2.6743 |
| Alkynge | R5170 | 33.70 | 0.35 | 7.57 | 2.69 | 0.78 | 21.20 | 6.09 | 0.11 | 4.5 | 0.07 | 0.065 | <0.01 | 0.04 | 22.8 | 99.18 | 2.5829 |
| Alkynge | R5171 | 31.47 | 0.34 | 7.31 | 2.98 | 0.32 | 24.55 | 4.46 | 0.10 | 4.23 | 0.09 | 0.058 | 0.01 | 0.04 | 23.6 | 99.24 | 2.6068 |
| Alkynge | R5172 | 31.90 | 0.35 | 7.39 | 3.44 | 0.65 | 24.21 | 4.26 | 0.13 | 4.10 | 0.08 | 0.062 | 0.01 | 0.04 | 23.1 | 99.07 | 2.6055 |
| Alkynge | R5173 | 41.02 | 0.45 | 9.50 | 4.47 | 0.78 | 15.01 | 4.92 | 0.13 | 5.90 | 0.06 | 0.093 | <0.01 | 0.05 | 16.9 | 98.5 | 2.6795 |
| Akngerre | R5175 | 37.48 | 0.44 | 9.06 | 3.95 | 0.52 | 12.66 | 9.41 | 0.12 | 5.83 | 0.05 | 0.09 | <0.01 | 0.05 | 19.8 | 98.94 | 2.6947 |
| Akngerre | R5176 | 37.89 | 0.44 | 8.78 | 3.77 | 0.45 | 12.64 | 9.45 | 0.09 | 5.55 | 0.05 | 0.084 | <0.01 | 0.05 | 19.9 | 98.69 | 2.7501 |
| Akngerre | R5177 | 36.78 | 0.43 | 9.01 | 3.97 | 0.52 | 15.54 | 7.36 | 0.13 | 5.41 | 0.05 | 0.088 | <0.01 | 0.04 | 20.1 | 98.91 | 2.5665 |
| Akngerre | R5178 | 43.24 | 0.50 | 10.05 | 4.33 | 0.39 | 9.92 | 7.66 | 0.11 | 6.43 | 0.04 | 0.088 | <0.01 | 0.04 | 16 | 98.42 | 2.7243 |
| Akngerre | R5179 | 46.84 | 0.49 | 10.25 | 3.97 | 0.65 | 9.22 | 6.65 | 0.13 | 6.67 | 0.03 | 0.082 | <0.01 | 0.05 | 14.3 | 98.68 | 2.7068 |
| Kwerralye | R5394 | 28.02 | 0.26 | 5.49 | 2.45 | 0.32 | 22.42 | 9.44 | 0.11 | 3.13 | 0.14 | 0.062 | <0.01 | 0.05 | 27.4 | 98.97 | 2.6329 |
| Kwerralye | R5395 | 25.29 | 0.19 | 4.11 | 1.52 | 0.32 | 25.19 | 9.83 | 0.13 | 2.22 | 0.12 | 0.047 | <0.01 | 0.04 | 30.2 | 98.89 | 2.6928 |
| Kwerralye | R5396 | 23.52 | 0.21 | 3.80 | 1.07 | 0.39 | 26.75 | 9.98 | 0.14 | 2.02 | 0.08 | 0.052 | <0.01 | 0.03 | 31.5 | 99.15 | 2.6054 |
| Itwe. | R5397 | 27.72 | 0.28 | 5.62 | 2.08 | 0.52 | 23.10 | 9.42 | 0.16 | 2.92 | 0.07 | 0.062 | <0.01 | 0.03 | 27.8 | 99.26 | 2.6381 |
| Itwe | R5398 | 25.93 | 0.25 | 4.98 | 2.28 | 1.03 | 24.45 | 9.63 | 0.18 | 2.47 | 0.08 | 0.056 | <0.01 | 0.03 | 28.9 | 99.24 | 2.6561 |
| 542.3 | R4234 | 43.84 | 0.57 | 10.00 | 5.23 | 0.85 | 8.79 | 8.31 | 0.4 | 4.12 | 0.03 | 0.096 | 0.007 | 0.03 | 16.9 | 98.33 |  |
| 556.4 | R4235 | 40.41 | 0.51 | 9.90 | 6.03 | 1.11 | 10.29 | 8.42 | 0.43 | 4.96 | 0.04 | 0.113 | 0.01 | 0.03 | 17.55 | 98.69 |  |
| 556.6 | R4236 | 37.05 | 0.48 | 8.67 | 4.53 | 0.91 | 12.55 | 9.39 | 0.38 | 4.5 | 0.05 | 0.097 | 0.01 | 0.03 | 20.7 | 98.44 |  |
| 607.7 | R4237 | 40.72 | 0.45 | 8.86 | 3.65 | 0.46 | 13.8 | 7.79 | 0.86 | 3.21 | 0.05 | 0.085 | 0.02 | 0.05 | 19.0 | 98.54 |  |
| 607.9 | R4238 | 50.26 | 0.49 | 9.28 | 5.83 | 0.78 | 7.87 | 5.99 | 0.61 | 4.45 | 0.04 | 0.111 | 0.007 | 0.03 | 14.0 | 98.96 |  |
| 655 | R4239 | 40.71 | 0.48 | 9.39 | 5.24 | 0.46 | 11.15 | 8.77 | 0.74 | 3.65 | 0.07 | 0.091 | 0.03 | 0.08 | 18.05 | 98.45 |  |
| 655.2 | R4240 | 40.77 | 0.43 | 8.72 | 4.12 | 0.46 | 13.57 | 7.68 | 0.83 | 3.32 | 0.05 | 0.079 | 0.01 | 0.05 | 18.9 | 98.53 |  |
| 704.3 | R4242 | 39.1 | 0.49 | 9.31 | 4.71 | 0.46 | 12.68 | 7.96 | 0.75 | 3.54 | 0.06 | 0.089 | 0.03 | 0.04 | 16.65 | 95.41 |  |
| 740.6 | R4243 | 42.36 | 0.43 | 9.08 | 4.15 | 0.46 | 12.22 | 6.57 | 0.81 | 3.62 | 0.04 | 0.077 | 0.03 | 0.04 | 14.4 | 93.83 |  |
| 820.7 | R4245 | 51.00 | 0.57 | 10.54 | 3.95 | 1.11 | 7.69 | 6.12 | 0.56 | 4.09 | 0.03 | 0.099 | 0.01 | 0.11 | 14.15 | 98.92 |  |
| 820.9 | R4246 | 51.47 | 0.56 | 9.71 | 4.09 | 1.18 | 8.44 | 5.76 | 0.55 | 3.71 | 0.04 | 0.083 | 0.01 | 0.04 | 14.40 | 98.87 |  |
| 875.2 | R4247 | 52.98 | 0.66 | 12.64 | 6.77 | 0.85 | 4.3 | 4.92 | 1.12 | 5.23 | 0.05 | 0.098 | 0.01 | 0.06 | 10.10 | 98.95 |  |
| 875.4 | R4248 | 57.9 | 0.63 | 10.23 | 3.34 | 0.72 | 6.61 | 3.98 | 0.87 | 4.7 | 0.05 | 0.077 | 0.01 | 0.06 | 10.65 | 99.11 |  |
| 931.8 | R4249 | 50.75 | 0.67 | 12.8 | 5.19 | 1.44 | 5.52 | 5.51 | 0.48 | 5.82 | 0.04 | 0.104 | 0.007 | 0.05 | 11.40 | 98.34 |  |
| 932 | R4250 | 51.67 | 0.67 | 13.1 | 4.74 | 1.44 | 5.39 | 5.43 | 0.44 | 6.17 | 0.04 | 0.104 | 0.007 | 0.05 | 11.25 | 99.06 |  |
| 972.2 | R4251 | 58.89 | 0.64 | 10.69 | 3.81 | 0.59 | 4.77 | 4.79 | 1.16 | 4.21 | 0.05 | 0.097 | 0.01 | 0.06 | 9.99 | 99.17 |  |
| 972.4 | R4252 | 67.32 | 1.11 | 7.23 | 2.47 | 0.65 | 4.96 | 3.31 | 1.13 | 3.36 | 0.05 | 0.098 | 0.01 | 0.08 | 8.10 | 99.24 |  |
| 1021.4 | R4253 | 50.38 | 0.64 | 10.97 | 3.81 | 0.65 | 7.8 | 5.86 | 1.04 | 4.67 | 0.07 | 0.101 | 0.02 | 0.05 | 12.8 | 98.22 |  |
| 1021.6 | R4254 | 51.78 | 0.64 | 10.65 | 4.17 | 0.65 | 7.46 | 5.51 | 1.07 | 4.44 | 0.07 | 0.100 | 0.02 | 0.06 | 12.1 | 98.07 |  |
| 1068.3 | R4255 | 28.16 | 0.22 | 4.47 | 1.86 | 0.39 | 19.66 | 11.39 | 0.24 | 2.34 | 0.03 | 0.060 | 0.03 | 0.02 | 23.9 | 92.38 |  |
| 1068.5 | R4256 | 24.89 | 0.2 | 3.61 | 1.43 | 0.39 | 21.61 | 11.59 | 0.22 | 1.82 | 0.03 | 0.054 | 0.04 | 0.02 | 24.4 | 89.91 |  |
| Error | all | 2.705 | 0.06 | 0.825 | 0.395 |  | 0.22 | 0.18 | 0.11 | 0.13 | 0.025 | 0.030 |  |  |  | 0.35 | 0.02 |

*Note: Errors are from 10 replicate analyses of the standard, CANMET SDMS2 (British Columbia granodioritic sand). Samples of Akngerre pedotype from borehole DR05DDH1 by meter level are all Akngerre pedotype, except for R4234 and, R4255-6 which are Alkynge pedotype.*

**Table S2.** Grain-size data from point counting thin sections (500 points) of Tonian samples from central Australia

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pedotype | Hoz | No. | % sand | % silt | % clay | Textural class | Gran fabric | Plasmic fabric |
|  | above | R5168 | 2.8 | 75.4 | 21.8 | silt loam | agglomeroplasmic | argillasepic |
| Akngerre | A | R5169 | 3.6 | 60.6 | 35.8 | silty clay loam | porphyroskelic | mosepic |
| Akngerre | A | R5170 | 3.4 | 64.4 | 32.2 | silty clay loam | agglomeroplasmic | insepic |
| Akngerre | Bk | R5171 | 17.2 | 58.6 | 24.2 | silt loam | agglomeroplasmic | insepic |
| Akngerre | Bk | R5172 | 18.2 | 58.4 | 23.4 | silt loam | agglomeroplasmic | calciasepic |
| Akngerre | C | R5173 | 22.8 | 56.0 | 21.2 | silt loam | agglomeroplasmic | calciasepic |
|  | above | R5174 | 7.2 | 89.0 | 3.8 | silt | porphyroskelic | calicasepic |
| Alkynge | A | R5175 | 2.4 | 67.2 | 29.4 | silty clay loam | agglomeroplasmic | bimasepic |
| Alkynge | A | R5176 | 1.6 | 69.4 | 29.0 | silty clay loam | agglomeroplasmic | mosepic |
| Alkynge | By | R5177 | 8.8 | 63.6 | 27.6 | silty clay loam | agglomeroplasmic | insepic |
| Alkynge | By | R5178 | 3.4 | 68.8 | 27.8 | silty clay loam | agglomeroplasmic | insepic |
| Alkynge | C | R5179 | 5.6 | 66.8 | 27.6 | silty clay loam | agglomeroplasmic | argillasepic |
|  | above | R5393 | 8.0 | 62.6 | 29.4 | silty clay loam | agglomeroplasmic | argillasepic |
| Kwerralye | A | R5394 | 4.0 | 61.4 | 34.6 | silty clay loam | agglomeroplasmic | insepic |
| Kwerralye | Bw | R5395 | 9.8 | 63.8 | 26.4 | silt loam | agglomeroplasmic | insepic |
| Kwerralye | C | R5396 | 22.2 | 71.2 | 6.6 | silt loam | agglomeroplasmic | calciasepic |
| Itwe. | A | R5397 | 9.0 | 60.0 | 31.0 | silty clay loam | agglomeroplasmic | insepic |
| Itwe | C | R5398 | 5.0 | 71.8 | 23.2 | silt loam | agglomeroplasmic | argillasepic |

**Table S3.** Mineral content from point counting thin sections (500 points) of Tonian samples from central Australia

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pedotype | Hoz | No. | % clay | % evaporite pseudomorph | % dolomite | % rock | % feldspar | % mica | % quartz | % opaque |
|  | above | R5168 | 27.2 | 0 | 27.4 | 2.8 | 19.4 | 2.8 | 15.6 | 4.8 |
| Akngerre | A | R5169 | 35.6 | 3.8 | 16.4 | 1.6 | 21.0 | 4.2 | 15.4 | 2.0 |
| Akngerre | A | R5170 | 34.6 | 0 | 32,2 | 2.2 | 15.2 | 4.4 | 10.8 | 0.6 |
| Akngerre | Bk | R5171 | 24.4 | 0 | 39.6 | 1.8 | 16.2 | 4.2 | 12.2 | 1.6 |
| Akngerre | Bk | R5172 | 24.4 | 0 | 36.4 | 1.6 | 17.8 | 5.0 | 13.4 | 1.4 |
| Akngerre | C | R5173 | 22.2 | 0 | 18.6 | 4.4 | 21.4 | 12.0 | 16.2 | 5.2 |
|  | above | R5174 | 2.6 | 0 | 69.0 | 1.8 | 13.2 | 5.6 | 7.4 | 0.4 |
| Alkynge | A | R5175 | 31.2 | 0 | 17.0 | 2.4 | 23.4 | 4.4 | 16.8 | 4.6 |
| Alkynge | A | R5176 | 28.4 | 0 | 27.0 | 1.8 | 17.0 | 8.6 | 13.6 | 3.6 |
| Alkynge | By | R5177 | 30.6 | 9.2 | 16.6 | 0.8 | 18.4 | 4.4 | 16.8 | 3.2 |
| Alkynge | By | R5178 | 28.4 | 1.8 | 14.8 | 1.6 | 23.4 | 6.0 | 20.6 | 3.4 |
| Alkynge | C | R5179 | 29.2 | 1.8 | 24.8 | 1.4 | 17.0 | 8.0 | 14.4 | 3.4 |
|  | above | R5393 | 30.4 | 0 | 18.6 | 4.8 | 20.6 | 2.4 | 15.4 | 5.6 |
| Kwerralye | A | R5394 | 37.4 | 0 | 11.8 | 3.8 | 23.4 | 2.4 | 18.0 | 2.6 |
| Kwerralye | Bw | R5395 | 27.0 | 0.2 | 19.4 | 3.2 | 26.2 | 1.6 | 18.0 | 4.4 |
| Kwerralye | C | R5396 | 7.0 | 0.4 | 51.4 | 4.4 | 17.4 | 2.8 | 14.8 | 1.8 |
| Itwe. | A | R5397 | 33.0 | 0 | 19.8 | 2.0 | 23.8 | 4.2 | 16.0 | 1.2 |
| Itwe | C | R5398 | 23.2 | 0 | 38.4 | 2.6 | 18.2 | 2.2 | 14.4 | 1.0 |

*Note: Evaporite pseudomorps in Akngerre are needles like mirabilite, and in Alkyngye are monoclinic like gypsum.*