**Supplementary Information**

Table S1. Modeled dose rate contributions and overall dose rates.

Stratigraphic Location Layer Modeled Layer dose Fractional Modeled

Thickness fractional Rate Dose rate total dose

(cm) Contribution (J/kg/ka) (J/kg/ka) rate (J/kg/ka)

**UT1605 - Hunter Lake - Fine Sand (150-250 µm)**  **0.931 ± 0.084**

Sand sample layer - gamma 43 1.000 0.308 0.308

Sand sample layer - beta 1.000 0.603 0.603

Cosmic 1.000 0.020 0.020

**UT1605 - Hunter Lake - Medium Sand (250-355 µm)**  **0.897 ± 0.080**

Sand sample layer - gamma 43 1.000 0.308 0.308

Sand sample layer - beta 1.000 0.569 0.569

Cosmic 1.000 0.020 0.020

**UT1606 - Stone Lake - Fine Sand (150-250 µm)**  **0.753 ± 0.063**

Sand sample layer - gamma 41 1.000 0.240 0.240

Sand sample layer - beta 1.000 0.492 0.492

Cosmic 1.000 0.021 0.021

**UT1606 - Stone Lake - Medium Sand (250-355 µm)**  **0.725 ± 0.060**

Sand sample layer - gamma 41 1.000 0.240 0.240

Sand sample layer - beta 1.000 0.464 0.464

Cosmic 1.000 0.021 0.021

**UT 1607 - Thompson Lake - Fine Sand (150-250 µm)**  **0.769 ± 0.089**

Silt above (u0) - gamma 23 0.450 0.175 0.079

Silt above (u0) - beta 0.000 0.204 0.000

Sand sample layer (u1) - gamma 6 0.100 0.302 0.030

Sand sample layer (u1) - beta 1.000 0.562 0.562

Sandy silt below (u2) - gamma 27 0.450 0.188 0.085

Sandy silt below (u2) - beta 0.000 0.230 0.000

Cosmic 1.000 0.013 0.013

**UT 1607 - Thompson Lake - Medium Sand (250-355 µm)**  **0.737 ± 0.085**

Silt above (u0) - gamma 23 0.450 0.175 0.079

Silt above (u0) - beta 0.000 0.193 0.000

Sand sample layer (u1) - gamma 6 0.100 0.302 0.030

Sand sample layer (u1) - beta 1.000 0.530 0.530

Sandy silt below (u2) - gamma 27 0.450 0.188 0.085

Sandy silt below (u2) - beta 0.000 0.217 0.000

Cosmic 1.000 0.013 0.013

**UT1608A - Fish Lake - Fine Sand (150-250 µm)**  **1.091 ± 0.209**

Organic layer above (u0) - gamma 27 0.450 0.593 0.267

Organic layer above (u0) - beta 0.000 0.989 0.000

Sand sample layer (u1) - gamma 6 0.100 0.299 0.030

Sand sample layer (u1) - beta 1.000 0.628 0.628

Course sand below (u2) - gamma 16 0.267 0.284 0.076

Course sand below (u2) - beta 0.000 0.547 0.000

Silty sand below (u3) - gamma 4 0.067 0.327 0.022

Silty sand below (u3) - beta 0.000 0.556 0.000

Sandy silt below (u4) - gamma 7 0.116 0.364 0.042

Sandy silt below (u4) - beta 0.000 0.591 0.000

Cosmic 1.000 0.026 0.026

**UT1609 - Bullhead Lake - Fine Sand (150-250 µm)**  **1.335 ± 0.243**

Sand and clays above (u0) - gamma 28 0.466 0.557 0.260

Sand and clays above (u0) - beta 0.000 0.943 0.000

Sand sample layer (u1) - gamma 4 0.067 0.379 0.025

Sand sample layer (u1) - beta 1.000 0.701 0.701

Sand below (u2) - gamma 15 0.250 0.636 0.159

Sand below (u2) - beta 0.000 1.035 0.000

2nd sand below (u3) - gamma 13 0.217 0.687 0.149

2nd sand below (u3) - beta 0.000 1.116 0.000

Cosmic 1.000 0.041 0.041

Depths adjusted for sediment compaction during coring; H2O content of 33 ± 3%; BAF of 0.89 used for fine sand samples and 0.84 for medium sand samples.

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