Appendix for

**Assessment of mercury enrichment in lake sediment records from Alberta Oil Sands development via fluvial and atmospheric pathways**

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Supporting Information on Sediment Core Dating, including Appendix figures A1 – A2

**Introduction:**

This appendix provides tables with lake and sediment core information and base data for THg concentrations.

A section provides Supporting Information on sediment core dating and figures that provide activity profiles of radioisotopes used in 210Pb and 137Cs dating of cores from all lakes and PAD 30 Hg and Zn enrichment factor temporal trends.

Table A1. Lake and sediment core information for floodplain lakes in the AOSR and PAD and upland lakes in the PAD (and vicinity) in northeastern Alberta.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Lake ID** | **Hydrological Setting** | **Coordinates****(decimal degrees)** | **Distance from AR6 (km)** | **Lake Depth\*****(m)** | **Core Length****(cm)** |
| Down 1 | Floodplain | 57.025, - 111.485 | 1 | 0.6 | 54 |
| Down 26 | Floodplain | 57.218, -111.604 | 26 | 0.5 | 42 |
| Down 58 | Floodplain | 57.524, -111.523 | 58 | 1.3 | 45 |
| PAD 23 | Floodplain | 58.389, -111.440 | ~170 | 1.3 | 43 |
| PAD 30 | Floodplain | 58.509, -111.517 | ~170 | 0.8 | 45 |
| PAD 31 | Floodplain | 58.494, -111.518 | ~170 | 0.9 | 36 |
| PAD 32 | Floodplain | 58.496, -111.447 | ~170 | 1.0 | 46 |
| PAD M2 | Floodplain | 58.417, -110.914 | ~170 | 1.3 | 42 |
| PAD M5 | Floodplain | 58.437, -111.050 | ~170 | 0.9 | 58 |
| PAD 18 | Upland | 58.896, -111.360 | ~210 | 8.6 | 49 |
| AC5 | Upland | 58.441, -110.676 | ~165 | 4.2 | 83.5 |

\*Corresponds to lake depth when the sediment core was extracted from the lake.

Table A2. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from Down 1 in the Alberta Oil Sands Region. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2010.05 | 52.89 | 0.0400 |
| 1 | 2007.76 | 53.35 | 0.0411 |
| 2 | 2003.84 | 52.51 | 0.0424 |
| 3 | 2001.06 | 50.96 | 0.0435 |
| 4 | 1995.16 | 49.70 | 0.0443 |
| 5 | 1990.89 | 47.67 | 0.0459 |
| 6 | 1987.55 | 48.09 | 0.0491 |
| 7 | 1984.04 | 46.94 | 0.0470 |
| 8 | 1980.31 | 47.26 | 0.0488 |
| 9 | 1976.50 | 47.42 | 0.0438 |
| 10 | 1972.62 | 44.87 | 0.0461 |
| 11 | 1968.89 | 44.76 | 0.0499 |
| 12 | 1965.15 | 43.74 | 0.0479 |
| 13 | 1961.18 | 42.83 | 0.0449 |
| 14 | 1956.84 | 42.58 | 0.0438 |
| 15 | 1952.65 | 41.98 | 0.0423 |
| 16 | 1949.00 | 40.23 | 0.0423 |
| 17 | 1944.84 | 38.57 | 0.0436 |
| 18 | 1940.38 | 37.72 | 0.0431 |
| 19 | 1935.64 | 36.44 | 0.0399 |
| 20 | 1930.12 | 34.24 | 0.0362 |
| 21 | 1923.81 | 34.56 | 0.0385 |
| 22 | 1917.05 | 34.20 | 0.0354 |
| 23 | 1910.82 | 33.81 | 0.0359 |
| 24 | 1905.06 | 31.89 | 0.0373 |
| 25 | 1899.19 | 31.29 | 0.0357 |
| 26 | 1893.29 | 30.81 | 0.0346 |
| 27 | 1887.92 | 31.21 | 0.0339 |
| 28 | 1882.43 | 32.03 | 0.0338 |
| 29 | 1875.31 | 34.01 | 0.0328 |
| 30 | 1867.20 | 35.55 | 0.0322 |
| 31 | 1859.41 | 35.71 | 0.0400 |
| 32 | 1851.74 | 35.20 | 0.0374 |
| 33 | 1844.40 | 33.67 | 0.0353 |
| 34 | 1837.36 | 32.58 | 0.0366 |
| 35 | 1830.41 | 31.47 | 0.0365 |
| 36 | 1823.71 | 31.61 | 0.0356 |
| 37 | 1817.13 | 32.73 | 0.0322 |
| 38 | 1810.58 | 34.31 | 0.0362 |
| 39 | 1803.49 | 34.70 | 0.0370 |
| 40 | 1796.86 | 34.28 | 0.0349 |
| 41 | 1790.53 | 37.28 | 0.0281 |
| 42 | 1783.78 | 37.37 | 0.0286 |
| 43 | 1777.09 | 37.76 | 0.0353 |

Table A3. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from Down 26 in the Alberta Oil Sands Region. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2017.68 | 41.67 | 0.0367 |
| 1 | 2017.05 | 34.63 | 0.0287 |
| 2 | 2016.28 | 27.17 | 0.0394 |
| 4 | 2012.40 | 16.91 | 0.0596 |
| 6 | 2007.19 | 16.15 | 0.0545 |
| 8 | 2000.76 | 11.57 | 0.0588 |
| 10 | 1994.00 | 11.10 | 0.0600 |
| 12 | 1986.50 | 11.01 | 0.0665 |
| 14 | 1976.21 | 9.48 | 0.0677 |
| 16 | 1963.00 | 6.84 | 0.0677 |
| 18 | 1948.67 | 7.01 | 0.0605 |
| 20 | 1936.57 | 7.77 | 0.0570 |
| 22 | 1926.40 | 9.45 | 0.0587 |
| 24 | 1916.98 | 11.30 | 0.0531 |
| 26 | 1908.83 | 13.26 | 0.0518 |
| 28 | 1898.57 | 11.48 | 0.0511 |
| 30 | 1885.36 | 7.40 | 0.0575 |
| 32 | 1870.75 | 7.77 | 0.0600 |
| 34 | 1858.46 | 8.28 | 0.0611 |
| 36 | 1846.44 | 7.43 | 0.0564 |
| 38 | 1834.49 | 9.65 | 0.0606 |
| 40 | 1823.20 | 11.41 | 0.0622 |

Table A4. Depth (top of interval), organic matter content (%OM) and THg concentration for the sediment core from Down 58 in the Alberta Oil Sands Region. %OM and THg concentrations are expressed per dry weight.

|  |  |  |
| --- | --- | --- |
| Depth (cm) | %OM | THg (mg/kg) |
| 0 | 9.08 | 0.0609 |
| 1 | 7.75 | 0.0617 |
| 2 | 8.05 | 0.0626 |
| 3 | 6.44 | 0.0643 |
| 4 | 5.98 | 0.0595 |
| 5 | 7.10 | 0.0645 |
| 6 | 7.69 | 0.0546 |
| 7 | 9.18 | 0.0555 |
| 8 | 8.50 | 0.0559 |
| 9 | 7.22 | 0.0616 |
| 10 | 7.34 | 0.0561 |
| 11 | 8.27 | 0.0685 |
| 12 | 7.96 | 0.0540 |
| 13 | 8.17 | 0.0577 |
| 14 | 7.39 | 0.0592 |
| 15 | 5.53 | 0.0720 |
| 16 | 5.11 | 0.0600 |
| 17 | 5.89 | 0.0573 |
| 18 | 5.56 | 0.0537 |
| 19 | 6.58 | 0.0818 |
| 20 | 7.10 | 0.0524 |
| 21 | 7.87 | 0.0593 |
| 22 | 6.62 | 0.0536 |
| 23 | 6.25 | 0.0581 |
| 24 | 5.66 | 0.0529 |
| 25 | 5.71 | 0.0582 |
| 26 | 6.51 | 0.0710 |
| 27 | 6.71 | 0.0611 |
| 28 | 7.70 | 0.0582 |
| 29 | 6.73 | 0.0633 |
| 30 | 5.41 | 0.0938 |
| 31 | 4.75 | 0.0536 |
| 32 | 6.07 | 0.0578 |
| 33 | 8.04 | 0.0447 |
| 34 | 6.17 | 0.0600 |
| 35 | 6.47 | 0.0646 |
| 36 | 5.75 | 0.0894 |
| 37 | 5.66 | 0.0633 |
| 38 | 6.89 | 0.0624 |
| 39 | 6.55 | 0.0621 |
| 40 | 6.90 | 0.0380 |
| 41 | 6.87 | 0.0532 |
| 42 | 5.35 | 0.0955 |
| 43 | 5.37 | 0.0535 |
| 44 | 5.35 | 0.0860 |

Table A5. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from PAD 23 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2010.74 | 59.32 | 0.0490 |
| 2 | 2007.67 | 58.64 | 0.0522 |
| 4 | 2005.83 | 56.34 | 0.0438 |
| 5.5 | 2001.33 | 55.69 | 0.0507 |
| 7 | 1998.28 | 55.15 | 0.0518 |
| 8.5 | 1993.27 | 52.56 | 0.0567 |
| 10 | 1990.69 | 49.41 | 0.0525 |
| 11 | 1988.34 | 49.08 | 0.0596 |
| 12 | 1986.13 | 47.13 | 0.0567 |
| 13 | 1983.21 | 45.98 | 0.0581 |
| 14 | 1981.06 | 47.51 | 0.0575 |
| 15 | 1978.53 | 46.43 | 0.0523 |
| 16 | 1974.84 | 44.17 | 0.0495 |
| 17 | 1972.08 | 44.27 | 0.0505 |
| 18 | 1968.41 | 40.12 | 0.0512 |
| 19 | 1965.39 | 41.36 | 0.0483 |
| 20 | 1962.24 | 41.47 | 0.0461 |
| 21 | 1957.40 | 39.93 | 0.0442 |
| 22 | 1953.07 | 38.27 | 0.0530 |
| 23 | 1948.33 | 37.95 | 0.0499 |
| 24 | 1944.34 | 33.98 | 0.0509 |
| 25 | 1939.22 | 36.43 | 0.0482 |
| 26 | 1933.13 | 39.60 | 0.0510 |
| 27 | 1927.97 | 33.41 | 0.0497 |
| 28 | 1923.56 | 29.65 | 0.0482 |
| 29 | 1917.49 | 28.95 | 0.0493 |
| 30 | 1911.24 | 31.68 | 0.0488 |
| 31 | 1906.80 | 31.49 | 0.0496 |
| 32 | 1903.25 | 28.25 | 0.0509 |

Table A6. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from PAD 30 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2016.37 | 11.47 | 0.0745 |
| 1 | 2015.92 | 8.36 | 0.0738 |
| 2 | 2014.94 | 7.63 | 0.0755 |
| 3 | 2014.01 | 7.36 | 0.0741 |
| 5 | 2012.66 | 9.16 | 0.0632 |
| 7 | 2008.44 | 18.72 | 0.0792 |
| 9 | 2001.45 | 45.92 | 0.0969 |
| 10 | 1998.93 | 53.63 | 0.1007 |
| 12 | 1989.71 | 59.17 | 0.0708 |
| 13 | 1983.06 | 56.50 | 0.0987 |
| 15 | 1973.99 | 52.74 | 0.1041 |
| 17 | 1961.64 | 44.95 | 0.1023 |
| 19 | 1948.17 | 44.15 | 0.0802 |
| 21 | 1939.43 | 38.23 | 0.0743 |
| 23 | 1927.96 | 24.63 | 0.0567 |
| 25 | 1911.91 | 34.06 | 0.0672 |
| 27 | 1896.22 | 18.66 | 0.0598 |
| 29 | 1869.79 | 12.97 | 0.0636 |
| 31 | 1845.80 | 14.85 | 0.0650 |
| 33 | 1824.65 | 19.75 | 0.0601 |
| 35 | 1800.52 | 14.06 | 0.0640 |
| 37 | 1774.89 | 11.25 | 0.0647 |
| 39 | 1748.05 | 20.94 | 0.0607 |
| 41 | 1730.90 | 27.09 | 0.0559 |
| 43 | 1710.38 | 14.87 | 0.0588 |
| 44 | 1698.62 | 14.09 | 0.0600 |

Table A7. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from PAD 31 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2010.29 | 11.84 | 0.0525 |
| 1 | 2009.85 | 8.27 | 0.0577 |
| 2 | 2008.67 | 7.95 | 0.0593 |
| 3 | 2007.29 | 6.54 | 0.0606 |
| 4 | 2005.87 | 6.87 | 0.0630 |
| 5 | 2004.44 | 6.25 | 0.0620 |
| 6 | 2003.17 | 6.26 | 0.0623 |
| 7 | 2001.89 | 6.43 | 0.0624 |
| 8 | 2001.03 | 6.14 | 0.0528 |
| 9 | 1999.98 | 10.53 | 0.0537 |
| 10 | 1998.50 | 7.80 | 0.0573 |
| 11 | 1997.07 | 9.64 | 0.0570 |
| 12 | 1995.49 | 7.34 | 0.0609 |
| 13 | 1993.90 | 8.22 | 0.0597 |
| 14 | 1991.30 | 9.46 | 0.0620 |
| 15 | 1988.88 | 11.44 | 0.0619 |
| 16 | 1986.70 | 27.15 | 0.0534 |
| 17 | 1983.54 | 43.36 | 0.0772 |
| 18 | 1978.67 | 43.10 | 0.0594 |
| 19 | 1972.88 | 43.17 | 0.0479 |
| 20 | 1965.50 | 39.39 | 0.0431 |
| 21 | 1958.08 | 34.25 | 0.0456 |
| 22 | 1950.74 | 29.82 | 0.0469 |
| 23 | 1943.30 | 29.21 | 0.0449 |
| 24 | 1934.70 | 25.36 | 0.0450 |
| 25 | 1924.40 | 28.10 | 0.0431 |
| 26 | 1912.36 | 22.91 | 0.0501 |
| 27 | 1905.04 | 22.93 | 0.0401 |
| 28 | 1894.12 | 22.39 | 0.0414 |
| 29 | 1877.85 | 21.91 | 0.0421 |
| 30 | 1863.15 | 21.78 | 0.0423 |
| 31 | 1850.50 | 20.77 | 0.0429 |
| 32 | 1838.01 | 20.35 | 0.0430 |
| 33 | 1823.92 | 18.38 | 0.0420 |
| 34 | 1809.85 | 21.19 | 0.0493 |

Table A8. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from PAD 32 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2014.73 | 38.46 | 0.0651 |
| 1 | 2012.20 | 30.18 | 0.0694 |
| 2 | 2007.92 | 29.86 | 0.0709 |
| 3 | 2002.82 | 23.87 | 0.0717 |
| 4 | 1998.03 | 22.22 | 0.0725 |
| 5 | 1993.74 | 18.90 | 0.0726 |
| 6 | 1989.53 | 16.87 | 0.0708 |
| 7 | 1985.46 | 14.97 | 0.0693 |
| 8 | 1982.50 | 15.54 | 0.0713 |
| 9 | 1979.91 | 17.36 | 0.0720 |
| 10 | 1974.78 | 14.41 | 0.0728 |
| 11 | 1967.58 | 15.02 | 0.0707 |
| 12 | 1960.74 | 12.99 | 0.0696 |
| 13 | 1954.66 | 14.41 | 0.0719 |
| 14 | 1948.88 | 16.11 | 0.0717 |
| 15 | 1942.76 | 16.26 | 0.0713 |
| 16 | 1934.40 | 13.05 | 0.0681 |
| 17 | 1924.91 | 13.28 | 0.0687 |
| 18 | 1915.48 | 12.27 | 0.0677 |
| 19 | 1904.70 | 13.11 | 0.0684 |
| 20 | 1893.76 | 11.38 | 0.0681 |
| 21 | 1882.81 | 11.15 | 0.0686 |
| 22 | 1872.32 | 15.39 | 0.0684 |
| 23 | 1862.59 | 14.21 | 0.0689 |
| 24 | 1853.25 | 17.29 | 0.0689 |
| 25 | 1845.21 | 18.87 | 0.0688 |
| 26 | 1837.22 | 20.47 | 0.0688 |
| 27 | 1827.77 | 15.77 | 0.0702 |
| 28 | 1817.90 | 16.90 | 0.0675 |
| 29 | 1808.46 | 16.28 | 0.0674 |
| 30 | 1798.94 | 17.06 | 0.0666 |
| 31 | 1790.12 | 18.15 | 0.0672 |
| 32 | 1781.96 | 23.50 | 0.0653 |
| 33 | 1773.34 | 20.99 | 0.0646 |
| 34 | 1764.50 | 15.19 | 0.0671 |
| 35 | 1756.23 | 24.04 | 0.0663 |
| 36 | 1747.39 | 16.56 | 0.0642 |
| 37 | 1737.87 | 14.54 | 0.0670 |
| 38 | 1727.62 | 13.35 | 0.0661 |
| 39 | 1715.68 | 11.96 | 0.0666 |
| 40 | 1702.60 | 12.88 | 0.0681 |
| 41 | 1690.45 | 13.18 | 0.0659 |
| 42 | 1678.93 | 12.02 | 0.0700 |
| 43 | 1666.41 | 11.91 | 0.0675 |
| 44 | 1653.70 | 15.54 | 0.0700 |
| 45 | 1640.36 | 12.67 | 0.0682 |

Table A9. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from M2 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2016.22 | 20.51 | 0.0693 |
| 1 | 2014.44 | 27.68 | 0.0792 |
| 2 | 2011.81 | 26.80 | 0.0794 |
| 4 | 2006.95 | 23.42 | 0.0787 |
| 6 | 2000.05 | 24.20 | 0.0782 |
| 8 | 1991.66 | 23.21 | 0.0754 |
| 10 | 1983.26 | 24.54 | 0.0716 |
| 12 | 1974.76 | 18.46 | 0.0652 |
| 13 | 1970.88 | 5.11 | 0.0639 |
| 15 | 1963.04 | 12.85 | 0.0651 |
| 17 | 1949.44 | 12.75 | 0.0609 |
| 19 | 1931.27 | 9.02 | 0.0636 |
| 21 | 1909.81 | 11.20 | 0.0606 |
| 23 | 1872.55 | 12.34 | 0.0642 |
| 25 | 1858.38 | 18.93 | 0.0613 |
| 27 | 1835.70 | 12.21 | 0.0601 |
| 29 | 1823.50 | 11.74 | 0.0598 |
| 31 | 1797.98 | 12.83 | 0.0596 |
| 33 | 1768.96 | 10.65 | 0.0803 |
| 35 | 1749.88 | 28.79 | 0.0605 |
| 37 | 1733.99 | 14.36 | 0.0634 |
| 39 | 1712.42 | 31.69 | 0.0636 |

Table A10. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from M5 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2014.71 | 32.06 | 0.0660 |
| 1 | 2013.37 | 26.77 | 0.0811 |
| 2 | 2012.45 | 25.88 | 0.0726 |
| 3 | 2011.82 | 23.97 | 0.0719 |
| 4 | 2011.35 | 33.98 | 0.0750 |
| 5 | 2010.98 | 25.25 | 0.0764 |
| 6 | 2010.63 | 24.13 | 0.0726 |
| 7 | 2010.27 | 22.10 | 0.0759 |
| 8 | 2009.86 | 20.58 | 0.0701 |
| 9 | 2009.38 | 21.87 | 0.0728 |
| 10 | 2008.93 | 24.08 | 0.0742 |
| 11 | 2008.49 | 26.05 | 0.0753 |
| 12 | 2008.06 | 26.74 | 0.0744 |
| 13 | 2007.63 | 23.89 | 0.0788 |
| 14 | 2007.25 | 23.54 | 0.0762 |
| 15 | 2006.92 | 22.99 | 0.0726 |
| 16 | 2006.65 | 23.91 | 0.0752 |
| 17 | 2006.30 | 25.23 | 0.0747 |
| 18 | 2005.62 | 23.00 | 0.0729 |
| 19 | 2004.77 | 27.92 | 0.0769 |
| 20 | 2003.85 | 28.67 | 0.0795 |
| 21 | 2002.89 | 22.61 | 0.0718 |
| 22 | 2002.06 | 19.87 | 0.0698 |
| 23 | 2001.17 | 16.60 | 0.0767 |
| 24 | 2000.19 | 18.91 | 0.0739 |
| 25 | 1999.00 | 18.37 | 0.0681 |
| 26 | 1997.06 | 14.40 | 0.0682 |
| 27 | 1995.51 | 15.41 | 0.0682 |
| 28 | 1995.14 | 15.08 | 0.0674 |
| 29 | 1994.96 | 14.91 | 0.0705 |
| 30 | 1994.49 | 14.58 | 0.0661 |
| 31 | 1993.73 | 12.73 | 0.0675 |
| 32 | 1992.88 | 13.05 | 0.0679 |
| 33 | 1991.85 | 12.82 | 0.0658 |
| 34 | 1990.58 | 10.18 | 0.0681 |
| 35 | 1989.00 | 7.10 | 0.0657 |
| 36 | 1986.88 | 7.72 | 0.0672 |
| 37 | 1984.17 | 8.04 | 0.0662 |
| 38 | 1981.72 | 8.02 | 0.0652 |
| 39 | 1979.80 | 8.74 | 0.0648 |
| 40 | 1977.80 | 8.17 | 0.0633 |
| 41 | 1975.69 | 7.04 | 0.0601 |
| 42 | 1973.55 | 8.50 | 0.0606 |
| 43 | 1971.49 | 8.26 | 0.0623 |
| 44 | 1969.44 | 8.05 | 0.0666 |
| 45 | 1967.35 | 7.78 | 0.0636 |
| 46 | 1965.24 | 7.62 | 0.0647 |
| 47 | 1963.11 | 7.64 | 0.0648 |
| 48 | 1961.02 | 6.39 | 0.0651 |
| 49 | 1958.99 | 7.11 | 0.0640 |
| 50 | 1956.91 | 7.46 | 0.0654 |
| 51 | 1954.82 | 7.98 | 0.0633 |
| 52 | 1952.68 | 6.96 | 0.0612 |
| 53 | 1950.66 | 7.79 | 0.0605 |
| 54 | 1948.86 | 8.82 | 0.0618 |
| 55 | 1947.02 | 7.76 | 0.0670 |
| 56 | 1945.08 | 7.07 | 0.0607 |
| 57 | 1943.21 | 8.41 | 0.0612 |

Table A11. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from PAD 18 in the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2010.05 | 52.89 | 0.0401 |
| 1 | 2007.76 | 53.35 | 0.0411 |
| 2 | 2003.84 | 52.51 | 0.0424 |
| 3 | 2001.06 | 50.96 | 0.0435 |
| 4 | 1995.16 | 49.70 | 0.0443 |
| 5 | 1990.89 | 47.67 | 0.0459 |
| 6 | 1987.55 | 48.09 | 0.0491 |
| 7 | 1984.04 | 46.94 | 0.0470 |
| 8 | 1980.31 | 47.26 | 0.0488 |
| 9 | 1976.50 | 47.42 | 0.0438 |
| 10 | 1972.62 | 44.87 | 0.0461 |
| 11 | 1968.89 | 44.76 | 0.0499 |
| 12 | 1965.15 | 43.74 | 0.0479 |
| 13 | 1961.18 | 42.83 | 0.0449 |
| 14 | 1956.84 | 42.58 | 0.0438 |
| 15 | 1952.65 | 41.98 | 0.0423 |
| 16 | 1949.00 | 40.23 | 0.0423 |
| 17 | 1944.84 | 38.57 | 0.0436 |
| 18 | 1940.38 | 37.72 | 0.0431 |
| 19 | 1935.64 | 36.44 | 0.0399 |
| 20 | 1930.12 | 34.24 | 0.0362 |
| 21 | 1923.81 | 34.56 | 0.0385 |
| 22 | 1917.05 | 34.20 | 0.0354 |
| 23 | 1910.82 | 33.81 | 0.0359 |
| 24 | 1905.06 | 31.89 | 0.0373 |
| 25 | 1899.19 | 31.29 | 0.0357 |
| 26 | 1893.29 | 30.81 | 0.0346 |
| 27 | 1887.92 | 31.21 | 0.0339 |
| 28 | 1882.43 | 32.03 | 0.0338 |
| 29 | 1875.31 | 34.01 | 0.0328 |
| 30 | 1867.20 | 35.55 | 0.0322 |
| 31 | 1859.41 | 35.71 | 0.0400 |
| 32 | 1851.74 | 35.20 | 0.0374 |
| 33 | 1844.40 | 33.67 | 0.0353 |
| 34 | 1837.36 | 32.58 | 0.0366 |
| 35 | 1830.41 | 31.47 | 0.0365 |
| 36 | 1823.71 | 31.61 | 0.0356 |
| 37 | 1817.13 | 32.73 | 0.0322 |
| 38 | 1810.58 | 34.31 | 0.0362 |
| 39 | 1803.49 | 34.70 | 0.0370 |
| 40 | 1796.86 | 34.28 | 0.0349 |
| 41 | 1790.53 | 37.28 | 0.0281 |
| 42 | 1783.78 | 37.37 | 0.0286 |
| 43 | 1777.09 | 37.76 | 0.0353 |

Table A12. Depth (top of interval), estimated year, organic matter content (%OM) and THg concentration for the sediment core from AC5, located southeast of the Peace-Athabasca Delta. %OM and THg concentrations are expressed per dry weight.

|  |  |  |  |
| --- | --- | --- | --- |
| Depth (cm) | Year | %OM | THg (mg/kg) |
| 0 | 2018.84 | 67.82 | 0.0544 |
| 1 | 2017.44 | 70.50 | 0.0524 |
| 2 | 2015.92 | 67.74 | 0.0592 |
| 3 | 2014.17 | 64.32 | 0.0680 |
| 4 | 2012.20 | 65.44 | 0.0755 |
| 5 | 2009.94 | 65.58 | 0.0727 |
| 6 | 2007.50 | 61.97 | 0.0721 |
| 7 | 2004.76 | 63.25 | 0.0712 |
| 8 | 2001.68 | 62.14 | 0.0721 |
| 9 | 1998.25 | 61.95 | 0.0714 |
| 10 | 1994.49 | 59.94 | 0.0744 |
| 11 | 1990.47 | 55.91 | 0.0855 |
| 12 | 1986.18 | 56.44 | 0.0834 |
| 13 | 1981.84 | 54.19 | 0.0851 |
| 14 | 1977.25 | 52.03 | 0.0795 |
| 15 | 1972.10 | 51.98 | 0.0842 |
| 16 | 1966.81 | 52.99 | 0.0871 |
| 17 | 1962.05 | 54.37 | 0.0851 |
| 18 | 1957.30 | 53.84 | 0.0725 |
| 19 | 1951.89 | 53.80 | 0.0662 |
| 20 | 1946.22 | 52.15 | 0.0646 |
| 21 | 1940.15 | 53.42 | 0.0636 |
| 22 | 1933.96 | 54.52 | 0.0582 |
| 23 | 1928.19 | 53.75 | 0.0509 |
| 24 | 1922.40 | 50.19 | 0.0541 |
| 25 | 1916.05 | 50.76 | 0.0492 |
| 26 | 1909.10 | 49.60 | 0.0462 |
| 27 | 1902.65 | 49.38 | 0.0486 |
| 29 | 1897.23 | 50.60 | 0.0525 |
| 32 | 1892.28 | 52.43 | 0.0432 |
| 34 | 1867.24 | 50.32 | 0.0439 |
| 36 | 1858.37 | 49.84 | 0.0322 |
| 38 | 1853.03 | 52.44 | 0.0360 |
| 40 | 1842.09 | 50.24 | 0.0346 |
| 42 | 1831.80 | 51.66 | 0.0340 |
| 44 | 1821.92 | 50.00 | 0.0267 |
| 46 | 1813.77 | 49.80 | 0.0227 |
| 48 | 1803.57 | 48.80 | 0.0216 |

**Supporting Information on Sediment Core Dating**

Sediment cores obtained from floodplain lakes offer valuable information on past environmental changes and their causes, but deposition is complicated by multiple sources of sediment and marked shifts over time in flux rates which are typically slower during periods without flooding and more rapid when flooding. Floodplain lakes are generally dominated by riverine inputs of water, sediment, and contaminants, although they span a continuum of connectivity from very frequent riverine inputs to highly episodic floods. At the latter end of the continuum, sedimentation of floodplain lakes can resemble that of upland lakes from a 210Pb-dating perspective.

Higher and more variable sedimentation rates of floodplain lakes depress the signal of 210Pb activity due to the atmospheric deposition because of variable dilution with inorganic rich sediment influx by river floodwaters. This lowers total 210Pb activities and the resultant unsupported 210Pb activities (which are calculated as total 210Pb minus 226Ra activities). High quality gamma spectrum count data are crucial in the face of this challenge, which is achieved, at least in part by use of high sediment mass for analysis by gamma ray spectroscopy and sufficiently long count time. For example, we typically use dry sample mass of 2-5 g per sample and extend duration of the run time so that a net of ~1000 210Pb counts are achieved per sample. For the core from Down 1, for example, we used on average 3.4 g of dry sediment mass per sample and mean count time was 3 days per sample. To improve estimates of supported 210Pb activity, 226Ra activity is determined from the weighted mean activity of 214Pb at 295 keV, 214Pb at 352keV and 214Bi at 609kev (Gilmour 2008). Detector efficiency calibration is also important, and we pay attention to this in our methods and use of standards, which has evolved over the years (IAEA 300 only for PAD 18, 23, 31) to employ muti-source calibration and verification (IAEA-312, IAEA 447, BL-4a, CLV-1, and internal standards).

In sediment records of floodplain lakes, and other rapid sedimentation environments, “statistical” background (where supported and total 210Pb activity estimates overlap) is reached in fewer half-lives than in records from non-flooded lakes with slower sedimentation. As a consequence, it is important to calculate of the 210Pb excess inventory below the “background” depth (Aj) and include it in the estimate of the total excess 210Pb inventory, in order to avoid errors in age-estimates inherent in the CRS (constant rate of supply) model (Appleby 2001; Sanchez-Cabeza and Ruiz-Fernandez 2012). We determined the Aj term for each core in the manner described by Appleby (2001, see Eq 34).

Below we provide graphs showing the radioisotope activity profiles and estimated age-depth relations in Figure A1.



Figure A1. Graphs showing 210Pb, 226Ra and 137Cs activity profiles (left) and age-depth relations (right), which includes both estimated (black) and extrapolated (grey) values for study lakes. The 137Cs peak is denoted by a grey star and the error bars = ±2 SD. Previously published profiles include Down 1, Down 26 and Down 58 (Klemt et al. 2020), PAD 23 (Hall et al. 2012), PAD 30, PAD 31, PAD 32, M2 and M5 (Kay et al. 2019), and PAD 18 (Wiklund et al. 2012). AC5 has not been previously published.



Figure A2. Time-series of enrichment factors relative to pre-industrial baselines for THg and Zn at PAD 30. The grey shaded region denotes the interval of oil sands mining and processing activities on the Lower Athabasca River beginning in 1967. The Zn data were published in Kay et al. (2020).