Supplemental Table 1. Trace element analysis.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample Id | Depth | Age (ka) | Ca | Mg | Ba | Sr | Al | Cu | Fe | K | Na | P | Pb | S | Zn | U |  |
|  | (mm) |  | wt % | wt % | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |  |
| ACH3-01 | 0.8 | 9026+/-55 | 37.3 | 0.455 | 10.70 | 385 | 47.7 | 8.9 | 50.9 | 1239 | 759 | 13397 | 0.35 | 3869 | 23.3 | 1.6 |  |
| ACH3-02 | 5.2 |  | 38.3 | 0.451 | 6.95 | 355 | 132.0 | 4.2 | 13.9 | 112 | 81 | 251.9 | 0.18 | 3014 | 3.27 | 1.66 |  |
| ACH3-03 | 11.0 |  | 37.9 | 0.474 | 7.10 | 362 | 11.7 | 0.6 | 15.9 | 70.5 | 108 | 148.1 | 0.09 | 2966 | 0.88 | 1.79 |  |
| ACH3-04 | 16.4 |  | 38.1 | 0.452 | 6.71 | 312 | 19.0 | 16.9 | 148.6 | 94 | 68 | 84.9 | 0.14 | 2526 | 5.42 | 1.67 |  |
| ACH3-05 | 22.6 |  | 38.7 | 0.382 | 8.48 | 423 | 12.0 | 13.1 | 13.2 | 118 | 52 | 97 | 0.09 | 2866 | 4.29 | 1.41 |  |
| ACH3-06 | 29.1 |  | 38.0 | 0.520 | 9.45 | 439 | 5.6 | 3.9 | 18.5 | 56.3 | 72 | 32.6 | 0.05 | 3305 | 1.40 | 1.75 |  |
| ACH3-07 | 35.1 |  | 38.0 | 0.452 | 10.39 | 383 | 16.8 | 3.7 | 15.3 | 54.2 | 58.8 | 66.8 | 0.11 | 2964 | 1.21 | 1.61 |  |
| ACH3-08 | 39.8 |  | 38.7 | 0.422 | 8.44 | 379 | 10.1 | 3.8 | 16.1 | 95 | 62.2 | 64.8 | 0.08 | 2759 | 1.76 | 1.73 |  |
| ACH3-09 | 44.3 |  | 38.0 | 0.480 | 13.7 | 405 | 5.9 | 1.8 | 12.2 | 95 | 61.7 | 68.3 | 0.07 | 3200 | 1.03 | 1.75 |  |
| ACH3-10 | 49.7 |  | 37.9 | 0.474 | 8.28 | 408 | 2.8 | 0.8 | 9.6 | 99 | 59.7 | 42.2 | 0.04 | 3019 | 0.35 | 1.66 |  |
| ACH3-11 | 53.5 |  | 37.3 | 0.483 | 8.18 | 374 | 3.6 | 1.7 | 8.6 | 71 | 64.7 | 46.4 | 0.09 | 2723 | 0.91 | 1.56 |  |
| ACH3-12 | 57.0 |  | 37.9 | 0.493 | 14.0 | 386 | 8.9 | 0.8 | 3.9 | 54.3 | 65.2 | 27.3 | 0.10 | 2567 | 0.61 | 1.58 |  |
| ACH3-13 | 60.9 |  | 37.9 | 0.465 | 7.19 | 364 | 2.5 | 0.6 | 4.2 | 56.3 | 50.3 | 35.8 | 0.07 | 2437 | 0.28 | 1.40 |  |
| ACH3-14 | 64.4 |  | 38.1 | 0.426 | 63.1 | 406 | 65.1 | 2.5 | 39.3 | 65.0 | 56.3 | 44.6 | 0.82 | 2436 | 4.67 | 1.48 |  |
| ACH3-15 | 69.1 |  | 39.0 | 0.489 | 8.19 | 367 | 2.4 | 0.8 | 4.3 | 55.1 | 61.3 | 41.7 | 0.05 | 2774 | 1.08 | 1.64 |  |
| ACH3-16 | 73.1 |  | 39.4 | 0.468 | 10.52 | 349 | 5.2 | 1.9 | 5.4 | 46.5 | 63.5 | 79.3 | 0.19 | 2703 | 1.18 | 1.71 |  |
| ACH3-17 | 77.1 |  | 39.0 | 0.508 | 24.5 | 384 | 12.8 | 5.9 | 51.4 | 55.5 | 69 | 40.7 | 0.51 | 2802 | 3.07 | 1.64 |  |
| ACH3-18 | 81.2 |  | 39.3 | 0.523 | 43.0 | 400 | 38.0 | 3.4 | 50.4 | 77 | 81 | 113.2 | 0.40 | 2859 | 2.85 | 1.63 |  |
| ACH3-19 | 84.9 |  | 39.2 | 0.476 | 80.0 | 386 | 52.5 | 3.5 | 458.0 | 47.1 | 62 | 124.8 | 0.89 | 2429 | 3.85 | 1.42 |  |
| ACH3-20 | 88.8 |  | 38.7 | 0.523 | 35.2 | 370 | 25.0 | 1.4 | 37.0 | 65.8 | 75 | 168.9 | 0.30 | 2585 | 1.81 | 1.52 |  |
| ACH3-21 | 92.4 |  | 39.0 | 0.508 | 19.9 | 351 | 8.3 | 2.3 | 10.6 | 50.1 | 67 | 111.3 | 0.16 | 2521 | 1.51 | 1.56 |  |
| ACH3-22 | 95.0 |  | 38.9 | 0.507 | 36.6 | 363 | 24.4 | 3.5 | 16.6 | 50.0 | 63 | 71.6 | 0.32 | 2531 | 2.16 | 1.49 |  |
| ACH3-23 | 98.0 |  | 37.8 | 0.456 | 11.5 | 289 | 6.4 | 2.8 | 8.6 | 44.4 | 55.3 | 71.3 | 0.11 | 2286 | 1.30 | 1.40 |  |
| ACH3-24 | 101.7 |  | 38.6 | 0.524 | 41.2 | 357 | 37.2 | 4.2 | 205.4 | 81 | 73 | 131.4 | 0.39 | 2541 | 2.86 | 1.51 |  |
| ACH3-25 | 105.2 |  | 37.8 | 0.527 | 76.7 | 437 | 136.6 | 9.8 | 164.6 | 124 | 79 | 103.6 | 0.70 | 2449 | 7.52 | 1.47 |  |
| ACH3-26 | 108.2 |  | 38.8 | 0.497 | 20.0 | 362 | 22.6 | 2.2 | 11.8 | 60 | 61 | 46.6 | 0.10 | 2537 | 1.33 | 1.56 |  |
| ACH3-27 | 111.9 |  | 38.0 | 0.575 | 21.4 | 405 | 8.1 | 2.3 | 7.6 | 84 | 77 | 89.9 | 0.08 | 2883 | 1.03 | 1.70 |  |
| ACH3-28 | 116.0 |  | 39.5 | 0.492 | 11.16 | 360 | 4.4 | 2.3 | 12.7 | 72 | 59.5 | 67.5 | 0.09 | 2556 | 1.11 | 1.65 |  |
| ACH3-29 | 120.5 |  | 41.0 | 0.525 | 49.6 | 402 | 18.5 | 4.1 | 7.9 | 63 | 69 | 71.6 | 0.15 | 2663 | 2.00 | 1.69 |  |
| ACH3-30 | 125.7 |  | 39.1 | 0.513 | 48.6 | 400 | 25.0 | 3.0 | 32.7 | 85 | 73 | 163.5 | 0.22 | 2744 | 2.31 | 1.67 |  |
| ACH3-31 | 130.1 |  | 38.1 | 0.583 | 70.5 | 433 | 49.3 | 3.8 | 76.8 | 106 | 86 | 105.8 | 0.36 | 3070 | 2.90 | 1.66 |  |
| ACH3-32 | 135.5 |  | 40.4 | 0.589 | 41.3 | 411 | 23.8 | 1.5 | 27.9 | 102 | 83 | 109.2 | 0.21 | 3144 | 1.88 | 1.72 |  |
| ACH3-33 | 140.0 |  | 37.7 | 0.577 | 153.9 | 551 | 142.5 | 9.3 | 200.9 | 150 | 102 | 211.5 | 0.99 | 3045 | 8.24 | 1.62 |  |
| ACH3-34 | 144.8 |  | 38.2 | 0.567 | 64.2 | 423 | 123.8 | 6.4 | 76.5 | 80 | 78 | 157.5 | 0.53 | 3070 | 5.44 | 1.61 |  |
| ACH3-35 | 149.2 |  | 40.0 | 0.566 | 25.2 | 372 | 15.9 | 0.9 | 30.8 | 56.5 | 68 | 77.0 | 0.17 | 2739 | 0.81 | 1.68 |  |
| ACH3-36 | 153.1 |  | 38.3 | 0.566 | 11.10 | 354 | 8.3 | 0.9 | 7.8 | 54.9 | 70 | 71.6 | 0.11 | 2813 | 0.94 | 1.67 |  |
| ACH3-37 | 156.3 |  | 38.3 | 0.600 | 16.4 | 416 | 17.3 | 1.0 | 13.9 | 104 | 87 | 124.4 | 0.13 | 3457 | 1.31 | 1.92 |  |
| ACH3-38 | 159.0 |  | 38.8 | 0.509 | 8.43 | 341 | 7.5 | 0.5 | 9.1 | 52.2 | 60 | 64.1 | 0.05 | 2825 | 0.68 | 1.62 |  |
| ACH3-39 | 162.1 | 9402+/-66 | 37.1 | 0.579 | 11.59 | 407 | 7.6 | 0.4 | 8.8 | 85 | 64 | 73.5 | 0.10 | 2600 | 0.97 | 1.56 |  |
| ACH3-40 | 167.0 |  | 38.2 | 0.556 | 14.4 | 410 | 8.6 | 0.7 | 7.9 | 64.8 | 62 | 38.7 | 0.08 | 2646 | 0.59 | 1.53 |  |
| ACH3-41 | 172.3 |  | 38.4 | 0.566 | 67.4 | 454 | 60.3 | 1.9 | 17.0 | 89 | 68 | 51.9 | 0.25 | 2671 | 1.95 | 1.55 |  |
| ACH3-42 | 179.8 |  | 37.9 | 0.574 | 7.70 | 431 | 10.6 | 0.3 | 16.0 | 100 | 77 | 51.3 | 0.04 | 3128 | 0.70 | 1.76 |  |
| ACH3-43 | 185.0 |  | 39.2 | 0.527 | 17.2 | 386 | 32.8 | 1.6 | 25.6 | 113 | 66 | 92.0 | 0.08 | 2818 | 1.64 | 1.65 |  |
| ACH3-44 | 190.0 |  | 39.0 | 0.603 | 9.83 | 425 | 4.0 | 1.1 | 4.3 | 88 | 84 | 43.2 | 0.09 | 3319 | 0.71 | 1.89 |  |
| ACH3-45 | 194.8 |  | 39.2 | 0.595 | 13.62 | 417 | 5.1 | 0.3 | 5.3 | 68 | 74 | 42.9 | 0.04 | 3200 | 0.08 | 1.71 |  |
| ACH3-46 | 199.5 |  | 38.1 | 0.590 | 7.49 | 397 | 7.4 | 0.6 | 11.4 | 82.7 | 83 | 51.2 | 0.05 | 3196 | 0.80 | 1.76 |  |
| ACH3-47 | 202.7 |  | 39.7 | 0.644 | 7.97 | 421 | 29.6 | 0.5 | 33.9 | 72 | 92 | 64.5 | 0.21 | 3537 | 1.13 | 1.88 |  |
| ACH3-48 | 205.3 |  | 37.2 | 0.565 | 6.95 | 377 | 22.2 | 0.8 | 152.4 | 80 | 71 | 65.4 | 0.13 | 3024 | 0.79 | 1.72 |  |
| ACH3-49 | 209.7 |  | 38.5 | 0.611 | 6.65 | 398 | 22.2 | 0.6 | 12.7 | 74 | 79 | 55.8 | 0.05 | 3170 | 0.68 | 1.77 |  |
| ACH3-50 | 214.6 |  | 39.1 | 0.588 | 6.74 | 361 | 12.8 | 29.6 | 77.5 | 71 | 75 | 49.9 | 1.23 | 3104 | 15.27 | 1.71 |  |
| ACH3-51 | 219.8 |  | 38.5 | 0.570 | 7.38 | 377 | 67.9 | 2.0 | 47.1 | 127 | 80 | 124.6 | 0.15 | 3116 | 2.39 | 1.82 |  |
| ACH3-52 | 224.9 |  | 37.8 | 0.572 | 7.48 | 393 | 3.7 | 0.2 | 4.2 | 82 | 78 | 49.8 | 0.01 | 3563 | 0.30 | 1.95 |  |
| ACH3-53 | 230.4 | 9442+/-71 | 38.3 | 0.599 | 6.81 | 398 | 14.2 | 0.8 | 21.0 | 82 | 75 | 46.5 | 0.11 | 2630 | 1.34 | 1.54 |  |
| ACH3-54 | 235.4 |  | 36.9 | 0.600 | 7.17 | 405 | 21.0 | 0.8 | 19.1 | 72 | 78 | 38.5 | 0.05 | 3374 | 0.46 | 1.87 |  |
| ACH3-55 | 240.4 |  | 36.9 | 0.566 | 6.89 | 390 | 4.5 | 0.1 | 6.5 | 69 | 73 | 34.1 | 0.01 | 3253 | 0.18 | 1.93 |  |
| ACH3-56 | 244.8 |  | 35.8 | 0.565 | 7.35 | 393 | 54.7 | 1.0 | 84 | 151 | 74 | 156.6 | 0.05 | 3367 | 2.46 | 1.88 |  |
| ACH3-57 | 250.1 |  | 37.8 | 0.587 | 7.05 | 417 | 13.3 | 0.3 | 4.8 | 64.8 | 83 | 31.9 | 0.02 | 3416 | 0.49 | 1.90 |  |
| ACH3-58 | 255.1 |  | 37.7 | 0.595 | 7.50 | 416 | 36.4 | 0.6 | 43.8 | 114 | 80 | 145.3 | 0.05 | 3607 | 2.22 | 1.95 |  |
| ACH3-59 | 260.0 |  | 34.1 | 0.528 | 6.70 | 374 | 23.6 | 0.4 | 23.5 | 81 | 67 | 70.1 | 0.04 | 3162 | 1.15 | 1.72 |  |
| ACH3-60 | 264.1 |  | 38.2 | 0.606 | 7.40 | 411 | 31.3 | 0.6 | 36.8 | 91 | 82 | 89.1 | 0.04 | 3575 | 1.41 | 1.87 |  |
| ACH3-61 | 269.1 |  | 38.9 | 0.584 | 7.45 | 397 | 47.1 | 0.8 | 58.1 | 93 | 78 | 140.1 | 0.06 | 3553 | 2.36 | 1.91 |  |
| ACH3-62 | 273.7 |  | 37.2 | 0.557 | 7.23 | 391 | 41.7 | 0.7 | 48.4 | 98 | 73 | 120.2 | 0.07 | 3375 | 2.44 | 1.82 |  |
| ACH3-63 | 280.4 |  | 36.4 | 0.574 | 7.23 | 417 | 19.2 | 0.6 | 21.4 | 77 | 72 | 86.7 | 0.05 | 3290 | 1.08 | 1.80 |  |
| ACH3-64 | 285.5 |  | 38.0 | 0.545 | 6.85 | 373 | 38.6 | 0.8 | 23.2 | 67 | 59 | 58.6 | 0.07 | 2967 | 1.17 | 1.60 |  |
| ACH3-65 | 289.8 |  | 36.2 | 0.579 | 6.51 | 383 | 6.7 | 0.2 | 5.8 | 50.4 | 70 | 35.3 | 0.02 | 3168 | 0.46 | 1.75 |  |
| ACH3-66 | 295.0 |  | 36.0 | 0.581 | 6.75 | 384 | 12.6 | 0.2 | 15.4 | 65.4 | 73 | 49.0 | 0.03 | 3216 | 0.77 | 1.87 |  |
| ACH3-67 | 300.2 | 9831+/-68 | 37.9 | 0.644 | 6.76 | 420 | 5.7 | 0.2 | 5.9 | 83 | 71 | 104.6 | 0.02 | 2941 | 0.39 | 1.72 |  |
| ACH3-68 | 502.6 |  | 39.5 | 0.551 | 7.61 | 434 | 22.5 | 0.8 | 30.1 | 147 | 75 | 257.1 | 0.05 | 3549 | 2.63 | 1.88 |  |
| ACH3-69 | 507.3 |  | 36.8 | 0.587 | 6.59 | 408 | 12.3 | 0.4 | 11.4 | 79 | 83 | 121.8 | 0.05 | 3223 | 0.98 | 1.85 |  |
| ACH3-70 | 511.8 |  | 37.6 | 0.609 | 7.23 | 413 | 5.0 | 0.2 | 4.7 | 64.8 | 83 | 31.6 | 0.05 | 3648 | 0.55 | 1.94 |  |
| ACH3-71 | 516.7 |  | 37.0 | 0.575 | 6.83 | 380 | 27.4 | 0.4 | 26.4 | 67.6 | 72 | 86.4 | 0.06 | 3238 | 0.64 | 1.85 |  |
| ACH3-72 | 520.8 |  | 37.6 | 0.578 | 6.54 | 381 | 12.8 | 0.2 | 9.6 | 58.1 | 74 | 33.6 | 0.03 | 3325 | 0.36 | 1.82 |  |
| ACH3-73 | 524.6 |  | 38.8 | 0.593 | 6.88 | 404 | 9.0 | 0.2 | 9.0 | 66 | 80 | 44.3 | 0.03 | 3478 | 0.30 | 1.94 |  |
| ACH3-74 | 529.4 |  | 37.4 | 0.615 | 7.52 | 410 | 28.7 | 0.9 | 54.4 | 77 | 82 | 60.0 | 0.08 | 3587 | 0.61 | 1.95 |  |
| ACH3-75 | 534.3 |  | 36.2 | 0.602 | 8.95 | 403 | 58.0 | 1.8 | 203.1 | 119 | 87 | 78.3 | 0.32 | 3586 | 2.18 | 1.92 |  |
| ACH3-76 | 539.1 |  | 36.5 | 0.614 | 7.15 | 412 | 19.1 | 0.6 | 29.5 | 85 | 82 | 91.9 | 0.15 | 3647 | 0.88 | 1.92 |  |
| ACH3-77 | 542.8 |  | 36.1 | 0.625 | 7.44 | 396 | 71.4 | 1.8 | 30.8 | 92 | 77 | 79.8 | 0.26 | 3322 | 2.49 | 1.77 |  |
| ACH3-78 | 546.7 |  | 36.2 | 0.618 | 7.17 | 415 | 6.9 | 0.3 | 6.4 | 71 | 82 | 51.7 | 0.08 | 3584 | 0.33 | 1.93 |  |
| ACH3-79 | 551.5 |  | 37.1 | 0.648 | 7.15 | 417 | 11.4 | 0.3 | 14.0 | 70 | 78 | 32.6 | 0.10 | 3537 | 0.45 | 1.88 |  |
| ACH3-80 | 554.5 |  | 36.7 | 0.629 | 7.80 | 426 | 25.0 | 0.7 | 19.4 | 77 | 81 | 67.2 | 0.07 | 3699 | 0.84 | 1.96 |  |
| ACH3-81 | 557.9 |  | 36.3 | 0.622 | 7.18 | 417 | 7.0 | 1.1 | 8.5 | 71 | 78 | 76.3 | 0.06 | 3564 | 0.82 | 1.92 |  |
| ACH3-82 | 561.6 |  | 35.8 | 0.610 | 8.90 | 408 | 54.0 | 1.2 | 23.7 | 87 | 81 | 128.1 | 0.16 | 3735 | 1.47 | 1.95 |  |
| ACH3-83 | 566.1 |  | 36.2 | 0.614 | 8.25 | 402 | 80.7 | 3.0 | 181.6 | 108 | 83 | 90.9 | 0.34 | 3655 | 2.61 | 1.89 |  |
| ACH3-84 | 571.3 |  | 36.4 | 0.580 | 7.00 | 395 | 18.4 | 0.7 | 31.2 | 68 | 74 | 65.6 | 0.09 | 3563 | 0.76 | 1.89 |  |
| ACH3-85 | 575.9 |  | 36.5 | 0.614 | 7.80 | 413 | 38.8 | 1.1 | 19.1 | 76 | 79 | 66.7 | 0.12 | 3763 | 0.96 | 1.92 |  |
| ACH3-86 | 579.7 |  | 38.4 | 0.620 | 8.87 | 402 | 59.2 | 1.7 | 68.5 | 91 | 79 | 88.4 | 0.23 | 3649 | 2.09 | 1.85 |  |
| ACH3-87 | 582.2 |  | 36.1 | 0.607 | 7.77 | 430 | 10.6 | 0.7 | 9.6 | 91 | 81 | 411.8 | 0.07 | 3882 | 1.00 | 2.08 |  |
| ACH3-88 | 585.3 |  | 37.0 | 0.651 | 8.34 | 468 | 8.8 | 1.1 | 5.5 | 123 | 87 | 1525.4 | 0.15 | 3973 | 1.51 | 2.50 |  |
| ACH3-89 | 589.5 |  | 36.6 | 0.695 | 8.00 | 476 | 9.6 | 0.6 | 8.7 | 91 | 87 | 596.9 | 0.12 | 3971 | 1.20 | 2.20 |  |
| ACH3-90 | 594.6 |  | 35.7 | 0.698 | 8.00 | 489 | 6.5 | 0.6 | 7.6 | 88 | 96 | 388.7 | 0.17 | 4185 | 0.92 | 2.20 |  |
| ACH3-91 | 598.3 | 10624+/-82 | 36.3 | 0.674 | 9.40 | 493 | 240.0 | 3.7 | 577.6 | 241 | 108 | 2357.1 | 0.64 | 3879 | 9.8 | 2.6 |  |
| **MDL** |  |  | **0.50** | **0.02** | **0.5** | **1.0** | **0.5** | **0.2** | **0.5** | **0.5** | **0.5** | **0.5** | **0.2** | **100.0** | **0.2** | **0.2** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |