

Appendix

Appendix A

1-Table 5.9: Leachable activity concentration ratio of $^{238}\text{U}/^{232}\text{Th}$, $^{238}\text{U}/^{40}\text{K}$ and $^{232}\text{Th}/^{40}\text{K}$ (East side of study area)

| Ser. No | Location | Depth (cm) | Code | Activity concentration in bq/kg | | |
|---------|----------|------------|------|----------------------------------|--------------------------------|---------------------------------|
| | | | | $^{238}\text{U}/^{232}\text{Th}$ | $^{238}\text{U}/^{40}\text{K}$ | $^{232}\text{Th}/^{40}\text{K}$ |
| 1. | 1E | 0 | S01E | 0.7726 | 0.6023 | 0.7796 |
| 2. | 2E | 5 | S02E | 0.5628 | 0.2090 | 0.3713 |
| 3. | 5E | 0 | S05E | 0.6913 | 0.3940 | 0.5700 |
| 4. | 6E | 5 | S06E | 0.7759 | 0.4640 | 0.5980 |
| 5. | 9E | 0 | E09E | 0.6052 | 0.4226 | 0.6983 |
| 6. | 10E | 5 | S10E | 0.7246 | 0.5368 | 0.7408 |
| Average | | | | 0.6887 | 0.4381 | 0.6263 |

2-Table 5.10: Leachable activity concentration ratio

of $^{238}\text{U}/^{232}\text{Th}$, $^{238}\text{U}/^{40}\text{K}$ and $^{232}\text{Th}/^{40}\text{K}$ (west side of study area)

| Ser. No | Location | Depth (cm) | Code | Activity concentration in bq/kg | | |
|---------|----------|------------|------|----------------------------------|--------------------------------|---------------------------------|
| | | | | $^{238}\text{U}/^{232}\text{Th}$ | $^{238}\text{U}/^{40}\text{K}$ | $^{232}\text{Th}/^{40}\text{K}$ |
| 1. | 1W | 0 | S01W | 0.4855 | 0.3933 | 0.8101 |
| 2. | 2W | 5 | S02W | 0.8750 | 0.2958 | 0.3381 |
| 3. | 5W | 0 | S05W | 0.8976 | 0.6286 | 0.7003 |
| 4. | 6W | 5 | S06W | 0.6120 | 0.4152 | 0.6784 |
| 5. | 9W | 0 | S09W | 0.9447 | 0.2334 | 0.2470 |
| 6. | 10W | 5 | S10W | 0.7438 | 0.3008 | 0.4045 |
| Average | | | | 0.7598 | 0.3779 | 0.5297 |

3-Table 5.11: Leachable activity concentration ratio
of $^{238}\text{U}/^{232}\text{Th}$, $^{238}\text{U}/^{40}\text{K}$ and $^{232}\text{Th}/^{40}\text{K}$
(South side of study area)

| Ser. No | Location | Depth (cm) | Code | Activity concentration in bq/kg | | |
|---------|----------|------------|------|----------------------------------|--------------------------------|---------------------------------|
| | | | | $^{238}\text{U}/^{232}\text{Th}$ | $^{238}\text{U}/^{40}\text{K}$ | $^{232}\text{Th}/^{40}\text{K}$ |
| 1. | 1S | 0 | S01S | 0.8977 | 0.3256 | 0.3627 |
| 2. | 2S | 5 | S02S | 0.5389 | 0.2816 | 0.5225 |
| 3. | 5S | 0 | S05S | 1.2365 | 2.2158 | 1.7919 |
| 4. | 6S | 5 | S06S | 0.9533 | 0.5164 | 0.5417 |
| 5. | 9S | 0 | S09S | 0.6127 | 0.2823 | 0.4608 |
| 6. | 10S | 5 | S10S | 0.5239 | 0.3055 | 0.5831 |
| Average | | | | 0.793833 | 0.654533 | 0.71045 |

4-Table 5.12: Leachable activity concentration ratio
of $^{238}\text{U}/^{232}\text{Th}$, $^{238}\text{U}/^{40}\text{K}$ and $^{232}\text{Th}/^{40}\text{K}$
(North side of study area)


| Ser. No | Location | Depth (cm) | Code | Activity concentration in bq/kg | | |
|---------|----------|------------|------|----------------------------------|--------------------------------|---------------------------------|
| | | | | $^{238}\text{U}/^{232}\text{Th}$ | $^{238}\text{U}/^{40}\text{K}$ | $^{232}\text{Th}/^{40}\text{K}$ |
| 1. | 1N | 0 | S01N | 0.9053 | 0.8236 | 0.9098 |
| 2. | 2N | 5 | S02N | 0.8473 | 0.5929 | 0.6998 |
| 3. | 5N | 0 | S05N | 2.6809 | 1.3704 | 0.5112 |
| 4. | 6N | 5 | S06N | 3.0299 | 2.7717 | 0.6878 |
| 5. | 9N | 0 | S09N | 0.3409 | 0.6728 | 1.9736 |
| 6. | 10N | 5 | S10N | 1.1835 | 0.8322 | 0.7031 |
| Average | | | | 0.9979 | 0.9998 | 0.9142 |

5-Table 5.13: Leachable activity concentration ratio
of $^{238}\text{U}/^{232}\text{Th}$, $^{238}\text{U}/^{40}\text{K}$ and $^{232}\text{Th}/^{40}\text{K}$ Average
(All side of study area)

| Location | Depth (cm) | Activity concentration Average in bq/kg | | |
|----------|------------|--|--------------------------------|---------------------------------|
| | | $^{238}\text{U}/^{232}\text{Th}$ | $^{238}\text{U}/^{40}\text{K}$ | $^{232}\text{Th}/^{40}\text{K}$ |
| East | 0-5 | 0.69 | 0.44 | 0.63 |
| North | 0-5 | 1.00 | 1.00 | 0.91 |
| South | 0-5 | 0.79 | 0.65 | 0.71 |
| West | 0-5 | 0.76 | 0.38 | 0.53 |

Appendix B Table(5.14-5.19)of all metals concentration results in (ppm),from Nyala soil samples area by XRF techniques

1-Table5.14



MINISTRY OF MINERALS
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وزارة المعادن
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 المختبر الكيميائي
 الخرطوم - شارع النيل - ص. ب 410

METHODS: XRF **ENTERY DATE:09/ 12/ 2015**
RECIPE : AXIOS **RPORT NO :741**
CLAIBATION : Protrace

| Lab NO | 5761 | 5762 | 5763 | 5764 | 5765 | 5766 | UNIT |
|-----------|---------|---------|---------|---------|---------|---------|------|
| Sender No | SI0S | S-06-S | S06N | S09N | S09W | S02N | ppm |
| Sc | 6.382 | 3.001 | 5.511 | 3.764 | 3.441 | 4.996 | ppm |
| V | 43.175 | 42.783 | 70.604 | 52.908 | 41.666 | 52.745 | ppm |
| Cr | 221.875 | 341.896 | 129.009 | 243.632 | 230.900 | 235.491 | ppm |
| Mn | 568.522 | 569.445 | 318.784 | 296.215 | 277.352 | 337.243 | ppm |
| Co | 5.868 | 4.887 | 7.271 | 3.295 | 4.067 | 6.116 | ppm |
| Ni | 12.054 | 10.398 | 16.628 | 10.108 | 7.798 | 12.208 | ppm |
| Cu | 10.652 | 5.583 | 14.792 | 7.452 | 5.139 | 11.909 | ppm |
| Zn | 21.562 | 30.053 | 36.032 | 18.892 | 8.560 | 30.689 | ppm |
| Ga | 12.601 | 7.520 | 11.189 | 7.934 | 7.029 | 9.684 | ppm |
| Ge | 0.422 | 0.106 | N.D | N.D | 0.115 | 0.087 | ppm |
| Br | 1.463 | 0.778 | 3.162 | 1.293 | 0.417 | 1.226 | ppm |
| Rb | 114.300 | 69.604 | 69.084 | 65.324 | 80.756 | 74.986 | ppm |
| Sr | 103.054 | 63.158 | 151.023 | 97.702 | 97.215 | 101.896 | ppm |
| Y | 28.543 | 15.545 | 17.923 | 31.422 | 9.666 | 18.947 | ppm |
| Zr | 699.122 | 263.028 | 298.218 | 858.960 | 105.514 | 295.127 | ppm |
| Nb | 18.631 | 7.005 | 12.044 | 13.275 | 3.432 | 9.183 | ppm |
| Mo | 5.512 | 8.586 | 2.104 | 9.303 | 7.878 | 7.391 | ppm |
| Ag | 4.906 | 4.701 | 3.827 | 3.720 | 4.293 | 4.696 | ppm |
| Cd | 0.828 | N.D | N.D | 1.754 | N.D | 0.414 | ppm |
| Sn | 6.176 | 4.397 | 4.701 | 3.594 | 3.736 | 4.664 | ppm |
| Sb | 2.834 | 0.365 | 0.869 | N.D | 2.111 | 0.916 | ppm |

1

2-Table5.15



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METHODS: XRF

ENTERY DATE: 09/ 12/ 2015

RECIPE : AXIOS

RPORT NO :741

CLAIBATION : Protrace

| Lab NO | 5761 | 5762 | 5763 | 5764 | 5765 | 5766 | UNIT |
|-----------|---------|---------|---------|---------|---------|---------|------|
| Sender No | SIOS | S-06-S | S06N | S09N | S09W | S02N | ppm |
| Te | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| I | N.D | N.D | 2.881 | 0.529 | 0.530 | N.D | ppm |
| Cs | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Ba | 680.488 | 253.750 | 325.242 | 368.362 | 453.059 | 373.412 | ppm |
| La | 42.209 | 14.937 | 36.812 | 51.411 | 18.440 | 28.680 | ppm |
| Ce | 91.833 | 29.394 | 67.750 | 108.811 | 29.945 | 50.594 | ppm |
| Nd | 31.197 | 12.609 | 28.554 | 40.981 | 9.966 | 23.709 | ppm |
| Sm | 6.501 | 1.371 | 5.504 | 5.063 | 5.821 | 4.330 | ppm |
| Yb | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Hf | 18.779 | 8.760 | 9.901 | 22.447 | 4.038 | 9.490 | ppm |
| Ta | 0.650 | N.D | 0.267 | 0.481 | N.D | N.D | ppm |
| W | 4.869 | 3.478 | 5.732 | 4.878 | 3.341 | 5.075 | ppm |
| Hg | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Tl | 0.962 | 0.013 | N.D | 0.404 | 0.191 | 0.598 | ppm |
| Pb | 22.838 | 16.422 | 15.249 | 19.769 | 20.436 | 20.734 | ppm |
| Bi | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Th | 11.917 | 7.171 | 8.952 | 30.411 | 4.514 | 9.863 | ppm |
| U | 2.316 | 2.536 | 13.383 | 3.846 | 1.582 | 3.100 | ppm |

3-Table5.16



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الخرطوم - شارع النيل - ص. ب 410

METHODS: XRF

ENTRY DATE:09/ 12/ 2015

RECIPE : AXIOS

RPORT NO :741

CLAIBATION : Protrace

| Lab NO | 5767 | 5768 | 5769 | 5770 | 5771 | 5772 | UNIT |
|-----------|---------|---------|---------|---------|---------|---------|------|
| Sender No | S01N | S06W | S02S | S05-5 | S05W | S01W | ppm |
| Sc | 4.521 | 3.483 | 1.888 | 2.786 | 3.652 | 3.679 | ppm |
| V | 69.071 | 44.226 | 29.640 | 31.178 | 39.698 | 41.762 | ppm |
| Cr | 132.593 | 213.359 | 233.569 | 180.902 | 181.840 | 197.426 | ppm |
| Mn | 555.553 | 253.211 | 212.438 | 252.807 | 239.064 | 303.147 | ppm |
| Co | 9.682 | 4.777 | 2.434 | 4.556 | 4.477 | 4.330 | ppm |
| Ni | 19.674 | 11.422 | 5.622 | 7.986 | 10.520 | 8.924 | ppm |
| Cu | 24.000 | 8.298 | 5.145 | 6.000 | 8.456 | 44.062 | ppm |
| Zn | 140.821 | 12.278 | 34.659 | 22.113 | 12.213 | 49.277 | ppm |
| Ga | 14.422 | 6.656 | 7.976 | 7.165 | 6.980 | 10.425 | ppm |
| Ge | 0.351 | N.D | N.D | 0.453 | N.D | N.D | ppm |
| Br | 7.989 | 0.728 | 0.765 | 0.715 | 0.649 | 1.689 | ppm |
| Rb | 95.088 | 4.713 | 77.326 | 68.617 | 51.085 | 90.812 | ppm |
| Sr | 178.661 | 83.138 | 72.560 | 64.131 | 92.304 | 124.831 | ppm |
| Y | 29.556 | 12.980 | 15.128 | 13.422 | 10.089 | 17.146 | ppm |
| Zr | 442.841 | 315.635 | 340.842 | 171.760 | 197.666 | 343.733 | ppm |
| Nb | 16.210 | 7.439 | 7.660 | 5.894 | 5.609 | 8.428 | ppm |
| Mo | 4.103 | 6.135 | 11.334 | 4.125 | 4.377 | 6.295 | ppm |
| Ag | 4.291 | 4.618 | 3.900 | N.D | 3.915 | 3.930 | ppm |
| Cd | N.D | N.D | 0.285 | ---- | N.D | N.D | ppm |
| Sn | 6.075 | 3.256 | 3.981 | 2.621 | 3.196 | 4.376 | ppm |
| Sb | 0.158 | N.D | 2.403 | 0.619 | 0.916 | N.D | ppm |

4-Table5.17



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METHODS: XRF

ENTRY DATE:09/ 12/ 2015

RECIPE : AXIOS

RPORT NO :741

CLAIBATION : Protrace

| Lab NO | 5767 | 5768 | 5769 | 5770 | 5771 | 5772 | UNIT |
|-----------|---------|---------|---------|---------|---------|---------|------|
| Sender No | S01N | S06W | S02S | S05-5 | S05W | S01W | ppm |
| Te | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| I | N.D | N.D | 0.416 | N.D | 0.189 | 1.544 | ppm |
| Cs | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Ba | 453.496 | 281.123 | 335.218 | 248.339 | 344.445 | 589.450 | ppm |
| La | 34.252 | 21.300 | 20.168 | 12.842 | 15.446 | 34.134 | ppm |
| Ce | 83.158 | 34.481 | 48.632 | 32.940 | 35.019 | 58.667 | ppm |
| Nd | 28.924 | 15.944 | 15.417 | 10.973 | 14.368 | 21.095 | ppm |
| Sm | 6.732 | 3.834 | 5.623 | 3.691 | 2.712 | 4.143 | ppm |
| Yb | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Hf | 12.329 | 9.992 | 9.794 | 6.221 | 6.854 | 9.630 | ppm |
| Ta | 0.129 | N.D | N.D | 0.233 | N.D | N.D | ppm |
| W | 5.912 | 4.028 | 3.167 | 3.139 | 2.899 | 3.909 | ppm |
| Hg | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Tl | 0.102 | 0.353 | N.D | N.D | 0.268 | N.D | ppm |
| Pb | 65.415 | 10.828 | 30.968 | 16.628 | 12.821 | 25.345 | ppm |
| Bi | N.D | N.D | N.D | N.D | N.D | N.D | ppm |
| Th | 14.070 | 7.466 | 8.618 | 4.687 | 5.724 | 15.548 | ppm |
| U | 4.725 | 1.695 | 1.723 | 2.150 | 1.906 | 2.805 | ppm |

5-Table5.18



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الخرطوم - شارع النيل - صندوق ب 410

METHODS: XRF

ENTRY DATE:09/ 12/ 2015

RECIPE : AXIOS

RPORT NO :741

CLAIBATION : Protrace

| Lab NO | 5773 | 5774 | 5775 | 5776 | UNIT |
|-----------|---------|---------|---------|---------|------|
| Sender No | S01E | S06W | S02S | S05-5 | ppm |
| Sc | 4.807 | 1.399 | 1.916 | 1.404 | ppm |
| V | 61.590 | 36.108 | 27.675 | 37.867 | ppm |
| Cr | 130.016 | 212.943 | 208.704 | 219.728 | ppm |
| Mn | 505.613 | 309.423 | 147.299 | 254.142 | ppm |
| Co | 10.320 | 4.381 | 2.003 | 3.550 | ppm |
| Ni | 17.465 | 9.306 | 6.786 | 9.161 | ppm |
| Cu | 30.173 | 31.707 | 11.724 | 19.881 | ppm |
| Zn | 244.810 | 109.547 | 49.249 | 66.425 | ppm |
| Ga | 13.495 | 9.207 | 5.211 | 6.909 | ppm |
| Ge | 0.142 | 0.230 | 0.065 | 0.025 | ppm |
| Br | 4.348 | 1.250 | 1.089 | 2.160 | ppm |
| Rb | 92.290 | 83.001 | 48.759 | 56.325 | ppm |
| Sr | 169.300 | 112.523 | 71.678 | 131.071 | ppm |
| Y | 25.660 | 13.967 | 10.165 | 13.808 | ppm |
| Zr | 372.820 | 198.401 | 202.926 | 213.277 | ppm |
| Nb | 14.046 | 6.900 | 4.904 | 8.475 | ppm |
| Mo | 3.530 | 7.735 | 7.220 | 8.246 | ppm |
| Ag | 3.484 | 4.144 | 4.082 | 3.109 | ppm |
| Cd | 0.747 | 0.356 | 0.209 | N.D | ppm |
| Sn | 6.358 | 4.749 | 3.239 | 3.176 | ppm |
| Sb | 1.432 | 0.020 | N.D | 0.234 | ppm |

6-Table5.19



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الخرطوم - شارع النيل - ص. ب 410

METHODS: XRF

ENTRY DATE: 09/ 12/ 2015

RECIPE : AXIOS

RPORT NO :741

CLAIBATION : Protrace

| Lab NO | 5773 | 5774 | 5775 | 5776 | UNIT |
|-----------|---------|---------|---------|---------|------|
| Sender No | S01E | S06W | S02S | S05-5 | ppm |
| Te | N.D | N.D | N.D | N.D | ppm |
| I | 1.480 | N.D | N.D | N.D | ppm |
| Cs | N.D | N.D | N.D | N.D | ppm |
| Ba | 462.547 | 399.019 | 327.792 | 289.533 | ppm |
| La | 36.342 | 18.740 | 22.199 | 18.861 | ppm |
| Ce | 74.646 | 40.095 | 27.040 | 40.296 | ppm |
| Nd | 26.535 | 16.987 | 14.177 | 14.940 | ppm |
| Sm | 5.390 | 1.171 | 3.337 | 4.440 | ppm |
| Yb | N.D | N.D | N.D | N.D | ppm |
| Hf | 11.423 | 6.796 | N.D | 7.685 | ppm |
| Ta | N.D | N.D | N.D | N.D | ppm |
| W | 4.953 | 4.594 | 4.009 | 4.121 | ppm |
| Hg | N.D | N.D | N.D | N.D | ppm |
| Tl | N.D | 0.019 | 0.576 | N.D | ppm |
| Pb | 50.090 | 58.648 | 17.408 | 19.063 | ppm |
| Bi | N.D | N.D | N.D | N.D | ppm |
| Th | 13.021 | 8.116 | 6.150 | 8.228 | ppm |
| U | 3.732 | 2.336 | 1.284 | 2.110 | ppm |