

Tables of Seismological Co-latitude

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Bullen (1937b, p. 160) suggests the use of a new latitude for the computation of distances involved in studies of seismic travel-times. He defines the "seismological latitude," θ , as:

$$\theta = 1.1\theta_1 - 0.1\theta_2$$

where θ_1 = geocentric latitude

and θ_2 = geographic latitude

Geocentric latitude is defined by the following equation:

$$\text{Tan } \theta_1 = 0.99327 \text{ Tan } \theta_2$$

The constant was computed from Jeffreys' (1952, p. 144) value of polar flattening.

The use of seismological latitude increases the accuracy of computations of great-circle distances and greatly simplifies the ellipticity correction for seismic travel-times. Bullen (1937b, p. 162) shows that the use of "seismological latitude" allows computations of travel-times with errors less than 0.1 second without recourse to the awkward triple-entry tables needed for complete ellipticity corrections (Bullen, 1937a).

The tables in this paper permit conversion of the geographic latitude to seismological co-latitude. The tables are entered by reading the geographic latitude to the nearest unit down the lefthand column and the nearest tenth across the page. Interpolations are possible to two or more orders of magnitude. The difference in values for an increment of 0.1 latitude are 0.099, 0.100, or 0.101 units so that interpolations may be made to sufficient accuracy by adopting a constant difference of 0.100 units. Thus reading the tables becomes very simple. For example, to find the seismological co-latitude corresponding to $65.^{\circ}316$ north latitude enter the northern hemisphere table (Table 1) at $65.^{\circ}3$ and read 25.862. The remaining digits beyond the tenth-place (0.016) are subtracted from this value to give 25.846. In the southern hemisphere table (Table 2) digits beyond the tenths-place are added to the values read. The seismological co-latitude obtained in this way is accurate ± 0.001 unit or approximately ± 100 meters and, therefore, is well within the limits of accuracy for seismological calculations.

TABLE 1
NORTHERN HEMISPHERE
For Conversion of Geographic Latitude to Seismological Co-Latitude

| Degrees | Tenths of Degrees | | | | | | | | | |
|---------|-------------------|--------|--------|--------|-------|-------|-------|-------|-------|-------|
| | 0.000 | 0.100 | 0.200 | 0.300 | 0.400 | 0.500 | 0.600 | 0.700 | 0.800 | 0.900 |
| 0 | 90.000 | 89.901 | .802 | .702 | .603 | .504 | .404 | .305 | .206 | .107 |
| 1 | 89.007 | 88.908 | .809 | .710 | .610 | .511 | .412 | .313 | .213 | .114 |
| 2 | 88.015 | 87.916 | .816 | .717 | .618 | .519 | .419 | .320 | .221 | .121 |
| 3 | 87.022 | 86.923 | .824 | .724 | .625 | .526 | .427 | .327 | .228 | .129 |
| 4 | 86.030 | 85.930 | .831 | .732 | .632 | .533 | .434 | .335 | .235 | .136 |
| 5 | 85.037 | 84.938 | .838 | .739 | .640 | .540 | .441 | .342 | .243 | .143 |
| 6 | 84.044 | 83.945 | .846 | .746 | .647 | .548 | .448 | .349 | .250 | .151 |
| 7 | 83.051 | 82.952 | .853 | .753 | .654 | .555 | .456 | .356 | .257 | .158 |
| 8 | 82.058 | 81.959 | .860 | .761 | .661 | .562 | .463 | .363 | .264 | .165 |
| 9 | 81.066 | 80.966 | .867 | .768 | .668 | .569 | .470 | .370 | .271 | .172 |
| 10 | 80.072 | 79.973 | .874 | .775 | .675 | .576 | .477 | .377 | .278 | .179 |
| 11 | 79.079 | 78.980 | .881 | .781 | .682 | .583 | .483 | .384 | .285 | .186 |
| 12 | 78.086 | 77.987 | .888 | .788 | .689 | .590 | .490 | .391 | .292 | .192 |
| 13 | 77.093 | 76.994 | .894 | .795 | .696 | .596 | .497 | .398 | .298 | .199 |
| 14 | .100 | 76.000 | 75.901 | .801 | .702 | .603 | .503 | .404 | .305 | .205 |
| 15 | 75.106 | 75.007 | 74.907 | .808 | .709 | .609 | .510 | .410 | .311 | .212 |
| 16 | .112 | 74.013 | 73.914 | .814 | .715 | .615 | .516 | .417 | .317 | .218 |
| 17 | .119 | 73.019 | 72.920 | .820 | .721 | .622 | .522 | .423 | .323 | .224 |
| 18 | .125 | 72.025 | 71.926 | .826 | .727 | .628 | .528 | .429 | .329 | .230 |
| 19 | .131 | 71.031 | 70.932 | .832 | .733 | .633 | .534 | .435 | .335 | .236 |
| 20 | 70.136 | 70.037 | 69.937 | .838 | .739 | .639 | .540 | .440 | .341 | .241 |
| 21 | .142 | 69.042 | 68.943 | .844 | .744 | .645 | .545 | .446 | .346 | .247 |
| 22 | .147 | 68.048 | 67.948 | .849 | .749 | .650 | .550 | .451 | .352 | .252 |
| 23 | .153 | 67.053 | 66.954 | .854 | .755 | .655 | .556 | .456 | .357 | .257 |
| 24 | .158 | 66.058 | 65.959 | .859 | .760 | .660 | .561 | .461 | .362 | .262 |
| 25 | 65.162 | 65.063 | 64.963 | .864 | .764 | .665 | .565 | .466 | .366 | .267 |
| 26 | .167 | 64.068 | 63.968 | .869 | .769 | .669 | .570 | .470 | .371 | .271 |
| 27 | .172 | 63.072 | 62.972 | .873 | .773 | .674 | .574 | .475 | .375 | .275 |
| 28 | .176 | 62.076 | 61.977 | .877 | .778 | .678 | .578 | .479 | .379 | .280 |
| 29 | .180 | 61.080 | 60.981 | .881 | .781 | .682 | .582 | .483 | .383 | .283 |
| 30 | 60.184 | 60.084 | 59.985 | .885 | .785 | .686 | .586 | .486 | .387 | .287 |
| 31 | .187 | 59.088 | 58.988 | .888 | .789 | .689 | .589 | .490 | .390 | .290 |
| 32 | .191 | 58.091 | 57.991 | .892 | .792 | .692 | .593 | .493 | .393 | .294 |
| 33 | .194 | 57.094 | 56.995 | .895 | .795 | .695 | .596 | .496 | .396 | .297 |
| 34 | .197 | 56.097 | 55.997 | .898 | .798 | .698 | .598 | .499 | .399 | .299 |
| 35 | 55.200 | .100 | 55.000 | 54.900 | .801 | .701 | .601 | .501 | .401 | .302 |
| 36 | .202 | .102 | 54.002 | 53.903 | .803 | .703 | .603 | .504 | .404 | .304 |
| 37 | .204 | .104 | 53.005 | 52.905 | .805 | .705 | .605 | .506 | .406 | .306 |
| 38 | .206 | .106 | 52.006 | 51.907 | .807 | .707 | .607 | .507 | .407 | .308 |
| 39 | .208 | .108 | 51.008 | 50.908 | .808 | .709 | .609 | .509 | .409 | .309 |
| 40 | 50.209 | .109 | 50.009 | 49.910 | .810 | .710 | .610 | .510 | .410 | .310 |
| 41 | .210 | .110 | 49.011 | 48.911 | .811 | .711 | .611 | .511 | .411 | .311 |
| 42 | .211 | .111 | 48.011 | 47.912 | .812 | .712 | .612 | .512 | .412 | .312 |
| 43 | .212 | .112 | 47.012 | 46.912 | .812 | .712 | .612 | .512 | .412 | .312 |
| 44 | .212 | .112 | 46.012 | 45.912 | .812 | .713 | .613 | .513 | .413 | .313 |

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TABLE 1 (Continued)

| Degrees | Tenths of Degrees | | | | | | | | | |
|---------|-------------------|--------|--------|--------|-------|-------|-------|-------|-------|-------|
| | 0.000 | 0.100 | 0.200 | 0.300 | 0.400 | 0.500 | 0.600 | 0.700 | 0.800 | 0.900 |
| 45 | 45.213 | .113 | 45.013 | 44.913 | .813 | .713 | .613 | .513 | .412 | .312 |
| 46 | .212 | .112 | 44.012 | 43.912 | .812 | .712 | .612 | .512 | .412 | .312 |
| 47 | .212 | .112 | 43.012 | 42.912 | .812 | .712 | .612 | .512 | .412 | .312 |
| 48 | .211 | .111 | 42.011 | 41.911 | .811 | .711 | .611 | .511 | .411 | .311 |
| 49 | .211 | .110 | 41.010 | 40.910 | .810 | .710 | .610 | .510 | .410 | .310 |
| 50 | 40.209 | .109 | 40.009 | 39.909 | .809 | .709 | .609 | .509 | .408 | .308 |
| 51 | .208 | .108 | 39.008 | 38.908 | .807 | .707 | .607 | .507 | .407 | .307 |
| 52 | .206 | .106 | 38.006 | 37.906 | .806 | .706 | .605 | .505 | .405 | .305 |
| 53 | .205 | .104 | 37.004 | 36.904 | .804 | .703 | .603 | .503 | .403 | .303 |
| 54 | .202 | .102 | 36.002 | 35.902 | .801 | .701 | .601 | .501 | .400 | .300 |
| 55 | 35.200 | 35.100 | 34.999 | .899 | .799 | .699 | .598 | .498 | .398 | .298 |
| 56 | .197 | 34.097 | 33.997 | .897 | .796 | .696 | .596 | .495 | .395 | .295 |
| 57 | .194 | 33.094 | 32.994 | .894 | .793 | .693 | .593 | .492 | .392 | .292 |
| 58 | .191 | 32.091 | 31.991 | .890 | .790 | .690 | .589 | .489 | .389 | .288 |
| 59 | .188 | 31.088 | 30.987 | .887 | .787 | .686 | .586 | .486 | .385 | .285 |
| 60 | 30.184 | 30.084 | 29.984 | .883 | .783 | .683 | .582 | .482 | .381 | .281 |
| 61 | .181 | 29.080 | 28.980 | .879 | .779 | .679 | .578 | .478 | .377 | .277 |
| 62 | .177 | 28.076 | 27.976 | .875 | .775 | .674 | .574 | .474 | .373 | .273 |
| 63 | .172 | 27.072 | 26.971 | .871 | .771 | .670 | .570 | .469 | .369 | .268 |
| 64 | .168 | 26.067 | 25.967 | .867 | .766 | .666 | .565 | .465 | .364 | .264 |
| 65 | 25.163 | 25.063 | 24.962 | .862 | .761 | .661 | .560 | .460 | .359 | .259 |
| 66 | .158 | 24.058 | 23.957 | .857 | .756 | .656 | .555 | .455 | .354 | .254 |
| 67 | .153 | 23.053 | 22.952 | .852 | .751 | .651 | .550 | .450 | .349 | .249 |
| 68 | .148 | 22.048 | 21.947 | .846 | .746 | .645 | .545 | .444 | .344 | .243 |
| 69 | .143 | 21.042 | 20.942 | .841 | .740 | .640 | .539 | .439 | .338 | .238 |
| 70 | 20.137 | 20.036 | 19.936 | .835 | .735 | .634 | .534 | .433 | .332 | .232 |
| 71 | .131 | 19.031 | 18.930 | .829 | .729 | .628 | .528 | .427 | .327 | .226 |
| 72 | .125 | 18.025 | 17.924 | .823 | .723 | .622 | .522 | .421 | .320 | .220 |
| 73 | .119 | 17.019 | 16.918 | .817 | .717 | .616 | .515 | .415 | .314 | .214 |
| 74 | .113 | 16.012 | 15.912 | .811 | .710 | .610 | .509 | .409 | .308 | .207 |
| 75 | 15.107 | 15.006 | 14.905 | .805 | .704 | .603 | .503 | .402 | .301 | .201 |
| 76 | 14.100 | 13.999 | .899 | .798 | .697 | .597 | .496 | .395 | .295 | .194 |
| 77 | 13.093 | 12.993 | .892 | .791 | .691 | .590 | .489 | .389 | .288 | .187 |
| 78 | 12.087 | 11.986 | .885 | .785 | .684 | .583 | .483 | .382 | .281 | .181 |
| 79 | 11.080 | 10.979 | .879 | .778 | .677 | .576 | .476 | .375 | .274 | .174 |
| 80 | 10.073 | 9.972 | .872 | .771 | .670 | .569 | .469 | .368 | .267 | .167 |
| 81 | 9.066 | 8.965 | .864 | .764 | .663 | .562 | .462 | .361 | .260 | .160 |
| 82 | 8.059 | 7.958 | .857 | .757 | .656 | .555 | .454 | .354 | .253 | .152 |
| 83 | 7.052 | 6.951 | .850 | .749 | .649 | .548 | .447 | .347 | .246 | .145 |
| 84 | 6.044 | 5.944 | .843 | .742 | .641 | .541 | .440 | .339 | .239 | .138 |
| 85 | 5.037 | 4.936 | .836 | .735 | .634 | .533 | .433 | .332 | .231 | .130 |
| 86 | 4.030 | 3.929 | .828 | .727 | .627 | .526 | .425 | .325 | .224 | .123 |
| 87 | 3.022 | 2.922 | .821 | .720 | .619 | .519 | .418 | .317 | .216 | .116 |
| 88 | 2.015 | 1.914 | .813 | .713 | .612 | .511 | .410 | .310 | .209 | .108 |
| 89 | 1.007 | 0.907 | .806 | .705 | .604 | .504 | .403 | .302 | .201 | .101 |
| 90 | 0.000 | | | | | | | | | |

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