

Supplemental Material

This supplement provides details of the core sample velocity-porosity prediction, and plots showing the seismic anisotropy analysis results (Figure S1) and the relation between primary core lithology, alteration, and Vp at the meter scale (Figure S2). Curve-fit parameters for the velocity-depth prediction are provided in Table S1. An electronic copy of the lab measurements on core samples from Hole U1309D at pressures 0-200 MPa are also provided (Table S2).

In Figure 8, the red curve predicts the relation between core sample P-wave velocity (Vp) and porosity (phi). The formula for the curve is based on the relationship determined by Carlson (2010), and subsequently simplified (Carlson, 2014), for upper crustal deep sea drill core samples. Here, the value representing the fractional area of grain contacts has been adjusted to lower crustal rock (gabbro instead of basalt/diabase, Af = 0.005):

$$V_p = 1050.6 (\phi)^2 - 105.85 (\phi) + 6.9 \text{ km/s}$$

Table S1. Velocity-depth model parameters for curves shown in Figure 7, following Carlson and Miller 2004 formula: $V_p = V_o + b \ln(z)$, where z is depth.

| Hole | Lithology | Vo (km/s) | b | R ² |
|--------------|-----------|-----------|--------|----------------|
| 504B Diabase | Diabase | 6.345 | 0.179 | 0.992 |
| 735B Gabbro | Gabbro | 6.786 | 0.130 | 0.986 |
| 894G Gabbro | Gabbro | 6.653 | 0.129 | 0.996 |
| 923A Gabbro | Gabbro | 6.720 | 0.152 | 0.967 |
| 1309D Gabbro | Gabbro | 6.767 | 0.0817 | 0.997 |

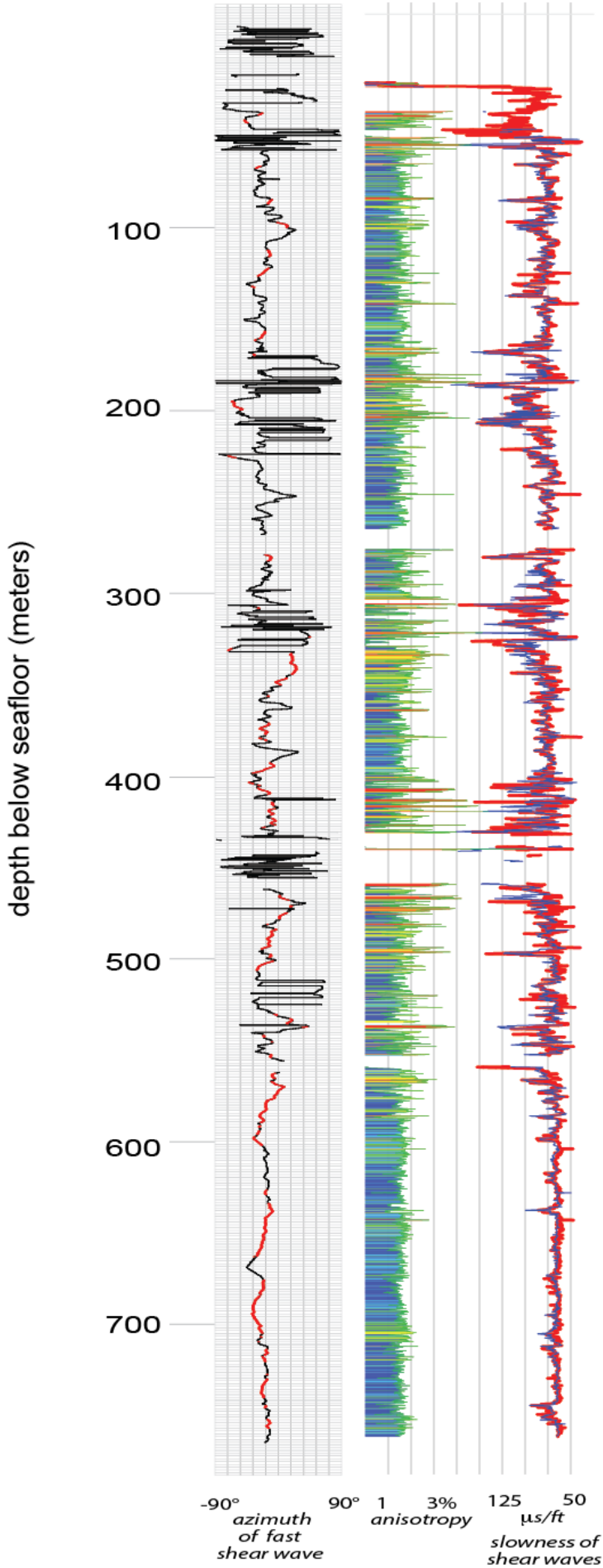
Figure S1. Seismic anisotropy results for IODP Expeditions 360 and 340T logging data.

Figure S2. Expanded view of Figure 5, showing lithology, alteration, and Vp for the deeper olivine-rich troctolite zone in Hole U1309D. Visual determination of overall alteration of core pieces (black dot) and sonic log (no averaging, red curve). Sample depths are pinned to top of each core barrel so, together with some uncertainty in wireline tool depth, an offset up to 1-2 m may occur between core and log data. Relation between lower, and more variable, Vp and higher alteration is evident regardless of primary lithology.

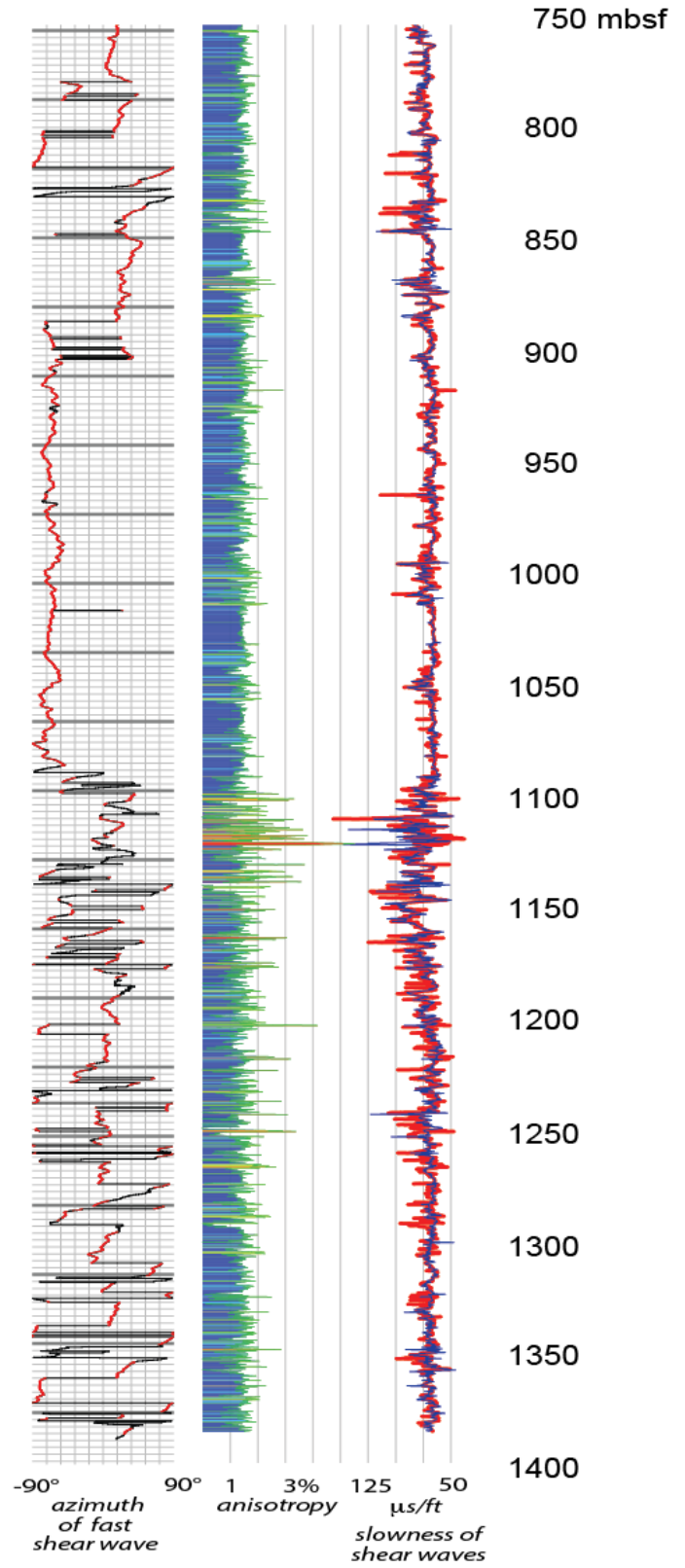
Table S2. TAMU lab measurements of Vp versus pressure for IODP Expedition 304/305 core samples. Density is g/cm³ and P-wave velocities are km/s for each pressure. The average of up- and down-pressure values, which agreed within <0.5%, are listed; calibration factor is corrected, superseding values reported in Collins et al. 2009.

| Sample | Depth (mbsf) | Density | Pressure (Mpa) | | | | | | | | | | | | |
|--------------------|--------------|---------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | | 0 | 0.5 | 2 | 5 | 10 | 20 | 40 | 60 | 80 | 100 | 140 | 180 | 200 |
| 1309D-47R-3-33 | 250.75 | 2.92 | 6.640 | 6.705 | 6.723 | 6.756 | 6.779 | 6.813 | 6.832 | 6.866 | 6.880 | 6.890 | 6.915 | 6.939 | 6.964 |
| 1309D-52R-2-49 | 273.58 | 2.95 | 6.656 | 6.691 | 6.741 | 6.784 | 6.781 | 6.824 | 6.865 | 6.891 | 6.906 | 6.924 | 6.947 | 6.970 | 6.978 |
| 1309D-53R-1-59(2) | 276.99 | 2.96 | 6.340 | 6.381 | 6.462 | 6.526 | 6.575 | 6.597 | 6.642 | 6.669 | 6.687 | 6.706 | 6.747 | 6.771 | 6.780 |
| 13-9D-54R-3-60 | 284.49 | 2.78 | 6.173 | 6.142 | 6.173 | 6.196 | 6.223 | 6.255 | 6.279 | 6.299 | 6.315 | 6.339 | 6.362 | 6.372 | 6.380 |
| 1309D-54R3-80(2) | 284.69 | 2.77 | 5.945 | 5.968 | 6.012 | 6.038 | 6.062 | 6.082 | 6.110 | 6.124 | 6.138 | 6.150 | 6.175 | 6.212 | 6.212 |
| 1309D-54R-4-86 | 286.21 | 2.96 | 6.241 | 6.276 | 6.359 | 6.441 | 6.482 | 6.511 | 6.550 | 6.580 | 6.601 | 6.623 | 6.676 | 6.702 | 6.711 |
| 1309D-55R-1-114 | 287.12 | 2.87 | 6.403 | 6.404 | 6.399 | 6.413 | 6.427 | 6.458 | 6.493 | 6.518 | 6.536 | 6.553 | 6.582 | 6.604 | 6.611 |
| 1309D-56R-3-95 | 294.29 | 2.75 | 5.966 | 5.983 | 6.017 | 6.045 | 6.062 | 6.090 | 6.115 | 6.122 | 6.137 | 6.151 | 6.173 | 6.191 | 6.195 |
| 1309D-57R-2-11 | 297.08 | 2.98 | 6.595 | 6.626 | 6.715 | 6.746 | 6.793 | 6.826 | 6.864 | 6.885 | 6.896 | 6.922 | 6.941 | 6.968 | 6.976 |
| 1309D-58R-1-114 | 301.54 | 2.87 | 6.915 | 6.951 | 6.999 | 7.052 | 7.098 | 7.129 | 7.169 | 7.186 | 7.199 | 7.221 | 7.234 | 7.247 | 7.264 |
| 1309D-59R-1-56 | 305.75 | 3.00 | 6.910 | 6.967 | 7.014 | 7.060 | 7.086 | 7.108 | 7.132 | 7.148 | 7.167 | 7.182 | 7.201 | 7.224 | 7.232 |
| 1309D-59R-3-103 | 309.03 | 2.96 | 6.584 | 6.654 | 6.775 | 6.775 | 6.796 | 6.825 | 6.855 | 6.876 | 6.893 | 6.911 | 6.927 | 6.967 | 6.980 |
| 1309D-60R-2-44(2) | 311.77 | 2.71 | 5.631 | 5.650 | 5.669 | 5.695 | 5.718 | 5.741 | 5.760 | 5.780 | 5.797 | 5.804 | 5.824 | 5.845 | 5.858 |
| 1309D-60R-3-60 | 313.42 | 2.79 | 6.173 | 6.219 | 6.294 | 6.327 | 6.334 | 6.367 | 6.401 | 6.416 | 6.431 | 6.439 | 6.469 | 6.481 | 6.504 |
| 1309D-61R-1-118 | 315.97 | 2.79 | 6.115 | 6.116 | 6.135 | 6.169 | 6.180 | 6.191 | 6.208 | 6.231 | 6.229 | 6.240 | 6.255 | 6.275 | 6.287 |
| 1309D-62R-2-67 | 321.68 | 3.09 | 6.671 | 6.690 | 6.815 | 6.865 | 6.921 | 6.973 | 7.031 | 7.047 | 7.079 | 7.095 | 7.117 | 7.152 | 7.160 |
| 1309D-63R-3-34 | 327.69 | 2.67 | 5.567 | 5.577 | 5.571 | 5.579 | 5.593 | 5.614 | 5.637 | 5.656 | 5.673 | 5.688 | 5.714 | 5.744 | 5.758 |
| 1309D-65R-1-83 | 334.83 | 2.83 | 6.088 | 6.085 | 6.110 | 6.143 | 6.175 | 6.205 | 6.235 | 6.255 | 6.266 | 6.283 | 6.300 | 6.324 | 6.334 |
| 1309D-65R-2-107 | 336.56 | 2.91 | 6.762 | 6.749 | 6.778 | 6.801 | 6.818 | 6.844 | 6.871 | 6.891 | 6.908 | 6.918 | 6.942 | 6.962 | 6.969 |
| 1309D-66R-2-15 | 340.45 | 2.75 | 5.881 | 5.890 | 5.916 | 5.945 | 5.966 | 5.990 | 6.018 | 6.035 | 6.044 | 6.059 | 6.074 | 6.093 | 6.105 |
| 1309D-67R-2-26 | 345.27 | 2.91 | 6.163 | 6.102 | 6.406 | 6.634 | 6.845 | 6.939 | 6.991 | 7.017 | 7.039 | 7.075 | 7.097 | 7.111 | |
| 1309D-68R-3-55 | 351.83 | 2.86 | 6.460 | 6.513 | 6.591 | 6.674 | 6.732 | 6.782 | 6.832 | 6.856 | 6.884 | 6.903 | 6.931 | 6.965 | 6.984 |
| 1309D-70R-2-10 | 358.78 | 2.80 | 5.741 | 5.765 | 5.820 | 5.903 | 5.991 | 6.109 | 6.229 | 6.292 | 6.333 | 6.360 | 6.407 | 6.435 | 6.441 |
| 1309D-72R-3-4 | 370.11 | 2.79 | 6.690 | 6.678 | 6.702 | 6.725 | 6.757 | 6.793 | 6.817 | 6.841 | 6.853 | 6.886 | 6.907 | 6.915 | |
| 1309D-74R-1-92(2) | 378.11 | 2.86 | 6.493 | 6.515 | 6.564 | 6.669 | 6.724 | 6.760 | 6.786 | 6.806 | 6.824 | 6.836 | 6.863 | 6.883 | 6.894 |
| 1309D-76R-1-111 | 388.00 | 2.95 | 6.608 | 6.675 | 6.710 | 6.768 | 6.831 | 6.898 | 6.925 | 6.948 | 6.959 | 6.982 | 7.002 | 7.013 | |
| 1309D-77R-1-51 | 392.20 | 2.96 | 6.323 | 6.350 | 6.405 | 6.483 | 6.596 | 6.743 | 6.809 | 6.841 | 6.858 | 6.883 | 6.912 | 6.923 | |
| 1309D-145R-1-76 | 713.36 | 2.88 | 6.491 | 6.545 | 6.582 | 6.628 | 6.741 | 6.830 | 6.861 | 6.889 | 6.907 | 6.930 | 6.954 | 6.963 | |
| 1309D-145R-3-127 | 716.56 | 2.81 | 6.629 | 6.690 | 6.753 | 6.766 | 6.774 | 6.800 | 6.830 | 6.838 | 6.856 | 6.873 | 6.886 | 6.899 | 6.917 |
| 1309D-147R-1-46 | 722.66 | 2.92 | 6.601 | 6.626 | 6.709 | 6.806 | 6.919 | 6.964 | 6.986 | 7.000 | 7.014 | 7.037 | 7.050 | 7.060 | |
| 1309D-147R-2-31 | 724.01 | 2.89 | 6.108 | 6.271 | 6.308 | 6.405 | 6.513 | 6.653 | 6.715 | 6.741 | 6.766 | 6.779 | 6.804 | 6.830 | 6.843 |
| 1309D-147R-4-18 | 726.49 | 2.97 | 6.623 | 6.635 | 6.673 | 6.724 | 6.780 | 6.828 | 6.854 | 6.877 | 6.890 | 6.904 | 6.931 | 6.953 | 6.963 |
| 1309D-148R-2-33 | 728.61 | 2.90 | 6.426 | 6.407 | 6.427 | 6.524 | 6.640 | 6.731 | 6.799 | 6.829 | 6.851 | 6.860 | 6.895 | 6.912 | 6.921 |
| 1309D-148R-3-23 | 729.97 | 2.87 | 6.340 | 6.363 | 6.387 | 6.487 | 6.599 | 6.710 | 6.776 | 6.807 | 6.825 | 6.843 | 6.866 | 6.893 | 6.907 |
| 1309D-149R-2-21 | 733.51 | 2.94 | 6.660 | 6.707 | 6.758 | 6.849 | 6.934 | 7.011 | 7.062 | 7.095 | 7.109 | 7.133 | 7.157 | 7.177 | 7.191 |
| 1309D-150R-1-67 | 737.27 | 3.04 | 7.283 | 7.313 | 7.343 | 7.384 | 7.405 | 7.415 | 7.425 | 7.436 | 7.456 | 7.467 | 7.477 | | |
| 1309D-150R-3-55 | 739.08 | 3.27 | 6.406 | 6.452 | 6.494 | 6.541 | 6.576 | 6.588 | 6.630 | 6.648 | 6.661 | 6.673 | 6.701 | 6.726 | 6.739 |
| 1309D-167R-2-98 | 815.74 | 2.97 | 6.489 | 6.490 | 6.529 | 6.627 | 6.698 | 6.724 | 6.863 | 6.922 | 6.953 | 6.969 | 6.999 | 7.027 | 7.037 |
| 1309D-168R-1-17 | 818.37 | 2.84 | 6.128 | 6.142 | 6.182 | 6.108 | 6.266 | 6.387 | 6.501 | 6.553 | 6.586 | 6.610 | 6.635 | 6.677 | 6.694 |
| 1309D-168R-4-20 | 822.34 | 2.92 | 6.164 | 6.289 | 6.383 | 6.532 | 6.614 | 6.697 | 6.848 | 6.906 | 6.942 | 6.961 | 6.988 | 7.007 | 7.016 |
| 1309D-169R-1-61 | 823.61 | 2.92 | 6.459 | 6.488 | 6.524 | 6.585 | 6.656 | 6.746 | 6.858 | 6.925 | 6.971 | 6.985 | 7.029 | 7.055 | 7.064 |
| 1309D-171R-4-34 | 836.65 | 2.89 | 6.391 | 6.331 | 6.361 | 6.461 | 6.533 | 6.590 | 6.673 | 6.720 | 6.737 | 6.758 | 6.784 | 6.802 | 6.810 |
| 1309D-172R-1-45 | 837.85 | 2.85 | 6.491 | 6.503 | 6.499 | 6.511 | 6.503 | 6.519 | 6.541 | 6.568 | 6.584 | 6.592 | 6.629 | 6.646 | 6.658 |
| 1309D-172R-3-52(2) | 840.41 | 6.534 | 6.538 | 6.587 | 6.650 | 6.695 | 6.737 | 6.770 | 6.793 | 6.808 | 6.822 | 6.846 | 6.870 | 6.880 | |
| 1309D-173R-2-51 | 843.84 | 3.07 | 6.198 | 6.259 | 6.290 | 6.421 | 6.550 | 6.658 | 6.731 | 6.774 | 6.797 | 6.833 | 6.852 | 6.870 | |
| 1309D-174R-1-63 | 847.63 | 2.80 | 6.454 | 6.470 | 6.466 | 6.512 | 6.612 | 6.674 | 6.755 | 6.794 | 6.825 | 6.845 | 6.878 | 6.901 | 6.910 |
| 1309D-174R-3-85 | 850.47 | 2.95 | 6.512 | 6.577 | 6.681 | 6.797 | 6.877 | 6.985 | 7.082 | 7.149 | 7.198 | 7.232 | 7.277 | 7.307 | 7.322 |
| 1309D-174R-4-41 | 851.39 | 2.86 | 6.486 | 6.531 | 6.592 | 6.653 | 6.691 | 6.843 | 6.968 | 7.029 | 7.061 | 7.090 | 7.109 | 7.118 | |
| 1309D-175R-4-78P | 856.25 | 2.92 | 6.259 | 6.272 | 6.453 | 6.538 | 6.657 | 6.802 | 6.895 | 6.985 | 7.037 | 7.074 | 7.122 | 7.136 | 7.151 |
| 1309D-176R-1-80 | 857.40 | 2.96 | 6.580 | 6.584 | 6.609 | 6.661 | 6.735 | 6.834 | 6.937 | 7.006 | 7.043 | 7.062 | 7.105 | 7.133 | 7.138 |
| 1309D-176R-3-81(2) | 859.68 | 2.99 | 6.022 | 6.228 | 6.525 | 6.700 | 6.819 | 6.948 | 7.142 | 7.218 | 7.264 | 7.300 | 7.331 | 7.368 | 7.368 |
| 1309D-177R-2-104 | 863.94 | 2.94 | 6.595 | 6.595 | 6.608 | 6.651 | 6.698 | 6.746 | 6.854 | 6.941 | 6.989 | 7.024 | 7.051 | 7.070 | 7.080 |
| 1309D-177R-3-123 | 865.32 | 2.96 | 6.819 | 6.831 | 6.892 | 6.935 | 6.973 | 7.076 | 7.157 | 7.210 | 7.234 | 7.260 | 7.286 | 7.302 | 7.323 |
| 1309D-179R-3-56 | 873.55 | 2.89 | 6.570 | 6.607 | 6.698 | 6.801 | 6.916 | 7.016 | 7.119 | 7.177 | 7.206 | 7.246 | 7.281 | 7.296 | |
| 1309D-180R-1-29 | 876.09 | 2.92 | 6.642 | 6.648 | 6.656 | 6.665 | 6.690 | 6.719 | 6.762 | 6.784 | 6.801 | 6.810 | 6.832 | 6.847 | 6.854 |
| 1309D-180R-2-32 | 876.92 | 2.92 | 6.380 | 6.425 | 6.500 | 6.565 | 6.525 | 6.800 | 6.871 | 6.953 | 6.981 | 7.004 | 7.032 | 7.056 | 7.061 |
| 1309D-180R-4-82 | 880.01 | 2.89 | 6.580 | 6.631 | 6.737 | 6.758 | 6.780 | 6.834 | 6.908 | 6.953 | 6.990 | 7.013 | 7.041 | 7.065 | 7.084 |
| 1309D-181R-1-63 | 881.23 | 2.93 | 6.422 | 6.555 | 6.607 | 6.640 | 6.719 | 6.826 | 6.942 | 6.979 | 6.997 | 7.011 | 7.044 | 7.067 | 7.081 |
| 1309D-184R-1-58 | 895.58 | 3.02 | 6.823 | 6.893 | 6.929 | 6.975 | 7.048 | 7.123 | 7.191 | 7.237 | 7.259 | 7.279 | 7.319 | 7.340 | 7.360 |
| 1309D-185R-1-70 | 900.50 | 2.95 | 6.262 | 6.340 | 6.465 | 6.553 | 6.656 | 6.749 | 6.789 | 6.817 | 6.835 | 6.867 | 6.881 | 6.900 | |

Hole U1473A



Hole U1309D (lower section only)



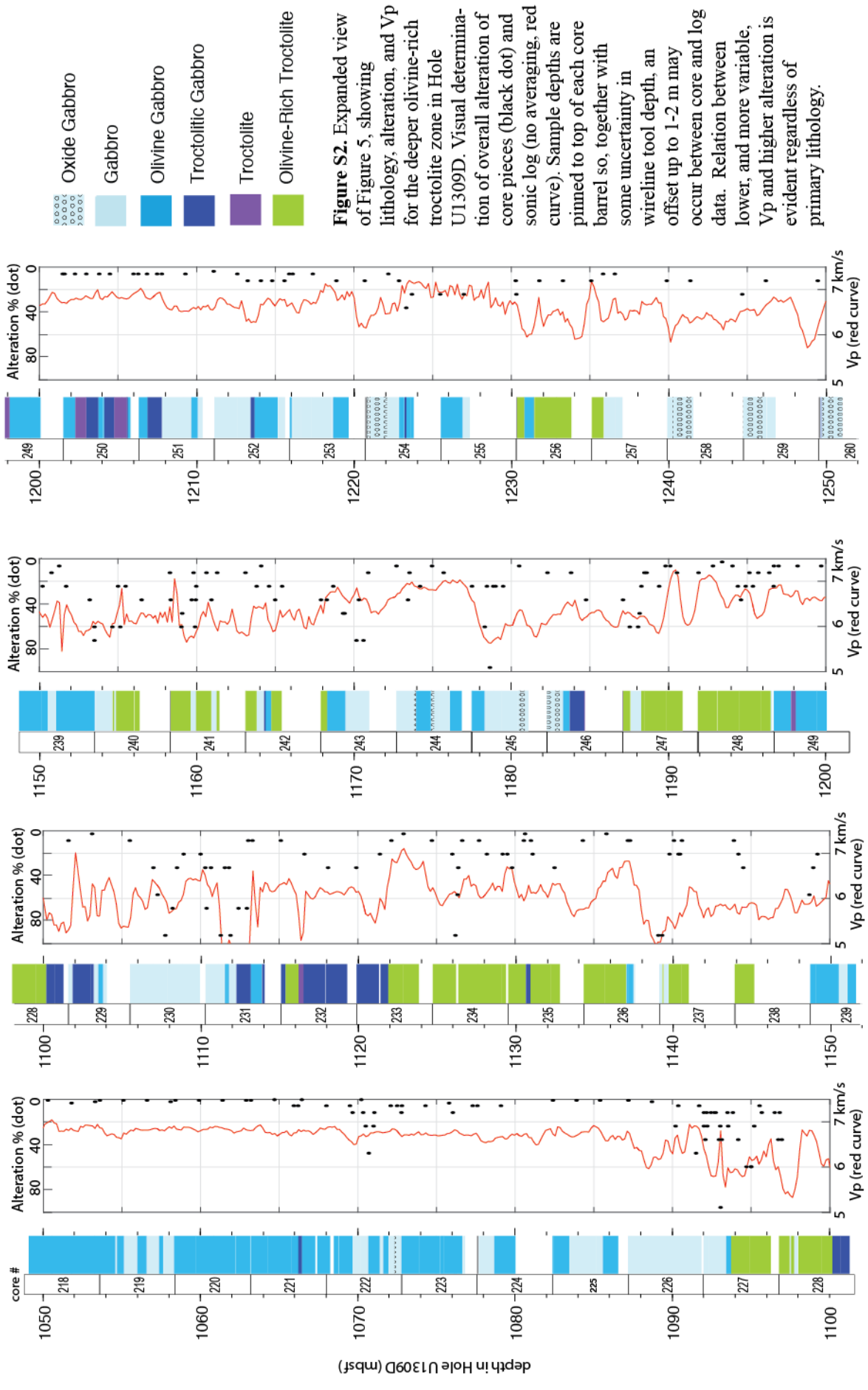


Figure S2. Expanded view of Figure 5, showing lithology, alteration, and Vp for the deeper olivine-rich troctolite zone in Hole U1309D. Visual determination of overall alteration of core pieces (black dot) and sonic log (no averaging, red curve). Sample depths are pinned to top of each core barrel so, together with some uncertainty in wireline tool depth, an offset up to 1-2 m may occur between core and log data. Relation between lower, and more variable, Vp and higher alteration is evident regardless of primary lithology.