

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Yellowstone National Park Obsidian Sources, Wyoming

| Site | Specimen | | Trace Element Concentrations | | | | | | | | | | | Ratios | | Geochemical Source |
|----------------|----------|-------------|------------------------------|---------|----------|---------|----------|----------|---------|-----------|-----------|----------|---|--------|-------|--------------------|
| | No. | Catalog No. | Zn | Pb | Rb | Sr | Y | Zr | Nb | Ti | Mn | Ba | Fe ₂ O ₃ ^T | Fe:Mn | Fe:Ti | |
| Obsidian Cliff | 1 | YOC-001 | 83 ± 8 | 38 4 | 263 4 | 3 13 | 77 3 | 181 8 | 49 2 | 302 95 | 170 47 | 33 13 | 0.92 0.11 | 65.8 | 97.2 | Obsidian Cliff |
| Obsidian Cliff | 2 | YOC-002 | 90 ± 7 | 40 4 | 263 4 | 7 9 | 80 3 | 175 8 | 44 2 | 438 95 | 187 47 | 34 12 | 1.27 0.11 | 78.7 | 92.4 | Obsidian Cliff |
| Obsidian Cliff | 3 | YOC-003 | 90 ± 7 | 35 4 | 256 4 | 6 9 | 80 3 | 176 8 | 51 2 | 390 95 | 195 47 | 38 12 | 1.26 0.11 | 73.5 | 102.1 | Obsidian Cliff |
| Obsidian Cliff | 4 | YOC-004 | 85 ± 7 | 38 4 | 260 4 | 5 9 | 82 3 | 174 8 | 51 2 | 397 95 | 208 47 | 34 13 | 1.25 0.11 | 67.2 | 99.5 | Obsidian Cliff |
| Obsidian Cliff | 5 | YOC-005 | 73 ± 7 | 40 4 | 261 4 | 3 10 | 82 3 | 180 8 | 48 2 | 389 95 | 171 47 | 33 13 | 1.18 0.11 | 82.3 | 96.0 | Obsidian Cliff |
| Obsidian Cliff | 6 | YOC-006 | 75 ± 7 | 40 4 | 254 4 | 6 9 | 83 3 | 176 8 | 48 2 | 367 95 | 177 47 | 23 13 | 1.25 0.11 | 83.2 | 107.2 | Obsidian Cliff |
| Crystal Spring | 7 | CRS-001 | 86 ± 7 | 36 4 | 258 4 | 7 9 | 80 3 | 179 8 | 52 2 | 411 95 | 176 47 | 32 13 | 1.15 0.11 | 77.5 | 89.1 | Obsidian Cliff |
| Crystal Spring | 8 | CRS-002 | 75 ± 7 | 37 4 | 239 4 | 17 9 | 76 3 | 172 8 | 46 2 | 719 96 | 190 47 | 27 13 | 1.34 0.11 | 80.7 | 60.1 | Obsidian Cliff |
| Crystal Spring | 9 | CRS-003 | 92 ± 7 | 39 4 | 265 4 | 6 9 | 85 3 | 180 8 | 49 2 | 458 95 | 188 47 | 35 13 | 1.27 0.11 | 77.6 | 88.1 | Obsidian Cliff |
| Crystal Spring | 10 | CRS-004 | 87 ± 7 | 34 4 | 254 4 | 10 9 | 80 3 | 179 8 | 48 2 | 493 95 | 203 47 | 36 12 | 1.36 0.11 | 75.5 | 87.7 | Obsidian Cliff |
| Crystal Spring | 11 | CRS-005 | 83 ± 7 | 34 4 | 262 4 | 5 9 | 82 3 | 182 8 | 51 2 | 434 95 | 182 47 | 44 12 | 1.28 0.11 | 82.0 | 93.6 | Obsidian Cliff |
| Crystal Spring | 12 | CRS-006 | 77 ± 7 | 36 4 | 257 4 | 5 9 | 81 3 | 173 8 | 47 2 | 433 95 | 200 47 | 45 12 | 1.30 0.11 | 73.5 | 95.1 | Obsidian Cliff |
| Tanker Curve | 13 | TKC-001 | 101 ± 7 | 38 4 | 314 4 | 4 9 | 99 3 | 171 8 | 66 2 | 369 95 | 206 47 | 30 13 | 1.23 0.11 | 67.2 | 105.0 | Tanker Curve |
| Tanker Curve | 14 | TKC-002 | 89 ± 7 | 41 4 | 320 4 | 5 9 | 102 3 | 172 8 | 58 2 | 278 95 | 189 47 | 15 14 | 1.13 0.11 | 69.2 | 126.5 | Tanker Curve |
| Tanker Curve | 15 | TKC-003 | 93 ± 7 | 34 4 | 291 4 | 5 9 | 96 3 | 167 8 | 62 2 | 286 95 | 151 47 | 20 13 | 0.86 0.11 | 73.4 | 96.5 | Tanker Curve |
| Obsidian Creek | 1 | OBSIC-A1 | 78 ± 7 | 35 3 | 259 4 | 6 7 | 76 3 | 173 7 | 45 2 | 401 95 | 179 47 | 25 8 | 1.14 0.11 | 75.3 | 90.6 | Obsidian Cliff |

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| | No. | Catalog No. | Zn | Pb | Rb | Sr | Y | Zr | Nb | Ti | Mn | Ba | Fe ₂ O ₃ ^T | Fe:Mn | Fe:Ti | |
| Obsidian Creek | 2 | OBSIC-A2 | 69 ± 6 | 40 3 | 248 3 | 7 7 | 78 3 | 177 7 | 46 2 | 437 95 | 189 47 | 31 8 | 1.30 0.11 | 78.8 | 94.1 | Obsidian Cliff |
| Obsidian Creek | 3 | OBSIC-A3 | 71 ± 6 | 38 2 | 263 4 | 6 7 | 79 3 | 177 7 | 49 2 | 348 95 | 180 47 | 37 9 | 1.21 0.11 | 79.1 | 109.5 | Obsidian Cliff |
| Obsidian Creek | 4 | OBSIC-A4 | 89 ± 7 | 39 3 | 252 4 | 5 7 | 75 3 | 176 7 | 47 2 | 380 95 | 150 47 | 26 9 | 0.81 0.11 | 70.2 | 69.9 | Obsidian Cliff |
| Obsidian Creek | 5 | OBSIC-A5 | 83 ± 7 | 37 3 | 267 4 | 5 7 | 81 3 | 177 7 | 43 2 | 284 95 | 152 47 | 30 9 | 0.91 0.11 | 75.7 | 101.4 | Obsidian Cliff |
| Obsidian Creek | 6 | OBSIC-A6 | 86 ± 6 | 34 3 | 260 4 | 7 7 | 82 3 | 175 7 | 44 2 | 410 95 | 187 47 | 49 9 | 1.04 0.11 | 65.3 | 81.5 | Obsidian Cliff |
| Obsidian Creek | 7 | OBSIC-A7 | 73 ± 7 | 39 3 | 246 4 | 6 7 | 76 3 | 176 7 | 47 2 | 233 95 | 140 47 | 23 9 | 0.69 0.11 | 67.6 | 96.1 | Obsidian Cliff |
| Obsidian Creek | 8 | OBSIC-A8 | 87 ± 6 | 36 3 | 258 4 | 6 7 | 79 3 | 179 7 | 47 2 | 476 95 | 183 47 | 37 9 | 1.19 0.11 | 76.2 | 80.3 | Obsidian Cliff |
| Obsidian Creek | 9 | OBSIC-A9 | 72 ± 7 | 41 3 | 256 4 | 7 7 | 79 3 | 175 7 | 41 2 | 332 95 | 160 47 | 52 9 | 1.02 0.11 | 78.9 | 98.0 | Obsidian Cliff |
| Obsidian Creek | 10 | OBSIC-A10 | 79 ± 7 | 40 3 | 259 4 | 7 7 | 81 3 | 177 7 | 46 2 | 451 95 | 187 47 | 32 9 | 1.01 0.11 | 63.7 | 72.6 | Obsidian Cliff |
| Obsidian Creek | 11 | OBSIC-A11 | 86 ± 7 | 41 3 | 254 4 | 8 7 | 76 3 | 172 7 | 46 2 | 457 95 | 169 47 | 39 9 | 1.10 0.11 | 78.1 | 77.3 | Obsidian Cliff |
| Obsidian Creek | 12 | OBSIC-A12 | 72 ± 6 | 38 2 | 252 4 | 6 7 | 77 3 | 174 7 | 48 1 | 396 95 | 181 47 | 20 9 | 1.23 0.11 | 79.3 | 98.2 | Obsidian Cliff |
| Obsidian Creek | 13 | OBSIC-A13 | 82 ± 7 | 34 3 | 260 4 | 7 7 | 78 3 | 171 7 | 44 2 | 353 95 | 165 47 | 33 9 | 1.01 0.11 | 74.5 | 91.4 | Obsidian Cliff |
| Obsidian Creek | 14 | OBSIC-A14 | 77 ± 7 | 36 3 | 254 4 | 5 7 | 76 3 | 171 7 | 52 2 | 247 95 | 128 47 | 43 11 | 0.75 0.11 | 82.7 | 97.9 | Obsidian Cliff |
| Obsidian Creek | 15 | OBSIC-A15 | 84 ± 7 | 29 3 | 239 4 | 5 7 | 76 3 | 167 7 | 46 2 | 241 95 | 119 47 | 33 10 | 0.70 0.11 | 86.7 | 93.6 | Obsidian Cliff |
| Obsidian Cliff | 1 | OCLIF-A1 | 85 ± 7 | 40 3 | 262 4 | 5 7 | 86 3 | 177 7 | 44 2 | 353 95 | 176 47 | 13 10 | 1.01 0.11 | 68.9 | 91.6 | Obsidian Cliff |
| Obsidian Cliff | 2 | OCLIF-A2 | 105 ± 7 | 39 3 | 289 4 | 5 7 | 88 3 | 190 7 | 48 2 | 395 95 | 167 47 | 36 10 | 0.88 0.11 | 65.4 | 72.8 | Obsidian Cliff |

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| | No. | Catalog No. | Zn | Pb | Rb | Sr | Y | Zr | Nb | Ti | Mn | Ba | Fe ₂ O ₃ ^T | Fe:Mn | Fe:Ti | |
| Obsidian Cliff | 3 | OCLIF-A3 | 95 ± 7 | 45 3 | 282 4 | 5 7 | 88 3 | 187 7 | 52 2 | 332 95 | 163 47 | 31 9 | 0.94 0.11 | 71.3 | 90.7 | Obsidian Cliff |
| Obsidian Cliff | 4 | OCLIF-A4 | 81 ± 7 | 41 3 | 250 4 | 6 7 | 79 3 | 167 7 | 45 2 | 389 95 | 154 47 | 26 9 | 0.72 0.11 | 60.8 | 61.3 | Obsidian Cliff |
| Obsidian Cliff | 5 | OCLIF-A5 | 70 ± 7 | 36 3 | 261 4 | 7 7 | 83 3 | 173 7 | 45 2 | 393 95 | 173 47 | 36 9 | 0.98 0.11 | 68.5 | 80.5 | Obsidian Cliff |
| Obsidian Cliff | 6 | OCLIF-A6 | 69 ± 7 | 37 3 | 267 4 | 6 7 | 83 3 | 179 7 | 46 2 | 392 95 | 200 47 | 30 9 | 1.19 0.11 | 67.9 | 96.3 | Obsidian Cliff |
| Obsidian Cliff | 7 | OCLIF-A7 | 72 ± 6 | 38 2 | 262 4 | 5 7 | 79 3 | 171 7 | 49 2 | 407 95 | 195 47 | 30 9 | 1.29 0.11 | 75.4 | 100.4 | Obsidian Cliff |
| Obsidian Cliff | 8 | OCLIF-A8 | 70 ± 7 | 38 3 | 249 4 | 6 7 | 76 3 | 172 7 | 48 2 | 276 95 | 154 47 | 34 9 | 0.83 0.11 | 68.9 | 96.2 | Obsidian Cliff |
| Obsidian Cliff | 9 | OCLIF-A9 | 71 ± 7 | 33 3 | 258 4 | 6 7 | 80 3 | 171 7 | 51 2 | 293 95 | 139 47 | 25 9 | 0.75 0.11 | 73.3 | 83.7 | Obsidian Cliff |
| Obsidian Cliff | 10 | OCLIF-A10 | 72 ± 7 | 33 3 | 261 4 | 7 7 | 80 3 | 174 7 | 49 2 | 340 95 | 166 47 | 42 10 | 0.93 0.11 | 68.8 | 87.6 | Obsidian Cliff |
| Obsidian Cliff | 11 | OCLIF-A11 | 67 ± 7 | 42 3 | 255 4 | 6 7 | 80 3 | 171 7 | 51 2 | 471 95 | 166 47 | 22 9 | 0.96 0.11 | 71.3 | 66.7 | Obsidian Cliff |
| Obsidian Cliff | 12 | OCLIF-A12 | 83 ± 7 | 33 3 | 263 4 | 7 7 | 82 3 | 175 7 | 47 2 | 205 95 | 117 47 | 42 10 | 0.57 0.11 | 74.7 | 91.0 | Obsidian Cliff |
| Obsidian Cliff | 13 | OCLIF-A13 | 72 ± 6 | 34 3 | 252 4 | 5 7 | 81 3 | 178 7 | 52 2 | 284 95 | 159 47 | 36 8 | 0.94 0.11 | 74.2 | 105.6 | Obsidian Cliff |
| Obsidian Cliff | 14 | OCLIF-A14 | 72 ± 7 | 32 3 | 247 4 | 8 7 | 77 3 | 164 7 | 47 2 | 443 95 | 180 47 | 25 9 | 1.20 0.11 | 78.1 | 86.4 | Obsidian Cliff |
| Obsidian Cliff | 15 | OCLIF-A15 | 65 ± 7 | 41 3 | 250 4 | ND ND | 79 3 | 174 7 | 48 2 | 147 95 | 113 47 | 38 10 | 0.49 0.11 | 69.5 | 108.1 | Obsidian Cliff |
| Obsidian Cliff | 1 | OCLIF-B1 | 90 ± 7 | 32 3 | 265 4 | 8 7 | 80 3 | 176 7 | 48 2 | 384 95 | 203 47 | 27 8 | 1.30 0.11 | 72.3 | 106.6 | Obsidian Cliff |
| Obsidian Cliff | 2 | OCLIF-B2 | 70 ± 7 | 34 3 | 258 4 | 6 7 | 82 3 | 177 7 | 52 2 | 391 95 | 196 47 | 25 8 | 1.30 0.11 | 75.5 | 104.6 | Obsidian Cliff |
| Obsidian Cliff | 3 | OCLIF-B3 | 83 ± 7 | 38 3 | 252 4 | 5 7 | 82 3 | 179 7 | 50 2 | 266 95 | 140 47 | 46 9 | 0.80 0.11 | 76.1 | 96.6 | Obsidian Cliff |

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| | No. | Catalog No. | Zn | Pb | Rb | Sr | Y | Zr | Nb | Ti | Mn | Ba | Fe ₂ O ₃ ^T | Fe:Mn | Fe:Ti | |
| Obsidian Cliff | 4 | OCLIF-B4 | 67 ± 7 | 34 3 | 254 4 | 4 7 | 80 3 | 175 7 | 43 2 | 374 95 | 166 47 | 30 8 | 1.16 0.11 | 84.0 | 98.2 | Obsidian Cliff |
| Obsidian Cliff | 5 | OCLIF-B5 | 72 ± 7 | 41 3 | 259 4 | 5 7 | 80 3 | 178 7 | 46 2 | 373 95 | 189 47 | 32 9 | 1.16 0.11 | 71.1 | 98.6 | Obsidian Cliff |
| Obsidian Cliff | 6 | OCLIF-B6 | 69 ± 7 | 36 3 | 262 4 | 7 7 | 80 3 | 177 7 | 49 2 | 366 95 | 168 47 | 30 8 | 1.09 0.11 | 78.7 | 95.2 | Obsidian Cliff |
| Obsidian Cliff | 7 | OCLIF-B7 | 76 ± 7 | 37 3 | 249 4 | 7 7 | 83 3 | 169 7 | 44 2 | 316 95 | 146 47 | 35 9 | 0.86 0.11 | 77.1 | 88.2 | Obsidian Cliff |
| Obsidian Cliff | 8 | OCLIF-B8 | 87 ± 6 | 38 3 | 270 4 | 8 7 | 83 3 | 179 7 | 50 2 | 391 95 | 206 47 | 29 8 | 1.23 0.11 | 67.2 | 99.6 | Obsidian Cliff |
| Obsidian Cliff | 9 | OCLIF-B9 | 69 ± 7 | 36 3 | 254 4 | 6 7 | 80 3 | 168 7 | 47 2 | 397 95 | 124 47 | 27 10 | 0.68 0.11 | 79.5 | 57.7 | Obsidian Cliff |
| Obsidian Cliff | 10 | OCLIF-B10 | 88 ± 6 | 40 3 | 265 4 | 8 7 | 82 3 | 174 7 | 47 2 | 473 95 | 156 47 | 35 9 | 0.97 0.11 | 77.9 | 66.9 | Obsidian Cliff |
| Obsidian Cliff | 11 | OCLIF-B11 | 78 ± 7 | 38 3 | 263 4 | 5 7 | 78 3 | 175 7 | 44 2 | 419 95 | 152 47 | 35 9 | 0.99 0.11 | 82.5 | 76.2 | Obsidian Cliff |
| Obsidian Cliff | 12 | OCLIF-B12 | 69 ± 6 | 37 3 | 259 4 | 7 7 | 79 3 | 171 7 | 50 2 | 417 95 | 186 47 | 43 9 | 1.26 0.11 | 78.8 | 96.2 | Obsidian Cliff |
| Obsidian Cliff | 13 | OCLIF-B13 | 71 ± 7 | 41 3 | 263 4 | 7 7 | 83 3 | 174 7 | 46 2 | 286 95 | 160 47 | 36 9 | 0.96 0.11 | 75.0 | 106.6 | Obsidian Cliff |
| Obsidian Cliff | 14 | OCLIF-B14 | 78 ± 6 | 36 3 | 271 4 | 6 7 | 81 3 | 180 7 | 45 2 | 436 95 | 180 47 | 42 9 | 1.28 0.11 | 83.5 | 93.4 | Obsidian Cliff |
| Obsidian Cliff | 1 | OCLIF-C1 | 80 ± 7 | 36 3 | 259 4 | 6 7 | 79 3 | 175 7 | 48 2 | 377 95 | 197 47 | 31 8 | 1.24 0.11 | 71.5 | 103.4 | Obsidian Cliff |
| Obsidian Cliff | 2 | OCLIF-C2 | 71 ± 7 | 33 3 | 256 4 | 7 7 | 80 3 | 179 7 | 45 2 | 407 95 | 194 47 | 29 8 | 1.31 0.11 | 77.4 | 101.9 | Obsidian Cliff |
| Obsidian Cliff | 3 | OCLIF-C3 | 77 ± 6 | 37 3 | 256 4 | 10 7 | 75 3 | 174 7 | 47 2 | 440 95 | 207 47 | 34 8 | 1.29 0.11 | 69.8 | 93.1 | Obsidian Cliff |
| Obsidian Cliff | 4 | OCLIF-C4 | 76 ± 7 | 34 3 | 250 4 | 6 7 | 79 3 | 171 7 | 46 2 | 405 95 | 214 47 | 28 9 | 1.23 0.11 | 64.0 | 96.1 | Obsidian Cliff |
| Obsidian Cliff | 5 | OCLIF-C5 | 81 ± 6 | 37 3 | 251 4 | 6 7 | 80 3 | 173 7 | 47 2 | 451 95 | 193 47 | 48 9 | 1.22 0.11 | 72.6 | 86.3 | Obsidian Cliff |

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| Obsidian Cliff | 6 | OCLIF-C6 | 81 ± 7 | 37 3 | 261 4 | 7 7 | 79 3 | 177 7 | 47 2 | 384 95 | 188 47 | 26 9 | 1.15 0.11 | 71.3 | 95.3 | Obsidian Cliff |
| Obsidian Cliff | 7 | OCLIF-C7 | 76 ± 7 | 36 3 | 252 4 | 6 7 | 76 3 | 175 7 | 44 2 | 392 95 | 172 47 | 22 9 | 1.15 0.11 | 79.7 | 93.3 | Obsidian Cliff |
| Obsidian Cliff | 8 | OCLIF-C8 | 74 ± 7 | 41 3 | 257 4 | 6 7 | 78 3 | 174 7 | 47 2 | 270 95 | 151 47 | 40 9 | 0.82 0.11 | 70.1 | 96.9 | Obsidian Cliff |
| Obsidian Cliff | 9 | OCLIF-C9 | 73 ± 7 | 35 3 | 252 4 | 7 7 | 78 3 | 177 7 | 43 2 | 436 95 | 199 47 | 28 8 | 1.31 0.11 | 74.4 | 95.2 | Obsidian Cliff |
| Obsidian Cliff | 10 | OCLIF-C10 | 70 ± 7 | 30 3 | 263 4 | 6 7 | 77 3 | 173 7 | 50 2 | 410 95 | 189 47 | 39 8 | 1.19 0.11 | 72.6 | 92.1 | Obsidian Cliff |
| Obsidian Cliff | 11 | OCLIF-C11 | 68 ± 7 | 34 3 | 264 4 | 7 7 | 80 3 | 181 7 | 45 2 | 423 95 | 188 47 | 39 9 | 1.20 0.11 | 73.9 | 90.1 | Obsidian Cliff |
| Obsidian Cliff | 12 | OCLIF-C12 | 73 ± 7 | 35 3 | 255 4 | 6 7 | 80 3 | 167 7 | 46 2 | 326 95 | 159 47 | 30 9 | 0.98 0.11 | 76.8 | 96.1 | Obsidian Cliff |
| Obsidian Cliff | 13 | OCLIF-C13 | 74 ± 7 | 32 3 | 257 4 | 8 7 | 73 3 | 170 7 | 44 2 | 315 95 | 160 47 | 46 10 | 1.00 0.11 | 77.0 | 100.6 | Obsidian Cliff |
| Obsidian Cliff | 14 | OCLIF-C14 | 70 ± 7 | 35 3 | 260 4 | 6 7 | 82 3 | 176 7 | 43 2 | 383 95 | 190 47 | 28 8 | 1.20 0.11 | 72.5 | 99.0 | Obsidian Cliff |
| Obsidian Cliff | 15 | OCLIF-C15 | 81 ± 6 | 35 3 | 248 4 | 6 7 | 76 3 | 169 7 | 45 2 | 408 95 | 182 47 | 31 8 | 1.21 0.11 | 78.0 | 94.4 | Obsidian Cliff |
| Obsidian Cliff | 1 | OCLIF-D1 | 74 ± 7 | 38 3 | 256 4 | 8 7 | 76 3 | 180 7 | 49 2 | 393 95 | 193 47 | 17 8 | 1.26 0.11 | 74.6 | 101.1 | Obsidian Cliff |
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| Obsidian Cliff | 7 | OCLIF-D7 | 67 ± 7 | 35 3 | 243 4 | 7 7 | 77 3 | 172 7 | 44 2 | 352 95 | 171 47 | 57 8 | 1.22 0.11 | 84.9 | 108.8 | Obsidian Cliff |
| Obsidian Cliff | 8 | OCLIF-D8 | 91 ± 7 | 37 3 | 273 4 | 5 7 | 79 3 | 181 7 | 47 2 | 377 95 | 177 47 | 29 9 | 1.12 0.11 | 75.2 | 94.6 | Obsidian Cliff |
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| Obsidian Cliff | 10 | OCLIF-D10 | 75 ± 6 | 40 3 | 256 4 | 7 7 | 78 3 | 173 7 | 48 2 | 416 95 | 191 47 | 36 8 | 1.31 0.11 | 78.3 | 99.4 | Obsidian Cliff |
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| Obsidian Cliff | 15 | OCLIF-D15 | 84 ± 7 | 37 3 | 260 4 | 6 7 | 84 3 | 179 7 | 48 2 | 423 95 | 170 47 | 48 10 | 0.99 0.11 | 71.0 | 75.9 | Obsidian Cliff |
| Crystal Spring | 1 | CRYST-A1 | 85 ± 7 | 38 3 | 264 4 | 7 7 | 81 3 | 174 7 | 48 2 | 468 95 | 190 47 | 32 8 | 1.35 0.11 | 81.5 | 91.6 | Obsidian Cliff |
| Crystal Spring | 2 | CRYST-A2 | 84 ± 6 | 36 3 | 250 4 | 5 7 | 77 3 | 175 7 | 49 2 | 385 95 | 206 47 | 38 8 | 1.17 0.11 | 64.2 | 96.7 | Obsidian Cliff |
| Crystal Spring | 3 | CRYST-A3 | 72 ± 6 | 31 3 | 252 3 | 6 7 | 76 3 | 174 7 | 44 1 | 430 95 | 191 47 | 33 8 | 1.27 0.11 | 76.7 | 94.1 | Obsidian Cliff |
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| Crystal Spring | 6 | CRYST-A6 | 71 ± 7 | 34 3 | 251 4 | 7 7 | 81 3 | 175 7 | 45 2 | 383 95 | 170 47 | 23 8 | 1.23 0.11 | 86.0 | 101.3 | Obsidian Cliff |
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| Crystal Spring | 9 | CRYST-A9 | 80 ± 7 | 42 3 | 262 4 | 6 7 | 82 3 | 182 7 | 45 2 | 396 95 | 184 47 | 24 8 | 1.11 0.11 | 70.9 | 89.5 | Obsidian Cliff |
| Crystal Spring | 10 | CRYST-A10 | 78 ± 6 | 35 3 | 262 4 | 4 7 | 81 3 | 180 7 | 46 2 | 480 95 | 195 47 | 41 8 | 1.27 0.11 | 74.3 | 84.4 | Obsidian Cliff |
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| Crystal Spring | 13 | CRYST-A13 | 78 ± 7 | 44 3 | 291 4 | 7 7 | 83 3 | 188 7 | 44 2 | 323 95 | 153 47 | 46 9 | 0.98 0.11 | 80.3 | 96.3 | Obsidian Cliff |
| Crystal Spring | 14 | CRYST-A14 | 82 ± 7 | 36 3 | 261 4 | 7 7 | 79 3 | 177 7 | 45 2 | 408 95 | 175 47 | 45 8 | 1.13 0.11 | 76.7 | 88.1 | Obsidian Cliff |
| Crystal Spring | 15 | CRYST-A15 | 74 ± 6 | 30 3 | 261 4 | 6 7 | 78 3 | 170 7 | 49 2 | 322 95 | 154 47 | 44 9 | 0.93 0.11 | 76.3 | 92.3 | Obsidian Cliff |
| Tanker Curve | 1 | GIBBR-C1 | 77 ± 7 | 40 3 | 311 4 | 6 7 | 96 3 | 170 7 | 59 2 | 362 95 | 209 47 | 17 8 | 1.23 0.11 | 65.6 | 106.9 | Tanker Curve |
| Tanker Curve | 2 | GIBBR-C2 | 98 ± 7 | 41 3 | 311 4 | 7 7 | 96 3 | 168 7 | 58 2 | 320 95 | 199 47 | 20 8 | 1.20 0.11 | 68.8 | 118.0 | Tanker Curve |
| Tanker Curve | 3 | GIBBR-C3 | 88 ± 7 | 42 3 | 314 4 | 5 7 | 98 3 | 165 7 | 59 2 | 311 95 | 197 47 | 11 9 | 1.11 0.11 | 65.0 | 112.8 | Tanker Curve |
| Tanker Curve | 4 | GIBBR-C4 | 89 ± 7 | 39 3 | 306 4 | 5 7 | 91 3 | 163 7 | 59 2 | 321 95 | 214 47 | 21 8 | 1.16 0.11 | 60.6 | 113.9 | Tanker Curve |
| Tanker Curve | 5 | GIBBR-C5 | 106 ± 7 | 50 3 | 344 4 | 5 7 | 106 3 | 179 7 | 63 2 | 354 95 | 180 47 | 17 9 | 0.92 0.11 | 61.4 | 83.9 | Tanker Curve |
| Tanker Curve | 6 | GIBBR-C6 | 90 ± 6 | 40 3 | 305 4 | 6 7 | 97 3 | 165 7 | 55 2 | 306 95 | 202 47 | 14 8 | 1.21 0.11 | 68.2 | 123.9 | Tanker Curve |
| Tanker Curve | 7 | GIBBR-C7 | 88 ± 7 | 42 3 | 296 4 | 6 7 | 97 3 | 163 7 | 57 2 | 266 95 | 180 47 | 27 8 | 1.06 0.11 | 69.8 | 124.6 | Tanker Curve |
| Tanker Curve | 8 | GIBBR-C8 | 86 ± 7 | 43 3 | 313 4 | 5 7 | 97 3 | 170 7 | 59 2 | 276 95 | 185 47 | 6 9 | 1.11 0.11 | 70.3 | 126.0 | Tanker Curve |

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
 NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Yellowstone National Park Obsidian Sources, Wyoming

| Site | Specimen | | Trace Element Concentrations | | | | | | | | | | | Ratios | | Geochemical Source |
|--------------|----------|-------------|------------------------------|---------|----------|---------|----------|----------|---------|-----------|-----------|-----------|---|--------|-------|--------------------|
| | No. | Catalog No. | Zn | Pb | Rb | Sr | Y | Zr | Nb | Ti | Mn | Ba | Fe ₂ O ₃ ^T | Fe:Mn | Fe:Ti | |
| Tanker Curve | 9 | GIBBR-C9 | 75 ± 7 | 40 3 | 308 4 | 4 8 | 95 3 | 164 7 | 58 2 | 259 95 | 197 47 | 19 9 | 1.03 0.11 | 60.1 | 124.3 | Tanker Curve |
| Tanker Curve | 10 | GIBBR-C10 | 79 ± 7 | 46 3 | 305 4 | 6 7 | 97 3 | 169 7 | 60 2 | 288 95 | 179 47 | 25 8 | 1.08 0.11 | 71.3 | 117.4 | Tanker Curve |
| Tanker Curve | 11 | GIBBR-C11 | 88 ± 7 | 45 3 | 311 4 | 5 7 | 99 3 | 174 7 | 59 2 | 392 95 | 180 47 | 25 9 | 1.14 0.11 | 74.4 | 92.5 | Tanker Curve |
| Tanker Curve | 12 | GIBBR-C12 | 86 ± 7 | 42 3 | 313 4 | 5 7 | 95 3 | 170 7 | 58 2 | 324 95 | 211 47 | 26 9 | 1.20 0.11 | 63.5 | 115.9 | Tanker Curve |
| Tanker Curve | 13 | GIBBR-C13 | 86 ± 7 | 40 3 | 331 4 | 7 7 | 100 3 | 172 7 | 64 2 | 258 95 | 168 47 | 1 10 | 1.03 0.11 | 74.1 | 124.6 | Tanker Curve |
| Tanker Curve | 14 | GIBBR-C14 | 81 ± 7 | 38 3 | 312 4 | 7 7 | 95 3 | 168 7 | 60 2 | 262 95 | 185 47 | 18 9 | 1.06 0.11 | 67.7 | 126.8 | Tanker Curve |
| Tanker Curve | 15 | GIBBR-C15 | 88 ± 7 | 42 3 | 308 4 | 5 7 | 97 3 | 168 7 | 60 2 | 317 95 | 210 47 | 35 8 | 1.19 0.11 | 63.4 | 117.6 | Tanker Curve |
| Gibbon River | 1 | GIBBR-B1 | 94 ± 7 | 46 3 | 324 4 | 5 7 | 99 3 | 170 7 | 59 2 | 234 95 | 173 47 | 81 13 | 0.94 0.11 | 66.3 | 126.5 | Tanker Curve |
| Gibbon River | 2 | GIBBR-B2 | 90 ± 7 | 45 3 | 304 4 | 5 7 | 95 3 | 168 7 | 61 2 | 318 95 | 206 47 | 93 12 | 1.18 0.11 | 64.8 | 117.0 | Tanker Curve |
| Gibbon River | 3 | GIBBR-B3 | 115 ± 8 | 45 3 | 331 4 | 7 7 | 104 3 | 178 7 | 63 2 | 121 95 | 139 47 | 82 12 | 0.53 0.11 | 53.9 | 137.3 | Tanker Curve |
| Gibbon River | 4 | GIBBR-B4 | 86 ± 7 | 45 3 | 327 4 | 4 9 | 101 3 | 176 7 | 61 2 | 272 95 | 187 47 | 128 12 | 1.03 0.11 | 64.8 | 118.9 | Tanker Curve |
| Gibbon River | 5 | GIBBR-B5 | 90 ± 7 | 44 3 | 308 4 | 6 7 | 101 3 | 171 7 | 62 2 | 286 95 | 195 47 | 89 12 | 1.12 0.11 | 65.8 | 122.2 | Tanker Curve |
| Cougar Creek | 1 | COUGC-A1 | 40 ± 7 | 33 3 | 217 4 | 21 7 | 55 3 | 160 7 | 24 2 | 551 96 | 137 47 | 18 14 | 1.04 0.11 | 100.4 | 61.3 | Cougar Creek |
| Cougar Creek | 2 | COUGC-A2 | 40 ± 6 | 28 3 | 227 4 | 19 7 | 57 3 | 150 7 | 24 2 | 570 96 | 139 47 | 14 15 | 1.15 0.11 | 107.0 | 65.0 | Cougar Creek |
| Cougar Creek | 3 | COUGC-A3 | 41 ± 6 | 29 3 | 237 4 | 17 7 | 59 3 | 146 7 | 26 2 | 549 95 | 155 47 | 27 13 | 1.17 0.11 | 93.4 | 68.6 | Cougar Creek |
| Cougar Creek | 4 | COUGC-A4 | 31 ± 7 | 29 3 | 203 4 | 18 7 | 54 3 | 132 7 | 20 2 | 328 95 | 106 47 | 4 12 | 0.66 0.11 | 99.5 | 66.8 | Cougar Creek |

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide. NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Yellowstone National Park Obsidian Sources, Wyoming

| Site | Specimen | | Trace Element Concentrations | | | | | | | | | | | Ratios | | Geochemical Source |
|--------------|----------|-------------|------------------------------|---------|----------|---------|---------|----------|---------|-----------|-----------|-----------|---|--------|-------|--------------------|
| | No. | Catalog No. | Zn | Pb | Rb | Sr | Y | Zr | Nb | Ti | Mn | Ba | Fe ₂ O ₃ ^T | Fe:Mn | Fe:Ti | |
| Cougar Creek | 5 | COUGC-A5 | 40 ± 7 | 40 3 | 255 4 | 18 7 | 66 3 | 147 7 | 24 2 | 386 95 | 126 47 | 314 13 | 0.81 0.11 | 90.8 | 69.0 | Cougar Creek |
| Cougar Creek | 6 | COUGC-A6 | 56 ± 6 | 30 3 | 213 3 | 21 7 | 57 3 | 156 7 | 24 1 | 587 96 | 150 47 | 303 13 | 1.19 0.11 | 99.1 | 65.5 | Cougar Creek |
| Cougar Creek | 7 | COUGC-A7 | 50 ± 6 | 30 3 | 227 3 | 19 7 | 58 3 | 148 7 | 23 2 | 585 96 | 140 47 | 463 13 | 1.18 0.11 | 109.0 | 65.3 | Cougar Creek |
| Cougar Creek | 8 | COUGC-A8 | 44 ± 6 | 33 3 | 239 4 | 19 7 | 62 3 | 148 7 | 26 2 | 529 95 | 144 47 | 148 13 | 1.14 0.11 | 100.6 | 69.4 | Cougar Creek |
| Cougar Creek | 1 | COUGC-B1 | 42 ± 6 | 29 3 | 240 4 | 14 7 | 60 3 | 145 7 | 25 2 | 372 95 | 124 47 | 94 13 | 0.89 0.11 | 101.2 | 77.7 | Cougar Creek |
| Cougar Creek | 2 | COUGC-B2 | 41 ± 6 | 29 2 | 228 3 | 16 7 | 58 3 | 144 7 | 23 1 | 598 96 | 153 47 | 247 13 | 1.23 0.11 | 99.7 | 66.1 | Cougar Creek |
| Cougar Creek | 3 | COUGC-B3 | 56 ± 7 | 34 3 | 249 4 | 17 7 | 60 3 | 144 7 | 27 2 | 429 95 | 161 47 | 105 13 | 0.92 0.11 | 70.8 | 69.6 | Cougar Creek |
| Cougar Creek | 4 | COUGC-B4 | 39 ± 7 | 33 3 | 251 4 | 14 7 | 63 3 | 147 7 | 24 2 | 396 95 | 134 47 | 105 13 | 0.92 0.11 | 92.2 | 75.4 | Cougar Creek |
| Cougar Creek | 5 | COUGC-B5 | 40 ± 7 | 35 3 | 238 3 | 12 7 | 64 3 | 142 7 | 27 1 | 479 95 | 155 47 | 143 13 | 1.19 0.11 | 94.4 | 79.4 | Cougar Creek |
| Cougar Creek | 6 | COUGC-B6 | 57 ± 6 | 30 3 | 233 4 | 17 7 | 59 3 | 143 7 | 22 2 | 450 95 | 146 47 | 89 13 | 0.97 0.11 | 84.9 | 69.7 | Cougar Creek |
| Cougar Creek | 7 | COUGC-B7 | 39 ± 7 | 34 3 | 243 4 | 15 7 | 61 3 | 144 7 | 22 2 | 405 95 | 135 47 | 96 14 | 0.96 0.11 | 94.8 | 76.5 | Cougar Creek |
| Gibbon River | 1 | GIBBR-A1 | 95 ± 7 | 43 3 | 310 4 | 6 7 | 97 3 | 170 7 | 59 2 | 205 95 | 146 47 | 79 13 | 0.78 0.11 | 70.5 | 120.5 | Tanker Curve |
| Gibbon River | 2 | GIBBR-A2 | 100 ± 7 | 42 3 | 305 4 | 6 7 | 95 3 | 174 7 | 57 2 | 210 95 | 154 47 | 78 13 | 0.74 0.11 | 62.2 | 111.7 | Tanker Curve |
| Gibbon River | 3 | GIBBR-A3 | 81 ± 7 | 46 3 | 318 4 | 7 7 | 96 3 | 172 7 | 61 2 | 258 95 | 157 47 | 72 13 | 0.82 0.11 | 66.9 | 102.1 | Tanker Curve |
| Gibbon River | 4 | GIBBR-A4 | 89 ± 7 | 43 3 | 265 4 | 7 7 | 79 3 | 178 7 | 50 2 | 341 95 | 167 47 | 72 13 | 1.05 0.11 | 75.9 | 97.6 | Obsidian Cliff |

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide. NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.