# GSA DATA REPOSITORY 2011208

## A major oceanic redox condition change correlated to the rebound of marine animal diversity during the Late Ordovician

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**Analytical Methods**:

***TOC and Pyrite*:** Each sample was crushed and milled to a uniform powder in an automated agate mortar device. For organic carbon analysis, about 2 g of powdered sample were treated with 6 N HCl for 24 h to remove carbonate minerals, followed by washing and filtering of the residue. The residue was then dried and weighed. Organic carbon contents were determined using a NC Instruments NC 2500TM elemental analyzer. Pyrite was quantitatively extracted by the chromium reduction method of Canfield et al. (1986), and the sulfide liberated was precipitated as $Ag_2S$. The precipitate was weighed to determine the concentration of pyrite sulfur, and the amount of Fe bound in pyrite was calculated with a molar Fe:S ratio of 1:2.

***V and Ni*:** Trace elements of V and Ni were analyzed in this study. Because organic matter cannot be digested completely by microwave oven, we applied a more effective digestion procedure as follows: Firstly, ~1.0 g sample powder was weighted into a porcelain crucible, and was combusted in a muffle oven at 800 °C for 2 h, and weighted again after the crucible cooled. The mass lost on ignition was recorded and used for latter correction. Then, ~100 mg of the ashed sample was weighted into a PTFE microwave digest vessel, followed by adding of 4 ml $HNO_3$, 1ml HF and 1 ml $HClO_4$. The mixture was allowed to react for a couple of hours and then subjected to Microwave-assisted heating. After cooling down, the resulting solution was transferred quantitatively into a 100 ml PTFE beaker, and the solution was heated on a hotplate until dry. Subsequently, another 1 ml $HClO_4$ was added and was heated again till dry to drive out HF. Finally, the material was re-dissolved in 20% $HNO_3$ and diluted to 50 ml with double distilled water. The obtained sample solution was diluted further 5 folds for ICP-MS analysis (Varian Single Collector Quadropole 820). During analysis, 80 ppb in solution was added in and worked as an internal standard. A commercially available multi-element standard was used to calibrate the instrument externally, and a certified reference material SDO-1 was used to validate this measurement and used for quality control purposes. Results were corrected to the weight of bulk rock, and analytical precision for trace element concentration is usually better than 5%.

**Table DR1: TOC, Pyrite contents, and V/(V+Ni) ratios for the Late Ordovician sediments from Poland**

| Sample | Depth (m) | Stage (I) | TOC (% ) | Py (%) | $\delta$34S (‰) | V (ppm) | Ni (ppm) | V/(V+Ni) |
|---|---|---|---|---|---|---|---|---|
| W63 | 603.7 | K | 0.07 | 0.55 | | | | |
| W62 | 604.8 | K | 0.08 | 0.57 | | | | |
| W61 | 605.8 | K | 0.11 | 0.08 | 6.4 | | | |
| W60 | 606.8 | K | 0.08 | 0.08 | | | | |
| W59 | 607.6 | K | 0.04 | 0.20 | | | | |
| W58 | 608.5 | K | 0.01 | 0.24 | 14.9 | 48 | 42.3 | 0.53 |
| W57 | 610 | K | 0.06 | 0.18 | | | | |
| W56 | 611 | K | 0.02 | 0.57 | 21.1 | | | |
| W55 | 612 | K | 0.04 | 0.30 | 19.4 | | | |
| W54 | 613.2 | K | 0.03 | 0.67 | | | | |
| W53 | 614.2 | K | 0.03 | 0.21 | 25.2 | 115 | 79.9 | 0.59 |
| W52 | 615 | K | 0.08 | 0.47 | 15.9 | | | |
| W51 | 616 | K | 0.09 | 0.03 | -2.4 | | | |
| W50 | 617.2 | K | 0.12 | 0.02 | | | | |
| W49 | 618.5 | K | 0.10 | 0.02 | -0.4 | 116 | 72.9 | 0.61 |
| W48 | 619.4 | K | 0.08 | 0.20 | 31.8 | | | |
| W47 | 620.5 | K | 0.06 | 0.66 | 29.1 | | | |
| W46 | 621.5 | K | 0.08 | 0.21 | | | | |
| W45 | 623 | K | 0.07 | 0.45 | 21.0 | 98 | 66.5 | 0.60 |
| W44 | 624 | K | 0.08 | 0.04 | | | | |
| W43 | 625.5 | K | 0.08 | 0.47 | 28.1 | | | |
| W42 | 626.7 | K | 0.06 | 0.31 | 29.8 | | | |
| W70 | 627.6 | K | 0.05 | 0.40 | 9.3 | 119 | 91.8 | 0.56 |
| W41 | 628.5 | K | 0.09 | 0.01 | | | | |
| W40 | 630 | K | 0.09 | 0.03 | | | | |
| W39 | 631.5 | K | 0.07 | 0.07 | 4.3 | 121 | 86.1 | 0.58 |
| W38 | 633.2 | K | 0.06 | 0.08 | | | | |
| W37 | 634 | K | 0.06 | 0.24 | 32.5 | | | |
| W36 | 635.4 | K | 0.08 | 0.01 | | | | |
| W35 | 637.3 | K | 0.09 | 0.02 | 16.7 | 95 | 92.9 | 0.51 |
| W34 | 638.4 | K | 0.10 | 0.00 | | | | |
| W33 | 639.2 | K | 0.15 | 0.02 | 14.4 | | | |
| W32 | 640.5 | K | 0.10 | 0.00 | | | | |
| W31 | 641.5 | K | 0.09 | 0.30 | 37.4 | | | |
| W30 | 642 | K | 0.06 | 0.08 | 21.8 | 110 | 82.8 | 0.57 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| W29 | 643.5 | K | 0.08 | 0.01 | | | | |
| W28 | 645 | K | 0.07 | 0.07 | | | | |
| W27 | 646.2 | K | 0.15 | 0.06 | -7.3 | 129 | 116 | 0.53 |
| W26 | 647.6 | K | 0.07 | 0.00 | | | | |
| W25 | 648.6 | K | 0.10 | 0.02 | | | | |
| W24 | 650 | K | 0.12 | 0.09 | -8.2 | 135 | 124 | 0.52 |
| W69 | 651 | K | 0.05 | 0.20 | | | | |
| W23 | 652 | K | 0.11 | 0.07 | 18.5 | | | |
| W22 | 653.5 | K | 0.09 | 0.43 | 30.1 | 156 | 120 | 0.56 |
| W21 | 655.5 | K | 0.09 | 0.29 | 23.2 | | | |
| W20 | 656.5 | K | 0.11 | 0.04 | 13.4 | 132 | 147 | 0.47 |
| W19 | 657.5 | K | 0.12 | 0.06 | | | | |
| W18 | 658.5 | K | 0.08 | 0.22 | 21.3 | | | |
| W17 | 659.5 | K | 0.09 | 0.06 | 8.7 | 136 | 124 | 0.52 |
| W16 | 660.4 | K | 0.15 | 0.06 | | | | |
| W15 | 662.3 | K | 0.13 | 0.14 | -4.9 | 136 | 115 | 0.54 |
| W14 | 663.7 | K | 0.10 | 0.09 | 17.1 | | | |
| W13 | 665.5 | K | 0.12 | 0.28 | -3.2 | | | |
| W68 | 666.6 | K | 0.14 | 0.17 | | | | |
| W12 | 667.2 | K | 0.10 | 1.21 | 25.0 | | | |
| W11 | 668.5 | K | 0.18 | 0.41 | 6.6 | 160 | 108 | 0.60 |
| W10 | 669.5 | K | 0.15 | 1.23 | 9.9 | | | |
| W9 | 670 | K | 0.29 | 0.71 | | | | |
| W67 | 671.5 | K | 0.10 | 0.09 | | | | |
| W66 | 673 | K | 0.13 | 0.11 | -3.9 | 147 | 110.2 | 0.57 |
| W65 | 674.5 | K | 0.08 | 0.02 | 22.0 | | | |
| | | | | | | | | |
| D115 | 207 | K | 0.94 | 1.25 | | | | |
| D140 | 208 | K | 1.03 | 1.47 | 12.9 | | | |
| D114 | 209 | K | 1.08 | 3.72 | | | | |
| D113 | 210 | K | 1.34 | 1.26 | | | | |
| D112 | 211 | K | 0.69 | 0.91 | 4.5 | | | |
| D111 | 212 | K | 1.45 | 0.72 | | | | |
| D110 | 213 | K | 1.28 | 1.47 | | | | |
| D109 | 214 | K | 0.66 | 1.18 | 7.0 | 141 | 43.8 | 0.76 |
| D108 | 215 | K | 0.81 | 1.17 | | | | |
| D107 | 216 | K | 0.69 | 1.24 | | | | |
| D106 | 217 | K | 0.66 | 1.72 | 6.6 | 139 | 58.3 | 0.70 |
| D105 | 218.5 | K | 0.63 | 1.45 | | | | |
| D104 | 219.3 | K | 0.72 | 1.10 | 2.7 | | | |
| D103 | 220.4 | K | 0.73 | 0.95 | | | | |

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|---|---|---|---|---|---|---|---|---|
| D102 | 221 | K | 0.73 | 1.34 | 6.1 | 120 | 48.3 | 0.71 |
| D101 | 222 | K | 0.67 | 0.95 | | | | |
| D100 | 223 | K | 0.62 | 1.11 | | | | |
| D139 | 224 | K | 0.67 | 1.06 | 4.9 | | | |
| D99 | 225 | K | 0.66 | 1.06 | | | | |
| D98 | 226 | K | 0.56 | 1.91 | 6.8 | 126 | 39.7 | 0.76 |
| D97 | 227.3 | K | 0.61 | 1.16 | 2.8 | | | |
| D96 | 228.3 | K | 0.69 | 2.85 | | | | |
| D95 | 230 | K | 0.69 | 1.15 | 3.8 | | | |
| D94 | 231 | K | 0.70 | 0.89 | | | | |
| D93 | 232.4 | K | 0.73 | 1.44 | 6.7 | 114 | 50.3 | 0.69 |
| D138 | 233.3 | K | 0.76 | 1.50 | | | | |
| D92 | 234.2 | K | 0.14 | 1.03 | | | | |
| D91 | 235 | S | 0.15 | 0.95 | 15.9 | 170 | 45.8 | 0.79 |
| D90 | 236.3 | S | 0.06 | 1.13 | | | | |
| D89 | 237.4 | S | 0.08 | 1.00 | 24.4 | 39 | 70.8 | 0.35 |
| D88 | 238 | S | 0.11 | 1.93 | | | | |
| D87 | 239.5 | S | 0.16 | 0.74 | | | | |
| D86 | 240 | S | 0.20 | 1.89 | 14.5 | 106 | 93.0 | 0.53 |
| D85 | 241 | S | 0.31 | 1.48 | | | | |
| D84 | 242 | S | 0.53 | 1.22 | | | | |
| D137 | 243.5 | S | 0.61 | 1.69 | 1.3 | 126 | 63.2 | 0.67 |
| D136 | 245 | S | 0.27 | 0.81 | | | | |
| D83 | 246.3 | S | 0.28 | 1.44 | 9.8 | 102 | 51.6 | 0.66 |
| D135 | 247.2 | S | 0.37 | 2.12 | | | | |
| D82 | 248 | S | 0.25 | 0.60 | 11.9 | | | |
| D81 | 249 | S | 0.26 | 0.99 | | | | |
| D80 | 250 | S | 0.28 | 1.04 | 14.5 | 89 | 65.6 | 0.57 |
| D79 | 251 | S | 0.30 | 0.95 | | | | |
| D78 | 252 | S | 0.28 | 1.28 | | | | |
| D77 | 253.8 | S | 0.34 | 0.77 | 5.2 | | | |
| D76 | 254 | S | 0.26 | 1.10 | | | | |
| D75 | 255 | S | 0.33 | 1.12 | 1.7 | | | |
| D74 | 256 | S | 0.40 | 2.50 | 10.5 | 100 | 59.2 | 0.63 |
| D73 | 257.8 | S | 0.31 | 1.24 | | | | |
| D72 | 258 | S | 0.26 | 0.96 | -1.7 | 61 | 51.5 | 0.54 |
| D71 | 259 | S | 0.37 | 1.21 | | | | |
| D70 | 260 | S | 0.25 | 0.96 | 6.2 | | | |
| D69 | 261 | S | 0.28 | 1.03 | | | | |
| D68 | 262 | S | 0.35 | 1.81 | | | | |
| D67 | 263 | S | 0.36 | 2.24 | 2.3 | 96 | 71.0 | 0.58 |

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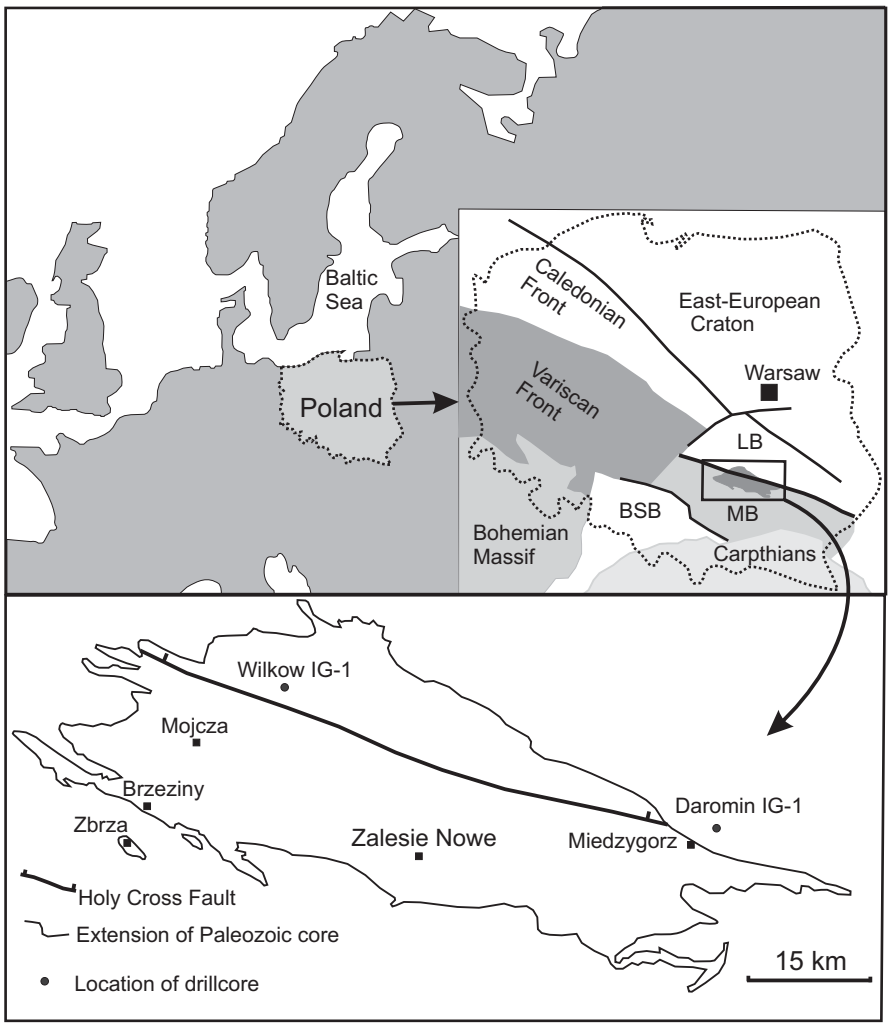
|---|---|---|---|---|---|---|---|---|
| D134 | 264 | S | 0.46 | 1.17 | | | | |
| D66 | 265 | S | 0.43 | 1.32 | 2.0 | | | |
| D65 | 266 | S | 0.39 | 2.47 | | | | |
| D64 | 267.2 | S | 0.45 | 2.73 | 3.4 | 88 | 45.5 | 0.66 |
| D63 | 268 | S | 0.52 | 2.16 | | | | |
| D62 | 269.5 | S | 0.45 | 1.92 | 3.1 | | | |
| D61 | 270 | S | 0.48 | 1.73 | | | | |
| D60 | 271.7 | S | 0.41 | 2.03 | 5.6 | 83 | 57.6 | 0.59 |
| D59 | 272.4 | S | 0.60 | 1.71 | | | | |
| D58 | 273 | S | 0.62 | 1.56 | | | | |
| D133 | 274 | S | 0.41 | 2.26 | 1.4 | 98 | 59.3 | 0.62 |
| D57 | 275 | S | 0.47 | 2.06 | | | | |
| D56 | 276 | S | 0.42 | 1.37 | | | | |
| D55 | 277.5 | S | 0.52 | 2.31 | 4.4 | 86 | 49.5 | 0.64 |
| D54 | 278 | S | 0.51 | 1.25 | | | | |
| D132 | 279.2 | S | 0.46 | 3.07 | 0.2 | 93 | 45.1 | 0.67 |
| D53 | 280.4 | S | 0.17 | 0.39 | | | | |
| D52 | 281 | S | 0.66 | 2.15 | | | | |
| D51 | 282 | S | 0.57 | 3.39 | -2.3 | 105 | 49.9 | 0.68 |
| D50 | 283 | S | 0.38 | 2.39 | | | | |
| D131 | 284 | S | 0.43 | 1.68 | | | | |
| D49 | 285 | S | 0.52 | 2.08 | -0.1 | | | |
| D48 | 286 | S | 0.49 | 2.28 | -0.9 | | | |
| D47 | 287.2 | S | 0.51 | 2.73 | | | | |
| D46 | 288.1 | S | 0.58 | 3.67 | -1.9 | 98 | 51.4 | 0.66 |
| D45 | 289.7 | S | 0.45 | 6.52 | -3.3 | 76 | 64.1 | 0.54 |
| D44 | 290 | S | 0.57 | 2.39 | | | | |
| D43 | 291 | S | 0.32 | 2.14 | | | | |
| D42 | 292.4 | S | 0.58 | 1.99 | | | | |
| D41 | 293.3 | S | 0.56 | 1.87 | 5.1 | 63 | 31.6 | 0.66 |
| D40 | 294 | S | 0.33 | 1.76 | | | | |
| D130 | 295 | S | 0.38 | 1.59 | 3.2 | | | |
| D39 | 296 | S | 0.56 | 2.48 | | | | |
| D38 | 297.7 | S | 0.37 | 1.19 | | | | |
| D37 | 298 | S | 1.04 | 5.95 | 4.7 | 73 | 52.3 | 0.58 |
| D36 | 299.7 | S | 0.81 | 2.59 | | | | |
| D35 | 300 | S | 0.66 | 2.55 | | | | |
| D34 | 301 | S | 1.19 | 3.40 | 10.0 | 71 | 50.2 | 0.59 |
| D33 | 302 | S | 0.59 | 2.45 | | | | |
| D32 | 303.3 | S | 0.54 | 2.93 | | | | |
| D31 | 304.3 | S | 0.48 | 3.25 | 11.8 | 84 | 47.4 | 0.64 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| D30 | 305.4 | S | 0.56 | 2.84 | | | | |
| D29 | 306.4 | S | 0.83 | 2.51 | | | | |
| D28 | 307.4 | S | 0.61 | 3.04 | 13.1 | 89 | 50.5 | 0.64 |
| D27 | 308.4 | S | 0.80 | 1.40 | | | | |
| D129 | 309.5 | S | 0.56 | 4.22 | 11.1 | 67 | 45.4 | 0.60 |
| D26 | 310.5 | S | 0.59 | 3.07 | | | | |
| D25 | 311.5 | S | 0.59 | 3.15 | 13.2 | 87 | 48.6 | 0.64 |
| D24 | 312.5 | S | 0.71 | 1.70 | | | | |
| D23 | 313.4 | S | 0.55 | 2.26 | 10.6 | 87 | 51.9 | 0.63 |
| D22 | 314.5 | S | 0.60 | 1.83 | | | | |
| D21 | 315.5 | S | 0.62 | 3.74 | 4.1 | 105 | 72.2 | 0.59 |
| D20 | 316.4 | S | 0.75 | 1.28 | | | | |
| D128 | 317.3 | S | 0.69 | 2.35 | 11.3 | 78 | 45.6 | 0.63 |
| D19 | 318.1 | S | 0.55 | 1.88 | | | | |
| D18 | 319 | S | 0.65 | 1.33 | | | | |
| D17 | 320.3 | S | 0.48 | 1.00 | -7.8 | 207 | 203 | 0.50 |
| D16 | 321.6 | S | 0.38 | 1.62 | | | | |
| D15 | 322.5 | S | 0.55 | 2.67 | 18.1 | 103 | 67.9 | 0.60 |
| D14 | 323.2 | S | 0.47 | 0.60 | | | | |
| D13 | 324 | S | 0.51 | 1.49 | | | | |
| D12 | 325.5 | S | 0.44 | 0.51 | -10.1 | 170 | 92.2 | 0.65 |
| D127 | 326.4 | S | 0.50 | 1.49 | -9.7 | 211 | 176.5 | 0.54 |
| D11 | 327.3 | S | 0.48 | 0.17 | | | | |
| D10 | 328.6 | S | 0.52 | 1.93 | | | | |
| D9 | 329.6 | S | 0.38 | 1.97 | 9.3 | 139 | 80.2 | 0.63 |
| D126 | 330.4 | LD | 0.48 | 3.59 | 0.2 | 118 | 74.3 | 0.61 |
| D8 | 331.2 | LD | 0.44 | 0.48 | | | | |
| D7 | 332.5 | LD | 0.48 | 2.08 | 9.5 | 97 | 46.9 | 0.67 |
| D6 | 333.6 | LD | 0.68 | 1.24 | | | | |
| D5 | 334.7 | LD | 0.55 | 0.47 | | | | |
| D4 | 335.5 | LD | 0.55 | 1.96 | 3.4 | 112 | 63.0 | 0.64 |
| D3 | 336.4 | LD | 0.58 | 1.08 | -1.2 | | | |
| D2 | 338.5 | LD | 0.18 | 0.59 | | | | |
| D1 | 339.6 | LD | 0.45 | 0.29 | 2.9 | | | |

Stage (I) – Stage (International); K-Katian; S-Sandbian; LD-Latest Darriwilian

Figure DR1


Baltic
Sea
Poland
Caledonian
Front
East-European
Craton
Variscan
Front
Warsaw
LB
BSB
MB
Bohemian
Massif
Carpthians
Wilkow IG-1
Mojcza
Brzeziny
Zbrza
Zalesie Nowe
Daromin IG-1
Miedzygorz
Holy Cross Fault
Extension of Paleozoic core
Location of drillcore
15 km