Geochemical study of the Ordovician/Silurian boundary section in Zdanow (Bardzkie Mts., Poland)

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The Zdanow section represents a part of the basinal sequence of the Bardzkie Mts. (Sudetes, SW Poland). The sequence, which includes the uppermost Ordovician to Lower Carboniferous sediments, belongs to an accretionary prism which is believed to be deposited to the north from Gondwana-derived Armorica microcontinent, located in the high southern lattitude during early Silurian. The O/S boundary interval is characterized by a transition from the flysh dominated Jodlownik Beds (upper Ashgill) into hemipelagic and pelagic Lower Graptolitic Shales (lower Llandovery) (Fig. 1). The Jodlownik Beds are represented by sandstones and siltstones laid down under oxygenated bottom conditions. Towards their top, intercalations of single layers of laminated hemipelagic dark shales appear and finally the deposition turns to black shales. The 30-cm thick black shales change abruptly to radiolarian bedded black cherts and siliceous black shales, deposited probably on a distal plain in fully pelagic setting, under anoxic bottom conditions. Within the studied interval, two layers of altered tuffs, mixed with clastic material, occur. The upper part of *Akidograptus acuminatus* Zone corresponds to the lowest part of radiolarian chert sequence, suggesting that the Ordovician/Silurian chronostratigraphic boundary may be located in underlying black shales (Fig. 1). The upper part of the Zdanow section, the S/D transition, was described earlier (Porebska and Sawlowicz, 1997).

Mineralogy and geochemistry

Mineralogical composition of the samples studied is generally similar, represented mainly by quartz and illite, with addition of plagioclases in sandstones and tuffs, kaolinite in sandstones and zeolites in tuffs. Relatively high content of TOC in light colour turbidites can be explained by the presence of grains of probably recycled organic matter. Organic matter in hemipelagic samples occur mainly as finely dispersed material in thin dark lamina.

Only some of the geochemical parameters (Table 1) which we regard useful for the interpretation of sources, deposition and diagenetic conditions are discussed here. Low Ga/Al_2O_3 ratio in Sample ZO1 may record high activity of a source area, e.g. weathering, during deposition of the Jodlownik Beds. Differences in source material and processes of its deposition in two populations - one deposited by density currents under oxic conditions and the other deposited as hemipelagites under anoxic conditions - are probably responsible for changes in Th/Sc ratios, and perhaps also La/Lu_n ratios. The strongly anoxic conditions of black hemipelagites are well reflected by V/V+Ni and U/Th ratios, rhenium content and Ce_{SN} anomaly. High contents of Mn, Co, and

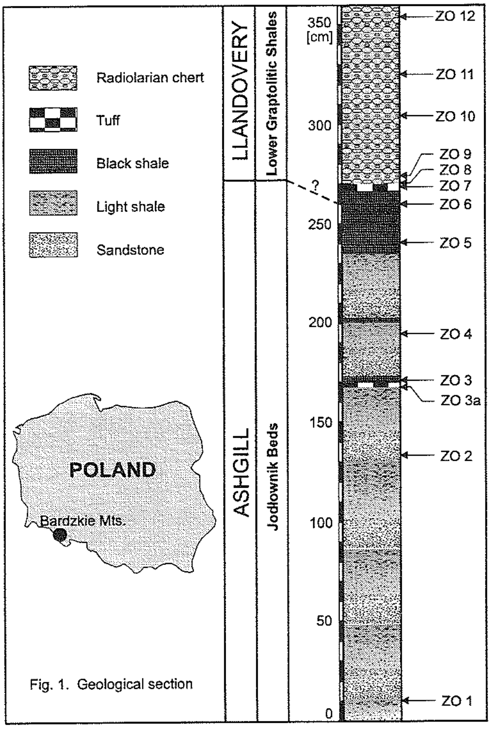

Fig. 1. Geological section

FIG. 1.

TABLE 1. Geochemical parameters of selected samples

Sample	Description	TOC %	Fe_2O_3 %	Th/Sc	Ga/Al_2O_3 ($\times 10^4$)	V/V+Ni
ZO1	light shale	1.66	5.5	1.43	0.88	0.49
ZO2	sandstone	0.12	1.8	0.75	1.57	0.62
ZO3A	tuff	0.47	10.9	1.78	2.01	0.90
ZO3	black shale	0.57	1.9	0.81	1.86	0.94
ZO4	light shale	0.33	3.6	1.36	1.83	0.73
Z05	black shale	0.21	1.3	0.90	1.57	0.92
ZO8	radiolarian chert	1.54	0.4	n.d.	n.d.	0.69
ZO10	radiolarian chert	1.33	0.5	0.55	n.d.	0.89
ZO12	radiolarian chert	3.07	0.4	0.60	n.d.	0.87

Sample	U/Th	Re ppm	MnO ppm	Co ppm	Ni ppm	Σ*REE* ppm	La/Lu_n	Ce_{SNanom}
ZO1	1.40	1	2690	15.0	55	91.2	1.33	1.05
ZO2	1.33	9	80	1.5	19	74.4	1.59	1.46
ZO3A	0.34	18	130	8.0	20	242.3	2.51	1.18
ZO3	0.77	15	80	1.5	11	184.2	2.07	1.14
ZO4	0.47	17	290	30.0	45	146.8	1.57	1.10
Z05	1.78	14	70	1.0	8	121.1	1.53	1.18
ZO8	11.00	13	50	1.0	39	16.5	0.84	0.65
ZO10	14.00	13	50	1.0	27	11.0	0.73	0.53
ZO12	6.33	112	60	1.0	50	49.7	0.50	0.50

possibly Zn in the light shales (ZO1 and ZO4) may be due to prolonged contact with seawater under oxic conditions and the formation of Fe-Mn oxyhydroxides, perhaps after the deposition of a turbidite sequence. There probably is a positive correlation between iron and sulphur content in dark colour samples, reflecting pyrite formation. Content of Co is high in light shales and very low in all other samples whereas content of Ni is high both in light shales and in black cherts. It is possible that under oxic conditions Ni behaves similar to Co whereas Ni content in TOC-rich radiolarian cherts may be related to radiolarians themselves and/or to the formation of Ni-porphyrins. Total content of *REE* seems to be controlled mainly by the content of clay minerals. Contents of sulphur and P_2O_5 are generally very low (<0.24% and <0.05%, respectively), except samples with volcanic material and high iron content (1.5–2.8% S and 0.17–0.23% P_2O_5). Two samples of tuffs have the chemistry similar to alkali basalt. Both the oldest layer of dark shale and continuous seqeunce of black cherts are directly preceded by the tuff layers (ZO3A and ZO7). Comparison of geochemistry of the latter with adjacent layers of shales and cherts does not show any significant element remobilization. It is possible that the supply of nutrients from volcanic sources triggered a local or large scale bioproductivity and resulted in temporary or long-term deposition of anoxic sediments. A drastic change in redox conditions and in style of deposition observed in the studied section may be related to a glacio-eustatic sea level fluctuation, recognized around O/S boundary in other regions (Brenchley, 1988).

References

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