Carbon isotopes of black shales in NW Hunan, China and the Early Cambrian atmospheric CO_2 level

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Total 82 Lower Cambrian black shale samples from the three sections in NW Hunan, China are analyzed for C isotopes of organic carbon ($\delta^{13}C_{org}$ = –34.9 to –28.8 ‰ with average –31.9 ‰) and carbonate. Because of very low carbonate contents in the black shales, only 11 samples analyzed yielded credible $\delta^{13}C_{carb}$ values from –4.0 to +1.7 ‰ with average –2.1‰. By which Δ_B defined as the isotopic difference between the burial fluxes of sedimentary organic matter and carbonate is −30.5 ‰. Kump and Arthur (1999) developed a model, according to Henry's Law at 25ºC and assuming phosphorus as an ultimate bio-limiting nutrient, to obtain an expression relating Δ_B to pCO_2:

$$\Delta_B = ((159.5\times[PO_4]+38.39)/\ 0.034pCO_2) - 33 \qquad (1)$$

where $[PO_4]$ (μmol/kg) proxies nutrient concentration in surface-ocean. Substituting the average carbon isotopic difference (−30.5 ‰) between the $\delta^{13}C_{carb}$ and $\delta^{13}C_{org}$ for Δ_B in equation (1), rearrangement of the equation yield a linear expression for relationship between pCO_2 and $[PO_4]$:

$$pCO_2 = 1881.2\ [PO_4] + 451.6 \qquad (2)$$

and thus would provide a means of estimating CO_2 concentration during sedimentation. Using our calculated average value for Δ_B −30.5 ‰ and assuming that $[PO_4]$ concentrations of the Early Cambrian ocean were similar to present (Holland, 1984) ranging roughly from 0.20 in oligotrophic surface-water to 3.5 μmol/kg in the nutrition-enriched deep water mass in modern ocean, the Early Cambrian atmospheric CO_2 concentration could range from 828 to 7036 ppmv. It should be 3 to 25 times pre-industrial revolution levels (ca. 280 ppmv). This is broadly consistent with predictions that the Early Cambrian atmospheric CO_2 level was as much as 20 times present day values (Kasting, 1993; Berner *et al*., 2001; Kaufman *et al*., 2003). If so, it would imply a high level of nutrient availability represented by phosphorus in the Early Cambrian. We relate the unusually low $\delta^{13}C_{org}$ values of the black shales to an anoxic oceanic environment, high atmospheric CO_2 content and warm greenhouse climate. It should be propitious to trigger the "Cambrian explosion".

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The Paleozoic SSZ-type ophiolite and subduction rollback in the eastern Junggar, nothwestern China

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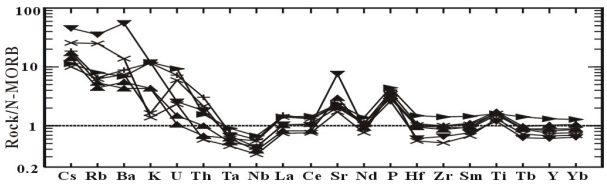
There are two Paleozoic ophiolite belts, Karamaili and Aermantai, in the eastern Junggar orogene, nothwestern China. The northerly Aermantai ophiolite, aged by 503 to 481Ma (Xiao *et al*., 2006; Jian *et al*., 2003), has been testified to forming in interarc basin setting (Jin *et al*., 2001) of supra-subduction zone (SSZ). Our data show that the southerly Karamaili ophiolite, generated in Silurian to early Devonian, contains some basaltic rocks with intermediate N-MORB/IAT composition (fig.1), in addition to E (N)-MORB and OIB reported by former investigators. We infer that the Karamaili ophiolite should have formed in a backarc basin of SSZ. The basalts with intermediate N-MORB/IAT composition formed in the early stage of the backarc basin, while the MORB-like and even OIB-type rocks formed in the "more expanding" stage of the backarc basin resulted from influx and upwelling of relatively enriched mantle driven by convective drag and succedent rollback of the subducted oceanic slab. Thus the two ophiolite belts constituted the Paleozoic intraoceanic "dual arc-basin systems" in Eastern Junggar by subduction rollback of oceanic slab, similar to the mulriple arc-basin systems of northwestern Pacific region. This dual arc-basin systems collapsed and closed at the early period of Later Paleozoic, and assembled in order to the southern margin of Siberian continent, on which the middle Cambrian (505Ma) active continental magmatic arc has been revealed by Windley *et al*. (2002).

Fig.1: N-MORB-normalized trace element patterns for basaltic rocks from the Karamaili ophiolite



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