

## Paleoredox changes of the Yangtze Sea during the Ordovician-Silurian transition and its deposition of black shales, south China

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The redox chemistry of Paleozoic oceans has important implications for understanding the processes of deposition and organic matter preservation of black shale, but empirical constraints on competing environmental models are scarce [1, 2]. To investigate the redox condition changes in the Ordovician-Silurian transition series of the Yangtze Sea, we examine the organic carbon content (TOC), pyrite sulphur content, pyrite sulphur isotope, and Fe species—including dithionite-extractable Fe (FeD), pyrite Fe (FeP), HCL-extractable Fe (FeH), and total Fe (FeT)—in black shale. Fe-TOC-S relationship and several ratios, that C/S ratio, the ratio between highly reactive Fe (FeHR=FeD+FeP) and FeT, and the ratio FeP/(FeP+FeH), known as the degree of pyritization (DOP), are used to evaluate the redox state of Yangtze Sea and the processes that led to the accumulation of organic matter-rich black shale deposits. These redox indices through three intervals, the mid Ashgill, Hirnantian, and early Rhuddanian, indicate that the anoxic-sulfidic marine water occupy most of the Yangtze Sea during the mid Ashgill and early Rhuddanian, while the Hirnantian possesses oxic marine water [3, 4]. Sulfate reduction occurs in euxinic water column and results in characteristic C/S ratio, FeHR/ FeT ratio, DOP, and Fe-TOC-S relationships. Elevated productivity, anoxia and high sedimentation rates support the formation of black shale deposits. For Hirnantian interval, organic matter sedimentation takes place through an oxygenated water column. We suggest that the Hirnantian oxic marine water is the integrative result of glacioeustatic sea-level fall and the influx of cold and oxygen-laden Boreal waters, however, the abrupt transition from oxic to anoxic marine water occurs in the early Rhuddanian resulting from the post-glacial rise in sea level and corresponding increase in surface-water nutrient availability [5].

[1] Calvert *et al.* (1992) *Geology* **20**, 757–760. [2] Pedersen & Calvert (1990) *Bull. Am. Assoc. Petrol. Geol.* **74**, 454–466. [3] Yan *et al.* (2010) *Geology* **37**, 599–603. [4] Zhang *et al.* (2000) *Global & Planetary Change*. **24**, 133–152. [5] Yan *et al.* (2009) *Palaeogeogr. Palaeoclimat. Palaeoecol.* **274**, 32–39.

## Pervasive reactive melt migration though the lower oceanic crust: Implications for the evolution of mid-ocean ridge basalt

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Mid-ocean ridge basalt (MORB) is the most abundant magma on Earth. It is generated beneath mid-ocean ridges by decompression melting of upwelling mantle, and, following processing in lower crustal magma chambers, erupted onto the seafloor. For more than four decades igneous petrologists and geochemists have relied upon MORB as their major window into the mantle, deriving its composition, melting processes and melt migration mechanisms from the erupted lavas. However, this approach assumes that modification of melts in crustal magma chambers occurs exclusively by fractional crystallisation, and can thus be easily corrected for.

Data from an extensive suite of lower crustal rocks from Hess Deep (equatorial Pacific Ocean) demonstrate that melts do not simply evolve by fractional crystallisation. The gabbros crystallised from melts that underwent extensive reactive porous flow, which modified both their major- and trace element composition. The degree to which this reactive signature is present increases up section throughout the lower crust, suggesting that it occurs on a crustal scale. Thus, magma in the lower oceanic crust evolves by a combination of fractional crystallisation and melt-rock reaction. If a reactive signature is present in MORB, this requires a reassessment of its use as a messenger from the mantle.