

Magmatic CO₂ degassing and global paleoatmospheric CO₂ contents

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Magmatic CO₂ degassing was undoubtedly a primary control on paleoatmospheric CO₂ levels. However, quantitative assessment of the flux to the atmosphere of magmatic CO₂ through time remains one of the most intractable aspects of modeling the global carbon cycle. Many geochemical models for the global carbon cycle quantify the magmatic CO₂ paleoflux by correlating with subduction rate; however, there are various reasons why this proxy is unsuitable (Kerrick, 2001). Estimates of magmatic CO₂ paleoflux coupling volumetric rates of magma production and melt CO₂ solubilities offers a viable alternative. Our current limited data base for the volume of arc magmatism through time, and uncertainties regarding CO₂ solubilities in melts of various compositions, confound this methodology for subduction-related magmatism. Flood basalts provide the most advantageous magmatic system for assessing the relationship between enhanced magmatic CO₂ degassing and elevated paleoatmospheric CO₂ contents. Because erosion and burial of flood basalts become more problematic with age, assessment of the volumetric record of flood basalt magmatism is more tractable with younger flood basalts. Using relatively conservative pre-eruptive CO₂ solubilities (i.e., 0.5 wt%), eruption of flood basalts of the Ontong-Java plateau could have produced 2-3 x 10¹⁸ moles/Myr and thus could have alone generated the estimated elevated atmospheric CO₂ contents (900-3,300 ppmv) during the middle-late Cretaceous. However, with pre-eruptive CO₂ solubilities of 0.5 wt. %, eruption of the North Atlantic igneous province, the major flood basalt volcanism during the late Paleocene-early Eocene (60-52 Myr ago), would have been insufficient to account for estimated atmospheric CO₂ contents (>2000 ppmv; Pearson and Palmer, 2000) during this time period. However, flood basalts may have pre-eruptive CO₂ solubilities >>0.5wt.% (Lange, 2002). With CO₂ solubilities of 2 wt%, degassing from the North Atlantic igneous province flood basalt volcanism could have resulted in CO₂ contents ~2X the pre-industrial value. The resultant global warming could have been a major factor in triggering the postulated massive CH₄ release by the dissociation of gas hydrates at ~55Ma (Dickens, 2001).

References

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δ¹³C-, ⁸⁷Sr/⁸⁶Sr-evolution trends of the Meso-Neoproterozoic carbonate deposits: west margin of the Siberian craton

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Reconstruction of the fragments of δ¹³C- and ⁸⁷Sr/⁸⁶Sr evolution curves was performed over carbonate deposits (within 1500 to 850 Ma) of the Enisey ridge and the Baikite anticline at the Western margin of the Siberian craton. Complex investigations of δ¹³C, δ¹⁸O (600 samples) and ⁸⁷Sr/⁸⁶Sr (180 samples) were carried out with the boreholes carbonates taking account of sedimentological and petrographic data. Geochemical criteria for the selection of ⁸⁷Sr/⁸⁶Sr in dolomites (limestones) were chosen as follows: Mn/Sr<2.5 (0.5); Fe/Sr<60 (5.0); Rb/Sr<0.005 (0.001). The most probable isotopic ratio for strontium - (⁸⁷Sr/⁸⁶Sr)₀ was established as follows. Carbonates were decomposed sequentially in 4 stages. In all the fractions, the characteristics to be determined were ⁸⁷Sr/⁸⁶Sr, and the content of Rb, Sr, Ca, Mg. For each sample, a fraction (one of 4) with minimal ⁸⁷Sr/⁸⁶Sr, Rb and maximal Sr content was taken into consideration (Ponomarchuk, et al., 1998).

δ¹³C-values are distributed over the range -0.2±0.5‰ (PDB) within the age 1500-1350 Ma, while upwards along the sequence δ¹³C varies within -2.0 - 2.0±3.0‰. Larger variations of δ¹³C (from -2.0±-3.0 to 4.0±6.0‰) are characteristic of the range 1000-850 Ma. Sharp negative shifts δ¹³C are observed near 1270-1250, 1100-1080, 1000, 950, 870 Ma (Khabarov et al., 2002). The δ¹⁸O values (PDB) are within the range -1.1 to -7.8‰, except one sample with δ¹⁸O=9.0‰. The behavior of δ¹³C- and δ¹⁸O-trends is anti-phase in the most cases.

(⁸⁷Sr/⁸⁶Sr)₀ in carbonates are characterized by increasing values (from 0.70404 to 0.7055) upward along the sequence. This trend is destroyed by the shifts of (⁸⁷Sr/⁸⁶Sr)₀, being increased. The highest (⁸⁷Sr/⁸⁶Sr)₀ values are observed in carbonate rocks of the age about 1100 Ma. For the first time, low (≅0.7050) isotope ratio (⁸⁷Sr/⁸⁶Sr)₀ was detected in carbonates from deposits younger than 1100-1080 Ma. Low isotope ratio (⁸⁷Sr/⁸⁶Sr)₀ in mesoproterozoic ocean are the evidence of active process of paleoproterozoic supercontinent destruction and the formation of ocean. An increase of (⁸⁷Sr/⁸⁶Sr)₀ in deposits aged ~1100 Ma is correlated with the closure of oceans and formation of the Rodinia continent. The moderate low (⁸⁷Sr/⁸⁶Sr)₀ in the early neoproterozoic sequences are evidenced about active rifting and spreading processes.

References

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