The role of magma 'fertility' in the formation of magmatic sulfide deposits

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A well-entrenched idea is that magmatic ore deposits in mafic-ultramafic rocks, such as the Ni-sulfide deposits of Noril'sk in Russia or the PGE deposits of the Bushveld Complex in South Africa, require parental magmas that are 'fertile', or unusually rich in ore metals. The magmas that formed the Bushveld Complex, for example, are thought to have had unusually high contents of platinum group elements (PGE). The idea has led to questionable models in which the parental magmas of these and other deposits acquire high metal contents from unusual sources such as metasomatised lithospheric mantle. Counter arguments are: (1) the vast range of Ni contents in magmas parental to Ni sulfide deposits, from about 1500 ppm in komatiites to about 80 ppm in the Sudbury melt sheet; (2) the comparable PGE contents in alkalic and tholeiitic mafic-ultramafic magmas, even though only the latter contain major ore deposits. Here I argue that the metal contents of primary mantle-derived magmas play only a minor role in the ore-forming process and that the important processes are those that act at upper crustal levels. Almost all mantle-derived magmas contain sufficiently high Ni, Cu, Cr and PGE contents to form a deposit; what is required is that the ore metals are efficiently extracted from a large volume of magma. In practice this requires that (a) a small fraction of the ore mineral is efficiently concentrated from a high-flux magma as it passes a 'choke-point' where changes in geological context or physico-chemical conditions cause segregation of the ore mineral, and/or (b) the ore minerals segregate at deeper crustal levels and are then remobilised and transported upwards, to becomes re-concentrated at a shallower level in the magma system.

Geochemical evolution of the global ocean during a Mid-Cretaceous OAE: Model development and sensitivity analysis

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The Mid-Cretaceous OAEs are witnesses of major perturbations of the Earth climate, which resulted from important changes in the biogeochemical functioning and structure of the ocean-atmosphere system. They are globally well documented by the ubiquitous presence of organic carbon-rich black shale layers characterized by unique geochemical and isotopic signatures. Nevertheless, numerous outstanding questions remain, not only concerning the general mechanisms that lead to the development of anoxic and/or euxinic conditions in the global ocean, but also regarding the influence of these particular environmental conditions on the enhanced carbon burial in marine sediments.

Here, we present a new version of the coupled Earth system model GEOCLIM. The new version combines a climate model (FOAM 3-D GCM) with a vertically resolved diffusion-advection box model of the global ocean, a pelagic biogeochemical model and a fully formulated diagenetic model (BNRS). The model is extended by coupling the sulphur and nitrogen biogeochemistry to the existing description of the carbon and phosphorus cycles. This structure allows investigating the dynamic interplay between the simulated oceanic conditions and sedimentary burial and recycling fluxes. The new model is thus particularly suitable to examine the feedbacks between climatic conditions, oceanic geochemical dynamics and diagenesis.

The model is used to explore the biogeochemical response of the global ocean to climate change during the Mid-Cretaceous A sensitivity study helps identify the most sensitive processes and parameters that control the development and the evolution of ocean anoxia and euxina. Model results show that ocean anoxia can easily develop into euxinia if nutrient availability is high enough to sustain enhanced primary production High production rates deplete oceanic oxygen concentrations and enhance sulphate reduction rates leading to a sulphide build up in the water column.