Carbon burial and benthic fluxes in coastal marine sediments: Model study and sensitivity analysis

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The response of calcareous coastal marine sediments to changes in ocean chemistry and productivity is not yet fully understood. The efficiency of seafloor carbon burial is nevertheless important to quantify in the context of ongoing ocean acidification. We developed a one-dimensional reactive transport model to study the effect of changes in particulate inorganic carbon (PIC) and particulate organic carbon (POC) deposition fluxes on carbon burial efficiency in coastal sediments. The model incorporates the transport processes of sediment accumulation, advection, diffusion, bioturbation and bioirrigation with reactions including the redox pathways of organic carbon oxidation, re-oxidation of reduced nitrogen, iron and sulfur compounds, acid-base chemical equilibria, and dissolution of particulate inorganic carbon (calcite, aragonite, and Mg-calcite). The following processes are also included: precipitation of iron sulfide and iron carbonate, sorption of Fe (II), ammonium and phosphate, sulfidization of organic matter, and pyritization.

Model predicted benthic fluxes of dissolved inorganic carbon (DIC) and alkalinity (A_T) are estimated to be 100 Tmol C/yr and 90 Tmol A_T/yr for the global coastal ocean, respectively. These return fluxes are weakly sensitive to changes in seawater pH, but are very sensitive to Fe (III) deposition fluxes. At least 93% of the labile POC is oxidized via sulfate reduction, which is responsible for ≥57% of alkalinity generation. PIC dissolution, ammonification, and iron reduction also contribute at least 10% to net alkalinity fluxes. The effect of changes in PIC and POC depositional fluxes up to 2X present-day estimates are simulated. Mg-calcite completely dissolves in all simulations, while aragonite dissolves completely when the POC:PIC ratio is greater than 7. Calcite dissolution commences when POC:PIC is greater than 10. The reactive-transport modeling approach proposed here thus provides a means to estimate changes in the magnitude of carbon and nutrients burial and recycling fluxes as a result of changes in ocean productivity.

Regional correlation of the Precambrian basement across the Baltic Sea (N Poland): Evidence from U-Pb dating of accessory zircon

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Accessory zircon is an extremely effective tool in deciphering the chronology and affinities of the covered Precambrian basement. One isolated drill hole close to the southern Baltic coast - Slupsk IG1, reached basement at 5095 m, and 25 m of basement core biotite gneiss was recovered. The protolith of the gneiss has been interpreted either as a sedimentary sequence, or a deformed granitoid, the age and origin of which might be analogous to the Mesoproterozoic rocks on Bornholm Island that were formed during Danopolonian orogeny. CL imaging shows that most of the zircon grains consist of a large core with simple igneous zoning surrounded by an overgrowth with little or no zoning. SHRIMP U-Pb isotopic analyses of 39 cores and 39 overgrowths have shown all to be almost the same age within analytical uncertainty, a result consistent with the rock being metaigneous. About 20% of the analyses, most with relatively high common Pb, are moderately to strongly discordant, indicating an episode of Pb isotopic exchange. With only two exceptions the analyses are co-linear, allowing the age of the event to be estimated from the lower concordia intercept, 513 ± 34 Ma. The upper intercept, and the mean radiogenic $^{207}Pb/^{206}Pb$ of the most concordant data, give estimates of the crystallisation age of the protolith that are the same within error, 1.74 Ga. This is more than 200 m. y. earlier than the Danopolonian orogeny (1.50–1.45 Ga). The zircon U–Pb ages provide a basis for a new interpretation of the Slupsk gneiss and thus the Late Paleoproterozoic regional correlations across the Baltic sea. The gneiss probably correlates with metaigneous rocks of the Blekinge Province [1] of southern Sweden, which record crust forming events at 1.77–1.75 Ga related to subduction along the southern edge of Fennoscandia. In contrast to the likewise coeval granitoids of the Transcandinavian Igneous Belt, the foliated 'gneissic' granitoids of Blekinge Province and the basement rock at Slupsk borehole are deformed. This proposed correlation between crystalline basement rocks from opposite sides of Baltic Sea is supported by similarities in the T $(Nd)_D$ model ages of juvenile crust in the two areas, 1.99–1.98 Ga.

[1] Johansson et al. (2006) GFF 128, 287–302.