

Graphite formation by calcite reduction during subduction

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The geochemistry of organic carbon in subduction zones may be strongly affected by mineral equilibria. We investigate here the geochemistry of carbon in siliceous-marbles at the direct contact with serpentinites in the Alpine lawsonite-blueschist meta-ophiolitic units of northern Corsica (France). We apply a set of spectroscopic (Raman) and isotopic methods to describe both the organic and carbonate components of the rocks across a reaction front where the equilibrium $\text{CaCO}_3 + \text{SiO}_2 + 2\text{H}_2 = \text{CaSiO}_3 + \text{C} + 2\text{H}_2\text{O}$ is evidenced.

The continuous reaction zone is composed by a centimeter thick pale nephrite layer at the contact with the serpentinites, followed by a thin wollastonite layer and a 5 to 20 cm thick dark zone composed of wollastonite, graphitic carbon, quartz but no calcite. There is a sharp (<0.5cm) transition to the overlying original metasediment composed of calcite+quartz which is significantly less rich in graphitic carbon. Raman spectroscopy shows that the graphitic carbon is better crystallized in the reaction zone compared to the non-reacted rock. Significant isotopic differences are observed apart the reaction front with $\delta^{13}\text{C}$ (graphitic carbon) and $\delta^{13}\text{C}$ (calcite) around -15‰ and 1‰ respectively in the pristine sediment far from the reaction zone, whereas $\delta^{13}\text{C}$ (graphitic carbon) is around 0‰ in the reaction zone.

We interpret the graphite in the reaction zone as formed from the destabilization and reduction of calcite under reducing conditions, possibly sustained by the underlying serpentinite body. Mass transfer calculation supports this hypothesis and shows that a complete reduction of calcite might have occurred. In addition, the temperature (430°C) of formation for this graphite is extremely low compared to any other natural process for graphite formation.

Pb isotopic composition of Himalayan Sediments

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Pb- and Nd- isotopic time-series from the authigenic fraction of Central Indian Ocean sediments have been interpreted as responding to changes in the relative amount of Himalayan weathering during the Neogene [1-3]. Such interpretation relies on the lack of change in the isotopic signature of the weathering in the Himalaya. Based on detrital records from the Bengal deep-sea fan, the Nd isotopic composition of the eroded rocks remained nearly constant for the last 20My [4, 5]. However, the associated variations in the Pb-isotopes are not known, and a more precise reconstruction is hampered by the lack of information about temporal changes in the isotopic composition of dissolved Pb and Nd carried by rivers draining the Himalaya.

We present Pb- and Nd-isotope time series, from the bulk detrital and silt-sized fractions as well as the authigenic fraction of deep-sea sediment from Ocean Drilling Program Sites 717 and 718 in the Bengal fan, along with Pb- and Nd-isotopic compositions of Himalayan river bedloads. The oldest ODP samples (7-17My) have relatively uniform Pb- and Nd-isotopic compositions, characteristic of a stable input from the High Himalaya Series. The youngest samples (<1Ma) are also fairly uniform with a shift towards more radiogenic values, implying a greater contribution of the Lesser Himalaya Series. During the Pliocene (1-7Ma) the detrital fraction have more variable Pb- and Nd-isotopic composition associated with a decoupling between the bulk and silt-sized fractions. In detail, Pb-isotopic composition of the detrital is controlled by 1) the source (and correlated with ϵNd), 2) the sorting and the mineralogy as witnessed by relationship with Zr, and 3) weathering and preferential loss of radiogenic Pb. Our results suggest a strong variability in the erosion and weathering regime of the Himalaya over the Neogene with implication on the interpretation of the authigenic records in the signature of deep water of the Central Indian Ocean.

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