
Carbon trapping during contact metamorphism in volcanic basins

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Résumé

Magmatic activity in young oceanic sedimentary basins impacts the transfer of life-essential volatiles, such as C, S, H and Cl between the surface and Earth’s interior. The emplacement of magmatic intrusions into sediments leads to significant remobilization and/or sequestration of carbon and sulphur in metamorphic aureoles. Core samples from the Guaymas Basin, collected during the IODP 385 expedition include Site U1546, where a tholeiitic sill was encountered. The metamorphic aureole below the sill is characterized by a pyrrhotite-pyroxene-calcite-siderite assemblage in a quartz-bearing matrix. Combining petrological and geochemical analyses, coupled with thermodynamic modelling, we show that cooling under closed-system conditions allows the precipitation of carbonates in equilibrium with sulphides. In contrast, the upper aureole remains unaffected by retrograde phase precipitation, suggesting that fluids have been evacuated from the system. While the degassing is not in question, we estimate that up to 31% of the carbon (equivalent to 1.05 Mt) may have been trapped in the metamorphic aureoles of the sill U1546 in the Guaymas Basin. At the basins scale, the volume of these metamorphic reservoirs, that are directly correlated to the magmatic activity, and their ability to trap volatiles, are important considerations for global cycles of the volatile elements. These findings contrast with the common view that metamorphic aureoles are always a source of volatiles, which has implications for estimating the volatile release fluxes during past episodes of increased magma-sediment interaction in analogous basin settings and their consequences on the atmospheric carbon cycle.

Mots-Clés: Contact metamorphism, Carbon sequestration, fluid, rock interactions, magma, sediment, IODP Expedition 385, Thermodynamic models

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