

High-Pressure rock carbonation: implications for interpretation of nature and magnitude of fluid flow in subduction zones

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Fluid fluxes in subducted oceanic crust can be very large and transfer massive quantities of volatile species from the slab to the shallow crust and hydrosphere. The recent discovery of HP rock carbonation process opens new perspectives on the fate of C in subduction zones. Defining the nature and magnitude of fluid flow responsible for rock carbonation is essential to better understand the impacts of this process on the long-term global C cycle. To address these questions, we use quantitative mass balance approach to assess fluid-driven element mobility, and enabling the calculation of time integrated fluid fluxes responsible for HP carbonation. Our results show that massive Ca and CO₂ addition occurred during open system fluid-rock interactions. Na gain is a general feature, whereas the mobility of other elements like Mn, Cr and Ni may vary from one sample to another. The overall trace element budget doesn't change during rock carbonation, with the exception of a slight enrichment in most incompatible elements (Gd, Td, Dy, Y, Ho). This later observation can be explained by the stability of accessory minerals like apatite, allanite and zircon and by garnet crystallization during carbonate precipitation. Furthermore, it suggests that fluids were mainly aqueous and very diluted. A conservative estimation of time integrated fluid fluxes gives a minimum value of 10^4 - 10^5 m³_{fluid} m⁻²_{rock}. It is concluded that rock carbonation is produced by regional-scale advective mass transfer by means of extremely channelized fluid flow along lithological boundaries.