Jay Ague
Henry Barnard Davis Memori
al Professor of Geology & Geophysics
Curator-in-Charge of Mineralogy and Meteoritics
Yale Peabody Museum

Decarbonation During Plate Convergence and Collision: Implications for the Deep Carbon Cycle

The reaction calcite + quartz => wollastonite + CO_2 is the archetypal model for metamorphic decarbonation. Silicate-carbonate reactions of this type operate in a wide range of rock types, are ubiquitous during metamorphism in subduction zones and orogenic belts, and have operated for most of geologic time. Metamorphic decarbonation releases CO_2 to the mantle wedge and arc magmas in subduction zones. This flux is augmented by stoichiometric dissolution of carbonate minerals where fluid fluxes are high. In collisional mountain belts, CO_2 is released by a host of metamorphic processes, particularly orogenic thickening and associated self heating. Our recent estimate of the areal orogenic flux (~10^{12} mol CO_2 km^{-2} Myr^{-1}; Stewart and Ague, 2018, *EPSL*) is comparable to that for volcanic arcs and mid-ocean ridges. Progressive CO_2 release during the Devonian Acadian orogeny coincides with warming and sea level rise, and may have helped drive the Taghanic biocrisis. Given the role that CO_2 has played in the development of Earth as a habitable planet, it is unlikely that life as we know it would have evolved without metamorphic decarbonation.