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Experimental investigation of factors controlling aragonite crystallization

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Ocean acidification reduces seawater pH, shifts the dissolved inorganic carbon (DIC) equilibrium (increasing [HCO_3^-] and decreasing [CO_3^{2-}]) and reduces the calcification rates of many calcareous marine organisms. Aragonite and calcite precipitation rates are determined by the seawater saturation state, Ω (reflecting the availability of CO_3^{2-} and Ca^{2+} for incorporation in the $CaCO_3$ precipitate). However, both aqueous HCO_3^- and CO_3^{2-} are inferred to attach to growing calcite crystal surfaces [1] and HCO_3^- is observed in both coral and synthetic aragonite [2]. Understanding the roles of both HCO_3^- and CO_3^{2-} in $CaCO_3$ precipitation is key to predicting the responses of calcareous organisms to ocean acidification.

We are conducting experiments to study aragonite precipitation at a constant saturation state (Ω = 4, 7, 10, 13 or 18) over varying seawater pH levels (pH= 8.337, 8.545 and 8.727). These changes in pH were accompanied by changes in [DIC] (850-7800 µmol kg^{-1}) and, subsequently, [HCO_3^-] but [CO_3^{2-}] remains essentially unchanged. All experiments were conducted at T = 25±0.1°C, salinity = 34 and using an aragonite seed. We correlated aragonite precipitation rates with concentrations of CO_3^{2-} and HCO_3^- ions. Our results show that the precipitation rate of aragonite reflects the CO_3^{2-} ion concentrations (fig 1) while HCO_3^- ion concentrations has a negligible effect on precipitation rate (fig 2). This implies HCO_3^- is not a substrate for aragonite formation and has important implications on the interpretation of O isotope proxies.

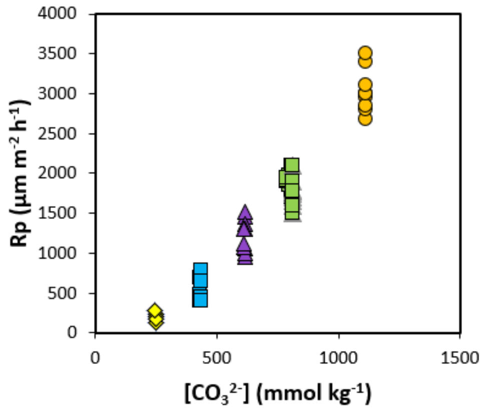

Figure 1 shows the precipitation rate of aragonite as a function of carbonate ion concentration. Different saturation states are denoted by different symbols: yellow diamonds show Ω = 4, blue squares Ω = 7, purple triangles Ω =10, green squares Ω = 13 and orange circles Ω =18

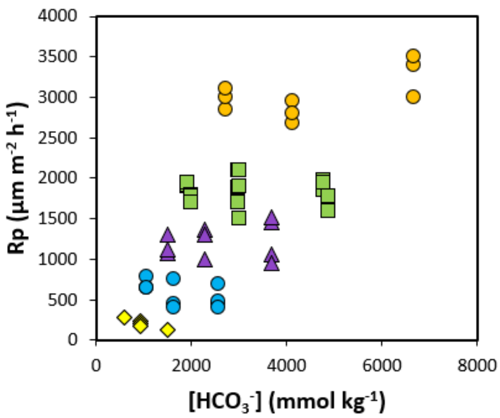

Figure 2 shows the precipitation rate of aragonite as a function of bicarbonate ion concentration. Different saturation states are denoted by different symbols: yellow diamonds show Ω = 4, blue squares Ω = 7, purple triangles Ω =10, green squares Ω = 13 and orange circles Ω =18