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Assessing the consequences of olivine addition to continental shelf sands as a method of ocean alkalinity enhancement

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The addition of olivine (Mg_2SiO_4) to continental shelf sand has been proposed as a method of ocean alkalinity enhancement via enhanced silicate weathering. However, the efficacy of this technique is still unclear, as are the secondary reactions that result from rapid, localized changes in pore water chemistry. To better understand which reactions are controlling pore water chemistry following olivine addition, three experiments were conducted using beach sand amended with commercially available olivine sand: 1) mini-flume experiments where seawater was pumped across the surface of sediment in a drop box to simulate continental shelf conditions; 2) batch reactor experiments to determine which reactions dominate in the deeper, stagnant pore water; and 3) flow through reactor experiments to constrain reactions and dissolution/precipitation rates in the well-irrigated surface sediment. Results demonstrate that the addition of olivine has rapid and drastic effects on shelf sand pore water and overlying water chemistry. We find geochemical signatures of mineral precipitation (calcite/aragonite and clay minerals) occurring immediately following pore water/mineral interaction. The stoichiometry of CO_2 transformation and sequestration following olivine addition is thus complicated and altered. The precipitation reactions and their seemingly rapid kinetics highlight the importance of understanding which secondary reactions occur as a result of enhanced olivine weathering and at what magnitude when attempting to account for CO_2 removal resulting from this technique.