

Anionic Resin as an MRV strategy for measuring DIC at ERW deployments

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Carbon dioxide removal (CDR) through enhanced rock weathering (ERW) leverages silicate mineral dissolution to capture atmospheric CO₂ as bicarbonate (HCO₃⁻), which is ultimately transported to oceans for long-term storage. Mati Carbon's ERW deployments in Indian rice paddies represent an ideal testbed for silicate weathering deployments. This is due to high temperatures and water flux conditions throughout the region, which accelerates silicate dissolution.

An early challenge for ERW deployments is the apparent discrepancy between solid-phase mass balance calculations and porewater alkalinity measurements. For Mati's deployments, porewater measurements are further obscured by the complex hydrology of rice paddies and the resultant water dynamics between interconnected and terraced systems. Moreover, lateral transport of water dominates the interior of paddies. At "bunds," (paddy boundaries) the vertical infiltration of water is orders of magnitude higher than on the field interior. Thus, naive collection of pore water samples to measure dissolved inorganic carbon (DIC) may provide spurious results.

We employ a resin-based monitoring, reporting, and verification (MRV) technique for direct bicarbonate quantification in ERW deployments rather than relying on porewater measurements of DIC. Anion exchange resins, mixed with inert glass beads, are encapsulated in unreactive cartridges and deployed in the field below the rooting zone, throughout the cropping season. These resins adsorb bicarbonate from soil pore water, which is subsequently eluted and quantified via acid-base titration. To capture bicarbonate transport effectively, we deploy resin devices in linear arrays along upstream and downstream bunds rather than within the field interior.

To calibrate resin performance, we have used response surface methodology (RSM) and central composite design to assess the effects of initial solution pH, bicarbonate concentration, and resin dose on adsorption efficiency. We employ a regression model to optimize bicarbonate retention under controlled conditions (30°C, 250 rpm stirring, 1 L feedstock volume). FTIR analysis confirms resin-ion interactions. We quantify the bicarbonate flux through deployed resin cartridges under field conditions using regressions from RSM results.