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In-Situ Soil pH and $p\mathrm{CO}_2$

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Partial pressure of CO_2 ($p\mathrm{CO}_2$) in the soil profile strongly affects the chemistry of the soil and its pH, especially in soils having pH > 6 (as determined under ambient conditions). Laboratory determination of soil pH under ambient conditions often may not accurately represent in-situ soil pH because $p\mathrm{CO}_2$ in the soil profile is commonly 10 to 100 times higher than that in the atmosphere (as a result of microorganism and root respiration coupled with slow removal rate). In-situ measurements of soil pH often meet many technical difficulties while measurements of soil $p\mathrm{CO}_2$ are more feasible. If the response of soil pH to changes in $p\mathrm{CO}_2$ is known, and if the actual $p\mathrm{CO}_2$ in the soil profile is available, then the in-situ soil pH can be calculated based on these two parameters. In a laboratory experiment, under controlled conditions, we have tested 20 different soils' pH response to changes in $p\mathrm{CO}_2$. As expected, the higher the ambient soil pH, the higher was the decline in soil pH (up to 3.5 pH units) following the increase in $p\mathrm{CO}_2$. Our measurements suggest diverse responses of soil pH to $p\mathrm{CO}_2$: in some of the calcareous soils the change in pH with $p\mathrm{CO}_2$ followed calcite equilibrium, but in others, the measured pH values did not follow the pattern expected from calcite equilibrium. Six of the studied soils showed some ability to buffer the pH, and the expected decline in the pH did not occur up to some threshold $p\mathrm{CO}_2$. The statistical analysis suggests that iron and manganese oxides play a significant role in the soil's buffering capability. N-containing species, organic and inorganic carbon and citrate-bicarbonate-dithionite (CBD) extractable Al, Mn and Fe may also contribute to the variability among soils' pH under various $p\mathrm{CO}_2$ levels. Our laboratory results clearly

demonstrate the difficulties involved in modeling the response of soil pH to changes in pCO_2. However, the laboratory measurements presented may provide a more accurate characterization of the soil pH behavior.