Partial digestion geochemistry of Nova Scotia soil samples: monitoring digestion conditions to understand how samples leach

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Partial digestions have been used in exploration geochemistry over the past 15 years to detect surface anomalies associated with buried mineralization. Vertical migration of elements from a primary mineralized source at depth to the surface is necessary to create these anomalies. Within the anomalous soils, elements transported from depth by groundwater typically reside in loosely bound sites on the surfaces of minerals. Partial digestions are designed to only leach such elements from the surfaces of these minerals, as they do not dissolve the minerals themselves, and thus do not liberate any elements contained within those minerals. As a result, partial digestions tend to suppress geochemical background and increase geochemical contrast, features that should make partial digestion results more interpretable and visually compelling than total digestion results. However, unlike strong digestions, soil matrices overwhelm weak digestions and thus it is necessary to carefully monitor the digestion conditions.

To investigate what happens during partial digestion geochemistry, B-horizon soil samples from study areas in Nova Scotia were leached using deionized water (probably the weakest partial digestion possible) and analyzed by ICP-MS. The partial digestions were analyzed for a suite of metals every 30 seconds for at least the first 30 minutes of leaching, and compared with results obtained over 2 hour batch digestions. During these temporal studies, the pH and pE of the solutions were also measured every 30 seconds to monitor digestion conditions. These results have also been compared with the results of analogous partial digestions obtained using an argon atmosphere to avoid any oxidation effects resulting from exposure to ambient air.

The results of these experiments have provided significant improvements in the understanding of how partial digestion conditions change over time, and how these changes can result in unintended, and sometimes, completely disastrous results. Special consideration of the condition of soil samples before collection, after drying, and during deionized water leach provides a unique understanding of the behaviour of labile elements during digestion. Essentially, the results conclusively demonstrate how the matrices of soil samples simultaneously buffer both the pH and pE conditions of the digestions, precisely because these buffers overwhelm the chemical controls exerted by these weak partial digestions. As a result, samples with different matrices will commonly undergo leaching under vastly different chemical conditions, undermining interpretation because the consequent results can't be rigorously compared. Interestingly, the results also demonstrate that partial digestion concentrations obtained with less than 10 minutes of leaching are typically less impacted by these matrix effects, and thus provide more accurate exploration results and better geochemical contrast than conventional (longer) leach times.

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