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Limitations of the Amorphous Silica Analysis for Runoff Sampling

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Different techniques are used to analyse runoff, soil and plant samples for extractable amorphous silica (ASi). Most methods that are used are modified versions of a method originally proposed by DeMaster (1981). Generally a sequential alkaline extraction is applied on 0.025-0.030 10^{-3} kg of material using 0.025l of a 0.1M solution of Na_2CO_3 to measure the Asi content of soils, sediments or plants. Si concentrations are measured after 3, 4 and 5 hours of extraction. It is then assumed that all ASi is dissolved within the first hour, after which a constant dissolution of the aluminosilicates present in the sediment or soils takes place. ASi concentrations are then estimated as the intercept value of the aluminosilicates dissolution line. However, in many cases it is not possible to use a predetermined quantity of soil or sediment material, e.g. when runoff samples are analysed. We investigated whether De Master's technique can still be applied when the amount of material that is analysed is variable.

For this study we analysed a series of runoff samples with known sediment concentrations (between 0.1 and 100 10^{-3} kg l^{-1}). From each sample subsamples of 0.005l and 0.025l were sequentially extracted. Our data show that the sequential alkaline method has a limiting threshold value. When the sediment concentration exceeds 6 - 8 10^{-3} kg $l^{-1}$and 1.6 - 1.8 10^{-3} kg l^{-1} for 0.005l and 0.025l samples respectively a constant ASi-concentration [μM] is reached. This corresponds to a solid/solution ratio of 1.8 10^{-3} kg l^{-1}.This implies that the solution process is incomplete when this threshold is exceeded. Below this threshold value the relationship between initial sediment concentration and measured Asi-concentration (μM) was linear (R^2=0.99), implying that ASi solution was complete until the threshold value was reached. We conclude that De Master's method can be applied reliably to determine ASi concentrations in samples with varying sediment concentrations, provided that a saturation threshold is not exceeded. For our samples (sediments derived from silty loamy soils) this threshold is 1.8 10^{-3} kg l^{-1}: However, the latter may vary depending on sediment characteristics and ASi concentrations. It is therefore suggested that, when studying ASi in sediments, the effect of sediment concentration on ASi-extraction is first evaluated.