Application of ICP-QQQ to isotope tracer studies

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ICP-MS analyses of trace and ultra-trace element concentrations in geological and environmental samples are often confounded by polyatomic or isobaric interferences that often require pre-concentration and/or removal of matrix ions prior to analysis by HR-ICP-MS. Even in these instances it is often necessary to use medium or high resolution to resolve residual interferences, which leads to a reduction in ion transmission and thus an increase in detection limits. The triple quadrupole ICP-MS instruments (ICP-QQQ) using reaction cell technology offer an alternative to HR-ICP-MS approaches. These instruments have a Q1—cell—Q2 configuration and Q1 is invariably set at the analyte mass. A reaction gas is introduced into the cell and leads either of two scenarios; 1. The interferent reacts with the gas and is mass-shifted away or 2. the analyte reacts with the reactant gas and is mass-shifted. Either of these scenarios leads to interference free measurement of the analyte ion. We demonstrate the utility of ICP-QQQ for three Earth Science applications. Gallium is used as an indicator in weathering studies because of its chemical similarity to Al. NH_3 reacts with Ga to form the +17 amu mass-shifted adduct. Although the reaction is only 1 -2 % efficient, the major interference, Ba^{2+}, is not mass shifted and thus Ga 69 can be measured in the presence of Ba with detection limits of *ca.* 0.3 ng/L. Interference free analysis of Ga 69 is essential for correct isotope dilution quantitation and for confirmation of quantification at m/z 71 by external calibration. The Sr87/86 ratio is often used to date marine carbonates and also as a tracer in weathering processes. Analysis of this tracer usually requires pre-separation of Rb87 from Sr. With O2 as the reaction gas in ICP-QQQ Rb is unreactive whereas Sr does react with O_2 and is shifted by 16 mass units. This allows for the interference free analysis of Sr 87/86 isotope ratios, albeit still constrained by the imprecision of a single collector ICP-MS. Finally, we have used NH_3 as the reaction gas to remove the Hg isobar interferences from Pt196 and 198 in studies of PGEs in ice. Ammonia effectively neutralizes Hg ions through gas phase charge transfer reactions and allows for precise isotope dilution or external calibration with detection limits of *ca.* 0.1 ng/L despite a 44% reduction in sensitivity compared to the no gas mode.