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The Nu Sapphire SP001 collision cell MC-ICP mass spectrometer: Application to high-precision measurements of K and Ca isotopes.

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The Nu Sapphire (UK Patent GB2535826) installed at Harvard (SP001) is a novel MC-ICP-MS instrument equipped with a dual-path design including both a conventional MC-ICP-MS (high-energy) path and a hexapole collision cell (low-energy) path. Following extraction of the ions from the ICP at 6 kV, the ions are deflected off-axis and decelerated into the collision cell. In the cell, the ions mix with He and H_2 gases to remove interfering species and are then re-accelerated to 6 kV on exiting the cell and then focused back onto the high-energy path. We have so far primarily used this instrument for K and Ca isotope measurements. For both K and Ca, the measurements are made in low resolution static mode to maximize sensitivity and measurement precision at the same time. For K, $^{39}K^+$ is measured in Faraday cup L4 connected to a pre-amplifier with a 10^{10}-ohm resistor and $^{41}K^+$ is measure in Faraday cup H3 with a 10^{11}-ohm resistor. For Ca, $^{40}Ca^+$ is measured in Faraday cup L4 connected to a pre-amplifier with a 10^{10} ohm resistor and $^{44}Ca^+$ is measured in Faraday cup H9 with a 10^{11} ohm resistor. We have found that NIST Ca standards have significant Sr and Ti that causes problems with the measurements. We are therefore using very high purity Ca and K solutions as our internal reference standards. We report values for both NIST and USGS and other standards that in general agree well with results from some other laboratories. The sensitivity achieved for K and Ca is approximately 1000 to 1,300 volts/ppm. The $\delta^{41/39}K$ and $\delta^{44/40}Ca$ measurements are typically reproducible to within 0.02 to 0.03‰ (2RSE) and the typical internal precision is 0.015‰ (2RSE). Our measurements demonstrate in detail the capability of the Nu Sapphire dual-path MC-ICP-MS to provide accurate and precise K and Ca isotopic data. We have now reported K and Ca isotope measurements for meteorites, oceanic basalts, a caldera complex, island arcs and oceanic sediments. In all cases the improved measurement capabilities provide new insights that could not have been obtained with previously available instrumentation.