Atmospheric ^{21}Ne abundance determined by the Helix-MC Plus mass spectrometer

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Analyses of noble gas isotopes by multi-collector, high resolution mass spectrometry have the potential to revolutionise applications in the cosmo-geo-sciences. The Helix-MC Plus noble gas mass spectrometer installed at the Australian National University (ANU) is equipped with unique high mass resolution collectors [mass resolution (MR): ~1,800 and mass resolving power (MRP): ~8,000], including fixed axial (Ax), adjustable high mass (H2) and adjustable low mass (L2) detectors. The high mass resolution of the L2, Ax and H2 collectors permits complete separation of ^{20}Ne (measured on L2 detector) from doubly charged interfering ^{40}Ar (required MR of 1,777), ^{1}H^{19}F (MR = 1450), $^{1}H_2{}^{18}O$ (MR = 894) and partial separation of the ^{21}Ne peak (on Ax detector) from interfering ^{20}Ne^{1}H (MR = 3,271), and ^{22}Ne (on H2 detector) from interfering doubly charged CO_2 (MR = 6,231). Because of the high MRP of ~8,000, ^{21}Ne can be measured, essentially without interference from ^{20}Ne^{1}H, by setting the magnet position on a ^{20}Ne^{1}H interference-free position. This capability provides an important opportunity to re-evaluate the ^{21}Ne abundance in the atmosphere. Our analyses demonstrate that ^{20}Ne^{1}H contributes ~4% to atmospheric ^{21}Ne measurements, with the corresponding production ratio of ^{20}Ne^{1}H to ^{20}Ne being ~1E-4. We calculate a new atmospheric ^{21}Ne/^{20}Ne ratio of 0.00287 relative to an atmospheric ^{22}Ne/^{20}Ne ratio of 0.102; this new value is distinctly lower than the current IUPAC recommended ^{21}Ne/^{20}Ne value of 0.00298. There are several significant implications ensuing from the newly determined atmospheric ^{21}Ne abundance. For example, in the area of Earth sciences the most critical issue relates to cosmogenic ^{21}Ne surface exposure ages, which involve the calculation of ^{21}Ne concentrations from excess ^{21}Ne, relative to the atmospheric ^{21}Ne/^{20}Ne ratio. For young samples, where cosmogenic ^{21}Ne contents are small and the ^{21}Ne/^{20}Ne ratio is close to the atmospheric value, the revised value could increase cosmogenic ^{21}Ne ages by ~30%.