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Isotope tracing of nitrate: lessons from Malta

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ABSTRACT

Average concentrations of nitrate in Malta's groundwaters are probably the highest among EU member states. This compromises the quality of an important resource - almost 60% of Malta's water supply being provided by groundwater. An $^{15}N/^{14}N$ + $^{18}O/^{16}O$ isotope study was undertaken as a core part of wide-ranging investigations into the potential sources of the nitrate pollution, its likely future trends, and possible ameliorative actions. The dual isotope ($^{15}N/^{14}N$ + $^{18}O/^{16}O$) approach was important for identifying waters affected by denitrification. Excluding these, groundwater from three physically and hydrologically distinct aquifers, with a very wide range in nitrate concentrations (24 to 410 mg NO_3 L^{-1}), had remarkably similar isotope compositions: 90% of samples lying within $\delta^{15}N \approx +8$ to +12‰, and $\delta^{18}O \approx +3$ to +6‰. The $\delta^{18}O$ values are entirely consistent with those expected for microbial nitrification in the presence of surface or groundwaters, and together with $\delta^{15}N$ values rule out nitrate derivation directly from fertilizers or sewage. In other studies the relatively high $\delta^{15}N$ values for the waters would probably have been interpreted as indicative of nitrate derived from manure. In Malta, however, cultivated soils have high $\delta^{15}N$ values, ≈ +6 to +11‰, very similar to the values for nitrate in the groundwater, and argue for a soil-derived source. The implications of a soil-source of such high nitrate levels are discussed, and the study emphasised the importance of characterising the compositions of soils in addition to other sources – a factor often neglected in isotope studies of nitrate.