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NITROGEN ISOTOPE FORENSICS OF DAIRY GREENWATER

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ABSTRACT: New Mexico dairies face the need for abatement of groundwater nitrate contamination. All of the nitrate contamination beneath a particular dairy, however, might not be derived from that dairy's greenwater (liquid dairy waste collected in lagoons). Rather, some portion of the observed contamination may have originated from current and historical chemical fertilizer usage, or from greenwater or fertilizer from an upgradient dairy. Stable isotope ratios of nitrogen can be used to identify sources of nitrate and processes leading to the formation or removal of nitrate from soils and groundwater. As part of the New Mexico Small Business Assistance Program, Los Alamos National Laboratory has been analyzing nitrogen and oxygen isotopes in nitrate collected from groundwater monitoring wells associated with dairies in and around Roswell, Portales, Dexter, Artesia, and Belen, NM. Nitrogen isotopes in greenwater, manure, and synthetic fertilizer have also been analyzed. General groundwater chemistry and field parameters have been used to identify nitrate source terms and nitrogen transformation processes occurring in the subsurface. Nitrate is the predominant nitrogen-bearing species now observed as a contaminant in dairy groundwater monitoring wells, and was, in most instances, likely formed from oxidation of reduced nitrogen-bearing species. Most agricultural sources of nitrogen, with the exception of nitrate fertilizers, occur in reduced form, and contain no primary oxygen. Nitrification of these reduced sources (ammonia, organic nitrogen) to nitrate must occur in the unsaturated zone above the aquifers studied or immediately upon these sources entering the aquifers, which tend to be oxidizing. Nitrate derived from greenwater sources has high N-15 and O-18 values ranging from approximately 8-25 ‰ and 3-15 ‰, respectively. The highest values are associated with trends of decreasing nitrate concentration, suggesting that in some instances, denitrification can follow nitrification, perhaps in a deeper portion of the unsaturated zone. Nitrate from monitoring wells located in or adjacent to land application areas that receive a mixture of greenwater, manure, and synthetic fertilizers (N-15 similar to 0 ‰) have lower N-15 and O-18. Probabilistic mixing ratios estimating the amount of greenwater-related nitrogen present in each water sample will be presented.

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