Identification of Sources of Nitrate in Ground Water-- A Feasibility Evaluation

Timothy B. Spruill[1]

Information is needed by State, county, and municipal water managers, as well as various industries, to determine (1) parties responsible for ground-water contamination and (2) where reduction and management efforts need to be focused to accomplish non-point-source management goals. Geochemical-isotopic indicators can be used to identify contamination sources. For example, N^{15} has been used to identify animal or fertilizer nitrogen contamination. However, N^{15} cannot always distinguish unique sources because of variability caused by fractionation of the isotope in the environment, particularly in areas where denitrification is taking place. In addition, the analysis is relatively expensive, so its use on a routine basis may not always be practical. A study is being conducted to determine if combinations of major ions (ionic concentrations or ratios of various ionic species), organic compounds, isotopes, and other chemical data exist as unique or multivariate indicators for sources of ground-water contamination. Can the source of the contaminated sample be determined from the chemical data alone?

Discriminant analysis and cluster analysis were applied to limited data collected from 20 sites in four source categories (commercial fertilizer, septic, chicken/fertilizer, and hog wastes) in summer and fall 1996. Preliminary results of the discriminant analysis indicate the following:

(1) Potassium may be useful in identifying hog-waste sources because potassium is elevated in hog wastes.

(2) The discriminant model correctly identified hog-waste-contaminated ground water, hog-lagoon water, and fertilizer-contaminated ground water. These samples were ionically unique.

While initial results were promising for some categories, the procedure produced inconclusive results in other waste categories. The chicken/fertilizer-contaminated ground-water samples were correctly placed in only 25% of the cases. Two of the four chicken/fertilizer category samples were placed in the septic-system category and one in the unknown category. One of the two septic-system cases was incorrectly placed in the chicken/fertilizer category. Initial results indicate a need to better distinguish between the chicken/fertilizer and septic-system categories. Other variables or ratios and greater sample sizes within each category could improve the discrimination power.

Five sources of nitrate-contaminated ground water currently are being evaluated--commercial fertilizer applied to crops, hog waste, chicken waste, human wastes, and commercial fertilizer applied to golf courses. Water samples will be collected and analyzed from 10 temporary wells per category. Potential indicators that are being investigated include N^{15} of nitrate, major ion concentrations, organic carbon, zinc, copper, and methylene blue active substances.

---

[1]U.S. Geological Survey, 3916 Sunset Ridge Road, Raleigh, NC 27607 (tspruill@usgs.gov)