Determining Sources and Timescales of Nitrate Contamination of Spring Waters from Isotopes and Other Chemical Indicators

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Human health and ecological concerns have arisen regarding Florida's spring waters as a steady increase in nitrate concentrations has been observed during the past 30 years. Springs discharge nearly 8 billion gallons per day and provide base flow for many rivers in Florida that flow toward coastal areas. Increased nitrogen loads in spring runs and streams have led to the formation of nuisance algal mats and exotic species of rooted aquatic plants. In response to these concerns by the State of Florida, several research studies have been using naturally-occurring isotopic and other chemical tracers to determine sources of nitrate contamination and age of ground water discharging from springs. Since 1997, more than 60 water samples have been collected from 44 springs and analyzed for isotopes (^{15}N, $^{3}H/^{3}He$, ^{18}O, ^{2}H, ^{13}C) and other chemical indicators (chlorofluorocarbons (CFCs), major ions, dissolved gases, and SF_6). Delta ^{15}N values of nitrate ranged from 2.6 to 12.9 per mil (median = 5.8 per mil) and indicated that nitrate in most spring waters originated from synthetic fertilizers. Mean transit times of ground water from the Upper Floridan aquifer that discharges from these springs ranged from 5 to 39 years, based on measured concentrations of CFCs, $^{3}H/^{3}He$, and SF_6 and various flow system models. Concentrations of these multiple transient tracers are consistent with a two-component hydrologic model with mixtures of varying proportions of young water (<8 years) from the shallow part of the aquifer and older water (20-50 years) from the deeper part of the flow system. Given residence times of 20 to 40 years for ground water discharging from most springs, it likely will take decades for nitrate concentrations to decrease to near background levels, even with immediate reductions in nitrogen inputs at the land surface.