

Use of Stable Isotopes as a Forensic Tool to Determine Sources of Perchlorate in Groundwater in the Chino Basin, California

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Perchlorate has been detected recently in a variety of environmental media, including groundwater, at concentrations that may be harmful to human health. A forensic technique has been developed using comprehensive stable isotope analyses (³⁷Cl/³⁵Cl and ¹⁸O/¹⁷O/¹⁶O) of perchlorate to distinguish the origin of perchlorate (synthetic vs. naturally occurring). Stable isotope analyses of perchlorate from known man-made (e.g., samples derived from electrochemically-synthesized ammonium- and potassium-perchlorate salts) and natural (e.g., samples from the nitrate salt deposits of the Atacama Desert in Chile) sources reveal systematic differences in isotopic characteristics that are related to the formation mechanisms (Bao and Gu, 2004; Böhlke et al., 2005; Sturchio et al., 2006)

There is considerable anecdotal evidence that large quantities of Chilean nitrate fertilizer were imported into Chino Basin in the early 1900s in support of the citrus industry, which covered the northern portion of the basin. Ten groundwater samples were collected throughout the Chino Basin. The sampling points included both private wells and municipal production wells. The samples were collected using a flow-through column containing a highly perchlorate-selective anion-exchange resin. These bifunctional anion-exchange resins (Gu et al., 2001) were originally developed at Oak Ridge National Laboratory and the University of Tennessee to selectively sorb the radioactive pertechnetate ion ⁹⁹TcO₄⁻ (pertechnetate is highly mobile in groundwater, and has a chemical behavior much like perchlorate). The exchange resin concentrates the typically low levels of perchlorate in groundwater so that a sufficient amount can be acquired for the perchlorate to be analyzed isotopically. Preliminary results confirm that most of the perchlorate in the Chino Basin is indeed derived from Chilean nitrate fertilizer.

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