Executive Summary

Perchlorate ion (ClO$_4^-$) has been targeted by the California Department of Health Services as one of the important water quality issues for drinking water supplies. Although the extent of contamination has not yet been determined, contaminated sites have impacted groundwater supplies in Northern and Southern California, and there are many more sites across the U.S. and abroad. A brief review of the available literature indicates an incomplete knowledge of important biogeochemical parameters necessary to understand the fate and transport of perchlorate, which are necessary to assess the risk of exposure at concentrations that may affect human or ecological health, as well as for the development of remediation technologies.

This project is focused on understanding three key biogeochemical processes that determine the fate and transport of perchlorate: (1) sorption via ion exchange in natural and synthetic media, including clays, silty soils and ion exchange media; (2) abiotic transformation of perchlorate under a range of environmental conditions, in particular different pH and redox conditions; and (3) biodegradation of perchlorate under various environmental conditions. Perchlorate is known to be very soluble in water, but may precipitate or form complexes under certain conditions. Work by the Air Force to remediate very concentrated perchlorate solutions indicates that certain bacteria will biodegrade perchlorate, but it is unknown whether either of these processes occurs naturally at a rate that is of relevance to protect groundwater sources. The information generated by the experimental studies proposed will be incorporated into existing fate and transport groundwater models to perform risk assessment as well as the evaluation of remediation strategies.

The research approach is divided into five main tasks:

1. An extensive literature review of perchlorate reactions;
2. Column sorption studies with various soils and ion exchange media, to determine the distribution coefficient, $K_d$, as a function of media properties;
3. Batch experiments of abiotic perchlorate degradation under several pH and redox conditions, with artificial groundwaters and in a soil matrix;
4. Biodegradation studies using different soil/groundwater matrices and pH and redox conditions, to determine the rate of microbial degradation;
5. Determination of kinetic parameters and incorporation of experimental values into a numerical model to evaluate various exposure scenarios.

A doctoral track graduate student will design and implement the experimental methods, with guidance from the Principal Investigator, as well as incorporate the parameter values into an existing numerical model for a subsequent analysis of exposure scenarios. This project will serve as seed money for a future project to evaluate various treatment technologies for perchlorate, in-situ and above ground, as well as validation of the numerical model using field data from known perchlorate sites.

The nature of this research is timely considering the recent discovery of perchlorate in drinking water supplies. This project will produce peer-reviewed manuscripts with the information that scientists and policy makers need to evaluate the risks that perchlorate poses to groundwater supplies, and for the selection of treatment technologies. The experimentally derived parameter values are applicable to any contaminant transport model.

**Key words:** perchlorate, fate and transport, remediation, sorption, biodegradation, kinetics, transformation, risk assessment, modeling, water quality