

**LINKING GEOCHEMICAL AND MICROBIOLOGICAL APPROACHES TO ASSESS NATURAL
ATTENUATION PROCESSES: EXAMPLES FROM 20 YEARS OF RESEARCH IN A CRUDE-
OIL CONTAMINATED AQUIFER NEAR BEMIDJI, MN**

Isabelle Cozzarelli*
U.S.G.S.
431 National Center
Reston, VA 20192
Voice: 703 648-5899
Fax: 703 648-5274
Email: icozzare@usgs.gov

Due to the prevalence of hydrocarbon-contaminated aquifers there has been considerable interest in identifying the processes that control their fate in the subsurface. The study aquifer, near Bemidji, MN, became contaminated when crude oil infiltrated into the surficial aquifer after a pipeline break in 1979. Investigations of the natural processes controlling the fate of the hydrocarbons have evolved over the past 20-years of research at the site. The approaches have ranged from early investigations designed to establish the distribution of the separate oil phase and the resulting plume-scale geochemical impacts to more recent studies designed to identify specific microbial reaction mechanisms within each redox zone. Geochemical investigations have established that the anoxic plume has evolved since the spill, from aerobic to iron-reducing and methanogenic conditions, impacting the transport of hydrocarbons in this system. In order to quantify the biodegradation rates investigators at this site have used a variety of tools to verify and test the field observations including laboratory and *in situ* microcosms and reactive transport modeling. This paper presents an overview of these techniques focusing on how an integrated approach has provided a comprehensive understanding of the hydrocarbon transformation processes in this system.