cis-DCE *trans*-DCE

Figure 2.2. Conformational isomers of 1,2-dichloroethene.

Chlorinated methanes, ethanes and ethenes clearly do not encompass all types of chlorinated solvents that may be encountered at hazardous waste sites. For instance, chlorinated propanes, which possess three carbon atoms joined by single bonds, can represent important groundwater pollutants. Some examples of chlorinated propanes include 1,2-dichloropropane, which is regulated in drinking water by the U.S. Environmental Protection Agency (USEPA) (2003). Another example is 1,2,3-trichloropropane, which has been detected at more than 20 National Priorities List sites identified by the USEPA (ATSDR, 1992). Although such species are not the focus of subsequent portions of this chapter, the physical and chemical principles developed for chlorinated methanes, ethanes and ethenes can easily be extended to include these additional chlorinated solvents.

Although this chapter is devoted to treatment strategies for chlorinated solvents, solvents with other halogen substituents (such as bromine or fluorine) are also frequently encountered in contaminated groundwater. A common example is 1,2-dibromoethane (also known as ethylene dibromide [EDB]), which was used as an additive in leaded gasoline (Baird and Cann, 2005). Methanes, ethanes and ethenes with mixed halogen substituents can represent important environmental pollutants as well, as is the case for common disinfection byproducts bromodichloromethane ($CHBrCl_2$) and dibromochloromethane ($CHBr_2Cl$). When necessary, key differences in the behavior and environmental fate of halogenated solvents with chlorine, bromine and fluorine substituents will be noted.

2.3 PROPERTIES

The behavior of chlorinated solvents in the subsurface is controlled to a large extent by their physical and chemical properties. The properties considered most relevant to chlorinated solvent fate and transport in the subsurface are summarized in Table 2.2. In order to maintain some consistency among the values presented, the majority of the values were obtained from Mackay et al. (1993), one of the very few sources that contain data for all of the chlorinated methanes, ethanes and ethenes. In general, there is reasonable agreement between these values and several other summary tables available (e.g., Pankow and Cherry, 1996; Fetter, 1999; Schwarzenbach et al., 2003; Chapter 1 of this volume). Table 2.2 is provided for purposes of discussion with regards to relevant trends in behavior and properties and is not intended as a set of values selected from a critical review of the literature. For a review of the primary literature, Pankow and Cherry (1996) is recommended because it provides a detailed review of the chlorinated solvent properties discussed herein as well as an excellent discussion of the history of production and industrial uses of chlorinated solvents.

The following discussion of chemical and physical properties is organized around the major processes that impact the fate and transport of chlorinated solvents in the subsurface, starting with the process by which pure phase chlorinated solvents dissolve into groundwater, followed by their partitioning between the three phases present in the subsurface: aquifer solids, water and air. An overview linking these partitioning processes to the relevant chlorinated solvent properties is provided in Figure 2.3. The discussion concludes with an introduction to transformation reactions, which are discussed in greater detail in Chapters 3 and 4.