Case 3. The result will be that some components of the mineral will be taken into solution leaving other components as a solid reaction product. If the solid reaction products form a barrier layer, the rate of reaction will be controlled by diffusion of reactants through the barrier layer. Control by the rate of chemical reaction at the mineral surface will usually produce a linear dependence of concentration on time if the reaction is first order (n = 1 in equation 7.1). Control by diffusion typically produces a square root of time dependence (Fig. 7.3).

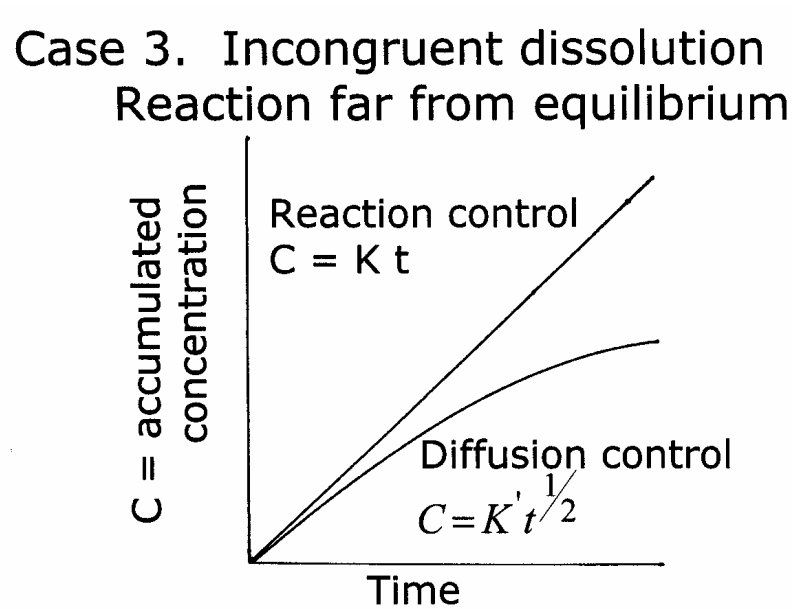


Figure 7.3 Schematic dissolution curves for materials dissolving by chemical reaction with the solvent.

Either of these mechanisms describes the dissolution of a single phase. In a heterogeneous material such a rock or mine spoil, there may be multiple phases, each releasing the same element but dissolving at different rates. The bulk rate curves for heterogeneous mineral assemblages does not lend themselves to easy mathematical analysis.

Alternative approaches to geochemical kinetics are various forms of flow-through experiments. These may be designed so that the material to be dissolved is continuously bathed in fresh solution. In flow-through experiments, the dissolving mineral never reaches equilibrium with the solution. The rate is given by the initial slope of the concentration/time curve and thus is usually the fastest rate. Instead of a continuous flow of solvent, the reaction vessels can be drained at periodic intervals and replaced with fresh solution. The column experiments are a variant of this experimental arrangement.

The materials in ADTI-WP2 leach columns, following an initial flush, undergo a 6-day weathering period as wet rock in contact with a flowing, $CO_2$-containing atmosphere. This is followed by a 1-day soak period in deionized water after which the water is rapidly drained for analysis and a subsequent weathering period begins. The release of leach elements from the test column is, therefore, episodic.