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Chapter 20

Silica Minerals

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Silica (from the Latin *silex,* meaning "flint") refers to silicon dioxide, SiO_2, in its various solid and aqueous forms. The *silica* mineral group is the second most abundant mineral group in the Earth's crust, exceeded only by the *silicate* mineral group, which also has the Si–O tetrahedron as its basic building block. Silica minerals, in contrast to most soil minerals, are produced in both high temperature igneous environments and low temperature aquatic environments. Quartz is the predominant silica mineral and perhaps the most universally recognized of all minerals. Silica minerals occur in some of the oldest and youngest rocks. The oldest fossils on Earth, for instance, are silica pseudomorphs of Precambrian cyanobacteria. Since great antiquity humans have used silica minerals for tools, ranging from flint scrapers in the early Pleistocene to quartz plates in wrist watches in modern times.

Opal is another important member of the silica group, although some opals, especially biogenic opals, are not minerals, technically, because they lack a crystalline structure. Silica minerals and opals enter soil via one of a number of processes involving in situ disintegration of rock, deposition of particles on soil surfaces by air and water, and in situ precipitation from solutions supersaturated with respect to soluble silica ($H_4SiO_4^0$). Silica minerals and opals depart soil as the result of erosion, dissolution, and leaching (Fig. 20–1).

While in soil, because of (i) their great abundance and (ii) chemical quiescence relative to most other minerals, silica minerals influence several environmentally important soil properties. For example, sandy quartz-rich soils are poor filters for septic systems because they have little surface area and ionic charge to adsorb pollutants. Yet, similar soils are good foundations for roads because they do not shrink and swell. This chapter describes the physical and chemical properties of silica, its abundance and formation, and its environmental significance with respect to adsorption capacity, respiratory diseases, and landscape stability pertinent to a nuclear waste repository.

I. STRUCTURE, COMPOSITION, AND MORPHOLOGY

Silica minerals include the SiO_2 polymorphs, quartz varieties, and the opals (Table 20–1). These different forms of silica are the result of various packing

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