



FIGURE 8.7 Model of two crystal layers and an interlayer characteristic of montmorillonite, a smectite expanding-lattice 2:1-type clay mineral. Each layer is made up of an octahedral sheet sandwiched between two tetrahedral sheets with shared apical oxygen ions that hold the sheets together. There is little attraction between oxygen atoms in the bottom tetrahedral sheet of one unit and those in the top tetrahedral sheet of another. This permits a variable space between layers, which is occupied by water and exchangeable cations. The internal surface area thus exposed far exceeds the surface around the outside of the crystal. Note that magnesium has replaced aluminum in some sites of the octahedral sheet. Likewise, some silicon atoms in the tetrahedral sheet may be replaced by aluminum (not shown). These substitutions give rise to a negative charge, which accounts for the high cation exchange capacity of this clay mineral. A ball-and-stick model of the atoms and chemical bonds is at the right.

poles. Therefore, **smectitic soils** are quite undesirable for most construction activities, but are especially well suited for a number of applications that require a high adsorptive capacity and the ability to form seals of very low permeability (see Section 8.15).

VERMICULITE GROUP. **The most common vermiculites are 2:1-type minerals in which the octahedral sheet is aluminum dominated (dioctahedral), but some magnesium dominated (trioctahedral) vermiculites also exist.** The tetrahedral sheets of most vermiculites have considerable substitution of aluminum in the silicon positions, giving rise to most of the very large quantity of negative charge associated with these clays. **The cation exchange capacity of vermiculites usually exceeds that of all other silicate clays including smectites (Table 8.1).**

The interlayer spaces of vermiculites usually contain strongly adsorbed water molecules, Al-hydroxy ions and cations such as magnesium (Figure 8.8). However, these interlayer constituents act primarily as bridges to hold the units together, rather than wedges driving them apart. **The degree of swelling and shrinkage is, therefore, considerably less for vermiculites than for smectites.** For this reason, **vermiculites are considered limited-expansion clays, expanding more than kaolinite, but much less than the smectites.**

Silicate Minerals

The main **nonexpanding 2:1 minerals** are the **fine-grained micas** and the **chlorites**. We will discuss the fine-grained micas first.

These examples of **unweathered micas** typically found