The good news is that you don't have to be an expert crystallographer (or linguist) in order to understand and appreciate the essence and beauty of crystal structure and systems. Here is the main point: all natural crystals come in one of seven forms – eight if you include "amorphous" materials such as glass and amber in the mix.

Recognizing these crystal systems in faceting rough can be a lifesaver when trying to identify gem materials and thereby avoid a scam. For example, if you have ever held a fluted, triangular, cushion-shaped crystal of natural tourmaline, you will always be able to recognize it (Figure 12-32).

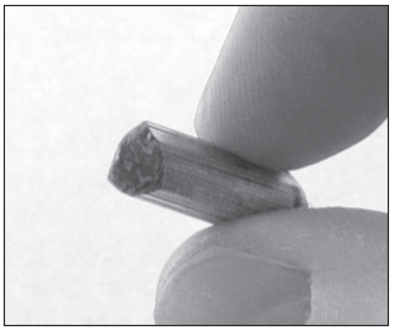

Figure 12-32 A crystal of natural tourmaline. Note the characteristic cushion triangle cross-section and the fluted outer walls of the crystal.

12.10.1 Crystal Systems and Habits

To prevent confusion later on, you should understand an important distinction made by mineralogists, namely the difference between crystal *systems* and crystal *habits*.

The crystal *system* is the underlying structure of the material, in other words, how it is put together at the microscopic level. The forces between separate atoms and molecules allow only a certain number of arrangements of angles between them. The result is a crystal lattice (uh oh…terminology alert) in one of seven possible forms: cubic, tetragonal, hexagonal, trigonal, orthorhombic, monoclinic, and triclinic. Oh yes, and amorphous, if you allow it…

The crystal *habit* is how a macroscopic crystal appears – what it looks like. In many instances, the crystal system expresses itself on these large scales, leading, for example, to the familiar hexagonal prism habit of aquamarine (Figure 12-33). Different conditions during crystal growth can lead to a wide variety of different outcomes (or habits), however. For instance, most sapphire crystals display the classic, tapering, hexagonal crystal habit, but those from Montana frequently appear flatter and tablet-shaped.

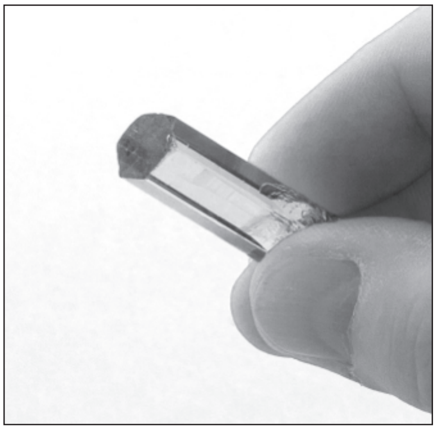

Figure 12-33 Aquamarine, a form of beryl, has characteristic crystals whose habit reflects its underlying hexagonal crystal system.

Mineralogists have come up with a large number of descriptive and occasionally fanciful names to describe crystal habits. These include acicular (needle-like), coxcomb (closely-spaced flaky crystals), drusy (minute crystals coating a surface), enantiomorphic (mirror-image), fibrous (displaying thread-like fibers), micaceous (sheet-like, as in mica), mamillary (rounded partial spheres…think malachite - I know, I know), plumose (feathery), sphenoid (wedge-like), tabular (flattened, tablet-shaped), and a couple of dozen more.

Once again, you don't need to memorize any terminology to understand and appreciate that the inter-atomic forces which create a particular mineral's crystal system can also produce an enchanting variety of crystal habits.

12.10.2 The Seven (or Eight, or Six) Crystal Systems

Right. Enough with the preliminaries. Let's get to the crystal systems themselves. As mentioned above, these systems reflect the underlying form of the crystal structure or lattice. Mineralogists classify these lattices, and hence the systems, in terms of so-called crystallographic axes. You can think of these as axes of symmetry and growth, or more practically, as the lines joining opposite faces or points of a perfect crystal.

For example, Figure 12-34 shows three perfect forms of the **isometric** or **cubic** crystal system. The lines joining opposite faces or points are all of equal length and meet each other at 90°. Examples of isometric gem crystals include fluorite, diamond, and garnet.

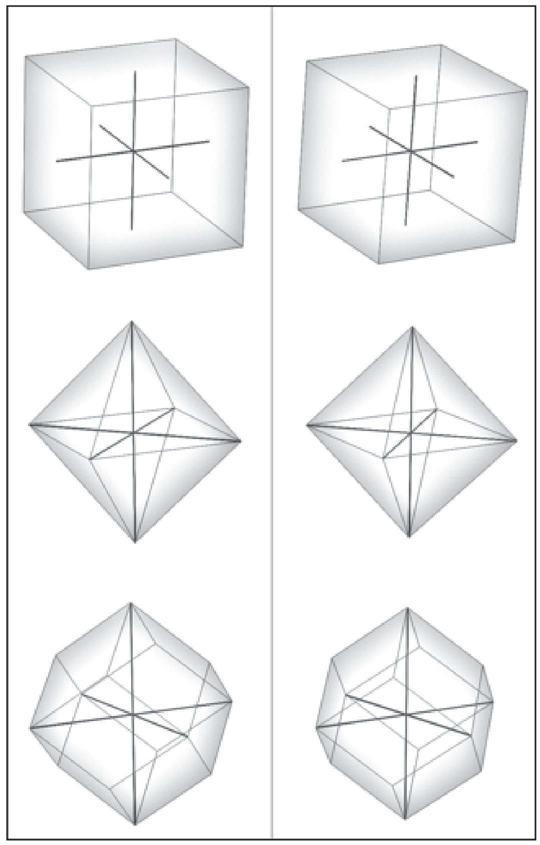

Figure 12-34 Three forms of the isometric or cubic crystal system: the cubic form, as in fluorite (top); the octahedral form of diamond and spinel (middle); and the 12-faced dodecahedron form of garnet (bottom). Note that these are three-dimensional renderings. Cross your eyes to see the effect and refer to Chapter 11.9 for more help on seeing these images in 3D.

If the three crystallographic axes intersect at 90°, but one axis is shorter or longer than the other two, you end up with the **tetragonal** crystal system. This leads to crystal shapes such as elongated rectangular solids and dipyramids (Figure 12-35). Zircon is an example of a gem in the tetragonal crystal system.

In the **orthorhombic** crystal system, the three axes are again at right angles to each other, but each axis is of a different length (Figure 12-36). This leads to shapes such as rhombic prisms and dipyramids. Peridot, topaz, and chrysoberyl form in the orthorhombic crystal system.

The **monoclinic** crystal system also exhibits three crystallographic axes of different length. Two of the axes meet at right angles, while the third is inclined (Figure 12-37). This results in prisms with inclined end faces. Few common gem materials form in this crystal system. Perhaps the best known is kunzite or spodumene. If you have cut this material, you are probably terribly familiar with the effect of large-scale weak interatomic bonds.

The **triclinic** crystal system breaks all the rules. Not only are the three axes of different length, but also none of them meet at right angles (Figure 12-38). This leads to inclined, asymmetric prisms and dipyramids. There are no common gem materials in the triclinic system (apologies to the one kyanite cutter out there…).