ACTIVITY 6 — VOLCANIC HISTORY OF YOUR COMMUNITY

Background Information

Geologists have developed classification schemes for igneous rocks that are based on the chemistry and mineralogy of the rocks. In almost all igneous rocks, the most abundant chemical elements are oxygen (O) and silicon (Si). Several other elements are also abundant in most igneous rocks: iron (Fe), magnesium (Mg), calcium (Ca), sodium (Na), and potassium (K). Geologists keep track of the elements in magmas and igneous rocks by expressing them as oxides. An oxide is a compound that consists of one or more atoms of a given element with one or more oxygen atoms. The major oxides that show the greatest variation in igneous rocks are silica (SiO_2), iron (FeO or Fe_2O_3), magnesium (MgO), calcium (CaO), sodium (Na_2O), and potassium (K_2O).

This practice of expressing igneous rock composition in terms of "oxides", however, is actually just a convenient "bookkeeping" device, because most minerals in igneous rocks are not oxide minerals. In almost all igneous rocks, most of the minerals are silicate minerals. Silicate minerals are those in which very tightly bonded units, called silica tetrahedra, consisting of a silicon atom surrounded by four oxygen atoms in a tetrahedral arrangement, are bonded, less strongly, to atoms of the various other abundant elements listed above. In most of the important silicate minerals the silica tetrahedra are in larger structures, also very tightly bonded, that are formed by sharing of oxygen atoms between adjacent silica tetrahedra. This phenomenon is called polymerization. It is similar to, but not the same as, the polymerization of carbon atoms, with which you may be familiar, and which makes the field or organic chemistry so rich and varied. Silica polymerization make the mineralogy of silicate minerals unusually varied—in fact, almost uniquely so.

Classification of Volcanic Rocks by Oxide Content.

	Basalt	Andesite	Dacite	Rhyolite
SiO_2	48-52	52-63	63-68	>68
FeO	10-12	7	5	2.5
MgO	10-16	3	2	~1
CaO	9.5	4.9	4.3	1.2
Na_2O	3	3.5	3.8	3.5
K_2O	1	1.5	2.2	4.3

All numbers are in weight percent.

When geologists made chemical analysis of volcanic rocks of all kinds from around the world, they found that the silica (SiO_2) content varies by as much as 40 weight percent, although as shown by the table above, the variation in silica content among the most common volcanic rocks is about 25 weight percent. Because of this large variation in the most common chemical component of the rocks, silica content can be used to characterize or classify igneous rocks. A simple classification scheme based on silica content is shown in the table above. This table also shows the abundance of the other major oxides. The weight-percent abundance of the other oxides is not nearly as great as that of silica, although the variation of two of them, FeO and MgO, is even greater than that of silica, when expressed as ratios of abundance rather than simple differences.

(To see this, form ratios of highest to lowest weight percentages for each of the oxides in the table above. Which ratio is by far the largest? That of MgO, ~ 16:1.)

The official classification of igneous rocks, agreed upon by convention and in use for many years, is based in large part on kinds and abundance of the major silicate minerals, and is much more intricate than the one presented in the table above. The simplified classification based on silica content is useful, however, because it captures the mainstream of variation in igneous rock composition. The *EarthComm* web site also contains a variety of links to web sites that will help you deepen your understanding of content and prepare you to teach this activity.