**Chemistry From Antiquity:Rocks**

The spirit of chemistry has existed from the earliest civilizations. Humans observed that the world in which we live is composed of a very large number of different things. One approach to this diversity is to organize it. This is the programme of Natural History. Each thing is named and “similar” things are grouped into an overall plan. Every chemist today needs to learn to observe and discriminate. Observable properties are used to discriminate between similar things.

Consider the class of natural objects that are commonly called **rocks**. Rocks are “hard.” There is a modern scale of hardness for rocks called the Mohs scale. A commercial kit can be purchased with standard samples of specific hardness, from 1-9. Diamond is scaled as 10, but not usually included in simple kits.

Mohs Hardness Kit: 1=talc, 2=gypsum, 3=calcite, 4=fluorite, 5=apatite, 6=orthoclase, 7=quartz, 8=topaz and 9=corundum. An unknown sample can be “scratched” by the test sample just harder than itself.

Another obvious difference between the samples in the Mohs kit is color. Rocks can be sorted by color. But, most rocks in nature are not a pure mineral and they appear inhomogeneous. Even so, multicolored rocks can be beautiful and the appearance can be used to identify the natural mineral. A nice example is chalcopyrite.

Solids are also characterized by their mass density. While a little more work is necessary to both measure the mass and the volume of the rock, this physical property is very useful in discriminating between different materials. The mass density of a sampling of minerals is:

Table 2.1 Densities of rocks and minerals. P.V. Sharma, 1997, pg17.

| Rock type or mineral | Density (wet) ($\times 10^3$ kg/m$^3$) |
|---|---|
| Sand | 1.6–2 |
| Moraine | 1.5–2 |
| Sandstones (Mesozoic) | 2.15–2.4 |
| Sandstones (Paleozoic and older) | 2.35–2.65 |
| Quartzite | 2.60–2.70 |
| Limestone (compact) | 2.5–2.75 |
| Shales (younger) | 2.1–2.6 (2.4)* |
| Shales (older) | 2.65–2.75 (2.7) |
| Gneiss | 2.6–2.9 (2.7) |
| Basalt | 2.7–3.3 (2.98) |
| Diabase | 2.8–3.1 (2.96) |
| Serpentinite | 2.5–2.7 (2.6) |
| Gypsum | 2.3 |
| Anhydrite | 2.9 |
| Rocksalt | 2.1–2.4 (2.2) |
| Zincblende | 4.0 |
| Chromite | 4.5–4.8 |
| Pyrite | 4.9–5.2 |
| Hematite | 5.1 |
| Magnetite | 4.9–5.2 (5.1) |
| Galena | 7.4–7.6 |
| Granite | 2.52–2.81 (2.67) |
| Granodiorite | 2.67–2.79 (2.72) |
| Syenite | 2.63–2.90 (2.76) |
| Quartzdiorite | 2.68–2.96 (2.81) |
| Gabbro | 2.85–3.12 (2.98) |
| Peridotite | 3.15–3.28 (3.23) |
| Dunite | 3.20–3.31 (3.28) |
| Eclogite | 3.34–3.45 (3.39) |

Note:
*Figures in parentheses are taken to be average values.

Why do you suppose Galena is so "heavy?" (PbS).

Rocks can also be divided into crystals, which can have a definite shape, and glasses, which can have any shape. Crystals can be cleaved along preferred axes and the angles measured with a Wollaston goniometer. Glasses shatter into irregular pieces, but can be carefully crafted into sharp arrow heads. Calcite ($CaCO_3$) is a good example of a material that can form very perfect crystals.

Obsidian is a naturally occurring volcanic glass.

While macroscopically observable properties were helpful in the early classification of rocks into distinct mineral classes, no real progress in understanding minerals occurred until it was realized that they were composed of microscopically observable atoms of different elements. While macroscopic measurements remain important for chemistry, deeper understanding can be gained by considering the atomic structure of minerals.