

2.3 Minerals

Rock-forming minerals can be defined as naturally-occurring, inorganic, crystalline substances with a definite small range in chemical composition and physical properties. In some cases composition can be expressed by a simple chemical formula such as quartz (SiO_2), calcite (CaCO_3), and magnetite (Fe_2O_3). However, with most minerals, the formula is complex, because of isomorphic ionic substitution and alteration. Minerals may be classified into **primary minerals**, which occur in bulk in igneous and metamorphic rocks and remain unaltered in mature soil, and **secondary minerals**, which are formed from other minerals or synthesized during the weathering of primary minerals. Primary minerals may be divided into those primary minerals which comprise the bulk of rocks, and accessory minerals, which make up only a minor part of rocks. Although about 2000 minerals have been identified, only 20 are common, and fewer than 10 of them form well over 90% of all rocks, as shown in Table 2.2.

Table 2.2 Relative abundance of minerals in the earth's outer crust, consisting of exposed rocks and soil

Name of mineral (group)	Percent
Plagioclase	39
Orthoclase	12
Quartz	12
Pyroxene (augite)	11
Amphibole (hornblende)	5
Mica	5
Clay minerals (in soil, sedimentary, and metamorphic rocks)	4.6
Olivine	3
Other minerals (mainly non-silicates)	8.4

Source: Foster (1978:36).

Modern techniques of mineral identification are discussed in Chapter 3 on mineralogy, however the physical properties of minerals used for identification are described here briefly.

2.3.1 Physical properties of minerals

The hardness of a mineral is defined as its resistance to scratching. Hardness depends on the strength of the atomic bonds. It is a difficult property to measure absolutely, but the Mohs hardness scale is used to evaluate the relative hardness of minerals in increasing order as follows:

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|-------------------|-----------------------|
| 1. Talc (softest) | 6. Feldspar |
| 2. Gypsum | 7. Quartz |
| 3. Calcite | 8. Topaz |
| 4. Fluorite | 9. Corundum |
| 5. Apatite | 10. Diamond (hardest) |

Any mineral in the hardness scale will scratch the minerals below it; that is, diamond will scratch all the other nine minerals. Some materials useful in testing hardness and their Mohs scale values are: fingernail 2.5, copper coin 3–4, window glass 5.5, knife blade 6, and steel file 6.5.

Colour may be green, white, colourless, or grey etc. **Streak** is the colour of the line of mineral powder formed when the sample is scratched by rubbing it against a hard object such as unglazed porcelain. **Streak colour** may be different from mineral colour. **Lustre** is the appearance of a freshly broken surface when seen in reflected light (metallic or nonmetallic: vitreous, greasy, pearly, dull, earthy). **Specific gravity** is the ratio of the mass of mineral to the mass of an equal volume of water. It can be calculated as follows:

$$\text{Specific gravity} = \frac{\text{Weight in air}}{\text{Weight in air} - \text{weight in water}}$$

Cleavage is breaking along defined planes. **Fracture** is breaking along irregular fracture lines.

Some physical properties of major rock-forming minerals are summarized in Table 2.3.

Table 2.3 Physical properties of some common rock-forming minerals

Mineral	Colour	Hardness (Mohs scale)	Lustre	Specific gravity	Fracture	Structure/ shape
Quartz	Any	7	Vitreous	2.55	No cleavage, conchoidal fracture	Hexagonal