

Identifying Rocks and Minerals

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1 Introduction

The purpose of this book is to help you identify some of the more common rocks and minerals, such as quartz, slate, and granite. I hope that when I finish you will be able to identify some of these rocks without being assisted by others.

2 Differences Between Rocks and Minerals

2.1 What's the difference between rocks and minerals?

A mineral is a naturally occurring, inorganic solid with a definite chemical composition and a crystalline structure formed by geological processes. A rock is an aggregate of one or more minerals whereas a rock may also include organic remains and mineraloids. Some rocks are predominantly composed of just one mineral. For example, limestone is a sedimentary rock composed almost entirely of the mineral calcite. Other rocks contain many minerals, and the specific minerals in a rock can vary widely. Some minerals, like quartz, mica or feldspar are common, while others have been found in only one or two locations worldwide.

3 Types of Rocks

There are three different types of rocks: Igneous, Sedimentary, and Metamorphic. The difference between each type is in how they are formed.

3.0.1 Igneous rocks

Igneous rocks have many distinct characteristics. For example, light-colored igneous rocks are more acidic, and have over 65% silica. Dark-colored rocks are more basic and have a higher percentage of ferro-magnesian minerals. Igneous rocks are broken up in to three main groups: acid, intermediate, and basic. Acid rocks have over 65% silica, intermediate rocks have 55-65% silica, and basic rocks have 45-55% silica.

Igneous rock forms when magma (molten rock) cools and solidifies. Extrusive igneous rocks are those formed when magma reaches the surface (at which point it is called lava), cooling and solidifying quickly. Intrusive igneous rocks are formed when magma slowly cools deep below the surface of the earth. Different sized grains form, depending on the conditions of the rock formation. Intrusive rocks are generally more coarse-grained than extrusive. Coarse grains are more than 3/16 of an inch; medium grains, 1/64-3/16; and fine grains, less than 1/64 of an inch. Granite, Rhyolite, Obsidian, Diorite, Felsite, Basalt, and Pumice are all examples of igneous rocks. All these characteristics are key in identifying igneous rocks.



Figure 1 Granite

3.0.2 Sedimentary rocks

Sedimentary rock forms when layers of sand and pebbles are compressed enough to form rock. Fossils are mainly found in sedimentary rock, specifically limestone because limestone is formed in warm, shallow seas and organisms and shells get fossilized at the bottom. There are three different grain sizes in sedimentary rock. Coarse which you can see with the naked eye. Medium which you can see with a hand lens, and fine which you can see with a microscope.

Sedimentary rocks are split into three different categories. Chemical, detrital and biogenic. Chemical refers to rocks containing minerals produced by chemical precipitation. Detrital refers to rocks which contain particles from preexisting rocks. While biogenic rocks contain fossil and shell fragments. Sandstone, Shale, Limestone, and conglomerate are all examples of sedimentary rocks. Igneous and sedimentary rocks are largely prevalent in the world



Figure 2 Sandstone



Figure 3 Shale



Figure 4 Limestone

3.0.3 Metamorphic rocks

Metamorphic rocks form when rocks are subjected to heat and pressure, but not to the point of melting. Depending on whether it was formed under just heat or heat and pressure the orientation of the crystals will be different. Contact metamorphic rocks are formed in just heat and crystals are randomly arranged.

Regional metamorphic rocks are formed in both heat and pressure, and have crystals that are aligned. The greater the pressure and temperature these rocks are exposed to the larger the grains. Medium to high grade metamorphic rocks occurs at a minimum temperature of 480 degrees f and a maximum temperature of 1,472 degrees f but can be much lower. Some examples of metamorphic rocks are Slate, Marble, and Granulite.



Figure 5 Slate



Figure 6 Marble

4 Hardness

The Mohs scale of mineral hardness characterizes the scratch resistance of various minerals through the ability of a harder material to scratch a softer material. It was created in 1812 by the German mineralogist Friedrich Mohs and is one of several definitions of hardness in materials science.

Mohs based the scale on ten minerals that are all readily available. As the hardest known naturally occurring substance, diamond is at the top of the scale. The hardness of a material is measured against the scale by finding the hardest material that the given material can scratch, and/or the softest material that can scratch the given material. For example, if some material is scratched by apatite but not by fluorite, its hardness on the Mohs scale is 4.5.

The Mohs scale is a purely ordinal scale. For example, corundum (9) is twice as hard as topaz (8), but diamond (10) is almost four times as hard as corundum. The table below shows comparison with absolute hardness measured by a sclerometer.

Hardness	Mineral
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase Feldspar
7	Quartz
8	Topaz
9	Corundum
10	Diamond

On the Mohs scale, fingernail has hardness 2.5; copper penny, about 3.5; a knife blade, 5.5; window glass, 6.5; steel file, 6.5. Using these ordinary materials of known hardness can be a simple way to approximate the position of a mineral on the scale.

Some mnemonics traditionally taught to geology students to remember this table are "The Girls Can Flirt And Other Queer Things Can Do" or "To Get Candy From Aunt Fanny, Quit Teasing Cousin Danny". Another Mnemonic is "Two Gypsies Called Flo And Fred Queued To Cut Diamonds."

An alternative table is shown below which has been modified to incorporate additional substances that may fall in between two levels.

Source: American Federation of Mineralogical Societies: Mohs Scale of Mineral Hardness

Hardness

Hardness	Substance or Mineral
1	Talc
2	Gypsum
2.5 to 3	pure Gold, Silver
3	Calcite, Copper penny
4	Fluorite
4 to 4.5	Platinum
4 to 5	Iron
5	Apatite
6	Orthoclase
6.5	Iron pyrite
6 to 7	Glass, Vitreous pure silica
7	Quartz
7 to 7.5	Garnet
7 to 8	Hardened steel
8	Topaz
9	Corundum
10	Diamond
11.1	Aggregated diamond nanorods
15.8	Lonsdaleite

To test the hardness of a specimen take it and try to scratch it with the first rock in your hardness kit, Talc. If it is scratched then the rock you're testing is hardness 1. If not then try to scratch the Talc with your rock. If the rock scratches the Talc then it is harder than the Talc. You should now repeat this process with the next rock in your hardness kit, Gypsum. Continue until you find a rock that scratches the specimen you're testing. The hardness of the rock that scratches your specimen is the hardness of your specimen.

5 Cleavage



Figure 7 Green fluorite with prominent cleavage.

Cleavage , in mineralogy, is the tendency of crystalline materials to split along definite crystallographic¹ structural planes. These planes of relative weakness are a result of the regular locations of atoms and ions in the crystal, which create smooth repeating surfaces that are visible both in the microscope and to the naked eye.²

1 <http://en.wikibooks.org/wiki/Crystallography>

2 * Hurlbut, Cornelius S.; Klein, Cornelis, 1985, *Manual of Mineralogy* , 20th ed., Wiley, ISBN 0-471-80580-7

5.0.4 Types of cleavage

Cleavage forms parallel to crystallographic planes:³



Figure 8 Biotite with basal cleavage.

- Basal or pinacoidal cleavage occurs parallel to the base of a crystal. This orientation is given by the $\{001\}$ plane in the crystal lattice (see the Miller indexes page in Wikipedia), and is the same as the $\{0001\}$ plane in Bravais-Miller indexes, which are often used for

³ * Hurlbut, Cornelius S.; Klein, Cornelis, 1985, *Manual of Mineralogy*, 20th ed., Wiley, ISBN 0-471-80580-7

rhombohedral and hexagonal crystals. Basal cleavage is exhibited by the mica group and by graphite.

- Cubic cleavage occurs on the $\{001\}$ planes, parallel to the faces of a cube for a crystal with cubic symmetry. This is the source of the cubic shape seen in crystals of ground table salt, the mineral halite. The mineral galena also typically exhibits perfect cubic cleavage.
- Octahedral cleavage occurs on the $\{111\}$ crystal planes, forming octahedron shapes for a crystal with cubic symmetry. Diamond and fluorite exhibit perfect octahedral cleavage. Octahedral cleavage is seen in common semiconductors. For lower-symmetry crystals, there will be a smaller number of $\{111\}$ planes.
- Dodecahedral cleavage occurs on the $\{110\}$ crystal planes forming dodecahedra for a crystal with cubic symmetry. For lower-symmetry crystals, there will be a smaller number of $\{110\}$ planes.
- Rhombohedral cleavage occur parallel to the $\{10\bar{1}1\}$ faces of a rhombohedron. Calcite and other carbonate minerals exhibit perfect rhombohedral cleavage.
- Prismatic cleavage is cleavage parallel to a vertical prism $\{110\}$. Cerussite, tremolite and spodumene exhibit prismatic cleavage.

5.0.5 Parting

Crystal parting occurs when minerals break along planes of structural weakness due to external stress or along twin composition planes. Parting breaks are very similar in appearance to cleavage, but only occur due to stress. Examples include magnetite which shows octahedral parting, the rhombohedral parting of corundum and basal parting in pyroxenes.⁴

5.0.6 Uses

Cleavage is a traditional physical property used in mineral identification both in hand specimen and microscopic examination of rock and mineral studies. As an example, the angles between the prismatic cleavage planes for the pyroxenes ($88\text{-}92^\circ$) and the amphiboles ($56\text{-}124^\circ$) are diagnostic.⁵

Crystal cleavage is of technical importance in the electronics industry and in the cutting of gemstones.

Precious stones are generally cleaved by impact as in diamond cutting.

Synthetic single crystals of semiconductor materials are generally sold as thin wafers which are much easier to cleave. Simply pressing a silicon wafer against a soft surface and scratching its edge with a diamond scribe is usually enough to cause cleavage; however, when dicing a wafer to form chips, a procedure of scoring and breaking is often followed for greater control. Elemental semiconductors (Si, germanium, and diamond) are diamond cubic, a space

4 * Hurlbut, Cornelius S.; Klein, Cornelis, 1985, *Manual of Mineralogy*, 20th ed., Wiley, ISBN 0-471-80580-7

5 * Hurlbut, Cornelius S.; Klein, Cornelis, 1985, *Manual of Mineralogy*, 20th ed., Wiley, ISBN 0-471-80580-7

group for which octahedral cleavage is observed. This means that some orientations of wafer allow near-perfect rectangles to be cleaved. Most other commercial semiconductors (GaAs, InSb, etc.) can be made in the related zinc blende structure, with similar cleavage planes.

5.1 References

- Mineral galleries: Mineral properties - Cleavage⁶

⁶ <http://mineral.galleries.com/minerals/property/cleavage.htm>

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