Some Experiences in Teaching Rock-making Minerals

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Abstract: There is a lot of knowledge about petrogenic minerals. When students study the mineral knowledge, they feel difficult to master it. I have explored for many years and found that teaching mineral knowledge in a hierarchical way is effective. First the mineral definition is taught. Second the physical properties of mineral are taught, such as mineral morphology, color, striation, luster, transparency, hardness, cleavage and so on. Finally several typical minerals are taught, such as pyrite, quartz, hematite, limonite, calcite, dolomite, gypsum and so on. This kind of propulsive teaching method is interlinked with each other, and the students have a good grasp of mineral knowledge.

1. Introduction

Rock-forming mineral is an important part of engineering geology course, the starting point of engineering geology course, and the foundation of subsequent knowledge of rock and geological structure. The knowledge of rock - forming minerals focuses on concepts, so it is difficult for students to master it. I have explored for many years and found that teaching mineral knowledge in a hierarchical way is effective. First the mineral definition is taught. Second the physical properties of mineral are taught, such as mineral morphology, color, striation, luster, transparency, hardness, cleavage and so on. Finally several typical minerals are taught, such as pyrite, quartz, calcite, dolomite, gypsum and so on. This kind of propulsive teaching method is interlinked with each other, and the students have a good grasp of mineral knowledge. My teaching experience can be your reference.

2. Teaching the definition of minerals and the physical properties of minerals

2.1 Teaching the definition of mineral

I give students the first emphasis on the definition of minerals, so that students can be clear about the extension and connotation of minerals. Minerals are naturally formed in the earth's crust. They are natural elements or compounds with certain chemical composition and physical properties. They are usually homogeneous solids formed by inorganic action.

2.2 Teaching the physical properties of minerals

The physical properties of minerals are the key and difficult point of petrogenic minerals. After the definition of minerals is made clear, students are taught about the physical properties of minerals. The physical properties of minerals include morphology, color, striations, luster, transparency, hardness, cleavage, and fracture [1].

The first is morphology of minerals. Most minerals are crystals with specific crystal structures. Mineral morphology is divided into monomer morphology and aggregate morphology. When the growth conditions are right, the formation of a single crystal of the same mineral has a certain geometric shape which is monomer form, such as mica flake monomer, scale chlorite monomer, platy plagioclase monomer, columnar amphibole monomer, cubic galena monomer, rhombohedral calcite monomer, rhomboid dodecahedral garnet monomer and so on. Because of the limited growth space, mineral crystals are often squeezed together to form an aggregate morphology, such as acicular rutile aggregate, sheet hematite aggregate, fibrous gypsum aggregate, granular arsenite aggregate, pea hematite aggregate, renal hematite aggregate, coxcomb pyrite aggregate, petal-shaped gypsum aggregate, sheaf zeolite aggregate, quartz cluster aggregate and so on [2].

The second is color. Minerals come in many colors, depending on their chemical composition and internal structure. According to the origin the color is divided into idiochromatic color, allochromatic color and parti-color. The idiochromatic color is the natural color of the mineral formed by its chemical composition and crystal structure, such as golden of gold, helvolus of chalcopyrite, emerald of malachite and so on. The allochromatic color is the color of minerals mixed with certain impurities. For example the pure quartz is colorless and transparent, but it is a smoky gray color when it contains carbon particles, a purple color when it contains manganese, and a rose color when it contains iron oxide. The parti-color is the color formed by the refraction and scattering of light by the oxide film inside the mineral or on the surface, for example a common rainbow on the cleavage plane of calcite.

The third is striation. The striation is the color of mineral powders. Mineral is usually characterized on unglazed porcelain plates for observation of its striation used to identify minerals. For example hematite can be red, iron black or steel gray, but its striation is always fuchsia; the striation of gold is golden [3].

The fourth is luster. The luster is the ability of mineral surfaces to reflect visible light. The luster is usually divided by the ability to reflect light into metallic luster, semi-metallic luster, diamond luster, glass luster, grease luster, silk luster, pearl luster and earthy luster. Firstly, metallic luster is highly reflective, such as it of galena and pyrite. Secondly, the semi-metallic luster reflects light relatively strong, such as magnetite luster. Thirdly, the diamond luster reflects light relatively strong, like the luster of diamond. Fourthly, the glass luster reflects light relatively weakly like a reflection from a glass surface. Fifthly, the grease luster like the reflection of grease is more common in light minerals such as the quartz fracture in the reflection. Sixthly, the silk luster like silk reflection is more common in fibrous aggregate minerals, such as the luster of the asbestos. Seventhly, the pearl luster is like pearl reflection such as reflection of mica. Finally, the earthy luster is dull as a clod such as the reflection of kaolinite.

The fifth is transparency. The transparency refers to the extent to which visible light is transmitted. Minerals are divided into transparent minerals, translucent minerals and opaque minerals according to transparency. Most metallic and semi-metallic luster minerals are opaque minerals; the glassy minerals are transparent minerals, such as quartz crystals and calcite; the minerals in between are translucent minerals, such as quartz and talc.

The sixth is hardness which is the strength of resistance to mechanical forces. Mohs hardness is usually used and ten minerals are selected as the standard, which are talc, gypsum, calcite, fluorite, apatite, orthoclase, quartz, topaz, corundum, diamond.

The seventh is cleavage, the inherent property of cracking along a certain crystal plane under external force. According to the degree of completeness of the cleavage plane, the cleavage can be divided into four levels, polar complete cleavage, complete cleavage, medium cleavage and incomplete cleavage. Firstly, the polar cleavage refers to the fact that minerals are easily split into thin slices and the cleavage surface is large, complete and smooth, such as mica cleavage. Secondly, the complete cleavage refers to the fact that the cleavage plane is often split into blocks and plates, and the cleavage plane is flat and bright, such as calcite and salt cleavage. Thirdly, the medium cleavage refers to the fact two groups of discontinuous and uneven cleavage planes in two directions appear, such as feldspar and amphibole cleavage. Fourthly, the incomplete cleavage means that it is difficult to have a complete cleavage plane, such as olivine cleavage.

The eighth is fracture. The fracture surface of a mineral without cleavage, which produces irregular fracture in any direction after hammer strike, is called fracture. The common fractures are the conchoidal fracture of quartz and the flat fracture of serpentine [4].

3. Teaching the definition of minerals and the physical properties of minerals

The physical properties of minerals are more abstract. By teaching a variety of real minerals, students will be able to further master the physical properties of minerals. There are only a few dozen types of petrogenic minerals, most of which are silicates and the rest are oxides, sulfides, halides, carbonates and sulfates, such as pyrite, quartz, calcite, dolomite, gypsum, olivine, pyroxene, hornblende, muscovite and so on.

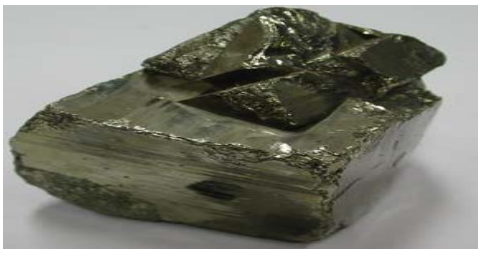

Figure 1. Pyrite

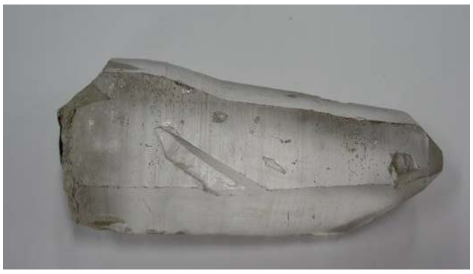

Figure 2. Quartz

The first is pyrite, as shown in figure 1. The pyrite is mostly a massive aggregate, some of which are developed into cubic single crystal, and there are often parallel fine and dense lines on the crystal face of the cube. The color is light copper yellow and the stripes are green and black. The hardness is 6 to 6.5. It is metallic luster, with jagged fracture. The relative density is 5.

The second is quartz, as shown in figure 2. They often develop into single crystals and form families, or dense or granular aggregates. Pure quartz is colorless and transparent, called crystal. The milky white quartz containing fine dispersed gaseous or liquid matter is called milky quartz. Quartz crystal surface is glass luster, and fracture is grease luster. The hardness is 7. Quartz without cleavage and with conchoidal fracture, its relative density is 2.65.

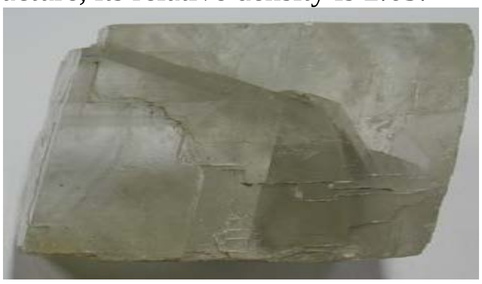

Figure 3. Calcite

Figure 4. Dolomite

The third is calcite, as shown in figure 3. The calcite often develops into single crystals or families of crystals with the morphology of granular, massive, fibrous, or stalactitic aggregates. The pure calcite is colorless and transparent; due to impurity infiltration, calcite is white, gray, yellow and so on. The calcite has glassy luster and perfect cleavage. Hardness is 3. Relative density is 2.72.

The fourth is dolomite, as shown in figure 4. The dolomite is usually a massive or granular aggregate, the single crystal of which is rhombohedral. The color is generally white, and brown with iron. The dolomite has glassy luster and perfect cleavage. Hardness is 3.5 to 4. The relative density is 2.85 to 3.1, which increases with the increase of iron content.

Figure 5. Gypsum

Figure 6. Olivine

The fifth is gypsum, as shown in figure 5. The single crystal of gypsum is usually platy, and aggregate of it is massive, granular and fibrous. The color is colorless or white, and sometimes transparent. It has glassy luster except fibrous gypsum with silk luster. Hardness is 2. It has extremely complete cleavage and is easy to split into thin flexible sections along the cleavage surface. The relative density is 2.30 to 2.37.

The sixth is olivine, as shown in figure 6. The aggregate of olivine is granular. The color is pale yellowish green to olive green, deepening with iron content. It has glassy luster. Hardness is 6 to 7. It has incomplete cleavage. The relative density is 2.30 to 4.4, deepening with iron content.

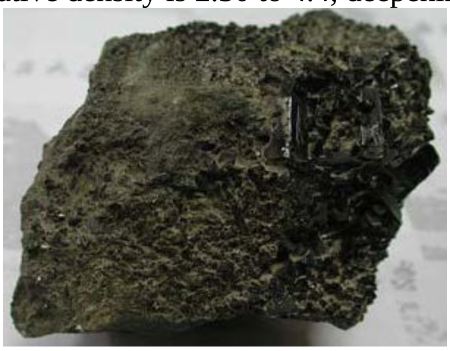

Figure 7. Pyroxene

Figure 8. Hornblende

Figure 9. Muscovite

The seventh is pyroxene, as shown in figure 7. The single crystal is short columnar and the aggregate is granular. The color is green or black. It has glassy luster. The hardness is 5.5 to 6. It has two sets of cleavage with parallel cylinders. The relative density is 3.2 to 4.4.

The eighth is hornblende, as shown in figure 8. The single crystal of it is long columnar and needle-like. The color is green or black. The hardness is 5 to 6. There are two sets of cleavage of parallel cylinders, whose intersection angle is 124^{o}. The relative density is 3.02 to 3.45, deepening with iron content.

The ninth is hornblende, as shown in figure 9. Muscovite single crystal is short columnar or plate - like, whose cross - section is often hexagonal. The aggregate of Muscovite is scaly. It has schistose complete cleavage. Muscovite flakes are colorless and transparent. It has pearly luster. The hardness is 2.5 to 3. The relative density is 2.77 to 2.88 [5].

4. Summary

This kind of propulsive teaching method is interlinked with each other. The Students fully recognize that the teacher's description of mineral knowledge is simple, focused and enlightening. Therefore, the students have a high attendance rate and have a good grasp of mineral knowledge. I hope that my teaching experience can be your reference.

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