Low Grade Metamorphism

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Metamorphic Rocks

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6.5.1 Schists of Low-Grade Metamorphism

Regional low-grade metamorphism takes place with a small increase in temperature (above 200 °C) at significantly increased directional pressure. The directed pressure or stress, as opposed to hydrostatic pressure, operates only in one direction. This type of high pressure under regional metamorphism affects recrystallization of mineral constituents of rocks resulting in the formation of new plate, e.g. leaf-like and elongated minerals. The longest surface of the new minerals is oriented perpendicular to the direction of pressure (Figs 6.2 and 6.3). Such orientation of minerals or *schistosity* is the significant feature of schist of low-grade metamorphism, and their slips and stick form is the basic feature of lepidoblastic and nematoblastic structure.

Typical low-grade metamorphic minerals are albite, muscovite, chlorite, actinolite and talc. The main and most widely spread metamorphic rocks from the group of low-grade schist metamorphism are argillaceous rocks namely slate, phyllites and schists as shown in Table 6.1.

Slate is an extremely dense, fine-grained metamorphic rock form under low-grade regional metamorphism emerged from pelitic sedimentary rocks such as shales and fine-grained tuffs (Table 6.1). The level of precrystallization of primary minerals witness very weak changes under the increase of only directed pressure and low temperature. These metamorphic rocks largely retain the primary mineral composition and structure of the original rocks, except a smaller or larger part of typical clay minerals, partially or fully recrystallized as illite, sericite and chlorite. Slate is characterized by an excellent flat schistosity, which is usually difficult to differentiate from sheet pelitic sedimentary rocks, due to the flat surfaces of schistosity split into sheets or thin plates. This structure is caused by parallel orientation of microscopic tiny leaves of illite and chlorite. The essential mineral ingredients of slate are cryptocrystalline quartz, feldspar (albite), chlorite, calcite and illite, and organic matter. These unique properties enable it useful for roofing, inner walls and as small board (slate) for small school children in the class room in the olden times.

The pelite sediments (claystone, mudstone and shale) turn into slate passing through rocks from the transitional stage between the diagenetic changes and the lowest degree of metamorphism. Such rock may be called as argillite. The slate contains a higher proportion of uncrystallized clay minerals, and instead of schistosity shows sheet or thin horizontal lamination, unlike argillite.

Phyllite is foliated metamorphic rock rich in tiny sheets of sericite mica. It presents gradation in degree of metamorphism ranging between slate and mica schist. The color varies between black and gray to greenish gray. Phyllite forms from pelitic sediments (shale and mudstone) at slightly higher degree of regional metamorphism from slate (Table 6.1). It may also result from finely grained tuffs and clayey tuffite. Phyllites have excellent fissility with tiny sheets showing thin schistosity due to the high content of mica and chlorite. The schistosity surfaces display silvery shine. The essential mineral ingredients of phyllites are microcrystalline quartz, fine-grained micas (sericite and muscovite) and chlorite. The quartz is usually in the form of elongated thin lenses or veins within the sheets, which contain mainly fine-grained mica and chlorite. Phyllites no longer include clay minerals, unlike slate, because of higher level of metamorphism and fully recrystallized into a fine-grained mica and chlorite.

Sericite schist is a variety of fine-sheet phyllites in transition to mica schist. It consists mainly of sericite ± quartz, i.e. clusters of very small slips of illite, muscovite and other mica that cannot be accurately determined by petrographic microscope (see sericite, Section 2.5.8.5.2). Sericite schist exhibits shining silver, gray, brown color with excellent fissility.

Green schists and *chlorite schists* are fine-grained to medium-crystalline schist of low-grade metamorphism resulting from basic igneous rocks at relatively low temperature and pressure (Figs 6.6 and 6.9). Some green schist may also occur in progressive regional low-grade metamorphism of calcite-rich pelitic sediments. Green schists are named after their characteristic green color, caused by the high content of green minerals like chlorite, epidote, actinolite and zoisite. In addition to these minerals, it includes quartz, acid plagioclase, tremolite, calcite, dolomite, magnesite and hornblende.

Glaucophane schists are formed in a regional low-grade metamorphism of basalt, diabase, feldspar arenite, graywacke sandstone and marl sediments at relatively low temperatures and high directed pressure (Fig. 6.9). The glaucophane schist includes a high content of Na-amphibole (glaucophane) associated with albite, epidote, garnets, mica, quartz and calcite.

Talc schist originates in regional low-grade metamorphism by transformation of ultrabasic igneous intrusive magmatic rocks (peridotite, dunite, and olivine gabbro) and also serpentinite that occurs by hydrothermal metamorphism from olivine-rich ultrabasic rock. They consist of Mg-silicate (talc, antigorite, and chlorite), actinolite, magnesite, calcite and dolomite. The talk is usually in the form of thin lenses or zones along the surface of schistosity. The calcite, magnesite and dolomite exist as irregular masses or veins.