The Earth's crust consists almost entirely of igneous, sedimentary, and metamorphic rocks (a fourth component, extremely small by volume, consists of meteorites and associated material of non-terrestrial origin). This chapter deals exclusively with metamorphic rocks. The nomenclature of igneous and sedimentary rocks is dealt with in chapters 2.8 and 2.9, respectively, of this Handbook.

Rocks with characteristics that have changed considerably (particularly in the form of disappearance or change of some of the minerals, in combination with the formation of new minerals) after being exposed to high temperature or pressure, or both, are called metamorphic rocks. Crystallization of new minerals is characteristic of metamorphism, and – after exposure to high pressure – plate-shaped minerals are commonly (re)oriented perpendicular to the main stress direction.

Metamorphic rocks can be derived from igneous or sedimentary rocks. In the former case, they are commonly called orthometamorphic rocks; in the latter case, parametamorphic rocks. It is, however, not always possible to recognize the igneous or sedimentary origin of a metamorphic rock. The prefixes ‘ortho’ and ‘para’ are also commonly used to indicate the parent material of specific metamorphic rock types. Metamorphic rocks may also undergo new phases of metamorphism but there is no prefix to indicate this (repeated) process.

As stated in the introduction to rock nomenclature (the chapter on igneous rocks, 2.8), classification of rocks into types and subtypes is in many cases arbitrary, since no commonly accepted nomenclature exists. This holds also for metamorphic rocks, particularly because of the gradual transition from one type of metamorphic rock to another (the rise in pressure or temperature, or both, that these rocks underwent constitutes a continuum). There is, however, a recommendation by the International Union of Geological Sciences (IUGS) concerning the classification of metamorphic rocks. This recommendation is followed here. It should be noted, however, that the recommendations by the IUGS differ in several cases from terms that are commonly used and widespread. Moreover, some previously commonly used terms have now become obsolete. Obviously, the use of ‘alternative’ terms might easily lead to confusion. Terms that should not be replaced by other terms will therefore be indicated here in italics but such terms should be printed in roman in scientific texts, whereas more loosely used terms that are often used according to the preference of a specific author will be printed here in roman.

### Subdivision of metamorphic rocks

Several types of metamorphic rocks are distinguished: regional metamorphic (produced by regionally increased pressure and temperature), contact metamorphic (produced by exposure to the heat of rising magma), burial metamorphic (produced by strongly increased pressure and increased temperature after deep burial), and dynamometamorphic (produced by the friction occurring during deep faulting). In each of these categories, the degree of metamorphosis can vary, depending on the pressure, the temperature, or both.

### Regional metamorphic rocks

After burial, clays change (under the influence of rising temperature and pressure at depth) first into claystones (only lithified) and shales (lithified, showing irregular cleavage, no or few new minerals). These two rock types are not yet metamorphic, because no new crystals have been formed inside. However, an ongoing increase in temperature or pressure, or both (for instance during orogenesis) will induce recrystallization. The resulting regional metamorphism, which is sometimes called ‘dynamothermal metamorphism’ (but this term should be avoided because of the possible confusion with dynamometamorphism), changes shales: first into phyllites (with newly formed micas) and then into schists (macroscopically easily recognizable new micas and other minerals, excellent cleavage). Schists are often named after the predominant mineral(s), for example, chlorite schist, or after the common characteristics of newly formed minerals, for example, greenschist.

Sandstones that have undergone such metamorphism are called quartizes; these are recognizable because fractures cut through the sand grains, whereas fractures in sandstones develop around the grain surfaces. Impure sandstones become paragneisses (whereas granites become orthogneisses). If the type of the original rock cannot be reconstructed, metamorphic rocks with a granite or sandstone composition are just called gneiss.

Limestones change by regional metamorphism in marbles; the original components are no longer recognizable. It should be mentioned here that many commercially exploited ‘marbles’ are, however, limestones that did not undergo metamorphism.

Since a wide variety of igneous and sedimentary rocks exist, regional metamorphosis results in an equally wide variety of metamorphic rocks, but the commonest types are mentioned above.
Contact metamorphic rocks
Contact metamorphism is relatively rare and commonly restricted to small areas. Because this type of metamorphism is due to the heat produced by nearby rising magma, one can usually distinguish a zone (called aureole, sometimes 'halo') around the magmatic body which has undergone this metamorphism. The degree of metamorphism decreases with distance from the magmatic body. Clays change by this type of metamorphism first into fine-grained fissile rocks called spotted slate, then into spotted schist, and finally into hornfels. A calcareous variety is sometimes called calc-silica hornfels.

Burial metamorphic rocks
Burial metamorphism (the terms 'load metamorphism', 'constructive metamorphism', and 'geothermal metamorphism' are also used but are better avoided) is fairly common and the names of the rocks formed in this way are, as a rule, the same as those that have undergone regional metamorphism. Newly formed minerals commonly do not indicate the degree of metamorphism, apart from the mineral glaucophane, which is characteristic of glaucophane-schist.

Dynamometamorphic rocks
Dynamometamorphic rocks (also called 'dynamic metamorphic rocks'; the names 'dislocation metamorphic rocks', 'cataclastic metamorphic rocks', 'kinetic metamorphic rocks' and 'mechanical metamorphic rocks' should be avoided) are sometimes recognizable as microbreccias formed during faulting, in which case they are called kakyrites or, if banded with cleavage parallel to the banding, mylonites. Clayey sediments become phylonites, a rock type that may contain large crushed crystals (porphyroclasts). A largely recrystallized phyllonite with irregular bands of large crystals or aggregates within a finer matrix is called flaser gneiss.

Ultrametamorphic rocks
Ultrametamorphism is an extreme form of metamorphism during which partial re-melting of the rocks can take place. The medium to coarse crystalline rocks thus formed are called migmatites.

Other types of metamorphic rocks
Several other specific conditions may occur that change igneous or sedimentary rocks into metamorphic ones. These conditions, such as the impact of a large meteorite or asteroid, lead to rare types of metamorphic rocks, commonly containing minerals that are hardly formed on Earth under other conditions. These rare conditions are considered beyond the scope of this chapter.

Further reading