This chapter will deal with the formation processes of mineral deposits, i.e., the minerals that can be extracted economically and profitably and are commonly designated as economic minerals. Minerals are important because they contain most of the elements we use. All the minerals found in nature however do not fulfill this criterion. There are a number of factors which categorize a mineral as an economic one. The most important of these is that an economic mineral is needed to be easily extractable and economically viable. For example, iron can be found in a number of minerals, but it is hematite and magnetite, which are particularly important from an economic point of view. Two categories of minerals fall under this group – ore minerals and industrial minerals. The economic feasibility of minerals also varies with their diversified zones of formation, which actually largely control their characteristics.

An ore is defined as a metalliferous, or an aggregate of metalliferous minerals, more or less mixed with gangue, which from the standpoint of the miner can be earned at a profit, or from the standpoint of the metallurgist can be extracted at a profit. The test of yielding a metal or metals at a profit seems to be the feasible one to employ. Ore minerals are chemical compounds formed naturally under favourable chemical conditions when their major constituents are available. Substitution of major constituents by trace metals may produce impurities in ore minerals. Both impurities and associated minerals in ore deposits can provide valuable metals as by-products, or create expensive problems for sustaining the environment.

Industrial minerals have been defined as any rock, mineral or other naturally occurring minerals of economic importance, excluding metallic ores, mineral fuels and gemstones (precious or semiprecious stones). These are designated as industrial, because either the mineral itself or its compounds/rocks has some
industrial application. Asbestos, barite (minerals), granite, sandstone, limestone (rocks), bauxite, ilmenite, chromite (metallic ores), all have industrial aspects.

The distinction between the ore minerals and the industrial minerals is: the ore minerals comprise the metallic minerals while the industrial minerals include only the non-metallic ones. In some cases, a single mineral can be used both as an ore and industrial mineral. For example rutile (TiO₂) can be used as an ore of titanium and also in the pigment industry as an industrial mineral. Hence though their economic viability depends on their mode of formation, it is their individual characteristics and uses which distinguish between the two groups of economic minerals.

Here we are mainly concerned about the formation of different deposits and their characteristics.

The importance of metals to the industrialized world stems from the vast array of properties that they exhibit, both in their pure form and when used in combined form in alloys, chemical compounds and composite materials. The choice of a metal for a particular use depends on the suitability of its properties, its price and the availability of substitutes.

Three main processes, by which minerals are formed, are igneous, sedimentary and metamorphic. A separate process of mineral genesis is also worthy to mention, is the process of oxidation and supergene (secondary) enrichment. Further categorization of each of these processes will be discussed under separate headings.

**10.1 IGNEOUS PROCESSES**

A large number of mineral deposits are hosted by igneous rocks. Igneous processes take place in magmatic systems, and involve crystals, immiscible liquids (magma, sulphide melt, oxide melt, water), and gases (as formed when water boils). Chemical and physical processes associated with the separation of crystals or immiscible liquids from magma, give rise to magmatic fractionation, which can produce a range of igneous rock types and may concentrate metals to form ore deposits. Both mafic and felsic rocks are associated with mineral formation.

**Mineral Deposit Formation**

There are a variety of processes of mineral deposit formation which can be categorized in a number of sections.

**Significance of Trace Elements in Ore-forming Process**

Any element which is present in a rock at concentrations lower than 0.1%, is defined as a trace element. During partial melting of rocks, these elements separate themselves into two types—compatible (affinity for solid phase) and incompatible (affinity for liquid phase). Hence during cooling and solidification