The applications of clays and their derivatives in the industries are many and varied. The suitability of a clay in a particular industry is determined by the properties of clay minerals present in it, which are in turn determined by the internal structures and chemical compositions of those clay minerals. General absence or scarcity of transition elements, which have strong pigmentation properties, facilitate the use of kaolinite-rich clays in production of high-quality porcelain. Owing to their distinctive structures, clay minerals exist with very fine grainsize and have high surface activity, and are therefore suitable as fillers in rubber industries. In addition to these properties, the whiteness of kaolinite makes it ideal filler in paper industry. Cation exchange property of some clay minerals, which is a result of their characteristic t–o–t–c layer structure, enables their use as filters and absorbents. The characteristic internal structure imparts to some clay minerals, esp. smectites, their distinctive lubricating and thixotropic properties, facilitating the use of bentonite clays in drilling fluids.

The easy availability of clays in almost all inhabitable places on earth and its certain characteristic properties facilitate its diverse use in the human civilisation since prehistoric time. The clays were widely used in building muddy huts or in the production of bricks, potteries etc. even in the most primitive forms of cultures. In the present age, the uses of clays and clay minerals are increasing day by day, and they are gradually replacing metals in various fields as cheaper, better and environment-friendly alternatives.

The diverse applications of clays and argilloids in the industries are elaborately described in the succeeding chapters of this Part. Clay is used in the industry in the following three forms:

- **Per se, with some beneficialations**: In the drilling fluids, absorbents and filters, clays can be directly used without any processing or alteration,
though some beneficiation may be needed. These uses of clay are described in Chapters 8 and 12.

- **In chemically altered form with much processing:** Some kaolinite-rich clays are the chief constituents of the ceramics that include potteries, porcelain and refractory materials. In these industries the clays undergo intense processing and alteration, and are transformed irreversibly to different materials. These applications of clays are described in Chapter 9.

- **As one of the raw materials, in subsidiary proportions:** In rubber and paper industries, clays are not the chief constituents – they are used as fillers with the main constituents (cellulose, rubber etc.). In paint and medicine industries also, small proportions of clays are mixed with other substances. Clays are processed and altered as per the requirements of these industries. These uses of clay are described in Chapter 11.

In addition to the above uses of clays and clay minerals, some industrial applications of associated minerals are also described in this part. For example, the uses of phosphate compounds in fertilizer industries and manganese compounds in battery industries are described in Chapters 10 and 14 respectively.

The applicability of clay in a particular industry depends on the characteristic properties of the clay mineral(s) present in it. The properties of a clay mineral, on the other hand, depend largely on its internal structure and chemical composition. This chapter lays a foundation for the subsequent discussion and explains how the chemical composition and internal structure control some of the common industrial applications of clay minerals.

### 7.1 CERAMICS: POTTERIES, REFRACTORIES AND PORCELAIN

Clays are, by definition, plastic at appropriate water content and hard when fired. In plastic state the clays can be moulded into any shape, which produces a hard, coherent mass when dry, and a water-resistant, brick-like material when fired. **Ceramics** are the various kinds of hard, brittle, heat and corrosion-resistant materials produced by shaping wet clay, drying it and then firing it at a high temperature. Being hard and impervious, the ceramics are widely used in all types of potteries; while their high melting point and refractory (i.e. heat-resistant, stable at high temperature) properties facilitate their use in the production of fire bricks, for lining furnaces, crucibles etc.

When fired above a certain temperature, the clay is vitrified, i.e. part of its components are molten to produce an impermeable glassy material. Vitrification generally takes place at about 1200°C – 1400°C, though different clay minerals may have different vitrification temperatures. **Earthenware** is porous, opaque and coarser ceramic that is fired below the vitrification temperature. It is opaque and its colour varies from light brown to reddish brown or darker shades of