Chapter - 1
INTRODUCTION
The industrial research efforts in 1948 at Union Carbide Corporation, USA, led to the discovery of a new class of minerals which proved to be of wide scientific interest and of immense technological importance. These minerals are called zeolites. The extent of international scientific and commercial interest in the zeolites can best be estimated by several large conferences on this mineral held in recent past in United States, Russia and many other countries.

A loose definition of a zeolite as given by Smith/1/ is:

"It is an aluminium silicate with framework structure enclosing cavities occupied by large ions and water molecules both of which have considerable freedom permitting ion exchange and reversible dehydration". Zeolites contain millions of molecular-size channels which measure a few angstroms in diameter. These minerals have a great affinity for water and as such adsorb large quantities of water on their inside surfaces. Essentially, zeolites are oxides of silicon or silicates where some silicon atoms are replaced by aluminium. The latter have only three electrons to form four bonds with four neighbouring oxygens. As a result, a charge imbalance is created in the crystal making it negatively charged. Positively charged metal ions (cations) such as potassium, sodium, magnesium and calcium readily enter into the cavities to neutralize the excess charge. Thus, these ions occupy positions within the network surrounded by loosely bound water.
molecules not filling the channels completely. They move about freely and can easily exchange their places with other ions. In short, the zeolites are crystalline hydrated aluminosilicates of group I and group II elements. Structurally the zeolites are "framework" aluminosilicates which are based on an infinitely extending three dimensional network of $\text{AlO}_4^-$ and $\text{SiO}_4^-$ tetrahedra linked to each other by sharing all of the oxygens.

The properties and uses of zeolites are being explored in many scientific disciplines namely, 1) modern inorganic and organic chemistry, 2) biochemistry, 3) mineralogy, 4) geology, 5) surface chemistry, 6) Oceanography, 7) crystallography, 8) catalysis and 9) in all types of chemical engineering process technology. The wide variety of applications includes separation of hydrocarbon reactions, drying of refrigerants, separation of air components carrying catalysts in the curing of plastics and rubber and a host of others.

Zeolites occur naturally and they differ mainly in their content of silicon and aluminium atoms. Mineral zeolites are often found in regions rich in volcanic ash, where oxides of silicon and aluminium are abundant. Over a period encompassing many decades, geologists and minerologists have been extremely interested in reproducing the formation of minerals in the laboratory by methods which were believed to simulate natural processes. Considering potential uses of mineral zeolites experiments were conducted to synthesize them in the laboratory. It is now possible to manufacture synthetic zeolites
Zeolites, otherwise called hydrated aluminosilicates, are formed under hydrothermal conditions. The term hydrothermal is used in a broad sense and includes the crystallisation of zeolites from the aqueous systems which contain the necessary chemical components. Many of the zeolites when heated to 300 or 400 °C get nearly dehydrated and then can act as efficient adsorbents. This characteristic property of zeolites is responsible for the potential uses of this material as water removers in many industrial processes. Because of their size selective adsorption the zeolites in the dehydrated state also play an important role as molecular sieves. Dehydration of zeolites is a complex process involving adjustment between all structurel components and external environment. Most zeolites may be dehydrated to some degree without major alteration of their crystal structure. They may subsequently be rehydrated, that is, adsorb water from the vapour or liquid phase. Zeolites may be classified into three groups depending upon their dehydration character as follows:

i) Zeolites which undergo gradual dehydration over a wide range of temperature. In general no structural disruption is caused in such cases and the lattice gets reformend under hydrothermal conditions.

ii) Zeolites in which sudden dehydration occurs over a short range of temperature. This results in the collapse of the structure which normally cannot be reconstructed under
iii) A combination of i) and ii) in which zeolites dehydrate in two steps. First dehydration is fast and the second one is slow.

The early investigation of the zeolite mineral was concerned with dehydration behaviour and its effect on optical properties. The optical properties studied were colour changes and the luminescence effects in zeolite minerals. Zeolites are found to fluoresce in different parts of the visible spectrum when illuminated by ultraviolet radiation /3/. Activator elements such as manganese, lead, silver, and copper can be introduced into the zeolite by cation exchange. Although zeolites exchanged with these activator ions do not exhibit photoluminescence when fully hydrated, dehydration was found to develop cathodoluminescence in the manganese-exchanged forms of some zeolites /4/. Copper and silver exchanged form responded to ultraviolet excitation: rehydration reversed this.

The phenomenon of thermoluminescence (TL) in some minerals has been observed in the past but its systematic and scientific evaluation started only in recent years. The TL study found its first potential application in the field of geochronology. Since then extensive work on thermoluminescence of geological minerals was carried out. It involved detailed basic studies regarding the build up, stability and many other aspects of thermoluminescence. Past couple of decades have produced considerable volume of literature on the TL phenomenon in a number of minerals and its application in some of the important branches of geology.
The present work originated out of two main considerations namely, i) dehydration and rehydration of zeolites have been earlier reported to be intimately related to their luminescence properties, and ii) thermoluminescence technique has established itself as a valuable tool in the study of minerals. TL measurements were made on two zeolites namely, scolecite and heulandite in as-received condition (virgin state), with and without beta irradiation, and in variously pretreated (thermally) specimens also with and without beta irradiation. Deccan Traps, western India, particularly areas around Poona, Nasik and Bombay, abound in these two varieties of zeolites under investigation. Although earlier workers observed enhanced TL in the zone of phase transition in certain minerals namely, quartz /5-7/ association of their TL with polymorphic changes has not been established. The results obtained in the present work clearly demonstrate that the dehydration and rehydration accompanying phase transformations in the zeolites examined have important bearing on the occurrence of their thermoluminescence.

In the present investigation, the disorganisation of the crystalline structures has been examined by different methods namely, TL technique, X-ray diffraction, TGA and DTA. The present studies on the zeolites mainly concern with the record of TL glow curves and their analysis. The TL glow curves were recorded under the influence of different physical factors such as variation in the dose of the exciting radiation and variation in the thermal pretreatments of the specimen.
REFERENCES


