CHAPTER-I

INTRODUCTION

One of the more important results of the global studies on the zonally metamorphosed pelitic sediments is that each terrain has undergone a unique history in terms of the ambient physical conditions, namely, pressure, temperature, gas fugacities etc., the succession of the chemical reactions and the degree of their completeness and the pressure-temperature path of the metamorphic progression. This uniqueness is apparently caused by a combination of factors which includes the local structure, the pressure-temperature gradient, the nature of the movements and the original composition of the sediments. While the bulk chemistry of the sediments, the structure and the movements affecting them can be determined with a good deal of certainty, an estimate of the intensive parameters of metamorphism e.g. temperature and pressure is more likely to remain at best semiquantitative. In spite of the fact that a great amount of experimental phase equilibrium work on various metamorphic mineral assemblages, in particular, corresponding to the pelitic sediments has been carried out in the past few decades (Evans, 1965; Ganguly and Newton, 1968; Ganguly, 1972; Hoschek, 1969; Richardson, Gilbert and Bell, 1969 and Chatterjee, 1972), quantitative estimate of the pressure and the temperature of metamorphism of natural assemblages, through a direct application of the phase equilibrium data, has remained largely elusive.

This is obviously because of large compositional differences between the experimental and the natural systems and the virtual impossibility of an experimental pressure-temperature calibration of each natural assemblage. Classical equilibrium thermodynamics provides an alternative in that, if the standard state thermodynamic parameters e.g. Gibbs free energy, entropy, heat capacity, molar volume and the activity-composition relations of the metamorphic minerals are known, a direct calculation of the metamorphic equilibria over a range of pressure and temperature is possible. A great deal of interest of petrologists has currently been directed to this problem, namely, pressure-temperature sensing of metamorphism through a direct calculation of the equilibria.

In this work, an attempt has been made to estimate the range of the pressure and temperature of the metamorphism over a part of the staurolite zone of the Lower Himalaya near Rajgarh, Himachal Pradesh, India. For this, a set of critical thermodynamic parameters of the constituent minerals has first been derived from experimental phase equilibrium data and calibrated against independently made pressure-temperature estimates; next, these parameters have been used in the calculation of a number of metamorphic equilibria pertaining to the Himalayan assemblages. The pressure-temperature estimates have been compared with those obtained from the experimental calibration of some selected mineral equilibria.

The investigated pelitic rocks are part of a great thickness of wide ranging unfossiliferous sediments of the Lower Himalaya or the Lesser Himalaya which occur practically all along the Himalayan range and have been assigned, with varying degrees of certainty, ages ranging from Archean to the end of the Paleozoic. These Lower Himalayan metamorphics characteristically occupy a position next to and higher up than the unmetamorphosed Tertiary sediments of the Sub-Himalayan foothills. Also, the Lower Himalayan metamorphics all along the Himalayan range have been characteristically invaded by sheets and laccolithic bodies of syn- to post-tectonic granites producing marked metamorphic effects. In fact, this belt has registered possibly the most dynamic phase of the Himalayan orogeny in which the geosynclinal sediments suffered large scale recumbent folding, overthrusting and regional metamorphism to a high grade followed up by the invasion of granite. The Lower Himalayan belt is followed up in the central core of the Himalayan range (physiographically the highest regions) by a distinct group of paragneisses, hybrid gneisses and granite making up the Great Himalaya.