Chapter II

Scope and object of the Work.

Plants take up their mineral nutrients from the soil by a process of ion-exchange. The plant tissues contain acid groups, capable of binding and exchanging cations and basic groups with a similar role towards anions. In the process of exchange between the plant and the soil, the clay fraction of the latter plays the most important part. Hence a study of the exchange behaviour of the clay fraction reveals, generally, the exchange characteristics of the soil as a whole.

Whereas exchange studies of soils and clays with the common major cations as well as the cations of the trace elements have been extensively carried out by different workers from different aspects, such studies with inorganic trivalent complex cations are rather meagre. Sorption and desorption studies with trivalent inorganic ions have been carried out by earlier workers. Not always could satisfactory results be obtained as the experiments were generally carried out either at low pH or at high pH.

At low pH of the medium, the interference of the H^+ in the exchange process can not be ignored, whereas high pH favours the existence of metal hydroxy ions rather than the simple metal ions. So, in most of the studies a proper knowledge of the interaction of the adsorbate with the adsorbent was lacking. Unless this is known in reasonable details an appreciation of the adsorption and desorption measurements may be difficult. It was therefore thought that for a systematic study adsorbents with as much as possible well defined surface characteristics and adsorbates which are stable over a wide range of pH would be most convenient. The inorganic ion-exchangers used in the present investigation consist of the clay minerals, montmorillonite and vermiculite, and the organic exchanger is the resin IRC-50. These provide more or less known features. The adsorbates $Coen_3Cl_3$ and $Co(NH_3)_6Cl_3$ are trivalent complex compounds of known structure. From structural considerations, the stability of these complex compounds is also well known.

The interaction of the above exchangers and the trivalent complex cations was therefore investigated under different conditions and from different angles in order to understand the mechanism of interaction and specificity of the ions, if any, which may be useful for identification purposes. In order to compare the results of exchange, similar experiments were also done with a simple bivalent cation, i.e., Mg^{2+}, on the clay minerals. The complex ions are suitable from another

aspect. Very low concentrations of the ions are measurable spectrophotometrically. This is necessary to study desorption, in particular, as well as sorption occurring at very low concentrations. The desorption studies of the trivalent complex ions and Mg^{2+} by different electrolytes reveal the extent of extractibility of these ions from the adsorbent surface, from which we can have an idea of the affinity of the ions for the minerals and resin surface as well as the relative desorbing abilities of the ions.

It may be mentioned in this connection that although the occurrence of the trivalent cobalt complex in soil is not reported in literature, the presence of cobalt in the bivalent form is well known and its function as soil nutrient is well established. Cobalt as Co^{3+} forms complex organic compounds. A considerable part of cobalt is dispersed through the soil in the crystal lattices of the aluminosilicates or fixed by the humus of the soil; another part is more loosely bound to the silicates as a result of base exchange. However, the main interest of the present investigation is restricted particularly to the study of the ion-exchange characteristics of the component of the soil using these complexes.

The studies of the adsorption and desorption on clay minerals and resins are useful from other points of view also. As for example, due to their characteristic structures and high exchange capacity, bentonite and vermiculite have recently been used for the decontamination of waste waters from nuclear pile plants. Another important

application of these minerals is in the mining practice. The adsorption of gold and other precious metals on these clays especially for exploring the "lost or locked in" gold in barren land sediments may be recalled. Recently, a continuous extraction of recoil products from the Szilard-Chalmers reaction on hexammine and trisethylenediamine cobaltic ions adsorbed on an ion exchange resin has been proposed for obtaining a high yield and specific activity. Apart from various practical applications, the experimental data may also be used for testing different theoretical models for describing ion exchange equilibria.