Chapter 8

Summary

Weathering is the most fundamental phenomenon governing the formation of soil and natural distribution of nutrients. The formation of soil is critical to support all forms of life. It is an essential process to obtain the geologically derived nutrients, like P, K, Mo etc for the life system. Phosphorus is one of the major, productivity defining nutrients in terrestrial as well as aquatic ecosystems. Because of the large time scale required for P to complete one cycle (i.e., 120 Gy), the flow of phosphorus can be considered unidirectional from the terrestrial (phosphorus containing rocks) to the oceans. In the formation of soil from a bed rock, P undergoes many transformations and fractionations, affecting its distribution and availability in different forms to the life system. In the study of soil chronosequences, it has been found that in the youngest of the soils the total phosphorus present is in the form of apatite P (AlP) and with time the dominance of other forms like organic (OP) and the occluded fraction (NAIP) become prevalent.

In the studies of development of vertical soil profiles, factors like flow of water under gravity and plants activities have been suggested to have important roles in the direction of weathering and soil development. For this study we attempted to understand the P fractionation pattern in weathering profile sequences in different climatic conditions. Two amphibolite profiles (semi arid-Yashodapura, and humid-Kakkavayal) and two gneisses profiles (semi arid-Kushalnagar and humid-Bachhalkad) were selected. Out of the four profiles three were vertical in nature and one (Yashodapura) was a core-rind complex, wherein the weathering proceeds from the outer layer towards the core. In this study two controls used for the comparison among different weathering zones and to compare the changes with respect to original rock are respectively, the base rock composition on which weathering has proceeded and the weathering status of zones calculated using CIA.

The presence of total phosphorus content in the bed rock was dominated by the apatite fraction and with increasing weathering, loss of AlP and increase in OP was observed. The AlP and OP follow a complementary pattern. The NAIP also increases with weathering but its contribution to the total phosphorus remains trivial.
Interestingly, the parent rock type does not affect the P fractionation pattern. It is the climate that seems to influence weathering to a greater extent. In the weathering profiles of both the climatic conditions, P can become bioavailable, but in different forms, i.e., the OP in humid and AIP in semi-arid conditions. The similarity in the phosphorus fractionation pattern with those of the soil chronosequences (Walker and Syers, 1976) led us to conclude that weathering zones of a profile can also be used to study the P fractionation pattern just as the soil profiles of a chronosequence.

In the spheroidal weathering of Yashodapura, the gravitational movement of water does not seem to control the weathering direction. The P fractionation pattern and organic matter content in such samples suggests that the microbes thriving in the pores of the bedrocks and weathering zones help in the concentric advancement of weathering front towards the core of the spheroid. This is different from the commonly known view in which in the vertically disposed weathering and soil profiles, gravitational movement and vegetation on the surface controls the movement of weathering front downward to the bedrock.

From the geochemical and weathering trends of sediments of Kaveri and Kabini rivers, it has been found that the catchment lithology ranges between gabbro to granodiorite rock types. The CIA values of sediments reveal that the lithologies in the upper catchments of Kaveri and Kabini rivers have undergone extensive weathering but to different extents. The Kaveri sediments are found to be more weathered than that of Kabini River. This can be attributed to the different conditions in the humid climate prevailing in the upper catchment.

The extensive weathering and enrichment in terms of OP on the surface of the weathering profiles is reflected in the sediments from the upper catchment. The most weathered zones of a weathering profile, rich in the organic fraction of phosphorus are eroded and supplied to the river. When this organic phosphorus and particle associated phosphorus (NAIP) enters the river system it undergoes physical, chemical and biological transformations. The P fractionation pattern in the sediments of the upper catchment shows that the organic fraction is a major contributor to the total phosphorus content. The similarity between the eroded materials and the surface weathering zones suggest a steady state of P fractionation in the upper catchments of the rivers.
In the lower reaches, at the confluence of Kabini with Kaveri, a change over to the dominance of apatite fraction is observed. At the confluence, the hydrodynamic conditions seems to change, and the organic fraction, generally associated with the suspended load gets resuspended and remobilised to get washed away to be deposited in the downstream, in the deltaic regions.

The grain size is an important indicator of association of P in various forms. In nearly pristine catchments of Kaveri and Kabini rivers, the P fractionation in the coarser sediment fractions is determined by the weathering in source rocks in the catchment itself. The role of finer fraction is very limited for the P distribution in the sediment samples. The role of oxyhydroxides minerals and organic matter of the clay size fraction is required to be dealt in detail in the future endeavours.

The sediments and associated nutrients produced in the catchments of tropical rivers essentially control the fertility in their floodplains and delta. The grain size properties and nutrient distribution in different grain sizes is crucial to understand to improve the quantity and quality of soils of the floodplains and delta of tropical rivers, such as in India.