FREE IRON OXIDE CONTENT IN EAST PAKISTAN SOILS

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A review of the literature on the free Fe_2O_3 content in some major soil groups of East Pakistan indicates that the amount of free Fe_2O_3 varies within wide limits. The free Fe_2O_3 content in these soils are rather low compared to its location in the humid Tropics. Red soils of Dacca have the highest amount of free Fe_2O_3 while the soils located on the Barind Tract has the lowest amount. In almost all the soils there is a downward enrichment of free Fe_2O_3 which is a clear sign of the Podzolic nature of these soils. While the downward movement of free Fe_2O_3 is true, no author as yet has put forward any suggestion about the possible mechanism of their movement. In this article the mechanism of movement of iron in soils has been discussed.

Free Fe_2O_3 in soils lends colour to soils. This colour effect is predominant both in highly oxidised and in highly reduced soils. Well-oxidised soils are red while the reduced soils are blue or bluish green. Between these extremes there are intermediate stages also having brown and yellow hue.

Iron oxides in soils are present in various forms, such as in primary minerals, in secondary layer-silicates and as iron oxides and hydrous oxides. A considerable amount of iron may be present in solution if the pH of soil is below 4.0. Iron oxides and hydroxide minerals may again be grouped into two classes—those which go into solution when treated with nascent hydrogen,[5] and those which are discrete mineral grains and are not affected by the above method of extraction. The iron oxides and hydroxides in the former group are loosely termed as free iron oxides in soils and the minerals in the latter group are known as resistant iron oxide minerals.

Like all other tropical soils free Fe_2O_3 is an important constituent in the soils of East Pakistan. This is probably more prominent in the red soils of Dacca. As a large part of this province goes under water during the rainy season a highly reduced condition develops in the soils of the low-lying areas. Since the areas of extreme reduction and oxidation occur side by side in some sections of East Pakistan, the role of iron oxides in these soils is readily intelligible.

Free Fe_2O_3 is also important in forming structural aggregates,[9,13] and thus increasing the porosity of soils. It is known at the present time that the different forms of iron oxides and hydroxides in soils may be either positively charged, negatively charged or even neutral depending on the pH value of the soil system. Swindale[15] has presented an interesting diagram of common iron minerals in soils. According to him only three forms of iron oxides and hydroxides are capable of forming aggregates with layers silicates. All other iron minerals are discrete and behave as inert materials in soils (Fig. 1).

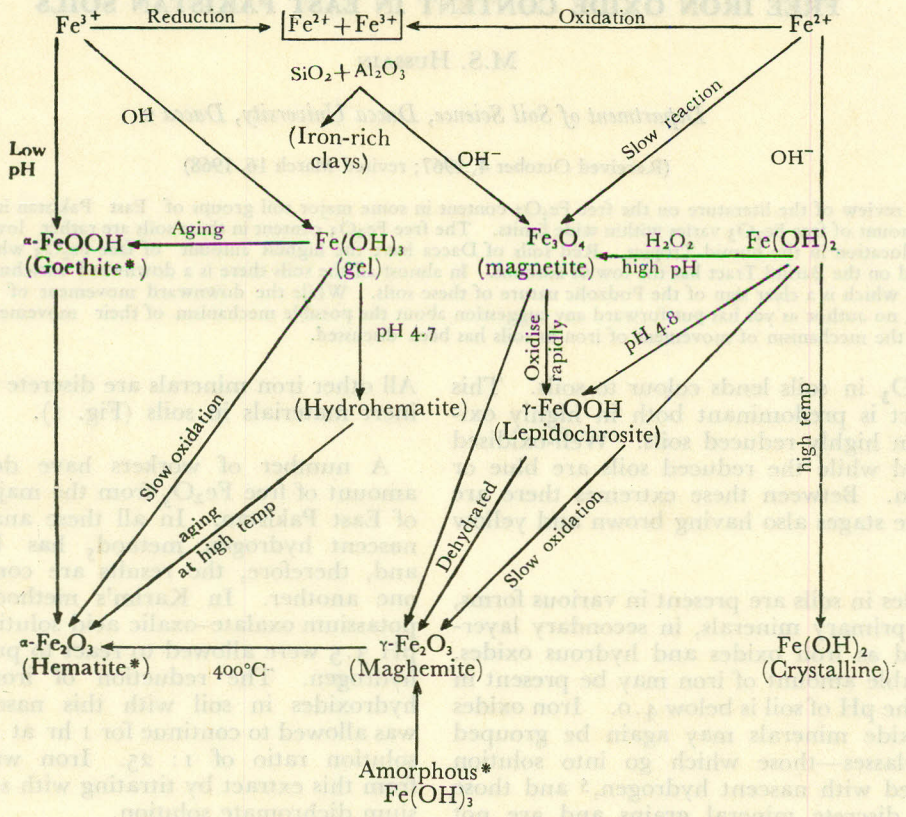
A number of workers have determined the amount of free Fe_2O_3 from the major soil groups of East Pakistan. In all these analyses Karim's nascent hydrogen method[5] has been followed and, therefore, the results are comparable with one another. In Karim's method Zndust and potassium oxalate–oxalic acid solution buffered at pH 3.5 were allowed to react to produce nascent hydrogen. The reduction of iron oxides and hydroxides in soil with this nascent hydrogen was allowed to continue for 1 hr at a soil: oxalate solution ratio of 1: 25. Iron was determined from this extract by titrating with standard potassium dichromate solution.

In this paper the distribution of free Fe_2O_3 in the soils of East Pakistan has been reviewed and the relationships among these soils with respect to free Fe_2O_3 have been discussed.

There is difference of opinion among soil scientists regarding what should and what should not be included in free iron oxides. Some believe that the specific iron minerals should be important in any classification while others think that the extent of dissolution of these minerals in a particular extraction should be considered.[15] However, the dissolution of Fe_2O_3 during extraction is directly related to the particle size of the minerals. In this paper by free Fe_2O_3 will be meant all those iron oxides and hydroxides which go into solution when treated with nascent hydrogen as stated in the procedure above.

Discussion

From the visual study of the colour of the major soils of East Pakistan it appears that the red soils of Dacca probably have the highest amount of free Fe_2O_3. Karim and Khan[7] in their study of these red soils reported an average free Fe_2O_3 content of 2.8%. Their values ranged between



*Iron minerals known to be important in forming structural aggregates in soils.

Fig. 1.—A classification of Iron oxides and hydroxides given by Swindale.[15]

1.6 and 4.1%. These authors discovered an enrichment of free Fe_2O_3 in the lower horizons of these profiles. This downward movement of free Fe_2O_3 lead the above authors to suggest that podzolisation is an active process in the soils under study. But they did not say anything regarding the mechanism of the movement of iron oxide from surface and their subsequent diposition in the B horizon of the soils.

The red soils of the Madhupur Tract contain 3.1% (average) of free Fe_2O_3.[11] This value is slightly higher than that reported by Karim and Khan. A clear sign of the impoverishment of free Fe_2O_3 near the surface and a preferential accumulation in the lower horizons was detected.[11] In few of these soils the vertical distribution of free Fe_2O_3 is irregular and the pattern seems to be controlled by lithology.

Islam[4] studied 28 soil samples from both low-land and highland areas of the Garo Hills region of Mymensingh district. In the soils from highland areas he reported a higher amount of free Fe_2O_3, but in the lowland soils the amount of free Fe_2O^3 was small. The range was from 0.3 to 13.0% The variation of free Fe_2O_3 content is high and in most of his soils there is a marked downward enrichment of free Fe_2O_3.

The average free Fe_2O_3 content in the soils along Sylhet foothills was reported to be 2.2% and the highest and the lowest values ranged from 0.6 to 3.6%.[6] In all these soils there was a trend of surface impoverishment of free Fe_2O_3.

In some soils from Courtbari area on the Lalmai Hills, an average free Fe_2O_3 content of 2.2% has been reported.[10] results showed that free Fe_2O_3 content gradually increased with depth in all the soils. This was regarded as a fodzolic character expressed in these soils but it was not clear as to how and why this iron oxide moved down.

In some soils of Janmara and Andharmanik vales of Chittagong 1.7% free Fe_2O_3 has been reported.[1] This percentage is low compared to that of the red soils of Dacca but there is similarity in the distribution pattern. In both these soils there is an increase of free Fe_2O_3 content with depth.

The lowest amount of free Fe_2O_3 (0.5%) in the soils of East Pakistan was encountered in the Barind Tract area.[8] There is a surface impoverishment of free Fe_2O_3 in these soils. Karim and Qasem[8] have suggested that the presence of high concentration of Ca^{++}ion is responsible for an irreversible precipitation of iron oxides in these soils.

After a survey of the available literature on the distribution of free Fe_2O_3 in the major soil groups of East Pakistan it is clear that iron oxides move downward during soil formation. In all the above studies it has been emphasized that the distribution of free Fe_2O_3 is authigenic in character in these soils. However, the mechanism as to how this movement of iron takes place has been explained.

Swindale and Jackson[14] have explained the mechanism of the movement of different elements in soils into two ways: firstly by "soluviation", and, secondly, by "Cheluviation" processes. In the "soluviation" proces elements usually go into solution and it is in the solution phase that they move down the profile. In the "Cheluviation" process the elements in soils first form complex with organic chelates and in the chelated form they move down and are reprecipitated in the lower horizons of the profile if conditions are suitable. They also stated that when the elements like Fe^{3+} and Al^{3+} form complexes with organic chelates they become stable and in this from they may easily be leached down in the soil.

It is not known at present in what form the free iron oxides in the soils of East Pakistan move down. But from other works[2,3,14] it may be assumed on theoretical basis that the "cheluviation" process possibly plays a significant role in the movement of free Fe_2O_3 down the profiles.

Conclusions

The mean free iron oxide content in the major soils of East Pakistan is 2.1%. This amount of free Fe_2O_3 is quite low compared to that in other soils occurring in the humid tropics.[12] This is possibly because none of the soils in East Pakistan is residual.

There is an increase of free Fe_2O_3 with depth in almost all the soils of East Pakistan.

Vertical distribution pattern of free Fe_2O_3 gives an indication of a mild podzolic nature of these soils.

The increase of free Fe_2O_3 content with depth seems to be related to the present cycle of soil formation in these soils.

Soils of the Madhupur Tract have the highest amount of free Fe_2O_3 (3.1%) while the red soils of the Lalmai Hills come next with about 2.2%. The soils of the Barind Tract have the lowest amount of free Fe_2O_3 (0.5%) among the soils studied so far in East Pakistan.

The mechanism of the downward movement of free Fe_2O_3 in the soils of East Pakistan is not known yet. And there is need for further research to find out whether "soluviation" or "cheluviation" processes singly or jointly are responsible for the movement of free Fe_2O_3 in these soils.

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