'Sigmond's Achievements in the Research of Forest Soils

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The activities of A. A. J. DE 'SIGMOND, the great classic of Hungarian soil science and his influence upon the advancement of this branch of science have not, perhaps, been duly assessed to date. His achievements -- in the fields of soil colloid chemistry and of the genetics of alkali soils or his research work concerning the phosphorus supply of the soils — which gained him international reputation during his lifetime have been appreciated and acknowledged. His activities in other branches of soil science, however, have not been duly considered, although they were just as important and valuable as those mentioned above.

It is most instructive to track the way 'SIGMOND followed in order to get a thorough knowledge of forest soils, to clarify their origin and the processes going on in them and to describe their properties. In his first publications dealing with these questions or in those which touched upon forest soils only briefly, the influence of TREITZ and the agro-geological school can be strongly felt. In "Our Soil" [1] published in 1919, he distinguishes grey and brown forest soils as TREITZ himself did. But here already he emphasizes the importance of acid leaching in the formation of these soils and points out that the wide range of forest soils are formed in proportion to the effectiveness of the leaching process. His treatise, "Chemical Criteria of Soil Leaching" [2] published in 1927, is rather illustrative of the development of his concepts. Here his conclusions are based partly on the analysis of the hydrochloric acid extract of a forest soil of Hűvösvölgy, partly on the distribution of exchangeable cations in that soil. According to these conclusions the results of acid leaching are the following:

1. The $CaCO_3$ and $MgCO_3$ contents in the original loess are completely washed out of horizons A, B_1 and B_2.
2. The mono- and bivalent cations extractable by concentrated HCl are leached more or less from the eluvial horizon into the illuvial horizons.
3. The ferric and aluminium oxides as well as the soluble silicic acid partly in the form of solutions, partly in that of collodial sols are entirely washed out of horizon A into horizon B.
4. It can be stated that among the absorbed cations magnesium ions predominate and even the monovalent cations are more resistant to acid leaching than the calcium ions.
5. Among the exchangeable cations hydrogen ions dominate, especially in the upper horizons. Their amount decreases with depth.
6. Exchangeable aluminium can also be found among the cations.

7. Of the soil forming minerals silicates are also transformed. As the first step hydro-silicates are formed.

These observations as well as the evaluation of the methods 'SIGMOND employed in his investigations call for the following remarks:

The method of the hydrochloric acid extract applied after HILGARD; the determination of exchangeable cations; the determination of water and KCl pH-value of the soil, the determination of the hydrolytic and exchange acidity proposed by DAIKUHARA-KAPPEN, as well as the determination of the quantity of H present in the absorption complex of the conductometric titration: all these were new methods which had not been used before in Hungarian soil science. Up to now these methods — with some modification — have been generally employed. The conclusions drawn, which are supported by the findings of GLINKA, are still up-to-date.

It is interesting, however, to notice that in this treatise he gives the equivalents of exchangeable cations in the percentage of the T-value and only later, in 1933, referring to HISSINK, does he adopt the use of the S-value in its present sense (sum of exchangeable cations) and the expression of V percentage to indicate the saturation degree [3].

Even in these early works he mentions that the analyses were performed by J. DI GLÉRIA, L. KOTZMANN (MADOS) and G. PÁVAI-VAJNA, so the 'Sigmond-school could claim significant results also in this field from the very beginning up to the present day.

In a study published in 1934 in the Földtani Közlöny ("Geological Bulletin") [4] he gives a thorough description of the processes taking place in forest soils. It is worthwhile quoting a passage word by word:

"As we have seen the main types represent the different types of soil forming phenomena. In each dynamic system, however, we can distinguish different stages of development and formation. In this regard the best known formation stages are those of the forest soils of temperate zones belonging to the H-soils. But these stages of development differ from those occurring in the case of other developing organisms. E.g. in the development of wheat we can distinguish the following stages: germination, stooling, shooting earing and ripening of corn. Here the development is a natural, inevitable process terminating with the ripening of corn. There are different stages of development in the formation of soil types, too, which are consecutive but not necessarily so and it would be hard to define which stage should be called "ripening" or the termination of development. It can be seen from the aforesaid that the formation of soils begins when the mineral and organic material starts decomposing and ends when the end products of decomposition have again formed a stable system. Within this range can all soils and soil types be found. Every main type represents a certain characteristic line of development but does not always result in the final stage: rock formation. On the contrary, we can say that it occurs the most rarely and it is rather an exception. That is why I am against qualifying the different development stages of soils as degrees of maturity, because more or less developed types there may exist but we can not determine which one of them represents the perfect, terminated or mature stage. This is inconsistent with the dynamic concept of the soil, too, because the termination of the dynamic system means that it has reached a stable state and ceased to be a soil. There are some, for instance, who qualify the well-developed podsolic soil as mature, because they adhere to the principle that the podsolic soil is only gradually formed; first brown then grey forest soil develops and through that the final result of acid leaching is a perfect podsolic soil, just as it can be observed in the degradation process of black steppe soils (chernozems). The prerequisite of this, however, is the previous formation of chernozems. Nevertheless, the well-developed chernozem soils can just as well be called "mature", even though degradation may turn them into podsolic soils. Furthermore: the podsolic soil does not always represent the final stage either, because as the iron pan becomes predominating it is getting humid and then swampy, the forest is becoming extinct and swamp vegetation gets prevalent while the direction of the dynamic development changes again. That's why it is not expedient to immerse ourselves too deeply in the Labyrinths of soil development, as diverse combinations and changes of Nature's powers are possible and if we base our system on these imaginary powers, then we may easily be mistaken".

It is apparent from this quotation that 'SIGMOND's views are definitely dialectic and genetic.

It is in his book entitled "The Principles of Soil Science" [6] that he writes the most on forest soils. Analysing FLOROV's ideas, he deals in detail with the concept of degradation. He also discusses – on the basis of the opinions of GEDROIZ and STEBUTT – the concept of podsolisation and contrasts it with degradation. He describes here the two possible ways of silicate decomposition: either the decomposition to oxihydrates, or hydratation and decomposition when the crystal structure remains unchanged. It is really instructive to consider how the forest soil types are placed in the dynamic soil classification system. The peculiarity of this is that while the ordinary forest soils of temperate zones can be found in the H-soil order and along with that in the sub-group of Humic-siallite soils, the brown earths described by RAMANN figure as an individual soil order of the Ferri-siallite sub-group. According to our present views this sharp division is not justified. Although he does not give a term to the concept of lessivage, what he writes on mechanical absorption outlines the essence of this process. On page 317 of his book [5], surveying GEDROIZ's views on absorption, he writes the following:

"He calls 'mechanical absorption' those phenomena which manifest themselves in the soil's retaining some part of the water suspensions filtering through it", and later on, . . . "The formation of the so-called illuvial horizons or layers can partly be attributed to this phenomenon."

He expounds his opinion on the colloid chemical interpretation of podsolisation when, reviewing the investigations of GEDROIZ and KELLEY, he writes about the decomposability of the absorption complex of the soil. On pages 499 [5] and 190 [60] of his book the following can be read:

"We may therefore safely conclude that there is only a slight inorganic complex in the absorption complex of podsolic soils and that even that will sooner or later be decomposed. The bulk of the absorption complex is a humus complex, which disperses readily as the absorbed cations are mainly hydrogen. The humic acids formed in the humus layer move downwards, leaching out from the upper horizons (A_1 and A_2) first the mono- and bivalent and afterwards some of the trivalent cations. The leaching of the iron oxide gels by the protective action of the humus colloids results in the upper horizon, as a whole, losing colour, the lower part of the A horizon (the so-called A_2 horizon) often becoming quite whitish-grey or ash-grey.

The colouring materials rendered mobile by the humic acid then precipitate in the lower horizons, where there is less moisture and more bivalent cations. First the humus emulsion breaks up and precipitates, destroying the stabilising effect of the protective colloids, while the Fe_2O_3, Al_2O_3 and SiO_2 dispersions also gradually coagulate. Thus, below the colourless A_2 horizon there is formed a brownish-black and then a rusty-brown iron horizon".

When discussing the conditions of the formation of brown-earths he seeks the explanation in carbonic acid leaching thus reconciling the theories of RAMANN, BALLENEGGER, STEBUTT and STREMME. In his opinion "Only those brown soils belong to the main type of brown earths in the formation of which the effect of acid humus ceased to play a role. This is due partly to the complete breaking up of the active part of humus into CO_2 and H_2O in a humid, warm climate, and partly to the fact that — as a result of the soil's low degree of leaching — the humus which may not be disintegrated is saturated, and thus it is not acid. In this way the warmer period of humid climate and the calcareous parent rock are favourable to the formation of brown earths" — he writes on page 611 of his book [5].

Though our present views based on newer experiences are slightly different from those of 'SIGMOND, his conception, in general, demonstrates quite well the difference between the formation of podsolic soils and that of brown earths.

Summarising all that 'SIGMOND wrote or published on forest soils and related methodical and evaluating processes we can point out that his views on soil dynamics and genetics were modern and very advanced not only in his own time but the most of them are valid even now. The analytical and evaluating methods he employed are still among the basic methods used in the analysis of acid soils. It is desirable that now, when we have much more data available and new methods and more extensive knowledge make the detailed characterization of soils possible, the conceptions set forth by 'SIGMOND be revaluated. By developing further his valuable ideas, we may effectively contribute to the better knowledge of forest soils.

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