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A scientist interested in soils (Philippe Duchaufour Medal Lecture)

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These are the most important findings of my scientific carrier.

Unfrozen water in frozen soils - In continental Antarctica, the intense cold, the paucity of liquid water and low biological activity posed the question on whether the surficial, grayish, sandy, material devoided of plants and humus could be legitimately called soils. This question was raised since 1916 when Antarctic soils were first analyzed. The question was later resolved by waiving the U.S.D.A requirements for the presence of higher plants. Nevertheless, one cannot usher the apparently lifeless, unconsolidated material into the realm of soils just by changing a definition! Proofs are required to show that soil formation in continental Antarctica is a present day process. This confermation was obtained by detecting ionic migration in frozen xeric soils. The experiment showed that radioactive ions, $^{36}Cl^{-}$ and $^{22}Na^{+}$, moved in the unfrozen interfacial films of water at the surface of soil particles. The higly dissociated and corrosive nature of the unfrozen water could explain, also, the observed weathering *in situ.*

Dynamic Pedology and Podzolization – For studying the process of podzolization, I used a different approach to the traditional pedological investigations; I called this approach *dynamic Pedology*. Dynamic pedology involves the collection, analysis and interpretation of the soil solution obtained in the field through lysimetry. Traditional pedology by analyzing the solid phase averages the sum total of all the processes since the soil initiated its development. Dynamic pedology is suitable for examining current processes. In weathering studies, soil solution composition allows to verify the thermodynamic stability of minerals. Also, the proton donors proposed as responsible for formation of soils can be identified in the soil solution. Contrasting with the drab, colorless Antarctic soils, the podzols are some of the most photogenic and aesthetic soils of the world. Soil solutions was collected from 45 tension lysimeters located in the central Cascades Mountains U.S.A. and analyzed for pH, major cations and anions and DOC. The study lasted 15 years. From the interpretation of these data I was able to produce a new theory for the process of podzolization that explained the presence of imogolite. The theory is based on the presence of two major proton donors that originate two chemical compartments. The upper one included the O, E and Bhs horizons.The lower, the Bs, the C and ground water. In the upper compartment, the organic acids acted as the major proton donors and complexing agents; here, the low pH depresses the dissociation of carbonic acid. In the lower compartment the major proton donor is carbonic acid formed by the high partial pressure of $CO_2$and the rise in pH. These two compartments rule two contrasting reactions: congruent and incongruent dissolution. The mineralas in the E and Bhs are congruently dissolved, although neogenic minerals are seasonally possible .The solution in this compartment is undersaturated with rispect to imogolite equilibrium, hence it is thermodynamically unstable. In the incongruent dissolution compartment, imogolite is present and thermodamic stable. The suspended fraction of the solution shows, in the upper compartment humic particles containig metals, in the lower compartment, only mineral grains were present. This theory appears also valid for Japan and northern Alaska.

The Role of Podzolization in the Formation of Peatland - In south eastern Alaska, following a chronosequence of marine terraces, it was discovered that podzolization was related to the formation of bogs, the final stage of plant succession.The formation of peatland was caused by the deterioration of the internal drainage as an iron-cemented pan developed during podzolization. Only extensive windthrow, a common phenomenon in S.E. Alaska, could revert the trend toward paludification by mechanically breaking the pan and creating windthrow mounds on which a new forest can be established.