The Talpetate of the Central-Pacific Region of Nicaragua: a Palagonitized Tuff from the Masaya Volcano

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Abstract: *In the Central Pacific area of Nicaragua, a talpetate (an indurated horizon) was studied through field morphological observations of soils profiles along toposequences, microscopy of thin sections, mineralogical, physical, and chemical analyses. The results of this study show that this talpetate is a volcanic tuff spread over 2 500 km², mainly west of the Masaya caldera. This tuff is composed of basaltic andesite ashes with labrador and pigeonite of the tholeiitic series.. Most of the basaltic glasses were "palagonitized" when the tuff was deposited, or shortly afterwards, thus leading to the formation of ferriferous smectites. However, a subsequent meteoric weathering was superimposed on this primary one. As a result halloysite was formed under a tropical climate characterized by a well-pronounced dry season. Under a more humid climate and with Andisols over the talpetate, gibbsitans, mangans, and allophans were formed on the surface and in the cracks of the talpetate. This tuff is the result of one or several piroclastic surges that took place during the phreato-magmatic explosions in the caldera of Masaya some 2000 years ago. We propose a change from the ambiguous term talpetate by "palagonitized tuff of Masaya" in order to name this indurated horizon of the Central-Pacific area of Nicaragua.*

Introduction.

In some volcanic soils of Nicaragua and in other countries of Latin America, there is an indurated horizon called "*talpetate*" which makes agriculture difficult and whose origin is controversial (Terra, 1992). The word *talpetate* comes from *tepetate* a náhuatl word (*tetl* = rock and *petatl* = bed). In spite of the fact that its etymology indicates that it is an indurated horizon, it does not give more information about its characteristics. Until the work of Prat (1991), there were two opposite points of view on the origin and the characteristics of *talpetate*. According to geologists, this horizon is the equivalent of a tuff called "Masaya tuff" or "Retiro tuff", which has as its origin a pyroclastic flow from a phreato-magmatic explosion (Williams, 1983) or could be an aerial volcanic deposit (the "triple layer" of Bice, 1980). In both cases, the Masaya caldera is identified as the source of this material. On the other hand, pedologists consider *talpetate* as an aerial deposit of fine volcanic ashes cemented later by lixiviation and accumulation of clay, silica and oxides of iron and aluminium, such as what happens in a B horizon (Marín *et al.*, 1971; Rodríguez, personal communication, 1985). However Prat (1991) clearly showed that it is a tuff emitted by the Masaya volcano with a phreato-magmatic origin, which under some special conditions suffers changes due to pedogenic processes.

Our purpose is to detail some aspects which clearly show the origin and the characteristics of *talpetate* as well as its presence in the soils of the Central-Pacific region of Nicaragua.

Materials and Methods.

Through its spatial distribution and its characteristics, it is possible to deduce the volcanic origin of the *talpetate*. However, differences in climate between the banks of the lake of Managua and those of the Pacific coast, and the heights of the Sierras of El Crucero-Las Nubes, have as a result different soil performances. On the other hand, it is sometimes difficult to determine with precision *talpetate* from all the others horizons more or less indurated.

That's why we study the spatial distribution of the *talpetate* whether at the profile, toposequence or regional level. We complet this work through macro and microscopic observations (optical microscopy, SEM with a Castaing probe, TEM, XRD), as well as physical-chemical analysis of the characteristics of some indurated horizons from a series of profiles distributed along a northeast - southwest cross-section of the Central Pacific region of Nicaragua.

Results.

Talpetate is made of andesite with pigeonite and labrador; this means it is a volcanic product whose composition borders between basalts and andesites. It belongs to the series of the tholeiites, which indicates that the magma had it's origin in the fusion of the oceanic plate but was a little bit "contaminated" when passing through the tephra crust. The primary minerals prevailing in the soldered cinders and the "triple layer" (Bice) are essentially dark basaltic glasses and, to a certain extent, andesitic and dacitic glasses. There are also plagioclases (labrador, andesite), augite, magnetite, and traces of cristobalite, quartz and hematite. In the case of the secondary minerals, the palagonitization of glasses (Honnorez, 1967) led mainly to the formation of ferriferous smectites. Under humid tropical climate and Andisol, there are processes of illuviation-concentration around the voids and formation of gibbsite, allophane and halloysite. Under dry tropical climate and brown soils with andic features there is halloysite but little allophane.

The presence in *talpetates* and in soldered cinders of products such as magnetite, microlites of glasses, palagonite, armoured nodules (Fisher and Schmincke, 1984) among others, prove the volcanic origin of these materials. The difference between them is not due to a meteorical weathering, but to a geological one. That means *talpetates* are a phase of a phreato-magmatic eruption where the conditions at the moment of the explosion (specially the water/solid ratio) were different. In one case weathering of the glasses by water resulted in palagonite and later in ferriferous smectites, whereas in other cases, this kind of weathering did not happen. Nevertheless, in all cases, the fusion and/or weathering of the glasses soldered them together, which is the main cause of the induration of *talpetates*.

The physical-chemical and microscopic characterization of *talpetates* and soldered cinders confirm the field observations. So, through them, we could define the source and possible development of events which generated these materials.

Talpetates, also called "Masaya tuff" or "The Retiro tuff" (whereas the soldered cinder is the "triple layer" of Bice) are volcanic tuffs deposited 2,000 years ago during one or several phreato-magmatic explosions of the Masaya volcano as a precolombian pottery prooves it (Prat, 1991). These kinds of explosions are the result of the contact between the phreatic water supplied by the lakes of Managua and Nicaragua with the magma of the volcano. These explosions generated devastating surges of semi-liquid material destroying and molding the vegetation and people. They formed also clouds of dust, cinders, and sand and inside them, the armoured nodules were formed (Fisher and Schmincke, 1984). These surges and aerial deposits covered 2,500 km^2 mainly west of the Masaya caldera. This orientation is partly due to the orientation of the winds blowing from east to west the main part of the year.

Due to their physical-chemical and morphological characteristics as well as their origin, we propose to call the *talpetates* that we studied "palagonitized tuff of Masaya". We must not forget that this product appears a few years after Christ, which means yesterday in geological time. It also covers the richer and more crowded region of Nicaragua. The Masaya volcano is still active...

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