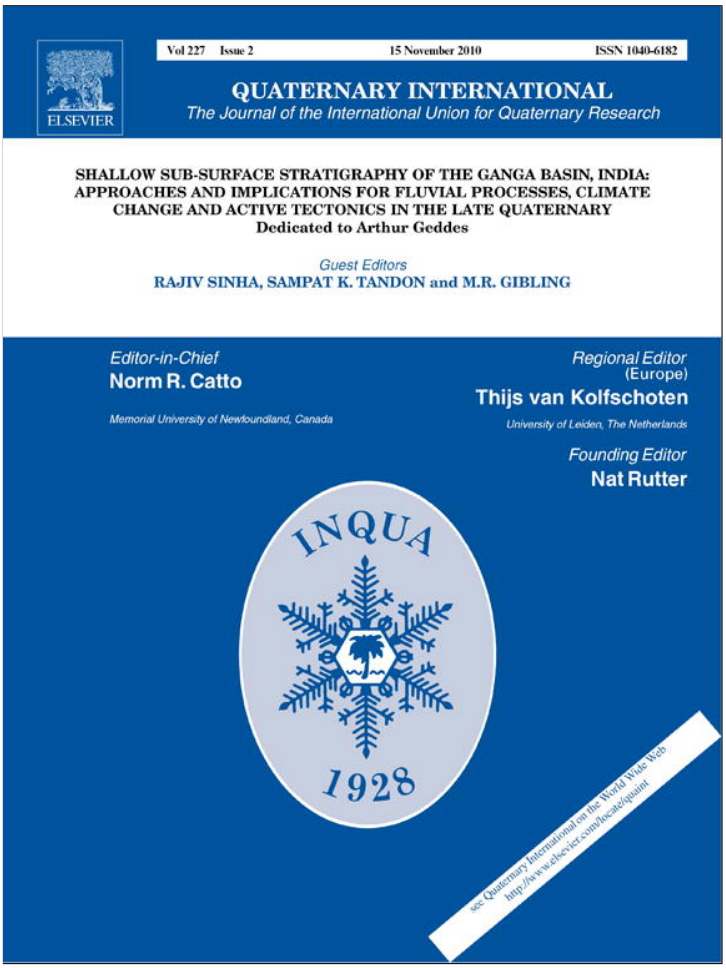

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Forum Comment

Comment on: "Genesis of subtropical soils with stony horizons in NE Argentina: Autochthony and polygenesis". H. Morras, L. Moretti, G. Piccolo, W. Zech. Quaternary International (2009), vol. 196 (1–2): 137–159

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We feel it necessary to comment the paper of Morras et al. (2009) in this journal. The authors presented there a re-interpretation about the origin of the "red materials-soils" outcropping in the Province of Misiones, northeastern Argentina. Particularly, they discussed the "tropical loess" theory (Iriondo, 1996; Iriondo and Kröhling, 1997, 2007, 2008; Iriondo et al., 1997) focusing their research on the premise that all the materials covering the landscape of Misiones are a product of the weathering of the K-basalt and subsequent pedogenesis, mainly using pedological criteria.

With specific regard to the province of Misiones, the origin of the red materials was originally investigated by us (Iriondo and Kröhling, 1997, 2008). Also, our works are the first in the Quaternary of northeastern Argentina. In the first part of the paper, the authors question the validity of those papers largely on the basis that all of their "complex outcropping profiles" are a solum (with thicknesses of several metres above weathered basalt), and discussed the autochthonous or allochthonous origin of materials based on the study of "stone lines", "ferruginous nodular horizons", "siliceous horizons" and "blocky structured horizons" (sic). Especially for the origin of surface material above the "stone lines", they failed to make a comprehensive study.

The authors seek to discredit geology (mainly physical stratigraphy and sedimentology) as the main basis for Quaternary studies of the tropical-subtropical regions. Their approach adopted is, in essence, a reinterpretation of the data and ideas presented in our original papers, with the addition of data not very suitable for discussing in proof the theme. The statements of Morras et al. (2009) misrepresent our geological descriptions of the region and misquote our work resulting from examination of every natural outcrop at the region (also extending to southern Brazil and NW Uruguay), and supported by varied sedimentological data (Iriondo and Kröhling, 2008).

According to Morras et al. (2009) different interpretations on the origin of gravelly levels in soils profiles may lead to very contrasting interpretations of the landscape history. The authors ignore our geomorphological investigations in the region (Iriondo and Kröhling, 2008), that could have contributed to more reliable interpretations. This is important if the authors wish to *"study the origin of these soils with "stone lines" and due to their significance for the reconstruction of the landscape evolution"*. Moreover, no detailed field descriptions of the profiles are provided in the paper of Morras et al. (2009) for comparison with those we have published. In the absence of significant geological data, we are unable to see how the paper invalidates our original conclusions. We believe they have inappropriately generalized their results, derived in general from not at all typical profiles for discussing our theory (several examples appear in photographs including those in the paper of the authors), and extending to the region. They have also drawn some conclusions from some weak inferences.

As we stated in the mainly critiqued paper by Morras et al. (2009), in the purpose of explaining the so-called "red earths", basic geological principles as the meaning of discordances are overseen. In that paper and in a recent one (Iriondo and Kröhling, 2008) we present strong rational arguments for recognizing the widespread occurrence of fine aeolian sediments in tropical regions. Such sediments can be transported and can undergo typical post-depositional processes in some of the major intertropical environments, especially in savanna biomes.

The "red earths" and the "red soils" have been recognized since the XIX century in the tropics, but an aeolian origin of an important part of them has been seldom proposed or sustained. Persistently, aeolian activity as a geomorphological agent in the tropics has been

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neglected and even denied. That is particularly mandatory when materials are red. According to a dogma originated in the French pedological literature in the 1920s, "red = alterations", no other processes are admitted. It is evident that this concept has influenced Morras et al. (2009) in their research in Misiones. Among some authors, Macar (1957) indicates a loessic origin for the fine-grained deposits of southeastern Brazil, that are very similar to the materials outcropping in some profiles of Misiones province. For that region, Lichte and Behling (1999) postulated an allochthonous origin, with significant aeolian participation of the fine sediments mantling the top of the hills (Iriondo and Kröhling, 2001). Two alternative origins have been frequently accepted in the scientific literature for the "red earths": the "lateritic" and the colluvial. Undoubtedly, an important proportion of the red and yellow caps in tropical regions are really laterites, and colluvial deposits can also be a widespread feature. However, aeolian deposits can be, as well, a major component of the landscape of low latitudes erroneously ascribed to other types of tropical products.

Morras et al. (2009) indicated that our main arguments supporting the theory of the tropical loess are the presence of a "stone line" consisting of platy-gravel sized silica, and the occasional appearance of a "buried soil". This is a misinterpretation. We summarized clearly in that cited paper (Iriondo and Kröhling, 1997) many field characteristics of the tropical loess without referring to the stone lines or to the buried soils as follows: "It covers as a mantle the former relief, lying in erosive discordance on the Cretaceous basalts (Misiones and SE Brazil) and sandstones, ferricretes and Tertiary rocks with typical thicknesses between 2 and 8 m. According to the granulometric composition, it is a loam, loamy silt, silty loam or clayey loam (normally the mean size is located in the silt fraction). The colour is reddish ochre or yellowish ochre to dark red (10R 3/6). The sedimentary fabric is porous and friable, powdery and massive. It forms steep slopes in gullies with columnar disjunctions in a loess-like structure. The mobilization of iron oxides and sesquioxides was dominant throughout the profile in the post-depositional phase of the sediment evolution. At the top of the tropical loess soils of the Oxisol-Ultisol Group develop, forming the substratum of rich forest".

It is important to note that the stone lines appear in low proportions in all the profiles that we have investigated on a region extending outside the province of Misiones in which the tropical loess appears (SE Brazil and Paraguay). For this reason, stone lines cannot be used for the interpretation of this type of sediment. Lichte and Behling (1999) also made an exhaustive bibliographic revision of the German literature on the Quaternary of southeastern Brazil, arriving to a similar conclusion about the aeolian origin of tropical covers.

Morras et al. (2009) said that "we consider quartz "stone lines" as allochthonous features"; that is incorrect. They also cited the work of other authors selectively and uncritically in order to bolster their own arguments (e.g. they did not discuss the complete bibliography on the interpretation of "stone lines"). Moreover, the authors said: *"Following the more traditional sedimentological conception, these gravelly levels would be named "stone lines" or "stone layers". Following the autochthonist interpretation…they are named and considered as "horizons"*. They, however, mentioned: "*In the more recent updatings of the Soil Taxonomy, "stone lines" are included among the lithologic discontinuities and it is said (p. 84) that a stone line "indicates that the soil may have developed in more than one kind of parent material. The material above the 'stone line' is most likely transported, and the material below may be of different origin. In other systems as in the old Belgian, French and Portuguese classifications, the "stone lines" are also considered as typical features of discordances"*. The definition reproduced by Morras et al. (2009) precisely coincides with our general interpretation of stone lines. Moreover, the authors stated that *"vertical and lateral variations in rock weathering intensity observed in several profiles provide evidence of in situ formation of this type of structured horizon"*. We do not deny the existence of weathering profiles in the K-basalt with a great variety of products. However, those are different from the aeolian red materials that locally appear on top of it.

It is evident that the authors worked on very selected outcropping profiles along Route 14. They selected some of the localities studied by us, but it is relevant to note that the profiles there may be formed by weathered basalt, soils, paludal deposits, ferricretes or tropical loess along a short horizontal distance or vertical segment investigated. According to the pictures presented by the authors in their paper, it seems that the only pictures with tropical loess are Fig. 7A and D. In consequence, the profiles studied by that authors are not from the typical tropical loess. Who could argue that Figs. 6 and 8 of Morras et al. (2009) do not correspond to a regolith? We deduce that the sampling strategy used by the authors, with their profiles located "near to" our profiles, arguing against our theory is apparent. The exclusion of more representative profiles without geological criteria by the cited authors seriously limits the applicability of their results. Clear and detailed geological descriptions are required for any rejection of our theory.

Morras et al. (2009) applied mainly soil analysis techniques. For this reason, their analytical results failed to produce sedimentological information of the parent material of their "red soils". The authors noted that *"red soils on hills in the central plateau of Misiones have a solum usually ranging between 3 and 7 m in depth"*. However, they did not present a clear description of pedological features and micromorphological data that substantiate such a thick soil (or polycyclic soil). They did not include complete laboratory data of the type profile of the Oberá Fm, although this unit is unrecognized by those authors as a formal lithostratigraphic unit representing our tropical loess. There are no OSL dating reports. They also misrepresent our laboratory data by omitting important results and ignoring statistical considerations. They discuss our interpretation mainly on the basis of two profiles, but surprisingly they have not worked in the type profile of the Oberá Fm (they argue that it was not found during a detailed surveying of the area, but the profile is situated very precisely in our publications and also it is very accessible). Instead, they prefer to select a profile dominated by weathered basalt and the structured horizons, not by the tropical loess (as they recognized clearly in their paper…"*the selected profile by chance though its morphology differs somewhat from the profile described by those authors*").

The authors imply that our sedimentological data are less accurate than their analyses without presenting detailed grain size and mineralogical results of "unequivocally" tropical loess. Our cited mineralogical results were probed recently by scanning electron microscope. Moreover, we never proposed a different origin for this type of sediment as the authors suggested. Also, we never said that the magnetite grains indicate aeolian input from the alluvial plains of the big rivers, as the authors interpreted. We have not found chlorite in our DRX of tropical loess profiles. It is really surprising that the authors tend to invalidate the use of the clay fraction as a sedimentological tracer.

Morras et al. (2009) said: *"Another detail that weakens the tropical loess hypothesis is the difference between the clay association found in the parent material of soils in Misiones and the supposed sources of those materials"*. In their efforts to criticize our hypothesis on the source of materials that compose the tropical loess of Misiones, they revised the antecedents on the clay mineralogy of soils in the Chaco and Pampean regions without including our results of these regions.

In conclusion, we believe that the investigators are incorrect in some of their assumptions and interpretations in this study. They

dismisses our study with the ad hoc explanation that "all" the red earths of Misiones are soils (but may be the parent material of any soils); yet they use no objective criteria, present no representative sedimentological analyses and cite no field evidence to support this conclusion. In other words, the autochthony theory of Morras et al. (2009) of all red earths of Misiones lacked geological control. The validity of the data cited by the authors cannot be judged rigorously because the localization of samples and the selection of the profiles studied (clearly observed in the photographs included in their paper) are not convenient for discussing our theory. Until the geochemistry of the correct profiles and detailed micromorphological and sedimentological data are accomplished and well understood, the result will remain dependent on the individual sampled profile (regolith or structured horizons or tropical loess).

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