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Dust, *terra rossa*, replacement, and *karst*: Striking chemical geodynamics in the Critical Zone

Enrique Merino

Geological Sciences, Indiana University, Bloomington, IN 47405, USA (merino@indiana.edu / Fax 1-812-855-7899)

Although terra rossa soils have long been thought to result from residual dissolution of limestone and/or to form by accumulation of detrital mud, ash, or dust in preexisting karst funnels in limestones, conclusive new field and petrographic evidence shows that terra rossa forms by replacement of limestone by authigenic red clay at a moving metasomatic front, with the clay's major chemical elements, Fe, Al and Si, coming from *dissolved* dust. Strikingly, the replacement of clay for limestone simultaneously triggers a reactive-infiltration instability, first modeled by Chadam et al (IMA J Appl Math, 1986), that causes the front to become fingered and "funneled" – precisely the morphology of karst, characterized by repeated, separate funnels of limestone dissolution! That is, the replacement of limestone by clay turns out also to "carve" the spaced, repeated karst fingers and sinks that contain the terra rossa itself. This is why terra rossa and karst are associated; this is how the karst morphology forms. Terra rossa is thus a metasomatic "claystone" plus its simultaneous lateritic and pedogenetic transforms, the whole being hosted in a simultaneously karstified limestone.

The apparent validity of both the residual and the detrital origins has been a smoke screen that for decades has kept investigators from even suspecting that the true origin of the terra rossa could be different, or that the way to find it should be petrographic. In fact, our petrography of the terra-rossa reaction front at Bloomington, Indiana, not only shows that the limestone is replaced by authigenic clay. It also provides the first direct evidence (in the form of clay-calcite microstylolitic contacts) that replacement takes place because the new clay crystals, *via* the induced stress they generate, *pressure-dissolve* the calcite host (as first proposed for any replacement by Maliva and Siever, Geology, 1988), not because the host dissolves first and somehow "pulls" behind itself the growth of the guest (as conventional wisdom has it). In turn, the fact

that replacement happens by pressure solution leads us to understand how it modifies the pore water chemistry to trigger the reactive infiltration instability that causes karst morphology.