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

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Although terra rossa soils have long been thought to result from residual dissolution of limestone and/or to form by accumulation on preexisting limestone karst of detrital mud, ash, or especially dust, conclusive new field and petrographic evidence for the terra rossa in southern Indiana, USA, shows that terra rossa forms by replacement of limestone by authigenic red clay at a moving metasomatic front, with the clay's major elements, Fe, Al and Si, coming from *dissolved* dust, as suggested by strontium isotope ratios.

Strikingly, the clay-for-limestone replacement triggers a *reactive-infiltration instability*, first modeled by Chadam et al (1986, IMA J Appl Math **36**, 207), that causes the front to become 'fingered' and 'funneled' on a cascade of scales – precisely the characteristic morphology of karst! That is, the replacement of limestone by clay turns out also to carve the repeated karst funnels and sinks that contain the terra rossa itself. This is why terra rossa and karst are associated, and how the karst morphology arises. Terra rossa is thus a metasomatic 'claystone' plus its lateritic or pedogenetic modifications, all hosted in a simultaneously karstified limestone. Karst limestone weathering is driven ultimately by eolian dust supply.

The partial validity of both the residual and detrital origins has been a smoke screen that for decades has kept investigators from even suspecting that the true origin of terra rossa could be different, or that the way to find it should be petrographic, not chemical. In fact, our petrography of the terra rossa at Bloomington, Indiana, not only shows that the limestone is replaced by red clay. It also provides the first direct evidence (in the form of clay-calcite contacts that are microstylolitic) that replacement takes place because the new clay crystals, via the local induced stress they generate as they grow, *pressure-dissolve* the calcite host (as first proposed by Maliva and Siever 1988, Geology **16**, 688), 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 the replacement happens via pressure solution leads us to understand how the resulting pore water chemistry triggers the reactive infiltration instability that causes the typical karst morphology.