



TERRA

the mystery of



Michael May

MICHAEL MAY IS A WKU GEOLOGIST WHO IS LOOKING FOR THE DIRT ON HIS RESEARCH TOPIC — TERRA ROSSA SOILS.

“Terra rossa, the red, iron- and clay-rich soil common in karst areas, is found above limestone bedrock,” May said. “What parents in the Bowling Green area haven’t encountered their children’s sports, school, or play attire stained with terra rossa? It literally touches all of our lives. Get some on your soccer clothes, or gardening clothes, and it will not wash out easily. That’s the iron in the terra rossa, the element that gives our

soil its red color. Exactly how this unusual soil forms has been a mystery.”

Geologists have proposed that by better understanding the origin of this red material there may be a more solid basis for finding and extracting enriched ores of iron, aluminum, and similar economically important elements, he said. For years, researchers have tried to determine the origin of terra rossa soil. One theory was that the red soil resulted from the dissolution of limestone and is simply an insoluble residue or leftover from that process. Another theory was that glaciers had

“bulldozed” the red soil as far south as southern Indiana and other terminal areas.

In the past several years, May has been collaborating with Dr. Enrique Merino and other researchers at Indiana University on another theory. “We’re throwing out the idea that it’s just a simple insoluble residue,” May said. “It doesn’t make sense geochemically to be able to take a rock that is about ninety-nine percent calcium, carbon, and oxygen, and magically get all that iron by simple dissolution.”

“Then the second discounted idea was that glacial ice could just push in such soil. We found the soil in central,



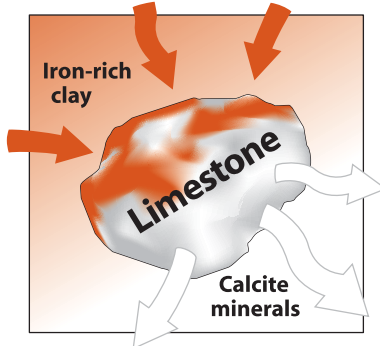
ROSSA

BY TOMMY NEWTON

south central, and western Kentucky, and the glaciers never touched those parts of Kentucky. So the question still remains: What kind of evidence should we be looking for to help us understand where all this red dirt originated?"

Their idea is fairly simple and based on the "conservation of mass principle." The principle is applied to fixed volumes, known as control volumes (or surfaces), as in a known volume of limestone. For a given control volume, the principle states that mass entering per unit time equals the mass leaving per unit time plus the increase of mass in

the control volume per unit time. Assuming a steady state flow of mass, mass in equals mass out, and there is

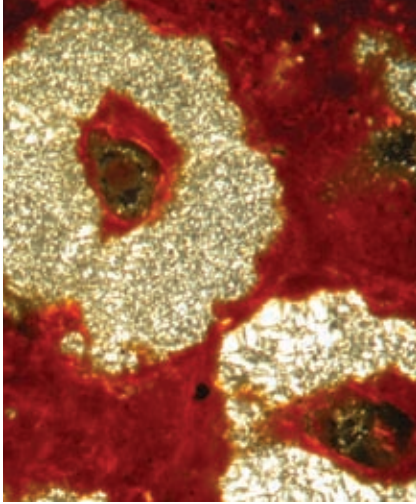


Conservation of mass principle
Limestone being replaced by iron-rich clays forming "terra rossa"

no volumetric change in the limestone — only a replacement of the rock's original minerals by minerals.

"Using that as a kind of thesis, what we came up with was that we could collect evidence in the field that would be suggestive of a mineralogical or chemical replacement process within the limestone," May said. "The problem always has been that people making the observations weren't trained in microscopic analysis of rocks. They didn't look for it so they didn't see it."

In recent years, May and others have been collecting samples.



Microscopic evidence showing original limestone being 'eaten away' or replaced by iron-rich minerals leaving ghost images of ancient marine fossils.

The best samples come from construction sites, such as the huge limestone rock resting near the Environmental Science and Technology Building. That rock was removed from the site of WKU's new Complex for Engineering and Biological Sciences. "That rock shows the interface where chemical and physical processes are changing our white limestone into something red," May said.

May began working on the replacement theory during his Ph.D. work at Indiana University. "It's an ongoing interest of mine to look at sedimentary rocks such as the limestones around Bowling Green with an eye toward the changes they undergo over time," May said. "And when I say time I mean geologic time — several hundred thousand to a few million years."

The samples, such as those from the rock removed at the WKU site or from a grocery store construction site in Bloomington, Indiana, revealed that the calcite (limestone's main mineral) is being replaced by iron-rich minerals.

"We're looking for bona fide textures that were characteristic of a certain limestone. For instance if it had seashells in it, we might find ghost outlines of the seashells in the terra rossa right at the limestone-terra rossa interface," May said.

Photographs from the microscopic analysis of the limestone show burrows of organisms that once lived on the sea floor. May said that texture also shows up in the nearby

Samples taken farther away from the limestone-terra rossa interface and closer to Earth's surface show more impact from weathering and other natural phenomena such as earthworms and microbes. "The question that is really out there is where did all this iron come from," May said. "Perhaps the best idea, but it can't be proven at this point, is that it's literally dust in the wind. We have a lot of iron-rich, airborne particulates that get moved all across the earth," he said.

WKU students have traveled to the Bahamas in recent years and have documented some red layers in otherwise white limestone there. "Where did all this red sediment come from?"

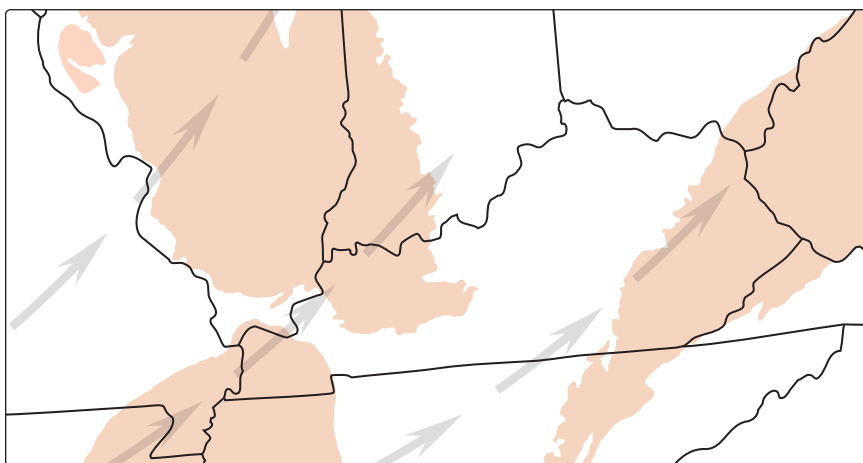
"The question that is really out there is where did all this iron come from?"

terra rossa soil. "If you have the same shapes of fossil grains in the terra rossa that you have in the immediately adjacent limestone, you should be able to see that it is not simply an insoluble residue. It's actually an active phenomenon where the limestone goes from calcite to an iron-rich series of minerals that are totally different, but it retains its original depositional texture," he said.


May said. The red, yellow, and brown dust has blown from Africa across the Atlantic Ocean and is affecting areas in the Caribbean causing demise of some coral reefs.

And if you travel up the Natcher Parkway, you'll see reddish or brown sedimentary rocks such as shale and sandstone. "Guess what they have?" May said. "Lots of iron in them. So as those were stripped off and eroded over hundreds of thousands or millions of years, they contributed to the raw materials of iron or iron oxide that could have easily been washed or blown into the karst plain area. And simply put, nothing is lost or gained. It is just recycled. Again just because you can't prove how the iron got there, doesn't mean it didn't get there. But I think it's a pretty good explanation."

The replacement phenomenon is ongoing. "Nature has been tricking people about terra rossa for a number of years just by what we call simple weathering or soil forming processes. Once this is converted mineralogically

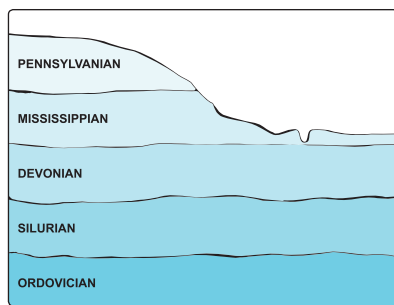


 *Prevailing winds transporting iron-rich clays from southwest*

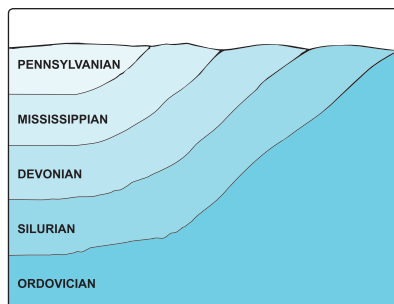
 *Potential iron sources from younger Mississippian and Pennsylvanian bedrock (sandstone and shale).*



“We have a lot of iron-rich, airborne particulates that get moved all across the earth”



Generalized geologic cross section showing karst plain with terra rossa in Mississippian rocks on right. Dripping springs escarpment and younger Mississippian and Pennsylvanian rocks on left potentially supplying karst plain with iron-rich material.



Generalized geologic cross section showing the regional bedrock dip resulting in exposure of rock layers of different ages. Mississippian rocks are host to well developed terra rossa soils.

or chemically, it also gets churned some more by natural soil forming processes — it freezes and thaws,” he said.

“The phenomena of weathering and replacement are little understood by a lot of people who do landscape analysis including geomorphologists because they don’t get microscopic views,” May said.

“All the rocks in the area appear to be eventually turning into this red soil.” The replacement theory also has economic value because companies that deal in enriched ores, such as bauxite for aluminum and laterite for iron, want to know the concentrations of elements in the ore. They also want to know the processes responsible for variations in concentrations. Some globally important metallic ores owe their genesis to mineralogical replacement processes, May said.

May’s work is a rare combination that bridges soil science, petrography, sedimentary geology, and geochemistry. “This research is interesting because it is getting involved with the complexities of geology,” he said.

“We’re not looking way out there at big mountains or other large features. It’s the opposite. It’s a matter of focusing on the microscopic and putting it in the context of the selection of samples in the field. People simply haven’t had the opportunities to look at it in this way.”

For WKU students, the research has given them opportunities to visit places like the Bahamas, to conduct hands-on applied research, and to present their findings at local, regional, and national conferences. “At this point, my work is to engage the students,” May said. “Through study abroad programs, we want to continue to provide students the opportunity to examine these rocks and ancient soils. We want to let students look at these things in the field and also under the microscope when we get back.”

May hopes the students will continue to share in his enthusiasm for the terra rossa research. “We know so little about the soil we walk on. I enjoy taking some dirt and finding out how old it is and what it’s made of.”