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# Origin of terra rossa soils in the Mediterranean region

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Terra rossa is a reddish clayey to silty/clayey soil that is especially widespread in the Mediterranean region, where it overlies limestones and dolomites. In some classification systems based on the Mediterranean climate as the major soil differentiating criterion, the term terra rossa is used as a name for the soil subclass "Modal Fersiallitic Red soil" when situated on limestones (Duchaufour, 1982). However, several national soil classifications (e.g. Croatian, Italian, Israeli) retained the term "terra rossa" for the hard limestone derived red soils. The nature and relationship of terra rossa to underlying carbonates is a longstanding problem that has resulted in contrasting opinions with respect to their parent materials and origins. In some isolated karst terrains, terra rossa may have formed exclusively from the insoluble residue of limestone and dolomite, but it most commonly comprises a variety of external materials, including aeolian dust, volcanic debris and clastic sedimentary particles that were carried to the carbonate terrain by various transport mechanisms. Some recent investigations in Indiana, USA (Merino and Banerjee, 2008) show that terra rossa forms by replacement of limestone by authigenic clay at a moving metasomatic front.

Terra rossa covers limestone and dolomite in the form of a discontinuous layer ranging in thickness from a few centimetres to several metres. It is also found along cracks and between bedding surfaces of limestones and dolomites. Thick accumulations of terra rossa like material are situated in karst depressions in the form of pedo-sedimentary complexes. Different authors have considered terra rossa to be soil, vetusol, relict soil (non-buried-paleosol), paleosol or pedo-sedimentary complex (soil-sediments). However, most authors today believe that terra rossa is a polygenetic relict soil formed during the Tertiary and/or hot and humid periods of the Quaternary. Investigation in the Atlantic coastal region of Morocco (Bronger & Sedov, 2002) shows that at least some terra rossa previously referred to as polygenetic relict soils should be regarded as Vetusols (soils that are marked by a continuity of pedogenic processes) according to the concept of Cremaschi (1987).

A bright red colour is a diagnostic feature of terra rossa and is a result of the preferential formation of haematite over goethite, i.e. rubification. Boero & Schwertmann (1989) concluded that it is of little relevance for the process of rubification whether the primary Fe sources are autochthonous or allochthonous as long as the general pedoenvironment remains essentially suitable for the formation of terra rossa. This pedoenvironment is characterised by an association of Mediterranean climate, high internal drainage due to the karstic nature of a hard limestone and neutral pH conditions. Terra rossa is formed as a result of: (1) decalcification, (2) rubification and (3) bisiallitization and/or monosiallitization. Since $Fe_d$/clay ratios are relatively uniform in most terra rossa,

translocation of clay particles is responsible for the distribution of the red colour throughout the whole profile. However, since terra rossa soils have been exposed to various climatic fluctuations they can be affected by eluviation, yellowing and secondary hydromorphy. Erosional and depositional processes operating on the karst terrains, induced by climatic changes, tectonics and/or deforestation might be responsible for both the patchy distribution of terra rossa and the thick colluvial or alluvial terra rossa accumulations in uvala and dolina type of karst depressions.

The main objective of this lecture is to give an overview of terra rossa soils in the Mediterranean region based on different aspects (bulk and clay mineralogy, heavy and light mineral fractions, grain size distribution, iron-oxide phases and distribution of $Fe_t$, $Fe_d$ and $Fe_o$, geochemical fingerprinting). Examples from Istria will be used to demonstrate these aspects (Durn, 2003; Durn et al., 1999, 2001, 2007).

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