Geophysical Research Abstracts
Vol. 17, EGU2015-4559, 2015
EGU General Assembly 2015

Soils on raised marine terraces in the Metaponto area, S Italy: not a simple chronosequence

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A sequence of Middle and Late Pleistocene raised marine terraces stretches along the Gulf of Taranto, S Italy, for more than 65 km from Rocca Imperiale, Calabria, in the SW to Taranto, Apulia, in the NE, in an approximately 25 km wide belt. The terraces formed as a result of the interplay between sea-level fluctuations and regional tectonic uplift over a time-span of ca. 780 ka. They were selected for establishing a soil chronosequence, in order to analyse rates of soil-forming processes in the central Mediterranean region. Indeed, several general trends of soil formation with terrace age were identified. For example, soil thickness and Fed/Fet ratios increase, while the weathering ratio (Ca+Mg+K+Na)/Al decreases with assumed terrace age. These changes could be best described by power functions (R2 = 0.88 for soil thickness, R2 = 0.87 for Fed/Fet, and R2 = 0.96 for (Ca+Mg+K+Na)/Al).

However, closer examination revealed that the soils did not simply form in the marine gravel bodies but in various kinds of sediments. The development of the landscape along the Gulf of Taranto turned out to be much more complex than previously expected. Sediment-soil successions exposed in several gravel quarries reveal that each terrace, after its original formation, was exposed to changing conditions in terms of climate, vegetation, level of erosion base (related to sea-level oscillations and/or tectonics), and other environmental factors during the Pleistocene and Holocene periods. As a result, it was subject to (i) further geomorphological and sedimentological evolution, including incision, denudation, deposition of alluvial sediments, and accumulation of colluvial deposits, in parts due to natural processes and in parts due to human activity; (ii) various directions and rates of soil development, corresponding to changing environmental conditions during glacial and interglacial periods. In some cases, there is evidence for a period of soil formation in the marine deposits prior to the deposition of the alluvial sediments. For example, a several metres thick marine gravel body, overlain by a layer of alluvial sandy-loamy sediments, is exposed in a gravel quarry on terrace T2 (assumed to have accumulated during MIS 5c). The boundary between the two sediment packages is very sharp and wavy, indicating a period of incision into the gravel body prior to the deposition of the alluvial sediments.

Based on these observations, the following chronological sequence of events is assumed for this site:
1) accumulation of the gravel body in a delta environment during MIS 5c;
2) period of soil formation during late MIS 5c, after the surface of the gravel body had fallen dry;
3) incision of creeks, cutting channels into the gravel body as sea level dropped during MIS 5b;
4) sea-level rise during MIS 5a, not reaching the same level as during MIS 5c due to progressing regional uplift in the meantime; wave action of the MIS 5a sea removed part of the MIS 5c gravel body and cut a cliff into it, thus shaping the seaward edge of terrace T2;
5) accumulation of alluvial deposits in the previously incised channels and on top of the erosional gravel-body surface during MIS 5a because of the raised erosion base level;
6) incorporation of sandy sediments from the near-by MIS 5a beach, possibly with some contribution from temporarily dry beds of the nearby torrential rivers, into the alluvial deposits.

Similarly complex sediment successions can be observed in several exposures. In addition, in some locations up to several metres of loess-like sediments are exposed. They probably accumulated during glacial periods, being blown out from the wide, temporarily dry river beds and from the exposed shelf. These observations led to a more differentiated reconstruction of the evolution of the landscape and soils in the Metaponto area.