



Rock varnish on the Messak plateau (Libyan Sahara): chronology of weathering process

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Rock varnish is one of the most peculiar features of the geomorphological landscape in rocky deserts; it is a dark multi-stratified coating that covers all the exposed rock surfaces, and it was originated by weathering process under wetter climatic conditions. In this sense across the Saharan massifs and especially on the Messak Sattafet plateau (SW Fezzan, Libya) rock varnish is a fossil feature developed on sandstone during the Quaternary. Micromorphological investigations and SEM-EDS analyses allow to define the complex microstructure of this alteration surface and to hypothesize the environmental context of formation. Rock varnish is composed by three micro-layer: 1) the outmost layer is very thin, light, birefringent, slightly laminated and mainly composed by quartz dust and alkaline elements. 2) the second coating is up to 60-80 micron thick, dark, opaque; the SEM analyses shows a stratified fabric while the EDS gives a chemical composition dominated by Mn and Fe oxides. 3) the innermost layer is the thicker (sometime more than 1 mm), very high birefringence, it is composed by clay minerals (very rich in Fe) and the EDS shows several concentrations of organic Carbon; it lies on the quartz grains of the sandstones, generally quite weathered. As clear in thin section, the innermost coating was deposited by clay illuviation, during a wet period. The second coating was originated by bio-mineralization (bacterial fixation of Mn); this process requires a semi-arid climate. The outer micro-layer, rich in quartz dust, is related to a completely dry environment and it was deposited by the wind. It is possible to delineate a reliable chronology of the weathering phases, based both on geoarchaeological remarks and Radiocarbon dating. Thanks to the high content in organic Carbon of the innermost coating, several samples were submitted to AMS Radiocarbon dating; the results (9200 ± 70 , 6030 ± 50 and 5460 ± 60 years BP) give the time of deposition of organic matter in the clayey layer during the illuvia-

tion process. The age of the Mn-oxides rich layer is furnished by the study of the development of rock varnish on rock wall engraved by prehistoric communities and on Neolithic megalithic stone structures, which correct age is given by archaeological investigations; it happened during the Middle Pastoral age (Middle Holocene). The achieved chronology is completely in accordance with the knowledge of the Holocene environmental changes happened in the SW Fezzan. On the Messak surface weathering process started at the beginning of the Holocene (between 9000 and 5500 yr BP); under wet environmental condition a strong illuviation of clay took place. The biological mineralization of Mn occurred during the Middle Holocene (5000-4000 years BP) in a phase of incoming aridity. The aeolian deposition of quartz dust and alkaline elements is the last phenomena of plasmation of the rock surfaces; it took place in the last millennia under a severe dry climate.