



Pleistocene calcrete deposits from southern Spain as indicators of climatic conditions and tectonic activity

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Quaternary calcrete horizons are common weathering products in arid and semi-arid regions of southern Spain. We have analysed a calcrete profile developed within poorly sorted gravels of an alluvial fan. These deposits were sourced from the Carrascoy Range, a fault generated mountain front located in the Internal Zones of the Betic Cordillera (South Spain). During the Pleistocene the climate in southern Spain was dry, either in the form of semi-arid/arid conditions or as seasonal moisture deficits. Alluvial channel incision trends appeared to be disrupted by episodes of alluvial aggradation produced during cold and dry glacial periods. At the top of the aggradational phases, pedogenic processes operated profusely, and, as a result, several calcretes (stage V mature calcrete profiles) were formed. We have analysed one of these calcrete profiles that appears subvertical within the forelimb of a regional fold in relation to the Carrascoy Fault activity. The calcrete consist of a densely cemented hardpan horizon (20 to 40 cm thick) overlain by a thin, 2-cm thick laminar crust. Below the hardpan horizon, carbonate concentrations gradually decrease to clast-coating textures. Calcretes form progressively and a wide range of carbonate phases occur within a single horizon, being the laminar crust the final stage of evolution within a mature pedogenic calcrete deposit, and, therefore, the carbonate within it postdates all the cement phases within the profile. The location of the latest cement phase of the calcrete deposit has been estimated by microscopic observations (to establish their suitability for dating) together with a detailed sedimentological analysis of the calcrete profile in the field. The laminar crust consists of less than 1 mm thick laminae characterized by the alternation of layers of micrite and layers of micrite with ooids, detrital grains and clays indicating environmental conditions in which sedimentation rates were low and episodic. By using radiometric $^{232}\text{Th}/^{238}\text{U}$ dating methods we obtain an age of formation of the laminar crust of ~ 209 Ka (upper part of the Middle Pleistocene). This age corresponds to the warm stage 7c within the glacial Riss period. As pointed out before, the studied calcrete appears subvertical as a result of the activity of the Carrascoy Fault, and, therefore, the fault was active only after the calcrete was formed. Our study permits, as well, to reliably asses the timing of changes in alluvial processes, to characterized this part of the stratigraphic succession as corresponding to an arid to semi-arid environment, and to conclude that this particular calcrete was developed during a relative European warm period within a glacial stage.