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TIMS U-Th dating of calcretes from Southern India: new insight into pedogenic processes in semi-arid regions

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Accumulations of calcium carbonate in weathering profiles (calcretes) are widespread in semi-arid lands where annual rainfall ranges between 600 and 400 mm/yr. There are only few studies so far on calcretes developed on non-calcareous parent rocks. Such cases are important as they raise (1) the question of the calcium sources, $i.e.$ local origin linked to *in situ* weathering or allochtonous origin from atmospheric input; and (2) assessment of stages and timescales of calcrete evolution, which has been a long standing problem. This study relates micromorphological observation and isotopic tracing (Sr, U, Th isotopes) of various pedogenic calcrete developed on the Precambrian basement in semi-arid Southern India. The two main settings are upland Karnataka (Gundlupet, ca. 900 m) and lowland Tamil Nadu (Coimbatore, ca. 400 m), respectively.

In this contribution, we focus on U-series dating by thermal ionisation mass spectrometry (TIMS). The U-Th analyses were based on the isochron method to correct the initial amount of ^{230}Th, based on the abundance of ^{232}Th. Coeval subsamples required for the isochron age determination were obtained by the Total-Sample Dissolution method [1,2]. Different scales of variation must be investigated in order to obtain a reliable age model, both for the lateral and vertical calcrete distribution at landscape and profile scale, and at the microscopic scale of specific facies. Micro-sampling (1g) of coeval sub-samples is based on the homogeneity of a given petrofabric identified in thin section. Six samples have been selected from one profile from the Coimbatore site, corresponding to distinct facies: laminar hardpan, massive hardpan, brecciated

hardpan. Three samples have been chosen from two profiles at the Gundlupet site, including isolated nodules and nodular hardpan facies.

The following results have been obtained:

(1) The sub-samples from each sample form well defined regression lines, statistically valuable in the 3D graph ^{230}Th/^{238}U vs ^{234}U/^{238}U vs ^{232}Th/^{238}U. (2) Our data demonstrate that the detrital phase is never at secular equilibrium, by contrast with the classical paradigm of the isochron dating method [1,2,3]. The two sites exhibit distinct isotopic composition of the detrital phase. At Gundlupet, it is characterized by ^{230}Th/^{238}U > 1 and ^{234}U/^{238}U < 1. At Coimbatore, the detrital phase has the following isotopic composition: ^{230}Th/^{238}U < 1 and ^{234}U/^{238}U > 1. (3) The U-Th results reveal distinct chronological stages for the profile at Coimbatore. The ages range from 304+/-38 Ka to 44+/-2.9 Ka (2σ), from the base to the top of the profil and are coherent with the evolutionary sequence based on micromorphological and mineralogical observations. For the Gundlupet site, a unique stage of formation at around 200 ka is suggested by the three samples, suggesting a major phase of weathering and massive Ca release. These U-Th ages also highlight the fact that there is no clear correlation between the periods of calcrete formation and climate variations during the last glacial cycles in this part of semi-arid South India.

References

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