Use of in situ-produced cosmogenic ^{10}Be for the study of Brazilian lateritic soil evolution

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Since the Tertiary, climatic conditions have induced the development of lateritic systems at the expense of stable cratons in intertropical areas. Even if lateritic structures have generally been well characterized (Nahon, 1986), their genesis and evolution still remain subject to controversy. Notably, the occurrence of quartz cobbles 'stone-line' in the surficial ubiquitous nodular layer is not well understood and gives rise to numerous questions. In this study, the ^{10}Be produced within the quartz mineral lattice (*in situ*-produced) has been used to characterize and quantify processes leading to the emplacement of two Brazilian lateritic soils. One is located on the São-Francisco craton within the Bahia State, at Itaberaba (12.5°S, 40.18° W), and the other one on the edge of the Amazonian craton, at Cuiaba (15°S, 53°W) in the Mato Grosso State.

Itaberaba site

Both the quartz vein which penetrates the saprolite at the summit of a rounded hill and its connected quartz rich 'stone-line' which travels downslope at the interface between a yellowish saprolite and a reddish sandy-clayey layer have been sampled at this site.

From the quartz vein up to 15 m away, the 'stone-line' centimetric to decimetric angular quartz cobbles lay at roughly 60 cm below the surface. Further away, they are incorporated in an indurated sandy-clayey matrix and their depth below the surface fluctuates irregularly from 80 down to 200 cm. Between 20 m to 24 m from the quartz vein, no quartz cobbles were found.

The exponential decrease with an attenuation length of 193 g.cm^{-2} of the ^{10}Be concentration as a function of depth along the quartz vein unambiguously indicates an autochthonous evolution (Brown *et al.*, 1994). In addition, when compared with the theoretical depth profile obtained using a mean erosion rate of 9.0 ± 0.5 m.My^{-1} deduced from the ^{10}Be concentration of the surficial quartz vein sample, this experimental profile allowed us to

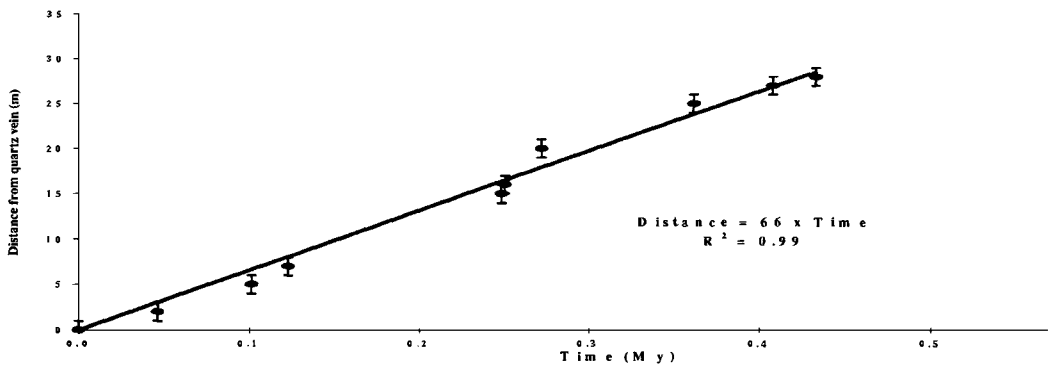

FIG. 1. Estimation of lateral displacements for Itaberaba 'stone-line'. Solid points correspond to the burial model. Slope of line corresponds to the horizontal displacement rate.

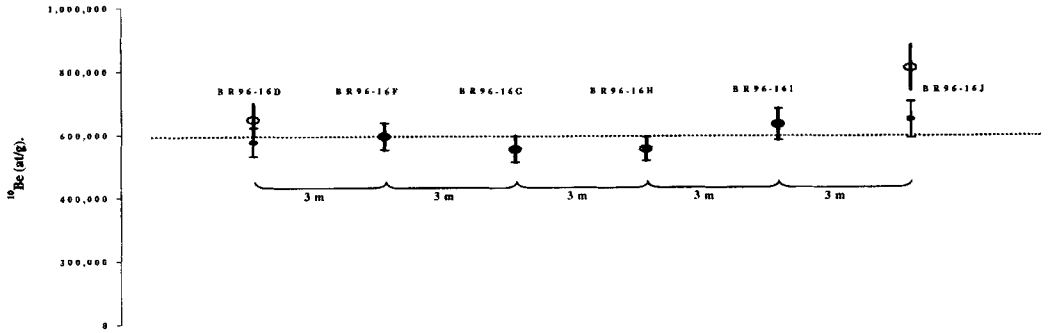

FIG. 2. *In situ*-produced ^{10}Be concentrations along the Cuiaba 'stone-line'. Open circles correspond to experimental data, solid points to the 100 cm depth normalized ^{10}Be concentrations. Dotted line shows the 100 cm depth normalized mean ^{10}Be concentrations.

evidence a collapse of 35% in the upper two meters subsurface depth.

Along the 'stone-line', the ^{10}Be concentration of the constituting quartz cobbles almost systematically increases with their distance from the quartz vein. This indicates that they continuously accumulated ^{10}Be during their migration from the source region (the quartz vein) to the sampling location. A burial model developed (Braucher *et al.*, 1997) to evaluate the rate of the downslope lateral displacements which thus give rise to the 'stone-line', yields to a mean downslope lateral displacement of 66 ± 5 m.My^{-1} (Fig. 1).

Cuiaba site

Quartz cobbles have been collected along a 'stone-line' travelling at roughly 1 m subsurface depth which has no obvious connection to any quartz vein at depth. Fieldwork observations of the relative structural uniformity of the surficial unit as well as the rounded shape of quartz cobbles, lead us to envisage the occurrence of an alluvial-like deposition event. In order to precise the processes involved in the emplacement of this 'stone-line', an additional vertical profile going from the surface down to the saprolite throughout the surficial deposit was thus sampled. This profile, 110 cm long, first penetrates a 20cm thick ferruginous hard crust, then goes through a 70 cm thick nodular layer with crust relicts and crosses the 'stone-line' at 90 cm.

Contrarily to what has been observed at the Itaberaba site, no systematic evolution of the ^{10}Be content as a function of the sample location along the 'stone-line' is evidenced at Cuiaba. The ^{10}Be concentrations measured within the 'stone-line' rounded quartz cobbles appear to be quasi constant all along the sampled sequence (Fig. 2).

The ^{10}Be concentrations measured along the vertical profile show an exponential decrease which implies not only that all studied samples have undergone their exposure history in the same relative position, but also that they all have been emplaced either with the same initial ^{10}Be concentration or with a negligible ^{10}Be concentration. First, this strongly suggests that the "stone line" emplacement results from almost contemporaneous rapid events. It most likely involves a sheet washing process at the surface of the lateritic palaeolandscape. The resulting surficial dispersion of allochthonous quartz cobbles is then almost immediately followed by colluvial deposition of weathered lateritic material including some scattered quartz cobbles. Then, in addition to the fact that inheritance is stochastic by nature, the observed exponential decrease strongly favours the hypothesis that all samples were emplaced with negligible ^{10}Be. Assuming no erosion, the mean concentration measured at 100 cm depth yields a minimum exposure time of ~0.5 My. This leads us to propose that the Cuiaba 'stone-line' results from contemporaneous rapid events that occur at least 0.5 My ago.

References

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