INTRODUCTION

In the study of Earth-surface environmental processes during the events associated with the Permian–Triassic boundary, a key issue is the nature of the latest Permian pre-extinction surface in shallow marine limestones in numerous sites, principally within the Tethyan realm. Sediments below this surface pre-date the extinction event, so that the limestones comprising these latest Permian facies contain diverse fossil remains of organisms that lived just before the extinction. At all reported sites, this surface is disconformably overlain by post-extinction sediments, which contain microbialites in many places, particularly in Tethys. The nature of the youngest pre-extinction surface remains controversial, originating by either physical erosion or dissolution. Furthermore, if the surface was created by dissolution, this could reflect ocean acidification or, alternatively, subaerial dissolution. These arguments were discussed by Collin et al. (2009) and Kershaw et al. (2012a).

In an attempt to solve the problem of the origin of the youngest pre-extinction surface, Lehrmann et al. (2015) provided a comprehensive treatment of the associated facies in the Nanpanjiang Basin in southern China, which although is of considerable value, contains some aspects we consider require further attention. Our comment primarily addresses their views regarding the environment of formation of calcium carbonate grain-coating cements in the boundary deposits. We also consider other aspects of their paper, all presented under several subheadings on specific points listed below. Thus, in this comment, we aim to clarify some of their reported observations and interpretations of the boundary deposits.

In preparing this comment, we reviewed thin sections used by Collin et al. (2009) and present further photographs showing the fabrics in better detail. Figure 1 shows outcrop views of a key site in the Great Bank of Guizhou (for location see Lehrmann et al. 2015, fig. 1). Figure 1C is a polished block showing there are two truncation surfaces in the latest pre-extinction facies, close together just below the post-extinction microbialite. Figure 2 shows the lower truncation surface and eroded clasts from the underlying sediment incorporated into the sediment above the surface.

POINT 1: PENDENT CEMENTS

Lehrmann et al. (2015) assembled detailed measurements of thicknesses of isopachous cements encrusting the grains in the grainstone below the final pre-extinction surface to reveal that those cements vary in thickness but the variation does not have a uniform orientation. Specifically, according to Lehrmann et al. (2015), the thicker parts of the cements do not consistently point downwards and Lehrmann et al. (2015) used this information to "refute" (in their words) the interpretation of Collin et al. (2009) of the presence of pendent cements (which should of course all point downwards) and meniscus cements.

Lehrmann et al. (2015, caption for fig. 12D) state there is a single generation of cement. Figures 3 through 6 of this comment, some of which are higher resolution versions of photographs published in Collin et al. (2009), show a thin rind of well-displayed isopachous fibrous cement formed at an early stage in the diagenetic history of the deposit. This rind did not cover all grains: some have prominent fibrous isopachous cement while others have little or none. Some grains have eroded/dissolved margins, and some of those have the early isopachous cement. A few grains show the first generation of fibrous isopachous cement overgrown by a second generation of grain-coating cement that has variable thickness and commonly has a diffuse appearance, not being as neatly fibrous as the earlier isopachous cement. It is this later cement that is pendent on some of the grains (Figs. 4, 5). Although it is certainly true that the number of grains with pendent and meniscus cement is limited, the limestone in which they occur is an eroded remnant, only a few cm thick, of foraminiferal grainstone directly below the final pre-extinction surface (Fig. 1C), also illustrated by Collin et al. (2007). The portion in which pendent and meniscus cements occur extends no more than 5 cm (and commonly less) below the final pre-extinction surface because there is an earlier erosion surface on finer-grained grainstone facies on which the foraminiferal grainstone was deposited (Fig. 2), described further below. Thus we contend that the description of pendent cements in the foraminiferal grainstone by Collin et al. (2009) remains valid, but accept that they may well be sparsely preserved, noting that only a few samples of the foraminiferal grainstone were collected by Collin et al. (2009).

POINT 2: GEOPETAL SEDIMENT AND SEQUENCE OF EVENTS

Geopetal sediment in these rocks was deposited after the isopachous cement and is present in photographs in Lehrmann et al. (2015, fig. 12). Rather oddly, in thin sections illustrated by both Collin et al. (2009) and Lehrmann et al. (2015), some of this geopetal material (which is quite dark) lines floors and vertical walls of small cavities and may represent oxidation in vadose cavities, mentioned as an expectation by Lehrmann et al. (2015).

Lehrmann et al. (2015) wrote: “The internal sediment consists of a darker micrite followed by a more diffuse micritic and peloidal material (Fig. 12A, 12C). The dark micrite adheres to particle walls and the peloidal sediment forms irregular convex-upward surfaces forming ‘gravity-defying’ fabrics (Fig. 12A, 12C). The gravity-defying fabrics suggest a microbial origin for the internal sediment. The peloidal internal sediments