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Reply to the comment on "Chronostratigraphy and paleoclimatology of the Lodève Basin, France: Evidence for a pan-tropical aridification event across the Carboniferous–Permian boundary" by Michel et al., (2015). Palaeogeography, Palaeoclimatology, Palaeoecology 430, 118–131

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ABSTRACT

Michel et al. (2015) present new radioisotopic age estimates coupled with paleosol data from the Lodève basin, France that indicate a Pennsylvanian–Permian trend toward aridity that is similar to trends seen in other western equatorial basins across tropical Pangaea. In their comment, Pochat and Van Den Driessche (2015) call into question these newly published U-Pb zircon chemical-abrasion isotope dilution thermal ionization mass spectrometry (CA-IDTIMS) age estimates from volcanic ash layers preserved within the Lodève Basin. Furthermore, Pochat and Van Den Driessche (2015) reject our assertion that the rates of sediment accumulation for the Carboniferous–Permian strata in the Lodève basin are in need of recalculation as a result of the new geochronological dates. Finally, Pochat and Van Den Driessche (2015) suggest that the paleosol data presented in Michel et al. (2015) do not provide meaningful proxies of paleoclimate change, and reassert the position presented in Pochat and Van Den Driessche (2011) that sedimentary strata are not strongly affected by paleoclimatic change compared with the influence of tectonic processes of the Lodève basin.

1. Geochronology

In their comment, Pochat and Van Den Driessche (2015) attempt a simplistic accounting of the numbers of crystals rejected versus included in our interpretations of crystallization and depositional age for volcanic tuffs of the Lodève basin. While Pochat and Van Den Driessche (2015) are correct that, in our investigation, we rejected 51 of 109 individual zircon analyses as unrepresentative of the events we were trying to date (as is clearly illustrated in the full analytical results table published in Michel et al. (2015) as the online Appendix A. Supplementary Table), they are incorrect in their assertion that we "…use contrary arguments in order to reject ages they consider either too young or too old, arguing either Pb-loss or inheritance, to fit their interpretation." In their view the rejection of some proportion of the analytical results calls into question the whole geochronological enterprise. We adhere to the alternative view that precise analytical data can resolve geological complexity stemming from known physical mechanisms (Pb-loss and crystal inheritance), and allow an objective statistical interpretation of the probability density function of the radioisotopic data, including the robust rejection of outliers. In this reply we welcome the opportunity to reiterate the analytical strengths of the CA-IDTIMS method of U-Pb dating, and reinforce the basis for their statistical interpretation.

The methods and applications of zircon CA-IDTIMS U-Pb analysis are well-established in a decade of literature (Mundil et al., 2004; Mattinson, 2005; Davydov et al., 2010; Mattinson, 2011; Burgess et al., 2014), and the reader is referred there for further details. Briefly, the chemical abrasion method mitigates the phenomenon of lead loss, the migration of the radiogenic daughter product out of the zircon-mineral lattice damaged by the radioactive decay process, which results in anomalously young apparent ages for zircons from volcanic tuffs. The effectiveness of the chemical abrasion method has been demonstrated in laboratory experimentation as well as natural samples, where it is the relatively small volume of higher uranium content—and therefore more highly damaged—zones within a zircon crystal that are selectively removed at the micron scale by the dissolution process. This partial dissolution leaves behind a residue of low-uranium zircon that has a greater probability of having remained a closed chemical system through geologic time. Annealing at high temperature prior to dissolution enhances the differential solubility of high- versus low-uranium zircon, by migrating

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