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Chronostratigraphy and Paleoclimatology of the Lodève Basin, France: Evidence for a pan-tropical aridification event across the Carboniferous–Permian boundary

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ABSTRACT

Paleosols preserved within the Carboniferous–Permian succession of the Lodève Basin, Massif Central, France change stratigraphically from Histosols to calcic Vertisols and Calcisols to gypsic Vertisols and ultimately back to calcic Vertisols and Calcisols. New high-precision U–Pb zircon ages (CA-IDTIMS) for tuff beds within the Lodève and adjacent Graissessac basins significantly revise the chronostratigraphy of these and correlated Permian terrestrial basins of eastern Euramerica. Under the newly revised chronostratigraphy presented here these stratigraphic changes in morphology indicate a substantial drying of paleoenvironments across the Carboniferous–Permian boundary with a trend toward progressively more arid and seasonal climates through most of the early Permian. This newly-realized chronology provides a paleoenvironmental and paleoclimatic timeline for eastern tropical Pangea that is contemporaneous with similar records in western Pangea and suggests pan-tropical, progressive climate change toward aridity and seasonality occurred from the Late Carboniferous through early Permian.

1. Introduction

There is a first-order correlation between atmospheric pCO_2 concentrations and global climate throughout the past half billion years (Royer et al., 2004). As present-day CO_2 increases there is a need to assess the effects of climate change in a warming world. Because the Carboniferous–Permian is the last icehouse to greenhouse transition on a vegetated and metazoan-populated Earth, and this time period corresponds to an increase in atmospheric CO_2 concentrations (Montañez et al., 2007), there has been a focus on reconstructing global terrestrial paleoclimate across this transition interval (e.g., Cecil, 1990; Cecil, 2003; Tabor et al., 2004; DiMichele et al., 2006; Montañez et al., 2007; Peyser and Poulsen, 2008; Tabor and Poulsen, 2008; Tabor et al., 2013; DiMichele, 2014). While Carboniferous–Permian terrestrial paleoclimate reconstructions based on paleosol records have emerged from the western tropics (Tabor and Montañez, 2004; Rosenau et al., 2013a,b) and high latitudes (Beauchamp, 1994; Gulbranson et al., 2010; Limarino et al., 2014; Gulbranson et al., 2015), only recently have proxy records of this nature been constructed for central and eastern tropical regions of Pangaea (Schneider et al., 2006; Thomas et al., 2011; Eros et al., 2012). Existing paleoclimate reconstructions from western tropical Pangea indicate the onset of seasonality toward the close of the Carboniferous and a clear aridification trend through the early Permian (Tabor and Montañez, 2002; Tabor et al., 2008; Bishop et al., 2010). While, there are hints of this aridity trend seen in eastern Ukraine during the Carboniferous–Permian boundary (Eros et al, 2012), the long-term trend of this aridity through the Permian is unknown. At this time it remains unclear if this paleoclimate trend is limited to the western tropics or if it extends throughout the tropics. The Lodève Basin in the south of France was chosen as an ideal location to extend Carboniferous–Permian climate trends from the western, to the central, Pangean landmass because of previously developed stratigraphic and paleoecological frameworks and the presence of multiple ashes throughout the succession (Körner et al., 2003; Schneider et al., 2006; Pochat and Van Den Driessche, 2011).

Presented herein are new chronostratigraphic constraints and paleosol data for the Carboniferous–Permian formations of the Lodève and adjacent Graissessac basins, southern France. The new chronostratigraphy places the majority of the basin infill within the Ghzelian to upper Sakmarian. Changes in paleosol micro- and macromorphology indicate a change from humid everwet climates in the latest Carboniferous to seasonal and semiarid climates, with a progressive trend toward aridity, through the early Permian. Therefore, this study documents a similar and contemporaneous climate trend in central Pangea as seen in previous

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