Geophysical Research Abstracts
Vol. 20, EGU2018-11303, 2018
EGU General Assembly 2018
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A new time scale constraining the timing of the Late Paleozoic Ice Age

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The reconstruction of geological events and processes in deep time depends on the availability of a robust chronostratigraphic framework. Generating such a framework depends on the occurrence of dateable material throughout the sedimentary successions of interest, and on the accuracy and precision of the obtained radioisotopic ages. Reconstructing the timing and extent of the Late Paleozoic Ice Age (LPIA) has been notoriously difficult because of the inability to confidently correlate near- and far-field glacial and postglacial deposits through the Late Carboniferous and Middle Permian. This is mainly due to the lack of age diagnostic, short ranged fossils in the mostly non-marine sections, as well as the lack of long continuous sections of outcrop, and sometimes erroneous correlations purely based on lithofacies in the absence of additional means for correlation.

The occurrence of zircon bearing volcaniclastic horizons throughout LPIA deposits in the Paraná and Karoo Basins of southern Brazil and South Africa, respectively, allows the calibration of depositional timescales by means of radioisotopic dating. Previous studies, based on SIMS and LA-ICPMS present a diachronous view of the glaciation history for southern Gondwana. We present new high-precision U-Pb single zircon ages from volcaniclastic layers containing primary volcanic zircon throughout southern Gondwana successions that are at odds with these previous findings. Complications can arise due to the mixing of older age components with juvenile volcanic crystals, as well as the potential of unrecognized open system behavior that produces spurious younger ages. These complications cause age dispersion that may be difficult to interpret, or is unrecognized if low temporal precision geochronological techniques are used, resulting in inaccurate radioisotopic ages. Our new ages from the Parana and the Karoo Basins have now resulted in a robust and exportable chronostratigraphic framework based on U-Pb zircon CA-TIMS ages with sub-permil level precision. Combined with Bayesian approaches for resolving the eruption age of dispersed age spectra, these data are used to facilitate the reconstruction of glaciogenic processes through the Carboniferous-Permian transition. Furthermore, the newly developed framework has fundamental implications for the understanding of global sea level, atmospheric pCO_2 and ocean chemistry. Initial results suggest an earlier termination of glacial conditions in the Paraná Basin compared to the Karoo Basin. Our ongoing efforts are aimed at refining the understanding of near- and far-field glacial records in these two areas, and ultimately their correlation with records from across Gondwana as well as the low-latitude records.