Over the past 500 million years, the development of life on Earth has been punctuated by five major extinction events. The rocks of the South African Karoo Supergroup, internationally renowned for their rich diversity of fossil “reptiles” recording biodiversity change over a period of 120 million years from the Carboniferous to the Jurassic periods, preserve evidence of two of these mass extinctions - the end Permian (252 million years ago) and end Triassic (200 million years ago). The end Permian, dubbed the mother of all extinctions, witnessed the demise of 90% of species in the oceans and 70% of land-living forms.

The rich fossil vertebrate fauna from the rocks of the even older lower Beaufort Group of the Karoo provide a unique window into the fauna of the ancient supercontinent, Pangaea, during the middle Permian (Guadalupian). One of the major groups of animals at the time, dinocephalian therapsids, was widespread across Pangaea; while other well-represented groups, including dicynodont therapsids, rhinesuchid temnospondyls and pareiasaurian parareptiles, were restricted to Gondwana.

Dedicated fossil collecting, identifying and recording of the position of fossils of these animals in the rock record of the lower Beaufort Group for almost three decades by an international team of palaeontologists, led by Bruce Rubidge from Wits University, has recently recognised a major extinction of life on land at the end of the Middle Permian period. Meticulously collected fossil ash beds, analysed by Sam Bowring and Jahan Ramezani at MIT in the USA using the CA-TIMS method, have provided remarkably accurate ages for different fossil-bearing horizons and a date of 260.259 ± 0.081 Ma has been achieved from a tuff immediately before the extinction. Michael Day, previously a doctoral student and later postdoctoral fellow at Wits and currently curator of vertebrates at the Natural History Museum in London, collated all the field evidence derived from studying the rocks and fossils.

Data analysed by the constrained optimisation (CONOP) algorithm reveals a 74–80% loss of species as a result of this extinction which affected mainly the large-bodied (3 m long) dinocephalians and pareiasaurs. These results correlate with large scale volcanic eruptions recorded form Emieshan in China and also correlate with an extinction previously recorded in the marine realm in China.

The causes of this mass extinction, now firmly quantified in the terrestrial environment for the first time, are unclear. However, recent research undertaken by Kevin Rey from the Wits team, using stable oxygen and carbon isotopes sampled from fossilised teeth of the therapsid Dictodon, one of the animals which survived the extinction, revealed positive excursion of δ13C values coinciding with the extinction peak which is followed by a return to pre-extinction δ13C values after the extinction. δ18O isotope values indicate constant temperature at the time but the δ13C isotope peak points to an increase in aridity in the South African paleoenvironment at the time of the extinction.

Recognition of this major extinction, the largest yet recorded on land, coupled with the dateable volcanic ashes from different horizons, both before and after the extinction event, offer new possibilities to understand the causes of major extinction events and their effect on biodiversity, as well as the rate of biodiversity recovery after the extinction. Because of the geographic advantage offered by the remarkable Karoo fossil record, coupled with a world-class team of researchers, South Africa is taking the lead in understanding Middle Permian biodiversity on the ancient continent of Pangaea.