Geophysical Research Abstracts
Vol. 18, EGU2016-13105, 2016
EGU General Assembly 2016

Multiple carbon cycle perturbations during the Carnian Pluvial Event and the eruption of Wrangellia Large Igneous Province in the early Late Triassic

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In the Late Triassic (∼230 Ma) a climate change from arid to markedly humid conditions, known as the Carnian Pluvial Event (CPE), is recorded in stratigraphic successions worldwide. The CPE impacted both deep- and shallow-water settings. Basins were characterized by the deposition of abundant terrigenous siliciclastics and locally by the establishment of anoxic conditions. High-relief microbial platforms switched to metazoan low-relief carbonate ramps. Palaeobotanical analyses evidence a shift towards more hygrophytic floral associations at different latitudes, and massive resin production. The CPE is also closely associated with biological turnover among some marine groups and seems to be linked to major evolutionary steps. A sudden 2–4‰ negative carbon isotope excursion in marine and terrestrial biomarkers and total organic matter has been documented at the onset of the CPE in stratigraphic sections in the Dolomites (Italy), the Northern Calcareous Alps (Austria), Transdanubian Range (Hungary) and in central Spitsbergen (Norway) and has been linked to the eruption of Wrangellia Large Igneous Province. This negative carbon isotope excursion is well biostratigraphically constrained with ammonoids at the boundary between the Trachyceras aonoides and the Austrotrachyceras austriacum ammonoid zones, and with sporomorphs at the boundary between the Concentricisporites bianulatus and the Aulisporites astigmosus assemblages, at the end of the early Carnian (Julian). However, sedimentological and palynological data show that the CPE was multiphasic, with at least three humid pulses. Carbon isotope data encompass only the first of these pulses. Here we present new δ13C data from organic matter collected in Carnian stratigraphic sections of the Southern Alps (Italy) across the entire CPE. Data show two 2–3‰ negative shifts follow the initial negative excursion (CPE1) and are dated to the latest Julian (CPE2, upper A. austriacum ammonoid zones) and to the earliest Tuvalian (CPE3, T. dilleri ammonoid zone). The occurrence of multiple isotopic excursions implies that global correlations need tight biostratigraphic constraints to be reliable, in the event that only one of the isotopic excursions related to the CPE is identified.