Estimating atmospheric pO_2 during the Phanerozoic using the $\delta^{13}C$ of terrestrial plant organic matter

R. TAPPERT[1,2]*, K. MUEHLENBACHS[2], R. C. MCKELLAR[2,3], A. P. WOLFE[2] AND M. SCHOELL[4]

[1]Inst. Mineralogy and Petrography, Univ. Innsbruck, Austria (*correspondence: ralf.tappert@uibk.ac.at)
[2]Dept. Earth Atm. Sci., University of Alberta, AB, Canada
[3]Royal Saskatchewan Museum, Regina, SK, Canada
[3]GasConsult International Inc., Berkeley, CA, USA

Since the initial emergence of land vegetation in the Ordovician, much of the organic carbon in terrestrial sedimentary rocks has been derived from C3-plants. Variations in the $\delta^{13}C$ of terrestrial organic matter should therefore reflect changes in the ^{13}C fractionation of plants, which in turn may relate to changes in atmospheric pCO_2 and pO_2. Using the $\delta^{13}C$ of terrestrial organic matter to quantify paleo-atmospheric compositions is not straightforward, because fossil plant organic matter can undergo compositional and isotopic changes during burial. In order to assess the effects of burial on the $\delta^{13}C$ of plant organic matter, we have analysed mean $\delta^{13}C$ values of fossil wood and coal from several localities and ages, and compared the results with mean $\delta^{13}C$ values of fossil resins (amber) from the same locations. Fossil resins are thereby representative of unaltered bulk plant matter [1]. Compared to coal and fossil wood, resins are depleted in ^{13}C by approximately 2‰. After correcting for this offset, we were able to reconstruct atmospheric pO_2 since the Ordovician using published analyses of terrestrial organic matter and following the approach outlined in Tappert *et al*. [1]. The results indicate that atmospheric pO_2 for most of the Phanerozoic was considerably lower (pO_2: 10-20%) than today. The highest pO_2 levels in the Palaeozoic were restricted to the late Carboniferous and Permian (pO_2: ~17-20%). Particularly low pO_2 prevailed from Ordovician to early Carboniferous, in the early Triassic, and from the late Jurassic to mid-Cretaceous.

[1] Tappert *et al* (2013) *Geochim. Cosmochim. Acta* **121**, 240-262.