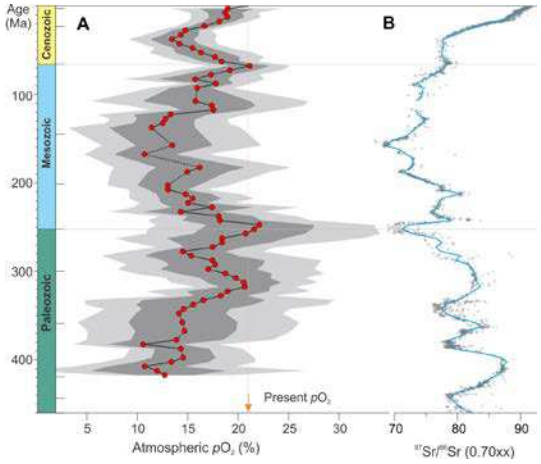
Geodynamic control of atmospheric pO_2 over the Phanerozoic Eon

MARTIN SCHOELL[1], RALF TAPPERT[2], KARLIS MUEHLENBACHS[2]

[1]GasConsult International Inc., Pleasanton, California, USA
[2] Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada

In a proof of concept [1] atmospheric pO_2 deduced from carbon isotopes ($\delta^{13}C$) of amber has been shown to accurately follow Cenozoic marine lithium isotopes ($\delta^{7}Li$), an accepted proxy for continental weathering and seafloor reverse weathering [2], suggesting that atmospheric pO_2 is controlled by geodynamic processes. Here we expand the pO_2 record using $\delta^{13}C$ of terrestrial organic matter, which is depleted in ^{13}C compared to amber by a constant factor of 2‰.



The new pO_2 reconstruction reveals several pO_2 oscillations between ~10-20% during the Phanerozoic, but it also suggests that pO_2 has never been significantly higher than today at any time during the Phanerozoic, including the Permo-Carboniferous. Reconstructed pO_2 variations resemble those of ocean carbonate $^{87}Sr/^{86}Sr$, which implies that the processes of O_2 generation and removal are the same that drive Sr isotopic variability, namely continental tectonics and sea floor alteration which was not considered in previous mass balance models. We propose that episodic pO_2 increases during the Phanerozoic were mainly generated by enhanced burial of organic matter and sulfides during episodes of major orogenic uplift and weathering, whereas decreases in pO_2 resulted from continual seafloor alteration.

[1] Tappert et al. (2013) Geochim. Cosmochim. A. 121, 240-263. [2] Misra S. and Froelich P.M. (2012) Science 335, 818-823.