Novel stable isotope systems tracing atmospheric O_2: progress, caveats, and outlook

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Recent advances in mass spectrometry have led to the development of a multitude of new isotope geochemical proxies that allow investigation of oxygen evolution and biogeochemical cycles in Earth's surface environments through time. The disappearance of mass-independent fractionation of sulfur isotopes (MIF-S) approximately 2.4 Ga ago [1] pinpoints the timing when our planet's atmosphere became globally oxidized above the pO_2 threshold value of 0.001 % of the present atmospheric level. Stable isotope variations of redox-sensitive elements such as molybdenum, chromium, selenium or uranium in sedimentary archives have further greatly refined our knowledge of the atmospheric and marine redox-evolution throughout Earth's history and give evidence, for example, for the existence of oxygen oases as old as 2.95 Ga and O_2 fluctuations throughout most of the Proterozoic [2-4].

This presentation aims to give a general overview of the progress made in this research area, especially, but not exclusively, featuring scientific findings obtained using the stable Cr isotope system. Strengths and caveats of the Cr isotope redox-proxy will be discussed and knowledge gaps regarding the cycling of Cr and its isotopes within the continent's critical zone and in the marine environment will be highlighted. On that note, we will demonstrate the importance of experimental studies for a better understanding of element cycling in modern and ancient sedimentary archives, and advertise the strength of multi-proxy approaches combining redox-, bio- and litho-sensitive isotope systems to investigate the biogeochemical evolution of Earth's surface reservoirs through time. An ever increasing number of specialized laboratories capable of producing high-precision stable isotope data will continue to result in new perspectives and integrated approaches of interpreting and modelling isotopic fractionation preserved in the rock record.

[1] Farquhar et al. (2000), *Science 289*, 756ff. [2] Planavsky et al. (2014), *Nature Geoscience 7*, 283ff. [3] Eickmann et al. (2014) *Nature Geoscience 11*, 133ff. [4] Gilleaudeau et al. (2016), *GeochemPerspectLetters 2*, 178ff.