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Carbon, oxygen and strontium isotope trends of Permian and Triassic seawater: Implication for coeval seawater, palaeotemperatures and environmental changes

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Carbon, oxygen and strontium isotope composition of seawater varied throughout Earth's history. Both, long-term trends and short-term anomalies can be used as indicators in carbon cycling, palaeotemperature, continental weathering and volcanic activity, amongst other inter-related factors. Additionally, seawater isotope fluctuations can serve as a stratigraphic tool. To reconstruct the geochemical evolution of Permian and Triassic seawater, proxies in carrier phases such as brachiopods, conodonts and whole rock carbonates have been used. The strength of the conclusions from the datasets depends critically on the diagenetic fidelity of the materials analysed, together with sufficient temporal and spatial resolution of data points. All the investigated successions are biostratigraphically well calibrated by index fossils.

The Late Palaeozoic deglaciation in the Early Permian is mirrored in a decline of the seawater oxygen isotope values due to a combination of warming and a return of isotopically light melt water into the oceans. The sea-surface-temperature-gradient was only slightly smaller than that of the modern oceans. Carbon isotope curves at several biostratigraphically well calibrated Tethyan Permian-Triassic boundary successions show a decline of about 4 permil, with a minimum at the boundary that was used to correlate the different sections of the Southern Alps. The trend involves several short-term high amplitude carbon isotope excursions in the Early Triassic, followed by predominantly low values during the Middle Triassic and a 2.5 permil rise. The causal scenarios for these rapid oscillations are at present equivocal, but may in part reflect a biological instability of the carbon cycle following the recovery from the End-Permian

extinction event and/or an input of “mantle”-derived carbon dioxide from enhanced volcanic activity. A strong decline of the seawater strontium isotope curve in the Early and Middle Permian is probably caused by a combination of a decline in the continental weathering rate due to the advancing deglaciation of Gondwana and an enhanced flux of low radiogenic strontium from hydrothermal circulation within young oceanic crust generated by the opening of the Neotethys. The subsequent rise of the seawater strontium isotope values in the Early Triassic is probably caused by enhanced supply of clastic material, and of radiogenic Sr, into the oceans during the intermittent humid phases within the mainly arid interval, coupled with the absence of a dense protective land plant cover that was slowly recovering from the latest Permian mass extinction.