



## **The Late Devonian mass extinction: new geochemical and geochronological insights**

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The Late Devonian marked a time of numerous successive environmental perturbations and biotic crises, collectively considered one of the 'Big Five' mass extinctions of animal life in the Phanerozoic. The Frasnian–Famennian boundary (~372 Ma) and Devonian–Carboniferous boundary (~359 Ma) represent the two largest and best known of these crises. These two major crises were interspersed by numerous smaller scale events (e.g. the Late Famennian Annulata Event: ~363 Ma) over a 20 million year period throughout the Late Devonian. However, despite representing a time of substantial floral and faunal turnover, there remains little consensus as to the cause of these events, either individually or collectively. As for most Mesozoic events, large scale volcanism and (one or more) meteorite impacts have been suggested as the cause, but marine anoxia, global temperature changes, and increased continental weathering have also been mooted as possible contributors towards the Frasnian–Famennian extinction and the other Late Devonian crises.

In this study, we present new geochemical and geochronological data from well-studied records in France, Germany, Poland, and Australia to investigate a number of the processes proposed above. The two Kellwasser events at and just below the Frasnian–Famennian boundary are investigated in detail, with additional study on a long-term record of weathering and/or volcanism through the Late Devonian. Of particular interest is the potential role played by increased continental weathering rates and subsequent nutrient influx to the marine realm which may have promoted anoxic conditions inferred from numerous sedimentary records of this time, and which is investigated here using sedimentary phosphorous contents and osmium-isotopes. The possible influence of volcanic activity is also of interest due to the established correlation between large scale volcanic events and extinctions/climate perturbations in the Mesozoic. A volcanic influence is tested through uranium–lead geochronology of ash beds interbedded with Devonian sediments, and analysis of sedimentary mercury concentrations, which have been used to support similar links to volcanism for numerous other geologic events. Constraining the potential impact, and timing, of such processes with respect to the Late Devonian crises will play a key role in the ongoing studies of these events.