Geophysical Research Abstracts
Vol. 12, EGU2010-3386-1, 2010
EGU General Assembly 2010

The « Kellwasser » Anoxic Events in Upper Devonian times : a global carbon cycle modelling test of the impact of Early Variscan moutain building

Vincent Lefebvre (1), Olivier Averbuch (1), Louis François (2), Thomas Servais (1), Laurent Riquier (3), and Nicolas Tribovillard (1)

(1) Lab. Geosystemes, University of Lille 1, 59655 Villeneuve d'Ascq, France , (2) Unité de modélisation du climat et des cycles biogéochimiques, Liège University, B-4000, Belgium, (3) Lab. Biogéosciences, University of Bourgogne, 21000 Dijon, France

The Late Devonian is a period of significant climatic and environmental changes exemplified by a severe biotic crisis of marine and tropical faunas (the Frasnian-Famennian crisis) and by the onset of an episod of glaciation on Southern Gondwana at some time in the Famennian. The major pulse of the faunal extinction occurs from the Late Frasnian to the base of the Fammenian over few million years. This time is marked by an extensive perturbation of marine environments expressed by two carbon-organic rich levels (the Kellwasser horizons) deposited under dysoxic to anoxic conditions. These two levels have been recognized in many places around the Prototethysian realm and are characterized by a positive carbon isotopic shift from 2‰ to 3‰ reflecting a period of enhanced organic carbon burial.
The causes of these two Anoxic Events remain strongly debated but, in recent years, our research group proposed these episodes to be linked to a large scale fertilization and stratification of sea waters (especially that from the Proto-tethysian realm) as the result of the incipient uplift of a large sub-equatorial mountain belt, i.e. Appalachian-Eovariscan-Ouralian cordillera. The latter would have enhanced, on one hand, the continental weathering and the related nutrient supply from continents and, on a second hand, the Proto-Tethys sea-water stratification by the progressive closure of the equatorial seaway linking it to the Panthalassa. The climatic impact of this Frasnian-Famennian carbon cycle perturbation might have led to a global cooling at the beginning of the Famennian as documented in the geological record by a significant sea-level drop and an associated hiatus expressed in numerous localities as well as δ^{18}O and palynological data. On the other hand, the large amount of organic carbon buried could have led to a rise in dioxygen concentration in the atmosphere in Late Devonian times.
To test this interpretation, we have used a global carbon cycle numerical model coupled with an Energy Balanced Climate Model (EBM). The model calculates phosphorus, carbon and oxygen concentrations and the alkalinity in each oceanic box as well as atmospheric $p\mathrm{CO}_2$ and δ^{13}C. The oceanic and continental configurations have been inferred from the Late Devonian palaeogeography (Polar ocean, Panthalassa and Proto-Tethys). Oceanic circulations have been modelled using the present-day circulation for the Panthalassa Ocean and the pre-perturbation Proto-Tethys realm, the latter evolving towards isolated conditions during the simulation. The mountain-building effects have been modelled by increasing the mechanical weathering specifically on uplifted continental areas. The respective effects of each process have been tested separately and then coupled to simulate the global environmental impact of mountain-building. As a result, we show that the incipient phases of orogenic development can lead to short-term carbon cycle perturbations such as that recorded at the Frasnian-Famennian boundary.