Timing and pacing of the Hangenberg Crisis (Devonian-Carboniferous Boundary) in the Chanxhe sections, Belgium

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Abstract

The Hangenberg Crisis, at the Devonian-Carboniferous Boundary, severely affected the marine realm. The crisis is characterised by several events associated with change in the sedimentation and biotic extinctions and turnovers. The Hangenberg Black Shale event that recorded the extinction peak in the pelagic realm corresponds to a widespread development of oceanic anoxia and/or dysoxia. The Hangenberg Sandstone event is associated with an extinction of neritic fauna in shallow-water settings, including the final demise of several classical Devonian faunas (stromatoporoids, quasiendothyrid foraminifers, placoderms, etc.). The succession of these events is nowadays explained by a combination of sea level fluctuations (third order transgressive sequence, out-of-sequence regression) and global climatic changes. Through the identification of Milankovitch cycles in the Chanxhe record, we aim at getting a better understanding of the timing and orbital forcing of the different events of the Hangenberg Crisis in shallow-water settings.
The sedimentary record of the interval of interest at Chanxhe is composed of 16 m of alternating decimetre-thick carbonate beds with shaly siltstones, which displays a clear cyclicity. The carbonate-siliciclastic alternations (_˜0.8 m) are bundled into larger cycles (_˜5 m) which are separated by intervals dominated by the shaly facies. This is followed by 11 m of carbonate dominated lithology with thin shale layers displaying a less clear cyclicity with _˜3 m thick cycles. Then the equivalent of the Hangenberg dark shales is recorded as two dark shaly intervals separated by a carbonate bed. After the Hangenberg dark shales, the section displays carbonates, with the Devonian Carboniferous boundary in massive carbonates 7 m above the top of the black shales.
Samples have been collected along the record every 10 cm which were measured by the portable X-Ray Fluorescence device (Tracer 5, Bruker), allowing to provide elemental data throughout the record. Spectral analysis is applied on Ca and Al, to identify the main cyclicity in the record. The 0.8 meter-thick limestone/shale alternations is clearly recorded in the Ca and Al records and are associated with precession cycles (18 kyr), while the 5 m-cycles are associated with short eccentricity (100 kyr). Prior to the Hangenberg anoxic events, the 100-kyr cycles became less clear and shorter (_˜ 3 m) which is interpreted as a long-term minimum eccentricity. During and after the Hangenberg, the cyclicity returns.. Severe anoxic events such as the Oceanic Anoxic Event II in the Cretaceous, as well as the

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upper Kellwasser Devonian anoxic event have been associated with long term eccentricity minima. It is essential to better understand the mechanism behind the astronomical forcing and anoxia expansion, and the identification of the long-term minima through the geologic time scale is key to better understand the climate forcing.

Keywords: Milankovitch, time scale, Devonian, Carboniferous