Doctoral Thesis

Geochemical and sedimentological evidence for environmental changes in the Valanginian (Early Cretaceous) of the Tethys region

Author(s):
Hennig Fischer, Susanne

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GEOCHEMICAL AND SEDIMENTOLOGICAL EVIDENCE FOR ENVIRONMENTAL CHANGES IN THE VALANGINIAN (EARLY CRETACEOUS) OF THE TETHYS REGION

A dissertation submitted to the
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presented by

Susanne Hennig Fischer
Dipl. Geol., University of Zurich
born August 2, 1966
citizen of Basel, BS

accepted on the recommendation of

Prof. Dr. Helmut Weissert
Dr. Hanspeter Funk
Prof. Dr. J.A. McKenzie
Prof. Dr. Karl Föllmi

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8.5 Conclusions

In the Valanginian, a well defined, global positive carbon isotope excursion occurs. This indicator of global change in the biospheric carbon cycle is preceded and accompanied by major ecological changes on river-influenced, shallow-water depositional environments in the Early Valanginian. The eutrophication of formerly oligotrophic carbonate platforms and the deposition of limonitic iron ore document increased weathering on the continent in a more humid and warm climate.

This global climatic change is interpreted as the sequel of increased volcanic activity and CO$_2$ input into the atmosphere, and the contemporaneous major eustatic transgression as the result of faster mid-ocean ridge spreading. The actual trigger of the positive $\delta^{13}$C excursion may have been a sudden release of methane gas hydrates increasing the already high pCO$_2$ of the atmosphere beyond an equilibrium threshold. Decreased calcification of pelagic nannoplankton and decreased C$_{\text{Carb}}$ deposition on submerged former carbonate platforms followed. Small temperature gradients in warm oceans resulted in sluggish oceanic circulation, large oxygen minimum zones and enhanced preservation of terrestrial and marine organic matter. A warm and humid climate on the continents increased the weathering rates and the nutrient availability for land plants, increasing terrestrial biomass.

At peak $\delta^{13}$C-values, water temperature dropped and boreal faunas invaded the Northern Tethyan region. Enhanced primary productivity on land and in the oceans is supposed to have lowered pCO$_2$ below initial levels and to be responsible for a global climatic cooling in the Late Valanginian. The Late Valanginian regression may even point to ice build-up in the polar regions. $\delta^{13}$C values first fluctuate at a high level; nutrient availability was probably still very good for primary productivity.

Later $\delta^{13}$C values decrease sharply, then more gradually until they reach pre-excursion values at the end of the Early Hauterivian. Increased thermohaline circulation due to stronger temperature gradients probably rapidly oxidised dissolved and particulate organic carbon in the oceans, lowering the global $\delta^{13}$C DIC values. The end of the calcification crisis, and returning high pelagic calcification rates presumably helped the C$_{\text{carb}}$/C$_{\text{org}}$ balance to go slowly back to the initial balance.

In the Early Hauterivian, the basal transgression indicates the end of the Late Valanginian cold period. The continuing high input of terrigeneous material documents a still humid climate with important continental runoff.

The Valanginian event is comparable with other well-known geochemical and sedimentological events like the Miocene Monterey-event, the Aptian / Albian and Cenomanian / Turonian boundary events, etc.

What always seems to happen is that sooner or later, a balance very near the initial starting point is reached. This will probably also happen with the actual anthropogenic climatic warming. Bearing in mind the time-span involved of hundred thousands or millions of years to reach this balance, this consideration is not very consoling regarding human time scales.