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## ***Interactive comment on “Ammonoid multi-extinction crises during the Late Pliensbachian – Toarcian and carbon cycle instabilities” by J. Guex et al.***

### **Anonymous Referee #2**

Received and published: 25 October 2012

Review of the manuscript “Ammonoid multi-extinction crises during the Late Pliensbachian-Toarcian and carbon cycle instabilities” by Guex et al.

1) General comments:

This manuscript presents new bulk carbon isotope data from Peru, which allow a better understanding of carbon cycle disturbances during the Toarcian interval (Early Jurassic). The negative and positive excursions are compared to data from European sections and discussed in terms of environmental disturbances, which could have impacted the diversity of ammonites. These new data are interesting and will probably help to understand the origin of Toarcian episodes (which are poorly documented for the Mid-

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dle and Late Toarcian). Nevertheless, I regret that the authors quickly compare their isotopic results with other previously published data and quickly discuss the origin of recorded trends (this is maybe because interpretations are dispersed in several parts of the manuscript). The discussion between carbon cycle and ammonite diversity is interesting and represent an important point of the paper. Nevertheless I think that the long part concerning ammonite morphology and environmental stress is “ad hoc” because it bring confusion and is far away from the main results of the manuscript, which are carbon isotope data. This part would deserve an own paper where each biotic event is clearly illustrated with figures. Otherwise it could be shortened and gathered to the previous discussion between carbon cycle disturbances and diversity. Finally, I think that the paper should be published but with major corrections, specifically in the organization because there is a big confusion between results, discussions, and conclusions.

## II) Specific comments:

Title: I wonder if the title is very appropriate. The new data are Toarcian  $\delta^{13}\text{C}$  data from Peru and it is not mentioned. . . It sounds like if the new isotopic data were a pretext to develop a global hypothesis mainly based on data from other works.

Introduction: It would be more percussive to add that your data are also the first Panthalassan data to document variations in carbon cycle in the middle and Late Toarcian. This allows a better appraisal of the global extent of previous contemporaneous data from Tethyan domains.

The authors often use the term “excursion” for isotopic variations. Sometime it is confusing because an excursion refers to a brief event, which comes back to a normal state. For example, the decrease of  $\delta^{13}\text{C}$  values recorded from the Variabilis to Thoursense zone cannot be considered as an excursion because successive values stay relatively low during the Late Toarcian. I suggest to distinguish “negative or positive excursions” from “negative or positive trends”.

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Discussion on carbon cycle disturbances: 1212 Line 2 to 13: I think the authors could further discuss the isotopic trends recorded during the Middle and Late Toarcian. Only Sandoval et al. (2012) is cited for comparison but many other papers provide bulk carbonate or belemnite carbon isotope data from Spain, southern France, etc : - Gomez et al. 2008: Seawater temperature and carbon isotope variations in belemnites linked to mass extinction during the Toarcian (Early Jurassic) in Central and Northern Spain. Comparison with other European sections - Harazim et al. 2012: Spatial variability of watermass conditions within the European Epicontinental Seaway during the Early Jurassic (Pliensbachian–Toarcian) - see also the data compilation of Dera et al. 2011. Jurassic ups and downs in a disturbed Jurassic world. I suggest to the authors to accurately compare the trends and to mention possible differences in timing, amplitude, trend and material (belemnite vs. carbonate)... This is very important to decipher global or local events. Also how to interpret this negative trend? Is it a return to a “normal” carbon cycle after the Early Toarcian positive excursion? Or an independent global geochemical disturbance? I think you should further discuss the origin of the negative trend recorded during the Middle-Late Toarcian.

Relations to ammonite extinction events: The correlation between carbon cycle disturbances and extinction is very interesting. But by reading the discussion, we could remain unsatisfied because the authors never clearly give hypotheses of killing mechanisms. Sea level fluctuations are briefly suggested but rather discussed as potential bias in the fossil record. It could be interesting to discuss the pacing of events, amplitude of events, and to give clear hypotheses of killing mechanisms linking carbon cycle and extinctions. Note that this kind of correlations was previously described at the Triassic-Jurassic boundary by Whiteside & Ward (2011) Ammonoid diversity and disparity track episodes of chaotic carbon cycling during the early Mesozoic Geology 2011;39(2):99-102.

Ammonites as morphological index of environmental stress: Here, the authors show that during crises, ammonites get atavist shells. As mentioned above, I suggest either

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to clearly reduce this “ad hoc” part and to include it to the previous one or to remove it. Also these remarks should be addressed: - Are phylogenetic hypotheses well constrained? - References to specific events are often missing (ex: 1214 line 6-11, 18-21) - The authors never mention that atavist morphology could also occur without crisis event - If conserved, this part should be illustrated with a figure giving few examples.

Be carefull because the conclusion is not a conclusion but a discussion!

### III) Technical corrections

1206 Line 20: remove “etc”

1206 Line 23: “massive “ rather “an immense”

1206 Line 24: The sentence is too complex. Maybe use “To explain this negative CIE, rapid releases of methane gas hydrates contained in marine continental margin sediments have been supposed (Hesselbo et al. 2000), and ascribed to a contemporaneous global warming event induced by volcanic episodes”.

1207 Line 5: the reference (Dera et al. 2010) concerns ammonites rather climate changes. Rather use “Suan et al. 2010: Secular environmental precursors to Early Toarcian (Jurassic) extreme climate changes Âž which specifically illustrates the cooling event by geochemical data

1207 Line 5 to 8: Any reference to illustrate the first CIE at the PT boundary?

1207 Line 16: Maybe cite papers, which directly show the differences between benthic and pelagic faunas (Hallam 1988) and quantitatively evaluate the severity of ammonite diversity drops during the Pliensbachian and Toarcian periods (ex: Cecca and Macchioni 2002 or Dera et al. 2010).

1207 Line 19: references for the two additional extinction events?

1207 Lines 20 & 21: This part is quickly discussed and deserves more attention because the new presented data more specifically discuss this time interval. Maybe add

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that current carbon isotope curves are scarce and mainly concerns the Mediterranean domain (Subbetic chains, Portugal, Iberian range) (Duarte et al. 1998; Gomez et al. 2008). Also add that signals show stable or fluctuating trends.

1208 Line 2: I think that the point (5) is a little bit “ad hoc” compared with the main data of the manuscript which concern biostratigraphic and geochemical data. I suggest removing this part.

1208 Line 5: The point 6 should be in second position because it introduces the correlation between geochemical and paleontological data.

1208 Lines 11 to 14: I don’t understand why this part is here in the introduction. Remove it or move it elsewhere in the discussion.

1208 Line 16: “Lithostratigraphy” instead of “Litho”

1209 Line 1: I don’t know if “resediments” exists.

1210 Line 3: remove “a” in “a known”

1211 Line 6: You cannot write that the values stay low across the PT boundary because you have no point during the Pliensbachian. Rather say that the values stay low around 0 ‰ at the very beginning of the Toarcian (tenuicostatum zone).

1211 Line 8: Specify “a minor negative inflexion of -0,5%”

1211 Line 11: “marine organic matter accumulations”

1213 Line 13: Why don’t you cite Mazzini et al. 2010 ?

1211 Lines 15 to 17: Be careful because the negative CIE is not indicative of organic matter accumulations (which are rather expressed by global rises in  $\delta^{13}\text{C}$ ). Also it cannot be directly interpreted as an oxic/disoxic index. It just indicate release of light carbon either ascribed to methane volcanic  $\text{CO}_2$  or to the Kuspert model.

1211 Line 24: Can we also invoke a sampling bias or diagenetic effect?

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1211 Line 24: According to what I mentioned above, this rise in  $\delta^{13}\text{C}$  is actually the real signature of organic matter burials at global scale during the progressive warming event.

1211 Line 17: it is rather 0,5%

1212 Lines 11 to 13: If I remember, the data of Mazzini et al. (2010) concerns the Early Toarcian and not the middle and Late Toarcian. This sentence may be deleted.

1212 Lines 15 & 16: Specify that this compilation of Dera et al. (2010) just concerns NW Tethyan and Arctic ammonites.

1212 Line 22: OAE not AOE

1212 Line 25: A low value is very relative. . .

1216 Line 24: Currently, we have no idea on the nature of gas ejected by the Karoo-Ferrar. . . The hypothesis invoking  $\text{SO}_2$  is possible but not verifiable for the moment. The authors should add alternative scenarios invoking high organic matter burials during the Late Pliensbachian as recently shown by Silva et al. (2011): Update of the carbon and oxygen isotopic records of the Early–Late Pliensbachian (Early Jurassic,  $\sim 187$  Ma): Insights from the organic-rich hemipelagic series of the Lusitanian Basin (Portugal). *Chemical Geology*

1216 Line 25: The hypothesis of Cl and F injections into seawater is rather speculative without geochemical analyses.

1217 1-2: Please, add references for these observations in Nevada and New Zealand.

1217 Line 4: The work of Gomez et al. (2008) essentially focuses on the Toarcian! Rather add Suan et al. (2010): Secular environmental precursors to Early Toarcian (Jurassic) extreme climate changes. Also note that the cooling event has been tested in the light of numerical modelling by Dera and Donnadiou (2012): Modeling evidences for global warming, Arctic seawater freshening, and sluggish oceanic circulation

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1217 Line 4: Glendonite are not present across the entire Pliensbachian. Recent works of Suan et al. (2011) show that they are just present in Siberian sediments during the spinatum Zone.

1217 Line 17: Give a reference for the cooling event mentioned during the Variabilis Zone.

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Interactive comment on Solid Earth Discuss., 4, 1205, 2012.

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