Response to Interactive Comment by Anonymous Referee #2

We thank the reviewer for their detailed and thorough review of the manuscript, which will allow us to significantly improve our manuscript. The referee's main point was addressing the lack of large-scale implications and comparison with neighboring areas with Upper Cretaceous sediments. We have addressed their main concerns and respond to their individual comments below. A revised manuscript along with edited and newly created figures will be uploaded shortly, which will include further comparison to nearby regions and a clearer statement of our study goals and the controversies we wish to elucidate. In the following, the referee comments are in italics, and we respond in regular font.

Anonymous Referee #2

This work deals with the paleogeographic and tectonic evolution during the Upper Cretaceous of an area of Continental Greece that belongs to the so-called Internal Hellenides. Little is known about the Cretaceous evolution of this sector of the Hellenides and many questions await answers. Apart from the number of oceanic basins, the polarity of the subduction zone, etc, there are questions about the origin, age, deposition paleoenvironment and the geodynamic significance of the Cretaceous sediments deposited unconformably on top of the obducted Vardar ophiolite complexes and the Pelagonian passive margin. Thus, this manuscript fills a significant gap in our knowledge of these issues.

It is a well-written and well-structured manuscript with a wealth of data clearly presented, but in the end, it leaves the reader partially dissatisfied. And this has to do mainly with the large-scale implications of the results and their comparison with other neighboring areas of the Internal Hellenides where Upper Cretaceous sediments are also observed. As the authors report, in order to elucidate part of the controversies, they studied this small Upper Cretaceous basin, but the part of their manuscript that refers to those is poorly developed. I believe that a better analysis of this would strengthen their work even more.

Based on that I have noted the following:

a) *The work that first described the Cretaceous sediments east of the Pelagonian (Almopias Zone) is not included in the reference list, although this work is about an area just north of the Kallipetra basin and gives detailed lithostratigraphic columns presenting their paleogeographic and tectonic evolution. This work is: Mercier, J., 1968. Etude geologique des zones Hellenides en Macedoine centrale(Grece). Ann. Geol. Pays Hell. 20 (792 pp.).*

We will enter in more detail with the comparison of the Lower Cretaceous basin referring to the work of Mercier, Robertson, Ricou and others. We hope that by adding some detailed comparisons with other Upper Cretaceous basins in nearby regions will strengthen the part of our manuscript that aims to elucidate the controversies.

b) *There is no comparison or correlation with other areas where the Cretaceous sediments are also observed. There could be a comparison apart from Mercier's work with the results of other papers, e.g. the paper of Sharp and Robertson (2006), who give anevolution model of a similar Upper Cretaceous basin north of the study area. Mercier(1968) places the beginning of the deposition of the Upper Cretaceous sediments in Aptian-Albian, while other researchers such as Sharp and Robertson and Galeos etal. (1994) describe even older aged sediments (Upper Jurassic). It could also be compared to other areas of the non-metamorphic Pelagonian, e.g. in Othrys Mt (Ferriere,1982) and Argolida (Baumgartner, 1985). It is important to comment on the age of onset of the deposition of the Upper Cretaceous sediments, as well as the age of the emplacement of ophiolitic complexes on them, highlighting the possible differences that may exist from region to region.*

We agree with this point (see reply above) and we will compare/correlate our units with others, specifically with ages of deposition and/or emplacement. We will be sure to read the literature stated below by the reviewer to compare to our work.

Ferriere J (1982) Paleogeographies et tectoniques superposees dans les HellenidesInternes au niveau de l'Othrys et du Pelion (Grèce). Soc Geol Nord Publ 8:1–970.

Galeos, A., Pomoni-Papaioannou, F., Tsaila-Monopolis, S., Turnsek, D. & Ioacim, C.1994. Upper Jurassic–Lower Cretaceous 'molassic-type' sedimentation in the westernpart of the Almopia subzone, Aridhea Loutra Unit (northern Greece). 7th Congress of the Geological Society of Greece, Thessaloniki, May 1994.

c) *The phrase "Upper Cretaceous basin" is used in two ways: either to describe the wider paleogeographic area where the Upper Cretaceous sediments were deposited or the small basin of Kallipetra. This dual use of the term confuses the reader. It must be made clear that the Kallipetra basin is part of a wider paleogeographic domain which, during the Upper Cretaceous, was the site of deposition of large thickness sediments.*

Thank you for bringing this to our attention - we will go through the manuscript to make sure this is cleared up to eliminate any confusion. In line 34, for example, we refer to the Kallipetra Basin and will rephrase this part of the text: "...by the deposition of metamorphic Pelagonian detritus in a Late Cretaceous basin (Schenker et al. 2015) subsequently referred to as the Kallipetra Basin in this study", and be sure to make clarify other references to 'Upper Cretaceous Basin' in our manuscript.

d) *An important key in the evolution of the basin is the origin of the fault that places the Vardar Oceanic Complexes (VOC) on the Upper Cretaceous sediments in the easternpart of the basin. According to the authors, the direction of tectonic transport of the VOC sealing Kallipetra Basin was from SSW to the NNE. It seems difficult that this transport can place the VOC on the sediments of the basin in a distance at least 4km into the basin and westwards, as shown by the geological map in Figure 3 and the geological sections in Figure 8. This could happen if the VOC nappe crossed the entire basin from southwest to northeast. Also, in the map of figure 3 the fault is characterized as a reactivated thrust fault. This is not clearly described in the text except perhaps from the sentence in line 490. A much better analysis and documentation of the interpretation given is needed.*

We do not fully understand the argument in this comment, however this, along with a similar comment from Reviewer 1, has alerted us to confusion over the reactivated thrust fault and direction of transport in our manuscript. We will make sure there is a better description and documentation of the reactivated thrust fault in section 5.6 'Sealing of the Kallipetra Basin and large-scale implications'. We will also add a series of 2D sketches that shows (1) the north eastward migration of the mounds is related to thrusting and not to normal faulting, (2) normal vs. inverted thrust, and (3) subsequent rotation of the fault into a 'normal' position.

e) *What is the origin of the basin and how is it associated with the growth of the Hellenides? Is it a fore-arc basin formed on top of an evolving accretionary wedge, is it a basin formed at the back of an orogenic wedge that collapsed due to underplating at its base, or is it a back-arc basin?*

Towards the end of the Kallipetra Basin timeline, the basin could be described as sediments accumulating in a foredeep generated ahead of an emplacing ophiolite. However, the basin formed under an extensional exhumation phase where there was a lot of erosion of both the Pelagonian continent and the Jurassic ophiolite, forming a depression. The upward deepening of the successions (before we shallow again due to

incoming ophiolite), suggests a phase of extension. Sharp & Robertson (1993) document a phase of extension affecting much of the Vardar Zone and other parts of the Hellenides in the Turonian - however this is when we document closure and compression in the Kallipetra. This brings further attention to an earlier important point raised by Referee #2 - that an analysis and comparison of our study site with Cretaceous Basins from other works will strengthen our study and highlight the heterogeneity that exists from region to region. We will build this information into the conclusions/interpretations of the Kallipetra Basin and how it was formed.
We had (1) Jurassic compression and ophiolite emplacement; (2) Re-opening under transtension/extension early-mid Cretaceous time; and (3) Closure and thrust fault reactivation in Late Cretaceous (and 'suture zone tightening').

f) *The evolution of the basin could be captured by a series of sketches, which can be either NE-SW striking cross-sections or 3D sketches, beyond the snapshot of Figure12.*

We think this will be a good addition to the manuscript that might help solidify some of our explanations and interpretations, especially with regards to your point (d). We will replace figure 12 with a snapshot of various times: (1) initial obduction; (2) exhumation/erosion; (3) deepening (4) shallowing, fault reactivation, and closure.

Comments on the text of the manuscript:
Line 28: There are dozens of references that could be placed here. It is better to include "e.g." at the beginning of the reference list.

Done.

Line 28: You should give the definition for the Internal Hellenides as the term is not only geographical or spatial but also has a geodynamic meaning by dividing the Hellenides into two areas with different evolution during the alpine orogenesis. Also, the first letter must be uppercase (Internal).

Corrected 'internal' to Internal - we also noticed this same mistake on line 35, which has also been corrected in the manuscript. Reviewer 1 also suggested we refer to the map or provide a definition of the Internal Hellenides, therefore we will make the positions of the Internal and External Hellenides more apparent in Fig.1 to address the concerns of both reviewers.

Line 34: What is the origin of this "Upper Cretaceous basin"? How was it created? Is it a single basin or more?

We will rephrase this part also considering the comment of reviewer 1.

Line 36: I think that the migration is towards the SW-SSW.

The migration direction depends on whether one is talking about present-day coordinates or not, therefore we will eliminate any confusion and simplify this sentence by replacing SSE with ‘southward’ in the text.

Line 41: What are these controversies? I believe it needs further analysis beyond a simple reference to “controversies” and the presentation of a figure (Figure 2). You need to clarify the problem that you want to solve with this work.

This is very similar to a point raised by reviewer 1 – we need clarify the controversies and the problem we wish to solve. The many and contrasting geodynamics models present in the literature source from the difficulties of connecting the Rhodope and the Pelagonian zone. This is a longstanding debate on the number and dimension of oceans in the Mesozoic Pindos-Vardar realm between researchers proposing a single unifying Early Jurassic Vardaric ocean that has been partly subducted, partly obducted and dismembered during successive tectonic events and researchers that embraced a multi-ocean early Jurassic scenario that led to several subduction zones. In these scenarios, the Cretaceous sediments were deposited on the eastern Pelagonian zone either within a Jurassic-Cretaceous passive margin or during a subsequent Cretaceous tectonic event (compressional or extensional depending on the authors). These geodynamic interpretations are presented in Fig.2 and display the different positions of the Pelagonia-Vardar margin relative to the Alpine orogenic wedge after the Jurassic convergence. By studying the small Upper Cretaceous Kallipetra Basin that lies on the Pelagonia-Vardar ‘suture zone’, we can begin to address questions on if and how the Pelagonian-Vardar margin was deforming. Our study will ultimately provide constraints on the position of the eastern Pelagonian margin relative to the Alpine orogenic wedge, hence ruling out some of the geodynamic models so far proposed.

Line 68: Add “e.g.” at the beginning of the reference list as there are numerous works that could be cited here.

We will add ‘e.g.’.

Lines 78-81: The area in which this stratigraphic gap has been described (Aptian-Albian) is very far from the study area and paleogeographically belongs to the wester nmargin of Pelagonian and not to the eastern. Furthermore, other researchers (e.g.

Sharp and Robertson 2006) argue that the onset of sedimentation occurs during the Aptian-Albian north of the study area.

We agree that the area to which we refer to is far from the study area. Therefore, we will investigate descriptions of the Aptian-Albian hiatus and/or deposition from other studies such as Sharp and Robertson (2006) that are closer to our study area and edit the text accordingly.

Line 82: There are papers that describe older in age transgressive sediments which unconformably overlay the Pelagonian and Vardar units (e.g. Mercier 1968; Brown and Robertson 2004; Sharp and Robertson 2006; etc). See also my comment b.

We agree, but here we are referring to transgressive sediments to the south and not to the north. We will also rephase this part.

Line 83: You need to add more references here. There are numerous works to be cited here, with primary data except from the synthetic work of Papanikolaou (2009).

Ok, we will add other works.

Line 92: Add "e.g." at the beginning of the reference list as there are numerous works that could be cited here.

We have added e.g. at the beginning of the reference list.

Line 95: Leucogneisses?

We will correct 'leucogneiss' to 'leucogneisses'.

Lines 95-96: Are you referring exclusively to the area west of the Kallipetra Basin or to the Pelagonian in general? If the latter is true you should add more references, as it is not only Schenker (2013) who describes the above lithologies. You could add "Schenker 2013 and references therein".

In this case, we are referring to and describing only the lithologies in the study area - hence just the area west of the Kallipetra Basin studied in Schenker (2013).

Line 111-112: The sentence 'the sediments belong . . . . . .as the Kallipetra bas-inÂ ̈z causes confusion (see also previous comment c). What is called as Kallipetra

basin? Is it the paleogeographic domain where the large thick Upper Cretaceous sediments were deposited or only the small basin under study?

The Kallipetra Basin is the small basin under study but could be correlated with other Late Cretaceous sediments found in nearby areas along the suture zone.

Lines 115-118: Please enter references as you seem to be referring to older works.

The work referenced here is Schenker et al 2015, we will add this to the manuscript

Line 141: What do you mean by the term "metapelitic zones"?

We mean 'diagenetic zones' or very low- to low-grade metamorphic zones. The term 'metapelitic zones' will be replaced by 'diagenetic zones'.

Lines 235-236: You argue that the fossils are deformed and reworked and are supplied by the VOC based only on the work of Schenker (2013). Apart from this study, I do not remember any other study that reports Lower Cretaceous sediments in the VOC. On the contrary, there are papers that support the start of deposition in Aptian-Albian(see also previous comment b). Even in your own work it is described that sediments of Kallipetra Formation with VOC form duplexes, so how are you convinced that the fossils belong to VOC and not to the Kallipetra formation? Îd'here are also studies that describe Upper Jurassic-Lower Cretaceous sediments unconformably on the VOC, which seal the tectonic emplacement of the VOC onto the passive margin of the Pelagonian. If you include those Upper Jurassic-Lower Cretaceous sediments in what you have named as Vardar Oceanic Complexes then you need to clarify that.

Thank you for your comment. We need to reassess the origin of these deformed/reworked fossils. The deformation and lack of preservation, along with their age distribution, still suggests that they are reworked and do not represent the depositional age of the unit from which they are found in. However, it is a possibility that they have been supplied from the very base of the Kallipetra Basin units that form the duplexes. We will reassess and adjust the manuscript accordingly to clarify the origin of the fossils.

Lines 311 and 312: Please correct the references. There is no Schenker (2014) in your reference list.

Schenker (2014) should be corrected to Schenker et al., (2014).

Line 415: Please enter reference as you seem to be referring to older work.

This work should be Schenker et al., (2015).

Line 449: The word "dramatic" has been struck through. I believe you need to delete that word.

Yes, dramatic needs to be deleted.

Lines 488-489: See my comment d. As in the following lines (490-492) you suggest a localized inversion that predated the start of the general convergence, you have to enforce your interpretation.

We will reinforce our interpretation with a series of sketches, as mentioned in our response to commend (d).

Lines 494-498: I suggest to delete this interpretation as you have already weakened it in the second sentence.

See reply on the heat source to reviewer 1.

Comments on the Figures

1. *Figure 2 shows various models of evolution of the Hellenides in the Cretaceous, which are not analyzed in the manuscript and in the end there isn't any suggestion about them. Therefore, it does not offer anything substantial to this work and could be removed.*

We will keep figure 2 but make sure we explain our study goals more clearly and refer back to the figure once we interpret our data, and we will make sure to be more specific on the controversies we would like to address (see reply on the scientific question to review 1).

2. In the geological map of figure 3 some things are not visible and difficult to distinguish, e.g. difficult to distinguish black dots from dark blue ones. Therefore, some symbols need to be magnified.

We, and Reviewer 1, agree that the dots are very small. We will make the dots much larger along with the text labels to make it more visible.

3. In the geological sections of Figure 8, there is a large number of faults. According to the manuscript and the map of figure 3, these are normal, thrust and strike- slip faults. In order for the reader to find out which is which, he must constantly resort to the map. Therefore, I suggest the relative slip of the fault-blocks should be plotted along the faults.

We appreciate having this brought to our attention. The relative slip of the fault blocks was plotted along the faults, however the reduction in size of the figure was not taken into account so the labels were no longer visible. We will make the relative slip symbols much larger and visible to the reader.

4. In figure 12 there is no legend explaining the symbols used to describe the different geological formations of the sketch. The sketch also gives a false impression that the basin has developed mainly east and northeast of the VOC. Perhaps the sketch should also include the western margin of the basin in order for the reader to have a complete picture. See also previous comment for 3D sketches.

We will create a series of sketches that show the evolution of the basin to replace the single snapshot displayed in Figure 12 and will be sure to add a legend. We will ‘snapshot’ the following phases of basin development - (1) initial obduction; (2) exhumation/erosion; (3) deepening (4) shallowing, fault reactivation, and closure.