Interactive comment on **"Ionian Abyssal Plain: A window into the Tethys oceanic lithosphere"** ***by*** **Anke Dannowski et al.**

Polonia (Referee)

alina.polonia@bo.ismar.cnr.it

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Manuscript n. se-2018-123 Title: Ionian Abyssal Plain: A window into the Tethys oceanic lithosphere by Anke Dannowski, Heidrun Kopp, Frauke Klingelhoefer, Dirk Klaeschen, Marc-André Gutscher, Anne Krabbenhoeft, David Dellong, Marzia Rovere, David Graindorge, Cord Papenberg, and Ingo Klaucke

This paper presents new results from the analysis of a seismic refraction and wideangle reflection profile acquired in the abyssal plain of the Ionian Sea. Main results concern seismic velocity distribution and crustal structure of the lower plate in a relatively undeformed region, seaward of the converging plate boundary, whose nature (oceanic/thinned continental) is still debated. It is a good paper, which provides interesting new data. The manuscript is concise, well written and illustrated, and it deals with topics of relevance that could be of general interest to the readers of the journal. I have some general comments and specific issues, which should be addressed to improve the overall good quality of the manuscript.

- We thank the reviewer for her useful remarks and thoughtful comments that substantially helped us to improve the manuscript. We applied changes to the manuscript which can be traced in the word document. We provide our answers to the comments directly in the PDF document. Below please find our discussion for every single major paragraph addressed by the reviewer.

The Calabrian Arc is described as a classic subduction system, where the lithosphere is actively subducting underneath Eurasia. However, the geodynamic setting of this unique convergent plate boundary is far more complex. The subduction system is segmented along lithospheric faults accommodating slab tearing, plate divergence and incipient rifting processes, which appear oriented parallel to the convergence direction. Moreover, the study region is located were the slab is already detached, and thus the rate of underplating might have slow-down recently. The deep fragmentation of the subduction system close to the study region, occurs along lithospheric faults, which were described as related to Mesozoic inherited discontinuities in the Tethys lithosphere (i.e. fracture zones) and are presently driving neotectonics. I suggest to discuss this complexity in the frame of the results of this new study.

- Our study focusses on the Ionian Abyssal Plain and the nature of its crust. Of course the subduction system is rather complex and this affects the overall tectonics of the region. However, it will not influence the nature of the subducting crust. To stay focussed on answering the research questions that have been addressed by the design of this profile we like to keep our discussion as lean as possible and leave the discussion on the subduction zone for studies that address questions on the subduction system, i.e. seismic profile DY-04.
- We added a discussion on the Malta Escarpment and the Apulian Escarpment that are interpreted to be transform margins [Gallais et al., 2011; Frizon de Lamotte et al., 2011].

It has been recently proposed that lithospheric faults segmenting the subduction system trigger serpentinite diapirism, which brings to the surface mantle derived rocks, representing a tectonic window into the Tethyan mantle. These findings are not discussed at all in this manuscript, but I think they are relevant because strictly related to the nature and structure of the lower plate, one of the main subjects of this paper. If serpentinites are inherited from the Tethyan ocean, they are Mesozoic

in age, and could have developed along fractures located near the boundary between the oceanic crust and the adjacent thinned continental crust as suggested by Polonia et al. (2017). The widespread presence of serpentinites suggests that the Tethyan Ocean, was not a magma-rich basin; serpentinization may have occurred along the OCT or may represent the product of hydration of exhumed mantle. The Authors might take into consideration the occurrence of serpentinites, and check whether it fits their data or suggest alternative possibilities. This would help future researches in this area.

- We agree that serpentinisation should be discussed in this study. Diapiric structures interpreted to be made of serpentinised mantle were found in the Calabrian Arc. The origin of the serpentinised material is expected to be in the subducting plate. With profile DY-05 we obtained a velocity profile which we now also discuss in the context of serpentinisation as suggested by the reviewer. As outcome we exclude to have major occurrence of serpentinised mantle in the IAP. This however, does not exclude potential serpentinisation in areas already subducted under the Calabrian Arc, possibly connected to fossil subducted fracture zones. However, the studied profile is exclusively situated in the IAP, thus, we are not able discuss the findings within the Calabria Arc based on our data. In any case it is at the limits of the resolution of wide angle data at this depth especially beneath the arc.

This comment brings me to the next issue dealing with uncertainties. Gravity modelling is very dependent on the forward modelling approach and parameters, and usually does not provide firm evidence to discriminate gabbros from mantle-derived lithologies, and it has been unable to provide solid evidence to unambiguously discriminate mantle lithologies at depth from other combinations of mafic and ultramafic rocks. (e.g., Escartin & Cannat, 1999; Dunn et al., 2007). Velocities are the strongest evidence pointing for an oceanic crust. However, I would suggest to include in the discussion as a reference, two additional velocity profiles to be compared with presented refraction data: exhumed mantle like in the Tyrrhenian Sea (Prada et al., 2014) and exhumed lower crust. High Vp/Vs data close to the study region should also be considered and discussed (D'Alessandro et al., 2016). Exhumed mantle does not probably fit the velocity profile reconstructed using the newly acquired data, but discussing this occurrence would eventually strengthen the conclusions. On the other hand, I am not sure that the velocity profile of an exhumed lower crust can be discharged.

- We included an intense discussion on the occurrence of exhumed serpentinised mantle as proposed by the reviewer. We included the recent work of Prada et al. (2016) and the work of Polonia et al. (2017) which is based on the findings of D'Alessandro et al. (2016). D'Alessandro et al. present a 1D model as an average model of the entire Ionian Sea, not the IAP exclusively. We updated Figure 4 and included improved and more sophisticated velocity-depth ensembles for the different lithologies that might occur in the study area. Based on the combination of absolute seismic velocities and velocity gradients, we can discriminate grabbos from mantle-derived lithologies (new Fig. 4). We do not see evidence for exhumed lower crust or serpentinised mantle in large volumes that could be resolved with the applied techniques.

Finally, in the geology background the Authors state that, if the Ionian lithosphere has a Tethyan affinity, its oceanic nature would support the hypothesis that the Adria microplate and the Ionian Sea, belong to a rigid promontory of Africa. However, thrust faulting and inversion structures in the abyssal plain (as described by Gallais et al., 2011 and in this manuscript) and below the accretionary wedge (Bortoluzzi et al., 2017) contradict such a 'rigid' connection to Africa. The Authors should discuss this apparent contradiction and suggest likely scenarios for tectonic inversion and basement involved tectonics in the oceanic lithosphere as evidenced in the multichannel seismic lines.

- We cleaned up and edited the discussions and re-wrote large parts of it. We sorted out things named as "rigid" or "non-rigid" connection and the broader meaning of the findings and implications that the oceanic nature of IAP provides. The oceanic plate seems to be less rigid than

expected for oceanic plates in general, which could be an effect of the subduction processes and the size of the remaining plate. Based on the interpretation that the Ionian crust is an oceanic domain, the Adria micro-plate most possibly did not have rigid connection to Africa and could move relative to Africa.

- As you will recognize from the revised version, the reviewer has sparked extensive revisions which have improved the manuscript considerably. In particular, the discussion on serpentinisation has added a novel aspect to the work which was previously not considered. We are hence grateful for the effort and time that the reviewer invested to advance the earlier version.