"The diverse crustal structure and the magmatic evolution of the Manihiki Plateau, central Pacific"

by K. Hochmuth, K. Gohl, G. Uenzelmann-Neben, R. Werner

Authors' response addressing the comments by M. Coffin (referee)

Some comments by the referee are repeated several times. We will respond to them once and refer later to the ***Author's response number*** written in bold italic letters below the original response.

Italic letters indicate *a quote from the revised manuscript or literature* cited in the text.

General Comments	
Referee comment:	**Author's response**
The authors should re-focus the paper on what the new data illuminate about salient LIP issues, eg, what is the nature of the HVZ, moving forward where Ridley & Richards (2010) left off regarding LIP petrogenesis, etc. Shear wave data and Poisson's ratios are relatively rare for oceanic LIPs, and much, much more could be done with them in a revised manuscript.	The revised manuscript includes a further examination of the nature of the HVZ and its indications regarding the tectonic framework of Ontong Java Nui and the Manihiki Plateau. We expand our interpretation in particular on using the shear-wave data and the derived Poisson's ratio model.

Specific Comments	
Referee comment	**Author's response**
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Line 2: Replace "It was" with "It is proposed to have been". While evidence for the Manihiki-Hikurangi reconstruction appears robust, this is not the case for the Manihiki-Ontong Java reconstruction.	Since the plate-tectonic reconstruction is still arguable and the proposed fit between Manihiki and Ontong Java still poses a lot of questions, we adopted this suggestion.
Line 3: Replace "experienced fragmentation" with "deformed internally," and "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974). This makes clear the distinction between the proposed "fragmentation" of Manihiki, Hikurangi, and Ontong Java and, in contrast, the relatively minor	This comment re-occurs in the referee's text and has been corrected throughout the manuscript. For a better distinction between the two tectonic processes - the rifting of Ontong-Java-Nui and the rifting of the Manihiki Plateau -, we refer to the diassemblage of Ontong-Java-Nui as fragmentation into the Manihiki Plateau, the Hikurangi Plateau and

deformation within Manihiki.	the Ontong-Java Plateau. The division of the Manihiki Plateau is now referred to as an internal deformation. ***Author's response number 1***
Line 8: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	The nomenclature is now in agreement with the terminology established by Winterer et al. 1974 throughout the manuscript. ***Author's response number 2***
Lines 13-14: The latest (V23) satellite-derived gravity field available from Scripps shows numerous highs indicating seamounts/sea knolls surmounting the Western Plateaus, a few of which have been sampled and dated (Hoernle et al, AGU abstract, 2009) as younger than ca 120 Ma. Thus, while along the two seismic profiles, the High Plateau and Western Plateaus may appear to differ with respect to secondary volcanism, overall both are surmounted by numerous seamounts/sea knolls. Hence, this conclusion is not supported by satellite gravity/bathymetric data.	The Western Plateau did experience later stages of volcanism, as can be derived form gravity data (Sandwell & Smith) and dredge samples (Hoernle 2009), although the nature of the late volcanism as well as the emplacement rate differs strongly. On the High Plateau massive basaltic flows and intrusions can be observed. These features are not present on the Western Plateau and, therefore, the volcanic activity was different and smaller. We revised the manuscript carefully to reduce the confusion, concerning the mode of volcanic activity on the two sub-plateaus during later volcanic stages: High Plateau → multiple seamounts, basaltic flow units, numerous volcanic extrusive and intrusive centers Western Plateau → volcanoclastic sedimentation, local seamount volcanism, no basaltic flow units ***Author's response number 3***
Lines 15-16: The decrease in depth to Moho has at least two plausible explanations: 1) crustal thinning, and 2) original thickness. In the absence of well-imaged normal faulting, the simpler explanation is that Manihiki Plateau crust thins towards its edges.	We agree that the decrease in Moho depth can be either due to crustal thinning or by the original thickness. In the case of the Manihiki Plateau, we have to consider the following issues: • plate tectonics (break-up of Ontong-Java Nui) • emplacement history (massive emplacement of igneous material during a first volcanic episode and regional secondary volcanism)

	An original crustal thickness would indicate, that the Western Plateau's crust thins due to the distance to the center of volcanic emplacement. This scenario can be assumed for the inactive margin of Ontong Java (northern margin). Here, a smooth decrease in depth towards the ocean basin can be observed. The HVZ ends before the transition into normal oceanic crust (Mochizucki, 2005). The HVZ is clearly traceable in the lower crust of the Western Plateau and in the Tokelau Basin. This points to the conclusion that the Tokelau Basin crust was emplaced as part of Ontong Java Nui. Crustal thinning is indicated by a stepward decrease in depth in the Moho, in the bathymetry in patterns of the reflection seismic data. The proposed fit between the Ontong Java Plateau and the Western Plateau of the Manihiki Plateau can be supported by bathymetric indications of seafloor spreading in the Ellice Basin (Taylor 2006, Chandler 2012, 2013). This spreading is characterized by a constant reorientation and jumps within the spreading centers, resulting in a rotation of Ontong Java (Chandler 2013), which could result in stretching at the conjugate margin, the Western Plateaus. We dedicated an additional section in the manuscript to the implications of the presence of the HVZ in the lower crust of the Manihiki Plateau. ***Author's response number 4***
Lines 16-21: On the basis of the above, these conclusions don't appear to be substantiated by the data, and the authors need to re-think their major conclusions.	In the revised version of the manuscript, we additionally emphasize the role of the HVZ and the mode of secondary volcanism on the Western Plateaus. The presence of the HVZ below the Tokelau Basin supports the previously presented interpretation of the presence of stretched LIP crust at the Western Plateaus. By comparison of the

	Western Plateau with the tectonically unaltered northern margin of Ontong Java we stand by our interpretation and exclude the possibility that the crust of the Western Plateaus is thinning due to its distance from the volcanic center located on the High Plateau.
Line 17: Replace “sub-plateaus” with “sub- provinces,” consistent with the terminology of Winterer et al (1974).	***Author’s response number 2***
Line 20: Replace “sub-plateaus” with “sub-provinces,” consistent with the terminology of Winterer et al (1974).	***Author’s response number 2***
Line 24: LIPs were first defined by Coffin & Eldholm (1994); primary references should be employed.	References were updated. (Bryan and Ernst, 2008; Coffin and Eldholm, 1994)
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Lines 1-2, 3-4, 5-6, 8-9, 13-14, 16, 17-19: References appear to be listed alphabetically; they should be listed chronologically. Again, primary references should be employed, eg, Coffin & Eldholm (1994), on the basis of work published previously (see references therein), described correlations between LIPs and extinctions events prior to any of the cited references.	The alphabetical listing of the references is due to the citation conventions of the journal. ***Author’s response number 5*** The references have been updated. (Bryan and Ernst, 2008; Coffin and Eldholm, 1994; Courtillot et al., 1999; Larson and Erba, 1999; Tarduno, 1998; Wignall, 2001).
Line 6: LIPs result in anomalously thick mafic (not oceanic) crust, and again, primary references should be cited.	The references have been updated. (Bryan and Ernst, 2008; Coffin and Eldholm, 1993; 1994; Wignall, 2001). Since this section is referring to LIPs in general the term mafic needs to be chosen for a characterization of the crust.
Lines 11-14: The two salient differences between LIPs and normal oceanic lithosphere are the 7.0-7.6 km/s lower crust and the greater crustal thickness. Primary references should be cited (eg, Coffin and Eldholm, 1994, should replace Coffin et al., 2006).	References have been updated. (Coffin and Eldholm, 1994; Ridley and Richards, 2010) The P-wave velocities expected for a HVZ within the lower crust of a LIP have been added in brackets.

Lines 19-21: This conclusion doesn't belong in the introduction, unless previous work is cited. It's not clear what is 'atypical' – different parts of Kerguelen and Ontong Java, for example, show different crustal characters, so why is Manihiki 'atypical'?	The Manihiki Plateau shows different characteristics such as the internal deformation in sub-provinces. These sub-provinces show an individual signature in the satellite gravity anomaly. The gravity anomaly signature changes on all LIPs, but mostly towards the margins. The Manihiki Plateau shows distinct large areas in the gravity anomaly map (e.g. the Western Plateaus), which are rather similar to the adjacent oceanic basins. Additionally, the Danger Islands Troughs are a unique setting separating to sub-provinces by a deep narrow trough.
Lines 22, 24: Replace "sub-plateaus" with "sub-provinces" and "Island" with "Islands," consistent with the ter-minology of Winterer et al (1974).	***Author's response number 2***
Line 25: Replace "The fragmentation" with "Internal deformation."	***Author's response number 1***
Lines 25-27: In current form, this sentence is ambiguous. Do the authors seek to understand how internal deformation (including formation of the Danger Islands Troughs) of Manihiki was related to breakup of Ontong Java Nui, or simply to under- stand the internal deformation of Manihiki? Replace "Island" with "Islands," consistent with the terminology of Winterer et al (1974).	The sentence has been reworded to the following: *"The fragmentation of the Manihiki Plateau poses the question, whether distinct phases of igneous or tectonic processes led to the deformation of the Manihiki Plateau and which role the Danger Islands Troughs played in this scenario."*
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Line 1: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 4-5: References should be cited for the age of Manihiki formation.	References have been added to cite the age of the formation of the Manihiki Plateau. (Clague, 1976; Hoernle et al., 2010; Ingle et al., 2007; Timm et al., 2011)

Lines 6-7: The 0.8% figure does not refer to Ontong Java Nui, but rather to Ontong Java plus Nauru Basin plus East Mariana Basin plus Pigafetta Basin. The authors should recalculate, adding Manihiki and Hikurangi to these. Also, references appear to be listed alphabetically; they should be listed chronologically.	Citation after Ingle (2007) *"…whether three of these features (Ontong Java, Manihiki, and Hikurangi) formed as a single LIP, despite their current separation by thousands of kilometers (Taylor, 2006; Worthington et al., 2006). If true, the area affected covered >1% of Earth's surface."* Therefore, the Ontong Java Nui covered approx. 1% of Earth's surface. References updated (Bryan and Ferrari, 2013; Coffin and Eldholm, 1993; Ingle et al., 2007; timm et al., 2011; Wignall, 2001) ***Author's response number 5***
Line 14: A reference for secondary Ontong Java volcanism needs to be cited.	Inoue et al. (2007) is cited here as a representative study on secondary volcanism on the Ontong Java Plateau.
Lines 21- 22: Replace "Cretaceous Magnetic Quiet Period" with its proper name, "Cretaceous Normal Superchron."	The term "Cretaceous Normal Superchron" is now used.
Line 25: As above, replace "experienced fragmentation" with "deformed internally." Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974). Line 27: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 1*** ***Author's response number 2***
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Line 1: Replace "are a failed rift separating" with "separate," as neither Clague (1976) nor Winterer et	The origin of Danger Islands Troughs is still debatable. Winterer (1974) proposed active rifting; Mahoney and

al (1974) identified the Danger Islands Troughs uniquely as rifts. Winterer et al (1974) raised the possibility of either extension or transform motion to account for the Troughs.	Spencer (1991) relate it to the arrival of a mantle plume and corresponding shear forces. Larson (1997) proposes a combination of both. The section has been reworded to: *"Further significant features of the Manihiki Plateau are the Danger Islands Troughs, which are created by rifting and/or transform forces separating the High Plateau from the Western Plateaus (Larson, 1997; Mahoney and Spencer, 1991; Winterer et al., 1974),…"*
Line 2: Replace "Clague, 1976" with "Winterer et al., 1974," which is the primary reference. Replace "Suvorov" with "Suvarov," the spelling used by Winterer et al (1974). Replace "Through" with "Trough."	The references have been updated. (Larson, 1997; Mahoney and Spencer, 1991; Winterer et al., 1974) ***Author's response number 2*** Spelling mistake is corrected.
Lines 11- 13, 22-23, 24: References appear to be listed alphabetically; they should be listed chronologically. Line 17: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 5*** ***Author's response number 2***
Lines 21-23: Reword this sentence to "Later stages of episodic volcanism on the Manihiki Plateau are also manifested by multiple seamounts on the High Plateau (Coulbourn and Hill, 1991; Beiersdorf et al., 1995b) and Western Plateaus (Smith and Sandwell, 1997; Hoernle et al., 2009).	This sentence was reworded to: *"Later stages of episodic volcanism on the Manihiki Plateau are also manifested by multiple seamounts and basaltic flow units on the High Plateau (Beiersdorf et al., 1995b; Coulbourn and Hill, 1991) and smaller seamounts on the Western Plateau (Sandwell and Smith, 1997)."*
Line 29: Replace "sub-plateaus" with "sub- provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
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Lines 22-25: The authors should detail the range of vertical and horizontal resolution of the data, as well as the uncertainties in P and S wave velocities.	We carefully re-examined the parameter uncertainties of our model for P-and S-waves especially for the intercrustal reflectors (see also our response to comments by reviewer M. Prada). The results of the re-evaluation are presented in the

	section *3.2 Processing and modeling of seismic refraction/wide-angle reflection data* of the manuscript.
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Lines 5-7: Was the latest version (V23) used?	The modeling was carried out on data from version 18. We compared the data from version 18 to the data provided in version 23. In the area of the Manihiki Plateau, the newer version grid shows no striking differences. The figures are updated with the newer grid (V.23)
Line 20: Replace "plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974). Line 23: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 2***
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Lines 1, 26: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 2***
Lines 1-2: Could this be a function of resolution and topography?	The station OBH 29 is placed directly in the Danger Islands Troughs. The station recorded very good data and so did the neighboring stations at the flanks of the Troughs. These stations provided data to image the Danger Island as well as both sub-provinces. Therefore, the data of station 29 can be relied on. The ray coverage in the crust of the Danger Islands Troughs is quite good. The lack of the upper crust is not due to misinterpretation but indeed present.
Line 5: Move "magmatic" to between "intrusive" and "features."	wording has been changed to *"Several extrusive and intrusive magmatic features…"*
Lines 9-14: Data coverage in the Penrhyn and Samoan basins is relatively limited – how confident are the authors that these are robust results?	The data can only be interpreted for the marginal oceanic basin in the vicinity of the Manihiki Plateau and not for the entire oceanic basin. The sentence has been rewritten to: *"The upper crust of the surrounding*

	ocean basins close to the margins of the Manihiki Plateau, the Penrhyn Basin…"
Lines 14-15: This sentence belongs in the discussion section.	The sentence has been deleted from the "Results"-section of the manuscript.
Line 22: Replace "the middle crustal layer extends to the basement" with "the upper crustal layer is absent, and the top of the middle crustal layer is acoustic basement."	The statement was rephrased in the revised version of the manuscript: *"…ridge-like structures at 230 and 270 km profile distance, the upper crustal layer is absent and the top of the middle crustal layer represents the acoustic basement."*
Line 26: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 2***
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Line 1: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 2***
Lines 15-16: Primary references should be cited (eg, Coffin and Eldholm, 1994, should replace Coffin et al., 2006).	The references have been updated. (Coffin et al., 2006; Ridley and Richards, 2010).
Line 17: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 19-20: Replace "very little" with "a few."	The sentence has been changed to *"…only a few interpretable signals were returned…"*
Line 24: Somewhere the authors need to state clearly that crustal thickness throughout (?) the manuscript refers to both sediment and igneous crust. The literature on LIPs contains a mix of work where crustal thickness can either be this combination or igneous crust only.	The term 'crust' is used throughout the manuscript as the combination of the igneous crust and the sediment column. This has been clarified in the manuscript.
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Line 8: Replace "Samoan" with "Tokelau."	This mistake has been corrected.

Line 9: Replace “Island” with “Islands,” as named by Winterer et al (1974).	***Author’s response number 2***
Lines 11-12: None of these references document that the “crust of the Manihiki Plateau is severely faulted;” the authors need to be more specific and cite the relevant literature. For example, Winterer et al (1974) and subsequent workers (eg, Ai et al (2008) and Pietsch & Uenzellman-Neben (submit- ted) showed that the margins of Manihiki, the Danger Islands Troughs, and the Suvarov Trough are severely faulted, but not the Manihiki Plateau in general. References ap- pear to be listed alphabetically; they should be listed chronologically.	The crust of the Manihiki Plateau is severely faulted at its edges as well as at the internal troughs. Internal fault systems are also present on the High Plateau (Pietsch and Uenzelmann-Neben 2014) and faulting is present on the Western Plateau. *“In general, the crust of the Manihiki Plateau is, at its margins and due to the troughs intersecting the plateau severely faulted (Ai et al., 2008; Pietsch and Uenzelmann-Neben, n.d.; Winterer et al., 1974)…”* ***Author’s response number 5***
Lines 16, 18: Replace “sub-plateaus” with “sub-provinces,” consistent with the terminology of Winterer et al (1974).	***Author’s response number 2***
Lines 17-18: The presence of a continuous HVZ beneath both the High and Western plateaus is a key result, as this is a defining characteristic of LIPs. The absence of a break in the HVZ between the sub-provinces argues against “fragmentation” of these parts of the plateau, but rather for “internal deformation.” Farther afield, the presence or absence of a HVZ beneath Robbie Ridge could be used to argue for or against, respectively, the reconstructions of Taylor (2006) and Chandler et al (2012, 2013).	In the revised version of the manuscript, we add an additional section (6.2) on the role of the HVZ at the different sub-provinces. In this section, we discuss the implications of the nature of the HVZ at the different margins of the Manihiki Plateau, such as • Continuous HVZ at the whole Manihiki Plateau → Plateau deformed internally and was emplaced by a single emplacement mechanism • HVZ thins towards the Tokelau Basin but is clearly still present → the Tokelau Basin crust shows indications of LIP crust • HVZ terminates at the Manihiki Scarp → tectonically intersected • HVZ is still present in the Samoan Basin → stretched margin with volcanic overprint we cannot report “normal”

	oceanic crust. The reevaluation of the HVZ can explain the nature of the break-up mechanisms acting between the Manihiki Plateau and the other parts of Ontong Java Nui. Whether the HVZ is present below the Robbie Ridge cannot be interfered by our data. ***Author's response number 6***
Lines 18-20, 24-25: References appear to be listed alphabetically; they should be listed chronologically.	***Author's response number 5***
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Lines 1-2: This is an interesting result. Could the presence or absence of a HVZ beneath the Tokelau Basin be a key indicator? If not an issue of resolution, what explanations could there be for the lack of a clear boundary?	The presence of a HVZ below the Tokelau Basin can be interfered from our data. The presence of the HVZ in the Tokelau Basin will be also discussed in an additional section on the HVZ (6.2). In general, the presence of the HVZ in the Tokelau Basin supports the hypothesis that the Western Plateau experienced a phase of crustal stretching. If the Tokelau Basin would consist of "normal" oceanic crust, we could not detect a layer of such high P-wave velocities. The presence of the HVZ might indicate that the crust of the Tokelau Basin at the margin of the Western Plateau was emplaced as part of Ontong Java Nui.
Lines 3, 18: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 6-7: Primary references should be cited (eg, Coffin and Eldholm, 1994, should replace Coffin et al., 2006). References appear to be listed alphabetically; they should be listed chronologically.	References have been updated (Christensen, 1996; Coffin and Eldholm, 1994; Richards et al., 2013; Ridley and Richards, 2010). ***Author's response number 5***
Lines 11-12: Pietsch & Uenzelmann-Neben (submitted) needs to be	Pietsch and Uenzelmann-Neben (2014) is referenced in the revised

referenced here.	version of the manuscript.
Lines 16-18: Although not observed on the Western Plateaus seismic profile, ample evidence exists for later stage/secondary volcanism on the Western Plateaus in the satellite-derived free air gravity field and predicted bathymetry, as well as ages of igneous rock samples from features surmounting the Western Plateaus (Hoernle et al, 2009). The authors need to consider all relevant data in making such conclusions, as opposed to only the seismic profiles.	***Author's response number 3*** The following sentences have been added to the revised manuscript to emphasis the fact, that the volcanic activity was present on both sub-plateaus, but shows a different intensity and form. *"Similar structures e.g. basaltic flow units cannot be observed on the Western Plateaus. The volcanic activity on the Western Plateau consists of seamounts and smaller, localized features (Hoernle et al., 2010; Sandwell and Smith, 1997)."*
Line 20: References appear to be listed alphabetically; they should be listed chronologically.	***Author's response number 5***
Lines 21-22: It is not clear why Ito & Taira (2000) is referenced here, as that work addresses the Ontong Java Plateau.	The citation of Ito and Taira (2000) has been removed.
Line 24: Winterer et al (1974) should be cited here, among others.	References have been updated. (Ai et al., 2008; Pietsch and Uenzelmann-Neben, n.d.; Viso et al., 2005; Winterer et al., 1974)
Page 1876	
Lines 4-6: Although not observed on the Western Plateaus seismic profile, ample evidence exists for later stage/secondary volcanism on the Western Plateaus in the satellite-derived free air gravity field and predicted bathymetry, as well as ages of igneous rock samples from features surmounting the Western Plateaus (Hoernle et al, 2009). The authors need to consider all relevant data in making such conclusions, as opposed to only the seismic and gravity profiles.	***Author's response number 3*** The following sentences have been added in the revised version of the manuscript. *"The upper crust of the Western Plateaus is heavily structured by fault systems and horst and graben features (Fig. 13). The volcanic activity on the Western Plateau is marked by small seamounts."*
Lines 6-7, 10-11: Identifying faults, horst, and graben from refraction data is extremely challenging; the authors	We prepare an additional figure, which shows part of the multi-channel data of profile AWI-20120100 in order

should present the reflection data to make their case. Aside from the one graben apparent on the seafloor, could the velocity discontinuities alternatively represent boundaries between original Western Plateaus crust and such crust modified by later stage/secondary volcanism?	to emphasize the presence of normal faulting in the basement. The suggestion, whether the velocity discontinuities might represent boundaries between the original Western Plateau crust and the crust modified by secondary volcanism, cannot be supported. The presence of the HVZ in the lower crust of the Western Plateau throughout the profile suggests a coupled emplacement. The discontinuous structure of the upper crust shows no clear evidence that makes it possible to link the proposed rock type to original or altered/added crust.
Lines 12-13: No compelling data are presented for the presence or absence of normal faults; the authors need to present the reflection data to make their case.	An additional figure showing the normal faulting in the reflection seismic data is provided in the revised version of the manuscript.
Lines 13-14: The decrease in depth to Moho has at least two plausible explanations: 1) crustal thinning, and 2) original thickness. In the absence of well-imaged normal faulting, the simpler explanation is that Manihiki Plateau crust thins towards its edges.	***Author's response number 4***
Lines 14-19: The authors have not made a compelling case for this; they need to present and consider all relevant data.	The evidence for the proposed crustal stretching at the Western Plateaus is further supported by additional arguments in the revised version of the manuscript. Please see the explanations and additions above.
Lines 20, 24, 26: Replace "Island" with "Islands," as named by Winterer et al (1974). Lines 20-21: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 22-23: What specifically are "relicts of a former spreading center," and how do they differ from lower crustal layer and crust-mantle boundary structures associated with pull-apart basins/releasing bends along transform faults? This	Further evaluation of all available data from the Danger Islands Troughs reveal that it is rather likely that the Danger Islands Troughs are pull-apart structures. We therefore re-phrase this section to: *"The absence of the uppercrustal*

interpretation seems to be over-reach.	*material and the lack of an updoming of the mantle might suggest, that the Danger Islands Troughs are formed as a series of pull-apart basins."*
Lines 22-26: Could another explanation be vertical resolution of the data and overall thinning of two middle crustal layers?	The vertical resolution has to be considered, although the velocity-rage (5.0-5.8 km/s), which is associated with the upper-middle crust, is not present in the middle or in the upper crust of the Western Plateaus. Additionally, the change-over between a four-layer crust on the High Plateau and a three-layer crust on the Western Plateau is quiet sudden exactly at the location of the Danger Islands Troughs (see also Fig.2b)
Lines 26-28: This conclusion is not justified by the foregoing analysis or data contained in the manuscript; the authors either need to present and consider all relevant data in support of this conclusion, or re-think the issues.	The addition of a figure of the reflection seismic data and the presence of the HVZ support the assumption of the Danger Islands Troughs being a prominent separation between the two sub-provinces of the Manihiki Plateau.
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Line 4: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Line 5: Replace "show amazing differences, especially in the upper crustal layers and the crustal thicknesses" with "on the basis of the seismic profiles, share a significant similarity in the presence of a continuous HVZ beneath the two, but differ in their upper crustal layers and the crustal thickness." In general, the authors appear to under-emphasize similarities, and over-interpret/over-emphasize differences between the two sub-provinces.	In the revised manuscript, the sentence is rewritten to: *"The Western Plateaus and the High Plateaus of the Manihiki Plateau exhibit similar features such as a continuous HVZ within the lower crust but also show amazing differences, especially in the upper crustal layers and the crustal thicknesses."* It seems important to include the HVZ here, since the manuscript will give additional insight into the nature and role of the HVZ at the Manihiki Plateau.
Line 16: Primary references should be cited; Coffin and Eldholm (1994)	References have been updated. (Coffin and Eldholm, 1994; Ridley and Richards, 2010)

should replace Coffin et al (2006).	
Lines 21-26: Two sentences contradict one another, namely “This layer is not resolved as a crustal unit in all LIPs...” and “...the Western Plateaus is missing a crustal layer present in all other oceanic LIPs.” The first statement appears to be true in both Ridley & Richards (2010) and Figure 15, so the second statement needs to be amended.	The contradicting sentences are changed to: *“The High Plateau along with other oceanic LIPs has an upper middle crustal layer of P-wave velocities 5.0 to 5.8 km/s (yellow to orange colors in Fig.15). This layer is present on all previously presented LIPs as a part of the middle crust but is not always resolved as an individual crustal unit. Surprisingly, this transitional layer is not present on the Western Plateaus (Fig.15).”*
Lines 24-26: The clause “a layer associated with mafic intrusions formed during a secondary volcanic phase” does not appear to be true; none of the three references cited explain the origin of this layer as a secondary volcanic phase. Again, references appear to be listed alphabetically; they should be listed chronologically.	Inoue et al. 2008 present data from the Ontong Java Plateau *“…observe evidence for volcanism or plutonism postdating the main 122 Ma emplacement phase of the OJP (Figures 5 and 6).”* Karlstrom et al. 2011 present a model of the petrogenis of LIPs,which includes intrusives of secondary volcanic phases in the upper middle crust. ***Author’s response number 5***
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Line 1: What is the history of the calcite compensation depth (CCD) in the vicinity of the Manihiki Plateau, and how might that inform the presence or absence of carbonate banks at significant depths?	The calcite compensation depth in the Pacific during the Cretaceous varied slightly around 3800m and rose in the Paleogene to 3400m (Van Andel, 1975). The Manihiki Plateau probably never resided in a depth deeper than today. Therefore, the dissolution of calcite does not play a role in the sedimentation of the Manihiki Plateau.
Lines 2-7: Inoue et al (2008) do not ascribe the upper crust of Ontong Java to any significant regional secondary volcanic phases; this interpretation is not common for LIPs other than Hikurangi and Manihiki.	Inoue et al. 2008 *“…observe evidence for volcanism or plutonism postdating the main 122 Ma emplacement phase of the OJP (Figures 5 and 6).”* Additional references of Timm et al. 2011 and Hoernle et al. 2010 are added in the revised version of the manuscript.

Lines 7- 8: References appear to be listed alphabetically; they should be listed chronologically.	***Author's response number 5***
Lines 11-15: Although not observed on the Western Plateaus seismic profile, ample evidence exists for later stage/secondary volcanism on the overall Western Plateaus in the satellite-derived free air gravity field and predicted bathymetry, in contrast to the authors' assertion, as well as ages of igneous rock samples from features surmounting the Western Plateaus (Hoernle et al, 2009). The authors need to consider all rel- evant data in making such conclusions, as opposed to only the seismic and gravity profiles.	This section was altered as follows: *"Buried seamount chains can also be located in gravity anomaly grids on the High Plateau of the Manihiki Plateau (Fig. 12). This seems not to be the case for the southern Western Plateaus. Neither the seismic refraction/wide-angle reflection data nor the multichannel seismic reflection data acquired on the Western Plateaus indicate extensive secondary volcanism such as the emplacement of basaltic flow units."* ***Author's response number 3***
Lines 15-16: Although what "This" refers to is not entirely clear, assuming that it refers to "fault complexes and ridge systems," the Kerguelen Plateau also has internal fault complexes, horst, and graben (eg, Coffin et al, 1986; Munschy et al, 1993). Therefore, this sentence should be amended.	This referred to the lack of intrusive features on the Western Plateaus. The sentence has been changed for clarification. *"This lack of intrusive features has so far not been reported for any oceanic LIP."*
Lines 17-20: The authors appear to under-emphasize similarities, and over-interpret/over-emphasize differences between the Western Plateaus and other LIPs. Crustal structure of Western Plateaus shows the primary salient characteristic of all oceanic LIPs, namely a HVZ, and that HVZ is continuous with the High Plateau. Above the HVZ, crustal structure of the Western Plateaus does differ from that of the High Plateau, but does not differ markedly from some LIP crustal structures documented in Ridley & Richards (2010) and Figure 15.	We meet the suggestion of the referee and will provide an additional section on the HVZ within the revised version of the manuscript. ***Author's response number 6***
Lines 20-21: Replace "all" with "key."	*"The High Plateau shows key features previously described for*

	oceanic LIPs." Sentence has been changed,
Lines 21, 25: Replace "sub-plateaus" with "sub- provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 21-23: On the basis of all relevant data, this conclusion is not justified. Both sub-provinces are characterized by later stage/secondary volcanism (Sandwell & Smith, 1997; Hoernle et al, 2009), so how specifically do their magmatic histories following formation differ? Evidence for different tectonic evolutions is not compelling. Arguably more interesting is that the High Plateau would appear to be the locus/main eruptive center for the en- tire Manihiki Plateau; it has the thickest crust, the shallowest bathymetry, probably a substantial subaerial emplacement and erosion history, and the thickest volcaniclastic sequences. The Western Plateaus, in contrast, were distal to the locus/main eruptive center, have crust that thins away from that center, and likely lacks a subaerial history and corresponding thick volcaniclastic sequences.	That the High Plateau is the center of the initial emplacement of the Manihiki Plateau cannot be interfered from our data. The secondary volcanism differs greatly between the two sub-provinces. This cannot be ignored. The magmatic evolution differs in the number of abundance of seamounts, the presents/absence of basaltic flow units, the general volume of volcanic material emplaced and the presence/absence of intrusions in the middle and upper crust.
Page 1879	
Line 1: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 3-5: This is not the case for Ontong Java, and the story is more complicated. There is no evidence from the main Ontong Java Plateau, with crust up to twice as thick as Manihiki's High Plateau, for subaerial em- placement and erosion, and only Manihiki's High Plateau shows evidence for subaerial emplacement and erosion.	This section is revised according to e.g. Roberge 2005, Korenaga 2005 and Mahoney 2001, who stated that the Ontong Java Plateau was emplaced at a depth well below 1000m. On the other hand, Thordason et al. (2004) report the presence of Lapilli in boreholes from the Ontong Java Plateau, which points to an subaerial emplacement.

Lines 6-8, 13: References appear to be listed alphabetically; they should be listed chronologically.	***Author's response number 5***
Line 8: Replace "Island" with "Islands," as named by Winterer et al (1974).	***Author's response number 2***
Line 11: Insert "proposed" between "The" and "conjugate." Lines 11-14: Crustal thinning is one possibility, but another equally valid expla- nation is distance from the locus/main eruptive centers. Assuming that the proposed Ontong Java-Manihiki reconstruction is correct, at least two main eruptive centers are required, one for OJP's main plateau and one for Manihiki's High Plateau, as it seems impossible to join these two areas of thickest crust (and in the case of the High Plateau, major subaerial emplacement and erosion). The authors should consider and discuss this possible explanation as well. None of the three references cited suggest that the crust has been thinned, but rather show that it is thinner on the OJP flanks than on the main plateau. References appear to be listed alphabetically; they should be listed chronologically.	By considering plate kinematic constraints (current work by K. Hochmuth), we have indications that the margin conjugate to the Western Plateaus might have been subducted. Therefore the cited data may only show the thinning of the Ontong Java crust and not the conjugate margin. The hypothesis of two or more main volcanic centers of Ontong Java Nui does not contradict our interpretation of the Western Plateaus as stretched LIP crust. The linking segment between Ontong Java and the High Plateau (the Western Plateaus) might have been emplaced with a similar crustal thickness, but since it was not supported by its own volcanic center, it was the slightly weaker and, therefore, facilitated the separation of Ontong Java and the Manihiki Plateau. ***Author's response number 4***
Lines 23-25: The case for deep crustal faults must be much more strongly justified (see above), preferably with seismic reflection data.	An additional figure displaying the seismic reflection data is added to the revised version of the manuscript.
Line 26: Delete "chain." Not all seamounts on the High Plateau appear to be parts of chains.	Text has been changed to: *"Simultaneously, a secondary volcanic stage started resulting in seamount volcanism and the emplacement of basaltic flows (Ai et al., 2008; Pietsch and Uenzelmann-Neben, n.d.; Winterer et al., 1974) on the High Plateau (Fig. 16)."*

Lines 27-28: Replace “The” with “We interpret,”, and replace “are visible in” with “from.”	Sentence has been changed. *“We interpret relicts of volcanic centers as well as the magmatic pathways within the crust from our data.”*
Lines 28-29: This sentence implies that the entire upper crust of the Manihiki Plateau formed by later stage/secondary volcanism; the age data of Timm et al (2011) argue strongly against this. The sentence must be amended accordingly.	The sentence was clarified to: *“The secondary volcanism formed the uppermost crust of the Manihiki Plateau…”*
Page 1880	
Line 4: Replace “Island” with “Islands,” as named by Winterer et al (1974). Also, alkaline basalts were emplaced elsewhere on the High and Western plateaus (Hoernle et al, 2009).	***Author’s response number 2*** The petrological data from the Danger Islands Troughs is unique on the Ontong Java Nui due to its enrichment with light rare earth elements and large-ion lithophile elements. Alkalic rocks have been reported from all over the Manihiki Plateau. To avoid confusion, the sentence has been changed to: *“At the Danger Islands Troughs, alkaline lavas with a strong enrichment in light rare earth and large-ion lithophile elements are emplaced (Ingle et al., 2007)*”
Lines 5-6: Although this may be true along the seismic profile, ample evidence exists for later stage/secondary volcanism on the overall Western Plateaus in the satellite-derived free air gravity field and predicted bathymetry, in contrast to the authors’ assertion, as well as ages of igneous rock samples from features surmounting the Western Plateaus (Hoernle et al, 2009). The authors need to consider all relevant data in making such conclusions, as opposed to only the seismic and gravity profiles.	***Author’s response number 3*** This section has been altered to avoid confusion about secondary volcanism on the Western Plateaus. *“At the Western Plateaus, we could not identify evidence for massive secondary volcanism in our data. Localized seamount volcanism is present throughout the Western Plateaus, but there are no indications for massive basaltic flow units as visible on the High Plateau.”*
Lines 6-9, 14-16: What is the evidence for the Western Plateaus	As the local depth during the emplacement of the Western

ever being close to sea level? If one assumes that Manihiki Plateau lithosphere in general, and Western Plateaus crust in particular, subsides as other plateaus and normal oceanic lithosphere (eg, Coffin, 1992; Ito & Clift, 1998; Wallace, 2002; Ingle & Coffin, 2004; Roberge et al, 2005), is it likely that the Western Plateaus were ever near sea level? Also, what is the history of the calcite compensation depth (CCD) in the vicinity of the Manihiki Plateau, and how might that inform the presence or absence of carbonate banks at significant depths?	Plateaus is not clear, this possibility cannot be ruled out and is briefly addressed.
Lines 9-11: Do the velocities rule out basalt as acoustic basement? Hoernle et al (2009) report on later stage/secondary alkaline volcanism from the Western Plateaus, so at least some of the upper crust is basalt. Lines 11, 14: Replace "carbonatic" with "carbonate."	The unusual low velocities are not present in the whole crust of the Western Plateaus. Basaltic structures can also be interfered from our data. Therefore, the findings of Hoernle 2009 are in agreement with ours. *"Also, the unusual low velocities of parts of the acoustic basement infer that the Western Plateaus experienced volcaniclastic and carbonate sedimentation (Fig. 13)."*
Lines 17-21: Could the thinning of the upper (sedimentary) crust be also related to the calcite compensation depth (CCD)?	The calcite compensation depth in the Pacific during the Cretaceous varied slightly around 3800m and rose in the Paleogene to 3400m (Van Andel, 1975). The Manihiki Plateau never resided in a depth deeper than todays. Therefore, the dissolution of calcite does not play a role in the sedimentation of the Manihiki Plateau.
Lines 21-22: Some clarification is needed; "unusual low velocities of the acoustic basement" (line 10) seems to contradict "mafic rocks are exposed in the upper crust"?	The exposed mafic rocks are exposed in the western part of the Western Plateau and the Tokelau Basin. The low velocity areas of the acoustic basement rather located to the eastern Western Plateaus.
Lines 23- 26: Volcanic activity moving its activity to the east seems to be a gross generalization: what about Suvarov Island on the southern High	The reflection seismic data (Pietsch and Uenzelmann-Neben, 2014) show a change in the region of the main volcanic activity between 120 Ma

Plateau and the seamounts to the north of the High Plateau? Again, the authors need to consider all relevant data in making such conclusions, as opposed to only the seismic and gravity profiles.	(main volcanic pulse) and later volcanic stages. The main volcanic activity of secondary volcanic phases moves mainly to the margins of the High Plateau. The central part of the High Plateau experienced little volcanism, but several volcanic centers are traceable in the eastern parts of the central plateau. The atolls and islands, which are still above sea-level, formed during even later and smaller volcanic events, which are restricted to the margins of the High Plateau.
Page 1881	
Lines 1, 20, 24: Replace “Island” with “Islands,” as named by Winterer et al (1974). Lines 21, 26: Replace “sub-plateaus” with “sub-provinces,” consistent with the terminology of Winterer et al (1974).	***Author’s response number 2***
Lines 7-9: Again, the decrease in depth to Moho has at least two plausible explanations: 1) crustal thinning, and 2) original thickness. In the absence of well-imaged normal faulting, the simpler explanation is that Manihiki Plateau crust thins towards its edges.	***Author’s response number 4***
Lines 10-11: The meaning of the “last magmatic pulse” needs clarification; is it the main formation of the Manihiki Plateau, or the later stage/secondary volcanism? Pelagic sediment has not covered the islands and atolls surmounting the plateau, so this sentence needs amendment. Tectonic features – faults, horst, graben, basins, ridges – post-date the main formation of the plateau, but appear to be older than some later stage/secondary volcanism, so the sentence needs further amendment.	The section has been rewritten. *“After the last main magmatic pulse ceased, further pelagic sedimentation covered most of the volcanic relicts and the faults and ridges generated by tectonic motion. The Manihiki Plateau subsided into the current water-depth of 2600 m for the High Plateau and 4000 to 3600 m for the Western Plateaus (Fig.16). The atolls and islands, which are currently above sea-level result from smaller volcanic pulses younger than 45 Ma (Pietsch and Uenzelmann-Neben, n.d.).”* It is true that several tectonic features such as the Suvarov Trough postdate

	the main formation of the Manihiki Plateau. These are local features and cannot be resolved by refraction seismic data. More detailed information on the volcanic and tectonic evolution of the High Plateau is currently in preparation by Pietsch and Uenzelmann-Neben.
Lines 11-13: From what levels did the High Plateau and Western Plateaus subside?	The High Plateau was close to sea-level. The emplacement depth of the Western Plateaus is unknown.
Lines 15-17: Again, the decrease in depth to Moho on the Western Plateaus has at least two plausible explanations: 1) crustal thinning, and 2) original thickness. In the absence of well-imaged normal faulting, the simpler ex- planation is that Manihiki Plateau crust thins towards its edges	***Author's response number 4***
Lines 17-20: Again, although this may be true along the seismic profile, ample evidence exists for later stage/secondary volcanism on the overall Western Plateaus in the satellite-derived free air gravity field and predicted bathymetry, in contrast to the authors' assertion, as well as ages of igneous rock samples from features surmounting the Western Plateaus (Hoernle et al, 2009). Thus, it was not "cut off from the magma supply initiating the secondary volcanic stages." References appear to be listed alphabetically; they should be listed chronologically.	***Author's response number 3*** ***Author's response number 5*** This section has been rewritten. *"The Western Plateaus had a limited magma supply initiating the secondary volcanic stages, which are present on the High Plateau, but also on the conjugate Ontong Java Plateau and Hikurangi Plateau (Hoernle et al., 2004; 2010; Mahoney and Spencer, 1991; Mahoney et al., 1993)."*
Lines 20-22: Replace "dissection" with "demarcation." Although the two seismic profiles differ, data and analyses presented in the manuscript do not present a compelling case that the High Plateau and Western Plateaus overall experienced different magmatic and tectonic evolution any more than different parts of each sub-province experienced different	In the revised version, we emphasize the multiple indications that the Western Plateau is in fact part of the LIP (e.g. continuity of the HVZ) but experienced stretching of the crust (normal faults visible in the reflection seismic data, HVZ below the Tokelau Basin). Together with the different modes of late volcanic activity, we are convinced, that the two sub-plateaus

magmatic and tectonic evolutions.	underwent a different evolution, which is partly coupled (e.g. initial emplacement and the timing and petrology of the secondary volcanism)
Lines 22-23: The authors need to clarify which trough is being referenced. If the Danger Islands Troughs, basalt samples analyzed by Ingle et al (2007) and Timm et al (2011) are evidence that upper (igneous) crust does crop out along them, as does volcaniclastic sediment (Werner and Hauff, 2007).	The Danger Islands Troughs are host of a thick sedimentary unit at its base. This sediments may easily consist of volcaniclastics. The deeper crustal material is present at the base of the trough. The flanks consist of upper crustal material, possibly emplaced during later volcanic phases.
Lines 23-25: Basalt samples described by Hoernle et al (2009) indicate that later stage/secondary volcanism affected the Danger Islands Troughs, indicating that magma supply to them were not necessarily limited. Was magma supply to the High Plateau limited? The islands, atolls, seamounts, sea knolls, and ridges surmounting the High Plateau would argue against this possibility.	The magma supply for the Western Plateau differs greatly from the much greater volume emplaced at the High Plateau.
Lines 25-27: Is this any different than the thousands of seamounts and sea knolls that have formed on normal Pacific Ocean crust? This conclusion seems self-evident.	The different source of the later stage volcanism seems to be important to state again an emphasis of the role of Manihiki in the “Super-LIP” Ontong Java Nui
Page 1882	
Lines 1-3: Replace “tectonic and magmatic overprint” with “tectonics and magmatism,” and “rifting” with “breakup.” However, a convincing case for the Manihiki Plateau’s role in the breakup of Ontong Java Nui has not been made in this version of the manuscript.	The HVZ in the lower crust as well as the crustal structure and thickness of the two main sub-provinces will help to unravel the break-up mechanisms such as crustal stretching and subsequent rifting (southern High Plateau and Western Plateau) and abrupt dissection (Manihiki Scarp).

Lines 6, 8, 27: Replace "sub-plateaus" with "sub-provinces," con-sistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Line 8: Replace "reconstructed" with "illuminated." The new data and analyses thereof do not provide much additional insight into temporal and spatial reconstructions of the Manihiki Plateau; rather, the main contribution is defining the crustal structure of the feature.	This sentence has been changed in the revised version of the manuscript. *"From this newly gained information on the crustal structure of the sub-provinces, the tectonic and magmatic evolution of this oceanic LIP can be further illuminated."*
Lines 9-10: Delete "in highly stretched LIP crust." The authors have not demonstrated that this crust is stretched; it could simply thin farther from the locus/eruptive center.	By the re-examining the role of the HVZ and by adding an additional figure of seismic reflection data, we provided further evidence throughout the revised version of the manuscript, that the Western Plateaus show stretched crust.
Lines 10-11, 12- 14, 20-21, 25-26: These statements are not correct. Mafic extrusives, including those from secondary volcanic stages, have been dredged from seamounts/sea knolls sur- mounting the Western Plateaus and from the eastern flank of the Western Plateaus exposed in the Danger Islands Troughs (Ingle et al, 2007; Werner & Hauff, 2007; Ho-ernle et al, 2009; Timm et al, 2011).	***Author's response number 3*** The secondary volcanism at the Western Plateaus was not extensive and localized.
Lines 11-12: Again, seismic reflection data must be presented to argue the case for "deep reaching faults."	The seismic reflection data show fault systems penetrating the crust.
Lines 12-13: Imaging the feeder system for either original formation or secondary magmatism is highly specula- tive, and the data and analyses presented in this version of the manuscript do not make a compelling case. Feeder systems are challenging to identify in dissected continental flood basalts; the resolution of wide-angle seismic data is arguably far too coarse – by orders of magnitude – to identify feeder	The term 'feeder-systems' might have been an overstatement. The Poisson's ratio model as well as the gravity data indicate relicts of major magmatic pathways within the crust.

systems.	
Line 15: Replace "the normal" with "a typical."	The sentence is reworded to: *"The High Plateau shows the typical crustal structure of an oceanic LIP…"*
Lines 22-23: Is this any different to physically separate parts of normal Pacific Ocean crust? This conclusion seems self-evident.	The paragraph has been reworded to clarify, that the different sub-provinces of the Manihiki Plateau experienced a different tectonic and magmatic history. This is important to note, since previous studies treated the Manihiki Plateau as a single crustal block. Assumptions drawn for the evolution of the High Plateau, were transferred to the Western Plateaus. Our data shows that the two sub-provinces play an individual role in the break-up of Ontong Java Nui.
Lines 25-26: Again, the authors have not demonstrated that this crust is stretched; it could simply thin farther from the locus/eruptive center.	***Author's response number 4***
Page 1883	
Line 1: Replace "sub-plateaus" with "sub-provinces," consistent with the terminology of Winterer et al (1974).	***Author's response number 2***
Lines 1-2: A convincing case for the Manihiki Plateau's role in the breakup of Ontong Java Nui has not been made in this version of the manuscript.	The re-examination of the linkage between the HVZ and the tectonic mechanisms acting on the plateau's margins supports the hypothesis that the margins of the Manihiki Plateau are indicators for the break-up style of Ontong Java Nui.

Tables and Figures	
Referee comment	**Author's response**
Page 1884 Line 12: Replace "Island" with "Islands," per the title of the paper.	***Author's response number 2***
Page 1890 The source of the bathymetry should be referenced.	GEBCO is now referenced as source of the bathymetry map.
Page 1891 Caption: Replace "Island" with "Islands," as named by Winterer et al (1974). Vertical exaggeration	***Author's response number 2***

should be indicated.	
Page 1892 Caption: Replace “Island” with “Islands,” as named by Winterer et al (1974).	***Author’s response number 2***
Page 1892 – 1903 vertical exaggeration should be indicated.	Vertical exaggeration is provided in the revised version of the manuscript.
Page 1902 On figure replace “Island” with “Islands,” as named by Winterer et al (1974). Caption: vertical exaggeration should be indicated.	***Author’s response number 2***
Page 1905 On figure replace “sub-plateaus” with “sub-provinces,” and replace “Island” with “Islands,” consistent with the terminology of Winterer et al (1974).	***Author’s response number 2***