United Nations Convention on the Law of the Sea

Commission on the Limits of the Continental Shelf

SUMMARY OF RECOMMENDATIONS OF THE COMMISSION ON THE LIMITS OF THE CONTINENTAL SHELF IN REGARD TO THE SUBMISSION MADE BY THE COOK ISLANDS IN RESPECT OF THE MANIHIKI PLATEAU ON 16 APRIL 2009[1]

Recommendations prepared by the Subcommission established for the consideration of the Submission made by the Cook Islands

Approved by the Subcommission on 31 July 2015

Approved by the Commission, with amendments, on 19 August 2016

[1] The aim of this Summary is to provide information which is not of confidential or proprietary nature in order to facilitate the function of the Secretary-General in accordance with Rule 11.3 of annex III to the Rules of Procedure of the Commission (CLCS/40/Rev.1). This Summary is based on excerpts of the Recommendations and may refer to material not necessarily included either in the full Recommendations or this Summary.

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GLOSSARY OF TERMS

60 M formula line	The line delineated by reference to fixed points determined at a distance of 60 nautical miles from the foot of the continental slope
60 M formula point	Fixed point determined at a distance of 60 nautical miles from the foot of the continental slope
200 M line	The line at a distance of 200 nautical miles from the baselines from which the breadth of the territorial sea is measured
2,500 m isobath	A line connecting the depth of 2,500 metres
Article 76	Article 76 of the Convention
Baselines	The baselines from which the breadth of the territorial sea is measured
BOS	Base of the continental slope
Commission	The Commission on the Limits of the Continental Shelf
Convention	The United Nations Convention on the Law of the Sea of 10 December 1982
Depth constraint	The constraint line determined at a distance of 100 M from the 2,500 m isobath
Distance constraint	The constraint line determined at a distance of 350 M from the baselines from which the breadth of the territorial sea is measured
DOALOS	Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations
FOS	Foot of the continental slope
Guidelines	The Scientific and Technical Guidelines of the Commission (CLCS/11 and CLCS/11/Add.1)
M	Nautical mile
Rules of Procedure	The Rules of Procedure of the Commission (CLCS/40/Rev.1)
Secretary-General	The Secretary-General of the United Nations

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I. INTRODUCTION

1. On 16 April 2009, the Cook Islands submitted to the Commission on the Limits of the Continental Shelf, through the Secretary-General[2] of the United Nations, information on the limits of the continental shelf beyond 200 M from the baselines from which the breadth of the territorial sea is measured, in accordance with paragraph 8 of article 76 of the Convention (the "Submission").

2. The Convention entered into force for the Cook Islands on 17 March 1995.

3. The Submission addressed the continental shelf of the Cook Islands concerning the Manihiki Plateau (Figure 1).

4. On 28 April 2009, the Secretary-General issued Continental Shelf Notification CLCS.23.2009.LOS giving due publicity to the Executive Summary of the Submission in accordance with rule 50 of the Rules of Procedure. Pursuant to rule 51 of the Rules of Procedure, the consideration of the Submission was included in the agenda of the twenty-fourth session of the Commission.

5. In note verbale UN/7/12/1A, dated 29 June 2009, New Zealand informed the Secretary-General that the area contained in the Submission made by the Cook Islands overlapped in part with the potential area of extended continental shelf of Tokelau, as indicated in the preliminary information provided by New Zealand on 11 May 2009, and that there may be a potential outstanding delimitation over the overlapping area of extended continental shelf. New Zealand, in the same note verbale, also confirmed that it had no objection to the Commission considering and making recommendations with respect to the Submission made by the Cook Islands, consistent with the provisions of paragraph 10 of article 76 of the Convention.

6. Pursuant to section 2 of annex III to the Rules of Procedure, the presentation of the Submission was made to the plenary of the twenty-fourth session of the Commission on 26 August 2009, by Terepai Maoate, Deputy Prime Minister, Head of Delegation; Michael Mitchell, Secretary, Ministry of Foreign Affairs and Immigration; Keu Mataroa, Executive Officer, Ministry of Infrastructure and Planning; and Vaipo Mataora, GIS Manager, Ministry of Infrastructure and Planning. The Delegation of the Cook Islands (the "Delegation") also included a number of advisers. In addition to elaborating on substantive points of the Submission, Mr. Mitchell indicated that Mr. Philip A. Symonds, a member of the Commission,[3] had assisted the Cook Islands by providing scientific and technical advice with respect to the Submission. In reference to the note verbale received from New Zealand, Mr. Mitchell recalled that, while there was a potential outstanding delimitation issue in respect of an area subject to the Submission, New Zealand indicated that it had no objection to the Commission considering and making recommendations on the Submission made by the Cook Islands.

7. The Commission addressed the modalities for the consideration of the Submission and decided that, as provided for in article 5 of annex II to the Convention and in rule 42 of the Rules of Procedure, the Submission would be addressed through the establishment of a Subcommission at a later date.

[2] Division for Ocean Affairs and the Law of the Sea ("DOALOS"), Office of Legal Affairs, United Nations.
[3] Mr. Symonds was a Member of the Commission from 2002 to 2007 and from 2007 to 2012.

8. The Subcommission for the consideration of the Submission made by the Cook Islands was established on 26 August 2011, during the plenary of the twenty-eighth session of the Commission. The following members of the Commission were appointed as members of the Subcommission: Messrs. Brekke, Carrera, Jaafar, Kalngui, Oduro, Park, and Urabe. The Subcommission elected Mr. Carrera as its Chairperson and Messrs. Brekke and Urabe as its Vice-Chairpersons.

9. Following its establishment, and during the twenty-eighth session of the Commission, the Subcommission met from 29 August to 2 September 2011, to commence its consideration of the Submission and to undertake a preliminary analysis of the Submission pursuant to paragraph 5(1) of annex III to the Rules of Procedure. The Subcommission determined that, given the volume and nature of the data contained in the Submission, it would require additional time to examine all the data. The Subcommission verified the format and completeness of the Submission and highlighted to the Delegation the availability of multi-beam echo-sounder data in the area of the Submission, which could be included in the Submission. The Subcommission informed the Cook Islands by a letter, dated 16 July 2013, that it decided to address the question of the test of appurtenance as a matter of substance, in the context of the main scientific and technical examination of the Submission.

10. The Subcommission continued its examination of the Submission during the twenty-ninth session. It held two meetings with the Delegation in which the Subcommission made a presentation and the Delegation made two presentations. On the basis of the information given by the Subcommission, the Delegation provided the Subcommission with additional multi-beam echo-sounder data in the area of the Submission and noted that, following the analysis of those data, it had amended the formula line and outer limits of its continental shelf beyond 200 nautical miles in the Submission.

11. The term of the 21 members of the Commission elected in 2007 expired on 15 June 2012. On 6 and 7 June 2012, during the twenty-second Meeting of States Parties to the Convention, and on 19 December 2012, during a Special Meeting of States Parties, 21 members of the Commission were elected for a term of five years (SPLOS/251, paras. 81-92; SPLOS/255, paras. 9-12) and this resulted in two vacancies in the composition of the Subcommission. The Commission subsequently appointed Messrs. Madon and Marques to fill these vacancies. In light of its decision on new working arrangements[4] and pursuant to rule 42 of the Rules of Procedure, the Commission also decided to appoint Messrs. Awosika and Heinesen to the Subcommission (CLCS/76, para. 20(b)) to allow Messrs. Kalngui and Urabe to be appointed as members of other subcommissions. Thus, the composition of the Subcommission became as follows: Messrs. Awosika, Carrera, Heinesen, Madon, Marques, Oduro and Park. The Subcommission subsequently elected Messrs. Madon and Oduro as its Vice-Chairpersons (CLCS/76, para. 40).

12. The Subcommission continued its examination of the Submission during the thirtieth, thirty-first and thirty-second sessions. For this purpose, the Subcommission created the following three working groups: geology and geophysics; geodesy, hydrography and morphology; and drafting and quality control. The geology and geophysics working group consisted of Messrs. Awosika,

[4] At the thirtieth session of the Commission, following a request by the Meeting of States Parties to the Convention (SPLOS/229, para. 1), the Commission decided to meet for a period of 21 weeks during 2013 and to adopt new working arrangements for its subcommissions, which resulted in changes in the membership of the existing subcommissions (CLCS/76, paras. 10-15).

Carrera, Heinesen, Madon, Oduro and Park. The geodesy, hydrography and morphology working group consisted of Awosika, Carrera and Marques. The drafting and quality control working group consisted of Awosika, Carrera, Heinesen and Oduro. During these sessions, the Subcommission held two meetings with the Delegation in which it made four requests for additional data and information in writing and by presentation and it made two presentations. During the course of the examination of the Submission by the Subcommission, the Delegation provided responses both in writing and as presentations, and provided additional material. The geology and geophysics; and the geodesy, hydrography and morphology working groups produced two reports at the thirty-second session.

13. Following a request made by the Commission (CLCS/76 para. 40), the Delegation submitted, on 11 September 2012, an Addendum to the Executive Summary of the Submission containing a revision of the outer limits of the Continental shelf of the Cook Islands. In its communication of 11 September 2012, the Cook Islands expressed the view that the revision to the outer limits of the continental shelf of the Cook Islands in the Manihiki Plateau (Figure 2) did not result in a significant departure from the original submitted outer limits.

14. On 9 October 2012, the Secretary-General issued Continental Shelf Notification CLCS.23.2009.LOS.Add.1 giving due publicity to the Addendum to the Executive Summary of the Submission.

15. On 18 November 2013, during the thirty-third session, the Subcommission provided the Delegation with a comprehensive presentation of its views and general conclusions arising from the examination of the Submission, pursuant to paragraph 10(3) of annex III to the Rules of Procedure, and the Delegation provided its initial response, pursuant to paragraph 10(4) of annex III to the Rules of Procedure.

16. In a letter dated 12 December 2013, the Cook Islands posed a number of questions seeking “to understand fully the views and general conclusions arising from the examination of parts or all of the Submission in the presentation made by the Subcommission in accordance with paragraph 10.3 of annex III to the Rules of Procedure”. In a letter of 7 January 2014, the Subcommission informed the Delegation that it would be in a position to respond to these questions during its following meeting in February 2014. Subsequently, the Subcommission decided not to respond to the questions raised by the Cook Islands but instead that the Chairperson of the Subcommission should make a statement, which was presented to the Delegation at a meeting on 27 February 2014 during the thirty-third session.

17. During the thirty-fourth, thirty-fifth, and thirty-sixth sessions, the Delegation provided three additional responses to the Subcommission pursuant to paragraph 10(4) of annex III to the Rules of Procedure. The Subcommission held five additional meetings with the Delegation and gave two presentations. During this stage of the examination of the Submission, the Delegation also provided additional material.

18. The Subcommission and the Delegation had an extensive series of communications and interactions during the consideration of the Submission by the Subcommission, which can be summarized as follows: eleven meetings between the Subcommission and the Delegation; six presentations made by the Subcommission; one document containing a number of questions from the Delegation to the Subcommission; one statement made by the Chair of the

Subcommission; seven presentations made by the Delegation; five requests for additional data and information from the Subcommission to the Delegation; 43 official communications from the Delegation to the Subcommission; and 37 official communications from the Subcommission to the Delegation. During its examination of the Submission, the Subcommission met over 23 weeks.

19. The Subcommission approved its Recommendations by vote on 31 July 2015, and submitted them to the Commission on 12 August 2015, for consideration and approval.

20. The Delegation made a presentation to the Commission, on 26 August 2015, in accordance with paragraph 15.1 bis of annex III to the Rules of Procedure.

21. The Commission prepared these Recommendations, which were approved without a vote on 19 August 2016, taking into consideration article 6 of annex II to the Convention and the procedures and the methodology outlined in the following documents of the Commission: the Rules of Procedure and the Scientific and Technical Guidelines.

22. The Recommendations of the Commission are based on the scientific and technical data and other material provided by the Cook Islands in relation to the implementation of article 76. The Recommendations of the Commission only deal with issues related to article 76 and annex II to the Convention and shall not prejudice matters relating to delimitation of boundaries between States with opposite or adjacent coasts, or prejudice the position of States which are parties to a land or maritime dispute, or application of other parts of the Convention or any other treaties.

23. The Commission makes these Recommendations to the Cook Islands in fulfilment of its mandate as contained in paragraph 8 of article 76, and articles 3 and 5 of annex II to the Convention.

24. The Commission makes these Recommendations to coastal States on matters related to the establishment of the outer limits of their continental shelf in accordance with paragraph 8 of article 76 of the Convention. The limits of the shelf established by a coastal State on the basis of these Recommendations shall be final and binding.

25. Throughout the examination of the Submission, the Subcommission requested and received support from the Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs.

II. CONTENTS OF THE SUBMISSION

A. Original Submission

26. The original Submission, received on 16 April 2009, contained three parts: an Executive Summary; a Main Body, which is the analytical and descriptive part; and Scientific and Technical Data.

B. Communications and additional material

27. In the course of the examination of the Submission by the Subcommission, the Delegation submitted additional material.

28. On 11 September 2012, following the decision of the Commission, as reflected in paragraph 40 of the Statement of the Chairperson on the progress of work of the

Commission during its thirtieth session (CLCS/76), the Cook Islands submitted an addendum to the Executive Summary of its Submission.[5]

III. EXAMINATION OF THE SUBMISSION BY THE SUBCOMMISSION

A. Examination of the format and completeness of the Submission

29. Pursuant to paragraph 3 of annex III to the Rules of Procedure, the Subcommission examined and verified the format and completeness of the Submission.

B. Preliminary analysis of the Submission

30. Pursuant to paragraph 5, section III of annex III to the Rules of Procedure, the Subcommission undertook a preliminary analysis of the Submission, in accordance with article 76 of the Convention and the Guidelines and determined that:

(i) the question of the test of appurtenance should be addressed as a matter of substance, in the context of the main scientific and technical examination of the Submission;

(ii) the outer limits of the continental shelf were determined by a combination of a line delineated in accordance with paragraph 7 of article 76 of the Convention by reference to fixed points not more than 60 nautical miles from the foot of the continental slope, and a line not exceeding 350 nautical miles from the baselines from which the breadth of the territorial sea is measured or not exceeding 100 nautical miles from the 2,500 metre isobath, which is a line connecting the depth of 2,500 metres;

(iii) it could not consider whether appropriate combinations of foot of the continental slope points and constraint lines had been used until the test of appurtenance was examined;

(iv) the construction of the outer limits did contain straight lines not longer than 60 M;

(v) the advice of a specialist, in accordance with rule 57, or the cooperation of relevant international organizations, in accordance with rule 56, would not be required; and

(vi) additional time would be required to review all the data and prepare its recommendations for the Commission.

C. Main scientific and technical examination of the Submission

31. Pursuant to paragraph 9, section IV of annex III to the Rules of Procedure, the Subcommission conducted an examination of the Submission based on the Guidelines and evaluated the following as applicable:

(i) the data and methodology employed by the coastal State to determine the location of the foot of the continental slope;

(ii) the methodology used to determine the formula line at a distance of 60 M from the foot of the continental slope;

[5] The addendum to the Executive Summary is available online at http://www.un.org/depts/los/clcs_new/submissions_files/cok23_09/Cook%20Islands%20Submission%20Executive%20Summary%20Addendum%2028%20August%202012.pdf

(iii) the data and methodology used to determine the formula line delineated by reference to the outermost fixed points at each of which the thickness of sedimentary rocks is at least 1 per cent of the shortest distance from such point to the foot of the continental slope, or not less than 1 kilometre in the cases in which the Statement of Understanding applies;

(iv) the data and methodology employed in the determination of the 2,500-metre isobath;

(v) the methodology used to determine the constraint line at a distance of 100 M from the 2,500-metre isobath;

(vi) the data and methodology used to determine the constraint line at a distance of 350 M from the baselines from which the breadth of the territorial sea is measured;

(vii) the construction of the formulae line as the outer envelope of the two formulae;

(viii) the construction of the constraint line as the outer envelope of the two constraints;

(ix) the construction of the inner envelope of the formulae and constraint lines;

(x) the delineation of the outer limit of the continental shelf by means of straight lines not longer than 60 M with a view to ensuring that only the portion of the seabed that satisfies all the provisions of article 76 of the Convention and the Statement of Understanding is enclosed;

(xi) the estimates of the uncertainties in the methods applied, with a view to identifying the main source(s) of such uncertainties and their effect on the Submission; and

(xii) whether the data submitted are sufficient in terms of quantity and quality to justify the proposed limits.

IV. RECOMMENDATIONS OF THE COMMISSION WITH RESPECT TO THE MANIHIKI PLATEAU

1. Geographical and geological description of the region

32. The Manihiki Plateau forms part of the Cook Islands, which comprise a series of islands spread over 2 million square kilometres of the western equatorial Pacific Ocean, between 8°S and 23°S, and 156°W and 167°W (Figure 3). The islands are divided into the Northern Group and the Southern Group. The islands of the Northern Group, with the exception of Penrhyn, are located on the Manihiki Plateau complex, named after the island of Manihiki. The other islands of the Manihiki Plateau complex are Nassau, Pukapuka, Rakahanga and Suwarrow. The islands of the Southern Group comprise Palmerston, Aitutaki, Manuae, Takutae, Atiu, Mitiaro, Mauke, Rarotonga and Mangaia which are all oceanic volcanic seamounts invariably capped by coral reefs. This Southern Group of islands and Penrhyn Island lie outside the Manihiki Plateau complex and they are, therefore, not relevant to the Submission and these Recommendations.

33. The Manihiki Plateau is a submarine feature covering an area of about 550,000 square kilometres and is elevated approximately 1,000 – 3,000 metres above the surrounding abyssal plain. This feature is recognized as a large igneous

province (LIP) along with other similar oceanic plateaus of the SW Pacific, as observed in global digital elevation models (DEM). The Manihiki Plateau is bounded by deep ocean basins: the Tokelau Basin to the northwest, the Central Pacific Basin to the northeast, the Penrhyn Basin to the southeast, and the Samoan Basin to the south (Figure 4).

34. Three of the islands of the Manihiki Plateau complex - Rakahanga, Manihiki and Suwarrow - are located on the High Plateau, whereas Nassau and Pukapuka are located within the southernmost part of the Danger Islands Troughs.

35. The Manihiki Plateau complex consists of three major and distinct morphological units: the High Plateau, the Western Plateaus and the North Plateau. These morphological units are separated by deep trough systems which are essentially fault-bounded grabens, possibly representing rift structures. The two major trough systems are the Danger Islands Troughs and the Suvarov Trough. The Danger Islands Troughs are believed to represent a failed rift system consisting of *en echelon* fault-bounded depressions that are up to 6,200 metres deep, and collectively extend for more than 350 kilometres in an almost north-south orientation.

36. On the eastern margin of the Manihiki Plateau, a major north-south trending transform fault system forms the Manihiki Scarp. This 750 kilometre-long scarp system consists of multiple, parallel, linear escarpments, each with several hundred meters of vertical displacement separating the High Plateau from the abyssal plain of the Penrhyn Basin. The escarpments and intervening ridges, troughs and seamounts appear to have been produced by a major transform fault system. A broad depression, called the High-North Basin, separates the High Plateau from the North Plateau, whereas an unnamed trough separates the Western Plateaus from the North Plateau. In addition, a number of narrow and elongated, previously unnamed, seafloor features were identified in the Submission to the north of the Manihiki Plateau region and were referred to as the Tangaroa and Avatea Spurs (located off the North Plateau), and the Nganaoa Spur (located off the High Plateau).

2. Consideration of the Submission

2.1 Introduction

37. The Subcommission proceeded with the main scientific and technical examination of the Submission, including the test of appurtenance, the formulation of which is described in paragraph 2.2.8 of the Guidelines.

38. During the preliminary analysis of the Submission, at the twenty-eighth session of the Commission, the Subcommission found that the hydrographic and bathymetric data base contained in the Submission did not include a considerable amount of multi-beam and single-beam echo-sounder (MBES and SBES) data[6] and information available in the public domain, which would have facilitated the consideration of the test of appurtenance.

39. In a letter dated 2 September 2011, the Subcommission informed the Delegation that it had undertaken a preliminary analysis of the Submission and had concluded that further time would be required to examine all the data. The Subcommission also indicated that it had identified additional public domain multi-beam

[6] 56 SBES surveys from Geodas and the SONNE cruise SO-193 MBES survey

echo-sounder data which were not included in the original Submission and was available to the Government of the Cook Islands.

40. The Subcommission then instructed its working groups (see paragraph 12 above) to consider the test of appurtenance during the main scientific and technical examination of the Submission.

41. The examination of the test of appurtenance was carried out during the thirtieth, thirty-first and thirty-second sessions. The Subcommission indicated in a presentation made at the thirty-first session, on 6 February 2013, that no questions or requests for clarification relating to the Submission had arisen to date. However, in a presentation made on 8 February 2013, the Subcommission made a request, for a copy of a specific scientific reference and any other publications related to recent geoscientific survey projects conducted across the northern part of the Manihiki Plateau and its surrounding seafloor highs.

42. On 30 July 2013, the Subcommission addressed a communication to the Delegation, providing its views to date concerning certain aspects of the Submission and requested additional data and information. On 5 August 2013, the Delegation transmitted to the Subcommission additional data and information from recent surveys.

43. The reports of the work conducted by the geology and geophysics, and geodesy, hydrography and morphology working groups, whose considerations are detailed below, were presented internally and consolidated by the Subcommission during the thirty-third session. The Subcommission subsequently proceeded to prepare a presentation to be delivered to the Delegation in accordance with paragraph 10.3 of annex III to the Rules of Procedure.

2.2 Geodetic, Hydrographic and Morphological Considerations

44. The geodetic, hydrographic and morphological data contained in the Submission dated 16 April 2009, were considered by the Subcommission. These data included: coordinates of baselines relevant to the Submission; a line determined at a distance of 200 M from the baselines; a distance constraint line determined at a distance of 350 M; geographic information system (GIS) projects, including Geodas SBES bathymetric data, one SBES bathymetric survey and an ETOPO1 DEM.

45. The SBES surveys included in the Submission covered a vast area, and therefore represented, in the view of the Subcommission, sparse coverage. The only MBES survey, R/V Sonne survey SO-193, contained in the Submission appeared not to have been used in the search for the base and the foot of the continental slope in the Submission.

46. Regional morphological data and information was provided in the Submission in the form of an ETOPO1 DEM. The Subcommission took note of the fact that a number of long profiles used by the Cook Islands to support the test of appurtenance were constructed solely on the basis of this model. The limitations of the application of predicted bathymetry through satellite altimetry techniques in the determination of the 2,500 m isobath and the search for the base and the foot of the continental slope are outlined in paragraphs 4.2.6 and 5.2.3 of the Guidelines.

47. In view of the geomorphologic complexity associated with the implementation of article 76 of the Convention in the Manihiki Plateau region and the significant gaps in the data as submitted, the Subcommission considered it important and necessary to inform the Cook Islands, in a timely manner, to the existence of a

large amount of MBES data available in the public domain. The Subcommission identified 18 MBES surveys in the Manihiki Plateau region. Sixteen of these MBES surveys were not contained in the original Submission, although they had been acquired before the Submission was made in 2009. In addition, R/V Sonne cruises, SO-223 and SO-224, had acquired relevant data, albeit after the Submission was made. A large number of SBES surveys data that might be relevant to the Submission had also been identified by the Subcommission.[7] These surveys provided wider data coverage and did not appear to differ in age and/or quality from the smaller subset included in the Submission.

48. In response to a letter from the Subcommission dated 2 September 2011, informing the Delegation of the existence of MBES data available in the public domain, the Delegation submitted a note verbale dated 19 March 2012, with MBES data, which was introduced by the Delegation, together with a revised GIS project, in a presentation on 24 April 2012. The Delegation also amended the outer limits of the continental shelf. Figure 10 shows the amended portion of the outer limits of the continental shelf and its original version.

49. The amendment to the Submission, made by the Cook Islands on 24 April 2012, also expanded the number of foot of continental slope points as shown in Figure 11. The Subcommission considered the base and the foot of the continental slope, as amended.

50. In response to a request from the Subcommission, dated 19 February 2013, data from the R/V Sonne cruises SO-224 and SO-225 were received from the Delegation, on 26 July 2013.

51. The role of morphology in the determination of the base of the continental slope was highlighted by the Cook Islands in the Main Body of the Submission. The role of geology and geophysics in the determination of the base of the continental slope was also highlighted by the Cook Islands, as outlined below. The foot of the continental slope was determined in all cases by means of the application of the general rule, i.e. at the maximum change in the gradient at its base.

52. The Subcommission examined the following key questions relating to natural prolongation:

- Can the natural prolongation be ensured morphologically and geologically from the islands to the base of the continental slope proposed in the Submission?
- What are the relevant issues to natural prolongation posed by the morphological and structural characteristics of the troughs located inside the Manihiki Plateau complex, which divide the High, Western and North Plateaus?
- What are morphological characteristics of the seafloor highs described as Tangaroa, Avatea and Nganaoa spurs in the Submission?
- What are the locations of the base of the continental slope around the islands?

53. Following the presentation made by the Subcommission on 18 November 2013, in accordance with paragraph 10.3 of annex III to the Rules of Procedure, the

[7] 192 SBES surveys

Subcommission understands that two morphological arguments have been given further emphasis by the Delegation of Cook Islands:

- The role of the bridges across saddles in the Danger Islands Trough region, as evidence for the morphological continuity from the High to the Western Plateaus; and
- The equivalence between the abyssal depths of 5,200 and 5,500 metres surrounding the Manihiki Plateau and the deep ocean floor in the sense of Article 76 in the region of the Manihiki Plateau.[8]

54. The Subcommission noted that no additional data and information of morphological continuity was provided by the Delegation between the Western and North Plateaus, or the High Plateau and the northern seafloor highs.

55. In the Submission (e.g. Section 2.5 of the Main Body), Cook Islands stated that the Manihiki Plateau can be subdivided into three major geomorphological units 1) the High Plateau in the east, 2) the North Plateau, and 3) the Western Plateau. These units are separated by deep troughs, and a basin, which possibly represent rift structures. Cook Islands further observed that the Manihiki Plateau is bounded by deep ocean floor basins on all sides. The Submission included a gradient analysis of the ETOPO1 DEM, shown in Figure 3.1 of the Main Body. The Subcommission conducted an independent analysis with the GMRT grid, which confirmed these results and illustrate, in the view of the Subcommission, the fragmented nature of the Manihiki Plateau (Figure 12).

56. According to the Cook Islands, despite this fragmentation, all elements of the Manihiki Plateau, including all troughs, saddles and spurs occur at significantly shallower depths than the deep ocean floor of the central Pacific Basin, which is found at a depth of approximately 5,300 metres (paragraph 2.6.2 of the Main Body). This was a key element in the arguments presented of submerged prolongation of the landmass of the Cook Islands to the BOS region around the Manihiki Plateau in the Submission.

57. The Subcommission was of the view that many seafloor highs shallower than the abyssal depths, including, but not limited to oceanic ridges, do not satisfy the criteria set out in article 76 of the Convention and in the Guidelines, and therefore cannot be considered part of the continental margin, but are part of the deep ocean floor.

58. The Subcommission, therefore, indicated that only those seafloor highs for which a morphological and geological connection to the High Plateau could be clearly demonstrated should be considered part of the continental margin of the Cook Islands. In other words, the Subcommission was of the view that the Manihiki Plateau is a complex and fragmented seafloor high and that the fact that some seafloor features are elevated above the deeper parts of the deep ocean floor, did not automatically make those features part of the continental margin of Cook Islands.

59. The Subcommission also indicated to the Delegation that its presentation of morphological continuities across those geomorphological units appeared to be mostly based on visual perception. The Guidelines focus on perceptual elements in a submission, such as map projections, vertical and horizontal scales, contour

[8] Main Body 2.5; Presentations made by the Delegation dated 19 November 2013, 27 February 2014, 26 August 2014, 28 August 201, and 26 August 2015.

intervals, units, colours and symbols. Paragraph 5.4.7 specifically discourages the use of visual perception alone to determine the base and the foot of the continental slope.

60. The Subcommission performed the search of the base of the continental slope in accordance with article 76 and 5.4.5 of the Guidelines and concluded that:

- The natural prolongation was not proven from the High to the Western Plateaus across MBES bathymetric profiles determined across the Danger Islands Troughs (DIT) between bridges (Figures 14 and 15);
- The natural prolongation was not proven from the High to the Western Plateaus across MBES bathymetric profiles determined across the Danger Islands Troughs (DIT) along the crest of bridges (Figures 16a, 16b, 17a, and 17b); and
- The natural prolongation was not proven from the North Plateau to the Western Plateaus to the High Plateau across MBES bathymetric profiles determined across the Danger Islands Troughs (DIT), along the crest of bridges (Figure 18a and 18b).

61. The Subcommission examined the northern seafloor highs using the available MBES and SBES data and information and concluded that the morphological continuity and natural prolongation of the Avatea and Tangaroa spurs from the North Plateau and the Nganaoa spur from the High Plateau was not sufficiently demonstrated.

62. The 200 M and 350 M lines in the Submission were reviewed and determined to be properly constructed by geodetic means through the method of envelope of arcs. However, while the line determined at a distance of 200 M from Penrhyn Island was clearly necessary in order to determine the breadth of the continental shelf beyond 200 M, the Subcommission took note of the fact that the Cook Islands also used the baselines of this island to determine the 350 M constraint (Figure 7). The Subcommission was of the view that Penrhyn Island was not located in the Manihiki Plateau complex (see paragraph 34) and did not have an entitlement to a continental shelf beyond 200 M. In a manner consistent with its past practice, the Commission does not recommend the application of the 350 M constraint line determined from Penrhyn Island.

63. The Subcommission also examined the construction of the depth constraint as submitted. Figure 4.8 in the Main Body shows a map depicting the general configuration of the 2,500 m isobath as determined by ETOPO1 grid dataset. The limitations of the application of predicted bathymetry through satellite altimetry techniques in the determination of the 2,500 m isobath and the search for the base and the foot of the continental slope are outlined in the paragraphs 4.2.6 and 5.2.3 and the Guidelines.

64. The Subcommission found that the approach employed in the Submission to apply the depth constraint, using the intersection of SBES survey data with the 2,500 m isobath determined by means of ETOPO1 predicted bathymetry, did not meet the provisions of the Guidelines, and in particular of its paragraph 4.2.1.

65. In addition, the Subcommission insisted on the fact that the coastal State would have to demonstrate that the measured 2,500 m isobath would conform to the general configuration of the continental margin, as stipulated in paragraph 4.4.2 of the Guidelines.

2.3 Geological and Geophysical Considerations

66. In its Submission, the Cook Islands provided a geological summary of the Manihiki Plateau, which indicated the following (Chapter 2.8 of the Main Body):

- the Manihiki Plateau formed during the Cretaceous as a result of the arrival of a mantle plume head;
- the Manihiki Plateau likely formed part of a much larger Large Igneous Province, comprising the Manihiki, Hikurangi and Ontong Java Plateaus prior to rifting;
- a triple junction between the Pacific, Farallon and Phoenix (Antarctic) plates occurred to the northeast of the Manihiki Plateau;
- the islands and seamounts of the Manihiki Plateau were shown to be a late stage event during the formation of the feature and, as such, were an integral part of it; and
- the origin of the spurs of the northeast Manihiki Plateau was presently unclear, however, they represented features inherently linked to the formation of the present day Manihiki Plateau composite feature.

67. In its Submission, the Cook Islands considered the Manihiki Plateau as one of several Early Cretaceous LIPs in the Pacific, which were thought to represent the surface location of mantle plume heads, or hot spots (Figure 20). According to the Cook Islands, LIPs represented massive emplacements of predominantly mafic rock formed by processes other than seafloor spreading in geologically brief intervals. The crustal thickness and structure of LIPs deviate substantially from normal oceanic crust. As stated in the Submission, "The Manihiki Plateau is an [LIP] coincident in age with other LIPs in the Pacific region […]. Therefore the Manihiki Plateau […] represents anomalous features, having undergone separate geological (magmatic) processes to normal oceanic basins. The Manihiki Plateau is therefore clearly distinguishable from normal oceanic crust [as] produced at mid-ocean ridges" (Main Body).

68. The Subcommission took note of the prevailing hypotheses in the scientific literature, on the origin of the Manihiki Plateau. According to these hypotheses, the Manihiki Plateau had been part of an oceanic LIP, which is believed to be a remnant of a formerly contiguous "Super LIP", called the Ontong Java Nui, which also included the Hikurangi and Ontong Java plateaus. According to a tectonic model, the Manihiki Plateau evolved during rifting at the triple junction of the Pacific, the Antarctic, and the Farallon Plate during the Barremian (about 127-121 Ma) that led to the separation of Manihiki Plateau from Ontong Java Plateau, and later at the Osbourn Trough to the southwest, separating the Hikurangi Plateau from the Manihiki Plateau (Figure 21).

69. The Subcommission also took note that subsequent rifting of the Manihiki Plateau resulted in fragmentation of the plateau and major structural discontinuities (for example, the Danger Islands Troughs), which separated the High Plateau from the Western Plateaus and the Suvarov Trough at the south eastern part of the High Plateau.

70. In the Submission, the Cook Islands referred to the deep troughs and a basin (i.e. the Danger Islands Troughs and Suvarov Trough, and the High-North Basin), as "rift structures", which probably resulted from post-formation rifting. Other

post-formation structures mentioned included the Manihiki Scarp: “Since these [Manihiki] escarpments truncate the High Plateau, they are believed to post-date construction of the Manihiki Plateau” (see paragraph 2.5.12 of the Main Body). The tectonic model of Coffin et al. (2007), which was presented by the Cook Islands, is a possible explanation for the origin of these troughs and basin features (Figure 22).

71. Cook Islands also stated that the elevated basins on the northern end of the High Plateau suggested a genetic relationship between the High-North Basin and the extensional event responsible for the High Plateau Basins. For this reason, the High-North Basin was considered an internal basin of the Manihiki Plateau and therefore not an element of the deep ocean floor. Its current morphological expression was likely the result of a failed rifting event or extensional modification of the plateau post-formation.

72. On the sea floor features to the north of the Manihiki Plateau (shown in Figure 23), the Cook Islands stated that “No publication exists with respect to its origin, but its morphology and orientation indicate a possible graben-horst structure. Such normal faulting may be related to extension during a rifting phase or extension related to uplift or underplating during the late stages of formation of the plateau” (paragraph 2.5.17 of the Main Body).

73. The Cook Islands further stated (paragraph 2.7.6 of the Main Body): “The origin of the northern Manihiki Plateau spurs has not been addressed in the literature. Whether these features are of igneous or tectonic origin remains a matter of uncertainty and requires further data and study”. Furthermore, Chapter 2.8 of the Main Body stated that: “[T]hey represent features inherently linked to the formation of the present-day Manihiki Plateau composite feature”.

74. In light of the limited geological and geophysical data and information contained in the original Submission, the Subcommission also considered it important and necessary to investigate if additional geological and geophysical data and information were available in the public domain, which could support the search for the base and the foot of the continental slope. The Subcommission identified and compiled the following information, which was not included in the Submission: 24 seismic reflection surveys; 2 seismic refraction surveys; gravity marine tracks, and one-minute Free-air and Bouguer gravity anomaly grids; magnetic marine tracks and a two-minute Emag grid; 41 scientific references; and 19 abstracts.

75. The Subcommission also identified a number of marine geoscientific surveys carried out by international organizations, such as the University of California at Santa Barbara Cruises KIWI Expedition Leg 11 (1998) and Japanese RV Hakuho-Maru 2003, 2005 and 2010, which were not included in the Submission.

76. The Subcommission agreed with the prevailing hypotheses on the origin of the Manihiki Plateau as having formed by breakup of a large LIP (Figure 22).

77. The Subcommission noted, however, that the post-emplacement rifting had resulted in fragmentation and segmentation of the Manihiki Plateau into its constituent parts (High Plateau, Western Plateaus and North Plateau) (Figure 23).

78. The High-North Basin and the seafloor highs identified to the northeast of the Manihiki Plateau complex were presumably formed by seafloor spreading in relation to the same post-emplacement rifting event and may be explained by the tectonic model in Figure 22.

79. However, due to the lack of conclusive geological and geophysical data and information, and the resulting uncertainties in the tectonic hypotheses, the Subcommission found that there was limited geological and geophysical support to substantiate the natural prolongation of the landmass beyond the High Plateau (2013_11_18_SC_PRE_COK_004).

80. In response to the Subcommission's presentation of its views and general conclusions, the Delegation made several presentations and submitted further data and information, particularly to substantiate its views that there was a geological continuity between the High and Western Plateaus across the Danger Islands Troughs. With respect to the Danger Islands Troughs, the Cook Islands concluded that, "geological continuity has not been broken across the Danger Islands Troughs by the rifting event that occurred post emplacement ~ 115 Ma" (COK-PRES-04-27-02-2014).

81. The Subcommission acknowledged the views in the scientific literature that the Danger Islands Troughs represented a failed rift system. Based on the geological data and information, the Subcommission maintained that the 'failed rifting' event had actually caused fragmentation of the Manihiki Plateau complex, which resulted in the complex bathymetric profiles that showed significant geomorphological discontinuities.

82. In relation to the geochronological and geochemical data, referring to recent scientific cruises and literature (COK-PRES-04-27-02-2014), the Cook Islands held that the geochronological and geochemical data from both sides of the Danger Islands Troughs were consistent with its view on geological continuity between the High and Western Plateaus.

83. The Subcommission, however, considered that the geochronological and geochemical information available thus far was based on samples that were taken mainly along the Danger Islands Troughs and around the edges of the High-North Basin (Figure 24). Additional samples were collected from a number of seamounts, which were all reported to relate to secondary phases of volcanism compared to the main plateau building stage. These samples may not necessarily be representative of the Western Plateaus, or even the High Plateau. According to the most recent cruise report on the Manihiki Plateau: "The origin, temporal and spatial evolution of widespread, high volume volcanism during the main plateau forming stage is, however, still unclear and cannot be reconstructed with the available sample set" (Werner et al., 2013).

84. In response, the Cook Islands submitted further information based on the SONNE SO-193 and SO-225 reports showing the extensive sampling of basalts from the Manihiki Plateau region. The Subcommission highlighted that it was aware of these sampling sites, but noted that those samples were taken mostly for petrological analyses and only a small subset was analysed for geochronology, as shown in the map of Timm et al. (2011) (Figure 24).

85. With regards to the crustal thickness of the Manihiki Plateau, the Subcommission pointed out that there were uncertainties in the crustal thickness estimates referred to in the original Submission. In response, the Cook Islands referred to the results of deep seismic transect across both the High and Western Plateaus (Figure 25a and b). The Cook Islands concluded as follows: "Refraction data indicate a thickened 3 layer crust throughout the Manihiki Plateau, typical of LIP's. Manihiki Plateau is everywhere underlain by a high velocity lower crust characteristic of LIPs. Some differences in character in the upper crust are seen between the High

and Western Plateaus, likely related to late-stage volcanic history, but show crustal continuity at mid- and lower-crustal levels." (Presentation by the Delegation on 26 August 2014, "Coffin_Manihiki_CLCS_2014")

86. The Subcommission was aware of the observed differences of the crustal thickness and structure between the Manihiki Plateau and 'normal' oceanic crust, the crustal thickness of the plateau being reported to vary from > 20 kilometres at the High Plateau, and decreasing to < 10 kilometres to the west on the Western Plateaus. The Subcommission also noted that there were a number of other differences between the High Plateau and the Western Plateaus. In a study referred to by the Cook Islands (Hochmuth et al., 2014), these differences led the authors to conclude that the Western Plateaus were 'atypical' of LIPs, on several aspects, in particular: (1) crustal structure, (2) lack of features, such as mafic intrusions in the upper-middle crust and basaltic flow units within the upper crust, and (3) the absence of a second magmatic phase in the Western Plateaus, unlike the High Plateau.

87. In light of the above, the Subcommission was of the view that the Danger Islands Troughs represented a geological and structural discontinuity between the High and Western Plateaus. However, several members of the Commission considered that the recent multibeam bathymetric data in the Danger Islands Troughs area, provided by the Delegation at the request of the Subcommission, demonstrated that significant bridges existed that could justify the morphological connections between the High Plateau and the Western Plateau across the Danger Island Troughs.

88. With regards to the sea floor highs referred to as 'spurs' to the north of the Manihiki Plateau region, the Subcommission noted that no further evidence with respect to the geological nature of these seafloor highs was contained in the Submission to justify interpreting those features as being inherently linked to the formation of the Manihiki Plateau. It was the view of the Subcommission that those sea floor features were most likely formed by sea floor spreading and were not geologically linked with any of the plateaus. The Commission noted that the examination of continental shelf generated from these features would necessarily involve the examination of whether or not these features could be classified as natural components of the continental margin.

89. Based on the geological and geophysical data and information submitted, the Subcommission summarized its overall views as follows:

90. Consistent with the prevailing scientific view, the Manihiki Plateau originated as a large LIP that broke apart subsequent to its formation. The Manihiki Plateau was subjected to post-emplacement rifting and seafloor spreading processes that led to the creation of deep troughs (Danger Islands Troughs and Suvarov Trough) and an 'internal basin' (High-North Basin) within the plateau complex. These features created geomorphological discontinuities between the different parts of the plateau complex.

    - The Danger Islands Troughs represent a geological/structural discontinuity across the Manihiki Plateau, particularly between the High and Western plateaus.
    - Due to the lack of conclusive geological and geophysical data and information, and the resulting uncertainties in the tectonic hypothesis, there is currently limited geological and geophysical support to

substantiate the natural prolongation of the landmass beyond the High Plateau.

- The spurs located to the northeast of the plateau complex, most likely formed by sea floor spreading, are not connected with any part of the plateau complex.

2.4 Conclusions

91. The Subcommission concluded that the scientific and technical data and information contained in the Submission, and the additional materials and information provided by the Delegation, do not support the location of the base and foot of the continental slope around the Western Plateaus, the Northern Plateau, and the northern seafloor highs referred to as "spurs" in the Submission.

92. However, the existing scientific and technical data and information would support a base and foot of the continental slope around the northern edge of the High Plateau (see Figure 5). The Subcommission, therefore, concluded that the test of appurtenance was passed.

93. The Subcommission is of the view that the 350 M constraint must be determined using only baselines from which the breadth of the territorial sea is measured, from islands that share the same natural prolongation. The baselines from which the breadth of the territorial sea of Penrhyn Island is measured are, therefore, not applicable to this Submission.

94. The 2,500 m isobath plus 100 M constraint must be determined from measured data and it must conform to the general configuration of the continental margin in accordance with all the provisions contained in the Guidelines.

95. Given these conclusions, the Subcommission could not approve the location of the outer limits of the continental shelf as presented in the Submission.

V. CONCLUDING RECOMMENDATIONS (ARTICLE 76 PARAGRAPH 8)

96. The Cook Islands pass the test of appurtenance based on the scientific and technical information contained in the Submission (see paragraph 92 above).

97. The scientific and technical data and information contained in the Submission are insufficient to support a morphological and/or geological prolongation from the northern edge of the High Plateau to the Western Plateau and the seafloor highs identified in the Submission as spurs.

98. The Commission is of the view that the 350 M constraint must be determined using only baselines from which the breadth of the territorial sea is measured, from islands that share the same natural prolongation. The baselines from which the breadth of the territorial sea of Penrhyn Island is measured are, therefore, not applicable to this Submission.

99. The determination of the 2,500 m isobath plus 100 M constraint should be constructed from measured data and the isobath should conform to the general configuration of the continental margin in accordance with all the provisions contained in the Guidelines.

100. Based on the analysis of the scientific and technical data and information contained in the Submission, and the additional materials and information provided by the Delegation, the Commission is unable to recommend on the precise location of the outer limits of the continental shelf in the region of the Manihiki Plateau. The

Commission recommends that Cook Islands make a new or revised submission taking into considerations the analyses and conclusions presented in these Recommendations.

FIGURES

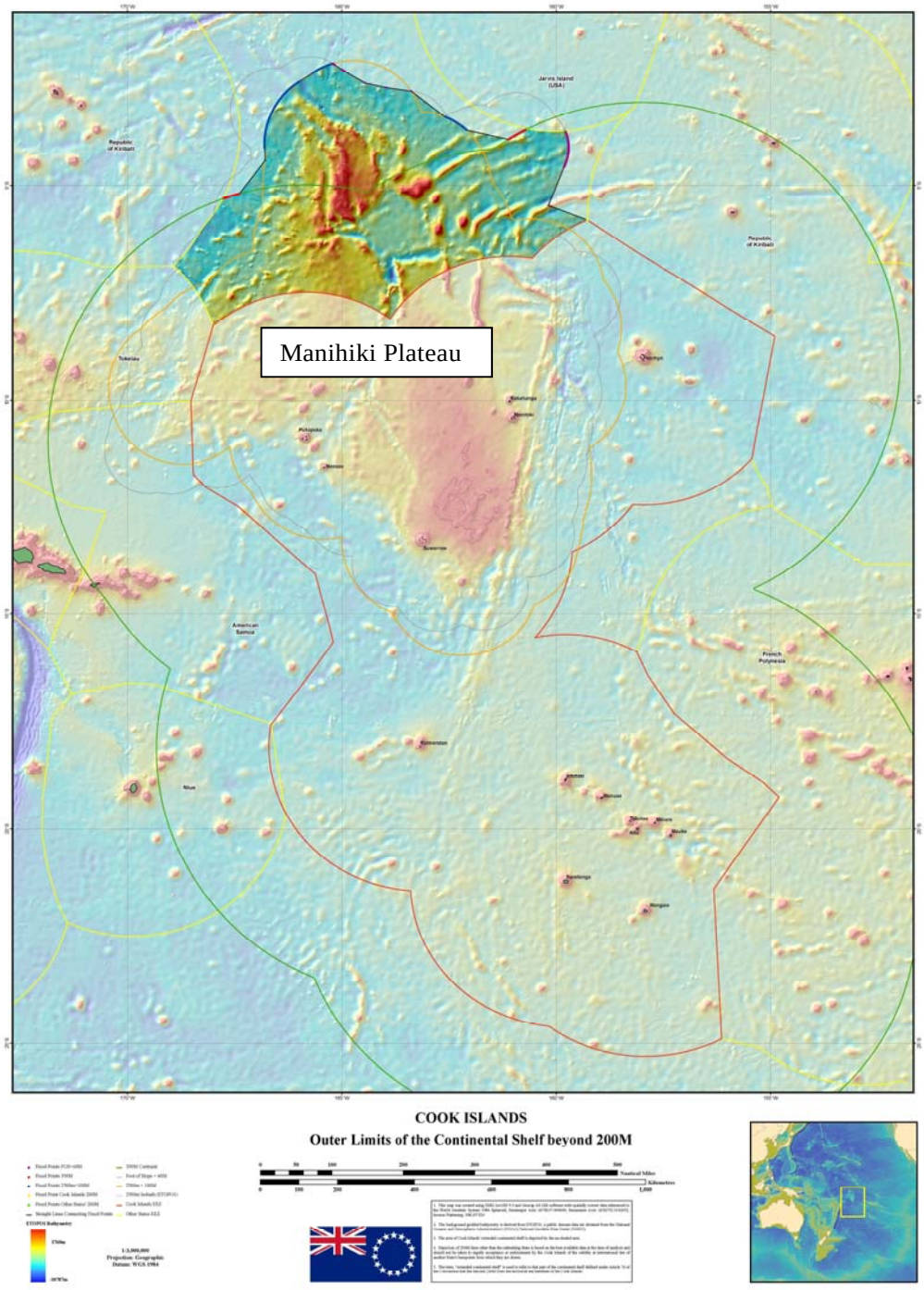
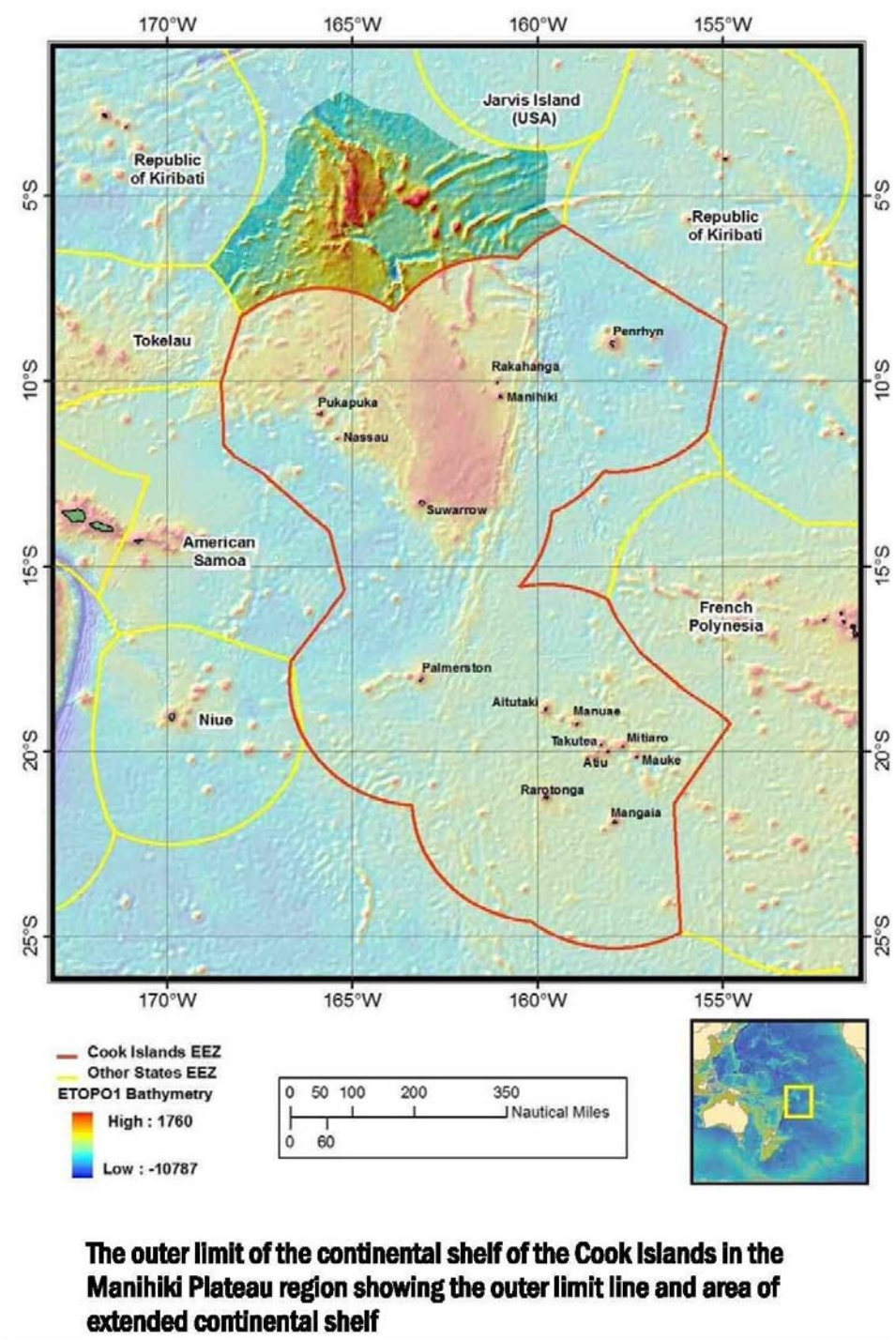


Figure 1: Map of the outer limits of the continental shelf included in the original Submission, dated 16 April 2009. (modified by Commission from Executive Summary)



The outer limit of the continental shelf of the Cook Islands in the Manihiki Plateau region showing the outer limit line and area of extended continental shelf

Figure 2: Map of the outer limits of the continental shelf included in the amended Submission, dated August 2012.

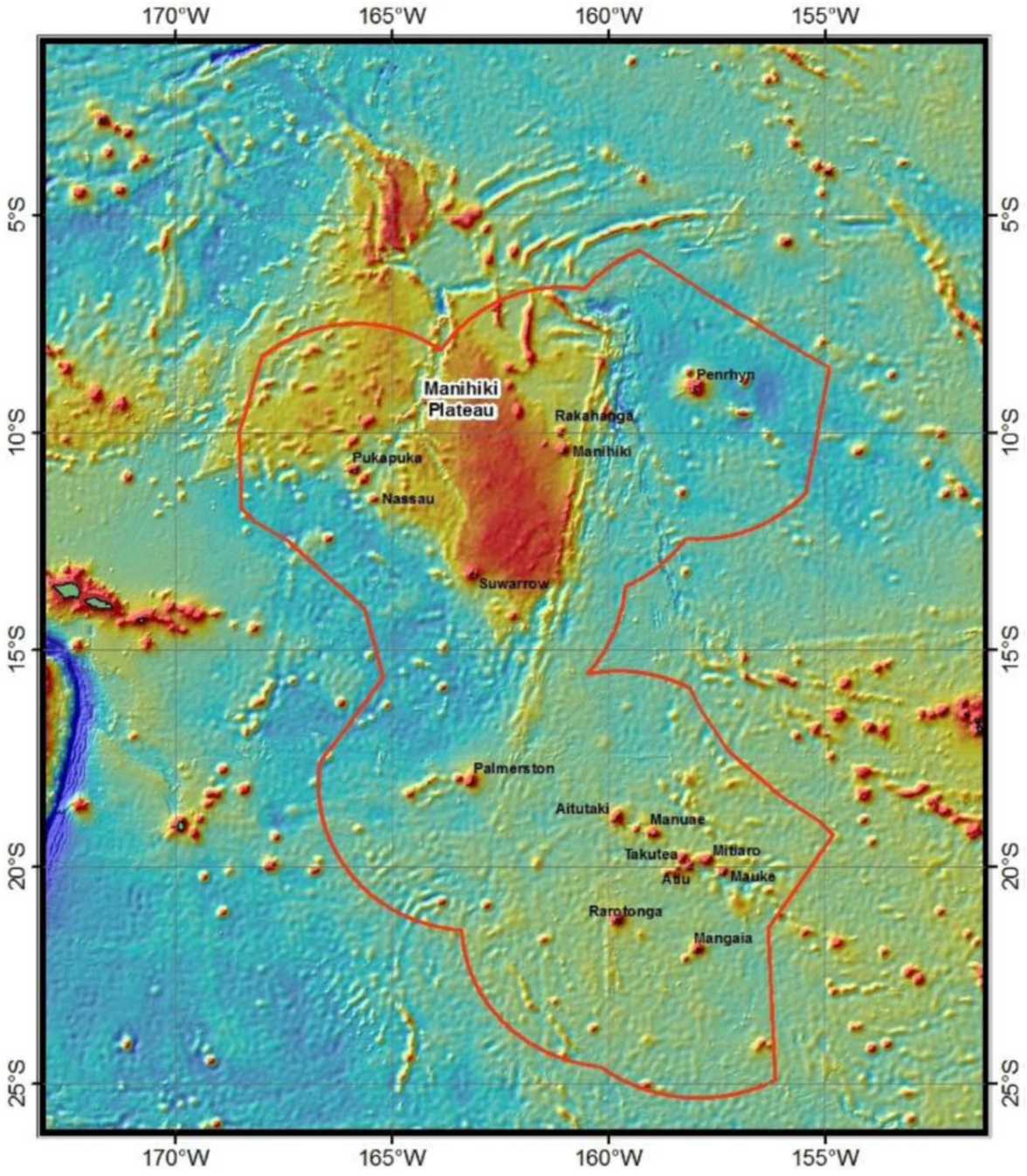


Figure 3: Map showing the location of the Cook Islands and the Manihiki Plateau (Figure 2.1 of the Main Body).

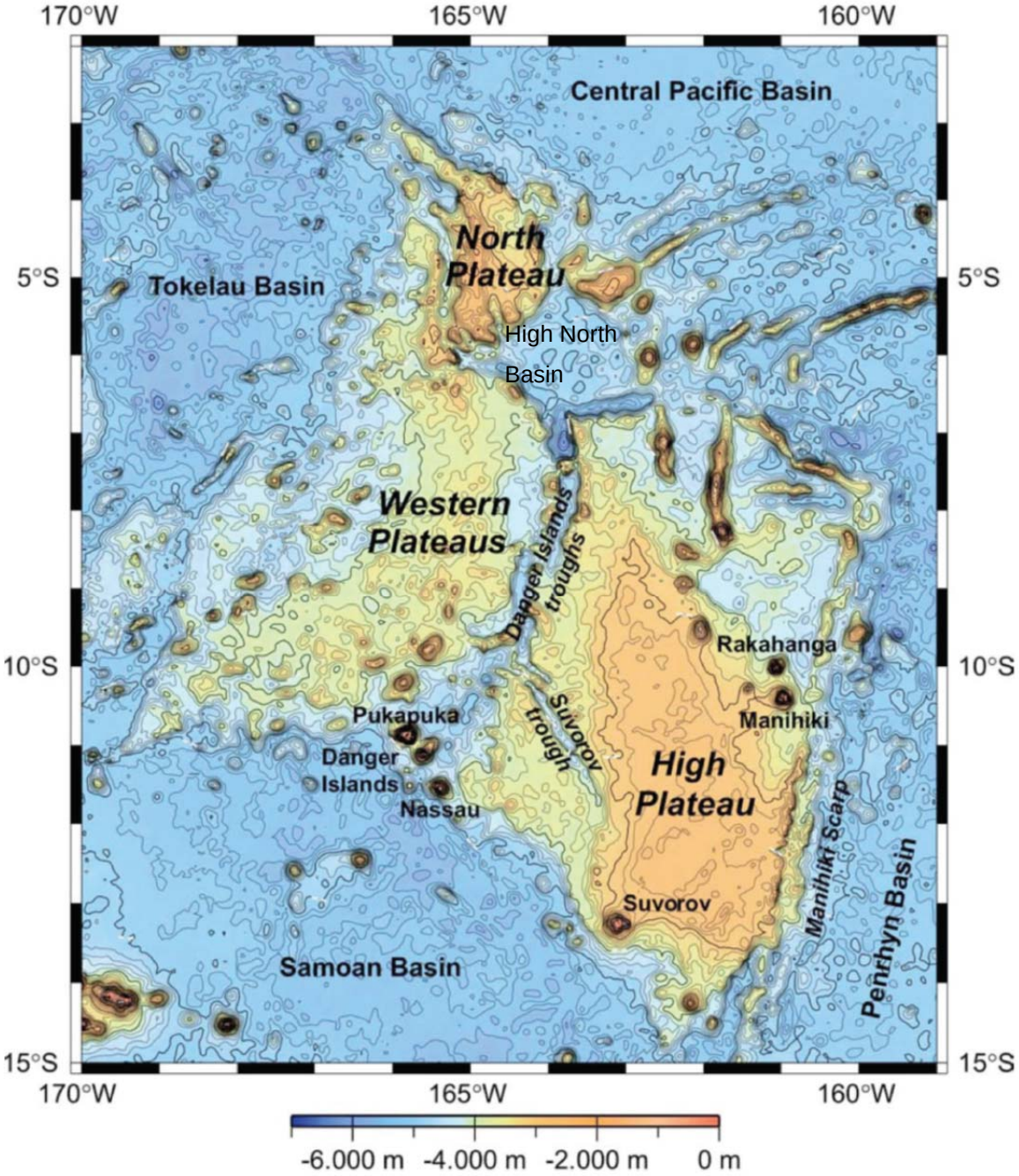


Figure 4: Bathymetric map mainly based on predicted bathymetry from satellite-altimetry, showing the three major morphological provinces and the main physiographic elements of the Manihiki Plateau region (from Uenzelmann-Neben, 2012). Islands: Rakahanga, Manihiki, Suwarrow, Nassau, and Pukapuka, three located on the High Plateau, and two in the Danger Islands Troughs region. Manihiki Plateau Complex: High, Western and North Plateaus. Manihiki (Escarpment) Scarp. Troughs: Danger Islands, and Suvarov. Basins: High-North, Tokelau, Samoan, Penrhyn, and Central Pacific.

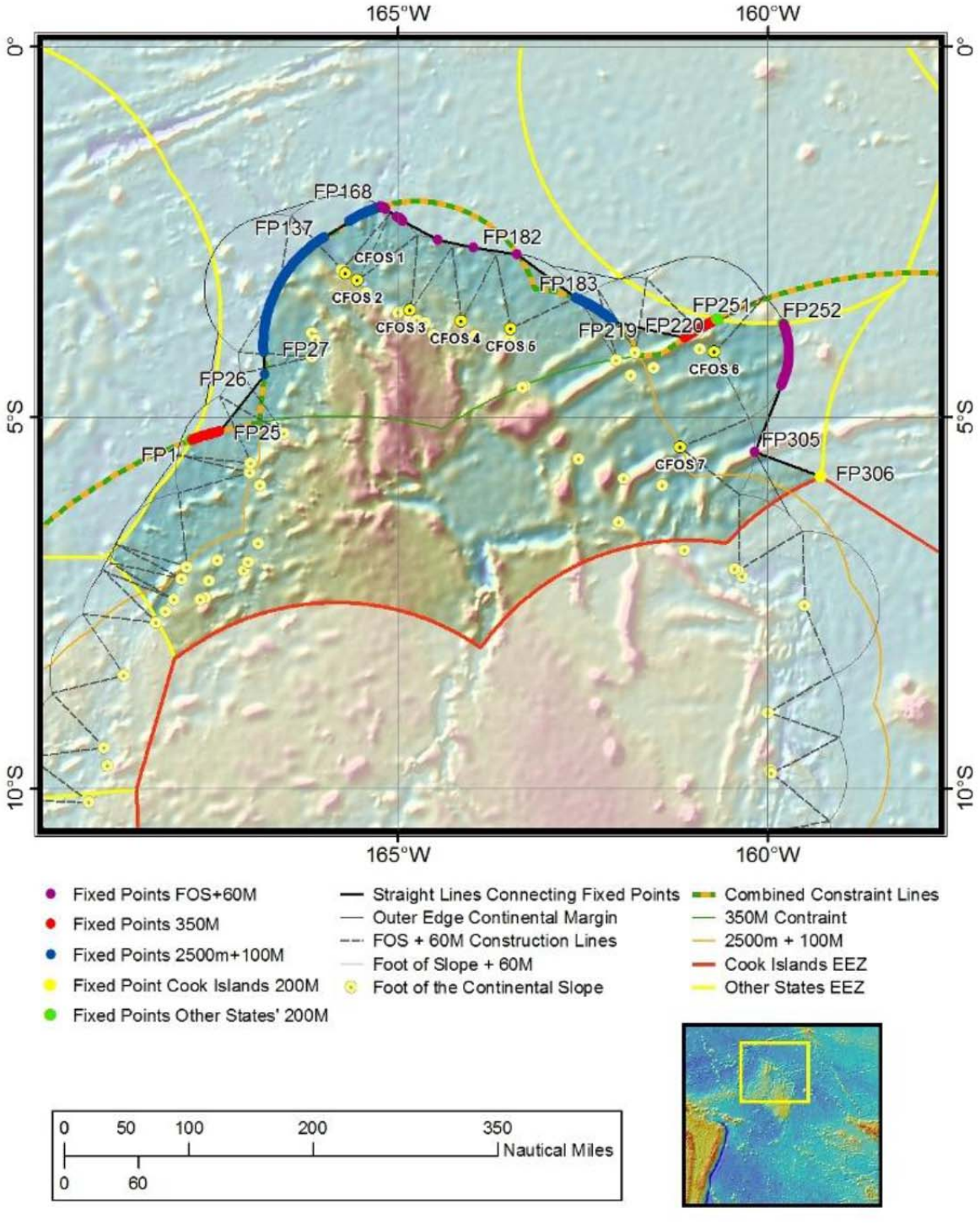


Figure 5: Map showing the determination of the outer limits of the continental shelf included in the Submission, dated 16 April 2009.

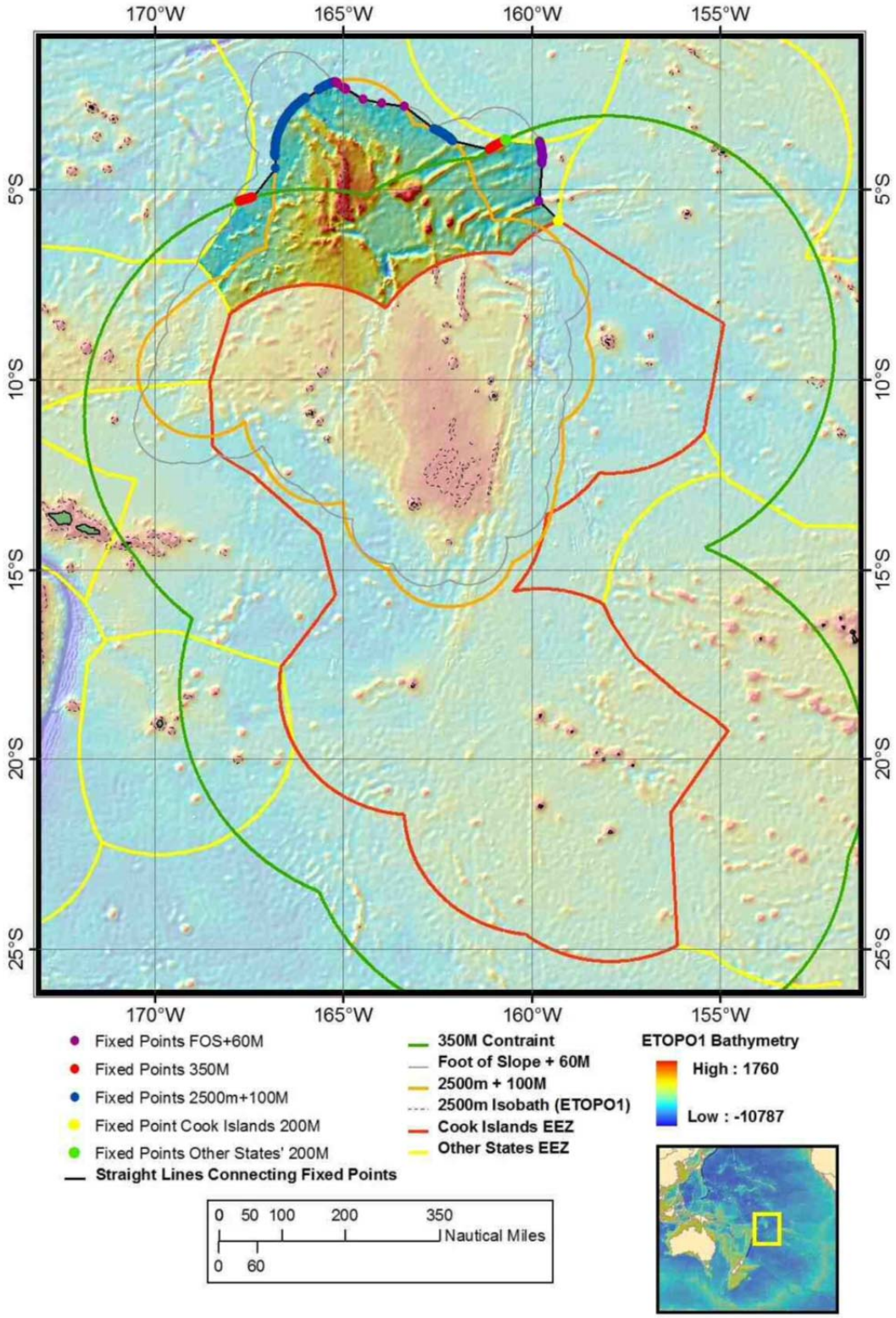


Figure 6: Map showing the determination of the outer limits of the continental shelf included in the amended Submission, dated August 2012.

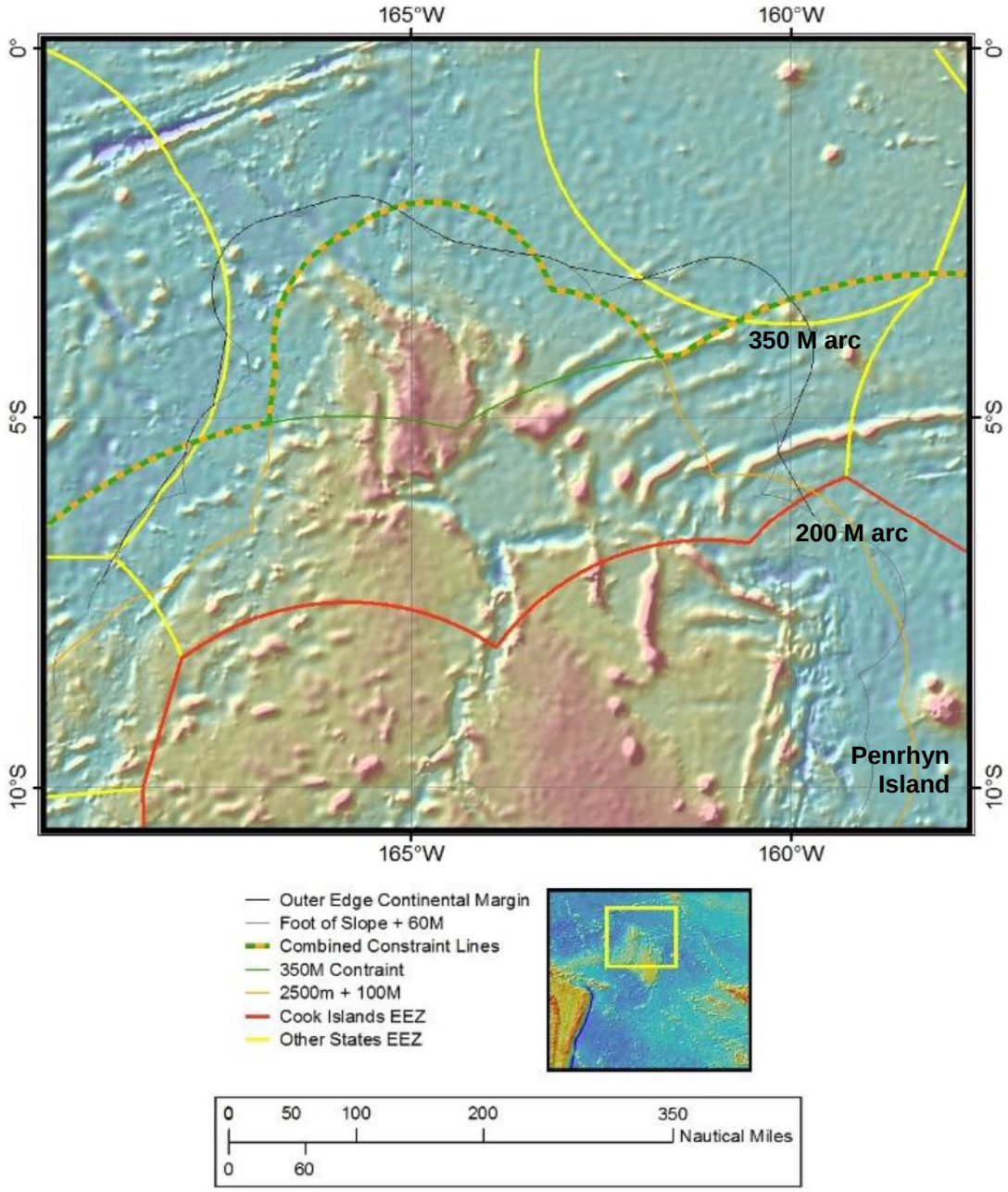


Figure 7: Map showing the outer edge of the continental margin derived from the 60 M formula line, the 200 M line, the 350 M constraint line and the 2,500 m + 100 M constraint line (Figure 5.1 of the Main Body).

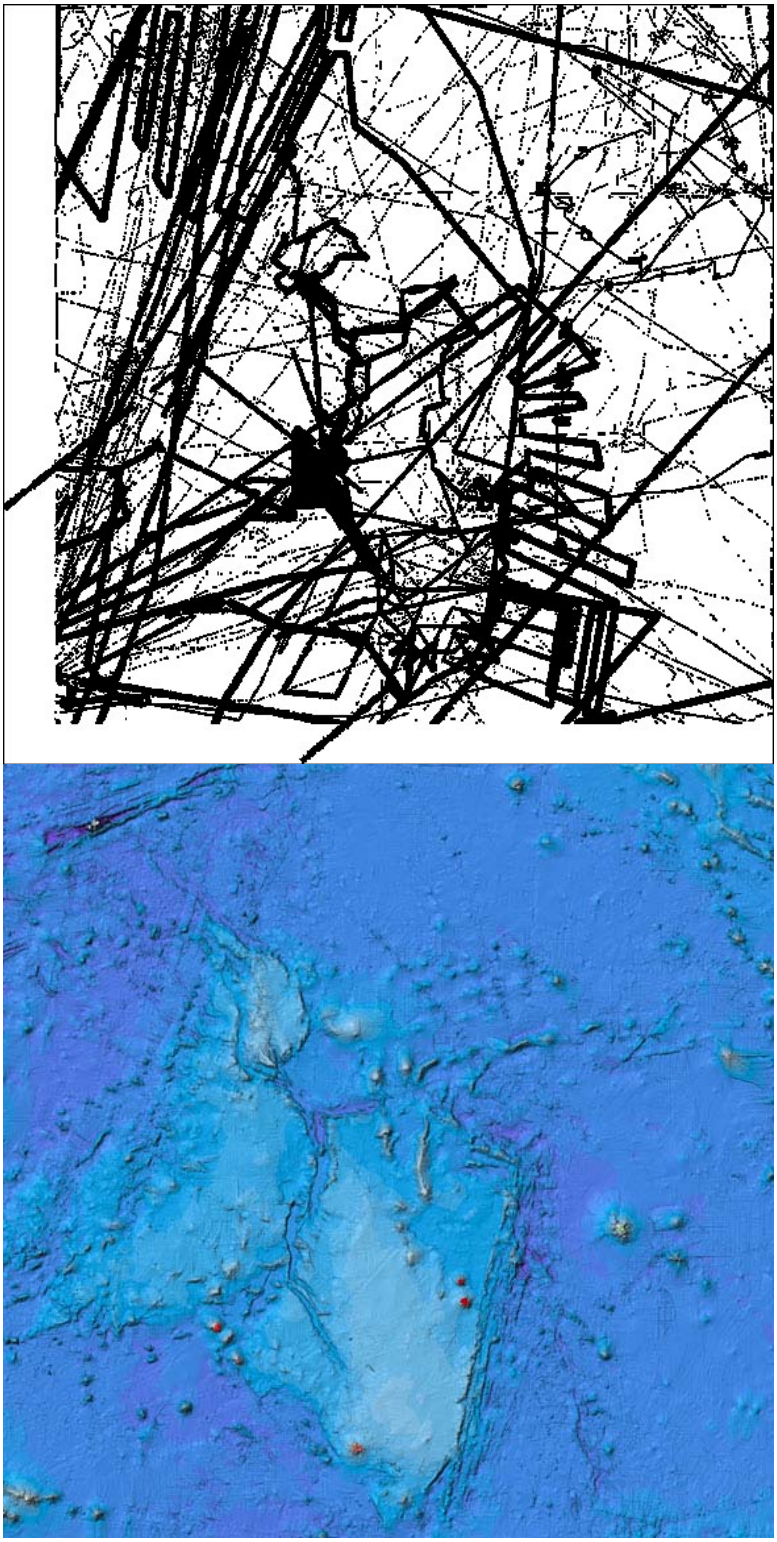


Figure 8: DEM determined from a 0.005° x 0.005° grid obtained by a kriging technique, below, using 192 SBES surveys and 18 MBES surveys, specified above (Constructed by Subcommission).

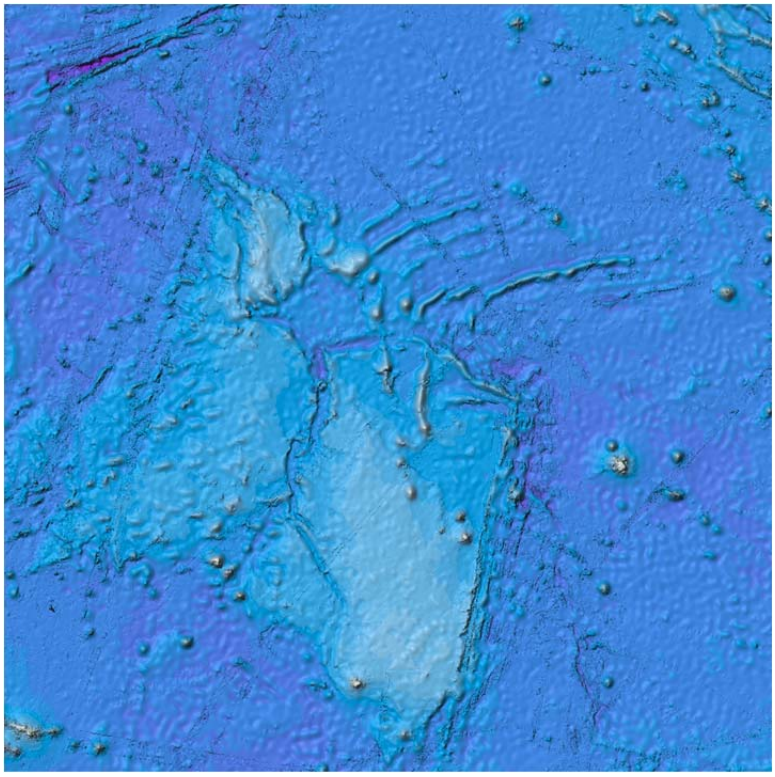


Figure 9: DEM determined by the Subcommission from the high-resolution GMRT grid available in the public domain (Ryan, et al., 2009).

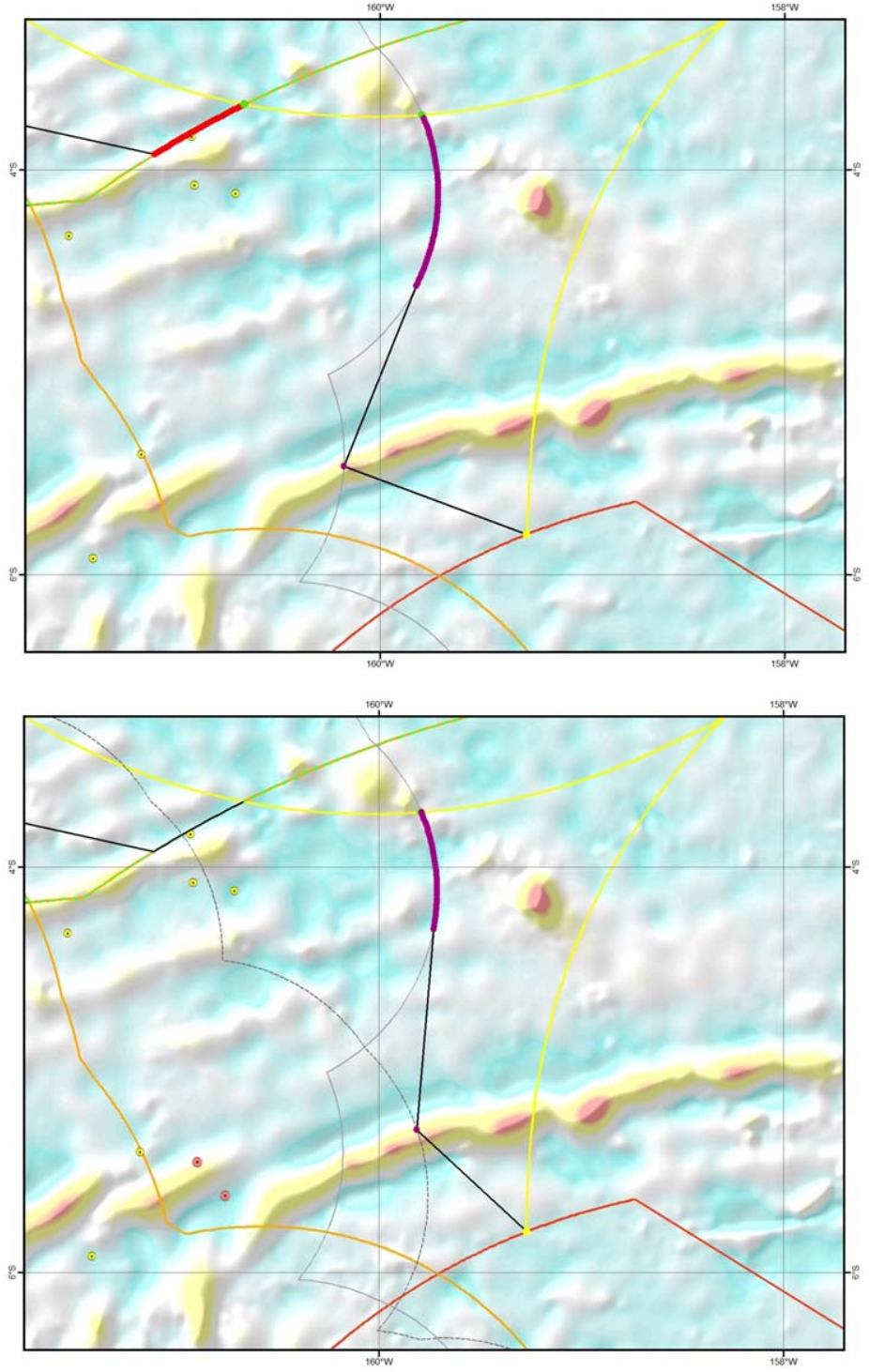


Figure 10: Portion of the outer limits of the continental shelf determined in the Submission, dated 16 April 2009 (above) and amended outer limits, dated 24 April 2012 (below).

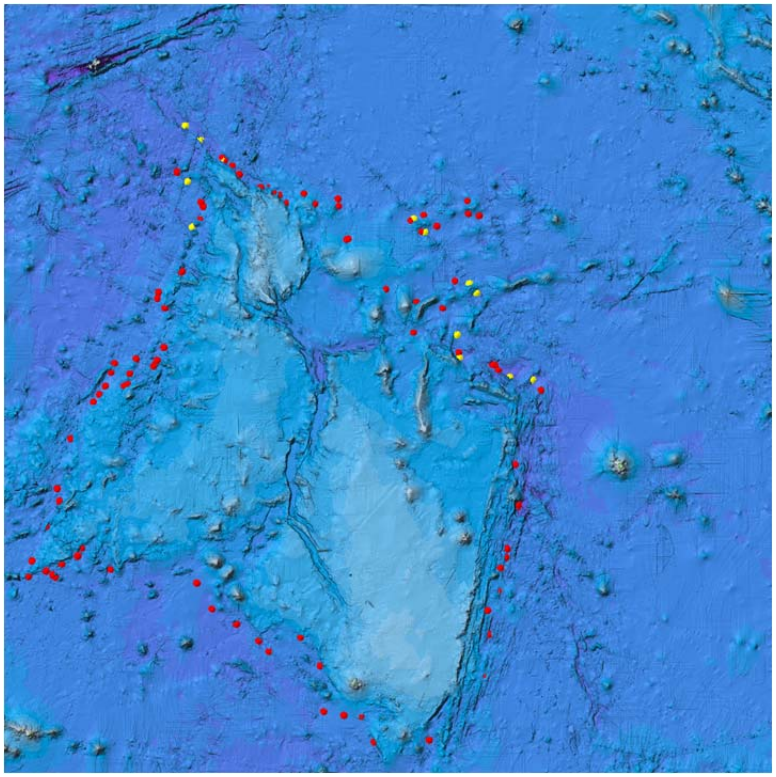


Figure 11: Foot of the continental slope points presented in the Submission, dated 16 April 2009 (red) and additional points included in the amendment, dated 24 April 2012 (yellow).

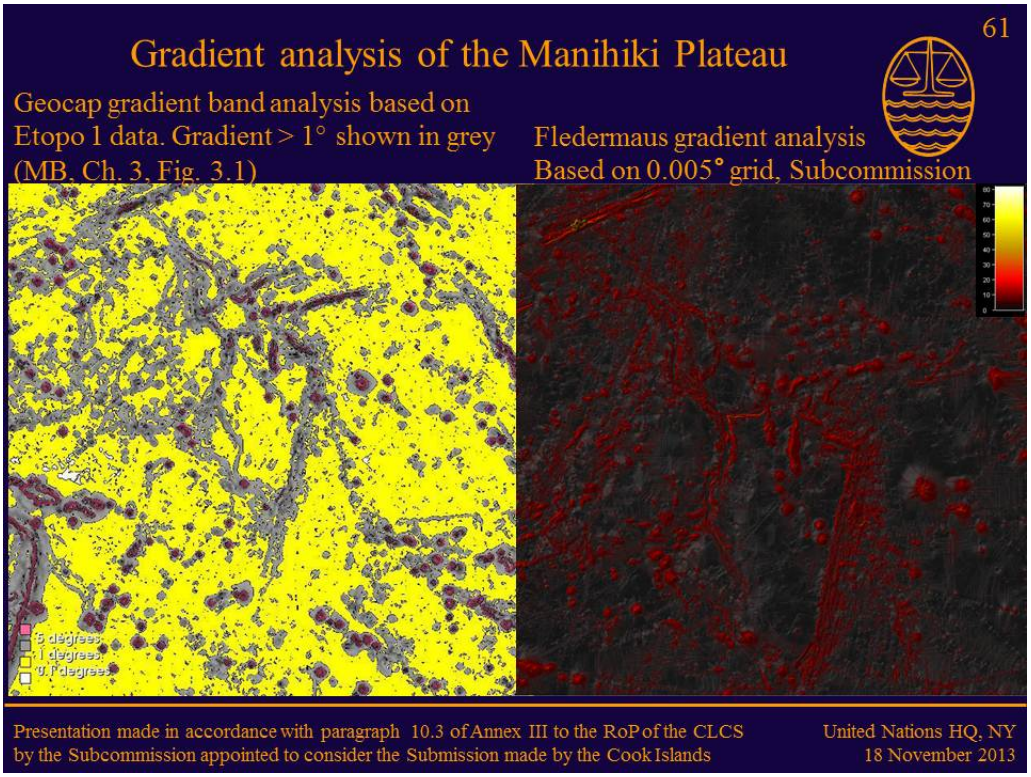


Figure 12: Gradient analysis of the bathymetry of the Manihiki Plateau with the ETOPO1 and GMRT grids included in the Submission, left, and conducted by the Subcommission, right, respectively.

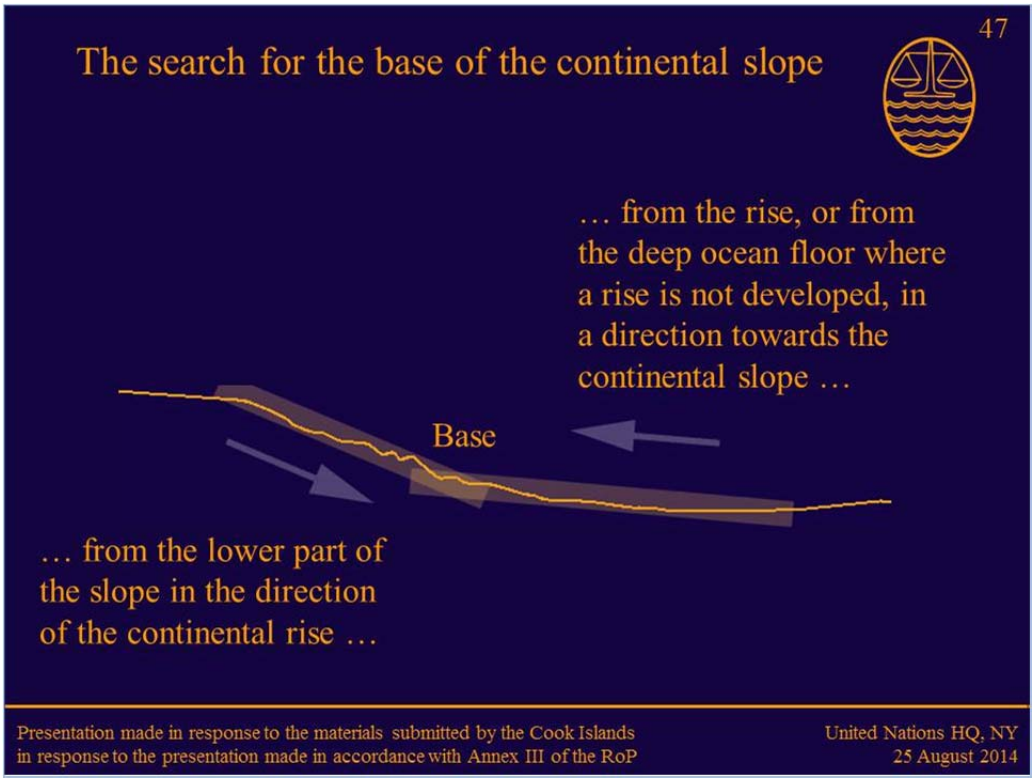


Figure 13: Graphical interpretation of the search for the base of the continental slope described in paragraph 5.4.5 of the Guidelines.

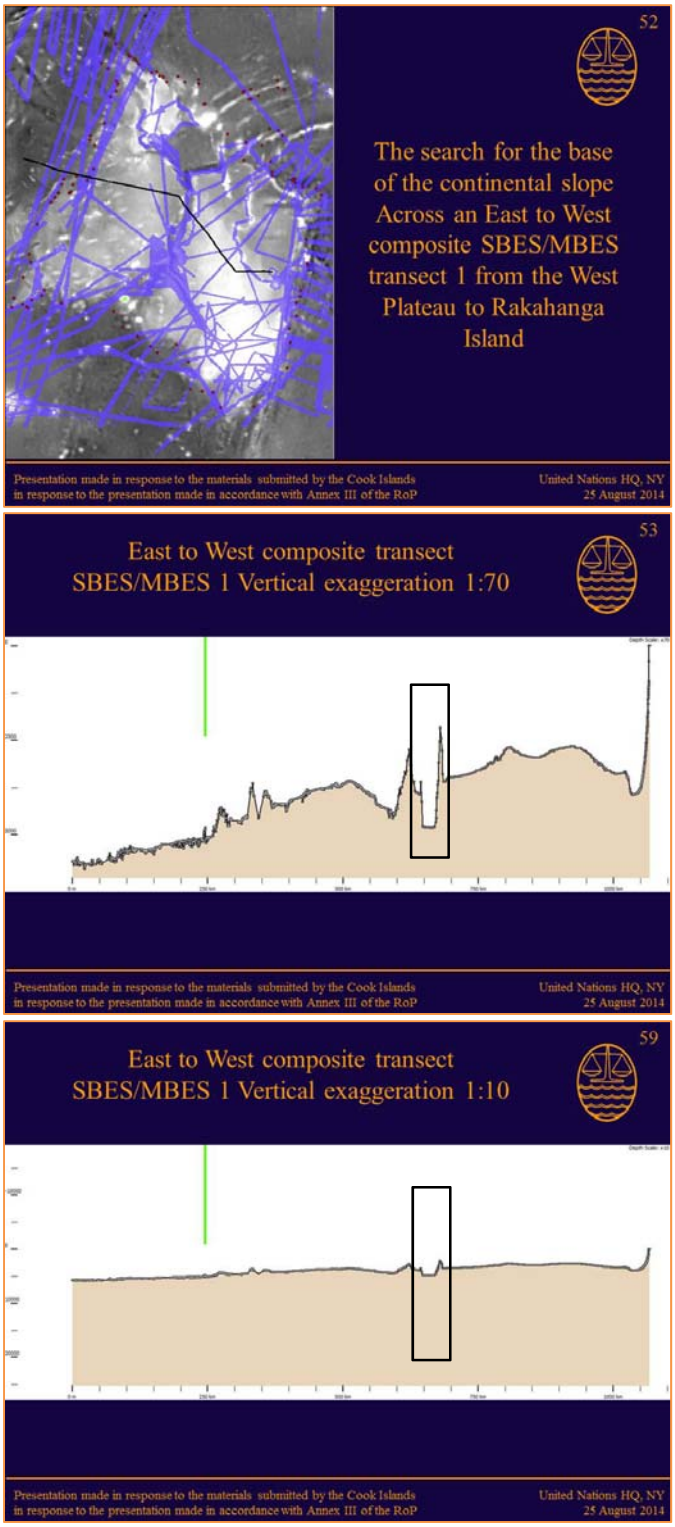


Figure 14: Examination of morphological continuity of the continental slope through bathymetric profiles at scales of 1:70 and 1:10 across the DIT between "bridges" located between the Western Plateaus and the High Plateau using a composite of SBES and MBES data only.

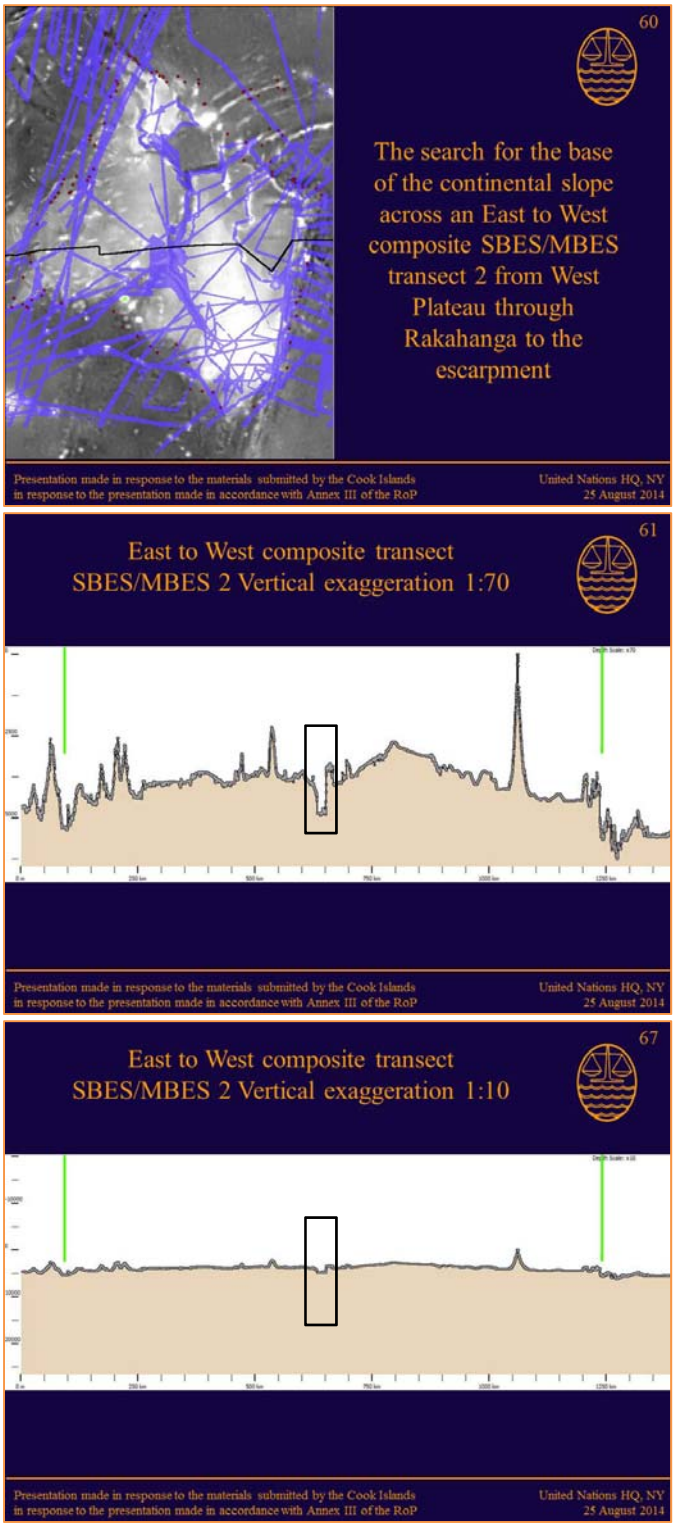


Figure 15: Examination of morphological continuity of the continental slope through bathymetric profiles at scales of 1:70 and 1:10 across the DIT between "bridges" located between the Western Plateaus and the High Plateau using a composite of SBES and MBES data only.

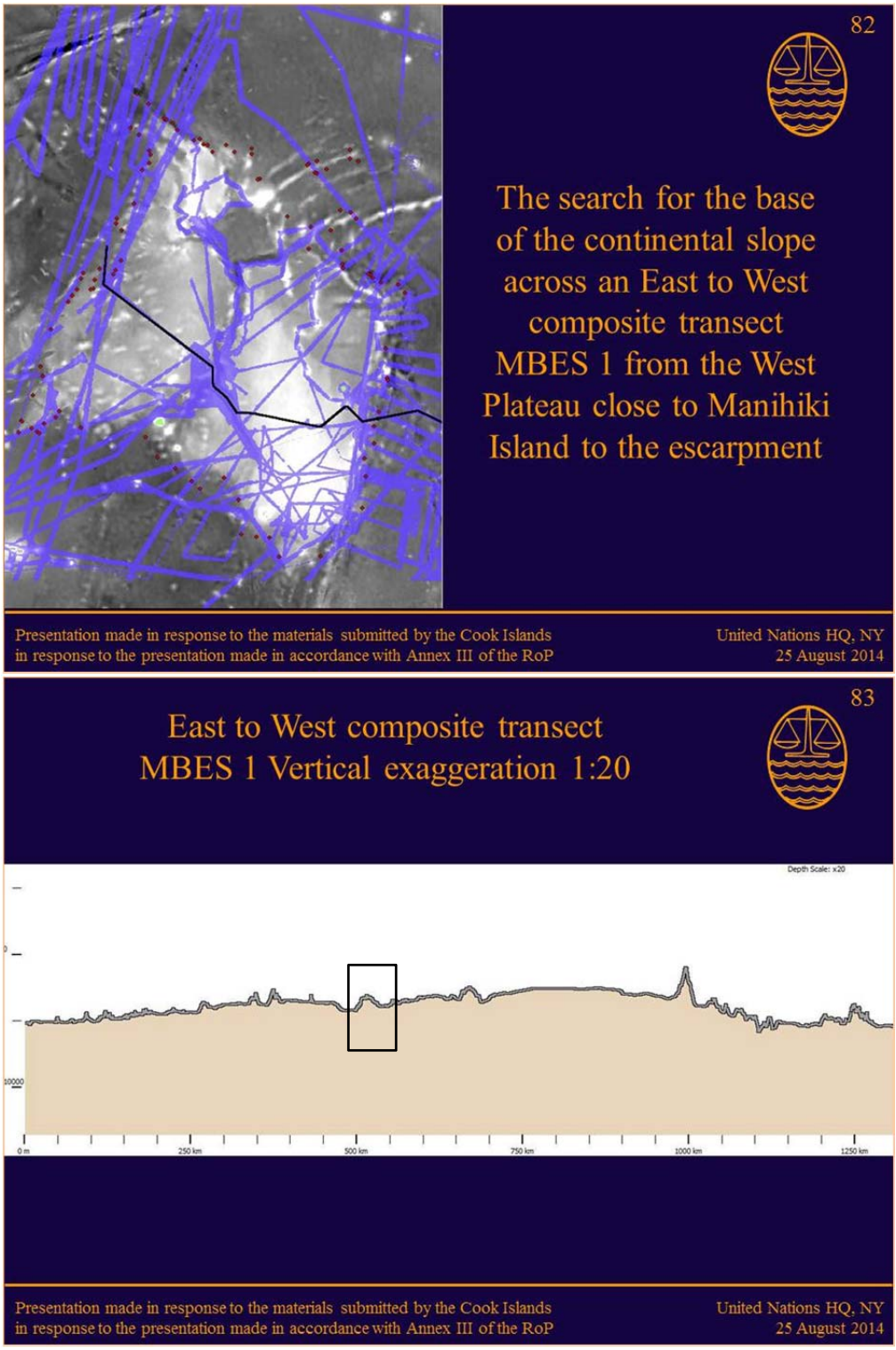


Figure 16a: Examination of morphological continuity of the continental slope through bathymetric profile at scale of 1:20 across the DIT along "bridges" located between the Western Plateaus and the High Plateau using MBES data only.

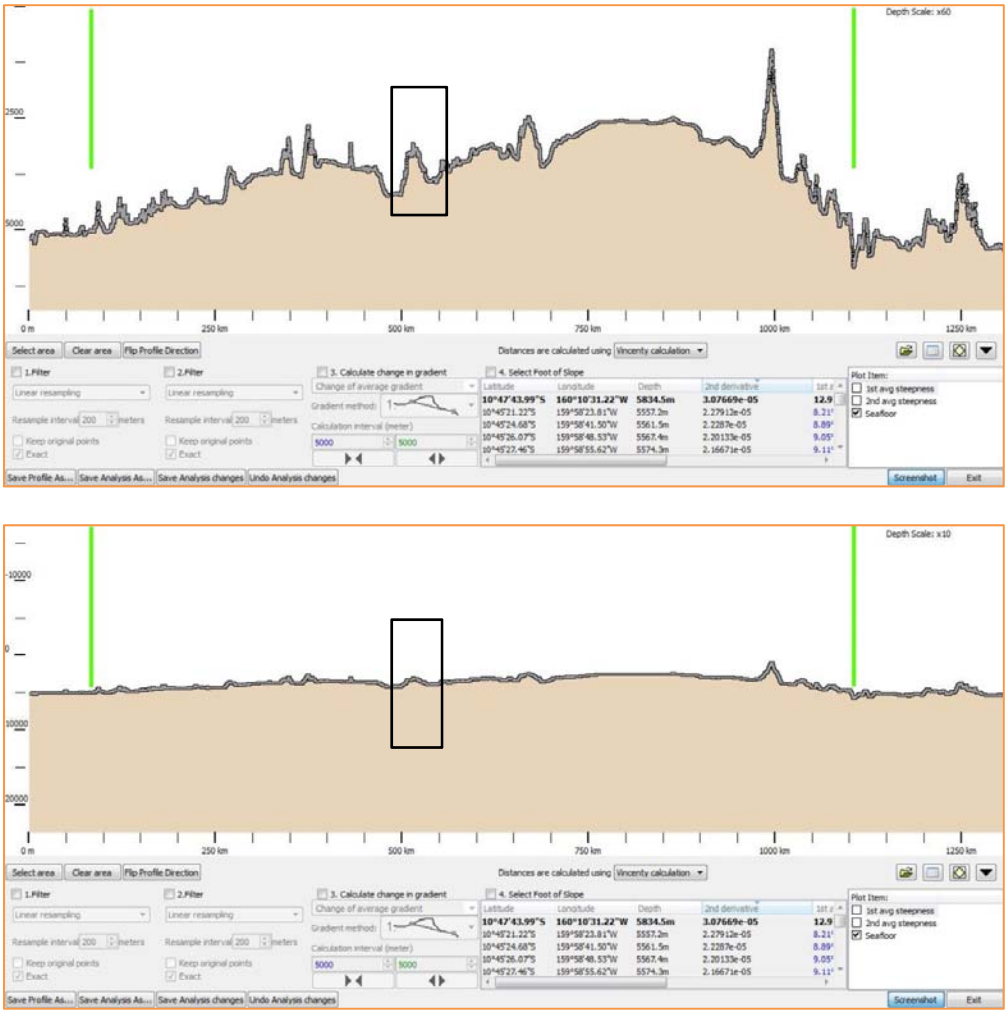


Figure 16b: Examination of morphological continuity of the continental slope through bathymetric profiles at scales of 1:60 and 1:10 across the DIT along "bridges" located between the Western Plateaus and the High Plateau using MBES data only.

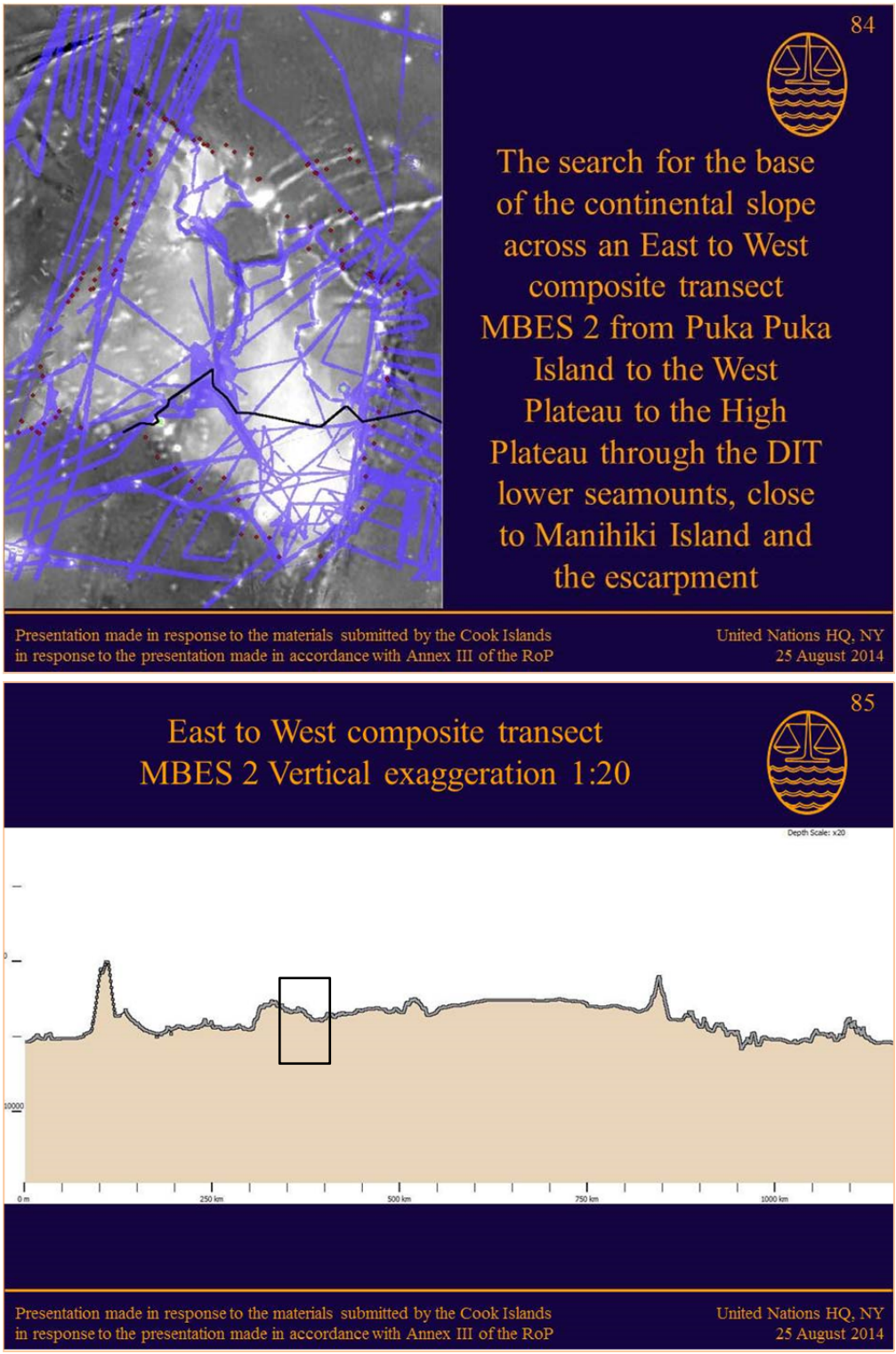


Figure 17a: Examination of morphological continuity of the continental slope through bathymetric profiles at scale of 1:20 across the DIT along "bridges" located between the Western Plateaus and the High Plateau using a composite of SBES and MBES data only.

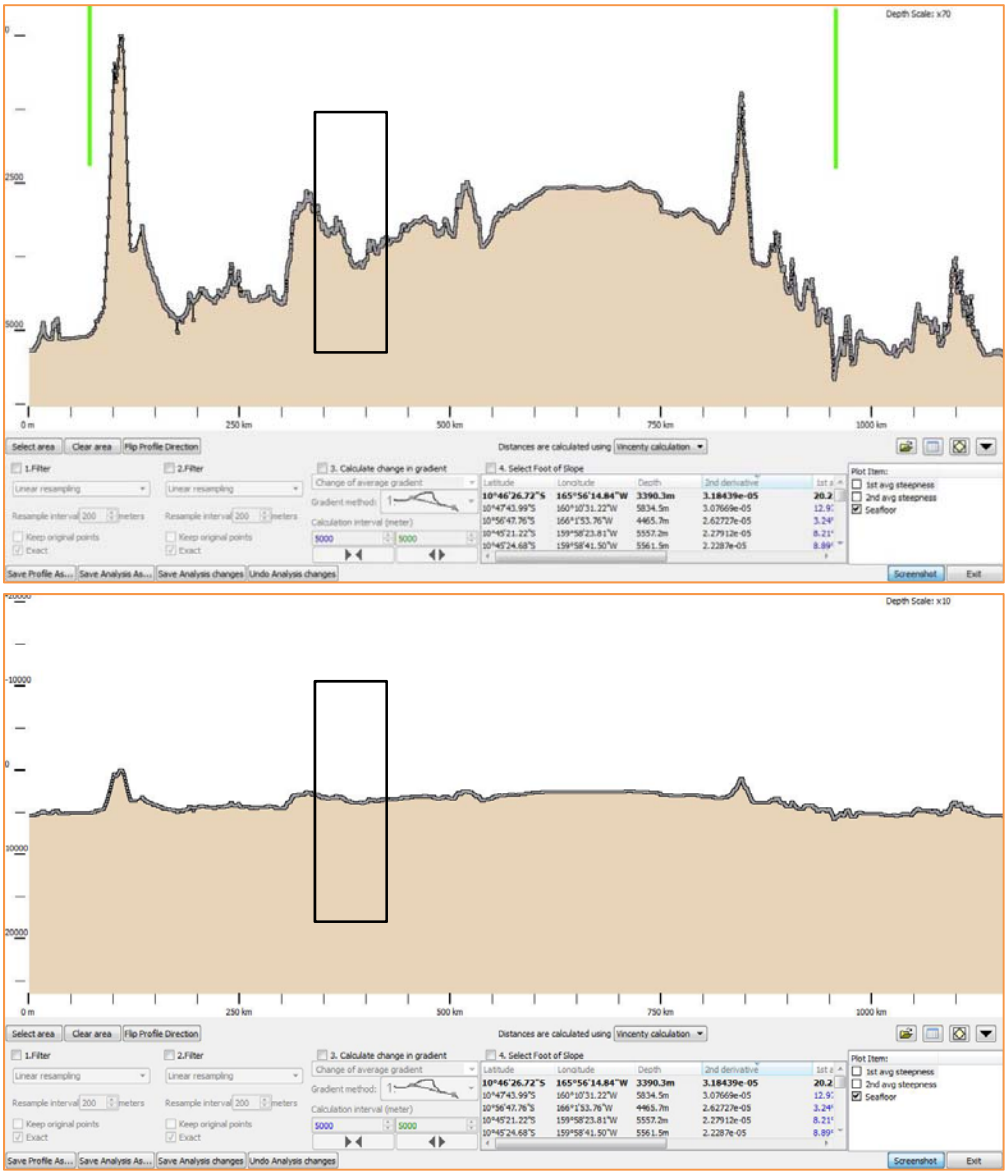


Figure 17b: Examination of morphological continuity of the continental slope through bathymetric profiles at scales of 1:70 and 1:10 across the DIT along "bridges" located between the Western Plateaus and the High Plateau using MBES data only.

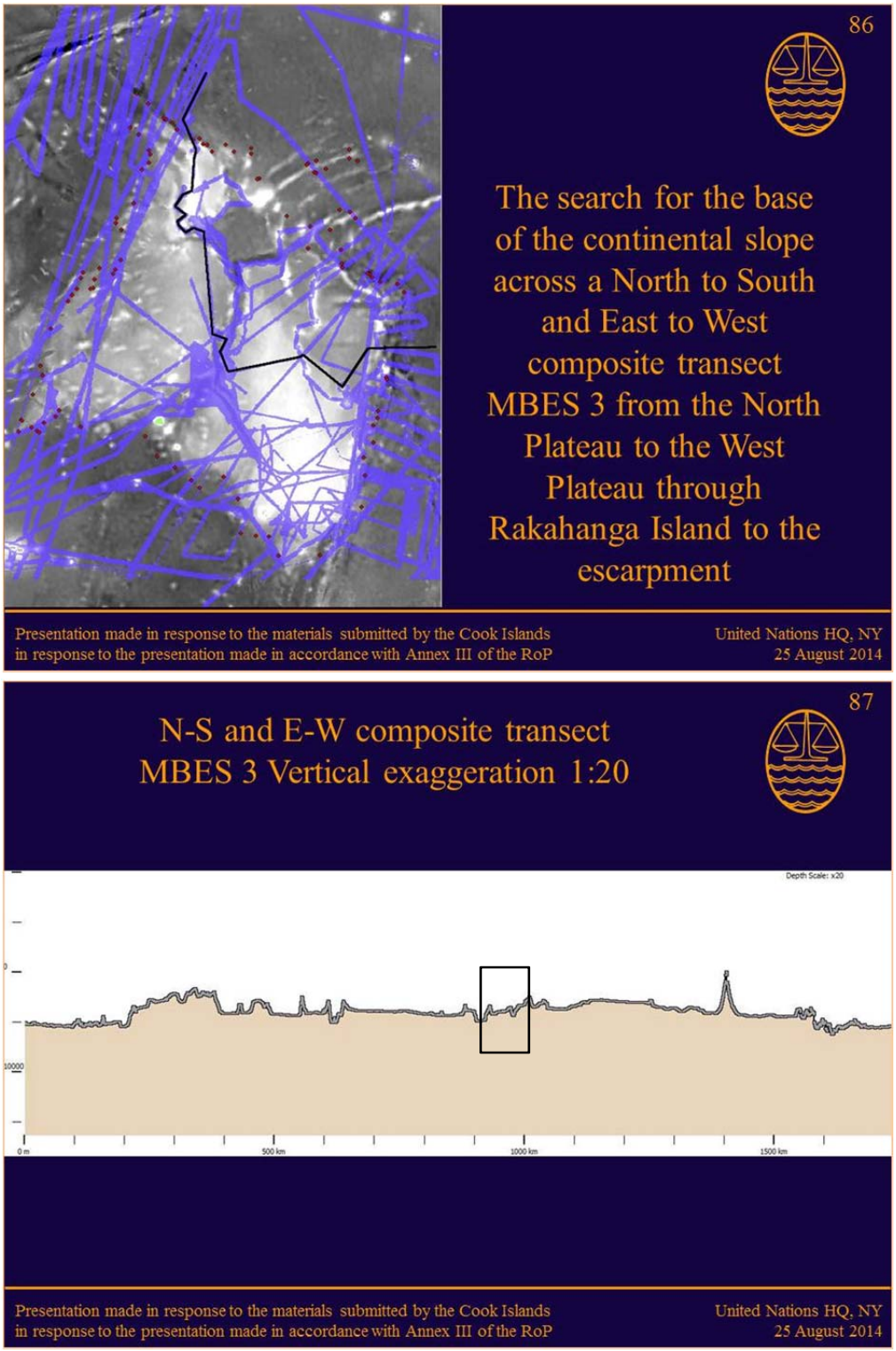


Figure 18a: Examination of morphological continuity of the continental slope through bathymetric profiles at scale of 1:20 across the DIT along "bridges" located between the North Plateau, the Western Plateaus and the High Plateau using MBES data only.

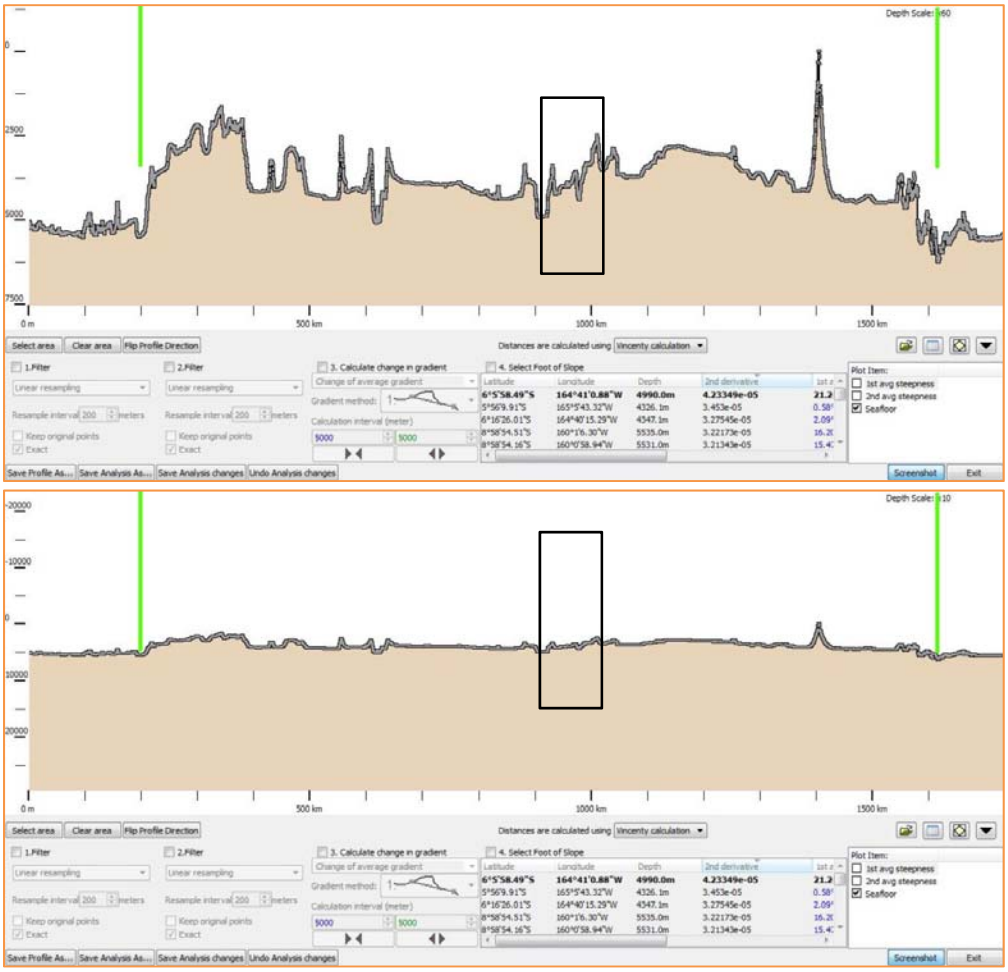


Figure 18b: Examination of morphological continuity of the continental slope through bathymetric profiles at scales of 1:60 and 1:10 across the DIT along "bridges" located between the North Plateau, the Western Plateaus and the High Plateau using MBES data only.

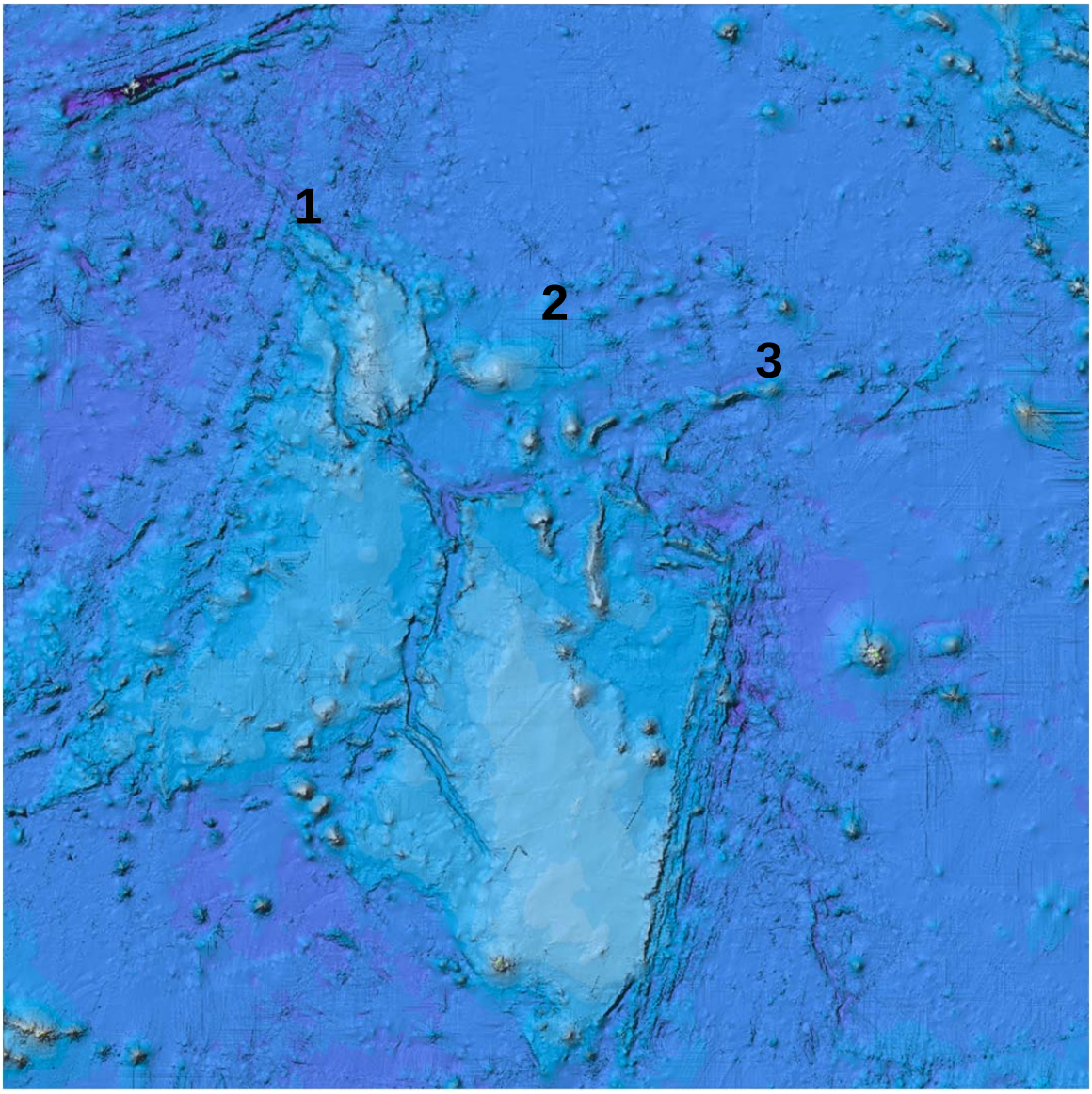


Figure 19: Northern seafloor highs contained in the Submission: 1: Tangaroa; 2: Avatea; and 3: Nganaoa.

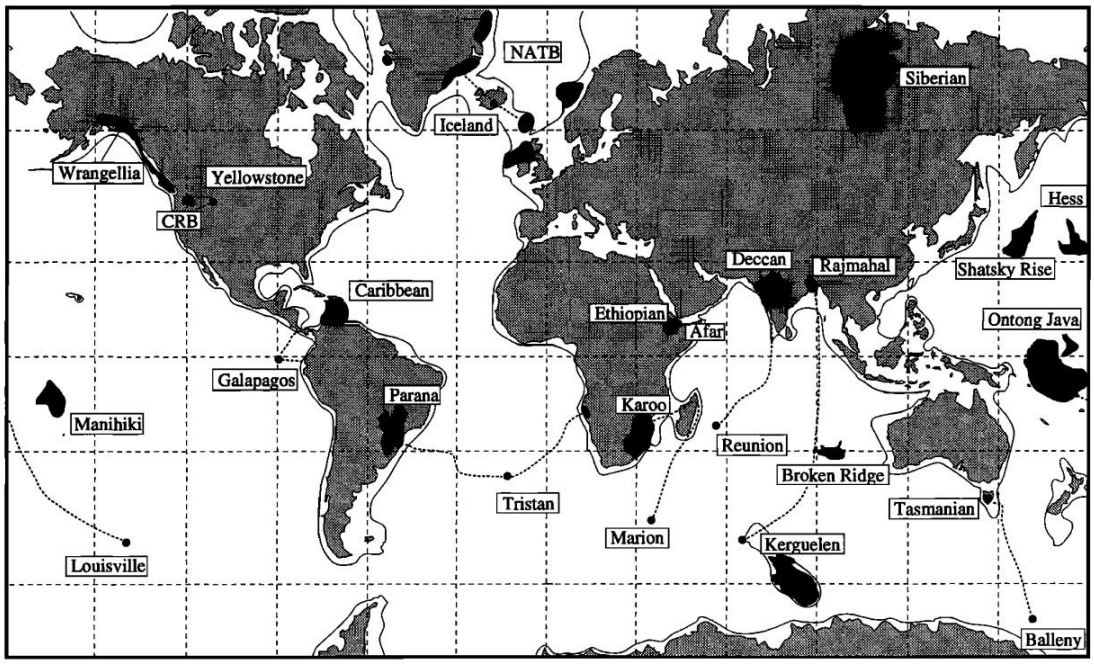


Figure 20: Map showing selected Large Igneous Provinces and associated hotspots (Figure 2.2 of the Main Body).

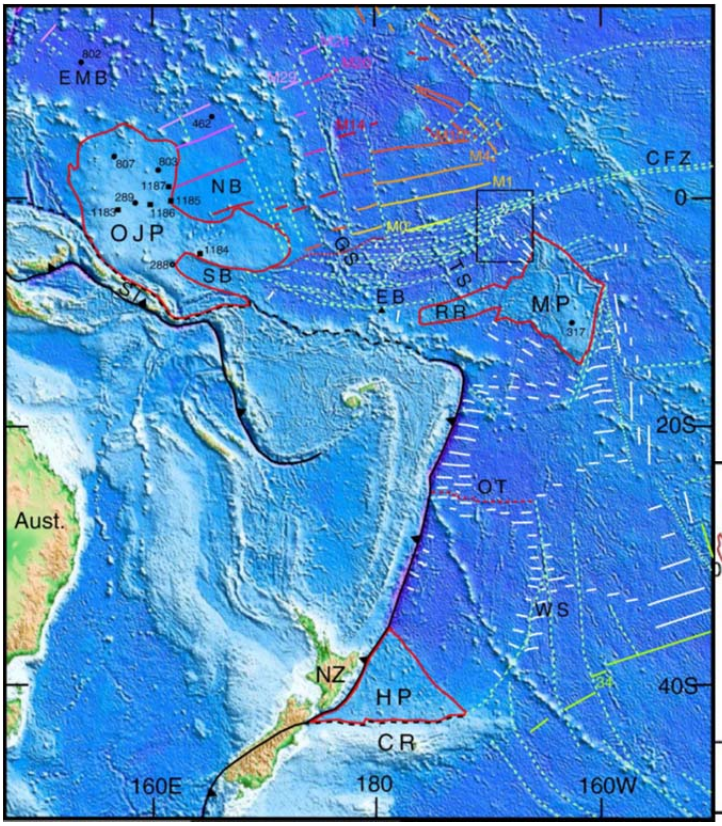
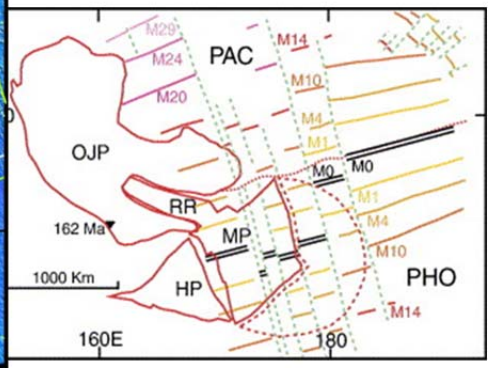


Figure 21: Left: Map showing the location (outlined in red) of the Ontong Java Plateau (OJP), Manihiki Plateau (MP) and Hikurangi Plateau (HP), together with other geographical and geological features in the region (Figure 2.11 of the Main Body).

Below: Reconstruction of the Ontong Java-Manihiki-Hikurangi Plateau (~125 Ma), before its break-up. Coarse dashed red line depicts possible former plateau east of MP (Figure 3 of Taylor (2006); inserted by the Subcommission).



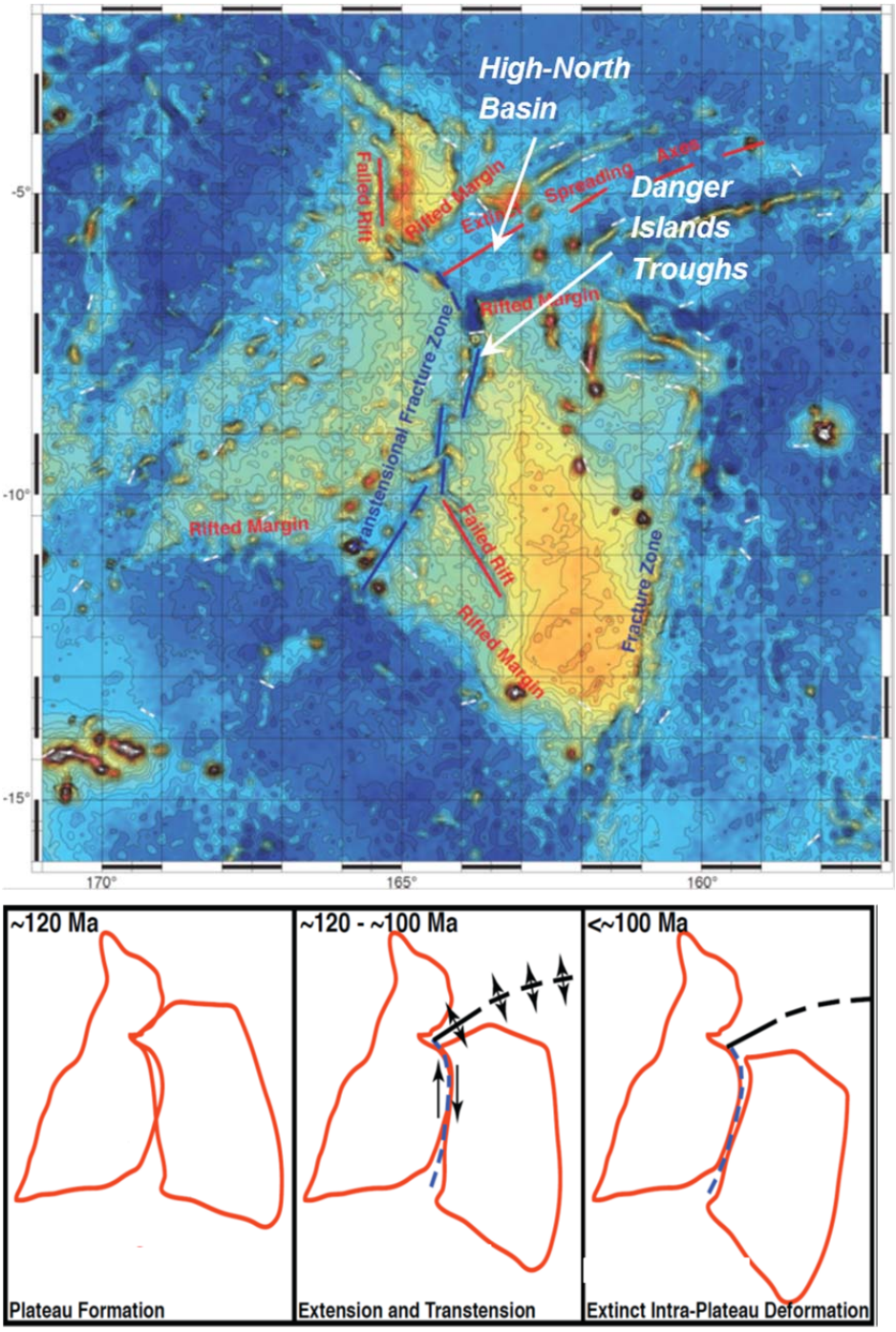


Figure 22: Tectonic model for post-emplacement deformation of the Manihiki Plateau. In this model, the High-North Basin probably formed by seafloor spreading and the right-lateral relict plate boundary continues uninterrupted to the south of the High-North Basin as the Danger Islands Troughs, which comprise a series of major *en echelon*, right-lateral faults that step to the right, producing extensional relay zones and pull-apart basins. Prepared by the Subcommission from Coffin et al., 2007.

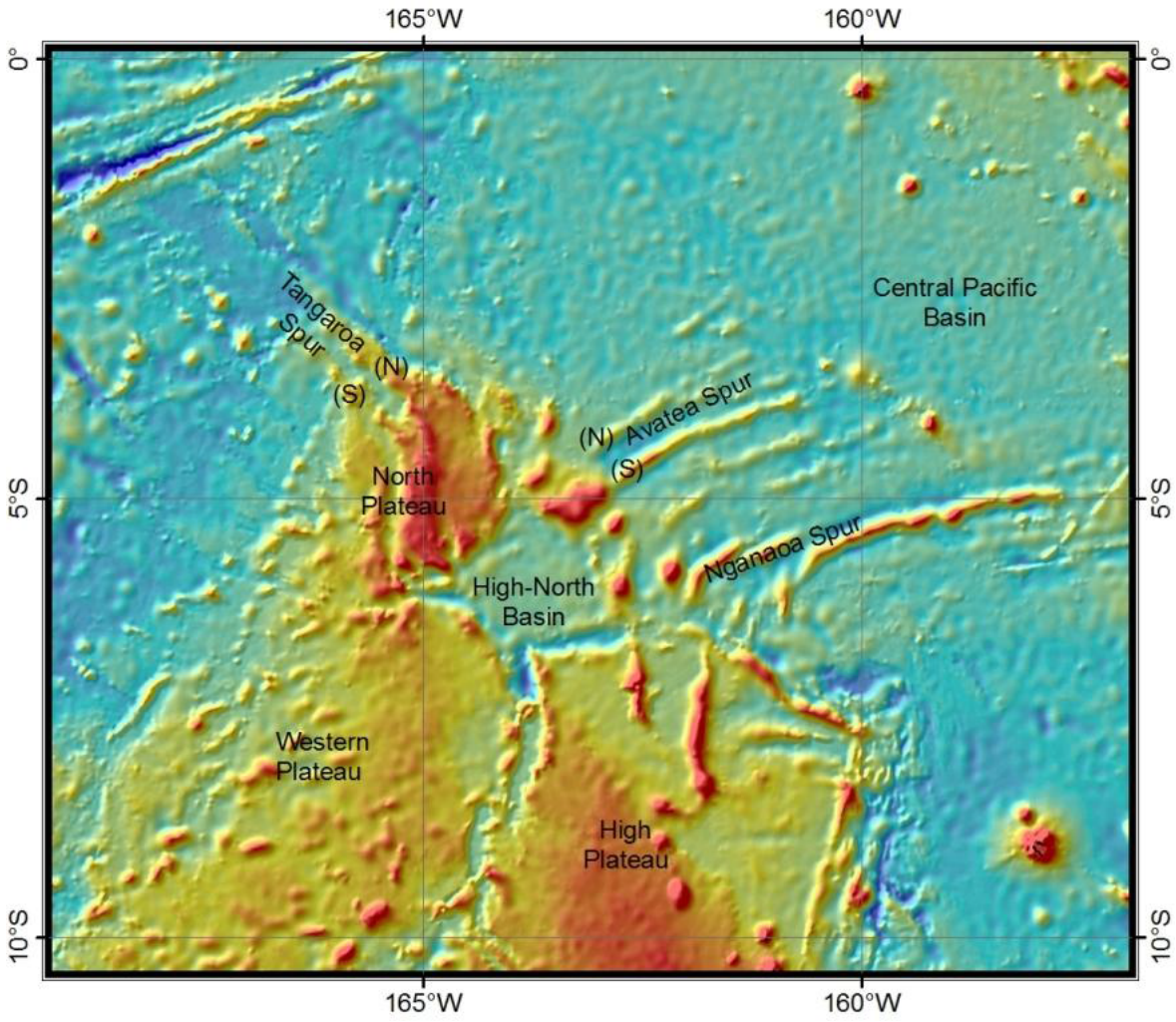


Figure 23: Sea floor features referred to as ‘spurs’ in the Main Body of Submission (Figure 2.6 of the Main Body).

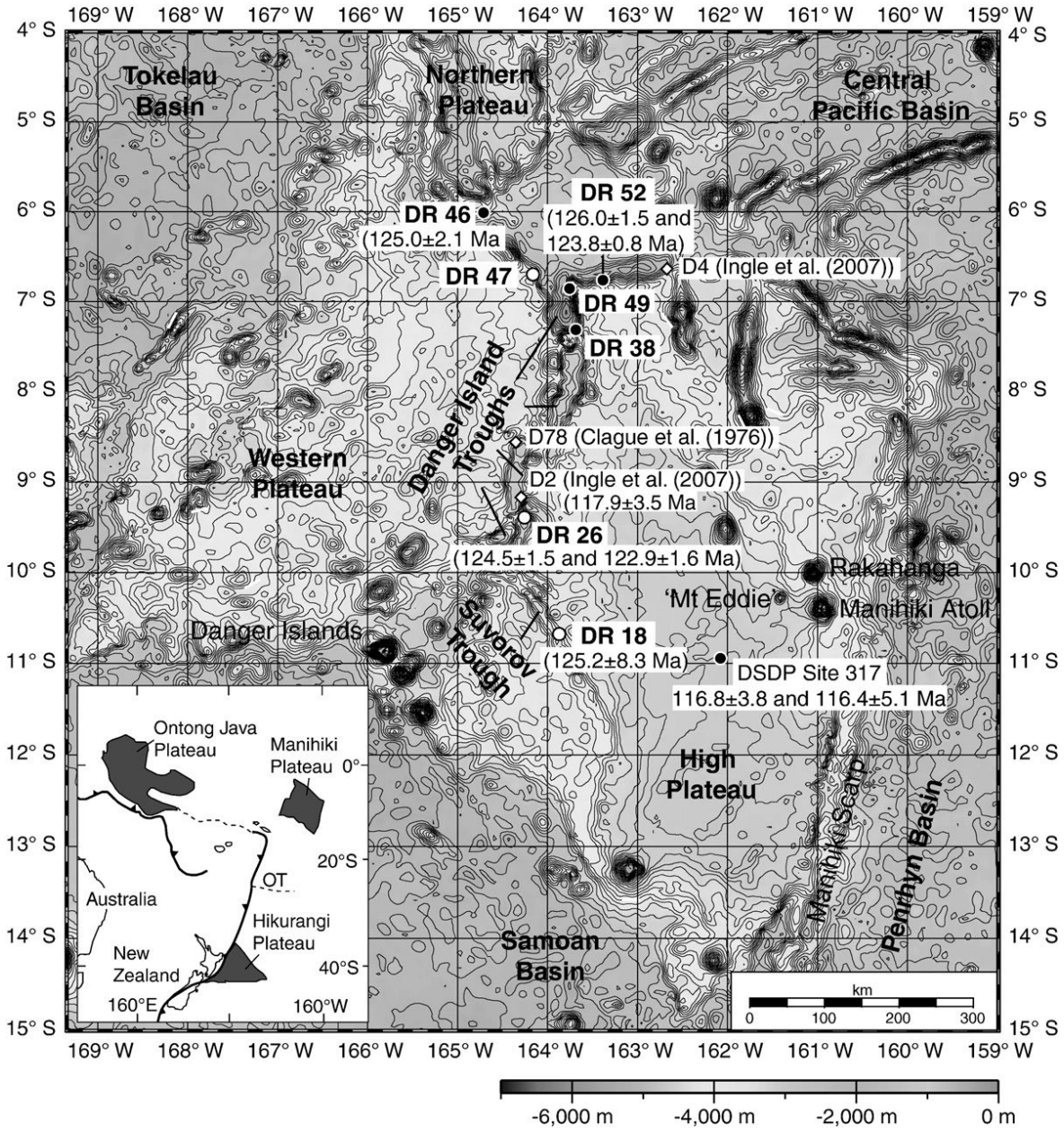


Figure 24: Geochronological samples with age dating from Timm et al. (2011) submitted in presentation by the Cook Islands (COK-PRES-04-27-02-2014).

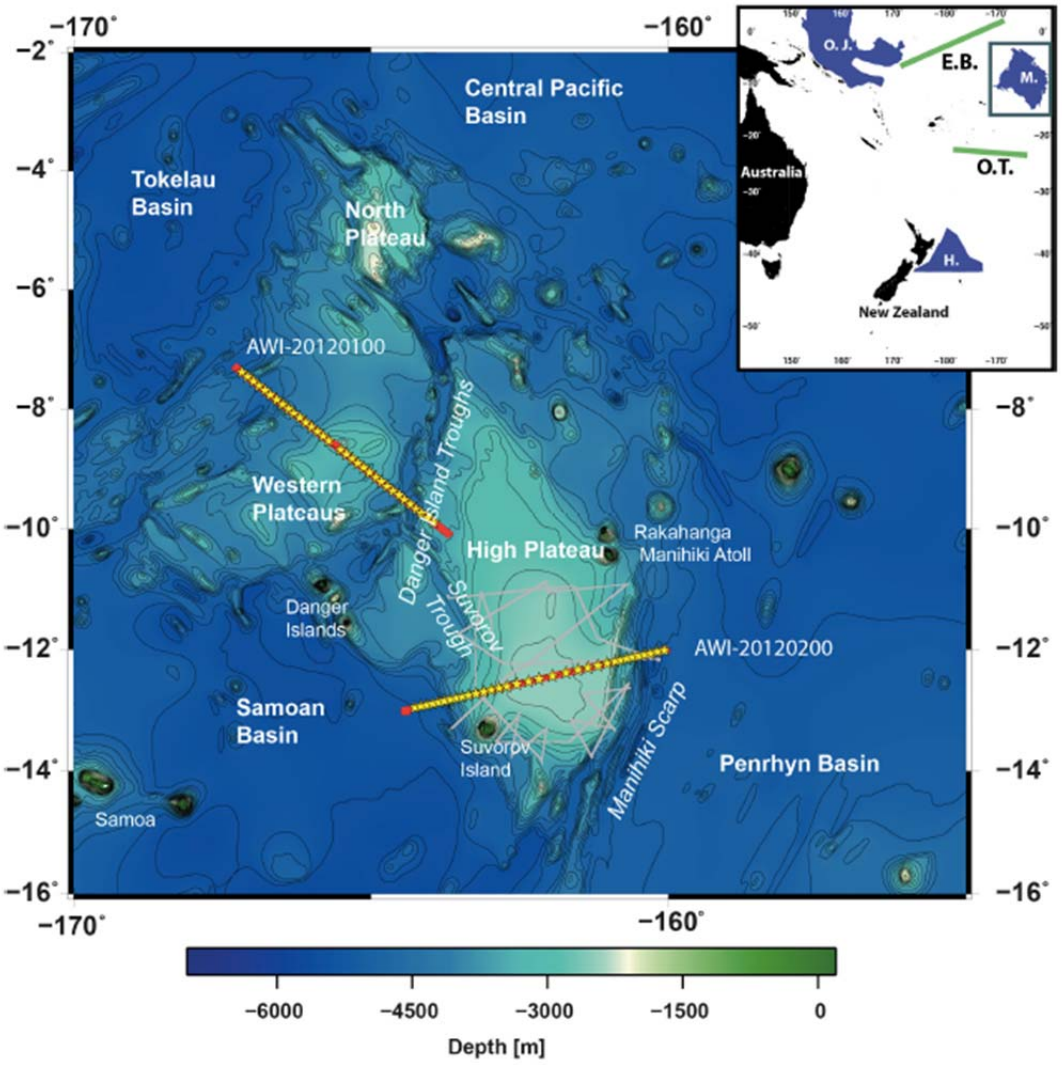


Figure 25a: Location map of seismic P wave velocity model of two deep crustal seismic refraction/wide-angle reflection lines, collected during SONNE cruise SO-224 in 2012, crossing the two main sub plateaus of the Manihiki Plateau: the Western Plateaus (AWI-20120100) and the High Plateau (AWI-20120200). Prepared by the Subcommission from Figure 1, 6 and 8 of Hochmuth et al. (2014), submitted by the Cook Islands in presentation COK PRES-04-27-02-2014, dated 27 February 2014, and presentation Coffin_Manihiki_CLCS_2014, dated 26 August 2014.

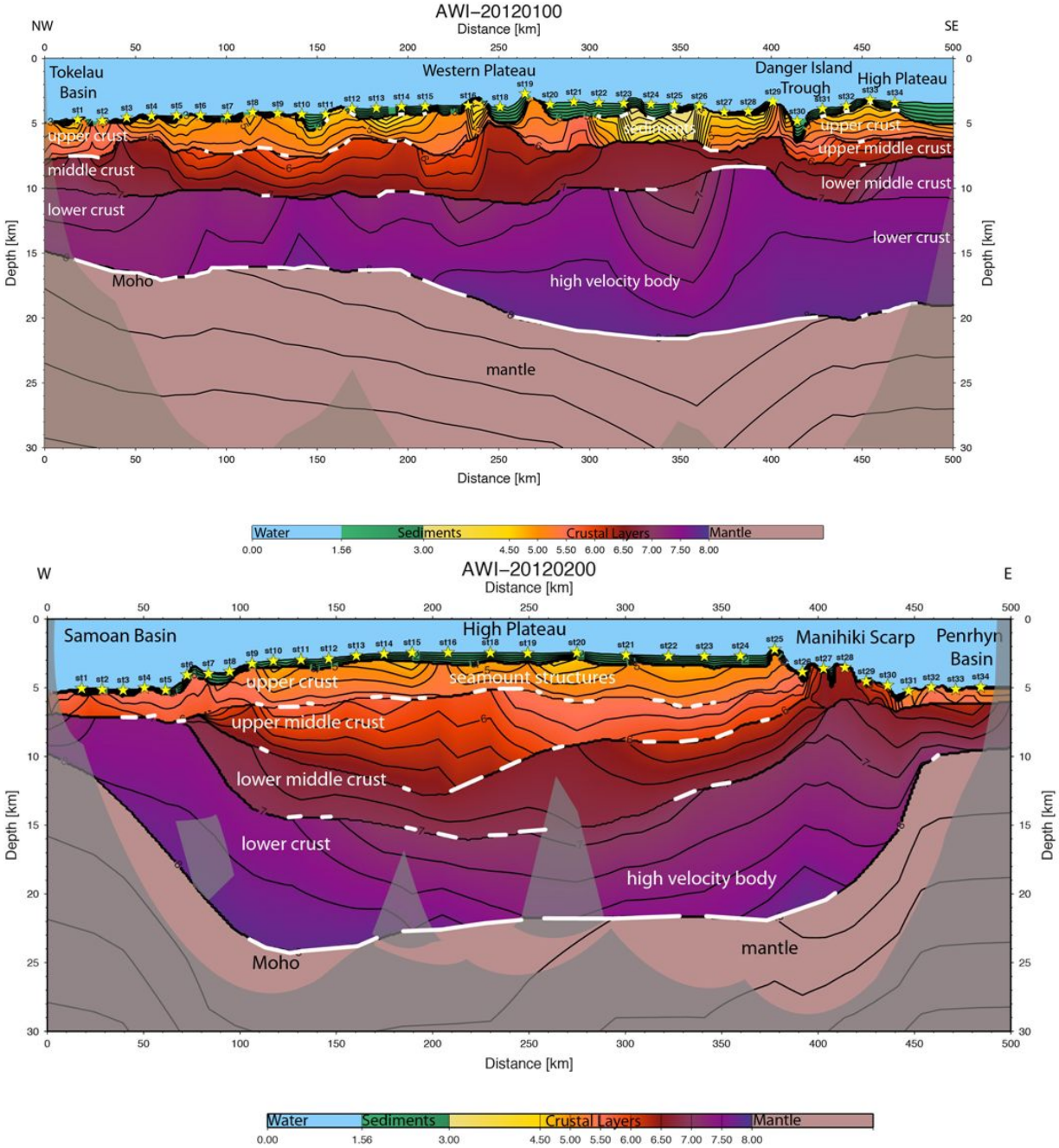


Figure 25b: Seismic P wave velocity model of two deep crustal seismic refraction/wide-angle reflection lines, collected during SONNE cruise SO-224 in 2012, crossing the two main sub-plateaus of the Manihiki Plateau: the Western Plateaus (AWI-20120100, above) and the High Plateau (AWI-20120200, below). Prepared by the Subcommission from Figure 1, 6 and 8 of Hochmuth et al. (2014), submitted by the Cook Islands in presentation COK-PRES-04-27-02-2014, dated 27 February 2014, and presentation Coffin_Manihiki_CLCS_2014, dated 26 August 2014.

REFERENCES

Coffin M.F., Werner R., Hauff F., Hoernle K., and F.S. Sonne 193 Scientific Party (2007). Extensional and Transtensional Tectonics of the Manihiki Plateau, Western Equatorial Pacific Ocean. AGU poster.

Hochmuth, K., Gohl, K., Uenzelmann-Neben, G., and Werner, R. (2014). The diverse crustal structure and magmatic evolution of the Manihiki Plateau, central Pacific, Solid Earth Discuss., 6, 1863-1905, doi:10.5194/sed-6-1863-2014.

Ryan, W.B.F., Carbotte, S.M., Coplan, J.O., O'Hara, S., Melkonian, A., Arko, R., Weissel, R.A., Ferrini V., Goodwillie, A., Nitsche, F., Bonczkowski, J., and Zemsky, R. (2009). Global Multi-Resolution Topography synthesis. Geochemistry, Geophysics, Geosystems, Volume 10, Number 3, Q03014, doi:10.1029/2008GC002332.

Timm, C., Hoernle, K., Reinhard, W., Hauff, F., van den Bogaard, P., Michael, P., Coffin, M. F., and Koppers, A. A. P. (2011). Age and geochemistry of the oceanic Manihiki Plateau, SW Pacific: new evidence for a plume origin, Earth Planet. Sc. Lett., 304, 135–146, 30 doi:10.1016/j.epsl.2011.01.025.

Uenzelmann-Neben, G. (2012): The expedition of the research vessel "Sonne" to the Manihiki Plateau in 2012 (So 224) , Berichte zur Polar- und Meeresforschung = Reports on polar and marine research, Bremerhaven, Alfred Wegener Institute for Polar and Marine Research, 656, 70 p. hdl: 10013/epic.40411 http://hdl.handle.net/10013/epic.40411.

Werner, R., Nürnberg, D., Hauff, F. and SO225 Shipboard Scientific Party (2013) RV SONNE Fahrtbericht/Cruise Report SO225, Manihiki II Leg 2, The Manihiki Plateau - Origin, structure and effects of oceanic plateaus and Pleistocene dynamic of the West Pacific warm water pool; 19.11.2012 - 06.01.2013, Suva/Fiji - Auckland/New Zealand GEOMAR Report, N. Ser. 006. GEOMAR Helmholtz -- Zentrum für Ozeanforschung, Kiel, Germany, 176 pp. DOI:10.3289/GEOMAR_REP_NS_6_2013.