[PS]Late Cretaceous Volcanism in Taranaki Basin: Examples from Seismic Reflection Data*

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Abstract

Volcanoes imaged in the subsurface can influence key aspects of a region's petroleum prospectivity through modification of factors such as heat flow, structural development, reservoir/seal quality, and distribution. Late Cretaceous volcanic centres associated with extension of the Zealandia continent and early rift basin evolution are known in several places onshore, and are being recognised increasingly in offshore areas as well. Petroleum exploration has targeted volcanic features, as evidenced by Kora-1 (Miocene oil discovery) and by the recent Romney-1 well in deep-water Taranaki. A good understanding of volcanic geological history, morphology, volcaniclastic paleo-environments and overall controls on potential reservoir/seal facies distribution and fluid migration pathways is clearly critical to improving the efficacy of future exploration of such plays.

Using 2D and 3D seismic data we have identified over 100 subsurface igneous bodies of varying age in New Zealand's northwestern province. In this poster, we illustrate five of the largest and best-defined Cretaceous volcanic complexes by means of a seismic composite line tied to the Romney-1 and Tane-1 petroleum exploration wells and time horizon maps using all available openfile seismic data. The seismic imaging, horizon interpretation of stratal relationships and age control from the wells indicates that there were multiple stages of volcanic activity during Late Cretaceous. The latest active period being about 75-71 Ma and the largest of the volcanoes being 73-72 Ma in age and comparable in size to Ruapehu-Tongariro Volcano Complex (40x60 km). We also observe an age trend in volcanism from north (older) to south (younger). Our results provide new information on the timing, scale, and geographic extent of likely Latest Cretaceous rift-related volcanism within the northwestern Zealandia.

Selected References

GNS Science Consultancy Report 2013/147, GNS Science Basin Screening Series: Deepwater Taranaki and Reinga-Northland Basins.

PR report 4951 Romney-1 Well Completion Report

Strogen, D.P., and P.R. King, 2014, A New Zealandia-Wide Seismic Horizon Naming Scheme: GNS Science, Lower Hutt, N.Z., GNS Science Report 2014/34, 20 p.

Late Cretaceous volcanism in Taranaki Basin: examples from seismic reflection data

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Summary and Conclusion

Volcanoes imaged by seismic data in the subsurface can influence key aspects of a region's petroleum prospectivity through modification of factors such as heat flow, structural development, reservoir/seal quality and distribution. Late Cretaceous volcanic centres associated with extension of the Zealandia continent and early rift basin evolution are known in several places onshore, and are being recognised increasingly in offshore areas as well. Petroleum exploration has targeted volcanic features, as evidenced by Kora-1 (Miocene oil discovery) and by the recent Romney-1 well in Deepwater Taranaki Basin. A good understanding of volcanic geological history, morphology, volcaniclastic paleo-environments and overall controls on potential reservoir/seal facies distribution and fluid migration pathways is clearly critical to improving the efficacy of future exploration of such plays.

Using 2D and 3D seismic data we have identified over 100 subsurface igneous bodies of varying age in New Zealand's Northwest Province. In this poster we illustrate five of the largest and best-defined Late Cretaceous volcanic complexes by means of a 2D seismic composite line tied to the Romney-1 and Tane-1 petroleum exploration wells and time horizon maps using all available openfile seismic data. The seismic imaging, horizon interpretation of stratal relationships and age control from the wells indicates that there were multiple stages of volcanic activity during the Late Cretaceous. The latest active period was c. 74-70 Ma, and the largest of the volcanoes being c. 73-72 Ma in age and comparable in size to Ruapehu-Tongariro Volcano Complex (40x60 km). We also observe an age trend in volcanism from north (older) to south (younger). Our results provide new information on the timing, scale and geographic extent of likely Latest Cretaceous rift-related volcanism within northwestern Zealandia.

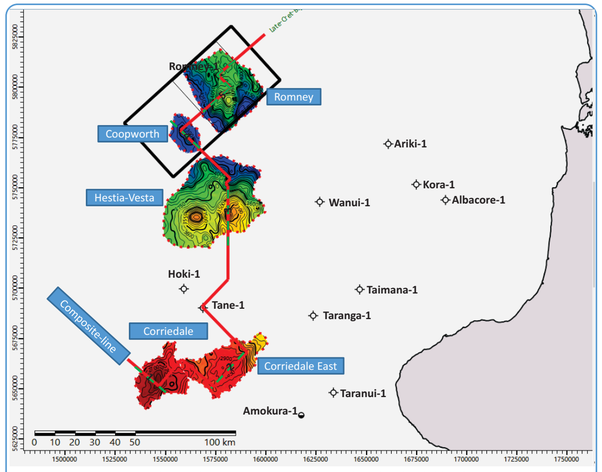


Figure 1. Location map shows the 2D seismic composite line (Red solid line) connecting the Late Cretaceous volcanic bodies in Taranaki Basin. Black rectangle box is 3D Romney Survey, dashed green lines are enlarged sections 1-5 (see Figure 6-10), red-dotted lines are the outlines of interpreted Late Cretaceous volcanoes. The contour lines (TWT in ms) show the volcanic reflector tops (Note: All volcanoes named after associated petroleum exploration prospects. See Reference 3).

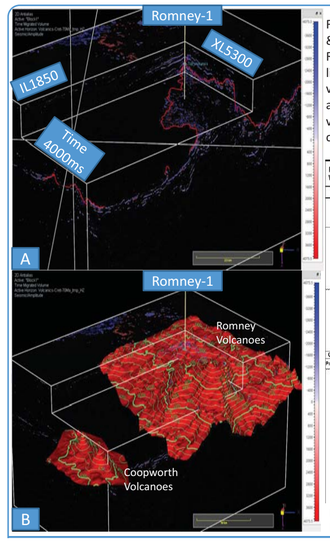


Figure 3. Late Cretaceous volcanic interpretation & 3D seismic clipped amplitude display at Romney Area (A. 3D Romney chair display. Red line is interpreted outline of Late Cretaceous volcanics based on clipped amplitude; B. In same area, red surface shows the 3D display of the volcanics topography and green lines are the contours of TWT at 50 ms interval).

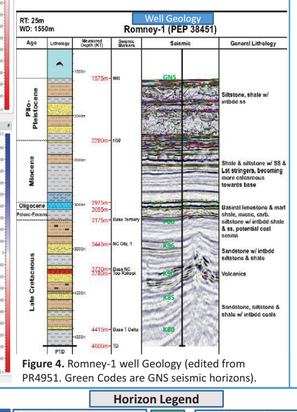


Figure 4. Romney-1 well Geology (edited from PR4951. Green Codes are GNS seismic horizons).

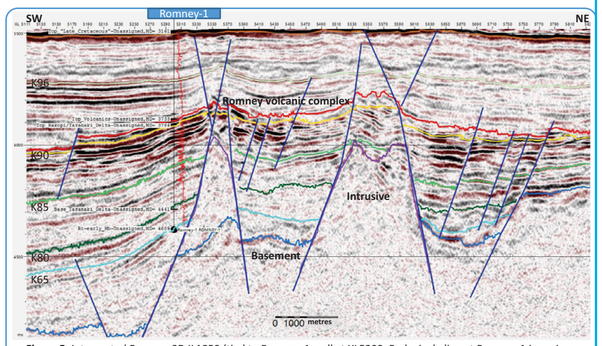


Figure 5. Interpreted Romney 3D IL1850 (tied to Romney-1 well at XL5300. Red wiggle line at Romney-1 is sonic log). Seismic horizon codes refer to Figure 2.

Summary of volcanic size and age relations

Two phases of volcanic activity (85-80? & 74-70 Ma) were observed based on well data, seismic imaging and horizon interpretation of stratal relationships . A summary of five studied volcanoes is listed below:

- Romney volcanic complex is about 32x35 km in size with moderate relief (TWT 220 ms and c. 500 m); active between 74-73 Ma and some cones with fault related deep-rooted intrusion;
- Coopworth volcanoes are about 12x20 km in size with evidence for two phases of activity: phase-1 occurred at about c. 85? Ma with high relief of c. 1200-1500 m (TWT 500-600 ms) after deposition of seismic horizon K65 (88 Ma?); phase-2 occurred at c. 73 Ma with low relief of c. 200-300 m. The volcanoes have two main vents;
- Hestia-Vesta volcanoes are about 40x60 km in size with evidence for two phases of activity: phase-1 occurred at about 81? Ma; phase-2 occurred at c. 72 Ma with high relief of c. 1500 m (TWT 700 ms). The seismic imaging shows multiple vents and intrusions;
- Corriedale-East volcanic field is about 20x40 km in size with multiple small cones and was active ~70 Ma with moderate relief (c. 500 m);
- Corriedale volcanic complex is about 20x27 km in size with one main and a few smaller cones active ~ 70 Ma; it has moderate relief of ~500 m (TWT 230 ms). The main volcanic cone has gone through a long period of erosion (c. 5 My). During the early Paleocene, it became submerged under the sea undergoing wave based erosion. Seismic imaged the intrusive under the volcanic complex.

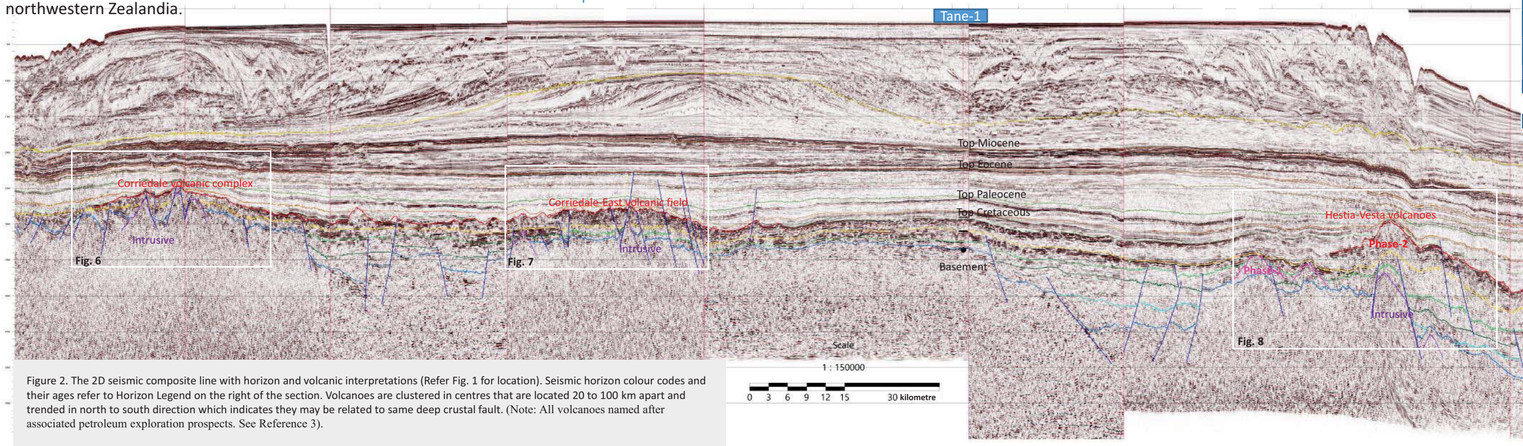


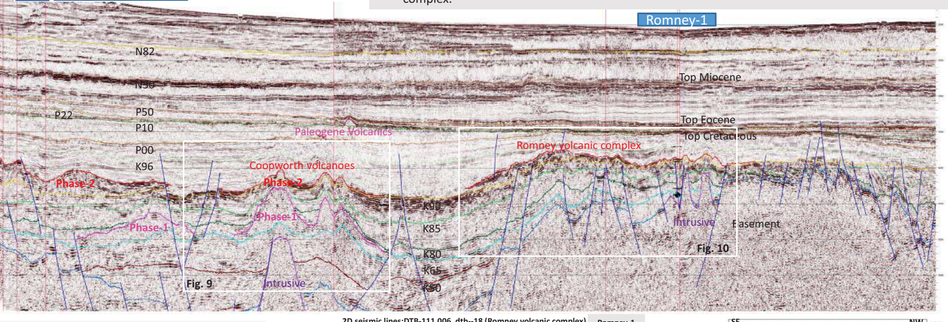
Figure 2. The 2D seismic composite line with horizon and volcanic interpretations (Refer Fig. 1 for location). Seismic horizon colour codes and their ages refer to Horizon Legend on the right of the section. Volcanoes are clustered in centres that are located 20 to 100 km apart and trended in north to south direction which indicates they may be related to same deep crustal fault. (Note: All volcanoes named after associated petroleum exploration prospects. See Reference 3).

Horizon Legend

Seabed	K85 (~80 Ma?)
N82 (~2 Ma)	K80 (~83 Ma?)
N50 (~7 Ma)	K65 (~88 Ma?)
P50 (~30 Ma)	K50 (~95 Ma?)
P22 (~48 Ma)	Basement
P10 (~56 Ma)	Paleogene Volcano
P00 (~66 Ma)	Phase-2 Volcano (74-70 Ma)
K96 (~68 Ma)	Phase-1 Volcano (85-80 Ma)
K90 (~74 Ma)	Igneous Intrusive

Fault Legend

Normal Faults



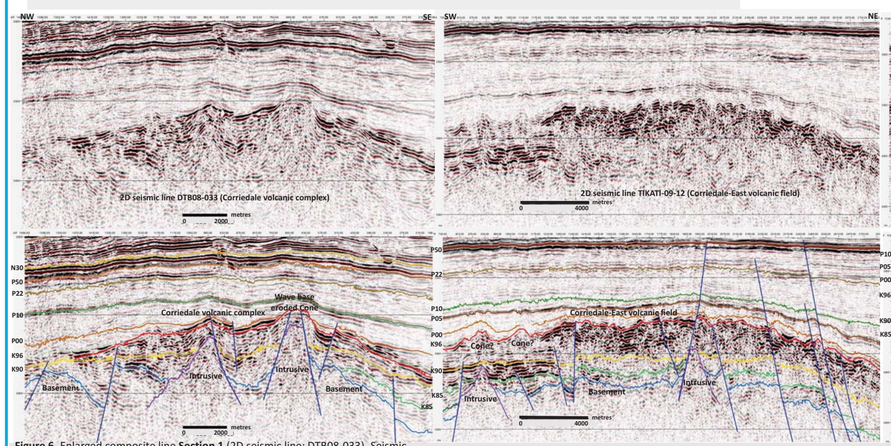


Figure 6. Enlarged composite line **Section 1** (2D seismic line: DTB08-033). Seismic horizon K96 (68 Ma) and P00 (66 Ma) onlap the top of volcanics. The shape of the volcanic cone indicates possible wave base erosion from latest Cretaceous to early Paleocene.

Figure 7. Enlarged composite line **Section 2** (2D seismic line: TIKATI-09-12). Seismic horizon K96 (68 Ma) onlaps the top of volcanic field at far left. The low relief and high amplitude volcanic reflector at top of volcanic field indicates lava flows.

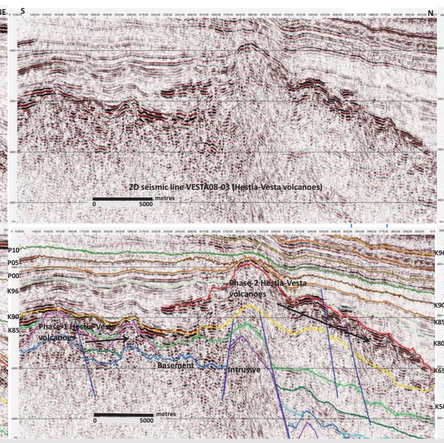


Figure 8. Enlarged composite line **Section 3** (2D seismic line: VESTA08-03). There are two phases of volcanic activity. Phase-1 occurred before deposition of horizon K85 (80 Ma) and phase-2 occurred before deposition of horizon K96 (68 Ma).

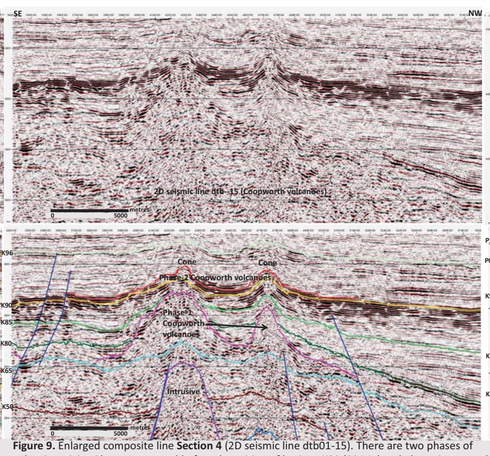


Figure 9. Enlarged composite line **Section 4** (2D seismic line dtb01-15). There are two phases of volcanic activity. Phase-1 occurred before deposition of horizon K80 (83 Ma) and phase-2 occurred just after deposition of horizon K90 (74 Ma). The evolution of the two phases of volcanic activity is displayed in Fig. 11

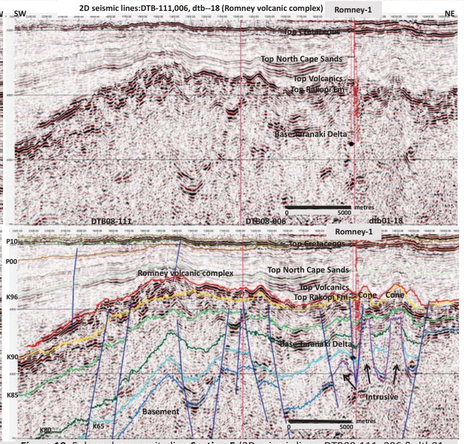


Figure 10. Enlarged composite line **Section 5** (2D seismic lines: DTB08-111, 006 & dtb01-18). Romney-1 well drilled on the side of volcanic cone and penetrated c. 50 m of clastic volcanics which is overlaying coaly Rakopi Formation (early Mh). Seismic shows that the volcanism occurred just after deposition of horizon K90 (74 Ma).

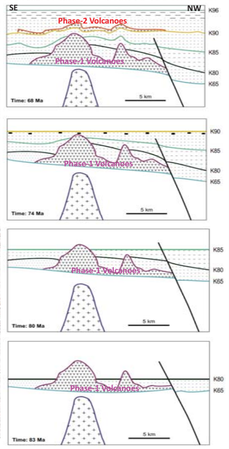


Figure 11. A cartoon diagram shows the evolution of Coopworth Volcanoes (Refer to Fig. 9) from 83 Ma to 68 Ma.

References: 1) PR report 4951 Romney-1 Well Completion Report; 2) GNS Science Report 2014/34 A New Zealand-wide seismic horizon naming scheme; 3) GNS Science Consultancy Report 2013/147 GNS Science basin screening series: Deepwater Taranaki and Reinga-Northland basins.

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