3D Canterbury Velocity Model (CantVM) – Version 1.0

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1. Background and Objective

This poster presents an overview of a new 3D seismic velocity model of Canterbury, New Zealand (CantVM). The model has been specifically developed to provide the 3D crustal structure in the region at multiple length scales for seismic wave propagation simulations, both broadband ground motion and more localized shallow site response analyses.

Figure 1a illustrates the 10 major earthquake events (Mw4.7-7.1) recorded at strong motion stations in the region which have been used in examining the models features (Razafindrakoto et al. 2015)

Multiple datasets were used to develop geologic surfaces and material velocities, as depicted in Figure 1b.

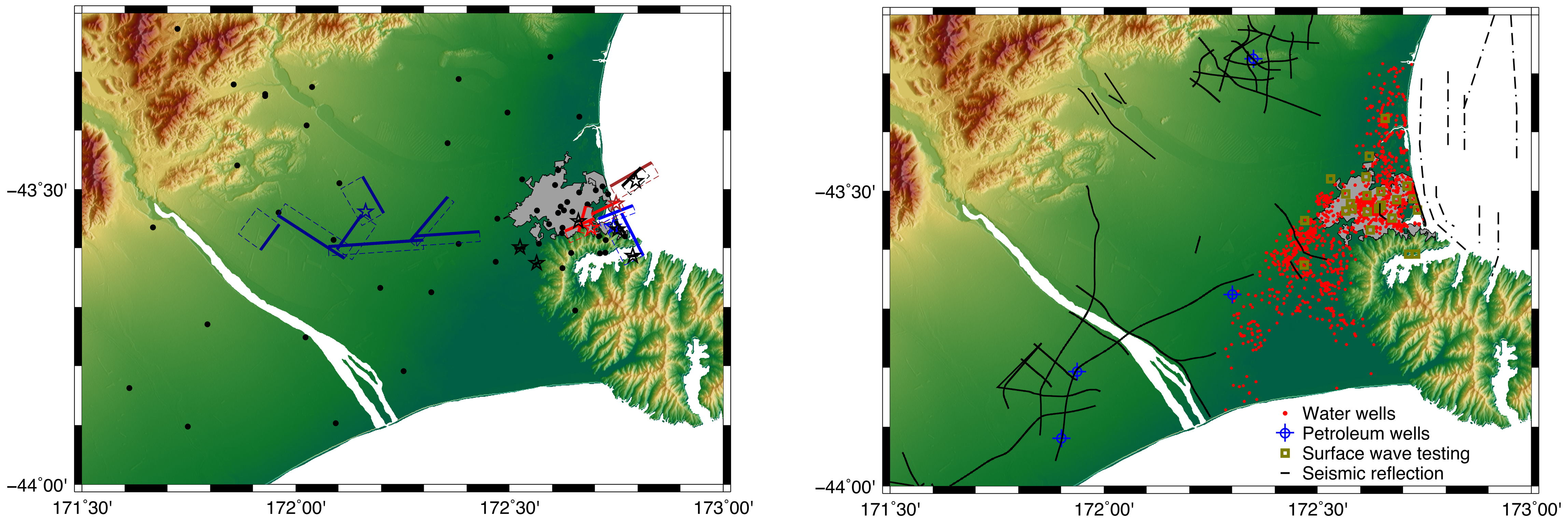

Figure 1: (a) The Canterbury region in the context of the 10 major events (Mw4.7-7.1) in the 2010-2011 Canterbury earthquake sequence and strong motion stations; (b) Data sources used in the development of the Canterbury Velocity Model (CantVM).

2. Modelled geologic surfaces

The 3D velocity model adopts a surface-based methodology in which velocity variations are individually prescribed within different geologic units. Table 1 illustrates the various geologic surfaces considered, and the regional units that comprise them. A total of 8 different units are considered (column 1), and the Quaternary unit is further differentiated into 10 different units for high-resolution representation of the shallow structure.

- Seismic reflection profiles and petroleum well logs over the past 50 years (Figure 1b) are the principal means by which the considered units were developed over the Canterbury region.
- Existing reflection profiles were reinterpreted to identify the critical seismic facies representing important lithological changes, e.g. using 3 units for the Miocene because of the strong impedance constrasts for the Miocene volcanics, yet only a single unit for the Paleogene.
- Figure 2 illustrates the considered seismic reflection profiles and one of the deeper geologic surfaces. Figure 3 illustrates the interbedded shallow Quaternary surfaces over the coastal Christchurch area.

Table 1: Modeled geologic units in the Canterbury Velocity Model (CVM)

CVM Unit	Period	Epoch	Waipara	Ashley	Christchurch	South Rakaia
Quaternary	Quaternary	Holocene Pleistocene	Canterbury gravels			
Pliocene	Neogene	Pliocene	Kowai Fm.			
Upper Miocene		Miocene	Tokama Siltstone/Mt Brown Fm.	Undiff	Undiff	Tokama Siltstone
Miocene Volcanics			Waikari Fm.	Starvation Hill Basalts	Banks Peninsula Vol. Group	Waikari Fm.
Lower Miocene				Undiff	Undiff	
Paleogene	Paleogene	Oligocene	Amuri and Otekaike Limestone			
		Eocene	Homebush Sandstone			
			Ashley Mudstone		View Hill Vol. Group	Ashley Mudstone
		Paleocene	Loburn Mudstone / Waipara Greensand Fm.			Loburn Mudstone
Late Cretaceous	Late Cretaceous	Late Cretaceous	Conway Fm. / Broken River Fm.		Conway Fm. / Broken River Fm.	
					Mt Somers Vol. Group	
Basement	Jurassic/ Triassic	Torlesse composite terrane (Greywackes)				

Period	Christchurch
Holocene	Springston Fm.
	Christchurch Fm.
Pleistocene	Riccarton Gravels
	Bromley Fm.
	Linwood Gravels
	Heathcote Fm.
	Burwood Gravels
	Shirley Fm.
	Wainoni Gravels
	Undiff

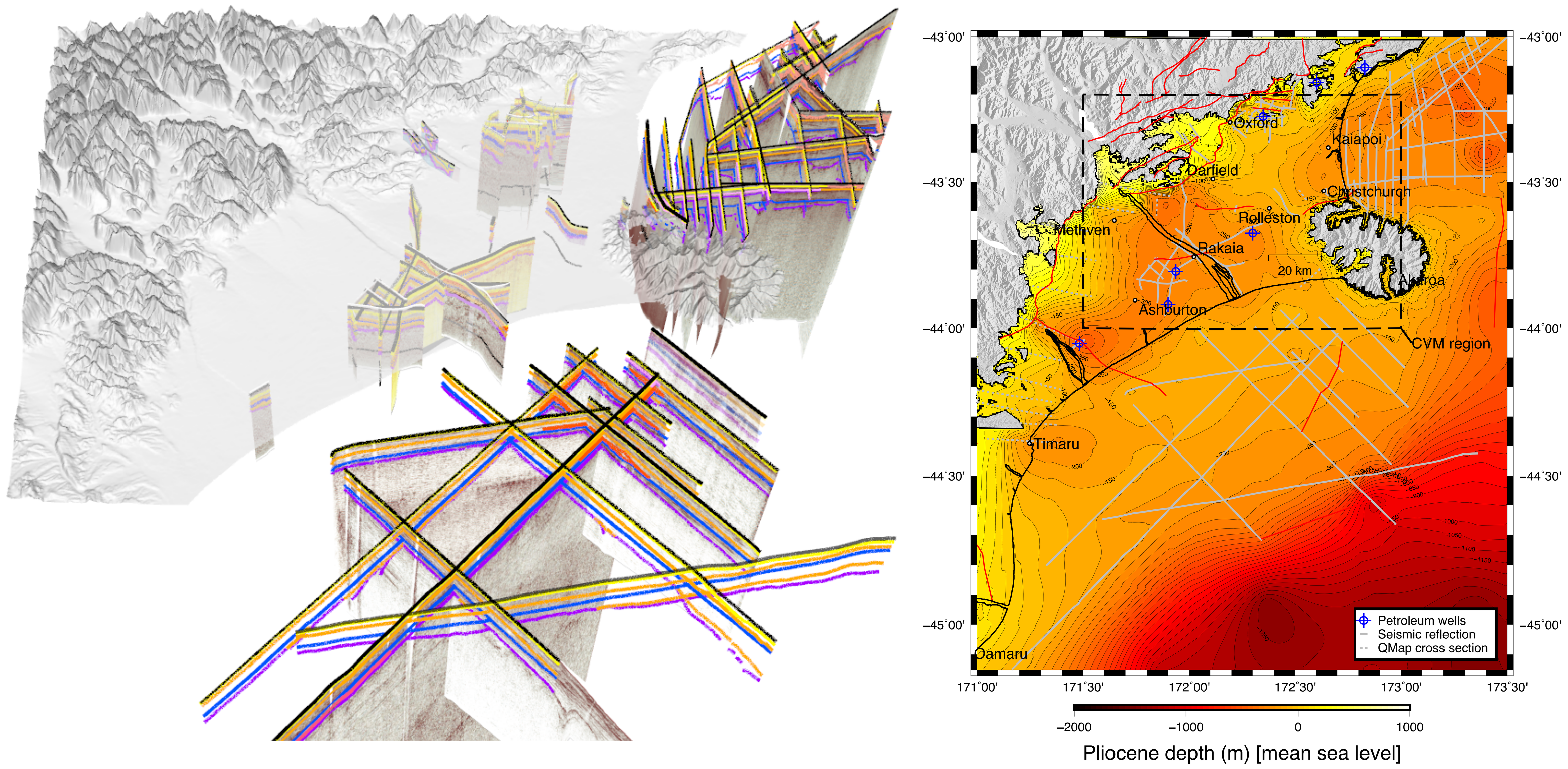

Figure 2: (a) Interpreted seismic reflection lines used in the development of geologic surfaces shown in Table 1; and (b) an example of the Pliocene surface contour depths over the modelled region.

The shallow Quaternary structure in the model of the urban Christchurch area is particularly detailed with 9 different units in the top 150m.

- Figure 1b illustrates the water wells in the region used to constrain the complex inter-bedded stratigraphy in Figure 3 (gravels, sands, silts, organics etc) near the coastline, including beneath urban Christchurch.

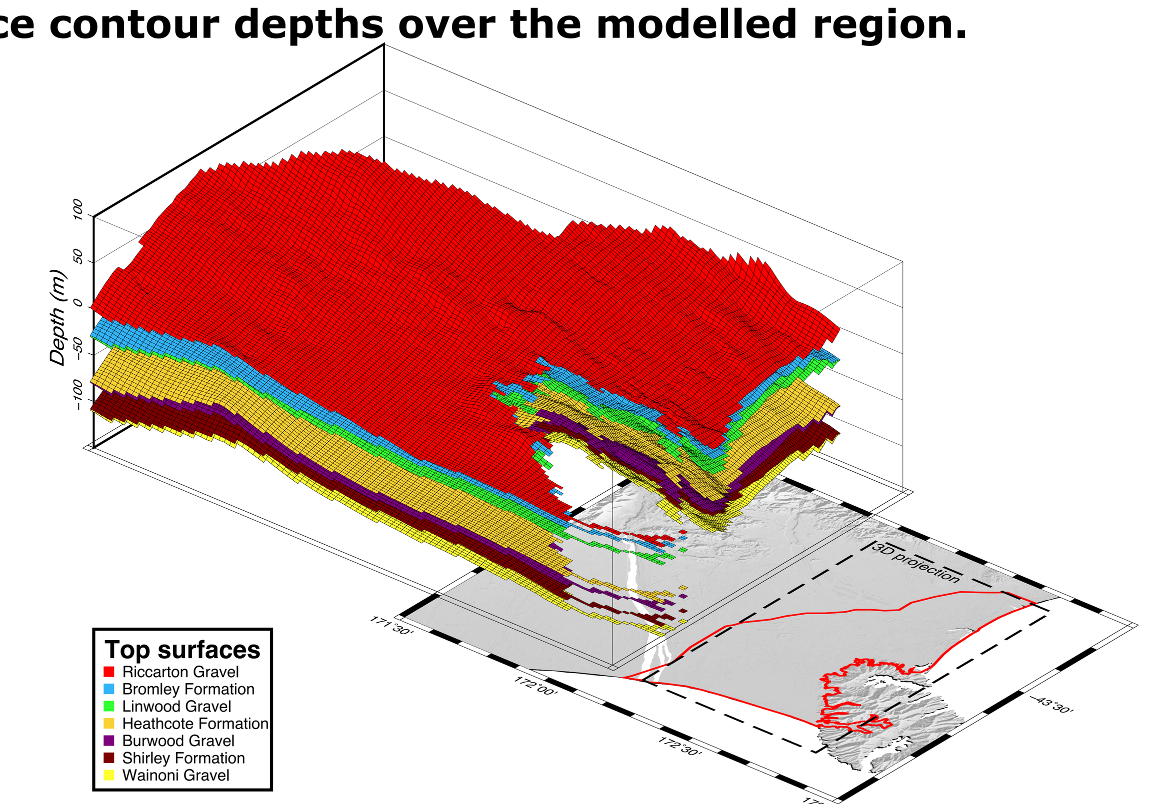

Figure 3: Geologic surfaces of the shallow inter-bedded Quaternary structure beneath Christchurch.

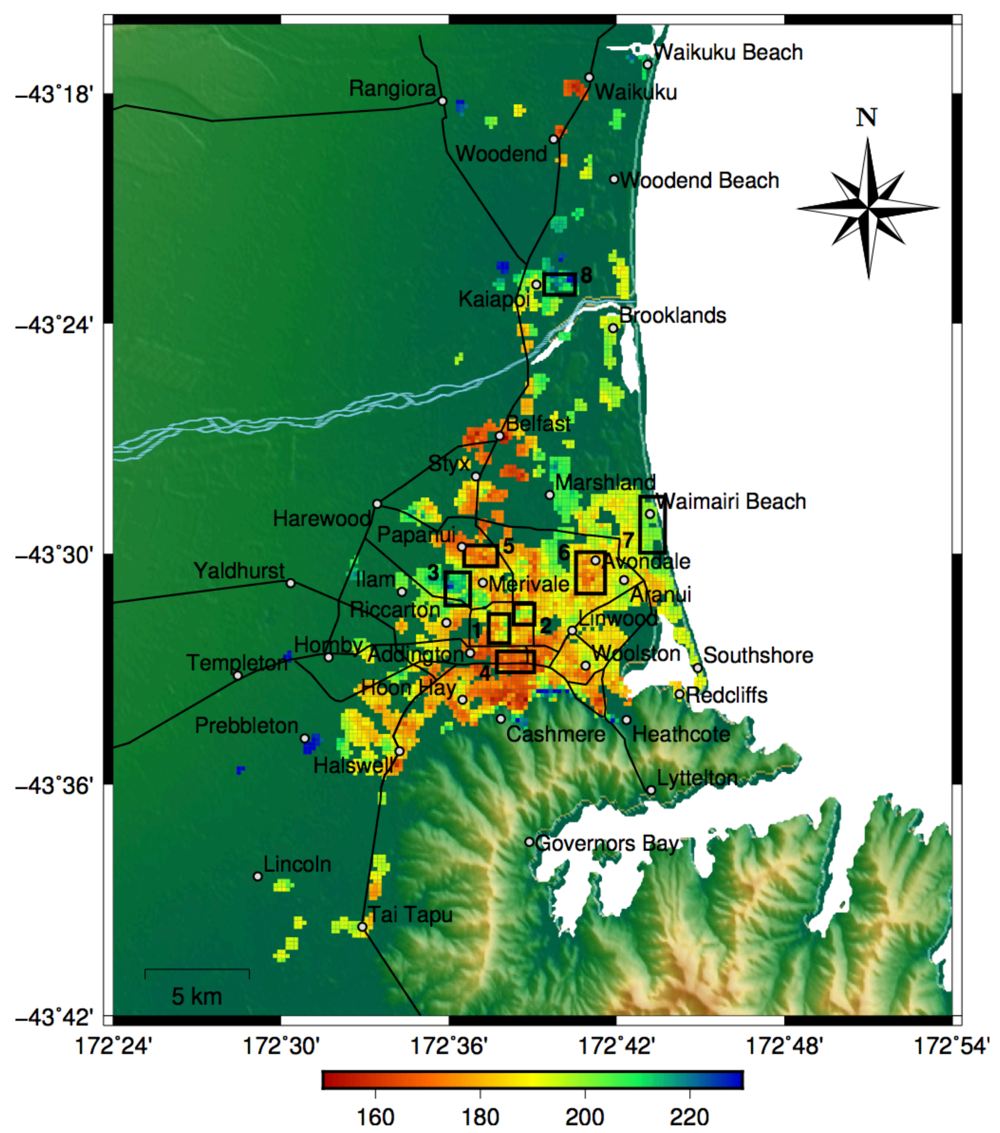

Figure 4: Vs30 model based on over 15,000 CPT logs

3. Seismic velocities

- Basement properties are controlled by 3D regional tomographic data (Eberhart-Phillips et al. 2010).
- P-wave velocities in all units were obtained from seismic reflection profiles.
- In deep geologic units, V_s is obtained from the empirical correlation of Brocher (2005), validated for NZ conditions.
- In shallow (z<1km) geologic units, V_s is obtained directly from active- and passive-surface-wave data (Cox et al. 2013). Geopsy was used for velocity inversion of the dispersion data allowing for velocity reversals in the interbedded Quaternary stratigraphy.
- The near-surface Springston and Christchurch Formations, utilize V_s obtained from over 15,000 cone penetration tests as shown in Figure 4 (McGann et al. 2014).