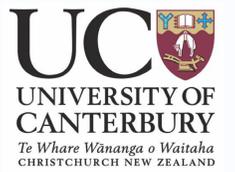


# Effect of stress level on cyclic resistance of undisturbed samples of pumiceous soil

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## Pumiceous Soils

- Soils containing pumiceous materials are known to exist across significant areas of the North Island and are the result of volcanic eruptions in the Taupo Volcanic Zone. These soils are encountered in both their original air-fall deposits, or as alluvially derived soils.
- Pumice grains are vesicular and as a result are lightweight and highly crushable (Figure 1).

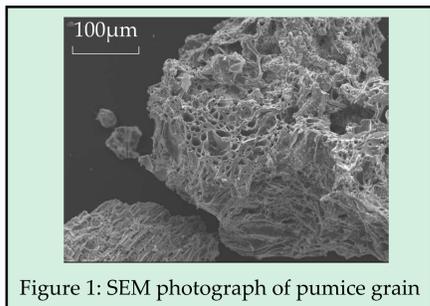


Figure 1: SEM photograph of pumice grain

- The tendency for crushing significantly changes the interpretation of CPT results in pumice-rich soils.
  - CPT insensitive to relative density in these soils (Wesley et al. 1999).
  - Existing simplified methods for predicting liquefaction resistance from CPT unlikely to be appropriate in these soils.
  - Orense et al (2020) showed that liquefaction resistance was generally under-predicted by the simplified methods compared to measurements in the laboratory.
- The extent of crushing that takes place in pumice-rich soils during loading is strongly linked to stress - level. (Miura & Yagi, 2003)
  - Does the liquefaction resistance of a pumice-rich soil vary significantly in the moderate stress range?**
  - How should we account for this with natural soils?**

## Undisturbed Sampling

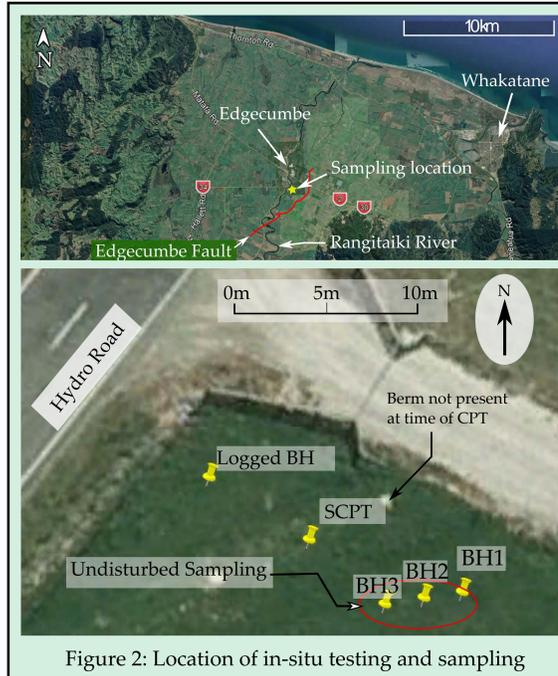


Figure 2: Location of in-situ testing and sampling

- Pumice noted from surface to depth of 7m
- Gel-push (triple tube) "undisturbed" sampling
- Samples frozen before transportation

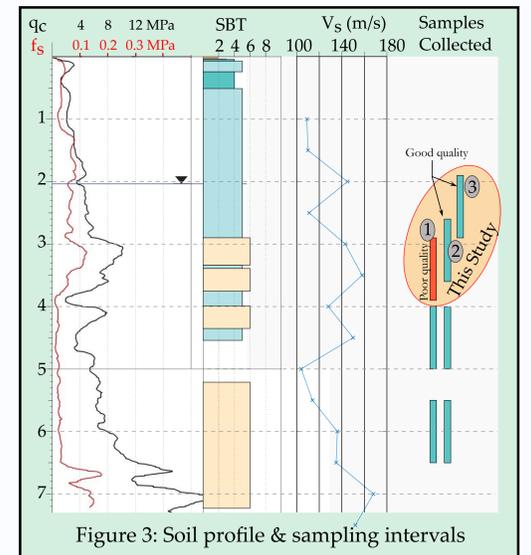


Figure 3: Soil profile & sampling intervals

## Laboratory testing

- Frozen specimens cored for triaxial testing
- Characterisation carried out after triaxial testing
- Pumice content determined by separation method (Stringer 2019)
- Big range in pumice content!
- Pumice fraction slightly coarser than hard grained fraction
- Soil specimens were generally clean sands
- Relative density (based on Japanese method) found to be very high for the high quality specimens

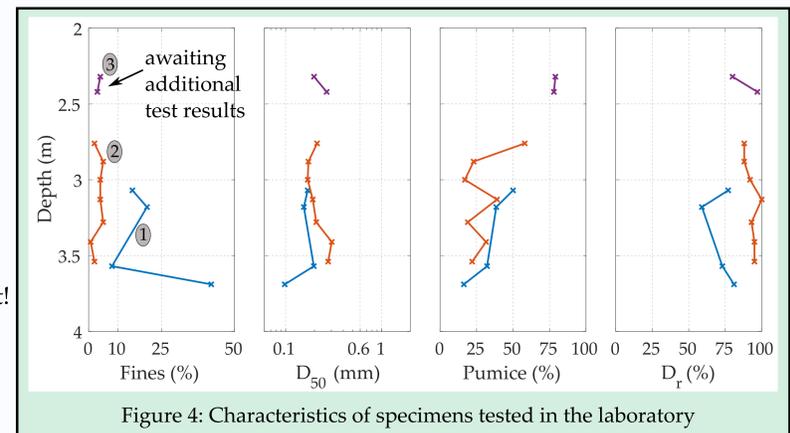


Figure 4: Characteristics of specimens tested in the laboratory

## Test Results

- Deformation during cyclic testing was relatively "ductile;" specimens did not "collapse" (consistent with high relative density)
- Clear difference in cyclic resistance observed due to disturbance.
- Some evidence that cyclic resistance decreases with increasing stress level.

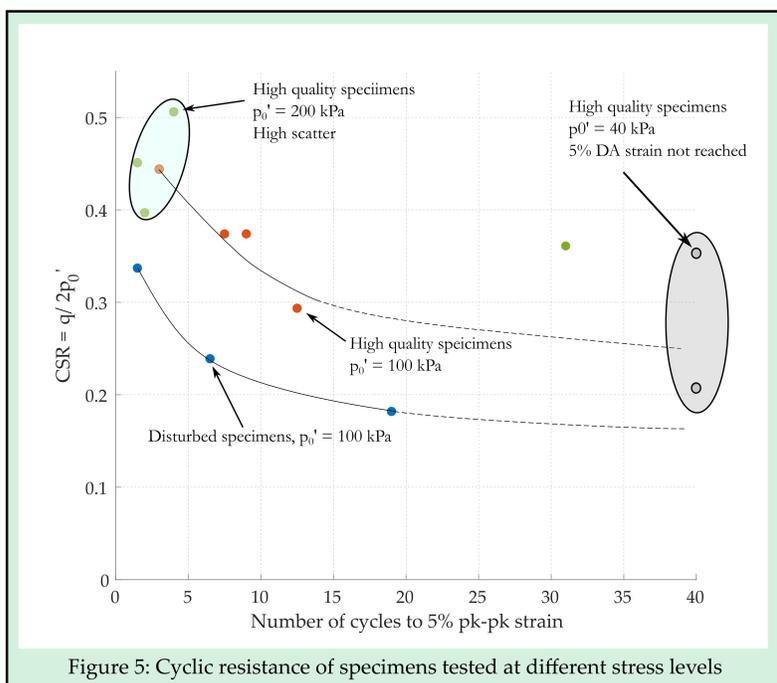


Figure 5: Cyclic resistance of specimens tested at different stress levels

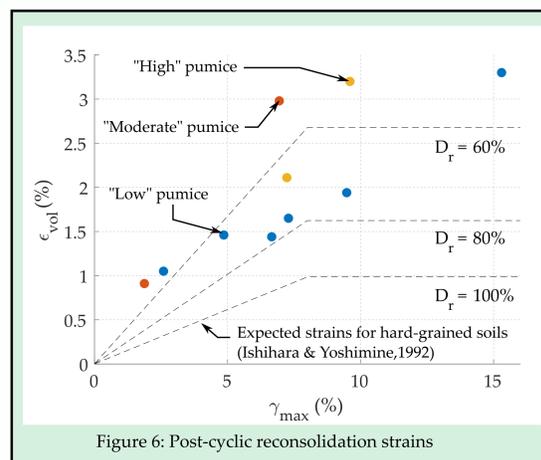


Figure 6: Post-cyclic reconsolidation strains

- Volumetric strains following cyclic loading larger than expected based on relationships for hard grained soils at similar relative densities.

## Summary

Samples of pumice rich soil were collected from the Rangitaiki Plains using gel-push sampling. Samples were generally similar in terms of particle size distributions and relative densities, but displayed large variations in relative density. Despite the differences in pumice content and stress levels during the tests, the differences in the stress path were generally quite subtle and requires further consideration. A decrease in the cyclic resistance was observed as the mean effective stress level was raised from 40 kPa to 100 kPa. The pumice rich specimens were found to exhibit larger than expected volumetric strains during reconsolidation following cyclic loading, which may act to exacerbate the effects of upward seepage following strong ground shaking.

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