Funded PhD Opportunity – The University of Auckland, New Zealand

PhD Title: Thermally sprayed synthetic high-silica volcanic glass formation to study the critical phase reactivity of pozzolanic pumice in concrete
Start date: October 2025 preferred (but could be delayed until Jan/Feb 2026)
Duration: 3 years
Stipend: NZ$35,000 + "University fees"/year

Research summary

Modern concrete production relies on Portland cement, which has a significant CO_2 footprint (5%-8% of global greenhouse emissions). One of the most common methods to reduce the carbon footprint of concrete is by using Supplementary Cementitious Materials (SCMs), with significant research attention and industrial interest being paid to the application of natural pozzolans. Pumice is a volcanic glass produced during explosive eruptions and is abundant in New Zealand. It is a proven natural pozzolan with the capacity to harden into a cementitious material when used as a partial cement replacement in concrete.

The PhD student allocated to this work will be part of a wider team investigating New Zealand pumice as a partial cement replacement in New Zealand cements. As a naturally produced material, pumice has a complex elemental and phase composition, together with a marked variability in the amorphous-to-crystalline structure ratio. All of these variables potentially play a role in the degree to which pumice acts as a SCM. It is challenging to identify the critical variables defining the SCM response with natural pumice materials because there is no way to independently control them.

The specific objective of this PhD student will be to use high-temperature plasma thermal spraying to simulate the conditions which generate high-silica volcanic glass from volcanic eruptions (melting of complex elemental compositions in a homogeneous liquid, followed by rapid solidification). By controlling the powder feedstock used for spraying, plasma-processed powders will be produced that sequentially vary compositions of interest. By spraying these into water we will ensure rapid solidification and the retention of high amorphous material concentrations. Subsequent heat treatment will enable the extent of crystallinity to be varied. Thermal analysis will study the phase evolution of the plasma-processed powders, and enable them to be cross-correlated with natural pumice materials. The main aim will be to enable the production of "synthetic" pumice powder that enables the critical variables of interest in natural pumice to be manufactured in a controlled manner. These will then be used to test the pozzolanic activity of the powders to explore which variables dictate the pozzolanic activity in natural pumice materials. The results will be cross-correlated with those of a parallel PhD project exploring natural pumice.

Project description

A fully funded PhD position is open within the Department of Chemical and Materials Engineering at the University of Auckland, within a multiyear Endeavour funding program on sustainable concrete through the use of natural materials. The PhD Scholarship covers a stipend ($35,000 per year tax-free) plus tuition fees for three years, the default duration of a PhD at the University of Auckland. The project management team for this PhD consists of Associate Professor Steven Matthews (Materials Engineer specialising in thermal spray coatings) as primary supervisor, supported by Dr Enrique del Rey Castillo (Civil Engineer specialising in concrete manufacture and application) and Dr Anke Zernack (Volcanologist specialising in Volcanic geochemistry).

The recruitment process will be conducted in two stages. The first stage is where expressions of interest are requested, with a deadline of 27 June 2025. In the second stage, selected candidates will be invited for an interview in July/August. The final decision will be made as soon as possible after the interviews, and the student will be expected to start as soon as is practicable before the end of February 2026.

The ideal applicant:

- Has an Honours/Master of Materials Engineering or Materials Science, Honours/Masters of Chemistry or Honours/Masters of Geology (Volcanology specialisation) with a strong research component.
- Is able to demonstrate a proficient scientific writing ability, ideally through papers published in top journals but alternatively through conference proceedings or Master thesis **A minimum GPE equivalent to the University of Auckland GPE of 7**, which can be calculated here https://www.gpecalculator.auckland.ac.nz/
- **Has English language skills that comply with the University of Auckland requirements**, which can be seen here https://www.auckland.ac.nz/en/study/applications-and-admissions/entry-requirements/postgraduate-entry-requirements/postgraduate-english-language-requirements.html
- Is able to work independently in the lab or at least have experience in working in the lab with some of the following methods:
    - Materials characterisation and surface analysis (XRD, XRF, SEM/optical microscopy, XPS, FTIR)
    - Thermal analysis (DSC, TGA and isothermal calorimeter), Thermal spraying (plasma spraying)
    - Sample preparation (metallographic preparation), and materials processing such as grinding, calcining and sieves.
    - Is confident with materials chemistry analysis (including the use of equilibrium phase diagrams and equilibrium thermodynamic analysis) and the interpretation of data generated from the surface analysis techniques above.

Questions/Queries
Please contact Associate Professor Steven Matthews: s.matthews@auckland.ac.nz

The University of Auckland, New Zealand
The University of Auckland is ranked 65th in the world by the QS World University Rankings 2025, making it New Zealand's highest-ranked university. It is also the largest and most comprehensive, with more than 45,000 students, including international students representing around 100 countries.

The University of Auckland ranked 152nd equal in the 2025 Times Higher Education World University Rankings, making it the top-ranked university in New Zealand.

https://www.auckland.ac.nz/en.html