22 April 2024

# RESEARCH PROGRAM PRODUCES HIGH REACTIVITY METAKAOLIN TO ADVANCE LOW CARBON CEMENT

Emerging mineral processing technology company, Zeotech Limited (ASX: ZEO, "Zeotech" or "the Company") is pleased to provide the following update on its metakaolin research and testing program ("Program") at Central Queensland University, Australia ("CQUniversity"), which has delivered very promising results.

## HIGHLIGHTS

- Results confirm that a high reactivity metakaolin ("HRM" or "metakaolin") can be produced from a range of the Company's Toondoon kaolin profiles.
- High reactivity metakaolin produced exceeds Australian Standard[1] and ASTM International Standard[2] for a manufactured pozzolan.
- High kaolinite content of Toondoon's raw ore, of between 80-90%, underpins a simple flowsheet and potential competitive advantage due to the limited beneficiation required to produce a high reactivity metakaolin.
- Metakaolin is in demand as a supplementary cementitious material ("SCM") that could advance low carbon cement and concrete by partially substituting clinker in Portland cement – this provides a considerably large market opportunity.
- Production and use of cement accounts for approximately 8% of worldwide carbon dioxide emissions[3].
- Use of SCM's is the most viable alternative to mitigate carbon dioxide emissions of the cement and concrete industries in the short term, and metakaolin is increasingly regarded as the most promising pozzolanic material for the future[4].
- Work now underway on a test pit at Toondoon with the aim to stockpile ~50 tonnes of high-grade raw kaolin, to produce larger quantities of metakaolin.

Zeotech, Chief Executive Officer, Scott Burkhart commented:

*"The program with CQUniversity has delivered some very promising results that further highlight the superiority of the Company's Toondoon kaolin and the potential to produce a high reactivity metakaolin product that could be used as a SCM to support production of low carbon cement and concrete.*

*The use of HRM as an SCM unlocks a considerable commercial opportunity for the Company and we will continue to advance discussions with industry and explore commercial pathways that could catalyse metakaolin production in Australia as an SCM for concrete and future zeolite manufacturing.*

[1] Australian Standard AS 3582.4
[2] ASTM International Standard C1897
[3] "Analysis of theoretical carbon dioxide emissions from cement production" Journal of Cleaner Production (2022)
[4] "Investigation into the suitability of natural clays from Central South Queensland, Australia, deposits as supplementary cementitious material". Central Queensland University (2024)

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*I would like to extend my thanks to project leaders, Dr. Kumaran Suntharavadivel, and Dr. Hassan Baji, from CQUniversity, for their effort and expertise that not only delivered some excellent results, but demonstrates the strong prospects of the Company's kaolin across a variety of profiles."*

### *Metakaolin for Low Carbon Cement and Concrete*

The Program has evaluated the optimum method of pozzolanic activation of four raw ore kaolin samples from the Company's Toondoon project, and two raw ore kaolin samples from the Company's Abercorn kaolin project, to maximise their potential commercial value.

A wide range of test methods and indicators were developed to determine the physical and mineralogical composition, reactivity, and mortar strength, alongside practical considerations such as water demand and workability.

The tests followed the Australian Standard[1] and the ASTM International Standard[2] for SCMs. Under the ASTM International Standard, the 'R3 test' (Rapid, Relevant, Reliable) was carried out on all samples to assess the pozzolanic reactivity of the metakaolin (fig. 1).

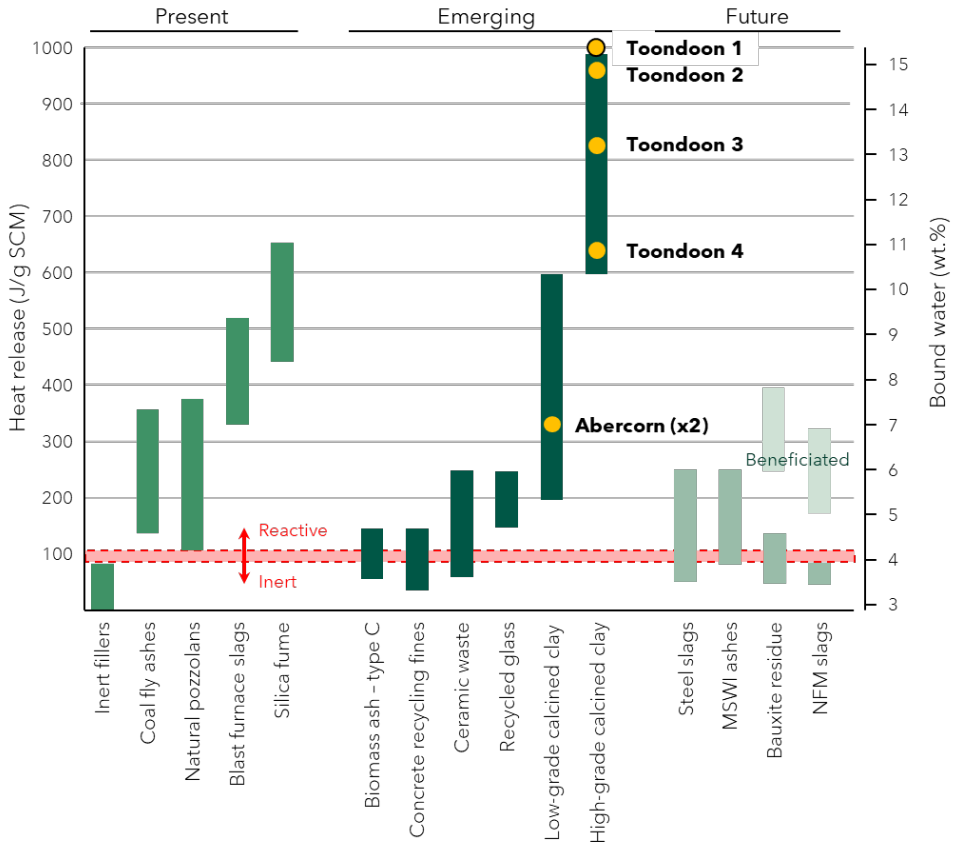


Figure 1 – Reactivity levels of Toondoon & Abercorn samples compared with presently used inert fillers and common, emerging and future SCMs ("Cement and Concrete Research" Snelling et al. (2023))

Results from the characterisation and reactivity tests have shown that all four kaolin samples from Toondoon are considered high-grade kaolin clays with high pozzolanic reactivity, capable of producing HRM.



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Two samples from Abercorn are considered low-grade kaolin clays by comparison, however, display characteristics of a reactive pozzolan and comparable performance to conventional SCMs such as fly ash.

The high kaolinite content of Toondoon's raw ore, of between 80-90%, is an important indicator of pozzolanic strength and underpins a simple flowsheet (fig. 2) and extends a potential competitive advantage due to the limited beneficiation required to produce metakaolin.

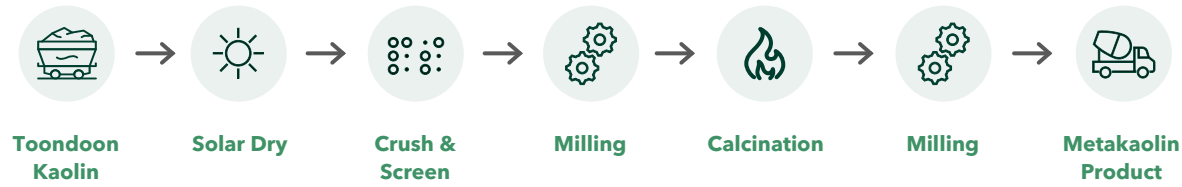


Figure 2 – Indicative flowsheet to produce high reactivity metakaolin from Toondoon kaolin.

Evaluation of the compressive strength was achieved using the common standard test named the Strength Activity Index ("SAI"). The Australian Standard[1] and the ASTM International Standard[5] use this test to evaluate the reactivity of blended cement made with Portland cement and SCM, that not only informs the strength of the samples but offers information regarding practical considerations, such as workability.

Compressive tests conducted on samples, adjusted for water demand requirements to achieve mortar flow consistency similar to that of the control sample, show that all clays can be classified as a Grade 1 pozzolan according to the Australian Standard[1].

Additional tests using commercial superplasticiser (to achieve mortar flow without the need for additional water) have further demonstrated the workability of the blended cement by achieving mortar flow within the range specified by the Australian Standard[61].

Compression strength is primarily expressed using the 28-day SAI factor, that assesses the strength of the cured mortar blocks made from the blended cement, relative to the strength of a control mortar sample (control is equal to 1.0).

The 28-day SAI factor of the four Toondoon samples (flow adjusted with superplasticiser) ranged between 1.24 and 1.35, surpassing the compressive strength of the control mortar sample by a large margin.

The 28-day SAI factor for the two Abercorn samples (flow adjusted with superplasticiser) were 0.99 and 1.06 respectively, indicating that this metakaolin blended cement can yield comparable strength to the control sample.

These results demonstrate that a HRM can be produced from a range of profiles from the Company's Toondoon raw ore kaolin, with minimal beneficiation, that meets the applicable standards for compression strength, and importantly, practical considerations such as workability.

[5] ASTM International Standard C618
[6] Australian Standard AS 3583.6



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*Background*

The aim of the Program was to investigate the suitability of the Company's Toondoon and Abercorn raw ore kaolin located in Queensland, Australia, as a SCM that could advance low carbon cement and concrete.

Concrete is the most widely produced and used man-made material and is formed from a mixture of Portland cement, aggregates, water and admixtures. Portland cement is the main binding agent in concrete that is primarily produced from clinker. Production and use of cement accounts for approximately 8% of worldwide carbon dioxide emissions[3].

Metakaolin is in demand as an SCM to partially substitute clinker in Portland cement, along with potential to partially or fully replace conventional SCMs such as fly ash and blast furnace slag that are increasing in cost, and are forecast to decrease in availability[4].

Use of SCM's is the most viable alternative to mitigate carbon dioxide emissions of the cement and concrete industries in the short term, and metakaolin is increasingly regarded as the most promising pozzolanic material for the future[4].

LC3 cement, for example, is a limestone calcined clay blended cement that uses up to 30% metakaolin to substitute clinker in Portland cement, and in doing so, can reduce carbon dioxide emissions by up to 40%[7].

*Next Steps*

The Program's findings will support ongoing commercial discussions with the cement industry to target the provision of a high quality SCM that could advance low carbon cement and concrete products, alongside expanded business development activities.

Work has commenced on a test pit at the Toondoon project that will aim to stockpile approximately 50 tonnes of high-grade raw kaolin, and planning is underway to produce larger quantities of metakaolin, to further support cement industry pilot trials and broader collaboration initiatives.

The Company expects to undertake a cost-benefit analysis to examine the potential economic benefits of utilising its metakaolin products, together with life cycle analysis that could evaluate the carbon benefit from using the metakaolin product in cement and concrete.

This announcement has been approved by the Board.

- End -

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[7] LC3 – Limestone Calcined Clay Cement

## About Zeotech

Zeotech Limited (ASX: ZEO) is a team of dedicated people, working together to build a future focused company, leveraging proprietary technology for the low-cost production of advanced materials 'manufactured zeolites' to deliver solutions aimed at addressing sustainability challenges.

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