ISSN 1893-1170 (online utgave)
ISSN 1893-1057 (trykt utgave)
Mineralproduksjon 11 (2023) B13-B18
MINERALPRODUKSJON
www.mineralproduksjon.no

Note

The Nypro database – An online information sharing arena for mine tailings resources, their characteristics, and potential applications

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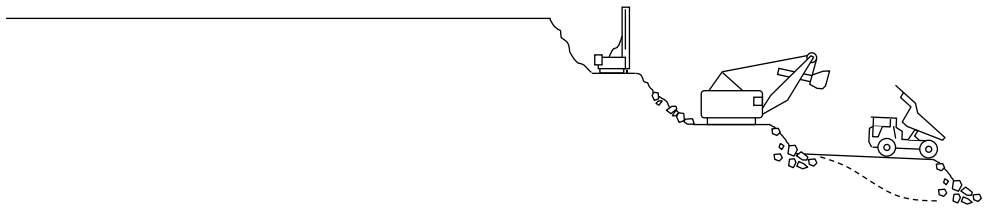
Deposition of mine tailings is one of the major controversies within the Norwegian mining industry and its public acceptance. The tailings represent valuable resources that could be put to alternative use, and increased data availability may facilitate new initiatives to do so.



1. INTRODUCTION

The mining industry plays an important role in the global economy through extraction of minerals and metals, representing fundamental resources in many industries. Automotive, electronics, and renewable energy are all examples of sectors which are dependent upon these resources to produce goods such as wind turbines, batteries, and solar panels. The demand for green technologies is increasing, and a steady supply of minerals and metals is required to sustain this development (Ali et al., 2017).

One of the major issues with extraction of minerals and metals is the significant generation of waste rock and mine tailings which must be managed in a sustainable manner (Prior et al., 2012). Several actors in the Norwegian mining industry practice submarine tailings disposal (STD), which is controversial due to potentially undesirable effects on the marine environment, e.g., seizure of large seabed areas, distribution of fine particles in the water column, and uncertain long terms effects on marine organisms (Ramirez-Llodra et al., 2022). In a circular economy perspective, STD also represents a waste of resources as the mine tailings

are made inaccessible and likely irreversible lost to the environment. Finding alternative uses for mine tailings would reduce the environmental concerns of STD as well as increase resource efficiency and constitute a prime example of circular economy in practice. In Norwegian context, there are however few examples of tailings utilisation on an industrial scale.

Previous research point at several barriers for achieving circular economy in mining (Gedam et al., 2021; Kinnunen and Kaksonen, 2019), amongst these the lack of information sharing across companies and industries (Høyli and Jakobsen, 2022). The availability of data on secondary materials is described as crucial for large-scale deployment of recovery practices within the EU (Blengini et al., 2019), and such information should provide sufficient detail (e.g., containing characteristics, concentrations and impurities) to be useful as a mine waste registry (Žibret et al., 2020). While some information on Norwegian mining wastes and tailings resources can be found in scientific literature (e.g., Kvassnes and Iversen, 2013; Ramirez-Llodra et al., 2022, 2015), national mining waste registries and other open governmental data, this information is often too generic and scattered across different sources.

This paper presents the Nypro database – an online information sharing arena and visualization tool for mine tailings resources, their characteristics, and potential applications. The purpose of the Nypro database is to increase data availability and create awareness of the opportunities for alternative utilisation of mine tailings from Norwegian mining industry.

2. MATERIALS AND METHODS

The methods for data collection included semi-structured interviews and project meetings with four major mining actors in Norway. The informants shared information on their respective tailings, including the location and amounts of tailings, type of mineral deposit, as well as physical and chemical properties such as particle curve, principal elements, and mineralogy. They also provided us with their insights on aspects relevant for database functionality.

The Nypro database is built on SINTIUM, which is a powerful data analytics and visualization tool developed by SINTEF. The development of the Nypro database has been an iterative process where the database has been presented and discussed during project meetings to identify areas for improvement and further development. The database is visualized through an open access webpage, accessible from https://nyprodatabasen.no.

3. THE NYPRO DATABASE

3.1 Basic functionality

Basic tailings information as the type of deposit, the responsible company and the annual tailings generation is shown in a table at the top of the database interface. Other tailings specific information such as mineralogy, principal elements, and particle curve is visualized in an interactive dashboard, as shown in Figure 1.

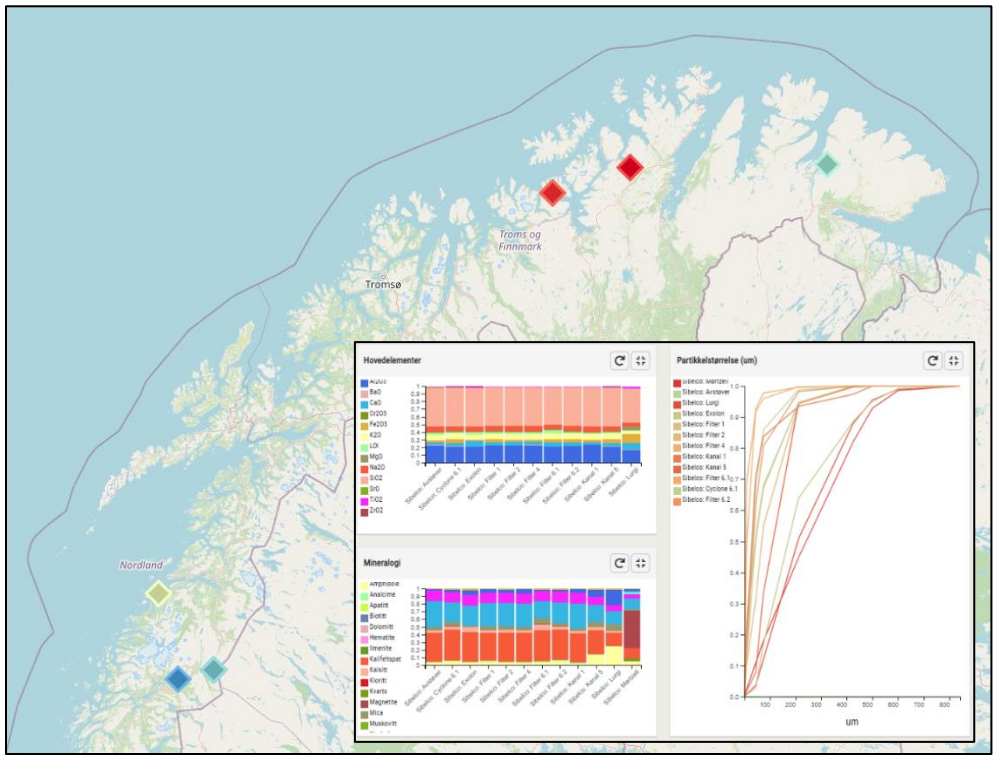


Figure 1 Interactive dashboard for visualization of tailings characteristics.

The database has filtering options based on geography (map hovering), mining company and specific tailings, as well as the content of principal elements and mineralogy. Only the tailings materials satisfying the given filtering requirements will be visible in the dashboard.

The database also holds functionality for a simplified combination of two or more tailings materials, which can be of interests as individual mine tailings materials

may not have the required characteristics to be suitable as a sole raw material for alternative applications.

3.2 Tailings screening tool

The database has an integrated screening tool (Figure 2) which allows for initial screening of tailings materials' suitability for production of lightweight aggregates (LWA). The LWA screening tool is based on Riley (1951), which defines a suitable 'expansion area' given by the ratio of SiO_2, Al_2O_3 and flux materials.

The location in the Riley diagram provides insights on how materials can be supplemented to acquire suitable characteristics, e.g., if it is located far to the right, the composition could be adjusted with addition of Al_2O_3 sources. The blue marker in Figure 2 is an example of the database's material mix-functionality where a nepheline tailing (red and orange markers) is mixed 50/50 with a SiO_2-rich quartzite.

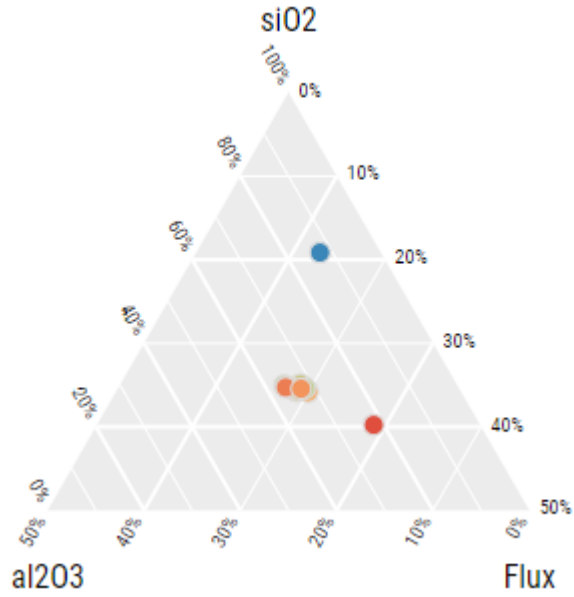


Figure 2. Tailings screening tool.

It should be noted that LWA production is a complex process that is affected by several other factors, amongst these the particle size and internal distribution of flux materials – factors which are not accounted for in the screening tool. In general, the screening tool can be useful as an initial assessment but cannot provide a definitive answer on the material's suitability.

3.3 Future perspectives and suggestions for database development

Being built on the SINTIUM framework, the Nypro database can be easily modified and improved to increase its usefulness and outreach.

For instance, database improvements can be achieved through some low-hanging fruits, such as i) widening the scope to include waste resources outside the mining industry, ii) providing more detailed characteristics (e.g., information on pyrite, magnetite, heavy metals, and alkali reactivity), and iii) including practicalities or limitations regarding access to specific tailings materials. A more extensive measure could be to explore the possibilities of interconnection with public/governmental databases to take advantage of already existing data on waste resources from Norwegian industries. Further, the database could be developed into a digital marketplace for waste resources where supply meets demand, e.g., by considering the demand for fine materials in ongoing and future construction projects.

The tailings screening tool could also be improved. First, it could offer suitability assessment for several potential applications, not just LWA. Second, it could consider additional factors influencing a tailings' suitability. Third, it could provide a list of appropriate additives to achieve suitable material mixes.

4. FINAL REMARKS

This paper has presented the Nypro database; an online information sharing arena that aims to share relevant information and create awareness of opportunities for alternative utilization of mine tailings from Norwegian mining industry.

Further development of the Nypro database could benefit from collaboration with similar initiatives, aiming to gather under one umbrella all relevant information on various waste resources, their characteristics, and potential applications.

ACKNOWLEDGEMENTS

This work has been supported by the Regional Research Funds dep. North (RFF Nord).

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