PREDICT

Phase transitions of salts under changing climatic conditions

DURATION
15/12/2019 - 15/03/2024

BUDGET
362 102€

PROJECT DESCRIPTION

The PREDICT project will look into the physical processes of salts. Salts are known to have kinetic properties that are unpredictable in nature and the theoretical predictions often deviate from experimental results. To counter this problem the Belgian Science Policy (BELSPO) has funded a four year PhD research, a collaboration between the Royal Institute for Cultural Heritage (KIK-IRPA), Ghent University (Department of Geology), University of Antwerp (Heritage Department) and the Belgian Building Research Institute (BBRI). The main aim is to investigate the physical phase transitions of salts and the formation of complex salts in a mixture under changing climatic conditions.

This research aims to shed light on how environmental conditions affect the formation of complex salts to prevent the deterioration of materials found in our built environment, such as, monuments, archaeological sites, road infrastructures and concrete constructions (figures 1 and 2). There is also an important need to understand the processes of salts in both the academic world and industrial applications. Furthermore, this subject overlaps with problems related to the understanding of geological systems, more specifically concerning chemical weathering and mineral formations on earth and planets. The project has the potential to impact these diverse fields as the research will focus on salts commonly found in building materials, which contain a wide diversity of salts that are also related to other fields.

Figure 1. Example of salt damage to historic masonry (Photo KIK-IRPA, Hof te Bree-Eik)

Figure 2. Example of salt damage to roads and bridges (Photo via Shutterstock)

Scientists are relying on theoretical models to predict phase transitions of salts. Based on the theoretical results, future predictions and risk management strategies are defined. Because physical experiments are rarely carried out there is an absence of data related to the kinetic processes within the calculations of thermodynamic models. Although these models are helpful to predict salt crystallization they are unfortunately not very reliable.

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To address this problem the experimental methodology starts with investigating the interactions between different ions in changing climatic conditions. Through experimental observations by means of Environmental Scanning Electron Microscopy/Energy Dispersive X-ray (ESEM/EDX) (figure 3) and microscopy coupled with a temperature and humidity generator (figure 4), the phase transitions and the formation of complex salts under realistic climatic conditions will be recorded. Salt crystals are identified by means of micro-RAMAN spectroscopy and X-Ray Diffraction (XRD) XRD.

Figure 3. Example, (E)SEM image of a recrystallized salt mixture (Photo KIK-IRPA)

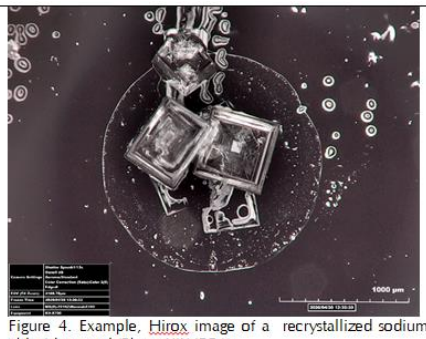

Figure 4. Example, Hirox image of a recrystallized sodium chloride crystal (Photo KIK-IRPA)

The result obtained at the microscale are correlated with ones obtained at the macroscale (i.e, in bigger salt mixture droplets in a climatic chamber). Realistic climate data are then used to predict the amount of crystallization cycles that occur over time. To validate the findings the research will incorporate case studies from different fields, consequently increasing the impact and contribute to the mitigation of and understanding of salts. Specific conditions are to be identified when salts undergo phase transitions to define critical potential risk events to avoid, mitigate, transfer, reduce or accept the formation of salts The outcome expects to aid the improvement of existing theoretical models to predict salt crystallization conditions and properties. Finally, sustainable conservation and risk management strategies are to be described in order to mitigate the impact of harmful salts. The outcome of this project aims to directly connect with the identified stakeholders to develop risk mitigation and solid management plans. The dissemination of the results on the project website, at conferences and in journals are considered an important action for the successful completion.

CONTACT INFORMATION

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LINKS

https://predict.kikirpa.be/