[EE] Evening Poster | M (Multidisciplinary and Interdisciplinary) | M-IS Intersection

[M-IS02]Conservation of geoparks, natural geosites and cultural heritage: weathering process and damage assessment

convener:Chiaki T. Oguchi(Institute for Environmental Science and Technology, Graduate School of Science and Engineering, Saitama University), Tetsuya Waragai(Graduate School of Science and Engineering, Nihon University), Miguel Gomez-Heras(Universidad Autonoma de Mdrid, 共同), Magdalini Theodoridou(School of Engineering, Cardiff University, Wales, UK)

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Geoparks, natural geosites and cultural geo-heritage are recognized as an important natural and cultural properties. Due to long years of suffering from weathering of rocks and earthen materials, they are often facing deterioration problems and somehow treatments or conservations might be necessary. Investigation from wide range of research fields such as geomorphology, engineering geology, geoarchaeology, conservation of cultural properties, petrophysics, geochemistry, geotechnical engineering, etc, however, our knowledge of many aspects of these materials is still limited. Here in this session, we accept discussions on original researches and case studies of documentation, measurement and monitoring techniques, experiments, predictive models, damage assessments, etc. We welcome papers from any kinds of research fields.

[MIS02-P05]**Biological self-healing for the protection of cultural heritage stone structures**

★ Invited Papers

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Keywords:self-healing, calcite biomineralisation, stone structures, cultural heritage, weathering

Geological materials are used in significant quantities for construction and comprise most cultural heritage building materials worldwide. However, they are subject to damage and deterioration through weathering and the stress state induced by in-service actions, eventually reaching such a state that they can no longer perform their primary functions. Deterioration may be physical, chemical, biological or a combination, and depends on the nature of the material in question. To prevent this from happening, or to reduce the rate at which it occurs, existing structures may be subject to regular maintenance programmes.

Maintenance is disruptive and costly. Mechanisms for protecting building stone are mostly limited to surface coatings to bind loosened material and ideally limit water ingress into the pore matrix without hindering the ability of moisture to exit from the stone as vapour. However, such treatments may limit this ‘breathability’ of the material, reducing its long-term performance, and can be limited to specific stones.

Although self-healing concepts have been applied to a range of materials, they have not been applied to construction geo-materials. Self-healing capabilities are ideally suited to porous geo-materials such as limestone or sandstone, where accessibility for maintenance or renewal can be limited. Biological self-healing would incorporate techniques able to sense damage or deterioration and adapt or repair themselves to restore their original properties or limit further deterioration. The opportunities in geo-materials for biological self-healing are considerable due to their bioreceptivity and suitability for biomineralisation, as well as the extent to which such materials are in use worldwide.

This work explores for the first time the potential for providing such materials with the ability to self-heal via naturally occurring biological mechanisms. Calcite biomineralisation is used as the basic mechanism, where spores trapped within calcite are exposed by damage and germinate into cells which heal the damage, re-encapsulating themselves and resetting the cycle. Calcium carbonates or similar minerals play a significant role in the structure of porous building stones, and so this method is well-matched to the substrate.

The bacterium Sporosarcina ureae has been one of the selected bacteria for healing and spore-assisted self-healing through calcite generation via urea hydrolysis. The ability of the system to operate as a protective (near) surface treatment on the model stone materials is explored, followed by optimization of operational parameters such as application methods and conditions of production of the initial healing phase. Following this, the optimised system will be applied to stone specimens and self-healing capability will be assessed on artificially weathered specimens.

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