

Unexpected effects of chemical and microbiological processes on geotechnical works

Professor Stephan Jefferis

Director Environmental Geotechnics Ltd, Visiting Professor University of Oxford

Seminar overview:

From time to time chemicals naturally present in the ground or introduced into it are involved in reactions which are sufficiently severe to cause risks to the health and safety of construction workers and/or end users of construction work and/or damage to structures. These reactions are often mediated by or accelerated by micro-organisms.

When investigating chemicals in the ground, site investigations tend to focus on sulphur species (because of the known effects of sulphates on Portland cements), pH and species recognised as associated with historic land contamination.

These species should not cause problems (though they still do) as there are well-established management procedures. A subtler problem is the change of speciation of some chemicals following change of the redox conditions in the ground. For example, a change from reducing to oxidising conditions can convert soluble iron Fe^{2+} species to the insoluble Fe^{3+} state. Fe^{3+} often precipitates as part of a voluminous biological slime which amongst other effects can cause biofouling of wells. In contrast reducing conditions can result in sulphate reduction to hydrogen sulphide – a very toxic and flammable gas.

Construction work can significantly alter the redox conditions: dewatering by desaturating soils may allow air and so oxygen entry into the ground whereas flooding will prevent it. Underground structures such as tunnels may introduce oxygen into soils which have been anoxic for geological time whilst introducing biodegradable organic species can scavenge oxygen.



Old Street: acid attack on tunnel lining
(<https://www.londonreconnections.com/2013/a-cid-works/>)

When and where:

Wednesday, 31 May, 19:00
Old Library, Sidney Sussex College

Queries:

Stefan Ritter
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Seminar overview (Cont'd):

All biological life requires energy to function and for bacteria this must be drawn from redox reactions, light or possibly thermal gradients. Therefore, it should be no surprise that bacteria are found where there is a redox gradient to exploit.

The lecture will present brief case histories of some unanticipated effects associated with sulphur, carbon, nitrogen and iron species including:

- hydrogen sulphide generation in a basement;
- sulphate and acid attack on tunnel linings;
- ammonia release after jet grouting;
- methane generation from degradation of grout materials;
- arsenic accumulation in rail track ballast.

and if times permits uranium and the odd non-nuclear explosion.

Biography:

Prof Stephan A. Jefferis is the Director of Environmental Geotechnics Ltd, a Visiting Professor at the University of Oxford, an Emeritus Professor of the University of Surrey and currently the Chairman of the British Geotechnical Association. He has over 40 years of experience in research and consultancy on geotechnical processes. He has worked extensively and internationally on the application of bentonite, bentonite-cement and polymer slurries in piling, diaphragm walling, tunnelling and cut-off walls. He is the author of over 100 papers and is regularly invited as a keynote speaker.



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