

Towards a Political Geology of Nuclear Waste Disposal: On Stability and the Deep Pulse of an Inert Earth

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The Deep Pulse of the Earth

Political geology offers a promising field for human geographers interested in the relationship between humans and the earth. As I already have discussed elsewhere (see Emmenegger 2024), Bobbette's new book *The Pulse of the Earth* provides a fascinating account of the interplay between geology and politics in Java's volcanic landscape since the late nineteenth century. Particularly valuable is Bobbette's (2023: 8) proposal to use "political geology as a method" to account for the material dimension of earthly politics, taking into account both the geos and the geological knowledge of an eruptive earth. Such a method brings together two often disconnected approaches to geopower – understood either in a Foucauldian sense as a form of geological knowledge used to govern the earth, or in a Deleuzian sense as the power of earthly forces (cf. Tola 2023: 564-565) – and reveals the two as less "mutually exclusive" than in dynamic interplay (Ibid.). Indeed, such an interplay seems obvious in Java, where earthquakes, volcanic eruptions, pyroclastic avalanches and tsunamis have shaped not only the landscape, but also epistemologies and knowledges of a dynamic earth. But how does this play out in places where the pulse of the earth is much deeper than at the eruptive margins of tectonic plates? In this contribution to the Book Forum, I want to explore what the method of political geology can offer to the study of the geological disposal of nuclear waste – a project that essentially relies on long-term geological stability.

A Political Geology of Disposal

Allegedly stable geological formations have been in the focus of deep geological disposal programs for the management of radioactive waste from nuclear power generation. As nuclear waste poses a long-term threat to life, a consensus has emerged among experts that the waste can be safely disposed of in a suitable geological substrate. Experts consider long-term stability an essential requirement for geological formations to qualify as 'host rocks', isolating and containing waste for as long as it takes for radioactive matter to decay.

Geological disposal as a strategy is thus based on a categorical distinction between a dynamic surface society and a stable subsurface geology – both characterized by radically different temporalities. As the discipline equipped or empowered to explore and evaluate geological substrates, geology has played a key role in geological disposal projects, opening up the subsurface as a frontier to be rendered legible, calculable and governable as what Braun (2000) has called a ‘vertical territory’ (see also Kim 2025). Maps and models used to describe the subsurface, as STS scholars suggest, do thereby not simply represent a reality ‘down there’, but enact and stabilize it for geological disposal projects to proceed. Surveying, sensing, drilling, mapping and modelling are thus not simply the geologist’s tools for gaining an ‘accurate’ understanding of the subsurface and the properties of potential host rock formations. Rather they serve as political technologies for reimagining of the subsurface as a site for disposal (Kearnes & Rickards 2017) or even for its production as an entirely ‘technological environment’ (Williams 2008: 2).

Geology stabilizes potential geological formations as host rocks for nuclear waste disposal in radical juxtaposition to the surface biosphere. However, as Bobbette (2023: 3) shows, the boundary between the *geos* and the *bios* is much blurrier: volcanology in Java was not about stabilizing volcanoes as resources, but rather about managing the inherent volatility and porosity of volcanoes to secure a colonial plantation economy – and thus about mediating human’s relationship to an eruptive earth. Similarly, the geology involved in waste disposal projects should not be reduced to its function as a technopolitical tool in a vertical territorialization of the subsurface as my discussion above suggests. Rather, it is part of a much more complex geosocial process of building relationships between humans and potential host rocks. As Kearnes and Rickards (2017: 53) have highlighted, assessing the suitability of a particular formation as a host rock involves “a complex web of verification and adjudication”. For geologists, then, investigating the suitability of potential host rocks is not simply a matter of accurately describing the intrinsic properties of the rocks, but rather of evaluating their ability to meet regulatory safety requirements and to perform long-term containment – ultimately in interplay with other natural or engineered components of country-specific multi-barrier disposal designs. Disposal geology is thus not just about stabilizing potential host rocks, but about their regulatory enrolment as what Barry (2013) has called ‘informed materials’ – or what I would call ‘informed strata’ for the long-term disposal of nuclear waste.

In order for the technopolitical project of disposal to proceed, geology is instrumental in establishing a relationship with host rocks as allies of humans wrestling with radioactive

waste. Geological knowledge production goes hand in hand with the 'delegation' of competences to specific host rocks, which are entrusted with the responsibility of ensuring the long-term safety of humans and the environment (Schröder 2016). However, as Schröder (2016: 12) has emphasized, this delegation is not straightforward, but is linked to 'prescriptions', meaning that non-human host rocks silently tell humans to do this or that. As she suggests, non-human host rocks have agency – despite or because of their supposed stability. Geological agency can be mediated by maps or models, especially at moments when these media prove geologists' prior assumptions about the constitution of the geos wrong (see e.g. Aschwanden 2020; Emmenegger 2025). It can also manifest materially, aesthetically and affectively in embodied encounters between scientists and rocks, for example in the form of drill cores and samples in laboratories (Schürkmann 2022) or rock laboratories (Geysmans et al. 2023). However, as Bosworth (2023: 13) warns: “denouncing the purported lifelessness or stability of the underground and simply replacing it with a lively and dynamic one is an all-too-simplistic movement of inversion”. Instead, he urges geographers to be sensitive to the “multiplicity of rhythms and temporalities” (ibid. 13) of materials and to the specific edifice of governance in which “capacities and affordances” (ibid. 4) can become effective.

To take this warning seriously, a political geology of waste disposal must account for geological agency not as the result of an inherent vitality or vibrancy of things, but as a relative property that emerges in specific human-non-human, geo-social, geopolitical and space-time entanglement. It suggests that the geological agency of potential host rocks is contingent on their specific geological rhythms and the regulatory edifice in which they are enrolled. Disposal geologists have claimed to be well equipped to feel this deep pulse of the earth and to reckon with deep time (Ialenti 2020; Emmenegger 2021) – not least because, like the volcanologists in Bobbette's analysis (2023: 3), they have conceived of geology not as “stable and fixed ... but as material that flows”. The consideration of geological rhythms or ruptures in deep time has led geologists to disqualify certain substrates as host rocks if they do not perform properly or in a way that cannot be compensated for by technological means. In turn, geologists have integrated other rock formations as collaborators in a dynamic multi-barrier disposal design, so that host rocks can effectively realize a specific set of affordances to ensure the long-term containment of radioactive waste – in entanglement also with engineered components (Schürkmann 2022). As it turns out, the dynamic nature of host rocks that 'flow' is not necessarily a techno-scientific problem. Rather, it is a challenge that experts claim to master in order for the host rock to be effective in containing nuclear waste and for the geological disposal concept to work.

And yet, as Kearnes and Rickards (2017: 49) have highlighted, the production of geological knowledge also has the ‘paradoxical effect’ of revealing the earth’s inherent instability, thus destabilizing the very “vision of subsurface stability and performance” on which disposal projects are built. Indeed, the revelation of geological instability is particularly risky in the context of long-running public controversies over nuclear power, energy and waste, and thus has the potential to disrupt not only the myth of containment, but more fundamentally social cohesion about nuclear dream. Against this background, it is hardly surprising that the nuclear industry has sought to reinforce the idea of a rather stable earth in public and political discourses at international (Schröder 2016) and national levels (see e.g. Sundqvist 2002). Often promoted as a rather hegemonic project, it has involved strategic attempts to build consensus around “a view of nature as fundamentally stable” (Anshelm & Galis, 2011: 418) – reimagining the subsurface for geological disposal so that it appears feasible not only to experts, but also to citizens. As I have shown in my own research in Switzerland, this has materialized in the staging of a stable host rock stratum and its public performance and enchantment (Emmenegger 2025). Subterranean maps, models and materials served not simply as representations of a reality ‘down there’, but as ‘political materials’ capable to publicly demonstrate that the chosen host rock would maintain its stability and thus provide long-term safety. Furthermore, these media allowed the geos to gain a visual and aesthetic presence in embodied encounters, almost as a lively heroic actor capable of containing radioactive waste, and rallying the public around a shared belief in its stability.

Geologic Politics of Inertness

The geological formations considered suitable as host rocks for nuclear waste disposal are far more inert than the volcanoes of Java – but more dynamic than expected. As I have shown, geological stability cannot be taken for granted as an inherent property of the subsurface. Rather, it emerges as a relational property of potential host rocks through their enrollment in the technopolitical disposal project. It shows that waste disposal geologists, like the volcanologists in Bobbette’s story, are also concerned with human’s relationship to a dynamic earth. To understand this geosocial process of relationship building, political geology offers a valuable method for analyzing geological knowledge-making not simply as a tool for stabilizing the subsurface as a disposal site, but as a medium through which host rocks become effective and affective in disposal projects and post-nuclear futures. And yet, a political geology of nuclear waste disposal must take into account the inertness of potential

host rocks and, importantly, the geo-logic politics constructing the inertness of life, and the liveliness of the inert.

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