Contaminants in Saprolite: Analysis of Research Gaps and Future Research Directions

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Abstract no. 258

1.Aims and objectives

Context

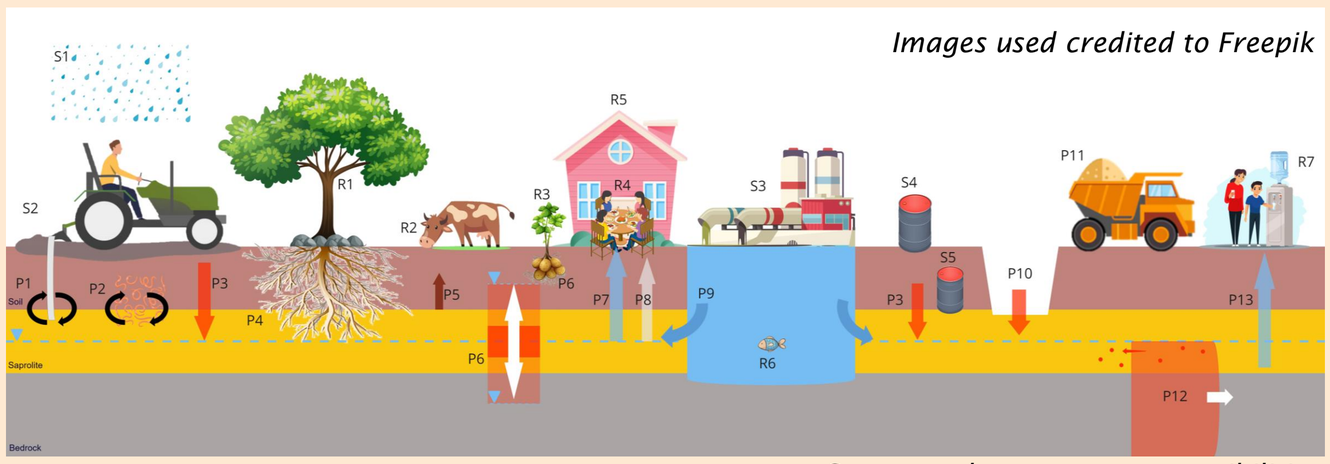
- Saprolite: transitional zone of highly weathered rock between soil and unweathered bedrock. Pedogenic processes transform saprolite into soil.
- Contaminants enter through: overlying contaminated soils, agricultural spreading, waste burial, contaminated surface water etc.
- Distinct properties due to isovolumetric weathering processes, position in hydraulic cycles, mineralogical changes with weathering.
- Particularly urgent to understand its role in contaminant fate and transport in the context of persistent, emerging contaminants.

Overall Scientific Aim (Full project):

To investigate the roles that saprolite plays in contaminant fate and transport. To what extent can the factors controlling contaminant fate and transport in saprolite be quantified and used to inform assessments of the potential risks to receptors?

Objective 1 (Focus of this poster):

Identify key findings, research gaps, and knowledge limitations about contaminant transport and fate in saprolite.



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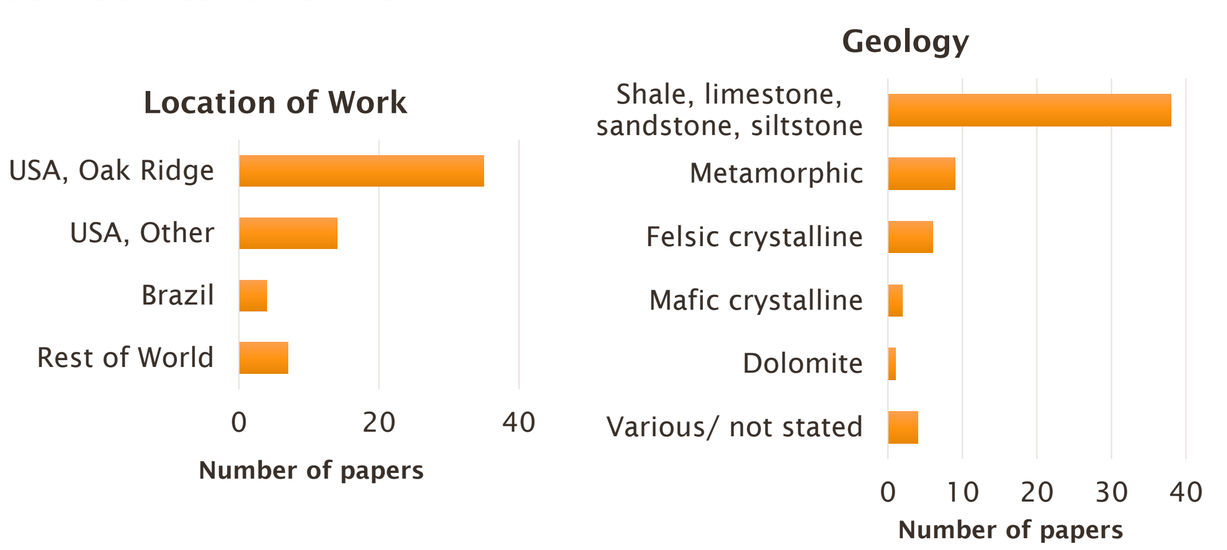
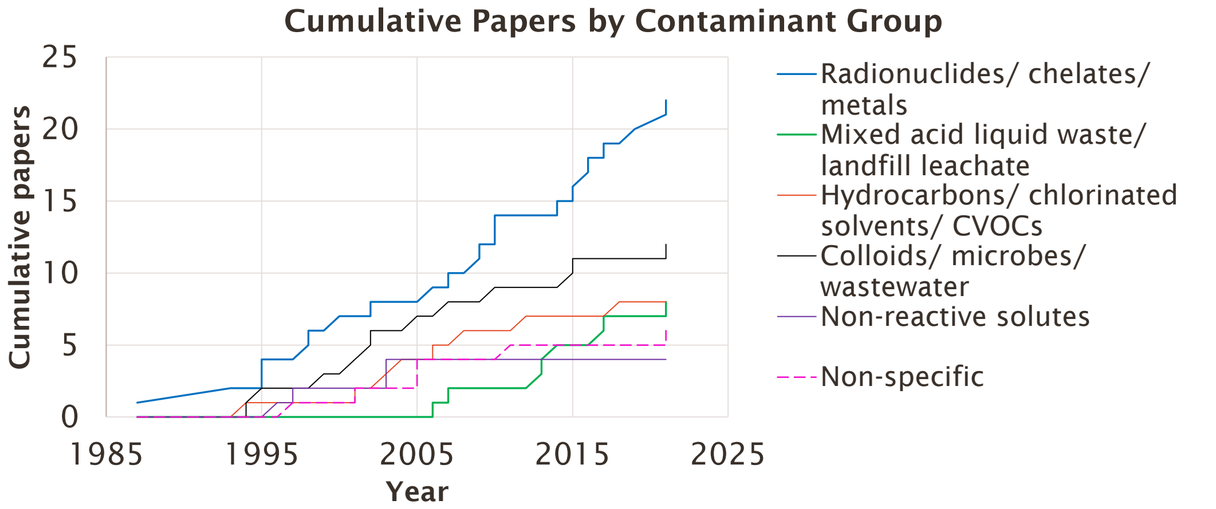
Source-pathway-receptor possibilities

2. Methodology: Systematic Literature Review

- Research question: 'What is the state-of-the-art of knowledge on the presence and behaviour of contaminants in saprolite?'
- Scopus search string 'TITLE-ABS-KEY(saprolit* AND (contamina* OR pollut*))' and Web of Science (WoS) search string 'TS=(saprolit* AND (contamina* OR pollut*))'.
  - Results = Scopus 140 + WoS 118. 170 papers when merged.
- Screen by abstracts according to criteria:
  - Must consider autochthonous/in-situ saprolite in its environmental context.
  - There must be a contaminant known to be present, suspected to be present, at risk of being present, or hypothetically present in the saprolite.
  - This must be a significant focus and purpose of the paper i.e., being investigated, not incidentally mentioned.
  - 108 papers.
- Read in full and extract information into a pre-formulated template. Further exclusions at this stage if the same criteria are not met.
  - 60 papers reviewed in full (+ 12 with access issues which will be added or excluded when these are resolved).

3. Results Overview





4. Discussion

- Dominated by one site: **Oak Ridge, Tennessee, USA.**
  - 58% of papers are solely from this site.
  - Interbedded shale, siltstone, limestone (occasional sandstone) geology.
  - Complex site, used for disposal of >300megalitres of concentrated uranium and nitric acid waste, 1951-1983[1].
- Depths from 'top' of saprolite to surface range from 0cm – 15.7m. Depths from 'bottom' of saprolite to surface range from 48cm – 64.7m. Thicknesses of saprolite range from 14cm – 49m.
- Plants and microbiological effects potentially overlooked factors.
  - 82% do not mention plants or roots, and 68% do not mention any non-contaminant biology or microbiology at all.
- Identified themes: saprolite fracture flow vs matrix flow; preferential pathways; saprolite protection of deeper groundwater; saprolite as a filter (colloidal contaminants, co-contamination); saprolite sub-strata; rapid transport; saprolite features controlling direction of contaminant migration; biodegradation; saturation; saprolite mineralogy and chemistry; seasonal effects of extreme event effects; transitional zones.

5. Potential Research Gaps

- There are major types of emerging contaminants of concern which are not addressed by any of these papers, including PFAS.
  - PFAS have pathways into saprolite, e.g., land spreading of PFAS-contaminated waste products.
  - Being strongly affected by air-water interfaces, PFAS behaviour at the transitional zones might be particularly interesting, including fluctuating saturation effects.
- Potentially important observed effects related to macropore infilling by clays at specific depth zones[2], but currently difficult to see how widespread/ varied these effects are due to over-representation of the Oak Ridge site.

References

1. Brooks, S.C., 2001. Waste characteristics of the former S-3 ponds and outline of uranium chemistry relevant to NABIR Field Research Center studies. *NABIR Field Research Center, Oak Ridge, Tenn.*
2. Driese, S.G., McKay, L.D. and Penfield, C.P., 2001. Lithologic and pedogenic influences on porosity distribution and groundwater flow in fractured sedimentary saprolite: A new application of environmental sedimentology. *Journal of sedimentary research*, 71(5), pp.843-857.

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