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A task-oriented perspective on the role of hydrogeological heterogeneity in transport modeling

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Summary

This poster aims to **highlight the changing influence of hydrogeological heterogeneity across solute arrival times** by:

- using particle tracking through an aquifer analog to measure particle paths
- relating time and distance spent in the hydrofacies to the arrival time distribution, and
- applying clustering of the hydrofacies for distinct segments of the arrival time distribution

Method

1. Solve velocity field over aquifer analog (Fig 1) and run particle tracking simulation.

Record paths of the particles through the hydrofacies.

2. Breakdown particle paths into proportions spent in each hydrofacies as a function of arrival times.

Proportions are in path distance (Fig 2b) and path time (Fig2c)

3. Apply Markov clustering to path transitions for segments of arrival time distribution

Clustering is done in a hierarchy (Fig 2d,e)

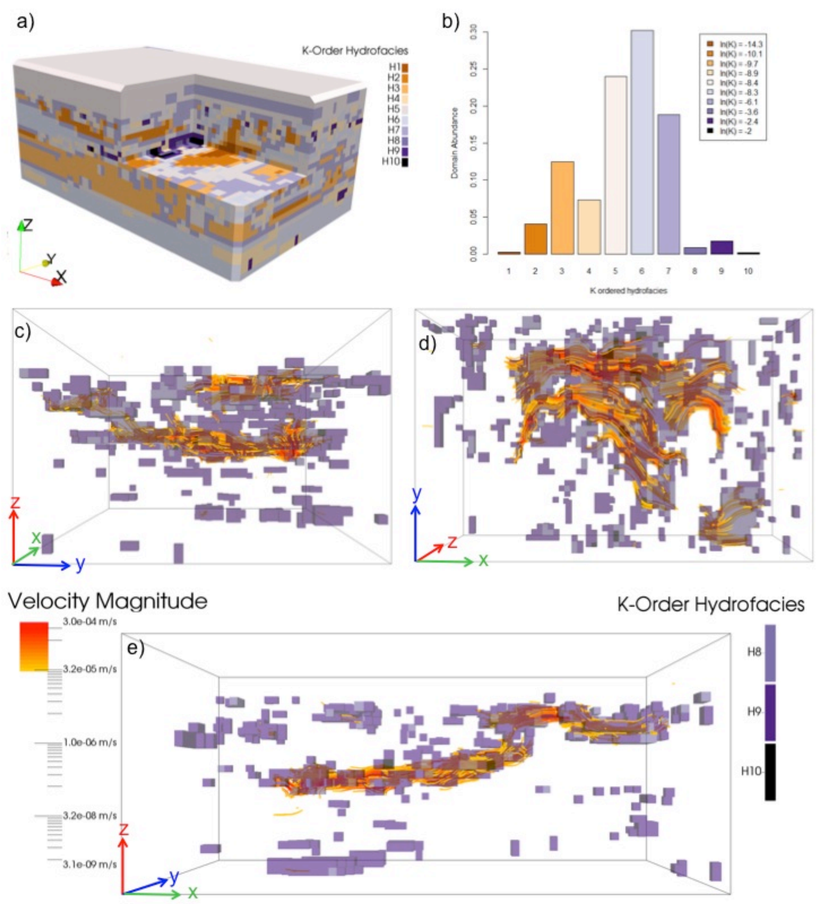
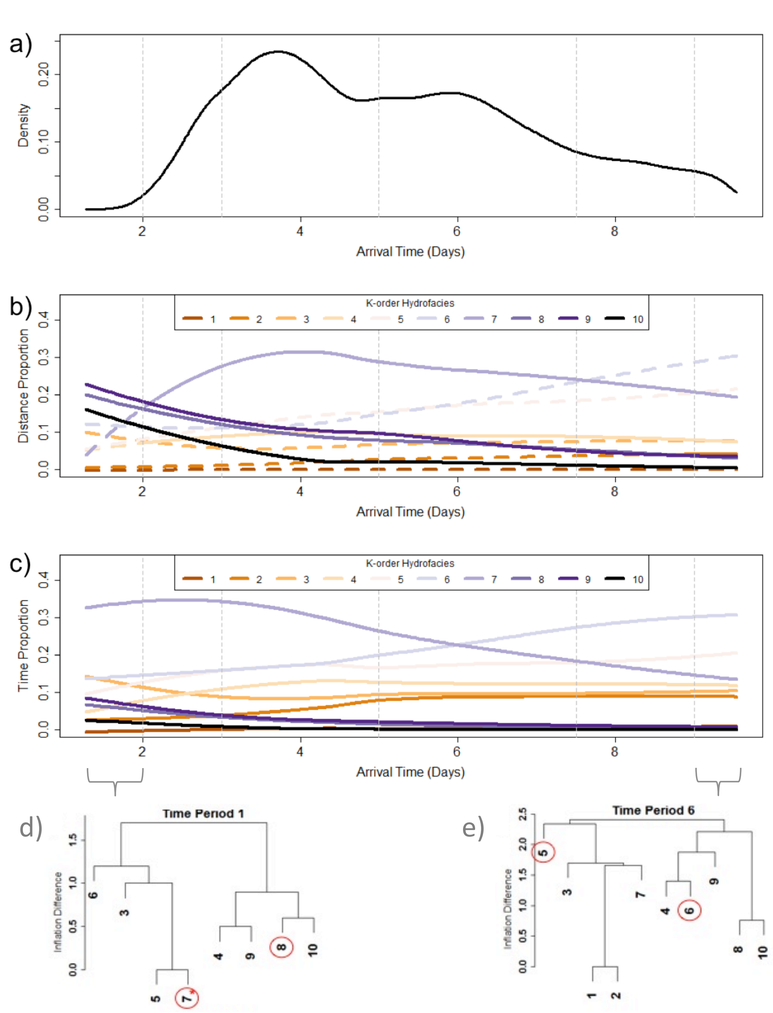


Fig 1 (above): a) Aquifer analog from [1], b) hydrofacies histogram, c-e) highest velocities with highest conductivity hydrofacies.
Fig 2 (right): a) arrival time distribution, b-c) path proportions, d-e) clustering hierarchies of particle transitions through hydrofacies



Results

- Distance traveled in high conductivity hydrofacies decreases with arrival time and is superseded by mid-range conductivity hydrofacies that are abundant in the domain
- Transition clustering is guided by decreasing conductivity hydrofacies with arrival time
- Clustering also shows that a low conductivity hydrofacies (H4) accompanies the high conductivity hydrofacies (H8-10) in a binary clustering case.

Implications

- The **roles of hydrofacies change over the arrival time distribution** of particles, indicating that for different prediction tasks, the approach for characterizing the domain ought to take different perspectives.
- Although intuitive that fast particles will travel through high conductivity paths, this study aims to **visualize** this phenomenon in **realistically complex** heterogeneity.
- Using an analog provides **insight** that is not possible from sparse field data. Although only one realization is used, the methodology is for **complex system analysis.**

References

[1] A. Comunian, P. Renard, J. Straubhaar, and P. Bayer. Three-dimensional high resolution fluvio-glacial aquifer analog – Part 2: Geostatistical modeling. *Journal of Hydrology*, 405(1-2):10-23, July 2011.