

DEPARTMENT OF GEOLOGY
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
1301 W. Green Street, Urbana, Illinois 61801
Phone: (217) 244-5431 FAX: (217) 244-4996

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Systems Geobiology Powers of 10 Exercise

Systems Geobiology is the study of complex interactions arising from the interplay of biological, geological, physical, chemical and even social systems across multiple spatial (microns to thousands of kilometers) and temporal (nanoseconds to eons) scales.

Systems Geobiology is distinct from Systems Biology and Biocomplexity in that these complex interactions are linked geological processes such as sediment deposition and mineral precipitation, thus allowing modern complex systems to be reconstructed from the ancient rock record.

Therefore, Systems Geobiology requires: (1) Tracking and prediction of organismal response to, and control of, environmental change utilizing the geological record. (2) Analysis of suites of fundamental physical, chemical and biological components within their geological and environmental context. (3) Linkage of biological processes with geological processes (i.e. sediment deposition, mineral precipitation, fluid hydrodynamics, etc.). (4) Integration across broad scales of time (nanoseconds to eons) and space (nanometers to light years).

This exercise allows students to systematically evaluate the spatial and temporal Powers of 10¹⁰ scales across which it is necessary to conduct Systems Geobiology analyses.

Students need to know the metric system for spatial and temporal measurements, as well as the numeric prefixes (yocto-, zepto-, atto-, femto-, pico-, nano-, micro-, milli-, kilo-, mega-, giga-, tera-, peta-, exa-, zetta, yotta-). Students also need to know the basic concepts of exponential notation, orders of magnitude differences and have seen the Powers of 10 movie.

The goal of this activity is to have students transition from an external theoretical understanding of the spatial and temporal scales over which integrative Systems Geobiology science is conducted, to a tangible systematically first hand experience with the scales required for conducting holistic integrative science.

The higher order thinking skill of this exercise is to be able to turn their “Powers of Observation” into a “Powers of 10” numerical breakdown and structuring of a complex environment.

The primary goal is to utilize and practice their Socratic reasoning skills via observation and knowledge of spatial and temporal frameworks.

The newly emerging field of Systems Geobiology requires linkage of biological processes with geological processes across broad scales of time (nanoseconds to eons) and space (nanometers to light years). Students are asked to specifically identify the scales of time and space across which Systems Geobiology research needs to be completed. They do this by making direct observations

of a field photograph taken at Mammoth Hot Springs in Yellowstone National Park. Students then translate 10 of their observations onto Powers of 10 charts. This is followed by a class discussion of their results on topics such as: What is missing? How will these analyses be synthesized across such broad scales?

The students evaluate the completeness of each other's observations and Powers of 10 formulation.

URL Resource: <http://www.powersof10.com/>

A handwritten signature in black ink, appearing to read 'B. Fouke', with a large, stylized loop at the bottom.

Bruce W. Fouke, Ph.D.

Office Telephone: (217) 244-5431

Cell Phone: (217) 898-5010

Email: fouke@illinois.edu

Associate Professor, Department of Geology

<http://www.geology.uiuc.edu/~fouke>

Associate Professor, Department of Microbiology

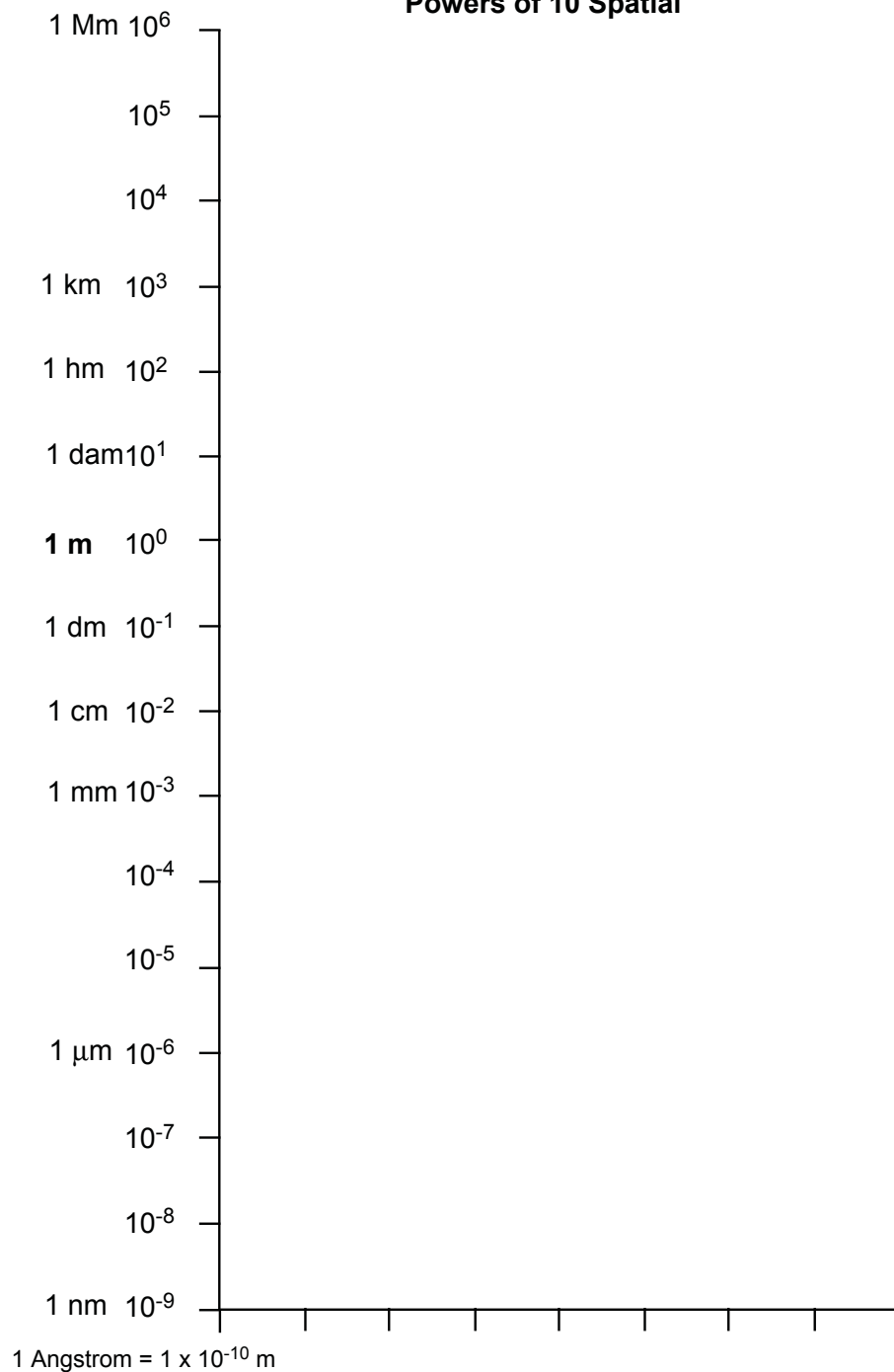
<http://mcb.illinois.edu/faculty/profile/1186>

Associate Professor, Institute for Genomics Biology

<http://www.igb.uiuc.edu>

Earth Circumference = ~ 46,350 km

Powers of 10 Spatial



Earth Formation = 4.6×10^9 yr

Powers of 10 Temporal

