

Geochemistry is the science that deals with the chemical composition and chemical changes and reactions in the solid Earth and its very components:

lithosphere: rocks and minerals,

hydrosphere: oceans, rivers, lakes, and groundwater,

atmosphere: the gaseous shell of our planet.



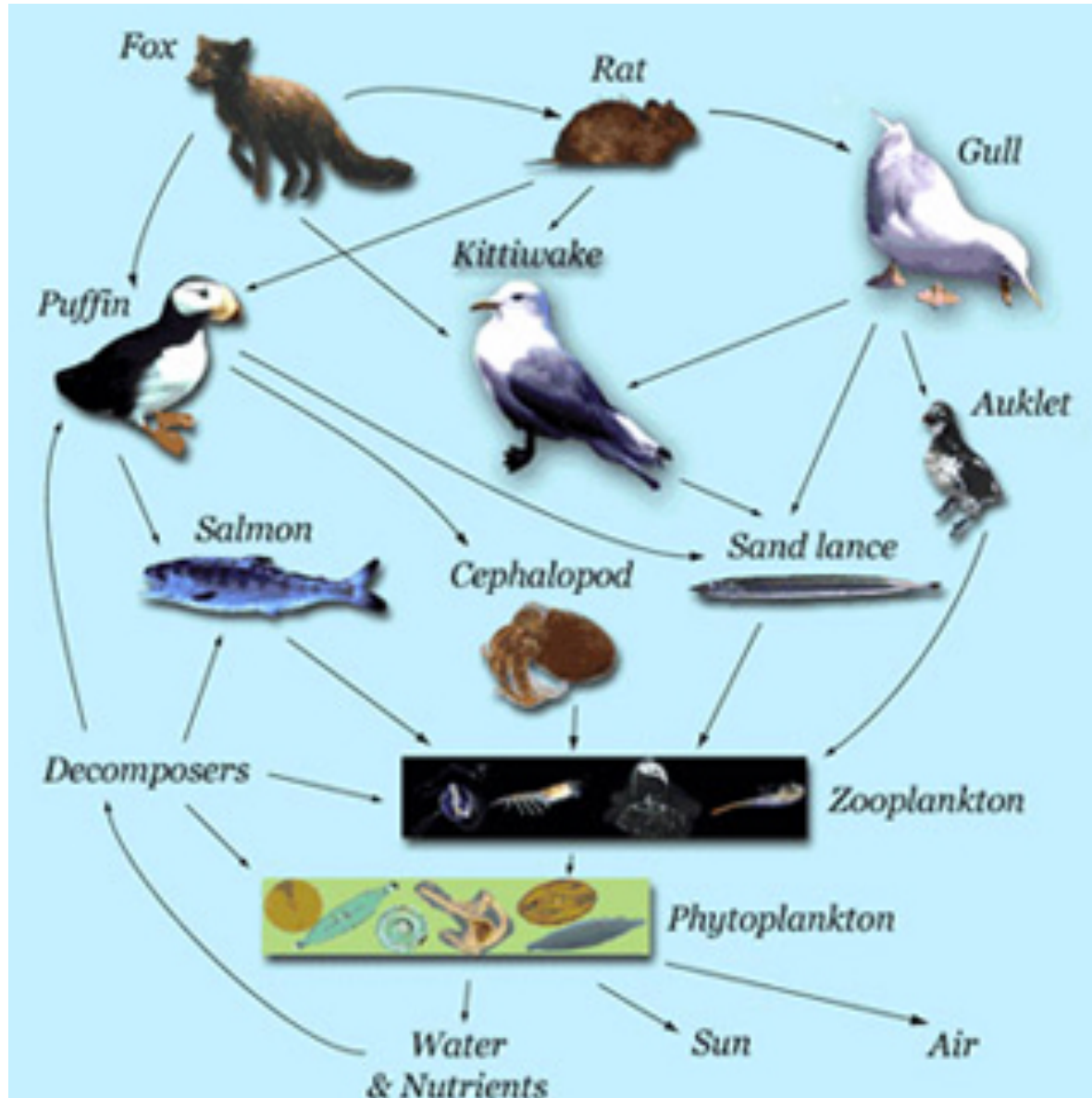
More specifically, it investigates the **relative abundance**, distribution, and transport of Earth's chemical elements and their isotopes.

Victor Moritz Goldschmidt (1888 – 1947)

Environmental geochemistry investigates the impact of natural geochemical processes, and anthropogenic (human-induced) environmental perturbations on our natural systems as well as on human health.

Complexity, Risk, and Uncertainty



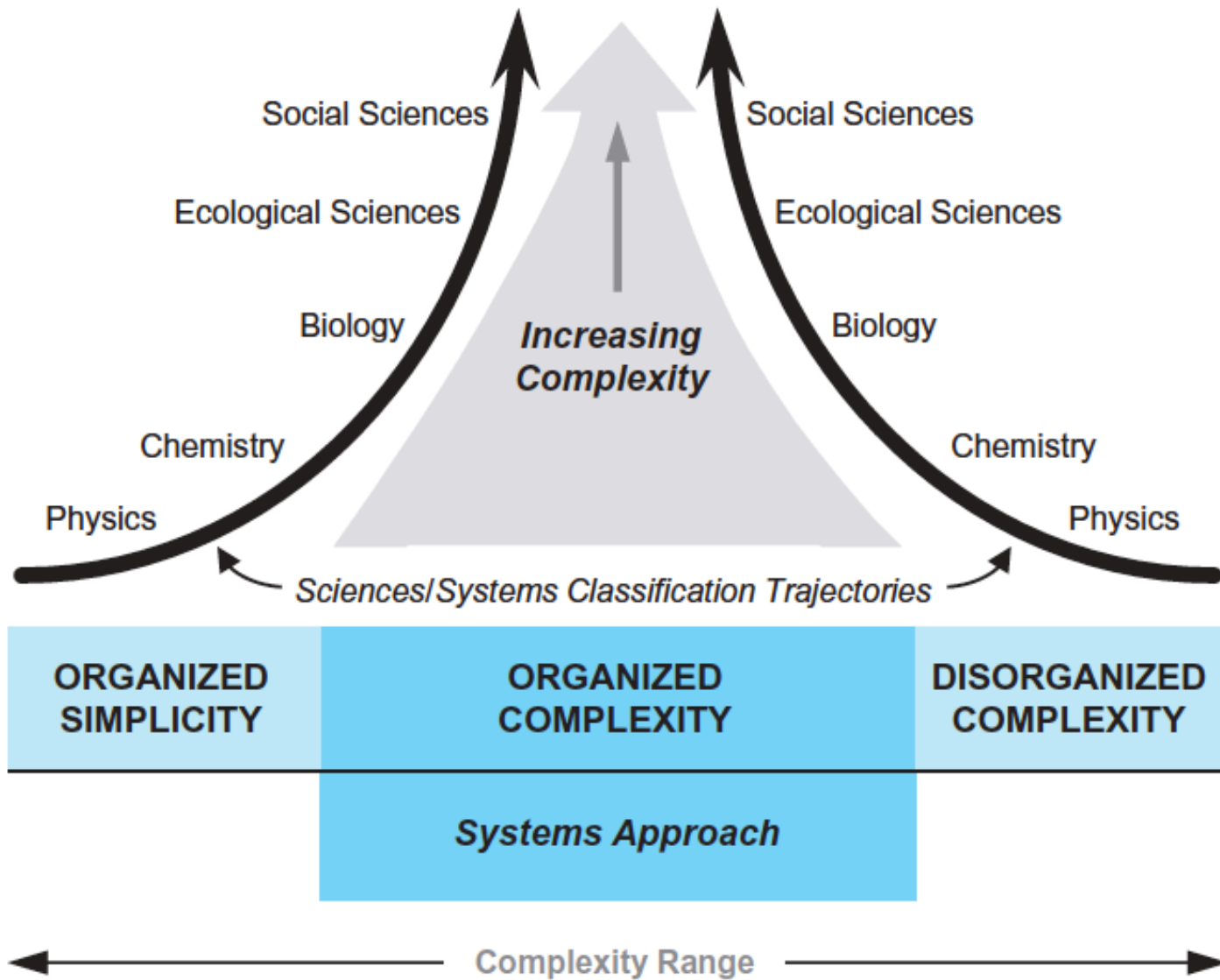


Dynamics of Complex Systems: Complexity in Ecology

- Non linearity
- Self-organisation
- Adaptation
- Critical phenomena
-

Complexity Range:	ORGANIZED SIMPLICITY	ORGANIZED COMPLEXITY	DISORGANIZED COMPLEXITY
Degree of Complexity:	<i>Lowest</i>	<i>Highest</i>	<i>Moderate</i>
System Scale:	<i>Small Number Systems</i>	<i>Medium Number Systems</i>	<i>Large Number Systems</i>
Applicable Principles:	<i>e.g., Newton's Laws</i>	<i>???</i>	<i>e.g., Boyle's Law</i>
Solution Approach:	<i>Mathematical Methods</i>	<i>Systems Approach</i>	<i>Mathematical Methods</i>

Weaver's ranges of system complexity.



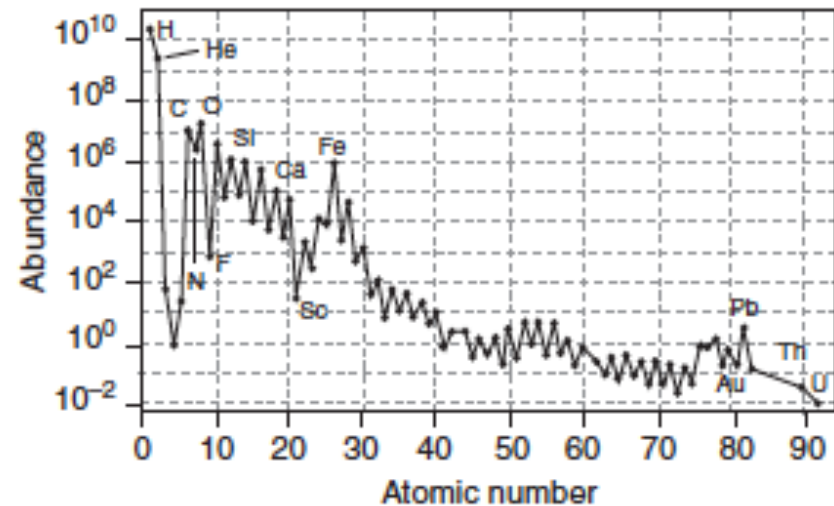
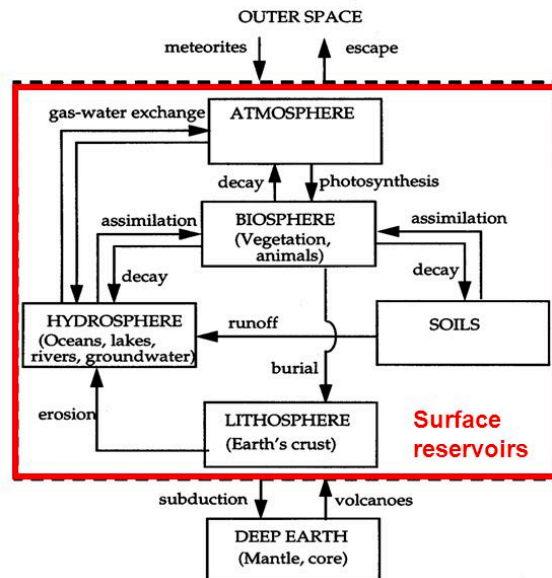
Complexity and the natural sciences. (Credit: Flood and Carson (1993), p. 252, Springer. Copyright © Springer Science+Business Media, New York 1993).

Geochemical cycle, developmental path followed by individual elements or groups of elements in the crustal and subcrustal zones of the [Earth](#) and on its surface. The concept of a geochemical cycle encompasses geochemical differentiation (*i.e.*, the natural separation and concentration of elements by Earth processes) and heat-assisted, elemental recombination processes.

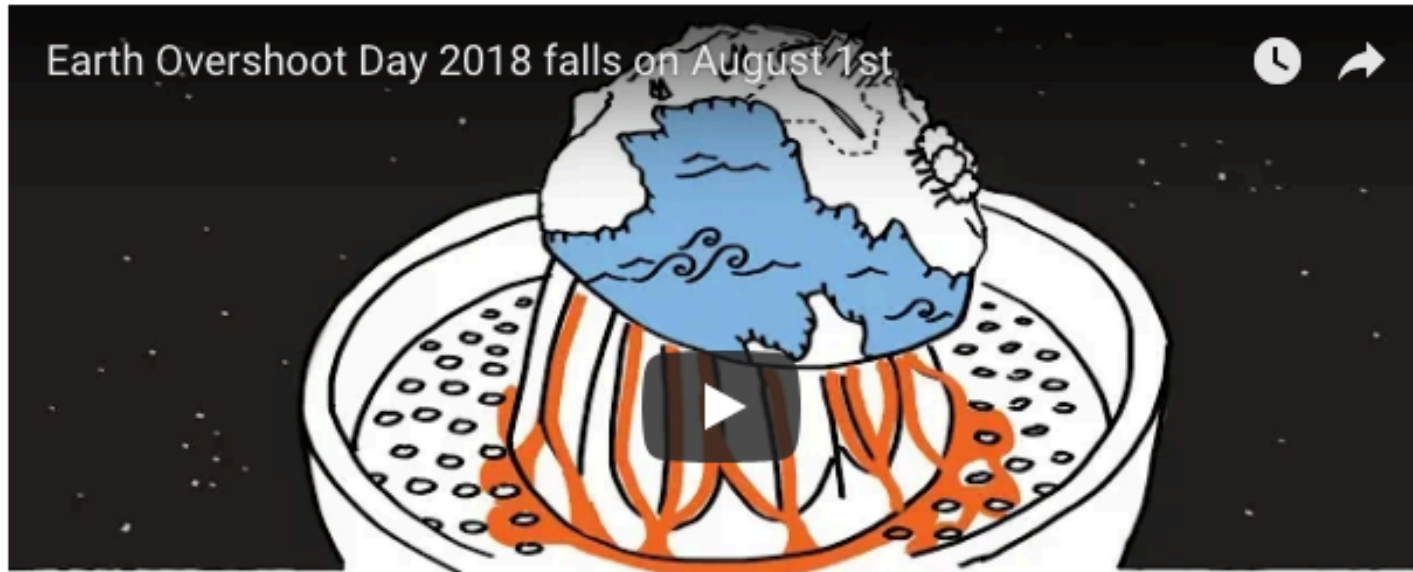
Biogeochemical cycle, any of the natural pathways by which essential [elements](#) of living [matter](#) are circulated. The term *biogeochemical* is a contraction that refers to the consideration of the biological, geological, and chemical aspects of each cycle.

BIOGEOCHEMICAL CYCLING OF ELEMENTS: examples of major processes

Physical exchange, redox chemistry, biochemistry are involved



Abundance of elements in the solar system normalized to $\text{Si} = 10^6$ on a logarithmic y -axis – this is a standard means of normalizing and plotting values for this type of data set.



EARTH OVERSHOOT DAY: AUG. 1, 2018

By the Numbers

3,800

million years ago life
first evident on Earth

104%

increase in world
population since 1970

-58%

decline in average
population size of
vertebrate species since
1970

60%

of humanity's Ecological
Footprint is carbon

The Ecological Footprint

MEASURES

how fast we consume resources and generate waste



Energy



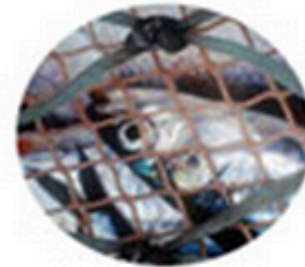
Settlement



Timber & Paper



Food & Fiber



Seafood

COMPARED TO
how fast nature can absorb our waste and generate new resources.



Carbon Footprint

Built-up land



Forest

Cropland & Pasture



Fisheries