

Applied Geochemistry

Ferian Anggara

Schedule and Outline

JADWAL KULIAH APPLIED GEOCHEMISTRY S2 REG, MPG & AUN
SMA 17A, 2016-2015
KULIAH REG INDONESIA & MPG SELASA (11.00-12.30, R 34)
KULIAH AUN KAMIS (09.00-10.30, R 34)

No.	MATERI	Februari		Maret			April			Mei			Juni						
		27	24	3	30	17	24	31	UTS	28	7	14	21	28	4	MT	UTS	UMS	
1	Dasar Kimia Organik & Geokimia HC	DHA																	
2	Geokimia Migas		DHA																
3	Geokimia Batubara			DHA															
4	Biomaterialisasi																		
5	Geokimia HC Lingkungan						FA												
6	Geokimia HC Lingkungan							FA											
7	Geokimia Greenhouse Gas																		
8	UTS + Ujian Tengah Semester																		
9	Dasar Kimia Organik & Geokimia HC								DHA										
10	Geokimia Migas									DHA									
11	Geokimia Batubara										DHA								
12	Biomaterialisasi											DHA							
13	Geokimia HC Lingkungan												FA						
14	Geokimia HC Lingkungan													FA					
15	Geokimia Greenhouse Gas														FA				
16	Ujian Akhir Semester																		

14 hari libur kerabatku tua Alim

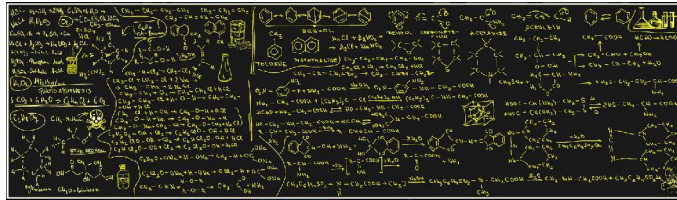
Curriculum vitae

- Name : Ferian Anggara, Dr. Eng
- Research interests:
 - Coal geology
 - Coal bed methane
 - CO₂-geological storage
- Email : ferian@ugm.ac.id
- Mobile : +62 812 275 8490
- Publication: please visit ferian.staff.ugm.ac.id

Environmental Organic Geochemistry

- Introduction
- Organic Pollutant
- Case studies
- Assignment

"Organic chemist"?



Chemistry of carbon

- They contain of element carbon
- 100-plus elements other than carbon combine with another to form about 70,000 inorganic compounds
- Carbon combines with itself and other elements to form about 4 million organic compounds.

Review

- Thermodynamics
- Aqueous solutions (Acid-Base and Solubility Equilibria)
- Oxidation-Reduction Equilibria

Environmental Geochemistry

- The field of study integrating the study of earth's chemical composition and earth system interactions with the interaction of humans with these systems (Sarkar et al, 2007).
- Earth science generally recognizes 4 spheres, the lithosphere, the hydrosphere, the atmosphere, and the biosphere as correspondent to rocks, water, air, and life.
- A new "sphere" or dimension exists in environmental geochemistry that is mindful of the human interactions with the earth systems whether natural or man-made.
- The chemical processes that couple the lithosphere, hydrosphere, atmosphere and biosphere (Sherman, 2011).

Applications of Environmental Geochemistry

- Predicting the fate and transport of chemical pollutants in rivers, lakes, soil and groundwater.
- Understanding controls on atmospheric CO₂
- Identification of paleo-chemical proxies to determine the history of environmental change

Sherman, 2012

Composition of Living Matter

	Proteins	Carbohydrates	Lipids	Lignin
Vascular plants	7	50	10	33
Phytoplankton	23	66	11	0
Diatoms	29	63	8	0
Zooplankton	60	22	18	0



Sherman, 2012

Chemical composition of biomass

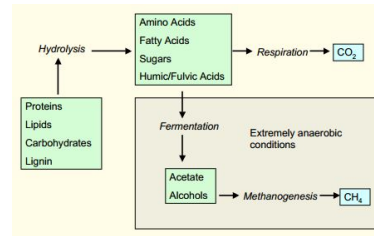
- Chemical constituents of organisms: lipids, proteins, carbohydrates and lignins (higher plants).
- Chemical composition of marine planktonic algae vs. terrestrial higher plant:
 - The OM of marine planktons: mainly composed of proteins (up to 50% and more), a variable amount of lipids (5 to 25%), and, generally not more than 40% carbohydrates.
 - Higher terrestrial plants are largely composed of cellulose (30 to 50%) and lignin (15 to 25%)

Tissot and Wette (1984)

Applied Geochemistry

Environmental Geochemistry-10

Biological Breakdown of Biomolecules

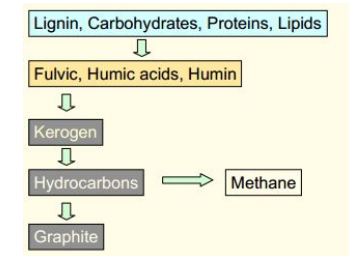


Sherman, 2012

Applied Geochemistry

Environmental Geochemistry-11

Abiotic Breakdown of Biomolecules



Sherman, 2012

Applied Geochemistry

Environmental Geochemistry-12

Pollution?



Applied Geochemistry

Environmental Geochemistry-13

Pollution by Organic Compounds



Applied Geochemistry

Environmental Geochemistry-14

Toxic organic chemical

The danger posed by any organic chemical – its toxicity – depends on three things:

1. Its concentration – how much of it there is
2. The susceptibility of the organism that is exposed to that concentration – some organisms are not affected by some chemicals, while others are; for example, some people are highly affected by the natural organic chemical in poison ivy, while others are not
3. The exposure – whether or not and for how long the susceptible organism has contact with the chemical.

Brown, 2015

Applied Geochemistry

Environmental Geochemistry-15

Anthropogenic components

- Anthropogenic = manmade
- Some anthropogenic organic compounds do not have a natural source (→ xenobiotic)
- Because they have no natural source their presence in the environment is unambiguously indicative of pollution.
- Their impact on the biosphere is significant because organisms have not had the opportunity to evolve in their presence, and so may lack the ability to metabolize or otherwise eliminate the chemicals

(Killops & Killips, 2005)

Applied Geochemistry

Environmental Geochemistry-16

Anthropogenic components

- Some of these compounds are
 - Toxic
 - Teratogenic (i.e. causing foetal deformities)
 - Carcinogenic (i.e. causing cancer).
- The more stable hydrophobic compounds tend to accumulate in certain tissues in higher organisms and cannot be metabolized.
- Because they are fat-soluble they can even be passed on to the offspring of animals (e.g. via milk for mammals and via egg yolk for birds and fish).

(Killops & Killips, 2005)

Applied Geochemistry

Environmental Geochemistry-17

Organic Pollutants

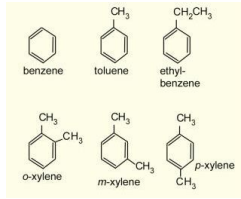
- BTEX Compounds
- Polycyclic Aromatic Hydrocarbons (PAH)
- Synthetic Chlorohydrocarbons
- Persistent Organic Pollutants (POPs)
- Polyfluorinated compounds (PFCs)

Applied Geochemistry

Environmental Geochemistry-18

BTEX Compounds

- BTEX is the term used for benzene, toluene, ethylbenzene, and xylene- volatile aromatic compounds typically found in petroleum product, such as gasoline and diesel fuel." - Environmental Protection Agency, 2010



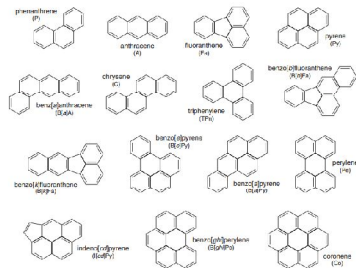
BTEX Compounds

- Exposure to each of the individual chemicals can produce neurological impairment via parent chemical-induced changes in neuronal membranes
- Benzene can additionally cause hematological effects, which may ultimately lead to aplastic anemia and acute myelogenous leukemia, and there is evidence that ethylbenzene is carcinogenic in other tissues.

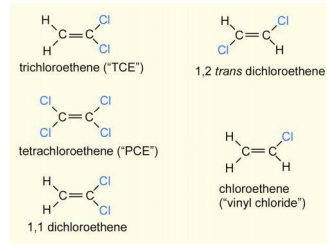
Polycyclic Aromatic Hydrocarbons (PAH)

- CO₂ and H₂O are the major products from combustion of fossil fuels
- In-efficient combustion → aromatic hydrocarbon that contain several fused benzoid rings → PAH
- Carcinogens
- Street dust and asphalt have been found to contain PAH
- Urban drainage water, fluvial transport → PAH concentration in lacustrine and near shore environment
- In ancient sediment:
 - wild fire, primarily initiated by lightning strike, are the most likely source of PAH in ancient sediment ;
 - wood fragment, coal, and ash linked to igneous activity

Major pyrolytic PAH found in sediments

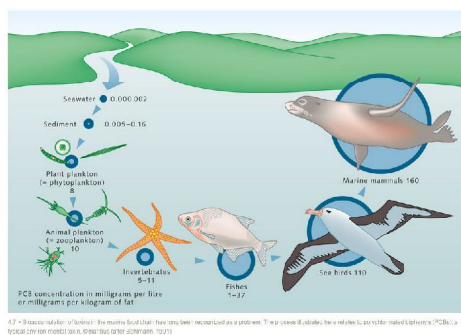


Synthetic Chlorohydrocarbons



Persistent Organic Pollutants (POPs)

- Substances that possess toxic properties and resist degradation
 - pesticides such as DDT and lindane,
 - industrial chemicals such as polychlorinated biphenyls (PCBs), and
 - substances such as dioxins, which are the unwanted by-products of manufacturing and combustion processes
- Can be transported over long distances and accumulate in the environment
- POPs cause problems because they are stored in the fatty tissue or organs of animals, where they can have toxic effects → disrupt endocrine system



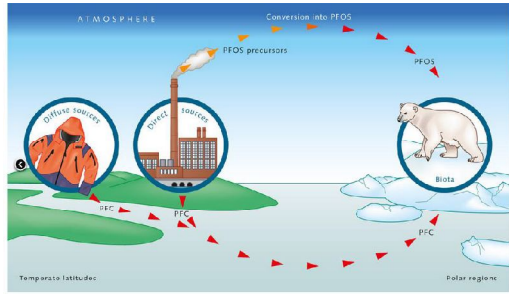
4,7 - Difluoro octahydro-2H-chromen-8-one (PFOS) has been recognized as a priority toxic chemical under the Stockholm Convention on Persistent Organic Pollutants (POPs).

Polyfluorinated compounds (PFCs)

- Non-natural origin
- Identified in the environment at the end of the 1990s
- Mainly used as fluoropolymers in the textile industry, for example, in the manufacture of breathable membranes for outdoor clothing, and in the paper industry in the production of water-, stain- and grease-proof paper (e.g. fast-food packaging), surface treatment of furniture, carpets and clothing textiles and in non-stick coatings for cookware (such as Teflon frying pans)
- Carcinogenic
- PFCs can be detected in water, soil, air and living organisms worldwide – including humans
- High levels of PFCs have been found in numerous foods as well as in human blood and breast milk



Furniture cushions typically contain 100,000 to 300,000 parts per million flame retardants.



4.9 - PFCs can travel great distances in water or air. Through a direct pathway, they sink to the ocean, where they are carried down to the sea. They can also be transported indirectly through the atmosphere. For example, volatile PFCs precursors are released into the atmosphere, where they are converted into PFOS, which is then transported back to the ocean as shown in this diagram. Source: Environmental Geochemistry, 28

Case study: Oil sand exploration in Canada



A picture is worth a thousand words

Organic chemicals

- hydrophilic and
- hydrophobic



End