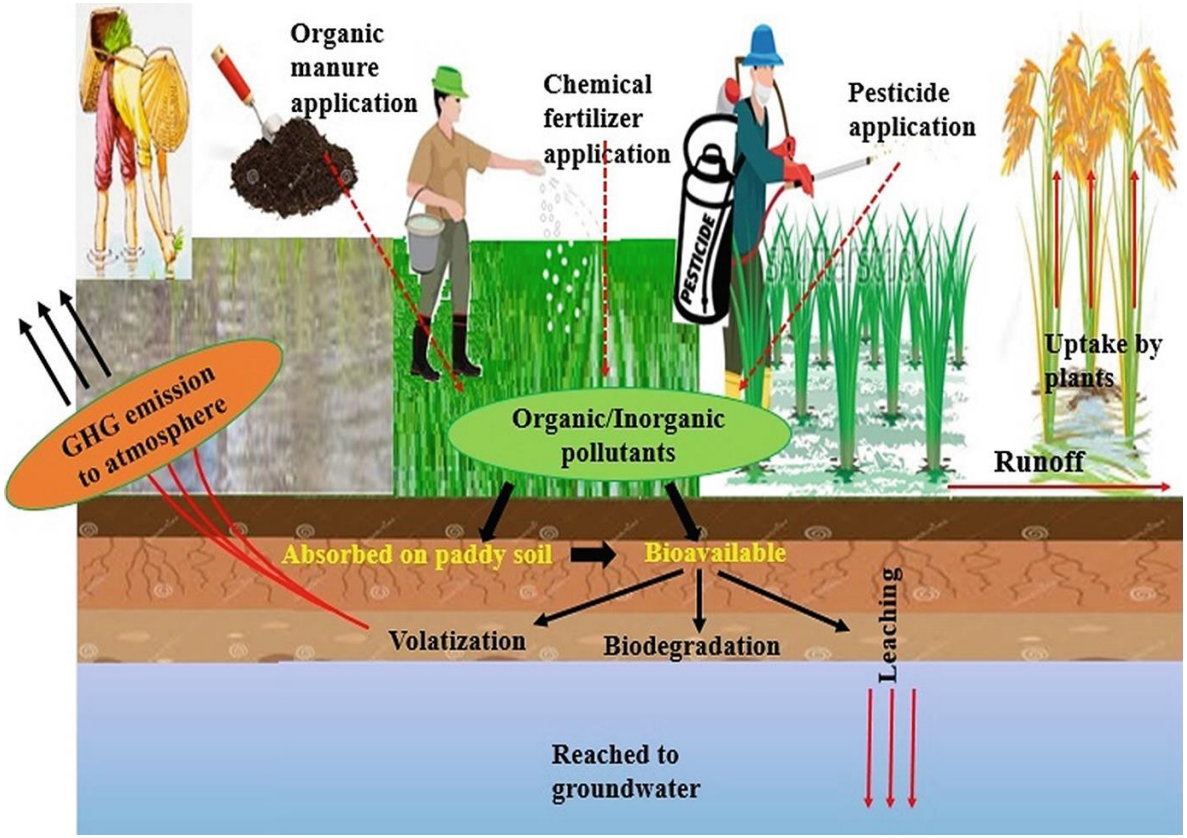
FATE OF SOIL POLLUTANTS-I

AAUE1003 SOIL POLLUTION
Oğuz Can TURGAY (Ph.D)

Department of Soil Science and Plant Nutrition
Faculty of Agriculture
Ankara Universty



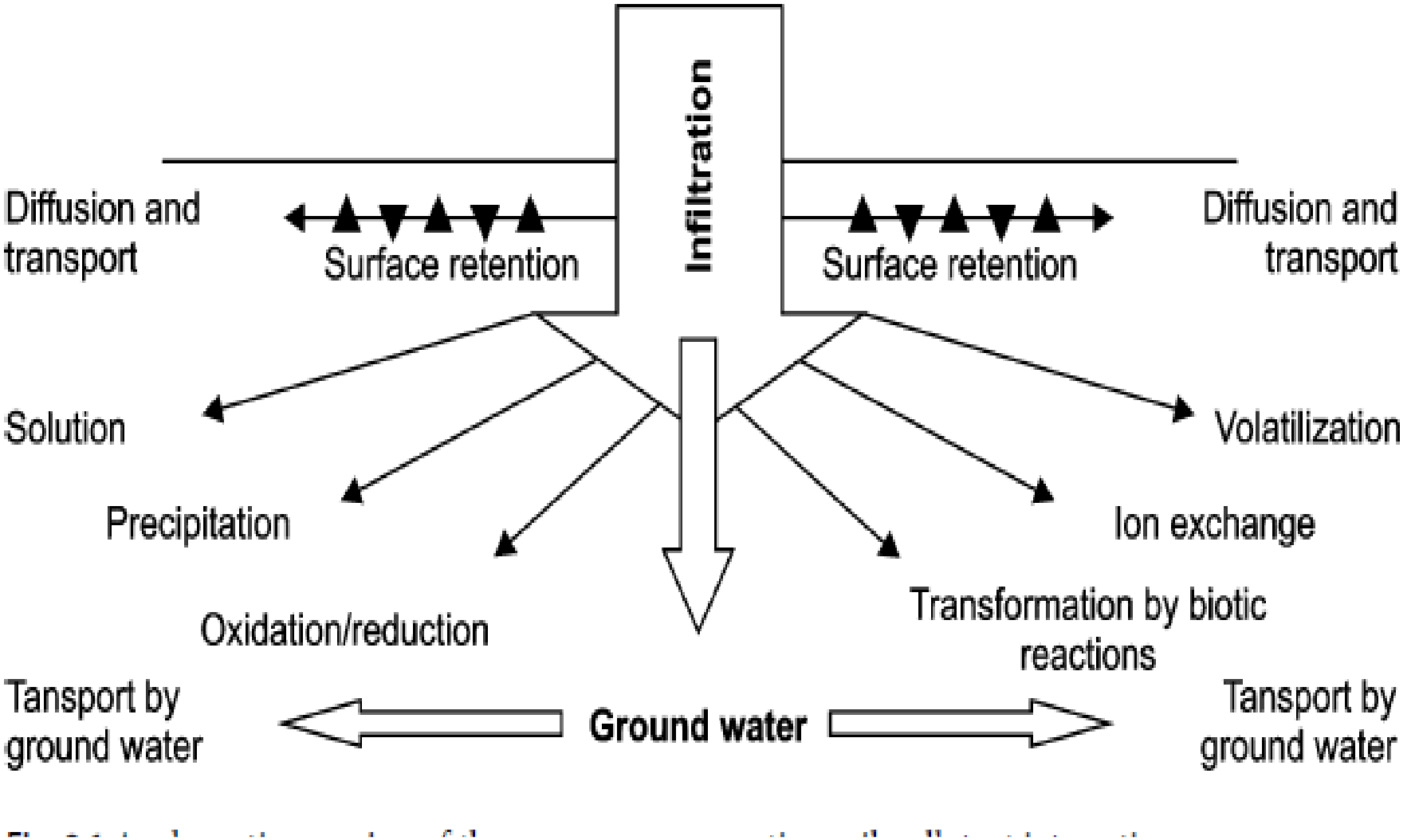
Fates of Soil Pollutants are related physical-biological-chemical processes in the soil

1) Dilution and retention on the surface or underground
2) Infiltration, difusion and transport (more related to water behaviours in soil
3) Chemical/biochemical stabilization (being fixed due to soil chemistry/biochemistry
4) alteration, transformation, biodegradation (chemical structural changes and conversions)

1 and 2 are the stages where the pollutant is mixed and dispersed into the soil and Generally related to physical soil properties

3 and 4 are the stage reflecting chemical and biological events in soil and period for the occurence of secondary "residual" pollutants

Soil-pollutant interactions



1. (retention)

1.1 Adsorptive retention)

Physical adsorption

The pollutant molecule binds to the surfaces of the soil grains by low energy Van der Waals bonds..

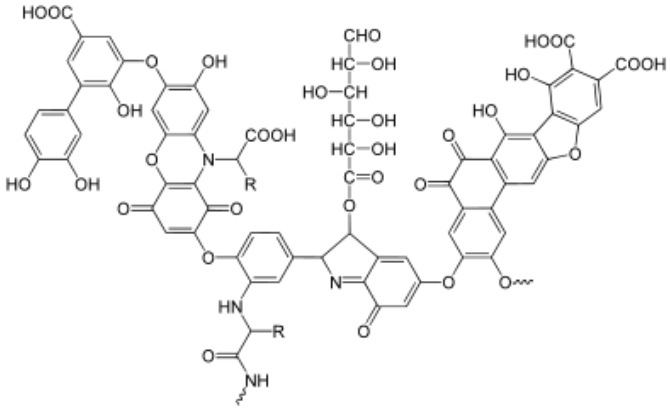
No change in pollutant characteristics during this adsorption process

- Chemical adsorption

The pollutant molecule binds to the sol surfaces by high energy covalent bonds.

Pollutant can change chamically.

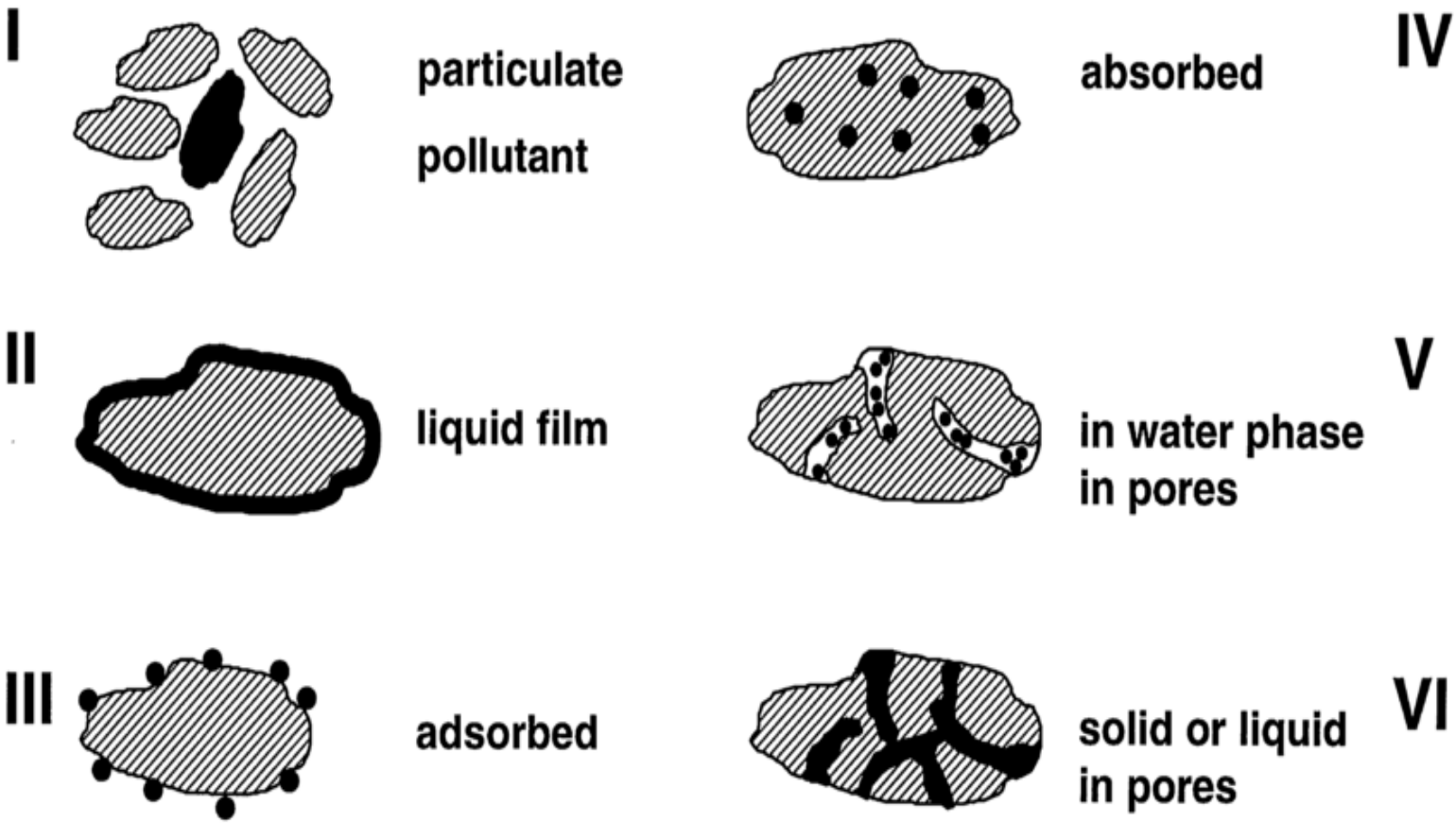
It is difficult to distinguish two sorption mechanisms. However, as the temperature increases, the pollutants held by physical adsorption decreases, which is the opposite in the case of chemical adsorption.



Clay minerals, zeolite, Fe / Mn (OH), Al (OH), humic materials, bacterial mucus compounds, plant residues constitute the general "adsorbents" (adsorbing soil surfaces)

Rock-forming minerals such as mica, feldspar, pyroxene and amphibole are also suitable adsorbers to which pollutants bind…

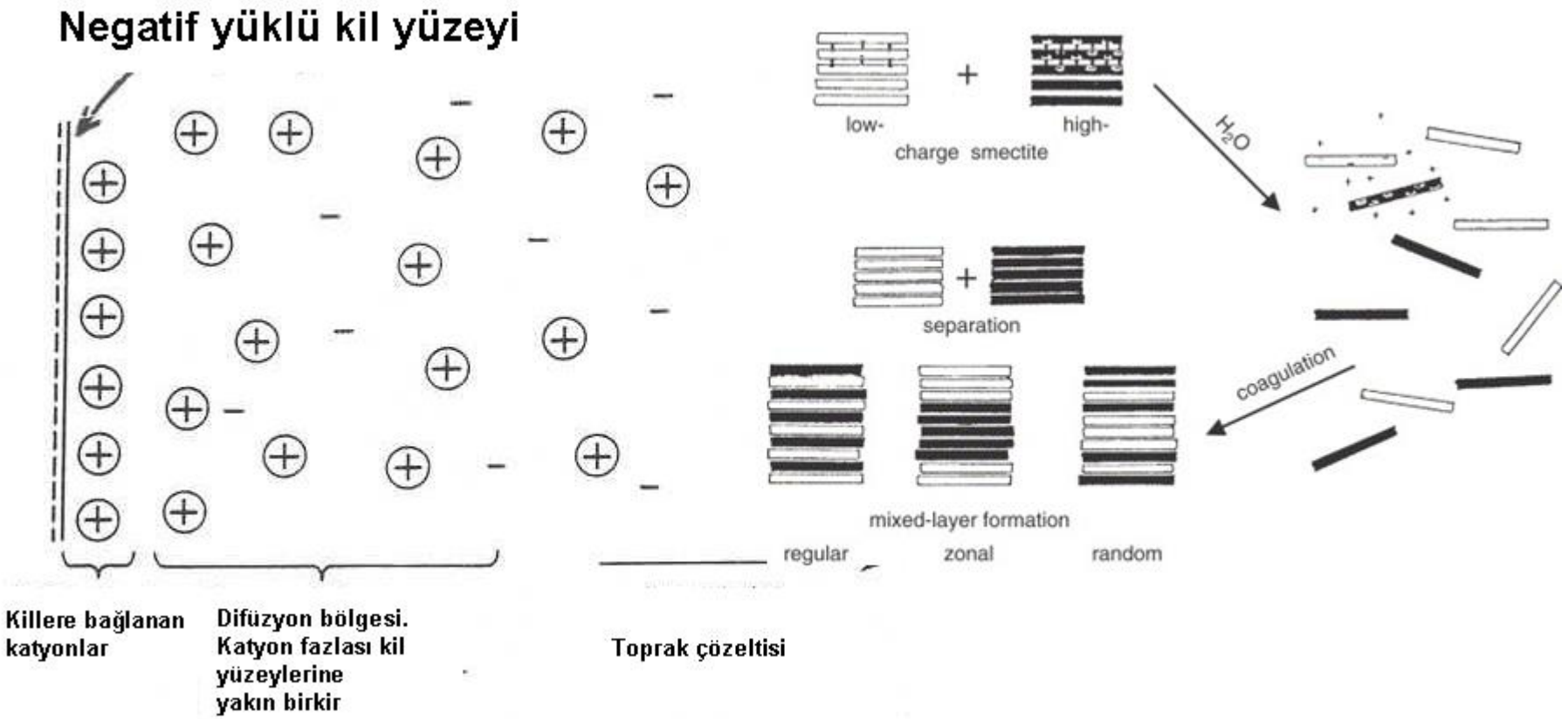
Soil pollutants can be retained in soil in many different ways depending on its own and soil characteristcs



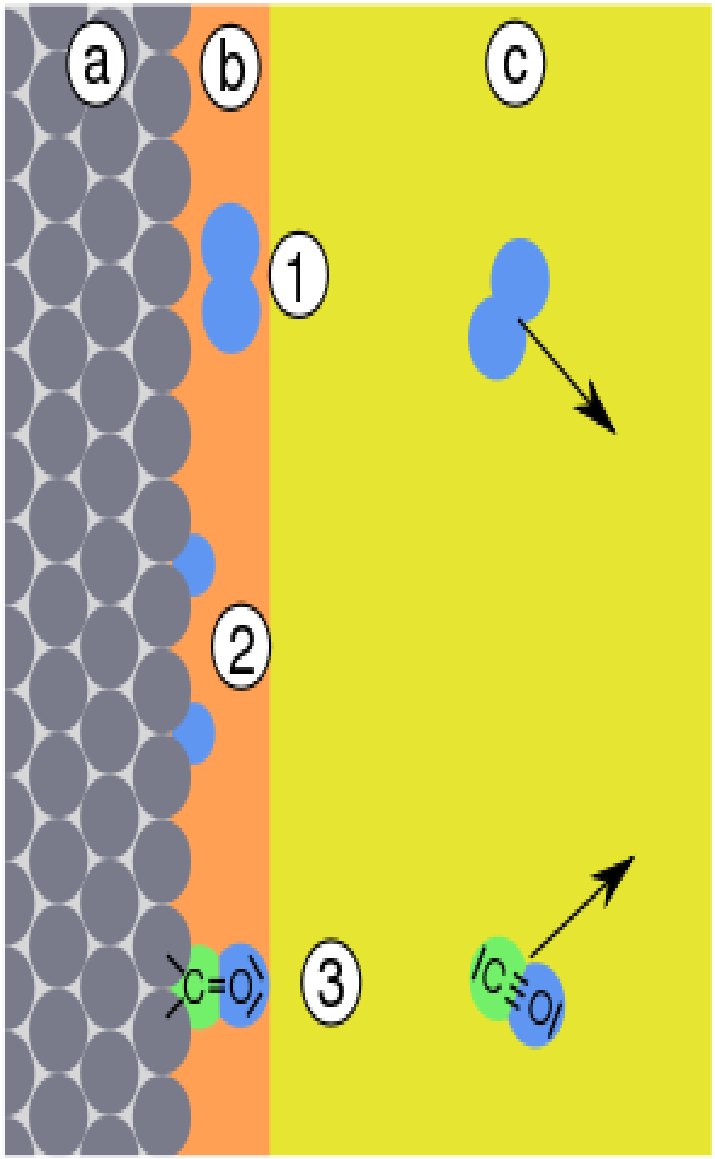
Physical adsorption

Physical adsorption is related to the high "surface energy" and ‘’ surface load" of clay minerals and colloids to adsorb pollutants.

These two properties cause ionic contaminants to bind to adsorbents.



Chemical retention (chemisorption)



- **The formation of covalent bonds during chemical retention provides a much greater binding energy compared to physical adsorption.**
- **The surface atoms of a molecule under chemical sorption can differentiate to allow bond formation, so the pollutant molecule loses its previous structural properties.**

a- colloidal surface
b- diffusion double layer
c- soil solution
1- pollutant molecule prior to chemical retention
2-chemical retention stage
3- pollutant molecule after chemical retention

Factors affecting the adsorption mechanism

Soil Properties;

- Soil mineralogical composition (clay type, montmorillonite, kaolinite)
- Particle size distribution clay + sand + silt %)
- Content and distribution of humic substances in soil
- Physical-chemical properties of soil solution
- exchange capacity of organic and mineral colloids in soil

Pollutant characteristics

- concentration and physical-chemical properties,

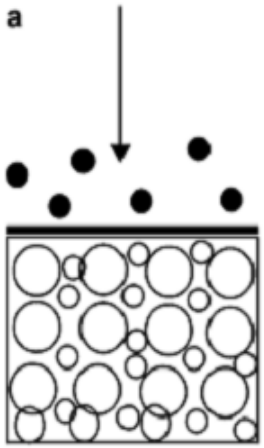
Secondary factors

- climatic conditions
- soil management (agriculture-industry-settlement etc.)

1.2 (non-adsorptive retention)

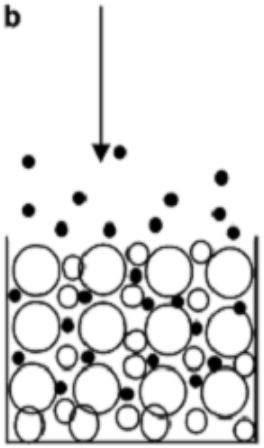
1.2.1 (entrapment)

Trapping of pollutant particles and dissolved molecules in soil pores is one of the important mechanisms for holding pollutants in the soil and can occur in three different ways;



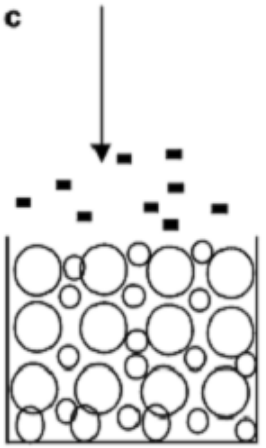
Tabakalanma

Kirletici > por büyüklüğü (biyolojik faliyetleri sonucunda da oluşabilir)



Süzülme

Kirletici = por (Kirletici>por olana kadar Süzülme süreci devam eder)



Fiziksel-kimyasal tuzaklanma

Kirleticinin toprak por uzayındaki hareketi fiziksel/kimyasal dönüşümler sonucu por çapından daha büyük kirletici moleküllerin oluşumu nedeni ile de sınırlanabilir

1.2.2 Precipitation

- **The retention of pollutants in the soil may occur during geochemical reactions when the pollutants contained in soil pores change from "insoluble" form to "dissolved" form.**

- **Precipitation are controlled by acid-base balance and redox conditions.**

- **These conditions are reversible and a previously precipitated compound can become soluble if conditions change.**

2. INFILTRATION

- The most common mechanism for contamination of soil water and in most cases groundwater along the profile near the surface.

- As the water moves towards the lower layers under the effect of gravity, it dissolves the pollutants they encounter and carries them to the lower layers.

- Once polluted waters reach groundwater, they are transported to different distances horizontally and vertically by geochemical movements.
- Water movements transporting pollutants are
  - Natural water cycle (precipitation-evaporation circulation)
  - Surface water flow
  - Additional water intake

2. INFILTRATION

2.1 Pollutant transport

Pollutants are transported into the geochemical water cycle by two mechanisms;

(1) Advection is the horizontal fluidity caused by groundwater moves in underground layers (calculated by Darcy's law).

(2) Dispersion; mixing of different fluids into the water movement irregularly during advection

Darcy's Law Formula

$$Q = \frac{-kA(P_b - P_a)}{\mu L}$$

$Q - total\ discharge\ in\ m^3/s$

$k - soil\ coefficient\ of\ permeability\ in\ m^2$

$A - cross\ sectional\ area\ of\ flow\ in\ m^2$

$P_b - initial\ pressure\ in\ Pa$

$P_a - final\ pressure\ in\ Pa$

$\mu - viscocity\ in\ Pa$

$L - length\ in\ m$

As a result…

Pollutants may exhibit different behaviors depending on;

- physical and chemical characteristics of the pollutant itself

and

- physical, chemical and biological characteristics of the soil contaminated

understanding of pollutant behaviors are closely related to ‘’the interactions between pollutant and soil environment’’