

## Preferential Flow in Soils

Preferential flow is the non-uniform movement of water through a soil profile along certain pathways. Three major types of these pathways are macropores, finger flows, and funnel flows, also described as flows over a sloping coarse layer.

### Macropores

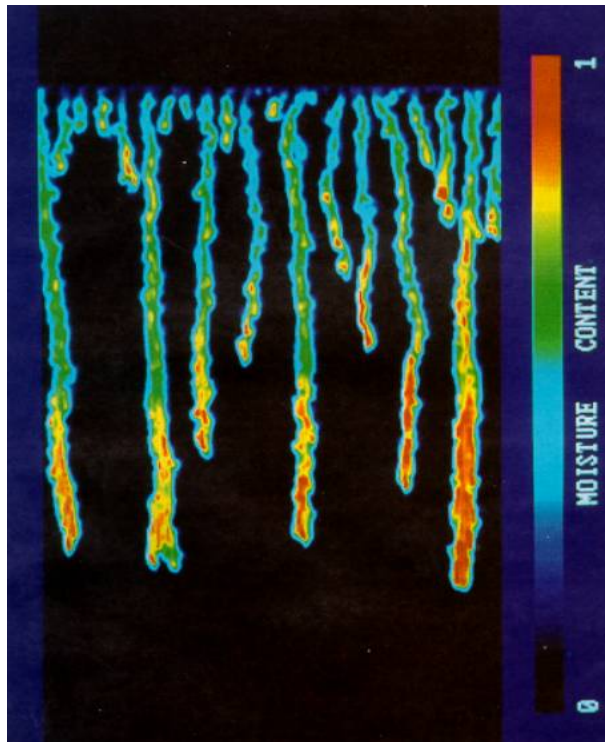
- Stan Brand

- Macropores are characterized as large diameter channels created by biological, geological or agricultural activity within the surface and subsurface of soil. Therefore, plant roots, soil cracks, soil fauna or human interaction influence the changes of the macropore flow structure.
- Macropores have a significant part in preferential flow patterns, hydraulic conductivity and evapotranspiration. The macropores play a major role in amplifying hydraulic conductivity of soil allowing water to infiltrate faster or for shallow groundwater to flow faster. Cracks also play a major role in the respiration of soil where the exchange of different gases occurs.
- The study or modeling of macropores helps to understand how the processes described work and what effect the changes within the soil can have on the environment. Furthermore, the greatest impact to the macropores is done by human interaction in manipulating the soil structure through agriculture and waste management. These two processes alone can cause a great danger to soil infiltration of groundwater. Therefore a greater understanding of macropores is needed to employ better methods of soil modification.

## Finger Flows

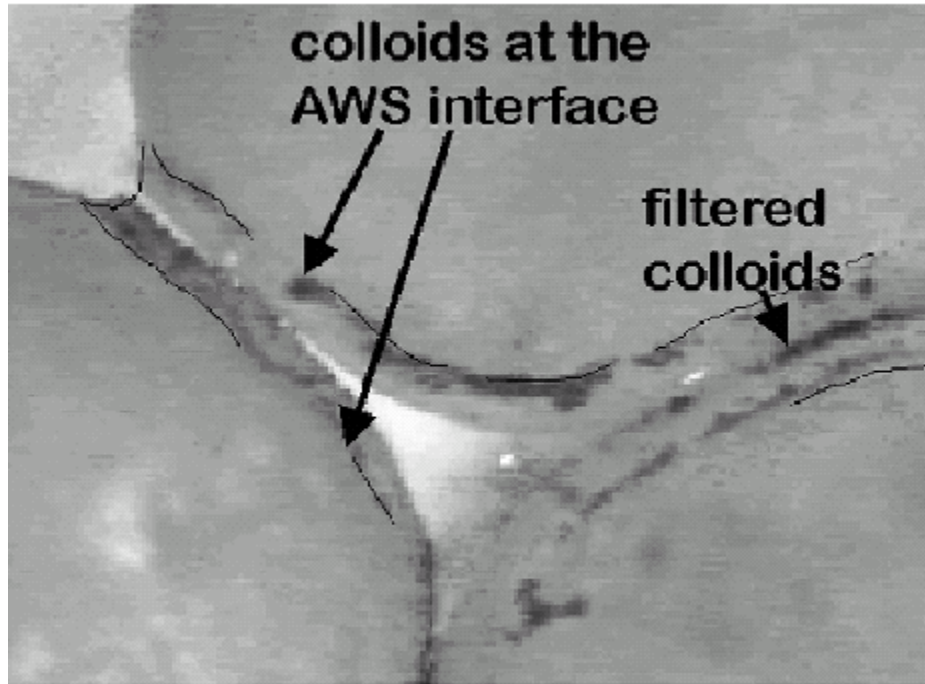
-Ivan Chen

- First seen in 1970s Eastern Long Island with Aldicarb pesticide
- This occurs mostly in coarser soils
- Water seeps through the ground into the ground water table at a rapid speed.
- Flows in sandwich like patterns water, sand, water, sand etc.
- Seen below, the flow merges into larger columns where the soil is less saturated with water.



- Water basically flows from wet to drier soils
- This flow pattern is found to be most prominent through the areas of sand soils
- How does it first start? → May get a start from the roots which give a natural channel for finger flow to begin.

- What assists in bringing the chemicals/ fluids down so far? → Colloids cause the liquids to bind to it and pull it down.



- Here it shows that colloids are binding fluids to itself
- However most colloids are caught at the surface leaving less at the deeper soil profile
- Colloids help in binding chemicals also thus if more are at the surface, then there is less to stop pesticides once it penetrates the surface allowing it to easily fall into finger flow and also allow pesticides to reach the ground water table at an alarming rate.

(All images are from this site:

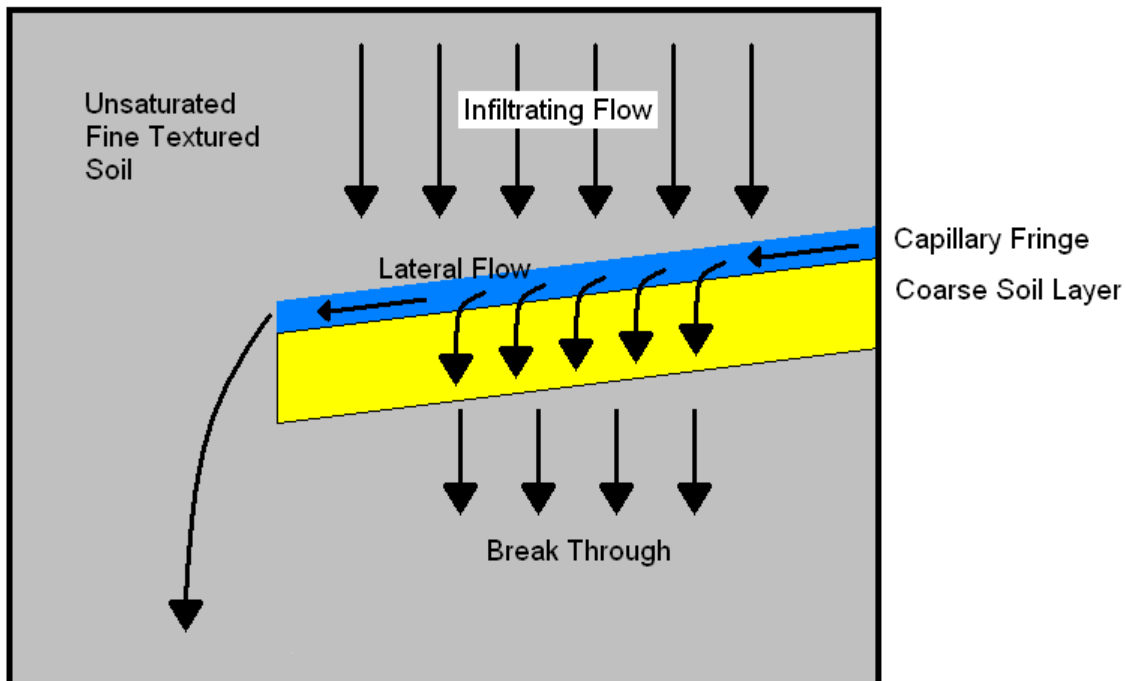
<http://soilandwater.bee.cornell.edu/Research/pfweb/educators/intro/fingerflow.htm> )

## Flow over a sloping coarse layer

-Adam Fox

- In unsaturated soils, water moving vertically through the soil profile does so due primarily to matrix forces, or the capillary affect of the pore spaces.
- When the infiltrating water encounters a change in particle size, such as a layer of coarse soil underlying a layer of fine textured soil, the water will pool up or accumulate along the boundary between the two layers because the matrix potential of the coarse soil is lower than that of the fine soil, which causes the water to be more strongly attracted to the smaller pore spaces.

### **Preferential Flow over a Sloping Coarse Layer**



Funneled Flow

© AGF 2008

- The restriction of the coarse layer causes the accumulated water to flow laterally across it by gravitational force.

- The water will flow through a layer of saturated soil along the boundary between the fine and coarse soils called the capillary fringe.
- The water will continue to flow laterally through the capillary fringe until the matrix potential of the coarse layer is equal to the matrix potential of the fine textured soil, at which point it will begin to move vertically downwards into the coarse layer. This is known as breakthrough.
- At the point of breakthrough, the lateral flow stop as the water moves downward. Above and below the breakthrough region, there is a region of partial breakthrough, where the water cannot penetrate completely into the coarse layer.
- The distance the water will travel along the textural interface is related to the rate of infiltration. A high level of infiltration will cause water to accumulate rapidly in along the boundary and increase the matrix potential quickly, which then allows the water to move into the coarse layer quickly, resulting in a small lateral displacement.
- Understanding the behavior of preferential flow over a sloping coarse layer is important in understanding groundwater recharge, subsurface storm flow, pollutant transport, and the design of waste disposal facilities.