

Scienze e Tecnologie per i Beni Culturali

Corso di Geologia Applicata

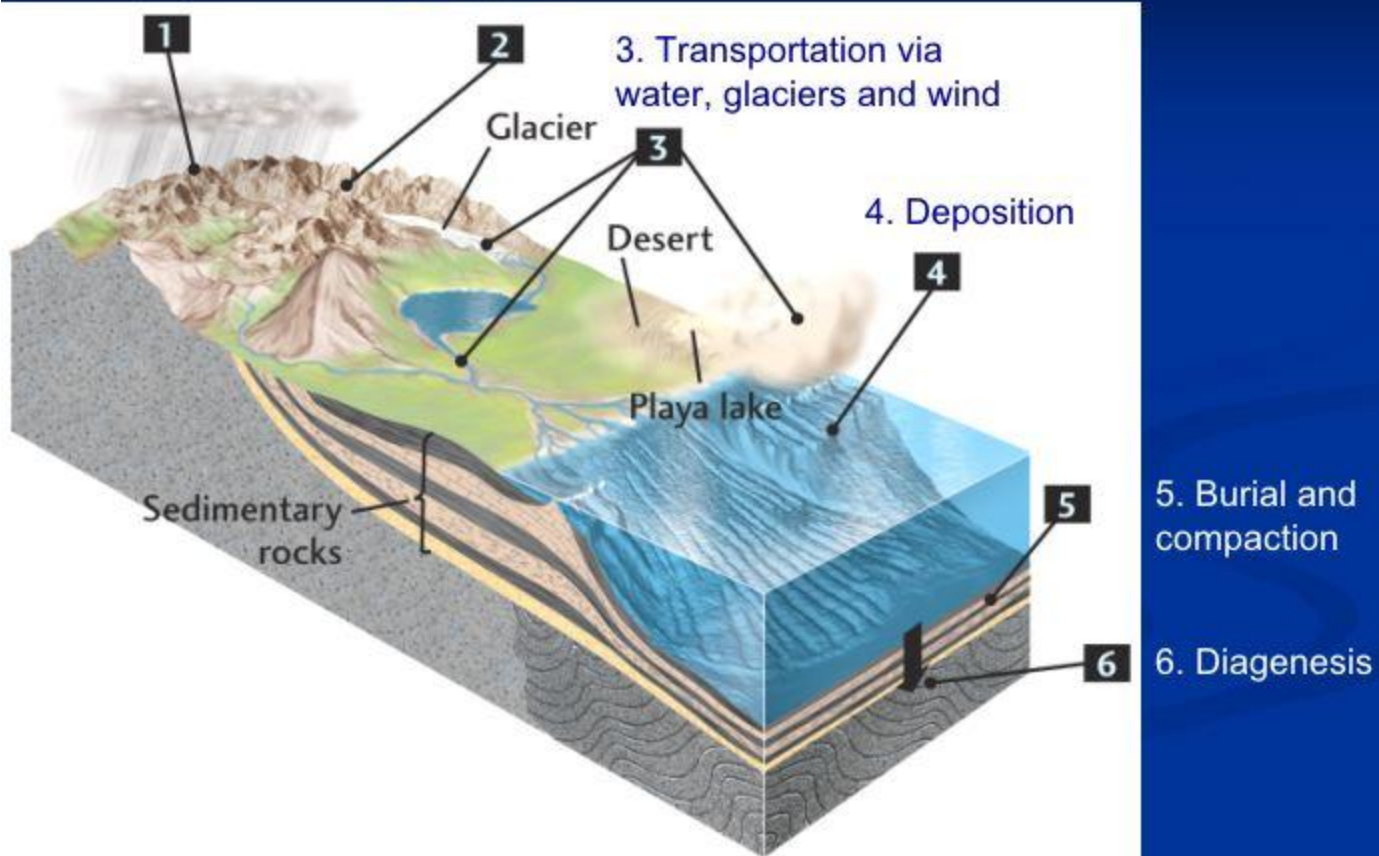
Dott. Maria Chiara Turrini

La modellazione del paesaggio

Sediment stages

1. Weathering

2. Erosion



Erosione

Erosion

Erosion is the **displacement of solids** (soil, mud, rock and other particles) by the agents of wind, water or ice, by downward or down-slope movement **in response to gravity**.

Severe soil erosion in a wheat field near Washington State University, USA





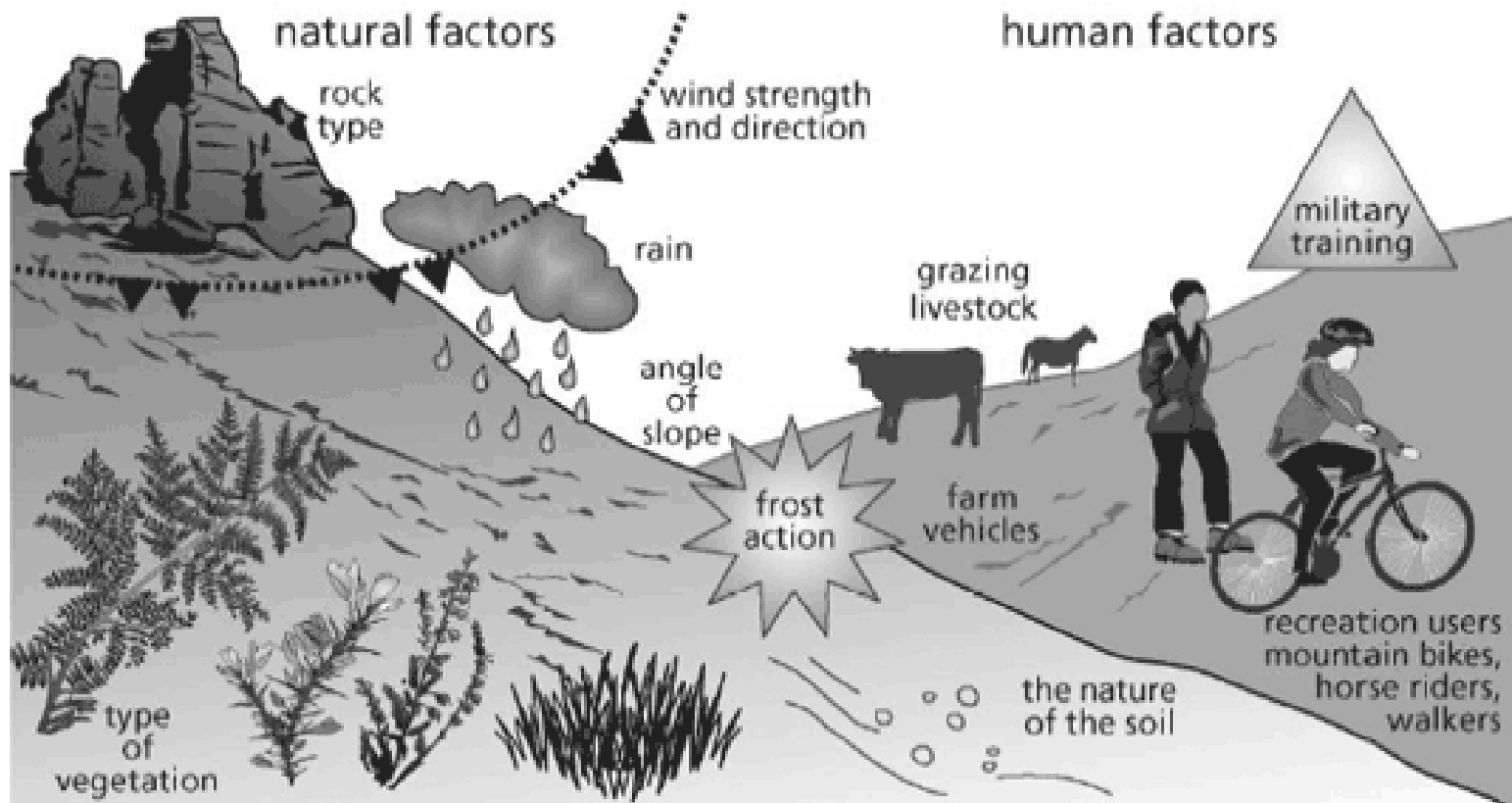
Erosion is an intrinsic natural process but in many places **it is increased by human land use.**

Poor land use practices include deforestation, overgrazing, unmanaged construction activity and road or trail building. However, improved land use practices can limit erosion, using techniques like terrace-building and tree planting.

Effetti dell'erosione – Frane superficiali

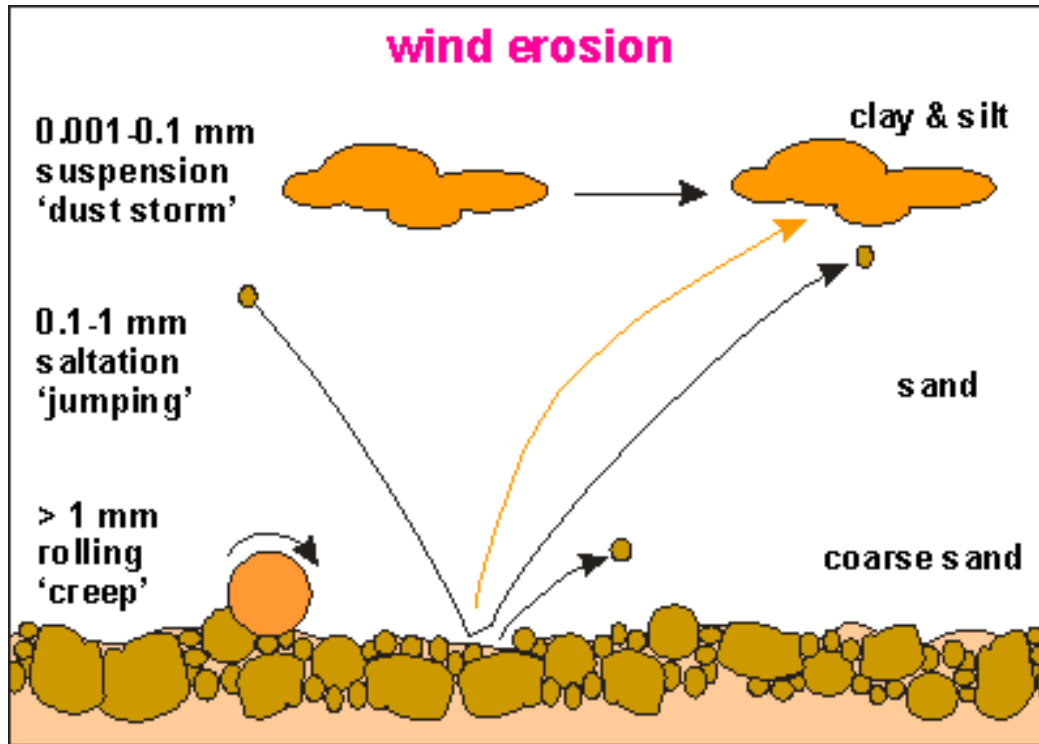


Fattori che determinano l'erosione del terreno



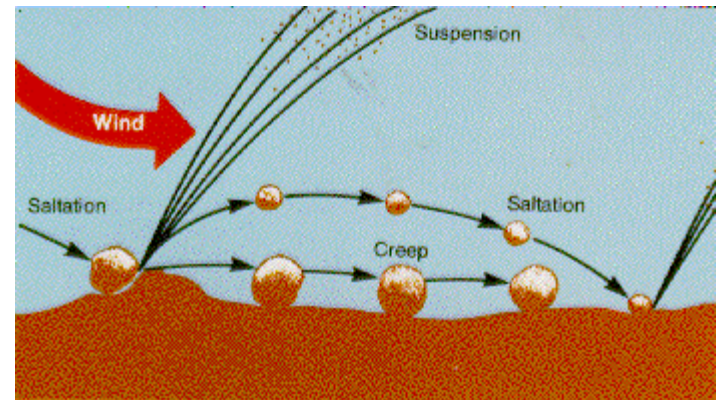
In questo schema manca l'attività antropica relativa all'edilizia e alle vie di comunicazione

Erosione del vento



Wind can be effective agent of erosion anywhere that it is strong enough to act.

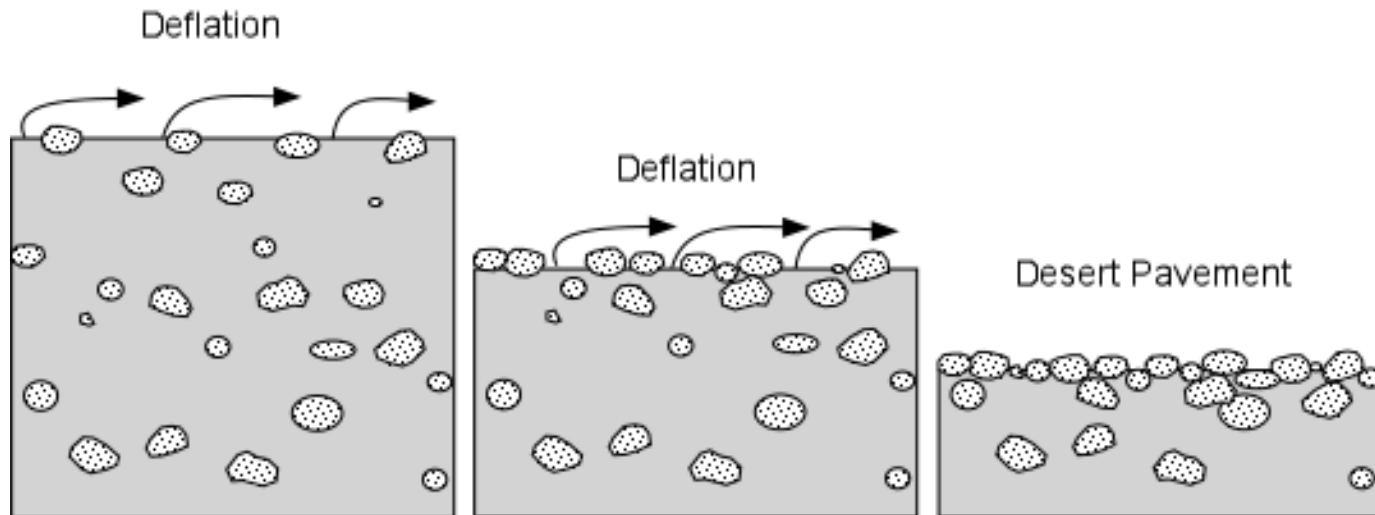
Wind can erode by **deflation** and **abrasion**.



Fine particles are moved easily (but not when wet) and when they are as small as clay and silt, they become **airborne**, reluctant to settle out again, even though air is 800 times lighter than water. Sand particles between 0.1 and 1 mm move by saltating (**jumping**) over the ground, like a sheet. Heavier particles move by **rolling**.

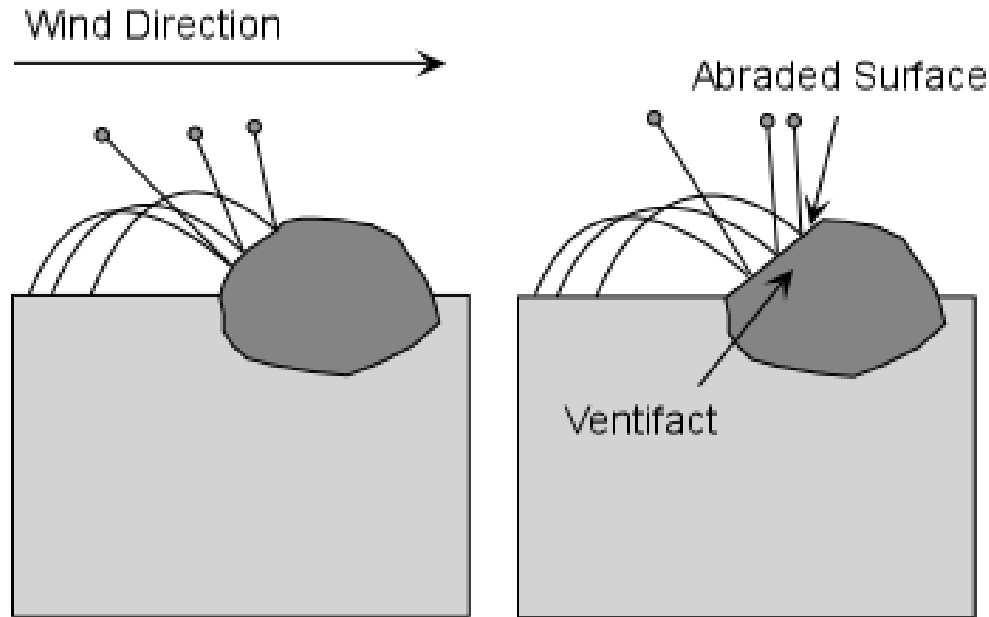
Wind Erosion **DEFLAZIONE**

Deflation is the lowering of the land surface due to removal of fine-grained particles by the wind. Deflation concentrates the coarser grained particles at the surface, eventually resulting in a surface composed only of the coarser grained fragments that cannot be transported by the wind. Such a surface is called desert pavement.



Erosione del vento

Abrasion



Ventifacts are any bedrock surface or stone that has been abraded or shaped by wind-blown sediment in a process similar to sand blasting.

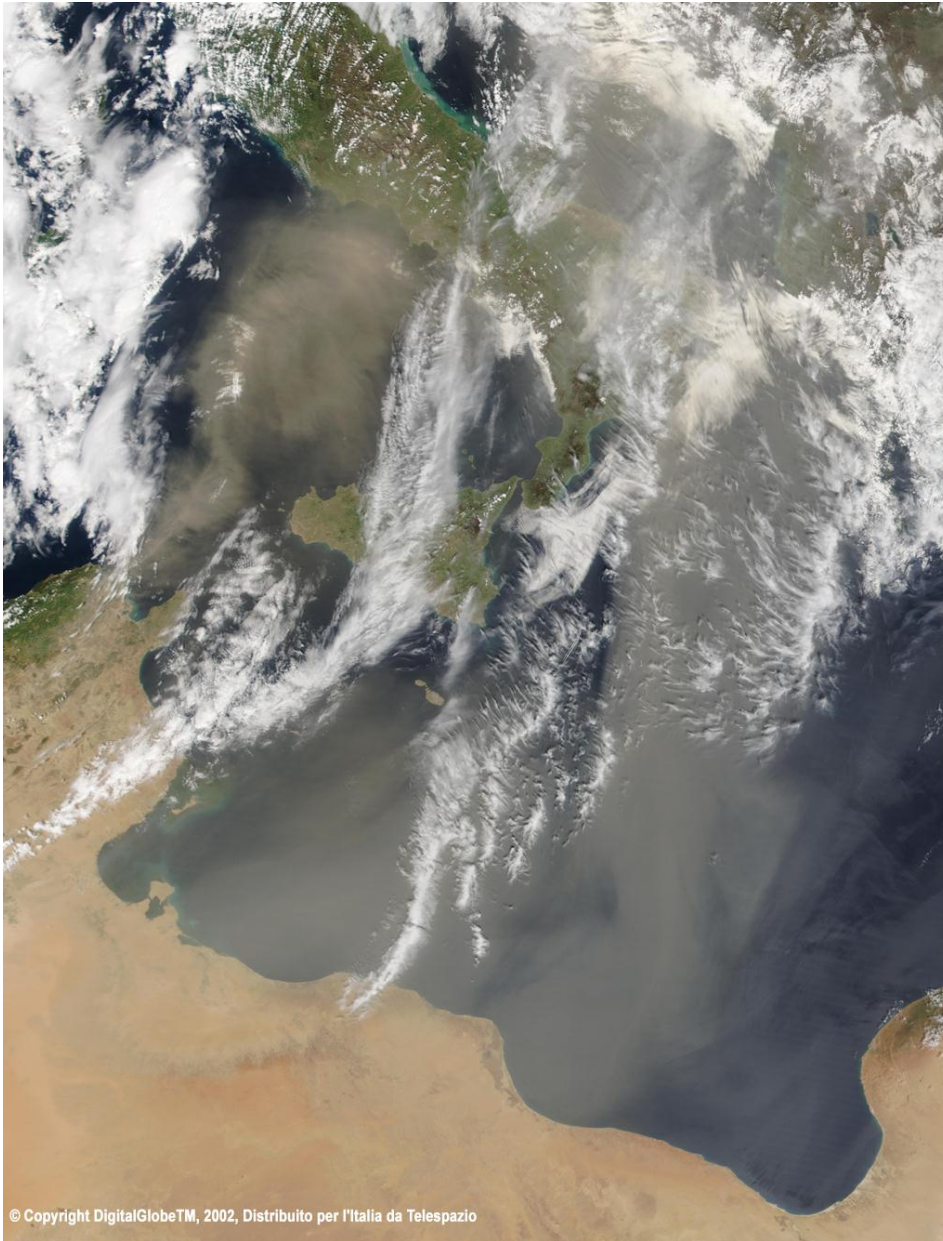


Polvere sollevata dal vento nel deserto

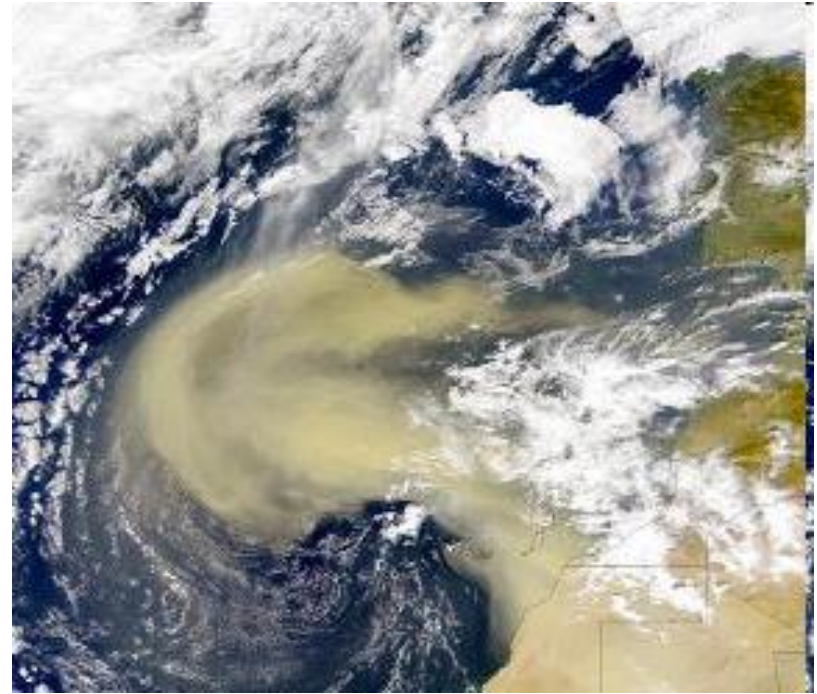


Tempesta di sabbia





© Copyright DigitalGlobeTM, 2002, Distribuito per l'Italia da Telespazio



Tempesta di sabbia vista da satellite



photo H. Roivainen

Terreno denudato dall'azione del vento (**deflazione**)

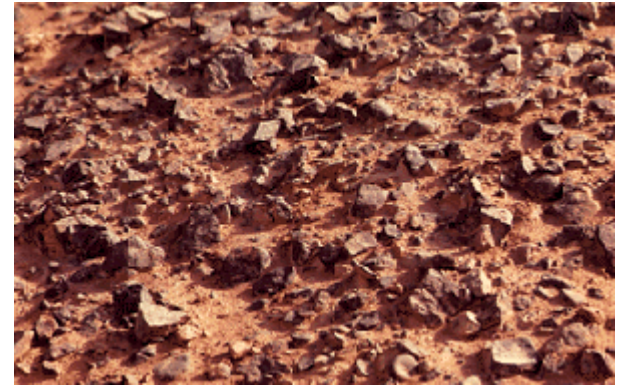
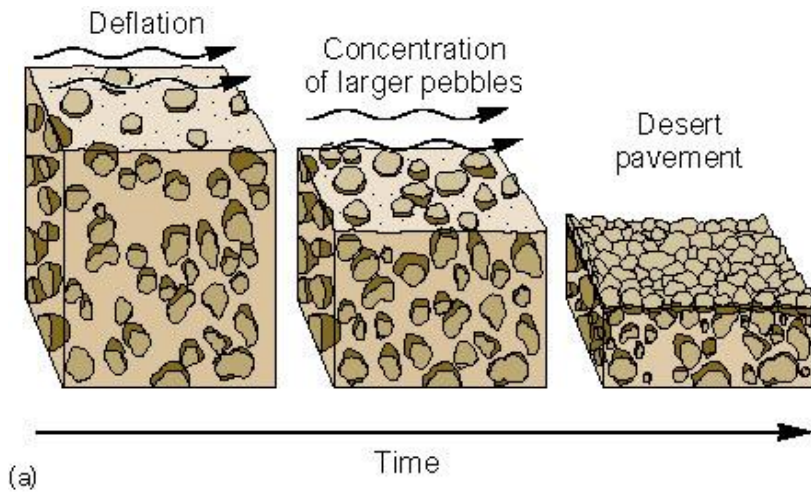


Il terreno fissato dalle radici delle piante è protetto contro l'erosione del vento



L'azione erosiva del vento lascia un terreno denudato, dove restano solo le particelle che il vento non è in grado di spostare (**pavimentazione**)

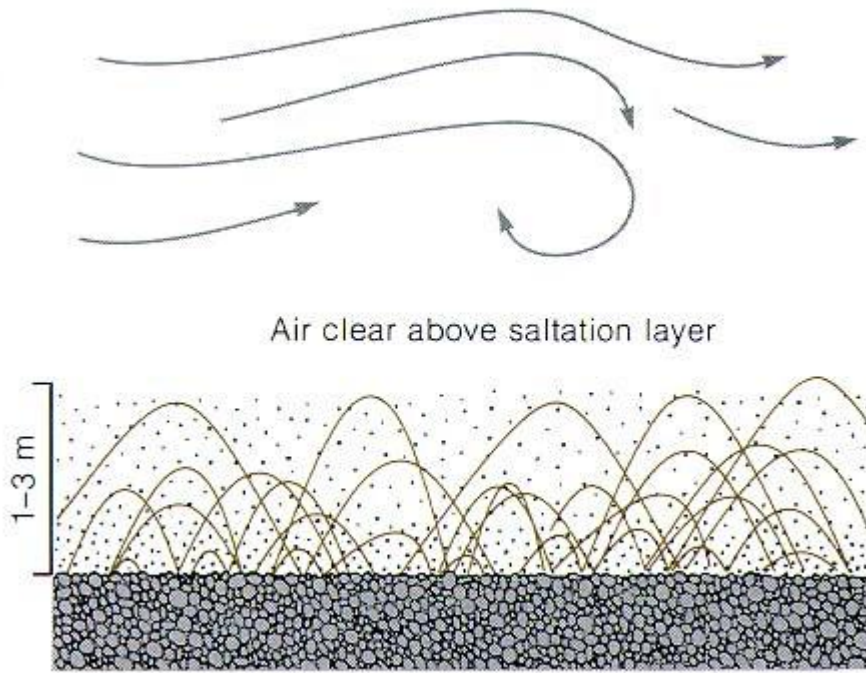
Deflazione



(b)

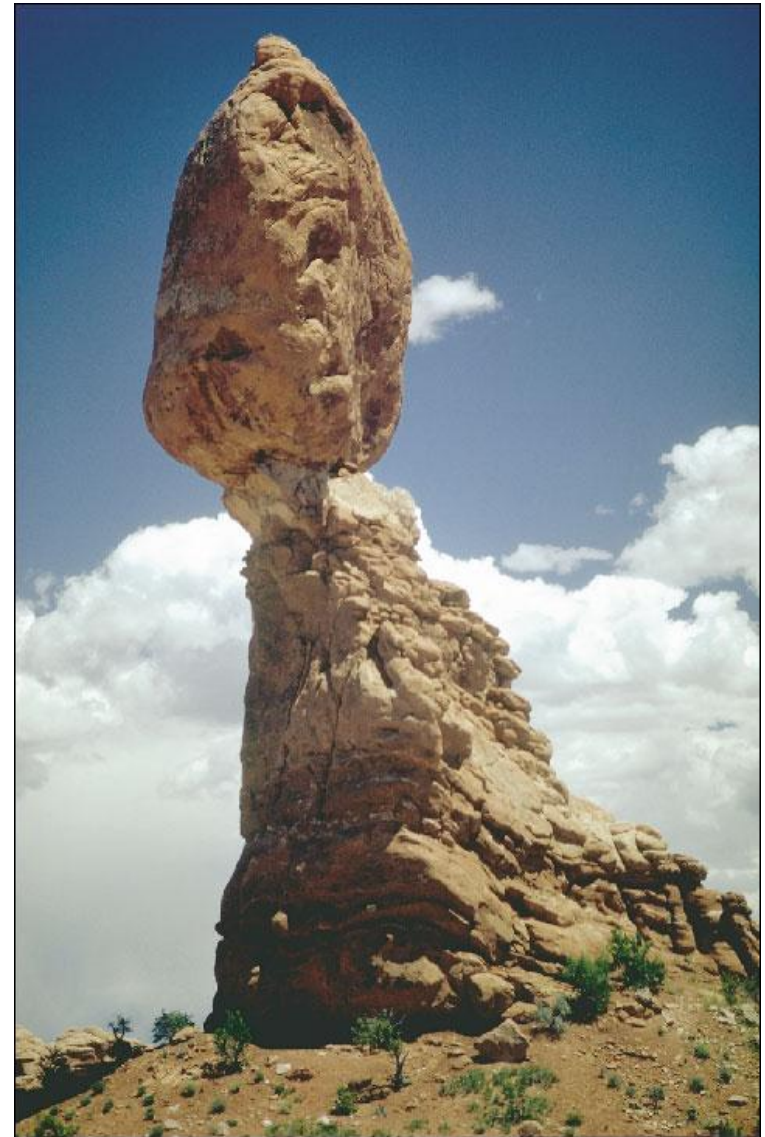


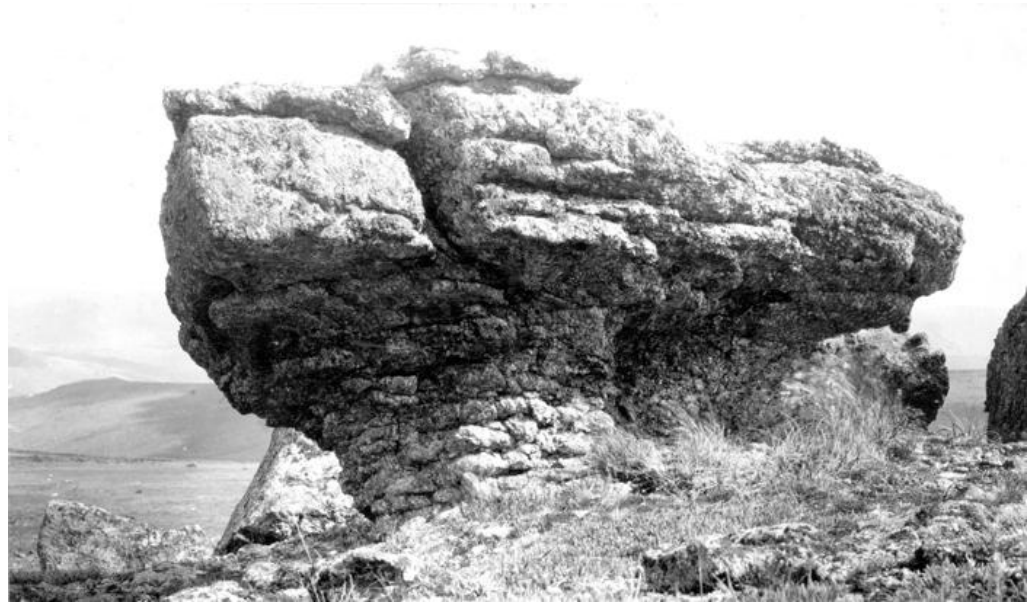
Abrasione



Abrasion is typically

- < 3 meters above ground (limit of sand bouncing height)
- affected by rock hardness, wind velocity, wind constancy





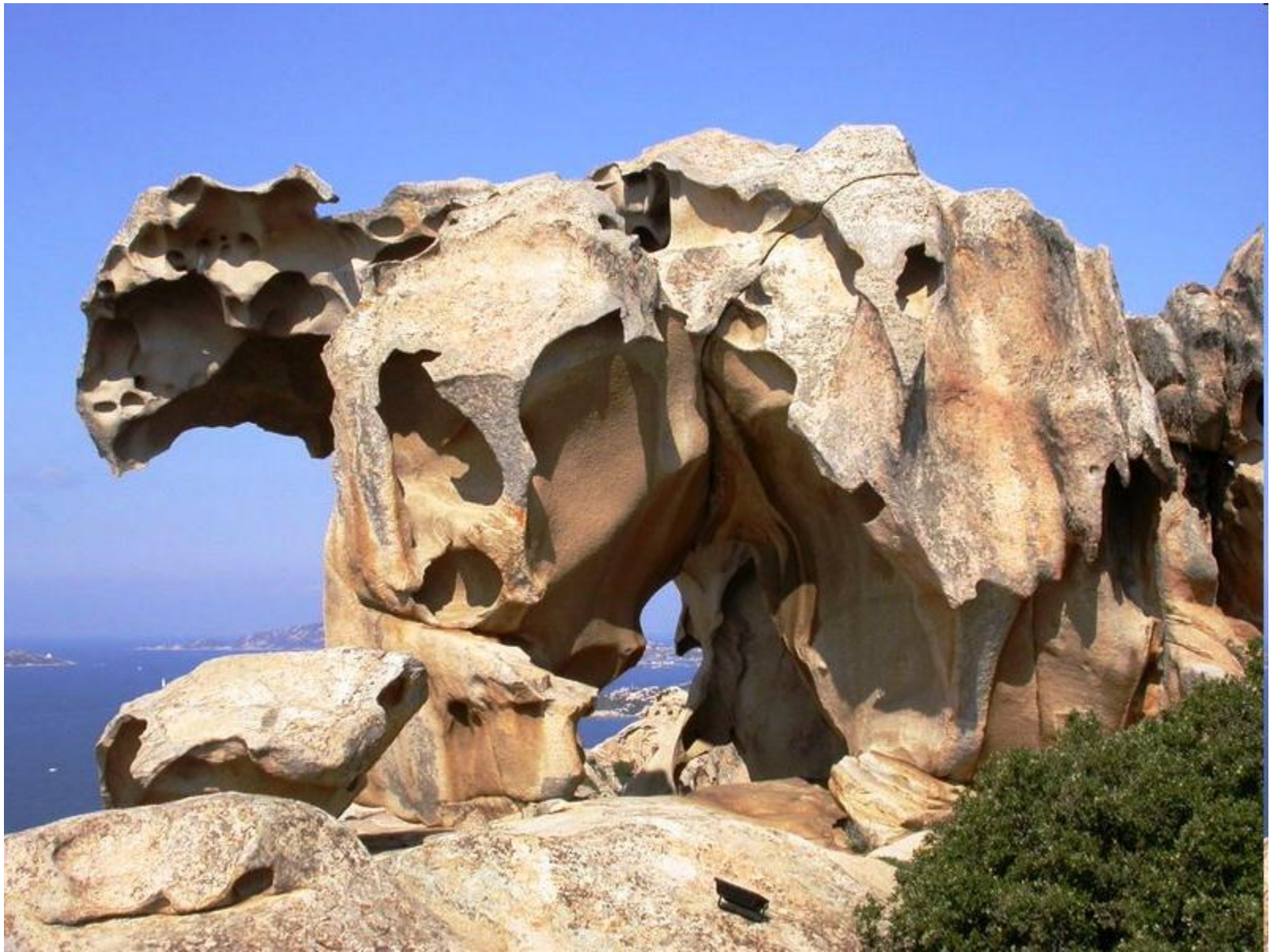
Rocce levigate e modellate
dall'azione delle particelle
prese in carico dal vento

Abrasione Formazione dei
“ventifacts” (sculture di
roccia)



Ventifacts are rocks that have been abraded, grooved, or polished by wind driven sand. These geomorphic features are most typically found in arid environments where there is little vegetation to interfere with eolian particle transport, where there are frequently strong winds, and where there is a steady but not overwhelming supply of sand.





La roccia dell'orso. Palau. Sardegna

In presenza di umidità atmosferica e rocce che contengono feldispati, non è da escludere anche l'azione dell'idrolisi (formazione di minerali argillosi) nella formazione delle sculture di roccia.

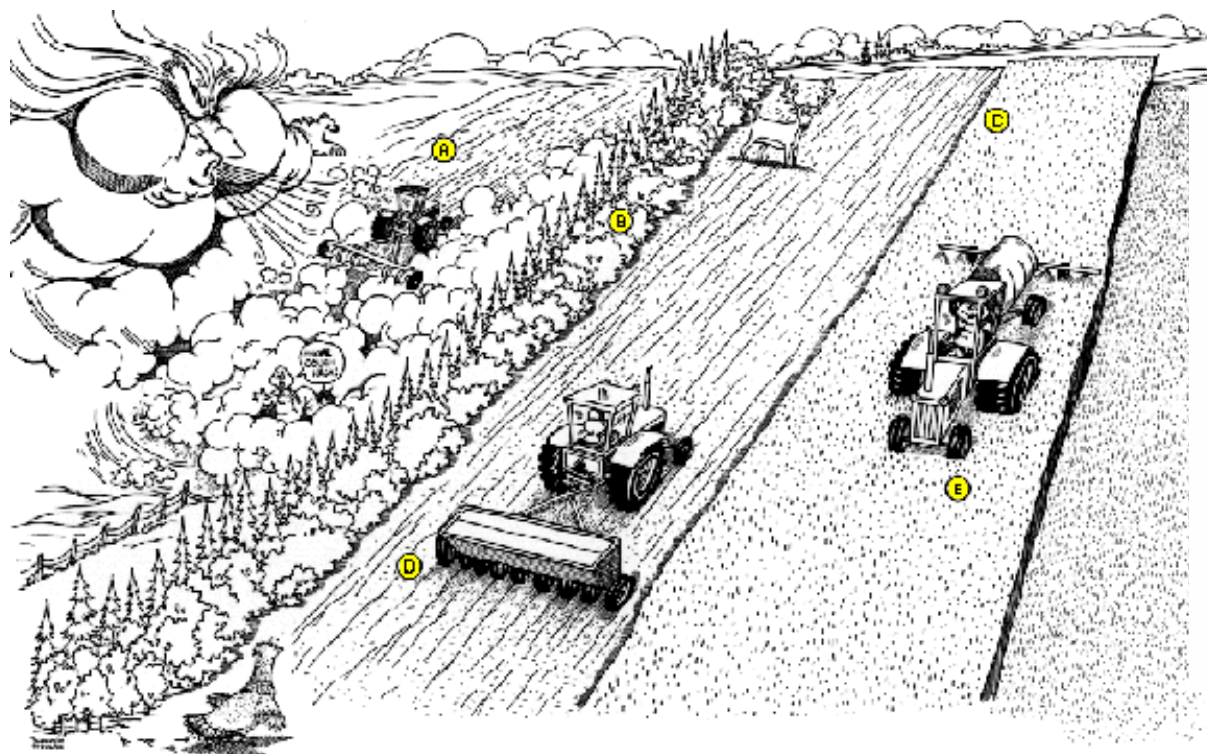


Fig. 1 Deposition of debris near the Agora.

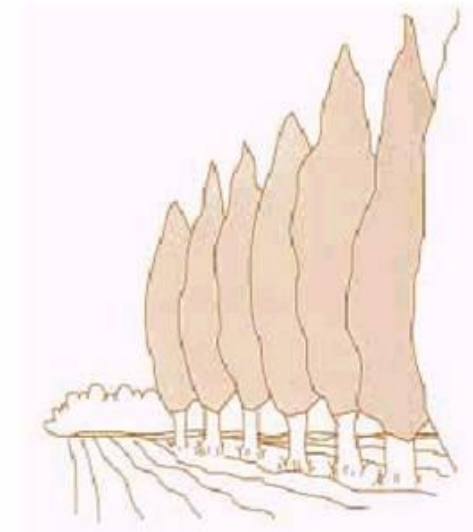


Fig. 2 The abrasion zone on the columns of the Great Colonnade.

L'azione del vento si esplica anche sui manufatti



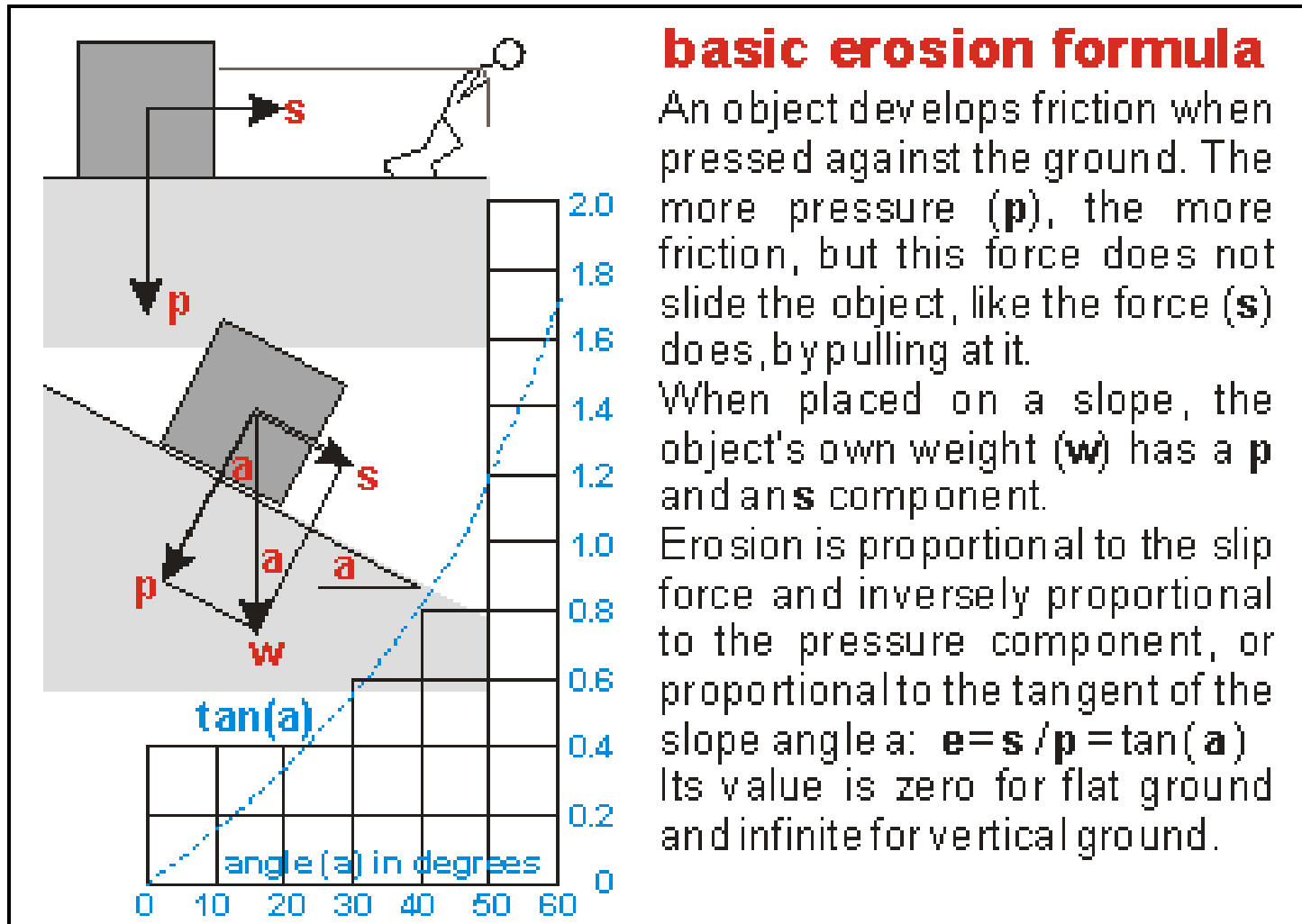
WIND EROSION PREVENTION

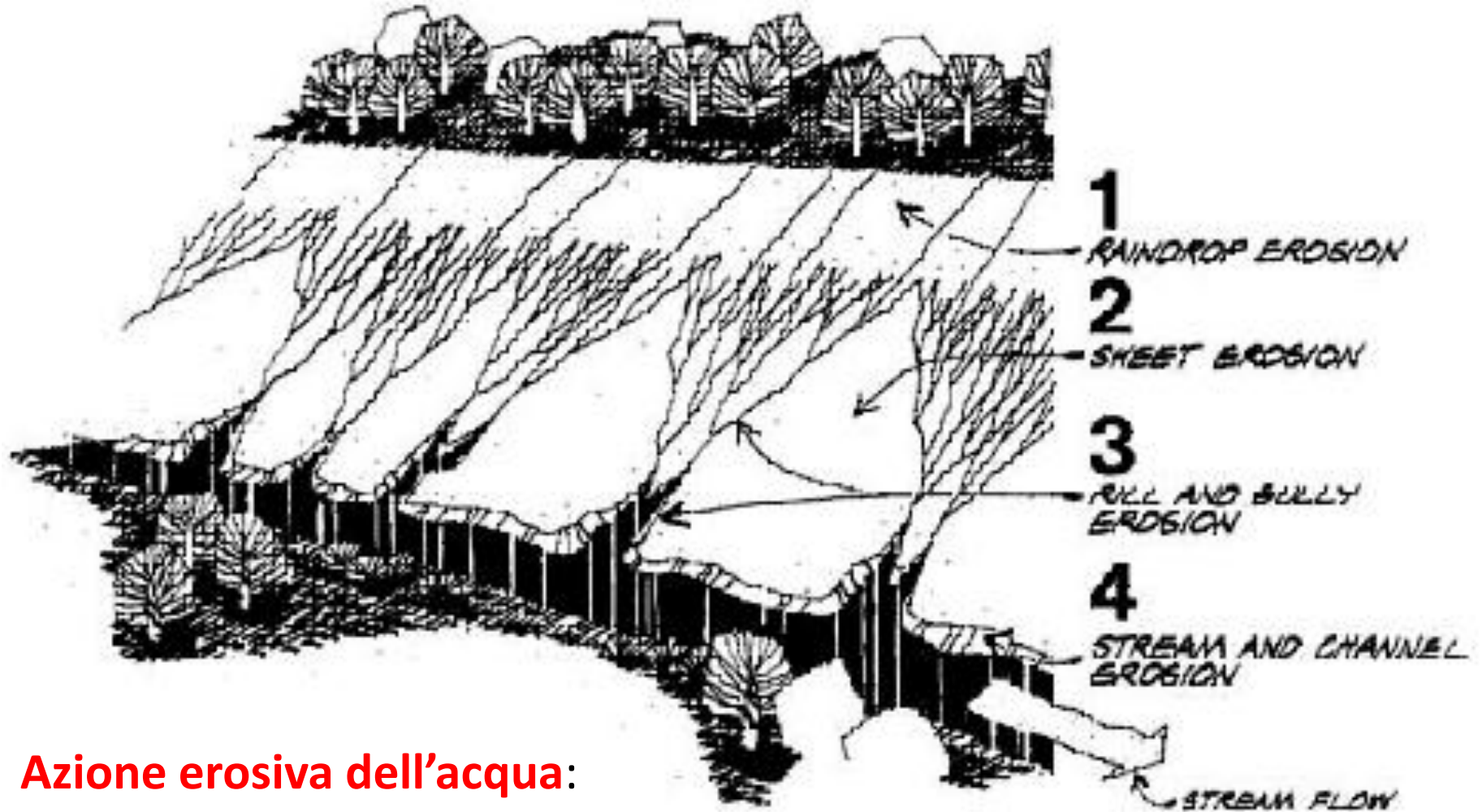


Il metodo più efficace per contrastare l'azione del vento è quello di piantare filari di alberi che hanno lo scopo di interrompere il percorso del vento e quindi diminuirne la velocità. Barriere frangivento.



Esempi di barriere
frangivento





Azione erosiva dell'acqua:

1 erosione dovuta all'impatto delle gocce

2 erosione laminare

3 erosione lineare (rivoli e solchi)

4 erosione torrentizia

splash erosion (erosione della pioggia battente):

consiste nell'azione meccanica esercitata sul terreno soprattutto dalle grandi gocce e dalla pioggia intensa

sheet erosion (erosione areale):

azione legata al ruscellamento diffuso, ossia quando le acque piovane scorrono in lamine su ampie aree

rill erosion (erosione a rivoli):

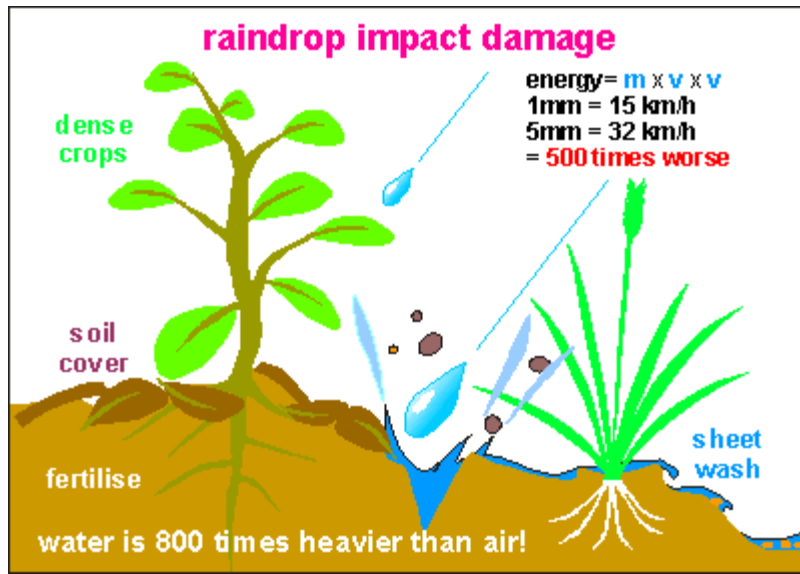
quando ha inizio una concentrazione delle acque in piccole depressioni (**rivoli**) che interessano solamente la parte più superficiale del terreno (pochi centimetri di profondità)

gully erosion (erosione a solchi):

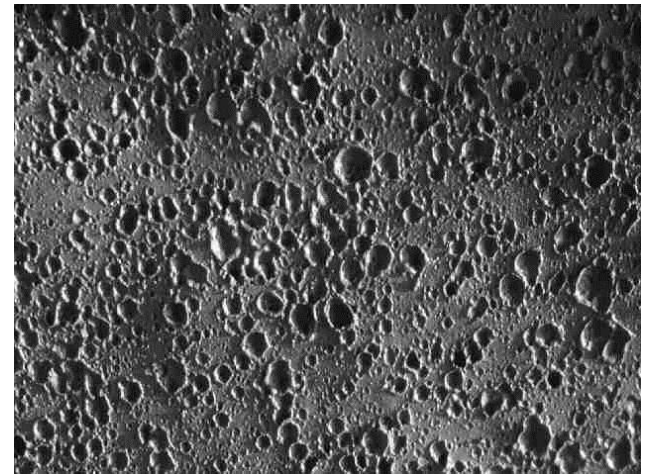
quando i rivoli si approfondiscono per una forte concentrazione del flusso superficiale, si passa ai **fossi** o **solchi di erosione** (l'evoluzione più spinta e più diffusa di queste forme porta all'origine dei calanchi)

sheet flood (inondazione a coltre o a lamina):

quando l'intensità della pioggia dà luogo ad un velo d'acqua di forte spessore che scorre ad alta velocità



Rain-splash erosion Occurs when raindrops fall on unprotected ground. The impact on the soil splashes away soil particles and digs a crater.



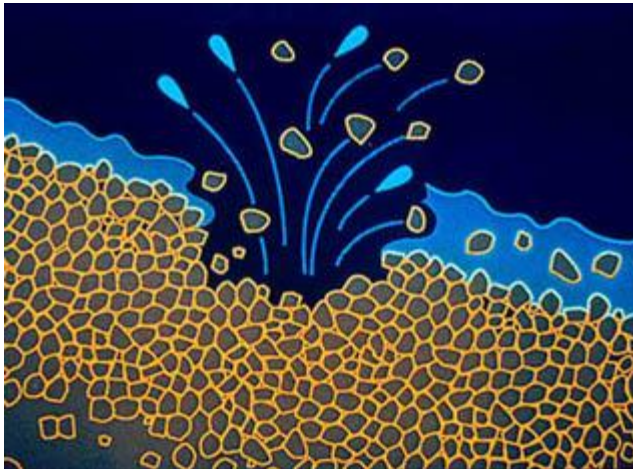
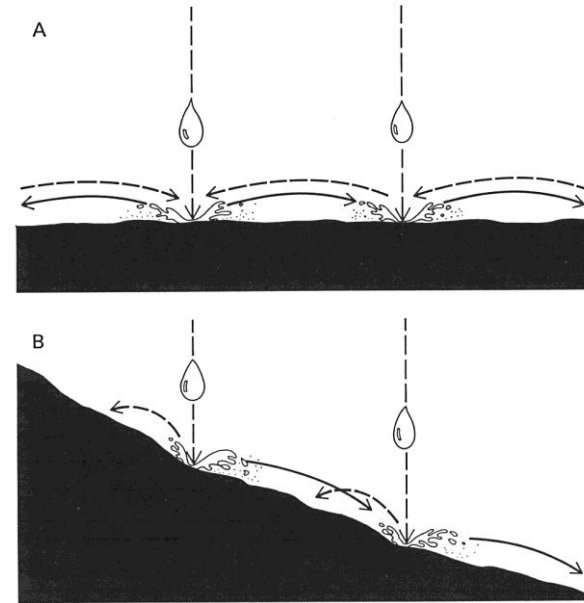
Rain is undoubtedly the largest cause of erosion. Water is about 800 times heavier than air, half to one third the weight of rock and about equal in weight to loose topsoil. When it flows, it can move loose substances with ease. Surprisingly, rain's most damaging moment is when a water drop hits the ground.



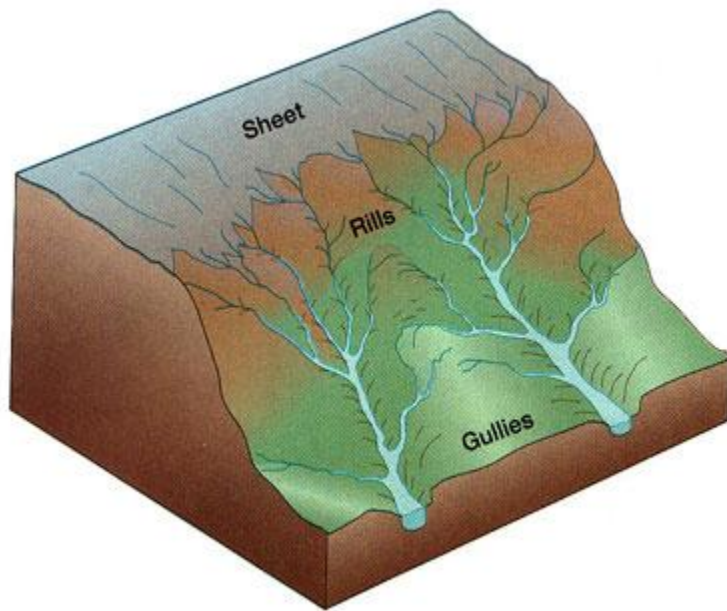
Water and soil splashed following a single raindrop impact



Diffuse overland flow. Note the raindrop impacts

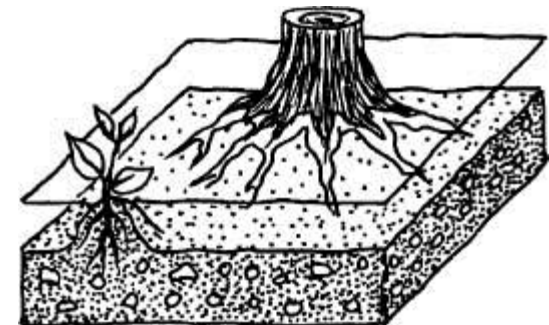


Quando una grossa goccia di pioggia arriva sulla superficie del suolo bagnato, produce un piccolo cratere. Le particelle di argilla e di silt vengono proiettate verso l'alto, producendo un disturbo sulla superficie del suolo. Se esiste una lamina di acqua che scorre, le particelle spostate dalla goccia di pioggia vengono portate via dalla zona dell'impatto, producendo così l'erosione laminare



Sheet erosion occurs when thin layers of the topsoil are moved by the force of the runoff water, leaving the surface **uniformly eroded**.

Sheet erosion is the **uniform removal of soil in thin layers by the forces of raindrops and overland flow**. It can be a very effective erosive process because it can cover large areas of sloping land and go unnoticed for quite some time.







Sheet Erosion due to rainfall > infiltration



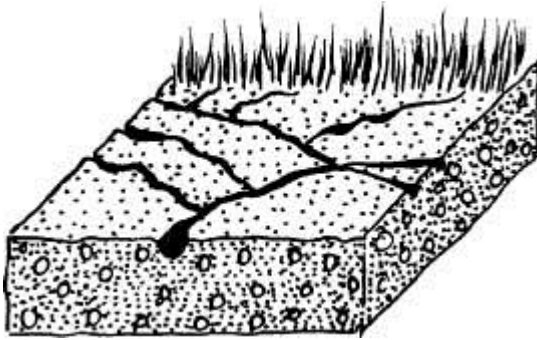
Erosione laminare





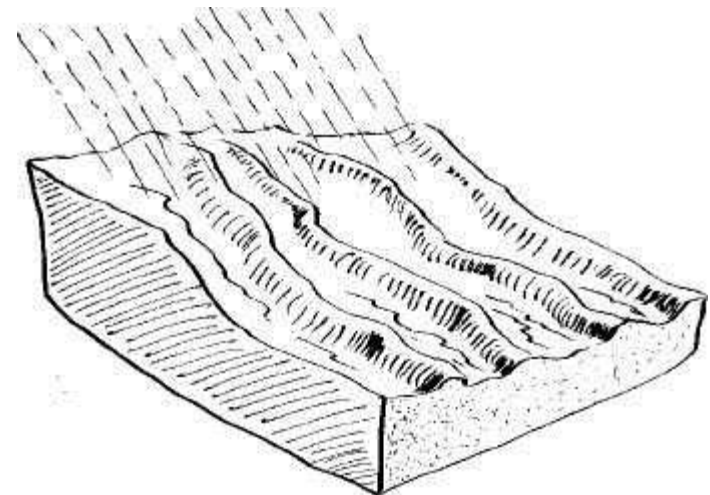
Si ha erosione laminare quando la quantità d'acqua che cade sotto forma di pioggia è superiore alla quantità d'acqua che infila nel terreno.

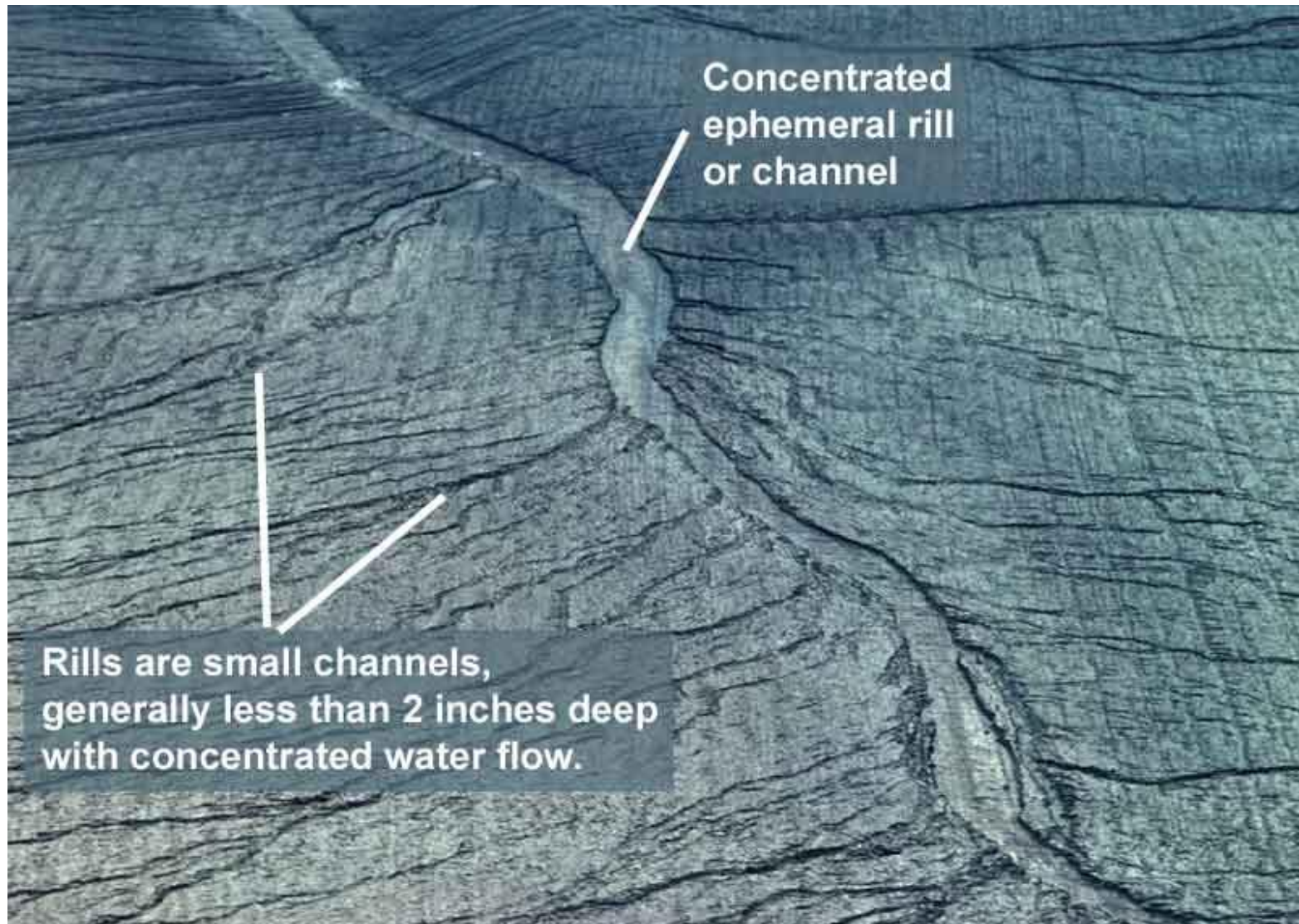
Nell'immagine l'erosione laminare ha portato via i semi lasciando il terreno completamente senza protezione



Rill erosion can occur on steep land or on land that slopes more gently. Because there are always irregularities in a field, water finds hollows in which to settle and low-lying channels through which to run. As the soil from these channels is washed away, channels or miniature dongas are formed in the field

Rill erosion is caused by runoff water when it creates small, linear depressions in the soil surface. These are easily removed during land tillage.





Concentrated
ephemeral rill
or channel

Rills are small channels,
generally less than 2 inches deep
with concentrated water flow.

Rill erosion is the removal of soil by concentrated water running through little streamlets, or headcuts. Detachment in a rill occurs if the sediment in the flow is below the amount the load can transport and if the flow exceeds the soil's resistance to detachment. As detachment continues or flow increases, rills will become wider and deeper.





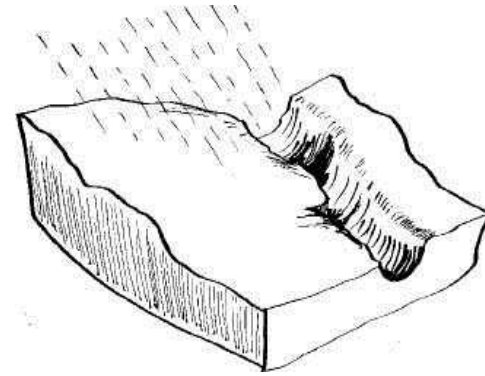
Two instances of gully erosion

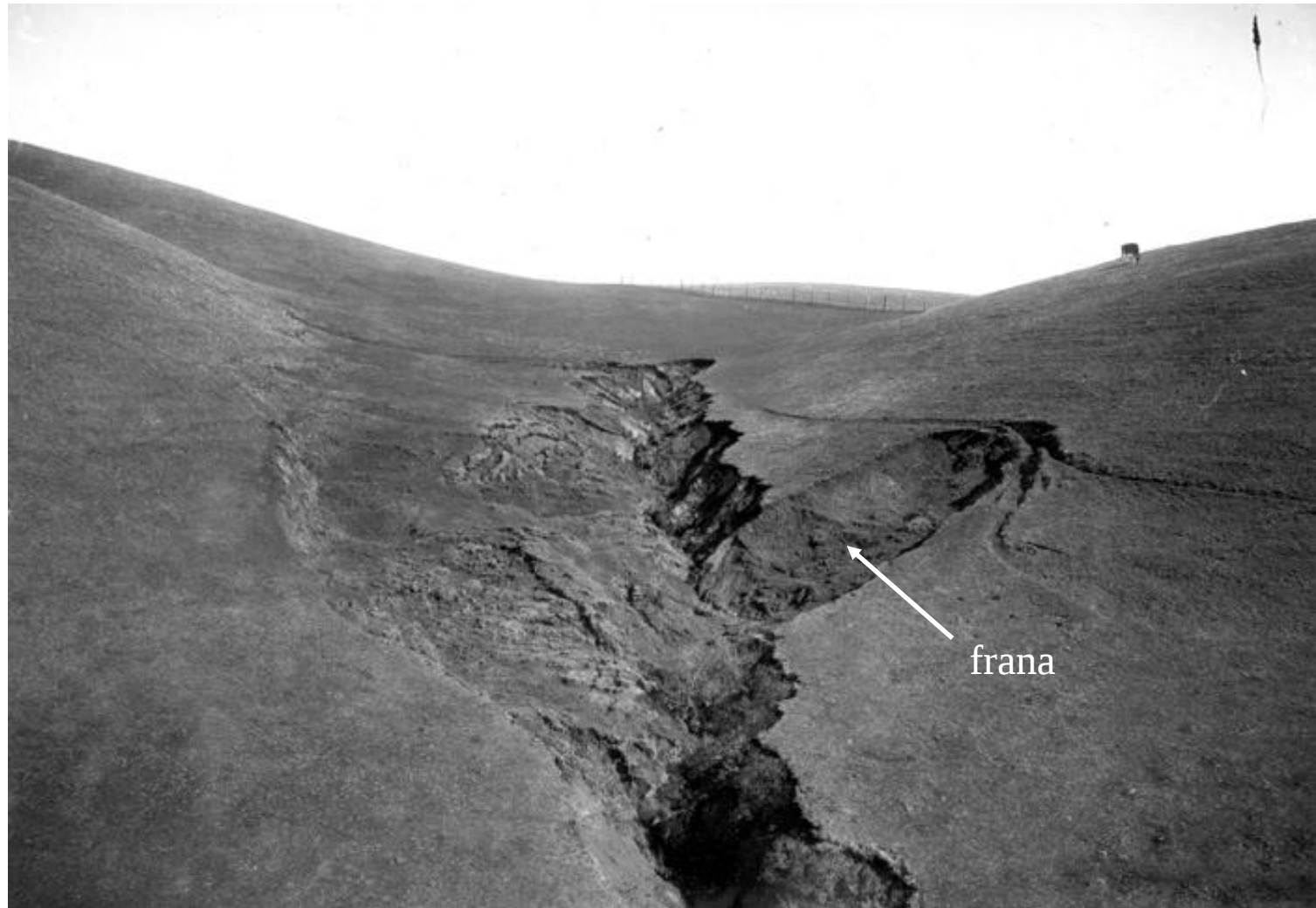


Gully erosion usually occurs near the bottom of slopes and is caused by the removal of soil and soft rock as a result of concentrated runoff that forms a deep channel or gully. On steep land, there is often the danger of gullies forming. Water running downhill cuts a channel deep into the soil and where there is a sudden fall, a gully head forms at the lower end of the channel and gradually works its way back uphill.

Gully erosion

Unlike rill erosion, gullies are too deep to be removed during normal cultivation with ordinary farm implements. They are formed from small depressions, which concentrate water and enlarge until several join to form a channel. The deepening channel undermines the head wall, which retreats upslope. The gully then widens as the side-walls are worn back.





Gully developing headward by sapping and modified by slipping. A characteristic landslip hollow at right



Active
headward
erosion on
right, with
inactive, largely
infilled older
examples to left

Headward erosion is a fluvial process of erosion that lengthens a stream, a valley or a gully at its head and also enlarges its drainage basin. The stream erodes away at the rock and soil at its headwaters in the opposite direction that it flows.



Gully erosion is when water makes a deep channel that washes away soil when it rains. Each time it rains, the channels get deeper as more soil is removed. The soil can wash away into creeks and streams and block the water flow and discolors the water, or damages roads. The loss of topsoil reduces the amount of area available for farming

Fattori del **dilavamento**:

1. natura del terreno (suoli o roccia);
2. fattori morfologici (pendenza, forma e lunghezza dei versanti);
3. fattori climatici (i climi con regimi di piogge incostanti favoriscono il dilavamento);
4. presenza di copertura vegetale (protegge il suolo);
5. fattori antropici (disboscamento e pratiche agricole; in questi casi può innescarsi l'erosione accelerata).



Evoluzione dell'erosione da laminare a lineare concentrata (rivoli e solchi) fino alla formazione dei calanchi





Calanchi – Bad Lands



Sistemi di prevenzione dell'erosione laminare e concentrata (Sheet, Rill, Gully Erosion)

Vegetation cover

The loss of protective vegetation through overgrazing, ploughing and fire makes soil vulnerable to being swept away by wind and water. Plants provide protective cover on the land and prevent soil erosion for the following reasons:

- Plants slow down water as it flows over the land and this allows much of the rain to soak into the ground.
- Plant roots hold the soil in position and prevent it from being blown or washed away.
- Plants break the impact of a raindrop before it hits the soil, reducing the soil's ability to be eroded.
- Plants in wetlands and on the banks of rivers are important as they slow down the flow of the water and their roots bind the soil, preventing erosion.

Land use (dal punto di vista dell'agricoltura)

Grass is the best natural soil protector against soil erosion because of its relatively dense cover. Small grains, such as wheat, offer considerable obstruction to surface wash. Row crops such as maize and potatoes offer little cover during the early growth stage and thereby encourage erosion. Fallowed areas, where no crop is grown and all the residue has been incorporated into the soil, are most subject to erosion.

Organic material

Organic material is the "glue" that binds the soil particles together and plays an important part in preventing soil erosion. Organic matter is the main source of energy for soil organisms, both plant and animal. It also influences the infiltration capacity of the soil, therefore reducing runoff.