

# Gravitational processes



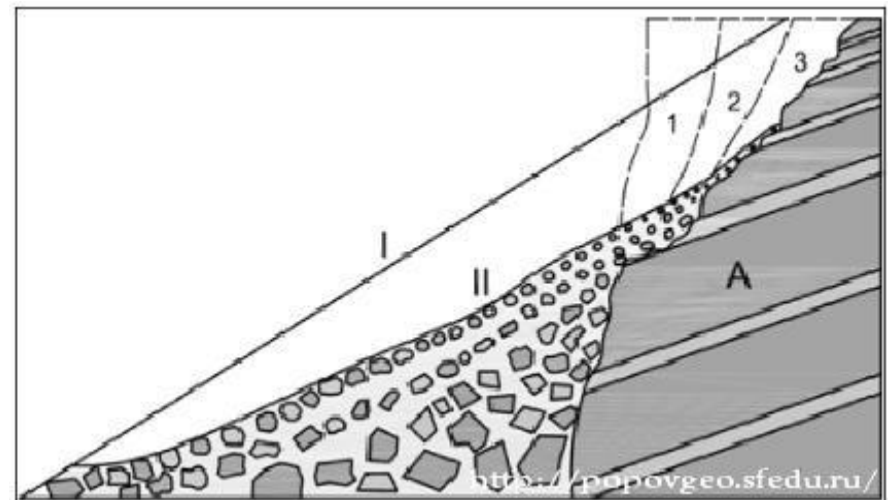
Landslides, landslips  
and other

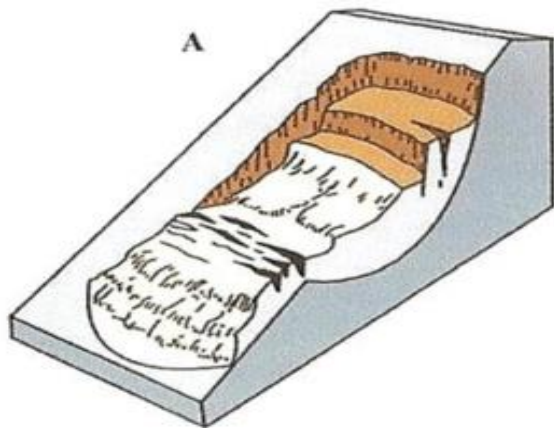


# Gravitational geological processes

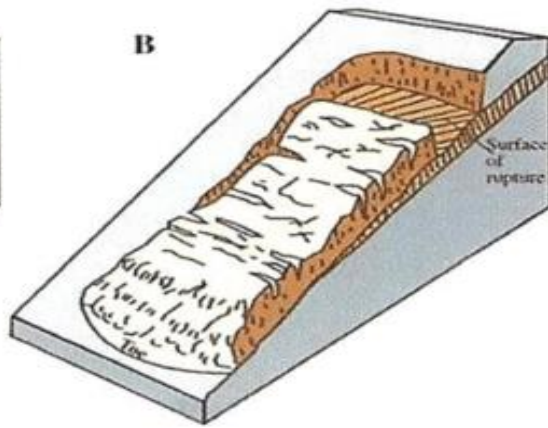
Gravitational geological processes, often called slope processes, are expressed in the movement of rocks along the Earth's surface under the influence of gravity from elevated areas of the relief to lower ones.

Gravitational processes develop only on steep slopes with an inclination angle of more than  $30^\circ$ .

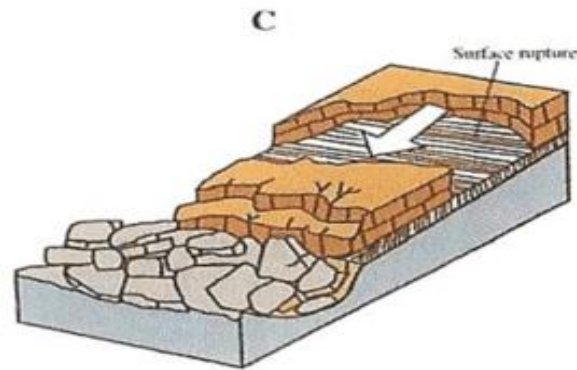




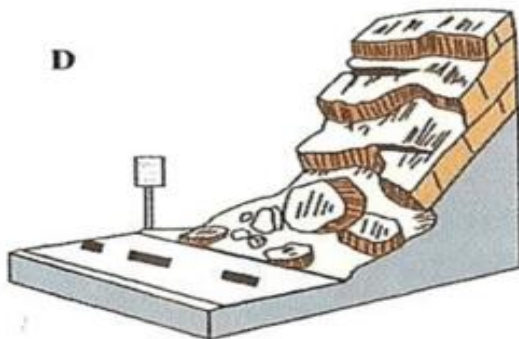
**Rotational Landslide**



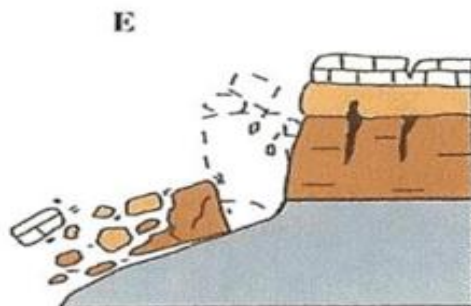
**Translational Landslide**



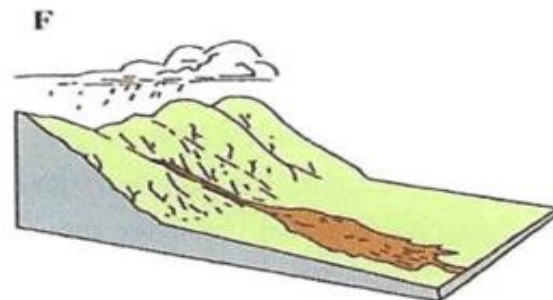
**Block Slide**



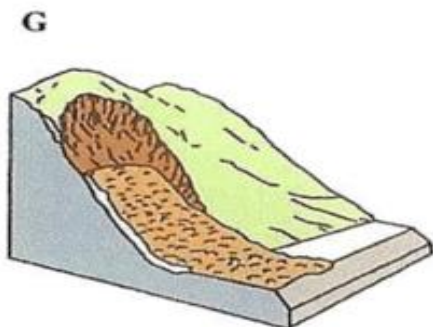
**Rockfall**



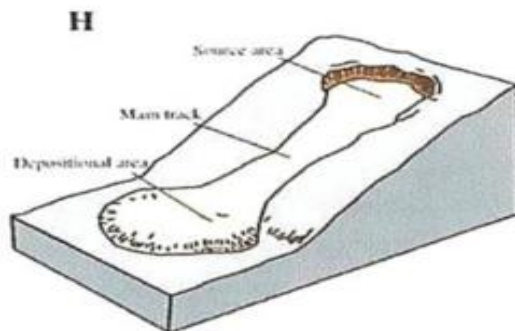
**Topple**



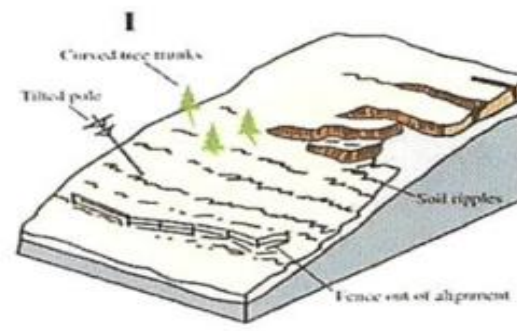
**Debris Flow**



**Debris Avalanche**



**Mudflow/slide**



**Creep**

# LANDSLIDES

Landslides are classified by their type of movement. The four main types of movement are:

- falls (обвал)
- topples(обвал с переворачиванием породы )
- slides (скольжение)— rotational and translational
- flows (оплывины)

Landslides (оползни)

Landslides can be classified as just one of these movements or, more commonly, can be a mixture of several. Geologists also refer to the type of material involved in the movement e.g. rock, debris, earth.



# FALLS

## Falls



Falls are landslides that involve the collapse of material from a cliff or steep slope. Falls usually involve a mixture of free fall through the air, bouncing or rolling. A fall type landslide results in the collection of rock or debris near the base of a slope.

Falls: the rock mass descends mostly through air by free fall, bouncing or rolling, after being separated from the rest of the slope.

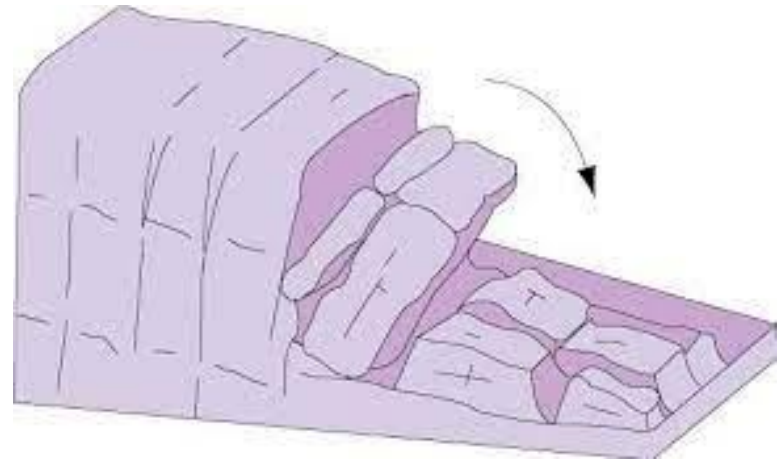
# Topples

Topple failures involve the forward rotation and movement of a mass of rock, earth or debris out of a slope. This kind of slope failure generally occurs around an axis (or point) at or near the base of the block of rock.

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Topples: movements of rock, debris or earth masses by forward rotation about a pivot point.

A topple often results in the formation of debris or a debris cone at the base of the slope; this pile is called a talus cone. New talus cones don't have any plants growing on them. Old talus cone can have weeds and even trees on them.



# Slides

Slides are characterised by a failure of material at depth and then movement by sliding along a rupture or slip surface. There are two types of slide failure, rotational slides (slumps) and translational (planar) slides:



# Rotational slides

A slide type landslide is a down-slope movement of material that occurs along a distinctive rupture or slip surface. If this slip surface is listric (curved or spoon-shaped) the slide is said to be rotational. The slip surface tends to be deeper than that of other landslide types and not structurally controlled. These landslides are characterized by a prominent main scarp and back-tilted bench or block at the top with limited internal deformation. Below this, movement is more or less rotational about an axis.

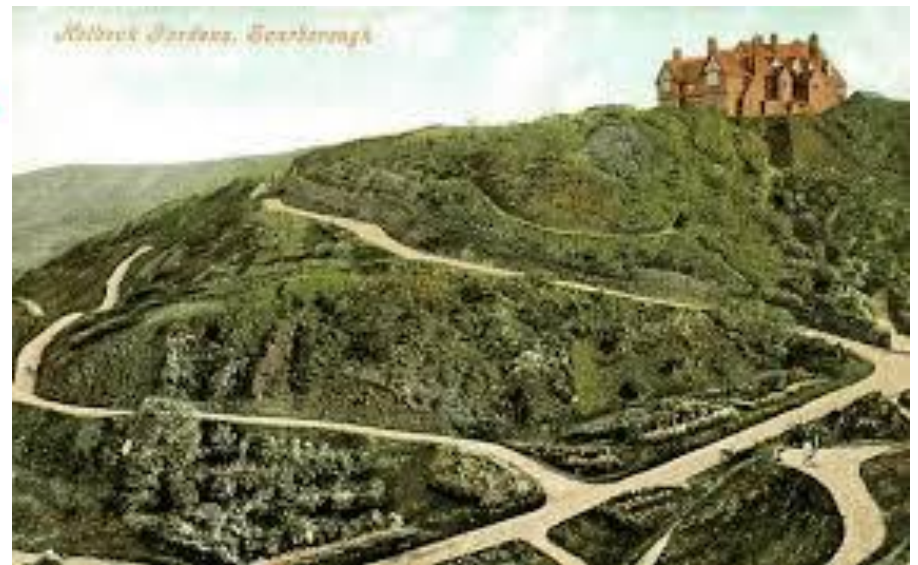


A good example of a rotational landslide is the Holbeck Hall landslide, in Scarborough North Yorkshire, England. The 1 million tonnes of cliff failed as a rotational landslide over a couple of days in June 1993 and destroyed the Hotel at the top of the cliff. The rotated blocks can be seen as grass covered 'benches' in the photograph.



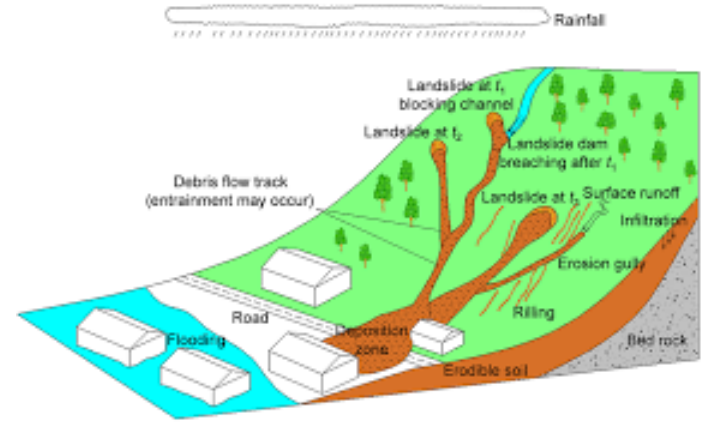
# Translational slides

A translational or planar landslide is a down-slope movement of material that occurs along a distinctive planar surface of weakness such as a fault, joint or bedding plane. Some of the largest and most damaging landslides on earth are translational. These landslides occur at all scales and are not self-stabilising. They can be very rapid where discontinuities are steep.



# Flows

Flows are landslides that involve the movement of material down a slope in the form of a fluid. Flows often leave behind a distinctive upside-down funnel shaped deposit where the landslide material has stopped moving. There are different types of flows: mud, debris and rock (avalanches). Two of the most common in the UK are mud flows and debris flows. Mud flows can be found on the south coast of England, often associated with larger complex landslides. Debris flows can be very rapid and usually occur on steep slopes

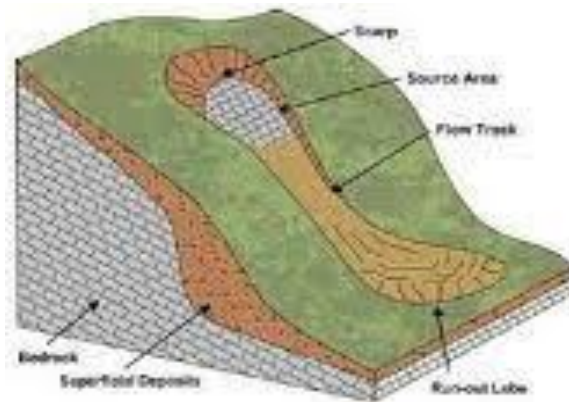


# Why do landslides happen?

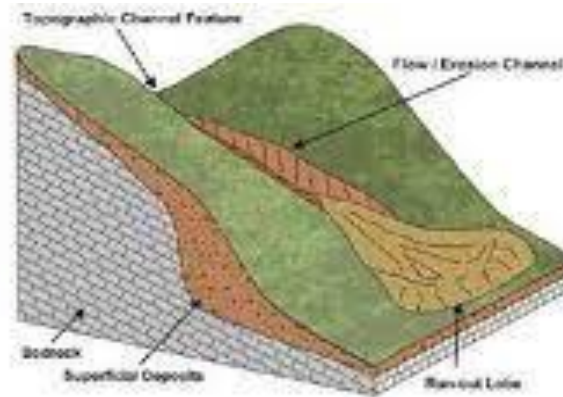
A landslide may occur because the strength of the material is weakened.

This reduces the power of the ‘glue’ that cements the rock or soil grains together.

Located on a slope, the rock is then no longer strong enough to resist the forces of gravity acting upon it.



a) Hillslope Debris Flow



b) Channelised Debris Flow

# What can increase the chance of a landslide?

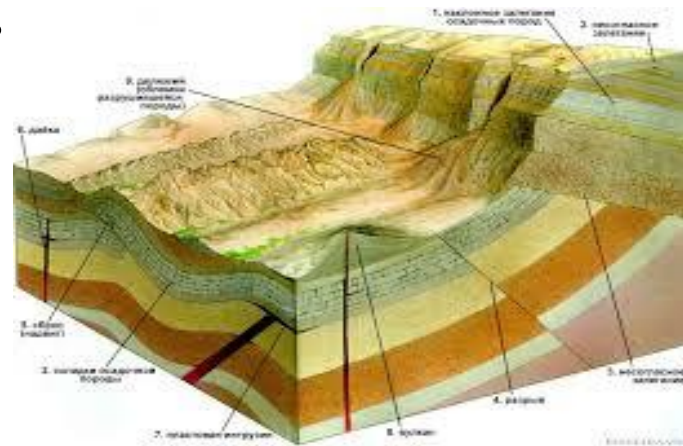
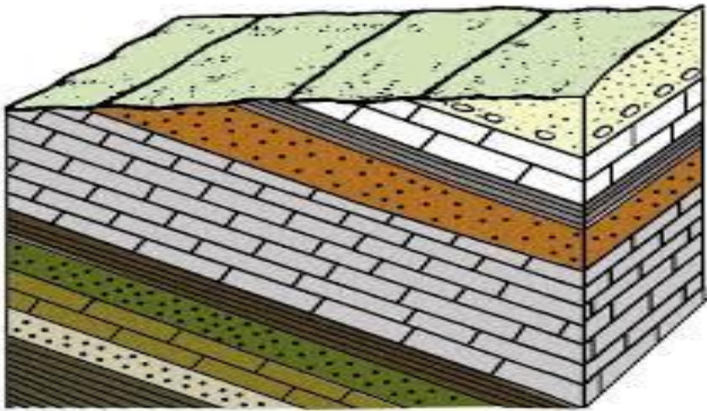
Several factors can increase a slope's susceptibility to a landslide event:

- water — adding water to the material on a slope, makes a landslide more likely to happen. This is because water adds weight, lowers the strength of the material and reduces friction, making it easier for material to move downslope
- erosion processes — such as coastal erosion and river erosion — if the bottom of a slope is continually eroded by the sea or a river, the slope will eventually become too steep to hold itself up



# What can increase the chance of a landslide?

- ❖ steepness of slope (крутизна склона)— the slope angle is a key factor as far as landslides are concerned. Any change to this that makes it steeper (such as coastal erosion) increases the likelihood of a landslide
- ❖ type of ‘rocks’ (тип пород) — soft rock such as mudstone or hard rock such as limestone — the type of rocks in the slope, and their combination
- ❖ shape of the rock ‘grains’ (форма зерен породы)
- ❖ jointing and orientation of bedding planes (ориентация залегания пластов породы), arrangement of the rock layers



# What can increase the chance of a landslide?

- ❖ weathering processes (выветривание)— for example freeze-thaw reduces the stickiness (cohesion) between the rock grains
- ❖ lack of vegetation (отсутствие растений) which would help bind material together
- ❖ Flooding (наводнения)
- ❖ volcanoes and earthquake activity nearby (вулканическая активность и землетрясения)
- ❖ human activity (деятельность человека)— mining, traffic vibrations or urbanisation which changes surface water drainage patterns



# What can increase the chance of a landslide?

- ❖ Human activity, such as agriculture and construction, can increase the risk of a landslide. Irrigation, deforestation, excavation, and water leakage are some of the common activities that can help destabilize, or weaken, a slope.
- ❖ Near populated areas, landslides present major hazards to people and property. Landslides cause an estimated 25 to 50 deaths and \$3.5 billion in damage each year in the United States.



# Other Factors

**Another factor that might be important for describing landslides is the speed of the movement.**

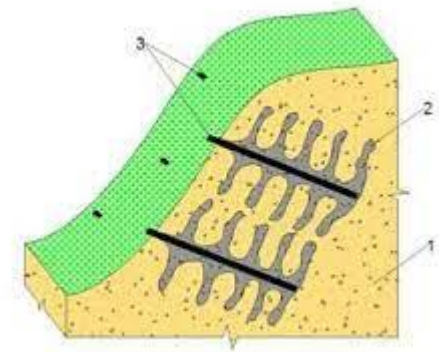
- ❖ Some landslides move at many meters per second, while others creep along at an centimeter or two a year.
- ❖ The amount of water, ice, or air in the earth should also be considered.
- ❖ Some landslides include toxic gases from deep in the Earth expelled by volcanoes.
- ❖ Some landslides, called mudslides, contain a high amount of water and move very quickly.
- ❖ Complex landslides consist of a combination of different material or movement types





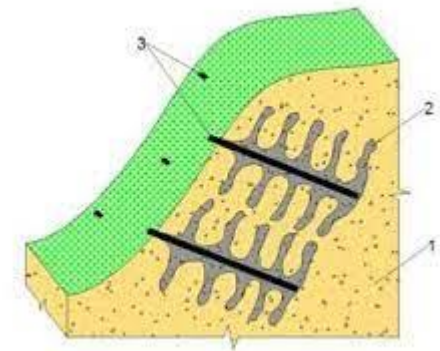
# Landslide control methods:

1. одерновка
2. древонасаждение
3. перехватывающие сооружение для атмосферных осадков (лотки, кюветы и др.) и подземных вод (горизонтальный или вертикальный дренаж),
4. подпорные сооружения
5. буны
6. волноломы
7. набережные и волнобойные стенки
8. организация свай и др.
9. Защита поверхности склона от разрушения



# Landslide control methods:

1. grassplanting
2. tree planting
3. intercepting structures for atmospheric precipitation (trays, cuvettes, etc.) and groundwater (horizontal or vertical drainage),
4. supporting structures
5. Guns
6. the breakwaters
7. embankments and wave walls
8. organization of piles, etc.
9. Protection of the surface of the slope from destruction



# Landslide control methods:

Меры защиты от обвалов и вывалов включают возведение камнеулавливающих сооружений. При принятии проектных решений - выборе параметров и расположения противообвальных конструкций - учитывается крутизна и высота склона (откоса), от которых зависит дальность отлета глыб.



# Landslide control methods:

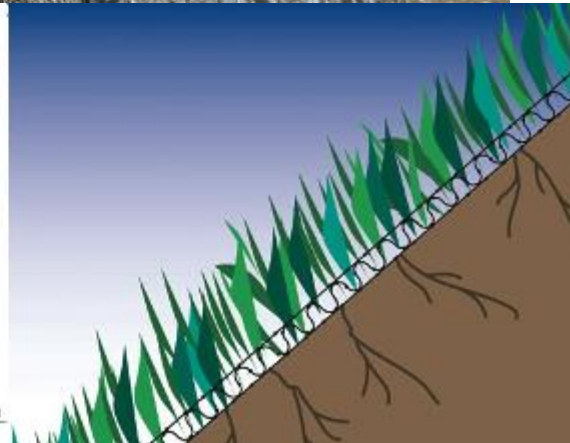
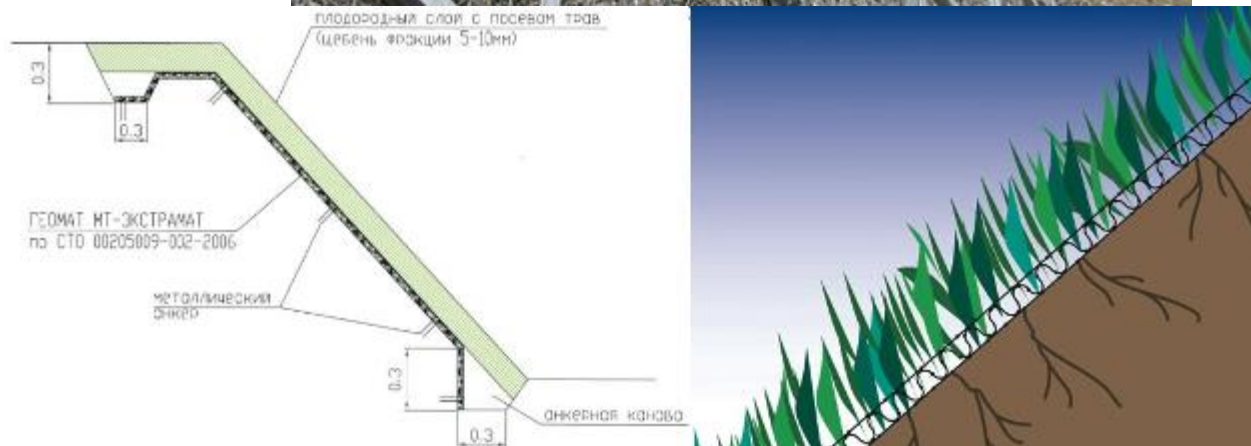
Protection measures against landslides and falls include the construction of stone trapping structures. When making design decisions - choosing the parameters and location of the anti-fall structures - the steepness and height of the slope (slope) are taken into account, on which the distance of the blocks flying away depends.



# Landslide control methods

Защита поверхности склона от разрушения

Protection of the slope surface from destruction



# Landslide control methods

Волноломы, буны  
Breakwaters, groins

