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LANDSLIDE CAUSES AND TRIGGERING MECHANISMS

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Landslide Causes and Triggering Mechanisms

Physical Causes—Triggers

- Intense rainfall
- Rapid snowmelt
- Prolonged intense precipitation
- Rapid drawdown (of floods and tides) or filling
- Earthquake
- Volcanic eruption
- Thawing
- Freeze-and-thaw weathering
- Shrink-and-swell weathering
- Flooding

Natural Causes

Geological causes

- Weak materials, such as some volcanic slopes or unconsolidated marine sediments, for example
- Susceptible materials
- Weathered materials
- Sheared materials
- Jointed or fissured materials
- Adversely oriented mass discontinuity (bedding, schistosity, and so forth)
- Adversely oriented structural discontinuity (fault, unconformity, contact, and so forth)
- Contrast in permeability
- Contrast in stiffness (stiff, dense material over plastic materials)

Morphological causes

- Tectonic or volcanic uplift
- Glacial rebound
- Glacial meltwater outburst
- Fluvial erosion of slope toe
- Wave erosion of slope toe
- Glacial erosion of slope toe
- Erosion of lateral margins
- Subterranean erosion (solution, piping)
- Deposition loading slope or its crest
- Vegetation removal (by forest fire, drought)

Highland, L.M., and Bobrowsky, Peter, 2008, The landslide handbook—A guide to understanding landslides: Reston, Virginia, U.S. Geological Survey Circular 1325, 129 p.

Landslide Causes and Triggering Mechanisms



D8-LOVOSICE

Photo: J. Novotný

Landslide Causes and Triggering Mechanisms



Photo: J. Novotný

Landslide Causes and Triggering Mechanisms



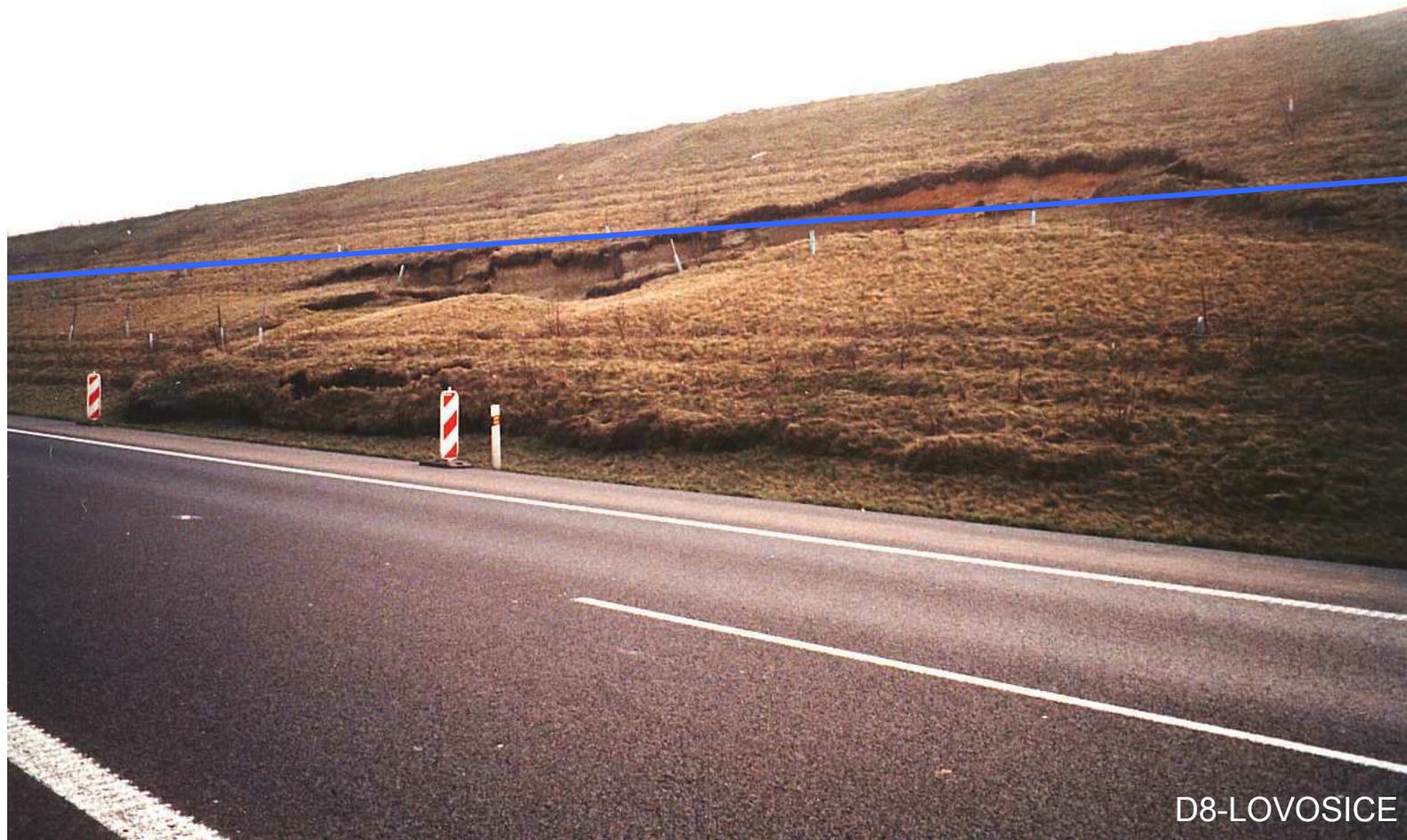
Photo: J. Novotný

Landslide Causes and Triggering Mechanisms



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Landslide Causes and Triggering Mechanisms

Precipitation



Landslide Causes and Triggering Mechanisms

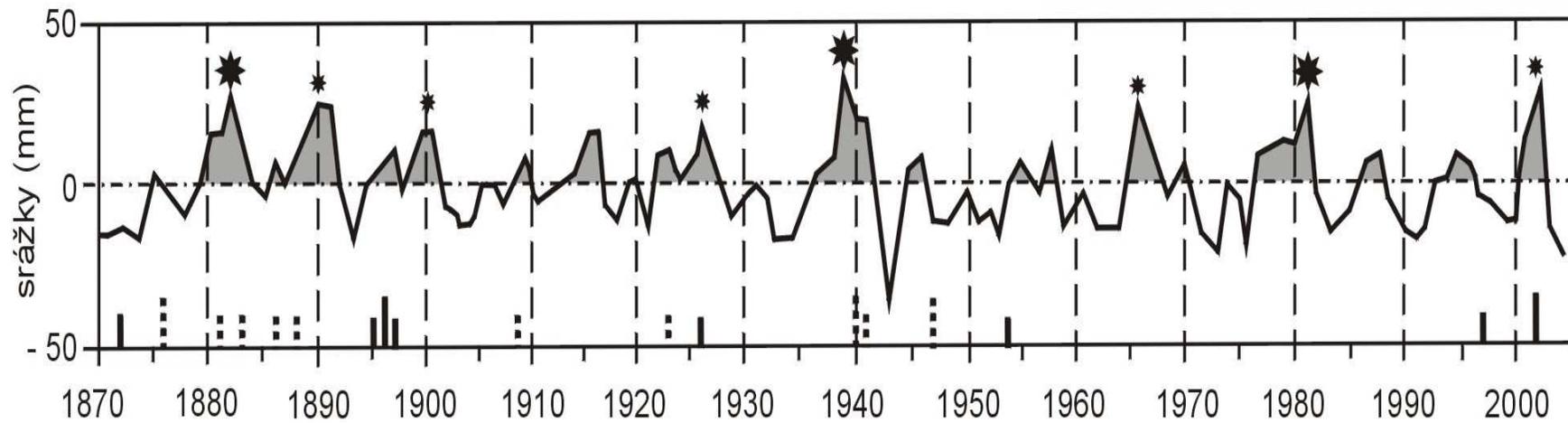
Precipitation



Photo: M.Šedivý

Landslide Causes and Triggering Mechanisms

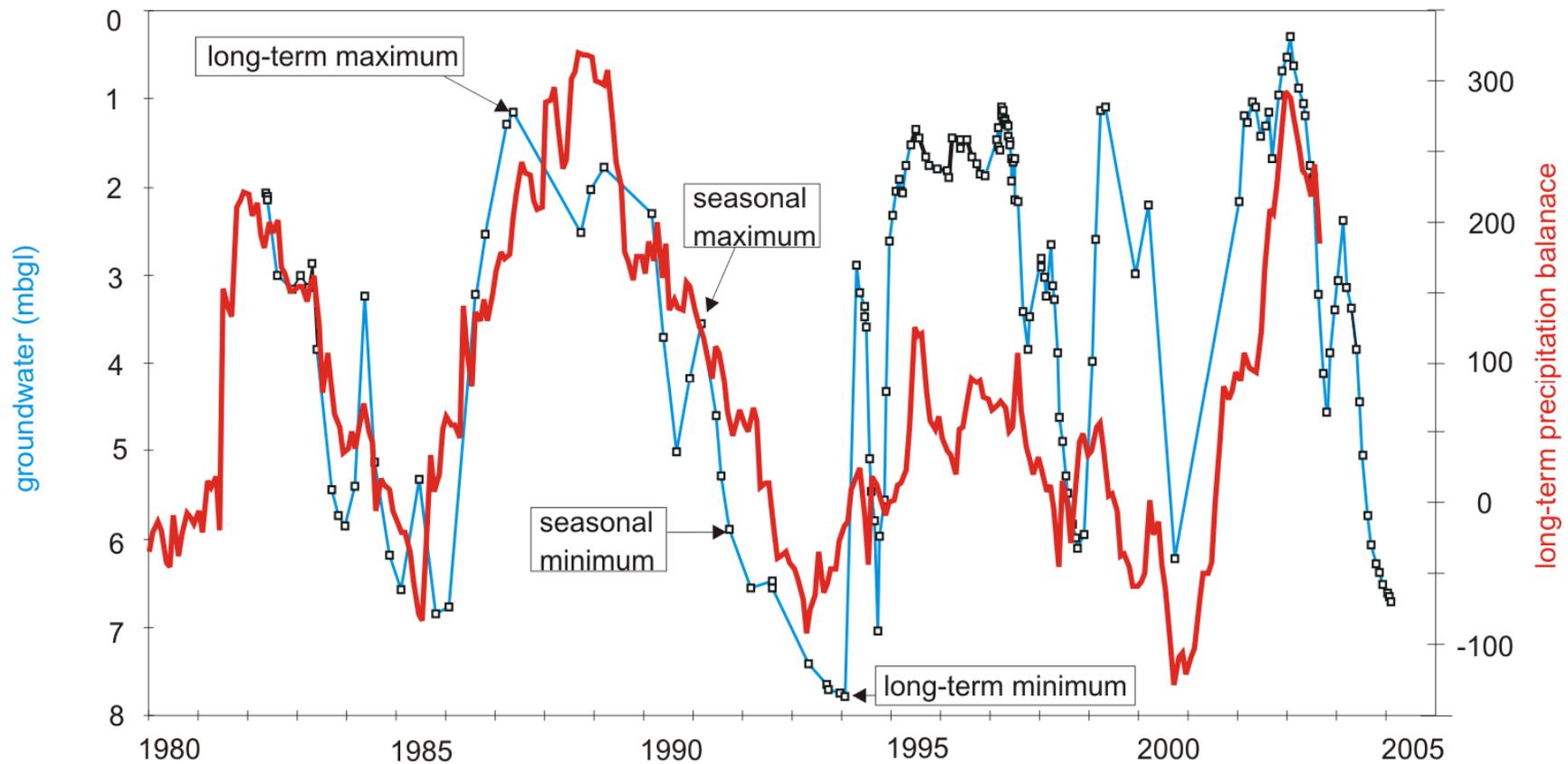
Precipitation



Landslide Causes and Triggering Mechanisms

Precipitation x hydrogeological regime

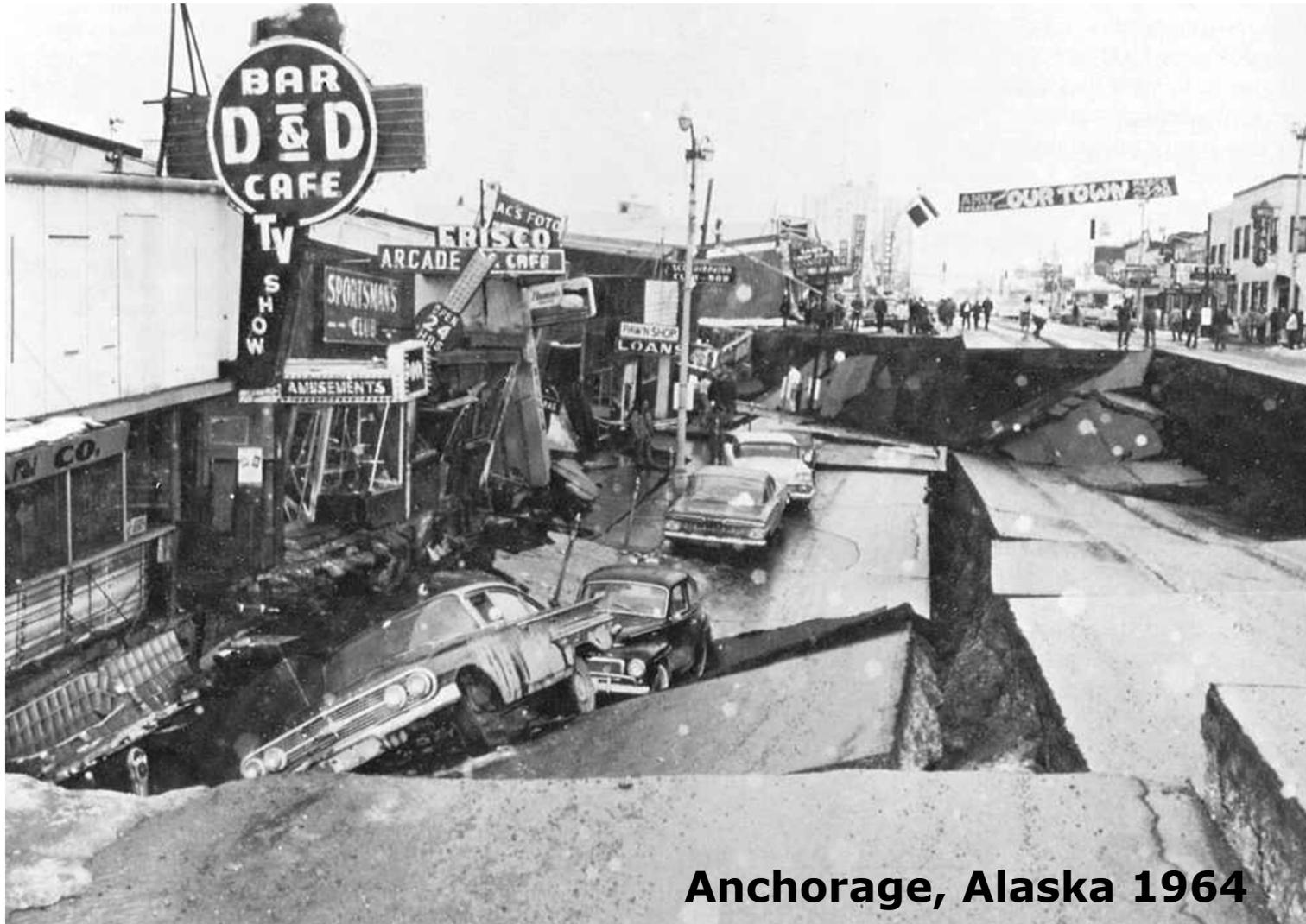
Třebenice landslide (Cretaceous claystones)



After J. Novotný 2005

Landslide Causes and Triggering Mechanisms

Seismicity



Anchorage, Alaska 1964

Landslide Causes and Triggering Mechanisms

Weathering

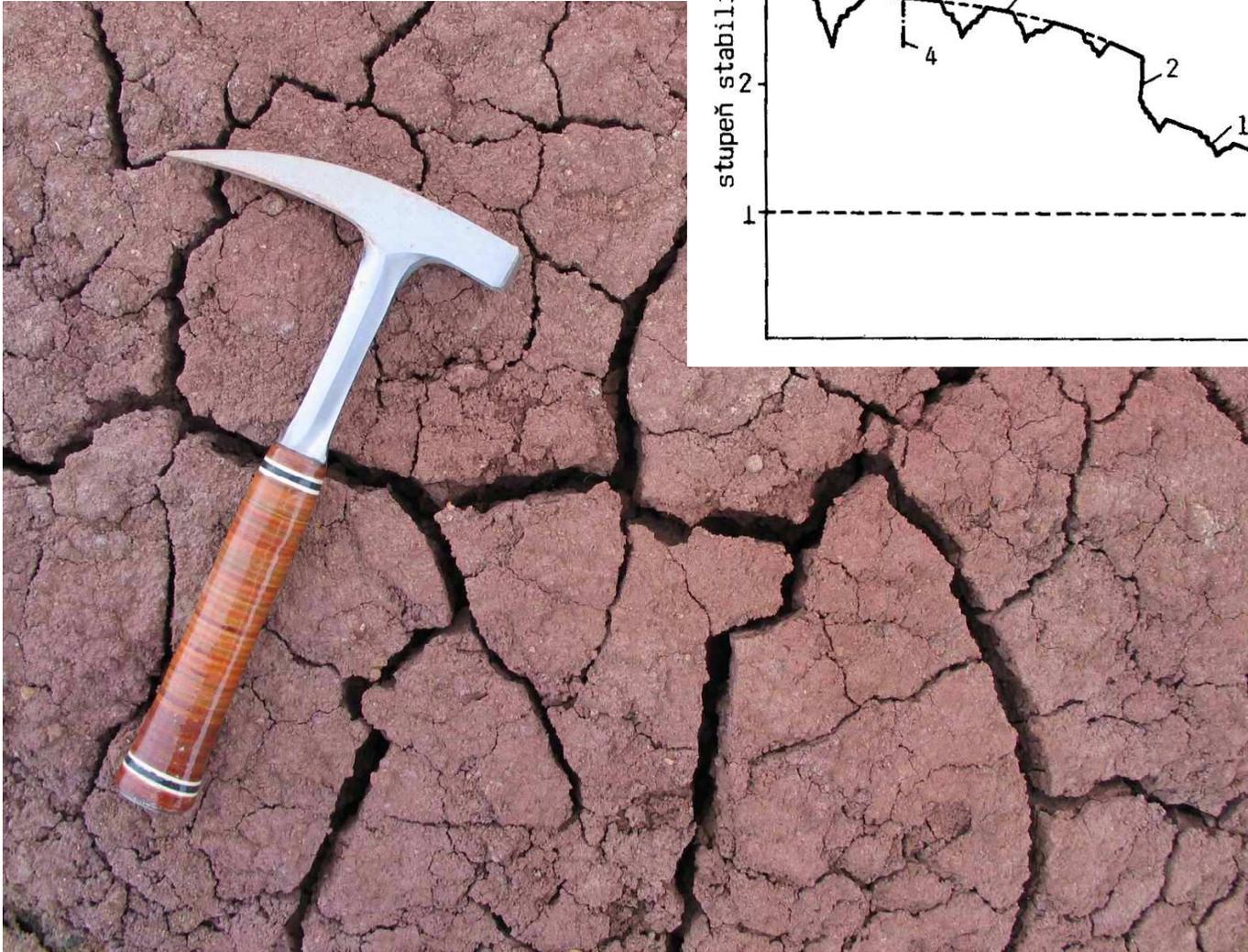


Photo: J. Novotný

Landslide Causes and Triggering Mechanisms

Tectonic disturbance (relict joints)

saprolites

Brazil, Rio de Janeiro vicinity



Photo: J. Novotný

Landslide Causes and Triggering Mechanisms

Tectonic disturbance (relict joints)

saprolites

Brazil, Rio de Janeiro vicinity

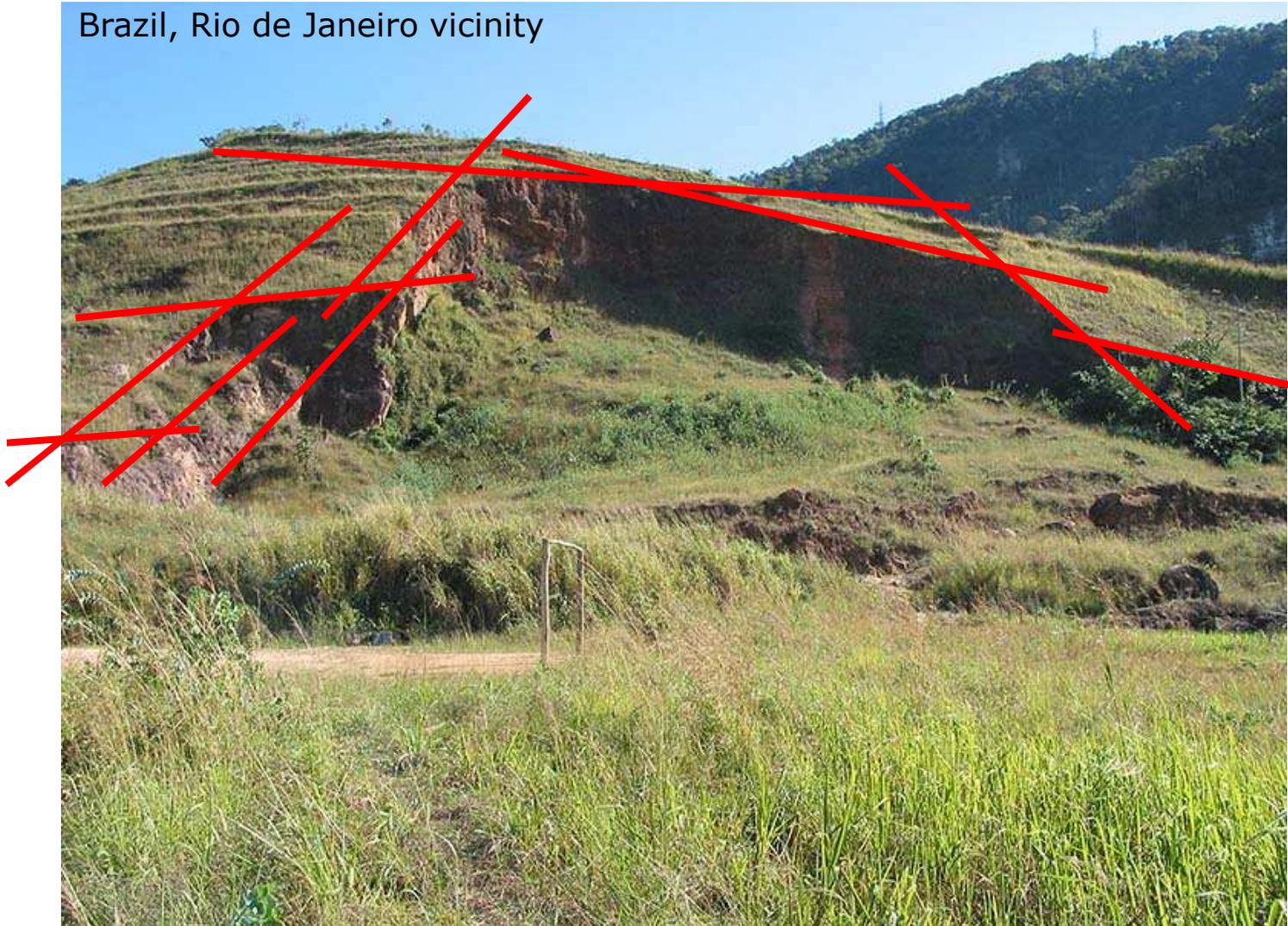


Photo: J. Novotný

Landslide Causes and Triggering Mechanisms

Saprolites without relict joints

Brazil, Rio de Janeiro vicinity

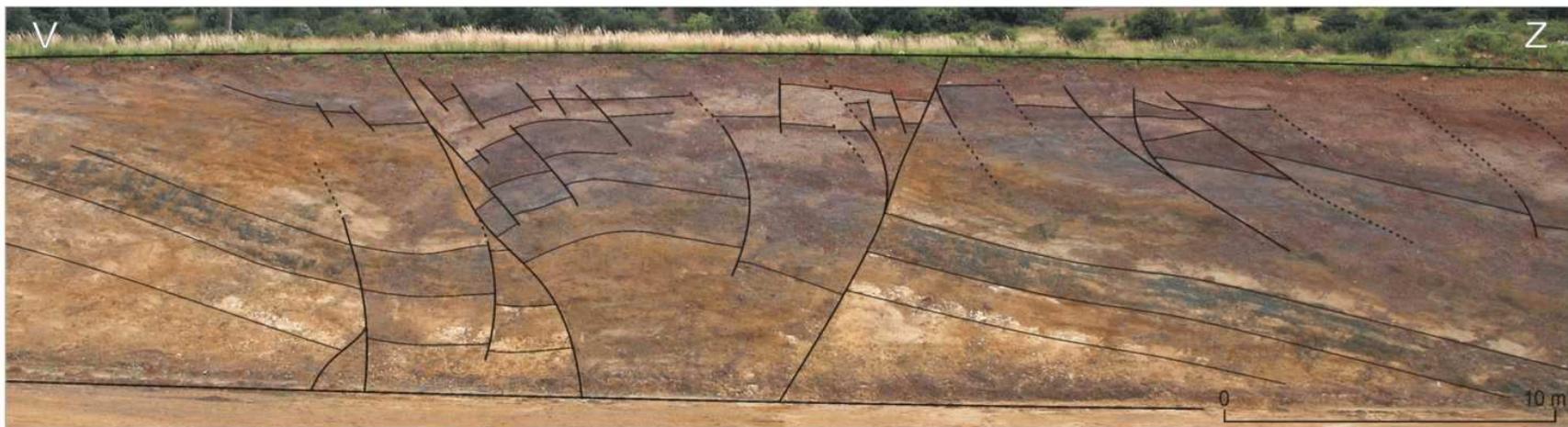


Photo: J. Novotný

Landslide Causes and Triggering Mechanisms

Tectonic / gravitational disturbance (relict joints)

Karlovy Vary



J. Novotný (2009)

Landslide Causes and Triggering Mechanisms

Tectonic / gravitational disturbance (relict joints)

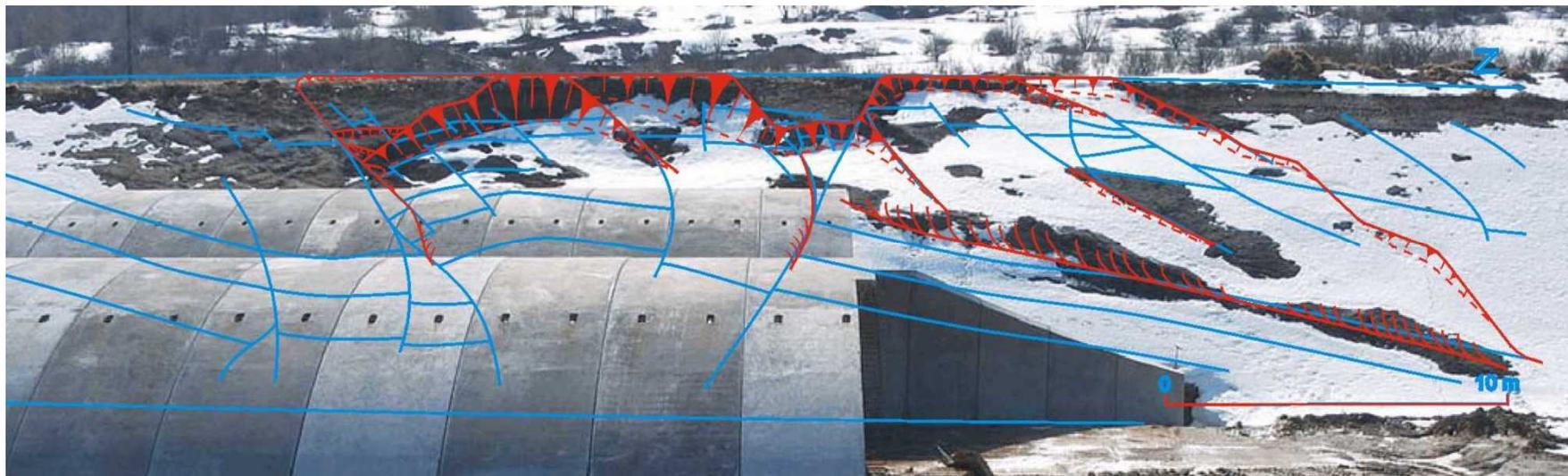
Karlovy Vary



Landslide Causes and Triggering Mechanisms

Tectonic / gravitational disturbance (relict joints)

Karlovy Vary



Landslide Causes and Triggering Mechanisms

Tectonic / gravitational disturbance (relict joints)

Karlovy Vary



Landslide Causes and Triggering Mechanisms

Human Causes

- Excavation of slope or its toe
- Use of unstable earth fills, for construction
- Loading of slope or its crest, such as placing earth fill at the top of a slope
- Drawdown and filling (of reservoirs)
- Deforestation—cutting down trees/logging and (or) clearing land for crops; unstable logging roads
- Irrigation and (or) lawn watering
- Mining/mine waste containment
- Artificial vibration such as pile driving, explosions, or other strong ground vibrations
- Water leakage from utilities, such as water or sewer lines
- Diversion (planned or unplanned) of a river current or longshore current by construction of piers, dikes, weirs, and so forth

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Landslide Causes and Triggering Mechanisms

Undercutting of the toe of the slope

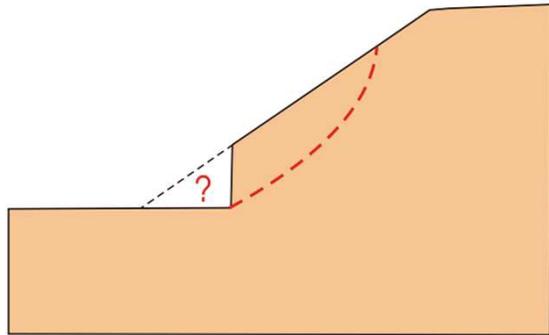


Photo: J. Novotný

Landslide Causes and Triggering Mechanisms

Load at the top of the slope



Photo: J. Novotný

Landslide Causes and Triggering Mechanisms

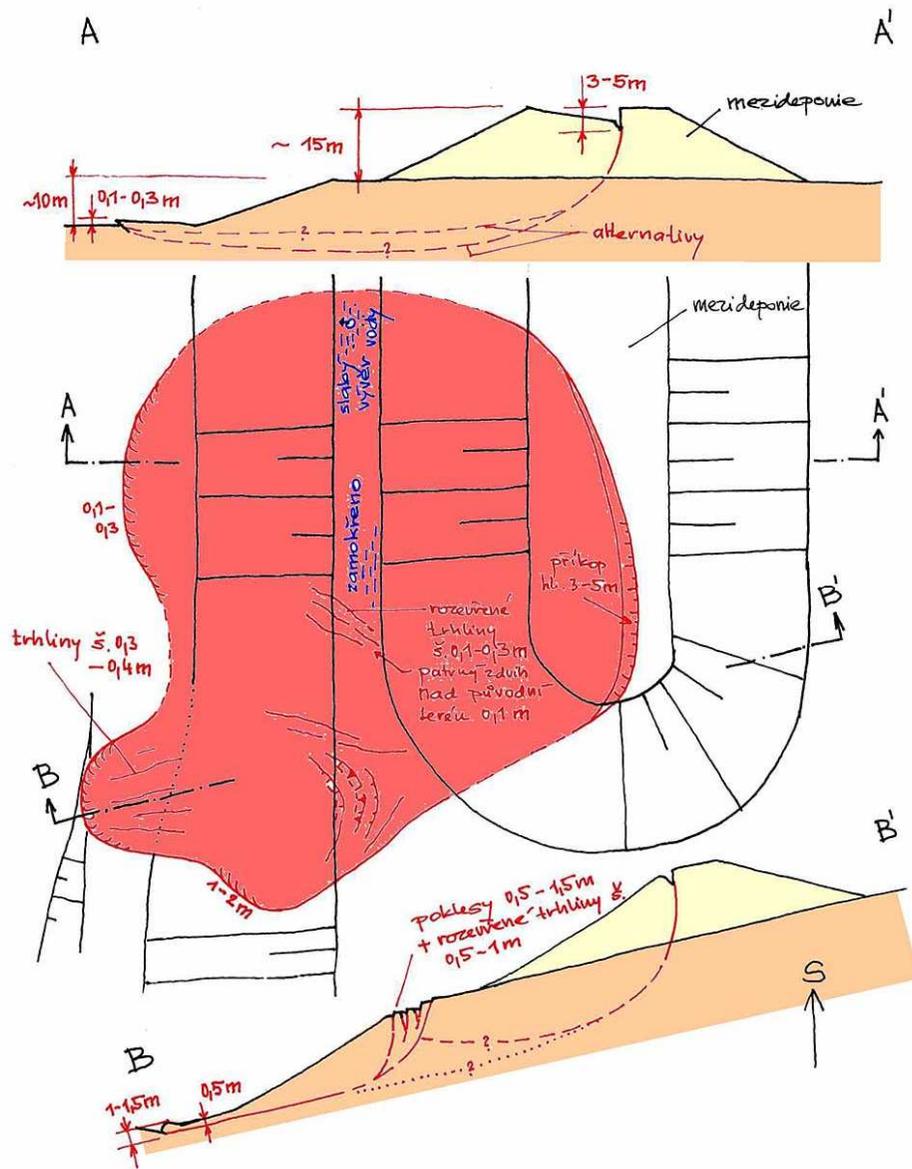
Load at the top of the slope



Photo: J. Novotný



Photo: J. Novotný



J. Novotný

Landslide Causes and Triggering Mechanisms

Piping by rapid opening of the cut in fully saturated sands



Photo: J. Novotný