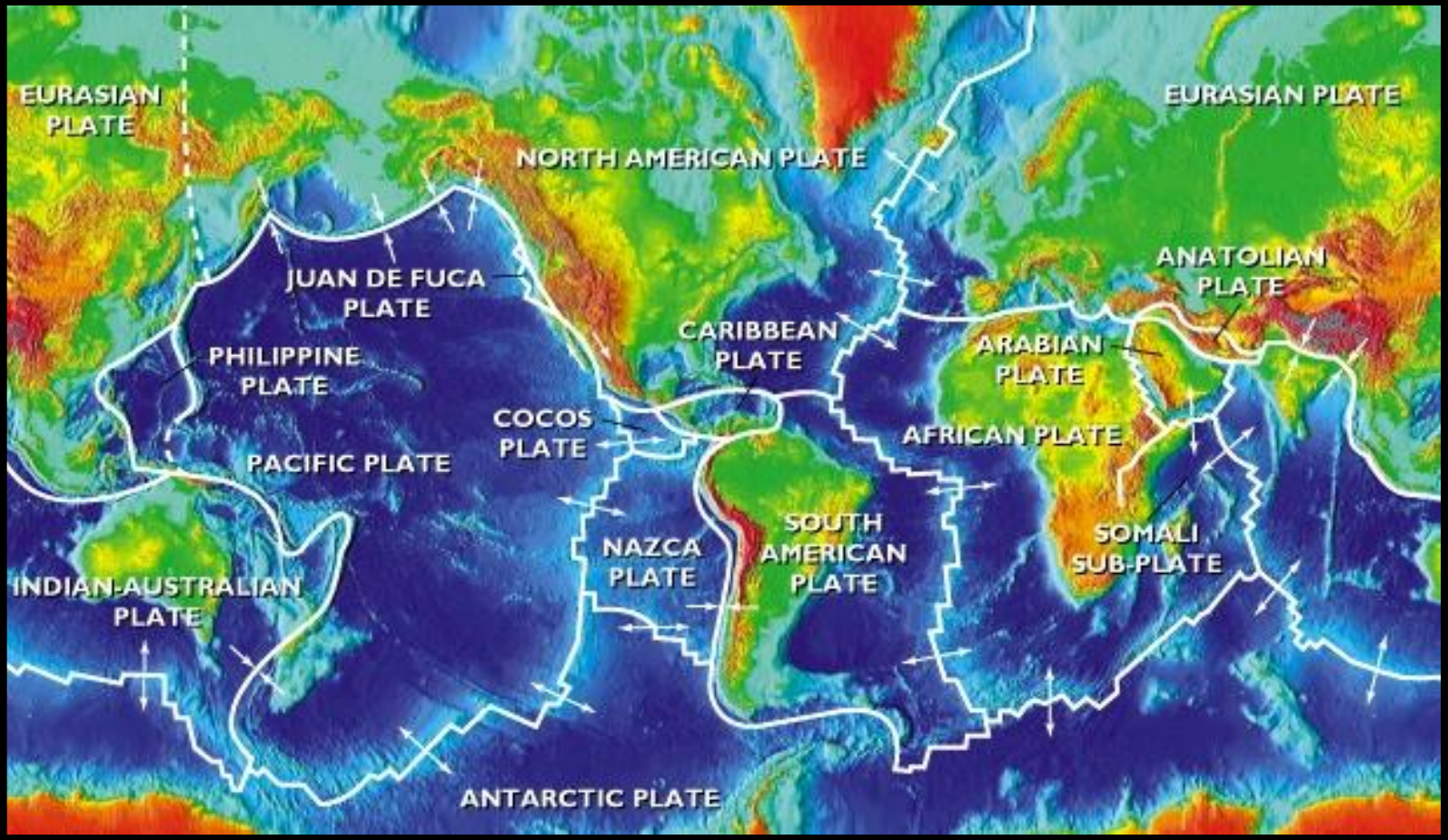
Tectonic geomorphology and paleoseismology

RNDr. Petra Štěpančíková, Ph.D.

Institute of Rock Structure and Mechanics
Czech Academy of Sciences, Prague, Czech Republic
Department of Neotectonics and Thermochronology

Tectonics – endogenous processes, structures and landforms associated with Earth´s crust deformation (movements of lithospheric plates)



Global scale tectonics: origin of continents and ocean basins

Time scales of tectonics:

depend on ***spatial scale*** at which the processes act:

Development of continents - thousands of millions years

Large ocean basins - hundreds of millions years

Small mountain ranges - several millions years

Small folds to produce hills - several hundred thousands years

Fault scarps - suddenly during earthquake

Neotectonics **-** crustal movements starting after the youngest orogenic phase or related to the youngest stress field occurring in the late Neogene and Quaternary

Active tectonics **–** tectonic processes that caused deformation of the Earth´s crust of local scale and on a time scale significant for humans (earthquakes)

Active faults – have moved during last 10.000 yrs – Holocene (paleoseismology)

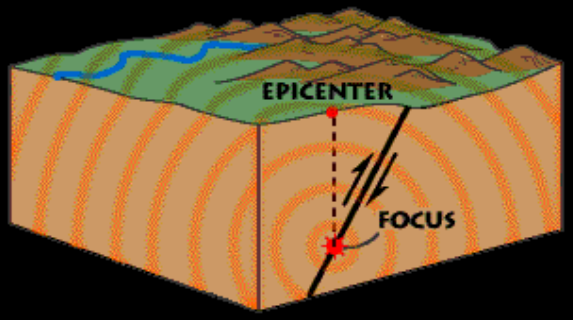
Potentially active faults (capable faults) – have moved during Quaternary (2.6 million yrs)

Rates of tectonic processes:

Very variable – 0.00X-X mm/year for fault displacement
X cm/year for movement on plate boundaries

Tectonic movements

Plate tectonics – movements on the plate margins produce stress (force per unit area) and strain (deformation – change in length, volume)



- Seismic movements

  - accompanied by earthquakes

  stress exceeds the strength of rocks, then rocks fail (rupture), energy is released in a form of an earthquake (elastic seismic waves) and faulting (breaking the rocks, rock deformation)

- Aseismic movements (tectonic creep)

  - more or less continuous movements with minimal seismicity, confined to narrow zone

Effects of earthquakes

Primary effects: ground-shaking motion and rupture of the surface

(consequences - shear or collapse of large buildings, bridges, dams, tunnels, pipelines)

Chi-chi EQ Taiwan 1999 with M=7.6

Landers EQ, Emerson fault, CA 1992, M=7.3

Secondary effects:

Liquefaction – water-saturated material transforms to liquid state (loose soil into mud) during shaking, compaction causes an increase of pore-water pressure = material loses shear strength and flows.

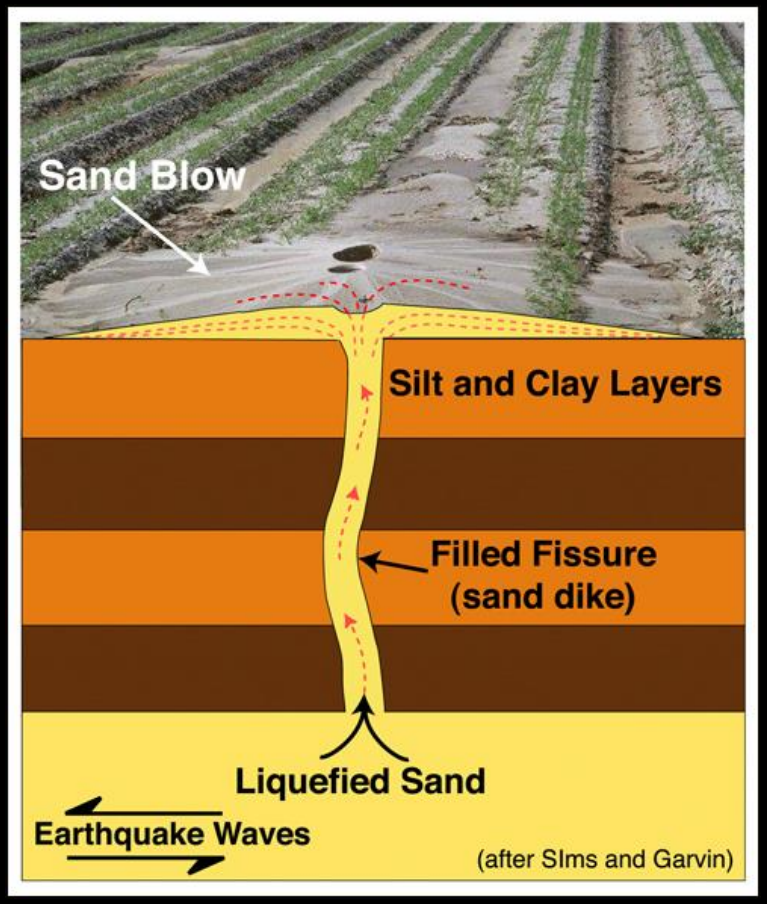
video

Water under the soil rises and the ground sinks causing extensive damage to buildings, roads and other structures.

Buildings tilted due to soil liquefaction,1964 earthquake, Japan.

Liquefaction

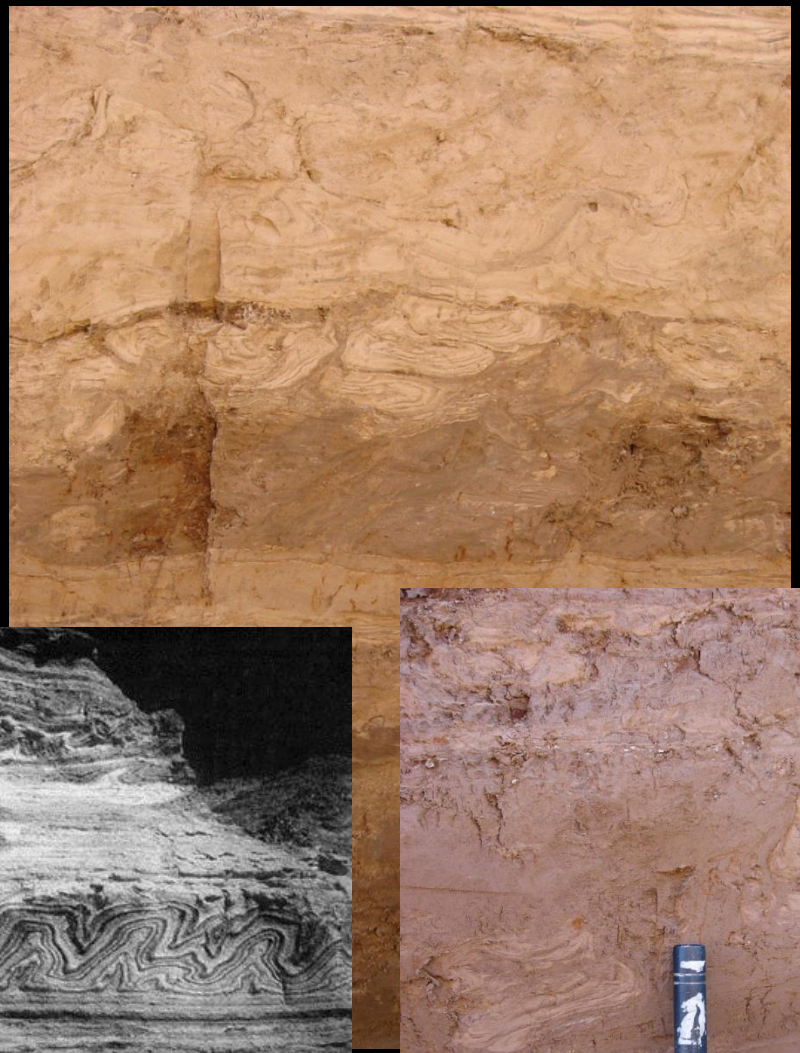
Loma Prieta , 1989

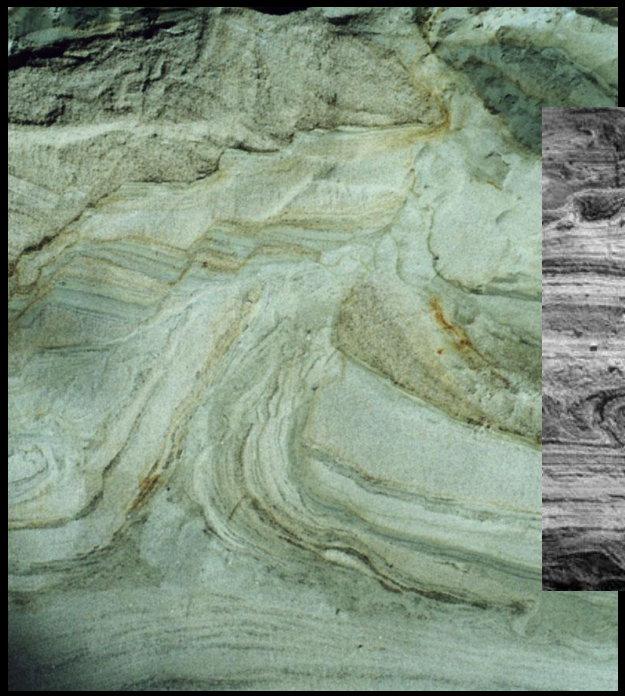


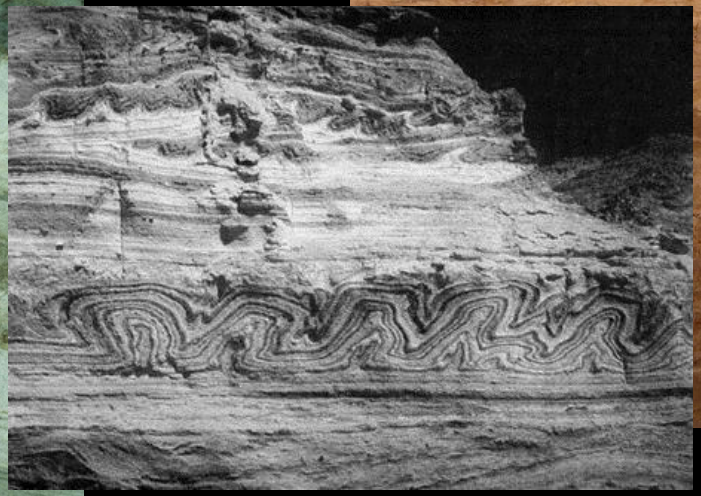
Layers of sand below the ground surface liquefy and, under the pressure of the overlying sediments, they exploit any fissure or other line of weakness to flow upwards and burst out on the ground surface as an eruption of sand and water.

Sand volcanoes, sand dykes

Seismites





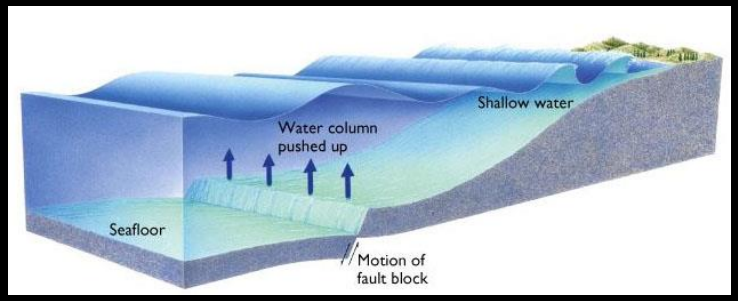


Escape structures

Landslides

Costarica, 2009, Mw=6.2, depth 6km, 550 foreshocks, 180 landslides

Tsunami - seismic seawaves



Floods – following collapse of dams

Fires

Long-term effects

Regional subsidence,
Change in groundwater level

Ghost forest

Change of coastal morphology

subsidence