2.3 GEOLOGIC PROCESSES AND LANDFORMS

FACTORS THAT CONTROL LAND FORMATION:
(1) EARTH MATERIALS, (2) GEOLOGIC PROCESSES,
(3) TIME OVER WHICH PROCESSES ACT

GEOLOGIC TIME SCALE IS, TO HUMANS, ALMOST INCOMP. LONG. SOME PROCESSES ARE VERY SLOW, AND POTENTIALLY DON'T INFLUENCE ENGINEERING PROJECT OVER TYP. DESIGN LIFE. OTHERS ARE VERY SHORT, + OFTEN INFREQUENT.

LONG PROCESS: EROSION OF HAWAIIN ISLAND OF KAUAI
SHORT PROCESS: EARTHQUAKE, LANDSLIDE, FLOOD

SHOW GEOLOGIC TIME SLIDE

EON	ERA	PERIOD	EPOCH	YRS. BEFORE PRESENT

SOILS THAT GEOTECHNICAL ENGINEERS DEAL WITH ARE PREDOMINANTLY FROM THE QUATERNARY PERIOD. WE OFTEN DISTINGUISH HOLOCENE (~15,000 YRS) FROM PLEISTOCENE (1.6 M YRS). SOMETIMES USE "PRE-QUATERNARY" AS WELL. RARELY DISTINGUISH OTHER PERIODS/EPOCHS/ERAS/EONS.

SOIL BECOMES LITHIFIED & FORMS SEDIMENTARY ROCK OVER TIME.

~~WE~~

GEOLOGIC PROCESSES: WEATHERING, GRAVITY, SURFACE WATER, ICE, WIND, GLACIERS, VOLCANIC ACTIVITY, BIOLOGICAL, CHEMICAL.

WEATHERING: ALTERATION OF ROCKS NEAR SURFACE DUE TO PHYSICAL, CHEMICAL, AND/OR BIOLOGICAL PROCESSES. PHYSICAL WEATHERING TENDS TO PRODUCE COARSER-GRAINED SOILS (BOULDERS, COBBLES, GRAVEL, SAND, SILT). CHEMICAL WEATHERING PRODUCES VARIOUS TYPES OF CLAY MINERALS.

SHOW TABLE 3.2

SURFACE PROCESS	DESCRIPTION	MATERIAL PRODUCED

KARSTIC FEATURES: RAIN WATER SLIGHTLY ACIDIC DUE TO DISSOLVED CO_2 FROM ATMOSPHERE, YIELDING CARBONIC ACID. CARBONATE ROCKS (e.g., LIMESTONE) ARE ATTACKED BY ACIDIC WATER & DISSOLVE RESULTING IN CAVITIES OR CAVERNS.

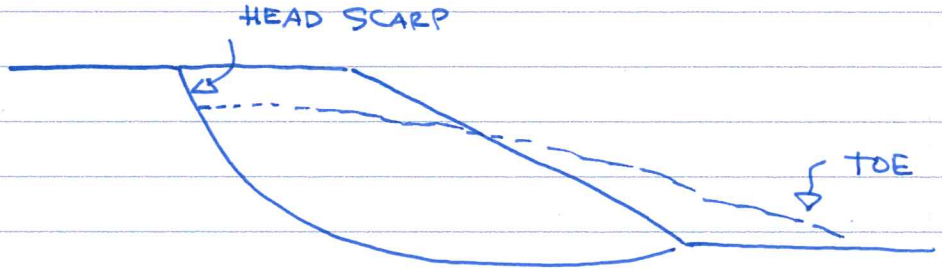
SHOW FIG. 3.4 & 3.5 + OTHER KARST FAILURES

RESIDUAL SOIL: WEATHERED AND NOT TRANSPORTED.

WEATHERING OCCURS AT SURFACE AND ALONG DISCONTINUITIES IN ROCK MASS. SHOW FIG. 3.6.
CAN BE VERY THICK IN TROPICS (10^s OF METERS).
WEATHERED GRANITE IS COMMON IN U.S. IS DECOMPOSED GRANITE.
RES. SOILS OFTEN LEAD TO LANDSLIDES & DEBRIS FLOWS.

GRAVITY PROCESSES

GEOLOGIC MATERIAL MOVES DOWNHILL (i.e., LANDSLIDE).
LANDSLIDE TYPES: FALL, TOPPLE, FLOW, SPREAD, SLIDE
→ SHOW FIG. 3.7



ANALYSIS OF SLOPE STABILITY IS COVERED IN CEE 121 & 123.

SURFACE WATER PROCESSES

SURFACE WATER FLOWS ON SURFACE OF EARTH IN RIVERS, STREAMS, etc.
GROUND WATER FLOWS BELOW SURFACE THROUGH SOIL.

FLUVIAL DEPOSITS

RIVERS & STREAMS ERODE SOIL AND CARRY IT AS SEDIMENT IN SUSPENSION.
HIGH VELOCITY CARRIES LARGE PARTICLES. SLOWER VELOCITIES CARRY FINE PARTICLES.
AS RIVERS SLOW, PARTICLES ARE DEPOSITED. EROSION & DEPOSITION OCCUR IN ALTERNATING SEQUENCES.

FLOOD PLAIN: LAND FORMED BY SEDIMENT DEPOSITION.
ALLUVIUM: SOIL DEPOSITED BY RIVER. CAN BE STREAM BED DEPOSITS OR OVERBANK DEPOSITS

→ SHOW FIG. 3.12 & 3.13 & 3.14

COARSE-GRAINED ALLUVIAL DEPOSITS ARE TYPICALLY ROUNDED FROM ABRASION DURING TRANSPORT.

ALLUVIAL FAN: STREAMS CARRY SEDIMENT ONTO VALLEY FLOOR. SHOW SLIDE. → SHOW FIG 3.18

MARINE & COASTAL LAND FORMS

WAVES CAUSE EROSION & DEPOSITION

COASTLINES CATEGORIZED AS DESTRUCTIONAL (ERODING) OR CONSTRUCTIONAL (ACCRETING) → SHOW FIG. 3.19

CLAY & SILT DEPOSITED IN OCEAN SETTLE IN SLOW-MOVING WATER. SALT CAUSES CLAY MINERALS TO FLOCCULATE & FORM MARINE CLAY.

LACUSTRINE LANDFORMS

SOIL DEPOSITED IN LAKES OFTEN FILLS UP LAKE AND FORMS A SWAMP

TYPICALLY SILTS AND CLAYS. COARSER PARTICLES DEPOSITED BEFORE REACHING LAKE.

VARVED CLAY CONSISTS OF THINLY INTERBEDDED SILTY CLAY DEPOSITS. SILT AT BOTTOM, GRADUALLY FINER TOWARD TOP.

ICE PROCESSES AND GLACIATION

FORMATION, MOVEMENT, AND MELTING OF GLACIERS IS IMPORTANT PROCESS THAT HAS RESULTED IN A NUMBER OF MAJOR LANDFORMS.

PLEISTOCENE EPOCH CHARACTERIZED BY MAJOR CONTINENTAL GLACIATION.

GLACIERS FORM WHEN SNOWFALL EXCEEDS MELT. SNOW TURNS TO CRYSTALLINE ICE UNDER HIGH PRESSURE & FLOWS DOWNSLOPE. GLACIAL EQUILIBRUM → SHOW FIG 3.23.

GLACIERS CAN BE MOUNTAIN OR CONTINENTAL. MOUNTAIN GLACIERS OCCUR IN VALLEYS, CONTINENTAL ON FLAT GROUND. THE LATTER CAN BE THICKER THAN 4 km, COMPRESSING SOIL & ROCK BELOW. WHEN GLACIERS MELT, CRUSTAL REBOUND OCCURS.

GLACIERS CAUSE EROSION (e.g., HALF DOME YOSEMITE)

GLACIERS CAUSE DEPOSITION.

- TILL: SOIL DEPOSITED AT BOTTOM OF GLACIER.
  - BASAL TILL: DEP. BY FROZEN GLACIER (DENSE)
  - ABLATON TILL: DEP. AS GLACIER MELTS.
- GLACIO-FLUVIAL: CARRIED BY MELTWATER

→ U-SHAPED VALLEYS

FJORDS: GLACIERS SUBMERGED AND MELTED DURING SEA LEVEL RISE.

WIND PROCESSES

EOLIAN LANDFORMS PRODUCED BY WIND EROSION & DEPOSITION

MOST PROMINENT ARE DUNES. SHOW FIG. 3.32

PRIMARY GEOHAZARD IS PROTECTING INFRASTRUCTURE FROM MIGRATING DUNES.

LOESS: (GERMAN löss) WIND BLOWN SILT. OPEN POROUS STRUCTURE. CEMENTED. CAN COLLAPSE UPON WETTING. CAN BE PRE-WETTED.

VOLCANIC PROCESSES:

EJECTED LAVA IS PYROCLASTIC DEBRIS CALLED TEPHRA.

LAVA THAT FLOWS OVER GROUND FORMS FLOW LANDFORMS.

LAHARS ARE MIXES OF VOLCANIC DEBRIS AND ICE & MUD. CAN MOVE QUICKLY AND KILL PEOPLE.

GROUNDWATER PROCESSES

WATER INVOLVED IN VIRTUALLY ALL GEOTECHNICAL ENGINEERING PROBLEMS.

IN SOIL, WATER FLOWS THROUGH SPACES BETWEEN GRAINS.
IN ROCK, WATER FLOWS THROUGH JOINTS & FISSURES.

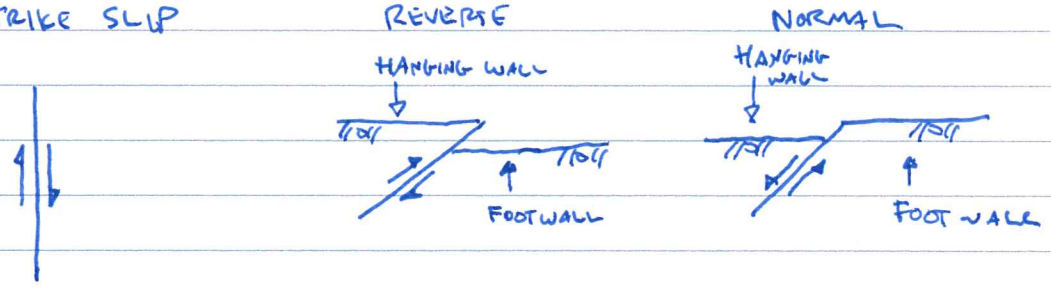
WATER MAKES SOIL HEAVIER AND WEAKER. MOVEMENT OF WATER INTRODUCES SEEPAGE FORCES.

TECTONIC PROCESSES

ORIGINATE IN EARTH'S CRUST AND SHALLOW MANTLE.

MOVEMENT OF PLATES PRODUCES COMPRESSION AND EXTENSION RESULTING IN FOLDING OF CRUST FORMING DOMES, FAULT BLOCKS, ANTICLINES, SYNCLINES, etc. SHOW FIGS. 3.35 & 3.36

TYPES OF FAULTING



e.g. SAN ANDREAS
RIGHT LATERAL