EARTH SCIENCE · KINDERGARTEN–GRADE 8 · QUICK REFERENCE

Earth Science (Rocks · Water · Sky)

Grades K–8 | 3 pages

Rocks, minerals and soil, the water cycle, clouds and weather, the earth's layers, plates, volcanoes and earthquakes, reading rock layers and the Flood as the course teaches it, the solar system, seasons, the moon and stars, and the resources, maps and careers of grade 8.

1 Rocks & soil | 2 Water & weather | 3 Inside the earth | 4 Reading the rocks | 5 Sun, moon, stars | 6 Resources & maps

1 ROCKS, MINERALS & SOIL

K–8 · the ground under our feet

Three kinds of rock

Kind	How it forms	Examples
Igneous	melted rock (magma, lava) cools and hardens	granite, basalt, obsidian, pumice
Sedimentary	sediments settle in layers and cement	sandstone, shale, limestone, conglomerate, coal
Metamorphic	rock changed by heat and pressure	marble (from limestone), slate (from shale), quartzite, gneiss

Rock cycle: any rock can be melted, broken into sediment, or squeezed into another kind. New rock can form fast: Surtsey rose from the sea in 1963; Mount St. Helens laid down layers in hours in 1980.

Sort a rock

Size: boulder, cobble, pebble, sand, silt, clay. **Test:** color, streak, luster (shiny or dull), hardness, layers, grains, fizz with vinegar (limestone). Label every specimen: where, when, who.

Mohs hardness scale

#	Mineral	Test	#	Mineral	Test
1	talc	fingernail	6	feldspar	steel file
2	gypsum	fingernail	7	quartz	scratches glass
3	calcite	copper penny	8	topaz	
4	fluorite	knife	9	corundum	
5	apatite	knife	10	diamond	only diamond

Minerals

A **mineral** is a natural, solid, non-living substance with a fixed makeup and crystal shape; rocks are made of minerals. **Ore** is rock worth mining for its metal. Gold is dense (19.3 g/cm^3): it sinks in the pan (Sutter's Mill, 1848).

Soil

- Soil = broken rock + humus (rotted plants and animals) + air + water + living things. Worms loosen and feed it.
- **Horizons:** O (leaf litter), A (topsoil, dark), B (subsoil), C (broken bedrock), then bedrock.
- **Sand** drains fast, **clay** holds water and molds, **loam** mixes both and grows the best crops.
- Keep soil: contour plowing, cover crops, windbreaks. The Dust Bowl (1930s) blew bare topsoil away.

Fossils

Remains or traces of once-living things buried quickly in sediment: shells, bones, prints, amber. Mary Anning found sea reptiles at Lyme Regis (1811). Fossil seashells sit on mountaintops; fossil graveyards hold thousands of animals buried together.

2 WATER & WEATHER

K–8 · the water cycle, clouds, wind, storms

The water cycle

1. **Evaporation:** the sun turns liquid water into vapor.
2. **Condensation:** vapor cools into droplets: clouds, dew, fog.
3. **Precipitation:** rain, snow, sleet, hail fall.
4. **Collection:** water runs into streams, rivers, lakes, the sea, or sinks into the ground (springs, wells, aquifers).

Water freezes at 32 °F / 0 °C and boils at 212 °F / 100 °C. Ice floats. About 71% of the earth is covered by water; 97% of it is salty sea.

Rivers

Source (spring or snowmelt) → **tributaries** join → **floodplain** → **delta** at the **mouth**. Running water rounds stones, carves canyons and builds deltas (the Nile). Waterfalls retreat upstream (Niagara). **Glaciers** are rivers of ice that scrape valleys and drop boulders.

Clouds (Luke Howard, 1802)

Name	Latin	Look	Weather
Cirrus	curl	high, wispy, icy	fair, change coming
Cumulus	heap	puffy, flat base	fair; towering ones storm
Stratus	layer	gray sheet	drizzle, overcast
Nimbus	rain	dark, heavy	rain or snow (cumulonimbus = thunderstorm)

Weather instruments

Tool	Measures
thermometer	temperature
barometer	air pressure (falling = storm)
rain gauge	rainfall in inches
wind vane	wind direction (named by where it comes *from*)
anemometer	wind speed
hygrometer	humidity

Weather and climate

- **Weather** is today; **climate** is the usual pattern over years.
- Warm air rises; cool air sinks. Wind is air moving from high to low pressure. Sea breezes blow onshore by day.
- **Fronts:** cold front = thunderstorms then clear; warm front = long steady rain.
- **Lightning** is a giant spark; thunder follows (5 seconds ≈ 1 mile). Go indoors.
- **Tornado:** go low, inside, away from windows. **Hurricane:** warm-ocean storm; eye in the middle; leave when told.
- A **rainbow** is sunlight bent by raindrops: red outside, violet inside.

MEMORY TRICK **Red sky at night**

"Red sky at night, sailors' delight; red sky in the morning, sailors take warning" (Matthew 16:2–3). Weather usually moves west to east.

3 INSIDE THE EARTH: PLATES, VOLCANOES, EARTHQUAKES

grades 6–7 · the dynamic earth

Earth's layers

Layer	State	Note
Crust	solid rock	5–40 mi thick; thinnest under oceans
Mantle	hot, slowly flowing rock	most of the earth's volume
Outer core	liquid iron and nickel	makes the magnetic field
Inner core	solid iron	Inge Lehmann found it from earthquake waves, 1936

Plates

The crust is broken into **plates** that move. **Divergent**: pull apart, new crust (Mid-Atlantic Ridge, Iceland). **Convergent**: collide, mountains or trenches (Himalaya: India pushes into Asia). **Transform**: slide past (San Andreas). Wegener's puzzle fit (1912); the course also studies catastrophic plate tectonics (Baumgardner) as a Flood model.

Volcanoes

Type	Shape	Example
Shield	broad, gentle, runny lava	Hawaii
Cinder cone	small, steep, cinders	Parícutin grew in a cornfield, 1943
Composite	tall, layered, explosive	Vesuvius (A.D. 79), Mount St. Helens (1980)

Krakatoa (1883) made the loudest sound in recorded history. Magma underground, lava above. Signs before an eruption: swelling, gas, small quakes (Pinatubo, 1991).

Mountains

Rock **folds** (anticline up, syncline down) and **faults** (breaks). The Himalaya, Alps and Appalachians are folded; some bent layers show no cracking (Sideling Hill).

Earthquakes

- Rock snaps along a fault: the **focus** is the break underground, the **epicenter** the point above it.
- **P waves** arrive first (push-pull); **S waves** second (side to side); surface waves do the damage. A **seismograph** records them.
- **Magnitude** (Richter, moment): each whole number ≈ 10× the shaking and ≈ 32× the energy. Lisbon (1755) started the science.
- A **tsunami** is a harbor wave from a sea-floor quake: if the water pulls back, run to high ground (Kamaishi, 2011).
- Buildings survive by flexing: Taipei 101's steel ball. Drop, cover, hold on.

MEMORY TRICK **Crust, mantle, core**

Like a peach: thin **skin** (crust), thick **flesh** (mantle), hard **pit** (core). A compass needle points along the magnetic field made in the outer core.

4 READING THE ROCKS: LAYERS, EROSION & THE FLOOD

grades 6–8 · earth history as the course teaches it

Steno's principles (1669)

- **Superposition:** in undisturbed layers the bottom one was laid first.
- **Original horizontality:** sediments settle in flat layers.
- **Lateral continuity:** a layer once stretched across the whole basin.
- **Cross-cutting:** a fault or dike is younger than the layers it cuts.

Weathering, erosion, deposition

Weathering breaks rock in place (ice wedging, roots, acid rain, heat). **Erosion** carries pieces away (water, wind, ice, gravity). **Deposition** drops them (deltas, dunes, moraines). Canyon Lake Gorge (2002) was cut in days by a flood.

Catastrophe or slow change?

- **Uniformitarianism** (Hutton, Lyell): the present slow rates explain the past. **Catastrophism** (Cuvier, Bretz's Scablands): great floods shaped the land quickly.
- The course reads **Genesis 6–9 as history**: a year-long global Flood that laid down vast layers, buried fossil graveyards, and was followed by one Ice Age (Agassiz saw glacier marks, 1837).
- Flat gaps between layers, coal seams, folded-while-soft rock and worldwide flood legends are weighed as evidence.

Dating methods

Radioactive atoms decay with a **half-life** (half the parent remains each half-life). A radiometric age rests on **three assumptions**: the starting amounts, no gain or loss, and a constant rate. Discordant dates (Mount St. Helens dacite, 1996) and carbon-14 in diamonds and coal are the course's test cases. Old-earth and secular readings are summarized fairly in grade 8.

Dinosaurs

Reptile kinds known from bones, eggs and nests; sorted by hips, teeth and feet. Behemoth (Job 40) and dragon legends are read alongside. Soft tissue in bone (2005) is discussed. Living fossils (coelacanth, 1938) look like their fossils.

Ice Age

Glaciers carved U-shaped valleys, left moraines and erratic boulders, and lowered sea level. Woolly mammoths lived along the ice edge. Ice cores are read by counting layers.

MEMORY TRICK **Oldest on the bottom**

A stack of pancakes: the first one poured is on the **bottom**. Anything that cuts the stack came **after** it.

5 SUN, MOON & STARS

grades K–5 · the sky

The solar system

Planet	Kind	Note
Mercury	rocky	closest, cratered
Venus	rocky	hottest, thick clouds
Earth	rocky	liquid water, one moon
Mars	rocky	red, two tiny moons
Jupiter	gas giant	largest, Great Red Spot
Saturn	gas giant	bright rings
Uranus	ice giant	Herschel, 1781; tipped on its side
Neptune	ice giant	farthest, windy

My Very Educated Mother Just Served Us Noodles. The sun is a star, 93 million miles away; the moon is 239,000 miles. Voyager's "pale blue dot" (1990).

Day, year, seasons

- **Rotation** on its axis: 24 hours, day and night; shadows swing and shorten toward noon (sundial).
- **Revolution** around the sun: 365¼ days, so every fourth year is a leap year.
- The axis tilts **23.5°**; the half tipped toward the sun has summer. **Solstices** about June 21 and December 21; **equinoxes** about March 20 and September 22.
- **Time zones:** 24 zones of 15° each, set by the railroads in 1883.
- Eratosthenes measured the earth with a shadow (c. 240 B.C.): about 24,900 miles around. Julian (46 B.C.) and Gregorian (1582) calendars.

Kepler and Newton

Planets move in **ellipses** with the sun at one focus, sweep equal areas in equal times, and farther planets take longer ($T^2 \propto a^3$). Newton: the same **gravity** that drops an apple holds the moon in orbit.

The moon

- **Phases** in 29½ days: new → waxing crescent → first quarter → waxing gibbous → full → waning gibbous → third quarter → waning crescent. We see the sunlit half from different angles.
- **Solar eclipse:** moon between sun and earth. **Lunar eclipse:** earth's shadow on the moon.
- **Tides:** two highs and two lows a day, pulled by the moon; spring tides at new and full moon, neap tides at the quarters.
- Galileo saw mountains on the moon (1609); Apollo 11 landed July 20, 1969.

Stars

- **Polaris**, the North Star, sits over the pole: find it from the Big Dipper's pointer stars. The **Southern Cross** guides the south.
- Star colors tell heat: blue-white hottest, yellow (our sun), red coolest. Orion and the Pleiades are named in Job 38:31.
- A **light-year** is the distance light travels in a year, about 5.9 trillion miles. Telescopes: refractor (lenses), reflector (mirror), Hubble and Webb in space.

6 RESOURCES, MAPS & CAREERS

grade 8 · the ground people work

Water underground

Rain sinks into porous rock and sand, an **aquifer**; its top is the **water table**. A **well** reaches below it; a spring is where it surfaces. Jacob's well (John 4). Western water rights: first in time, first in right.

Fuels

Coal, oil and natural gas come from buried plants and sea life. Oil and gas collect in **traps**, porous reservoir rock capped by shale. Drake's well (1859), Spindletop (1901). A barrel refines into gasoline, diesel, jet fuel, asphalt and plastics.

Mining

Open-pit (Bingham Canyon) for shallow ore, **underground** shafts for deep seams. Mine Act (1977) after Monongah (1907); **reclamation** law (SMCRA, 1977) puts the land back. Every tool, wire and brick began as rock.

Materials (K)

Wood, stone, metal, glass, plastic, cloth: sort by property (hard, soft, bends, floats, waterproof) and pick the right material for the job.

Maps

- **Topographic maps:** contour lines join equal heights; close lines mean steep ground; the contour interval is the step between lines.
- William Smith drew the first geological map (1815) by tracing rock layers and their fossils.
- **GIS** stacks map layers (roads, rock, water, elevation) by coordinates; QGIS is free. USGS maps show your county's geology.

Careers

Geologist, driller, miner, soil scientist, well driller, surveyor, meteorologist (National Weather Service since 1870; first tornado forecast 1948), storm chaser, aviation weather. Interview one; keep a field notebook.