

**CTY Course Syllabus
Dynamic Earth**

Day 1	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	Welcome, course expectations Observation and Inference	Discussion <ul style="list-style-type: none"> • Supply check • Lunch orders for field trips • Academic Honesty Policy Activity: Group Discussion of Rules Pre-assessment Check names for accuracy Lab 1: Observations vs. Inferences Lab 2: Mineral descriptions based on qualitative properties	assessment of student knowledge, Group member familiarity, building consensus within a group, Observation vs. Inference, quantitative & qualitative observations	Copies of Pre-assessment Paper for students to write rules suggestions Pictures for observation and inference Need (for each pair): one mineral, index card
Afternoon	Mineral Characteristics Mineral composition	Short lecture: What is a mineral and how to identify one Discussion <ul style="list-style-type: none"> • Lab safety protocols • Notebook organization <u>Group Activity:</u> Mineral Make up sheets Lab 3: Mineral ID Mayhem! <i>Field Trip #1:</i> Mineral exhibit	Class Organization, Properties of common minerals, structure, composition, identification, Moh's hardness scale, Periodic Table of elements and molecular calculations, Composition of specific minerals	Copies of Mineral Make up WS Copies of mineral articles Copies of Mineral ID chart and mineral ID resources For each group: Mineral ID sets in a Tupperware container

Day 2	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	Mineral Characteristics (review) Identification & formation of Igneous Rocks	<u>Group Activity:</u> Mineral stories Short Lecture: Formation of Igneous Rocks (Extrusive vs. Intrusive) Lab 4: Growing Crystals	reinforce mineral characteristics Imaginary story of migration of mineral to the case, correct lab safety, formation and characteristics of different rock types, relationship of component parts to whole rock, formation environment and crystal size, how rock composition influences appearance,	Set up for each pair: paper plate, weighing tray, candle, plastic tweezers, salol
Afternoon	Igneous Rocks Sedimentary Rocks	Discussion of Lab 4 results Lab 5- Identification of Igneous Rocks Short Lecture: Formation of Sedimentary Rocks Lab 6: Physical Weathering Lab 7: Chemical Weathering	forms and types of fossils, How rocks are made from minerals, common chemicals in rocks, correct lab safety, formation and characteristics of different rock types, relationship of component parts to whole rock, formation environment and crystal size, how rock composition influences appearance, Sediments relationship to mechanical rock weathering and generation of lithic products	Set up rock ID labs Each group needs: tupperware container, set of rocks removed from box Copies of Rock ID resources & Rock ID charts Need (for each pair): sugar cubes, Tupperware containers Need (for each pair): vinegar, chalk and plastic containers (2)

Day 3	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	Formation/Identification of Sedimentary Rocks Fossil formation & Types of fossils	Lab 8 – Identification of Sedimentary rocks Guest speaker- Stanford’s very own fossil guru – Dr Stephan Graham	forms and types of fossils, How rocks are made from minerals, common chemicals in rocks, correct lab safety, formation and characteristics of different rock types, relationship of component parts to whole rock, how rock composition influences appearance, visit to working paleontology collection and with practicing geologist	Set up rock ID labs Each group needs: tupperware container, set of rocks removed from box
Afternoon	Geologic Time History of the Earth	<u>Lab 9:</u> Geologic time in 365 days Students Presentations of enrichment activities: <ul style="list-style-type: none"> • “The Present is the Key to the Past” (article) • Toilet Paper timeline of the earth 	major geologic time divisions: eon, period, epoch, era, time periods of geologic timeline, scope of geologic time, types of fossils	Prepare calendar and list of dates Need: 1 roll of toilet paper

Day 4	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p>Metamorphic Rock formation from other rocks</p> <p>Relative and Absolute Dating- how are they different and what can we learn from these methods?</p>	<p>Quiz: Crystal Size and cooling time</p> <p>Short Lecture Identification/ Formation of Metamorphic Rocks</p> <p>Lab 10: Metamorphic Rock ID</p> <p>Finish lab 7: Chemical Weathering</p> <p>Lab 11: Radiometric decay A. with licorice</p>	<p>How rocks are made from minerals, common chemicals in rocks, correct lab safety, formation and characteristics of different rock types, relationship of component parts to whole rock, formation environment and crystal size, how rock composition influences appearance,</p>	<p>Set up rock ID labs</p> <p>Each group needs: tupperware container, set of rocks removed from box</p> <p>Need- Red Vine for each kid</p>
Afternoon	<p>Relative and Absolute Dating- how are they different and what can we learn from these methods?</p> <p>What fossils tell us about the earth in the past</p>	<p>Lab 11: Radiometric decay B. with pennies</p> <p>Lab 12: Crayon Rock Cycle</p> <p><u>Group Activity</u>: Stratigraphy and Cross Sections- using the Laws of superposition and cross-cutting relations</p> <p>Short Lecture: How does absolute dating work?</p> <p>Lab 13: Mystery of the Far Flung Fossils</p>	<p>Dating techniques- absolute dating, relative dating, radioactive decay, isotopes, ½-life, how different isotopes demonstrate different ages and are used by geologists</p> <p>Review of rock types and formation of each</p> <p>Law of superposition and cross-cutting relationships, igneous intrusions, review of how sedimentary rocks form</p> <p>Fossils as evidence for plate tectonics, formation and destruction of supercontinents,</p>	<p>Need: 100 Pennies for each group, Tupperware, graph paper for each kid</p> <p>Each group needs: 2-3 crayons, plastic knives, tin foil, tub of hot water</p> <p>Need: copies of cross sections for each kid</p> <p>Need: Fossil Catalogues and data chart</p>

Day 5		Lab Activities	Skills Obtained	Notes/Other
Morning	Plate Tectonics Examples of plate boundaries Rate of plate motion Spreading Centers	Discussion: What is plate tectonics? Theory vs. Law in science Lab 14: The Earth's Moving Continents	Fossils as evidence for plate tectonics, mountain belts as evidence for plate tectonics, shape of the continents as evidence for plate tectonics, glacial evidence for plate tectonics, formation and destruction of supercontinents Layers of the earth, phase transition inside the earth, mantle convection Theory vs law vs hypothesis, plate tectonics is not "just a theory," strength of scientific theories	Need: Instructions + set of 4 continents for each pair
Afternoon	Group reading: <ul style="list-style-type: none"> • <i>"Memories of Gondwana"</i> • <i><u>Crystal Desert</u></i> • <i>"Evolution of the Continental Crust"</i> • <i>"Garden of Eden" – <u>The Universe Below</u></i> • <i>"The Earth Moves" & "The Fire Below" – <u>A Short History of Nearly Everything</u></i> 	Group Activity: Reading article and preparing Poster & presentation as a group. Group Activity: Presentations of posters	Examples of what happens at plate boundaries, hydrothermal vents, why plates move, cycle of plate movement, jigsaw reading techniques, scanning large technical writing for important information, group presentations, cooperative skills	Copies of articles for students Posterboard and markers for posters

Day 6	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	Layers of the Earth & How plate tectonics works Types of Plate Boundaries Hot Spots Rate of Plate Motion	<u>Group Activity:</u> Layers of the Earth Short Lecture: What makes plates move? <u>Paper Lab –</u> HI hot spot	Layers of the earth, phase transition inside the earth, mantle convection Convergent, divergent, transform boundaries, hot spots & what they tell us about plates, unsolved mysteries in science Mathematical modeling, metric conversion, using scale, reading a map	Layers of Earth templates & red, brown, yellow, orange construction paper Copies for paper labs, diagrams of plate boundaries, types of faults
Afternoon	Types of Plate Boundaries Earth’s place in the Universe Focus on Divergent Boundaries	Group Activity: Labeling plate boundaries Guest Speaker: Seth Shostak from SETI <u>Paper Lab –</u> Mid Atlantic Ridge Spreading Zone	Mathematical modeling, metric conversion, using scale, reading a map The earth’s place in the solar system, uniqueness of life on the planet, researchers with really big possibly unsolvable questions Rate of plate motion, seafloor spreading, what happens at a divergent boundary and why	

Day 7	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p>Focus on Divergent Boundaries</p> <p>Focus on Convergent Boundaries</p> <p>Earthquake Risk</p>	<p>Paper Lab – Mid Atlantic Ridge Spreading Zone (finish)</p> <p>Begin Lab 15: Earthquake Risk in the US</p> <p>Group Discussion: Magnetic Reversals and Seafloor Spreading</p> <p>Group Activity: Labeling 3 types of Convergent Boundaries</p>	<p>magnetic orientation of basaltic rocks, polar wandering, magnetic reversals as evidence for seafloor spreading and plate tectonics</p> <p>How volcanoes form, differences between continental and oceanic crust, how density relates to plate tectonics, subduction, reviewing layers of the earth</p>	<p>Copies of lab and maps for Lab 15</p> <p>Convergent Boundary Diagrams</p>
Afternoon	<p>Focus on Convergent Boundaries</p> <p>Richter vs Mercalli Scale, Measuring earthquakes</p> <p>Plate Tectonics in the Future</p> <p>Richter Scale</p>	<p>Finish Labeling Convergent Boundaries</p> <p>Lab 16: Modeling Three Types of Faults</p> <p>Finish Lab 15: Earthquake Risk in US</p> <p>Storytime: Earthquakesaurus (from “The Sizesaurus”)</p> <p>Group Activity: CA fault flipbooks</p> <p>Lab 17: Richter Tubs of Science</p>	<p>Identification of different scales used to measure earth movement and history of both, Mercalli vs. Richter scales, scales of magnitude and intensity, How the richter scale works, logarithms, How plate Boundaries affect our lives</p>	<p>Copies of Fault Models</p> <p>Copy of earthquakesaurus, flipbooks</p> <p>Need beans and large bin</p>

Day 8	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p><u>Field Trip #2:</u> USGS Western Region Headquarters</p> <p>Forams and relative/absolute dating</p> <p>Viewing Seismographs at USGS visitors center</p> <p>Lunch at USGS office</p>	<p><u>Group Activity:</u> how a scientist uses foram samples and drill cores and conducts research</p> <p>Lab 18: Microscopic observations of benthic, planktonic and invasive forams</p> <p>Lab 19- Sand exploration (analysis of sand samples from around the world using microscopes)</p> <p>Group Activity: taking a rubbing of the USGS satellite marker</p> <p>Quiz: Determining geologic history from a geologic cross-section</p>	<p>Biostratigraphy, relate to well lab, relate to ½-life lab and dating techniques</p> <p>Real-world data collection and applications of geologic data for climate and biotic response to climatic change</p> <p>Properties of sediments/ sedimentary rocks, supporting conclusions with evidence, determining provenance based on sediment characteristics</p> <p>scope of global plate movement, How global networks work together to monitor earthquakes</p>	<p>Take photos for slide show T-shirt for Mary</p> <p>Bring: sand samples, toothpicks, weighing dishes, copies of sand lab instructions, crayons, copies of quiz</p>
Afternoon	<p><u>Field Trip # 3:</u> San Andres fault zone & Crystal Springs Reservoir</p>	<p>Group Activity: Observing the dam that withstood the 1906 earthquake</p> <p><u>Group Activity:</u> sketching an outcrop</p> <p>Group Discussion: Why are these lakes here and why are these rocks so easy to break?</p> <p>Group Activity: Acting out an earthquake on the San Andreas fault</p>	<p>How plate tectonics relates to our lives, how plate tectonics can shape land features, small scale and large scale results of faulting, strike slip faults, transform boundaries, CA state rock- serpentinite, sketching landforms as a way of collecting & recording geologic data</p>	<p>Bring copies of trail map and brochure about fault and dam, copies of CA map showing faults</p>

Day 9	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p>Physics of earthquake waves</p> <p>Remote Sensing Rate of the earth</p> <p>Earthquakes and plate boundaries</p>	<p>Article: What do earthquake waves tell us about the inside of the earth? (review parts of the earth)</p> <p>Lab 20 : Slinky Earthquake waves</p> <p>Lab 21: Plotting Earthquakes & Volcanoes (earthquakes only)</p> <p>Quiz: Fault Couture</p>	<p>earth movement and wave generation, layers of the earth, phase changes within the earth, how scientists can know things about the earth that they cannot see, indirect methods of observation</p> <p>connection between earthquakes and plate boundaries</p> <p>review of types of faults</p>	<p>Need: Copies of Seismic wave Article</p> <p>Need: 1 slinky for each pair</p> <p>Need: newspapers, markers, stapler</p>
Afternoon	<p>Locations of volcanoes in the world/ Volcanoes and plate boundaries</p> <p>SiO₂ and volcano location</p> <p>Physical Characteristics of Shield volcanoes and Stratovolcanos</p> <p>1906 earthquake articles:</p> <ul style="list-style-type: none"> • “All, All is Destruction” <i>Stanford Magazine</i> • “Future Shocks” <i>Smithsonian Magazine</i> <p>Types of volcanoes and volcano hazards</p> <ul style="list-style-type: none"> • “Volcano Hazards” USGS publication • Excerpt from <i>Volcanoes</i> 	<p>Finish Lab 21: Plotting Earthquakes & Volcanoes (volcanoes w/ SiO₂ content only)</p> <p>Lab 22: Making and Comparing Volcano Models</p> <p>Volcano & Earthquake reading and Group presentations</p> <p>Movie: Supervolcano</p>	<p>Global earthquakes in relationship to plate location, connection between volcano location and SiO₂ content of lava,</p> <p>Differences in volcano shape and slope</p> <p>Major historical quake of CA</p> <p>How 1906 changed seismology forever, effects of 1906 quake at Stanford, predicting earthquakes, subduction zone earthquakes, volcanic hazards, different types of volcanoes & their plate boundary setting, how SiO₂ content effects eruptions and volcano appearance, how human lives, life on earth in general and climate are affected by volcanic eruptions</p>	<p>Need: Maps of the world, EQ data, volcanoes and SiO₂ data</p> <p>Need: copies of volcano models</p> <p>Copies of article, Earthquakesaurus, and flipbook pages</p> <p>Copies of articles for students</p> <p>Need for each group: poster paper, markers</p> <p>Reserve AV room</p>

Day 11	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p>Volcanic Hazards & how eruptions affect society</p> <p>Stream Erosion</p> <p>Wave erosion</p>	<p>Movie: Supervolcano (finish & discuss)</p> <p>Short Lecture: Things that Shape the land, High Gradient and Low Gradient Streams</p>	<p>Review of volcanic hazards erosional processes, review mechanical rock weathering and generation of lithic products, Deposition, introduction and application of various river system terms: meanders, oxbow, braided stream, gradient</p> <p>Experimental process, physical modeling, stream parts, labeling and recording landforms created</p>	<p>Reserve AV room</p>
Afternoon	<p>Stream and Wave erosion</p> <p>Ocean Waves</p> <p>Ocean surface Currents</p>	<p>Lab 25: Modeling Water Erosion A. erosion by streams B. erosion by waves</p> <p>Group Discussion of results of labs</p> <p>Short Lecture: What is a wave?, types of waves, how ocean waves move</p> <p>Lab 26: Sneaker Drift</p>	<p>erosional processes, review mechanical rock weathering and generation of lithic products, Deposition, introduction and application of various river system terms: meanders, oxbow, braided stream, gradient</p> <p>Experimental process, physical modeling, stream parts, labeling and recording landforms created</p> <p>Similarities between light, sound, seismic, ocean waves; definition of a wave, motion of a water particle as a wave passes, changes in wave energy with depth in the water column, wavelength, changes in wave shape as wave energy approaches shore</p>	<p>Set up stream tables with sand & risers</p> <p>Fill bucket of water</p> <p>Aluminum cake pans for wave lab</p> <p>Need: Copy of sneaker drift handout for each kid</p>

Day 12	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p>Review of fault types and forces</p> <p>Global ocean circulation</p> <p>Meteorites & Craters</p>	<p>Quiz: Which type of force creates which type of fault at which type of plate boundary??</p> <p>Short Lecture: labeling ocean surface currents</p> <p>Lab 27: Finding meteorites</p> <p>Short discussion: Meteors/ meteorites, how to find them</p> <p>Lab 28: Making Craters</p>	<p>Locating of meteorites in different terraines, terrestrial crater formation and why they are so hard to find</p>	<p>Need: copy of plate diagrams for each kid</p> <p>Need: Copy of world map, red & blue markers for each kid</p> <p>Need: Blue and green aquarium rocks</p> <p>Need: Pans of flour and sand, two or three sizes of rocks</p>
Afternoon	<p>Layers of the Atmosphere, atmospheric temperature changes</p> <p>Meteorites</p> <p>Hurricanes & Tornados</p> <p>How changes in the earth can affect human lives</p>	<p>Group Activity: Graphing the layers of Atmosphere</p> <p>Meteorite Reading: "Tunguska Mystery" Scientific American</p> <p>Short lecture: Severe Weather (formation of and destruction caused by tornados and hurricanes)</p> <p>Group Activity: Natural Disaster Articles</p> <p>Prepare for Field Trip tomorrow</p>	<p>Ordering of the layers of the atmosphere, creating a line graph to better analyze data, making hypotheses based on data, dangers of meteorites in the past and future, how thunderstorms lead to tornados, Fujita intensity scale for tornados, three criteria for hurricane formation, hurricane categories, destructive effects of wind speed and storm surge, how storm surge is created due to low pressure at center of storm, making decisions as a group, review of earthquakes and volcanoes, writing a creative story based on scientific information</p>	<p>Copies of atmospheric temperature data & graph paper (on 1 handout)</p> <p>Copies of article for students</p> <p>Copies of sample sentences for each group</p> <p>List of stuff to bring tomorrow for RAs</p> <p>Emphasize for kids to dress warm</p>

Day 13	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<u>Field Trip # 5: National Marine Sanctuary Office, Half Moon Bay</u> Lunch in downtown Half Moon Bay	Group Activity: How do ocean waves operate? Video: KQED- “The Science of Big Waves” <u>Group Discussion:</u> What is Mavericks? What conditions make Mavericks? Group Activity: acting out the Maverick’s Wave Group Discussion: How meteorologists predict surf	parts of surface waves, calculation of wave period, remote sensing of the seafloor, wave generation, storm forecasting, wind duration, wind speed, fetch, near real time data on waves, connections between atmosphere, oceans & seafloor features	Get pics of students at lab for show! Take water
Afternoon	<u>Field trip #6: Pillar Point Harbor and Beach</u> Wave physics Review of rock types, rock ID, erosion Cloud nomenclature	Beach walk: what do you find? Where did it come from? <u>Group Discussion:</u> parts of a wave, how waves form, move and break <u>Quiz:</u> beach landform puzzle Thank you cards for Guest Presenters Storytime: <i>The Cloud Book</i>	rough geologic time of section of exposed beach, relationship of rock hardness to changes on land erosion, influence of ocean topography on wave propagation, relate samples and observations from both field trips, naming conventions for clouds, using clouds to predict the weather, clouds we saw today at the beach	

Day 14	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	<p>How the earth's activities can affect humans</p> <p>Clouds</p> <p>Tornados</p> <p>Glacial formations, landscapes and deposits</p> <ul style="list-style-type: none"> • "Ice on the Move" • Excerpt from <i>Fundamentals of Earth Science</i> • Excerpt from <i>EarthComm</i> textbook 	<p>Group Activity: Natural Disaster Articles (finish & selected students read articles)</p> <p>Short lecture: Stratus vs cumulus clouds, how they form and why we care + the three ingredients to make a cloud</p> <p>Lab 29: Weather in a bottle</p> <p>A. Clouds</p> <p>B. Tornados</p> <p><u>Group Reading:</u> Glaciers (parts, formation, deposits) and jigsaw</p>	<p>Stratus & cumulus and the type of air movement that creates each, how meteorologists use clouds to predict upcoming weather, three essential ingredients for a cloud, cloud condensation nuclei, applying learned concepts to a scientific model, how glaciers formed</p> <p>glacial deposits including moraine, esker, drumlin, kettle, kame, cirque, arête, U-shaped valley</p> <p>parts of a glacier, how glaciers can be affected by climate and how they can affect global sea level</p>	<p>Need: 1 water bottle for each student, matches, warm water (heated in beaker on hot plate), dish soap, food coloring, small pieces of paper (or glitter)</p>
Afternoon	<p>Glacial formations, landscapes and deposits</p> <p>Review of Igneous Rocks & Crystals</p> <p>CTY Geological Society Conference</p>	<p><u>Group Reading:</u> Glaciers (parts, formation, deposits) and jigsaw</p> <p>Group Activity: Geode Smashing!</p> <p>Group Project: Students will work in groups to interpret the geologic history of Yosemite National Park, prepare a poster with their ideas and present to the class in scientific conference format</p> <p>Presentation of student certificates of completion</p>	<p>student interpretation of technical materials, synthesis and application of course content, cooperative learning, applying new and old knowledge to solving a problem, how scientists work & collaborate to develop hypotheses and theories</p>	<p>Copies of final project assignment & additional resources, poster paper, markers, index cards</p>

Day 15	Lesson/Lecture Topic	Lab Activities	Skills Obtained	Notes/Other
Morning	Student Presentations of Final Project Post Assessment SPE's	X	X	Copies of post assessment for each kid SPE's & pencils
Afternoon	X	X	X	X