SACRAMENTO CITY UNIFIED SCHOOL DISTRICT
BOARD OF EDUCATION

Agenda Item#__9.1g__

Meeting Date: July 18, 2013

Subject: **Approve High School Course of Study: Honors Geology 1P and 2P**

- ☐ Information Item Only
- ☒ Approval on Consent Agenda
- ☐ Conference (for discussion only)
- ☐ Conference/First Reading (Action Anticipated: _____)
- ☐ Conference/Action
- ☐ Action
- ☐ Public Hearing

Department: Academic Office/Curriculum and Instruction

Recommendation: Approve the Course of Study for "Honors Geology 1P and 2P"

Background/Rationale: "Honors Geology 1P and 2P" is a dual credit college-level laboratory course with Sacramento City Community College's Course Geology 302, Physical Geology. Students successfully completing this course may obtain 4 units that are UC/CSU transferable. Honors Geology provides an understanding of the dynamic nature of earth processes and includes the study of plate tectonics, rocks, minerals, volcanoes, earthquakes, crustal deformation and mountain building, geologic time, geologic hazards, energy and mineral resources, earth's water and the geomorphology of rivers, glaciers, deserts and coastlines. Students completing this course will attain an understanding of the interconnectedness of all science, and the significant controls that Earth systems exert on human activities.

The purpose for the Honors Geology course is to include a rigorous class that meets the "D" laboratory science requirement with a "Green" emphasis for students applying to college. The US Bureau of Labor Statistics projects a 23 percent increase in geoscience jobs between 2008 and 2018. Students completing the course will gain exposure to the field of study as well as other areas of science as they pursue scientific understanding of the basic constraints of Earth's natural systems and environments.

Financial Considerations: Instructional materials will be covered by school site.

Documents Attached: Course of Study for ""Honors Geology 1P and 2P"

Estimated Time of Presentation: N/A
Submitted by: Olivine Roberts, Chief Academic Officer
Iris Taylor, Assistant Superintendent of Curriculum & Instruction
Approved by: Jonathan P. Raymond, Superintendent

COURSE OF STUDY

FOR

HONORS GEOLOGY 1P & 2P

Segment	High School Grades 11th and 12th
Length of Course	One Year
Developed by:	Chesshuwa Beckett
Developed at:	Rosemont High School
First Edition	Fall 2012

SACRAMENTO CITY UNIFIED SCHOOL DISTRICT

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SECTION I – GENERAL INFORMATION **PAGE**

SECTION II – COURSE UNITS (ESSENTIAL CONCEPTS)

SECTION III – ALIGNMENT WITH CALIFORNIA STATE SCIENCE CONTENT STANDARDS

(Only the California State Content Standards for Earth Science, Biology, Chemistry, Physics, and Investigation and Experimentation that are used in the Dual Credit Honors Geology course are listed.)

SECTION I – GENERAL INFORMATION

COURSE DESCRIPTION

Honors Geology is a dual credit college-level laboratory course with Sacramento City Community College Course Geology 302, Physical Geology. Students successfully completing this course may obtain 4 units that are UC/CSU transferable. Honors Geology provides an understanding of the dynamic nature of earth processes and includes the study of plate tectonics, rocks, minerals, volcanoes, earthquakes, crustal deformation and mountain building, geologic time, geologic hazards, energy and mineral resources, earth's water and the geomorphology of rivers, glaciers, deserts and coastlines. Students completing this course will attain an understanding of the interconnectedness of all science, and the significant controls that Earth systems exert on human activities. Students will attend at least one field trip.

COURSE PREREQUISITES

- **Algebra:** Students will need an understanding of algebra in order to calculate discharge, rate, density, gradient, isostacy, sinuosity, and other relationships. In addition, students will be required to use Excel spreadsheets, graph data, and do statistical analysis of the data.
- **Biology:** Students will need an understanding of evolution, photosynthesis and respiration
- **Chemistry:** Students will need an understanding of atomic structure, ionic and covalent bonding, pH, radioactive decay rates, states of matter, and energy flow.

COURSE LENGTH

One Year (Comprehensive Written Final Exam)

GRADE LEVEL

11^{TH} – 12^{TH} Grade

TEXTBOOKS

- Exploring Geology, Reynolds, Johnson, Kelly, Morin, Carter, McGraw-Hill, 2^{nd} edition, 2010
- Laboratory Manual in Physical Geology, AGI, NAGT, 9^{th} edition, 2011

COURSE RATIONALE

The purpose for the Honors Geology course is to include a rigorous class that meets the "D" laboratory science requirement with a "Green" emphasis for students applying to college. Presently, the majority of schools across the nation do not include a substantial earth science or geology component. Due to this lack of exposure in high school, there is a significantly lower level of geology literacy in our citizens and there are too few college students pursuing careers in any of the geosciences. The US Bureau of Labor Statistics projects a 23 percent increase in geoscience jobs between 2008 and 2018. According to the "Status of the Geoscience Workforce 2011," published by the American Geoscience Institute, due to the age demographics of the geoscience discipline, a meager 12 percent replacement rate for attrition will boost the increase in geoscience jobs from 23 to 35 percent. The need to fill these jobs will not go away; "as in any free market system, when human resource capital is lacking for a given profession or discipline, substitution of talent from other disciplines and or importation of human capital from other countries will be used to meet the economic and societal goals" (Status of the Geoscience Workforce 2011).

Students completing this course will enter college with a more sound basis for choosing fields of study, whether in science or other disciplines. They will be more informed citizens, no matter what they choose to study because they will have a scientific understanding of the basic constraints of Earth's natural systems and environments.

STUDENT ASSESSMENT

Students will be assessed based on various methods; homework, exams, laboratory activities, lab quizzes, teacher observations, article analysis, and field trip. In order to earn 4 UC/CSU transferable units students must complete the class with an A or B. There is also a mandatory field trip that students will attend. At the end of the year, there will be a cumulative exam, allowing students to make many connections among the topics studied all year.

SECTION II – COURSE UNIT DESCRIPTION

Unit 1 – What is Geology?

Objectives

1. Break Earth Science into its constituent parts (geology, meteorology, oceanography, and astronomy) and distinguish the overlapping areas and distinctiveness
2. Demonstrate the Scientific Method
3. Deconstruct the nebular hypothesis for the origin of the solar system into its component pieces
4. For the planet earth, distinguish the following: hydrosphere, atmosphere, biosphere, and geosphere and appraise the inter-connectedness of the spheres
5. Describe what "earth system science" is. Asses a closed and open system
6. Evaluate the difference between a cycle and a flow
7. Asses positive and negative feedback systems
8. Know the layers of the Earth, how the layers differ, and analyze the evidence that we have for the existence of the different layers

Reading: Chapter 1 and Chapter 2

Laboratory Activities:

- Laboratory 1: Observing and Measuring Earth Materials and Processes **(Numbered Labs are from the textbook *Laboratory Manual in Physical Geology*)**

Science Content Standards

- **Earth Science** 1(a, b, c, d, e, f), 2(a, b), 4(a, b, c), 8(a, b, c)
- **Physics** 4(a, b, d)
- **Investigation and Experimentation** 1(f, g, i, k, l)

Unit 2 – Plate Tectonics

Objectives

1. Synthesize the evidence for and against Alfred Wegener's Continental Drift
2. Evaluate the process of seafloor spreading and support how it led to the theory of plate tectonics
3. Assess what happens at each of the following and give examples
    a. Ocean-ocean convergent boundaries

b. Ocean-continent convergent boundaries
c. Continent-ocean convergent boundaries
d. Divergent boundary
e. Transform fault boundary

4. Defend the theory of magnetic reversals and its role in seafloor spreading
5. Evaluate the changes in the plates from Pangaea to the present and predict changes for the future
6. Connect convection currents to plate tectonics
7. Calculate the rate of plate movement
8. Relate the formation of Hawaii to the plate tectonic theory
9. Explain how magnetic dip can be used to determine the location of continents in the past

Reading: Chapter 3

Laboratory Activities:

- Laboratory 2: Plate Tectonics and the Origin of Magma
- Plate Tectonics Puzzle
- Plate Tectonics Model Lab
- Seafloor Spreading Worksheet
- Drifting Continents and Magnetic Fields Lab

Science Content Standards for California Public Schools

- **Earth Science** 3(a, b, e, f)
- **Biology** 6(a, b, c), 8(c, d, e)
- **Investigation and Experimentation** 1(f, g, i, k, l, n)

Unit 3 – Minerals

Objectives

1. Distinguish the various properties of minerals
2. Distinguish the major mineral forming elements, and whether they are found as anions or cations
3. Apply the identification tests for minerals to multiple specimens (test for the following physical properties of minerals: Crystal structure, Moh's Hardness Scale, Cleavage, Streak, Acid test, Luster, Fracture, Density (specific gravity), Magnetism, Optical properties)
4. Distinguish among the following silicate structures and give examples of each: Isolated, Single- chain, Double chain, Sheet, Framework
5. Distinguish and recognize the uses for the following:

a. Silicates: Quartz , potassium feldspar, plagioclase feldspar, olivine, biotite and muscovite mica, kaolinite, talc, hornblende, augite,
b. Metal ores: hematite, magnetite, galena, azurite
c. Carbonates: calcite
d. Elements: sulfur, graphite
e. other non-silicates: halite, fluorite, gypsum

Reading: Chapter 4

Podcasts:

- Silicates: http://www.youtube.com/watch?v=8q-Hzq0WXXw,
- Mineral Properties Part 1: http://www.youtube.com/watch?v=FK9KlOAvFrA
- Mineral Properties Part 2: http://www.youtube.com/watch?v=y4HdZTyXm-4

Laboratory Activities:

- Laboratory 3: Mineral Properties, Uses, and Identification
- Crystal Tree Formation Lab
- Hardness Lab
- Silicates Lab

Science Content Standards for California Public Schools

- **Earth Science** 3(c)
- **Chemistry** 1(b, d, e), 2(a, b, c)

Unit 4 - Igneous Rocks, Magma and Volcanic Eruptions

Objectives

1. Break the rock cycle into its constituent parts
2. Distinguish between intrusive and extrusive igneous rocks
3. Distinguish between felsic, intermediate, and mafic igneous rocks
4. Assess the mineral composition and formation of the following igneous rocks
    a. Phaneritic: Granite, diorite, gabbro, peridotite, any phaneritic porphyry, granite pegmatite
    b. Aphanitic: rhyolite, Andesite, basalt, scoria, any aphanitic porphyry
    c. Glassy/pyroclastic: pumice, obsidian, tuff
5. Outline Bowen's Reaction Series
6. Relate igneous rock formation to Plate Tectonic settings

7. Evaluate the formation of the following intrusive feature
    a. Dikes and sills
    b. Batholiths, laccoliths, stocks, volcanic neck
    c. Hydrothermal veins
8. Distinguish between shield volcanoes, composite volcanoes, fissure flows and lava domes and evaluate the following
    a. Kind of lava
    b. Tectonic location
    c. Shape and size
    d. Eruptive style
    e. Examples
9. Differentiate the differences between the following volcanic features
    a. Lava flows, pyroclastic flows, lahars
    b. Crater, caldera
    c. Lava tubes
    d. Tephra: ash, cinders, bombs, blocks
10. Evaluate the effects of volcanoes on human and environmental interaction

Reading: Chapter 5 and Chapter 6

Podcasts:

- Bowens Reaction Series: http://www.youtube.com/watch?v=en6ihAM9fe8
- Melting Magma: http://www.youtube.com/watch?v=muu2DeXmJAU
- Magma Differentiation: http://www.youtube.com/watch?v=_NN2qJVoPBo

Laboratory Activities:

- Laboratory 4: Rock-Forming Processes and the Rock Cycle
- Laboratory 5: Igneous Rocks and Volcanic Hazards
- Bowen's Reaction Series Lab
- 3 Volcano Profile Google Earth assignment

Science Content Standards for California Public Schools

- **Earth Science** 3(c, e, f)
- **Chemistry** 7(a, c, d)
- **Physics** 3(c)

Unit 5 – Sediments and Sedimentary Rocks

Objectives

1. Assess the following processes of weathering
    a. Physical
        i. Exfoliation
        ii. Frost wedging
    b. Chemical
        i. Oxidation
        ii. Dissolution
        iii. Hydrolysis
2. Evaluate the chemical and physical weathering of granite
3. Distinguish between weathering, erosion, and deposition
4. Distinguish between clast sizes: clay, silt, sand, granule, pebble, cobble and boulder
5. Break the sedimentary environments into their constituent parts and assess the kind of sediment found in each
    a. Continental: lake, river, desert, glacier
    b. Coastal: delta, beach, tidal flat
    c. Marine: deep sea, continental shelf, tropical reef
6. Explain oil formation and synthesize the process to store it in sedimentary rocks
7. Organize sedimentary rocks by mineral composition and environmental formation
    a. Clastic rocks: sandstone, conglomerate, shale, arkose, breccia
    b. Chemical rocks: limestone, chert, rock salt, ironstone
    c. Biochemical: coal
8. Explain the formation of ripple marks
9. Assemble a timeline of steps in the formation of soil. Account for alternative steps
10. Defend sustainable agricultural practices for the preservation of California soils

Reading: Chapter 7

Podcasts:

- Sedimentary Facies: http://www.youtube.com/watch?v=sI-ac36PlmQ
- Sedimentary Rocks http://www.youtube.com/watch?v=G0ru-kLpedo

Laboratory Activities:

- Laboratory 6: Sedimentary Rocks, Processes, and Environments
- Calcareous Precipitates Lab
- Sedimentary Environments Google Earth Lab

Science Content Standards for California Public Schools

- **Earth Science** 3c, 9a

Unit 6 – Metamorphic rocks

Objectives

1. Break the causes and effects of metamorphism into its component parts
2. Distinguish between regional (Barrovian), Contact, Hydrothermal, Blueschist, and Eclogite metamorphic zones by describing each in terms of temperature and pressure
3. Synthesize tectonic settings based on different zones of metamorphism
4. Analyze the changes in texture of metamorphic rocks as more pressure is applied
5. Determine the parent rock and degree of metamorphism for each of the following metamorphic rocks:
    a. foliated: slate, phyllite, mica schist, gneiss
    b. unfoliated: marble, quartzite, hornfels
6. Delineate the processes that lead to the deposition of gold, and discuss the history of gold mining in California

Reading: Chapter 8

Laboratory Activities:

- Laboratory 7: Metamorphic Rocks, Processes, and Resources
- Laffy Taffy Demo

Science Content Standards for California Public Schools

- **Earth Science** 3(c), 7(d), 9(a)

Unit 7 – Earthquakes and Earth's Interior

Objectives

1. Analyze the elastic rebound theory
2. Distinguish among the speed and kind of movement of p-waves, s-waves and surface waves
3. Interpret seismograms in order to determine the following
    a. P-wave and S-wave interval
    b. Location of epicenter
    c. Richter magnitude
    d. First motion (pull or push)

4. Describe the effects of earthquakes: shaking, liquefaction, landslides, tsunamis, fires
5. Distinguish between magnitude and intensity, and tell which scales measure each
6. Understand how we determine seismic risk and the present state of tsunami warning and earthquake prediction.
7. Determine how well prepared your family is for an earthquake.
8. Understand how seismic waves give us information about the interior of the Earth
9. Outline the history of the San Andreas Fault and compare it to other major faults

Reading: Chapter 12

Podcasts:

- Introduction to Earthquakes: http://www.youtube.com/watch?v=15QRpBq-aT8
- Seismic Waves http://www.youtube.com/watch?v=mZ2e6cy4Cwo
- Magnitude and Intensity http://www.youtube.com/watch?v=ClXIWcLhETo
- Effects of Earthquakes http://www.youtube.com/watch?v=01N52gLIEB8

Laboratory Activities:

- Laboratory 16: Earthquake Hazards and Human Risks
- Virtual Earthquake Lab
- Seismograph Analysis and Epicenter Location Activity

Science Content Standards for California Public Schools

- **Earth Science** 3(d), 9(b, d)

Unit 8 – Rock Deformation and Mountain Building

Objectives

1. Compare and contrast tectonic forces that result in the following faults:
    a. dip slip faults
    b. normal
    c. reverse and thrust
    d. strike slip faults
        i. right lateral
        ii. left lateral

2. Evaluate different kinds of folds and interpret surface outcrops of the following:
    a. anticlines and synclines
    b. plunging and non-plunging
    c. basins and domes

Reading: Chapter 11

Podcasts:

- Folds, Dip and Strike: http://www.youtube.com/watch?v=UzZFMWH-lSQ
- Joints and Faults: http://www.youtube.com/watch?v=XvEAFrRwNzM

Laboratory Activities:

- Laboratory 10: Geologic Structures, Maps, and Block Diagrams
- Isostasy Lab

Science Content Standards for California Public Schools

- **Investigation and Experimentation** 1(a, d, g, h, i, l)

Unit 9 – Topographic Maps

Objectives

1. Generate a written description of information from a topographic map

Podcasts:

- Rules of Contour Lines: http://www.youtube.com/watch?v=v1-S-ED2Fa4

Laboratory Activities:

- Laboratory 9: Topographic Maps, Aerial Photographs, and Orthoimages
- Contour Line Activity
- Local Topographic Map Activity
- Profile and Slope Activity
- GPS Lab

Science Content Standards for California Public Schools

- **Investigation and Experimentation** 1(a, b, c, d, h)

Unit 10 – Deep Time, Fossils & Evolution

Objectives

1. Organize the history of Earth, geologic time into the following eras: Precambrian, Paleozoic, Mesozoic and Cenozoic, and describe the major events that occurred in each
2. Interpret rock layers based upon
    a. Principle of original horizontality
    b. Principle of superposition
    c. Principle of cross-cutting relationships
    d. Principle of faunal succession
3. Categorize the following
    a. Formation
    b. Unconformity: disconformity, nonconformity, angular unconformity
4. Evaluate the principle of radiometric dating

Reading: Chapter 9

Podcasts:

- Absolute Time: http://www.youtube.com/watch?v=ei_C0PWDs9s

Laboratory Activities:

- Laboratory 8: Dating of Rocks, Fossils, and Geologic Time
- Cross Section/Relative Dating Analysis
- Rock Correlation Practice

Science Content Standards for California Public Schools

- **Earth Science** 1(f), 8(b)
- **Biology** 6(a, c), 8(c, d, e)
- **Chemistry** 11(f)

Unit 11 – Glaciers

Objectives

1. Describe the formation and movement of a glacier
2. Evaluate the different kinds of glaciers
3. Distinguish and describe the formation of the following erosional features: fiord, horn, arête, cirque, hanging valley, striations
4. Distinguish and evaluate the formation of the following depositional features: terminal, recessional, ground, medial and lateral moraines, outwash plain, erratics, till
5. Distinguish and describe the formation of the following ice features: crevasse, snow line, terminus, iceberg
6. Prioritize possible causes of the Pleistocene Ice Age
7. Evaluate the Snowball Earth theory

Reading: Chapter 14

Podcasts:

- Glacial Erosion: http://www.youtube.com/watch?v=AG3luuhc-5Y

Laboratory Activities:

- Laboratory 13: Glacial Processes, Landforms, and Indicators of Climate Change
- Glacier Google Earth Lab

Science Content Standards for California Public Schools

- **Earth Science** 1(c), 6(c, d), 8(b)

Unit 12 – Surface Water and Groundwater

Objectives

1. Break the Hydrologic cycle into its component parts
2. Evaluate permeable and impermeable rocks and sediments
3. Analyze the flow of water through the ground using the following terms
    a. Aquifer, aquiclude
    b. Water table
    c. Discharge, recharge
    d. Water table well
    e. Artesian well
    f. Plume

g. Cone of depression

4. Assess the formation of a limestone cavern, hot springs and geysers
5. Describe the following parts of a stream system: channel, divide, flood plain, headwaters
6. Evaluate the changes in a stream valley over time, from young to mature and old.
7. Analyze drainage patterns and explain why each develops: dendritic, trellis, radial
8. Explain how a stream flows, transports sediment, erodes and deposits
9. Predict the following affects of a stream's ability to erode and deposit based on: gradient, velocity, base level, volume, bed load, friction, discharge
10. Calculate a stream's discharge
11. Explain the formation of the following stream features: water gap, delta, meander, oxbow lake, alluvial fan, stream terraces, incised meanders, distributary
12. Describe the process of stream piracy
13. Appraise the water transportation and usage system in California. Condemn or defend the current system

Reading: Chapter 16

Podcasts:

- Life History of a Stream: http://www.youtube.com/watch?v=SfJ-XfPtBas

Laboratory Activities:

- Laboratory 11: Stream Processes, Landscapes, Mass Wastage, and Flood Hazards
- Laboratory 12: Groundwater Processes, Resources and Risks
- Landslides and Mass Wasting Lab
- Stream Table Demonstration Lab
- Porosity and Rate of Flow Lab

Science Content Standards for California Public Schools

- **Earth Science** 9(c)
- **Investigation and Experimentation** 1(c, d)

Unit 13 – Oceans and Coasts

Objectives

1. Evaluate how wind interacts with water to produce surface currents and how the Coriolis Effect produces the Ekman spiral and Ekman transport
2. Explain the formation of geostrophic currents and describe how the geostrophic currents interact with land masses resulting in gyres
3. Explain upwelling and downwelling, Langmuir circulation, relate them to El Nino, and their ecological significance
4. Synthesize thermohaline circulation as a result of properties of vertical currents related to density differences
5. Measure the characteristics of open ocean waves (wavelength, height, period, etc)
6. Synthesize the relationship of wave size to wind speed, duration, and fetch, wave dispersal, wave trains, constructive and destructive interference, and wave sets
7. Predict how waves behave when they enter shallow water, including wave refraction, diffraction, and why they break, as well as their effect upon the landscape
8. Evaluate longshore and rip currents and know their effects upon sediment transport and deposition
9. Compare the effects of human structures upon shoreline erosion and deposition
10. Deconstruct the composition of seawater into its major, minor, and trace constituents.
11. Explain how environmental factors affect salinity and how the stability of salinity affects world's oceans
12. Outline the Principle of constant proportions and residence time
13. Evaluate the relationship between depth and pressure and use the gas laws to explain solubility
14. Explain how light is affected as it travels through seawater
15. Compare and contrast thermoclines and haloclines and how they differ with latitude.
16. Outline and prioritize the causes tides

Reading: Chapter 10

Laboratory Activities:

- Laboratory 15:Coastal Processes, Landforms, Hazards, and Risks
- Salinity Lab

Science Content Standards for California Public Schools

- **Earth Science** 3(a), 5(a, b, d, g)
- **Chemistry** 1(e), 2(a, b, d, h), 4(a, b, c), 6(a, d (part), e (part)), 7(a)
- **Physics** 3(a, c, d), 4(a, b, c, d)

Unit 14 – Energy and Natural Resources

Objectives

1. Differentiate and evaluate energy sources and their effectiveness
2. Explain how oil and natural gas forms
    a. Summarize where the organic material in petroleum comes from
    b. Summarize how oil and gas naturally form by burial and heating
    c. Evaluate the role of a reservoir rock and impermeable seal
    d. Describe how petroleum is trapped by an anticline, salt dome, fault, thrust-related fold, unconformity, and facies change
3. Evaluate how coal and coal-bed methane forms
    a. Summarize how coal forms
    b. Describe the different types of coal, ranking them from lowest quality to highest quality
    c. Summarize how coal is mined from strip mines and underground mines
    d. Summarize coal use and the environmental downsides
4. Summarize oil exploration and production
5. Explain alternative reserves of hydrocarbons
    a. Explain how methane is extracted
    b. Explain gas hydrates and how they occur
    c. Potential hazards of gas hydrates
6. Evaluate nuclear energy
    a. Summarize how nuclear fission releases energy and is used to generate electricity
    b. Summarize the settings in which uranium deposits form
    c. Argue the positive and negative aspects of the use of nuclear energy
    d. Analyze the geologic setting of Yucca Mountain and describe the material that may be stored there
7. Summarize the processes that can form a mineral deposit
8. Summarize and prioritize the effectiveness and environmental impact of alternative energy sources
    a. Hydroelectric

b. Geothermal
c. Solar
d. Wind
e. Biomass
f. Ethanol

Reading: Chapter 18

Laboratory Activities:

- Reclamation Lab
- Interactive Energy Lab

Science Content Standards for California Public Schools

- **Chemistry** 11(a, b, c, d, e, f)
- **Investigation and Experimentation** 1(m)

Unit 15 – Global Climate Change

Objectives

1. Relate ocean currents to their influence on climate
    a. Describe the main flow of surface currents in the Northern and Southern Hemispheres and it influences sea temperatures
    b. Explain how ocean currents influence temperature and precipitation on adjacent lands
2. Summarize what causes short term climate variations
    a. Explain what a monsoon is and how it affects rainfall
    b. Relate the tilt of Earth's axis to seasons
3. Explain what causes the location of Rain Forests
    a. Summarize where rain forests occur and what conditions produce enough precipitation to form a rain forest
    b. Explain threats to rain forests and why rain forests are ecologically and genetically important
4. Explain desert formation
    a. Analyze what deserts and other arid lands are and where they form
    b. Describe desertification
    c. Evaluate common features of deserts and how the features form
        i. Alluvial fans
        ii. Washes

iii. Playas
iv. Dunes
v. Pediments
vi. Desert pavement
vii. Caliche
viii. Desert varnish
ix. Natural stains

Reading: Chapter 13

Podcasts:

- Deserts: Wind Erosion and Deposition: http://www.youtube.com/watch?v=l8q1ss5M7ts
- Desert Landforms: http://www.youtube.com/watch?v=f-lGKjXsAHM
- Desert Distribution: http://www.youtube.com/watch?v=ckLzy3F_60g

Laboratory Activities:

- Earth's Energy Budget Lab
- Vostok Ice Core Analysis
- Sea Ice Extension for the Earth as a System Learning Activity

Science Content Standards for California Public Schools

- **Earth Science** 4(a, b, c), 5(a), 6(a, b, c)

Unit 16 – Careers in Geology

Objectives

1. Explore careers in geology with Industry Experts
2. Students will participate in a culminating high quality performance based assessment to solve real world problems related to local geology

SECTION III – ALIGNMENT WITH CALIFORNIA STATE SCIENCE CONTENT STANDARDS

Only the California State Content Standards for Earth Science, Biology, Chemistry, Physics, and Investigation and Experimentation that are used in the Dual Credit Honors Geology course are listed.

EARTH SCIENCE

Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a basis for understanding this concept:
   a. Students know how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system.
   b. Students know the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.
   c. Students know the evidence from geological studies of Earth and other planets suggest that the early Earth was very different from Earth today. d. Students know the evidence indicating that the planets are much closer to Earth than the stars are. e. Students know the Sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.
   f. Students know the evidence for the dramatic effects that asteroid impacts have had in shaping the surface of planets and their moons and in mass extinctions of life on Earth.

2. Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time. As a basis for understanding this concept:
   a. Students know the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.
   b. Students know galaxies are made of billions of stars and comprise most of the visible mass of the universe.

Dynamic Earth Processes

3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis for understanding this concept:
   a. Students know features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.
   b. Students know the principal structures that form at the three different kinds of plate boundaries.
   c. Students know how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
   d. Students know why and how earthquakes occur and the scales used to measure their intensity and magnitude.
   e. Students know there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
   f.* Students know the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.

Energy in the Earth System

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:
   a. Students know the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
   b. Students know the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.
   c. Students know the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.

5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:

   a. Students know how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.

   b. Students know the relationship between the rotation of Earth and the circular motions of ocean currents and air in pressure centers.

   d. Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms.

   g.* Students know features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.

6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:

   a. Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.

   b. Students know the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.

   c. Students know how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.

   d.* Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.

Biogeochemical Cycles

7. Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept:

   d.* Students know the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

Structure and Composition of the Atmosphere

8. Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life. As a basis for understanding this concept:
   a. Students know the thermal structure and chemical composition of the atmosphere.
   b. Students know how the composition of Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen.
   c. Students know the location of the ozone layer in the upper atmosphere, its role in absorbing ultraviolet radiation, and the way in which this layer varies both naturally and in response to human activities.

California Geology

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
   a. Students know the resources of major economic importance in California and their relation to California's geology.
   b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.
   c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
   d.* Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

PHYSICS

Heat and Thermodynamics

3. Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:
   a. Students know heat flow and work are two forms of energy transfer between systems.
   b. Students know that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.
   c. Students know the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.

Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:
   a. Students know waves carry energy from one place to another.
   b. Students know how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).
   c. Students know how to solve problems involving wavelength, frequency, and wave speed.
   d. Students know sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.

CHEMISTRY

Atomic and Molecular Structure

1. The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept:

   b. Students know how to use the periodic table to identify metals, semimetals, nonmetals, and halogens.

   d. Students know how to use the periodic table to determine the number of electrons available for bonding.

   e. Students know the nucleus of the atom is much smaller than the atom yet contains most of its mass.

Chemical Bonds

2. Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules. As a basis for understanding this concept:

   a. Students know atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.

   b. Students know chemical bonds between atoms in molecules such as H_2, CH_4, NH_3, $HCCH_2$, N_2, Cl_2, and many large biological molecules are covalent.

   c. Students know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.

   d. Students know the atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.

   h.* Students know how to identify solids and liquids held together by van der Waals forces or hydrogen bonding and relate these forces to volatility and boiling/ melting point temperatures.

Gases and Their Properties

4. The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases. As a basis for understanding this concept:

a. Students know the random motion of molecules and their collisions with a surface create the observable pressure on that surface.

b. Students know the random motion of molecules explains the diffusion of gases.

c. Students know how to apply the gas laws to relations between the pressure, temperature, and volume of any amount of an ideal gas or any mixture of ideal gases.

Solutions

6. Solutions are homogeneous mixtures of two or more substances. As a basis for understanding this concept:

a. Students know the definitions of solute and solvent.

d. Students know how to calculate the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.

e.* Students know the relationship between the molality of a solute in a solution and the solution's depressed freezing point or elevated boiling point.

Chemical Thermodynamics

7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:

a. Students know how to describe temperature and heat flow in terms of the motion of molecules (or atoms).

c. Students know energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.

d. Students know how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.

Nuclear Processes

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:

a. Students know protons and neutrons in the nucleus are held together by nuclear forces that overcome the electromagnetic repulsion between the protons.

b. Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by $E=mc^2$) is small but significant in nuclear reactions.
c. Students know some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
d. Students know the three most common forms of radioactive decay (alpha, beta, and gamma) and know how the nucleus changes in each type of decay.
e. Students know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.
f.* Students know how to calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed.

BIOLOGY/LIFE SCIENCES

Ecology

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:
   a. Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.
   b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
   c. Students know how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:
   c. Students know the effects of genetic drift on the diversity of organisms in a population.
   d. Students know reproductive or geographic isolation affects speciation.
   e. Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.

INVESTIGATION AND EXPERIMENTATION

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, students should develop their own questions and perform investigations. Students will:

   a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

   b. Identify and communicate sources of unavoidable experimental error.

   c. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

   d. Formulate explanations by using logic and evidence.

   f. Distinguish between hypothesis and theory as scientific terms.

   g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.

   h. Read and interpret topographic and geologic maps.

   i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

   k. Recognize the cumulative nature of scientific evidence.

   l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

   m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

   n. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).