Lab #3
Interpreting Earth Data

Learning Objectives

- Learn about, use, and interpret the various datasets included on the "Our Dynamic Planet" CD-ROM
- Structure of a science paper
- Using real Earth data to observe, identify, classify, and describe geologic features.
- Represent observations in map and cross-sectional views
- Interpret and relate topographical features and Earth data to a theory or model
- Develop and write scientific argument
- Understand how scientists practice science

Preparation and materials checklist:

__ Homework #3 completed and answers entered into computer.
__ Rhetorical levels assignment
__ Finalize Earth Summit group section presentation
__ Read this chapter (Interpreting Earth Data)
__ Read or review "Anatomy of a Science Paper"
__ Work on Earth Summit tectonics paper (due at beginning of next lab)

Activities Schedule:

• Section announcements and discussion	**(5 min)**
• Earth Summit group presentations and class discussion Use feedback (content, style) forms for presentations	**(45 min)**
• TA led class discussion about rhetorical levels homework assignment	**(10 min)**
• TA leads class discussion on paper formats, references, and plagiarism Critical analysis of web site credibility	**(10 min)**
• Analysis of sample papers	**(15 min)**
• Groups work on Earth Summit tectonics paper Use the "Our Dynamic Planet" CD MAP screen. Identify on-line resources	**(20 min)**

Introduction

This is the last section where you will meet as a group to work with the "Map" software. It is also the last section devoted to preparing you to write your Earth Summit tectonics paper. So, it is vital that you access all of the resources available to you by paying particular attention to the pre-lab homework assignment, which is due at the beginning of this lab section.

Your objective during this lab section is to leave with a good idea of how your Earth Summit tectonics paper will look when completed. The homework exercises and previous lab sections have been preparing you for this. Your previous work has given you practice using the Map software and you should now be able to discriminate between the three kinds of plate boundaries.

About the Map Data

You will need to make a reference to the sources of data accessed by the Map software when writing your tectonics paper. The following is some of the information that you can extract for your methods section. Read "Resource 4: Writing with Integrity" to clarify how to work with this information. Don't copy the lab book!

ETOPO5 Elevation Dataset:
ETOPO5 was generated from a digital data base of land and sea-floor elevations on a 5-minute latitude/longitude grid. The resolution of the gridded data varies from true 5-minute for the ocean floors, the U.S.A., Europe, Japan, and Australia to 1 degree in data-deficient parts of Asia, South America, northern Canada, and Africa. Data sources are as follows: Ocean Areas: US Naval Oceanographic Office; U.S.A., W. Europe, Japan/Korea: US Defense Mapping Agency; Australia: Bureau of Mineral Resources, Australia; New Zealand: Department of Industrial and Scientific Research, New Zealand; balance of world land masses: US Navy Fleet Numerical Oceanographic Center.

Volcanoes Dataset:
These data came from the Smithsonian Institution Global Volcanism Program. They have been compiled from the geological literature on volcanoes and reports from correspondents. Some terrestrial (on land) volcanoes are not listed. It is inevitable that the remnants of some older volcanoes have been eroded or covered by new volcanic activity, but it would be surprising if major volcanoes were missing. More importantly, very few of the multitudes of undersea volcanoes are listed. We know that volcanic activity is one of the major processes involved in the creation of the new oceanic crust. Active volcanism has been observed on the axis of mid-ocean spreading centers and the many seamounts are known to be volcanic in origin. These are not included in the database because so few of them have been observed.

The following is an excerpt from the text that accompanies the volcanoes database:

SMITHSONIAN INSTITUTION
GLOBAL VOLCANISM PROGRAM
NHB MRC 119, Washington, DC 20560

VOLCANOES OF THE WORLD - 1993

These data are basically those in our 1981 book, "Volcanoes of the World," but have been updated to include new volcanoes and new eruptions through mid-1993 with additional information from the literature and our correspondents.

Earthquakes Dataset:
The earthquake data are from World-Wide Network of Seismic Stations. Earthquake monitoring instruments are run by universities and government institutions of many nations. Readings from these instruments are collected at the National Earthquake Information Center (NEIC), in Boulder Colorado. Quake magnitudes, locations, and origin times, are computed. For larger quakes, the "fault plane" (related to the orientation of the slip) of the quakes is also computed. Some of the seismic stations have very simple instruments and mail their data to NEIC, but some transmit their signals by satellite (since about 1990). So it is possible to access nearly real-time earthquake locations.

The interpretation of earthquake hypocenter data requires some caution. Every quake location has an error. The computed locations will be more accurate for quakes occurring after the middle to late 1980's than in the 1960's, because seismic stations have been added since then. The best locations may be accurate to a few km while the least accurate may have an error of as much as 50 km. Oceanic quakes far from islands (which may have seismic stations) will have a greater location error than those on land. For example, quakes near Japan will have a higher accuracy than quakes on the East Pacific Rise. You need to be careful when interpreting subtle patterns with this dataset. If you make a quake cross-section and see all of the quakes at a constant depth, along a horizontal line, this means that the analysis program did not have enough data to compute an accurate depth, so just set it to a constant value. This could mean that depths are much shallower. This effect is observed at remote oceanic areas.

Heat flow Dataset:
The heat flow data were provided by Prof. Carol Stein, from Northwestern University. The heat flow used here is a measure of the heat that is flowing out from the deep to the surface. Generally heat flow will be high where the shallow crust or upper mantle is very hot, and low when it is cooler.

The measurement is made by dropping a torpedo-shaped probe from a ship, which buries itself vertically in the sediments. The temperature at the top and bottom of the probe is measured. The temperature difference, plus a clever way of measuring the in-situ thermal conductivity of the sediments, allows heat flow to be calculated. Care is needed in interpreting these data. The measurements are difficult and subject to contamination due to non-ideal geological settings. For example, if heat flow is measured in an area where water is circulating through the crust, most of the heat will be removed by the water and the heat flow measurement will not accurately reflect heat flowing from deep within the Earth. A nearby seamount or ridge can also affect the heat flow values.

To be safe, never rely on a single heat flow data point. Several points must agree, in order to take a value seriously.

Click Spots

The images and movies that are in the "ClickSpot" library were collected from the faculty and students of the UCSB Dept. of Geological Sciences, and various other sources. Some of the video material came from other sources, but you will not be able to refer to the source unless it appears in the caption.

Maps

The maps used for the oceanography software have all been computer-generated from the ETOPO5 elevation database.

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A. Online Homework (due at lab start)

Questions that provide clues:

To prepare for this exercise write short answers (one or two sentences) to the following questions. You will need to be familiar with the chapters of your textbook that cover plate tectonics and the structure of the seafloor. **The answers to these problems should help you formulate your own questions, some of which you may want to incorporate into your tectonics paper. Use these questions as hints as how to do more than the minimum.**

1) What are the differences between the Pacific Ocean and the Atlantic Ocean Basins? (Note: the differences are huge!)

2) The Mid-Atlantic Ridge has an "S" shape. Why?

3) Do volcanic eruptions have anything do to with the depth of the ocean on the west coast of South America?

4) Why does the western Pacific Ocean have so many islands?

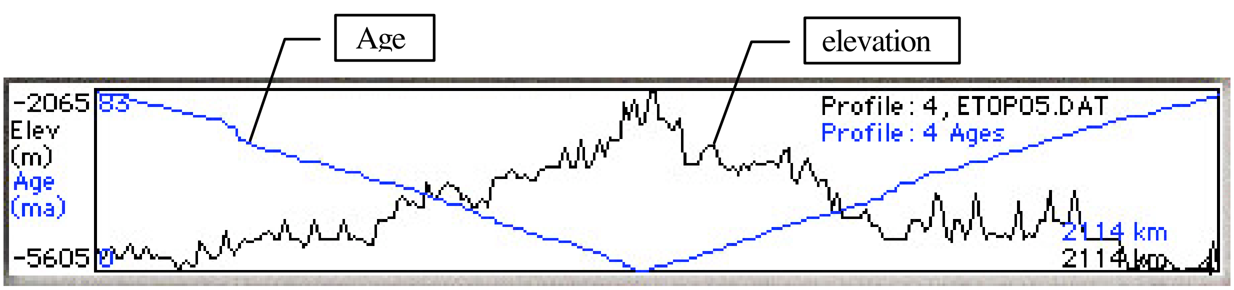
5) In the Hawaiian Islands, only the Big Island of Hawaii has active volcanic eruptions. Why?

6) Some island chains have age dates (e.g. Hawaiian Island chain). Is there a pattern? Why?

7) Why does the Hawaiian Island chain lie along a straight line? Why does it suddenly swerve to the north, again along a straight line.

8) Many island chains in the western Pacific lie along an arc. Why is this?

9) Can you use earthquake data to determine how steeply a subducting slab dives into the lithosphere? Are there differences between subduction zones? Why, where?



10) The picture above shows a profile across a section of the Mid-Atlantic Ridge. Use the figure to compute the spreading rate at this profile location.

B. Homework Part 2: On-line Student Paper Analysis Exercise

In the oceanography science writing assignment, papers that get high grades tend to use specific kinds of sentences, while papers receiving low grades do not. This exercise shows you an example of a high graded and a low graded paper from a previous oceanography class. To help you learn to discriminate between strong and weak science writing, you will classify sentences from these two papers into different kinds of statements that are used in science writing. I hope that you will analyze your own writing this way, to improve your class assignments.

Before doing this assignment, read **Resource 2: Elements of a Science Investigation**

Discussion: This assignment specifically targets the kind of statements that go into creating a good science paper. The classification of sentence type is not an exact process and leaves some room for interpretation. This method of analyzing science arguments can not discriminate between good and faulty logic. For instance, suppose the investigator observed a pattern of quakes along the Mid-Atlantic Ridge, then inferred from that that the Peru-Chili trench, many thousands of km away, was a subduction zone. The classification of sentences could come out the same, except that the logical connection between sentences could be utterly lacking. This analysis can help you focus on the kinds of statements that go into an argument, but you need to make sure that your data actually support your interpretations.

This exercise is discussed in detail in the Resources section of this lab manual, under “Elements of a Science Investigation.” Read it before attempting this exercise.

First, read "Paper #1":

Each of the specified sentences in problems 1 to 6 will be classified according to whether it:

1. Includes an observation, or description of an observation.
2. Names or classifies an observation in terms of geological features.
3. Describes a feature that has been observed and clasified, or that the author implies has been observed and classified.
4. Describes relationships between different ob served and classified features.
5. Describes or explains a model or theory.
6. Describes relationships between and/or observed features that match (or disagree with) model features.

Problems:

1. Sentence 9 can be classified as (paper #1):
2. Sentence 11 can be classified as (paper #1):
3. Sentence 8 can be classified as (paper #1):
4. Sentence 26 can be classified as (paper #1):
5. Sentence 22 can be classified as (paper #1):
6. Sentence 14 can be classified as (paper #1):
7. In the "Online Student paper Analysis" exercise, paper #1 has about how many sentences that classify as observations?

   1, less than 2
   2, between 3 and 5
   3, between 5 and 6
   4, more than 6

8. In the "Online Student paper Analysis" exercise, paper #2 has about how many sentences that classify as observations? Use the same choices as for problem 7.

9. Writing for scientific journals requires that:

   1, data be carefully described and illustrated
   2, when possible, a theory or model is described
   3, the relationship between the data and theory is shown
   4, a discussion of related research or knowledge is included
   5, all of the above

10. Referring to the requirements for writing in this class, paper 1 and 2 compare in the following way:

    1, paper 1 is weakest because it does not discuss the theory enough and spends too much time describing profiles
    2, paper 1 is best because it has the most data discussion, and it discusses how the observations relate to the plate tectonics theory
    3, paper 2 is strongest because it has the best theoretical discussion and shows how the observations relate to the plate tectonics theory

11. For writing assignments in this class, it is most important to write about:

    1, lots of facts that are extracted from the textbook or internet
    2, theoretical results from quality research studies
    3, earth data that supports my assertions
    4, a lot of references from various sources name or classify an observation in terms of geological features.

Paper 1:

Introduction

The area of study is the Kurile trench, identified as a small area on the class CDROM (Fig. 1).**(1)** This area corresponds to a plate boundary thought to exist by geologists between the Pacific plate and the Indo-Australian plate (Segar, p.62). **(2)** The data collected supports the theory of plate tectonics at a convergent plate boundary.**(3)**

Methods

The data includes topographical profiles created through the ETOP05 elevation dataset which consists of digital elevation data of sea floor and land.**(4)** The sources for this data come from: Ocean Areas—US Naval Oceanographic Office; USA, W. Europe, Japan, Korea, US Defense Mapping Agency; Australia: Bureau of Mineral Resources; New Zealand: Department of Industrial and Scientific Research; US Navy Fleet Numerical Oceanographic Center.**(5)** Gridded data varies in resolution from 5 minutes latitude/longitude to 1 degree.**(6)** Earthquakes are from USGS preliminary determination of epicenters and volcano data are from the Smithsonian Institution Volcano database. **(7)**

Observations

Three profiles taken along the coastal region of the Khamchatka Peninsula display the topographic features of an oceanic trench (see Fig. 2 for profile locations).**(8)** Thousands of volcanoes exist parallel to the trench and 200-400 km inland (Fig.2).**(9)** The trench lies at 60 degrees N latitude and 160 degrees E longitude and extends for 2,200 km in length along this coast.**(10)** One profile displays the gentle upward slope of the Pacific Ocean Basin which then becomes drastically altered by the sudden drop-off of the trench (Fig.3).**(11)** Following the trench, a virtual linear rise occurs as the profile moves northwest and inland.**(12)** A second profile confirmed the presence of the trench 500 km to the south of the first profile, but showed a 400 km long basin located behind the vertical rise of the volcanoes. **(13)** The basin dips 3,000 m below sea level (Fig. 4).**(14)** A third profile shows both the existence of the trench another 250 km to the south and the land features described by the first two profiles (Fig.5).**(15)**

Earthquakes' foci were also plotted along the same path as the middle topographic profile of the Khamchatka coast.**(16)** The plot shows earthquakes occur consistently along this trench (Fig.6).**(17)** A cross section of earthquake activity along the middle profile shows a descending pattern of earthquakes to depths of 600 km (Fig.7).**(18)**

Interpretations

Areas such as the Kurile Trench along the Khamchatka coast show the characteristic patterns of a continental convergent margin between two plates.**(19)** In this scenario, a plate containing oceanic crust collides with a plate made of continental crust**.(20)** One of the plates descends beneath another, into the Earth's asthenosphere (Fig.8).**(21)** A topographic trench is formed where one of the plates begins its descent.**(22)** This process is called subduction.**(23)** The sinking plate causes a corresponding pattern of deep earthquakes along its boundary.**(24)** Melting magma along the upper edge of the plate rises to the surface, creating volcanoes.**(25)** Figure 9 shows a cross-section diagram across the middle profile, showing the subduction model and observations of topography, quakes, and volcanoes that occur in agreement with the model.**(26)**

Paper 2

Introduction

I will discuss the motions of the plates and their effecting result on the sea floor and the Earth.**(1)** At the center of my discussion will be the Mid-Atlantic Ridge and why it has formed into an S shape.**(2)** It is an underwater mountain range, also known as an oceanic divergent margin**.(3)**

Observations

The Mid-Atlantic Ridge is a very interesting part of our Earth.**(4)** It is an underwater mountain range, also known as an oceanic divergent margin.**(5)** This ridge runs north to south down the center of the Atlantic from the North Pole to Antarctica.**(6)** Many different plates meet at the ridge including the North American, the Eurasian, the South American, and the African Plate.**(7)** The ridge extends at one point as deep as 5,625 m below sea level.**(8)** It stretches east to west from Europe and Africa to the east coast of the Americas, 2,547 km.**(9)** This is evident in Figure 1.**(10)**

An oceanic divergent margin means that the plates, which form the Earth, meet and disperse in opposite directions.**(11)** The resultant gap from these diverging plates is filled up with uprooted, low density magma.**(12)** This process leads to the series of volcanoes which form into a ridge in the gap left by the plates.**(13)** This process is known as sea floor spreading.**(14)** This is also illustrated in Figure 1.**(15)** The aging crust then sinks steadily down, while the mountains in the ridge slowly move outward while new ones fill in their place.**(16)** The mountains move in the direction of the plate.**(17)** This part of the process, combined with narrowness of the Atlantic and the shape of the continents, leads to the S shape formed by the ridge.**(18)**

Interpretations

My study shows the Mid-Atlantic Ridge is an oceanic divergent margin that is formed in an S shape due to many different factors including ocean size, plate motion, volcanic activity, and sea floor spreading.**(19)** This is proven by the data gathered from the map program and is reinforced by the area's topography, which includes volcanoes and earthquakes.**(20)**

Lab Section #3 Activities:

1) Group Presentations.

You and your group are expected to come to the lab section prepared to make a five minute presentation in scientific meeting format (see Resource 1: How to Make a Class Presentation), about the tectonics of your Earth Summit country. Each group member is expected to contribute to the presentation. There will be an individual grade assigned to each member as well as an overall group score. The other students in the section will fill out short forms to give each group feedback on their strengths and weaknesses. This is an opportunity to show what you have learned about giving scientific presentations, so be well prepared.

2) Class discussion:

The TA will lead a discussion about the rhetorical levels homework assignment followed by a discussion on paper formats, references and plagiarism. Critical analysis of web site creditability will also be discussed.

3) Meet with your group to help each other with the Earth Summit tectonics paper:

The paper is an individual assignment, but the goal here is to help each other expand their ideas. Because of the short length of the paper, each group member might want to emphasize a different aspect of the tectonics. You will use the "Our Dynamic Planet" CDROM Map screen to access data and create figures. Also use this time to identify on-line resources for your papers. Be sure to follow the guidelines from "Anatomy of a Science Paper" in the resources section of this lab manual.

Summary:

You should now be well prepared to finish your tectonics paper. Remember, it is an individual assignment even though you are allowed time in section to work as a group.

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Presentation Feedback Form

Group members:

Presentation topic:

Group	low – med - high	Points
1. The topic was clear.	0 – 1 – 2 – 3 - 4	
2. The data was interpreted correctly.	0 – 1 – 2 – 3 - 4	
3. Data, figures or sketches supported the interpretations.	0 – 1 – 2 – 3 - 4	
4. Alternative interpretations, if any, were also presented?	0 – 1 – 2 – 3 - 4	

1. What was the most effective part of the presentation?

2. Suggestions for improvement:

Presentation Feedback Form

Group members:

Presentation topic:

Group	low – med - high	Points
1. The topic was clear.	0 – 1 – 2 – 3 - 4	
2. The data was interpreted correctly.	0 – 1 – 2 – 3 - 4	
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4. Alternative interpretations, if any, were also presented?	0 – 1 – 2 – 3 - 4	

1. What was the most effective part of the presentation?

2. Suggestions for improvement:

Blank

Presentation Feedback Form

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Blank

Presentation Feedback Form
Group members:

Presentation topic:

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3. Data, figures or sketches supported the interpretations.	0 – 1 – 2 – 3 - 4	
4. Alternative interpretations, if any, were also presented?	0 – 1 – 2 – 3 - 4	

1. What was the most effective part of the presentation?

2. Suggestions for improvement:

Blank

TA Scoring Rubrik

Member #1	low – med - high	Points
1. I could hear the presenter.	0 – 1 – 2 – 3 - 4	
2. Contribution was significant	0 – 1 – 2 – 3 - 4	
3. Presentation was logical and accurate	0 – 1 – 2 – 3 - 4	

Member #2	low – med - high	Points
1. I could hear the presenter.	0 – 1 – 2 – 3 - 4	
2. Contribution was significant	0 – 1 – 2 – 3 - 4	
3. Presentation was logical and accurate	0 – 1 – 2 – 3 - 4	

Member #3	low – med - high	Points
1. I could hear the presenter.	0 – 1 – 2 – 3 - 4	
2. Contribution was significant	0 – 1 – 2 – 3 - 4	
3. Presentation was logical and accurate	0 – 1 – 2 – 3 - 4	

Group score	low – med - high	Points
1. The topic was clear.	0 – 1 – 2 – 3 - 4	
2. The data was interpreted correctly.	0 – 1 – 2 – 3 - 4	
3. Data, figures or sketches supported the interpretations.	0 – 1 – 2 – 3 - 4	
4. Alternative interpretations, if any, were also presented.	0 – 1 – 2 – 3 - 4	

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