Chapter 3
Anatomy of a Science Paper

Writing the Paper

The following sections discuss the format of the paper assignment that I give to my students. In fact, these are the exact instructions that I give my students. There are many variations in format for a science paper, but this one is a common format. One of my students commented that she organized an art history paper like this and got an A, so it is conceivable that there is some applicability to other kinds of writing.

General writing tips:

1) The paper should be organized carefully. Follow the structure discussed below.
2) Each section of your paper will be composed of paragraphs. Each paragraph should begin with a topic sentence which states the point you will make in that paragraph. Every sentence after that should support the topic sentence. Paragraphs are typically 4 to 8 sentences long and each sentence should address only one point.
3) Make your sentences simple, but vary their length to make the paper interesting.
4) Avoid the passive tense. It is boring. An example of the passive tense is: "It was shown that.....". An example of the active tense is: "I have shown that ....."
5) Avoid contractions. These are for more informal writing, like that in this workbook. Say "can not" instead of "can't".
6) Be careful with “Replace All” on your word processor. You may replace words that you don’t intend to replace.

Visual Presentation:

Your paper should be clearly typed and thoroughly proofread. Spelling mistakes are not acceptable. Use your spell checker. Double space the text and use either 10 or 12 pt text size. Remember, the TA's and professor have to read many of these papers, so hard to read formatting receives an immediate negative reaction. Leave enough margin space for comments. If possible, put the figures close to the text where they are referred to. If this is impractical, put all the figures at the end of the text. Each figure must have a figure caption.

Do not photocopy figures from the book. A crude sketch is preferable to a machine-copied figure. Be sure and use sketches to illustrate your ideas.

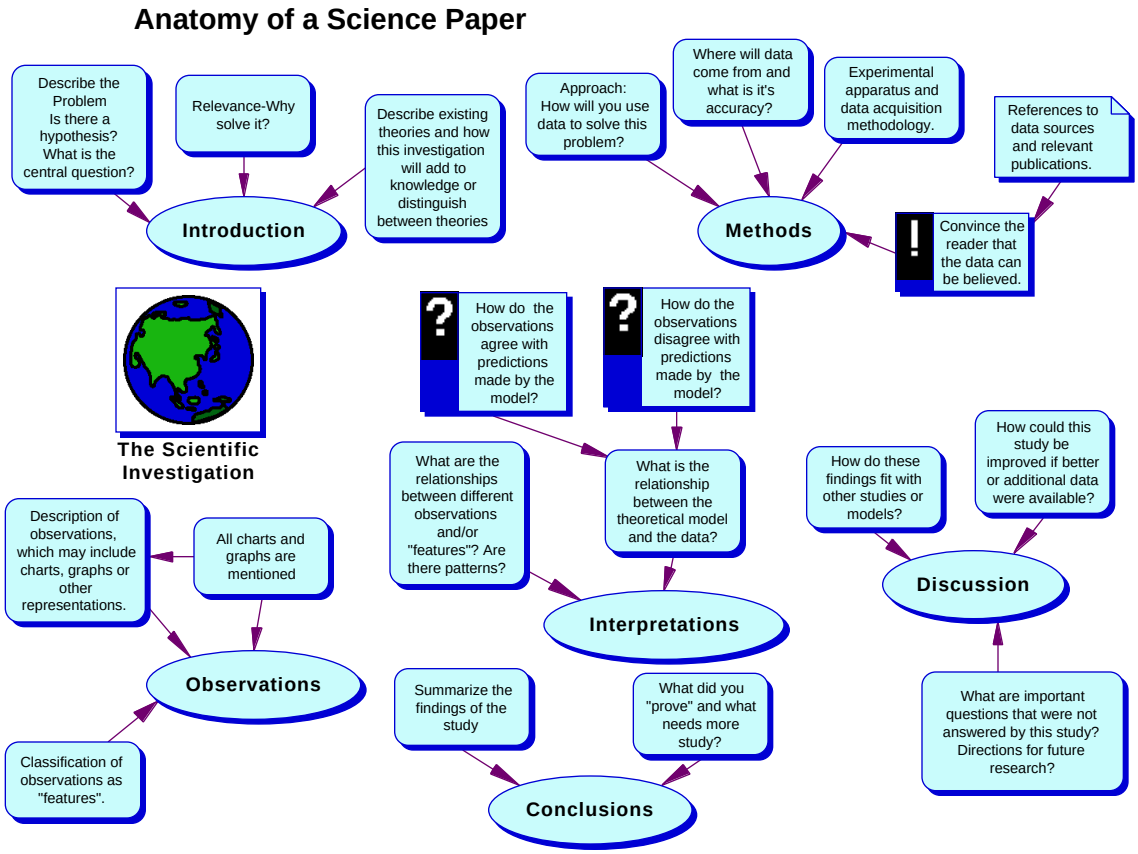


Figure 3.1. This diagram shows the headings that must be used for this science paper. Please pay careful attention to the boxes with arrows pointing at each elliptical heading box. These boxes are reminders of the content that belongs with each heading.

Headings

Technical writing follows a specific format. This format varies, depending on the subject and requirements of the magazine or journal publishing the article. But, there are common features to all formats. The format described here will be**. Your paper must have headings matching those described below**.

- Abstract
- Introduction
- Methods:
- Observations
- Interpretation
- Discussion
- Conclusions
- Figures and Captions
- References

Abstract:

The abstract is a short summary of your paper, including the conclusions. It should be self-contained. This means that there are no references to the paper or to figures in the paper. The

reader who wants to see whether the paper is of interest will read the abstract first. Different journals and publications vary in their abstract requirements. For this paper, make it less than 1/2 page. It should be the last section you write.

Here is an example of an abstract from a recent publication in a professional journal. It is longer than your abstract should be, but shows important components that must be included.

Sample Abstract

The recent intermediate-depth seismicity in northern Columbia and western Venezuela was analyzed to understand its origin and its presumed relationship to a subducted lithospheric slab in northwestern South America. The study area is located to the north and east of the Bucaramanga nest, which is a particular region in northern Columbia that presents a high concenration of intermediate-depth earthquakes. To the north of the nest, the seismicity of the area is sparse, and most of the events are of low magnitude (M_b<5.1). Thus only 23 earthquakes were large enough to be investigated using teleseismic data. The isodepth curves reflect a slab striking in the NNE-SSW direction and dipping approximately at 25^o- 32^o to the southeast. This observation is corroborated by the trend and plunge of the T axes of the focal mechanisms, which are generally parallel to the gradient of the slab defined by the spacial distribution of the hypocenters. These results indicate that the intermediate-depth earthquakes in western Venuzuela and northern Columbia are apparently related to the presence of a continuous lithospheric slab subducted near the Northern coast of Columbia. The two largest earthquakes, located at a significant distance from the from the Bucaramanga nest, present similar fault plane solutions. Moreover, they also agree with those of the two largest earthquakes reported inside the nest. This similarity suggests that the Bucaramanga nest lies on the same subducted slab where the other earthquakes occur. There is not enough shallow seismic activity to define the lcation where the Carribean lithosphere is subducted beneath the South American plate. However, the extension of the slab toward the surface, inferred from the intermediate-depth seismicity, suggests that the subducted lithosphere may still be attatched to the Carribean plate.

(Modified from: "Intermediate-depth seismicity in northern Colombia and western Venezuela and its relationship to Caribbean plate subduction" By Gustavo Malave and Gerado Suarez TECTONICS Vol 14, No 3, pp 617-628.)

Practice: Find and mark sentences in the above abstract that tell:

- What the author did for his/her experiment
- Why the experiment is interesting or useful
- The observations that the author made
- Interpretation of the observations
- Discussion and conclusions

Introduction Heading

A very important part of a science paper is the introduction. It is in this section that the reader decides whether or not you have something to say. You should orient the reader. Why are you writing this essay? What are you going to discuss? Why should the reader be interested in this topic? What is the scope of the study and what ideas do you want to explain? Although there are many approaches to writing an introduction, a good rule is to make sure the reader could read it alone, and come away with a basic understanding of your work. This is particularly important when writing a proposal for research funds. The reviewer, who is usually very busy, may only read the introduction. Even worse, a weak introduction may cause a negative first impression that is difficult to change later in your text.

Here are some examples of weak and strong sentences that might appear in an introduction:

Strong statements:
I will discuss the general shape of the sea floor and discuss how the motion of the plates affects that shape. I will show how the topography is related to the distribution of volcanoes and earthquake and how these data can be used to determine the kind of boundary between the various plates.

Weak statements:
Plate Tectonics is really a neat subject. I'm writing this to satisfy the writing requirement and will discuss lots of interesting features.

Introduction checklist
The Introduction should cover:
___ What is the topic of investigation in your paper?
___ How does your work fit into and advance the existing knowledge? Some background may be needed in order to do this. This is also where you try to convince the reader that your work is worthwhile and interesting. Don't just say it's interesting and important. Say *what's* interesting and why.

Methods Heading
This section is where you discuss how and where you got the data. Maybe you made your own measurements, for example, if you went to sea and measured depth profiles, or possibly you measured earthquakes with seismic equipment. For this course, you will be accessing data from existing databases. You should describe those databases and explain any of the inherent limitations of the data.

Here are some examples of statements that might appear in a Methods section:

Strong statements:
This study is based on sea surface temperature data acquired by the Nimbus satellite. The data are available from NASA at http://www.nasa.gov/data/nimbus/SST/ and are accurate to about 0.5 C. The temperature data are available on a 5km grid spacing at 1 week intervals.

Weak statements:
The software used in this course is really cool. It shows the locations of volcanoes and earthquakes, and the topography can be displayed using the ETOPO5 database, which is on the "Exploring the Deep" CD. This is a really cool course and I will learn a lot from these data.

Methods checklist
The Methods section should contain:
___ A description of how the data were collected
___ A discussion of the source and accuracy of the basic data that you will use
___ A discussion of what you did do with the data, once it was found
___ References to data sources (see Chapter 5 for a description of the CD-ROM data)

Observations Heading

Your observations or "data" are described in this section. It is not necessary to talk about conclusions or reasoning here. Just stick to what you observed.

Qualitative Observations:

Qualitative observations are not really specific, often relating to some arbitrary and unspecified reference. For example: " the waves are big", or "that hill was quite steep". To an experienced big wave rider, the waves may be quite small, but to a non-surfer, they may seem quite large. Steepness of a hill on a hike is also very subjective. A person who hikes a lot may find a hill much less steep than a couch potato. Qualitative observations are not very useful in technical writing, unless you are specifically discussing your reaction to an observation (which is rarely done).

Quantitative Observations:

Quantitative means you are actually observing **Quantities**. For example: "the waves are between 10 and 12 feet high", or "the hill rises at a 45 degree angle", or "the hill rises at a 50% grade".

Clarity of Observations:

The discussion on "Using Figures" should be read carefully. You should be sure to first tell the reader where you made your observations. The location could be marked on a map. When maps are of a very local area, an inset showing a larger area that is more familiar to the intended reader will be provided.

Examples of observations:

strong observations:

Many volcanic mountain ranges (chains) such as the Andes, the Aleutians, and the Japaneses Islands run parallel to deep, long oceanic trenches.

The Japan-Kiril trench is ____ km long and ranges in depth from ____ to more than 9000 m.

The East Pacific Rise begins at about 56^{o}S 118^{o}W and ends near the end of the Gulf of California. It has a typical elevation of -2800m, significantly higher than the surrounding seafloor which is typically 4000m or more beneath the sea surface

weak observations:

Volcanoes are next to trenches.

The trench near Japan is deep and long.

Observations checklist:

The observations section should contain:

___ A description of each observation
___ Screen printouts illustrating your data
___ A reference to each figure in the paper. Don't assume that the reader knows why you put in a particular figure. Explain, in the text, what the figure shows.

___ Quantitative observations, whenever possible
___ Figures must be in the order they are referred to in the text. Refer to figure 1, then 2, etc.
___ Make sub-headings, if appropriate, for observations in different areas. For example, you might have, for area subheadings: *South America, Tonga-Fiji Region, Global Observations,* etc.
___ Use more than one profile to characterize a linear feature. There may be interesting variations along the feature that will add substance to your paper.

A good way to get a C or less on this paper is to ignore the data on the CD-ROM "Our Dynamic Planet", and make a book report on plate tectonics. This kind of paper misses the point of the assignment.

Interpretations Heading

Here is where you relate your theory or model to the observations. You may need to adjust the theory to fit the data. Generally, this is an iterative process of creating a model or prediction of the outcome, taking data, and then modifying the model to fit the data.

Each interpretation must be backed up by one or more observation(s). Simple sketches or cartoons should be used at this point.

Conflicts in the data:
Unfortunately, the real world is not so nice as your textbook. Data rarely agree perfectly with your interpretation. Data also have errors, so may be expected to disagree to some extent. It is important to be forthright about where the data disagree with your model. Maybe you can refine or improve your model if you expand your thinking to consider modification or complexities in your model.

You will find that earthquakes do not always produce "classic" textbook patterns, and the volcanoes distribution may be missing volcanoes where observations are not available.

Honesty:
It is very important to refrain from over-interpreting your data, or exaggerating its accuracy. It is also important to include all of your data, rather than only select data which agree with your preconceived ideas. Sometimes we observe data that do not fit with our expected conclusions. It is very tempting to just forget about it or blame it on a malfunctioning measuring instrument. Discarding good observations is a way to miss a very important discovery that might just disagree with preconceived ideas.

Science has a very high "trust factor". This is because the ethics of science are based on honesty and openness of reporting. Experiments must be repeatable by others, and important experiments are always checked or repeated. Journal articles are critically reviewed by other scientists who are experts in the field. Of course, there may be great debates about the meaning of the observations. These debates are part of the scientific process. Scientific honesty means that the person making the observations is scrupulous in reporting "just the facts". The facts are not only the observations, but the accuracy of the observations.

Example, Observation and following Interpretation:
The Observation: *The topography shows a trench-like feature (Figure 3) which plunges to a depth of 8,000 meters from a depth in the West of 3,000meters. This trench extends along the full Western margin of South America, for about XXXXX km. The Andes mountain range lies to the West, along the western boundary of South America***. The Interpretation:** *The many active volcanoes in this mountain range suggests that it was built by volcanic activity (Figure 4). Several cross-sections of earthquakes (Figure 5) show a descending pattern characteristic of subduction zones. Figure 6 shows a sketch of my model for this structure, which is a classic subduction zone.* **Note that these interpretations are backed by observations**.

You should be particularly careful to look at more than one profile in your study area. For South America, you would want to do a number of sections along its western boundary. This might allow you to make a more detailed picture of the shape of the descending slab.

Interpretations checklist:
The Interpretations section should contain the following:
___ Interpretation of each of the observations that you present in the Observations section
___ How your interpretations relate to those of others (e.g. your textbook)
___ References (see "References" discussion) to any material discussed from other sources
___ A sketch (model) of your interpretation of the observations
___ A discussion of the sketch (model) and how your observations support it.
___ A discussion of any data that disagree with your observations

Discussions Heading
Your findings are put into a broader context in this section. This is also where you can write about aspects of plate tectonics theory that are not supported by your investigation, and how these ideas add to an understanding of your investigation. For example, you could discuss mechanisms that cause plate motion, and other plate tectonics ideas that you have no data to support, but would like to discuss because it adds breadth to your paper. You are cautioned that this should not be a general review of plate tectonic theory just to pad the paper, so be sure that your discussion is relevant to your investigation.

Conclusions Heading
Here you summarize your findings without carefully explaining your logic or reasoning. The busy reader who is not a specialist may skip or skim the Methods and Observations section of a technical paper, focussing on the Introduction, figures, figure captions, and Conclusions. So, leave out everything but "the Beef". Don't worry so much about paragraph structure in the conclusions, because you are supposed to summarize many results together.

Examples of phrases that might be used in Conclusions follow:

Strong statement:
The western boundary of the South American continent is a convergent plate boundary. This conclusion is supported by topography, volcanoes, and earthquake hypocenter locations.

Weak statement:
This study shows that the western boundary of South America has a trench, volcanoes, and lots of earthquakes.

I really learned a lot from writing this paper.

Conclusions checklist:
The conclusions section of your paper should contain:
___ A summary of each of your main conclusions
___ Any speculation about interpretations that you would like to make, but are not fully supported by the data.
___ A discussion of what further research on the topic might be needed, and the significance of its possible outcome

Using figures to illustrate your paper:

The old cliche that says a picture is worth a thousand words applies especially in science and technical writing. This kind of writing can get complicated and extremely difficult to understand. Any time you can illustrate a point with a picture or sketch, the clarity of the presentation is enhanced. Most people are not really very good at visualizing geometrical shapes and physical phenomena that have been described with words. A picture fills in questions in the reader's mind and lessens the tedium of pages of text.

The busy reader may only look at your figures and read the captions. This underscores their importance. Figure captions should briefly describe what the figure shows. For this example, figure 3.2 would have a caption that said something like: "Locations of the three studies discussed in this paper." That would be enough.

When writing a technical paper related to the earth, it is important to show the reader where the study took place. Where is the study location on the earth? Figure 3.2 shows how this can be done on a Mercator map of the world like the one in your lab manual. Each study area is clearly marked so that you can refer to it in the text without requiring the reader to remember previous location descriptions. All locations that you mention in the text must be indicated on the location map.

Since you will be using profiles in your paper, you will want to use figures to show samples of profiles. Maybe you want to illustrate the geometry of a trench, or show profiles across a mid-ocean ridge. Figure 3.3 shows a figure that would successfully show the location of a number of profiles.

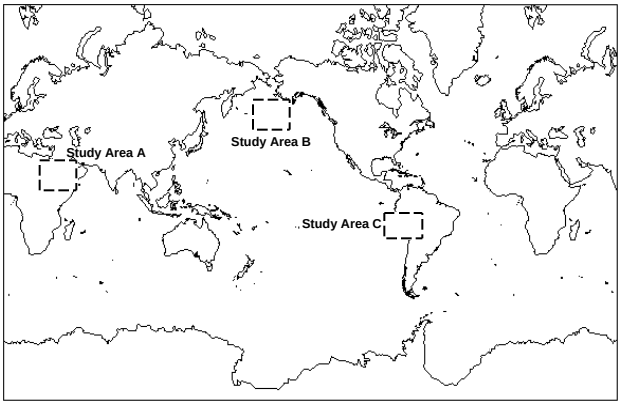


Figure 3.2. Areas of study.

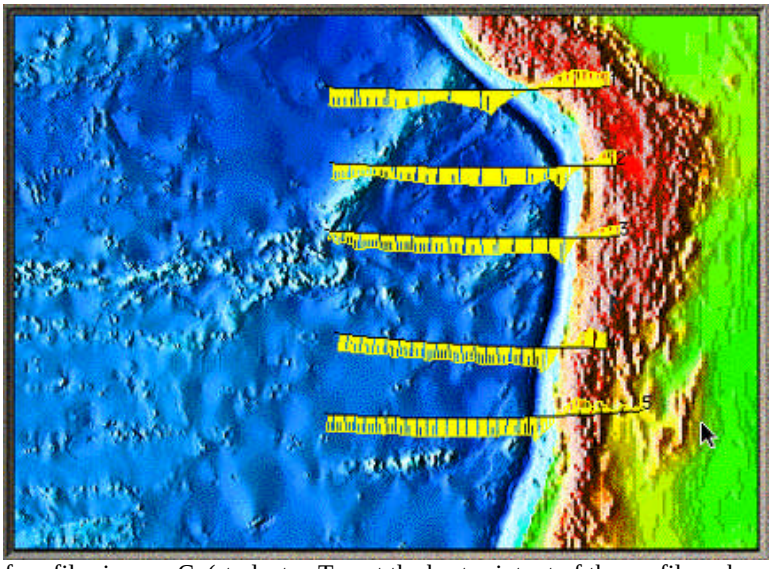


Figure 3.3. Locations of profiles in area C. (students: To get the best printout of the profiles, change the color of the "Great Circle Plot" to yellow (Optns menu).

Figure 3.4 shows an example of how you might print a series of detailed profile plots, which give vital information like the elevations and distances. You should think of the figure 3.3 profiles as merely locating the profile positions, which figure 3.4 shows the actual profile data.

Mistakes using figures:

Believe it or not, you can over-use figures. A big pile of figures showing everything you did will simply not produce a good paper. It is the job of the technical writer to condense the information so that the reader can easily assimilate the information and come away convinced of the correctness of the conclusions. That is the main purpose of using figures, but don't overdo it. If you have lots of figures, you might try combining them. However, each figure should not be too complex. You have to exercise some judgement and restraint to keep the balance between having too many figures and having figures that are too complicated.

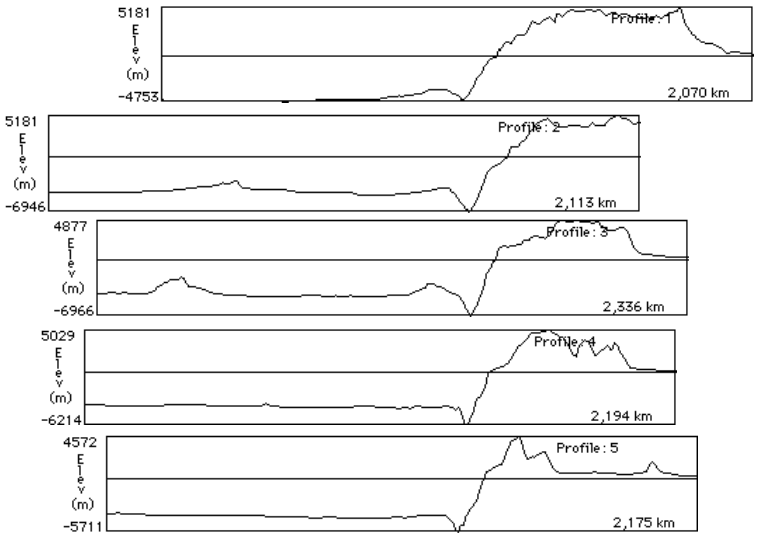


Figure 3.4. Detailed plots of profiles shown in figure 3.3.

Here are the figures referred to in the text. For readability, it is best to put the figures near to where they are referred to, rather than group them all at the end of your paper.

Symbols to use on maps:

The symbols to the left can be drawn on the map to indicate the presence of mountains. If the mountains are volcanoes, you could put a wiggly line indicating smoke coming out. Colored pencils can be used to advantage, to make your map more readable.

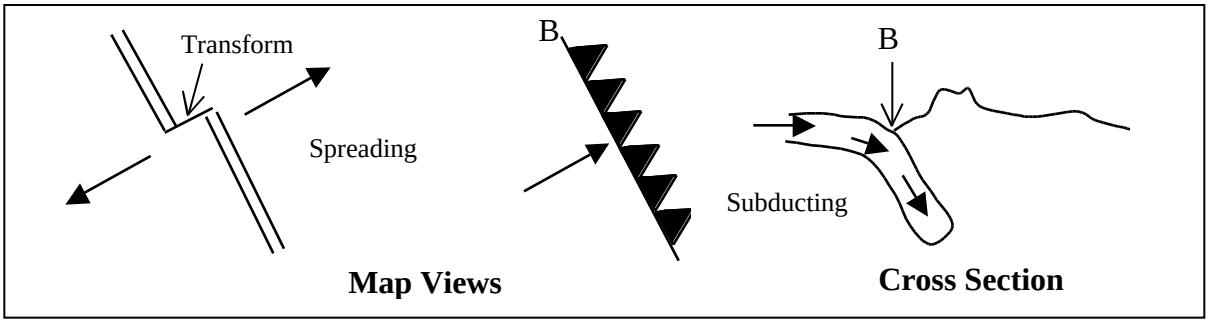
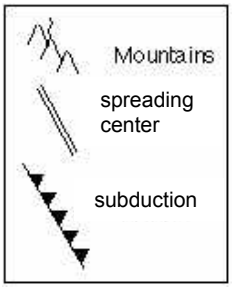


Figure 3.5. Symbols to use when sketching plate boundaries. The left sketch indicates spreading and transform, while the two rightmost figures represent convergence and subduction. In map view (middle sketch) the sawtooth line is placed at "B" in the cross-section view. The heavy arrows represent the direction of plate motion.

The above symbols are used to represent the three types of plate boundaries. The rightmost cartoon shows how the middle cartoon (map view) might look in cross section view. The saw teeth are pointed in the direction of motion of the plate that is descending and the line (B) is drawn at the surface boundary between the two plates (see "B" on both cartoons).



Legends:
Although the use of particular symbols may follow a convention, it is always important to include a "legend". This is a section on the map that shows the meaning of the symbols. An example of a legend is shown at the left. It is simply a listing of what each symbol, line type, or line color means. Other information that you should put on a map is an arrow showing the direction of north. For the world map, north is obvious, so you don't need it. Smaller maps require a north arrow.

Figures checklist:

___ Each figure shown has a numbered caption, which describes the figure.
___ Each figure is mentioned and explained in the text.
___ Figures are numbered according to the order in which they are mentioned in the text.
___ Figures are clear and easy to read. If the data do not show up clearly on the figure, mark on it with colored pen.
___ There are no figures that are photocopied from the text, or any other source.

References:

All data, text, and figures that you get from other sources must be referenced. When you speak of other peoples' work in the body of your text, you use a reference. For example:

> *In recent years, considerable effort has been directed towards investigationg the biological consequences of climate change (see Bolin et al. 1986; Chapin et. al. 1992; Fautin et al. 1992, for reviews).*

Or:

> *Ocean uptake of carbon is simulated with the world ocean general circulation model (OGCM) of Toggweiler et al. (1989), as modified by Toggweiler and Samuels (1993). etc.*

There are various styles for referring to others' work, and you may choose any style that is clear. Don't mix styles, though. Notice that you are referring to the author's name, and a date. This will identify a specific reference in the reference list, which must appear at the end of your paper. An example follows:

References:

Toggweiler, J.R. and B. Samuels, 1993. Is the magnitude of the deep outflow from the Atlantic Ocean actually governed by southern hemisphere winds? in *The Global Carbon Cycle*, edited by M. Heimann, pp. 333-366, *Springer-Verlag*, New York.

Hurley, P.M., (1968) Absolute abundance and distribution of Rb, K, and Sr in the earth. *Geochem. Acta*, 32, 273-283.

Note that the first reference is to a book and the second is to a scientific journal article. Each journal requires a slightly different format for references. You may use the format above.

Form of book reference to use:
<Author>, <Year>, <Title>, <Title of book>, <editor or edition of book>, <page numbers of your reference>, <Publisher>, <City of publisher>.

Form of paper reference to use:
<Author>, <Year>, <Title>, <Name of journal>, <Volume number of journal>, <page numbers of article>.

Internet references:
An action-alert posted on the web:
American Psychological Association, (1995) *APA public policy action alert: Legislation would affect grant recipients* [Announcement]. Washington, DC: Author, Retrieved January 25, 1996 from the World Wide Web: http://www.apa.org/ppo/istook.html

An article from a newspaper on the web:
Sleek, S. (1996, January). Psychologists build a culture of peace. APA Monitor, pp. 1,33. Retrieved January 25, 1996 from the World Wide Web: http://www.apa.org/monitor/peacea/html

Be sure to reference quotes from your textbook and from the lab workbook.

Final checklist:

__ Name, section, and perm number at the top.

__ All specified headings included (see "Format of Paper" below.

__ The paper may include any number of figures and drawings. Small figures should be included in the text (drawing them on the computer is optional). Full page figures can be inserted at the closest spot where they are referred to.

__ Double space the paper. Minimum words for writing credit = 1800.

__ Do not include any figures xeroxed from the textbook.

__ Two copies must be handed in.

Hand in your mid-term paper and a copy. Credit will not be given without a copy

Writing with Integrity

It's actually not that easy to avoid cheating, even with the best of intentions, especially with the wide variety of information available online. It's very easy to cut and paste text from the Internet into your own writing, thereby making the implicit claim that the words are your own. But, claiming something for your own that you took from someone else is what we call cheating.

In my own work, I often need to extract information from someone else's writing. It can be challenging to avoid using the same words. Changing prepositions is not enough.

Here are some hints to make it easier to extract information from others without cheating:

1. Read and make notes on main points or main items of information. Don't use whole sentences.
2. Once you have enough notes, put them away for a few hours. The idea is to forget the original source's prose while retaining the essence of the information.
3. Write from your notes.

Sometimes you will want to quote a source. When you do this, set the text as a complete paragraph, in another font perhaps, and provide a reference. The format for this is explained in "Anatomy of a Science Paper" in the supplemental chapters of this lab book.

In **group work**, you can apply the same principles. In this class, the extent of group work will be to gather information and make in-section or in-class presentations. Writing assignments are done individually. Since presentations will mostly be from "bullets," rather than written papers, it should be easy to use your own words. Be sure that you don't copy each other's figures either.

From studies of student behavior, it appears that a large portion of students engage in behavior that most faculty would call cheating, and they have no problem with it. Isn't it too bad that sometimes this expensive college education that you are paying for could be compromised because of busy-ness, competing priorities, and various disasters that just happen? But keep in mind that if you do cheat, you also cheat yourself. I'm against it. The world is too darned full of people who lie simply to enhance their own self-interest. Consider our political system. It's really NOT ok to cheat. So here's the stick, assuming you've read this far. All written assignments are submitted in computer readable form and it is feasible, therefore, to correlate every paper in the class, and from past classes. I will do this, and if I catch cheaters, I will act. I sincerely hope that this paragraph is irrelevant to you.

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Small Area Description (bring 5 copies to section meeting)

Learning objectives:

- Learn the MAP software
- Represent data in the form of figures and drawings
- Classify (name) observations as specific geological features
- Find relationships between geological features and data
- Visualize a model of a plate boundary in your small area and understand how data can be used to support that model
- Write about and argue for your model

Requirements:

1. One page, maximum, with one page of figures (~400 wds, double space, 1" margins, 12 pt font)
2. Observations and Interpretations sections only
3. Five copies due at <*insert due date*>, with
4. A copy of the "Author's Self Analysis" (next page) attached. Note that this requires that each sentence that fits one of the discourse categories be numbered according to which category it fits into.

Suggestion:

- Do the writing analysis exercise of Chapter 2 first.

If you select "Area Maps" under the "Data" popup menu, the Map screen displays rectangles that outline regions where detailed maps are available. One of these "small areas" will be assigned by your TA for a short paper. The purpose of this exercise is to begin your work on the mid-term paper, but in a small area that can provide focus for your thoughts, rather than the entire earth.

A tectonic boundary is contained within the assigned region. First, determine what kind of boundary it is. Draw a cross-section of it, or find a drawing in your textbook. Use the Map data to argue that your drawing is correct.

The figures must include: a) a world map showing the location of the small area, b) data plots showing your observations, c) an area map where you mark the tectonic features, 4) a cross-section sketch across the plate boundary zone showing the important features. The theory is in your text, "Plate Tectonics Lecture" on the CDROM, and this lab book.

Fit the text portion of your work on a single page. Fit the figures on a second page. The "Author Self Analysis" will be the third page. Use the "Graphics Workshop" tool to compose your figures. You will not be able to compose an entire page of figures. Break the page of figures into smaller parts and cut and paste them onto a final figure.

If you work on your own computer and have a color printer, this is an ideal opportunity to use your expensive equipment and graphics software. Import the images into your word processor and arrange and size them on a single page.

Carefully read the "How to Write a Science Paper" section of this lab book. For this assignment, the emphasis is on your ability to use the MAP software, describe your observations, classify your observations into "features" (ridge, trench, island, mountain, etc), and relate the data to a model of the plate boundary.

This assignment is not about quantity. Focus on pertinent features. Extraneous information will confuse the reader. Remember that you are trying to find evidence that supports your cartoon of the plate boundary in the small area. Information that is not relevant should not be used.

Do only the Observations and Interpretation sections.

Do not photocopy figures from your textbook. A hand drawn sketch is better.

Common mistakes:

- Not referring to your figures, in your text
- Drawing a cartoon that is not supported by the data (e.g. subduction zone backwards)
- No index map
- Too many figures that are hard to read
- No figure captions.
- Poor spelling and grammar
- Ignoring MAP data-making a book report on what's in the textbook

Author's Self Analysis of Small Area paper

Author's Name:

The goal of this assessment is to help you analyze your own small area paper before you turn it in for a grade. This also helps communicate the important elements that you should include in your science writing.

This assignment is a part of the small area writing assignment. A copy should be attached to each of the 5 copies of the paper you bring to the lab session.

Observations Checklist:

___ A description of each observation. Guide the reader in what to look for in each observation.
___ A reference to each figure in the paper. Don't assume that the reader knows why you put in a particular figure. Explain, in the text, what the figure shows.
___ Quantitative observations, whenever possible
___ Screen printouts illustrating your data
___ Figures must be in the order they are referred to in the text. Refer to figure 1, then 2, etc.
___ Use more than one profile to characterize a linear feature. There may be interesting variations along the feature that will add substance to your paper.

Interpretations checklist:

___ Interpretation of each of the observations that you present in the Observations section
___ How your interpretations relate to those of others (e.g. your textbook)
___ References (see "References" discussion) to any material discussed from other sources
___ A sketch (model) of your interpretation of the observations
___ A discussion of the sketch (model) and the relationships between your observations and the model
___ A discussion of any data that disagree with your model

Science discourse analysis:

In the "Online Student Paper Analysis" exercise, you classified sentences according to how they fit into a presentation of scientific data. You will now analyze your own writing using the same classification scheme. B**e sure you have done the online exercise before attempting this**.

Insert, after each sentence that can be classified into the following categories, the number of the classification in the list below, e.g. **(3)** would go after the period closing a sentence that fit category "*3. describe a feature*" Use bold type. After you have done this, count the number of sentences for each category and enter it into the correct place below.

1. include an observation, or description of an observation _____
2. name or classify an observation in terms of geological features _____
3. describe a feature (it is best that the author has already observed and classified this feature, but a sentence fits into this category anyway). _____
4. describe relationships between different observed and classified features _____
5. describe or explain a model or theory _____

6. describe relationships between and/or observed features that match (or disagree with) model features _____

If any of the categories have no sentences, consider whether you have omitted an important kind of statement that would improve your paper.

Small Group Feedback for Small Area paper:

Author's Name: _____ Reviewer's Name:_____

Suggested review procedure, for each paper:

1) Decide whose turn it is to be reviewed, then distribute the copies of the paper to the group members. Read the author's paper. Allow 5 minutes (maximum) to individually read and analyze each of the papers.
2) When you are completed, discuss your findings with the group.
3) Give your filled out feedback form to the author for future reference.

Be sure to acknowledge the author's strengths. Reviews should emphasize positive points, while offering constructive suggestions for improvement of weak areas.

Feedback on author's self-analysis

1. Review the author's analysis of her/his Small Area paper. Do you agree with the author's classification of statements in the paper?

2. Has the author included all items from the self-analysis checklist?

Specific suggestions for improving or expanding author's argument

3. Observations or descriptions of observation

4. Classifications, or naming, of observations in terms of geological features

5. Descriptions of features that have been observed and classified

6. Explanations of relationships between observations and classifications of features

Mid-Term Science Paper Assignment

Due date: See syllabus
Length: 7-8 pages. You can satisfy a UCSB writing requirement by writing 1,800 words for no less than 6 pages, double-spaced and not counting figures.
Grading: See Exams and Grading under Overview of Class in Table of Contents. The Grading Rubric for TAs is in the How to Write a Science Paper section.

Learning Objectives:
1. Use real earth data to observe , identify, classify, and describe geologic features
2. Represent observations in map and cross-section views
3. Interpret and relate topographical features and earth data to a theory or model
4. Develop and write scientific argument
5. Understand how scientists do science

Purpose:
This assignment is to complete a good quality scientific paper. It should demonstrate your comprehension and communication of the theory of plate tectonics and how data confirm that theory. The data includes topographic features and other data on the "Our Dynamic Planet" CDROM. For example, comprehension is demonstrated as you observe, interpret, and relate your evidence to general geological science knowledge of plate tectonics. Communication is demonstrated two ways: first, by the organization of your logic trail that shows you understand scientific argument; second, by the organization of your paper and how you present your supporting evidence.

Assignment:
This assignment is the culmination of your recent work to understand plate tectonics and scientific writing about the earth. This project is an extension of the Small Area Description project. You will expand that project by studying other regions of your choice. You may expand the small area topic in any way that expands your evidential support for plate tectonics theory. Specifically, you will be observing, identifying, classifying, and describing earth data, and then arguing how they relate to the theory of plate tectonics.

Evidence to support your observations and interpretations will be found in the "Our Dynamic Planet" software and your textbook.

How to Write a Science Paper:
Be sure to carefully read this section in your Lab Book. Check Table of Contents.

Checklist for Mid-Term Paper:
Be sure to double-check your almost final draft against this checklist, and against the checklists for each of the headings specified in "How to Write a Science Paper."

Format checklist:

__ Name, section, and perm number at the top.

__ All specified headings included.

__ The paper may include any number of figures and drawings. Small figures should be included in the text (drawing them on the computer is optional). Full page figures can be inserted at the closest spot where they are referred to.

__ Double space the paper. Minimum words for writing credit = 1800.

__ Do not include any figures photocopied from the textbook.

__ Two copies must be handed in.

Mid-Term paper score sheet:

Student's name:_____Perm: _____

Graded by:_____

Overall:

Item	low – med - high	Points
1. Clear (readable), focussed and interesting	0 – 1 – 2 – 3 - 4	
2. Accurate punctuation and spelling	0 – 1 – 2 – 3 - 4	
3. All paper sections are included and include the appropriate content.	0 – 1 – 2 – 3 - 4	
4. Figures are numbered, clear and easy to read, referred to in the text, and have informative captions.	0 – 1 – 2 – 3 - 4	
Abstract		
1. Clear and concise description of the investigation and its results	0 – 1 – 2 – 3 - 4	
Introduction		
1. A clear, solvable problem is posed, based on an accurate understanding of the theory of plate tectonics, and the inquiry assignment.	0 – 1 – 2 – 3 - 4	
Methods		
1. Demonstrates an understanding of the data and its inherent limitations.	0 – 1 – 2 – 3 - 4	
2. References the data sources.	0 – 1 – 2 – 3 - 4	
Observations		
1. Observations are clearly supported by figures that show data and location of data when appropriate.	0 – 2 – 4– 6 - 8	
2. Clear distinction between observations and interpretations	0 – 2 – 4– 6 - 8	
3. Available data are used effectively. Multiple kinds of data are used when available. Data are relevant to the investigation. Adequate data are acquired.	0 – 2 – 4– 6 - 8	
4. Data/observations are adequately referenced in the text and illustrated in figures.	0 – 2 – 4– 6 - 8	
Interpretations		
1. The problem, model, and supporting data are clearly connected in the text and figure(s), showing that the interpretations follow logically from the data.	0 – 2 – 4– 6 - 8	
2. A clear distinction is made between portions of the model that are supported by data from this investigation, portions supported by other references or background knowledge, and those that are supported by neither this investigation or other references.	0 – 2 – 4– 6 - 8	
3. The model figures are clear and show the correspondence between the observations and the model. Data or observations are shown on the model sketches and clearly indicate the correspondence between data and model features.	0 – 2 – 4– 6 - 8	
Discussion		
Discussion clearly illustrates the broader aspects of plate tectonics theory that apply to the investigation. Irrelevant content here will result in a lower score.	0 – 2 – 4– 6 - 8	
Conclusions		
Conclusions clearly describe the major findings of the paper and relate them to other background knowledge about plate tectonics.	0 – 2 – 4– 6 - 8	
References		
References in correct format	0 – 1 – 2 – 3 - 4	