CHAPTER 1

Before You Write — Preparation

Nearly all scientists enjoy research, the actual doing of science. But many say that the most difficult part of their work is sitting down to write about their research. Some find it hard to get started. They're intimidated by staring at a blank page or an empty computer screen. Others find the entire writing process painful, a necessary evil in the accomplishment of their work. Still, writing is unavoidable if they are to record and communicate their results.

Several techniques will help you get started writing. Once you have started, other methods can help you improve your writing. Quite simply, the only way to get better at writing is to write. Like plumbing or cooking or playing basketball, the more you work at writing, the better you get. It may also help to have someone advise you, telling you which mistakes are easily avoidable and giving you hints to improve your work. But the act of writing will help you clarify your thinking and improve your ability to communicate it.

Choose your writing instrument

Use whatever mechanics appeal most to you. You may want to make the first pass in longhand, or use a typewriter. A personal computer with a word-processing program can make the logistical aspects of writing much easier: you can revise, rearrange, cut, and check spelling and syntax with the touch of a few keys.

Find your writing method

Professional writers use a variety of mechanical techniques and working conditions. Some writers start early in the morning; some work only late at night. Truman Capote claimed that he wrote the first drafts of all his work while lying in bed. Find the method that works best for you and use it to get the product you want.

Make an outline

An outline will help make the rest of the job easier. The level of detail in the outline will depend on your writing experience, the complexity and length of the work, and the publication for which you are writing. Many scientific journals have a standard format that consists of an abstract, a statement of the problem, a review of pertinent literature, a description of research methods and results, and conclusions. It may help you to outline your work with a few words of summary under each of these categories or the categories a particular journal requests.

Paleontologist Stephen Jay Gould is well known for writing about geology, natural history, and the history of science. But even in his technical articles, Gould uses a fairly unconventional writing style, avoiding the usual stylistic conventions and writing in a more narrative style and organization. If you are a good enough writer, you may be able to get away with the same thing. For almost all writers, however, a journal's format may have the advantage of providing an established framework within which you can work.

Think about your audience

A time-honored axiom of writing is to know your audience. You should know the readers' level of understanding of your subject. Some readers will be able to understand complex technical ideas and polysyllabic words without any explanation. After all, the purpose of scientific jargon is to provide a precise and short (though often inelegant) method of communicating technical information. For other audiences, concepts and words may require some definition. You should always keep that level of understanding in mind. Similarly, the audience's level of interest may vary from publication to publication. If you are writing for readers who are unfamiliar with your particular area of expertise, they may require additional explanation to make the relevance of your work clear.

Imagining your audience as one person may help you visualize your readers. That is, think of a person you know who might read your article, such as a colleague or friend. Try to envision this person reading the article, to see if he or she can understand it. Anticipate your reader's questions, both in terms of subject matter and in the technical level of the writing, and then answer the questions. Also, ask yourself what you would like to know as a reader, and then provide that information. Writers should never leave their audience with questions that they could have answered.

You may be your own best audience. You should know, even before you sit down to write, what you want to communicate, which ideas you want to convey. Obviously, you must be interested in and excited about your specific line of research, or you wouldn't have pursued it. You should bring that same interest and excitement to your writing, using your judgment in deciding what is important. If you write about the things that are important to you, you will almost certainly be a better writer.

Put your ideas on paper

Some writers spend hours on the first sentence of a report. They write nothing beyond that first sentence until they are happy with it, no matter how many times they have to rewrite it. For most researchers, however, a better approach is to get something — anything — down on paper without worrying about the grammar, syntax, or misspelled words. The very act of writing will often help you get started. You don't need to worry too much about the way things come out the first time. There is plenty of time to fix them later.

BEFORE YOU WRITE — PREPARATION

- Choose your writing instrument.
- Find your writing method.
- Make an outline.
- Think about your audience.

CHAPTER 3

Getting It Written

> Scientific research is not complete until the results have been published. Therefore, a scientific paper is an essential part of the research process. Therefore, the writing of an accurate, understandable paper is just as important as the research itself. Therefore, the words in the paper should be weighed as carefully as the reagents in the laboratory. Therefore, the scientist must know how to use words. Therefore, the education of a scientist is not complete until the ability to publish has been established. (From Robert A. Day, *How to Write and Publish a Scientific Paper.*)

We assume that you have decided where to submit your paper and have the appropriate style manual or sheet of instructions. We also assume that you have written an outline from which to proceed.

Decide on a title

It is wise to devote some care to this label for your product, because readers deserve an accurate statement of an article's contents. Two requirements are involved:

- The title should tell what the paper is about.
- The title should not be long and cumbersome.

Meeting these requirements will also help make your paper easy to cite by future workers. Remember that increasing use is being made of computer-oriented indexing and searching techniques. When indexed, most of the words in your title should help a reader search the literature by key words. Editors sometimes must modify titles of papers; you can help both editor and reader by keeping the title of your article brief and specific. Avoid such words as *introduction, principles, selected, investigations,* and *recent.*

Express the title clearly

After deciding on the title content, be sure to express the title clearly. A succession of words that seems to make perfect sense to you may not be clear to othrs. In *Abandoned Copper Mine Subsidence Study,* the first word, an adjective, can modify any of the following four words, all of which are nouns. Presumably, the author did not want to refer to an abandoned study. The title may be improved by using a modifying phrase: *Subsidence Study of an Abandoned Copper Mine.* The real subject of the paper, however, is not the study but the subsidence. Why not call it *Subsidence at an Abandoned Copper Mine?*

Another title starts with the words *Submersible Observations.* To the author, both these words are nouns, but to many readers *submersible* is an adjective meaning capable of functioning under water. Relating *submersible* to *observations* is difficult. *Observations from a Submersible* would have done the job nicely.

Follow writing guidelines

The following section provides some general guidelines for clear writing. The explanations are not intended to be comprehensive but rather to emphasize specific points. The chapter Reference Shelf lists many excellent references that give detailed information.

Declarative sentences. A straightforward, declarative sentence is the most useful vehicle in scientific writing. A subject (person, process, or thing) acts on or affects an object or result. Such a sentence is a normal forward-action unit, in which the verb is in the active voice:

> The rocks / contain / plagioclase.
>
> Diagenetic changes / may destroy / the open porous structure.

A number of variations on this basic framework exist. In both sentences, the verbs *(contain, may destroy)* may have adverbs as modifiers, for example, *commonly contain,* and *may ultimately destory.* In the second

sentence, the subject and object are modified by adjectives *(diagenetic, open, porous)*. A phrase adds further meaning: *the open porous structure of the diatomite*.

Nonrestrictive clauses. A nonrestrictive, or *which* clause, which is not essential to the meaning of the sentence but adds to it, may be included. Such clauses are set off by commas:

Many of the rocks contain plagioclase, which has normal zonation.

Restrictive clauses. You may need a restrictive *that* clause, which is essential to the sentence meaning and requires no commas:

the open porous structure that typifies normal diatomite

Passive voice. An alternative structure turns the sentence around:

Plagioclase / is contained / in the rocks.

The open porous structure / may be destroyed / by diagenetic changes.

The verbs are in the passive voice. That is, the subject of the sentence is being acted upon and is thus passive. Most good writers view the passive voice unfavorably; the active voice is inherently more dynamic and usually shorter. If the rocks contain plagioclase, that's the way to say it. But we don't lay down an absolute antipassive rule. If the sentence subject is the texture and structure of diatomite, it is logical to place the subject first and use the passive voice. You would then discuss the diagenetic changes.

Beware of the passive voice with weak verbs, such as *is seen, is found, was made,* and *was done*. Avoid passive verbs when preparing an abstract (discussed in a later section).

Subject-verb agreement. The verb in a sentence must agree with its subject in number, even though subject and verb may be separated:

A collection of museum-grade minerals, rocks, and fossils was available.

By putting the verb close to the subject, you will be more likely to notice any disagreement between subject and verb.

There is/There are. Starting sentences with the words *There is* or *There are* is permissible, but in general this usage should be avoided. *There is an abundance of fossils* means *Fossils are abundant.*

Sentence length. Try to vary the length and complexity of your sentences. No reader likes a paper full of short, choppy sentences, or long sentences with numerous subordinate clauses and other decorations. To test how well you are doing, when you finish a paragraph or a page read it out loud. You should be aware of the sounds that "words make on paper," as E.B. White put it. Rework your sentences until they sound right.

Paragraph length. Just as there is no set length for a sentence, there is no predetermined length for paragraphs. When writing for scientific journals, authors should write paragraphs that focus on one idea. They should use as many sentences as necessary, then begin a new paragraph when shifting focus or ideas. Thus, lengthy paragraphs (about eight, 10, or 12 sentences) are permissible in scientific writing, even though they may be frowned on in other types of less formal writing.

Transitions. As you shift focus from one paragraph to the next, be sure to include transitions: words or phrases that connect paragraphs. Such transitions make life easier for your readers by telling them how you are changing directions, how the discussion to come is related to the subject they were just reading. Sometimes a single word provides that transition. Words such as *however* or *although* at the beginning of a sentence wave a flag to the reader that you are about to qualify or perhaps even contradict what was written in the preceding paragraph. Sometimes phrases or even entire sentences are necessary to perform a transition. For example, the first sentence in the third paragraph of this chapter acts as a transition sentence:

After deciding on the title content, be sure to express the title clearly.

The first part of the sentence describes the purpose of the preceding paragraph, and the second part clues the reader to the rest of the paragraph. That transition sentence ties the two paragraphs together.

Avoid fancy writing

This sentence is from a letter sent out by a geological consulting firm:

> *To properly categorize and document current investigative methodologies, an intensive data gathering effort must be initiated.*

How does that sound when you read it out loud? Is that the way we normally talk? Of course not. The sentence has dressed up a simple thought to look impressive. To *properly categorize and document* (we will forgive the split infinitive) apparently means to determine or find out. *Current investigative methodologies* is an elaborate way of saying methods or techniques now being used. The sentence winds up with a typical passive voice construction:

> An intensive data gathering effort must be initiated.

By whom? In this final flourish, we may omit *intensive*, as presumably no one would make a lackadaisical data-gathering effort. Note the hyphen, not in the original, but needed because *data-gathering* is a unit modifier of *effort*. Translated into English, the sentence becomes

> *To find out what methods are now being used, we need to obtain information.*

or even

> *We need more data on methods now in use.*

These two suggested revisions are shorter than the original and may be said aloud without embarrassment.

A type of fancy writing that should be avoided is the use of long terms based on classical Latin instead of shorter equivalents from the Anglo-Saxon. *We initiated measurement of the adjacent arenaceous strata* means *We started measuring the nearby sandstone beds*. There are exceptions, when *approximately* sounds better than *about*, or *subaqueous* better than *under water*. One author, however, wrote that dune sands were moved about by *aeolian mechanisms*. He meant wind.

Don't let your modifiers dangle

Every adjective, adverb, phrase, or clause modifies some term in a sentence. An obvious rule is that the modifier must go near, preferably next to, the term modified. This sentence was in a book:

> *Beginning 4 billion years ago, the authors show how microbes invented all of life;s essential systems.*

To avoid implying excessive age for the authors, the sentence might well have been rephrased:

> *The authors show how microbes, beginning 4 billion years ago, invented all of life's essential systems.*

Keep modifiers next to what they modify, lest absurdity result. A special case is the adverb that floats unattached:

> *Hopefully, the job will be done this week.*

There is nothing in this sentence for hopefully to modify. It should be replaced by *We hope* or *It is hoped*. Floating adverbs do not belong in serious writing. The author who wrote *This study was gratefully supported by the National Research Council* should have said *I am grateful to the National Research Council for its support*. Of course, such adverbs can be used correctly. We speak hopefully when we say you won't misuse them.

Nouniness and how to avoid it

No doubt you will agree that *field* is a fine upstanding noun. So is *oil*. Put them together and you have *oil field*, two nouns end to end. No problem here. We can even take a third noun, *giant*, and place it in line, making *giant oil field*. This phrase hardly poses any difficulty, but from here on things get progressively messier. We have the production record of the field, which we designate *giant oil field production record*. This phrase contains some interesting data, which we analyze, giving us a *giant oil field production record data analysis*. We then construct a diagram based on these data — a *giant oil field production record data analysis diagram* — and

naturally conclude with a preliminary interpretation. So the paper is entitled *Giant Oil Field Production Record Data Analysis Diagram Preliminary Interpretation.*

Readers should never be asked to fight their way through such clotted prose — nine nouns and an adjective, all in a heap. The cure for such writing is the phrase. By using a few prepositions, we can recast the title into English that is immediately understandable:

> *Preliminary Interpretation of a Data-Analysis Diagram of the Production Record of a Giant Oil Field*

or, if you prefer:

> *Data-analysis Diagram of the Production Record of a Giant Oil Field: Preliminary Interpretation.*

We hyphenate *data-analysis* to make it a unit that modifies *diagram,* and we convert the other terms into prepositional phrases. Nothing can be done to make that title a model of graceful prose, but at least we can make it comprehensible.

Each of the following titles has appeared in geological literature. Can you translate them into English?

> *Canadian Superior Harmattan Area Gas Processing Plant Sulphur Recovery Exemption Application*
>
> *Multiple Pulse Incoherent Scatter Correlation Function Measurements*
>
> *Heavy Mineral Magnetic Fraction Stream Sediment Geochemical Exploration Program*

Unit modifiers

We have already mentioned a type of three-word expression in which the first two words modify the third — as in *three-word expression.* Although putting a hyphen between the first two words clearly aids the reader, this bit of help is often omitted. For example, a tectonic lineament roughly coextensive with a part of the 38th parallel has been referred to as the *38th parallel lineament.* This phrase is poor usage; it implies that there are a lot of parallel lineaments and this is the 38th. The expression is given its correct meaning by a hyphen: *38th-parallel lineament.* The first two words make a unit that modifies the third.

Such expressions as the following require a hyphen: *high-level terrace, rare-earth element, low-angle fault, mean-dip map.*

Somethimes editors will remove hyphens for reasons that are not obvious to authors. If you think a hyphen is needed, discuss its value with the editor. Its inclusion may be needed.

Sexist language

Sentences that refer only to one sex when they could equally apply to both can often be corrected (and shortened) by using plural constructions. For example:

> *The geologist should use the reflection and refraction profiles when he is uncertain of the dip of underlying formations.*

might be rewritten:

> *Geologists should use reflection and refraction profiles when they are uncertain of the dip of underlying formations.*

Instead of writing

> *When the geologist begins, he or she should visit the site immediately,*

write

> *Geologists should begin by visiting the site immediately.*

Spelling

If you have trouble remembering that *consistent* is spelled with an *e* and *resistant* with an *a*, don't feel bad; our language is full of teasers like that. Help is always available. The most obvious source is the dictionary. Keep one nearby and don't be embarrassed to use it. The *Glossary of Geology* and the *Dictionary of Geology* are also helpful. If you use a word processor, use the spelling checker with it.

For quick reference, you may want to make a list of words that give you trouble. The following list seems to bother some geologists.

symmetrical (two m's)

consistent, persistent

desiccate (one *s*, two *c*'s)

discernible

eustasy, isostasy (no *c*'s)

fluorite, fluorspar

liquid, liquefy

occurred, occurrence (two *c*'s, two *r*'s)

permeable, permeability

phosphorus

predominant, resistant

soluble

Mohs

Punctuation

The best way to learn about this subject is to note how various punctuation marks are used in material that you read, and to use references such as those listed in the chapter Reference Shelf. Counsel here is brief.

Comma. A comma, which seems to give the most trouble, marks a slight pause in the flow of words. For example, in the preceding sentence, the *which* clause stands out from the main sentence and is enclosed by commas.

Semicolon. A semicolon marks a slightly longer pause than a comma.

Period. For a full stop, or period, William Zinsser remarks that there isn't much to say about it except that "most writers don't reach it soon enough." (*On Writing Well*)

Colon. The most common use of a colon is to tell what's coming.

Dashes. A long dash separates:

No vestige of a beginning — no prospect of an end.

Some writers also use dashes to denote a more emphatic form of parentheses:

The sea left behind layers of shale and limestone — generally shale in the shallow sea and limestone where it was deeper — along with deposits of coal.

A hyphen connects, as in unit modifiers such as *low-angle fault*, and between syllables at the end of a line of type.

Apostrophe. An apostrophe denotes possession. The general rule is an apostrophe goes inside an s if the possessor is singular, outside if plural: *the rock's age, the pebbles' average size.* Depending on your stylebook, you may write *the 1980's* or *the 1980s*.

Quoting

You may sometimes want to quote the words of another writer. You should repeat these words verbatim, enclose them in quotation marks, and cite the source from your list of references, for example (*Snarf, 1984*). Copyright permission is necessary for quotations of several paragraphs or a page or more. Or you may rephrase another author's remarks in your own words — as long as you give the source.

References

You should have a list of references at the end of your article. The entries must be in the format required by the journal to which you send your paper. Journal editors are fanatics in this matter, so be sure to follow the instructions in the journal's guidelines to authors. If guidelines are unavailable, use a recent journal issue as a model. If you aren't writing for a publication but are preparing a document such as a company report, adopt a format for the references and use it consistently. Spell authors' names correctly and verify all information. Listing references is loaded with opportunities for error.

Software packages are now available that let you compile references as you work, then make style adjustments according to your avenue of publication. These packages can help you make sure that your reference style is appropriate and consistent.

TO GET YOUR MANUSCRIPT WRITTEN

- Decide on a title.
- Express the title clearly.
- Follow writing guidelines.
- Avoid fancy writing.

CHAPTER 4

Revise!

One widespread misconception about professional writers is that they get it right the first time. Not many do. The difference between ordinary writing and good writing often lies in revision. Revision is far more radical than checking copy for grammatical mistakes, punctuation problems, and syntax errors. It requires looking at every word, every sentence, and every paragraph to make sure that each is where it is supposed to be and says what you want it to say. With every reading, ask these questions:

- Does the sequence of sentences make sense in a paragraph, or should some sentences be moved?
- Does the order of the paragraphs flow logically from one to the next?
- Are the paragraphs connected by transitions?

Revise as much as necessary. Revision often requires reworking a manuscript several times before it is finished. As you revise, consider the following guidelines.

Use action verbs

Verbs are the action part of a sentence; good writing usually uses active, visual verbs, not nondescript verbs, such as *is*, *was*, or *have*. One mode of revision is to underline all the verbs. Underlining may help you pay special attention to them and show if you are using vivid active verbs or dull passive ones.

Also, look to the readability of your sentences. If a verb is placed far from a subject, your readers may have trouble following the sentence meaning. Placing the verb close to the subject may help.

Vary sentence length

Don't use all long or all short sentences. A short sentence on the heels of a long one often has substantial impact.

Shorten manuscript

Look for ways to shorten your manuscript. Research has shown that short words are usually easier to understand than long ones; short sentences are easier than long ones; and short paragraphs are easier than long ones. Shorter versions also get your ideas across in less space, making readers more likely to read them.

Seek colleague advice

You may want to show your manuscript to colleagues before you submit it, partly for technical reasons but also for readability. The sentences that seem the clearest to you may cause your readers confusion. The results may be, at least at first, somewhat painful. Writing is such a personal process— our words become so much a reflection of ourselves that they are like flesh and blood — that criticism can be hard to take. Most writers learn, however, that such criticism is most profitable and heads off mistakes later. You should understand that dealing with critical analysis is part of the professionalization of your work; that is, criticizing your writing can lead to improvement, the same way that you may benefit from critical suggestions about research techniques or other facets of your work. If your colleagues can help you in the revision process — shortening, polishing, improving — take all the help you can get.

REVISING

- Use action verbs.
- Vary sentence length.
- Shorten manuscript.
- Seek colleague advice.

CHAPTER 6

Abstracting the Essence

The most-read part of a paper may be its abstract. Effective abstracts are concise, summarize conclusions and recommendations, and are amenable to computer storage and retrieval. In terms of number of readers, an abstract is easily the most essential part of a technical paper.

To help explain what an abstract is, we have included two views of abstracts. View one, by Kenneth K. Landes, was published in the *Bulletin* of the American Association of Petroleum Geologists in 1966 (Vol. 50, No. 9, p. 1992). View two is an excerpt from "Standards for writing abstracts" by B.H. Weil.

View One

A Scrutiny of the Abstract, II

ABSTRACT

> A partial biography of the writer is given. The inadequate abstract is discussed. What should be covered by an abstract is considered. The importance of the abstract is described. Dictionary definitions of "abstract" are quoted. At the conclusion a revised abstract is presented.

For many years I have been annoyed by the inadequate abstract. This became acute while I was serving a term as editor of the *Bulletin* of the American Association of Petroleum Geologists. In addition to returning manuscripts to authors for rewriting of abstracts, I also took 30 minutes in which to lower my ire by writing "A Scrutiny of the Abstract." This little squib has had a fantastic distribution. If only one of my scientific outpourings would do as well! Now the editorial board of the Association has requested a revision. This is it.

The inadequate abstract is illustrated at the top of the page. The passive voice is positively screaming at the reader! It is an outline, with each item in the outline expanded into a sentence. The reader is told what the paper is about, but not what it contributes. Such abstracts are merely overgrown titles. They are produced by writers who are either (1) beginners, (2) lazy, or (3) have not written the paper yet.

To many writers the preparation of an abstract is an unwanted chore required at the last minute by an editor or insisted upon even before the paper has been written by a deadline-bedeviled program chairman. However, in terms of market reached, the abstract is the *most important part of the paper*. For every individual who reads or listens to your entire paper, from 10 to 500 will read the abstract.

If you are presenting a paper before a learned society, the abstract alone may appear in a preconvention issue of the society journal as well as in the convention program; it may also be run by trade journals. The abstract which accompanies a published paper will most certainly reappear in abstract journals in various languages, and perhaps in company internal circulars as well. It is much better to please than to antagonize this great audience. Papers written for oral presentation should be *completed prior to the deadline for the abstract*, so that the abstract can be prepared from the written paper and not from raw ideas gestating in the writer's mind.

My dictionary describes an abstract as "a summary of a statement, document, speech, etc...." and that which *concentrates in itself the essential information* of a paper or article.... May all writers learn the art (it is not easy) of preparing an abstract containing the *essential information* in their compositions. With this goal in mind, I append an abstract that should be an improvement over the one appearing at the beginning of this discussion.

ABSTRACT

> The abstract is of utmost importance, for it is read by 10 to 500 times more people than hear or read the entire article. It should not be a mere recital of the subjects covered. Expressions such as "is discussed and "is described" should *never* be included! The abstract should be a condensation and concentration of the *essential information* in the paper.

View Two

An abstract, as defined here, is an abbreviated, accurate representation of a document. The following recommendations are made for the guidance of authors and editors, so that abstracts in primary documents may be both helpful to their readers and reproducible with little or no change in secondary publications and services.

Make the abstract as informative as the document will permit, so that readers may decide whether they need to read the entire document. State the purpose, methods, results, and conclusions presented in the document, either in that order or with initial emphasis on findings.

For various reasons, it is desirable that the author write an abstract that the secondary services can reproduce with little or no change. These reasons include the economic pressures on the secondary services caused by continuing increases in the volume of scholarly publication; the need for greater promptness on the part of the secondary services in publishing information about the primary literature; and the growing value of good authors' abstracts in computerized full-text searching for alerting and information retrieval.

In the proposed standard the term *abstract* signifies an abbreviated accurate representation of a document without added interpretation or criticism and without distinction as to who wrote the abstract. Thus, an abstract differs from a brief *review* of a document in that, while a review often takes on much of the character of an informative or informative-indicative abstract, its writer is expected to include suitable criticism and interpretation. While the word *synopsis* was formerly used to denote a resume prepared by the author, as distinct from an abstract (condensation) prepared by some other person, this distinction no longer has real meaning.

Types of abstracts

An abstract should be *informative;* that is, it should present quantitative and qualitative information. Space limitations may influence the amount of information you can present but not the quality. Informative abstracts are especially desirable for texts describing experimental work and documents devoted to a single theme. Discursive or lengthy texts, however, such as broad overviews, review papers, and entire monographs, may permit an abstract that is only an *indicative* or descriptive guide to the type and contents of a document. A combined *informative-indicative* abstract must often be prepared when limitations on the length of the abstract or the type and style of the document make it necessary to confine informative statements to the primary elements of the document and to relegate other aspects to indicative statements.

Abstracts should not be confused with the related, but distinct, terms *annotation, extract,* and *summary.* An *annotation* is a note added to a title or other bibliographic information of a document to comment or explain, such as the notes on the references shown in the chapter entitled Reference Shelf in this book. An *extract* signifies one or more portions of a document selected to represent the whole. A *summary* is a restatement within a document (usually at the end) of its salient findings and conclusions and is intended to complete the orientation of a reader who has studied the preceding text. Because other vital portions of the document (for example, the purpose and methods) are not usually condensed into a summary, the term should not be used synonymously with *abstract.*

Format

For long documents, such as reports and theses, an abstract generally should not exceed 500 words and preferably should appear on a single page. Most papers and portions of monographs require fewer than 250 words. Fewer than 100 words should suffice for notes and short communications. Editorials and Letters to the Editor often will permit only a single-sentence abstract.

Begin an abstract with a topic sentence that is a central statement of a document's major thesis, but avoid repeating the words of a document's title if the title is nearby.

In abstracts specifically written or modified for secondary use, state the type of the document early in the abstract if the document type is not evident from the title or publisher or if it will not be clear from the remainder of the abstract. Explain either the author's treatment of the subject or the nature of the document,

for example, theoretical treatment, case history, state-of-the-art report, historical review, report of original research, or literature survey.

Write a short abstract as a single, unified paragraph; use more than one paragraph for long abstracts, for example, those in reports and theses. Write complete sentences, using transitional words and phrases for coherence.

Avoid terms, acronyms, abbreviations, and symbols that may be unfamiliar to your readers unless you define them the first time they occur in the abstract. Include short tables, equations, structural formulas, and diagrams only when necessary for brevity and clarity. Try not to cite references.

A well-prepared abstract enables readers to identify the basic context of a document quickly and accurately, to determine its relevance to their interests, and thus to decide whether they need to read the entire document. Readers for whom the document is of fringe interest often obtain enough information from the abstract to make their reading of the whole document unnecessary. Therefore, every primary document should include a good abstract. Secondary publications and services that provide bibliographic citations of pertinent documents should also include abstracts if at all possible.

a research team who are working collaboratively. Some abstracts only have one or two authors, some have many. Be sure to provide co-authors a chance to edit drafts of the abstract, preferably with plenty of time before the submission deadline.

Writing the abstract

If you've never been to a GSA meeting or read a bunch of abstracts, start by reading 5-10 abstracts from previous meetings. These can be accessed here

http://geosociety.org/meetings/searchabstracts.htm

The purpose of an abstract is not to tell the reader the topic of the study, but rather it is to deliver the findings of the study. In other words, a good abstract should have all the elements found in a good peer-reviewed published paper. This includes background/introduction, methods, results, discussion, and conclusions.

I recommend the following general formula, although of course deviations may be necessary:

1 sentence: Summary statement to place your study in context, define the overall purpose or problem being addressed.

1 sentence: Summary statement of your approach to the problem – mapping done, analyses performed, methods, etc.

3-5 sentences: Meat of the abstract. Results/Data.

3-5 sentences: Interpretive discussion.

1 sentence: Summary statement listing the conclusions of your study.

1 sentence: Statement relating your study back to the "big picture" – why does this work matter? How will it impact science and society?

Paying for the Conference

Several sources of support are available:

1. http://geosociety.org/grants/travel.htm (travel grants from sections or divisions usually require that the student be presenting at the conference)
2. The days of student volunteers running the 35mm slide projectors are over, but there are still a lot of volunteer opportunities at the meetings. Student volunteers can get registration often get costs covered – check the conference website. Do it early, because volunteer slots are usually limited.
3. Connect with other students to share rooms/travel expenses, etc. http://rock.geosociety.org/forumstudenttravel/

Example abstracts

2010 GSA Denver Annual Meeting (31 October –3 November 2010)

Paper No. 165-3

Presentation Time: 8:35 AM-8:50 AM

SEDIMENTARY GEOCHEMISTRY OF DIATOMACEOUS RIFT-VALLEY FILL: EXAMPLES FROM THE PLEISTOCENE OLORGESAILIE FORMATION, KENYA

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Recent advances in micropaleontology, palynology, isotope geochemistry, clay mineralogy, and related fields provide a powerful, multi-proxy tool kit for paleolimnology and allow detailed reconstructions of paleoenvironments and paleoclimatic conditions in East African Rift basins. This study presents the results of whole-rock geochemical analyses of altered lacustrine sediment in the Pleistocene Olorgesailie Formation, Kenya, within paleosols of Member 1 (UM1p) and Member 7 (UM7p). Based on Ar/Ar dates these are constrained to ~0.99-0.97 and ~0.90-0.78 Ma in age, respectively. Several major oxides and ratios provide useful indicators of paleoenvironmental processes. For example, SiO_2 in these units ranges from 62-83 weight%, and TiO_2 ranges from 0.4-1.7 weight%. These two indicators are strongly inversely related (e.g. UM1p: r^2=0.84, p<0.0001), reflecting the competing geochemical signals of diatom productivity and preservation versus detrital input. Samples of UM1p laterally distributed over ~3km of the basin have lowest SiO_2/TiO_2 ratios to the west, suggesting a detrital source in that direction. In contrast, UM7p SiO_2/TiO_2 ratios are less variable across the field area, consistent with observations of more uniform primary lithology in the unit.

Elemental ratios such as Ba/Sr and $(Fe_2O_3+MnO)/TiO_2$ provide data on variability in post-depositional paleo-hydrolytic or paleo-oxidative conditions, respectively. Significant relationships are also found between these indicators of diagenesis (e.g. UM1p: r^2=0.45, p<0.001). Both UM1p and UM7p have higher Ba/Sr and $(Fe_2O_3+MnO)/TiO_2$ to the east, suggesting greater weathering in that direction at times of subaerial exposure. Weathering indicators are overall more severe in UM7p, consistent with its interpreted longer period of exposure and pedogenesis. These diagenetic and pedogenic conditions are of particular interest for paleoenvironmental studies focused on terrestrial flora, fauna, or hominin paleoecology, as they reflect conditions during low lake level and subaerial exposure.

Lateral variability of primary and diagenetic geochemical signatures is important to consider in the interpretation of data from sediment cores, serving to remind us of the importance of sedimentary facies models to contextualize geochemical data.

2011 GSA Annual Meeting in Minneapolis (9–12 October 2011)

Paper No. 36-11

Presentation Time: 9:00 AM-6:00 PM

BIODEGRADATION OF DEEPWATER HORIZON CRUDE OIL ENHANCED BY NA-MONTMORILLONITE AMENDMENT IN IMPACTED SALT MARSHES, BARATARIA BAY, LOUISIANA

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The Deepwater Horizon disaster released ~4.9 million barrels of oil into the Gulf of Mexico, impacting over 500 km of salt marsh in the heart of Louisiana's fisheries and tourism industries. Based on lab experiments following Spain's 2003 Prestige oil spill, Warr et al. (2009) hypothesized that high-layer charge montmorillonite can enhance microbial biodegradation rates by altering the charged environment near the cell wall. Here we test this hypothesis in the field, and extend it to the anaerobic microbial communities dominating salt marshes. In early September, 2010, we seeded ~4m^2 test plots in oiled marshwith ~0.5cm of commercial Na-montmorillonite. Enhanced smectite:kaolinite ratios in the sediment were monitored by XRD.

Serial GC/MS analyses of surface oil in the marsh between September 2010 and May 2011 show losses of *n*-alkane petroleum hydrocarbons. These persisted in the marsh as recently as May 22, 2011, consistent with the slow rate of anaerobic biodegradation. Polycyclic aromatic hydrocarbons (PAHs), which are of particular concern because of their carcinogenic effects, have also decreased during this time.

Preliminary data suggest that clay-amended sites have more advanced biodegradation, based on total *n*-alkane and PAH abundances, as well as ratios of specific compounds to more conservative consituents such as hopane. Pristane/phytane ratios have remained roughly constant (~0.75) in both control and experimental settings. Preferential loss of lower molecular weight compounds is clearly observed; PAH profiles are now dominated by alkylated homologues. In clay-amended sites, loss of lower molecular weight compounds is more advanced.

Transcript analyses of functional genes indicate that Fe-reducing, sulfate-reducing, and methanogenic prokaryotic communities are metabolically active at both control and experimental plots. Analyses are underway to identify microbiological differences among the sites. Benchtop microcosm experiments are also underway to monitor petroleum hydrocarbons, pore water chemistry, and gene expression in a more controlled environment. If successful, clay enhancement of biodegradation is potentially a useful technique in remediation of oil-contaminated sites, especially those in anaerobic environments in which natural attenuation rates are very slow.