Tips for scientific writing

Contents

Appendices

Tips for scientific writing

Acknowledgement

David Lindsay has given the Department of Mines, Industry Regulation and Safety (DMIRS) permission to create this document as a handy guide for in-house geologists. The source of this information was David's PowerPoint presentations delivered to geologists and his published book:

Lindsay, D 2011, Scientific writing = thinking in words, CSIRO Publishing, Collingwood, Victoria, 122p.

Introducing your writing

Your primary aim in writing is to have as many people as possible *read* it, *understand* it and be *influenced* by it. To keep the reader interested, use the following:

- Structure (put the most important information first)

- Logic (ideas in their proper sequence — not at random)

- Readability (style and fluency)

- Economy (no red herrings).

We use these points as guides because readers can only take in and retain information by relating it to what they already know or expect to find out. The key is to get readers to expect certain sorts of information and then deliver the detail in a way that satisfies their expectations. So, if you understand what motivates a scientific reader, then you are a long way down the track to being a successful scientific writer.

Convincing the reader

Don't make your scientific article just a compilation of information; turn it into a scientific story — the more exciting and fascinating the story, the better the scientific article.

Here are some useful points to follow:

- Start with a title that convinces readers they will learn something useful if they read on.

- Use the sections that follow to entice the reader to continue to read and learn more.

- Write in a style that is simple and avoid trying to impress.

- Don't emphasize unfamiliar expressions and jargon that are likely to suggest to readers that they are not well enough informed to understand your story.

When you write something that provides information, present it in a way that sets up the information that will follow. That way the reader becomes curious and finds it hard to put your article down. More importantly, the reader is no longer an absorber of knowledge but a seeker of knowledge.

Basic rules about getting started

Here are some guidelines to getting started:

- Never start to write anything before you work out how it should end.

- Reduce the section of work in front of you to manageable chunks that you can handle.

- Write the opening sentence of that section — then the last sentence. It tells you where you are going.

- Then, fill in the sentences between the two.

- Write in the style that you would use in a conversation with a friend — fix the imperfections later.

- Get down what you want to say, even if it is a rough version, and build up your confidence — fix it later.

- For most people, fixing (or editing) existing text is much easier than creating new text.

So, what's the good news about writing reports? There are no hidden agendas — the most acceptable style is plain, simple English.

The only constraints are:

- precision

- clarity

- brevity.

Structure

The physical structure of a scientific article is well known and, with a few minor variations or additions, is practically universal:

- Title

- Abstract

- Introduction

- Methodology

- Results (including tables and figures)

- Discussion

- Acknowledgements

- References

The logical structure of a scientific article is different from its physical structure. It revolves around the Introduction, so it's a good idea to start drafting your Introduction first.

Title

This is the most read part of your article. It has two functions: to attract other geologists to read your paper; and to provide the best information possible to help search engines find your article easily.

Use the following points to create your title:

• Carefully choose the keywords in your article.

• Rank these keywords in order of importance.

• Construct your title using all of the keywords and trying, as closely as you can, to put them in rank order.

• If the title is too long, drop off the least important keywords first.

• Edit the title to try to give an indication of your main result or main conclusion.

There are two sorts of titles you can use:

Indicative:

> *Structure of the Protein Phosphatase 2a Holoenzyme*

Conclusive:

> *Loss of myogenin in post-natal life leads to normal skeletal muscle but reduced body size*

Abstract

An abstract or summary is placed at the beginning of all GSWA publications. The abstract comprises a brief and factual summary of the contents and conclusions of the paper, refers to any new information the publication may contain, and gives an indication of its relevance.

Style of writing

These are some rules to follow:

• Use complete sentences rather than a list of headings.

• Use first person sparingly, when referring to the author.

• Use standard or general, rather than proprietary, terms.

• Avoid unnecessary contractions.

• Using acronyms is not recommended unless they are very well known.

• Assume that the reader has some knowledge of the subject but has not read the paper.

• Have an intelligible abstract in itself without reference to the article following. The abstract should not cite sections or illustrations by their numerical references in the text.

Content of the abstract

Because the title of the article is usually read as part of the abstract, the opening sentence should be framed to avoid repetition of the title. If, however, the title is not sufficiently indicative, the opening sentence should indicate the subjects covered. Usually, the beginning of an abstract should state the objects of the investigation.

It is sometimes valuable to indicate the treatment of the subject by words such as 'brief', 'exhaustive' or 'theoretical'.

The abstract should indicate newly observed facts, conclusion of an experiment or argument, and, if possible, the essential parts of any new theory, treatment, apparatus or techniques. It should contain the names of any new compound, mineral species, geological formations, or new numerical data, such as physical constants; if this is not possible, it should draw attention to them. It is important to refer to new items and observations, even though some may be incidental to the main purpose of the article; such information may otherwise be hidden although in fact it may be useful.

When giving experimental results, the abstract should indicate the methods used; for new methods the basic principle, range of operation, and degree of accuracy should be given.

It is only in the most unusual circumstances that the abstract will contain citations or, indeed, any reference to earlier work. The abstract should be as concise as possible; around 200–300 words are appropriate. See Appendix 1 for an example of an abstract.

Introduction

A good Introduction should describe a series of logical steps that end in a statement of what the research or project is about, why you did it and what results you expected. It will give background and context.

Use your introduction to predict what you sensibly have thought you might find or conclude — and justify that prediction based on the information that was available to you before you carried out the work.

This will mean:

- the reader will know exactly what you are talking about as introduction and background and, more importantly, why

- you will be providing the exact information and nothing more than is necessary as background for the reader

- you will put readers into a position to interpret your later material, methodology, results and conclusions as they read them rather than waiting until the end

- their interpretation will be based on the same background as yours so they will be less likely to get it wrong

- you will have a focus — the reader will have a focus

- everyone wins.

Body text

When writing your document, try to limit the heading levels to three or four if you can. Having more subheadings can get confusing. Ensure that all the different sections flow logically from each other, and that the headings reflect the content of that section.

Paragraph style

The three sections of a paragraph are:

- The topic sentence (this is what this paragraph is going to tell you)

- The logical reasoning (this is the guts of what I want to say)

- The concluding sentence (this is what it means).

The traditional structure of a paragraph is, in every way, ideal for writing a technical report. From a reader's point of view the topic sentence says 'this is the issue I am going to read about in the block of text'; the middle bit says 'this is what the author wants me to take in'; the concluding sentence answers my question 'so what?'.

Just as every sentence must have a verb, every scientific paragraph should have a conclusion.

Results

Separate your Results section from the both the descriptive body text and the Discussion sections. This preserves the objectivity of the Results.

Check your results section. Does it have the following:

- text, and tables or figures

- standalone tables (or graphs) and text. Readers should be able to understand what the table is presenting without having to read the text

- tables or figures not repeated verbatim in the text

- clear text.

Discussion

This section means discussion of your findings and not the findings of others. Discuss your findings in relation to those of others, the 'real world' (practical application or contribution to generic thinking in geology). Your arguments should lead to conclusions.

References

This section is an alphabetical listing of sources you referenced in the text of the paper.

Language — common verbal stumbling blocks

Ensure that you run a spell check and remember to have the 'check grammar' option ticked to weed out obvious mistakes. The most important thing is to make sentences flow smoothly so that the reader is conscious of the message but not the way it is delivered. Get rid of verbal stumbling blocks and write to match the way a reader reads.

Tense

Follow these guidelines:

- Use simple past tense for everything that has happened in the past, i.e. at least 90% of what you write.

- Use present tense for principles and 'housekeeping', i.e. the rest.

Noun clusters

Omitting prepositions in sentences is acceptable where the missing word is clearly understood, but do not present long strings of nouns.

Example:

> *Soil nitrogen uptake*

Does this mean 'nitrogen taken up from the soil' or 'nitrogen taken up by the soil'?

Example:

> *A large vehicle fleet operator mileage restriction has now been imposed.*

This has several interpretations:

- A restriction has now been imposed on the mileage of operators of large fleets of vehicles.

- A restriction has now been imposed on the mileage of operators of fleets of large vehicles.

- A large restriction has now been imposed on mileage by the operators of fleets of vehicles.

Where several nouns are clustered and there is also a real adjective in the cluster, it is often hard to know to which noun the adjective refers.

Three ways of fixing the problem:

- Insert the missing prepositions, i.e. of, by, in, from, to

- Replace one of the nouns with an adjective

- Hyphenate words to show that they should be read as one.

Sentences beginning with subordinate clauses

Researchers are reluctant to make bold statements because they know their peers will scrutinize these carefully and expose any lack of precision or undue generalization. The longer the subordinate clause the worse the problem — in effect, readers respond to this by mentally ignoring the qualifying or subordinate clause while they search for the main clause. So, place the key message at the beginning of the sentence!

Example:

> *Although the results so far are for only a single ethnic group and the numbers are relatively small, laryngitis appears to be a consequence of too much talking.*

Becomes:

> *Laryngitis appears to be a consequence of too much talking although the results so far are for only a single ethnic group and the numbers are relatively small.*

It's possible a condition or reservation may be the key issue in a sentence. In this case you are justified in placing the conditional clause first.

Nouns instead of verbs

Look at each noun in the sentence and seed if there is a verb derived from the same stem. If so, simply use the verb to replace the noun.

Example:

> *There is a need for certainty of description of the area of land affected by a Carbon Right.*

Becomes:

> *Land affected by a Carbon Right needs to be described accurately.*

Multiple negatives

It is not uncommon.	*It is common.*
This does not mean that it won't work.	*It means that it will probably work.*
It is not unreasonably inefficient.	*It is not reasonably efficient.*

Imprecise words

If you can, give the exact number or a rounded version of it.

Example:

> *A considerable number of sites was surveyed.*

Better:

> *Seventy-four per cent of sites were surveyed.*
>
> Or
>
> *About three-quarters of the sites were surveyed.*

'A number' adds no information. 'A few', 'several', 'some', 'many' or 'most' all give more information.

Remember that the rounded version would only be appropriate if the precise figure were given elsewhere, such as in an accompanying table or figure.

Passive voice

Active voice is essential if it is important to identify the doer of the action; passive voice is acceptable if it didn't matter who did the action. Using active voice instead of passive voice often shortens the statements.

Examples of passive voice:

> *Many kilometres were walked checking and amending the boundaries of the maps.*
>
> *All amendments on the maps have been done in red for high visibility.*
>
> *No problems were encountered.*

A mixture of active voice and passive voice can introduce a welcome variety to your writing.

Example:

> *It is believed that new boundaries will need to be surveyed.*

Passive voice:

> *In conclusion, the subject of regularity in the action of the bowels is too important to be omitted. Constipation in infants, whether breast fed or bottle fed is extremely common. A healthy child, under one year, should have at least three actions in 24 hours. This is not generally realized, and very frequently a baby's bowels are regarded as regular if there is one motion in the 24 hours. As to methods of remedying this: The best is that which consists in altering the diet to bring this result about, and thus if possible avoiding recourse to drugs etc. Constipation, however, must be put an end to, or the child's health will eventually suffer, to a greater or lesser degree.* (121 words)

Changed to active voice:

> *We cannot ignore that children need to use their bowels regularly because they are often constipated whether fed from the breast or the bottle. A healthy child, under one year, should have at least three actions in 24 hours. Many people do not realize this and think that one action every 24 hours is regular enough. The best remedy is for parents to alter the diet and avoid drugs, if possible. However, whatever the remedy they use, they must end constipation or the child's health will suffer.* (88 words)

Acronyms and abbreviations

Whenever possible, be frugal in your use of abbreviations and always be aware of their catastrophic impact on readability. If you are not going to use an acronym more than three times in your article, write the expression out in full each time.

Example (to avoid):

> *FSH and LH were measured by RIA and E2 was extracted with RT, purified by TLC and measured by CPB.*

Footnotes, appendices and parentheses

Some guidelines are:

- Avoid footnotes, appendices and anything in brackets whenever you can.

- If the information is incidental to your main message, consider leaving it out.

- If it is important, delete the parentheses and incorporate it in the main message to show that it is important.

- Position breaks for citations of authors and dates where they will do least harm to the flow.

How to avoid sending the reader to sleep

- Begin each sentence with words that signal (in general terms) what is to follow in the rest of the sentence.

- The readers read (more or less) what they expect to find.

- The sentences then flow, one after the other, so the reader does not tire.

There are two methods of using the beginning of the sentence to signal what is to follow:

1. Begin the sentence with something that was made clear in the previous sentence.

2. Use signalling words that act as signposts for reading.

Here is a simple example of using reader expectation:

The students were randomly selected and allocated to three treatment groups. A new piffometer with twice the speed of old instruments was used to determine the speed at which students in the three groups learned to farnarkle.

Becomes:

The students were randomly selected and allocated to three treatment groups. These three groups were monitored for their speed of learning to farnarkle using a new piffometer with twice the resolution of old instruments.

Using 'signpost' words

'Signpost' words always refer to points made in the previous sentence:

• In contrast	*However*
• In addition	*Moreover*
• There are three reasons, possibilities…	*First… Second…Third…*
• Therefore	*So, Thus*
• Consequently	*As a result*

Editing for style and fluency

Before you submit your manuscript check the following:

- Is the paragraphing right?

  - Check the first sentence to see that it defines the topic and check the last sentence to see that it is a genuine conclusion. Check the remaining sentences to see that they are relevant to that topic and are part of its development towards the conclusion.

- Do the sentences flow?

  - Examine the first words of each sentence and ensure that they include words that were used in the previous sentence or are 'signpost' words that relate the rest of the sentence to what preceded it.

- Are there stumbling blocks?

  - Check for words and expressions that may possibly distract the reader from the task of absorbing the message by causing doubt, introducing ambiguity, or needing several moments of contemplation to decipher.

- Can it be shortened without losing the meaning?

  - Remove expressions that don't add meaning such as, 'our studies show …' or 'analysis of the data revealed …'. Check if there are nouns that you can replace by verbs with the same stem and rephrase the sentences accordingly.

- Does it say what you want it to say?

  - The previous four steps are largely mechanical and can be done without considering closely the precise message you want to give in the paragraph. You should now re-read the amended paragraph to verify that it still says exactly what you wish it to say.

Appendix 1
Example of an abstract

THE CRUSTAL EVOLUTION OF THE RUDALL PROVINCE FROM AN ISOTOPIC PERSPECTIVE

ABSTRACT

The Rudall Province, in the Paterson Orogen, is part of the West Australian Craton and now lies to the east of the Archean East Pilbara Terrane. Components within the Rudall Province have previously been linked to the Arunta Orogen of the North Australian Craton based on similarities in timing of magmatism, deformation, and metamorphism and hence have been regarded as exotic terranes on the margin of the WAC. The Rudall Province is divided into three lithotectonic elements known as the Talbot, Connaughton, and Tabletop Terranes. The southern two terranes (Talbot and Connaughton) were affected by magmatism related to collision between the West and North Australian Cratons during the 1800–1765 Ma Yapungku Orogeny. Zircons within the Talbot Terrane and Connaughton Terrane indicate crustal residence ages of 3.4 – 2.4 Ga, with strong isotopic and, in the case of inheritance, temporal affinity to detritus that originated from Capricorn Orogen basement sources (e.g. 2005–1970 Ma Dalgaringa Supersuite of the Glenburgh Terrane). Furthermore, the range of Hf isotopic compositions in c. 1800 Ma magmatic zircons in the Rudall Province has similarity to that in the c. 1800 Ma Bridget Suite, which has an undisputed association to the Pilbara Craton. Hence, sources for all isotopic compositions preserved within the Rudall Province are present within the proximal West Australian Craton. There is no necessity to invoke transfer of exotic North Australian Craton lithotectonic units to the West Australian Craton margin and to suggest an accretionary style of orogenesis for the Rudall Province.

The Tabletop Terrane has been regarded as a different far-travelled block with crust unique to the other components of the Rudall Province. This inference was based on the resemblance of magmatism in this terrane to that in the northern Gawler and Musgrave regions. However, the similarity of source compositions throughout all three terranes of the Rudall Province implies that the Tabletop Terrane was derived from crust of similar composition to the Connaughton and Talbot terranes. A phase of crust formation at 1.9 Ga is indicated by zircons within a Talbot Terrane c. 1450 Ma monzogranite, which have mantle-like oxygen isotope ratios. This timing of crust formation is distinctive and implies an affinity to a major deep lithospheric source of similar age documented in the Musgrave Province and could indicate a regional underplate of this age. These data indicate that the major suture between the North and West Australian Cratons lies to the east of the Rudall Province (present-day coordinates).

KEYWORDS: continental accretion, crustal evolution, earth crust, hafnium isotopes, lutetium isotopes, oxygen isotopes, radiometric dating, structural evolution, zircon, zircon dating

Appendix 2
Useful resources

The following style guides related to preparing manuscripts are available on the intranet page:

- Manuscript template

- Working with styles in the manuscript template

- GSWA guide to preparing manuscripts

- Preparing graphics for manuscripts

- GSWA house style

- Spelling and other useful stuff

- Use and reporting of geochronology and isotope results — style guide

- Guide to referencing.

The following links may also be useful:

- Utah State University, Department of geology, Scientific Writing: http://geology.usu.edu/htm/staff-pages/dave-liddell/sedimentation-and-stratigraphy/scientific-writing/

- How to write an introduction: some suggestions by Sandro Etalle: http://www.win.tue.nl/~setalle/introduction.html

- How NOT to write a paper by Oded Goldreich: http://www.wisdom.weizmann.ac.il/~oded/writing.html

- How to Write a Paper in Scientific Journal Style and Format, by Greg Anderson

- http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtoc.html

- How to Write a Scientific Paper, by E. Robert Schulman: http://members.verizon.net/~vze3fs8i/air/airpaper.html.

For more information, email **publications@dmirs.wa.gov.au**.