

Fundamentals of scientific writing

Geological Data Analysis

In just about any career in geology (petroleum, environmental, USGS, NPS, academic) you will find yourself communicating the results of your analysis using written reports and journal articles. These formats are also the primary means by which you can ingest the work of other geologists. Therefore, an integral part of conducting geological data analysis is communicating that analysis using the written word. The best data analysis in the world isn't worth much if it's not communicated in a clear way. In order to improve your abilities to communicate your science, it helps to understand the specific formats in which this communication traditionally is written. While there are many specific formats that will depend on both sub-field and audience, most scientific reports have a format that is somewhat similar to a journal article. Consequently, this is the format that we are practicing throughout this course (Lab 6, Lab 7, and the term project).

1 Dissecting the journal article format

Abstract

- Very brief summary. Typically one paragraph.
- Explains the basic problem/question, why it is relevant, what was done in this study, and the primary conclusions.
- The abstract boils down the entire article into its most essential parts.

Introduction

- Sets up the problem/question(s) addressed in the report
- Briefly explains relevant background
- Explains why the problem/question is important, how it relates to prior work in the field, and how this work contributes to what is already known (What is the knowledge gap that is being filled?).
- Closes with a brief summary of what was done in the study, without any conclusions or interpretations.

Methods

- What was done.
- Enough detail that hopefully another scientist in the field could reproduce the result.
- How were data collected/selected?
- Quality control/quality assurance
- What types of models were used? How were they run (settings/parameters)?

- What statistical techniques were used (at least if they are anything beyond very standard analyses that don't require explanation to a scientific audience)?

Results

- What were the results derived from the described methods?
- Just the bare facts. **No conclusions or interpretations!**
- It's ok to say something like, "Bed 7 has the highest porosity and permeability values." However, you don't want to say something like, "Let's drill Bed 7, baby!" Or even, "Bed 7 has the best reservoir characteristics." These statements include aspects of interpretation.
- Generally, all figures that include new data or analysis should be included, and described, in the results section (as opposed to discussion).
- This is also where you would include any data tables (unless they are big, then they might go in an appendix or supplementary material).

Figures

- Selected to illustrate the key points (more about this later).
- Each figure should have a number and caption. Caption should briefly state what is in the plot, explain any use of line styles, color, etc., and often also includes some statement describing the results. For a journal article, a good goal is to write captions in such a way that an expert in the field could only look through your figures and captions and understand the main points of the paper.
- Use figure numbers to refer to figures in text. Usually, this is best done in parentheses, e.g. "Porosity and permeability display a positive correlation (Figure 3)." You can also use the figure numbers directly in a sentence, such as "Figure 3 depicts the relationship between porosity and permeability." However, the first option often gives a cleaner explanation of the results, without breaking up the line of argumentation with saying what's in a figure.
- Figures are numbered by the order in which they appear in the text. All figures should be referenced somewhere in the text.
- Make sure figures have appropriate fonts that are visible at the scale of the final paper.

Discussion

- Here is where you make your interpretations of the patterns and raw analysis results described in the results.
- Explain what you think the results mean.
- What implications do the results have more broadly?

- How do the results relate to prior work? Do the results confirm, add to, or conflict with prior studies?
- What unanswered questions do the results open up (future work)?
- What limitations or caveats that are important to interpreting the results?
- While a good results section will contain material that essentially all the readers can agree on, the discussion section contains aspects of interpretation that may be less certain. Here there is some room for disagreement, uncertainty, and hypothesizing.

Conclusions

- Succinctly summarize the conclusions of your analysis.
- What did we learn from the study?
- What are the broad implications?
- These conclusions often combine aspects of the raw facts (results) and the interpretations and implications (discussion).