What makes a good Geophysical Prospecting paper?

M.N. Luheshi & T.J. Moser

Abstract

Geophysical Prospecting welcomes and wishes to attract good quality submissions. Considering what characterises a high impact paper gives a good guide to achieving quality. High impact papers often include innovative fundamental research ideas and/or developments of existing methodologies with a clear path to address practical resource discovery and sustainable exploitation. They should also include enough information on methods and data to allow, where possible, reproduction of the reported findings. As well as these characteristics, high quality papers follow well established principles on precision, logical reasoning, conciseness, clarity and accessibility. What makes a good paper is significant innovation, presented clearly in a candid manner, highlighting both benefits and limits. Editorial policy requires that submissions have a clear purpose: what is significant about your work, why does it merit publication, which scientific innovation, new data, new insights are presented? What is the expected benefit to the community? Does the paper adhere to a high standard of openness and transparency? How does your contribution add value to geophysical prospecting?

1 Introduction

1.1 Purpose and principles

The fundamental reason for writing a paper is to communicate to technical communities new data, results and knowledge. It should be written explicitly with the needs of the ***reader*** in mind. Who will be the audience? Do you, the author, expect the paper to be read by only those interested in a specialized topic? Or is it something that would be of use for a broader community? Could your paper be useful for readers with expertise beyond Geophysical Prospecting (GP), such as global seismology or medical imaging? The message would vary depending on your assessment of the targeted readership.

Your paper presents evidence of your contribution relative to previous literature. It also helps to establish your track record and assist others to adapt your work and verify your findings using other datasets.

Scientists are attracted by innovation. There is no greater compliment than having one's work cited as a contribution that enables further research and development. High impact research papers are often characterised by novelty and clarity of presentation. Significant advances in theory and/or application presented in a lucid manner attract colleagues' attention.

Good papers have a clear storyline. A 'road map' giving an overview of the structure is critical. What is your agenda? What is the problem addressed in your paper? What is the context (geological, geophysical, theoretical …) of the work? Which solutions have been proposed before? What is your view of these solutions? How can people reproduce your findings? If you use specialist software, have you provided enough information on this to allow reproduction of your results?

What method(s) will you be presenting to make a case for your proposition? Do not hesitate explaining even basic notions, especially in the Introduction. If the topic is theoretical, then a presentation of the theory is required. If the case involves data analysis, then a description of database is needed (placed in an appendix, if extensive). What are the results from your analysis? If computer codes were used, then a description of the code is needed; whether it is "home grown", or uses other people's code commercial or open source?

Ideally an interested reader should be able to reproduce your results. It is understood that data are sometimes restricted to authorised workers; but where they can be sourced from the public domain the source should be signposted.

This is then followed by a clear discussion of what has been learnt and/or demonstrated. A good discussion can have an impact beyond the field presented and add value to a wider readership!

Finally, what do you conclude – how has your work extended the science? What are the limitations of your work? What still remains to be solved/addressed? What is your view on outstanding challenges for future research?

1.2 Categories

GP welcomes four categories of submission: Original Papers (including case histories), Research Notes, Review Papers and Letters to the Editor.

Original Papers should communicate some combination of significant new science, results, workflow or technology. They are the most common category and are generally of relevance to readers with interest in a particular topic. Under this category GP also welcomes case histories. A good case history paper should be a serious study of an area, using sound methodologies (especially if demonstrating the application of new techniques), addressing open geological/exploration questions, finding alternative models to the current knowledge and hopefully integrating the results from different geophysical methods.

Review Papers have a different purpose. These present an analysis of existing knowledge illustrating the state of the art in a subject and leading to new insights. Review Papers are of broader interest and will appeal to experts and newcomers to the topic. They will also tend to be of lasting interest and often form a starting point for others' research. A very good reference for this topic is in Moldwin et al. (2017).

Research Notes are short (4-6 pages) and usually cover a single topic or result, typically related to ongoing work. These tend to be short lived and are often of interest to a more specialised and limited readership.

Letters to the Editor are brief comments about a publication in GP (1-2 pages). They may be followed by a reply by the author of the publication. Research Notes and Letters to the Editor are paper categories meant to enliven the scientific debate.

1.3 Motivation

Readers expect a clear presentation of the motivation for your work and its intended purpose. Do you have good and new results that you want to share with colleagues? Does your submission describe significant innovation or is it just another addition to a 'stamp collection'? Why should the exploration geoscience community take note of this work? What could be the impact in terms of practical application? Can people independently validate your findings? Will it open a new research theme or develop existing ideas? Does it solve a pressing problem? Many papers in GP have a

methodology for exploration as their main topic: how does the proposed methodology improve the existing ones? Is it more accurate, more efficient, more general or a combination of these?

A frank description and assessment of how your proposal extends and develops a research topic is very important. We encourage you to be open about any limitations and to give due consideration to such questions as what difference do you feel your work will make? You should also always be clear about underlying assumptions.

1.4 Novelty/controversy

Submitted papers should contain sufficient new material, new insights, new data analyses. Do not present numerous 'variations' on the same theme. It will be better to appeal to the reader's appetite with a new recipe rather than serving a reheated dish.

GP does not shy away from controversial papers and very much welcomes submissions that are outside the 'mainstream'. Unusual perspectives are not a barrier to publication (all papers undergo the same review process). Some humility, however, is wise: you may think that you are years or even decades ahead of your peers – but you need to substantiate this. Document and prove all your statements. They must be acceptable for current reviewers and readers. Peer review is done by current state-of-the-art geophysicists. The burden of the proof is always on you.

2. Before writing

Consider writing 'as you speak'. Think about your audience. Use short, active sentences. Use simple language and avoid jargon and redundant adjectives. Be economical with the use of equations.

You should organise your thoughts and make up your mind about what you want to say. What are your key messages? What are your priorities? How are your messages and conclusions logically related?

If your paper has multiple authors, you should subdivide tasks and decide on 'leading author' and 'corresponding author'.

You should prepare your material by first making an agenda for yourself with a list of things to do and to be addressed. Collect and make sure that you read any references (and make sure that they are up to date). Save yourself the embarrassment of missing a recent publication which could put your results in an unintended perspective or even make it obsolete.

Prepare an outline of your paper. You may find it useful to use widely available templates (e.g. Authorea templates, with LaTeX and Word support, see GP website).

2.1 Language

Submissions need to be in clear simple English. There is a big distinction between detailed grammatically correct English and readability. It is too easy to write technically correct but complex sentences. This often arises when you translate a text from another language directly into English. This can result in a presentation that is 'unnatural' and inefficient, or even outright clumsy. To achieve clarity and ease of readability, it is best to write in English from the start – avoid translating from another language. Note that the primary role of reviewers is to review the science, while also checking that the text is clear and correct.

Native English speakers should beware of using oversophisticated language. "International" English will be more understandable to GP's multi-national readership and will make your paper more likely to be acceptable.

2.3 Title

It is important to use an "attractive" title. This gives an immediate impression to readers and is the first point of access to your paper. The title should be an invitation to read the paper It signals the content of the paper and together with a good abstract, can encourage readers to engage with your paper. It should succinctly cover the contents and the message of the paper. Try to avoid using slogans or overselling the message.

2.3 Abstract

Write a good abstract. Landes (1966) offers a good classical guideline for writing abstracts - (http://sepwww.stanford.edu/sep/prof/abscrut.html)

"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, replete with such expressions as 'is discussed' and 'is described.' It should be a condensation and concentration of the essential qualities of the paper. "

Your abstract should be brief and contain the following key pieces of information while being succinct and clear.

- A statement of aims, key questions or hypotheses.
- A rationale that explains the importance of the questions being asked (that is broad, not focused on a particular study area).
- Brief coverage of the methods and analyses, the main results and important interpretations or inferences that are made.
- An explanation of why your findings are important.
- A clear statement of what makes your work is novel or significant.

A good title and abstract will often decide whether your paper is read at all. Give this careful consideration before writing the body of the paper. The abstract should be a mini-paper by itself and should not contain references.

2.4 Introduction

Claerbout (1991) gives some very good advice about introducing your subject. He states that the Introduction comprises three parts:

- 'The Review - Summarises relevant literature giving context to your research; and shows where existing knowledge ends.
- The Claim (most important!) - Briefly states the original contribution brought by your paper and how it connects to prior knowledge in The Review and extends it.
- The Agenda - Outlines the structure of the rest of the paper and shows how it works to support The Claim'

3. When writing — Style guide

You should consider that different readers will approach your paper in diverse ways. The paper may be laid out in a formalised structured way, but some readers will sample it in ways that suits their personal approach (e.g., read the abstract and then skim the figures, …). Figures, especially, can

quickly give the gist of a story and so deserve extra attention. Once interest is engaged, such readers will then follow up and address the details as needed.

There are numerous formal 'style guides' available. These often fall into the category of descriptions of layout and linguistic criteria (what a journal does or does not allow). These considerations are important, of course. Equally important though is clarity of communication – what are you trying to say? The communication aspect of style can get lost in the formal structural and grammatical considerations.

A research paper is first and foremost about communicating scientific ideas in a *precise*, *concise*, *clear* and *accessible* way . These four characteristics are core to the primary objective of writing a good paper.

3.1 Precision

Geophysics is a quantitative science. As geophysicists, we follow well-established and rigorous scientific methods. We observe, we propose hypotheses, we make and test predictions. We make quantitative measurements and draw inferences from the data, and try to validate our hypotheses (theories).

In common with all branches of science we routinely manage uncertainties and invoke assumptions. Complexity is ever present. Never hide the details and always be open. Assumptions should be explicit. Avoid mystifying and puzzling the reader. Say what you did and provide information so that others can verify your results.

Setting the scene and describing your work requires a high degree of precision – this is imperative. Avoid sloppy writing; this is often an indication of poor thinking!

3.2 Conciseness

Be succinct. Nobody likes reading long complicated sentences or repetitions. These should be avoided. Mastery is only revealed in its limitation (J.W. von Goethe) - in plain English: less is more. Research papers are for presenting precise scientific ideas. They are not literary novels.

You should also avoid digressing away from your main topic. Keep to your main theme.

3.3 Clarity

Stick to your 'storyline'. You have presented a workflow and this is the reader's guide for how your story will unfold. Short sentences using simple language work best. A brilliant paper is often a reflection of deep experience and rich expertise, which are to be welcomed. However, there is no need to demonstrate erudition. It is wise to avoid pedantry. Avoid adopting a profound or 'authoritative' tone. A balance needs to be drawn between informing and impressing ("Inform rather than impress" - Sven Treitel)!

Ambiguity is the enemy of clarity. It works in novels but not in science. It must be avoided. Make sure that the meaning of every statement in the paper is unambiguously clear. Reviewers often puzzle about 'what do they mean'? This a common reason for rejecting a manuscript.

Do not hold back inconvenient material; this is not collegial and verging on the unethical. Equally, do not hold back information for personal strategic reasons. For example, where code is used, you must declare this and state whether this is accessible to others.

It is common for scientists to use jargon. Although a useful shorthand for fellow experts, jargon is a barrier to the wider community. Equally abbreviations and acronyms can distract readers and

discourage them from persevering. Uncommon abbreviations are not likely to stick in readers' minds: instead, they add unneeded burden to readers' efforts to understand complex concepts. Where an expert community uses a well-known and recognised short hand (e.g., "names" for algorithms), then these can be accommodated

3.4 Accessibility

If a paper is not accessible to your audience, it has basically failed in achieving its primary goal. A common observation is the excessive use of numerous complex mathematical equations. Short, concise, summary maths has its place in good papers. Keep the notation simple in line with established literature, consult mathematics text books for notation if needed. Equations are often an efficient way of communicating analyses. However, excessive inclusion of lengthy derivations in the main body of a paper is likely to be counterproductive and a barrier to accessibility. Only the most dedicated experts will engage with such a paper. The consequence is that a possibly valuable contribution will be ignored by much of your audience. Best practice is to use appendices for lengthy mathematics. It is preferable to make sure that your paper can be followed without needing a detailed understanding of the mathematics. Clearly, this does not apply to cases where the derivation of the mathematical relation(s) is the central purpose of the paper.

Make sure all terminologies are reasonably defined or referenced. The objective of the publication should be to reach a wider audience than just the closest colleagues in the field. Abuse of abbreviations is usually a sign of weakness and inconsiderate to the reader. GP has a strict policy against abbreviations: they are not allowed in the abstract or in section headers; must be kept to a minimum in the main text and must be defined at the first occurrence in each major section.

Another important consideration is 'visual style'. Long sentences and long paragraphs can be a barrier. Large blocks of text can put off readers. In some ways adopting a journalistic approach is preferable. Ideas can still be presented clearly without raising a 'visual' barrier.

Applying these four characteristics – precision, conciseness, clarity, accessibility - will greatly improve the chance that your paper will communicate your ideas efficiently and effectively. Potential readers have access to large volumes of diverse sources of information and your paper needs to compete for their attention. Make it easy for them.

4. Before submitting

4.1 Layout

The following is a useful checklist– adherence to this will result in a draft that is in 'good shape'. The list is frequently ignored and often leads to delays in review and in production.

- Ensure compliance with the GP checklist (see the GP home page).
- Consult with colleagues and integrate any feedback. This is an absolute 'must do' – do not expect reviewers to fix any issues with your paper. Integrating your colleagues' feedback before submission will shorten the review process.
- Ask a fluent English speaker to read and check your proof. This is a necessary step for papers written by authors who are not fluent in English.
- Responsibility for writing a good paper in high quality English rests with the author(s).
- Avoid use of the passive case (e.g. 'their car was broken into', better to use 'someone broke into their car')
- Equations – must be concise, summarizing and clarifying rather than confusing. A compact equation could say much more than a long paragraph of text. Equations are part of a

grammatical sentence and should be punctuated accordingly. Abbreviate frequently occurring expressions. All equations should be numbered, for reference within or outside the paper. Make sure mathematics is correct (incorrect maths is fatal). Avoid repeated expressions (abbreviate them by introducing new variables). Make sure that the same font is used for inline mathematical expressions and displayed equations. Pay extra attention to the typesetting of vector algebra – submissions often suffer from inaccurate algebra typesetting: scalars are in italics, vectors are bold and in lower case and matrices are bold in upper case.

- Figures – should be readable, effective with no overcrowding of unnecessary details. Explain all displayed details/data. Always make sure the scale of displayed details is clear; add labels, physical units and ranges (alternatively scale bars in maps/sections). Ensure that you use high resolution images. Make sure physical units (preferably expressed in International Standard units) are the same as in the body of the paper. Add figure captions. Make sure the 'information density' of your figures is uniform. Avoid congestion of detail without excessive use of empty spaces. Where useful, use logarithmic scale. If you need to show additional detail, this is best done with a 'zoomed' insert in your figure.
- Tables – use to summarize numerical data. Consider whether data are better presented in figure form. Some ideas/explanations are better presented as illustrations (sketches and diagrams can be a very powerful tool for presenting complex thoughts).
- Algorithms – use to summarize the proposed methodology in pseudo code. Keep notation close to the mathematics and use well-established program structures (e.g. For… While). Use line numbers and refer to these in the text when explaining the Algorithm. Number Algorithms like Figures and refer to them in the text accordingly. Clear state what the input and output is and name the algorithm when appropriate.
- Sections and subsections – organize the material in major sections with lower level subsections as appropriate. Section numbering (as in this paper) is not mandatory, but it is recommended.
- References – make sure these are up to date and all references in the reference list are quoted in the text and vice versa. The choice to add or leave out references cannot be informed by commercial or legal arguments. It has to be based on scientific merit and relevance to your manuscript.
- References to software. When external codes are used (commercial or open source) refer to these.
- Do not submit a paper expecting that the editors will fix any problem or will rewrite the paper. Papers with significant weaknesses are likely to be rejected without review.

The above list is in the form of bullet points – it is a check list. Bullet points are a useful way of listing a number of items and will make it easier for a reader to recognise differences between the listed items. As a rule, the items in a bullet list can be listed interchangeably in any order. You should, however, take care with inappropriate use of bullet points, for instance when trying to make an argument or present an analysis. When the points you want to make follow one from another it is better to present them in a normal running text, using connective words highlighting the logical flow, such as 'but', 'and', 'so', 'because', 'or', 'either', 'instead', 'therefore' and so on.

4.2 What to avoid

Any original, well-organised and well-written manuscript reporting new and interesting results will always be reviewed with consideration. Usually, the reviewers and editors will provide feedback so

that the paper can be improved. GP almost never accepts a paper without at least one minor revision.

Common reasons for rejection of a paper by GP include:

- lack of novelty, plagiarism (an obvious point, but critical) and commercialism.
- Incremental research, a minor development to methodology or application
- topics that are out of scope,
- poor organization/sloppy writing,
- repeated major revisions (GP generally accommodates only a single major revision)
- and ignoring feedback by reviewers and editors.

You must avoid duplicating material from other papers, whether published by other authors or by yourself – avoid (self-)plagiarism. Also ensure that any references are accessible; i.e., published in English and can be easily sourced by readers.

4.3 Addressing feedback reviewers and editors

Make sure that you address all comments and feedback one-by-one in the form of a reply-to-the-reviewers. When you agree with the comments, implement these in the revised paper. When you differ with the reviewers, explain and document why you think you are right and your argument and analysis should prevail. Revise your paper accordingly. In most cases, when the reviewers did not completely follow your arguments, readers will have similar problems.

Note that reviewers and editors are volunteers. It can be frustrating for them if their comments are ignored. Substantial discounting of reviewers' comments is likely to lead to rejection of your paper. Further, when responding to comments, always use a respectful, professional tone and avoid personal engagements in your response letter! We highly recommend to our reviewers to do the same and provide constructive but also critical comments. It is a "peer-to-peer" review process. There is no higher scientific authority than colleagues in your field of expertise.

4.4 Data and software

Wherever possible you should make available data and software used in your paper. It is a requirement that peers can reproduce results your using measured data and comparable software that . If you use computer software developed by others, you need to declare what code has been used and whether it is publicly available. The same applies to datasets.. When using open source code, make sure you include proper attribution.

It is recognised that this is not always feasible for reasons of confidentiality and/or commerciality. In such instances authors should provide sufficient information to allow others to replicate their findings using alternative codes and analogue data sets.

Conclusions

The above is a guide to writing a good paper. Detailed formal 'Author Guidelines' for submitting papers to the journal can be found at Geophysical Prospecting (https://onlinelibrary.wiley.com/page/journal/13652478/homepage/forauthors.html). A paper submitted to GP also needs to comply with these formal publication guidelines.

We urge you to approach this advice in the spirit that it is intended. The advice is aimed at encouraging and facilitating the writing of high quality papers. The intent is to guide you to best practice for writing a paper that is more likely to achieve a high impact. This advice is intended to make it easier for you to present your ideas in a coherent and engaging way.

Good new ideas introduced with a good abstract and presented in a clear way, will always be welcome in GP. We hope these guidelines help you present your thoughts in a rigorous, attractive and accessible way.

References

Claerbout J.F. 1991. A scrutiny of the introduction, The Leading Edge 10: 39-41.

https://doi.org/10.1190/1.1436777http://sepwww.stanford.edu/sep/prof/Intro.html.)

Landes K. K. 1966. Scrutiny of the abstract, II, Bulletin of the American Association of Petroleum Geologists, 50, 1992.

Moldwin, M. B., Florindo, F., Okin, G., Robock, A., Rohling, E. J., Cardenas, B., Painter, T. H. (2017). Why and how to write a high-impact review paper: Lessons from eight years of editorial board service to Reviews of Geophysics. Reviews of Geophysics, 55, 860–863. https://doi.org/10.1002/2017RG000587