"In real and important ways, the structure of the prose [is] the structure of the scientific argument. Improving either one will improve the other."

1. Start a unit of discourse should generally define the topic of discussion. Thus, in a paragraph, the first sentence should usually be the topic sentence; in a sentence, the subject should usually be up front.

2. The start of a unit of discourse should generally also provide "linkage" and "context"—linkage connecting the topic of discussion to what has come previously, context relating it to what is to come.

3. The last part of a unit of discourse should generally contain and emphasize the most important observations or arguments.

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A Writing Guide for Petrological (and Other Geological) Manuscripts

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'The journey is one of choices, judgement, of logic—if... then... and also... if not... therefore, the small words that have little use alone become instruments of power.'

Janet Frame (1988), The Carpathians

ABSTRACT

Many of the manuscripts received by the Journal of Petrology are not well written, and the problem is of concern with respect to (a) obtaining prompt, thorough, balanced evaluations of the scientific content, (b) the imposition on reviewers, (c) the time and effort that editors have to spend improving the writing, and (d) the frustrations that the authors themselves undoubtedly experience. The manuscripts are generally long (typically 30–40 pages of typescript plus diagrams), but if they are scientifically acceptable and well written—and if the timing is right for everyone concerned—they can go through the review process in a couple of months. By contrast, poorly written manuscripts stand a large chance of being rejected outright, even though their scientific content may be fundamentally sound and interesting; and if they are accepted, several revisions are sometimes required, a process that can all too easily stretch into a second year. The skill of writing is obviously worth cultivating.

Ideally, a manuscript should embody a smooth, accurate, clear and concise, logical flow of information and ideas, free of ambiguity and with the only repetition being that necessary for emphasis or clarity. The problems associated with preparing manuscripts for publications such as the Journal of Petrology divide broadly into two categories. One comprises a multitude of relatively minor points—some grammatical, some relating to the subject, some pertaining to the format of the journal itself. In principle, these problems should not be difficult, at least for authors with English as a first (or strong) language. Awareness and care are the main ways to avoid them. The problems of the other category are difficult. Principal among them are (1) awkward, words, ambiguous, unclear, and inaccurate sentences; (2) lack of coherence and unity, most commonly in paragraphs, but frequently also in larger sections of the text; and (3) repetitious, unfocussed, and unnecessarily detailed descriptions and discussions. These problems are essentially matters of logic, and they concern the ability to manipulate words so that observations and thoughts are described clearly and in sensible order, and arguments are developed in reasonable ways. This ability involves verbal techniques and vocabulary that are, for most of us, acquired only through long-term experiences of effective teaching, extensive reading, much practice in writing, and constructive self-criticism.

In this guide, we make recommendations on several dozen matters in the first category. The problems of the second category cannot be resolved by any general recommendations, because their detailed characteristics tend to be idiosyncratic to the author and the subject material. The best overall, short-term solution we can suggest is that authors (especially those with limited experience) try, as much as is practicable, to write their first drafts in the simplest of sentences. Then, after the sentences
The focus of the text is unclear. It seems to be discussing some form of writing or communication, but the context is not provided.

RECOMMENDATIONS ON WRITING PROBLEMS

A WRITING GUIDE

INTRODUCTION
In any case, third-person constructions frequently require the passive voice, hence they often instead of the active-voice form. For example, you might want to say, "The book was read," which is passive. In this case, the person who read the book is not known or is not important. However, if you want to say, "John read the book," the active voice is more appropriate.

In the context of writing, it is important to consider the passive voice and its potential impact on the clarity and effectiveness of your communication. The choice between active and passive voice depends on the intended effect and the information being conveyed. The passive voice can be useful in avoiding attribution or in situations where the agent of an action is unknown or unimportant. However, overuse of the passive voice can make text less direct and less engaging. Therefore, it's essential to strike a balance and choose the voice that best serves your purpose.

In the example given, the first-person active voice is used to convey a direct and personal experience. The second example demonstrates the use of the passive voice, which is often used in formal writing to maintain a more objective tone.

In conclusion, while the passive voice offers flexibility and neutrality, it is crucial to use it judiciously to maintain clarity and effectiveness in writing.
7. 'This', 'that', 'these', and 'those' without an antecedent

These words, called demonstrative pronouns, are useful for maintaining continuity of thought between sentences. In the ways they are used by scientists, however, their reference is frequently uncertain or ambiguous. To avoid this problem, add a noun that will identify the reference (thereby changing the pronoun to a demonstrative adjective):

This result is satisfactory.
These observations are important to the argument.
An exception in which the reference is clear is:
That is not a satisfactory result.

Try, though, not to use demonstrative pronouns and adjectives too frequently. They soon become monotonous.

8. 'That' vs. 'which' (restrictive vs. nonrestrictive clauses)

Use 'that' for restrictive clauses, 'which' for nonrestrictive clauses, as in the examples to follow (note the punctuation):
The house that Jack built stands on a hill.
Jack's house, which was made of wood, collapsed in the earthquake.
The parts that had failed were discarded.
The replacement parts, which were expensive, were put into use.

Note that the 'that clauses' are critical to identifying the subject, whereas the 'which clauses' provide additional, possibly important, but less definitive information. The common error is to use 'which' where 'that' is appropriate, so do a 'which hunt' on your manuscript.

Also note that, like participles, 'that' and 'which' can both modify the wrong thing:

Incorrect: The parts of the apparatus that had failed were disposed.
Correct: The parts that had failed in the apparatus were disposed.

And remember too, they are supposed to modify specific nouns, not some implicit concept or general clause or phrase:

Incorrect: The ash bed is paler pink, which indicates a lesser degree of oxidation. (Here as in section 3, pink is a predicate adjective, not a noun, and because the 'which' cannot sensibly modify 'ash bed,' we conclude that it is being forced incorrectly to cover the thought embodied in the entire preceding independent clause. See section 3 for correct versions of this sentence.)

To use 'which' where 'that' is recommended obviously is not going to cause your manuscript to be rejected. In fact, many people would even argue that the rules given here are outdated. The value of the rules, however, is that, if you can understand and follow them, then not only will your writing be more consistent, but in a small way also, you will understand more about why you are saying what you are saying.

9. Hyphens

Use hyphens in most two-word unit modifiers. For example:
low-pressure conditions (as opposed to 'conditions of low pressure'); 1-cm thickness;
1-atm pressure; self-perpetuating process; mid-Atlantic Ridge.

Exceptions are made for comparatives, superlatives, and '... ly' words:
the less altered sample; the best preserved example; an unusually swift stream.

In most other cases, British and American conventions differ. By American practice, the use of hyphens is minimal, so there are many words like 'overdue' (which we use in this guide),

'downwelling', and 'sheetlike', but relatively few like 'all-like' where the spelling necessitates hyphenation. Words with the prefixes 'pre-', 'syn-', and 'post-' are not usually hyphenated, nor are those with prefix 'post-':
premetamorphic, syntectonic, postmagmatic, nonideal, nonrestrictive.

By British practice, however, most such compounded words are hyphenated. Journal of Petrology is published in Britain, but it accepts either British or American conventions on this matter (just be consistent).

10. Commas, semicolons, colons, and dashes

Commas: Some people write successfully (smoothly) with only a few commas, but most of us need them to keep things sorted out. Having too many yields choppy sentences. All grammar books and many dictionaries contain long lists of uses and examples—and this guide itself amply demonstrates our own preferences and practice. Our only specific comment pertains to lists in which three or more items are separated by commas and the last item (and sometimes more than the last) is preceded by 'and'. We have been encouraged by a couple of publishers (Carnegie Institution of Washington, and Princeton University Press) to put a comma before the 'and', a practice that is not common but that is certainly helpful on occasion.

The rock contains about 60% quartz, 25% albite and orthoclase combined, 10% biotite, and 5% muscovite, plus traces of garnet, magnetite, and sparsite.

Semicolons: As shown by the sentence you are now reading, semicolons can be used in place of conjunctions for tying together closely related independent clauses; they can be used in complicated lists, particularly those in which some items contain commas; and they should precede the 'and' at the start of the last item in such lists.

Colons: As shown to the left, colons can set off subheadings, or they can provide a break before a list. They can also precede the citing of an example: e.g., as here.

Dashes: An abrupt change or suspension of thought—as in this example—can be separated out by dashes—as can afterthoughts. Dashes can also be used before examples like colons—e.g., as here; and before lists, also as here, where they seem to keep the sentence flowing rather than bringing it to a stop like a colon.

We might emphasize here that, although punctuation such as the above outlines the structure of sentences and makes them easier to follow, it rarely in itself corrects awkward, ambiguous or unclear sentences. They generally represent problems of wording, and to avoid them essentially requires an understanding of—or, at the least, a sensitivity to—the functions of clauses and phrases (see Appendix 2 and sections 57–60).

11. Transition words, terms, and techniques

The English language has many words and terms that are not conjuctions but serve, nevertheless, to bridge and smooth the gaps or changes or thought within and between sentences and between paragraphs. It is important to learn to use them if you want your writing to flow and your line of thought to be clear—but do not overuse them. Principal transition words are:

accordingly, again, also, although, apparently, conceptually, consequently, conversely, eventually, evidently, doubtless, finally, first (second, third), furthermore, hence, however, indeed, inevitably, later, meanwhile, moreover, namely, nevertheless, next, nonetheless, now, otherwise, overall, perhaps, possibly, surprisingly, specifically, still, subsequently, then, therefore, though, thus, too, yet.
15. 'Compliment' vs. 'compliment'
The first completes; the second is an expression of admiration.

16. 'Comprise'
'Comprise' is a verb that seems to appeal strongly to geologists, probably because it is an alternative to the much used 'compose'. More often than not, though, it is not used correctly, and even when it is used according to commonly cited rules, it sometimes does not sound right. Its proper relationship to 'compose' is popularly described as follows:

The parts compose the whole. The whole comprises the parts.

If we change voice and turn these sentences around, we obtain:

The whole is composed of the parts. The parts are comprised in the whole.

It is incorrect to say 'comprised of'.

The matter of 'sounding right' is most peculiar. For example, for some reason, this sentence to us seems wrong:

A rock comprises minerals.

A possible explanation is suggested by the relationship of 'comprise' and 'include':

A 'whole' comprises all parts but includes only certain parts.

Thus, in stratigraphy:

A group may comprise several thick carbonate formations and include a few thin sand beds.

Accordingly, the above sentence that does not sound right may be faulty in that it does not define a 'whole', whereas the following sentence seems alright because it does:

The rock comprises five main minerals.

(The use of the definite article probably also helps.) But remember, the 'whole' is entirely a definition of the moment. In the next sentence, for example, it comprises only 50 of every 100 parts:

Plagioclase comprises 50 per cent of the gabбро.

17. Correlative conjunctions: 'both ... and', 'either ... or', ...

Correlative conjunctions ('both ... and', 'either ... or', 'neither ... nor', 'if ... then', 'not only ... but also') should be followed directly by the same grammatical form—a verb for a verb, an adjective for an adjective, a prepositional phrase for a prepositional phrase—whatever:

Incorrect: Either the magma was too cool or too rich in silica to be fluid.
Correct: The magma was either too cool or too rich in silica to be fluid.

A principal problem resulting from misuse is ambiguity:

Ambiguous: The layers both became thicker and coarser grained with stratigraphic height.
Possibility 1: Both layers became thicker and coarser grained with stratigraphic height.
Possibility 2: The layers became both thicker and coarser grained with stratigraphic height.

18. 'Criteria, criterion'

Criteria are ... criterion is ... data are ... datum is ... phenomena are ... phenomenon is ... spectra are ... spectrum is ... ; strata are ... stratum is ... ; tetrahedron is ... tetrahedrons are ...

19. 'Due to', 'owing to', 'because of'

'Due to' is adjectival, whereas, 'owing to' is adverbial, but because they have similar connotations, they are often used incorrectly for each other. Whichever is right, though, it commonly happens that a better sentence can be produced by substituting 'because of', so we recommend that you examine that possibility:

Incorrect: Due to bad weather, the trip was cancelled. (Here, 'due to' incorrectly modifies the verb 'cancelled'.)

Correct: Owing to bad weather, the trip was cancelled. ('Owing to' correctly modifies 'was cancelled').

Better: Because of bad weather, the trip was cancelled.

Correct: The eruption was due to excessive gas pressure. (Here, the phrase, 'due to ... pressure', is a predicate adjective correctly attached to 'the eruption' by the linking verb 'was').

Better: The eruption occurred because of excessive gas pressure.

Correct: The eruption stopped owing to depletion of the water content of the magma. (Here, 'owing to' correctly modifies 'stopped').

Better: The eruption stopped because of depletion of the water content of the magma.

20. 'Extremely' vs. 'relatively'

Something described as 'extremely' should be at some limit (highest, lowest, most, least, ...). What authors usually mean is 'relatively'—e.g., in terms of an implied comparison with some overall population.

21. 'If' vs. 'whether'

'If' applies for one condition (possibly compound); 'whether' is used when two alternatives are involved (one of which may only be implied).

If we are late and it is raining, then go on by yourself.

They tried to determine whether or not the map is accurate.

22. 'Important', 'interesting', 'reasonable', 'significant'

Things are 'important' only in some context; 'interesting', 'reasonable', or 'significant' only for some reason. Be specific: explain the context; give the reason(s).

Significant' has both common, qualitative uses and specialized, statistical applications. Be careful not to confuse them; the specialized use requires a rigorous statistical test.

23. 'Infer' vs. 'imply', 'evidently' vs. 'apparently'

Infer' means 'deduce by reasoning'. 'Imply' means 'to express indirectly'.

We see smoke; we infer fire.

His silence implied consent.

The common error is to use 'infer' when 'imply' is required.

The use of 'evidently' implies that what is being said is supported directly by some observation. By contrast, 'apparently' implies that the support arises indirectly by way of some deduction or inference based on one or more observations. In both cases, the observations should be made clear.

24. 'It's' vs. 'its'

'It's' indicates possession, as in 'its color'. 'It's' is colloquial for 'it is'.

25. 'Presently' vs. 'currently'

The anomaly is that 'presently' means 'in the near future'.

We are currently (now) doing this; we will presently (soon) do that.

26. 'Principal' vs. 'principle'

'Principal' means 'of highest rank' or 'foremost'. A 'principle' is a fundamental truth.
Note: By the above definitions, $K_p$ has the same numerical values whether the element concentrations are in mol/l, cation % or wt. %, whereas $D$ values depend on the concentration units if the phases do not have the same stoichiometry. A recent, but now deeply ingrained misfortune of petrology is ‘$Mg$-number’. It is inconsistently defined as either $Mg/(Mg+Fe)$ or $100Mg/(Mg+Fe)$, and it is variously, awkwardly, and inadequately denoted as $Mg\%$, $mg\%$, $mg\%, or$ $Mg\%$. If fact, the quantity is not a ‘number’ at all; it is a ‘proportion’. Our experience is that, handy as the ‘moniker’ may be in conversation, if one is careful in writing to avoid undue repetition, it is better to use the ratio itself. For thermodynamic treatments, we recommend:

$$X_{Mg} = Mg/(Mg+Fe)$$

with the oxidation state of $Fe$ being defined according to the circumstances (and the phase by a superscript if it is important).

In references to multiple values of $K_p$ or $X_{Mg}$ use ‘$K_p$ values’ or ‘$X_{Mg}$ values’—not ‘$K_p$’ or ‘$X_{Mg}$’. By common journal practice, abbreviations are seldom pluralized (see section 69).

35. ‘Electron microprobe’, ‘powder X-ray diffraction’

Use ‘electron microprobe’—not ‘electron probe’ or ‘probe’.

Use ‘powder X-ray diffraction’—not ‘X-ray powder diffraction’.

36. ‘Enriched, depleted’ vs. ‘richer, poorer’

Geochemists have popularized the terms ‘enriched’ and ‘depleted’ through frequent comparisons of the concentrations of elements and isotopes in rocks with their abundances in various (inevitably abstract) estimates of the average composition of the Earth. ‘Enriched’ and ‘depleted’ have many legitimate uses in petrology—for example, in studies of igneous differentiation (where the comparison may be with the inferred original magma composition or between rocks of an apparent genetic series) and in discussions of metasomatism (where the standard is usually an apparently original or less altered composition of the same rock formation). By virtue of their popularity, however, the words are frequently misused, almost to the point that the problem is a plague! In most cases, the appropriate words are merely ‘richer’ or ‘poorer’, or ‘higher’ or ‘lower’. Commonly, for example, the authors are simply comparing two rocks, and in the absence of independent evidence that they do not have, it is impossible to say whether the rock that is richer in the constituent in question is ‘enriched’ or whether the one that is poorer is ‘depleted’. Often too, there is confusion as to whether the constituent is enriched or depleted in the rock, or the rock is enriched or depleted in the constituent. And in extreme cases, the misapplications can be ludicrous. A basaltic magma will be described as enriched or depleted when the intended application is to the mantle source area of the magma. A mantle peridotite will be said to be enriched without saying in what it is enriched or by what standard of comparison. (In one case, it seemed that the peridotite was enriched in dikes.) Or an olivine cumulate will be described as being less depleted in the highly olivine-compatible element Ni than in its parental basaltic magma. We have also heard of a rock with a high value of $^{13}C$/$^{12}C$ but a low absolute content of $^{13}C$ being described as ‘enriched in $^{12}C$’ (the per mille difference of the isotopic ratio from that of a standard).

So remember, ‘enrichment’ and ‘depletion’ are processes, and if you are tempted to use ‘enriched’ or ‘depleted’, ask yourself what process is implied and whether the word is appropriate and justified in that context. And if you use the words, be sure to say what is enriched or depleted, that it is something that can be enriched or depleted, and that you identify the standard of comparison.

37. ‘Include’ vs. ‘contain’

In petrology, the word ‘include’ has special meanings: plastos include xenoliths; minerals include other minerals and fluid inclusions. Try, therefore, to avoid the common, everyday use of the word, because they can lead to ambiguities or wrong impressions.

Poor: The platon is mostly granodiorite but includes gabro, diorite, and granite.

Better: The platon is mostly granodiorite but embodies substantial units of gabro, diorite, and granite.

Bed: Primary minerals include quartz, feldspar, and biotite. (Ambiguous.)

Good: The primary minerals are quartz, feldspar, and biotite.

38. ‘Geologic’ vs. ‘geological’; ‘petrologic’ vs. ‘petrological’

There does not seem to be any modern rule for choosing between these terms. We have followed an early US Geological Survey practice whereby natural relationships end with ‘ic’, and human works with ‘al’ (see Anonymous, 1958, p. 159). Thus, we have ‘petrologic features’ and ‘geological map’. We are told that the ‘al’ endings are preferred in British English.

39. ‘Horizon’ vs. ‘unit’, ‘bed’, ‘layer’, or ‘zone’

A ‘horizon’ has no thickness. In geological applications, it is a plane or surface, such as a contact, or a bedding or layering plane. Usually the appropriate word is ‘unit’, ‘bed’, ‘layer’, or ‘zone’.

40. ‘Intrusion’ vs. ‘intrusive’; ‘volcanic’ vs. ‘volcanics’

‘Intrusion’ is a noun—as in ‘layered intrusion’; ‘intrusive’ is an adjective—as in ‘intrusive contact’. ‘Volcanic’ is also an adjective. Some government surveys accept ‘volcanic’ as a noun, as in ‘volcanics and sediments’, but in point of fact, most of the ‘sediments’ that geochemists write about are actually ‘sedimentary rocks’, so why not be rigorous and also write about ‘volcanic rocks’.

41. ‘Lithology’, ‘chemistry’, ‘geochemistry’

‘Lithology’ is essentially synonymous with ‘petrography’. Different rock types or units should not be called ‘lithologies’. They can, however, be called ‘lithologic units’. ‘Chemistry’ and ‘geochemistry’ are disciplines. Authors often entitle a section of their manuscript ‘Whole-rock Chemistry’ when they mean ‘Whole-Rock Chemical Compositions’—or, ‘Whole-Rock Major(Trace)-Element Relations(Variations)’. As a discipline, geochemistry encompasses isotopic as well as chemical relationships. Often manuscripts have one section called ‘Geochemistry’, devoted entirely to whole-rock chemical variations, and another entitled ‘Isotopic Relations’.

42. ‘Most Fe-rich’, ‘least Fe-rich’

Try to avoid terms of this type. The ‘most Fe-rich rock’ presumably is ‘the rock richest in Fe’, and the ‘most Mg-rich rock’ should be ‘the most magnesium’. But the ‘least Fe-rich rock’ carries a hint of ambiguity. Is it the same as the ‘most Fe-poor rock’? We think that both would be better described as ‘the rock poorest in Fe—if that is what is really meant’. But often authors are actually referring to ratios such as Fe/Mg or Fe/(Fe+Mg), in which case ‘the most Fe-rich rock’ might have the highest Fe/Mg but be relatively low in Fe itself. If you mean percentage content of Fe or Mg, be sure your intention is clear. If you mean a ratio, say so.
A writing guide

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A WITNESS GUIDE

1. EARING AND DOGUA NURSE II

25. Interagency Medical Transfer protocol

The program and method process
the sentences with appropriate conjunctions and transition terms, by compounding predicates, and by substituting pronouns for nouns; and the presentation can be shortened and focused by subordination. This approach is illustrated in section 60, where it is used together with techniques of paragraph construction described in section 59.

58. Basic requirements: vocabulary and the skill to use it; care, constructive self-criticism

Chances are, you do not realize how large your vocabulary is. We all understand many more words than we ever speak, and we all speak many more than we ever use in writing. Developing an active vocabulary requires an interest in words and their meanings and connotations, and in the variety of ways in which they can be used. So be alert for applications that might be useful to you. A thesaurus attached to your word processor is a handy utility, but for developing sensitivity to words, there is no substitute for extensive reading of well-written material—from any field.

Being too careful can be a fault, but it is not common in writing. An extra round of revisions never seems to hurt. Constructive criticism of one's own work requires the right attitude as well as a knowledge of what is good and bad in writing practice. If someone tells you that your writing is deficient, don't take offense; they're probably right. What is important is to learn to recognize the deficiencies yourself. Scientists rarely become outstanding writers, because their subject material is too limiting, and they do not get enough practice. A good test of your skill is to read occasionally some text that you wrote just a few months previously. If you are like us, you will often be impressed by how opaque it seems now.

59. Paragraph construction

In principle, the major problems enumerated above are matters of logic in practice, they are problems of composition. Paragraph construction is arguably the most important single aspect of composition. If you can produce a good paragraph—and, perhaps more importantly, if you can recognize whether you have one—then you are well on your way. Production of a whole manuscript is essentially an extension of the same techniques and logic.

Variegates vary enormously in character, however, so the logic is not simple, and any explanations that we can offer are not likely to make you adept at constructing them. Good writers seem to define and organize elegant paragraphs almost instinctively; poor writers fumble with even the simplest.

The one construction rule that is always cited is that a paragraph should support or develop a single idea defined by a topic sentence. In most cases, the topic sentence is the first sentence, and commonly the text develops from it by progressing from the general to the specific, ideally with all sentences keeping to the topic by way of their sequencing and transition words and through references to key words or phrases in the topic sentence. The pattern is enormously variable, though. (Writing is boring when it is not.) The topic sentence sometimes does not appear until the middle, or even the end of the paragraph, and other methods of development are frequently used.

Probably the most common paragraph construction problems are lack of coherence and unity—the line of thought is disjointed, the text rambling, things just don't hang together. In some cases, particular sentences belong in another paragraph, in others, the sentence sequencing is inappropriate, and shuffling is needed. Often the problem is a matter of maintaining continuity of thought by way of appropriate conjunctions, transition words, or key words or phrases, or by continuing the same verb tense. Hypothetical examples of these problems are invariably lengthy, however, and they always seem a little silly, so they are not illustrated.

One book on technical writing (Reisman, 1962) lists seven ways to develop paragraphs from topic sentences: description, argumentation, enumeration, comparison and contrast, details in sequence, definition, and example. It is difficult to judge whether this classification is realistic or complete, but certainly if it is, some of the ways must have many variations. However, on the premise that any guidelines are better than nothing, we give some partial examples below. The first sentence in each case is the topic sentence; key words are italicized; and transition words are prominent. In (1), (4), and (7), the topic sentence defines the general situation; the ensuing text gives specific information. In (1), modal abundances and grain sizes are described in parallel for the different minerals.

(1) Description

The gabber is melanocratic and coarse grained with strong planar lamination. Typically it contains 40-45 modal % Augite, 15-20% hypersthene, about 10% titanomagnetite, and only 20-25% plagioclase. Olivine occurs sporadically, locally amounting to 5-10%. The grain size of the pyroxenes is generally 1-2 cm. The magnetite is mostly aggregated in irregular clots, about a centimeter across, and the plagioclase occurs as subhedral laths, commonly 2-3 cm in length. By comparison, the olivine grains are small (1-5 mm), and they commonly have irregular shapes because of recrystallization. The lamination is mainly defined by the plagioclase laths, but the pyroxene crystals also show some parallel alignment...

(2) Argumentation

This interpretation leads to similar problems. The rock does not contain enough iron; it is too rich in...and too poor in... Furthermore, it... And there are...

(3) Enumeration

The metamorphism occurred in three stages. In the first... In the second stage... And in the third stage... (If you announce a specific number of points as here, be sure that they are all readily identifiable.)

(4) Comparison and contrast

The two units are similar in their major element compositions but differ greatly in their trace constituents and isotopic relationships. Rock A is rich in K2O, Al2O3, and poor in CaO and Na2O, and both carry moderate amounts of MgO, FeO, Fe2O3, and K2O. But the latter unit is rich in Ti, V, and Ba, whereas the lower is... And similarly in isotopic ratios, the upper unit is... but the lower is... (Some interpretation or evaluation of these relationships should follow.)

(5) Details in sequence

In the next part of the study, melts were crystallized at controlled cooling rates. In a typical series of experiments, five charges of a chosen composition were held at a temperature 5°C below its liquidus for 20h to ensure equilibrium partial melting. One charge was then quenched and examined microscopically to be sure that a few crystals had survived as seed. Then, if plagioclase was the residual solid, the other charges were cooled at a rate of 5°C/h. If, on the other hand, the liquidus phase was diopside, the cooling rate was...

(6) Definition

The general characteristics of the magma can now be defined qualitatively. The abundance of olivine in the cumulate succession implies that silica was low, and magma high. The prevalence of bornholmbite indicates a high water content, and...

(7) Example

Here, 'pellite' and 'sandstone' serve as second-order key words.

None of the formations appears, however, to have changed significantly in composition during the metamorphism. For example, the Jaghead peltite has exactly the same chemical features as a sillimanite grade as at chlorite grade, and the Topnotch sandstone shows as much variation in a single outcrop at any one grade as it does between outcrops at the extreme of grade. The peltite is
At the other extreme, similarly comprehensive descriptions and comparisons are made, but quantitative data are never cited; all the information is qualitative: 'they tend to increase', or they are 'higher' or 'lower'—and if readers want even a rough range for some variable, they are obliged to forage through tables and find it for themselves.

In the case of discussions, there is often an ironic situation that simple, non-controversial interpretations are explored and supported at great length, whereas major, contentious ones are skipped over almost parenthetically.

And a common flaw of both description and discussion is repetition. Thus, in field-based studies, particular constituents of a rock are sometimes mentioned six or eight times in a single paragraph, and the names or designations of specific rock types may recur eight to a dozen times per page through large sections of the manuscript as the rocks are compared and contrasted in terms of a seemingly endless list of constitutive minerals, chemical, physical, and other properties. And commonly there is no indication or explanation of why the data are significant or where the description or discussion is leading. Faced with so much uncoordinated information, even the most dedicated readers soon bog down and lose interest.

Because these problems depend on the material, it is difficult to make recommendations that might be broadly useful. In relation to field problems, though, it is perhaps worth emphasizing that much of the processing of information that goes on in geology is effectively concerned with sorting, categorizing, and collating observations and data. Thus, as we explore rocks in terms of their many characteristics, we are searching for natural patterns and associations. We are seeking order in subject materials at that first sight often appear chaotic, with the hope that order will reveal relationships pertinent to geologic history and petrogenetic process. A prime measure of success of this effort, then, is whether we can describe in an orderly (and convincing) way what we have learned—and what is still in doubt.

From the text, qualified readers should be able to obtain an overview of the results, with relative ease, and an unambiguous detailed picture with reasonable effort. They should not have to assimilate all the detail and sort it out themselves!

What seems to be required, then, is that the authors identify and emphasize the general patterns in their data and observations, and the significant departures from them, and, in the broadest possible way, give some indication of why their observations are important (be it only to say that they are 'general' or 'typical' features). The judgements involved as to what is significant will depend on the problem and the authors' view of it, and they are not likely to be easy. There is always the possibility, for example, that an observation that appears minor at first sight has major significance.

In general, diagrams and graphs are especially critical to this problem, because they can illustrate general patterns in important subsets of the data while also showing detail. They can also be a problem themselves if they are too complicated, but in principle, they have two end-member functions that are both obviously valuable. One is to portray observations and data, in which case the related text should be a description of the illustrated relationships; the other is to support the text, thereby making it simpler to write and understand. Original geological maps and phase diagrams are prime examples of the first function in that they are direct records of observational data. More common, though, are plots of analytical results, and for them, the choice of parameters can be critical. (For example, the chemical variations in tholeiitic volcanic rocks can usually be effectively illustrated in plots against MgO, but the variations in calc-alkaline rocks seem better represented against SiO₂.) Important too is a reference framework within the graph. Analytical data are generally more informative when they are portrayed on a background of comparative data, or on some experimental or theoretical framework. Particular care should also be taken in labelling graphs and writing the captions. Diagrams serve their scientific purpose much better if they are convenient to the reader (see sections 56 and 74).

Diagrams to support text should, of course, be simplifying. For example, if you are dealing with a complex array of rock types, it may be helpful to illustrate their observed or inferred relationships on a schematic 'family tree' before getting on to describe them. The reader then has an overview, and the descriptions can be directed to documenting and developing concepts represented in the diagram. Interpretations arising out of data descriptions and analyses are often best portrayed in semi-quantitative, semi-semantic diagrams. We emphasize 'semi'- because truly quantitative representations tend to be too complicated (if not impossible), and completely schematic interpretations often seem to have little bearing on reality.

The text that does describe detail should usually be organized to proceed from the general to the specific—be it from section to section, within sections, or within paragraphs. In other words, try, without being repetitious, to give the reader some indication of what is coming next (and why) before getting into the detail. (Summary tables may be helpful.) When you are describing data, direct the reader's attention to the pertinent tables and figures at the start of a section and to each specific diagram at the beginning of the paragraph or sentence as you set out to describe or discuss it. (Don't hold off until the end of your description and then say: 'All these features can be seen in Figs. . . .') Use parallel structures to organize descriptions and to minimize switching back and forth in comparisons. And try to keep the description 'moving' by incorporating figure numbers and quantitative data into the flow of words, rather than interjecting them parenthetically (as between commas, dashes, or actual parentheses). In referring to the works of others, recognize that the citation must go where it is needed for accuracy, but try also to work it into the sentence structure so that the authors' names are part of the word flow. When you do put references in parentheses, do it at the ends of sentences or between clauses so as not to disrupt the continuity of thought. Most of all, though, do not include any detail that does not have some real or potential significance that you can actually specify.

4. Writing for the reader

In the paper entitled 'The science of scientific writing' that appeared when this guide was in the final stages of preparation, two specialists in linguistics, Gopen & Swan (1990), argued that writing problems such as those described above commonly arise because scientists do not understand their readers' tendencies, needs, and expectations. Gopen & Swan pointed out that readers do not just read; they interpret—and their interpretations depend strongly on the way the information is presented. In the arts, being able to write material that is open to many interpretations is regarded as a talent (Shakespeare was an expert) and to a degree, at least, the same is true in science. Your observations and data can mean one thing to you but may inspire very different ideas among your readers, depending on their knowledge and experience. But presumably you want your readers to at least appreciate your perspective, so a reasonable objective is to try to maximize the possibility that they will see and understand it.

In their presentation, Gopen & Swan (1990) illustrated examples of problematical scientific writing and attempted to explain why the problems occur and how to correct or avoid them. They also demonstrated rather nicely that jargon and scientific complexity are not necessarily the root problems (as scientists like to claim), and that poor organization and conceptual gaps in scientific writing frequently require readers to work much harder to understand the argument than should be necessary. And ultimately, they came to the same
According to the general standards and to the actual examination of the facts, the above refers to the information contained in the paper.

(1) The party's claim as to non-disclosure of facts is unfounded—there are no recordable facts nor any material that needs to be disclosed in the matter.

(2) The party's claim as to non-disclosure of facts is unfounded—there are no recordable facts nor any material that needs to be disclosed in the matter.
The writing process

Most books on technical writing propose a series of steps such as the following for preparing a manuscript: (a) define the objective; (b) do the research; (c) organize the data; (d) write an outline; (e) write the first draft; (f) revise; (g) get reviews from others; (h) revise again; (i) get it cool—that is, get away from the manuscript for a while to refresh your outlook; and (j) revise again. A common contention too is that, if you make a sufficiently detailed outline, a first draft is easy to write.

Although we basically recommend this scheme, our criticisms are that, for long manuscripts at least, it grossly understates the difficulties of the first draft and it considerably overestimates the value of outlining. In our experience, first drafts are never easy, and outlines are no panaceas. The reason, we have come to realize, is that in scientific studies (as opposed perhaps to technical evaluations), the writing is so much a part of the research. As we noted earlier, the writing process commonly brings to light important observations and ideas, and in this way it can greatly influence—and even define—the focus and scope of the manuscript. The present document is a case in point; it began as a modest list but became increasingly complex as we thought more about the problems involved.

Another reason we downplay outlining is that, with word processors, the concept of a 'first draft' can be almost meaningless. One can now correct, revise, and reorganize text so easily while writing it that, by the time the manuscript is completed, some parts may literally have been through a dozen drafts.

The best approach to manuscript preparation, we think, is to treat as an analogue counterpart to the main research effort. One of our colleagues claims to be able to develop his papers completely in his head before he begins writing, and prolific authors do seem to have exceptional skills in this regard. For most of us, though, many of our ideas (and even some of our observations) are often still only rather vague perceptions when we start out, and the most of the work of writing is essentially a process of turning these perceptions into well-formulated thoughts, and organizing them into a sensible linear sequence of words. This work is difficult (perhaps 'extremely' so), but it also has a certain appeal because it is creative. After all, many people want to write. Approaching the writing as a research effort is also a recognition of the possibility that significant discoveries might arise from it. By comparison, trying to set up and follow a comprehensive, detailed outline for a large manuscript is mechanical and stilted—and, for most of us, unrealistic.

As indicated in section 61, our impression is that many authors are not using their word processors effectively. In particular (although obviously we cannot be sure), it seems to us that, in addition to not being sufficiently knowledgeable of the various rules and techniques of writing that we have tried to describe above—and to not seeking enough reviews—these authors are not doing enough revision and rewriting. It is in these respects, of course, that word processors have their greatest strength; therefore, we attempt below to describe what we think is a reasonable sequence of steps for formidable authors who want to stay a word processor. We do this with some reluctance, because we appreciate that writing is an individualistic process and, hence, that what we describe may not work for you. But our hope is that most authors with problems will find at least a few of our suggestions helpful. We apologize too for describing the procedure in terms of steps for you to follow, but that seems the most effective approach in terms of our objective.

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* In Disquisitions to Authors (4th ed.). Bishop et al. (1978) quoted 'one eminent jurist' as saying that 'there is no such thing as "good writing"; there is only good rewriting.'
68. British vs. American spelling

Journal of Petrology accepts either British or American spelling; just be consistent. Some common differences: the British use aluminium, amygdale, analyse, centre, colour, dye, favour, metre, orientate, Palaeozoic, programme (except in ‘computer program’), and sulphur; Americans use aluminium, amygdale, analyze, center, color, dye, favor, meter,
rocks and minerals, provide information sufficient to locate the sample sites, preferably on some map.

Frequently authors have collected much more data than can be published in journals, in which case only selections should be presented. A data repository is currently being managed for the Journal of Petrology by Dr. M. J. Le Bas at The University of Leicester, and presumably it will be maintained indefinitely, so authors are encouraged to provide complete data sets for it.

FINALE

77. Perfectionism

All the above comments are concerned with making your manuscript better, both in itself and in terms of minimizing the work that other people have to do to turn it into a published paper. But there is another side to the coin—trying to make it too good. At some point, you have to stop revising and send the manuscript to a journal. Usually the deciding factor is time—you have to move on to another job.

But remember too, perfection is not the goal. A useful way of looking at science (and life in general) is that it is an ever-continuing conversation or dialogue. If the current topic interests you, and you want to participate, then you have to insert your voice into it. You say what you have in mind as well as you can and hope that your observations and insights will be appreciated and have effect. If they are good, they may; if they are not, they probably won’t, no matter how well they are said. But if you hold back because you are trying to get your words exactly right, the topic may change (or you may have to leave) and what you had in mind will never be heard—or someone else will say it.

And there is also an edge to the coin. Reviewers and editors should not demand perfection either. But remember, editors do have some investment in your paper (not much, mind you, but some), and being editors, they have probably seen more standards for comparison than you. In some obscure way also, they have your interests at heart; they are doing their job because they want to see your work published.

78. The power of words

'The journey is one of choices, judgement, of logic... words... become instruments of power.'

In this guide, we have tried to show that manuscript preparation is indeed such a journey. We hope our recommendations will eliminate many wrong choices and help make some of the judgments a little easier for authors so that they can concentrate more on the problems of logic.

As for the power of words, what petrologists or geologists seem generally to think of as the 'science' in their manuscripts essentially comprises the observations and insights that have arisen from their work. The purpose of reviewers and editors is to try, on the basis of their knowledge and experience, first, to ensure that the science is accurate and reasonable, and, second, to see that the presentation is intelligible. The distinction is not always clear, however. In our experience at least, manuscripts tend to form a two-end-member system that we sometimes describe as having good science at one end and poor writing at the other, but that is almost as well portrayed as having good writing at one end and weak science at the other. The best scientific contributions typically are clearly written, and in all cases, when the writing is improved through revisions, the science invariably benefits. The strongest observation, though, is that the most difficult manuscripts to deal with (by far) are those in which you can scarcely focus on the science in terms of anything but writing problems. The well-written manuscript is, by contrast, the proverbial breath of spring. You quickly recognize that the authors are saying what they mean, and mean what they say, and you sense that even if the science is problematical, it is still likely to be interesting. The writing problems never are.

With that, our last recommendation:

79. Do as we say, not as we do.

Nostra culpa!

ACKNOWLEDGEMENTS

We acknowledge again—this time with thanks—the use of Hatten Yoder's list of recommendations as seed. Hat also reviewed the manuscript, and he should probably be a co-author, but we feel we can credit him more this way for what is good, while sparing him from identity with parts that he may not approve of (including this sentence). Hat was one of the original editors of the Journal of Petrology, and over the years he has reviewed an enormous number of manuscripts. His generosity in this work, particularly in his promptness and thoroughness, is most remarkable. We are personally indebted to him in all of his roles—as Director, critic, teacher, and friend.

Our present Director, Charles Prewitt, also reviewed the manuscript, and his comments were valued because of his experience as both a professor and an editor.

We are especially pleased to thank Felix Chayes for many detailed, thoughtful comments. Felix is one of the few Earth scientists we know who writes with an admirable style that is distinctively his own. In particular, we have always enjoyed his ability to develop scientific arguments in ways that are (deliberately) humorous.

Other readers who made useful comments were Gray Bebout, Marilyn Fogel, Bjorn Myson, Craig Schifferies, Dave Virgo, and Jimmin Zhang at the Geophysical Laboratory, Dodie James at the University of Edinburgh, and several of the present and past editors of the Journal of Petrology.

Finally—and not least—we thank the authors whose writing inspired this guide. We have ultimately benefited from the journey of their manuscripts; we hope the journey of ours will be helpful to them.

REFERENCES


APPENDIX I

Basis, production, and responsibilities

As indicated in the text, "we" means T.N.I. and D.R., loosely in our roles as editors. The contributions of L.M.I. as consultant are explained below.
INDEX AND CHECK LIST
Summary of comment headings

Some matters of grammar and composition

1. Voice
2. Person
3. Dangling participles
4. Tenses

A WRITING GUIDE

5. Anthropomorphism (personification)
6. The anonymous 'it'; and 'there is', 'there are,'...
7. That, 'that', 'then', and 'there' without an antecedent
8. 'That' vs. 'which' (restrictive vs. nonrestrictive clauses)
9. Hyphens
10. Comma, semicolons, colons, and dashes
11. Transition words, terms, and techniques
12. Parallel structures

Problematical common terms

13. 'An hour', 'an hypothesis'
14. 'Based on', 'on the basis of'
15. 'Complementary', 'complement'
16. 'Computer'
17. 'Co' in conjunctions 'both... and'; 'either... or'
18. 'Criteria, criterion'
19. 'Due to', 'owing to', 'because of'
20. 'Extremely' vs. 'relatively'
21. 'If' vs. 'whether'
22. 'Important', 'interesting', 'reasonable', 'significant'
23. 'In' vs. 'imply'; 'individually' vs. 'apparently'
24. 'It's vs. 'it'
25. 'Presently' vs. 'currently'
26. 'Principal vs. 'principle'
27. 'Quite'
28. 'Since', 'for', and 'as' vs. 'because' or 'inasmuch as'
29. Time and space adverbs
30. While vs. 'whereas'
31. 'Yet' or 'still' vs. 'but'

Matters relating to paratextual terminology and notation

32. Acronyms and contractions
33. 'Catalyst', 'comprise'
34. Distribution coefficients, Mg-numbers
35. Electron microscope, powder x-ray diffraction
36. 'Enriched, depleted' vs. 'richer, poorer'
37. 'Exceed' vs. 'exceed'
38. 'Geologic', 'geological', 'petrologic' vs. 'petrological'
39. 'Horizontal' vs. 'level', 'flat', 'level'
40. 'Irradiation' vs. 'irradiate', 'radioactive' vs. 'radioactivity'
41. 'Lithology', 'chemistry', 'geochemistry'
42. 'Most Fe-rich', least Fe-rich
43. 'Phase', 'mineral phase'
44. 'Phase' vs. 'rock unit, variety, or facies' or 'stage'
45. Ranges and scales
46. 'Rocks' vs. 'rock bodies', 'minerals' vs. 'mineral grains or crystals'
47. 'Rocks vs. 'minerals'; 'minerals vs. 'rocks'
48. 'Theory', 'concept', 'hypothesis', 'interpretation', and 'models'
49. Unimportant, minor, and oversold words

General outlines
50. Abstract and introduction
51. Method of investigation
52. Descriptive sections
53. Discussion and concluding statements
54. Footnotes
55. Diagrams, photographs, and figure captions

The major problems and the writing process
57. Irrelevant material, repetition, lack of coherence and unity, awkward wordy, ambiguous, tedious, and incoherent sentences
58. Basic requirements: vocabulary and the skill to use it; core, constructive self-criticism
59. Paragraph construction
60. Subordination and sentence sequencing
61. Detailed descriptions and discussions
62. Writing for the reader