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How to write a manuscript for a journal

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With 5 Figures and 1 Table

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Although nobody reads more (or should read more?) papers in the literature than students, many appear to find it difficult to write their own manuscripts in the same style that all these scientific papers are written in. In part, this can be excused because a published paper is the final result of many months of corrections, review and editing. For all these steps between the initial manuscript and the final product, there are not many guidelines that explain which parts of this process are done by who (author, supervisor, editor, or copyeditor) and what the formatting differences between manuscript and final product are. In fact, there are practically no guidelines how manuscripts should be formatted while they are being written. This document will help the interested student to learn this. As the first author is a geologist himself, this article is predominantly tuned to manuscripts in the Earth sciences. Places in this article where writing-style opinions are expressed in the first person singular perspective (the German "Ich-Form") generally refer to view points of the first author). However, most of the guidelines pertain to all sciences alike.

Large parts of the present document may be considered as a "tick-list" for the writing of your own manuscript. Please also note that, although this document is written to help you with writing articles for scientific journals, most of the guidelines are the same whether you are writing a thesis, a field report, a consultancy document or a grant application. Do your editor, co-author, proof reader, supervisor and especially yourself therefore the favour and follow these guidelines – even during the early stages of your manuscript. It will save everybody time.

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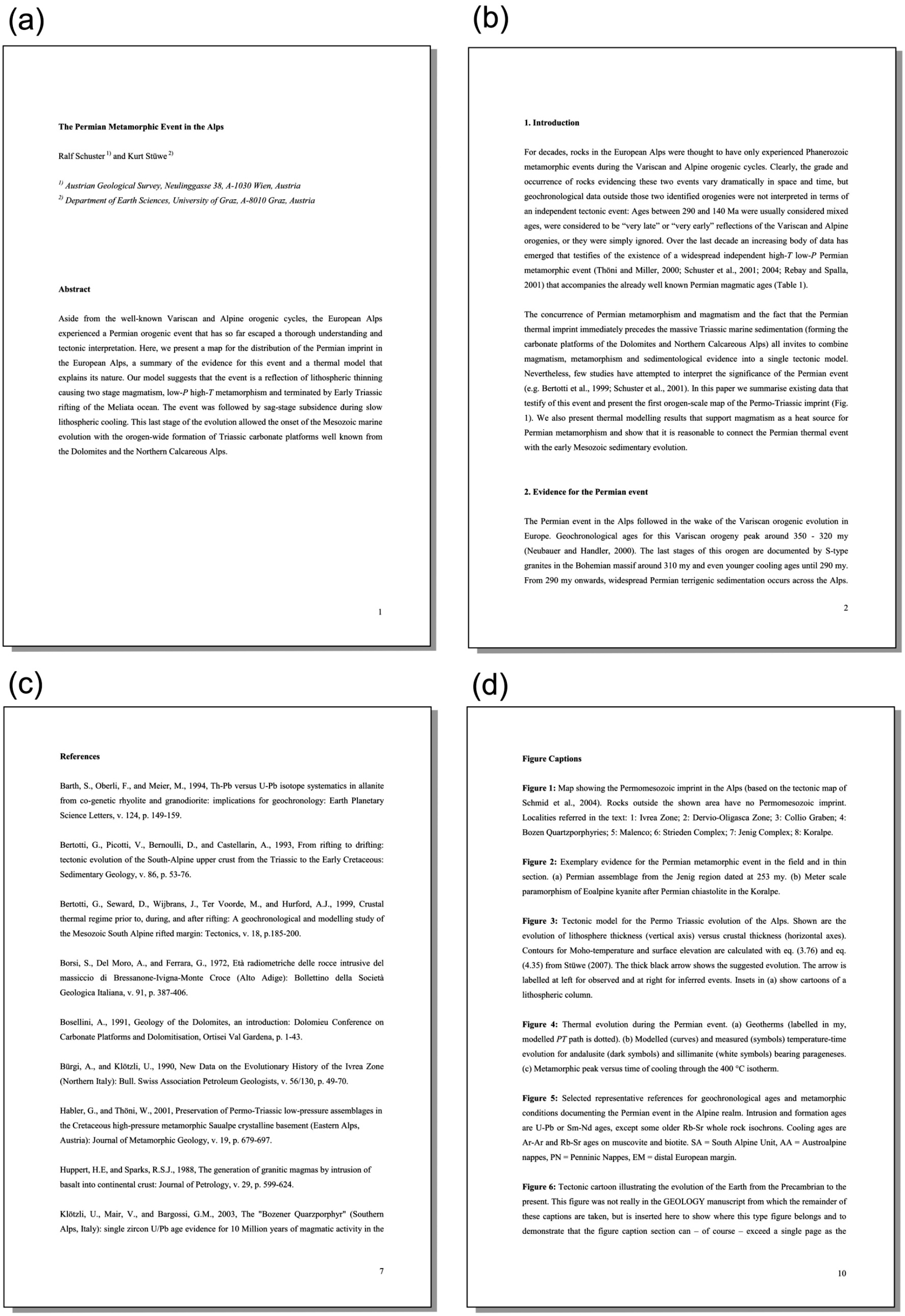
1. General Remarks on Manuscript Style

When writing a manuscript, there is a series of very general rules how the manuscript should look like and there are very little deviations in this style between manuscripts for theses, journal, books or reports. After the manuscript stage – (i.e. during copy-editing and printing), there are of course large differences between different publishers and journals with respect to page format, font, editorial style and more. However, during the manuscript stage, the layout and editorial style of most manuscripts should look the same and for most of the points below there are no compromises! So try to follow the suggested style as close as possible. The general layout of your manuscript should be made up of nine sections:

1. page 1:	Title, authors, affiliations
2. page 2:	Abstract (usually no more than 1 page)
3. page 3 to n:	Body of paper
4. page (n + 1)	Acknowledgements
5. page (n + 2) to m:	References
6. page (m + 1) to x:	Figure captions
7. page (x + 1) to y:	Table captions
8. page (y + 1) to z:	Figures (one per page)
9. page (z + 1) to end:	Tables (one per page)

As a very first point, please note that nowhere in this document there is a suggestion that your manuscript needs to be complete before you show it to somebody! Manuscripts should always be edited according to the guidelines presented here, but everybody acknowledges that you are a student in the process of learning how to write manuscripts, so don't think you need to pass a complete manuscript to your peers! In fact, you may do your time management a lot of damage if you have your supervisor or co-author look at the manuscript at a (too) late stage (as the scientific direction may need adjusting). Even if you simply have written the headings on an empty page, this may be the stage where you want to give your manuscript to somebody to look at to discuss where to go from here. However, it is emphasized that the editorial style suggested below should be followed rigorously at all stages of the manuscript writing – even while the manuscript is still incomplete.

For digital housekeeping whilst writing your manuscript, it is advisable to keep the first seven sections (from the list above) in a single text file (Microsoft WORD or LaTeX or whatever) and each figure and table in a separate file bearing the name of the figure (e.g. "fig1.cdr") or name and version date (e.g. "fig1_8312.cdr"). During your research, it may also be helpful to keep all work done for a certain figure in a folder bearing the name of the figure (e.g. a folder with the name: "fig1_stuff").


(a)

The Permian Metamorphic Event in the Alps

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Abstract

Aside from the well-known Variscan and Alpine orogenic cycles, the European Alps experienced a Permian orogenic event that has so far escaped a thorough understanding and tectonic interpretation. Here, we present a map for the distribution of the Permian imprint in the European Alps, a summary of the evidence for this event and a thermal model that explains its nature. Our model suggests that the event is a reflection of lithospheric thinning causing two stage magmatism, low-*P* high-*T* metamorphism and terminated by Early Triassic rifting of the Meliata ocean. The event was followed by sag-stage subsidence during slow lithospheric cooling. This last stage of the evolution allowed the onset of the Mesozoic marine evolution with the orogen-wide formation of Triassic carbonate platforms well known from the Dolomites and the Northern Calcareous Alps.

1

(b)

1. Introduction

For decades, rocks in the European Alps were thought to have only experienced Phanerozoic metamorphic events during the Variscan and Alpine orogenic cycles. Clearly, the grade and occurrence of rocks evidencing these two events vary dramatically in space and time, but geochronological data outside those two identified orogenies were not interpreted in terms of an independent tectonic event: Ages between 290 and 140 Ma were usually considered mixed ages, were considered to be "very late" or "very early" reflections of the Variscan and Alpine orogenies, or they were simply ignored. Over the last decade an increasing body of data has emerged that testifies of the existence of a widespread independent high-*T* low-*P* Permian metamorphic event (Thöni and Miller, 2000; Schuster et al., 2001; 2004; Rebay and Spalla, 2001) that accompanies the already well known Permian magmatic ages (Table 1).

The concurrence of Permian metamorphism and magmatism and the fact that the Permian thermal imprint immediately precedes the massive Triassic marine sedimentation (forming the carbonate platforms of the Dolomites and Northern Calcareous Alps) all invites to combine magmatism, metamorphism and sedimentological evidence into a single tectonic model. Nevertheless, few studies have attempted to interpret the significance of the Permian event (e.g. Bertotti et al., 1999; Schuster et al., 2001). In this paper we summarise existing data that testify of this event and present the first orogen-scale map of the Permo-Triassic imprint (Fig. 1). We also present thermal modelling results that support magmatism as a heat source for Permian metamorphism and show that it is reasonable to connect the Permian thermal event with the early Mesozoic sedimentary evolution.

2. Evidence for the Permian event

The Permian event in the Alps followed in the wake of the Variscan orogenic evolution in Europe. Geochronological ages for this Variscan orogeny peak around 350 - 320 my (Neubauer and Handler, 2000). The last stages of this orogen are documented by S-type granites in the Bohemian massif around 310 my and even younger cooling ages until 290 my. From 290 my onwards, widespread Permian terrigenic sedimentation occurs across the Alps.

2

(c)

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(d)

Figure Captions

Figure 1: Map showing the Permomesozoic imprint in the Alps (based on the tectonic map of Schmid et al., 2004). Rocks outside the shown area have no Permomesozoic imprint. Localities referred in the text: 1: Ivrea Zone; 2: Dervio-Oligasca Zone; 3: Collio Graben; 4: Bozen Quartzporphyries; 5: Malenco; 6: Strieden Complex; 7: Jenig Complex; 8: Koralpe.

Figure 2: Exemplary evidence for the Permian metamorphic event in the field and in thin section. (a) Permian assemblage from the Jenig region dated at 253 my. (b) Meter scale paramorphism of Eoalpine kyanite after Permian chiastolite in the Koralpe.

Figure 3: Tectonic model for the Permo Triassic evolution of the Alps. Shown are the evolution of lithosphere thickness (vertical axis) versus crustal thickness (horizontal axes). Contours for Moho-temperature and surface elevation are calculated with eq. (3.76) and eq. (4.35) from Stüwe (2007). The thick black arrow shows the suggested evolution. The arrow is labelled at left for observed and at right for inferred events. Insets in (a) show cartoons of a lithospheric column.

Figure 4: Thermal evolution during the Permian event. (a) Geotherms (labelled in my, modelled *PT* path is dotted). (b) Modelled (curves) and measured (symbols) temperature-time evolution for andalusite (dark symbols) and sillimanite (white symbols) bearing parageneses. (c) Metamorphic peak versus time of cooling through the 400 °C isotherm.

Figure 5: Selected representative references for geochronological ages and metamorphic conditions documenting the Permian event in the Alpine realm. Intrusion and formation ages are U-Pb or Sm-Nd ages, except some older Rb-Sr whole rock isochrons. Cooling ages are Ar-Ar and Rb-Sr ages on muscovite and biotite. SA = South Alpine Unit, AA = Austroalpine nappes, PN = Penninic Nappes, EM = distal European margin.

Figure 6: Tectonic cartoon illustrating the evolution of the Earth from the Precambrian to the present. This figure was not really in the GEOLOGY manuscript from which the remainder of these captions are taken, but is inserted here to show where this type figure belongs and to demonstrate that the figure caption section can – of course – exceed a single page as the

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Fig. 1: Formatting example of four important pages of a manuscript. (a) Title page. Note that – in this case – the abstract is short enough to fit with the title on one page without looking crowded. (b) Page 2. (c) Page *n* + 2. (d) Page *m* + 1. The sections these pages belong to are listed in the table in the text.

1.1 Page Layout

When writing your manuscript, do not try to format your manuscript in the way the printed papers look like, but it is advisable to follow the following style:

Page size and margins: Use A4 page size. The default page margins provided by WORD are generally OK. A rough guideline is 2–3 cm on all four sides of your page.

Justify the text: Left- or both sides justified text are both good options, but it should be one of the two and it should be done consistently throughout the manuscript.

Page numbers: Place them in the bottom right corner of your manuscript starting with the title page and finishing with the last page of the table captions.

Line numbers: This is optional. Some journals, supervisors and reviewers want them, others don't. Reviewers find them usually very useful because it makes it is easy to refer to a certain line in a review. I personally think it looks ugly, so I often don't do it myself in my own manuscripts.

Line spacing: Use 1.5 lines. Single spaced text is hard to edit and although many journals ask for double spacing, few authors actually do that. 1.5 lines spacing appears to be the common format of manuscripts these days.

Font and font size: Use 12 point in an easy to read font. Common fonts used in manuscripts are "Times New Roman" or "Arial". 11 point is sometimes used, but 12 point is more common.

Line indents: Don't use line indents at starts of paragraphs or anywhere else. The only exception I usually tolerate is the use of hanging indents in the reference section as the reference section takes a lot of space if each reference is paragraph separated from the next and is hard to read if its not.

Paragraph separations: To separate paragraphs from each other, simply hit the return button once, i.e. insert one extra line. Do not use any formatting options that do paragraph separations in different width from line separations (this is one of those things that copy-editors get grey hairs from).

1.2 Global Manuscript Edits and Consistency Checks

Uniform style: Make sure that the entire manuscript is in the same font, has the same page margins, has the same line spacing etc. Don't use "styles" or other options that the writing software of your choice provides. When your manuscript is typeset by the journal, the copy-editor will only cut and paste your text into his/her own typesetting package and they have to erase any formatting stuff that you have done before they start. This will only cause trouble.

Headings: Section headings are the only exception where you are allowed to use different sizes, bold script etc. – but don't exaggerate. 14 or 16 point bold (in the same font as the rest of the manuscript) is a common style for first level headings to offset them from a 12 point text.

Never insert figures or tables into the text: Figures follow the end of the text and tables follow after that as described on the first page of this document (see above). Even for theses and reports (that you later typeset yourself), you are well-advised to not insert figures into the manuscript until the very last step. You come into devils kitchen with page jumps and all kinds of other problems if you insert your figure into the text too early. Journal editors don't want you to do this at all.

Total manuscript length: Typical manuscripts for scientific papers that are to be published in international journals in the Earth and biological sciences are between 10 and 30 manuscript pages long (in the layout described here and without figures and tables). Theses and reports are of course a different story.

Heading hierarchy: Decide on the number of heading levels you want to use. Most journals don't allow more than 3 levels of subheadings. The numbering and sub-numbering of headings (as done here) is uncommon in many journals, but it may be quite useful for theses and reports as it may be helpful to structure your thoughts during the writing stage. Also: never have main heading and subheading immediately follow each other. Common styles for headings are:

1st level heading:	14 pt, bold font, Capitals for all nouns
2nd level heading:	12 pt, bold font, Capitals only for first word
3rd level heading:	12 pt, no bold font, Capitals only for first word

Reference style: All citations in the text should be of the same style. All references in the text neet to be listed at the back of your manuscript and vice versa. About all statements in your manuscript it must be either clear that they are yours or they must be referenced. This and other details about referencing in manucripts is explained in detail in the section on references below.

Figure citing style: All figure citations in the text should be in the same style (i.e. decide if it is: "Fig. 10" or: "fig. 10" or: "Figure 10"). Make sure that figures are cited in the text in the order they occur. That is: the first citation of figure 3 in the text should not occur before the first citation of figure 2. Even when figures contain a, b and c make sure that fig. 1c is no cited in the text before fig. 1a.

Proper names and location names: All proper names must be in the same spelling and style. This means, it is not so important if it is: "Eo-alpine" or: "eo-alpine" or: "Eoalpine", but it is important that you make your choice of spelling and capitalisation consistent throughout your manuscript. Especially with local names where different spellings are known (just imagine the case for Arabic or Chinese names). Make a decision what you use and then be consistent. With respect to locations mentioned in text, make sure that they are seen on a figure somewhere and vice versa. Decide to use local names for localities if you can (use "Milano" and "Wien" for the two cities in Italy and Austria). Don't mix local names and English names in one paper (i.e. don't use "Vienna" and "Wien" in the same manuscript). Use only one transliteration system in one paper (e.g. for the Ukrainian locality name "Чоп" there exists the german transliteration "Čop" and the English transliteration "Chop") (see Duden Satzanweisungen, p. 173–201).

Perform consistency checks: Before you give your manuscript version / draft to your peer, perform a series of consistency checks. You may consider them "boring" to do or even "useless", but if you do not do them, your peer will do it and waste his/her time and may become less interested in reading through your work. It is also a matter of courtesy to do it. It's a good thing to do in the evening and takes less time than you may be spending to complain about this boring task. So: do it! Some typical checks are:

Are all headings of the same level in the same style?
Is the entire manuscript in the same format (justification, line separation, font etc.?
Are reference citations in text all the same style?
Are all references cited in the reference list?
Are all figures cited in the right order and the same style ("Fig. 1" vs. "fig. 1" etc.)?
Are all proper names spelled consistently?
Are all mathematical variables explained?
The list of consistency checks is much longer – so insert your own below:
…….
…….
…….

1.3 Mathematics

Variables: Mathematical variables should always be in italics, but units not! So: "s" means seconds without explanation, but "*s*" is a variable that needs to be defined.

Use few variables: If you define a variable or other abbreviation that is only used a handful of times in the entire manuscript, you should consider to rather write it out instead. As soon as you introduce a variable the reader needs to remember what it means every time it occurs. So if there are only few occurrences, no need to introduce it in the first place.

Abbreviations: There are some common abbreviations like T for temperature, P for pressure. Use those if there is a common abbreviation. Don't forget to explain each variable the first time you use it in the text even if it is a common one.

Choice of processor: If you have a lot of Maths in your manuscript consider using LaTeX instead of WORD as your word processing package. LaTeX mathematics looks much prettier!

SI units: Try to stick to the SI units (seconds s, meters m, joules J, kilogram kg and the derived units Pa for pressure, N for Newton and so on). Some common deviations from the use of SI units in geology are the use of "my" for "million years" (1 my = 3.15 x 10^{13} s) and "kbar" for pressure. It's fine to use these as they are deeply entrenched in the literature, but if you do – be consistent (i.e. don't mix the use of seconds with million years in one manuscript).

Million Year: Follow journal style for the use of "million years" abbreviation. This may be "my", "Ma" or "m.y." If there is nothing prescribed, then I suggest to use "my" for a duration (e.g. "Metamorphism lasted for 80 my during the Paleozoic") and "Ma" if you mean a time in the past (e.g. "Metamorphism occurred 80 Ma ago in the Cretaceous.

Equation editor: Microsoft WORD has quite a nice equation editor, but it also has some problems. For example, it does not allow you to write units (which are not in italics) or an explaining word (also not in italics) into an equation. So be careful.

Numbering of equations: Equations should be numbered consecutively and used by citing "eq. 7" or: "equation 7" or: "eq. (7)" or something like this in the text. To offset equations from text, simply insert a paragraph break or even an extra line. There may be a journal-specific suggestion how to cite equations in the text.

Equations are part of the text: Remember that equations may occur in mid sentence. Whether a comma or a colon follows an equation, or whether you start with a capital or not in the next line depends on the sentence (even if it is in a separate line, the sentence goes on).

Axes on diagrams: Cartesian diagrams don't naturally have "*x*" and "*y*" axes. They have an "abscissa" and an "ordinate" or a "vertical" and a "horizontal" axis if you wish, but don't call axes "*x*" and "*y*" unless you define what these are in terms of variables.

Tensors, vectors, scalars: The symbols for vectors are often in bold, tensors often with capital letters and there are other common styles as well. However, nothing is so important as it is to be consistent and explain what each variable is.

Writing out numbers: Make a decision on writing out numbers or not. Often it is best to write out the numbers from one to ten, but write them in digits for larger numbers, i.e. its "nine my", but: "90 my". Also be careful with comma and dot. In German a comma is used to indicate where the decimals start. In English a comma is used to separate every 3 orders of magnitude. That is: "10,000" in English means ten thousand. "10,000" in German means ten point zero, zero, zero, i.e. ten accurate to three digits.

Latitude and longitude, compass directions: Writing out latitude and longitude in degrees, minutes and seconds or in degrees and decimal degrees is both possible (i.e. 36° 30' 00" = 36.5000°), but be consistent. The use of north, east, south and west or N, S, E, W is similar. Make a decision on what you want to use and be consistent. Don't forget to explain your reference system (e.g. WGS84) in the methods section!

1.4 References

At all stages of the manuscript writing, your manuscript should have a reference list that matches the citations in the draft of the text. That is: all text that you have written already should be cross referenced and be accompanied by a corresponding reference list. If your manuscript is still in the early stages, some references may fall out later again (and in this case you have typed it in for nothing), but references are such an integral part of scientific writing, that it is only sensibly possible to review or proofread you manuscript or help you further if the reference list that matches the text citations. So make sure that all references cited in text are in the reference list and vice versa. There is no need to list papers in your reference list that are not cited in the text. The style of the reference list at the end of your manuscript is discussed in section 2.5. For citations in the text use the following guidelines:

Citing in the main body of text: In the text, any statement of a fact or interpretation must be either referenced or it must be clear that it is from your own interpretation / observation: For example, the sentence: "Garnet crystals are up to 1 cm in size" does not need a reference, if it's clear that you refer to your own thin sections or your own area of study where you have a fair knowledge that what you say is true. However, "Garnet crystals in the Alps are usually up to 1cm in size" generally would require a reference (unless you are some Guru of Alpine Geology and have demonstrably a good knowledge of this fact). Even if you have cited a certain paper one line earlier: if you make a new statement on a different fact, cite it again.

Cite at the end of a sentence: Of course there is situations where a complicated sentence requires a reference that pertains only to the first half of the sentence (e.g. "In the Alps, garnet crystals are up to 1 cm in size (Smith and Wesson, 2000), but in my study area in the Himalaya they are only 1 mm in size"). In general, however, the need for such a mid-sentence quote usually indicates that you should break up the sentences up into two. So – if at all possible, place the references at the end of the sentence.

Use a consistent reference style in text: Typically in citing style it is discerned between publications according to (a) single, (b) double and (c) multiple authored papers. Single authored papers should be cited by last name and year, double authored papers by both names and year and multiple authored papers by first author, followed by "et al." and year. Here are some examples for typically used citing styles:

Single authored paper:	Double authored paper:	Multiple authored paper:
(Smith, 2000)	(Smith and Wesson, 2000)	(Smith et al., 2000)
(Smith, 2000)	(Smith & Wesson, 2000)	(Smith et al., 2000)
(Smith 2000)	(Smith and Wesson 2000)	(Smith et al., 2000)
[Smith, 2000]	[Smith and Wesson, 2000]	[Smith et al., 2000]
[SMITH, 2000]	[SMITH and WESSON, 2000]	[SMITH & al., 2000]

If your article is for a journal, then look in a recent issue what style they require and use this style already in your manuscript. If it is for a monograph or thesis, then pick your own style, but be consistent throughout your manuscript. Some journals also cite by numbers in the order references are cited in the manuscript (e.g. "Garnet crystals in the alps are 1 cm in size [4]."). In this example "[4]" is the fourth paper that you cite in your article. This uses less space in the text. This style is common in physics journals, but in Earth science there are only few journals that do it like that (EARTH AND PLANETARY SCIENCE LETTERS is one). Titles of papers or page or anything else do not feature in citations in the text of your manuscript.

Referencing unpublished work: Citing "in prep.", "pers. comm." or "in print" is OK to do, but don't use it excessively. Journals will allow you to cite "in prep." and "in print" work during the manuscript stage, but will make you cut them out if they are not published by the time your paper goes to print.

2. Content and Style of Manuscripts: Section by Section

We now explain how each section of a manuscript should be designed both with respect to content and with respect to style.

2.1 Title Page

The title page of a manuscript needs to be its own. Only if the abstract is very short, you could place it together with the title stuff on the title page. Usually this is not done. Don't start in the very first line. Follow the approximate aspect ratio for the layout of this page as shown on Fig. 1. The page numbering should start on this page. Other than that, the title page only contains the title, the authors and the affiliations of the authors.

Title should be as short as possible: The title of a paper is crucial. Spend some time on thinking about it when your manuscript is finished. The title should be short and yet capture the essence of the content. Remember to adjust the title to the scope of the journal. For example, a title of "The bizarre tectonic evolution of my study area" will be great for a journal with regional focus, but will be difficult to get published in a journal with a conceptual focus or international distribution. If you turn your story around and write: "My study area: an example for a bizarre tectonic evolution" you stand much better chance to get your manuscript past the review stage. Simply think: Regional titles for regional journals. Conceptual titles for conceptual journals etc.

Also remember that you may need to rewrite parts of the introduction once you have adjusted the title. Quite often I find that I need to do that at the very end of the manuscript writing. Remember that 90% of the people that see your paper will only read the title whilst scanning the literature in the hope to discover something of interest. So it is quite OK to lean out or even exaggerate a bit (but only a bit) with the title if you think that it helps to capture your audience. The style of the title should be the same style as the first order headings in the remainder of the manuscript. Don't use fancy different fonts or the like. Central justification is often nice to look at for the title.

Author list and affiliations: Who should be an author on your manuscript is discussed in section 3. The affiliation that need to be seen on the title page is the postal

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Fig. 2: Suggestion for the style of the author- and affiliation list on the title page. For remainder of page layout see Fig. 1a.

address where the work was done. In countries were publications are directly related into the institute budget for the next year, this is a very important line. When you see multiple affiliations for one author, then this usually means that his/her funding came from more than one institution. Sometimes you see the words: "now at institution b" behind the affiliation (see Fig. 2). This means that the work was done whilst at institution "a" but the author can now be reached at "b". Note that there is a difference to the "double affiliation" explained above. On Fig. 2 is a suggestion where the authors and their affiliations should be placed on the title page of a manuscript.

2.2 Abstract

The Abstract is actually not unlike the conclusion section of your paper, complemented with a "condensed" introduction section. In fact, it should summarise your entire paper in less than 1 page (only 150 words for journals of the American Geophysical Union AGU). The style of the abstract deviates from the remainder of the manuscript in as much as it is uncommon to list references (unless a given reference is at the heart of subject of your manuscript) and no abbreviations or acronyms. Everything else should be in the same style as the remainder of the paper: Page justification, page number (2 in this case) 1.5 line spacing etc. Have a look at figure 1 to see how the layout should look like. With respect to its content, the abstract should have three parts.

First part of abstract: One or two sentences justifying what you did. For example: "Life on Mars has intrigued many scientists over the years. Here we report of the first conclusive proof ..." Don't make this justification too long! Many authors confuse the abstract with an introduction to their work. All your findings need to be mentioned in the abstract in an abbreviated form. In fact, if the relevance of your findings is self evident, then you can leave any introductory sentence justifying what your did off all together.

Second part of abstract: The next 2–10 sentences (depending on the allowed length of the abstract) should explain what you did and what the results of your analysis are. For example: "In our study we analysed rocks from Mars for organic compounds and found embryos of little green men. Isotope analysis shows that these compounds are made of Helium nuclei ..."

Third part of abstract: The end of the abstract is a 1–2 sentence conclusion and/or possibly an interpretation for the wider reaching implications. for example: "We conclude that life on Mars is possible after all. Our conclusion supports the idea of NASA to settle people there before too long."

Keywords: Usually, journals require 3–5 keywords for indexing purposes. At the end of the abstract is the place to put them, in a single line, starting with the bold font word: "keywords:"

2.3 Main Body of Manuscript

The body of a scientific paper consist typically of sections that deviate not very much between different scientific disciplines. In the first part of this section we discuss what each of these sections should contain. Then we explain how to edit them.

Introduction section: This is the part where you capture your readership. You have about three lines "time" to do this. If you haven't gotten to the reason why your paper should be of interest to anybody by the third line – then you have lost. So don't fall into the trap starting with "My study area is located at latitude xyz longitude xyz". If you almost DID start your manuscript like this – think again: Is there really no better reason why you did all your work than to collect new data for region xyz ? What about: "Region xyz is the missing link to explain the tectonic evolution of the Alps because....? You can then continue with: "In order to solve this problem I have studied.....". I maintain that this style (i.e. posing a problem) is independent of the subject. Even if you are publishing a (seemingly boring) taxonomic study of foraminifera, there will be (hopefully) a larger picture why it is essential to collect this data for understanding planet Earth.

Large scale setting section: In Earth science papers, there is typically the "geological setting" section. From the philosophical point of view this section is really a part of the introduction, so it can be a subsection of the introduction, or a section of its own. For many papers you may not need such a section at all (depending on the theme and scope of your paper). If you do feel you need one, then keep in mind that you can't keep the reader forever from your own work and really need to tell him or her only the essence necessary to understand the later conclusion of your paper. The length of the geological setting section very much depends on how much info you feel the reader needs in order to focus onto your problem.

Materials and methods section: Commonly (but not always) scientific manuscripts require a "methods section". If your manuscript contains analyses made with some complicated mashine like an electron microprobe or a mass spectrometer, then list the model type of the mashine and the most important mashine specifics (acceleration voltage, beam diameter, mashine manufactorer etc.). In numerical modelling studies, describe the code you used, the software and the origin of digital data sets (if you used any). In biological studies you may need to mention the voucher material (e.g. "dried herbarium specimens are deposited in the herbarium of the University of Graz"). In some cases it would be necessary to read something about the methods of preparation and preservation here. In this chapter also list the means for determination you use (e.g. "Plant species were determined after Flora Europaea Tutin et al. 1964") Also the methods used for the preparation of slides for chromosome counting, or the methods and processes for molecular biological methods should be given here. If your paper contains geographic northings and eastings, then mention which geodetic system you use for the geographic coordinates. Also, you may want to use this section to explain what acronyms you use.

Data section: In the data section you describe what you found. The most common mistake people make in this section is that they mix data and interpretation. Never write something like: "Garnets grew syntectonically" and not even: "Garnets contain spiral shaped inclusion trails and are therefore interpreted to have grown syn-tectonically". Simply write: "Garnets contain spiral inclusion trails" and keep the interpretation that this means syntectonic growth for the "interpretation" section of your manuscript. Try to be as descriptive as you can.

Interpretation: This is the section in which you interpret your data. It is where you define a *PT* path from the mineral chemistry and petrography or it is the place where you infer a sequence of deformation events from superposition of fabrics described earlier. Try to avoid wide reaching tectonic interpretations and keep those until later and focus on the direct interpretation of the observations.

Discussion: This is the section where you discuss the wider implications of your interpretation. Sticking to the examples from above, you can discuss here what your derived *PT* path means for the tectonic evolution of your area or how you interpret your deformation sequence in terms of a stress regime. This is also the place where you can question your own interpretation and discuss what alternative interpretations of your data are possible, what the error bars on your interpreted results are and so on.

Conclusion: Conclusion is not unlike the abstract. Thus, in some ways, you may not need a conclusion at all and many papers do – in fact – subsume the conclusion section within the discussion section. Personally I find conclusions useful and often make them as a point by point summary of the main results. The one-sentence-justification of your work that you may want to have in the abstract is – of course – not necessary here. A useful sentence I often start the conclusion section with (but not obligatory) is: "In summary from above, we draw the following conclusions from this study: ....."

Aspects of style of the main body of the manuscript

Consecutive Headings: Never have two consecutive headings with no text in between. If you have a main section with three subsections and you feel you want to start the first subsection immediately after the main section heading – think again. Usually, this means that you only have a list of points you want to communicate and they are not integrated into a story yet.

Avoid attributive clauses (Attributsätze): Those are very common German construct, but don't make good scientific English. Although they may be grammatically correct English, it's usually not very clear. For example: "Garnet crystals, which are generally pyrope rich, are up to 1 cm in size." Much better English would be: "Garnet crystals are up to 1cm in size. They are generally pyrope rich."

Avoid long sentences: As a general guideline it may be said that sentences more than 3–4 lines long should be shortened.

Avoid quotes: This is common in humanistic disciplines. In the natural sciences, the excessive use of quotes is a privilege of gurus in review papers.

No footnotes: Again, this is something very common in humanistic disciplines, but not really done in science.

Not too short or too long paragraphs: As a general guideline, join paragraphs that are shorter than 4–5 lines together and break up paragraphs that are more than two thirds of a page.

Start of paragraphs: Start your paragraph so that the first few words (i.e. the first half of the first sentences) make it clear what offsets it from the last section. For example, if you have a petrographic description in which each paragraph deals with the description of one mineral, try to start with the mineral name. E.g. start the paragraph on garnets with something like: "Garnet crystals are the third common phase in the rocks". Another example: if you have a discussion of several theories in the discussion section start the respective paragraph with: "One theory says ......" and the next with: "The other theory says....."

Don't use formatting options to produce lists: If you have a list of points number them with 1.,2. 3..... or with (i), (ii), (iii) or (a), (b), (c) or whatever, but write them into the running text, especially if they are short (only one line).

References: Aside from your own data, references are – in science – one of the most important parts of your article. You need them to show where the state of the art of your subject is and many aspects of your article. Everything about references, how to cite them and where to use them is discussed in section 1.4 and 2.5.

Et al., e.g. and id est: Remember that "et al." stands for Latin: "et alia" ("and others") so that "al" is an abbreviation for "alia" (or "aliae" (fem.) Or: "alii" (masc.)) and is therefore followed by a colon as it is an abbreviation. Remember that "e.g." stands for "exempli gratia" – which means "for example". Remember that "i.e." stands for Latin: "id est" ("that is") and should be used as such.

Avoid the excessive use of acronyms and abbreviations: When you do use them, explain once where they come from and then rigorously use them from there on. E.g. "mineral abbreviations after Kretz (1973)". Try to have no more than 3–5 acronyms in your manuscript. Once you have used "MCT" for "Main Central Thrust", "STD" for "South Tibetan Detachment" and "MFT" for "Main Frontal thrust" in a manuscript on Himalayan tectonics, you have used up the patience of your readers trying to remember them all.

Common Germanicisms: Several mistakes of native German speaking scientist are common in english language manuscripts: (a) Its "Earth" if you refer to the Globe and "earth" if you mean soil. (b) Its "grateful" not "greatful". (c) Use "respectively" only for connecting two adjectives to two nouns and use it at the end of the sentence. Be careful: the German word "beziehungsweise" is also commonly misused as a substitute for "and" or: "or" or: "I mean something else" even in German. An example for correct use is: "The sky and the grass are blue and green, respectively". (c) No complicated sentences.

Spaces and hyphens: Check your manuscript for consistency of spaces between units and variables. i.e. is it "15 kbar" or "15 kb" or: 15 ky or: "15.000" years, or: "700 °C" or: "700 °C" "north-south" or "north – south". Most manuscripts are with a space although mathematically strictly there should be no space between variables and units. Also be careful to discern between long hyphens and short hyphens. Short hyphens are used to connect two words (e.g. "green-coloured") long hyphens are the German "Gedankenstrich" and are used in references and to insert attributive clauses (although you should avoid them – see above).

Italics and bold font: The use of italics in the text or bold font to highlight stuff is generally not done. Italics should be reserved for mathematical variables and for scientific names of plant and animal taxa (*Acer pseudoplatanus*, *Anser anser*, but Festuca spec. if the species is not determined. **Ranges and errorbars**: Do not confuse a range of numbers with a distribution of numbers: If you have made 10 estimates of temperature and they range between 20 °C and 40 °C then do not write: "The data show temperatures of 30 plus/minus 10 °C. The use of "plus/minus" usually implies that it is a standard deviation around a mean value (i.e. a Gaussian distribnution). Also note that it is common to have a space between number and unit for degree Celsius or Kelvin, but no space for degree of latitude or longitude (i.e. "30° north").

Scientific writing: This document helps you to edit your manuscript and not to write. So: for scientific writing, I must refer you to other literature. However, there are a few simple tricks that I want to mention. The most important one is that you need to keep in mind at all times that your manuscript is interesting! After all, you have worked on it for months (or years) because you were interested in the result. So don't exclude the possibility that others want to know too! Keeping this in mind you should write your manuscript in the same style you might write a novel, a report on your holiday activity to a travel journal or other stories of that sort. Words like "however" or: "nevertheless" or: "On the other hand" or: "Therefore", or: "In contrasts, ..." are good words to start a new sentence and to connect it to an argument brought forward in the previous line. For manuscripts written in German language the Duden series "Satzanweisungen und Korrekturvorschriften" contains many useful hints.

2.4 Acknowledgements

This is the section where the reader learns who has contributed to the manuscript. Field assistants or laboratories who provided analyses are typical candidates for acknow-

> H. Maier is thanked for accompanying us in the field. H. Hesse at Vienna University is thanked for help with the analyses. F. Schiller and an anonymous reviewer are thanked for providing reviews of an earlier version of this manuscript and H. Frisch is thanked for his efficient editorial handling. This paper was written with funding of FWF project number 12345.

Fig. 3: A typical acknowledgement section for a scientific paper.

ledgements (if they are not co-authors). Your mum is not a candidate for the acknowledgement section, but reviewers or editors are – even if they are anonymous. Funding institutions and project numbers usually should be listed too. A typical acknowledgement section may read as follows:

2.5 The Reference List

Use a consistent reference style in the reference list: Most journals give you their required style of citing. If you know already the journal you want to submit your article to, then use their style from the start onwards. Below are some examples. Note that there are only slight differences, but any editor (be it a journal editor or your supervisor reading your thesis) will jump at you if you have not followed your chosen style consistently throughout your manuscript.

Smith A. and Wesson P., 2000. On the use of hand guns. Nature, 22, 36–72.
Smith A. and Wesson P. 2000. On the use of hand guns. Nature, v. 22: 36–72.
Smith A., Wesson P. (2000): On the use of hand guns. Nat., vol. 22, p. 36–72.

When citing books, you usually need to list the publishers and the total page number of the book. For example:

Smith A., Wesson P. (2000) Encyclopedia of Barbie Dolls. Springer Publishers, 270 p.

When citing articles that have appeared in edited books, then you need to list the editors and both the title of the article you want to cite together with the title of the book it appeared in:

Smith A., Wesson P. (2000) On the use of hand guns. In: Einstein A. (ed.), Gun and knife handling in North America. Geol. Soc. of America Memoir 22, p. 36–72.

References should be listed alphabetically in the reference list: When there is several papers with the same first author, then his single authored papers go first, then the double authored ones, then his/her "et al." papers. Within each of these go by year (if there are several "Smith and Wesson" papers. If there is more than 1 paper by the same authors in the same year, then use "a" and "b" where "a" is for the paper that cited first in the text of your manuscript (e.g. Smith and Wesson, 2000a).

2.6 Figure and Table Captions

Start each caption with the words: "Figure 1:" using bold font. Fig. 1d shows how the figure captions page should look like.

The first sentence of each figure or table caption must capture the essence of the whole figure / table. For example, when you have a plate with 6 photomicrographs of thin sections from (a) to (f), then do not start your caption with: "(a) Image of a garnet crystal.....". Instead, the first sentence should be: "Photomicrographs of rocks from the Schlossberg." ...

Make sure there is no duplication of information between figure or table caption and text. Think through what information you want in the caption and what in the text. In general any interpretation of the figure should be in the text (not in the caption) and the caption is reserved for straight explanation of what is to be seen. For example, the bulk composition for a whole rock chemical plot can either be given in the figure caption or in the text, but there is no need for both.

Write your figure and table captions in the same font, style, line spacing etc. as the remainder of the manuscript. Separate each figure and table captions from the next by an extra line break, just like you separate paragraphs from each other in the text (see Fig. 1d).

Make sure the figure / table captions are on page (m + 1) to x of the manuscript and NOT on the figures themselves. For some reason authors often have the captions for figures separate, but for tables they are inserted at the bottom of the table. Try not to do this.

2.7 Figures

Figures build the skeleton of your paper. The order, number and content of your figures parallels the logic build-up of the text and both are at the heart of good science. The order of figures very much depends on the theme of your paper. If you make a regional study, then Fig. 1 is usually a map of your study area. If you make a conceptual study, then Fig. 1 may be a cartoon of the microstructure you are trying to explain. In total aim at a figure to text ratio which is no more than about 1 figure for every two to three pages of text. Here are 2 examples what the figures of a manuscript of about 20 pages (6–8 figures) may contain:

> **Classic "hard rock" papers on a given terrain**: Figure 1: Map with inset of where the region is. Figure 2: Plate with 8 field photographs. Figure 3: Plate with six photomicrographs. Figure 4: diagram showing plots of chemical data, stereo-plots of structural data, (Tables with data belong here too). Figure 5: Phase diagram showing thermobarometry, or: block diagram showing 3D structure, or: modelling result of some sort. Figure 6: Tectonic interpretation, paleogeographic sketch, 3D model, map reproduced from figure 1 showing interpreted structure or stress directions.
>
> **Conceptual modelling study of a microstructure**: Figure 1: Cartoon or photograph showing microstructure. Figure 2: Numerical model set up or analogue model geometry. Figure 3: Model results either in form of numerical diagrams or photos of the analogue set up. Figure 4: Model results with different set of boundary conditions. Figure 5: Some test of the model results using real rocks. Figure 6: Interpretative figure of the application.

Of course there are zillions of variations to these general examples, but you will notice that there is a general order that is independent of the subject. This includes: 1. Setting the scene 2. The data. 3. The modelling interpretation of the data using a model. 4. The wider discussion and interpretation of the data.

Style of figures in manuscript

Maps

> Don't use previously published maps – it doesn't work. In fact, strictly speaking, you are not even allowed to use them as they are copyrighted. More importantly however, you will find that any map published previously does not quite suit what you need to show in your paper. Redrafting maps is almost always necessary for each paper (this is why you often read "modified after…" in a map-figure caption) – at the very least for style consistency reasons.
>
> Make sure there are not too many lines on the map that are not explained.
>
> Make sure all geographic locations discussed in text are on the map and vice versa.
>
> If you abbreviated regional names – explain them in the figure caption.
>
> Grey shades are much prettier than patterns.

Photographs

Decide if photos need to appear in colour. If not then immediately convert them to B&W to see if they still show what you want to show.

Highlight important features by drawing over the top of them with lines, arrows etc.

To avoid huge megabyte sizes reduce the figures to the size they should eventually appear in and down-sample them to about 300 dpi

Trim photographs so that they only show what's needed. The resolution of digital cameras these days allows to blow up small sections of a photo if you only need a small section.

Diagrams

Make sure the axes are labelled and the labels explained in the caption.

Don't go over the top with fanciness.

Placing the figure on the page: Place each figure on its own page (page numbering not needed). Place the figure in the middle of the page.

Labelling: Write the following words in the bottom right corner of each figure: "Figure x; Your Name and co-authors 20xx". Make sure these words are the same font and style (and the figure numbers are consecutive) on all figures.

Aspect Ratio: Keep the aspect ratio of the production medium in mind. If you produce your figure in approximately the length – width ratio of the journal page you are thinking of (or the thesis page) then you wont get into trouble later on.

Size: Produce the figure in approximately the same size it will eventually be published in. Don't do it more than 2–3 times as large anyway. This way, you avoid having to think about the legibility of text sizes (5 point fonts are generally the minimum size journals allow), the changes of line-widths or all those other horrors, that occur when downsizing figures that were produced in different sizes.

Layers: Personally I am not a friend of "layers" as they are supported by Corel or Adobe. They confuse the editor and even yourself if you look at it 6 month later for revision (as you may forget which layers are switched on and which switched off). The same thing is true for multiple pages within each figure file. Simply have one file per figure.

Maps: On maps, all labelled locations should be used in the text somewhere and vice versa. In fact, it is even more important that all geographic locations mentioned in text are to be found somewhere on your map.

Colour or no colour: Even at manuscript stage produce figures that are supposed to be published in B&W in B&W and colour figures in colour. If you make a nice figure from colour-field photographs, that will eventually be published in B&W, you may get unwelcome surprises.

Font and font size: Make sure you use the same font on all figures. Typically "Arial" is a good font for figures, even if the text is in "Times New Roman". Make sure that the smallest size lettering is at least about 5 or 6 point large.

2.8 Tables

EXCEL sheets: Don't provide Excel tables. It's of course OK to produce them in EXCEL, but in the end you should make a pdf when you submit them.

Analyses: Microprobe analyses should list the major components, the cations of the calculated mineral formula and possibly end member activities, mole fractions or other variables calculated from the composition that are used elsewhere in the text.

Numbers: Remember that the digits behind the comma (or dot in English) should be significant numbers! That is: if you say: SiO_2 = 64.00%, then this means something different from SiO_2 = 64.0%.

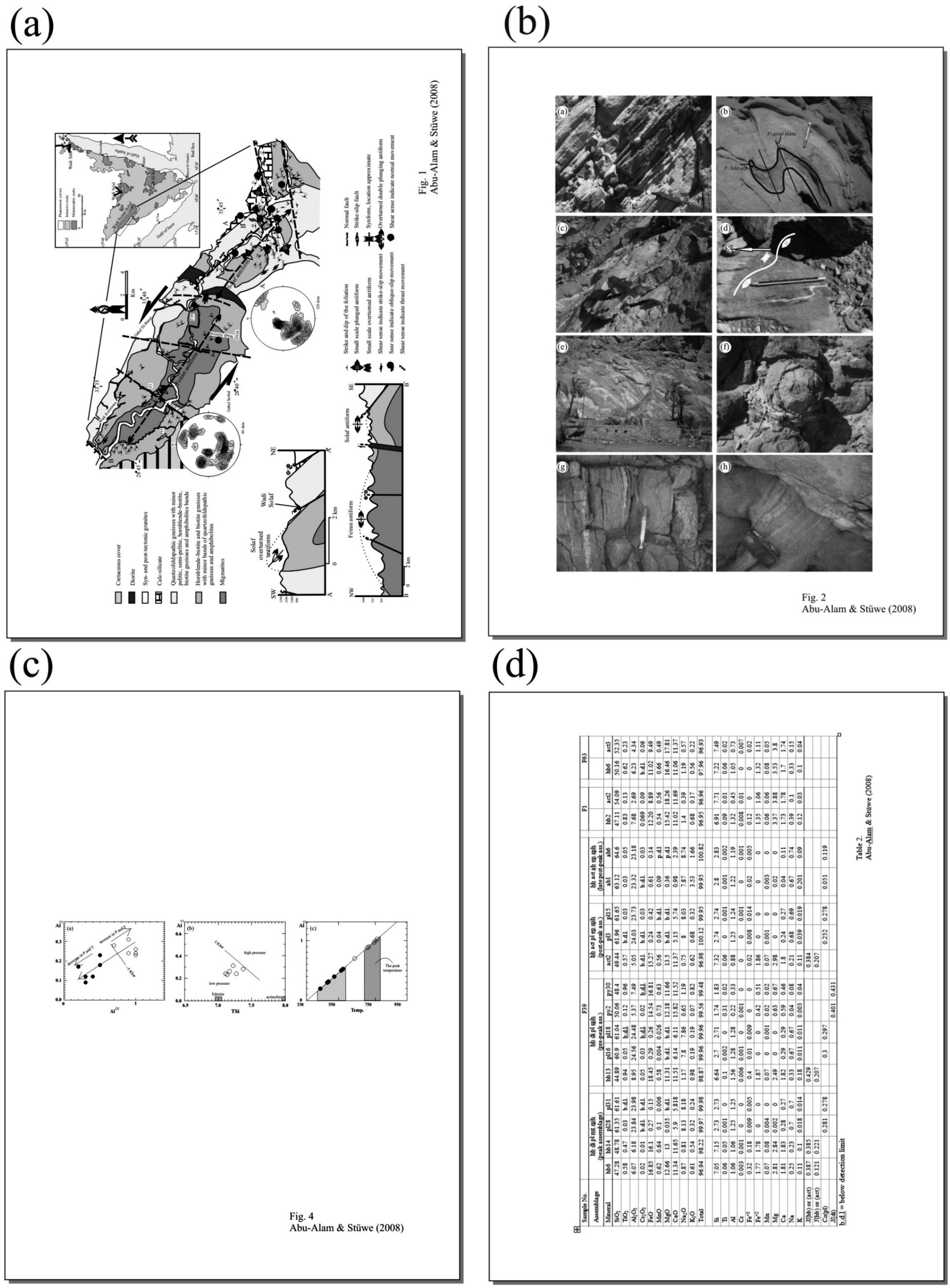

Fig. 4: Some examples how the figures and tables should look like. (a) Typical figure 1 of a field manuscript showing map. (b) Typical figure 2 of a field based manuscript showing field photographs. (c) Typical diagram page. (d) Table. With all figures notice the labelling at the bottom right corner of figure (table) number and date. Also notice that the relative sizes of all figures are roughly those as they eventually should be published.

3. Etiquette of Manuscript Writing

With "Etiquette" of manuscript writing I mean some "do's" and "don'ts" to keep everybody involved happy whilst you write your manuscript. With "do's" and "don'ts" I do not mean any grossly wrong behaviour, let alone the wild and wonderful stories you often hear about stealing data, stealing manuscripts and criminal or semi-criminal actions. I simply mean a series of little polite gestures that make sure that small misunderstandings don't get out of hand. Here is a list of things to help you with this.

Authorship: Discuss the authorship with all co-authors and your supervisor BEFORE writing it down anywhere on paper on the first page of your manuscript. Authorships are touchy issues and once written down it's much harder to change it than beforehand. You are well advised to start your scientific career without any thoughts about corruptive co-authors, egocentric supervisors or plagiaristic reviewers. All of this DOES exist, but such characters are fortunately few and far between. Be optimistic and assume that your supervisor wants the best for your future and recommends you something that is fair and best for you. Fortunately it is common practise these days that students who have done the majority of the work are 1st author. An old wisdom says that authorship is deserved by anybody who has contributed substantially to one of 3 parts: (i) having the idea; (ii) having done the work or: (iii) having written the paper. Remember that the person who paid for the data, the field work or your salary usually has done a lot of work for this manuscript long before you ever thought of this paper (i.e. during the grant writing and application procedure for the project that pays you).

Editing: Whatever you have written at the stage you want to discuss your work with your peers (supervisor, co-author, friends) try to have it edited according to the style described here! This is absolutely independent of how far your manuscript is at. Insert the references (see section 1.4) and proofread the style, even if there is only a few paragraphs of a manuscript "in work" that is as yet to progress a long way. I have heard many times: "Can you please read this for the science only – I know the style is in a mess, but I can clean this up later easily myself" ... Well, – if it's so easy for you to clean the style up – then do it before you show your manuscript to anybody. Science is clarity! So the difference between the "good science" of your manuscript and "good editorial style" is actually smaller than you think (see section on philosophy below).

English language: Don't excuse a bad writing style by blaming it on your lack of command of the English language. Experience shows that – with very few exceptions – authors who write bad English are also bad writers in their own tongue! Usually, if you know how to formulate something concisely and clear in German, then you will also find it easy to write this in reasonable English (even if your English is limited). Scientific language should be simple and written in short sentences, so there is no need for elaborate poetic style. So you don't need many words, but you DO need to have your argument and story well laid out – in German as in English.

Hard copies: Personally I am a friend of hard copies of manuscripts. Whether you share this view or not, make sure that IF you print a hard copy, then (hand-) write the date (and possibly a version number) on the top right corner of the hard copy of your manuscript. At the latest stage when your manuscript is submitted for publication you should give a hard copy of the entire manuscript to all authors involved (with handwritten submission date and journal name on it).

Keep everybody updated: Make sure all authors know where the manuscript is at, during all stages of the manuscript writing and publishing procedure. The critical times when you should inform everybody are: (i) when you start writing, (ii) when you submit, (iii) when it's in print.

4. The Publishing Procedure

One of the main reasons to write manuscripts at all, is to publish them eventually. In fact, publishing your work is an essential responsibility of you as a scientist. You owe this your funding institution, the tax payer who supports you, your mum or – at the very least – to yourself so that you can remind yourself of what you did in the future. Publishing your work in a journal with a proper review system is a lengthy process, but it's worth it. Here is a step by step summary what happens during the publishing procedure. All publishing (with some exceptions) is a process where no money is involved. It is all done on an honorary basis.

4.1 Submitting Your Article

Once your manuscript is finished according to the guidelines explained above and all authors have been asked and given their OK, it is your job as the lead author to submit your manuscript for publication in a journal of your choice. (Asking for research money through grants is actually a very similar procedure and will be explained at the end of this section). For this you are well-advised to make your decision on the journal you want to publish your work in a bit before finishing your manuscript as the style of writing may depend a bit on the journal. There are three aspects that are important to think about when choosing a journal:

1. Journal Scope: Your work must fit into the scope of the journal. All journals have on their home page an explanation what type of work they specialise in publishing. However, this text is often very general and often you get a much better feel for the journal scope by leafing through a few of the most recent issues. The journal scope will determine the way you write your introduction. For example, in AFRICAN JOURNAL OF EARTH SCIENCE, an introduction pointing out the regional relevance of studying the border of east Gondwana in Sudan is perfectly OK, but if you publish this article in PRECAMBRIAN RESEARCH you may want to rather point out why its important to know this boundary for the understanding of Precambrian geology in general and why Sudan is the best place to look at this.

2. Quality and level of work: Try to get a feeling if the level of your findings is appropriate to the level of the journal. Try to stand back and decide. In general, you can consider all journals with impact factor above 2 to require a substantial amount of research to successfully publish therein. An experienced advisor will help you to pitch not too high and not too low.

3. Practical reasons: There are several very practical reasons for the choice of journal.

Page limits: Several journals have page limits and your research may be too long or too short for a given journal. For example, GEOLOGY limits its articles to 4 printed pages, while JOURNAL OF PETROLOGY has a reputation for publishing very long manuscripts.

Page charges: Some journals charge for publishing each page and most journals charge for publishing colour figures. Keep this in mind when picking your journal.

Turn around time: There may be reasons why you need to publish quickly, be it because you are in competition with another group or because you need the track record for a job application. Find out how long the journal of your choice takes from submission to publication (typically this time is between 5 months and 1 year)

Rejection likelihood: If you REALLY need to publish your work, but you are not confident that it will pass the review hurdles, then it may be important to find out what the rejection rate of the journal of your choice is.

Once the decision on a journal has been made, its time to actually submit your article. These days most journals have an online submission system and you will need to upload your manuscript and figures. At the very latest you will see at this stage that the layout described on p. 2 of this document is crucial, as this is also the order things need to be uploaded.

Add a cover letter: When you upload your article you will be asked if you do want (or you must) upload a cover letter. Whether you are asked to do that or not I (as an editor) always consider it polite if authors do write one. Fig. 3 shows a suggestion for the wording of a cover letter (a minimum cover letter that is). You will see that the letter includes suggestions for reviewers. If you do that – then be careful not to name too close of a friend. It will ruin your reputation if you do and you are found out. Pick people you think of experts in the field of your research. Naming people you do not want to review your work is also perfectly OK to do. There may be good reasons to do so: for example if they are in a competing research group. Once you are all done, give your co-authors a hard copy of the manuscript (with handwritten submission date on front page). Ask your co-authors if they need / want a soft copy of the manuscript.

Submission by the 2nd author: There may be reasons why the first author does not do the submission himself/herself. For example, if the 1st author is a student who just finished his or her thesis and is on an extended trip outside reach or interest of the submission procedure. In this case, it is very important that the submitting author keeps the first author informed of every step as good as possible. Note that it is quite uncommon that somebody submits the manuscript who is not the first author.

Journal of African Earth Science
Nile Street, 1234 Cairo, Egypt
http://www.africageology.org

Graz 30.11.2012

Dear editor,

Please find enclosed / attached a manuscript with the title:
"Tectonic Evolution of the Arabian Shield" which we would like to submit for publication in "Journal of African Earth Science". The article deals with an important part of the tectonic evolution of Africa and we therefore feel it is appropriate to your journal.
The following colleagues may form part of a list of appropriate reviewers:

- Name, email address, expertise
- Name, email address, expertise

We are looking forward to hear from you
Sincerely
Alfred Wegener

Fig. 5: Suggestion for the style of a (minimum) cover letter accompanying the submission of a manuscript for publication in a peer reviewed journal.

4.2 The Review Procedure

Once your article has been submitted it's waiting time. You can expect an acknowledgement of receipt by the editor within a few days (or even automated acknowledgement from the submission system) and you can ask to get one if you don't get one automatically, but other than that you should wait at least two to three months before you bother your pained editor with questions on the whereabouts of your manuscript. Behind the scenes and outside your knowledge the following procedure is happening:

Editor at work (1-10 days): The editor reads your manuscript and checks if it is appropriate for the journal, if it is edited well, the English OK etc. Once this is done, and the editor finds your article in principle OK and appropriate for the journal, he/she will think about possibly reviewers. Usually he/she will now pick two sometimes even three reviewers. In general the editor may want to pick one reviewer with regional expertise on your study region and one reviewer with conceptual expertise on your subject. As both reviewers should NOT be from your department or be your friends or enemies, it's not a trivial task to find appropriate reviewers. Even if the editor finds them, they may decline to review your article because its a lot of work and the entire procedure operates with no money flowing anywhere. The editor can – of course – also decide to accept your paper for publication right away or reject it. While the former practically never happens, right out rejection is quite common.

Reviewers at work (1 week–3 months): Once the editor has found 2 reviewers, they will receive the manuscript for review (often this is by getting a password to access it via the online system). To an experienced reviewer the review of an article for a high profile Journal (impact factor >1) will take about 1–3 full days, often more. I myself spread a review over about a week. When the reviewers are finally done (and this often takes several "gentle reminders" by the editor they will write their review of your paper and send it anonymously or signed back to the editor. Typical reviews are 2–5 single lined typed pages long plus a tick-sheet in which they make some formal recommendations and ratings on questions like: (i) is the data OK, (ii) is other relevant work cited properly, (iii) are interpretations justified by data, (iv) is the English OK, (v) are the figures legible .....

Editor decision (1–2 weeks): The editor now reads the reviews and decides on your manuscript. Normally this decision is one of four possibilities. The editor will then send you a letter with the decision and the reviews (usually anonymous). The typical four types of decisions are:

Publish with no revision. (This really hardly ever happens)
Publish with minor revision. (If you get this decision – its big smiles all round)
Publish with major revision. (This is very common.)
Reject (with either invitation to re-submit, or without). This is not so uncommon either.

Author at work (1 day–3 months): Now it's your job to work through the reviews and accommodate the reviewers comments. It is good to keep in mind that the reviewer has a distant view point and therefore the same view point most of your readers will have once the manuscript is published. Thus, for example, if the reviewer criticises something and you feel: "This is what I said anyway" then at the very least this means the reviewer didn't understand you. Unless there is a good reason to NOT do a certain point, you are well advised to simply do what they suggest. With your resubmission you will usually need to submit a detailed point by point explanation how and where you accommodated the reviewers comments.

Editor at work: Now the editor has to compare your re-submission with the comments of the reviewers and look if the comments have been implemented or – if they were refuted – if this is justified to do so or not. The editor is free to decide whatever he/she wants: (i) Send the manuscript out for review again, (ii) reject it, (iii) accept it for publication with no further change. If he accepts it, but thinks there is still too many editorial inconsistencies, he may just send it back to you asking you to "clean up" your manuscript – this is actually very common. However, don't count on the editor doing that. The editor may angrily reject your manuscript at this stage because he/she feels the authors were careless. This happens regularly! In general, if you had two reviews of your manuscript with both only suggesting minor revision (and you have written a careful letter explaining how you accommodated these), the editor will accept your paper. If you had two reviews suggesting major revision, the editor often sends it out to one final reviewer for a 2nd check (this may be the same person who did the first review).

4.3 The Publishing

Once the editor accepts your article for publication with no further revision he/she will write you a letter to this effect and pass on your article to the publishing house. From now on your manuscript is outside the hands of scientists and in the hands of the publishers. Soon after receiving your manuscript, the publishers will write you an email with a few forms attached. These forms will be:

Copyright transferral form: You will now need to transfer the copyrights of your work to the publishing house. Usually the first author signs on behalf of all authors.

Reprint order form: In the "old days" reprints of journal articles were a common thing to collect and pass around. Although this has almost stopped with the advent of pdfs and cheap printers, journals still try to sell reprints and this form is to order some.

Colour plates: If your journal charges for colour figures, you will now need to pay and / or size them up.

Once you have filled those forms out, your manuscript will be copy edited by the publishers and typeset in their typesetting software to look like the articles in their journal. If there is a lot of problems the editor has not cleaned up, the manuscript may come back to you at this stage with a "query form" asking you to clean up stuff. Often this occurs with references and citations, in particular "in print" citations about which you will be asked to fill in the details. Once all this is done, the publishers will send you the "proofs" of your paper.

Proofs: On the proofs you will see for the first time how your paper will look like when published and it's the last time you can make any changes. However, you can only change things that screwed up during type setting. If you want to add new sentences or delete some or do any other changes to text and figures that you should have discovered earlier, then you may be charged for those as it may mess up the entire page layout and thus cost extra time for the type setter. One of the most common problems on the page proofs I have encountered are (a) that an important figure was reproduced too small, whilst an unimportant one was reproduced as a whole page or (b) that mathematical symbols in the text did not reproduce in the correct style. When you correct things on proofs, it is recommended that you use proper correction symbols. For manuscripts written in German, the duden Series "Satzanweisungen und Korrekturvorschriften" gives you guidelines.

Once the page proofs have been returned, it will not be long before your article will be published online and a few months later it will appear in the journal. Congratulations! The entire procedure may take anything between a few months and up to more than a year. There is also no money involved. Neither the authors, nor the reviewers or editors get paid for their work. The entire procedure only works for the sake of science and as honorary jobs – but its worth it! It is understood by universities worldwide that the salary for a scientist means that he / she should be responsibly involved with this procedure.

Online repositories: A new way of publishing are "online repositories". These are simply additional data that belong to your paper, but for which the space in the journal is too tight. Journals have therefore allocated web-space for those and you can refer to these data in your paper.

4.4 Grants, Theses and Books

Grant proposals: Grant proposals are actually not very different. Most granting institutions work like journals. Upon receipt of your funding application, they will send it out for review and have your application evaluated externally by independent reviewers. Once back from review, the funding application usually goes through a panel meeting where the funding is decided upon. Grant proposals also have a similar layout to papers: The need to have an introduction, a methods section and carefully assembled reference section. Usually, they also have an "aims" section, and a "time plan" and of course a "budget" section.

Books: Books are a bit different. For writing books, the review procedure actually happens BEFORE you start writing, not after. If you want to write a book, then you discuss this with the editor of the publishing house. If he or she agrees in principle, then you will have to write a preliminary content page, a few pages of text sample and submit this with your CV to the publishing house. Based on this information, you and the planned book will be evaluated for market value etc. If the publisher decides in the end your book should be written, a contract will be made between you and the publisher and you can start writing your book without the worry that nobody will ever publish it. In reality, authors only approach publishing houses about the plan to write a book if they have already collected their lecture notes or writings for years and have the book pretty much ready in their head. Of course all this is only true for scientific texts. If you want to write a novel, you must have a complete manuscript first, unless it's called Harry Potter.

Theses: Theses are – in principle – the same as journal articles. In fact, in Australia, PhD theses are dealt with exactly the same was as journal articles with anonymous external review etc. Even Bachelors theses and Masters theses get reviewed outside your immediate peers like your supervisor. I am a strong believer that review of Bachelor Masters and PhD theses outside the responsibility of the supervisors is the only way to have an objective evaluation system. In fact, for a PhD thesis I maintain that you only deserve one if you actually found out something new and have proven that you can work as an "independent scientist". Really, the only way you can prove this is by publishing a paper or two or three in an international peer reviewed journal. Thus, PhD exams are in some ways redundant if you have published a couple papers.

5. Quality of Science

The quality of science is a much-discussed subject among scientists. Scientist talk about "bad science" and "good science", but it is not trivial to define what exactly they actually mean with such qualitative statements, let alone measure it. In this section I provide some important aspects how to think about the quality of science both from the philosophical and the "analytical" side.

5.1 Philosophical Remarks

I am a strong believer that good science is intimately related to modelling. Without a model in mind, the collection of meaningful data in nature is difficult. Before you get defensive and want to argue that there are very good scientists who are not modellers, think again! Just try to consider what modelling really is, because not all modelling must involve mathematics (although many people think so). Models are tools that we use to describe the world around us in a simplified way so that we can understand it better. It is widely accepted that a scientific model is a tool for the description of nature that has the three following properties:

Clarity of description: A good model should describe a large set of observations with a comparably small set of parameters: it must be more simple than nature itself.

Predictive power: A good model must be useable as a tool to make predictions about fact that have not been observed yet.

Testability: It must be possible to test a good model by making new experiments or observations.

Note that none of these three requirements includes "correctness" or "accuracy". The deciding factor for a good model is the balance between accuracy and simplicity. Accurate description of nature is a virtue that remains reserved to (explanation-free) collections of measured accurate data. (Although: remember that many measured data may not be accurate either – see below).

If you accept the definition of a model given above, then you will share the view that all good science is some sort of modelling. Sadly, many geologists misunderstand the word model and think of it only as something complicatedly mathematical that has little to do with field work. However, I very much argue that even good field mapping is some sort of modelling. I want to illustrate this using a geological mapping exercise as an example:

A map is a transformation of reference frames; for example the projection of the geographic position of field locations onto a piece of paper. However, a geological map that is a mere representation of field data in a new reference frame (i.e. our piece of paper) may be a good map but is usually a poor geological map. It may still be useful to find a given outcrop of a given lithology, structure or metamorphic grade, and it is the job of the geological survey geologists to record this fact by fact as detailed as possible, but as scientists we are usually unsatisfied by simply documenting what is there. Usually we want to go beyond that and map to clarify field relationships, for example when we infer where a lithological contact is underneath a meadow. We make maps so that we can explain some features of nature to a colleague geologist without him or her having to do the same amount of field work we invested to produce the map in the first place. In order to achieve this aim, the geological map must illustrate field relationships in a simplified and interpreted manner.

This forces the field geologist to a constant decision-making process. First of all the geologist has to decide what is to be mapped. Is it topography? Is it structure? Is it metamorphic isograds or is it lithology? Which of these (and many others) is to be mapped depends on the question with which we go into the field. Then, the geologist has to decide on the scale on which the map should be produced. This decision is not trivial! The scale of the map depends on the problem to be solved. Once the scale is decided upon many more decisions are to be made. Which observations are too small to be mapped and should be neglected? Which ones should be drawn into the map? Which ones are to be emphasized by lines? Can a contact seen in two outcrops be mapped as a line, even in the paddock separating the two outcrops? The geologist is modelling!

If the map is good, then it helps the reader – like any other good model – to understand nature quickly and easily. It also helps to make predictions how the geology may look at different places that were not mapped yet. For example, constructing profiles across our map helps us (to a certain degree) to explain how the geology looks underground. In numerical-, analogue-, conceptual- or thought-models this process is the same. Mathematical models consist of a series of rules that determine which observations in nature are to be neglected and which ones are to be emphasized. The former will not appear in an equation, the latter will appear as a parameter in the equation. As such, a mathematical model is no different from the field work of a geologist.

Every model can therefore be considered as a tool that can be used to make predictions about observations in nature. Just as a geological map can be used to construct cross sections and thus predict the geology underneath the surface, a numerical model can be used to make predictions about temperatures, forces or velocities which cannot be observed directly because of their enormous time scale or depth. If the choices of parameters that we consider in our model (and the rules that relate them to each other) are good, then our model is good and it will predict many new observations which will be proven to be correct by future observations. If our choice of parameters and rules is bad, then our model may explain the one or other field observations, but it will predict many other features that will be proven wrong by future observations. Modelling is therefore an iterative back and forth between the choice of parameters and rules that are to be considered or neglected, new observations in nature and finally improvement of the model based on the new observations. Good models are consistent with a large number of observations, but models are hardly ever unique in fitting those observations. Understanding the difference between consistent and unique between good and accurate and accurate and precise are at the heart of doing good science.

Consistent versus unique: The difference between consistent and unique is an important one that is often not recognized, even by modellers themselves. Unique means – as the word says – that the model is the very only explanation for a set of observations. Consistent means that the proposed model does explain a set of observations, but that other models may also explain the same set of observations. The largest majority of models are consistent but by no means unique. For example, the heliocentric Copernican model for the solar system is a model which is consistent with our observations of when the sun rises and sets and so on. However, a geocentric model in which the planets and the sun rotate around the earth is possible too. The geocentric model is amazingly more complicated than the heliocentric model and it involves weird planetary motions including epicycles and cycloid curves. However, it also is consistent with our observations on planetary motions. Neither the heliocentric, nor the geocentric model are therefore unique. When viciously defending a model in a discussion it is always sobering to remind oneself that practically all models are only consistent (at best).

Good versus accurate: The difference between good (or possibly: "adequate") and accurate models is related to the difference between consistent and unique models, but it is not quite the same. Here, it is important to realize that the best model must not be the most accurate model! The best model is the one that finds the best balance between accurate description and simplicity. A good example for this is given by a comparison of Newton's law of gravitation and relativity theory when applied to the description of planetary motion. Newtonian theory states that the gravitational attraction, F, between two masses is directly proportional to the masses of the two bodies m1 and m2, and inverse proportional to the square of the distance r between the two bodies. This model is incredibly simple and may be described by a simple equation: F = G (m1 m2)/ r2. The constant of proportionality is called the gravitational constant, G. This model describes the elliptic motions of the planets (that were discovered by Kepler in order to improve the Copernican model) extremely well. However, very detailed measurements early this century showed that the motions of some planets differ a bit from those described by the equation above. These differences may be explained with the model of general relativity, which describes the planetary motions more exactly than Newton's law. Indeed, general relativity shows that many concepts of Newtonian physics are ``wrong", for example the constancy of mass (general relativity states that mass depends on speed). Thus, one might consider Newton's model to be superseded by general relativity and use this new model from now on. However, general relativity is much harder to grasp than the intuitive understanding of the simply equation above. It is therefore often not very practical to use. In fact, for the largest majority of purposes – for example to find a planet with a telescope in the sky, or for the interpretation of gravity anomalies by a geologist – Newton's model is sufficient. Thus, for most purposes Newton's model is better (because simpler), albeit less accurate. In short, a good model should find a good balance between simplicity of the model and accuracy in describing a set of observations and this balance depends on the problem to be solved.

Accuracy versus precision: In the last paragraph we have used the word correct to describe a very good correlation between model description and observation in nature. In general this is the same what is meant by the word accurate. However, precision is something different. Precision describes how good a model or an experiment can be repeated with the same result. Let us illustrate this with an example. A radiochemical analysis may indicate that a rock formed 100 my ago. This analysis is very precise if every time we perform it, we arrive at the same age of 100 my. This applies to errors as well. The analysis is still called very precise if we come up with an answer of 100 ± 50 my, if that answer is reproducible with the identical error limits and we know these error bars very well. However, the radiometric age above is not very accurate. In fact, even analyses with very small analytical errors may be not very accurate at all. It could be that a precise but inaccurate age of 100 ± 0.1 my was obtained for a rock that actually formed 150 my ago, which in itself bears important information, for example, why the chosen radiometric system re-equilibrated 50 my later.

In conclusion of this section remember that a model is a description of nature that is (a) clear and simple, (b) has a good predictive power and (c) can be tested with further observations. A good balance between accuracy and simplicity is at the heart of every model and the better you made this choice, the better is your science.

5.2 Measuring the Quality of Science

Most people will agree that it is impossible to measure the quality of science and yet, most of us have a pretty good feeling about what is good and what is bad science. Measuring the quality of science is also one of the most discussed questions in the context of publishing, or evaluating publishing scientists. Clearly, the simple answer to the individual scientist is: "A good journal is the one that publishes the most interesting articles (to me)". Correspondingly, the best scientist is the person I can learn the most about nature from. However, in many situations this is not sufficient. For example when you need to choose the best scientist for a given job, there may be the need to quantify the question "who is the best scientist". Also when journals compete for being subscribed to by libraries, they may want to quantify somehow that they are better than other journals. Of course you are right if you argue that this is all impossible to measure. For example, how do you compare the following two types?

> There may be the proverbial grumpy scientist who never had students or research projects and never published papers and only sat in his room and thought and – in the end he/she published the relativity theory (it is being said that Albert Einstein was a bit like this).
>
> On the other hand, there may be the busy ferret-type scientist who dances on all parties, is loved by students and colleagues, publishes lots of papers every year in the local geological society newsletter but is not known beyond your university and his results have little lasting impact.

So who is "better"? Despite the impossibility of answering this question, the really only way that is used today to measure and quantify scientific output is through the products of THOMSON SCIENTIFIC (formerly called "Institute for Scientific Information" ISI). They produce a series of statistics on published work and their products are the most widely used source of information when you are forced to quantify the quality of scientific work (which is – for example – needed when departments are evaluated and the like). The most important products of the ISI are:

Science Citation Index (SCI): The SCI is probably the most widely used scientific citation data base. It started in the sixties. Today it lists 3700 journals and is published as CD-rom.

Science Citation Index Expanded (SCIE): The SCIE is the online sister version of the SCI, but is a different product. It lists almost 6000 journals from 150 different sub-disciplines of the sciences. Within the Earth science, the SCIE lists the following categories (i) Crystallography, (ii) Geochemistry and Geophysics; (iii) Geology; (iv) Geoscience multidisciplinary; (v) Mineralogy. (Other disciplines listed by the SCIE and possibly relevant for Earth Scientists, but for which no journals were chosen are Biology; Thermodynamics; Astronomy; Engineering.

Web of Science: The "Web of Science" is a connection of various data banks, of which the SCI and the SCIE are the most important ones, but it also joins in the data of the SSCI (Social Sciences Citation Index) and the A&HCI (Arts and Humanities Citation Index). Disadvantage of the Web of Science is the absence of Conference contributions. The most important search options in the Web of Science are:

General Search helps to find authors and papers.

Cited Ref Search helps to find authors and all their papers.

Journal Citation Reports: The JCR are produced from the SCI and SCIE data. As their most important number, they produce the impact factor for each journal.

Two of the most important uses of these products are to spy on the quality of a journal or the quality of a scientist. Scientists may be looked at by:

Total cites: This is the number of citations the publications of this author have received in the literature by other authors. It turns out that 90% of the articles published in the literature receive less than 1 citation per year, so any paper that you write that receives a handful of citations may be considered as a good one! Only very few papers are cited more than 100 times within about 10 years after publication. Of course this measure if floored by some problems (for example, one of the most cited papers of all time is the suggestions for mineral abbreviations by Kretz, 1973) but there is really no other quantifiable measure.

Hirsch index: The Hirsch Index was only invented 2–4 years ago and is a way to sum up the profile of a scientist in a single number. This number is given by the number of papers x that a scientist has published that have received at least x citations. Scientists with a high international profile have usually a Hirsch index around 15 or more. Some are above 20, but there are only very few world wide that have a Hirsch index above 40.

Journals may be evaluated on the basis of:

Impact factor: The impact factor is given by the average number of citations each paper in this journal gets per year in the year following the evaluated year. That is, if a journal published in 2008 twelve monthly issues with 10 articles each and there is a total of 120 citations of these articles in papers in the literature in 2009, then its impact factor for 2009 (published at the start of 2010) is 1. Journals strive to have an impact factor above 1 and you will see from the table below that there are only about 150 journals worldwide that have achieve this in the disciplines of Earth science.

Half life: The half life is a measure how rapidly the interest in an article or the articles in a journal decays after publication. For authors, it is the rate at which the annual number of citations decreases in later years (this must not decrease at all, but usually does).

Tab. 1: A random choice of some scientific journals with high impact factors from the Earth science, from zoology and biological sciences extracted from Science Citation Index (SCIE) listed journals. Abbreviations are: cites = total citations of articles per year; impact = impact factor; 5 = five year average impact factor; im = immediaticy index; articles = number of articles per year; half l = half life; eigen = eigenscore; iscore = impact score.

Journalname	cites	impact	5	im.	articles	half l.	eigen	iscore
REV GEOPHYS	4582	**6,9**	12375	0,72	25	>10.0	0,01176	7902
EARTH-SCI REV	2828	**4,31**	6146	0,854	41	6,3	0,01538	3211
EARTH PLANET SC LETT	26488	**3.873**	4445	0,563	503	8,3	0,12507	2422
J PETROL	7069	**3.806**	4256	0,5	86	9,5	0,02368	2,19
GEOLOGY	18873	**3.754**	4161	0,66	285	9	0,07036	2,18
GEOCHIM COSMOCH AC	32873	**3.665**	4419	0,719	395	>10.0	0,08079	1939
GEOL SOC AM BULL	10021	**3.354**	3579	0,579	95	>10.0	0,02024	1,78
PRECAMBRIAN RES	5127	**3.247**	3562	0,625	96	7,5	0,01753	1447
CHEM GEOL	12562	**3.231**	4146	0,5	254	8,5	0,04291	1768
CONTRIB MINERAL PETR	9899	**3.216**	3674	0,588	85	>10.0	0,02151	1908
J GEOPHYS RES	122233	**2.953**	3402	0,613	2510	9,1	0,36602	1,39
LITHOS	4318	**2.937**	3457	0,768	142	6,4	0,01914	1492
J METAMORPH GEOL	3067	**2.753**	3857	0,509	53	8,5	0,00954	1549
GEOPHYS RES LETT	41309	**2.744**	2917	0,469	1474	5,7	0,25797	1551
J GEOL	4503	**2.607**	2978	0,524	42	>10.0	0,00735	1411
TECTONICS	4577	**2.398**	3349	0,539	89	>10.0	0,01335	1631
AM J SCI	5023	**2.375**	3486	0,649	37	>10.0	0,00621	1855
BASIN RES	975	**2,31**	2743	0,129	31	7,2	0,00492	1468
J GEOL SOC LONDON	4461	**2.304**	2976	0,546	97	>10.0	0,01299	1367
AM MINERAL	10676	**2.203**	2329	0,442	226	>10.0	0,02707	1065
TERRA NOVA	1820	**2.065**	2574	0,125	64	6,8	0,00915	1,33
PHYS EARTH PLANET IN	4648	**2.026**	2436	0,368	125	9,4	0,02124	1416
TECTONOPHYSICS	12310	**1.729**	2179	0,255	161	>10.0	0,03074	1069
TRENDS ECOL EVOL	19073	**11,564**	16,853	2,487	80	7,8	0,06371	7,750
GLOBAL CHANGE BIOL	10842	**5,561**	6,600	1,204	230	4,9	0,05297	2,643
J ECOL	11390	**4,690**	5,651	0,692	133	>10.0	0,02495	2,103
ECOLOGY	42832	**4,411**	5,826	0,668	337	>10.0	0,08380	2,427
J BIOGEOGR	7909	**4,087**	4,604	0,971	173	6,1	0,02761	1,646
BIOL CONSERV	13288	**3,167**	3,907	0,602	329	6,1	0,04224	1,253
OIKOS	16164	**3,147**	3,940	0,522	207	9,5	0,03805	1,590
BIOL INVASIONS	2636	**3,074**	3,565	0,631	198	3,9	0,01176	1,165
TAXON	2746	**2,747**	3,037	0,570	79	6,8	0,00951	1,140
PRESLIA	523	**2,638**	2,386	0,125	24	5,6	0,00160	0,676
BASIC APPL ECOL	1306	**2,422**	2,979	0,422	83	4,7	0,00618	1,039
J VEG SCI	4803	**2,376**	2,987	0,273	110	9,0	0,00923	0,968
ZOOL J LINN SOC-LOND	2529	**2,031**	2,374	0,519	106	10	0,00593	0,910
J ZOOL SYST EVOL RES	639	**1,850**	1,852	0,409	44	5,2	0,00240	0,630
ZOOMORPHOLOGY	739	**1,786**	1,531	0,583	24	>10.0	0,00093	0,457
HYDROBIOLOGIA		**1,784**						
RESTOR ECOL	2253	**1,665**	2,490	0,420	100	6,9	0,00697	0,858
J ZOOL	6321	**1,545**	1,930	0,328	125	>10.0	0,01100	0,713
EXP APPL ACAROL	1629	**1,391**	1,449	0,795	83	8,2	0,00317	0,407
APPL VEG SCI	690	**1,349**	1,877	0,273	44	5,5	0,00223	0,549
FOLIA GEOBOT	651	**1,320**	1,400	0,000	19	9,6	0,00133	0,474
LICHENOLOGIST	988	**1,222**	1,144	0,395	43	9,5	0,00172	0,307
ZOOTAXA	3978	**0,891**	0,788	0,302	1389	2,7	0,01627	0,188
J SYST EVOL	98	**0,880**	0,891	0,259	54		0,00068	0,355
PHYTOCOENOLOGIA	344	**0,674**	1,103	0,611	18	7,3	0,00085	0,351
APPL ENTOMOL ZOOL	1299	**0,616**	0,819	0,228	79	9,6	0,00228	0,249
PHYTON-ANN REI BOT A	278	**0,537**	0,438	0,067	15	7,9	0,00057	0,131

6. Further reading

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