Essential tips for a rock-solid geoscience PhD: Part II

In the second of a three-part focus, Melanie J Leng & Anson Mackay advise on how to ensure your PhD experience is a good and productive one.

We previously gave tips on how to choose the right project and supervisor, as well as how to manage the student-supervisor relationship and your time. Here we offer advice on the practical side of doing PhD research.

Training

Most geoscience PhD students have access to training courses and some will be compulsory. In the UK, Doctoral Training Partnerships collates training courses across universities to offer a wider choice and to facilitate cooperation and sharing of good practise. Funding bodies, such as NERC also offer training. You should take the initiative, know what courses are available and determine with your supervisor which are essential.

Organising your data

Train yourself to be competent in a data analysis and drawing package. For data analysis, R—free software for statistical computing and graphics—is probably essential, and will augment what you can do with your data. Coding for many geoscientists is becoming essential, and increasingly code is required for peer-review as well. Make sure that your coding is clean and really well annotated so that you can understand what you have done, and others can repeat what you have done. Bespoke analytical packages are also important.

To present your data, become an expert in a drawing package. The learning curve with all new software packages is steep, but the view from the top is worth it. Gantt charts are useful to illustrate the start and finish dates of different elements of your work (at experiment to thesis scale); to break down your work into chapter/thesis sections (good for supervisory meetings); and to show the dependency of activities. Slack is a great way to interact with key members of your project team.

During your PhD you will read *a lot*. Even for experienced researchers, there is too much information out there. Being organised about your reading is essential and it is critical that you keep on top of references to read and cite—there are software packages to help with this. Keep PDF versions of key papers and annotate them as you go.

Backup your files on the university server (there will be a university policy), as well as other places, such as Dropbox and Google docs (and periodically update an external hard drive in case you lose internet access). Some data-storage platforms may not be particularly secure and specific restrictions might apply.

Presentations

Dissemination of knowledge is an essential part of the PhD processes and you should try and give many presentations. This can be terrifying at first, so prepare well. Start local, presenting to your peers and supervisors, and work up, aiming for a big international conference. At conferences, presentations are given as talks or posters. Each have their strengths, so try both. Think about potential questions you may get from the audience, and even prepare a couple of slides if relevant to address those. You will likely have a tight travel budget, so discuss a strategy with your supervisor. Perhaps save for a major international conference in your third year (like the European Geosciences Union General Assembly). Many small grants are available for students, through your university or relevant associations and learned societies. Specialist organisation membership is usually cheap for students and you can attend their meetings and training courses.

Many people find public speaking daunting. Book a presenting course at your university and practise, practise, practise. Some people have debilitating stage fright or extreme anxiety. If this is you, seek help through your supervisor, the postgraduate office, and welfare office. There are tricks you can do to lessen the stress. Use presenting packages that allow presenter notes that the audience cannot see, or write out memory aides on small cards. The benefits of presentations are tangible and once accomplished, it feels amazing.

In your final year, consider organising a conference session with fellow early career researchers. Aim to get a diverse group of speakers together (reflecting especially on gender, ethnicity, stage of career) and consider publishing the session papers in a special journal collection. This will help you understand the publishing process and raise your profile.

Writing

Start early and write often. Your first major pieces will likely be a literature review and an annual report or transfer report (to transfer from MPhil to PhD). These should form the basis of a thesis structure, which you should plan from the start (including what data will go into what chapters, though this may change) and review regularly with your supervisor. Many universities now encourage a thesis composed of papers. Remember that papers are different to chapters, requiring a tighter writing style and having less room for descriptions and discussion. You'll also need all co-authors to consent on the content.

When writing papers, agree in advance what data you will include and who you need to co-author with. This can be tricky if you are part of a large multi-(inter)national project where data are owned by different people and may be ready for publication at different times. It is important to be clear about expectations of who will do what early on in the paper development.

Discuss with your co-authors which journal to submit to. Journals have different audiences and while impact factors are commonly looked at, by themselves they are not a measure of the quality of a journal or the papers they contain. You may wish to make your paper open access (OA), so that anyone can read your research, not just those who have access to personal or

institutional subscriptions. Many subscription journals offer to make individual papers OA for a fee (article processing charge, or APC). Alternatively, there are a growing number of OA-only journals, where costs for article production and publication are borne only by people paying an APC ('gold' open access). These can be very expensive, but such fees are usually dealt with by institutions, who reach agreements with funders to cover the costs of publishing (for example, for NERC-funded PhD studentships, where the gold route maybe stipulated).

Alternatively, green OA allows you to deposit, for free, the final manuscript (after peer-review but before journal formatting) into a an electronic repository (e.g. most institutions have their own repositories, as do funding bodies such as NERC). But copyright and embargo conditions may exist, and will depend on what contract you signed with the publisher of the journal. A few journals, such as *Volcanica*, are now appearing that offer diamond OA. Here papers are free to publish and to read, and the costs are covered by external investment. Finally, most journals now allow you to upload your draft manuscripts into a preprint repository such as EarthArXiv, where earlier versions of your work are free to down load and me commented upon. Be aware that the field of publishing is rapidly changing, and you should keep informed about recent developments in Open Science.

We highly recommend, and your funding body may insist, that data be submitted to a data repository such as Pangaea, or NOAA. Make sure that as you collect and organise your data, metadata are considered carefully too.

Once you start publishing (including conference abstracts with ISBN numbers), set up Google Scholar and ORCID accounts (which will update automatically) for maximum outreach. Once a paper is out, consider blogging about it (for the non-specialist) or recording a video introduction (and link these activities to your social media). Many academics have their own social media profiles, such as ResearchGate or Academia. These networks can be really useful to connect with other scientists, but restrictions still exist on what papers can be uploaded.

If you are aiming for an academic position (a post-doc, fellowship, teaching fellow or lecturing position), you might want to undertake a thesis "by papers" and to therefore organise your research around a series of projects or experiments that can be published independently. Some universities require a traditional thesis, so you might have write your papers and then convert them into monograph-style chapters. And it is easier to convert papers into chapters than vice versa, plus you will get more input and advice from co-authors on a paper than you would for your singled-authored thesis chapter.

If your institution allows a thesis by papers, the pros are: publications that greatly enhance your CV and greater input from co-authors in writing the papers. The down sides are: papers can be much harder to write than thesis chapters and will require more time; there is less room for speculation; negative results often do not make into a journal paper, whereas in a thesis chapter you can explore experiments that did and didn't work; you are at the whim of co-authors and their timetables; the more co-authors the more complex the writing (you have to satisfy them all). In the geosciences, multi-authored papers are the norm.

Finally, social media is a great way to practise writing, from 280 character tweets to longer blog posts. But we'll cover that in more detail in part III.

Look out for part III, which includes advice on how to plan for your career beyond the PhD, in the November issue of Geoscientist.

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