**Pitching your PhD for your Confirmation Report**

**Confirmation Report Instructions**

The Confirmation Report is a fully-illustrated and referenced written report. The maximum length 10,000 words, which is quite long. I would aim for around 6000 words for the main body of the report. You may want to have an appendix. Students should consult with supervisor on the structure and length of this report.

The Confirmation Report generally should contain:

1. A statement of the research topic and the research question(s).
2. An account of the research context, including background to the topic, a rationale for its relevance to contemporary scholarship, and a brief review of relevant literatures.
3. An account of the proposed research design, methods of data collection and analysis (including a statement on ethics) and, where appropriate, any results obtained from the PhD research so far (results are not expected for all students). This is usually broken down by chapter after a general introduction.
4. Preliminary identification of the key thesis chapters and/or publications arising from the research (as appropriate). This is usually indicated by the chapter sections of the report. Sometimes students indicate potential journals to which they might submit the manuscripts.
5. A detailed plan for the next 6 months and an outline plan for the next 18 months. Gantt chart or timeline might be useful here. This is a first draft of the PhD timeline that you may want to revisit and update across your PhD.
6. A data management plan (don't forget this!). What are the requirements of your funding agency, etc.? How will you follow open science best practice (see <https://osf.io/>)? Where will you store your data and code? Are there available public data repositories? How will you version control your work? What will you do about privacy concerns with your data?
7. An brief overview of the supervisory arrangements. Who are your supervisors and co-supervisors? What support will different members of your supervisory team provide?
8. An assessment of resources needed to complete the project. What funding, laboratory, computing and training resources do you require? How will you acquire those resources during your PhD?
9. The Ethics Determination Form – Needs to be filled out and approved before fulfilling the confirmation process.
10. Confirmation presentation:

* A short (normally 10-15 minutes) illustrated presentation outlining the research proposed, followed by 5 minutes of questions.
* Normally delivered at the Annual PGR Conference in spring. Can also be held in a department seminar or lab group meeting.
* Attended by the student’s supervisor(s), Advisor and preferably all academic members on the student’s Confirmation Panel.
* The presentation content should include: the research question/s, the rationale for the research, relevant theoretical and methodological issues, technical and procedural aspects of data collection and analysis. If appropriate, it may report on initial findings.

**Developing your PhD Plan**

*Coming up with a title can help communicate what your work is all about. It also makes your PhD plan feel more concrete. Have a think, but don’t worry about coming up with something perfect right away!*

**The working title** *Just list keywords if you can’t come up with a title:*

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| Coal mines – sustainable heat extraction – numerical modelling |

**Your name and your supervisory team**

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| Mylene Receveur, Christopher McDermott, Stuart Gilfillan, Andrew Fraser-Harris,  Ian Watson (Coal Authority), Andrew Gunning (RSK) |

**Overall Aims**

*Coming up with the overall pitch for a PhD can be daunting. But knowing why you are doing the research you are planning to do can really help figuring out the more specific goals of your research. Keep revisiting this pitch and refining it as you progress throughout your PhD it might change quite a lot or it might not, but it should be the anchor to the work that you do.*

**The hook** *Here is what is known about your general field – the big picture of your research*:

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| Abandoned flooded coal mines constitute low-temperature geothermal reservoirs that can be used for energy storage and production (Adams and Younger, 2001). Former mine workings, shafts, drift and roadways form an interconnected network of channels and open tunnels of high hydraulic conductivity compared with the surrounding rock, and that are generally filled with water. This enhanced ‘mine reservoir’ permeability gives the opportunity to extract water at a relatively high rates and provide the surrounding community with potential low carbon heat energy, using open-loop ground source heat pumps systems. Heat energy from flooded mine could be used as heating source for both water and space heating/cooling purposes (Farr et al., 2016), participating to the UK objective of decarbonizing heating by 2025..  Mine water geothermal systems have already been implemented worldwide, such as Heerlen in the Netherlands (Bazargan et al., 2008) or Mieres, Spain (Jardón et al., 2013). In the UK, the first systems were implemented in Shettleston and Lumphinnans in Scotland in 1999. In Scotland, the existence of pumping systems in mines where post-closure water treatment schemes have been implemented by the Coal Authority to avoid environment contamination gives opportunities to limit the costs associated to the potential installation of new pumping system for geothermal production. However, a few is known about the source of heat and recharge mechanisms in mines. Temperature measurements in mines in Scotland indicated the lack of correlation between the depth of the measurement and the temperature, therefore highlighting the contribution from other energy sources / mechanisms than the geothermal gradient.  Understanding heat transfer mechanisms and recovery in mines during heat production is essential to evaluate the sustainability of the system. Predicting long-term mine water production temperature represents a challenge, mostly linked to the complexity of mine systems geometry (i.e. high hydraulic conductivity channels within porous medium, interconnected network of channels…), the lack of knowledge about boundary conditions (i.e. recharge water…) and the complex groundwater flow. The main difficulty here arises from the necessity to solve simultaneously for heat transport in the mine workings and the surrounding porous medium. Most of past studies used various assumptions and simplifications to assess the sustainability of heat extraction from mine workings. The main purpose of this research is to understand why different mines have different temperatures, by developing a conceptual model and numerical tool allowing to predict mine water temperatures. Findings will be used to assess the main thermal processes and heat recovery rate in mines to support the dimensioning of ground source heat pump system and their integration within larger scale energy grids. |

**The knowledge gap** *Here is what is not known about your general field – the gap you will fill:*

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| Analytical and numerical models have been developed worldwide in order to predict mine water recovery after the closure of mines, when dewatering stops. Despite those models give a good insight into the mine geometrical complexity issue and tips about how to overcome them through simplifications, only a few of them considered thermal aspects for geothermal extraction purposes.  Analytical models encompass the study of XXX, who evaluated heat transfer processes through a mine channel of simple geometry surrounded by a homogeneous rock mass. Numerical solutions of heat transfer have also been developed for more complex conceptual approaches (i.e. flow in a dual-porosity medium composed of a caved zone and overlying fracture zone, exchanges at the interface between a borehole and surrounding rock, water mixing within boreholes…). Other numerical models made the attempt to determine precisely the thermal breakthrough time and evaluate the long-term sustainability of heat extraction in specific abandoned mines, using numerical codes able to solve simultaneously for pipe flow and 3D porous media flow. Such models however require detailed knowledge of the 3D interconnections of mine working and networks of shafts, roads and galleries, together with a sufficient amount of temperature and water recovery data allowing to calibrate and validate the models.  This phD aims at creating a new conceptual approach to understand heat processes and recovery in abandoned flooded coal mines, taking into account the overall picture and complexity of a mine, and developing a numerical tool to predict long-term water production temperature and the sustainability of the production. Using typical mine geometries and different production scenarios, the outcome of the research is to provide scientists and authorities with typical values for modeling input, reproducible and usable for multiple case study modeling applications. Thus, this predictive tool would also be used to provide a scientific guide to the design of production system and support the licensing of heat by the Coal Authority. |

**The PhD motivation** *Here is how you are going to fill this knowledge gap – your methods plans*:

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| * Understand the different sections of a mine + flow/heat transfer processes within heat reservoir type + set mathematical equations * Set typical conceptual models for different geometrical situations (i.e. horizontal layers, dipping layers, syncline) * Sensitivity analysis on: 1) the type of mining, 2) the number of mined seams (+possible interconnections), 3) the thermal/hydraulic properties of the surrounding rocks, 4) the height of fracture zone, 5) the initial hydraulic gradient * Identify clear boundary conditions (more case specific): 1) precipitations, 2) presence of aquifers above/below + possible interconnections with the considered mine workings, 3) solar input 🡪 determine recharge rate from different source (i.e. rainfall recharge and infiltration rate according to the mine geometry and the actual flooding level, groundwater or seawater recharge potentially identified from geochemical analysis) + seasonal/long-term surface temperature changes and its impact of geothermal gradient… * Inclusion of discrete features: 1) shafts (heat losses), 2) roadways (privileges flow path to the shaft) * Set new steady state for different production scenarios: 1) abstraction/injection in same working, 2) in different workings, 3) up-gradient/down-gradient * Calibrate model using existing or new data: estimate mined rock characteristics (permeability, hydraulic/thermal conductivity, heat capacity), use corrected surface temperature and geothermal gradient, chemical analysis (i.e. recharged water origin), integrate hydraulic channels/barriers and medium heterogeneities * Predict the sustainability of heat extraction / rate of heat renewal for different production rates * Compare results for different mines and validate with measured temperatures * Repeat modeling and output typical values for different case scenarios. |

**The take-home message** *Here is why this research matters to the bigger picture of the field:*

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| Flooded coal mines represent a great interest as low carbon energy resource. However, the main issue relates to the difficulty to assess the sustainability of heat extraction from such a complex system, and the extent of the zone of influence of this extracted heat. The outcome of this research aims to guide the licensing of heat by the authorities, by providing a tool able to assess the sustainable production rate from mine workings and the rate of heat recovery. |

**Plans for specific chapters**

*A PhD is generally made up of three or four chapters. When you are developing your PhD plan it is a good idea to draft out those chapter ideas at an early stage and to build the literature review around both the bigger picture motivation for your research and the specific themes of your planned chapters. The chapters are usually ranked from least to most risky. Start with the chapters that are most well developed, that the datasets are already in place, etc. and then work towards the chapters that are most fuzzy in your mind that are more likely to get changed later. Include a fourth chapter if you think there is one chapter you might drop or if you want to choose between two different chapter ideas. Consider including a literature review chapter in your PhD if appropriate. Set up a meeting with your supervisor(s) to discuss your draft PhD plan once you have one together before you start writing.*

**Chapter 1**

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| *Specific ‘what we know’ hook:*  *Specific knowledge gap:*  *Research question: What are the main heat sources in mines, which contribute the most to heat recharge? What is the rate of recharge?*  *Hypothesis:*  H1:  H0:  etc.  *Methods (bullet points):*   * Develop a set of models with different input/ BC and thermal/hydraulic properties for a same production scenarios and mine structure to evaluate which properties impact mine temperature the most * For a same set of hydraulic/thermal properties, recharge and production scenario, see how temperature changes when different mine structures are considered. * For a same mine structure and rock properties/input, how production scenario (production/extraction rates, injection/production location) does affect temperature changes * Sensitivity analysis of different parameters * Conceptual model set up = SPATIAL STRUCTURE + TEMPORAL EVOLUTION   *Anticipated results (what you anticipate finding out your hypothesis and null and/or alternative hypotheses spelled out in words):*  If we find this … this will mean …  If we find that … that will mean… |

**Chapter 2**

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| *Specific ‘what we know’ hook:*  *Specific knowledge gap:*  *Research question: What are the disturbances caused by productions?*  *Hypothesis:*  H1:  H0:  etc.  *Methods (bullet points):*   * Look at measurement areas where flooding of mine is occurring and temperature changes over time * Analyze conductivity logs to understand change in temperature with depth * Compare the temperature of mines relatively to depth/location of the measurements and proximity of recharge area * VARIATIONS OF TEMPERATURE WITH DEPTH (impacts of mine workings layering, interconnectivity)   *Anticipated results (what you anticipate finding out your hypothesis and null and/or alternative hypotheses spelled out in words):*  If we find this … this will mean …  If we find that … that will mean… |

**Chapter 3**

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| *Specific ‘what we know’ hook:*  *Specific knowledge gap: guide the licensing of heat*  *Research question: What is the area of impact of heat extraction from mine?*  *Hypothesis:*  H1:  H0:  etc.  *Methods (bullet points):*   * Specific case study used to calibrate / validate the model * Compare output model to temperature/flow measurements * GUIDE LICENSING OF HEAT   *Anticipated results (what you anticipate finding out your hypothesis and null and/or alternative hypotheses spelled out in words):*  If we find this … this will mean …  If we find that … that will mean… |

**Chapter 4 (optional)**

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| *Specific ‘what we know’ hook:*  *Specific knowledge gap: the reason for the lack of correlation between mine water temperature and depth*  *Research question: Why different mines have different temperatures?*  *Hypothesis:*  H1:  H0:  etc.  *Methods (bullet points):*   * Compare heat flux, fluid geochemistry, water sources between mines * Compare different modeling results between different mines * validate results with actual temperature measurements (at which depth?) * CAN PREDICTIVE TOOL BE USED   *Anticipated results (what you anticipate finding out your hypothesis and null and/or alternative hypotheses spelled out in words):*  If we find this … this will mean …  If we find that … that will mean… |

**Timeline**

What is your timeline for your research plans? *These notes can turn into a Gantt chart or similar to illustrate your timeline.*

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| **Year** | **Activities** |
| 2019 | * Write PhD plan * Complete RPMG training course * etc. |
| 2020 winter/spring |  |
| 2020 summer |  |
| 2020 autumn |  |
| 2021 winter/spring |  |
| 2021 summer |  |
| 2021  autumn |  |
| 2022 winter/spring |  |
| 2022 summer |  |
| 2022  autumn |  |

**Data management plans**

Describe your data, code and version control management plan.

**Supervisory arrangements**

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| **Title** | **Name** | **Institute** |
| Principal supervisor | Christopher McDermott | University of Edinburgh |
| Co-supervisors | Andrew Fraser-Harris  Stuart Gilfillan | University of Edinburgh |
| External Advisors | Ian Watson  Andrew Gunning | Coal Authority – CASE Sponsor  RSK |
| UoE advisor |  | University of Edinburgh |
| External Collaborators | David Banks | Glasgow University |

**Required resources**

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| **Fundings** | **Courses / resources identified** |
| Software license |  |
| Conferences |  |
| Journal open-source license |  |

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| **Skills / Training** | **Courses / resources identified** |
| Coupled thermal and groundwater modelling | Hydrogeology 2 course (self-directed learning) |
| Python | NMDM course (E4 DTP training)  Self-directed learning |
| Hydrodynamics  Geothermics | Journals/books (self-directed reading) |

Computing needs?

**Ethical considerations**

* Data management, storage and diffusion: access to data from the Coal Authority requires the definition of a license agreement (To be done in January).
* No fieldwork required

**Health and safety considerations**

* Visit of mines organized by external organizations (Coal Authority, University of Newcastle, David Bans…)

**References**

A full reference list.

**Appendix**

Any additional information that should be included in an appendix.