



## **PEER/PECRE Award**

### **Pools Engagement in European Research / Postdoctoral and Early Career Researcher Exchanges**

#### **Award Report - 17/08/2017**

**Dr Jean-Christophe Comte**, Early Career Lecturer in Hydrogeology, School of Geosciences, University of Aberdeen.

Exchange with the *Hydrogeophysics and Non Destructive Testing Modelling Unit*, University of Oviedo, Summer 2016 (**Dr José Paulino Fernández Álvarez**, Head of Unit).

#### **Summary**

Thanks to the financial support from SAGES, I undertook over the summer 2016 two visits to the Hydrogeophysics Group at the University of Oviedo, Spain, led by Dr Fernández-Álvarez. The visits aimed at initiating a research collaboration between our two institutions in the field of the application of advanced geophysical methods to aquifer modelling. The first visit took place in June 2016 and the second in July-August 2016. During these fruitful visits, I undertook a number of activities including; interactions/training activities with the Group's staff and PhD students; seminar given to the department of Mining Engineering, including PhD and MSc students; reception of significant technical inputs to ongoing research activities which led to a co-authored publication in 2017; visit of two active research sites of the group; design and initiation of a grant proposal to be submitted to a EU-Marie Curie fellowship and to EPSRC standard research grant in 2017; appointment as PhD external examiner for one the Group's PhD student.

#### **Visit details**

The two visits totalised a combined duration of four weeks over the summer of 2016: 15-30 June and 24 July-3 August. An additional visit, funded by the University of Oviedo took place 21-24 September for participation to a group PhD viva as panel member.

#### **Interaction with the Group and Department's Staff and Students**

Many fruitful interactions/training took place during the visits. Dr Fernández-Álvarez introduced me to individual researchers in his team. I was more specifically introduced to a PhD student carrying out FEFLOW modelling of heat and geothermal resources in flooded coal mines. I was particularly interested in the model meshing methodology that incorporates the complex mine gallery network in 3D from from which I learned approaches to address some challenges faced with regards to the meshing of fracture rock flow models as part of parallel research projects. I was also able to advise the student on aspects of variable-density heat modelling. I also had various discussions with Dr Fernández-Álvarez on possible long-term collaborations on research that expands on another finishing PhD student Mr Gonzalez-Quiros, who uses multi-physics modelling codes to couple

geophysical methods with groundwater flow model. Such techniques are very promising for modelling and monitoring saltwater intrusion in coastal aquifers, one of my key research areas (see more details in the grant application section below). We also discussed possible future participation of Dr Fernández-Álvarez to teaching at the new Geophysics MSc in Aberdeen where he could provide relevant training to Aberdeen students with regards to inverse methods and application of geophysics to post-mine environmental problems. As part of a seminar given to the Department of Mining Engineering, which was attended by Staff members, PhD and MSc students, and entitled *'Modelling groundwater resources in complex hydrogeological environments using combined approaches: Integrating in situ hydrogeological and geophysical experiments with numerical models'*, I met and discussed with various members of the Department.

### Field visits

I carried out a number of field visits during my stay in Oviedo. A first visit was arranged with the Water Company to visit the geothermal plant installed in the flooded coal mine of Mieres that is studied by the aforementioned PhD student. This geothermal plant is the largest in Spain and the only one installed in a former coal mine (Figure 1a); it is used for heating and cooling the local hospital and the University. I got the chance to see the installation, which includes the borehole infrastructure (Figure 1b) as well the monitoring station (Figure 1c) that records the temperatures and flow rates within the mine and along the distribution.



a



b



c

Figure 1. (a) Mine shaft with and geothermal station underneath; (b) pumping boreholes installed in the main mine well; (c) monitoring screen for abstraction/injection water temperature and variations along the distribution loop.

Another visit was arranged to an active coastal research site that was considered ideal as part of the development of future collaborative research proposals. The site is a coastal aquifer near Gijón located between the coastline and an operational limestone quarry that is permanently dewatered in order to maintain a groundwater level at about 40m below sea level. The aquifer, composed of karstified limestone (Figure 2a,b), is likely to be undergoing saltwater intrusion that theoretically takes place as soon as the groundwater level is below sea level. We visited the coastline that provides outcrops of the karstified limestone (Figure 2a) as well as some private wells and properties (Figure 2c) that were planned to be instrumented with monitoring loggers and surveyed with transient electromagnetics in order to image the possible ongoing saltwater encroachment.



**a**



**b**



**c**

*Figure 2. (a) highly karstified carboniferous reef limestone outcropping at the coastline; (b) close up view of the karstified reef limestone along the road; (c) monitored properties between the quarry and the coast (the quarry wall can be seen in the background)*

## **Publication**

As part of close and regular interactions with Mr Gonzalez-Quiros during my visits, he assisted me in re-analysing and modelling geophysical data from a heterogeneous coastal aquifer in Ireland that was the focus on my ongoing research activities at that time. The new geophysical modelling code used, with the assistance of Mr Gonzalez-Quiros, improved significantly the comparison with and calibration of the groundwater models. This piece of work was eventually integrated into a research paper with Mr Gonzalez-Quiros as co-author, which was published early 2017 in *Water Resource Research*, the highest impact water resources journal: **Comte, J.-C., C. Wilson, U. Ofterdinger, and**

**A. González-Quirós (2017), Effect of volcanic dykes on coastal groundwater flow and saltwater intrusion: A field-scale multiphysics approach and parameter evaluation, *Water Resour. Res.*, 53, 2171–2198, doi:10.1002/2016WR019480.** This work has also seeded the subsequent development of funding applications.

### **Initiation of grant applications**

Following the various discussions with Dr Fernández-Álvarez and Mr Gonzalez-Quiros, several lines of future research proposal were developed, which over the following months materialised into 2 grant proposals that are currently at finalisation stage: (1) a EU Marie Curie Fellowship application lead by Mr Gonzalez-Quiros and hosted by the University of Aberdeen on the topic of ‘Multiphysics modelling of saltwater intrusion into heterogeneous coastal aquifers’ (submission deadline 14<sup>th</sup> September 2017) which will involve field research both at the Spanish site and Ireland (2) an EPSRC Standard Research Grant on innovative geophysical monitoring of coastal aquifers lead by myself in Aberdeen and involving a consortium of partners composed of Dr Fernández-Álvarez (University of Oviedo, Spain), the University of Savoie, France, Queen’s University Belfast and the British Geological Survey. The proposal is expected to be submitted at the end of September.

### **PhD panel participation**

Following my last visit in Oviedo, the University invited me to act as a panel member (the overseas external examiner in the Spanish system) for the PhD defence of Mr Gonzalez-Quiros, on the topic of ‘Identification of Hydrogeological Properties by Joint Use of Microgravity and Pumping Test Data Analysis’. The defence took place on the 23<sup>rd</sup> of September with travel and subsistence funded by the University of Oviedo. The PhD was awarded with the highest level of distinction.

### **Financial summary report**

Funding awarded:	£2,700.00
Funding spent:	£2,136.32
Funding returned:	£563.68

#### Detail of expenditures:

International flights:	£714.46
Hotel accommodation and subsistence:	£861.14
Local travels (train, taxi, car hire, fuel, etc.):	£560.72