

Shuqing Yao

Department of Geology & Petroleum Geology, School of Geosciences
Meston Building, University of Aberdeen, Aberdeen AB24 3UE, Scotland, UK
Phone: +44 (0)7709647090, Email: shuqing.yao@abdn.ac.uk

1. A brief CV emphasising the academic qualifications back to first degree level

Current Education

2015-present – PhD in Geology – University of Aberdeen (UK).

Project: Unravelling the controls on hydrothermal dolomitisation geometries in shallow-marine carbonate reservoirs, **supervised by** Dr. Enrique Gomez-Rivas, Prof. John Howell, (University of Aberdeen) & Dr. Juan Diego Mart ın-Mart ın (University of Barcelona).

Awards & Funding: University of Aberdeen Elphinstone Scholarship and China Scholarship Council (CSC) PhD grant. I have a grant from CSC that pays for my stipend, and was awarded an Elphinstone grant to cover my fees at the University of Aberdeen. However, neither of these grants includes funds for research costs such as fieldwork. Therefore, the BSRG grant will greatly help me to be able carry out fieldwork for my PhD project.

Project outline: This project is addressing the influence of sedimentary facies and diagenesis (especially stylotisation) on the geometries of fault-associated dolomitisation. The results will provide new insights for better predicting reservoir quality in carbonates. For my PhD project, we have built virtual outcrop models from the Benic  ssim area (Maestrat Basin, E Spain) using terrestrial LiDAR and UAV based photogrammetry. These models are being populated with existing stratigraphic data from the different outcrops, and are being used for mapping the dolomitised geobodies in detail. The work would greatly benefit from a focused and intensive field campaign to acquire more logs and samples which are directly tied to the virtual outcrops. Therefore, I am applying for the BSRG grant in order to support a fieldwork season.

Previous Education

2009-2012 – MSc in Oil & Gas Resource Prospecting and Exploration– Jilin University (China).

Project: Oil shale resource evaluation in Dumi, **supervised by** Prof. Zhaojun Liu.

Awards: Four graduate school level awards.

2005-2009 – BSc in Resource Surveys Engineering– Jilin University (China).

Project: Sedimentary facies study in Tanan, Mongolia, **supervised by** Prof. Zhaojun Liu.

Awards: Two university level awards and one college level award.

Professional Experience

2012-2015 – Assistant engineer in petroleum geology– Shengli Oilfield, SINOPEC (China).

Duties: Integrated analysis of geologic data to identify locations of exploration wells and evaluated those wells in Chunliang (Shengli Oilfield). These include sequence stratigraphy, stratigraphic correlations and tectonic interpretation.

Awards: One award at the SINOPEC corporate level, two at the Oilfield level and four at the Research Institute level.

Publications

11 papers published in scientific journals in the past five years, one reserve report with oral presentation at SINOPEC reserve conference 2014, and two graduation theses. A reference list of the main publications is attached at the end of this application.

Research Specific Training:

I started my PhD in September 2015. To date I have received training in virtual outcrop geology (LiDAR data acquisition and postprocessing), mapping with virtual outcrop models, and carbonate sedimentology. In February 2016 I am attending courses on the use of Petrel and Eclipse for reservoir modelling.

2. An outline of present and proposed research

Unravelling the controls on hydrothermal dolomitisation geometries in shallow-marine carbonate reservoirs

Supervisors: Dr. Enrique Gomez-Rivas, Prof. John Howell & Dr. Juan Diego Mart -Mart 

Introduction of the PhD project and source of proposed research

The fault-related introduction of dolomitising fluids into carbonates is a well-documented aspect of carbonate reservoirs. However, predicting the geometry of the resultant dolostone bodies and the role that the host rock facies play in controlling those geometries is less well understood and at present predictive models are lacking. Initial work by the principal supervisor suggests that subtle facies changes and the distribution of stylolites can have significant impact on the passage of fault sourced fluids through carbonates (Gomez-rivas *et al.* 2014). The goal of the current study is to use modern field acquisition techniques (virtual outcrops) combined with traditional field and lab work to map the distribution of dolostones and to use reservoir style simulation models that capture the impact of well constrained dolomitisation on reservoir performance.

Specifically the principal aims of the project are (i) to understand what controls fault-associated dolomitisation geometries, (ii) how replacement affects reservoir quality distribution and (iii) how would systems with different replacement geometries respond during production. To address these aims, a state-of-art workflow “from outcrop to simulation” (Buckley *et al.* 2008, Howell *et al.* 2008) is applied to a case study of world-class hydrothermal dolomitisation in the Benic ssim area (Maestrat Basin, E Spain). This consists of building virtual outcrop models with terrestrial LiDAR and photogrammetry, and populate them with stratigraphic and structural data acquired in the field. The models allow mapping facies, sequences and structures with high-detail. These can subsequently be exported for creating static and dynamic reservoir models, in order to predict the behaviour of the petroleum system under different scenarios.

A first field season was undertaken in October 2015. Virtual outcrop models of the Benic ssim outcrop were collected using LiDAR and UAV. Initial field data were also collected. Since the field season, the majority of time has been spent processing the VO data and compiling the existing traditional field data into a format that can be used for the reservoir modelling. However more field data are required. This is the focus of the current proposal.

Outline of proposed research

Objectives: I am applying for support to undertake fieldwork comparing two outcrops in the Benic ssim area. They are excellent outcrop analogues of fault-related dolomitised reservoirs. This area shows a wide variety of fault-associated dolomitisation geometries ranging from (i) massive replacement around fault zones, including stringers of preserved limestones, (at “La Ferradura” outcrop, Fig. 1a) to (ii) completely stratabound dolostones that extend several km away from the faults, following specific layers (at the “Raco del Moro” outcrop, Fig. 1b). (Mart -Mart  *et al.* 2013, 2015) Seismic-scale faults acted as feeding points for the dolomitising fluids in the area. Much of these large scale geometries are captured in the virtual outcrops, but the photo-realistic models lack the resolution to capture the fine scale detail and further field work is required to address issues such as the role stylolites played on the dolomitising fluid flow system within the host rock.

The two outcrops that have been chosen represent different dolomitisation styles affecting the same host rocks, and as such comparison of the two will improve understanding of what determines the transition between fault-restricted and stratabound dolomitisation geometries.

Support from BSRG would be used for the following work tasks:

- (i) Collect and correlate a series of stratigraphic logs at “La Ferradura” outcrop, and map the dolomitised geobodies in the field, with special focus on the fine scale detail not captured in the virtual outcrop.

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- (ii) Sample the logged sections for a petrographic study of the facies and diagenesis
- (iii) Test new methods for logging and mapping directly onto virtual outcrops in the field.

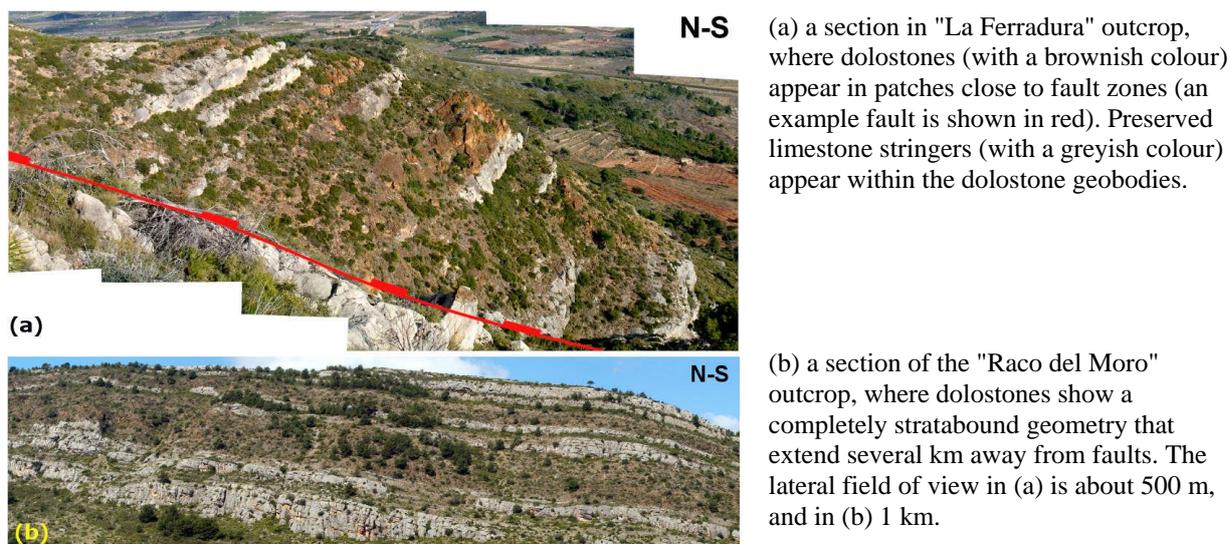


Fig. 1. Field views of the Benassal Fm in the Benicàssim area.

Significance: This project will provide significant advances to understand what factors determine the geometries of diagenetic alterations in carbonate reservoirs, especially the relationship with large-, seismic-scale geometries and fine scale detail. The results will provide rules to better predict dolomitisation geometries and associated reservoir quality in reservoirs affected by hydrothermal dolomitisation. This grant will allow the collection of the fine scale detailed data required to supplement the larger scale data already acquired in the mapping and virtual outcrops. This will allow me to build a set of reservoir models for my PhD project that cover a wide range of reservoir geometries depending on the distribution and petrophysical properties of the dolostones and preserved limestones.

Research plan: I plan to go to the Benicàssim outcrop (E Spain) for a 14-days field season in May 2016, in order to log and sample the stratigraphic succession and map the dolomitised geobodies. At least 10 sections for logging will be chosen with the help of the virtual outcrop models, and based on existing field data. The logs will be integrated into the virtual outcrop models in order to map the detail of the facies, faults and dolostones geobodies. 40 samples will be selected for thin sections and carbon-oxygen stable isotope analysis, in order to characterise the sedimentary facies, their diagenetic evolution and estimate the petrophysical properties to populate reservoir models.

Impact of the grant

An award from BSRG will have a significant impact on my research. It will allow a second field season that will be used for the collection of significant volumes of detailed, fine scale data which will be critical to the interpretation of the virtual outcrops and the final reservoir models.

References:

- BUCKLEY, S.J., HOWELL, J.A., ET AL. 2008. Terrestrial laser scanning in geology: data acquisition, processing and accuracy considerations. *Journal of the Geological Society*, **165**, 625-638.
- GOMEZ-RIVAS, E., CORBELLA, M., ET AL. 2014. Reactivity of dolomitizing fluids and Mg source evaluation of fault-controlled dolomitization at the Benicàssim outcrop analogue (Maestrat basin, E Spain). *Marine and Petroleum Geology*, **55**, 26-42.
- HOWELL, J., VASSEL, A., ET AL. 2008. Modelling of dipping clinoform barriers within deltaic outcrop analogues from the Cretaceous Western Interior Basin, USA. *Geological Society, London, Special Publications*, **309**, 99-121.
- MARTÍN-MARTÍN, J.D., GOMEZ-RIVAS, E., ET AL. 2013. The Upper Aptian to Lower Albian syn-rift carbonate succession of the southern Maestrat Basin (Spain): Facies architecture and fault-controlled stratabound dolostones. *Cretaceous Research*, **41**, 217-236.
- MARTÍN-MARTÍN, J.D., TRAVÉ, A., ET AL. 2015. Fault-controlled and stratabound dolostones in the Late Aptian-earliest Albian Benassal Formation (Maestrat Basin, E Spain): Petrology and geochemistry constrains. *Marine and Petroleum Geology*, **65**, 83-102.

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3. A breakdown of the Budget

Total budget

A 14-day fieldtrip to the Benicàssim outcrop (E Spain) will be conducted in May 2016. A breakdown of this research budget is listed in the table below. The total budget for the proposed fieldtrip is £1,180, of which £500 is requested from BSRG.

Item		Quantity	Cost (£)/Unit	Total Cost (£)	
Fieldtrip expenses	1. Transportation	Airfare	1	£200/flight	£200
		Vehicle Rental	14	£15/day	£210
	2. Subsistence	Accommodation	14	£25/night	£350
		Subsistence	14	£21/day	£294
	3. Miscellaneous	Fuel	80	£1/litre	£80
		Motorway toll	1	£60 in total	£60
Total Budget				£1,194	
Total Budget requested to BSRG				£500	

Funding request

The amount requested from BSRG is £ 500 (highlighted in orange in the budget table above). These will be used to cover my airfare from Aberdeen to Barcelona and 14 days' of subsistence in the field area.

Cost not account for

The extra costs to carry the project out (accommodation in the field area, rental car, fuel and motorway tolls) will be covered by myself and my supervisors. Thin sections will be made for free by the Department technicians.

4. Referee

John Howell
Professor of Geology and Petroleum Geology
School of Geosciences, University of Aberdeen
Aberdeen AB24 3UE, Scotland, UK
john.howell@abdn.ac.uk

5. List of main publications of the candidate

Journal Papers

- WU ZHIHUA, LIU XINQIU, YAO SHUQING. 2015. Study of the fault system and fine structure interpretation of m block. *China Chemical Trade*, **7**, 190-190.
- LI BAOYI, YAO SHUQING, SUN PINGCHANG, ET AL. 2014. Characteristics and origin of Oil Shale in Meihe Basin. *Global Geology*, **33**, 457-464.
- ZHAO HANQING, LIU ZHAOJUN, YAO SHUQING, ET AL. 2013. Quantitative division of sequence stratigraphic units based on wavelet inversion of logging curve. *Global Geology*, **32**, 372-378.
- YAO SHUQING, LIU ZHAOJUN, CHEN YONGCHENG, ET AL. 2011. Seismic reflection characteristics of Lower Cretaceous Tongbomiaof formation in Tanan sag, Mongolia. *Global Geology*, **30**, 641-647.

Conference Papers

- YAO SHUQING, LIU ZHIYONG. 2014. Report of incremental predicted petroleum reserves of E₃S₃, E₁₋₂K₁, Mz in Gao96 block of Qingcheng Arch, Shengli Oilfield. *Annual SINOPEC reservoir management conference in Nanjing, China*.
- SUN PINGCHANG, LIU ZHAOJUN, MENG QINGTAO, LIU RONG, ZHEN ZHEN, YAO SHUQING, XU YINBO. 2013. The organism evolution of mudstone in sequence framework and its influencing factors of Paleocene in Huadian basin, China. *29th IAS meeting of Sedimentologists in Schlading, Austria*.

Graduation theses

- YAO SHUQING. 2012. The evolution characteristics of organic matter within sequence framework of paleogene Meihe Formation, Meihe Basin. *Jilin University Archive*.
- YAO SHUQING. 2009. Sequence stratigraphic characteristics of Lower Cretaceous Tongbomiaof formation in Tanan, Mongolia. *Jilin University Archive*.