Working title: **Field-based analysis of deep-water sedimentary successions: the Lauzanier system, Maritime Alps, France/Italy.**

A PhD studentship to be run by the Turbidites Research Group in the School of Earth and Environment at the University of Leeds

Supervisors: Prof. Bill McCaffrey[1], Dr. Marco Patacci[1], Dr. Luca Barufini[2], Dr. Marco Fonnesu[2]. 1. University of Leeds, School of Earth and Environment; 2. ENI spa, Milan.

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Summary

- Opportunity to undertake field-based mapping and sedimentological data collection in a stunning Alpine setting.
- Join an integrated research group, with linkage to international research associates and industry
- Attend international conferences in the Europe, the US and elsewhere
- Project sits alongside linked research as part of a larger programme
- Tutoring in career development (academia, industry and beyond)

Deep marine clastic systems are volumetrically the most important sedimentary environment on the surface of the earth. Built by particulate gravity currents (turbidity currents, debris flows, hybrid flows), they can build a bewilderingly complex array of landforms, such as canyons, channels, levees and semi- or unconfined depositional lobes, and the transitions between them. Depositing flows often traverse sedimentary basins where they may be fully-, partly- or unconfined, depending on the magnitude of the flow and the size of the basin. In the present state of knowledge, the organisational style of such deposits is difficult to predict. If the flows are unconfined, then self-governing processes of lobe deposition and compensational stacking may prevail - yet the rules governing this style of deposition remain a matter of debate; if fully confined, the present view is that tabular, non-compensating sheet-form deposits prevail, albeit possibly tapering distally - yet this understanding is currently being challenged.

This project will assess the relative roles of internal vs. external controls in the development of sheet-form turbidite sandstone, principally through a field study in the Annot turbidite system (Maritime Alps), linked to the development of the hosting system (Fig. 1). A further approach will be to exploit large dataset analysis to better understand lobe and sheet architecture development. As well as developing fundamental new understanding, the work will also find practical application in the hydrocarbon industry by enabling prediction and characterisation of turbidite sheet and lobe architectures based on prior knowledge of their conditions of formation and/or their outline geometrical configuration.

Fig. 1. Eo-Oligocene fill of the Lauzanier Basin, Alpine Tertiary foreland basin, Maritime Alps. A lower unit of tabular and tapering sheets is succeed by higher net-to-gross upper unit via an intraformational unconformity. This beautifully exposed ground extends to 2,500 m and is a fabulous field area!

Aims and objectives.

- Log and describe a turbidite sheet system (Fig 1), through logging, collection of high resolution photo panels and development of 3D models
- Resolve the relationship between the sheet system and a related overlying system that erodes into the sheet system, is coarser grained and is apparently channelised
- Use data mining approaches to place the field study into the context of sheet systems studied elsewhere

The first goal of this project is to assess the relative roles of internal vs. external forcing, as expressed by the ratio size of flow to size of basin, in the development of sheet-form turbidite sandstone. This goal will be achieved through a field study in a spectacular and well exposed setting spanning the French-Italian border in the Maritime Alps in the Annot turbidite system: the Lauzanier Basin. The basin fill is exposed across four high-Alpine valleys. An earlier study in the three valleys on the French side of the Franco-Italian border (Mulder et al., 2010) has established a good stratigraphic framework, and an initial architectural interpretation; a fourth valley on the Italian side of the border was not considered by Mulder et al. The stratigraphy can be divided into two units: a lower interval comprises a mixture of coarse-grained tabular sands that can be traced without significant thickness change across the outcrop and tapering sands that are laterally impersistent. A coarser grained (conglomeratic) upper interval erodes via an intraformational angular unconformity into the underlying unit. In this project the sedimentary succession of the lower Unit will be studied across all four valleys with a combination of techniques such as logs, high-resolution photopanels and 3D models; reconnaissance work has shown that the

fourth valley may hold the key to unravelling the story of system development. Particular attention will be paid to facies associations of those beds that taper vs. those that are tabular, including the facies characteristic of bed termination. The analysis will focus on differentiation of the vertical organisational styles intervals characterised by tapering beds vs. those characterised by tabular beds, to assess what mechanisms of compensational stacking may occur. The role of tabular beds in re-setting instantaneous lateral bathymetric gradients will also be assessed.

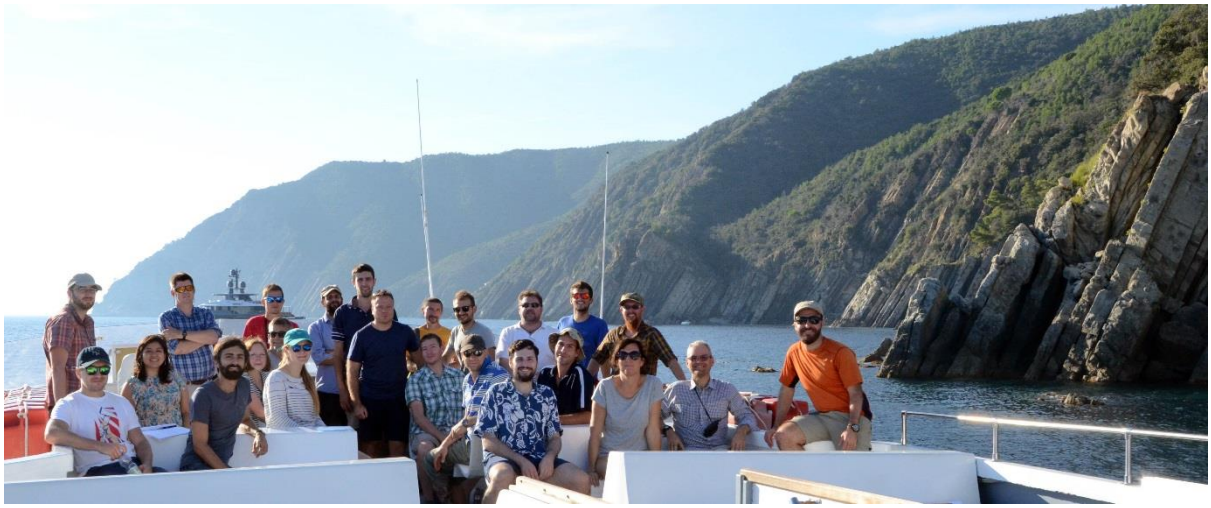

Fig. 2. The 2018 TRG European sponsors meeting excursion to the Cretaceous-Palaeocene Gottero System, Ligurian coast, NW Italy

A final goal will be to exploit large dataset analysis to better understand lobe and sheet architecture development, based upon a combination of prior submarine studies, the new field data and new analysis of seismic data. This work package will exploit the Deep-Marine Architecture Knowledge Store (DMAKS), a relational database designed and populated by members of TRG at Leeds. Data uploaded to DMAKS will be derived from the field study, from the peer-reviewed literature and possibly from a seismic study.

Both fundamental and applied research themes fall within the project remit, and the project scope can evolve depending on the interests and aptitudes of the student.

Eligibility. Applicants should have a BSc degree (or equivalent) in geology, earth sciences, geophysics or a similar discipline. An MSc or MGeol in applied geoscience or petroleum geoscience (or similar) would be an advantage. Skills in field-based geological data collection and field sedimentology and stratigraphy are desirable. Experience of using GIS software would be useful, though is not essential.

Training. The successful applicant will work within the inter-disciplinary Turbidites Research Group, which is part of the wider Sedimentology Group at the School of Earth and Environment, University of Leeds. The TRG has graduated 24 PhD students to date, and has twelve on-going research projects related to deep-marine clastic sedimentology via field studies, physical and numerical modelling and seismic studies, and (https://trg.leeds.ac.uk/page-people.php). The project will provide specialist scientific training, as appropriate, in: (i) field-based techniques for the sedimentological and

architectural analysis of clastic successions; (ii) relational-database theory and practice; (iii) statistical analysis; (iv) geological interpretation of seismic datasets. The mixed pure- and applied-science nature of this research project will enable the student to consider a future career in either academia or industry. In addition, the student will have access to a broad spectrum of training workshops provided by the Faculty that include an extensive range of training workshops in statistics, through to managing your degree, to preparing for your viva (http://www.emeskillstraining.leeds.ac.uk). The successful candidate will be strongly encouraged and supported to publish the outcomes of their research in leading international journals.

The project will be run as a CASE award, supported by ENI spa; as well as a £1k pa stipend enhancement, there will also be an opportunities for the appointed applicant to undertaken an internship with ENI in Milan. Such placements will involve working embedded in a team of applied geology professionals.

References and bibliography

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Prelat, A. and Hodgson, D. M. (2013). The full range of turbidite bed thickness patterns in submarine lobes: controls and implications. *Journal of the Geological Society of London* **170**(1): 209-214.

Further Information

For more information about this project and other TRG activities contact:
Bill McCaffrey, w.d.mccaffrey@leeds.ac.uk, http://trg.leeds.ac.uk/