UGRL Project Proposal: Trace element analysis of natural gold as an indicator of ore genesis

1. **Research Project Leader:** Dave Banks, and Rob Chapman

2. **Scholarship Project Supervisor:** Dave Banks, Rob Chapman and Carl Spence-Jones

3. **Working title of Scholarship Project:** Trace elements in natural gold

4. **Period of Scholarship Project Work** Summer 2017, summer 2018. Dates tbc

5. **Summary of the research to which the Scholar will contribute:**

Leeds is the world leader in research focussing on the implications of the mineralogy of natural gold for both ore forming processes and exploration. Characterizing the mineralogy of natural gold allows us to generate new insights into ore systems, which we apply to develop new approaches for commercial exploration. Hitherto, gold alloy has been analysed using the electron micro probe (emp) and inclusions of other minerals are systematically recorded using scanning electron microscopy (sem). Recently, laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) has been applied to provide quantitative data for an additional suite of elements present in gold only at trace and ultra-trace levels. These new data sets provide unique opportunities for new fundamental studies of mineralizing systems.

Over a period of 25 years gold samples have been obtained from localities worldwide and these unique gold collections provide us with an additional advantage within this new field of study. We will capitalise on this platform through study of both new material from internationally significant localities and re-analysis of existing sample sets. Some samples from UK localities, are not economically significant in themselves, but represent generic styles of mineralization with globally important examples.

6. **Summary of the work to be undertaken by the Scholar:**

Minerals formed in ore deposits have been used by geologists either to gain insights into ore forming processes, or as detrital ‘indicators’; useful as vectors to undiscovered mineralization. Studies of natural gold in these contexts is a research speciality at Leeds. This project will advance our understanding of the characteristics of natural gold so that they may be applied in different research directions.

You will:
1. Re-evaluate historical analytical data of natural gold in the light of recently developed interrogation methods
2. Undertake analyses of selected samples by LA-ICP-MS to quantify trace element concentrations
3. Synthesise old and new data (using both Excel and the ‘iogas’ geochemical software) to permit interpretation of the new data sets to inform studies of regional metallogeny and generic ore forming processes.
4. Have responsibility for various outputs: relating to the existing and newly generated data base:
   i. Construction of data bases which conflate LA-ICP-MS and EMP data
   ii. Generation of a year end report (year 1) focussing on new insights into regional metallogeny.
   iii. Generation of a poster, presented (by you) at the Vancouver Exploration Roundup in 2018.
   iv. Generation of a paper for submission to a peer reviewed journal (2018)
7. **Detail of the work to be undertaken by the Scholar** (see note ii):

The role of the scholar in the project falls into four categories:

1. **Interrogation and reorganising of existing analytical data bases.**

   Early analytical programs (undertaken 1994-2000) mainly focussed on indigenous gold but early methodology did not always report the trace element values even if they were measured. Consequently at present, we do not know whether there is further useful information in these data sets. The scholar will focus firstly on areas of the UK where a better understanding of the gold genesis has implications either for regional geology or generic mineralization processes. New analyses by LA-ICP-MS will be generated to permit a new and better informed interrogation of these sample suites. One important output from the project will be a standardization of data reporting and the capability to import excel based data directly into ‘Iogas’ geochemical software.

2. **Analysis of new sample suites**

   In the second year we will focus on new sample suites gained in 2017, either as a consequence of fieldwork by staff (Eastern Europe and/or Alaska and/or S. America) or through donations of sample suites from economically important deposits worldwide. The scholar will gain experience of EMP, SEM and LA-ICP-MS analysis, and be at the forefront of applying new knowledge to interpreting the ore forming processes in areas of global of economic significance.

3. **Data organization and recording**

   In year 1 the scholar will refine existing Excel spreadsheets to include the relevant data as described in ‘1’ above. Additionally the scholar will use ‘Iogas’ software to facilitate manipulation of the much larger analysis spreadsheets produced by LA-ICP-MS, where each gold grain is characterized according to 40 elements. New data from LA-ICP, EMP and SEM -analysis obtained in year 2 will also require recording in both Excel and Iogas formats.

4. **Dissemination.**

   Student outputs will in part be dependent upon the sample suites chosen for study in year 1 and made available to the project in year 2. The study will contribute to the seminar series of the Ores and Minerals Group in IAG, and the scholar will be given responsibility for planning one seminar each year.

   **Year 1**

   Report of UK regional-based study, including interpretation of the new data sets in terms of regional metallogeny

   **Year 2.**

   Lead author on a paper submitted to a peer reviewed journal. (written during 2017-2018)

   Poster to be presented at Vancouver Exploration Roundup, (Jan 2018) Content based on year 2 outputs.

8. **Detail of the Leadership development to be undertaken as part of the project**

   The project involves generating large data bases to a specified format. Merging existing data bases with new data sets demands compatibility of the analytical results generated by different techniques. The Quality Assurance/Quality Control (QA/QC) element of the raw data is paramount to the success of the project and will provide the scholar with transferrable experience of this key procedure.

   Elsewhere, the project will develop other generic attributes:

   i. Project planning
   ii. Time management skills,
   iii. Data processing (We envisage the student enrolling on postgraduate-facing training courses relevant to the work, namely, ‘Excel for Researchers’ (parts 1 and 2)
   iv. Communication skills (by both formal scientific writing to a professional standard and poster)
   v. Organisation of internal seminars to present new data and facilitate discussion.
   vi. Scientific writing (supported by the UoL in house ‘Writing for Publication course’).
Overall our aim is to provide a young scholar with an unparalleled opportunity to develop their academic CV during their period of undergraduate study.

9. Outputs expected of the Scholar (including the final report)

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<thead>
<tr>
<th>Outputs</th>
<th>Date</th>
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<tbody>
<tr>
<td>Year 1</td>
<td></td>
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<tr>
<td>i. Updated data base of selected historical data augmented by new LA-ICP-MS data</td>
<td>End summer vacation 2017</td>
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<tr>
<td>ii. Report focussing on regional study underpinned by 'i' above</td>
<td>Reading week 2017</td>
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<td>iii. Seminar presentation to ores group</td>
<td>End sem 1 2017</td>
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<tr>
<td>Year 2</td>
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<tr>
<td>i. New data sets relating to mineralogy of gold form selected localities worldwide</td>
<td>End summer 2018</td>
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<tr>
<td>ii. Report focussing on regional study underpinned by 'i' above, and implications for generic ore forming processes</td>
<td>December 2018</td>
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<td>iii. Poster, based on year 2 study</td>
<td>Poster abstract December 2018</td>
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<td>Poster presentation January 2019,</td>
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<td>iv. Seminar presentation to ores group</td>
<td>Post Roundup conference 2018</td>
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<tr>
<td>v. Paper in peer reviewed journal</td>
<td>Student would be first author of a paper submitted to a leading journal.</td>
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10. Details of supervision arrangements (see note v)

Year 1. (July- August)
RC: introduction to historical data bases, rationale for area selection and methodology for Updating DB: introduction to :LA-ICP-MS methodology – analysis of small sample set
CSJ: logas training
RC/DB/CSJ : progress meetings (4) during summer and preparation of report
RC/DB/CSJ: support with seminar presentation including ‘dry run’ (Nov 2017)

Year 2
DB::LA-ICP-MS analysis of new sample sets  July- August 2018
RC/DB/CSJ progress meetings (4) to discuss results and their interpretation
RC/DB/CSJ: support with design and production of poster (Dec 2018)
RC/DB/CSJ: support with preparation of peer reviewed paper (Student’ final year)