THE INDUSTRY, ACADEMIA AND GOVERNMENT NEXUS IN GEOCHEMISTRY

Graham Brown[1] and Michael Daly[2]

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Geochemistry is a key specialist sub-discipline in the global exploration and production of resources. It complements conceptual geological thinking, analytical modelling and traditional fieldwork as part of a multi-disciplinary effort. When properly integrated into the discovery process, geochemistry is a key component of exploration success: conventional geochemical techniques have, for example, played an important role in the discovery of many deposits of base metals, precious metals and oil and gas. Going further along the value chain, geochemistry also plays a key role in the management of oil and gas reservoirs as they are produced. Geochemistry, therefore, is an integral part of both petroleum and mineral industries and it continues to develop and improve its contribution.

However, the awareness, quality and usage of geochemistry can be highly variable in the petroleum and the mineral worlds. To tackle this, one of the major areas for improvement is in in-house and undergraduate teaching of organic and applied exploration geochemistry and industry-relevant research and development (R&D).

Industry wants to constantly improve its efficiency in finding, developing and producing resources. This objective is supported by the technologies available and our capability to deploy and develop them. Effective geochemical tools and techniques (e.g. direct petroleum and ore detection, vectors to ore bodies and petroleum pools, fertility indicators) that reduce risk and improve discovery success are needed in all geological settings and all geographic/geomorphological environments, both onshore and offshore.

As exploration moves into new terrains (e.g. transported cover or prospects existing below salt layers), new techniques need to be developed and new approaches and work flows created (e.g. 'mineral systems' mapping versus traditional 'anomaly hunting'). This should also include an improved understanding of the underlying geochemical processes that operated during ore- and petroleum formation and migration. Furthermore, as our understanding of the geological processes of basin formation, subsidence and sedimentary fill improves, additional demands are made of geochemical modelling. The geothermal evolution of an area of interest and source rock maturation, petroleum expulsion and subsequent migration requires constant upgrading as the input data improves.

However, no matter how good our tools, without capable people they are nothing. Both the mineral and petroleum world require good people – well-rounded practitioners with the capacity to make full (and correct) use of the available geochemical toolbox: this includes everything from the choice of the most appropriate sample medium/method, to planning/implementation of a survey, through to proficient modelling/evaluation/interpretation of the results.

For this type of capability development, the university relationship is crucial and needs to be considered in the two dimensions of education and research. In education, we feel there is a gap in the undergraduate teaching of applied exploration (and mining) geochemistry at some universities. This is to a large degree solved in the petroleum industry by the widespread availability of MSc courses, which at least include some organic geochemistry. However, if applied geochemistry can be taught to a high standard – something that, for the most part, still remains to be done – then that would have a very beneficial impact on the whole exploration sector.

Industry needs universities to generate well-rounded exploration geoscientists with a comprehensive understanding of the geochemical techniques needed to explore for deposits. While the oil and gas industry has accepted the need to do a large amount of in-house and third-party training of young explorers, the mining/exploration industry has (increasingly) limited capacity to provide an analogous level of required training on an in-house basis. The pool of experienced professionals within the exploration industry who can provide in-house training in applied exploration geochemistry is relatively small. Universities, possibly with financial and/or in-kind industry support, have an opportunity to close this gap. The recent establishment of the Acme Industrial Research Chair in Exploration Geochemistry at the Mineral Deposit Research Unit (University of British Columbia, Canada) is an encouraging development in this regard.

The strategic alignment of research objectives with the long-term needs of industry is a key challenge. However, industry alone should not dictate research directions. The ability to undertake process-oriented research, without consideration of immediate industrial impacts, must be retained. Equally, solving the issues of industry should be recognised as a valid and highly impactful goal of applied research, one that will have academic benefits as well.

Danger to these ideal goals comes when funds are directed to government-initiated R&D projects, politically driven by R&D management, with only limited industry input and even less academic appreciation. As a result, industry-relevant objectives and deliverables may be only vaguely defined; outcomes are often of no, or at best limited, relevance to industry or academia. Recognising this issue does, however, lead to a number of solutions:

1. Collaborative initiation of R&D projects by industry, academia and government.
2. The delivery minded definition of project objectives, products and purpose.
3. Commitment by industry to participate on a long-term basis.
4. Effective monitoring and management of project progress.

Many researchers/lecturers in the academic geochemistry community are unfamiliar with what is done by geochemists in the petroleum/mining/exploration industry. Therefore, they are unaware of some of the social, scientific and technological challenges that face the industry and that could benefit from research. A more open dialog between industry and academia might help, one in which industry can clearly articulate their research needs and strategic priorities. The Centre for Doctoral Training initiative of the Natural Environment Research Council (UK) has been a good step in this direction. Unfortunately, to date, much of it appears to be academia talking to academia about industry. Industry needs to not only be a provider of funds but be committed to an outcome, which requires industry to have a meaningful relationship with academia.

A successful industry–university partnership has several dimensions. Perhaps the most profound development would be if a industry–university partnership is developed beyond a single project or phase of funding. The Industrial Associate programme run by the Department of Earth Sciences, University of Cambridge (UK), has achieved this over several years, and it has proved to be an effective model where industry collaboration has benefitted both parties. This Cambridge programme

1 E-mail: graham.brown1958@btinternet.com

2 E-mail: mikeldaly@yahoo.co.uk

has also produced a significant number of high-quality doctoral students who have either gone on to work in industry or remained in academia but worked on industry problems.

In contrast, one off studentships and projects, initiated by an interested individual and not followed through as that person moves on, have the hallmarks of the worst of university/industry collaboration. They achieve nothing beyond completion of an immediate goal and create very little long-term value for the financial and time investment involved. The issue here requires discipline on both sides. Universities will rarely resist money for a studentship; but, in some cases, they should. Equally, industry needs to have the discipline to see beyond the next cycle and to develop long-term and sustainable relationships that will have significant long-term benefit. This only comes with commitment and a clear view of direction and a belief in process-based research.

Graham Brown and **Mike Daly**

ABOUT THE AUTHORS

Graham Brown (MSc, CGeol, EuroGeol) has over 35 years' experience in the mining and exploration business. He is co-founder and director of the private Finnish exploration and development company Sakumpu Exploration Oy and a former Group Head of Geosciences and Exploration at Anglo American plc. His team has has received industry awards and been credited with discovering the world-class Los Sulfatos copper deposit in Chile (Propectors and Developers Association of Canada) and the northern Finland Sakatti deposit (Fennoscandian Mining and Exploration). Brown served on the council of the Society of Economic Geologists from 2012 to 2014 and is currently the industry representative on the science advisory boards of both the British Geological Survey and the Natural History Museum (UK).

Mike Daly is a British geologist, explorer, and petroleum executive based at the University of Oxford Department of Earth Sciences (UK). He is widely known for his role as global exploration chief for British Petroleum (BP) and for his academic contributions to geology and tectonics, focusing on Africa. Daly joined Zambia's Geological Survey Department in 1976. After a decade of geological mapping and academia, he moved into the petroleum industry and joined BP, where he developed a technical and business career in exploration. Daly became BP's exploration chief in 2006. He retired from BP in 2014 and is now a non-executive director of Tullow Oil and a partner at Macro Advisory Partners.