

Integrating new tactics for mineral exploration and Social License to Operate into geoscientists' training and life-long learning: Lessons learned through the INFACT Project

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Effective transfer of knowledge gained through international research and development projects (i.e. FP7, H2020 etc.) to either university curricula or to vocational training often fails. For this reason, the INFACT project, financed through the H2020 programme, paid special attention to knowledge transfer in the disciplines of mineral exploration and mining. A key objective of INFACT objective was to provide knowledge transfer opportunities for master's and PhD students, young scientists, the community, wider society, policy makers and exploration practitioners in the areas of mineral exploration and Social License to Operate. This was achieved through integrating education initiatives with a variety of stakeholders into INFACT's tasks, to enable a longer-lasting impact. Emphasis was put on activities that included formal education as well as lifelong learning for wider society and professional development through passive (informative) and active training. The topics addressed focused on the raw materials value chain, upstream primary exploration activities, the sustainability aspects of exploration tools, and social acceptance of mining and exploration best practices. In addition, education initiatives provided a mechanism to disseminate information regarding the INFACT project and its progress via tailored messages for respective key stakeholders.

Le transfert efficace des connaissances acquises grâce à des projets internationaux de recherche et de développement (c'est-à-dire FP7, H2020, etc.) vers les programmes universitaires ou vers la formation professionnelle échoue souvent. Pour cette raison, le projet INFACT, financé par le programme H2020, a accordé une attention particulière au transfert de connaissances dans les disciplines de l'exploration et de l'exploitation minière. Un objectif clé de l'objectif d'INFACT était de fournir des opportunités de transfert de connaissances aux étudiants de maîtrise et de doctorat, aux jeunes scientifiques, à la communauté, à la société au sens large, aux décideurs et aux praticiens de l'exploration dans les domaines de l'exploration minière et de la licence sociale d'exploitation. Cet objectif a été atteint en intégrant des initiatives d'éducation avec une variété de parties prenantes dans les tâches d'INFACT, afin de permettre un impact plus durable. L'accent a été mis sur les activités qui incluent l'éducation formelle ainsi que l'apprentissage tout au long de la vie pour la société au sens large et le développement professionnel grâce à une formation passive (informative) et active. Les sujets abordés ont porté sur la chaîne de valeur des matières premières, les activités d'exploration primaire en amont, les aspects de durabilité des outils d'exploration et l'acceptation sociale des meilleures pratiques minières et d'exploration. En outre, les initiatives d'éducation ont fourni un mécanisme pour diffuser des informations concernant le projet INFACT et ses progrès par le biais de messages personnalisés destinés aux principales parties prenantes respectives.

La transferencia efectiva de conocimientos adquiridos a través de proyectos internacionales de investigación y desarrollo (por ejemplo, FP7, H2020, etc.) a los planes de estudios universitarios o a la formación profesional a menudo fracasa. Por esta razón, el proyecto INFACT, financiado a través del programa H2020, prestó especial atención a la transferencia de conocimiento en las disciplinas de exploración y minería de minerales. Un objetivo clave del proyecto INFACT era brindar oportunidades de transferencia de conocimientos a estudiantes de maestría y doctorado, jóvenes científicos, la comunidad, la sociedad en general, los responsables políticos y los profesionales de la exploración en las áreas de exploración minera y Licencia Social para Operar. Esto se logró mediante la integración de iniciativas educativas con una variedad de partes interesadas en las tareas de INFACT, para permitir un impacto más duradero. Se hizo énfasis en actividades que incluían la educación formal, así como el aprendizaje permanente para la sociedad en general y el desarrollo profesional a través de la formación pasiva (informativa) y activa. Los temas abordados se centraron en la cadena de valor y comercialización de las materias primas, las actividades de exploración primaria upstream (aguas arriba), los aspectos de sostenibilidad de las herramientas de exploración y la aceptación social de las mejores prácticas de minería y exploración. Adicionalmente, las iniciativas de educación proporcionaron un mecanismo para difundir información sobre el proyecto INFACT y su progreso a través de mensajes personalizados para los respectivos inversionistas.

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Introduction

Sustainable economic growth and energy transition processes are and will be based on intensive mining

(and recycling) activities. The challenges that these processes bring can be classified into three broad categories: (1) rapid demand growth caused by the rising global population as well as the increased material

needs for climate change policies and UN sustainable development goals; (2) constraints on supply arising from inadequate investment in exploration and new capacity, growing community resistance to mining, governance problems in many host countries, long gestation periods for new mines, growing government regulations to protect the environment and for other reasons, and declining amounts of identified mineral resources; and (3) the inability of recycling and secondary production to contribute greatly to mineral commodity supply until the mid-21st century (Tilton *et al.*, 2018).

Exploration discovery of raw material resources requires perpetual innovations that change the geological targets of exploration, the physical places that are reached, or the way they are explored for. Despite Europe's rich history of mining and residual mineral wealth, current conditions within the EU present social, environmental, political, legislative, cost, technical and physical obstacles to raw material exploration. To overcome this innovation, dialogue and reforms are needed. Experiences (Proctor and MacCallum, 2019) and recent studies (Mitchell, 2020) indicate such an approach can build public trust and can invigorate and equip the exploration industry, thus unlocking unrealised potential in new and mature areas.

The INFACT project (<https://www.infact-project.eu/>) sought to develop exploration techniques more acceptable to society and at the same time test two-way communication with stakeholders during the exploration process (MacCallum, 2016; Proctor and MacCallum, 2019; Mackenzie *et al.*, 2020). At its outset, INFACT reviewed all existing publicly available best practices for exploration, with a view to building on these. As its legacy, INFACT aims to integrate all promising outcomes from its work on both these aspects and all promising new practices learned into education and life-long learning for geoscientists. This integration work started early in the INFACT project and will continue after its completion. Identified stakeholders for INFACT include the affected communities, exploration practitioners, wider society and policymakers at a national and EU level.

INFACT established realistic benchmarks conditions at each of three test sites against which to assess requirements and outcomes and to ensure meaningful quality technical and social testing.

All three test sites – Sakatti (Finland), Geyer (Germany) and Minas de Riotinto and Cobre las Cruces (Spain) – were subsequently redefined as permanent European Reference Sites (ERS) to enable ongoing benchmarking and related endeavours, in

support of recommendations for EU exploration policy reform.

This paper focuses on the knowledge transfer achieved through stakeholder engagement and various education activities, as well as lessons learned from these activities across the INFACT project.

The approach and strategies used

Engagement of appropriate stakeholders during all INFACT activities maximised the adoption and implementation of its results. The higher education, life-long learning and wider society education initiatives that were integrated and that are presented in this paper form the foundation for a long-lasting impact of the INFACT project. A number of communication mechanisms were applied in leveraging the performance and impact of networking, dissemination and education objectives of the INFACT. These included:

- clustering, linking and transferring the knowledge and know-how to other stakeholders, EU projects and research and industry consortia,
- dissemination to various target groups, and
- traditional educational activities designed for students (in higher education), experts (lifelong learning) and the public.

The clustering with, linking to, and knowledge and know-how transfer to other Horizon 2020 projects included attending meetings of other projects (i.e. MIREU project workshop on Social License to Operate – SLO), or organising joint meetings, organising joint data acquisition campaigns at the three reference sites and writing joint papers on exploration in Europe (with the PACIFIC, MIREU and Smart Exploration projects).

Dissemination to various target groups involved the use of social media (i.e. LinkedIn, Instagram, Facebook, YouTube, Twitter), printing of brochures, leaflets, posters etc., issuing regular e-Newsletters (3-4 times annually), and actively participating at relevant international conferences.

Much is possible for education activities designed for students, experts (also called professionals or practitioners) and the public, but content must be both focused and relevant to each group, whether covering technical matters or environmental, social and governance (ESG) aspects.

Stakeholder engagement

The engagement with stakeholders was an integral part of INFACT, as no matter how technically revolutionary, advanced

and/or novel the developed techniques are, without public acceptance such a technique is merely a tool that cannot be applied. Consequently, understanding the public perception, its attitude and acceptance of or antipathy towards the exploration tools, method and processes plays an essential role in shaping the future of any exploration campaign. To address these issues, INFACT included the following activities (ATC *et al.*, 2019)

- Investigating the knowledge, perception and opinion of the public about exploration and mining and typical exploration work;
- Analysing the media coverage and media responses to exploration techniques;
- Undertaking active and innovative engagement of stakeholders at all three reference sites and with expert stakeholders laterally and vertically across society in order to obtain relevant information for the future development of the exploration processes;
- Mitigating and testing for field operation risks associated with Health, Safety, Environment & Community during work at each reference site; and
- Optimising the effectiveness of stakeholder engagement activities by effectively employing the established INFACT network.

The above-mentioned activities, which were developed and regularly benchmarked and evaluated during the INFACT project at the three reference sites, helped to improve the environmental, social and governance protocols/approaches for the exploration campaigns. Based on the outcomes, the knowledge gained was disseminated mainly via short courses (or workshops) for graduate students, academic publications, presentations in virtual conferences and on-line courses on environmental, social and governance aspects, focused on experts from the exploration industry.

Discovery Roadmap and its support in developing long-term solutions

Developing proper, understandable and realistic recommendations associated with policy reforms, plans for improved availability of quality exploration data, and education gaps related to civil society, the state and industry were the goals of the INFACT, summarised in the document titled the "Discovery Roadmap". These were aimed at the highest decision-making levels in order

for INFACT findings to inform both legislative and formal development (SRK, 2019).

Focussing on both extent and quality of existing protocols and services, a series of detailed reviews and gap analysis were carried out on existing policies, environmental and social conditions, and technical capabilities related to mineral exploration and mining. In order to change and ameliorate the “status quo”, a series of recommendations was provided for improving the technical, environmental, social and governance aspects of mineral exploration in Europe.

One of the key findings was that for Europe to be able to source and extract the critical raw materials required for a “greener” society, in addition to promoting less invasive search techniques, both environmental and social concerns and considerations needed to be given greater parity. Use of the term “NIMBYism” (Not in my backyard) was seen as offensive by large sectors of society, who felt overlooked and undervalued by current policies and practices related to mining.

While the EU has an impressive range of regulations and frameworks to protect the natural environment, social protections are less rigorous, with many EU states relying on national planning laws and only one EU convention – 1998 the Aarhus Convention, which makes provision for the right of everyone to receive environmental information that is held by public authorities.

One of the key outcomes from INFACT, in addition to recommending greater social protections and considerations within the minerals sector, has been to integrate issues such as social performance and Social Licence to Operate principles into all geoscience education at all levels.

Innovative technologies in mineral exploration

Mineral exploration and the successful exploitation of resulting discoveries, besides facing technical (i.e. prospectivity, exploration interest and exploitation possibilities) and social challenges (i.e. economic conditions, social and environmental acceptance, and legislative aspects), has historically also been hampered by shortages of skilled geoscientists (i.e. TBR’s Skills and Labour Market Team, 2012; European Migration Network, 2015; Australian Mining, 2018; Mining People International, 2018; The West Australian, 2018). This is compounded by the rapidly changing skills needed to apply technological innovations in modern exploration and mining operations.

At the same time, the current curricula in applied geophysics at many European

universities are developed taking into account mainly the needs of the hydrocarbon industry, with focus upon control source seismics, while the number of specialised courses in potential fields, electric and electromagnetic methods are limited. As a result, graduates are not familiar with the modern equipment for data acquisition or methods of non-seismic data processing and interpretation that are routinely used in mineral exploration and mining. Another problem is limited access of university teachers to digital materials from recent mineral exploration campaigns owned by private companies. In parallel, geoscience student numbers are declining in undergraduate and post-graduate levels as mining is perceived to be a “dirty” industry. All of these factors limit the availability of European graduates suitably trained to find ready employment with companies involved in exploration.

In cooperation with the PACIFIC project, also funded from Horizon 2020, the INFACT team organised a four-day course called “Winter School on Sustainable Mineral Exploration” in Huelva, Spain. This course, held in March 2020, was developed as an interactive workshop on social, environmental, and technical aspects of sustainable mineral exploration. The curriculum of the course followed the sequence of a modern grassroots exploration campaign to introduce concepts like best practices, stakeholder engagement and non-invasive exploration techniques. The technical content covered common airborne exploration methods with an emphasis on innovative geophysics, including hyperspectral imaging, UAV magnetics, and low-frequency airborne electromagnetics.

The workshop targeted European master’s and PhD students and post-doctoral researchers. In all, 40 participants attended in person and 13 followed parts of the programme remotely, due to the Covid-19 outbreak.

Impact creation including outreach and dissemination

A special part of INFACT was devoted to impact creation; this includes outreach and dissemination activities. It also focused on higher education, life-long learning and wider society awareness raising. The impact activities were related to exploration campaign activities, the sustainability aspects of exploration tools and exploration best practices in both technical and social areas.

Within the INFACT project strong emphasis was placed on the instant inclusion of the project’s results in the areas of

technical and geological, and social science research into the higher education at the graduate level via:

- i. Upgrading several courses with recent developments in non-invasive geophysical techniques for mineral exploration for MSc students of geophysics at Oulu Mining School (OMS);
- ii. Including students in short field courses on exploration techniques (MSc students of geophysics at Freiberg University); and
- iii. Giving several lectures and online courses on the social aspects of mineral exploration in Europe were given:
 - a. *Communication, dialogue and public consultation* for MSc students of Leuphana University of Lüneburg, Germany;
 - b. *Public engagement in mining and mineral exploration: case study INFACT* for MSc students at Stuttgart University, Germany;
 - c. *Environmental and social aspects in mining* for MSc students in Geology and Environmental Management of Mining Resources at the International University of Andalusia, Spain.

And in addition, two education events were held for two local high schools in Andalusia, Spain.

At the postgraduate level the “immediate” inclusion of the results was achieved with i) the inclusion of a PhD student into the INFACT’s tasks in the field of geophysics; ii) full-time employment of a postdoctoral researcher in geology; iii) direct knowledge transfer via internal workshops, field campaigns and research for the students involved.

The aims were twofold, firstly to immediately transfer the know-how to the students and secondly to test and shape the courses to develop an ideal knowledge transfer path.

Life-long learning (LLL) activities were focussed on addressing the experts in technical and social fields of exploration in early and mid-stages of their career. A Life-Long Learning Mining Value Chain programme at Oulu Mining School includes three courses (Introduction to Mining, Mining Geophysics, and Ore Geology and Society) that draw their content and know-how directly from INFACT results.

Another mode of life-long learning was performed through the international collaboration on airborne geophysics that enabled

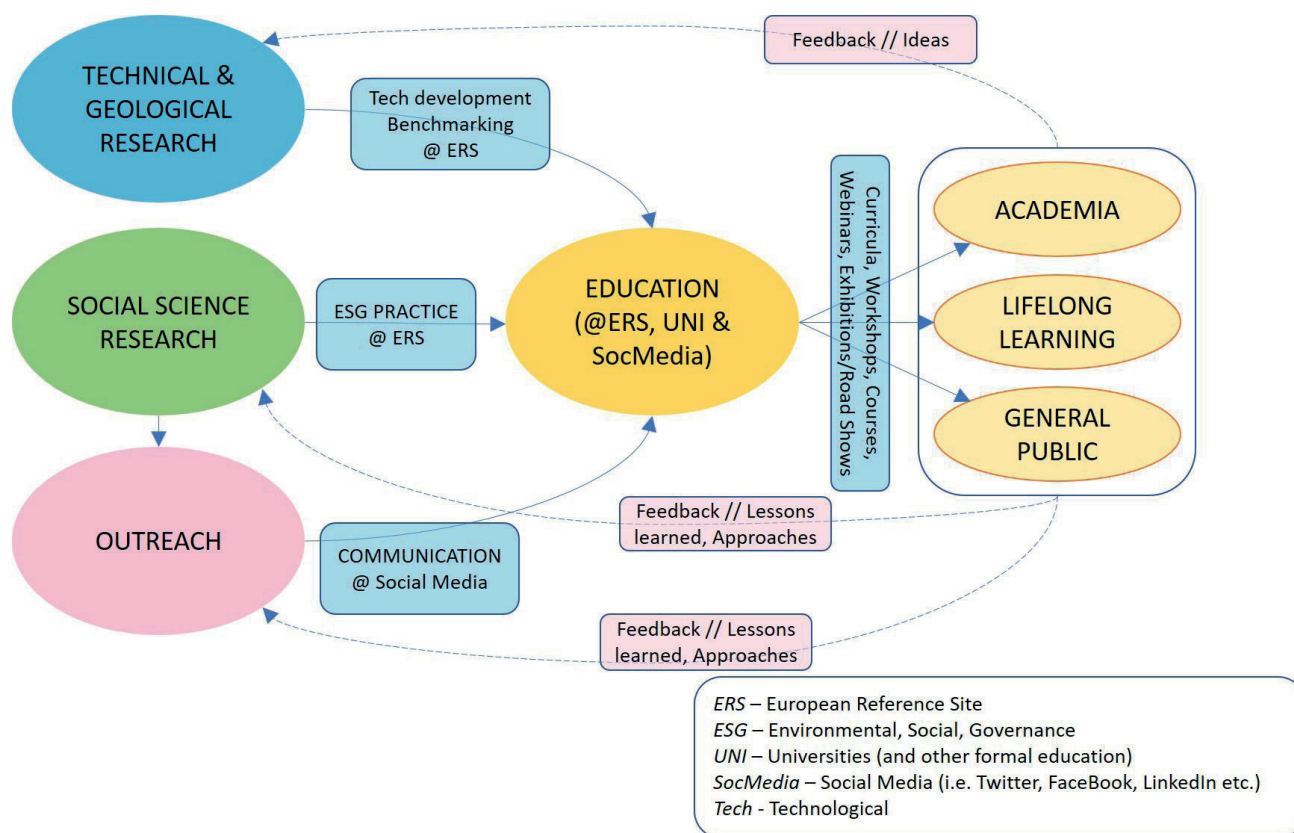


Figure 1: Consortium-stakeholders learning loop, as adopted in the INFACT project.

state-of-the-art knowledge transfer with one of the partners (Helmholtz Institute Freiberg for Resource Technology), hosting Canadian experts for a week of research and collaboration on integration and advanced processing of airborne geophysical data, including specific geophysical data generated within the INFACT project over the reference sites in Finland and Germany.

The clustering activities performed with other “sister” projects are listed in the previous section.

Experts from the field of geoscience were regularly informed on the INFACT’s development and any interesting results through the weekly news compilation (EFGeoWeek), monthly newsletter (GeoNews) and through the social media campaigns. Also, a course on the novel approaches in the Social License to Operate and Environmental, Social and Governance domains is being prepared in a form of an on-line training/lecture for Competent Persons in the exploration industry.

Transfer of knowledge performed within the INFACT project

Types of activities have been presented above. This section provides an overview of the quantity of activity. Firstly, it must be

noted that the numbers of outreach events is not final, as during the preparation of this paper the INFACT project was close to its end, not all activities had been collated for the last six months of the project. Within the first 30 months, a huge number of activities and/or events were performed, targeting different audiences: the general public, experts, policy- and decision-makers, primary and secondary school pupils, and stakeholders in wider fields (NGO, environmentalists, local groups etc). All activities had the purpose to include, integrate, educate and inform. Roughly 800 events were performed by INFACT project partners and more than 500 by linked third parties.

Project partners estimate that the events organised by the INFACT consortium in the period between November 2017 and April 2020 reached an audience of more than 20,000 through public presentations, more than 600 through workshops and up to 50,000 through newsletters. Considering the educational events, 15 undergraduates and 60 postgraduates attended and two PhD students gained practical experience. In addition, approximately 150 experts attended life-long-learning events.

Lessons learned

From the very beginning of INFACT the “educational” component was designed in a circular mode, as a “consortium-stakeholders learning loop” in order to optimise the knowledge and know-how transfer to the various stakeholders. In addition, the benefits of the feedback received from these groups helped the INFACT consortium shape, adapt and enhance all content developed within the INFACT project – from new exploration search techniques to concepts, knowledge and processes. *Figure 1* shows the educational loop that INFACT adopted.

Conclusions

During the INFACT Project several challenges of future mineral exploration were addressed – novel geophysical techniques and novel environmental, social and governance approaches. The lessons learned were successfully integrated into various types of training courses in the three countries with the reference sites and form a good basis for strengthening the expertise of geoscientists that work (or will work) in the raw mineral exploration industry on a daily basis.

The chosen approach of a learning loop (a two-way learning process) proved to bring benefits to both the end-users/stakeholders and to the INFACT project partners, resulting in an optimal use of the project's resources. At the same time, it brought useful and applicable results to the exploration and mining sector in Europe (and beyond), to local communities where the exploration and mining activities are ongoing or could be developed in the future,

and to the wider European public, which more and more will depend on domestic raw mineral supply.

In this aspect it is essential that geoscience education is tightly linked to the actual developments in the sector, drawing directly and instantly from progress, from newly-acquired know-how and from the in-situ lessons learned. It is only by enabling this that trust between the community and industry can be built and tightened.

Acknowledgments

The authors would like to thank the European Union's Horizon 2020 research and innovation programme for financing the INFACT project through grant agreement no.776487 and the reviewer for helping to improve this paper.

References

- ATC, UEF, DIA, SYKE, 2019. Feedback report from local landowners and communities on test site plans and analysis of test site engagement practices. INFACT report, unpublished (available as a document - Deliverable D2.5 at the INFACT project repository site).
- Australian Mining, 2018. Skills shortage drives up wages. URL <https://www.australianmining.com.au/news/skills-shortage-drives-up-wages/>. Accessed 28.09.2020.
- European Migration Network, 2015. Determining labour shortages and the need for labour migration from third countries in the EU – Synthesis Report for the EMN Focussed Study 2015. European Commission. URL https://ec.europa.eu/home-affairs/sites/homeaffairs/files/what-we-do/networks/european_migration_network/reports/docs/emn-studies/emn_labour_shortages_synthesis_final.pdf. Accessed 28.09.2020.
- MacCallum, C., 2016. A Social Licence through Sustainable Development in Mining. Proceedings of Mining and Communities Solutions, 2016 Vancouver, Canada. Published by InfoMine, © 2016 InfoMine.
- Mackenzie, S., Everingham, J., Bourke, P., 2020. The Social Dimensions of Mineral Exploration. SEG Discovery, No 121 (1), 16-28.
- Mining People International, 2018. Experts warn skilled labour shortage looms for mining. URL <https://www.miningpeople.com.au/news/experts-warn-skilled-labour-shortage-looms-for-mining>. Accessed 28.09.2020.
- Mitchell, P., 2020. Top 10 business risks and opportunities – 2020. Ernst & Young Global Limited. URL https://www.ey.com/en_ro/mining-metals/10-business-risks-facing-mining-and-metals. Accessed 09.08.2020.
- Proctor, M., MacCallum, C., 2019. The Canary in the Cage: Community Voices and Social License to Operate in Central Eastern Europe. Proceedings of the 6th International Congress on Environment and Social Responsibility in Mining, Santiago, Chile.
- SRK, 2019. Summary report of the online expert consultation. Report of expert stakeholder meetings T2.4 - A. INFACT report, unpublished (available as a document - Deliverable D2.10 at the INFACT project repository site).
- TBR's Skills and Labour Market Team, 2012. Geoscience skills needs of UK industry. The Geological Society of London. https://www.geolsoc.org.uk/~media/shared/documents/policy/PN01212R_Geoscience_Skills_Needs_final_report.pdf?la=en. Accessed 28.09.2020.
- The West Australian, 2018. Diggers & Dealers 2018: Looming mining skills shortage needs 20-year solution, says Evolution boss. (7 August) <https://thewest.com.au/business/mining/diggers-dealers-2018-looming-mining-skills-shortage-needs-20-year-solution-says-evolution-boss-ng-b88920706z>. Accessed 28.09.2020.
- Tilton, J.E., Crowson, P.C.F., DeYoung, J.H., Eggert, R.G. Jr., Ericsson, M., Guzmán, J.I., Humphreys, D., Lagos, G., Maxwell, P., Rade-tzki, M., Singer, D.A., Wellmer, F.-W., 2018. Public policy and future mineral supplies. *Resources Policy*, 57, 55–60. DOI: 10.1016/j.resourpol.2018.01.006.