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NEWSLETTER

Portugal – the only Lithium producer in the EU

Batteries not included…

By Brendan Clifford (MCS, FELMICA)

Several years ago, Goldman Sachs was quoted as calling lithium 'the new gasoline'; a term not to be taken lightly by one of the world's largest investment banks. Since that time, EV and electrification of industry has continued to grow as new and improved technologies become available. Lithium-ion battery technology has also gotten better, and with no immediate substitute on the horizon, the drive for (no pun intended) and investment in lithium and the wish to develop new lithium sources in Europe and around the world intensifies. In turn, this electrification strategy is designed to support the Green Deal and European decarbonisation initiatives and more recently the importance of lithium has been recognised in the new Critical & Strategic Critical Raw Materials lists. Whilst identification of lithium resources, its concentration and chemical conversion for the manufacture of ion batteries plays out, one should not forget that lithium, due to a series of unique properties, also finds application in a wide range of other industries.

For many years the ceramic, glaze and glass industries have recognised that by adding lithium, in the form of lithium-bearing feldspar, to its formulations, can reduce the 'eutectic' (melting temperature) during the firing phases which in turn allows manufacturers to reduce the temperature at which they operate their kilns. In ceramics, lithium can also improve thermal shock resistance, which refers to a material's ability to withstand sudden temperature changes without cracking and is the additive of choice in oven-to-tableware products. If lithium is incorporated into glazes, it can enhance transparency and create a glossy finish. In the case of glass, lithium improves strength, durability, and chemical corrosion resistance. It also imparts some unique optical properties making lithium an ideal additive for specialty lenses and prisms.

In addition to its use in ceramics, glazes and glass, lithium has found other non-battery applications such as production of aerospace lubricants where its viscosity and high thermal stability are advantageous.
As a multi-mineral producer of raw materials and ceramic bodies, MCS (Mota Ceramic Solutions) is aware of the importance of lithium and in 2022 produced 155,000 tonnes of lithium-bearing feldspars in Portugal for important local and international ceramic market sectors.
In conclusion, lithium's unique properties make it a versatile material in ceramics and other applications. For this reason, it can be expected that the demand for, and use of lithium, in the form of lithium-feldspars will continue to grow, particularly during periods of high energy costs and efforts by energy-intensive industries to reduce their carbon footprint. MCS takes a proactive interest in lithium applications and developments and whilst it currently follows a 'batteries-not-included strategy it is proactive in understanding the implications of the increasing likelihood of lithium-bearing hard rock sources in Portugal and Europe. MCS also remains optimistic that the company, and country, can play its part in the development and use of this often misunderstood mineral.

Upper Photo: Product storage facility at MCT. Below: Lepidolite from Goncalo deposit mined by MCT. Lower left: lithium bearing concentrate from pilot plant trials, low right: floation cell at LNEG pilot plant in Porto. All photos: GKZ

...but potentially feasible

By Wolfgang Reimer, (GKZ)

During the HORIZON 2020 FAME project (2014-2018) – partners investigated the feasibility to produce a lithium concentrate fit for lithium battery salt production from the pinkish lithium bearing mineral lepidolite, extracted by SMC, a subsidiary of FELMICA (MSC Group), that holds the mining permits of the Gonçalo mineral deposit. The FAME experts designed a flow sheet that had to meet the chemical and economic goals to achieve a marketable product. The flow sheet was tested in a Mill-Flotation Pilot Plant at LNEG (the Portuguese Geological Survey) in Porto.
The first section of the flowsheet is a mill closed circuit to grind the ore to <250 µm; small content of some heavy minerals are removed / recovered within this closed circuit. The second step is a bank of froth flotation cells to recover lithium mica minerals, lepidolite in this case. Finally, a second differential flotation circuit is applied to the rejects of the lepidolite flotation to firstly remove some muscovite and subsequently to promote a feldspar (albite)/quartz separation, in order to upgrade these industrial minerals as raw materials for the ceramics industry.
In the end, the trials proved that the flowsheet seems to be a successful example of almost "zero waste" mining, as it maximizes the upgrading of the mining material in primary Li concentrates and secondary metallic and non-metallic marketable by-products. Continuous flotation runs done so far, have demonstrated the technical feasibility to produce lepidolite concentrates above 4.0% lithium oxide (Li_2O) at Li recoveries > 65%. These have been further tested for metallurgical lithium extraction at FAME partner GEOS Freiberg laboratories in Saxony, Germany, to produce a high quality 99.5% Li carbonate (Li_2CO_3), under Li recoveries > 93%.

The European spectral library – a GREENPEG database of pegmatite ores and host rocks

Multispectral data processing helping to identify Li-deposits

By Joana Cardoso-Fernandes (UPORTO)

The analysis of multispectral air and space borne data is an essential requisite of the GREENPEG Toolset, a multi-layered set of ground and remote exploration tools to enhance environmentally friendly and efficient exploration of LCT-NYF pegmatites. This article describes the different stages of ground truth and image processing towards the identification of new spectral data sets of indicator mineral assemblages of pegmatite ores and its host rocks.

Photo: Pegmatite sampling in the FELMICA exploration license in northern Portugal (February 2022) Photo: UPORTO

Fieldwork and sample collection

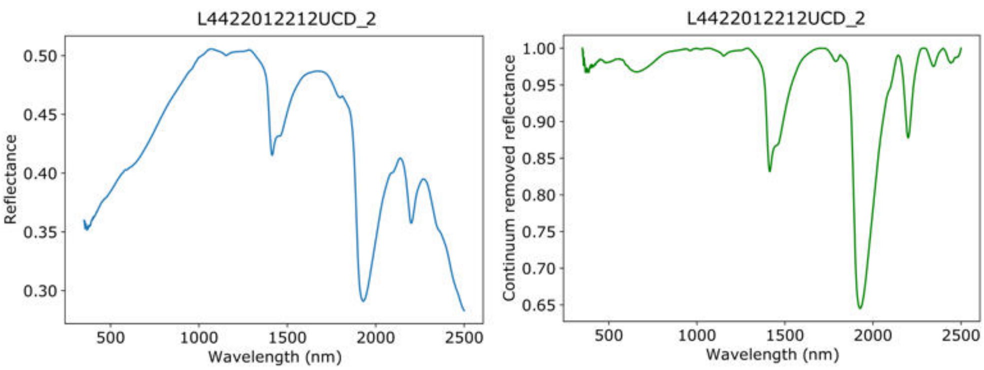
The surface and/or drill-core samples were collected as a joint effort of the GREENPEG partners, in distinct field campaigns. Drill-core samples from Austria and Ireland were made available by European Lithium ECM and Blackstairs Lithium, respectively. NGU and UIO contributed with field samples from Norway. UPV provided samples from Spain and Portugal. Field campaigns in collaboration with FELMICA allowed UPORTO to complete the database with representative field samples from Portugal. Thus, the GREENPEG spectral database includes representative samples from Nb-Y-F (NYF) and Li-Cs-Ta (LCT)-type pegmatites and host rocks from pegmatite locations in Austria, Ireland, Norway, Portugal, and Spain.

Photos: Spectral measurements were conducted in surface (left) and drill-core samples (right), from Norway and Ireland, respectively. The figure on the left also shows the software for collecting the spectra, while the sample photograph on the right shows a red circle indicating the spot analyzed. (Photos: UPORTO)

High-resolution spectral measurements

The database provides the spectral signature, obtained through reflectance spectroscopy studies, from pegmatites with distinct genesis, mineralogy, structure, and host rocks. The measurements were conducted using the FieldSpec 4 spectroradiometer. The spectroradiometer equipment has a fiber optic cable connected to a probe with an internal light source, allowing it to measure the electro-magnetic energy reflected by each mineral or rock sample in the lab within the range between 350 and 2500 nm.

With three different detectors and 2151 channels in the aforementioned spectral range, the FieldSpec 4 spectroradiometer provides a much higher spectral resolution than the one obtained by satellite sensors, allowing one to obtain information about the spectrally active minerals in each sample. For each spot analysed, a description was made regarding the sample color, type of surface, and the location of each measurement was annotated and photographed.



Images: Representative spectra of an albitized pegmatite sample from Ireland showing features of montmorillonite mixed with white mica/illite. Raw (left) and continuum removed (right) spectra. (Images: UPORTO)

The spectral library

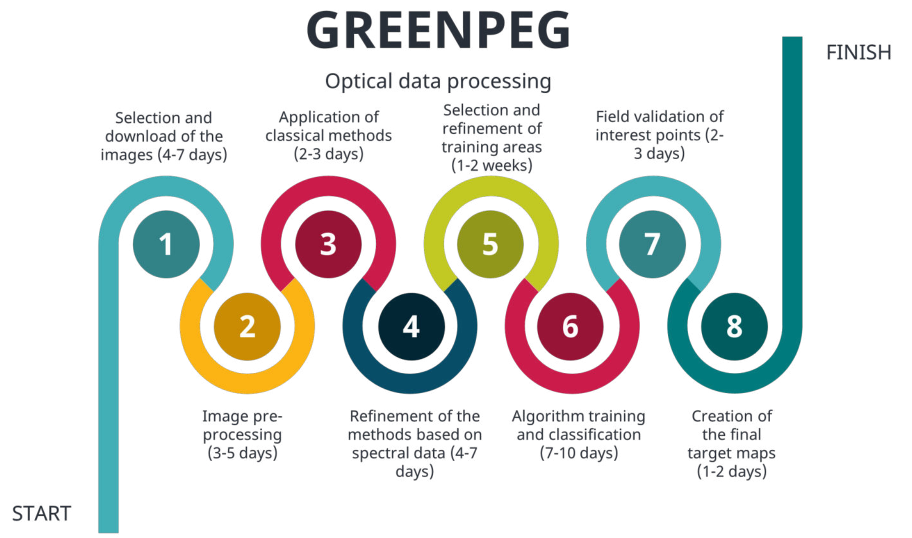
The spectral database contains the reflectance spectra (raw and with continuum removed), sample photographs, and main absorption features automatically extracted by a self-proposed Python routine. Whenever possible, spectral mineralogy was interpreted based on the continuum-removed spectra. The advantages and added value of the presented spectral library reside on its European scale and possible use as a reference for pegmatite exploration at a global scale through satellite image processing, for example.

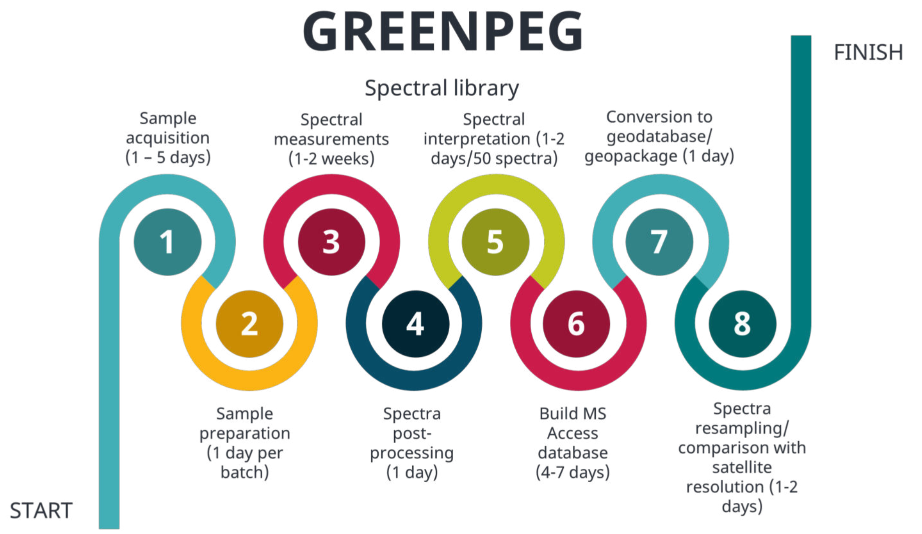
This extensive database provided in multi-formats represents, therefore, a high-quality dataset to be used by multiple users of different backgrounds, from academia to the mining industry. Data usability and accessibility were a priority. Thus, GREENPEG partners ensured clear interoperability with a Geographic Information System (GIS) environment to fully exploit the data provided. The database is publically available on GREENPEG's Zenodo platform.

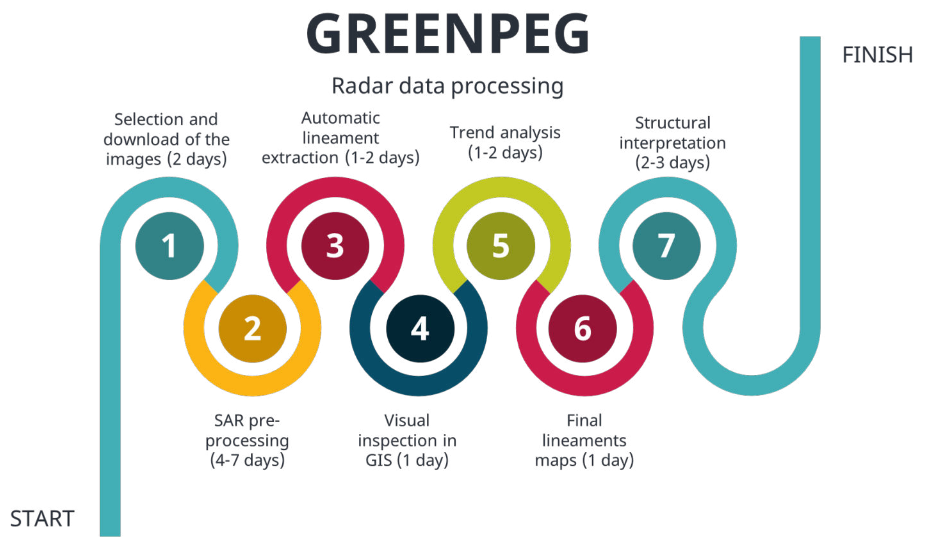
GREENPEG roadmaps for the processed image data

By Joana Cardoso-Fernandes (UPORTO)

As part of work package 2 of the GREENPEG project ("Province scale (<10,000 km²) methodology testing"), three separate roadmaps were created for the processed image data. Each roadmap concerns a different type of data, namely: (i) optical data, (ii) spectral data/spectral library, and (iii) radar data.







The expected time frame of each step in the roadmaps concerns just one case study area. Moreover, the obtained following the roadmap for the construction of the spectral library is integrated into the roadmap for optical data processing, after step number three. Thus, it is clear how each type of data can be integrated into the GREENPEG proposed methodology to produce target maps at the province scale. As can be seen in the images, optical data processing should be carried out between 30 and 51 days, maximum, and includes the selection of satellite images to download, image pre-processing and application of classical methods for image processing, refinement of the methods based on the spectral data obtained in the lab, selection and refinement of the training areas for algorithm classification, field validation of the identified interest points, and creation of the final target maps. In its turn, the creation of a spectral library may take between 17 and 41 days, considering 50 to 100 spectra, respectively. After the acquisition, the samples should be dried in a muffle furnace to remove any moisture from their surface. The spectral measurements must be conducted in a dark room and accompanied by the necessary annotations and photographs. After the spectra post-processing (i.e., continuum removal, etc.), the spectral mineralogy can be interpreted. A database can be built with all available information and later converted to a geodatabase or geopackage format for interoperability with GIS. Finally, the spectra can be resampled to match a satellite sensor resolution, allowing the comparison of the spectral behaviour of the samples with the spectral signatures of corresponding pixels. Lastly, radar data processing can take 12 to 18 days to complete. After the image selection and download, the synthetic aperture radar (SAR) images must be pre-processed. The automatic lineament extraction algorithm allows the identification and extraction into a vector file of the most noticeable lineaments. The following visual inspection in a GIS environment is a fundamental task to remove any possible man-made structures extracted. After removing all unwanted lineaments in the visual inspection step, trend analysis is achieved through the creation of rose diagrams with the lineaments' mean direction. The final lineament maps can be created allowing for spectral interpretation by comparing the extracted lineaments with previously mapped structures.

How multilaterial, coordinated research funding supports the LIB´s community

By Dina Carrilho (FCT)

Research funding coordination on raw materials and the circular economy is the main joint activity of the 3 Pan-European networks of public research funding organisations from EU countries and regions and non-EU countries (ERA-MIN and subsequent ERA-MIN2 and ERA-MIN3), supported by European Commission, since 2011 until 2025, and coordinated by Portugal (FCT) since 2016. Through the implementation of 7 joint transnational calls (2013-2021), a total of 79 innovative research projects financed with €60 million of public funding (including €10 million contribution of the European Union) have addressed critical challenges facing the metallic, construction and industrial minerals industry, such as resource scarcity, environmental impacts, and social issues, which are essential for the raw materials research community to advance the development of responsible, sustainable and resource efficient raw materials supply chains. The outcomes of these projects had impact not only on the national and regional research priorities but also on the priorities and challenges of the ERA-MIN Research Agenda (2013) and the Strategic Implementation Plan (2013) of the European Innovation Partnership on Raw Materials, supporting the Raw Materials EU Policies. Moreover, under the ERA-MIN framework, 13 R&I transnational projects on raw materials supply for batteries and recycling of end-of-life batteries were supported with public funding of €12 million not only from EU countries and regions but also from Argentina, Brazil and South Africa. As a member of ERA-MIN Joint Calls, FCT (Portugal) provided funding to a total of 26 collaborative research projects focused on sustainable mining and mineral processing, as well as the development of new technologies and processes for the extraction and recycling of minerals of which 7 projects have developed effective lithium and antimony prospecting, new recycling technologies and improve the efficiency of existing ones and have focused on developing new processes for recovering valuable raw materials from batteries.

Through its involvement in ERA-MIN, FCT is helping to promote a more sustainable and efficient mining activities and the development of new technologies that can reduce the environmental impact of mining activities, while also ensuring a secure and reliable supply of critical mineral resources for Europe's economy and industries. Moreover, ERA-MIN funded R&I projects are helping to create a more sustainable and secure supply of non-fuel, non-food raw materials, including critical raw materials, in the EU chain, and reduce the EU's dependence on raw materials from non-EU countries, through promotion of transnational research on responsible sourcing, recycling and re-use of EoL products, and recovery and substitution of critical raw materials, which is particularly relevant for lithium-ion batteries, providing support to fundamental and applied research and innovation, strengthening international cooperation, and improving the competitiveness of EU industries towards the transition to a circular and a low-carbon economy.

GREENPEG at a glance

Many of the raw materials for green energy production can be sourced from lithium-caesium-tantalum (LCT) and niobium-yttrium-fluorine (NYF) pegmatites. Being relatively common in Europe, pegmatite deposits have the size and grade to especially attract small mining operations. GREENPEG aims at reducing exploration costs and impact on environment by developing two innovative and competitive toolsets, including: three new instrumental techniques and devices (piezoelectric sensor, helicopter-complementary nose stinger magnetometer, drone-borne hyperspectral imaging system), two new datasets and work flows for prospect scale (<50 km^2) and district scale (50-500 km^2) exploration. Validation will be ensured from industry-led trials at locations in Norway, Austria, Ireland, Finland, Portugal and Spain testing different surface environments, morphology and geological settings.

With the development of exploration technologies tailored to pegmatite ore, GREENPEG closes a technology gap, counteracts the lack of specific exploration strategies and increases the competitiveness of users. Furthermore, GREENPEG will feed the EU raw materials data base in support of responsible and secure sourcing and attracting investments.

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