Critical metals are the metals supply disruption of which can entail severe industrial and/or economic consequences for sectors such as renewable energy, mobility and defense. Since these metals are associated with significant supply risk, there is a strong interest in exploring their alternative sources. A good example is lithium. This metal was listed as a critical metal for the European Union in 2020. The currently used lithium comes from the Andean salars and from granites or lithiniferous silicate pegmatites (lepidoolite, or spodumene). There is currently no significant lithium production in Europe but several prospects are underway.

According to the studies of Deetman et al. (2018) and Mulvaney et al. (2021), the global demand for lithium could increase tenfold between 2015 and 2050, mainly due to the demand on materials required for the production of lithium-ion batteries for electric vehicles. The same authors report the possibility of depletion of current lithium resources by 2060-2090 (Mulvaney et al., 2021). The search for new resources is therefore essential to meet the future demand.

In the framework of a collaborative research program between LabEX RESSOURCES21 and Imerys, the granite massif of Beauvoir will be examined from the mineralogical, geochemical, and metallogenic perspectives. The work focuses on the formation of intrusion (age, nature of magmatic processes leading to the formation of hyper-differentiated granites), the mineralogy of critical or strategic metal carriers, such as Li, Nb-Ta, Sn-W, and the most efficient methods of separating the rare metal-carrying phases.

The Beauvoir site is located in the Échassières district, Auvergne-Rhône-Alpes region, 470 km from Nancy (Figure 1), in the north-east of the French Massif Central.

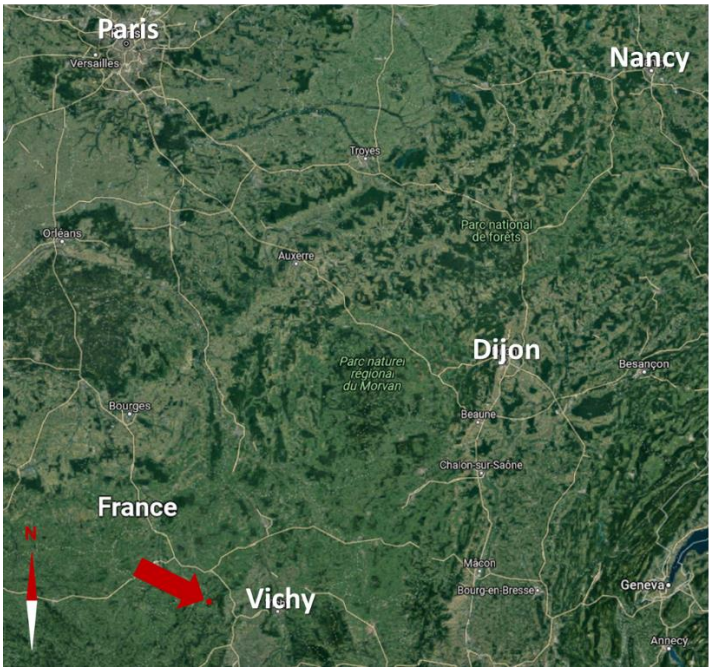

Figure 1 – Geographic location of the Beauvoir site

Beauvoir site has been exploited by Imerys for kaolin production for several decades. The site comprises a quarry and a plant that employs size- and gravity-based separation. These methods are among the "greenest" separation techniques because they do not require the use of reagents.

In January 2022, seven researchers, four doctoral researchers and two engineers affiliated to CNRS, GéoRessources, and CRPG – members of the Université de Lorraine belonging to LabEX RESSOURCES21 visited the site for the first meeting between the scientific and the industrial teams (Figure 2).

Figure 2 – The scientific team of LabEX RESSOURCES21 and the industrial team of Imerys working on the Beauvoir project

Geological setting

Owing to the works conducted by the teams of the GPF scientific drilling campaign (synthesis in the special issue of Geology of France (1987), and Cuney et al. (1992)), the subsoil structure of Beauvoir was proposed in accordance with the schematic representation given in the Figure 3.

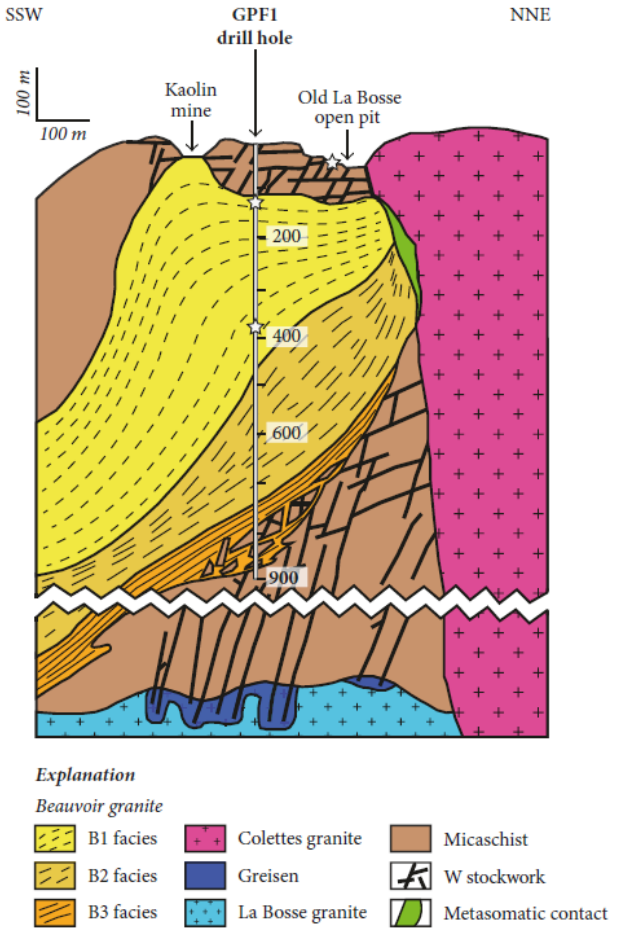

Figure 3 – Schematic representation of the Beauvoir granite (Géologie de la France, Aïssa et al. (1987) et Cuney et al. (1992))

The project

The LabEX RESSOURCES21 scientific team is composed of ten permanent researchers, two post-doctoral and five doctoral researchers. The project comprises three major axes:

First axis – Geology

The actions of this axis of the project are aimed at establishing the relationship between the distribution and the content of rare and critical metals and magmatic and hydrothermal phenomena, along with the use of geological dating methods to understand the formation of pluton over time.

Axe 2 – Characterization

The actions of the second axis of the project are dedicated to: (1) the development of portable tools designed to detect and quantify in a fast and practical manner the rare and critical metals and (2) the establishment of the relationship between geochemistry and mineralogy of the studied rocks.

Axis 3 – Processing options for metal recovery

The third axis is dedicated to the development of a processing route suitable for the recovery of lithium-bearing minerals and phases-carriers of other rare metals such as, for example, Nb and Ta, using gravity and flotation separation methods, coupled with modelling tools.

The visit to the Beauvoir site

Despite the difficult sanitary situation in January of 2022, the scientific team was welcomed on site for one and a half days in strict compliance with all health and safety regulations.

On the first day of the mission, the scientific team (divided into three groups in accordance with the scientific interests) visited the kaolin quarry (Figure 4) and the drill core storage facility.

Figure 4 – Kaolin quarry. Beauvoir, Imerys.

The geologists and engineers of Imerys presented the general drilling plan for the years of 2021-2022, the equipment installed on the site, the various aspects of the sampling procedure, how geological anomalies are treated and the methods used to capture the representative images of the cores. The acquisition of the core images is conducted in a closed black box, where the cores are exposed to light with constant characteristics, as well as UV light. Each core is characterized with three images: wet core, dry core and core under UV light. If necessary, color tablets are introduced for reference.

At the drill core storage facility, doctoral and post-doctoral researchers were able to make their first pre-selection of samples for their future studies.

The following half-day was dedicated to the exchange between the industrial and the scientific team. The doctoral and post-doctoral researchers presented their research projects and their strategies to achieve the set objectives. Between the presentations, short Q&A sessions with the members of industrial team took place.

The visit concluded with the demonstration made by the representatives of the «characterization» axis, which consisted in presenting the portable tools and showing their use directly on the drill cores coming from the new drilling campaign; LIBS (Laser-Induced Breakdown Spectroscopy) was presented by Naila Mezoued (Figure 5) and the XRF (X-ray fluorescence) by Jean Cauzid.

Acknowledgement

The scientific team wishes to thank Imerys and the geologists and engineers of the Beauvoir site for the excellent welcoming visit.

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Figure 5 – Demonstration of the the portable tools (LIBS) by Naila Mezoued

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