The GREENPEG project toolset to explore for buried pegmatites hosting rare metals and high purity quartz to feed the energy transistion

Axel Müller[a,b], Marco Brönner[c] Julian Menuge[d], Claudia Pohl[e], Klaus Brauch[e], Georgios Tassis[c], Claudia Haase[c], Ben Williamson[f], Ana Teodoro[g,h], Kerstin Saalmann[c], Joana Cardoso-Fernandes[g,h], Alexandre Lima[g,h], Kate Smith[f], Frances Wall[f], Douglas Santos[h], Encarnación Roda-Robles[i], Mario Hopfner[j], Idoia Garate-Olave[i], Jon Errandonea-Martin[i], John Harrop[k], Lawrence Carter[f], William Keyser[a], Haoyang Zhou[a], Teimoor Nazari-Dehkordi[d], Thomas Unterweissacher[l], Ralf Steiner[l], Wolfgang Reimer[m] and Carla Pueyo Lloret[a]

[a]Natural History Museum, University of Oslo, Oslo, Norway; a.b.muller@nhm.uio.no; [b]Natural History Museum, London, UK; [c]Geological Survey of Norway, Trondheim, Norway, marco.bronner@ngu.no; [d]School of Earth Sciences, University College Dublin, Dublin, Ireland, j.f.menuge@ucd.ie; [e]terratec Geophysical Services, Heitersheim, Germany, pohl@terratec-geoservices.com; [f]Camborne School of Mines, University of Exeter, Penryn, UK, B.J.Williamson@exeter.ac.uk; [g]University of Porto, Department of Geosciences, Porto, Portugal, amteodor@fc.up.pt; [h]Institute of Earth Sciences – Porto Pole, Porto, Portugal; [i]Departamento de Geología, Universidad del País Vasco-UPV/EHU, Leioa, Spain, encar.roda@ehu.eus; [j]IFU GmbH Privates Institut für Umweltanalysen, Lichtenau, Germany, mho@ifu.de; [k]Blackstairs Lithium Ltd., Dublin, Ireland, jcharrop@gmail.com; [l]GEO Unterweissacher GmbH, Regio-Tech, Hochfilzen, Austria, thomas@geo-unterweissacher.at; [m]Geokompetenzzentrum Freiberg e.V., Freiberg, Germany, wolfgang.reimer@gkz-ev.de; https://www.greenpeg.eu/

GREENPEG, a European innovation project financed by the European HORIZON 2020 programme, has developed an exploration approach for the discovery of buried pegmatite ores in the form of an integrated, multi-method, sustainable and economically viable toolset. The toolset consists of a complementary suite of adjusted conventional and newly invented methodologies and new data processing approaches optimised for the target size, surface environment, depth, geological setting, mineralogy, chemistry and petrophysics of pegmatite ore deposits. Its development is based on a modified genetic model for European pegmatite-type ore deposits by Müller et al. (2022) and a multi-scale (province, district and prospect) and multidisciplinary approach. By improving the targeting of pegmatite deposits, and thus the effectiveness of exploration, the delivered toolset will reduce exploration time and costs, the level of environmental disturbance from the use of relatively invasive techniques, and social impacts such as noise. The toolset developed has been adjusted, optimised and tested for commercialisation under Technical-Readiness-Level-7 conditions in three European demonstration and exploration brown field sites: Wolfsberg in Austria, Leinster in Ireland, and Tysfjord in Norway. The toolset encompass a wide array of technologies, including satellite image processing and both airborne and ground-based geophysics and geochemical approaches and three new instrumental demonstrations to effectively identify buried (up to 100 m depth), small (10,000 - 1,000,000 m^3) and clustered pegmatite ore bodies. The toolset includes three instrumental demonstrations comprising the first European EASA certified helicopter-compatible nose stinger magnetometer which will allow lower altitude airborne surveys down to about 50 m above ground, a drone-borne hyperspectral imagery system and a piezoelectric spectrometer for rapid and efficient detection of buried pegmatites. The toolset comprises as well two freely available databases, a petrophysical database for pegmatite ores and host rocks to adjust parameters of geophysical exploration methods (Haase & Pohl 2022) and a spectral reflectance database of pegmatite minerals and ores for satellite image processing (Cardoso-Fernandes et al. 2022). The toolset will be easily deployable by small and medium sized enterprises and accessible to exploration and mining companies in "strategic knowledge-based consultancy services", offered by GREENPEG partners and as publication during 2024.

References

Cardoso-Fernandes, J. & GREENPEG Consortium, 2022: Spectral Library of European Pegmatites, Pegmatite Minerals and Pegmatite Host-Rocks – The GREENPEG Project Database. *Earth System Science Data Discussion 2022*, 1-19. https://doi.org/10.5194/essd-2022-386.

Haase, C. & Pohl, C.M., 2022: Petrophysical Database for European Pegmatite Exploration—EuroPeg. *Minerals 12*, 1498. https://doi.org/10.3390/min12121498.

Müller, A., & GREENPEG Consortium, 2022: GREENPEG - Exploration for pegmatite minerals to feed the energy transition: First steps towards the Green Stone Age. In: Smelror, M., Hanghøj, K. & Schiellerup, H. (eds) The Green Stone Age: Exploration and Exploitation of Minerals for Green Technologies. *Geological Society, London, Special Publications, 526*. https://doi.org/10.1144/SP526-2021-189.