Prospecting for spodumene pegmatites by statistical evaluation of trace elements in magmatic muscovite

Schuberth-Hlavac, Gerald[1]; Mali, Heinrich[2]; Schuster, Ralf[1]; Steiner, Ralf[2]; Rohrhofer, Sandro[2]; Zahrl, Marcel Aaron[2]; Sweda, Martin[2]; Horvat, Christian[2]; Knoll, Tanja[1]

1 Geological Survey of Austria, Neulinggasse 38, A-1030 Vienna, Austria; 2 Chair of Geology and Economic Geology, Montanuniversität Leoben, A-8700 Leoben, Austria.

During the past years, about 1,400 sites of pegmatite occurrences belonging to the Austroalpine Unit Pegmatite Province were investigated in the frame of the projects MRI_Pegmatite I/II. These projects are part of "Initiative GBA-Forschungspartnerschaften Mineralrohstoffe – MRI" and aim to investigate the economic potential of the rocks with respect to lithium and other rare elements. The investigated pegmatite dikes formed during Permian lithospheric extension by anatectic melting of aluminum rich metapelites. Based on the appearance in the field and the mineralogical composition simple pegmatite, evolved pegmatite, leucogranite and spodumene-pegmatite are distinguished. They appear in different levels of the Permian middle and lower crust embedded in certain host rocks. Field and analytical data concerning the investigated pegmatite occurrences are available in a database. Of special interest for prospection on additional spodumene-pegmatite dikes are more than 2,000 major and trace element contents on magmatic muscovite determined by SEM/EDX and LA-ICPMS. This collection of data allows the pegmatite occurrences to be categorized and visualized in maps showing regional fractionation trends and prospective areas in a variety of ways. Data analysis shows that commonly applied simple parameters such as K/Rb ratio are not able to distinguish the classes general pegmatite, leucogranite and spodumene-pegmatite because they are not distinct enough. In contrast, Classification and Regression Trees (CART) provide much more accurate predictions. The CART algorithm was used because, on the one hand, it creates binary decision trees that, in contrast to black box models such as artificial neural networks, can also be understood by non-experts and, on the other hand, this algorithm can deal with partially incomplete data sets. Before the calculation of the CART all muscovite analyzes were checked for correctness using statistical methods like box-plots and correlation matrices and then further examined using machine learning methods. The tree generated using all available data has a prediction accuracy of 97 %. This in-sample forecast overestimates the accuracy of the forecast. Dividing the available data into a randomly created training data set and a validation data set results in different trees depending on the data sets in the training data set. However, it allows carrying out out-of-sample tests. These still show a forecast accuracy of mostly over 94 %. It turns out that the lithium and beryllium contents are particularly well suited to distinguishing the different pegmatite classes. In addition to these, the elements cobalt, phosphorus, iron, zinc, lead, tantalum, titanium and manganese proved to be indicative. Based on the results about a dozen of potential spodumene-pegmatite occurrences were identified, which will be checked in the field in the near future.