

## **A Novel Approach for Delineation and Mapping of K-Rich Igneous Rocks and Their K<sub>2</sub>O Content to Support Unconventional Potash Exploration**

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Potassium(K)-rich igneous rocks encompass a range of alkaline and silica-undersaturated rocks, including syenites and their volcanic equivalents (trachytes). These silicate igneous rocks are characterized by high K<sub>2</sub>O concentrations and have been the subject of numerous investigations, either for their geodynamic implications or for their association with critical mineral resources. More recently, researchers have dedicated further studies to assessing their potential as unconventional sources of potash for agricultural K fertilization. Their geological exploration has become a priority in many countries, particularly those with high agricultural productivity and dependence on imported potash fertilizers. In this study, we propose a new approach integrating remote sensing, GIS, and field data to efficiently identify K-rich igneous rocks over large regions and map the K<sub>2</sub>O content with high spatial resolution within the selected potential areas. Our methodology involves the use of ASTER thermal data to rapidly delineate potential areas and select the most suitable for fieldwork and optimized sampling. To obtain a high-resolution geochemical map of K<sub>2</sub>O content, we used a deep neural network method assisted by 10-m spatial resolution Sentinel VNIR data to interpolate a limited number of geochemical sample data. The proposed approach was successfully applied over a large-scale area of the Moroccan High-Atlas Mountains, where K-rich alkaline intrusions have been reported. It has proven to be relatively rapid and cost-effective. The results have allowed for the identification of the famous Tamazeght geological alkaline complex, which spans an area of 100 km<sup>2</sup> within an initial exploration area of more than 40,000 km<sup>2</sup> and contains alkaline igneous rocks of diverse natures. The obtained K<sub>2</sub>O geochemical map for this geological massif—well-known to host the K-rich syenites—has shown a good coefficient of determination value of over 60%.