Uranium Prospectivity Mapping Across the Australian Continent via Unsupervised Cluster Analysis of Integrated Remote Sensing Data

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Exploration geologists are increasingly being inundated by a large volume and variety of digital spatial data. Unsupervised clustering algorithms, such as Self-Organizing Maps (SOM), provide opportunities to gain insights, not evident from a single dataset, into complex geological phenomena by efficiently integrating and recognizing patterns within these data and generating manageable and interpretable outputs. This study demonstrates "data fusion" for mineral exploration and highlights the potential for data-driven clustering analysis to assist geoscientists in gaining robust understanding of the geological controls on mineralization in regolith dominated terrains.

We interpret the nature of uranium mineralization across the Australian continent by integrating remotely sensed, continental-scale geophysical and mineralogical data using SOM. We combine the outputs of our cluster analysis with uranium occurrence data (n = 1138) to construct prospectivity maps of regional uranium mineralization for the Australian continent. Furthermore, we divide prospective areas into several unique groups. These groups represent subtle but significant differences in regolith and bedrock geophysical and mineralogical characteristics of uranium mineralization targets.

A total 11.94% of the samples input into the SOM analysis are likely to be prospective for uranium mineralization. Areas mapped for uranium prospectivity intersect the location of uranium mines (operating and historic) with an accuracy of 88.89% (n = 119). By interrogating the unique geophysical and mineralogical characteristics of uranium prospectivity groups we can distinguish regions of older landscapes with subdued topography dominated by arid climatic conditions, and relatively young landscapes over thin crust exhibiting moist climatic conditions and deeply weathered regolith profiles. These broad groups can be further subdivided into areas likely to represent magmatic-hydrothermal, unconformity, and calcrete-hosted paleochannel uranium deposits.

The clustering analysis methodology presented here can be applied to investigate other bedrock- and regolith-associated mineral commodities and at local and/or prospect scales. Our techniques provide additional tools for the exploration geologist to develop a robust understanding of the likely geological context of target mineralization. In turn, this will help to define the geological controls on mineralization and will contribute significantly to developing appropriate exploration strategies.