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## Automated Detection of Geophysical Features Characteristic of Carbonatites-Alkaline Ring Complexes

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Carbonatite-alkaline complexes are rare rock types that are often enriched in critical elements such as rare earth elements (REE), U, Th, Nb, and sometimes Au, Cu, PGE, and diamonds. These rocks typically occur as ring complexes or linear dykes in extensional settings such as intra-continental rifts associated with deep crustal faults and show ring-like oval-circular or linear geometries. These rocks often display well-defined anomaly patterns in geophysical datasets, which can map poorly exposed carbonatite-alkaline complexes in deeply weathered and under-cover terranes. The geophysical anomalies are generally manually interpreted and analysed using visual methods, which are time-consuming and often subjective. This study develops a machine learning-based, completely automated workflow incorporating convolutional neural networks (CNN) based UNET for automatic detection and extraction of geophysical anomaly features at a wide range of scales using convolution filters. The input images are passed through a series of downsampling filters to retain their bare essential features. These are then upsampled to resemble the desired geophysical anomaly patterns persisting at multiple depth levels, following which they are extracted and examined in the geological context. The workflow is demonstrated for mapping major structural features associated with carbonatite-alkaline complexes in a study area in NW India. Manually derived and mapped structures were used to train the algorithm. As such algorithms require a large amount of training data, the input and training data were segmented to generate a robust dataset. The algorithm successfully delineated major structural and morphological features that conform with the visually mapped and interpreted features. An intersection over union (IOU) ratio of ~0.8 was obtained for the test images. This workflow can potentially improve the efficiency of prospectivity assessments of critical element deposits associated with carbonatite-alkaline complexes and can be applied to discover carbonatite-alkaline ring complexes from geophysical data in deeply weathered and under-cover terrains.