Application of multivariate statistical techniques to soil geochemistry of southern Australia

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The trace-element signatures of 81 soils, commonly associated with calcrete, from across southern Australia were investigated and related to their bedrock lithologies.

Hierarchical cluster analysis (HCA) assisted in identifying quite homogenous groups of variables and classifying elements of different sources on the basis of the similarities of their chemical properties. The elements in the first major group (Ce, La, Sm, Lu, Yb, Th, K, Eu, Ba, Rb, Cs, Na and Hf) have relatively high concentrations in granite and their association in the soils of the study area reflects such bedrock. This group also includes a quite distinct subcluster (Ce, La, Sm, Lu, Yb and Th) and K. The highly significant correlation of K with REE and Th is reflected in its inclusion in this cluster which arises from these elements' common geochemical behaviour in more radioactive granites. The association of Fe-Sc-Co-Cr can be reasonably designated as the signature of underlying mafic rocks in the soils of the study area. The elements As and Sb are statistically connected which is explained by their geochemical characteristics.

R-mode factor analysis (RFA) of the soil data is consistent with the results from HCA: First factor (F1) from RFA and first group from HCA, F2 and F4 from RFA and second group from HCA and F3 with the third group in HCA. Based on RFA, 40.9% of the total variance emerges from factor one identified as a reflection of a felsic rock source. The second factor contributes 24.4% of the total variance, and is related to soil derived from basic and ultrabasic sources. The third factor shows the contribution of coprecipitation of Br and Ca during pedogenic processes, with a variance of 10.2%. Factor 4 at 8.6% total variance includes high loadings of As and Sb (0.714 and 0.769, respectively) in the soils of the study area. This factor may be considered as a mineralisation factor. In arid and semi-arid areas of low water-table where the formation of a near-surface hydromorphic dispersion pattern is inhibited, the major surface indication of buried mineralization may be biogenic anomalies resulting from the uptake of metal by deep-rooted plants and this may also be reflected in their adjacent calcareous soils in the study area.

In this low-density sampling project, it can be concluded that the use of multivariate techniques is a helpful means of manipulating, interpreting, and representing data concerning soil geochemistry and also in determining the mineralization potential of a large area and delineating local areas of interest. The model describes the main regional multielement pedogeochemical patterns in the study area and the geographical distribution of the geochemistry of factor scores delineates boundaries which define how surficial material, despite disturbance, reflects the underlying lithology.