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Geochemical provenancing, can it meet evidentiary standards?

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Determining the geographical origin of natural materials and derivatives, can provide valuable information during an active investigation and for evaluation of court evidence. In the investigative phase, spatial information can be used to (re)direct resources with limited legal risk. In the court phase, the diversity of geochemical parameters and provenancing models, and lack of standardized approaches, create challenges for presenting evidence that meets the "beyond reasonable doubt" standard. One important factor affecting levels of "doubt" is the "error rate" of a technique, as referred to in the globally accepted Daubert standard for admissibility of evidence.

Historically, soil evidence has often been provided by experts, geologists and soil scientists with subjective local knowledge, in some cases leading to valuable information. However, modern forensic science requires the systematic determination of error rates and reduction of false negatives that could lead to missed geographical source locations, and false positives possibly leading to wrongful convictions. Thus, an empirical approach is now required.

With the emerging availability of regional, national, and continental scale geochemical surveys, such empirical approaches are now becoming feasible. This coincides with a forensic paradigm shift favouring a Bayesian approach to evaluate the evidential value of geo-evidence. In that process, the probability of a natural material's composition (soil, food, remains) being geochemically indistinguishable to the composition at the origin, is weighed against the commonness, or Random Match Probability (RMP), of that composition in a regional or global database, resulting in a Bayesian Likelihood Ratio (LR). This also allows assessing the accuracy (error rate) of both the analytical and spatial predictions.

In the presentation we will use the recently completed urban geochemical atlas of Canberra and global Sr, O and H isoscapes to show different provenancing models. These models were challenged with samples of known origin to assess their performance. The main conclusion is that most models are good at excluding areas of low investigative interest but proving origin "beyond reasonable doubt" is challenging as on average only around 70% of known samples are correctly spatially attributed. We will discuss the plausible confounding factors and provide suggestions for future targeted research.