**Resource estimation of roll front uranium deposits by using traditional and machine learning methods for Nichols Ranch uranium deposit in Wyoming**

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# **ABSTRACT**

The fundamental component of resource estimation is domain modeling. However, in such deposits as roll front uranium is deposited in sandstone and on the contact of oxidized and reduced rock domains which makes it difficult to model. The Grade - Thickness (GT) contour method is one of the most applied resource estimation techniques in roll-front uranium deposits. However, explicit modeling and GT contouring by using the GT information extracted by drill holes is exceedingly difficult, time consuming and inconsistent.

This research studies domain modeling of roll front uranium mineralization using the GT values within the radial basis function (RBF) **aided** implicit modeling framework. And compares the spatial associations of the RBF determined domain of mineralization to the domains obtained by GT contours. Then, the block grades within the domain of mineralization are estimated by using Kriging and selected machine learning models to compare their spatial associations and overall, in-situ tons and grade estimates with each other and GT contours.

The domain of mineralization modelled by RBF appears to spatially correlate well with the domain of mineralization obtained by GT contours. The performance of the selected machine learning models was quite good with k -NN having values of R2=0.792, RMSE=0.0216, and MAE=0.0048 and the random forest with R2=0.751, RMSE=0.0236, and MAE=0.0077. A visual validation of these models, swath plots, grade tonnage curves suggests that the k -NN and Ordinary Kriging (OK) results are remarkably close to each other perfectly aligning with the drillhole intersections in terms of grades while random forest (RF) estimates show significant deviations of higher grades from the other methods and the supporting drill hole information. For final comparisons, it was observed, in the study area, that the difference between GT in-situ resource estimates and OK and k -NN results were approximately 4% and 1% respectively.