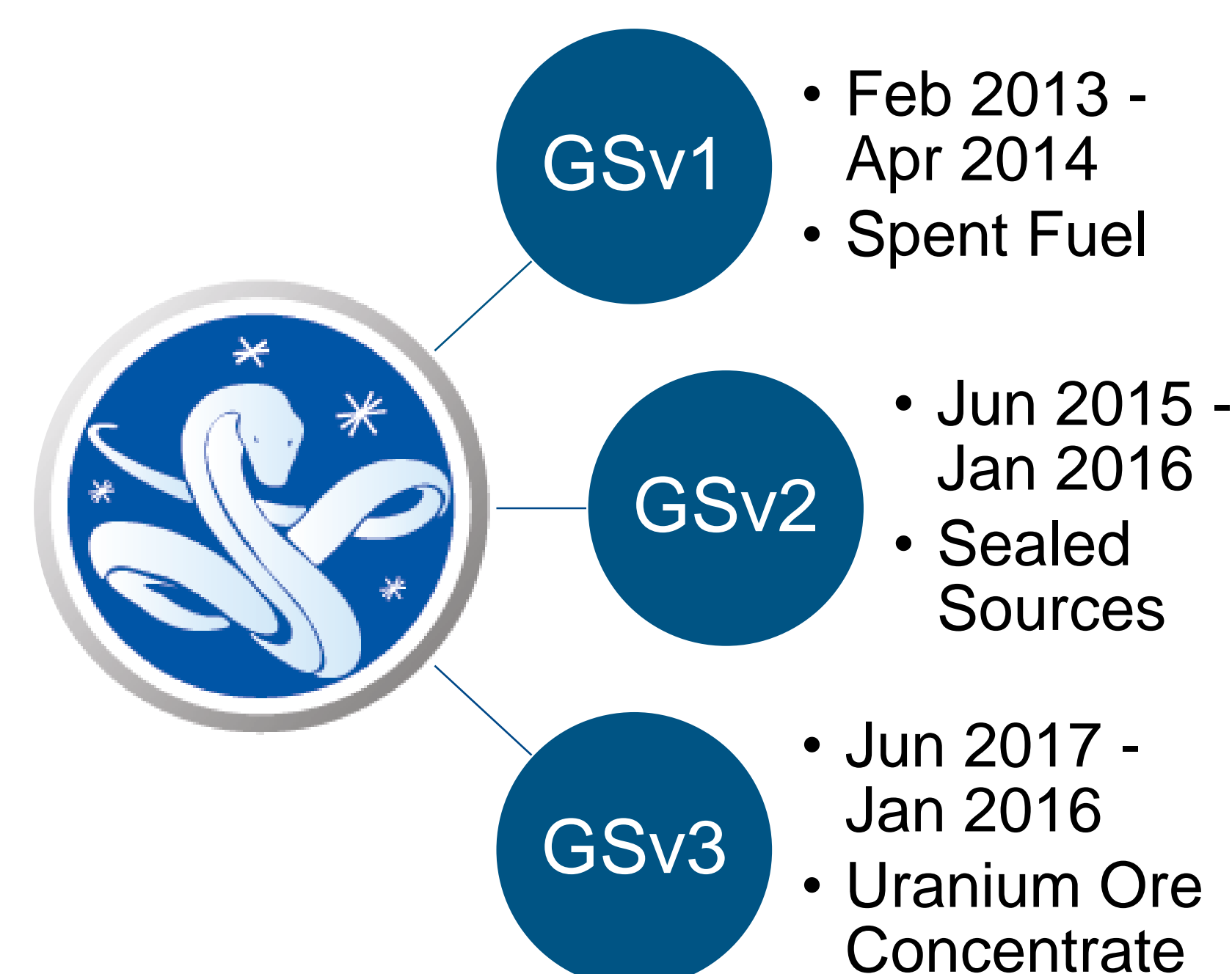


A National Nuclear Forensics Library is a national system of expertise, information, and communication that may be utilized to identify nuclear or radioactive material found out of regulatory control. LLNL is engaged in assisting countries with NNFL development. We provided the data and framework for a virtual, web-based exercises designed to raise awareness about the technical aspects of creating and using national nuclear forensics libraries, creating a new surrogate data set for uranium ore concentrate (yellowcake) based on real measured geochemical data for similar materials.

THE GALAXY SERPENT EXERCISES

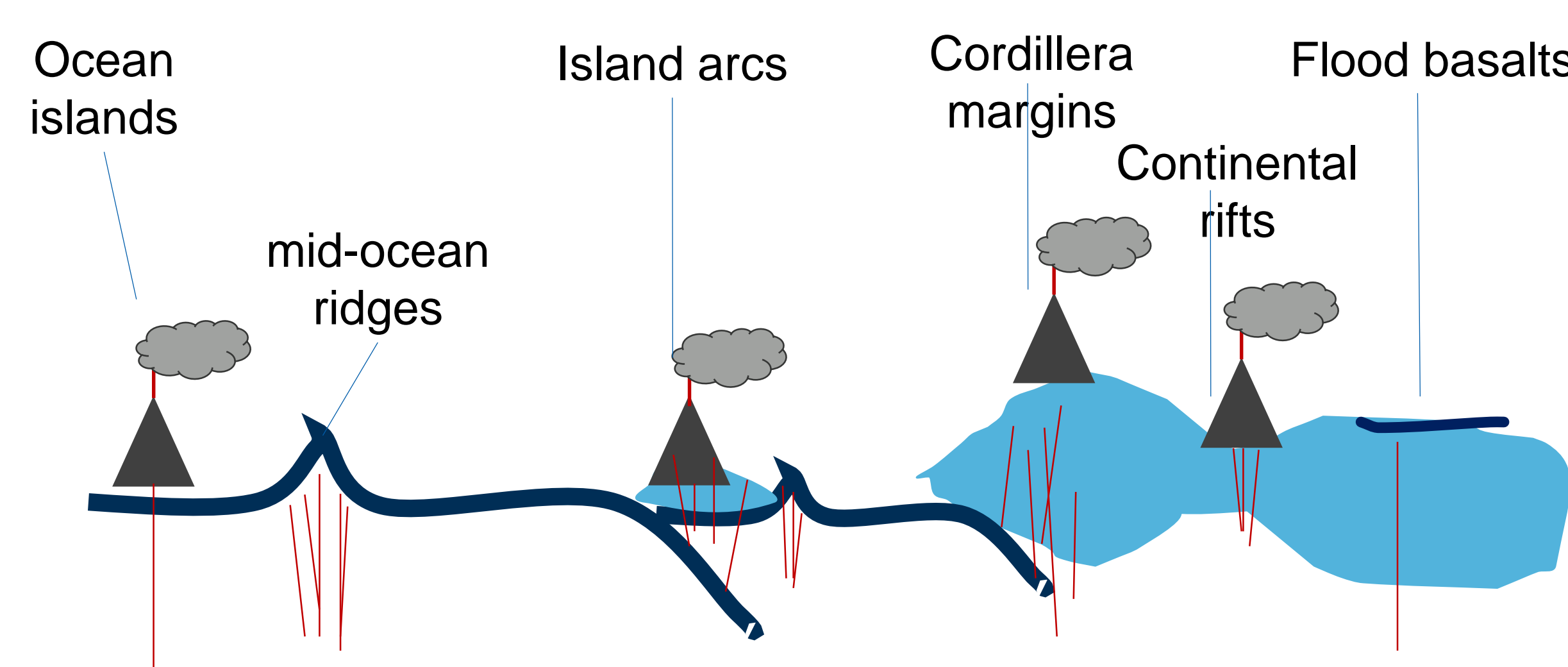
- Sponsored by US Department of State, the International Technical Working Group for Nuclear Forensics
- Web-based virtual exercises designed to exercise NNFL capabilities on a number of nuclear and radioactive materials
- Three iterations have been run so far



THE CHALLENGE

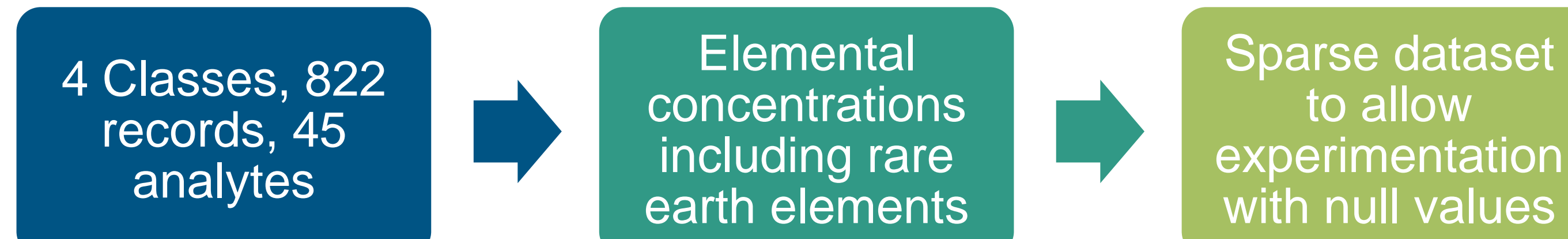
- Produce a realistic dataset resembling UOC that can be used for algorithm development activities
- Protect sensitive and proprietary information
- Preserve elemental covariance and data characteristics
- No data loss or distortion
- Create a dataset that is large enough for research, but not ungainly

THE APPROACH

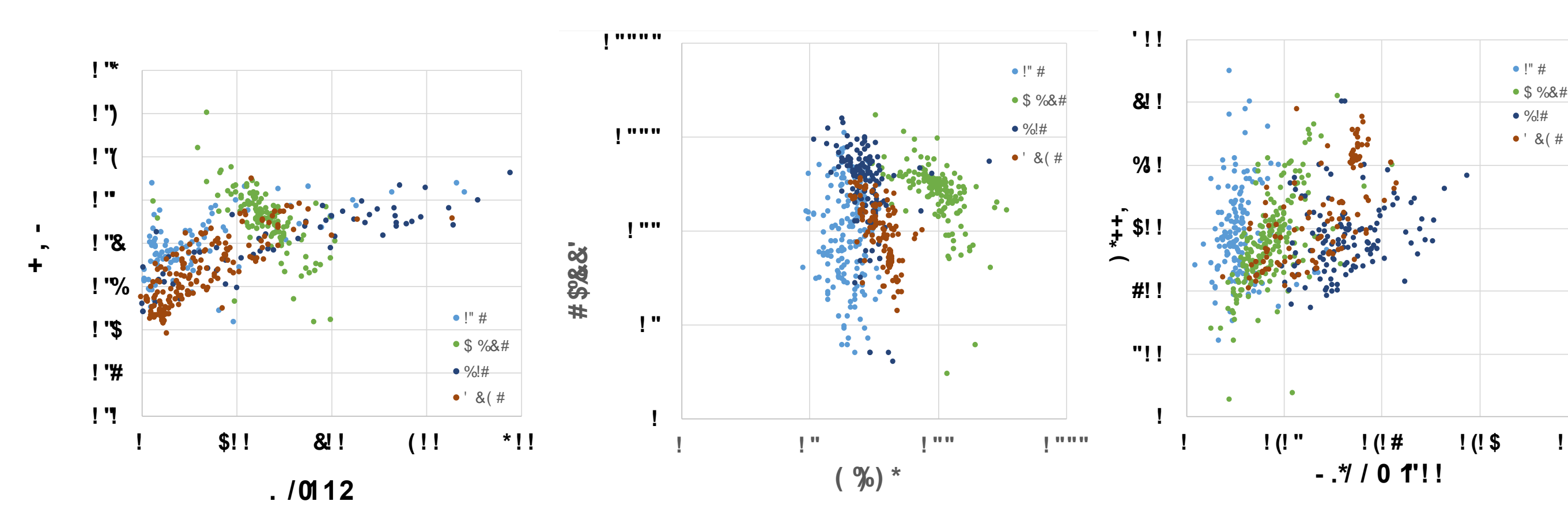


Most basalts are about 75% $\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{CaO} + \text{MgO}$.

Most UOCs are about 75% U.

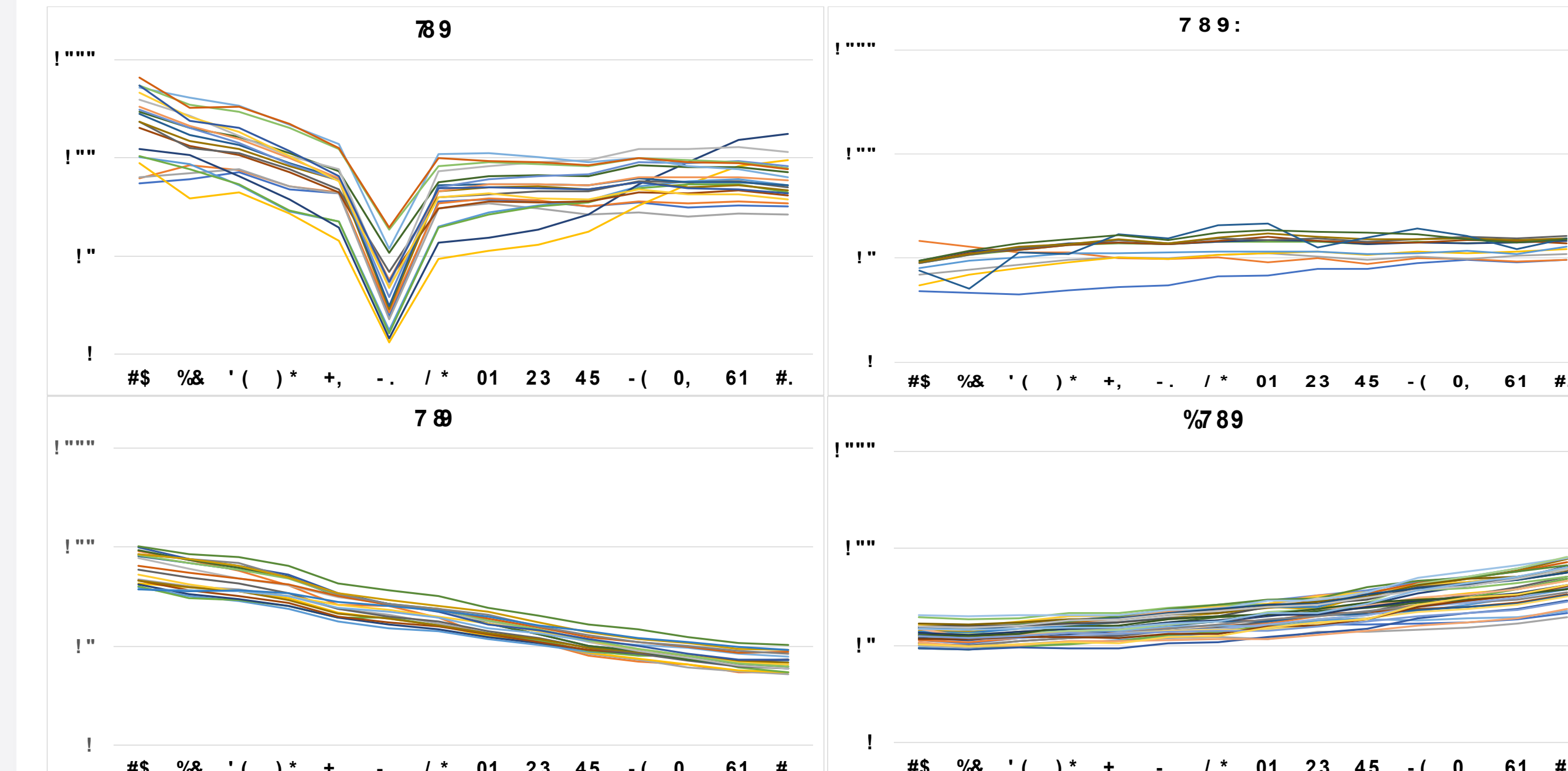


A NOVEL MULTIVARIATE DATASET

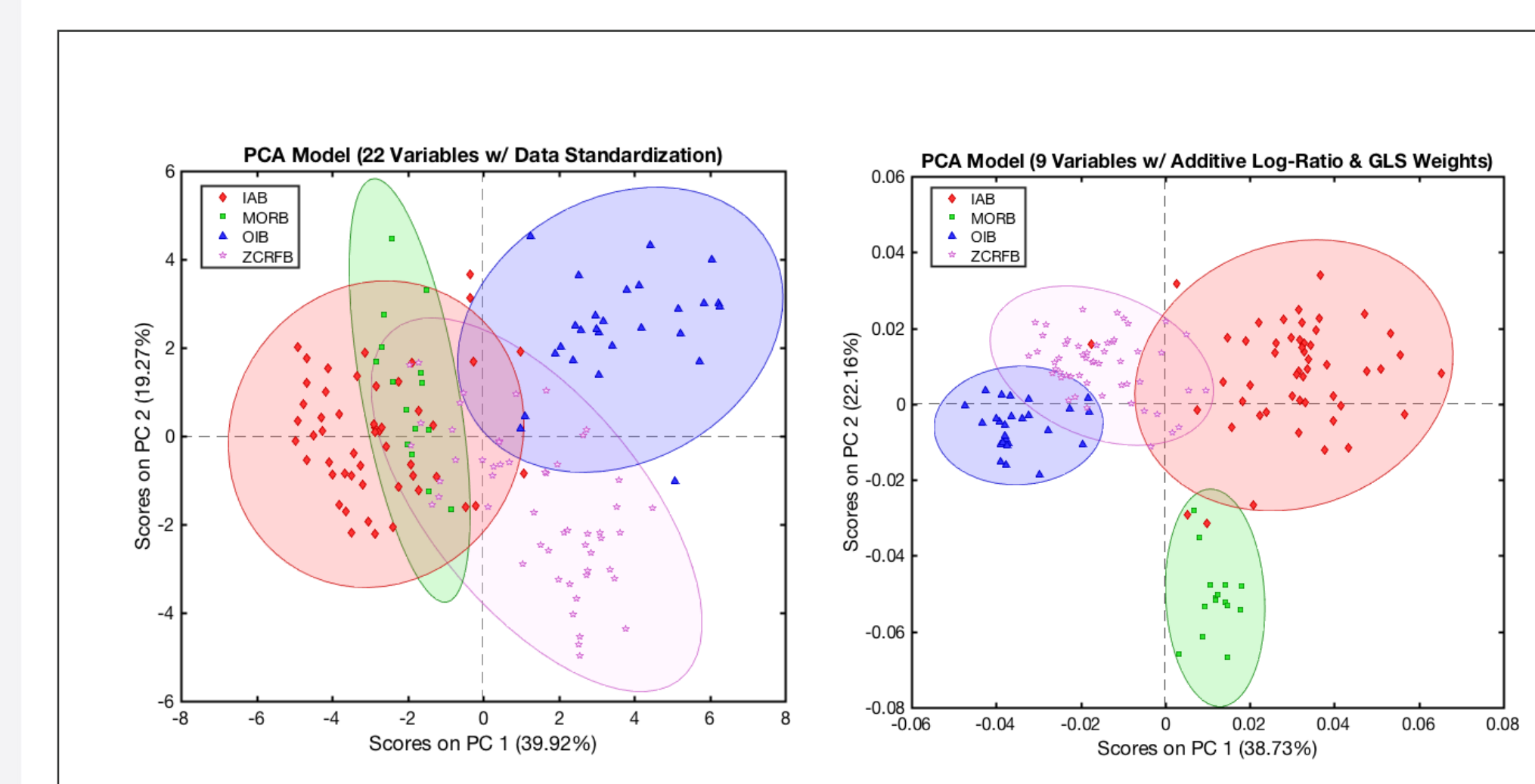


Four classes of surrogate UOC material plotted in multielement space. Trace element discrimination diagrams show that the four classes are separable and distinct from one another, but with somewhat overlapping compositions.

ELEMENTAL COVARIANCES ARE PRESERVED



Chondrite normalized are earth element patterns for samples from each of the four classes represented in the data set.



PCA plots showing the four classes with no missing value imputation and differing preprocessing approaches.

CONCLUSIONS

- We created a robust geochemical dataset ideally suited for experimenting with multivariate analytical approaches
- Because the geochemical data has intrinsic covariance, the data provides an opportunity for meaningful interpretation of multivariate approaches
- More than 15 teams from at least 10 different countries participated in the GSv3 exercise
- LLNL is positioned as a leader in the development of NNFLs and algorithm development for pre-det provenance assessment

COLLABORATORS



We have developed a robust geochemical dataset for exercising NNFL capabilities.