

Introducing Orange-Volcanoes: a New Tool for Petrological, Geochemical, and Volcanological Data Mining

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We present Orange-Volcanoes, an extension (add-on) of the open-source platform Orange Data Mining, specifically designed to advance data-driven analysis in petrology, geochemistry, and volcanology. The combination of Orange and Orange-Volcanoes enables the rapid application of machine learning, statistical analysis, and predictive modeling to large petro-volcanological datasets, supporting visual and interactive data exploration. The platform's visual programming environment fosters collaborative research, ensuring reproducibility and accessibility for scientists, educators, and students without requiring programming skills.

The ability to apply diverse statistical and machine learning tools to geochemical data, while interactively visualizing step-by-step results, makes Orange and Orange-Volcanoes valuable assets for managing multivariate datasets and supporting petrological investigations. The ability to apply explainable artificial intelligence techniques, such as feature importance and Shapley additive explanations, allows users to interpret the underlying drivers of geochemical variability better, enhancing understanding of magmatic processes. Through case studies, we demonstrate the application of Orange-Volcanoes in clustering geochemical data and conducting petrological assessments. As the volume of geochemical, petrological, and volcanological data grows, this tool facilitates the future integration of data mining and machine learning techniques into scientists' workflows. Orange-Volcanoes represents a significant step toward a transparent, reproducible, and collaborative scientific approach.

Orange-Volcanoes is open source. Codes are available for downloading and collaboration at the following link: <https://github.com/AIVolcanoLab/orange3-volcanoes>. The install instructions and the documentation is available here: <https://orange3-volcanoes.readthedocs.io/>