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Quantifying crust thickness with machine learning: a study based on the global arc and Tibet magmatic geochemistry

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Crust thickness is a crucial factor to study the evolution of the crust in Earth's history. There is a correlation between arc magma whole-rock geochemistry and crustal thickness. Previous studies have proposed empirical equations with geochemical indicators such as Sr/Y and La/Yb. These empirical formulas have been applied to the study of crustal thickness evolution during geological history and the crustal thickness evolution in orogenic belts. However, a large error bar exists in the calculation of crustal thickness using those traditional empirical formulas for geochemical indicators. Compared with the traditional empirical formulas, the machine learning approach has the advantage of combining multiple elements and fitting nonlinear relationships, which can invert the crustal thickness more efficiently using geochemical elemental characteristics.

Here, we collect previously published intermediate to felsic geochemical whole-rock data on global Pliocene-Quaternary arcs, using the Local Outlier Factor (LOF) to exclude the outlier data. A machine learning model is then built, using supervised learning algorithms for whole-rock major and trace elements with the crust thickness from the CRUST1.0 Model. The machine learning model could significantly improve the accuracy of the crustal thickness. Subsequently, we applied the model obtained from the training to igneous geochemical data from the Tibetan Plateau to invert the history of crustal thickness changes on the Tibetan Plateau.