Geophysical Research Abstracts
Vol. 19, EGU2017-1729, 2017
EGU General Assembly 2017

Space-time patterns in ignimbrite compositions revealed by GIS and R based statistical analysis

Melanie Brandmeier (1,2) and Gerhard Wörner (1)

(1) Georg-August-Universität Göttingen, GZG, Goldschmidtstr. 1, D-37077 Göttingen, (2) Esri Deutschland GmbH, Team Science and Education, Ringstr. 14, D-85402 Kranzberg

GIS-based multivariate statistical and geospatial analysis of a compilation of 890 geochemical and ca. 1,200 geochronological data for 194 mapped ignimbrites from Central Andes documents the compositional and temporal pattern of large volume ignimbrites (so-called "ignimbrite flare-ups") during Neogene times. Rapid advances in computational sciences during the past decade lead to a growing pool of algorithms for multivariate statistics on big datasets with many predictor variables. This study uses the potential of R and ArcGIS and applies cluster (CA) and linear discriminant analysis (LDA) on log-ratio transformed spatial data. CA on major and trace element data allows to group ignimbrites according to their geochemical characteristics into rhyolitic and a dacitic "end-members" and differentiates characteristic trace element signatures with respect to Eu anomaly, depletion of MREEs and variable enrichment in LREE. To highlight these distinct compositional signatures, we applied LDA to selected ignimbrites for which comprehensive data sets were available. The most important predictors for discriminating ignimbrites are La (LREE), Yb (HREE), Eu, Al_2O_3, K_2O, P_2O_5, MgO, FeO_t and TiO_2. However, other REEs such as Gd, Pr, Tm, Sm and Er also contribute to the discrimination functions.

Significant compositional differences were found between the older ($>$14 Ma) large-volume plateau-forming ignimbrites in northernmost Chile and southern Peru and the younger ($<$ 10 Ma) Altiplano-Puna-Volcanic-Complex ignimbrites that are of similar volumes. Older ignimbrites are less depleted in HREEs and less radiogenic in Sr isotopes, indicating smaller crustal contributions during evolution in thinner and thermally less evolved crust. These compositional variations indicate a relation to crustal thickening with a "transition" from plagioclase to amphibole and garnet residual mineralogy between 13 to 9 Ma. We correlate compositional and volumetric variations to the N-S passage of the Juan-Fernandéz ridge and crustal shortening and thickening during the past 26 Ma. The value of GIS and multivariate statistics in comparison to traditional geochemical parameters are highlighted working with large datasets with many predictors in a spatial and temporal context. Algorithms implemented in R allow taking advantage of an n-dimensional space and, thus, of subtle compositional differences contained in the data, while space-time patterns can be analyzed easily in GIS.