

# The Statistics of Geochemical Rock Sampling Revisited

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Selecting rock samples is generally the first in a long line of geochemical data collection steps. While great care is often taken in sampling, biases are nearly always imparted onto resulting geochemical data during this crucial step. In this work, we reevaluate the geochemical uncertainty imposed on whole-rock geochemical data during sampling – in particular, the random uncertainty that arises in these data depending on the size of the sample collected – sampling error.

Here, we present the results of a case study conducted on a coarse-grained, K-feldspar megacrystic granite, which is commercially quarried in southern India and has the trade name ‘Sapphire Brown’ (SB) Granite. Subsamples of various masses (0.625, 1.25, 2.5, 5 and 10 kg) were taken from a large, quarried slab of the SB granite for whole-rock major- and trace-element analysis with multiple subsample sizes and replicate analyses.

The empirical results obtained for the SB Granite can be compared to theoretically-based estimates of sampling error for this granite. The input data for the theoretical modelling include the mineralogy and grain sizes of the granite, as well as the size of the sample collected. As predicted by theory, our data for the SB granite show a decrease in the magnitude of sampling error with increasing sample size. However, our results also highlight flaws in the existing theoretical approach, namely due to geochemical ‘closure’. As a consequence, existing theoretical models either markedly overestimate or underestimate the predicted magnitude of sampling error for many elements.

To improve its predictive capability, we have refined the theoretical framework to incorporate the effects of closure. Estimates of sampling error derived from the revised theoretical model are in much better agreement with the empirical data for the SB granite. This model is coded in an open-source software package, that can be used by the community to estimate geochemical sampling error from a wide range of rock types.