THE MINIMUM NUMBER, AND MASS, OF SAMPLES FOR MINERAL EXPLORATION OF ASTEROIDS.

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Introduction: We compiled and validated a database of 1,187 meteorites containing 28,961 elemental abundances for 65 atomic elements from 121 peer-reviewed papers. The element abundances were compared with anomalies and minimum mining levels of 120 mines/exploration projects. Mineral exploration requires collection of large numbers of samples from each rock type present. Geological models and statistical analysis help predict heterogeneity of rock types and variability of metal content to minimize mining, blending, and processing issues. Even geochemical soil or helicopter sampling programs collect hundreds of samples.

While a single-sample asteroid mission can collect valuable scientific data it provides limited information on variability of chemistry or spatial distribution of rock types which might not be equally distributed across, or below, the surface. Petrologic and chemical composition of chondrite subgroups can be heterogeneous [1, 2, 3]. Where element abundances from few samples are in the lower 25% quartile of a Gaussian/non-Gaussian distribution we may, falsely, conclude an asteroid is not worth pursuing; contrary, if they are in the top 75% quartile, we might expend effort evaluating asteroids with no potential. Thus, we develop a method to calculate the minimum number of samples for first-pass asteroid sampling programs, to cover element abundances ranges, and improve statistical confidence [4].

A few milligrams of sample can help classify rock types, and improve knowledge of the history of an asteroid; but, a grain can bias results. We, therefore, calculate the optimal sample size to minimize such issues, with sufficient sample for petrologic and repeat chemical analysis.

On Earth, broad spacing of drill lines and separation of drill holes allows one to 'infer' a resource; confidence (or *status*) increases as separation between drill lines/holes decreases [5]. The number of surface samples needed to define the near-surface 'resources for asteroids of different radii, and distances (range) that metal concentrations are contiguous can be predicted [6]. We conclude that probes with the capacity to collect dozens of samples or which can analyze many elemental abundances, rapidly, are essential.

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