Name(s)
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Project Number
S0608

Project Title
Investigating the Chemical Signatures of Meteorite Impacts

Abstract

Objectives/Goals
Impact cratering plays an integral role in the evolution and formation of planetary systems. Chemical anomalies are accepted phenomena at impact sites, but few, if any, published models adequately describe the kinetics and thermodynamics of impact-induced chemical changes.

Methods/Materials
Utilizing x-ray fluorescence, inductively-coupled plasma mass spectrometry, and variable pressure SEM/EDX, this study analyzed the trace chemical composition of shock-metamorphosed granite and obtained quantitative data, which were further analyzed using parametric frequentist statistics and resampling techniques.

Results
The concentrations of Cu, Ni, Pb, Zn, and Rb changed in a statistically significant manner at the 99% confidence level.

Conclusions/Discussion
Based on chemical and thin section analyses, a cohesive model was developed to describe how impact-induced chemical changes occur. As the impactor collides with the target material, most of the impactor melts. As shock waves and subsequent rarefaction waves move through the target, partial melting of mineral phases begins. Material from the impacting body combines with the partial melt, thereby amalgamating an extraterrestrial component into the target. Characteristics of the amalgamation process are related to the partitioning coefficients, ionic radii, ionic charges, and electron configurations.

Ongoing work focuses on the determination of the relationship between chemical composition and proximity to interstitial boundaries.

Summary Statement
XRF, ICP-MS, and SEM/EDX were used to determine the chemical effects of the impact process; by combining chemical and thin section analyses, a model describing the chemical kinetics and thermodynamics of the impact process was developed.

Help Received
Washington State University provided XRF and ICP-MS equipment; Intel Corporation provided SEM/EDX; Carol Evans, Heidi Black, Susan Lato, and Ann Burrell aided paper and abstract preparation.