MINERAL NETWORK ANALYSIS APPLICATIONS IN COMPARATIVE PLANETOLOGY. S. M. Morrison[1], C. Liu[1], A. Eleish[2], A. Prabhu[2], P. Fox[2], J. Ralph[3], J. J. Golden[4], R. T. Downs[4], and R. M. Hazen[1]. [1]Geophysical Laboratory, Carnegie Institution for Science, 5251 Broad Branch Road NW, Washington DC 20015, shaunnamm@email.arizona.edu, [2]Tetherless World Constellation, Department of Earth and Environmental Sciences, Rensselaer Polytechnic Institute, Troy NY 12180, [3]Mindat.org, 128 Mullards Close, Mitcham, Surrey, CR4 4FD UK, [4]Department of Geosciences, University of Arizona, 1040 East 4th Street, Tucson AZ 85721-0077.

Introduction: Network analysis characterizes multi-dimensional systems and investigates trends therein [1-2]. Network analysis techniques are applied to biology [3] and paleogeography [4], social networks [5-6], and technology [7-8]. Recent mineral ecology studies [9-10] have illustrated network visualization techniques, as well as statistical metrics by which mineral networks can be evaluated and characterized. In this study, we apply mineral network analysis techniques to material from HED (Vesta) meteorites [11], Martian meteorites [12], and the Moon [13].

Data: We have compiled mineral co-occurrence data in Vestan (62), Martian (90), and lunar (23) samples. These data are in addition to Earth mineral co-occurrence data from petrologic compilations of igneous rocks [14-15] and large databases [11]. Along with co-occurrence, we have populated our databases with other mineralogic information, such as mineral chemistry, structural complexity, and physical properties.

Network Analysis Techniques:

Network Visualizations: Minerals and their co-occurrence can be represented by a network of nodes (minerals) and links (co-occurrence of two minerals). The color, size, length, etc. of nodes and links can represent a function or feature of the dataset, such as frequency of co-occurrence or chemical composition (Fig. 1). The flexibility of network vizualizations allows us to display multi-dimensional data in ways that reveal previously unrecognized trends.

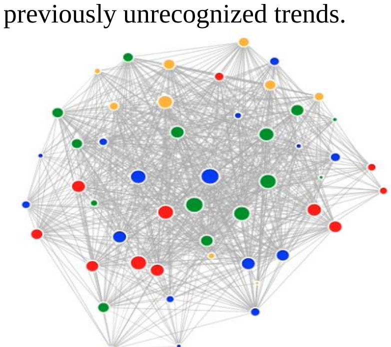

Figure 1. The force-directed network of rock-forming igneous minerals illustrates species coexistence in intrusive rocks. Node diameter represents mineral abundance. Node color indicates structural group: quartz and feldspars (red); felspathoids and zeolites (yellow); mafic minerals (green); accessory minerals (blue).

Metrics: Statistical metrics allow for evaluation of trends within a mineral system and for comparision of one system to another. These metrics include: density, a measure of interconnectedness; betweenness centrality, a measure of the number of shortest paths that pass through a given node or "degrees of separation" in a network; and degree centrality, the number of links connected to a given node.

Comparative planetology: This study will quantitatively investigate and compare the multi-dimensional mineralogic trends in HED meteorites, Martian meteorites, Apollo Lunar samples, and terrestrial igneous rocks. We will identify equilibrium phase relationships, chemical trends, and geologic settings, with the intent of characterizing the similarities and differences between these planetary bodies.

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