The Range of Geochemistries of Terrestrial Planets in the Universe

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Terrestrial planet formation appears to be a robust result of star formation [1, 2]. The collapse of molecular clouds into stars, proto-planetary disks and eventually terrestrial planets is a process that involves a series of fractionation events. Hydrogen, helium and other volatiles are removed leaving the more refractory elements. The refractory elements are then further fractionated as a result of cooling, condensation sequences and chemical affinity. To address the issue of habitability we need to know the details of the resultant planets.

The bulk compositions, elemental abundances and geochemistries of terrestrial planets elsewhere in the universe can now be constrained more precisely by spectroscopic measurements of the relative abundances of elements in their host stars. Chemical composition can also be constrained by estimating the variability in the fractionation effects of protoplanetary accretion disks and planetesimal assemblage. We compare spectroscopic elemental data from large samples of nearby stars. We identify and correct for selection effects and then compare the relative elemental abundances of these stars to the Sun. We establish plausible ranges for the ratios of the elements with the most important influence on habitability. To address the problem of fractionation variability during planet formation, we analyze the bulk compositions of the bodies of the inner Solar System and quantify the chemical variability within our Solar System. We combine these two analyses to arrive at the best estimates of the range of geochemistries offered by terrestrial planets in the universe. These are the ranges that need to be explored with detailed models.

References

[1] Wetherill 1990, “Formation of the Earth” Ann. Rev. Earth Plaent. Sci, **18**:205-256.

[2] Ida, S. & Lin, D.N.C. 2004, ApJ, **604**, 388-413 Toward a deterministic model of planetary formation. I. A desert in the mass and semimajor axis distributions of extrasolar planets.