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The influence of silicate melt composition on distribution of siderophile elements among metal and silicate liquids

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Abstract

Liquid metal–liquid silicate partitioning of Fe, Ni, Co, P, Ge, W and Mo among a carbon-saturated metal and a variety of silicate melts (magnesian–tholeiitic–siliceous–aluminous–aluminosiliceous basalts) depends modestly to strongly upon silicate melt structure and composition. Low valency siderophile elements, Fe, Ni and Co, show a modest influence of silicate melt composition on partitioning. Germanium shows a moderate but consistent preference for the depolymerized magnesian melt. High valency siderophile elements, P, Mo, and W, show more than an order of magnitude decrease in metal–silicate partition coefficients as the silicate melt becomes more depolymerized. Detailed inspection of our and other published W data shows that polymerization state, temperature and pressure are more important controls on W partitioning than oxidation state. For this to be true for a high and variable valence element implies a secondary role in general for oxidation state, even though some role must be present. Equilibrium core segregation through a magma ocean of ‘ultrabasic’ composition can provide a resolution to the ‘excess’ abundances of Ge, P, W and Mo in the mantle, but the mantle composition alone cannot explain the excess abundances of nickel and cobalt in chondritic proportions. © 1997 Elsevier Science B.V.

Keywords: carbon; siderophile elements; partitioning; core

1. Introduction

Many recent theories of the origin of the Earth suggest an early ‘global’ melting event where segregation of the metallic core occurred through a significantly or almost completely molten silicate mantle

[1–4,15]. During this ‘hot accretion’ scenario, the composition of the molten silicate mantle may influence the distribution of many siderophile (core-loving) elements among metal and silicate phases. The one to three orders of magnitude depletion of siderophile elements in the terrestrial upper mantle, relative to their abundances in the undifferentiated chondritic meteorites shows the geochemical imprint of core segregation. The absolute abundances of many of these elements in the upper mantle, however, are 10–1000 times higher than the abundance

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