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# Evolution of asteroid (4) Vesta in the light of Dawn

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Asteroid (4) Vesta has been visited by the NASA Dawn spacecraft in 2011/12. The combination of compositional/elemental information from the three onboard instruments with mineralogical information from the howardite-eucrite-diogenite (HED) clan of stony achondrites has shed new light on the surface lithologic heterogeneity and the early evolution. Although petrologic/chemical models have tried to unravel the evolutionary processes, inconsistencies exist for some chemical major element/phase [e.g., 1, 2]. A revised evolutionary model is presented here [3].
The three oxygen isotope signature of HEDs and, thus, of proto-Vesta is best met by a mixture of 80% ordinary plus 20 % CV chondrites. Assuming a 27Al-triggered magma ocean within the first MA after accretion and taking into account the reliable major element data of the silicate fraction of the chondritic mixture results a crystallization sequence that differs from the earlier models [1, 2, 3]. The crystallized phase obtained by 'MELTS' software [4] starts with olivine and continues with minor olivine plus orthopyroxene until the liquid reaches a Kd value (partition coefficient) of 0.31 where the fractionated melt is in equilibrium with the residual liquid [5]. The abundance of minerals and rocks formed in this model are converted in volume proportions assuming a spherical shape of early Vesta (262 km radius) with a core (FeNi, FeNiS) radius of 110 km [6]. Two scenarios are considered to describe the early bulk silicate Vesta. First, the early-crystallized olivine accumulated at the base of the silicate shell is accounted for a dunitic lower mantle having a thickness of 46 km while the later crystallized phases form an orthopyroxenitic upper mantle and a crust of thickness 84 and 22 km, respectively. Second, an olivine-rich lower mantle that gradually changes to orthopyroxene-rich upper mantle is expected having an overall shell thickness of 137 km, with a 15 km thick crust.
An important result is that the deep-seated olivine-rich mantle has not been accessible to the deep excavation processes by large impacts such as the Rheasilvia basin formation [7]. This is likely the reason why olivine-rich exposures detected by Dawn are of exogenic origin [8].
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