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Estimations on the Physical Conditions at the Sea Floor of the Potential Subsurface Ocean of Jupiter's moon Europa and its Implications for Life

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Abstract

We present a model for the inner structure of Jupiter's moon Europa. The conception is based on a three layer model, consisting of a rocky core, a silicate mantle and a water-ice layer, that allows us to determine the radial gradients of mass, gravity, and pressure. Rough estimations on the physical conditions at the bottom of the potential subsurface water ocean of Europa will be given.

1. Introduction

The interior is modeled as spherically symmetric, chemically homogenous shells that surround a spherically symmetric and homogenous core. In our model, we assume a rocky core and a silicate mantle surrounded by a global water-ice layer. The ice-layer is assumed with an average density for an ice-/water-layer of about 1000 kg m^{-3}, which might be varied depending on the chemical composition, but the major factor in our model is the variation of the silicate core and mantle density. In the following section we will present different scenarios.

2. Scenarios

We have computed different scenarios, which differ in the assumptions on the composition of the rocky core and the silicate mantle. One scenario deals with a core density similar to the density of the uppermost part of the Earth's mantle primarily made up of olivine-rich rocks [4]. The next scenario is based on the assumption that Europa's core composition is similar to Io's composition [5]. For a further scenario we assume a silicate core with the same density as the soil below the Arctic Sea. The idea of the last scenario assumes typical hydrated carbonaceous CI chondrites, which might be the building blocks of icy moons like Europa. The density of the different calculated layers can be assumed to be nearly constant due to the mean radius of Europa of 1565 ± 8 km [3]. Therefore, the uncompressed density [2] of the satellite is almost equal to its bulk density.

3. Summary

Our model will yield estimations about the inner structure of Europa and it can also be applied to other icy moons. It will give us a rough overview about the physical conditions at the bottom of the potential subsurface water ocean. To verify the model, we extend it to a 5- and 12-layer model corresponding to the different layers of the Earth. The results of these adapted models are in good agreement with the Preliminary Reference Earth Model (PREM, [1]). Europa's subsurface ocean might be the first place in the solar system to search for both extant life and a second origin of life. The subsurface ocean is predicted due to its interaction with a rocky ocean floor, to maintain a potential geochemically rich environment suitable for an origin and a maintenance of life.

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