



HAL
open science

Early evolution of Venus and Earth constrained by the reproduction of measured Ar, Ne isotope and K/U elemental ratios

Helmut Lammer, Martin Leitzinger, Petra Odert, Christoph Burger, Darya Kubyshkina, Manuel Scherf, Thomas Maindl, Colin Johnstone, Nicola Tosi, Athanasia Nikolaou, et al.

► To cite this version:

Helmut Lammer, Martin Leitzinger, Petra Odert, Christoph Burger, Darya Kubyshkina, et al.. Early evolution of Venus and Earth constrained by the reproduction of measured Ar, Ne isotope and K/U elemental ratios. European Planetary Science Congress 2018, Sep 2018, Berlin, Germany. pp.EPSC2018-291. insu-04458509

HAL Id: insu-04458509

<https://insu.hal.science/insu-04458509>

Submitted on 14 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Early evolution of Venus and Earth constrained by the reproduction of measured Ar, Ne isotope and K/U elemental ratios

Helmut Lammer, (1), Martin Leitzinger (2,1), Petra Odert (1), Christoph Burger (3), Darya Kubyschkina (1), Manuel Scherf (1), Thomas Maindl (3), Colin Johnstone (3), Nicola Tosi (4,5), Athanasia Nikolaou (4,5), Emmanuel Marcq (6), Luca Fossati (1), Nikolai V. Erkaev (7, 8), Manuel Güdel (3), Lena Noack (9), Kristina G. Kislyakova (3,1), Florian Ragossnig (3), Elke Pilat-Lohinger (3)

(1) Space Research Institute, Austrian Academy of Sciences, Graz, Austria, (2) Institute of Physics/IGAM, University of Graz, Austria, (3) Department of Astrophysics, University of Vienna, Austria, (4) Institute of Planetary Research, Department of Planetary Physics, DLR, Berlin Germany, (5) Department of Astronomy and Astrophysics, Berlin Institute of Technology, Germany, (6) LATMOS, Université de Versailles Saint-Quentin-en-Yvelines, Guyancourt, France, (7) Institute of Computational Modelling, FRC Krasnoyarsk Science Center SB RAS, Krasnoyarsk, Russian Federation, (8) Siberian Federal University, Krasnoyarsk, Russian Federation, (9) Department of Earth Sciences, Freie Universität Berlin, Germany

Abstract

We show that the measured present day atmospheric Ar, Ne isotope ratios and elemental K/U ratios measured for Venus and Earth can be reproduced by a combination of EUV-driven hydrodynamic hydrogen escape and impacts happening during accretion. We find that both protoplanets formed within the solar nebula and accreted large enough masses able to capture thin hydrogen envelopes, which were then lost within a few 10s of million years after disk dispersal. We further show that early Venus was surrounded by a denser primordial hydrogen-dominated atmosphere compared to a less massive proto-Earth that accreted its final mass by pre-fractionated dry impactors and about two percent carbonaceous chondrites after the thin primordial hydrogen envelope was lost. Our results agree with hafnium-wolfram isotope chronometric evidence that favors a fast accretion scenario of the Earth with a late Moon-forming impact. We conclude with a discussion on the implications of these findings in relation to planetary evolution of terrestrial exoplanets and their potential habitability.

Acknowledgements

We acknowledge support by the Austrian Fonds zur Förderung der Wissenschaftlichen Forschung, Nationales Forschungs Netzwerk (FWF NFN) project S116-N16 and the subprojects S11603-N16, S11604-N16, S11606-N16, and S11607-N16. H.L. and

P.O. acknowledge support of the FWF project P27256-N27. D.K. and L.F. acknowledge the Austrian Forschungsförderungsgesellschaft FFG project "TAPAS4CHEOPS" P853993. The authors thank ISSI for the support of the ISSI team "The early evolution of the atmospheres of Earth, Venus, and Mars". N.T. and A.N. acknowledge support from the Helmholtz Association (project VH-NG-1017). M. Güdel and L. Noack acknowledge the collaboration within the COST Action TD 1308. The authors also thank the International Space Science Institute (ISSI) in Bern, the ISSI-Beijing team "Astrobiology" and the ISSI team "The Early Evolution of the Atmospheres of Earth, Venus, and Mars".