LATE ACCRETION
ONTO TERRESTRIAL PLANETS

3 Postdoc Positions (100% E13 TV-L) and 15 Positions for Doctoral Students (75% E13 TV-L)

Late Accretion onto Terrestrial Planets (***TRR 170***) is a transregional collaborative research center located in Berlin and Münster (Germany). Founded in 2016, the center is funded by the German Research Foundation (DFG) and is comprised of research groups at the Freie Universität Berlin (FUB), Technische Universität Berlin (TUB), Universität Münster (UM), Museum für Naturkunde, Berlin (MfN), Max-Planck-Institut für Sonnensystemforschung (MPS) and Deutsches Zentrum für Luft- und Raumfahrt, Berlin (DLR). The focus of TRR 170 is the interdisciplinary study of the late growth history of terrestrial planets from the last giant collisions between planetary embryos to the terminal phase of late bombardment, approximately 3.8 billion years ago. The program also provides a broad, interdisciplinary, planetary science education for doctoral students.

We invite applications for 3 Postdoc and 15 PhD positions for a third funding period (2024–2027). Contingent on a positive funding decision by the DFG, the positions will be available from 1 January 2024 until 31 December 2027. The starting date is flexible. Currently, the regular working time for full (100%) employment is 39 hours and 50 minutes per week (Münster) or 39 hours and 24 minutes per week (Berlin). Postdoctoral positions require a doctoral degree in earth sciences, or, in exceptional cases, in chemistry, or physics. Doctoral positions require a master of science, Diplom in earth sciences or geophysics, or, in exceptional cases, in computer sciences, chemistry, or physics. Good English language skills (written and oral) are required. For details about the individual positions and projects, see the descriptions below. Active participation in TRR 170-related activities (seminars, meetings, workshops) is expected.

The participating institutions are equal opportunity employers and are committed to increasing the proportion of female academics. Consequently, we actively encourage applications by women. Female candidates with equivalent qualifications and academic achievements will be preferentially considered within the framework of the legal possibilities. We also welcome applications from candidates with severe disabilities. Disabled candidates with equivalent qualifications will be preferentially considered, although some restrictions related to accessing laboratory facilities may apply in some projects.

Applications should be written in English and include a cover letter, the names of three (postdoc positions) or two (doctoral positions) referees, CV, copies of degree certificates and transcripts, all combined into a single pdf. Please indicate which position(s) you are applying for and email your application to trr170-office@geo.fu-berlin.de. Review of applications will begin **20 November 2023** and will continue until all positions have been filled.

Two doctoral positions A1-D1 and A1-D2 (FUB): The scope of work in position A1-D1 will be to obtain chronological constraints on the early bombardment history of the Moon by *in situ* analysis of minerals in lunar impact rocks using the U-Pb SIMS method, combined with petrological and geochemical data. The successful candidate on position A1-D2 will examine the record of chemically zoned minerals in lunar highland rocks and apply diffusion models to derive information on re-heating and cooling rates of lunar impact breccias for a better understanding of the isotopic age record. Both candidates are expected to have strong skills in petrology and geochemistry or geochronology. Experience in electron microbeam techniques, image processing software, diffusion modeling and mass spectrometry is

beneficial. For more information, please contact Harry Becker (hbecker@zedat.fu-berlin.de) and Timm John (timm.john@fu-berlin.de) at the Institut für Geologische Wissenschaften, FU Berlin.

Doctoral position A2 (UM): The goal of this project is to identify and date the oldest terrains on the Moon with crater size-frequency distributions (CSFDs), combine these results with geological mapping, and apply a numerical modelling approach to estimate the distribution and thickness of ejecta deposits relevant for the mapping area. The ideal candidate has a strong background in planetary geology, remote-sensing based geological mapping, image processing, GIS, and geostatistical methods, numerical modelling or equivalent expertise. Experience in the field of planetary chronostratigraphy is desirable. For more information, please contact Harald Hiesinger at the Institut für Planetologie, WWU Münster (hiesinger@uni-muenster.de).

Doctoral position A4 (TUB): This project will follow-up on our studies of the interior structures of lunar impact basins, using altimetry and gravity data from the Lunar Reconnaissance Orbiter (LRO) and the GRAIL mission. The successful candidate is expected to have strong skills in geodesy, geophysics, or astrophysics. Good programming skills and experience of modeling on the basis of planetary remote sensing data are also desirable. For more information, please contact Prof. Jürgen Oberst, at the Institut für Geodäsie and Geoinformationstechnik, TU Berlin (Juergen.Oberst@tu-berlin.de).

Doctoral position A5 (UM): The PhD student will investigate the origin of seconday crust on the Moon, which includes the lunar Mg-suite, by a series of high-pressure high-temperature experiments. The ideal candidate has a strong background in petrology and geochemistry. Experience with piston-cylinder apparatus and electron microprobe are desirable. This project will be done in close cooperation with DLR in Berlin. For more information, please contact Stephan Klemme at the Institut für Mineralogie, University of Münster (Stephan.klemme@uni-muenster.de).

Two doctoral positions A6 (UM, TUB): We will update the inventory of impact basins on Mercury and study their morphologies and ages, using image-, altimetry-, and gravity data from the MESSENGER mission. We will also carry out a comparative study of light plains on Mercury and the Moon. The ideal candidate has a strong background in image processing, planetary geology and mapping, GIS, and geostatistical methods, or equivalent expertise. Experience in the field of planetary chronostratigraphy is also desirable. For more information, please contact Harald Hiesinger at the Institut für Planetologie, Universität Münster (hiesinger@uni-muenster.de) and Jürgen Oberst at the Institut für Geodäsie and Geoinformationstechnik, TU Berlin (Juergen.Oberst@tu-berlin.de).

Doctoral position B3 (MPS): The late accretion determines a planets' final physico-chemical setup and later evolution. Using a large variety of impact rocks from the Moon and asteroids as witness plates of the late accretion in the inner solar system this project will address the nature and origin of the late accretion using a novel isotopic tracer. The student will conduct high-precision isotopic analyses of planetary samples from asteroids, Moon, and the Earth, making use of our new in-house state-of-the-art wet chemistry clean-rooms and mass-spectrometer facilities. Previous experience in isotope geo-/cosmochemistry is desirable. The project is embedded in the International Max Planck Research School for Solar System Science (IMPRS) at the University of Göttingen and applications should be made through the IMPRS portal (https://www.mps.mpg.de/solar-system-school). Off-cycle applications will be considered for this position. For more information, please contact Timo Hopp at the Max Planck Institute for Solar System Research in Göttingen (hopp@mps.mpg.de).

Two doctoral positions B6 (MPS): Isotope anomalies in planetary materials are a key tracer of material flow in the solar system, and as such have led to profound new insight into the dynamics of the solar protoplanetary disk and the accretion history of the terrestrial planets. However, the use of these anomalies is still under-explored with regard to volatile elements, such that first-order questions about the origin, timing, and delivery mechanisms of the (life-enabling) volatile element budget in the terrestrial planets remain unresolved. The doctoral students at MPS will address these issues by conducting isotopic analyses of planetary samples from asteroids, Mars, Moon, and the Earth, making use of our new in-house state-of-the-art wet chemistry clean-rooms and mass-spectrometer facilities. Previous experience in isotope geo-/cosmochemistry is desirable. The project is embedded in the International Max Planck Research School for Solar System Science (IMPRS) at the University of Göttingen and applications should be made through the IMPRS portal (https://www.mps.mpg.de/solar-system-school). Off-cycle applications will be considered for these positions. For more information, please contact Christoph Burkhardt at the Max Planck Institute for Solar System Research in Göttingen (burkhardtc@mps.mpg.de).

Postdoctoral position B7 (UM): Here we will investigate the fractionation of moderately volatile trace elements and their stable isotopes during degassing of lunar and terrestrial silicate magmas. The postdoc will design and execute experiments to simulate the evaporation of moderately volatile trace elements in the experimental laboratories, and he/she will also determine the fractionation of non-traditional stable isotopes during evaporation using state-of-the-art MC-ICPMS and TIMS techniques in clean room laboratories. The ideal candidate has a strong background in experimental petrology and geochemistry. For more information, please contact Stephan Klemme at the Institut für Mineralogie, University of Münster (Stephan.klemme@uni-muenster.de).

Postdoc position C1 (UM): This project will investigate core segregation and the formation of an early atmosphere on the terrestrial planets with a focus on the partitioning of highly volatiles (H, C, N) among different planetary reservoirs. The candidate will perform high pressure experiments combined with nano- and micro-analytical characterization of the samples (FIB/TEM, nanoSIMS). Candidates are expected to have a solid background on high pressure techniques (laser-heated diamond anvil cell and/or multi-anvil apparatus), geochemical modeling and computing/programming skills. For more information, please contact Carmen Sanchez-Valle (sanchezm@uni-muenster.de) and Arno Rohrbach (arno.rohrbach@uni-muenster.de) at the Institut für Mineralogie, Universität Münster.

Doctoral position C2 (UM): The dispersion and equilibration of impact-delivered material within a solidifying magma ocean and the subsequent thermochemical evolution of Earth and Mars, will be explored using numerical models. The successful candidate is expected to have a M.Sc. degree in geophysics, physics or geological sciences with strong skills in physics or geophysics and should be experienced in numerical modeling and fluid dynamics. For more information, please contact Christian Maas at the Institut für Geophysik, Universität Münster (christian.maas@uni-muenster.de).

Two doctoral positions C4 (UM, MfN): This project will investigate giant impacts such as the Moon forming impact, the dynamics in a solidifying magma ocean resulting from such events and the subsequent thermochemical evolution of the Earth, Moon and Mars with numerical models. The successful candidates are expected to have strong skills in physics or geophysics and should be experienced in numerical modelling. For more information, please contact Ulrich Hansen at the Institut für Geophysik, Universität Münster (hansen@earth.uni-muenster.de) and Kai Wünnemann at the Museum für Naturkunde Berlin (wunnema@zedat.fu-berlin.de).

Two doctoral positions C5 (FUB, DLR) and C6 (FUB): Project C5 will investigate how volatiles were distributed between atmosphere, surface and interior during the magma ocean (MO) and subsequent post MO giant steam atmosphere phase on early Mars. Atmospheric models will be updated for weathering and surface deposition parameterizations as well as atmospheric escape processes in hot, high pressure atmospheres. The work will be performed in close collaboration with planetary interior partners from other projects, in particular C6. A M.Sc. degree in physics, chemistry, geophysics or planetary sciences is required. Experience in numerical modelling of atmospheric climate-chemistry processes is desirable. In project C6, we will study the crystallization and redox evolution of the Martian magma ocean. We will specifically focus on the distribution of volatiles between the solidifying magma ocean, the solid mantle, and the metal core and how the onset of mantle convection affected the inventory of volatile elements in the mantle. Project C6 will be accomplished in close collaboration with other members of TRR 170, specifically from C5. A M.Sc. degree in physics, geophysics or planetary sciences is required. Experience in planetary sciences and numerical modeling is advantageous. For more information on project C5, please contact Heike Rauer (heike.rauer@dlr.de) at the Institut für Geologische Wissenschaften, FU Berlin and Lee Grenfell at the Institut für Planetenforschung, DLR (lee.grenfell@dlr.de). Concerning project C6, please contact Lena Noack (lena.noack@fu-berlin.de).

Postdoc position C7 (FUB): This project aims at an exploration of the long-term evolution of the disk that remained after the Moon has formed in a scenario of a giant impact of a planetary embryo into the proto-Earth. The dynamics of the fading disk and the potential delivery of further mass to the Earth and Moon will be studied in terms of N-body simulations. A doctoral degree in physics, astronomy or astrophysics is required. Ideally, the applicant should have a background in the numerical modeling of astrophysical disks. Experience with N-body simulations of particulate, self-gravitating disks will be an advantage. For more information, please contact Jürgen Schmidt (juergen.schmidt@fu-berlin.de), Institut für Geologische Wissenschaften, FU Berlin.