LATE ACCRETION
ONTO TERRESTRIAL PLANETS

3 Postdoc Positions (100% E13 TV-L) and 16 Positions for Doctoral Students (75% E13 TV-L)

Late Accretion onto Terrestrial Planets (***TRR 170***) is a transregional collaborative research center located in Münster and Berlin (Germany). Founded in 2016, the center is funded by the German Research Foundation and is comprised of research groups at the Westfälische Wilhelms-Universität Münster (WWU), Freie Universität Berlin (FUB), Technische Universität Berlin (TUB), Museum für Naturkunde, Berlin (MfN) 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 16 PhD positions for the second funding period (2020–2023). The positions are available from 1 March 2020 until 31 December 2023. 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's of science, diploma 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.

The participating institutions are equal opportunity employers and are committed to increasing the proportion of women 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 (max. 10 MB). Please indicate which position(s) you are applying for and email your application to trr170@uni-muenster.de. Review of applications will begin **15 January 2020** and will continue until all positions have been filled.

Postdoc position B3 (WWU): This project will use nucleosynthetic isotope anomalies to determine the origin of late-accreted materials, their relation to planetary building blocks, and the dynamics of the late stages of terrestrial planet formation. The successful candidate will have a strong background in isotope geochemistry and cosmochemistry, and high-precision isotope measurements. For more information, please contact Emily Worsham (worsham@uni-muenster.de) at the Institut für Planetologie, WWU Münster.

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

Postdoc position C2 (MfN): This project will investigate how the impactor material from the Moon-forming event and subsequent large collisions was distributed and entrained in a convecting magma ocean on Earth and the Moon. The successful candidate is expected to have strong skills in physics or geophysics and should be experienced in numerical modelling. For more information, please contact Kai Wünnemann (kai.wünnemann@mfn.de) at the Museum für Naturkunde, Berlin.

Doctoral position A1 (FUB): This project will obtain new 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 candidate is expected to have strong skills in petrology and either geochemistry or geochronology. Experience in electron microbeam techniques, image processing software and mass spectrometry is also desirable. For more information, please contact Harry Becker at the Institut für Geologische Wissenschaften, FU Berlin (hbecker@zedat.fu-berlin.de).

Doctoral position A2 (WWU): The goal of this project is to test/improve the lunar production and chronology functions, to study parameters affecting crater size-frequency distributions (CSFDs), and to refit previous CSFDs with the updated production and chronology functions. The ideal candidate has a strong background in planetary geology, remote-sensing based geological mapping, image processing, GIS, and geostatistical methods, or equivalent expertise. Experience in the field of planetary chronostratigraphy and radiometric age dating methods are 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 investigate the interior structure 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. Basic knowledge of programming in Fortran or C and some experience working with (planetary) remote sensing data is 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 (WWU): The aim of this project is to experimentally determine new trace element partition coefficients with high accuracy, which are critically needed to model the evolution of the lunar magma ocean. The PhD student will conduct experiments in 1 atm gas mixing furnaces and in piston-cylinder apparatus. The experimental run products will be characterized using several state-of-the-art analytical techniques (e.g. FEG-EMPA, LA-ICPMM, MC-ICPMS). The experimentally determined partition coefficients will be used in a geodynamic model that enables trace and major element modeling of lunar magma ocean evolution. Experience with experimental petrology and/or trace element geochemistry is

desirable. For more information, please contact Stephan Klemme at the Institut für Mineralogie, WWU Münster (stephan.klemme@uni-muenster.de).

Two doctoral positions A6 (WWU, TUB): We will produce a new 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 planetary geology, remote-sensing based geological mapping, image processing, 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, WWU Münster (hiesinger@uni-muenster.de) and Jürgen Oberst at the Institut für Geodäsie and Geoinformationstechnik, TU Berlin (Juergen.Oberst@tu-berlin.de).

Doctoral position B5 (WWU, FUB): This project will study volatile-rich clasts within chondritic and achondritic breccias that differ from known meteoritic materials and bulk meteorites. The project will also include comprehensive C-isotope analysis of C-rich minerals (notably of graphite) within fragments and rocks of chondritic (E-chondrites, ordinary chondrites) and achondritic origin. Candidates should be experienced in electron microscopic techniques (e.g. SEM) and other analytical methods with high spatial resolution (e.g. electron microprobe, LA-ICP-MS, SIMS). Knowledge of meteoritics and mineralogy of extraterrestrial rocks is desirable. The candidate will start in Münster and will move to Berlin for the second part of the project. For more information, please contact Addi Bischoff at the Institut für Planetologie, WWU Münster (bischoa@uni-muenster.de), and Timm John at the Institut für Geologische Wissenschaften, FU Berlin (timm.john@fu-berlin.de).

Doctoral position B7 (WWU): This project will use mass-dependent isotope variations in experimental and planetary samples to investigate volatile depletion mechanisms in nebular and planetary environments. Candidates should have a strong background in geochemistry. Prior clean lab and mass-spectrometry experience is desirable. For more information, please contact Christoph Burkhardt at the Institut für Planetologie, WWU Münster (burkhardt@uni-muenster.de).

Doctoral position B8 (FUB): This project will study the petrology, trace element composition, and mass-dependent isotopic composition of CAIs in carbonaceous chondrites to constrain the re-enrichment processes of volatile metals in refractory inclusions and the environments in which this enrichment took place. Characterization of the mineralogy, textures, and the distribution of the target elements by electron beam methods will provide the petrologic context for the isotopic work. The work on this project will be supported by complementary experimental work project B7, while project B1 will provide the methodological expertise to analyze the stable isotope compositions. The successful candidate will have a strong background in geochemistry. Experience in electron beam methods is desirable. For more information, please contact Timm John at the Institut für Geologische Wissenschaften, FU Berlin (timm.john@fu-berlin.de).

Doctoral position C1 (WWU): This project will investigate accretion and core formation on the terrestrial planets with a focus on the partitioning of siderophile and/or volatile elements among different planetary reservoirs. The ideal candidate has experience in experimental high-pressure techniques, geochemical modelling and Python-based programming. For more information, please contact Arno Rohrbach at the Institut für Mineralogie, WWU Münster (arno.rohrbach@uni-muenster.de).

Doctoral position C2 (WWU): This project will investigate how the impactor material of the Moon forming event and subsequent large collisions is distributed and entrained in a convecting magma ocean on Earth and the Moon. The successful candidate is 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, WWU Münster (hansen@earth.uni-muenster.de).

Doctoral position C3 (WWU): This project will investigate the importance of core-mantle interaction for the thermochemical evolution of Earth's mantle, and in particular for the formation and persistence of geochemical reservoirs in the mantle. The ideal candidate has experience in geophysical fluid dynamics and numerical modelling. For more information, please contact Ulrich Hansen at the Institut für Geophysik, WWU Münster (hansen@earth.uni-muenster.de).

Three doctoral positions C4 (WWU, DLR, MfN): This project will investigate the Moon forming impact, the dynamics in a solidifying magma ocean and the subsequent thermochemical evolution of the Earth and Moon 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 Doris Breuer at the Institut für Planetenforschung, DLR Berlin (doris.breuer@dlr.de), Ulrich Hansen at the Institut für Geophysik, WWU Münster (hansen@earth.uni-muenster.de), or Kai Wünnemann at the Museum für Naturkunde Berlin (kai.wuennemann@mfn.de).

Doctoral positions C6 (DLR): This project will investigate the internal evolution and volatile degassing of Earth and Mars subsequent to the early magma ocean phase. The focus will be on developing a coupled model addressing time-variable redox state, gas speciation and volatile release during magmatic ascent. The ideal candidate has a background in theoretical petrology and/or computational geochemical modeling. For more information, please contact Frank Sohl at the Institut für Planetenforschung, DLR Berlin (frank.sohl@dlr.de) and Lena Noack at the Institut für Geologische Wissenschaften, FU Berlin (lena.noack@fu-berlin.de).