Project Title: Understanding structure of Martian crust via numerical modelling of meteoroid strikes on the ground

Lead Institution: Curtin University

Main Supervisor: Dr Katarina Miljkovic, Department of Applied Geology
Co-Supervisor: Prof Phil Bland, Department of Applied Geology
Associate Supervisor: Prof. Kai Wünnemann, Museum für Naturkunde, Berlin, Germany

Project enquiries: katarina.miljkovic@curtin.edu.au

InSight

Project background
The space mission InSight (Interior exploration using Seismic Investigations, Geodesy and Heat Transport) will place a geophysical station on the surface of Mars in 2018. The seismic instrument SEIS (Seismic Experiment for Interior Structure) on-board InSight will quantify the seismic activity of the planet, which could be caused by a number of processes, from tectonic activity to meteorite impacts. This innovative mission will record meteoroid impacts onto the surface of Mars through seismic responses of the atmosphere and the ground. Complex physics (much of it unsolved) lies behind the shock wave that is released during a hypervelocity impact. This will also be a way to study Martian atmosphere and interior.

Project aims and methods
The aim of the project is to define variations in impact-induced seismic signatures in different types of geologic media. The project will include simulations and analyses of seismic signatures and cratering morphology caused by different projectile and target properties using the iSALE numerical impact modelling hydrocode. The iSALE hydrocode is the leading hydrocode for modelling shock wave progression through geologic media [1-3] with many users around the world.

This work will have important applications in data analyses of the forthcoming InSight mission to Mars. The aim is to build a systematic catalogue of possible seismic and cratering signatures, which can be used to analyse the seismic signatures recorded by the InSight mission [e.g., 4], back-trace the meteoroid impact conditions and determine the local crustal target properties. The expected outcomes will provide a synthesis of results and data into a coherent understanding of the crustal structure of Mars, contributed from both the seismic and impact-cratering perspectives.

Candidate
The ideal candidate would have a background in planetary geophysics, physics, geology, or astronomy, with an interest in Martian geophysics and space mission involvement.

Training

Training will depend on the specific interests and abilities of the PhD candidate, but must include learning or being able to manipulate the iSALE hydrocode. Additional training may include active involvement with the InSight mission science team, python programming, supercomputing usage, image processing, data manipulation and visualization.

References / Reading List

[1] K. Wünnemann, G.S. Collins, H.J. Melosh (2006) A strain-based porosity model for use in hydrocode simulations of impacts and implications for transient crater growth in porous targets , Icarus 180, 514-527.

[2] N. Güldemeister, K. Wünnemann (2017) Quantitative analysis of impact-induced seismic signals by numerical modeling, Icarus 296, 15-27.

[3] K. Miljković, G.S. Collins, S. Mannick, P.A. Bland (2013) Morphology and population of binary asteroid impact craters, Earth and Planetary Science Letters 363, 121–132.

[4] Daubar, I.J., A.S. McEwen, S. Byrne, M.R. Kennedy, B. Ivanov (2013) The current martian cratering rate, Icarus 225 (2013) 506–516.