RAS Discussion Meeting

In-situ geophysical studies of planetary interiors: past, present, and future

Friday 13th November 2009
RAS Lecture Theatre, Burlington House, London
Organisers: Nick Teanby and Neil Bowles (Oxford).

Program

10:00	10:30	Tea and Coffee
10:30	10:40	Introduction
10:40	11:10	Tilman Spohn (DLR) ”Interiors of terrestrial planets: Moon and Mars”
11:10	11:40	Bruce Banerdt (JPL) ”Surface-Based Geophysics on the Terrestrial Planets”
11:40	12:00	Mike Kendall (Bristol) ”Imaging planets using seismology: lessons learned from Earth”
12:00	12:20	Alan Smith (MSSL) ”Penetrators for Planetary Exploration and Science”
12:20	12:40	Graham Stuart (Leeds) ”Strategies for seismological exploration of the planets - an Earth perspective”
12:40	14:00	Lunch and Posters
14:00	14:20	Tom Pike (Imperial) ”A Microseismometer for Planetary Exploration”
14:20	14:40	Axel Hagermann (OU) ”Apollo lunar surface geophysics - what we know we don’t know, we know we know, and we might not know we know”
14:40	13:00	Richard Katz (Oxford) ”Magma Dynamics in the Terrestrial Mantle”
13:00	13:30	Guided discussion
15:30	END	

Abstracts

Tilman Spohn

Interiors of terrestrial planets: Moon and Mars

Moon and Mars have become the focus of geophysical exploration of terrestrial planets other that the Earth. It is hoped that in the not too distant future networks will be established that will include e.g., seismometers and heat flow probes. We already good topography and gravity data for Mars. For the Moon missions like LRO will are expected to provide data of similar quality for the Moon. We are still missing highly accurate data on the crustal magnetization of at least Mars and data on its rotation parameters. Mars interior structure features a crust of varying thickness, on the average 60km, a mantle with phase transitions and a core of roughly half the planetary radius. It is speculated that the core is entirely fluid (no inner core) which is consistent with the absence of a dynamo and with the chemistry of the core as suggested by Martian meteorites. The dynamics of the mantle - which governs the dynamics of the core as well - is dominated by convection and crust growth through mantle partial melting. For the Moon the crust is probably primordial - result of a magma ocean - and the core is comparatively small. It is possible that the core once generated a magnetic field and there are magnetized crustal units. However, alternative explanations exist for the remanent magnetization. It is likely that the Moon is lacking a solid inner core just like Mars. If sulfur is the dominating light element in the cores of the two planets then both could be in - or could be entering in the future - the snowing core regime with iron crystals forming at the core-mantle boundary and sinking towards the interiors. Whether the flow associated with iron snow can drive a dynamo is - yet - unknown.

Bruce Banerdt

Surface-Based Geophysics on the Terrestrial Planets

Geophysics provides unique views of the deep interior of a planet, which in turn provides a window into its origin, evolution and current level of geologic activity. Despite this, of the nearly 200 spacecraft that have been launched into deep space in the past 50 years, only six have successfully carried geophysical instrumentation to the surface of another planet. I will discuss the history of planetary geophysical measurements, what has been learned, remaining salient questions, and prospects for the future.

Alan Smith
Penetrators for Planetary Exploration and Science

Despite the fact that to date no penetrator has been successfully deployed on another planetary body, confidence in their use is high thanks to a wealth of heritage from ground-based applications and trials. The UK Penetrator consortium continues to develop associated technologies and to study a range of potential applications. Recent discoveries of water on the Moon together with an evolving international Mars exploration programme warrants their consideration as complementary technologies to soft landers. The application of penetrators for Lunar (e.g. through MoonLITE) and Martian research will be described.

Tom Pike, Werner Karl, Anisha Mukherjee, Ian Standley
A Microseismometer for Planetary Exploration

This talk will describe the development of a micromachined seismometer suitable for deployment in a variety of future missions. At the heart of the instrument is a silicon suspension with a high quality factor and an extremely sensitive capacitive transducer which is able to operate at a wide range of tilt angles. The current measured noise is 3 ng/?Hz at 20 s, with the capability of a further order of magnitude improvement. The suspension has been tested in a simulated penetrometer deployment, surviving shocks up to 14,000 g with suitable encapsulation. Potential mission scenarios which take advantage of the unique capabilities of the microseismoemter will be discussed.