CONTACT GROUP ASTROBIOLOGY & PLANET TOPERS JOINED MEETING

Friday March 8th 2013, ROB, Brussels

Program

starting time	SPEAKERS	TITLES
9h30	*welcome coffee*	
10h	**Mareike Godolt (Invited talk)**	**PLAnetary Transits and Oscillations of stars (PLATO)**
10h50	Michaël Gillon (ULg)	CHEOPS (CHaracterizing ExOPlanet Satellite)
11h10	Ludmila Carone (KULeuven)	Global Circulation Model (GCM) applied to extrasolar planets.
11h30	Laetitia Delrez (ULg)	Searching for water in the atmosphere of the hot Saturn WASP-49b
11h50	Cyrielle Opitom (ULg)	TRAPPIST: TRAnsiting Planets and Planetesimal Small Telescope
12h10	Lena Noack (ROB)	Self-consistent formation of continents on early Earth
12h30	*lunch*	
13h20	Seann Mckibbin (UGhent)	Isotopic dating of hydrothermal mineralisation in carbonaceous chondrite asteroids using Mn-Cr decay
13h40	Geneviève Hublet (ULB)	Internal 26Al-26Mg isochrons in eucrites and diogenites: chronology of the magmatic activity in 4-Vesta.
14H00	**Kevin Lepot (U Lille) (Invited talk)**	**Isotopic and nanoscale textural evidences for the biogenicity of the oldest cellular structures (3.4 billion years old)**
14h50	Luc Cornet (ULg)	Towards a calibrated molecular dating of the cyanobacterial origin of the chloroplast .
15h10	Nadia Van Roosbroek (ULB)	Formation of the IIe non magmatic iron meteorite, and origin of its silicate inclusions.
15h30	Vinciane Debaille (ULB)	How to preserve a chemically heterogeneous martian mantle? A plate tectonics point of view.
15h50	*coffee*	
16h10	Ana Catalina Plesa (DLR)	Thermo-chemical convection in planetary mantles: advection methods and magma ocean overturn simulations
16h30	Lê Binh San Pham (ROB)	Effects of meteorites and asteroids bombardments on the atmospheric evolution on Mars
16h50	Katarina Miljkovic (IPGP)	Morphology and population of binary asteroid impact craters.
17h10	Elodie Gloesener (ROB)	Discovery of Martian methane and link with clathrates in the crust of Mars
17h30	Séverine Robert (BISA)	Studying methane in the Mars atmosphere using NOMAD instrument onboard TGO 2016.
17h50	*pause*	
18h-19h	PlanetTOPERS Executive Committee Meeting	

abstracts (by alphabetical order)

GLOBAL CIRCULATION MODEL (GCM) APPLIED TO EXTRASOLAR PLANETS

Ludmila Carone (KUL)

It is our objective within an IDO-project (KU Leuven funding interdisciplinary research) to develop a global circulation model (GCM) that can be applied to extrasolar planets. We have adopted the open source MITgcm developed for the Earth as a start-point for our modeling efforts. The model was complemented with an idealized thermal forcing by Held&Suarez, 1994, and, Williamson et. al., 1998, to reproduce the structure of the Earth's annual troposphere and stratosphere.

This model was extended to different parameter regimes by changing the planetary rotation period, surface gravity and the planetary radius to prepare a set-up suitable for terrestrial exoplanets. The results of this parameter study are very promising, as they match similar studies conducted with other GCMs and generally agree with large scale circulation patterns found on other Solar System planets. In the end, it is our goal to combine the dynamics with chemical models and to compare the results with observations of exoplanets.

TOWARDS A CALIBRATED MOLECULAR DATING OF THE CYANOBACTERIAL ORIGIN OF THE CHLOROPLAST

Luc Cornet[1,2], Emmanuelle Javaux[2], Denis Baurain[1]

[1]Eukaryotic Phylogenomics, Dept of Life Sciences, University of Liege, B-4000 Liege; [2]Palaeobiogeology, Palaeobotany, Palaeopalynology, Dept of Geology, B18, University of Liege, B-4000 Liege

Cyanobacteria are an important bacterial phylum, and are the principal primary producers of our planet. This group is morphologically diverse and has colonized almost every habitat on Earth. Cyanobacteria form a rather ancient group whose presence is evidenced by microfossils dated at about two billion years (2.1 Ga) and geochemical evidence at least at 2.45 Ga. They played a crucial role in Earth history through the evolution of oxygenic photosynthesis, with drastic consequences on the chemical evolution of the atmosphere and oceans, and the diversification of eukaryotic life.. Beside these prokaryotes, some eukaryotic lineages that evolved later contain specialized organelles, the chloroplasts (or plastids), in which photosynthesis takes place. It is now widely accepted that plastids derive from endosymbiotic cyanobacteria thateventually integrated into their phagotrophic hosts. According to the available data, suchendosymbiosis occurred only once (probably around 1.5 Ga ago) and gave rise to all existing plastids (ignoring the special case of *Paulinella chromatophora*).Two types of studies have examined the phylogeny of cyanobacteria and the origins of plastid. Those based on 16S rRNA cover almost the whole cyanobacterial diversity but have a weak phylogenetic resolution due to the size of the molecule. In contrast, phylogenomic studies using hundreds of orthologous genes from complete genomes have a better resolution but at the expense of a sampling biased toward unicellular strains. This explains why the identity of the contemporaneous cyanobacterial lineage most closely related to eukaryotic plastids remains unclear.The aim of this PhD project is to shed light on plastid origins and on the timing of their acquisition. To this end, we will sequence a few dozens of new genomes, mostly in multicellular lineages. A robust phylogeny of cyanobacteria will be established through phylogenomic approaches, which should allow the determination of the stem group of theplastids. This phylogeny will also permit to improve our understanding of cyanobacterial evolution.To date our molecular trees, we will use fossil calibration points, some of which will be re-analyzed by microscopy and microchemistry, which should help us to refine their taxonomy by comparison with their modern counterparts.

HOW TO PRESERVE A CHEMICALLY HETEROGENEOUS MARTIAN MANTLE? A PLATE TECTONICS POINT OF VIEW.

V. Debaille[1*], C. O'Neill[2], A. D. Brandon[3], P. Haenecour[4], Q.-Z. Yin[5], N. Mattielli[1], A. H. Treiman[6]

[1] Laboratoire G-Time, Université Libre de Bruxelles, CP 160/02, 50 Avenue F. D. Roosevelt, 1050 Brussels, Belgium. (vinciane.debaille@ulb.ac.be). [2] GEMOC ARC National Key Centre, Earth and Planetary Science, Macquarie University, New South Wales 2109, Australia. [3] Department of Earth and Atmospheric Sciences, University of Houston, Houston TX 77204, USA.[4] Laboratory for Space Sciences and Earth and Planetary Sciences Department, Washington University, St. Louis MO 63130-4899, USA. [5] Department of Geology, University of California Davis, One Shields Avenue, Davis, CA 95616, USA.[6] Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston TX 77058, USA.

Introduction: The study of Martian meteorites has widely shown that the Martian mantle is poorly mixed and hence preserves chemical signatures inherited from the early times of planetary differentiation. However, how to preserve such a chemical heterogeneity is still a matter of debate. Some have suggested that the martian mantle has stopped convecting a long time ago in order to prevent convective mixing [1], while recent numerical modelling indicate that mantle convection is still active in Mars [2] despite it should have erased the observed chemical heterogeneity.

Here we propose to use the Earth as an analogue to understand Mars. The finding of a resolvable positive ^{142}Nd anomaly of μ^{142}Nd = +7 ± 3 ppm relative to the modern convecting mantle in a 2.7 Gyr old tholeiitic lava flow from the Abitibi Greenstone Belt in the Canadian Craton effectively extends the early Archean convective mixing time to ~1.8 Gyr, i.e. even longer than present-day mantle mixing timescale [3], despite a more vigorous convection expected in the Archean. We postulate that the requirement of a delayed mixing in a strongly convective mantle is best explained by long periods of stasis in the global plate system, with scarce episodes of subduction throughout the Hadean and Archean [4]. Our numerical model confirms that in absence of continuous plate tectonics, the convective mantle mixing is relatively inefficient in erasing the chemical heterogeneities inherited from the primordial differentiation of the early Earth.

This result is particularly relevant for Mars, as the planet has shown a stagnant-lid for at least the last 4 Gyr of its history [5]. According to the model developed here, the absence of plate tectonics in Mars allows reconciling the paradox of a convective but poorly-mixed Martian mantle.

References: [1] Bouvier, A. et al. 2005 *Earth Planet. Sci. Lett.* 240: 221-233. [2] Li, Q.-S. and Kiefer, W. S. 2007 *Geophys. Res. Lett.* 34: L16203. [3] Kellogg, L. H. and Turcotte, D. L. 1990 *J. Geoph. Res.* 95: 421-432. [4] O'Neill, C. et al. 2007 *Earth Planet. Sci. Lett.* 262: 552-562. [5] Lenardic, A. et al. 2004 *J. Geophys. Res.* 109: doi:10.1029/2003JE002172.

SEARCHING FOR WATER IN THE ATMOSPHERE OF THE HOT SATURN WASP-49b

Laetitia Delrez[1]; L. Delrez[1]; M. Lendl[2]; M. Gillon[1]; E. Jehin[1]; D. Queloz[2]

[1]Université de Liège, AGO ; [2]Observatoire astronomique de l'Université de Genève

At the forefront of comparative exoplanetology, the atmospheric characterization of transiting exoplanets is revealing the intimate nature of these 'new worlds'. In this exciting context, we present here some preliminary results of our VLT program that consisted in monitoring in ESO phase 90 four transits of the new 'hot Saturn' WASP-49b with the FORS instrument in spectroscopic mode. The aim of this program is to precisely measure the transmission spectrum of WASP-49b between 740 and 1070nm to constrain the thermal structure and scattering properties of the planet's atmosphere. Furthermore, the probed spectral area covers amongst others the 950nm water band that we aim to use to measure the water mixing ratio of this hot Saturn.

CHEOPS

Michaël Gillon

ULg, Institute of Astrophysics and Geophysics

The HARPS and Kepler exoplanet search projects have revealed that more than 50% of the sun-like stars in the Solar neighborhood are orbited by close-in super-Earths. To understand the exact nature of these ubiquitous planets requires the detection of some of them transiting bright nearby stars to make possible their detailed spectroscopic characterization. This will be the main goal of the CHEOPS space mission, a project led by Switzerland and involving ESA and several European countries, including Belgium. CHEOPS (CHaracterizing ExOPlanet Satellite) will be a 30cm space telescope fully dedicated to high-precision time-series photometry of bright and nearby exoplanet host stars.

Scheduled for launch in 2017, it will use its exquisite photometric potential to search for the transits of super-Earths previously detected around bright nearby stars by radial velocity measurements. The detected transits will provide unique opportunities for more detailed atmospheric studies. CHEOPS will also drastically improve the characterization of Neptune-size planets found by ground-based transit surveys, notably by the Next-Generation Transit Survey (NGTS) that will begin operating from Chile in 2014 and in which Liege University is involved.

DISCOVERY OF MARTIAN METHANE AND LINK WITH CLATHRATES IN THE CRUST OF MARS

Elodie Gloesener

Royal Observatory of Belgium 3 avenue Circulaire B1180 Brussels, Belgium

The recent detection of methane in the Martian atmosphere generated a large interest among the scientific community in particular because the source of this gas is still unknown and because it is a potential biomarker. Methane, observed at a level of 10 parts per billion and per volume, has a non-uniform distribution. In addition, there is a correlation between the mixing ratio of water vapor and methane. This phenomenon can be explained by the existence of methane clathrates on Mars. These chemical compounds are formed by the inclusion of gas molecules in the cavities of a water molecules network and are stable at high pressure and low temperature. Whatever the process of methane formation, past or present CH_4 can be stored in clathrates and emissions of this gas, observed at the present time, may be due to the dissociation of the clathrates due to a change in temperature, pressure or composition. Current conditions of Mars do not allow them to be stable on the surface but they can remain stable in the crust if they were formed below a certain depth depending on the surface temperature conditions. For a temperature change diffusion inside the crust (skin depth) depending on the timescale involved it is though possible to obtain destabilization of clathrates.

We have calculated the distribution of methane and carbon dioxide clathrates in the Martian crust, assuming that the latter was constituted of basalt with pores filled with ice. The results showed that the clathrate stability zone approaches the surface with increasing latitude (therefore increasing the possibility to have methane degassing near the pole) and that CO_2 clathrates were formed at shallower depth than methane clathrates (therefore increasing the possibility to have methane if methane is mixed with CO_2). We also studied the destabilization of clathrates due to seasonal variations in temperature, change in obliquity and an increase of the water salinity. The thermal oscillations caused by the variation of the obliquity could have destabilized clathrates on all latitudes while the thermal oscillations due to the succession of the seasons destabilize clathrates at high latitude only.

INTERNAL ^{26}AL-^{26}MG ISOCHRONS IN EUCRITES AND DIOGENITES: CHRONOLOGY OF THE MAGMATIC ACTIVITY IN 4-VESTA.

G. Hublet[1], V. Debaille[1], J. Wimpenny[2], Q-Z. Yin[2],

[1]Département des Sciences de la Terre et de l'Environnement, Université Libre de Bruxelles, CP 160/02, 50, Av. F.D. Roosevelt, 1050 Brussels, Belgium, ghublet@ulb.ac.be, [2]Department of Geology, University of California, Davis, CA 95616

Eucrites and diogenites are igneous rocks belonging to a magmatic serie of meteorites: Howardite-Eucrite-Diogenite (HED). Eucrites are basaltic achondrites and are among the oldest known volcanic rocks in the solar system [1]. They resulted from early magmatic activity on 4-Vesta [1, 2]. Recent studies have demonstrated an excess in ^{26}Mg in eucrites [3-5], implying that they can be dated by the ^{26}Al-^{26}Mg isotopic system. Diogenites are more ultrabasic and probably younger due to the lack of excess in ^{26}Mg.

Usually, they are considered to be all contemporaneous and are dated by whole rock isochrons. Previous results obtained on seven eucrites show that only five of them have an excess in ^{26}Mg that is fully resolvable [6] These results suggest that all eucrites do not have the same crystallization age or may have been perturbed by secondary processes such as metamorphism before or after ^{26}Al was extinct. In this case, dating these meteorites with internal isochrons is certainly more appropriate. Currently, only a few studies have investigated internal isochrons in eucrites [5, 7].

We performed mineral separation on three eucrites : Y-792510, a highly metamorphic eucrite [8], Y-793591, an ordinary eucrite and Y-980433, a cumulative eucrite and three diogenites (Bilange, Johnstown and Tatahouine). Three different mineral fractions were obtained for eucrites and six to eight for diogenites. Previous ages calculated on those three eucrites were based on well-known CAI. Internal isochrons on Y-792510, Y-793591 and Y-980433 eucrites indicate an age of 4562.24 (±1.95), 4561.42 (±1.72) and 4557.54 (±1.22) million years (Ma) respectively when using the Efremovka (E60) CAI age [9] as anchor value. In opposition, isochrons obtained on diogenites are flat, suggesting an age younger compare to eucrites.

These results can be interpreted in terms of magmatic activity on 4-Vesta. The age obtained on Y-792510 and Y-793591 eucrite correspond to the crystallization age of these eucrites. The younger age obtained on Y-980433 cumulative eucrite indicate that some inner parts of 4-Vesta took ~ 7 Ma to cool below the closing temperature of the Al-Mg isotopic system. Finally an age < 4557 Ma for diogenites suggests either a slow cooling rate for Vesta or a second period of magmatic activity on this asteroid. This study reveals a complex magmatic history on 4-Vesta.

References:

[1] Lugmair G.W., et al. (1998) *GCA, 62,* 2863-2886. [2] Wadhwa M., et al. (2004) *LPSC, XXXV,* #1843. [3] Bizzarro M., et al. (2005) *Astron J, 632,* L41-L44. [4] Schiller M., et al. (2010) *GCA, 74,* 4844-4864. [5] Srinivasan G., et al. (1999) *Science, 284,* 1348-1350. [6] Hublet G., et al. (2011) *Workshop on Formation of the First Solids in the Solar System, #9058*. [7] Nyquist L.E., et al. (2003) *EPSL, 214,* 11-25. [8] Takeda H., et al. (1991) *Meteoritics, 26,* 129-134. [9] Amelin Y., et al. (2002) *Science, 297,* 1678-1683.

ISOTOPIC AND NANOSCALE TEXTURAL EVIDENCES FOR THE BIOGENICITY OF THE OLDEST CELLULAR STRUCTURES (3.4 BILLION YEARS OLD)

Kevin Lepot[1,2,3], Kenneth H. Williford[1,4], Emmanuelle J. Javaux[2], Takayuki Ushikubo[1], Kenichiro Sugitani[5], Koichi Mimura[6], Michael J. Spicuzza[1], John W. Valley[1]

[1] *NASA Astrobiology Institute, WiscSIMS, Department of Geoscience, University of Wisconsin, 1215 W. Dayton St., Madison, WI 53706, USA*

[2] *Paléobiogéologie, Paléobotanie & Paléopalynologie, Département de Géologie, Université de Liège, 4000 Liège, Belgium*

[3] *Université Lille 1, Laboratoire Géosystèmes, CNRS UMR8217, 59655 Villeneuve d'Ascq, France (present address)*

[4] *Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109, USA*

[5] *Department of Environmental Engineering and Architecture, Graduate School of Environmental Studies, Nagoya University, Nagoya, 464-8601, Japan.*

[6] *Department of Earth and Environmental Sciences, Graduate School of Environmental Studies, Nagoya University, Nagoya, 464-8601, Japan.*

The oldest evidences of life, ca. 3.5 billion years old, come from sulfur isotope ratio indicating sulfur metabolism, and bedded deposits named stromatolites. Finding diagnostic geochemical (isotopic and molecular) biosignatures in organic matter preserved in such ancient rocks remains difficult due to 1) the metamorphic alteration caused by deep burial and 2) the abundance of seafloor hydrothermal systems that may have produced abiogenic organic compounds. Because the earliest microorganisms likely had simple morphologies, cellular imprints in organic matter are difficult to distinguish from abiogenic microstructures such as migrated hydrocarbons precipitated along grain boundaries of variable shapes. Abundant cell-like organic microstructures have been recently reported in the 3.4 Gyrs old Strelley Pool Formation from Western Australia. We measured carbon isotope ratio at the microscale (15 µm spot) in these organic microstructures using Secondary Ion Mass Spectrometry (SIMS). We characterized the texture and structure of organic matter using Raman spectromicroscopy, Scanning Transmission X-ray Microscopy, Scanning Electron Microscopy, Focused Ion Beam and Transmssion Electron Microscopy. Textural analyses revealed strong similarities with younger microfossils down to the sub-micrometer scale and distinguished spherical and lenticular cell-like structures from other, non-biogenic textures. Raman spectromicroscopy and carbon isotope ratios distinguished the indigenous cell-like structure and kerogen from late migrated bitumen. SIMS revealed C-isotopes heterogeneities between spherical and lenticular cell-like structures and kerogen clots, and internal heterogeneties in lenticular structures. The heterogeneities can be explained by selective diagenetic preservation of the distinct isotopic

fractionations inherited from different precursor biomolecules. Altogether, our data argue for the biogenicity of cell-like structures and for the preservation of cellular morphologies.

ISOTOPIC DATING OF HYDROTHERMAL MINERALISATION IN CARBONACEOUS CHONDRITE ASTEROIDS USING MN-CR DECAY

*Seann McKibbin, Trevor Ireland, Yuri Amelin, Hugh O'Neill, Peter Holden

Research School of Earth Sciences, Australian National University; *Current affiliation: Earth System Sciences, Vrije Universiteit Brussels

Hydrothermal systems in early forming protoplanets, driven by the decay of radioactive short-lived 26Al, were one of the earliest 'habitable' environments in the Solar System. Fluid-rock reactions drove mineralisation of carbonates in the interior of protoplanets corresponding to CI- and CM-type carbonaceous chondrite compositions, and fayalite (olivine) in those of CV- and CO- types. These samples are now available in the lab as meteorites, and can be dated using another short-lived system, 53Mn-53Cr (half life = 3.7 Myr).

Temporal components have been involved in thermal modelling of carbonate precipitation in early Solar System bodies, but fayalite precipitation has only been investigated from a thermodynamic perspective. One of the obstacles to understanding the chronology of fayalite as well as carbonate was a lack of reliable mineral standards which are required to obtain Mn-Cr ages for these phases. New understanding has been recently achieved for carbonates; I present here attempts to produce and use Cr-bearing olivine and fayalite in these investigations. Despite these efforts, the results from different labs are contradictory. The timescale for fayalite precipitation in early Solar System bodies is therefore at present very poorly understood, and hinders understanding of the thermal evolution of the CV and CO parent bodies.

SELF-CONSISTENT FORMATION OF CONTINENTS ON EARLY EARTH

L. Noack (1), T. Van Hoolst (1), D. Breuer (2) and V. Dehant (1)

1) Royal Observatory of Belgium; 2) German Aerospace Center

In this study we investigate how Earth's surface might have evolved with time and examine in a more general way the initiation of plate tectonics and the possible formation of continents on an Earth-like planet. For this purpose we use a 2D/3D mantle convection code and develop a new model for self-consistent formation of continental crust by tracing and remelting of subducted basaltic crust.

TRAPPIST: TRANSITING PLANETS AND PLANETESIMAL SMALL TELESCOPE

C. Opitom, E. Jehin, M. Gillon, J. Manfroid, L. Delrez, P. Magain

Université de Liège, AGO

TRAPPIST is a 60-cm robotic telescope that has started robotic operations in December 2010 at the ESO La Silla Observatory. Operated from Liège (Belgium) it is devoted to the detection and characterisation of exoplanets and to the study of comets and other small bodies in the Solar System. We describe here the hardware and the goals of the project and give an overview of the results obtained during the first 2 years of operations.

FORMATION OF THE IIE NON MAGMATIC IRON METEORITE, AND ORIGIN OF ITS SILICATE INCLUSIONS.

N. Van Roosbroek[1], V. Debaille[1], S. Goderis[2], J. W. Valley[3], and Ph. Claeys[2].

[1]Laboratoire G-Time, Université Libre de Bruxelles, B-1050 Brussels, Belgium, (nvroosbr@ulb.ac.be), [2]Earth System Sciences, Vrije Universiteit Brussel, B-1050 Brussels, Belgium, [3]Dept. of Geoscience, Univ. of Wisconsin-Madison, Madison, WI, 53706, USA.

Introduction: Recently, the Mont Dieu meteorite was confirmed as a fine octahedrite IIE iron meteorite [1, 2, 3]. The well preserved ~450 kg fragment of the non-magmatic iron (NMI) Mont Dieu II meteorite preserved at the Royal Belgian Institute of Natural Sciences, in Brussels was studied. The metal phase shows a clear widmanstätten texture, composed essentially of kamacite, with fine lines of Ni-rich taenite, and locally troilite associated with schreibersite. The study focuses on the abundant large, rounded, brownish silicate inclusions present in Mont Dieu. These were studied under SEM/EDX, major and trace elements were determined by ICP-OES & ICP-MS, and oxygen isotopes were measured.

Silicate inclusions: The silicate inclusions are characterized by coarse-grained granular texture, crossed by metal veins. Round structures (~ 1 mm in diameter) composed of ferromagnesian minerals are present mainly and interpreted as relict chondrules. Three are well preserved barred olivine chondrules, a feature that to our knowledge has so far not been described in other non-magmatic iron meteorites, except for Netschaëvo NMI IIE [4]. Low Ca-pyroxene, olivine and albitic plagioclase are the major mineral phases. FeO-rich glass, chromite, troilite, schreibersite, (chlor)apatite and Fe-Ni metal are found as minor mineral phases often surrounding the chondrules.

The oxygen isotope analyses carried out on Mont Dieu yield a mean $\Delta^{17}O$ of 0.714±0.024 ‰. The fayalite and ferrosilite molar contents of the seven recrystallized chondrules are similar to those observed in H-type ordinary chondrites that have been linked to IIE NMI based on their oxygen isotopic compositions [5]. In terms of its oxygen signature, Mont Dieu II falls within the range defined for H 3-6 chondrites [5; 6].

Interpretation: The mineralogy, major element composition of Mont Dieu II silicate inclusions and its oxygen isotopic values shows similarities with the H-chondrites. Based on the analyses, an impact formation model for Mont Dieu II is proposed, where an H-chondrite parent body was impacted by a Fe-Ni impactor. A position near the edge and at a shallow depth of the magma pool is favored for Mont Dieu II, because fast cooling is necessary to preserve the chondrules and glass.

References: [1] Grossman J. N. (1997) *Meteoritics & Planetary Science, Supp. 31,* A159-166. [2] Desrousseaux A. et al. (1996) *Meteoritics & Planetary Science, 31,* A36. [3] Van Den Borre N. et al. (2007) *Meteoritics & Planetary Science*, *42*:A153. [4] Olsen E. and Jarosewich E. (1971) *Science, 174*, 583-585. [5] Clayton R.N. and Mayeda T.K. (1996) *Geochemica and Cosmochimica Acta 60*, 1999-2017. [6] Folco L. et al., (2004) *Geochemica and Cosmochimica Acta 68*, 2379-2397.

STUDYING METHANE IN THE MARS ATMOSPHERE USING NOMAD INSTRUMENT ONBOARD TGO 2016.

S. Robert[1], R. Drummond[1], L. Neary[1], V. Wilquet[1], A. Mahieux[1], F. Daerden[1], A.C. Vandaele[1] and the NOMAD Team

[1] Belgian Institute for Space Aeronomy, 3 Ave Circulaire, B-1180 Brussels, Belgium

The NOMAD instrument will leave Earth towards Mars onboard the Trace Gas Orbiter (ESA/ROSCOSMOS) in 2016. One of its tasks will focus on the search of trace gases in the Martian atmosphere, especially organics like methane. The recent observations of CH_4 by four groups (Mumma et al. 2009 ; Formisano et al. 2004 ; Krasnopolsky et al. 2004 ; Fonti and Marzo, 2010) indicate regions of localized release and high temporal variability. The global picture is not fully understood and more data are needed to explain the processes at play. NOMAD will address this need.

NOMAD will be described and a short review of the recent observations of methane and related species on Mars using infrared spectrometers will be presented.