University of Winnipeg Planetary Spectrophotometer Facility (PSF)

The University of Winnipeg's Planetary Spectrophotometer Facility was established in 2003, and builds on our experience in planetary science and remote sensing.

The main goal of the PSF is to enable spectroscopy-based analysis of planetary materials and analogues and includes both field-portable and laboratory (bench-top) instruments, as well as some associated instrumentation.

Areas of Research Interest

The relevant astrobiology expertise at the University of Winnipeg is focused on the uses of optical spectroscopy largely for understanding the astrobiological potential of other planets from a geological perspective. PSF activities in this area include:

- characterizing the geology of terrestrial analogue environments and materials that can provide insights into the possibility of similar environments and extinct or extant life on other planetary surfaces
- identifying and characterizing new terrestrial analogue sites that may have astrobiological importance
- analyzing optical remote sensing data from various planetary missions
- developing analytical techniques and instruments for planetary exploration

Recent and Ongoing Projects

Recent and ongoing projects relevant to astrobiology include:

- a concept study of a drill-equipped Mars rover (Inukshuk)
- a concept study for a Mars microrover (Kapvik)
- a Mars Methane Analogue Mission to explore technologies and operational scenarios for determining the origin (biogenic/abiogenic) of methane on Mars; this mission will be undertaken at asbestos mines in Quebec which offer goos geological analogues to Mars
- a sample return mission from a primitive (organic-bearing) asteroid (OSIRIS-REx)
- a proposal to investigate the trace gas composition of Mars from an orbiter (MATMOS)

PSF Facilities

The facilities available at PSF fall into a few main categories:

(1) planetary simulation facilities and sample quarantine and handling;
(2) field portable spectrometers;
(3) laboratory spectrometers, and
(4) associated equipment.

1. Planetary simulation facilities and sample quarantine and handling:

- a large (0.4 m^3) and small (10 cm^3) capacity Mars surface environment simulation chamber with the ability to reproduce Mars atmospheric pressure and composition, temperature control, and UV irradiation environment
- a large capacity (0.3 m^3) sealed glove box for sample handling and analysis in a neutral environment

2. Field portable spectrometers are portable, battery operated units for use in the field:

- ASD Field Spec Pro HR spectrometer: 300 - 2500 nanometre range
- Ocean Optics S2000 spectrometer: 200-1160 nanometre range
- D&P Model 102F FTIR spectrometer: 2 - 16 microns range

3. Laboratory spectrometers are bench-mounted units at the PSF for measurements of optical spectra in various modes (transmission, reflectance, ATR, etc.):

- Buck Model 5000 dispersive IR spectrometer: 2 - 16 micron range
- Bruker Vertex 70 and Hyperion 2000 micro-FTIR: 0.4 - 200 micron range
- Jasco V570 dispersive spectrometer: 200 - 2500 nanometre range

4. Other (associated) equipment. Optical spectroscopy studies in the field and in the laboratory can be extended with the PSF's additional instrument capabilities:

- a CRI 1-megapixel hyperspectral imager: 400 - 720 nanometres
- a CRI 1-megapixel hyperspectral imager: 650 - 1100 nanometres
- a Nuance 320x256 pixel hyperspectral imager: 1200 - 2450 nanometres
- a Delta Nu Advantage 200A field-portable Raman spectrometer: 200 - 3400 cm^{-1}
- a Delta Nu Rockhound field-portable Raman spectrometer: 200 - 2000 cm^{-1}
- a Carlos Erba EA1110 CHNS/O elemental analyzer
- an Oxford Instrument XMET-3000 field-portable XRF analyser (Z>Mg)
- a field-portable Palintest multi-parameter water quality analyser

The PSF also has a publicly-accessible data base of reflectance spectra for a wide range of minerals and other geological materials. Additional details on the PSF, its capabilities, and downloadable data bases can be found at the web site: http://psf.uwinnipeg.ca

PSF - Selected Recent Publications

Cloutis, E.A., P. Hudon, C.S. Romanek, V. Reddy, M.J. Gaffey, and P.S. Hardersen (2010) Spectral reflectance properties of ureilites. *Meteoritics and Planetary Science,* in press.

Cloutis, E.A., S.E. Grasby, W.M. Last, R. Léveillé, G.R. Osinski, and B.L. Sherriff (2010) Spectral reflectance properties of carbonates from terrestrial analogue environments: Implications for Mars. *Planetary and Space Science,* 58, 522-537.

Palomba, E., A. Zinzi, **E.A. Cloutis**, M. D'Amore, D. Grassi, and A. Maturilli (2009) Evidence for Mg-rich carbonates on Mars from a 3.9 μm absorption band. *Icarus, 203,* 58-65.

Rice, M.S., J.F. Bell III, **E.A. Cloutis,** A. Wang, S.W. Ruff, M.A. Craig, D.T. Bailey, J.R. Johnson, P.A. de Souza Jr., and W.H. Farrand (2009) Silica-rich deposits and hydrated minerals at Gusev crater, Mars: Vis-NIR spectral characterization and regional mapping. *Icarus,* in press; doi: 10.1016/j.icarus.2009.03.035.

Clark, B.E., M.E. Ockert-Bell, **E.A. Cloutis,** D. Nesvorny, T. Mothe-Diniz, and S.J. Bus (2009) Spectroscopy of K-complex asteroids: Parent bodies of carbonaceous meteorites?. *Icarus, 202,* 119-133.

Pompilio, L., G. Pedrazzi, M. Sgavetti, **E.A. Cloutis,** M.A. Craig, and T.L. Roush (2009) Exponential Gaussian approach for spectral modeling: The EGO algorithm, I. Band saturation. *Icarus, 201,* 781-794.

Horgan, B.H., J.F. Bell III, E.Z. Noe Dobrea, **E.A. Cloutis**, D.T. Bailey, M.A. Craig, L.H. Roach, and J.F. Mustard (2009) The distribution of hydrated minerals in the north polar regions of Mars. *Journal of Geophysical Research - Planets, 114, E01, E01005* doi:10.1029/2008JE003187.

Wang, A., J.F. Bell III, R. Li, J.R. Johnson, W.H. Farrand, **E.A. Cloutis**, R.E. Arvidson, L. Crumpler, S.W. Squyres, S.M. McLennan, K.E. Herkenhoff, S.W. Ruff, A.T. Knudson, W. Chen, R. Greenberger, and the Athena Science Team (2008) Light-toned salty soils and coexisting Si-rich species discovered by the Mars Exploration Rover Spirit in Columbia Hills. *Journal of Geophysical Research - Planets, 113, E12,* CiteID: *E12S40* doi:10.1029/2008JE003126, 35 pp.

Gallie, E.A., D.A. Lyder, B. Rivard, and **E.A. Cloutis** (2008) Equivalence of modified Gaussian model in wavenumber and Gaussian in wavelength for deconvolution of hyperspectral reflectance spectra. *International Journal of Remote Sensing 29 (14),* 4089-4096.

Cloutis, E.A., K.A. McCormack, J.F. Bell III, A.R. Hendrix, D.T. Bailey, M.A. Craig, S.A. Mertzman, M.S. Robinson, and M.A. Riner (2008) Ultraviolet spectral reflectance properties of common planetary materials. *Icarus,197,* 321-347. doi: 10.1016/j.icarus.2008.04.018.

Cloutis, E.A., M.A. Craig, R.V. Kruzelecky, W.R. Jamroz, A. Scott, F.C. Hawthorne, and S.A. Mertzman (2008) Spectral reflectance properties of minerals exposed to simulated Mars surface conditions. *Icarus, 195,* 140-168. doi: 10.1016/j.icarus.2007.10.028.

Cloutis, E.A., M.A. Craig, J.F. Mustard, R.V. Kruzelecky, W.R. Jamroz, A. Scott, D.L. Bish, F. Poulet, J.-P. Bibring, and P.L. King (2007) Stability of hydrated minerals on Mars. *Geophysical Research Letters, 34,* L20202, doi:10.1029/2007GL031267.

Johnson, J.R., J.F. Bell III, **E. Cloutis**, M. Staid, W.H. Farrand, T. McCoy, M. Rice, A. Wang, and A. Yen (2007) Mineralogic constraints on sulfur-rich soils from Pancam spectra at Gusev crater, Mars. *Geophysical Research Letters, 34,* L13202, doi:10.1029/2007GL029894.

Cloutis, E.A., F.C. Hawthorne, S.A. Mertzman, K. Krenn, M.A. Craig, D. Marcino, M. Methot, J. Strong, J.F. Mustard, D.L. Blaney, J.F. Bell III, and F. Vilas (2006) Detection and discrimination of sulfate minerals using reflectance spectroscopy. *Icarus, 184,* 121-157.

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