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INNOVATION
EXPLORATION
OBSERVATION
INSPIRATION

Canadian Space Agency Program Update

Dr. Victoria Hipkin

MEPAG

February 22nd 2017

Canadian Space Agency | Agence spatiale canadienne

Canada

Government of Canada: Innovation Agenda

- New Federal Government – October 2015
- Canada's Innovation Agenda– June 2016
- New Space Strategy – June 2017

"[the] Space Strategy is in effect a research and innovation strategy that will support growth in the sector and leverage the benefits of space for all Canadians."

Source: Minister Bain's Speech at the Aerospace Industries Association of Canada Summit on 16 November 2016

Highlights of 2016-17

Canadian Budget 2016

June

Canadian Government launches Innovation Agenda

Consultations

Applications sought: Canadian astronauts (2)

September

OSIRIS-REx Laser Altimeter

Launch of OLA on NASA OSIRIS-REx

October

MSL APXS EM2 approval

APXS

November

Canadian MSR Analogue Deployment (Utah)

Applications sought: Canadian Space Advisory Board

Canadian Space Exploration Workshop (Montreal)

December

ESA Ministerial

NeMO SAR Concept Study posting

March

Canadian Space Advisory Board convened

CSEW Science Priorities report

Canadian Budget 2017

April

Canadian Space Strategy

June

OSIRIS-REx Laser Altimeter

- ‘High power’ laser: direct heritage from CSA’s Mars Phoenix MET
- 4% of sample to be curated in Canada

PI: Mike Daly, York
Built by MDA, Brampton

~400 samples to date
10 MSc & PhD theses

Quantify rock chemistry, relate rock formations along traverse, triage and context for sampling, elemental correlations

EM2: APXS - CANADA'S CONTRIBUTION TO MSL

PI: Ralf Gellert, Guelph
Built by MDA, Brampton

Participating Scientists:
Richard Leveille, McGill
John Moores, York
Mariek Schmidt, Brock

UNIVERSITY of GUELPH

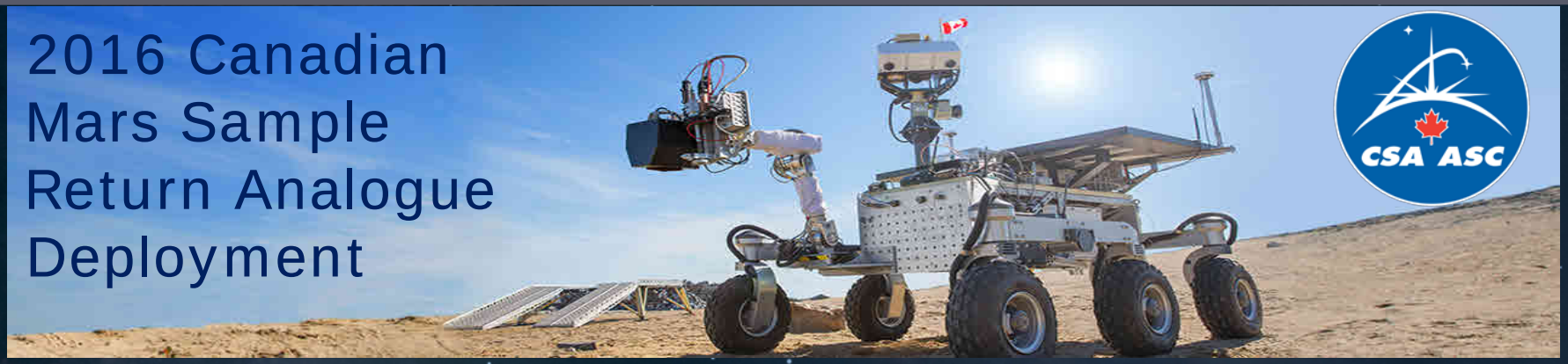
CSA ASC

APXS

NASA

MARS SCIENCE LABORATORY

2016 Canadian Mars Sample Return Analogue Deployment



22nd Oct – 18th Nov, Utah

Week 0	Set-up
Weeks 1&2	Cache Rover Mission
Week 3	Fetch Rover Technology testing
	'human rover' Cache Mission continuation
	Field validation team

The road to the Canadian 2016 MSR Analogue Deployment

iMARS 1 Working Group

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016

CSA MSR analogue mission Science Definition Team (with NASA, JPL participation)

Stimulus: prototype rovers, drill, vision system, science instruments

Rover, hardware, and instrument tests

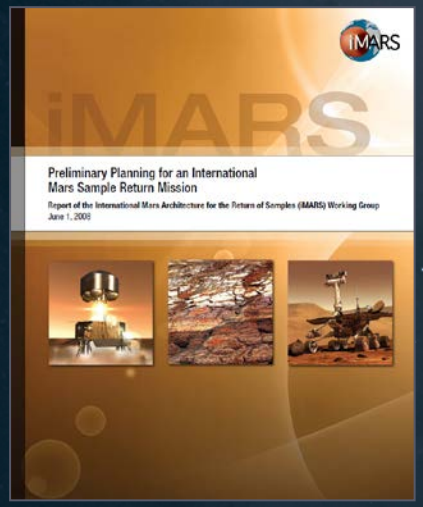
Analogue geological sample library contract

MSR Field Site selection contract

iMARS 2 Working Group

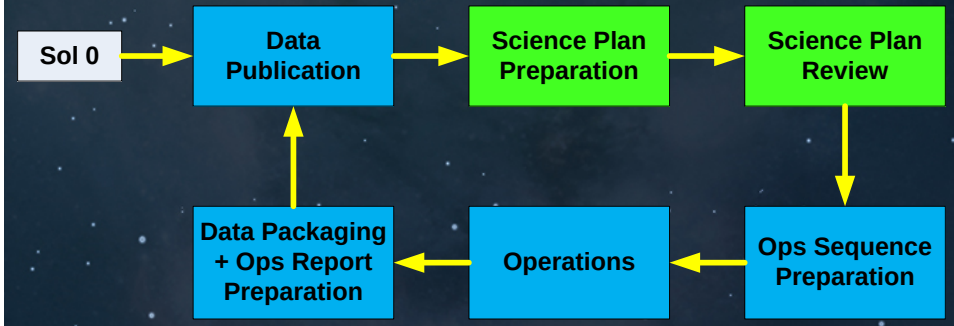
Utah Field Deployment

Utah Analogue Deployment



2016 Canadian MSR Analogue Deployment

Building on successful 2015 operations..



NSERC CRSNG

2016 Canadian MSR Analogue Deployment

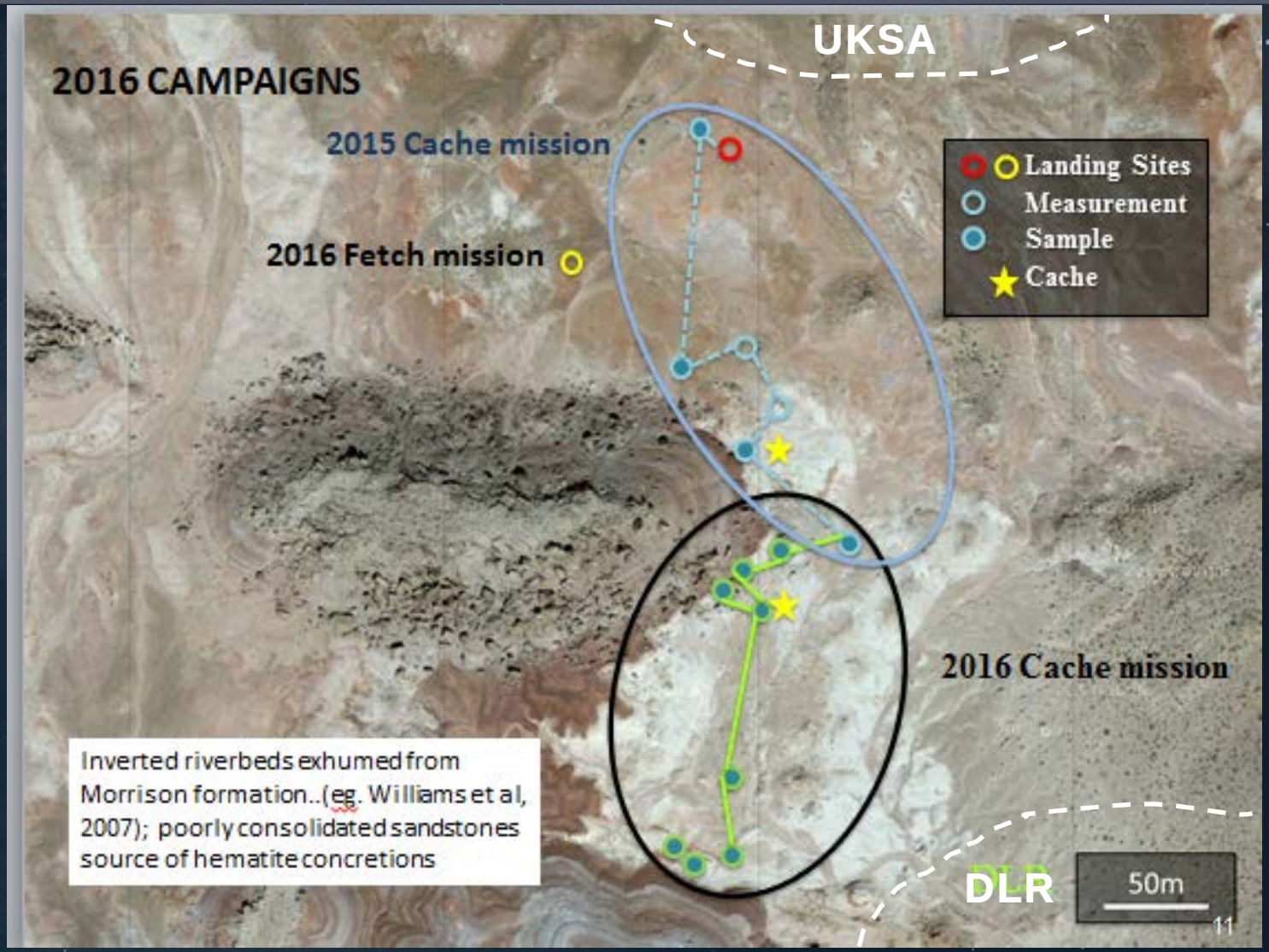
Objectives: Cache science & Fetch technology

Element	Objective	Implementation
International collaboration	Develop and strengthen partnerships + position Canada for future contributions	USA: NASA, Stony Brook University, JPL, UNLV UK: UK Space Agency, Imperial College London Germany: DLR
Science / Operations	Advance MSR science operations and sample targeting. Co-ordination through Science Plan Western Centre for Planetary Science and Exploration; McGill University; The University of Winnipeg	Sought 'highest organic carbon' samples: Utilized autonomous targeting & decision-making to increase efficiency of Mars 2020 simulated payload Tested the *accuracy* of sample selection vs. traditional field party Tested the *efficiency* of remote science operations using pre-planned strategic traverse days *Determine factors that affect the quality of sample-selection decision (analysis of returned samples)*
Technical Development	Advance selected rover autonomy and arm positioning technologies	929m fully autonomous traverse. Navigated to sample cache locations and returned samples to MAV
Communications	Attract and inspire the general public in STEM subject matter	Messages from the CSA about MSRAD were displayed more than a million times on social media.
Education / Training	Provide valuable learning opportunities to students	Participation of > 30 appreciative students & PDFs

2016 Canadian MSR Analogue Deployment

Analogue site

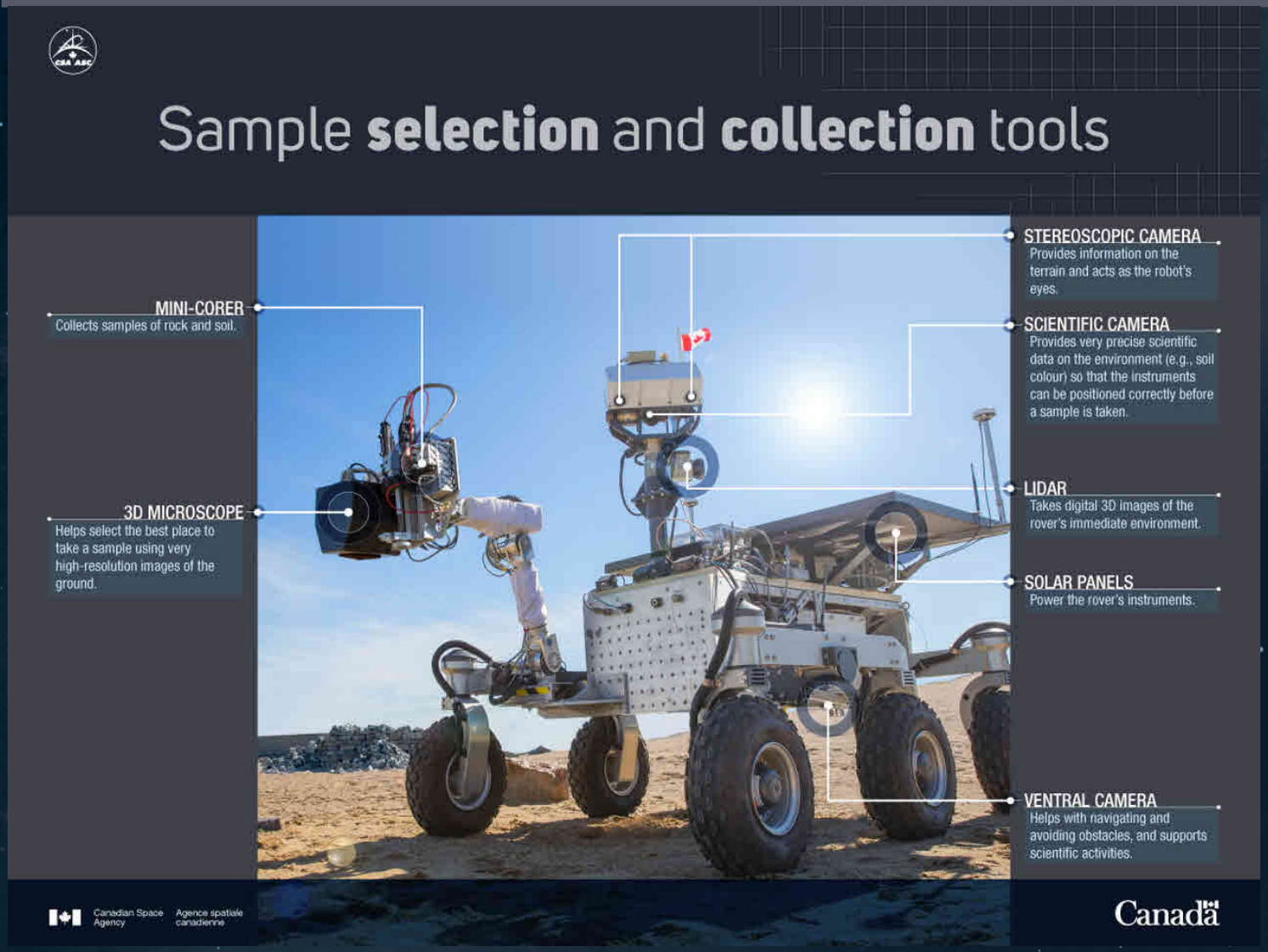
5km NW of Hanksville, Utah



2016 Canadian MSR Analogue Deployment

Weeks 1 & 2: Cache mission

‘Mars 2020’ simulated payload



Hand-carried:

Delta-Nu Rockhound Raman (785nm);

B&W Tek iRaman (532nm)

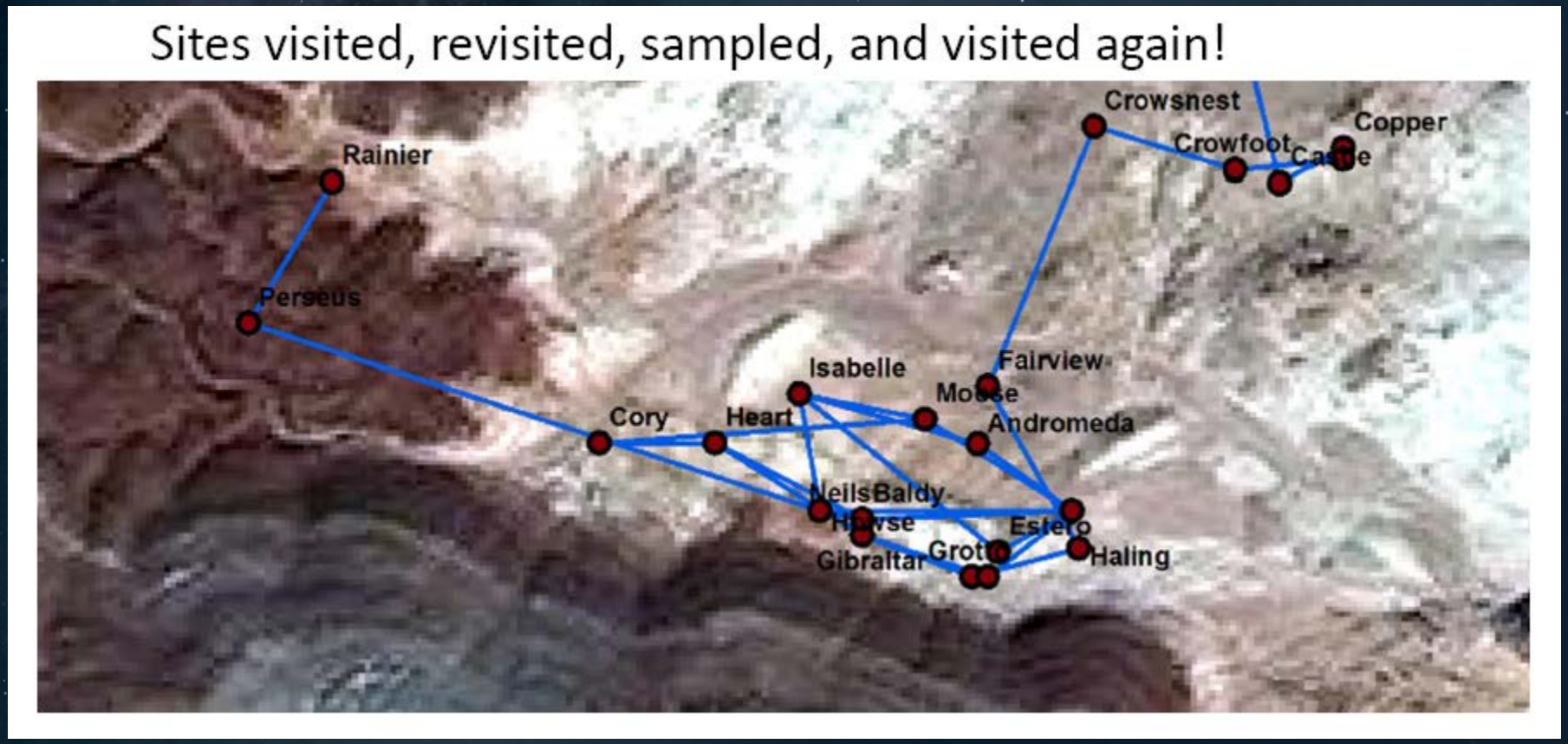
SciAps Z-500 contact LIBS

VIS-IR: ASD Fieldspec 3

2016 Canadian MSR Analogue Deployment

Week 3: Cache Mission continued

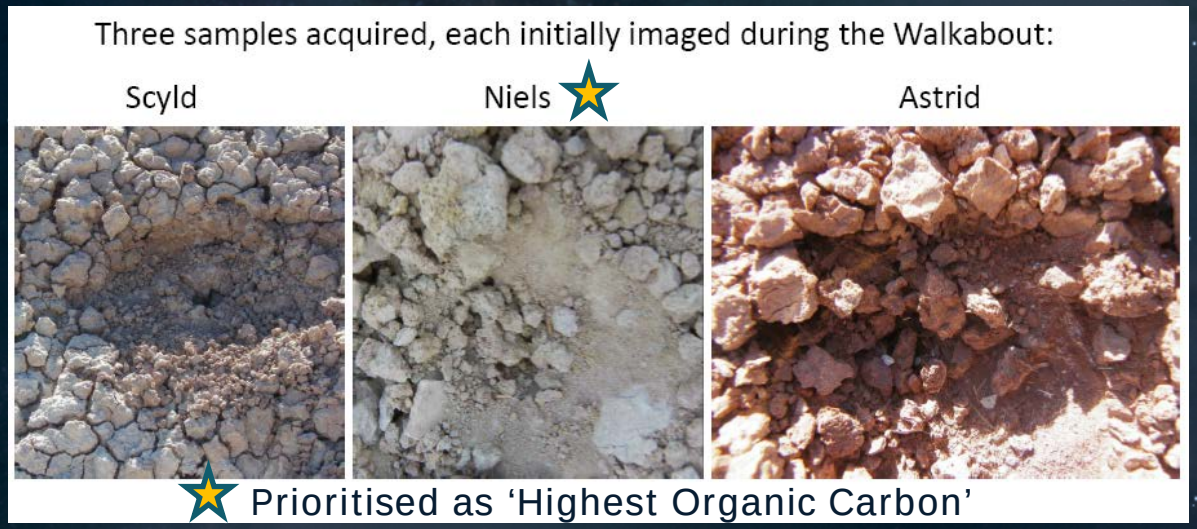
Hand-held instruments only, 1 day = 3 sols



2016 Canadian MSR Analogue Deployment

Science & Operations Results

48th LPSC poster session 621: Environmental Analogs VI (Thurs)



Stratigraphic section and depositional model developed by remote science team at Western

Caudill et al, *CanMars 2016 MSR Analogue Mission Science Overview* **[#1969]**

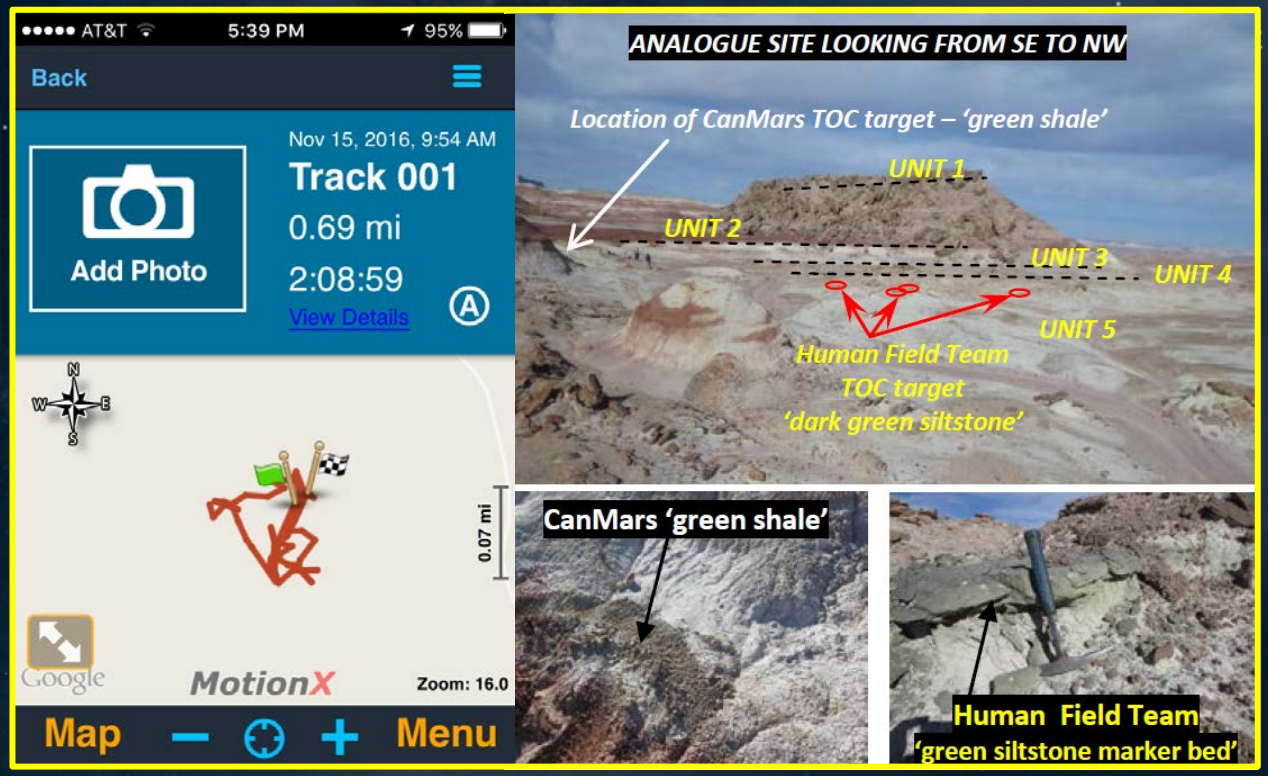
Pre-planned 'Strategic observation days' – use of autonomous rover targetting, and, science team resources to improve depositional model with the expectation this would improve decision-making. With support from Scott McLennan, Ken Williford and Raymond Francis.

- Pilles et al, *Implementation of Strategic Traverse Days During the CanMars 2016 Mars Sample Return Analogue Mission* **[#2018]**
- Francis et al, *Advanced Rover Science Autonomy Experiments in Preparation for the Mars 2020 Mission: Results from the 2016 CanMars Analogue Mission* **[#2402]**
- Kissi et al, *Application of Autonomous Science Targeting Using TextureCam for the CanMars 2016 Analogue Mission* **[#1542]**

2016 Canadian MSR Analogue Deployment

Science & Operations Validation

48th LPSC poster session 621: Environmental Analogs VI (Thurs)



Human field team given same task to perform in one day: Seek priority organic carbon sample for 'return to Earth'.

Beaty et al. *Field Validation for the 2016 CANMARS Analogue Mission* **[#2750]**

Hipkin et al, *Learning from Traditional Field Geology and 2016 CANMARS Rover-Based Remote Science Operations Approaches to Sample Selection* **[#2709]**

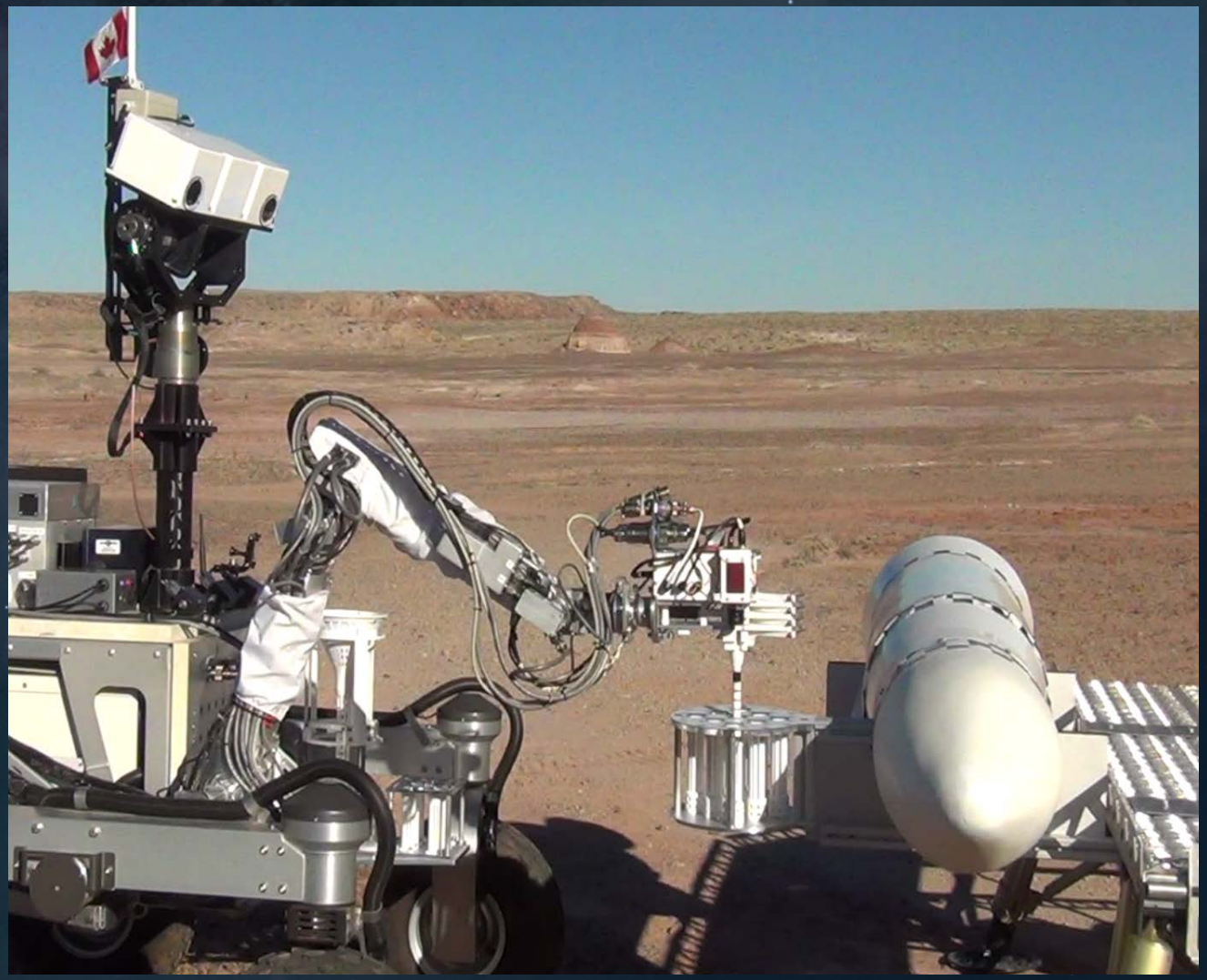
Cloutis et al, *A Hydrologic- and Biosignature-Driven Field Campaign at an Inverted Fluvial Channel Site: Hanksville, UT, USA* **[#2464]**

Extensive data set. Further validation planned after analysis of 'returned samples'.

2016 Canadian MSR Analogue Deployment

Week 3: Fetch mission

Seek, capture, transfer to MAV



2016 Canadian MSR Analogue Deployment

Rover technology results

Science mission (Ops weeks 1&2)

Distance traveled (autonav)	316 m
Number arm placements, rock absrasions, cores taken	1
Number of sols	10
Total ops time (ExDOC)	44 h

Fetch mission (Ops week 3)

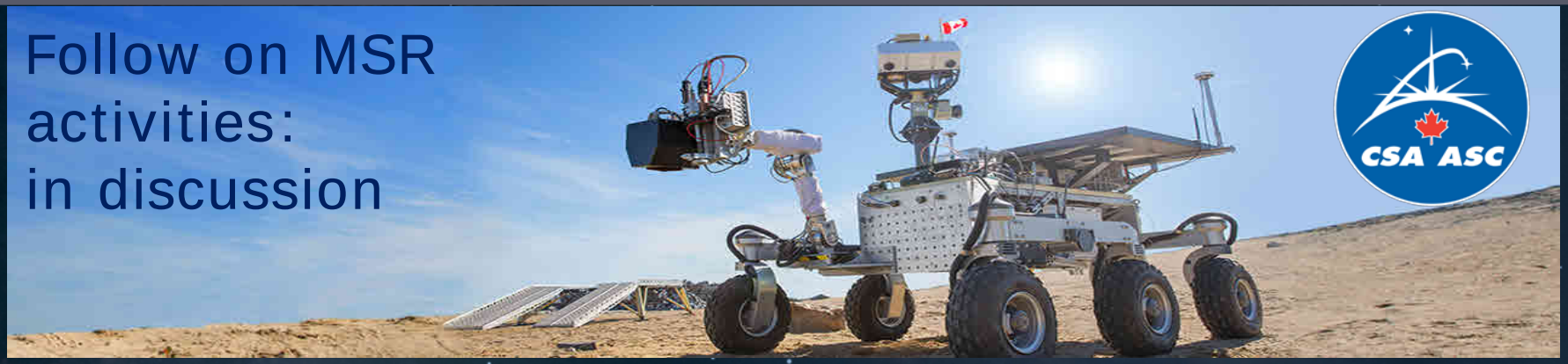
Distance traveled (autonav)	613 m
Samples captured	6
Samples delivered to the MAV	6
Number of sols	6
Total ops time (ExDOC)	47 h

- Vision systems approach for sample transfer to the MAV worked well
- Arm operations in an unstructured environment remains challenging
- Tube handling requirement for avoiding magnetism adds complexity
- 3D printing machine allows the team to deliver quick prototypes

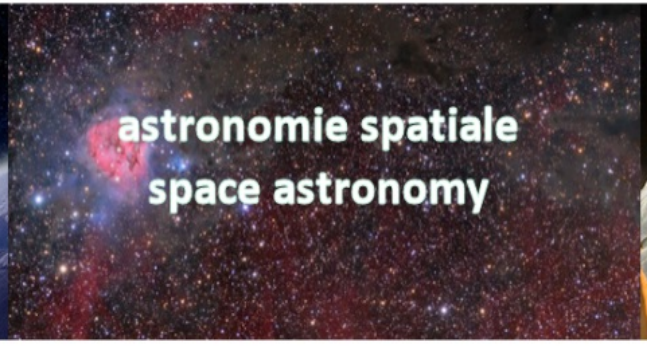
Video

MSRAD-2016-Fetch-Rover-Ops-Sol-1-short-story-with-CSA-watermarks.mp4

Follow on MSR activities: in discussion



Canadian Space Exploration Workshop
22-23 November 2016



INNOVATION

What science objectives and investigations should Canada pursue to effectively engage in future space exploration missions?
(mid-2020 to 2040)

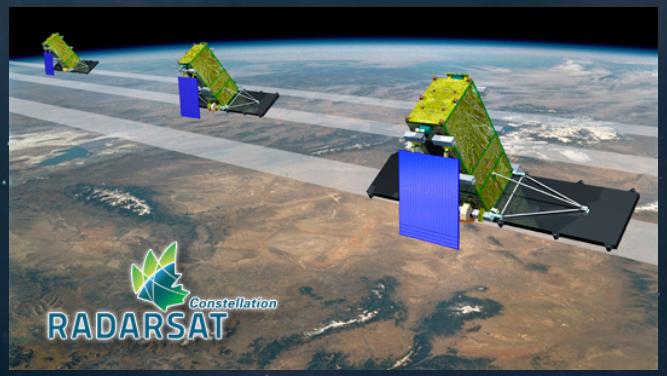
Topical Teams:
Astrobiology
Planetary Geology, Geophysics & Prospecting
Planetary Atmospheres
Planetary Space Environment

Final report anticipated April-May 2017

EXPLORATION

CSA Mars SAR Concept Study RFP

- RADARSAT (1995), RADARSAT-2(2007), RCM (2018)
- C-band, polarimetric, 1 x 3m resolution
- Interest in next-generation P-band for terrestrial permafrost



- Canadian community interested in Mars SAR
  - Canadian Mars SAR Studies in 2007 and 2009
  - P,C band, polarimetric

- 2017 Concept Study RFP based on NEX-SAG report
- 2017 Space Technologies Development Program RFI
  - Mars SAR Signal Amplifier / Antenna Technologies

Questions?

asc-csa.gc.ca

Canada