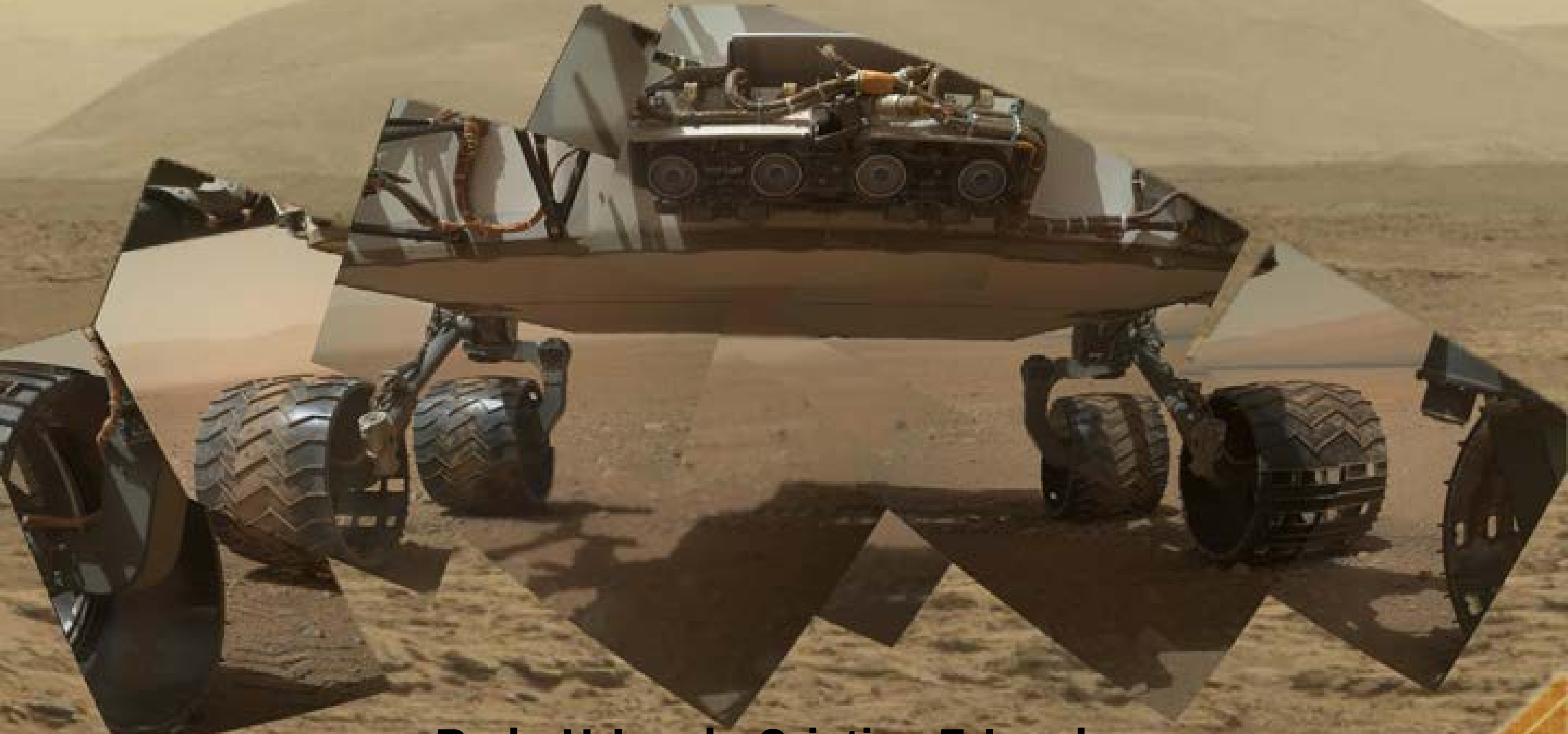
MARS EXPLORATION SCIENCE PROJECTS FROM CURIOSITY TO MARS2020



Radu H Iacob, Cristina E Iacob
(1) ON Semiconductor, (2) STARSIC

October 2014

VISION OF THE MESP PROGRAM

- STUDENTS SHOULD BENEFIT OF CAPTIVATING HANDS-ON ACTIVITIES TO DEVELOP AFFINITY FOR SCIENCE, TECHNOLOGY, ENGINEERING AND MATH (STEM)
- SPACE EXPLORATION OFFERS EXCITING OPPORTUNITIES FOR STUDENTS TO ENGAGE IN SUCH ACTIVITIES
- SPACE EXPLORATION PROVIDES THE PREREQUISITES FOR ACTIVITIES PER NATIONAL SCIENCE EDUCATION STANDARDS AND NEXT GENERATION SCIENCE STANDARDS
- SPACE EDUCATION CAN BE IMPLEMENTED AT ANY EDUCATIONAL LEVEL K-20, INTRACURRICULUM AND EXTRACURRICULUM
- SPACE EDUCATION HAS SIGNIFICANT INSPIRATIONAL POTENTIAL

WHY SCIENCE PROJECTS?

Engage

Curiosity

Imagination

Creativity

Talent

to develop

PASSION FOR DISCOVERY

and

THE FOUNDATION OF SCIENTIFIC THINKING

WHY MARS? THERE ARE EXCITING QUESTIONS ABOUT MARS

- How is Mars compared to Earth? Mars Orbiter/Mars Odyssey
- Was Mars habitable? Spirit/Opportunity/Curiosity
- What life-forms potentially lived on Mars? ExoMars/Mars2020

- What happened to Mars? Maven/InSight/TGO
- Is Mars hosting life today? ExoMars/Mars2020
- Can humans live on Mars?

  Curiosity/ExoMars/Mars2020/Mars One/Mars Orion
- Can Mars be terraformed? All missions

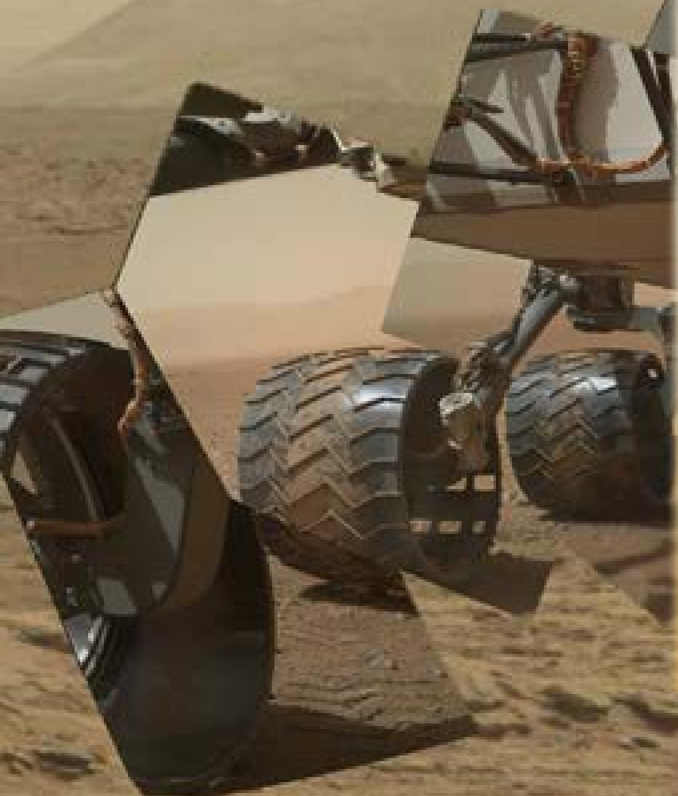
2. OBJECTIVES

- Fulfilling Learning Experience Develops Research Skills
  - Discovery/Question the status quo, inquire from a different angle
  - Ideation/Launch hypotheses
  - Learn/Test hypotheses
  - Demonstrate / Research, use imagination and creativity, apply knowledge to prove your hypotheses
  - Conclusions/ Cross-proof the results

- Insight to Fundamental Questions
  - Who are we?
  - What is our role in Universe?
  - How are we going to evolve as a species?

3. APPROACH

A. Discovery / Collect Inputs



- NASA's Curiosity mission updates
- Curiosity / NASA social media
- NASA websites / DLN
- Curiosity E/PO
- STEM resources
- Curiosity data / Planetary Data System
- Research papers
- NASA's Digital Learning Network
- Online academies (Khan, Coursera, edX)

3. APPROACH

B. Ideation (Processing the Information)

- Use critical thinking
- Define hypotheses

C. Learning/Test the hypotheses

- Learn science facts about the subject
- Check possibilities
- Select valid hypotheses

3. APPROACH

D. Demonstrate

- Create plan
- Build demonstrator
- Collect and process field data
- Corroborate information
- Validate results

E. Formulate Conclusions/Publish Results

- Student science fairs, science contests, STEM events
- Student participation at science conferences

4. CHOOSING THE SUBJECT

- Ancient Lakes on Mars - understanding a past habitable environment

- Mineral Formations on Mars – attempting to explain the origin of “curios” formations

- “Active” Rocks on Mars – understanding active processes that shape the Mars rocks nowadays

- Martian Water and Sand – water behavior on Mars at very low air pressure

- Climate Change on Mars – a history of global changes on Mars based on existing knowledge base, on current and future observations
- Explorer Base on Mars – choosing the best location for a human base and how to overcome the main challenges of long-term living on Mars

5. THE PROJECT
SHELL FORMATIONS AT POINT LAKE

PEOPLE TO PEOPLE STUDENT AMBASSADOR PROGRAM WORKFLOW

- Multiple teams working in collaboration
- Multiple locations
- Common goal

- 3 student teams at different geolocations:
  - San Francisco
  - Los Angeles
  - Las Vegas

A. DISCOVERY / COLLECTING INPUTS

- o NASA notes on Point Lake images
- o MSL raw images at Point Lake
- o NASA Planetary Data System

B. IDEATION - HYPOTHESES

1. The shells resulted from gas inclusions in igneous mat.
2. The shells are sedimentary non-igneous formations
3. The shells are the result of secondary phases of minerals (e.g. hydrates from ice pockets in soil)
4. The shells are the result of ancient life-forms

C. LEARNING – TEST THE HYPOTHESES

Research Plan

i. General information on Earth analogs
   - Team SF: California Academy of Sciences
   - Team LA: La Brea Tar Pits
   - Team LV: LV Natural History Museum

ii. Learn / Laboratory investigations
   - Map position of observable shells
   - Determine the size of shells

   - Note specific characteristics: shape, granularity, filling, inclusion in surrounding bed
   - Results: physical data as input for testing hypothesis

iii. Select valid hypothesis
   - Earth analog fossils are not consistent with Mars data therefore, hypothesis 4 is dropped

D. DEMONSTRATE – PROVE HYPOTHESES

Research Plan

i. Process Mars data

ii. Meeting with MSL Science Team (JPL, AMES)

iii. Field study of volcanic sites (Lassen, Mojave Hole-In-The-Wall, River Mountain)

- Study rock shapes, texture, distributions
- Search for round rock formations or shells, collect data
- Observe erosion patterns on volcanic beds
- Note other characteristics of volcanic sites (e.g. lava tubes, craters)

iv. Field study of sedimentary sites (San Mateo Coast, Mono Lake, Valley of Fire)

- Search for round formations or tafoni/shells, collect data
- Observe erosion patterns on sedimentary beds
- Note other characteristics of sedimentary sites (layering, smoothness etc.)

D. DEMONSTRATE – PROVE HYPOTHESES

v. Field study of weathered mineral sites
- Search for round rock formations or shells, collect data
- Observe erosion patterns
- Note other characteristics of surrounding bed (layering, granularity etc.)

vi. Corroborate results from the 3 teams

vii. Compare results with processed Mars data
- Compare surroundings
- Compare aspect, size, filling
- Compare erosion patterns
- Compare dominant components of the light spectrum

viii. Present results to the MSL Science Team (JPL, AMES)

E. CONCLUSION – PUBLISH RESULTS

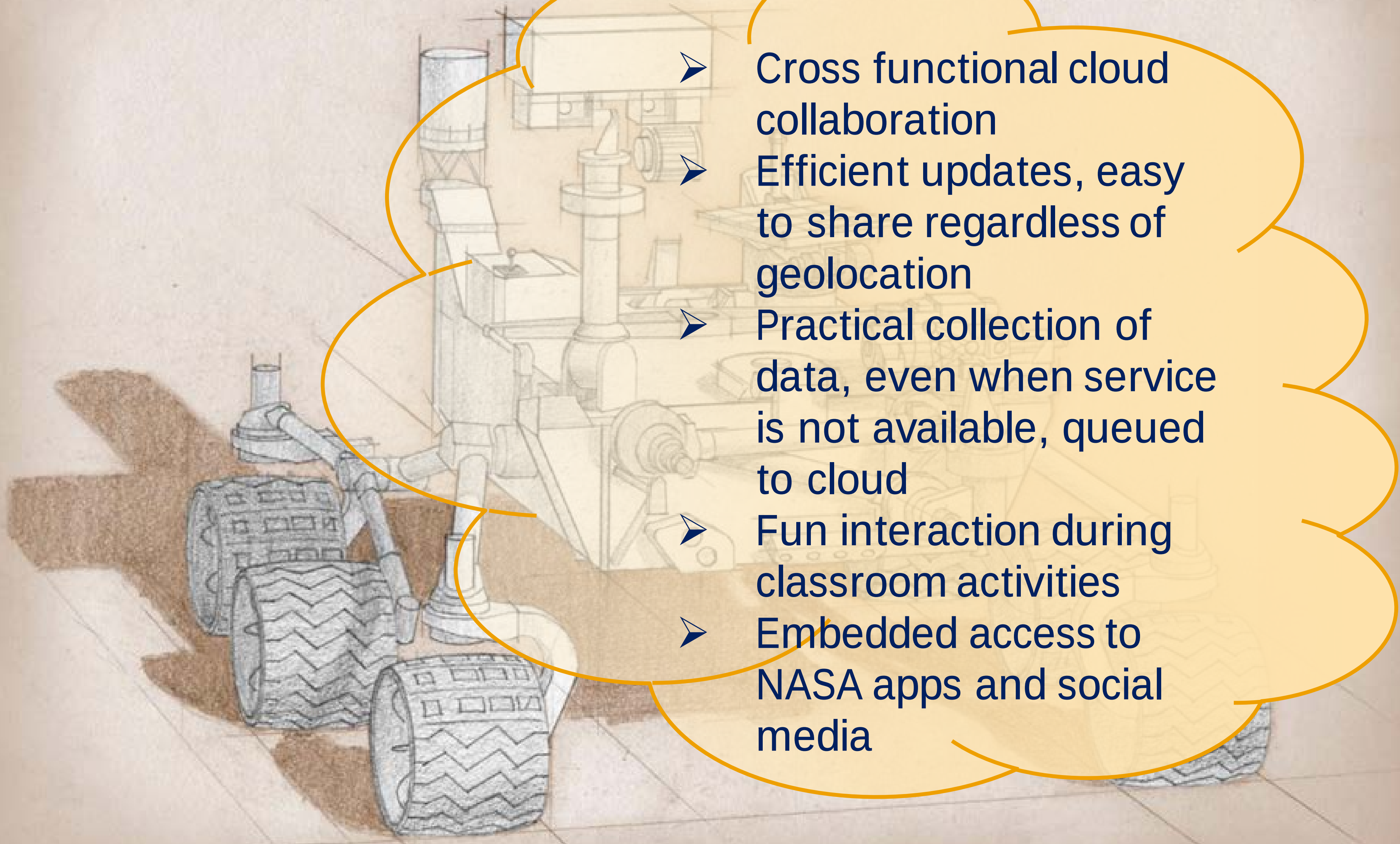
Activity Plan

i. Use data to create comparative analysis representations
ii. Formulate conclusions
iii. Create graphical presentation
iv. Participate and present at science event (science fair, STEM event, science conference)

F. PROJECT TIMELINE

	Activity	Team SF	Team LA	Team LV	Output
1	Discovery - Collect Inputs	MSL updates	JPL Photojournal	NASA PDS	Images, information
2	Ideation - Define Hypotheses	Hangout	Hangout	Hangout	4 Hypothesis
3	Learn – Earth Analogs	SF Academy of Science	La Brea Tar Pits	LV Natural History	Earth analogs
4	Learn – Lab Investigations	Determine size	Map objects	Observe specifics	Pre-requisite conclusions
5	Demonstrate – MSL Science Team	NASA Ames	JPL	Hangout	Integrated information
6	Demonstrate – Volcanic Sites	Lassen Volcanic	Mojave Hole In The Wall	River Mountain	Notes on igneous
7	Demonstrate – Sedimentary Site	San Mateo Pacific Coast	Mono Lake	Valley of Fire	Notes on sedimentary
8	Demonstrate – Weathered Minerals	Death Valley	Death Valley	Borax Site	Notes on minerals
9	Demonstrate – Corroborate Results	Compare findings	Compare findings	Compare findings	Processed field data
10	Demonstrate – Correlate w/ Mars	Hangout	Hangout	Hangout	Final conclusion
11	Demonstrate – MSL Science Team	NASA Ames	JPL	Hangout	Final comments
12	Conclusion – Prepare for Publication	Comparative analysis	Data graphs	Concluding narration	Final presentation

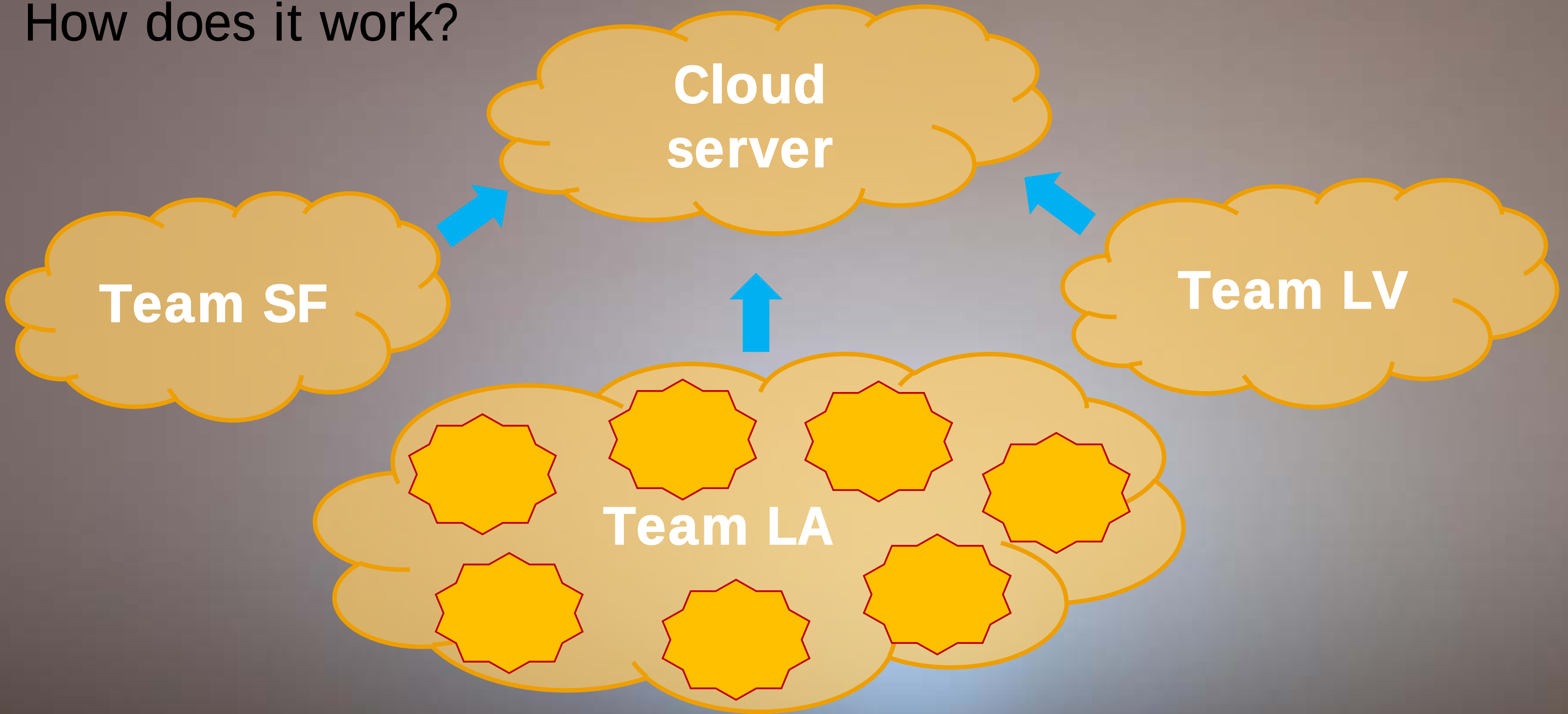
6. RESOURCES – MOBILE PLATFORMS APP



- Cross functional cloud collaboration
- Efficient updates, easy to share regardless of geolocation
- Practical collection of data, even when service is not available, queued to cloud
- Fun interaction during classroom activities
- Embedded access to NASA apps and social media

6. RESOURCES – MOBILE PLATFORMS APP

How does it work?



6. RESOURCES – RESEARCH AND EDUCATION

- NASA MSL Mission http://mars.nasa.gov.msl
- NASA Planetary Data System http://pds.nasa.gov
- NASA Digital Learning Network http://www.nasa.gov/offices/programs/national/dln
- ASU MarsEd STEM Lesson Plans

  http://marsed.mars.asu.edu/stem-lesson-plans
- ASU Mars Exploration Student Data Teams

  http://marsed.mars.asu.edu/mesdt
- ASU Mars Student Imaging Project

  http://marsed.mars.asu.edu/msip
- National Science Education Standards

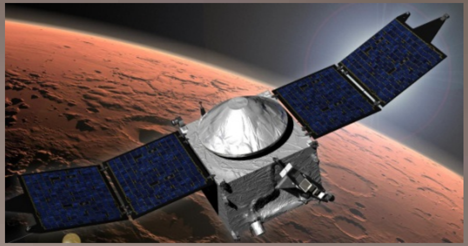
  http://www.nap.edu
- Next Generation Science Standards

  http://www.nextgenscience.org

7. NEW MARS MISSIONS

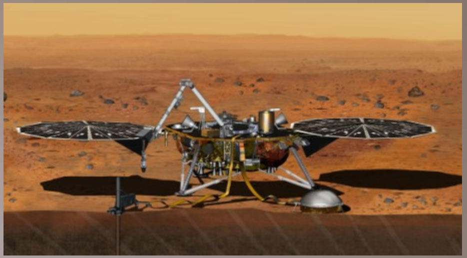
MAVEN

- eight science instruments to take measurements of the upper Martian atmosphere
- will also dip to 80 miles above the planet to sample Mars' atmosphere
- provide communications relay support for future rovers on the Martian surface



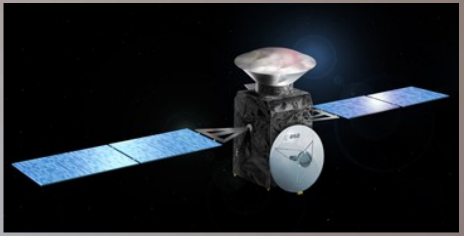
InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport)

- geophysical lander on Mars to study its deep interior
- will detect the fingerprints of the processes of terrestrial planet formation
- will measure the planet's "vital signs": "pulse" (seismology), "temperature" (heat flow probe), and "reflexes" (precision tracking)



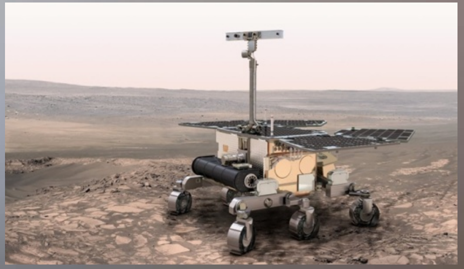
ExoMars TGO (Trace Gas Orbiter)

- study the Mars atmosphere
- “Electra” telecommunication radios for future ExoMars surface missions
- Collaboration of ESA, Roscosmos, NASA



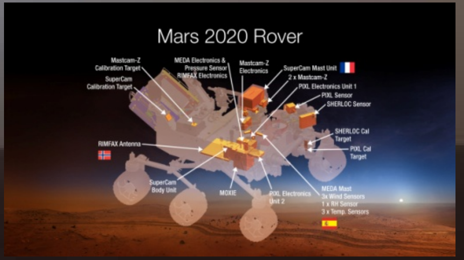
ExoMars Rover

- series of missions designed to understand if life ever existed on Mars
- NASA: Mars Organic Molecule Analyzer (MOMA), designed to help answer questions about whether life ever existed on Mars, as well as its potential origin, evolution, and distribution on the Red Planet



Mars 2020

- collect and store diverse rocks and soils to understand past habitable conditions
- to seek signs of past and present microbial life
- monitor weather and dust in the Martian atmosphere
- test the ability to extract oxygen from the Red Planet's carbon-dioxide atmosphere



8. CONCLUSIONS

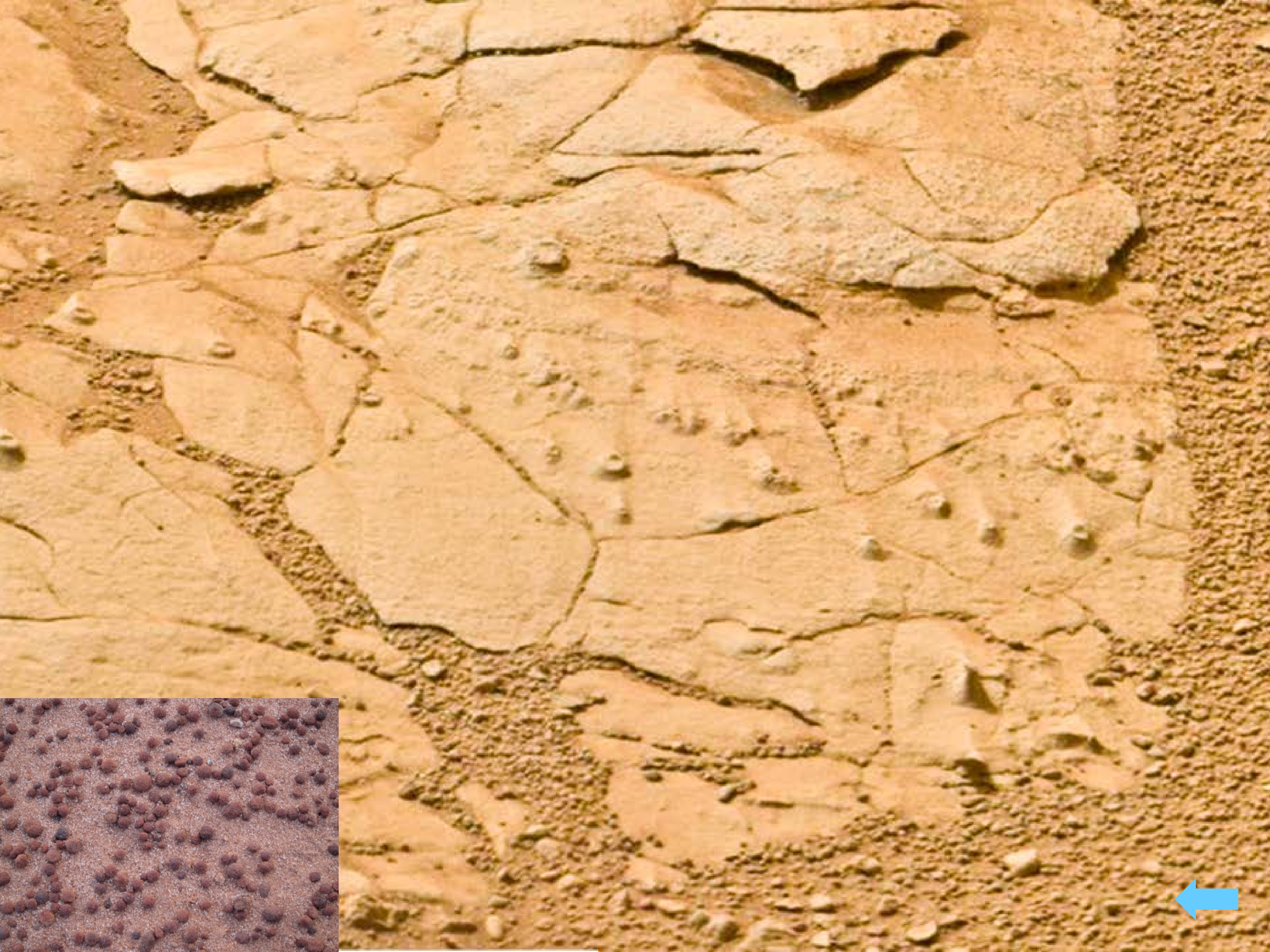
- **MARS EXPLORATION WILL CONTINUE TO OFFER RESOURCES FOR STUDENTS TO ENGAGE IN STEM, PROVIDING EXCITING HANDS-ON RESEARCH OPPORTUNITIES**

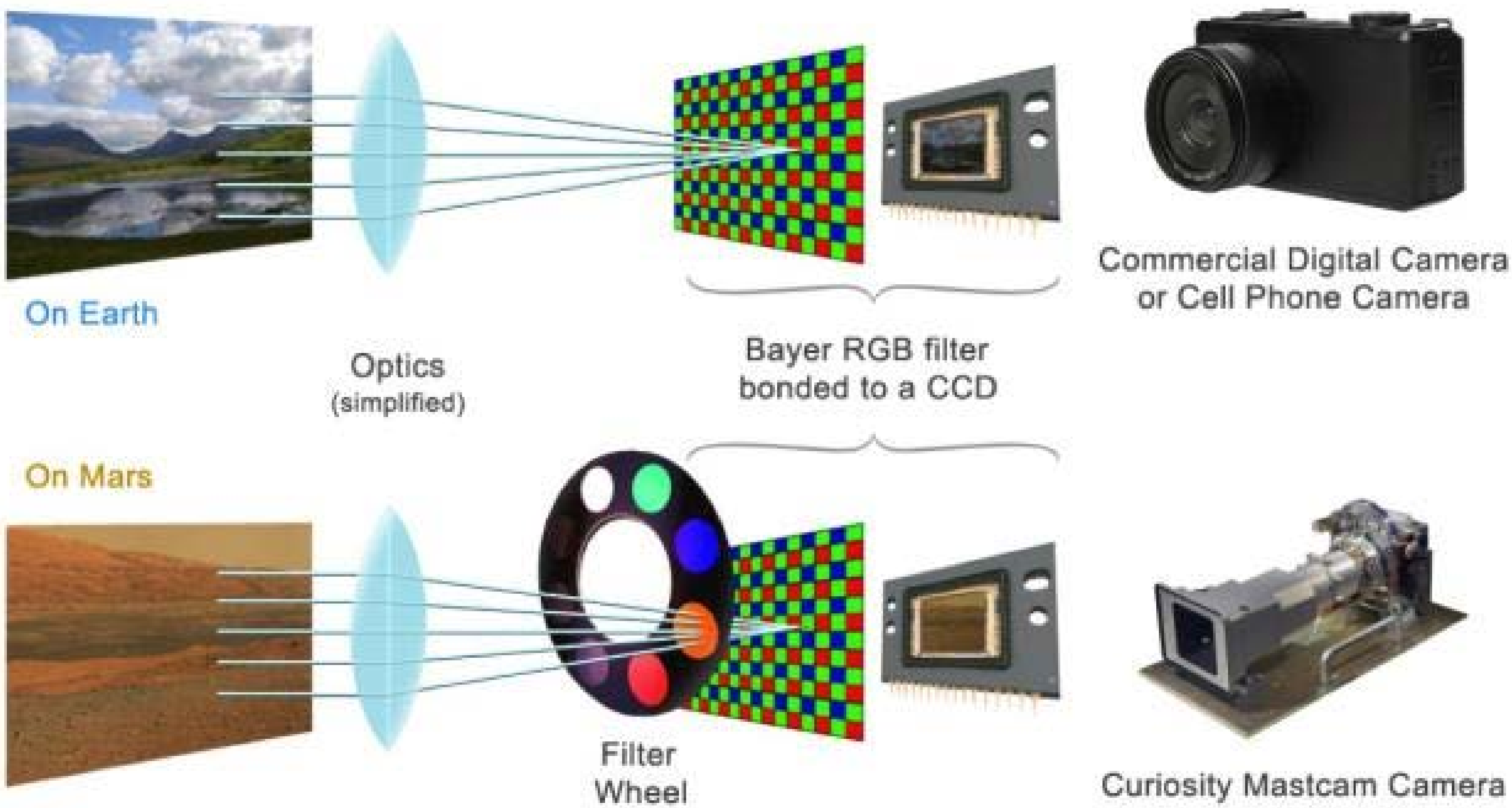
- **SPACE EXPLORATION IS FUELING THE IMAGINATION, CURIOSITY, TALENT AND CREATIVITY OF THE YOUNG GENERATION**

- **SPACE EXPLORATION INSPIRES A POSITIVE ATTITUDE TOWARD THE WORLD, BY EMPHASIZING THE COSMIC DIMENSION OF THE HUMAN BEING**

THANK YOU!

radu.iacob@onsemi.com





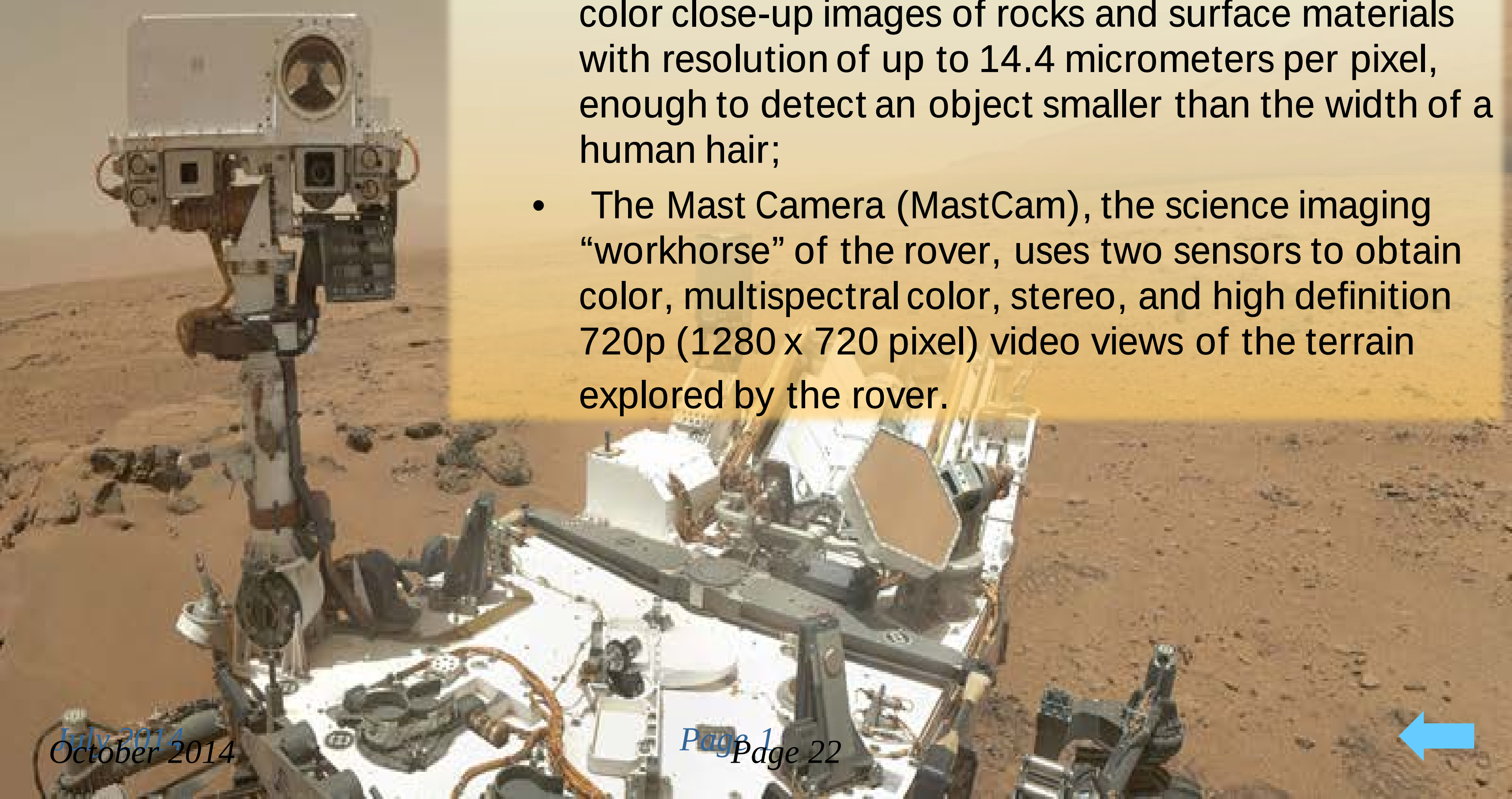
NASA/JPL-Caltech/MSSS/ASU: J. Be /H.Kline

Schematic cartoon only: Components not shown at their actual relative sizes

MARS

Curiosity uses KAI-2020 image sensors on four separate camera systems:

- The Mars Descent Imager (MARDI) that acquired hundreds of natural color images at a rate of 4 frames per second during descent to the Martian surface;
- The Mars Hand Lens Imager (MAHLI) that acquires color close-up images of rocks and surface materials with resolution of up to 14.4 micrometers per pixel, enough to detect an object smaller than the width of a human hair;
- The Mast Camera (MastCam), the science imaging “workhorse” of the rover, uses two sensors to obtain color, multispectral color, stereo, and high definition 720p (1280 x 720 pixel) video views of the terrain explored by the rover.



B.

"GOOSE EGG" STRUCTURE IN LIMESTONE BEDS ASSOCIATED WITH COLEMANITE DEPOSIT NEAR CALLVILLE WASH, NEV.