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NASA/JPL-Caltech/MSSS



Recent Results from Curiosity's SAM Instrument and Looking Ahead to MAVEN

Curiosity's primary scientific goal is to explore and quantitatively assess a local region on Mars' surface as a potential habitat for life, past or present

- Biological potential
- Geology and geochemistry
- Role of water
- Surface radiation




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Curiosity's Science Objectives

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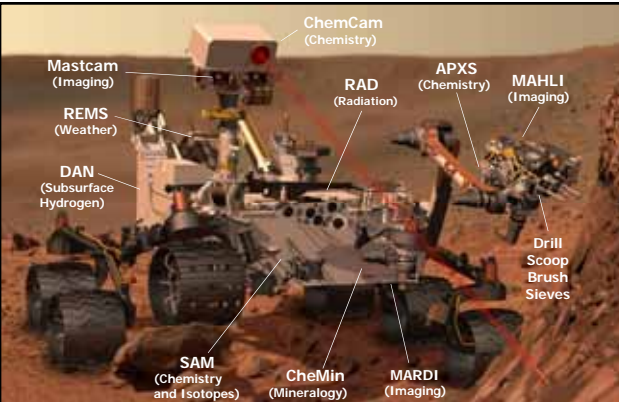


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150-km Gale Crater contains a 5-km high mound of stratified rock. Strata in the lower section of the mound vary in mineralogy and texture, suggesting that they may have recorded environmental changes over time.



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ChemCam (Chemistry)

Mastcam (Imaging)

REMS (Weather)

DAN (Subsurface Hydrogen)

SAM (Chemistry and Isotopes)

CheMin (Mineralogy)


MARDI (Imaging)

RAD (Radiation)

APXS (Chemistry)

MAHLI (Imaging)

Drill Scoop Brush Sieves



Curiosity's Science Payload

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**Curiosity's Sampling System**

- Cleans rock surfaces with a brush
- Places and holds the APXS and MAHLI instruments
- Acquires samples of rock or soil with a powdering drill or scoop
- Sieves the samples (to 150  $\mu\text{m}$  or 1 mm) and delivers them to instruments or an observation tray
- Exchanges spare drill bits

**Sample Manipulation System and Housing**

- Tunable Laser Spectrometer
- Gas Chromatograph
- Chemical Separation and Processing Laboratory
- Wide Range Pump
- Electronics
- Solid Sample Inlets
- Atmospheric Inlets

Column #	Chemistry
GC1	MXT20
GC2	MXT5
GC3	Carbobond
GC4	ChirasilDex
GC5	MXT CLP
GC6	MXTQ

### QMS: Quadrupole Mass Spectrometer

Previously flown on

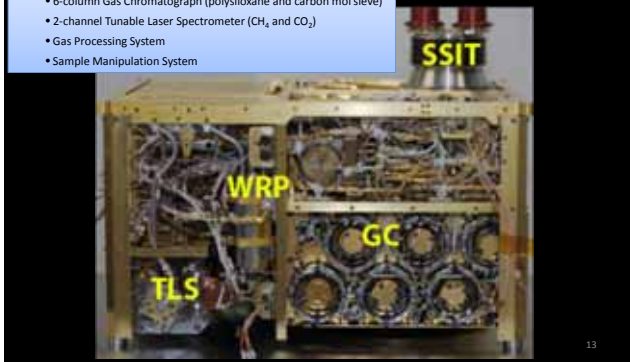
- Cassini Orbiter
- Cassini GCMS [CONTOUR, Nozomi]
- Galileo Probe
- Pioneer Venus Orbiter
- Earth orbiting spacecraft (AE, DE, San Marco, AEROS, OGO)



### The SAM suite

**SAM suite instruments and major subsystems**

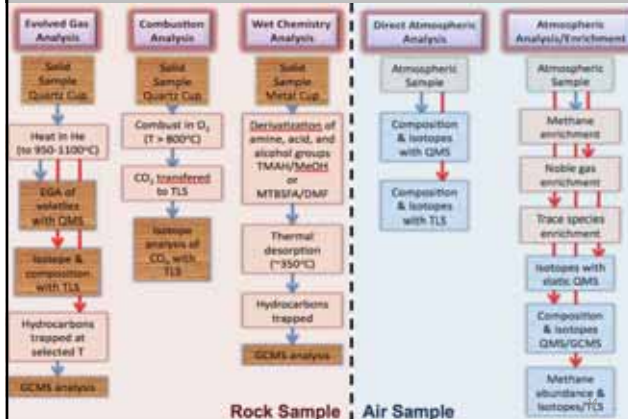
- Quadrupole Mass Spectrometer
- 6-column Gas Chromatograph (polysiloxane and carbon mol sieve)
- 2-channel Tunable Laser Spectrometer (CH<sub>4</sub> and CO<sub>2</sub>)
- Gas Processing System
- Sample Manipulation System



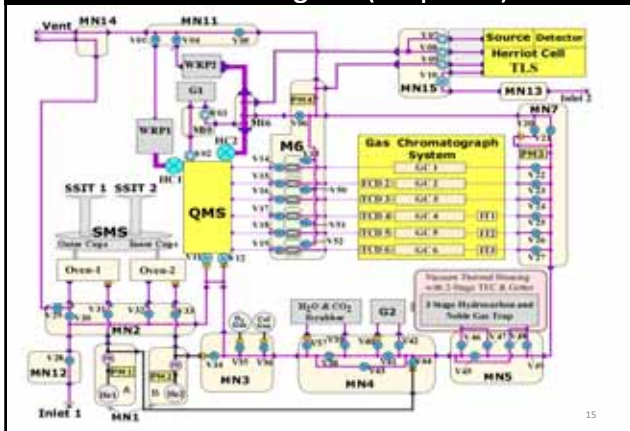
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### SAM measurement modes

On board command SCRIPTS control each sequence



### Gas Flow Diagram (simplified)



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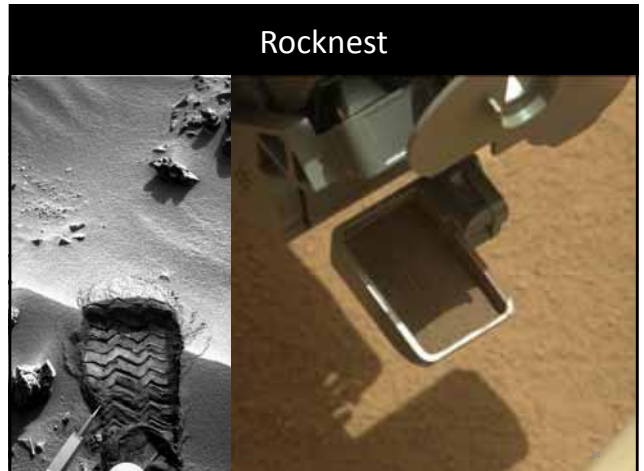
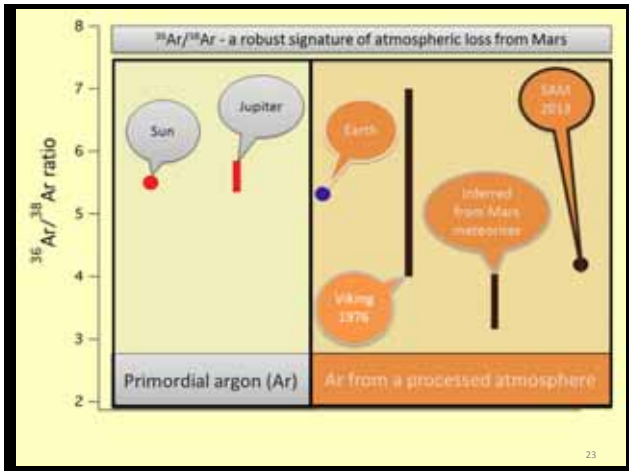
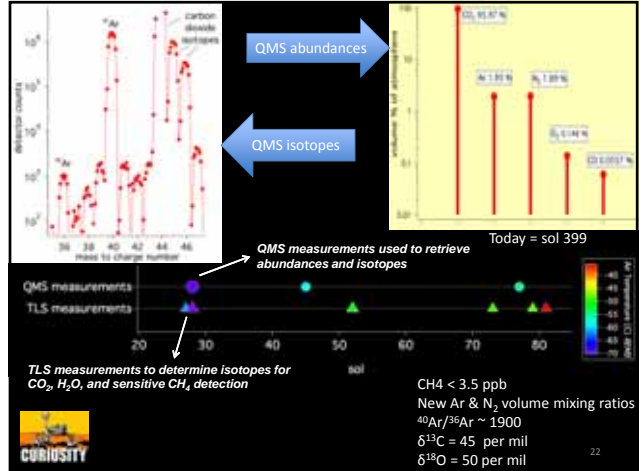
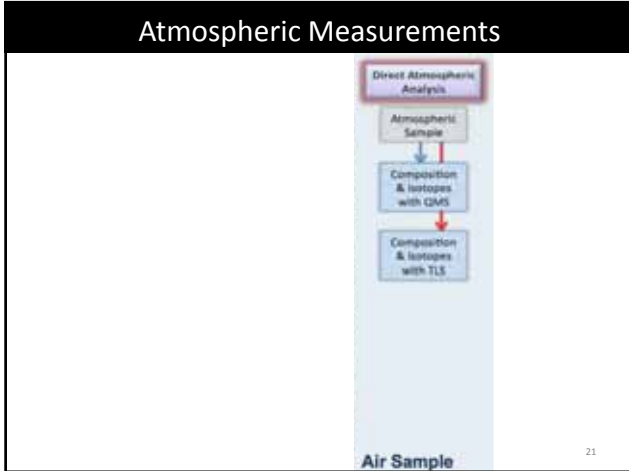
### SAM Integration

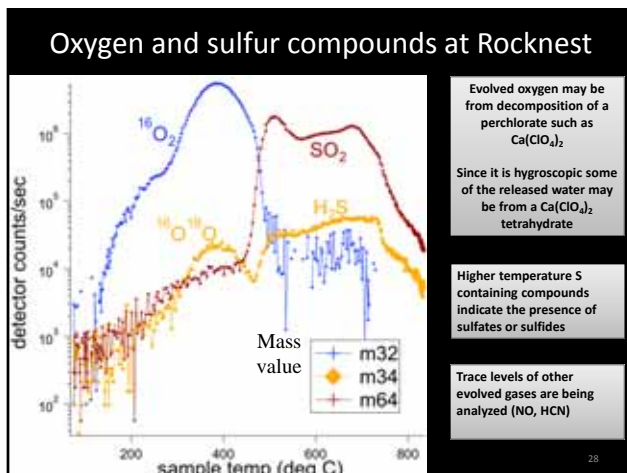
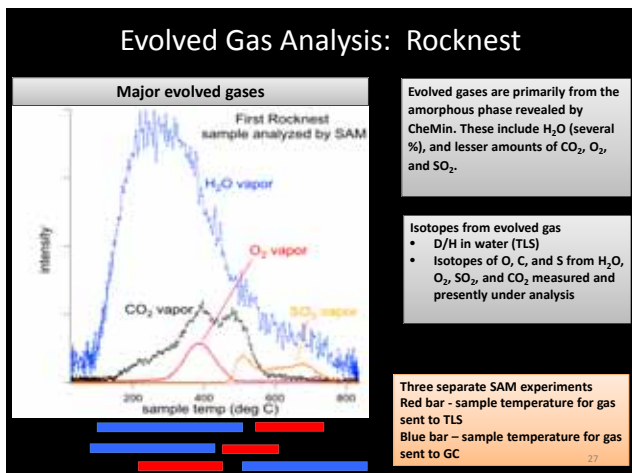
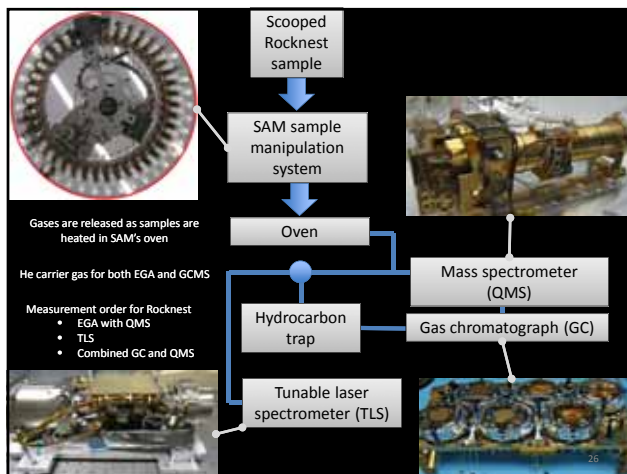
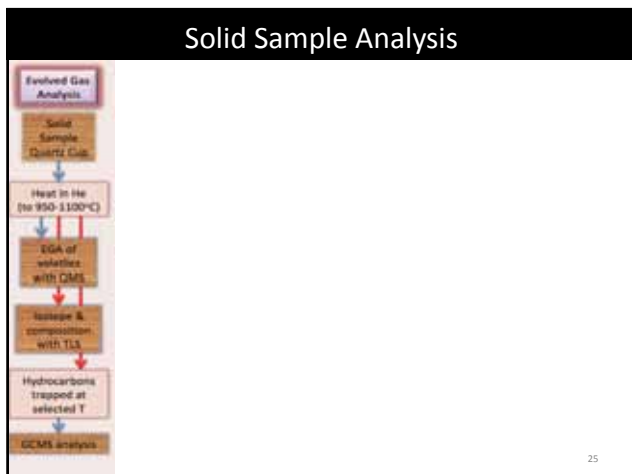


SAM integrated into rover January 2011



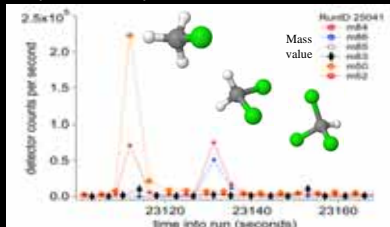






### Chlorinated compounds found in Rocknest

CH<sub>3</sub>Cl, CH<sub>2</sub>Cl<sub>2</sub>, CHCl<sub>3</sub>, and a C<sub>4</sub> compound were detected



SAM results show that the Rocknest sand drift does NOT contain abundant organics

Organic compounds that arrive from space in the form of micrometeorites may be transformed by a variety of mechanisms

- Cosmic radiation
- Ultraviolet radiation
- Hydrogen peroxide
- Dust induced electrical discharges
- Other oxidants in soil/dust

Although the Cl in these organic compounds is Martian, it is presently unclear whether the carbon is Martian or terrestrial. This remains to be established with ongoing analysis, future laboratory work, and experiments on Mars.

Curiosity's search for organics in other environments and samples will continue

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### Yellowknife Bay and John Klein

Gypsum veins?



Crossbedded layers

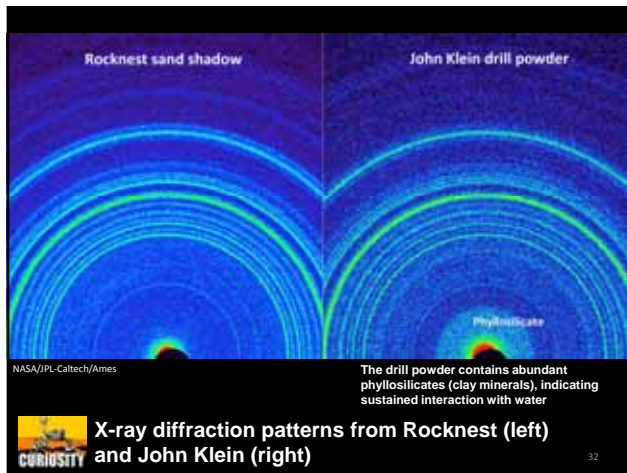


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Curiosity's 1.6-cm drill bit, drill and test holes, and scoop full of acquired sample

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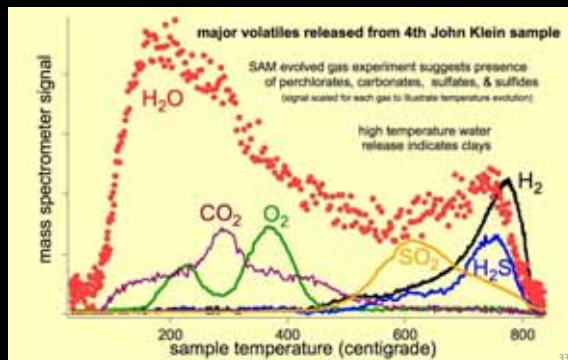
The drill powder contains abundant phyllosilicates (clay minerals), indicating sustained interaction with water

X-ray diffraction patterns from Rocknest (left) and John Klein (right)

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## John Klein Sample (JK4)

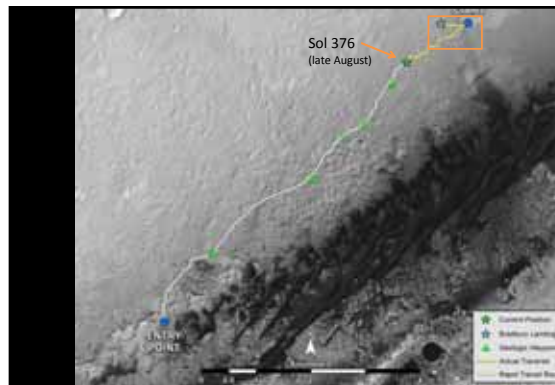


## An Ancient Habitable Environment at Yellowknife Bay

- The regional geology and fine-grained rock suggest that the John Klein site was at the end of an ancient river system or within an intermittently wet lake bed
- The mineralogy indicates sustained interaction with liquid water that was not too acidic or alkaline, and low salinity. Further, conditions were not strongly oxidizing.
- Key chemical ingredients for life are present, such as carbon, hydrogen, oxygen, phosphorus, and sulfur
- The presence of minerals in various states of oxidation would provide a source of energy for primitive organisms

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## Destination Mt. Sharp

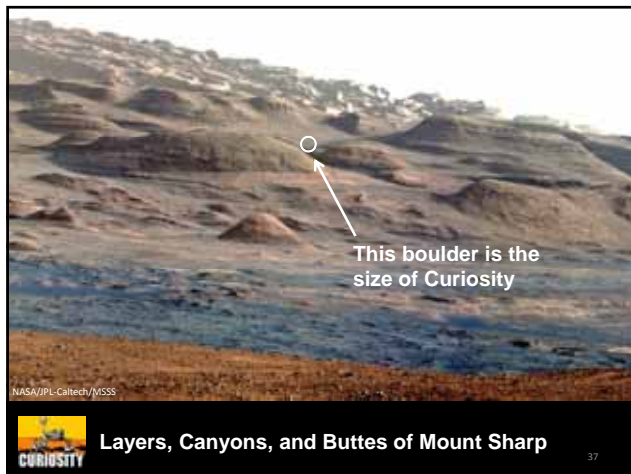


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Curiosity set off for Mount Sharp on July 4, passed its landing site, and continues on...

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**MAVEN** What Science Questions Will MAVEN Address?

*MAVEN will determine the role that loss of volatiles to space has played through time, providing definitive answers about Mars climate history:*

- What is the current state of the upper atmosphere and what processes control it?
- What is the escape rate at the present epoch and how does it relate to the controlling processes?
- What has the total loss to space been through time?

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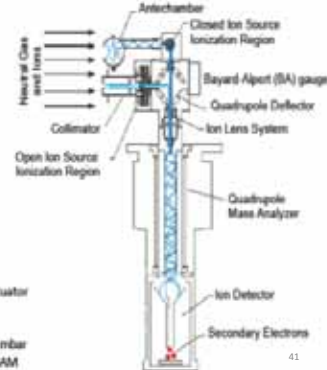
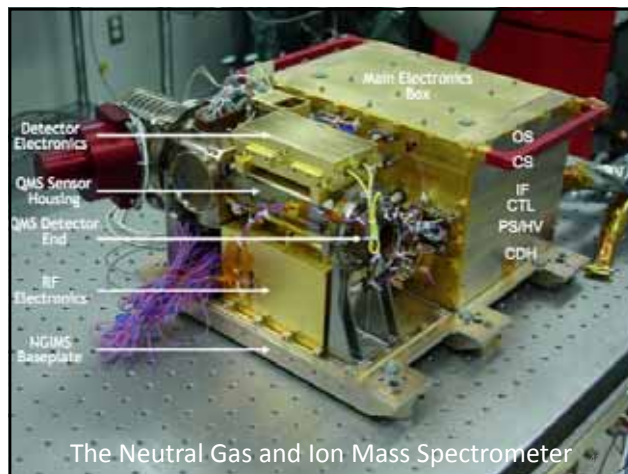
**MAVEN** MAVEN Will Measure the Drivers, Reservoirs, and Escape Rates

- MAVEN will determine the present state of the upper atmosphere and today's rates of loss to space.
- Essential measurements allow determination of the net integrated loss to space through time.

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### The Neutral Gas and Ion Mass Spectrometer

- **Neutral Gas Sampling:**
  - (1) closed source (non wall reactive species)
  - (2) open source (wall reactive species)
- **Positive Ion Sampling:** thermal and suprathermal (< 30 eV)
- **Ion Source:** electron beam ionization
- **Electron Energy:** 75 eV
- **Mass Range:** 2 to 150 amu (H to Xe)
- **Quadrupole Radio Frequencies:** 2
- **Resolution/Crestalk:** 10<sup>4</sup> for adjacent masses
- **Detector System:**
  - redundant pulse counting multipliers
  - sample period 30 ms, integration period 27 ms
  - dynamic range 10<sup>9</sup>
- **Scan Modes:**
  - (1) programmed mass or mass band scan
  - (2) survey (scan in 1/10 or 1 amu steps)
- **Electrical Interfaces:** RS-422, power, heater, PRT, actuator
- **Deployment Mechanism:** jettisoned metal ceramic break-off cap
- **Internal Bayard-Alpert Pressure Gauge:** 10<sup>-4</sup> to 10<sup>-6</sup> mbar
- **Inheritance:** CONTOUR NGIMS, Cassini INMS, MSU SAM

The Neutral Gas and Ion Mass Spectrometer

MAVEN – designed to determine the role that loss of volatiles to space has played through time and provide answers about Mars climate history



Launch date: November 18, 2013

# CURIOSITY

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## THANK YOU!

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