Mars Stratigraphy Mission. C. J. Budney[1], S. L. Miller[1], and J. A. Cutts[1], [1]Jet Propulsion Laboratory, Pasadena, CA 91109-8099, Charles.J.Budney@jpl.nasa.gov, Sylvia.L.Miller@jpl.nasa.gov, James.A.Cutts@jpl.nasa.gov.

Introduction: The Mars Stratigraphy Mission lands a rover on the surface of Mars which descends down a cliff in Valles Marineris to study the stratigraphy. The rover carries a unique complement of instruments to analyze and age-date materials encountered during descent past 2 km of strata.

Science Objectives: The science objective for the Mars Stratigraphy Mission is to identify the geologic history of the layered deposits in the Valles Marineris region of Mars. This includes constraining the time interval for formation of these deposits by measuring the ages of various layers and determining the origin of the deposits (volcanic or sedimentary) by measuring their composition and imaging their morphology.

Science and Measurement Requirements: Specific science requirements for the mission include:

1. Examine a cliff or ridge containing at least 2 km of exposed layering.
2. Determine the mineralogy and chemistry of layers at 1-m intervals down the stratigraphic column.
3. Determine the mineralogy and age of core samples collected from layers at 100-m intervals down the stratigraphic column.
4. Determine morphology of layers continuously along the stratigraphic column.
5. Provide context for layers continuously along the stratigraphic column.

Measurement requirements include the following:

1. Composition of the layers (mineralogy and chemistry). This can be accomplished using Raman and X-ray fluorescence (XRF) spectrometers.
2. Age dating with an accuracy to ±100 My or better. Age dating starts at the top of stratigraphic column. This will allow comparison with age estimates derived from cratering statistics.
3. Multispectral imagery.

Operational requirements include the following:

1. Rover requirements.
   i) Rover must find cliff edge or ridge.
   ii) Rover must be able to be lowered over cliff edge. The mobility system must handle slopes from horizontal to vertical.
   iii) Rover must stop every 1-m interval for science measurements.
2. Ground interactions: At the dating site, images of the local scene will be acquired and downlinked to the science team. This and other data will allow the science team to select locations for collecting samples for analysis. The sample will be obtained through drilling to 5 cm.

Mission Design: The mission as designed would launch in 2007 on a Delta 7925. The mission would arrive at Mars in 2009 using a Type IV transfer. At arrival the lander would enter Mars's atmosphere directly and use active lift-vector roll control to land in a circle with 20 km diameter centered at about 14° S and 68° W, near the southern canyon wall of Valles Marineris. A soft landing would be achieved by using a parachute followed by terminal descent on liquid-fuelled rocket motors. After landing, the rover would deploy and begin a maximum 50-day traverse to the canyon clifftop. At the clifftop, the rover would anchor a tether which it would use to rappel 2 km or more down the cliff to perform a 200-day study of the strata exposed in the cliff. During the traverse and the cliffside science operations, the rover would communicate with Earth via a communications orbiter in a low equatorial orbit.

Flight System: The flight system has four principal elements: the cruise stage, the entry/descent system (heatshield, backshell, and parachute), the lander, and the rover. The rover is considered to be the payload of the lander. The lander carries no other instruments and has no power or communications capability.

The architecture for the Mars Stratigraphy mission is similar to that of the former MSP 2001 mission. A cruise stage delivers the entry system to the Mars atmosphere. The carrier is discarded prior to atmospheric entry and an actively controlled ballistic entry is used to provide precision targeting capability to the desired landing site. The entry system (heatshield, backshell, and parachute) is discarded after atmospheric entry and the lander provides powered descent. A relatively soft landing will be made at an altitude of up to 4.5 km near the desired touchdown site. Laser radar will be used for determining altitude and 3D imaging of the local terrain to provide for obstacle avoidance during final approach.

The rover is deployed from the lander and proceeds to the cliff edge. The rover anchors a cable near the cliff edge and lowers itself down the cliff side, collecting data as it descends. The rover is similar in capabilities to the Athena rover, but with an inflatable wheel mobility system. The mobility system will handle slopes from horizontal to vertical, including the slopes in between. The rover also includes a cable and anchoring system for lowering the rover down a cliff.

Launch margin was sufficient to allow examination of the option of delivering two rovers on a single lander.

Technology: The Mars Stratigraphy Mission was designed assuming spacecraft technologies that are planned for 2004. The rover mobility and cable system, the age dating instrument and the XRF are additional required technology developments.

Study history and acknowledgements: This study was conducted August 1999 by the JPL Advanced Projects Design Team (Team X). Much of this abstract is extracted from the Team X report.

Conclusions: The Mars Stratigraphy Mission is an exciting and feasible concept for exploration of the stratigraphy of Mars.