Martian atmospheric pressure observations onboard BEAGLE-2 / Mars Express

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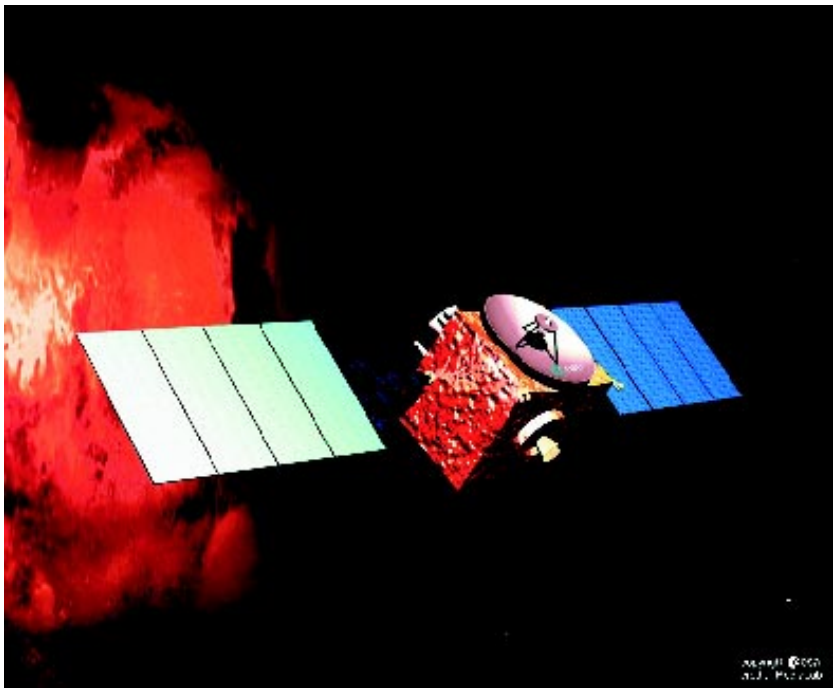
The Mars Express mission is due for launch in June 2003, arriving at Mars in December of 2003. If all goes well, it will be at Mars at the same time as the ISAS spacecraft Nozumi and the NASA Mars Exploration Rovers, Mars Odyssey, and possibly Mars Global Surveyor. Mars Express includes an orbiter and a small lander, called Beagle 2, to be deployed on the Martian surface.



Mars Express spacecraft orbiting Mars (artist's illustration). Courtesy of ESA.

Beagle 2 has a landed mass of 30kg, and it uses airbags and parachute to descend to the surface, with an intended surface lifetime of 180 Martian days. Beagle 2 will land in the Isidis Basin, at 270W and 10.5N. Due to the constraints from the insertion orbit used by the Mars Express orbiter, contact will not be made with the lander via Mars Express until 14 days after landing. However contact will be established earlier via Mars Odyssey or Global Surveyor if feasible. The Beagle 2 payload astrobiology, field geology and sample acquisition and investigation and monitoring of the local environmental conditions, using a suite of small sensors. One part of the environmental sensor suite (ESS) is a miniaturized Barobit atmospheric pressure device (16 grams) developed by the Finnish Meteorological Institute (FMI).

Martian atmosphere and the Beagle 2 environmental sensor package

The environmental sensor suite (ESS) investigating the Martian atmosphere will operate throughout the mission lifetime and is intended to study both short (seconds, minutes, days) and long term (seasonal) timescale variations in the local environment. One of the major themes of the Environmental Sensors Suite (ESS) is the study of the landing site meteorology, and the involvement of atmospheric and aeolian dust. It was considered a high science priority to be able to study variations on short timescales, in particular quantifying dust devils, due to their probable effect on the atmospheric dust loading and erosion rates. Large-scale phenomena will be characterized in collaboration with orbital experiments (e.g. Mars Express PFS).

The global mean pressure on Martian surface is of the order of 7 mbar. Large spatial and seasonal variations occur due to surface altitude variations and the CO2 cycle between the polar caps and the atmosphere, causing the surface pressure to vary between about 5...13 mbar at extreme locations. In addition to this there are synoptic scale fluctuations produced by traveling meteorological disturbances (passing fronts, different forms of atmospheric waves). Daily variation is characterized by a strong semidiurnal (twice-daily) oscillation caused by thermal tides. Particularly interesting short time-scale features are sudden drops of 10...50 µbar, caused by dust devils.

Barobit is expected to add on the earlier surface pressure observations of the two Viking landers and the Mars Pathfinder. Together with other atmospheric instruments aboard the Beagle2 lander, Barobit is to carry out long term observations to improve the characterization of synoptic scale phenomena, planetary boundary layer, dust storm onset and evolution and the intertwined CO2, H2O and dust cycles.

Barobit operations and instrument structure

During the surface phase of the mission Barobit will be operating throughout the mission at regular intervals. Default operation mode is a low rate sampling mode. In the low rate mode one sample (consisting of 9 readings) is taken every 30 minutes. By user command or in case of detecting dust impacts or other signs of interesting atmospheric phenomena the system enters high rate sampling mode. In that mode one sample (consisting of 3 readings) is taken four times per second.

The fundamental idea and structure of the Barobit are based on the MVACS/EGA/EGA-P experiment flown onboard Mars Polar Lander in 1999. The instrument consists of one capacitive pressure sensor (Vaisala Barocap(r)) and electronics for creating pressure dependent measurable voltage.

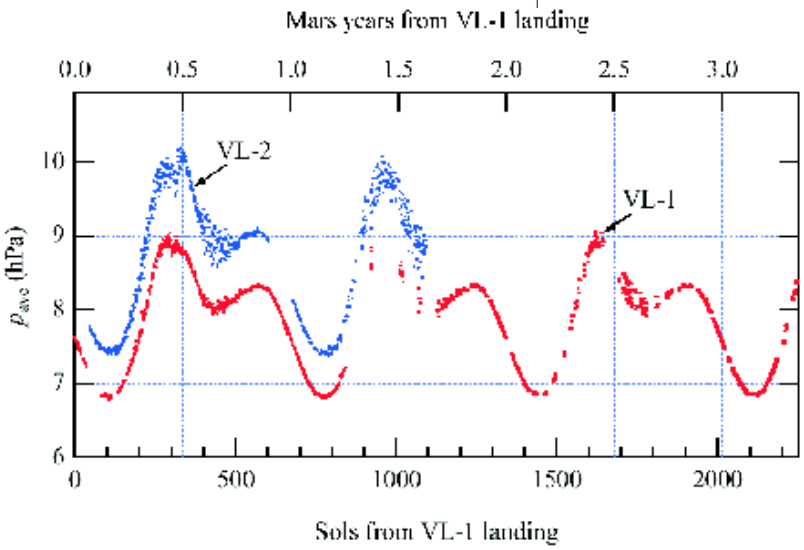
The Barobit was originally specified and developed to be used for housekeeping purposes. It was tailored for Beagle 2 with a short notice to be used for science investigations. The instrument specifications are:

Measurement range	0 ... 30 hPa
Resolution	1 Pa
Power demand	4 mW
Oper. temperature	-70 ... +80 C
Dimensions	30 x 30 x 14 mm
Mass	16 g

This sensor technology has been used in FMI's space applications since 1989, and e.g. the sensors in Barobit models have been monitored since then.

The sensor capacitance and a reference capacitance are included in an RC-oscillator in a Vaisala CAPIC(r) circuit. Output of the CAPIC is a frequency signal, which is converted into a dc-voltage. Due to temperature dependence of Barobit an AD590 temperature sensor is included to enable temperature compensation afterwards.

The same type of sensor technology will be used in forthcoming Mars missions, e.g. NetLander / ATMIS experiment slated for launch in 2009.



Martian surface pressure cycles as observed by the Viking Landers (courtesy of James E Tillman, University of Washington).

Barobit pressure device mounted onboard the Beagle 2 landing vehicle (http://netlander.fmi.fi/BAROBIT/)