RATIONALE FOR SEISMIC MEASUREMENTS ON MARS BY A SINGLE STATION Ph. Lognonné and W.B. Banerdt [1]Institut de Physique du Globe de Paris (Département de Géophysique Spatiale et Planétaire, 4 Avenue de Neptune, 94100 Saint Maur des Fossés, France, lognonne@ipgp.jussieu.fr).[2]Jet Propulsion Laboratory, California Institute of Technology (Mail Stop 183-501, 4800 Oak Grove Drive, Pasadena, CA 91109, bruce.banerdt@jpl..nasa.gov),

Introduction: We present here some of the scientific objectives which can be achieved by a single seismic station on Mars, equipped with a 3 axis VBB seismometer and a 3 axis Short Period Seismometer [1]. We assume that this station is also equipped with meteorological sensors, including infra-sound and pressure, in order to perform a complete meteorological noise correction. The science objectives are listed in order of increasing difficulty.

Seismic source localization: A VBB seismometer will allow the detection of seismic waves in the teleseismic frequency range (0.05-1Hz), for which diffraction effects might be reduced, especially at the lowest frequencies. The determination of the polarization of these waves will therefore be possible, providing the azimuth of the event. Together with the difference of arrival times between P and S waves, it will be therefore possible to determine an approximate epicentral distance and to propose two possible locations. With additional hypothesis on the focal mechanism and on the Martian tectonics, it will be possible to favor one of the two locations. Such information will be crucial for the future landing sites of a Long Lived Network.

Receiver function: The crustal thickness is an important parameter for all Martian geophysical models. The joint use of the altimeter and radio-science experiment on MGS allowed the determination of the lateral variations of the Martian crust, but no absolute determination of its volume was possible due to the non-uniqueness of gravity inversions. Indeed, only a seismic determination of the crustal thickness can provide the necessary anchor for such inversions, as demonstrated by recent Lunar models [4].

The receiver method technique is based on a spectral ratio between the vertical and horizontal components. As such, this ratio allows the cancellation of the effect of the seismic source radiation. Moreover, the probable regolith structure on Mars will provide a low velocity zone near the surface, which will straighten seismic rays and reduce therefore the azimuth dependence of the short period data. This method was successfully applied to the Lunar Apollo data [2].

Local 3D subsurface and crustal structure: By using the '09 MSL rover, the deployment of explosive active seismic sources might be considered. Alternatively, impactors mounted on the MSL carrier and released a few days before landing can be used. The activation of these sources can provide a set of seismic profiles, recorded by the Short Period seismometers, which can be used to study the subsurface structure, especially the existence liquid water [3].

Water will affect both the seismic velocities and especially the attenuation of short period seismic waves. Meteorite impacts occurring at a larger distance can also be used, if detected, at longer periods. The isotropic character of the seismic source, polarization of the body waves and travel times of P and S waves can indeed be used to provide a determination of the position of the impact, while Lg and Rg surface waves can be used to constrain the crustal structure.

Gravity Love number determination: To measure gravity variations, the very long period gravity output of the seismometer might be used. Due to contamination with the solar thermal effect at the main diurnal and semi-diurnal periods, the Sun tide will not be detected. However, the Phobos-induced tides, of the order of 0.5 μgal, are subdiurnal with typical periods shorter than 6 hours, unrelated to the solar periods. Given the much lower noise level at these periods, they can be accurately measured by the experiment with a stack of about 1 year of data. The measurement accuracies are most likely sufficient to be able to distinguish between different hypotheses concerning the core of Mars, and thus to better constrain the core [5]. For example, the difference between a solid and a liquid core in the main Phobos-induced tide is about 5 times larger than the measurement accuracy, taken here to be 1 nGal, and a change in the gravity signal equal to the accuracy corresponds to a change in core radius of about 60 km

Free oscillations: The determination of the free oscillations of Mars allow, without the knowledge of the source position, the determination of the interior structure of the planet [6]. Quakes large enough to excite normal modes are expected at a rate of a few every Martian year and can therefore be detected if a long lived power system is used. These data will provide a precise model of the Martian mantle, especially in term of shear waves.

Number 5: In addition to its pathfinder role, the seismic measurement onboard MSL might be a potential number 5 station for a 4-station network, either Netlander, if a launch scenario is found for 2009, or for a future 2011 mission. It can be shown that this 5th station will strongly improve the detection efficiency of the network. A 4-station network is able to detect the direct P and S waves generated by quakes, distributed globally on Mars, with an efficiency of ~60%. A 5-station network can achieve an efficiency up to 90%. 50% more events will therefore be useful for the determination of the seismic velocities of the mantle. This improvement is even stronger for the detection of the PKP core-sensitive seismic phases, and allow a doubling of the number of events used in the final inversion of the internal structure. In conclusion, a MSL '09 geophysical station may almost double the science return of a 4-station network for seismology in terms of quake detection, while decreasing by two the risk of failures in the achievement of a network with 3 or more operational stations.

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