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3D interpretation of SHARAD radargram data using seismic processing routines.

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Ground penetrating radar on board a satellite has entered the field of planetary geology. Two radars are making subsurface observations of Mars possible. In 2003, ESA launched the Mars Express equipped with MARSIS, a low frequency radar which was able to detect only the base of the ice caps. Since December 2006, the Shallow Radar (SHARAD) of Agenzia Spaziale Italiana (ASI) on board the NASA Mars Reconnaissance Orbiter (MRO) is active in orbit around Mars. The SHARAD radar covers the frequency band between 15 and 25 MHz. The vertical resolution is about 15m in free space. The horizontal resolution is 300-1000m along track and 1500-8000m across track [1]. The radar penetrates the subsurface of Mars up to 2 kms deep, and is capable of detecting multiple reflections in the ice caps of Mars.

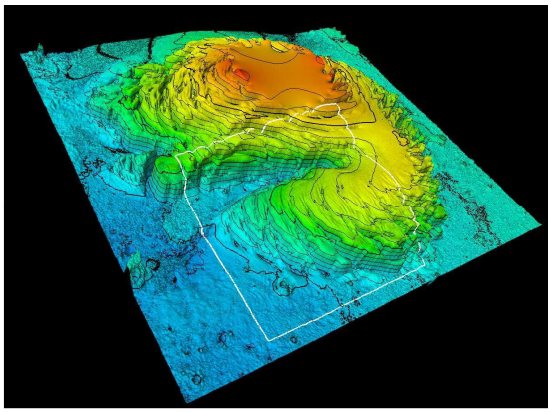

Figure 1. The North Polar region and the selected region of interest.

Considering the scarcity of planetary data, relative to terrestrial data, it is essential to combine all available types of data of the area of interest. Up to now SHARAD data has only been interpreted separately as 2D radargrams [2]. The Geological Survey of the Netherlands has decades of experience in interpreting 2D and 3D seismic data of the Dutch subsurface, especially for the 3D interpretation of reservoir characteristics of the deeper subsurface. In this abstract we present a methodology which can be used for 3D interpretation of SHARAD data combined with surface data using state-of-the art seismic software applied in the oil and gas industry.

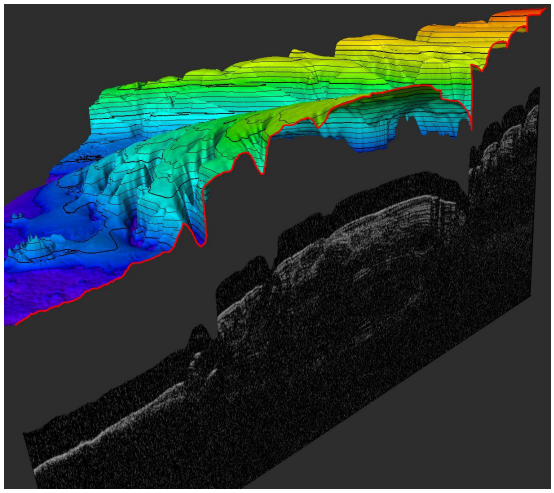

Figure 2. MOLA data matches the first reflector of the SHARAD data.

We selected a region that would be most suitable to demonstrate 3D interpretation. The Titania Lobe [3] of the North Polar ice cap was selected based on the abundancy of radar data and the complexity of the ice lobe, see figure 1. SHARAD data is released to the scientific community via the Planetary Data System. It includes ‘Reduced Data Records’ (RDR) data, a binary format which contains the radargram. First the binary radargram data and corresponding coordinates were combined and converted to the commonly used seismic seg-y format. Second, we used the reservoir engineering software package Petrel of Schlumberger to interpret the radar data in 3D, using its powerful seismic interpretation tool.

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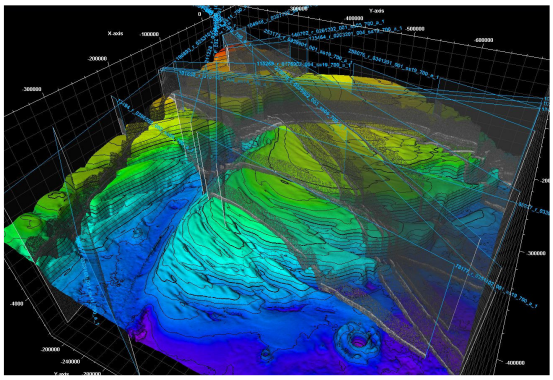

Figure 3. A combined view of MOLA data and SHARAD data.

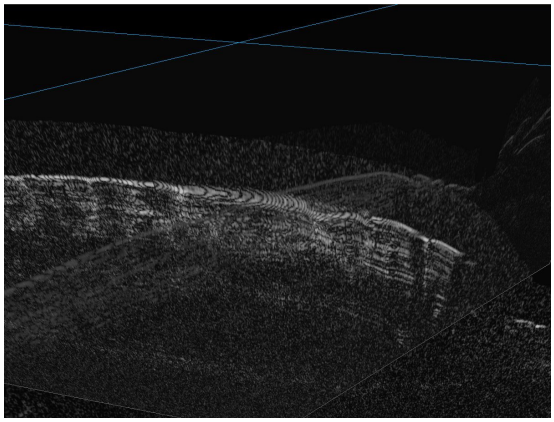

Figure 4. Two crossing SHARAD radargrams; the highlighted one shows a deformation pattern while the one perpendicular to it shows less sign of it.

Since the radardata does not contain an absolute vertical time reference, the surface reflection in the radargram is referenced to the Mars Orbiter Laser Altimeter (MOLA) topography data of the region, see figure 2. By doing this, we can visualize all radar traces in 3D and interpret the combined 3D dataset altogether. Furthermore, MOLA and high resolution satellite images can be projected simultaneously in Petrel as a reference, see figure 3. This method gives much more insight in the data than analyzing each 2D radargram individually: an anomaly that is spotted in a 2D radargram can be validated by a radargram that is positioned perpendicular to the first one, see figure 4. This method helps us to distinguish between different layers and detect instrument and cross-track anomalies. Furthermore, we can perform automatic analyses such as estimating volumes of different formations, see figure 5. This helps us to understand the formation process of the ice cap.

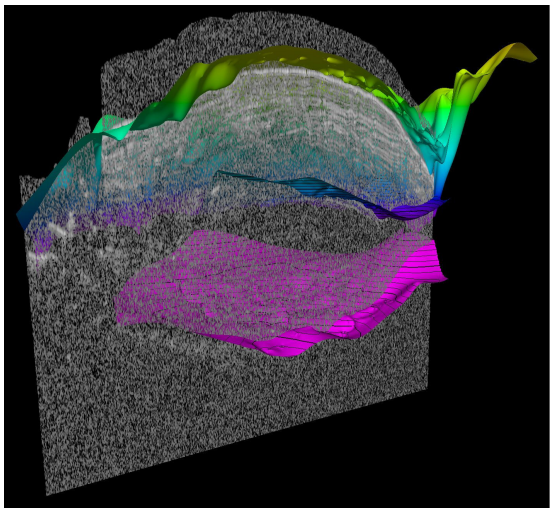

Figure 5. Example of the interpretation methodology. The surface and base of the ice cap were interpreted.

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References

[1] R. Seu et al. (2007) *JGR*, 112, E05S05.

[2] R.J. Phillips et al. (2008) *Science*, 320, 1182.

[3] J.W. Holt et al. (2007) *Int. Conf. on Mars*, #3372.