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Processing and Calibration for the WISDOM Radar Applied to Field Measurements

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Abstract

The capabilities of the WISDOM GPR, which is part of the 2020 ExoMars rover payload, are demonstrated on field test data from two different sites. The objectives of this paper are calibration, data processing and polarimetric classification of buried scatterers.

1 Introduction

The WISDOM GPR is part of the 2020 ESA-Roscosmos ExoMars rover payload. It operates at frequencies between 500 MHz and 3 GHz yielding a centimetric resolution and a penetration depth of about 3 m in Martian soil. Its primary scientific objective is the detailed characterization of the material distribution within the first meters of the Martian subsurface as a contribution to the search for evidence of past life [1]. In addition to the primary scientific objectives, the WISDOM data is supposed to be embedded in terrain visualizations [2] in order to support the drilling operations [5].

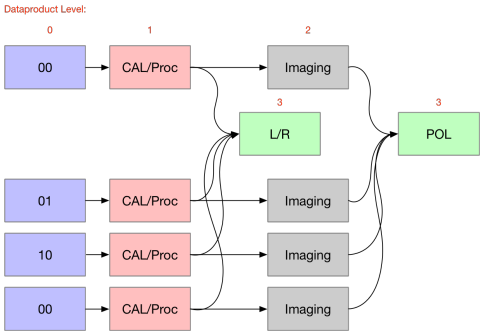

Figure 1: WISDOM calibration and data processing scheme.

2 Calibration and Processing

The WISDOM data measured along the rover path is subjected to calibration and pre-processing (removal of ringing artifact). From the fully polarimetric measurements a left-right discrimination [4] and classification of the buried scatterers is possible. The processing scheme is depicted in Fig. 1. The processing consists of a calibration using freespace laboratory measurements of the WISDOM antenna pattern, time-domain transform of the measured data, removal of ringing artifacts, spatial high-pass filtering, imaging (Stolt) and subspace projection. The processed results are decomposed using Entropy-α analysis for classification.

3 Field Data

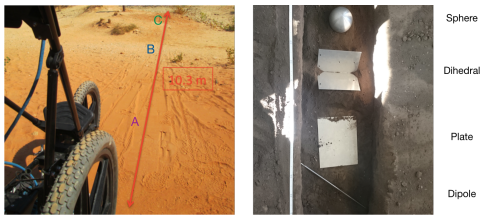

Figure 2: Depiction of the test sites. Left: Site 1, right: Site 2.

The WISDOM data processing, calibration and analysis has been testen on different occasions, e.g. during the SAFER experiments [3].

Here we present further data from field measurements. The two test sites are depicted in Fig. 2. At site 1, the measured track is approx. 10m across plain and flat terrain with limited vegetation and surrounding scatterers. The regions relevant for the radargram processing are marked A,B and C. Feature B seems to

be a channel with distinctive material properties and structure. At site 2 the measured track is approx. 2m across plain soil inside a concrete channel. Inside this channel different scatterers have been buried.

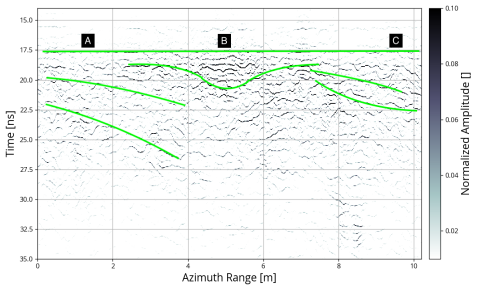

Figure 3: CS (subspace projection) processed radargram of site 1 with marked features.

The processed radargram result of site 1 is depicted in Fig. 3. After processing, the channel B is clearly visible in the data. In region A the signature of a descending subsurface horizon is visible. Region C exhibits different surface structure and density. The classification results of site 2 are depicted in the Fig. 4 and Fig. 5. The buried scatterers are clearly visible in the C-scan and correctly classified in the Entropy-α-plane.

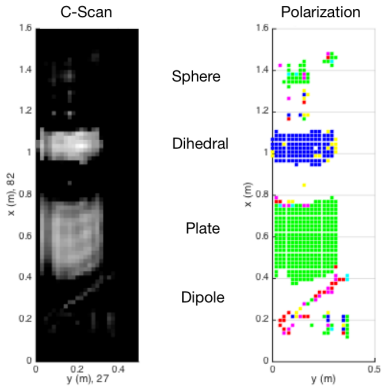

Figure 4: C-Scan and polarization of measurement site 2.

4 Conclusions

The derived WISDOM calibration and processing scheme yields stable results at the expected resolution. The processed data can be embedded in a terrain visualization, aiding in the selection of viable drill sites.

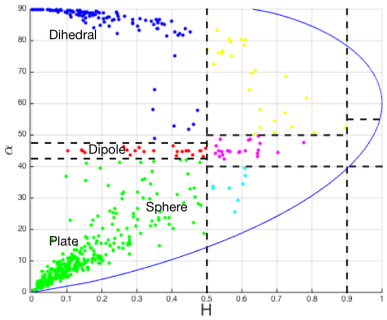

Figure 5: Polarization behavior of site 2. The buried objects are classified correctly in the expected regions.

Acknowledgements

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