MIGRATION VELOCITY ANALYSIS OF RIMFAX OBSERVATIONS OF JEZERO'S SUBSURFACE

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BACKGROUND

The RIMFAX instrument on Perseverance has been acquiring observations of Jezero crater's subsurface by transmitting and recording reflected radio frequency (RF) signals [1]. The recorded signals are typically reflections from dielectric heterogeneities. Point heterogeneities (such as rocks and voids) produce hyperbolic diffractions (Figure 1), while laterally contiguous dielectric horizons lead to horizontal or dipping reflectors.

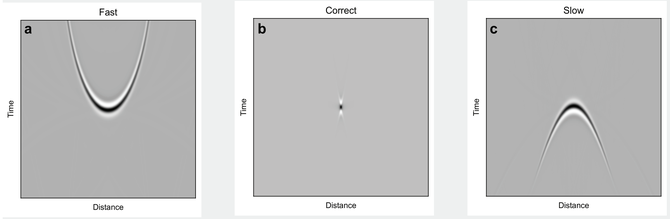

Figure 1. Migration of a diffraction. Image obtained by (a) fast velocity, (b) correct velocity (hyperbola focused), (c) slow velocity.

RIMFAX data contain many reflectors and diffractions. Interpreting subsurface geology from the data requires repositioning the reflections to their true locations in the subsurface. This repositionsing, referred to as **migration**, collapses diffractions back to points, moves reflectors to correct depths and 2D geometries, and increases the signal to noise ratio, thus producing high-quality images.

Migration requires knowledge of the radar wave velocity field in the subsurface. When data are migrated with incorrect velocities, the diffractions do not collapse (Figure 1), the reflector depths do not represent true depths in the subsurface, and the resulting data still have poor SNR. Prior estimates of radar wave velocities show significant lateral and depth variations ranging from ~0.098 – 0.2 m/ns [2, 3]. In order to generate images that account for variable subsurface wave velocities, we present a novel approach with heritage in the analysis of terrestrial radar and seismic data.

METHODS

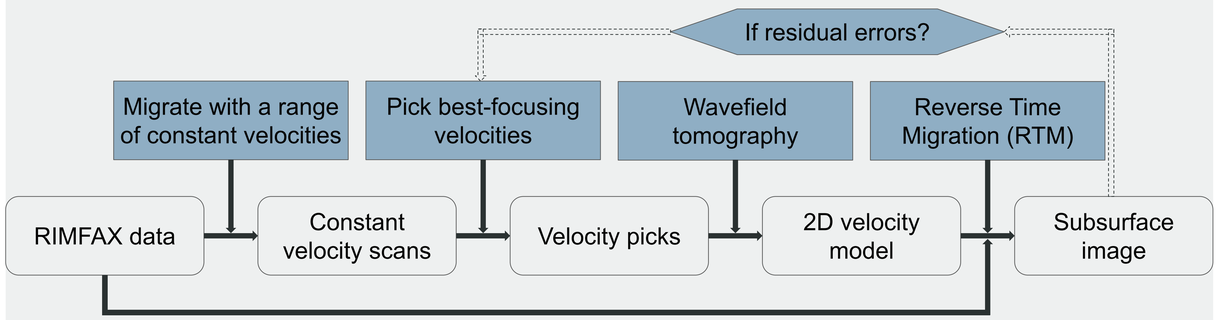

Figure 2. Flowchart of the migration velocity analysis (MVA) approach.

We use a **migration velocity analysis (MVA)** approach where velocity estimation and migration are implemented in an iterative manner [4]. We iterate through the steps shown in Figure 2 till a velocity model that migrates the entire radar section without any diffraction errors is obtained. All steps are implemented in Madagascar [5]. RTM results for shallow mode RIMFAX data from sol 1007 (location shown in Figure 3), obtained from a single iteration of the MVA approach are shown in Figure 4.

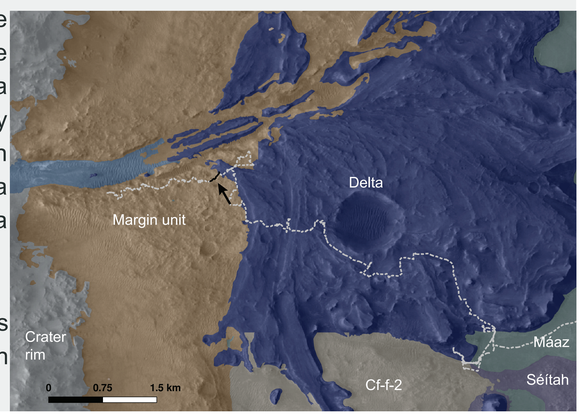

Figure 3. The Jezero delta region with Perseverance traverse is shown as a dashed grey line; Sol 1007 traverse is shown in black. Geologic map from [6].

RESULTS

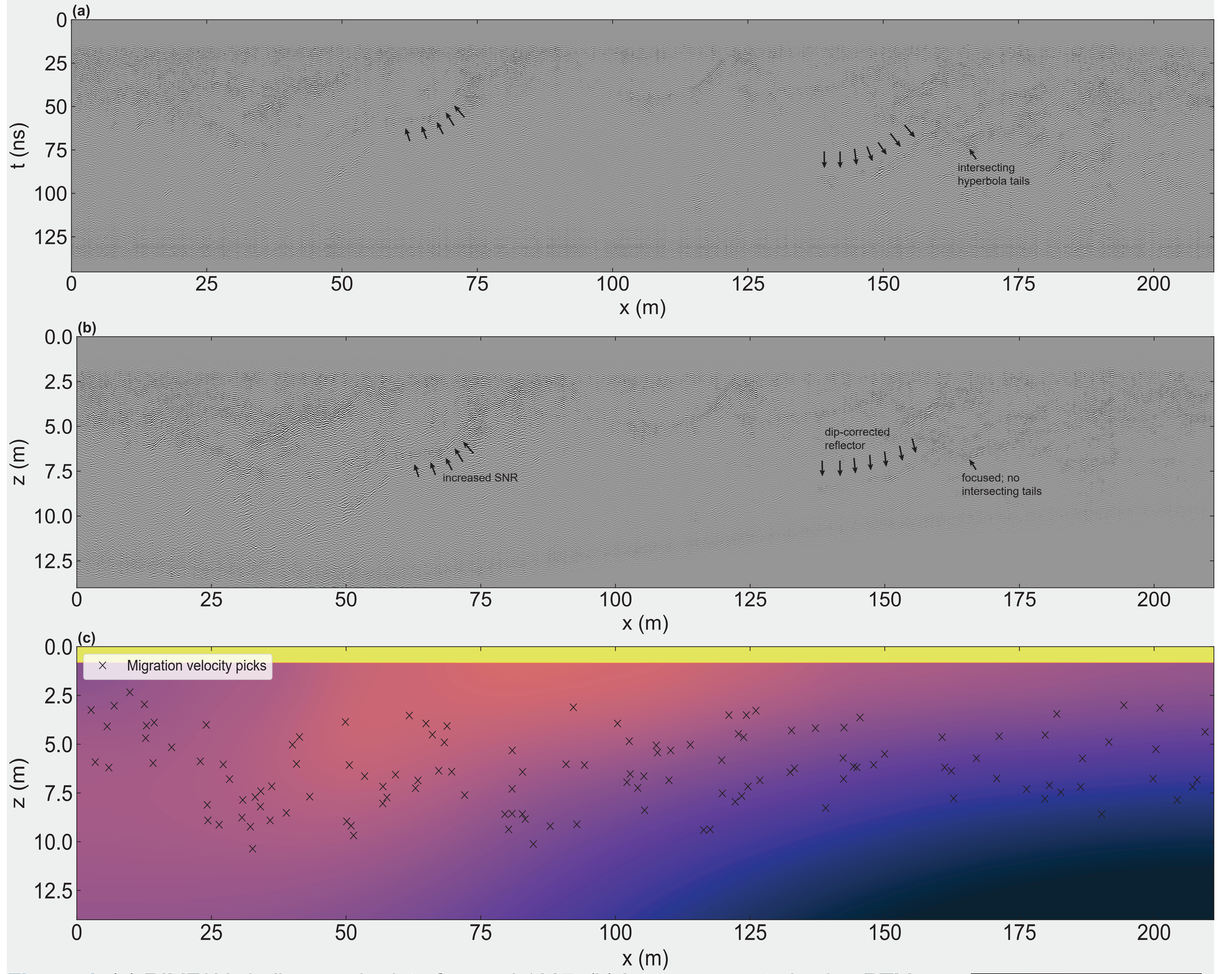

Figure 4. (a) RIMFAX shallow mode data from sol 1007. (b) Image generated using RTM. (c) 2D velocity model obtained using waveform tomography and then input to the RTM.

SIGNIFICANCE

High-SNR images generated using the MVA approach would be valuable for establishing subsurface stratigraphy and contact relationships along Perseverance's traverse. Furthermore, since RIMFAX wave velocity in the subsurface is controlled by lithology, the 2D velocity models themselves would provide information about variations in lithology.

REFERENCES

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