

1. Introduction/Background

- Bonaire Island is a carbonate platform located on the western Caribbean Plate. It is approximately 90 km off the coast of Venezuela.
- Bonaire is comprised of igneous basaltic basement rock with overlying carbonates.
- Originating in the Pacific Ocean during the Cenozoic on the eastern edge of the Caribbean Plate, it has since shifted back from the leading edge of the plate.
- Below I compare the carbonate facies of the bowling, 2017 GPR study on Bonaire.
- Regional Map of the Caribbean Plate

2. Key Questions

- Where is the contact between the igneous basement rock and the overlying Carbonate?
- Does this study help identify a constraint for structural deformation observed in northern Bonaire?
- Does the seismic study data correlate with the GPR study data?

3. Methods

- All data processing was done via Rayfract Software.
- Import shot data and define shot geometry. Data is imported via Sed file.
- Using a parameter box to fill in the shot location and station spacing.
- Pick first breaks using Polyline Picking. This is a semi-automatic way of picking arrivals, by drawing a straight line directly overpicks arrivals. The software then automatically picks the arrival.
- Adjust first breaks. Although, the software automatically picks the first breaks they are not always accurate. It is essential to work through each shot and adjust the “Noised” first breaks for the correct first arrivals. This will increase the accuracy of your velocity model and reduce artifacts.
- Run a DeltaV initial model (Figure 6). DeltaV is a turning ray inversion method that delivers a continuous depth vs. velocity profile for all profile sections.
- Input the DeltaV model into a Wavepath Eilonal Tomography processing inversion (WET Time). This refines the initial model by allowing the user to change parameters i.e. number of iterations, Wavepath frequency, Wavepath width, etc.
- Analyze Tomograms for artifacts and reprocess first breaks to increase the accuracy.

4. Results

- Variability of Velocities in Carbonates

Intrinsic properties in carbonates, such as porosity vary causing the velocities of seismic waves passing through them to vary as well. We observe a range of velocities in what is interpreted as carbonate lithologies. This can explain why at certain locations the velocities are not consistent. Velocities in carbonate samples from other locations in the Caribbean Basin range from ~1800-2000 m/s (Anselmetti and Eberli, 1993). As porosity increases the velocity decreases. Although, the average was ~2300 m/s. As noted in fig. 6, there were core samples taken at the locations marked with the yellow circles. Only granular porosity was found at the locations. Granular porosity found at the location shows a major porosity having slightly higher velocities.

- Karst Features Interpretation

Karstified features form by dissolution of rocks such as carbonates. This process can cause and drainage systems underground which cause disruptions in our seismic waves. One aspect of karstification has on P-Wave velocity models is it can cause scattering of the surface waves and result in low velocities. On fig. 7 the grey facies in the GPR model is karstic features, and in the first ~200m of the velocity model there is a consistent low velocity which is due to the karstified features. ~500-800m there is a karstified feature on the GPR model, but that does not correlate well to the velocity model. Although, the karstified feature at ~1500m seems to correlate well with the consistent low velocities at that location.

- Igneous Basement Interpretation

First in the velocity model the HVZ is interpreted as the igneous basement rock, and this is due to the high velocity contrast between the overlying carbonates. ‘Igneous basaltic rock’ depending on density and pressure can have velocities between 4000-6400 m/s (Geibert and Carsten, 1982). The HVZ in fig. 6 exhibits velocities that post to the igneous basement. The shape of the HVZ also helps determine that it is a monolithic igneous due to it upwelling into the carbonate. and the GPR shows a change in elevation (truncation) at this location. Although, the two areas with velocities of ~3000 m/s overlaps the two red 4500+ m/s areas seem rather low for igneous basalt. But I believe this is due to the karstified features directly above not allowing for accurate modeling of those areas.

5. Discussion

- I compare the karstic facies of the Bowling, 2017 GPR study to my long tomography velocity model.
- Although GPR does penetrate as deep as seismic the two interpretations seem to correlate at the shallow depths that the GPR can reach.
- Blue facies
- Correlates to the velocity zones of ~2000-2800 m/s. The areas on fig. 7 labeled “carbonate facies 1” correlate to the blue facies above.
- Brown facies
- Correlates to an increase in velocity to ~2500-3200 m/s. The areas on fig. 7 labeled “carbonate facies 2” correlates to the brown facies.
- Orange facies
- Correlates to a lower velocities of ~1900-1600 m/s. The areas on fig. 7 labeled “carbonate facies 3” correlates to the orange facies.
- Red facies
- Correlates to a higher velocities than previous zones at ~3000-3400 m/s. The areas on fig. 7 labeled “carbonate facies 4” correlates to the red facies.
- Yellow facies
- Correlates to the velocities similar to other carbonates at ~2200-3200 m/s. The area on fig. 7 labeled “carbonate facies 4” correlates to the yellow facies.

6. Future Work

- I'm graduating this May, so there is possibility I can continue this project if I am accepted into graduate school.
- If so, the next step is to write a paper for publication.

References/Acknowledgments

- Anselmetti and Eberli, 1993
- Gebhard and Carlson, 1982, Compressional-wave velocities in basalts from the Rio Grande Rise
- Sulaica, 2015, Facies Distribution and Paleogeographic Evolution of Neogene Carbonates in Bonaire, Netherlands Antilles, MS Thesis, Texas A&M University.
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