DR 2004153
This data repository contains Appendix DR1, three figures, and four movies. For more information on how to view the movies, read on.

DR2004##

DATA REPOSITORY ITEM: M. Grasmueck, R. Weger and H. Horstmeyer, Three-dimensional ground-penetrating radar imaging of sedimentary structures, fractures, and archeological features at submeter resolution.

Appendix DR1. Full-Resolution 3D GPR Acquisition and Processing Parameters

Miami (USA) oolite 3D GPR data cube at Ingraham Park

Date	18. July 2001
Latitude/Longitude	N 25º42′23″, W 80º15′38″ (UTM NAD27)
Area covered	46 x 24 m
Grid density	0.1 x 0.2 m, 121 parallel NNE-SSW running lines spaced by 0.2 m, with one radar trace recorded every 0.1 m.
Sampling rate	0.3 ns, 928 samples per trace
Imaged depth range	Max. 7 m
Time to acquire dataset	9 hrs
GPR Antenna	100 MHz , shielded bistatic antennae, 0.56 m transmitter-receiver separation, 0.8 m wavelength
Acquisition system	“RADSEIS” (Grasmueck, 1996)
Processing	1)Drift correction of onset time. 2)Removal of low period signal offsets by mean filtering. 3)Amplitude decay compensation with the same gain function applied to all traces. 4)Bandpass filtering 30-240MHz. 5)Constant velocity 3D phase shift time migration (velocity = 0.08 m/ns).

Callosa (Spain) 3D GPR survey

Date	25. August 2001
Latitude/Longitude	N 38º08′, W 00º52′
Area covered	39 x 26 m
Grid density	0.1 x 0.2 m, 130 parallel NNE-SSW running lines spaced by 0.2 m, with one radar trace recorded every 0.1 m
Sampling rate	0.8 ns, 660 samples per trace
Imaged depth range	> 20 m
Time to acquire dataset	1 day
GPR Antenna	100 MHz , unshielded bistatic antennae, 1.0 m transmitter-receiver separation, 1.0 m wavelength
Acquisition system	“SAGAS” (Lehmann and Green, 1999)

Processing	1)Drift correction of onset time. 2)Removal of low period signal offsets by mean filtering. 3)Amplitude decay compensation with the same function applied to all traces. 4)Bandpass filtering 40-200 MHz. 5)Constant velocity 3D phase shift time migration (velocity = 0.10 m/ns).

<u>Recommended grid spacing for full-resolution 3D GPR surveying</u>

Antenna Frequency	100 MHz	250 MHz	500 MHz
Approximate Wavelength	1 m	0.4 m	0.2 m
Recommended Grid spacing	0.1 - 0.2 m	0.05 - 0.1 m	0.02 - 0.05 m

In general less than quarter wavelength trace spacing in all directions, see Grasmueck et al. 2003 and 2005.

Appendix DR1. Additional Figures DR1-DR3

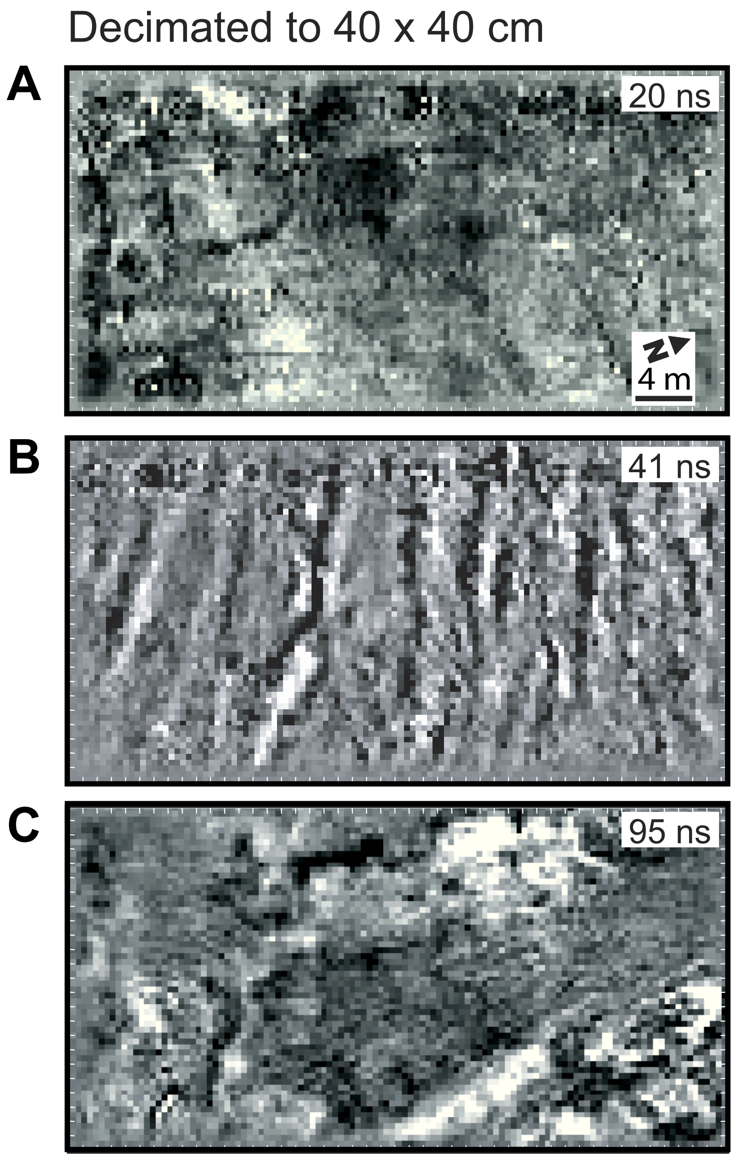


Figure DR1. A-C: Simulation of commonly acquired coarser pseudo 3D GPR data grids for Miami oolite survey. Decimation of our 0.1×0.2 m field data to 0.4×0.4 m and identical 3D migration processing results in loss of definition and interpretability of small-scale internal structures seen in Figure 2.

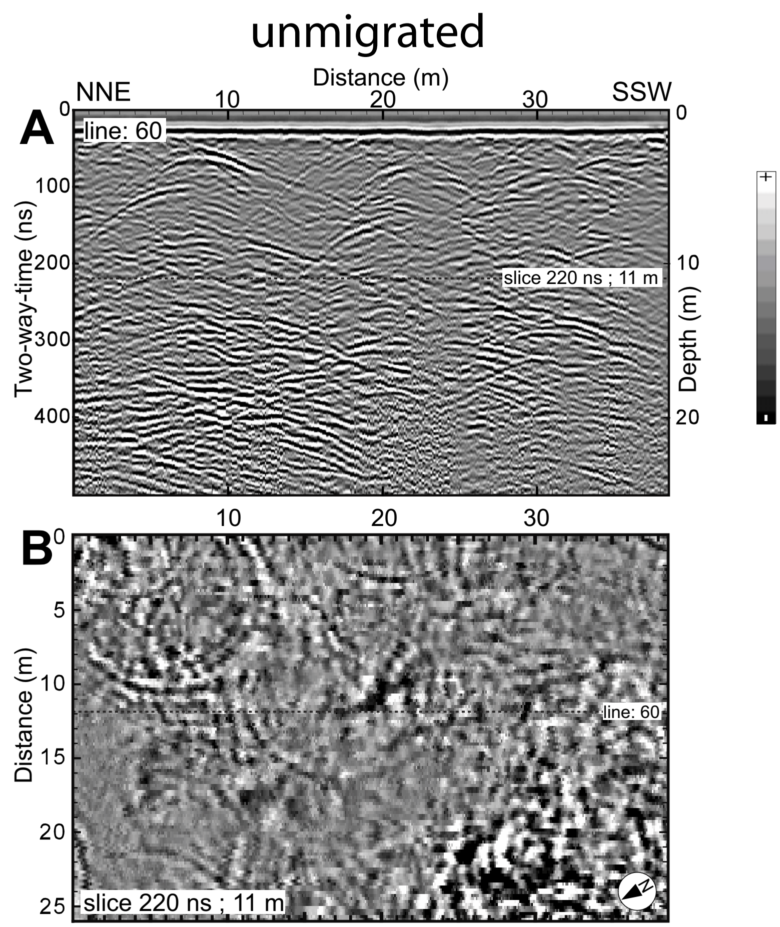


Figure DR2. Densely sampled, but unmigrated Callosa 3D GPR data set is full of chaotic diffraction patterns. A: On vertical cross sections diffracted energy from fractures is manifested in hyperbolic crisscross patterns with no clear definition of fracture geometry. B: Horizontal slices through unmigrated 3D data set display diffraction circles.

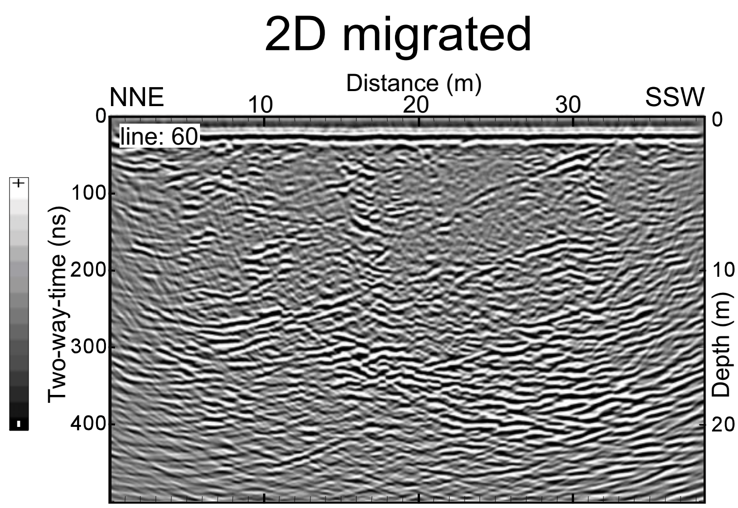
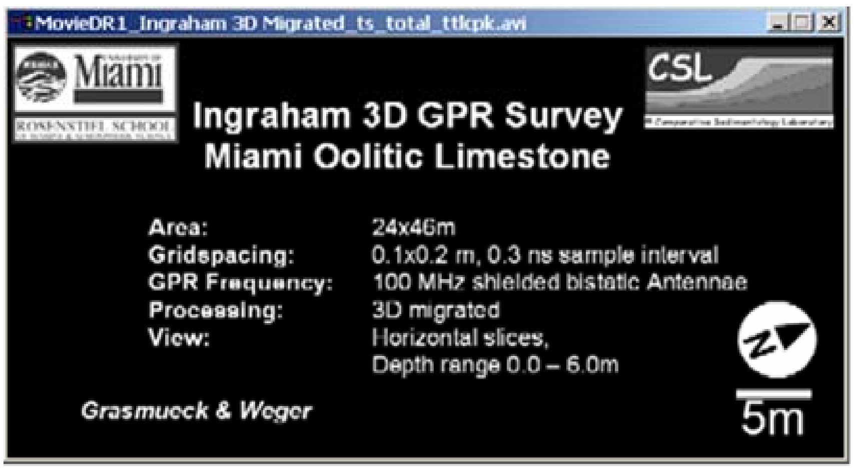


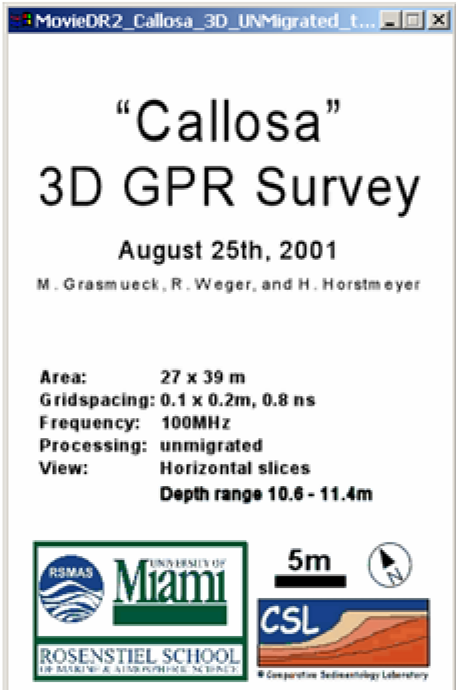
Figure DR3. Two-dimensional (2D) migration processing of single profiles in Callosa GPR data set collapses some of the diffractions, but no clear picture of fractures emerges. Out-of-plane events contaminate the profiles.

Appendix DR1. Animations of 3D GPR volumes

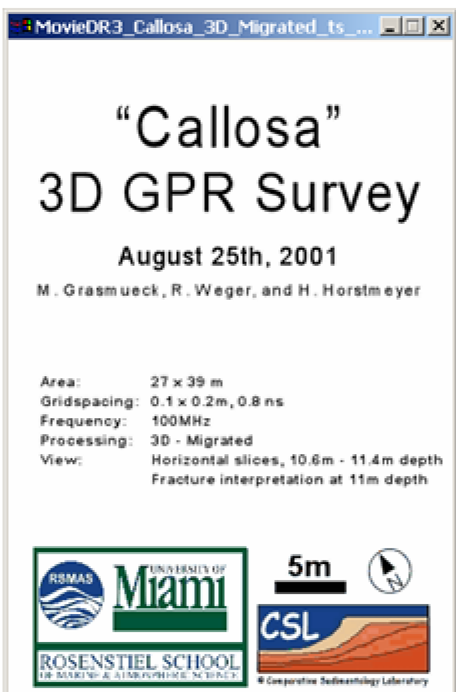
Movies in .avi format can also be downloaded from http://mgg.rsmas.miami.edu/groups/csl/gpr/. For best interactive performance use mplay32.exe to play movies. (this player is delivered with all windows platforms: Do a search for mplay32.exe in File Explorer)



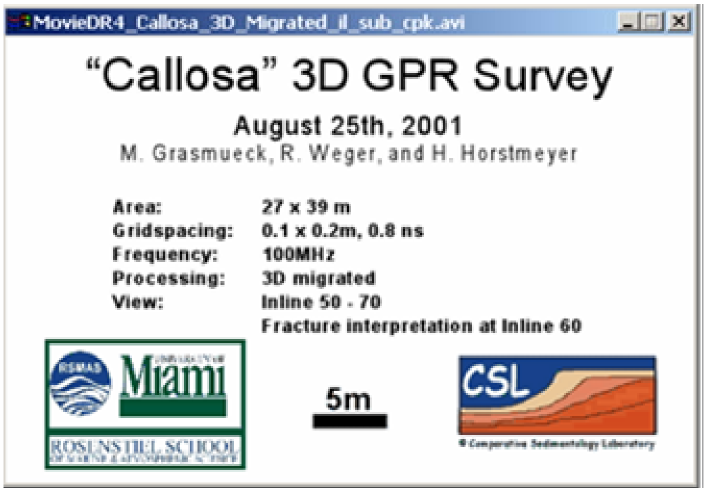
Movie DR1. Horizontal-slice animation from 0 to 6 m depth through 3D-migration-processed Miami oolite 3D GPR data volume. Graphic pixels correspond to real measurements on a 0.1 × 0.2 m grid with no interpolation applied. Vertical separation of consecutive slices is 1.2 cm. Movies are best viewed with mplay32.exe allowing fast interactive animation with computer mouse. By scrolling through data volume, characteristic internal patterns of anthropological and sedimentological origin can be seen: 0–1 m depth, soil with remnants of human activities; 1–2.7 m depth, dipping beds from prograding oolitic barrier bar; 2.7–6 m depth, subhorizontal ooid shoal packages with internal lineation patterns.



Movie DR2 . Horizontal-slice animation from unmigrated Callosa fractured limestone 3D GPR data set. Movie covers depth range of 10.6–11.4 m. Graphic pixels correspond to real measurements on a 0.1 × 0.2 m grid with no interpolation applied. Vertical separation of consecutive slices is 4 cm. Circles on slices are caused by diffractions from fractures.



Movie DR3. Horizontal-slice animation from migrated Callosa fractured limestone 3D GPR data set. Movie covers depth range of 10.6–11.4 m centered at interpreted 11.0 m depth slice. With rapid animation of consecutive time slices, spatial continuity and dip of fractures can be visually assessed. Focused diffractions line up as elements of four discrete sets of fracture orientations.



Movie DR4. Vertical profile animation from migrated Callosa fractured limestone 3D GPR data set. Movie covers vertical rock slab of 4 m thickness centered at interpreted line 60. With rapid animation of consecutive profiles, spatial continuity and dip of fractures can be visually assessed. Subhorizontal fractures are traceable as semicontinuous reflections with consistent dip. Near-vertical fractures are imaged by numerous focused diffraction points aligned in steep orientations.

References cited

Grasmueck, M., Weger, R., and Horstmeyer, H., 2003, How dense is dense enough for a "real" 3D GPR survey?: Society of Exploration Geophysicists, 73nd Annual International Meeting, Expanded Abstracts, p. 1180–1183.

Grasmueck , M., Weger, R , Horstmeyer, 2005, Full-resolution 3-D GPR imaging: Geophysics, v. 70 (in press).