Visualization of the Terashake 2.1 Dataset

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1. Introduction

Many of the scientific questions posed by the contest involve the motion of the seismic waves through certain areas of the simulation volume, rather than the nature of the waves. This led us to the conclusion that the simplest way to get a clear picture of this motion would be to show the shape and position of the waves as they moved in a time-varying "movie." The major obstacle of this approach was getting the enormous quantity of data into a form that could be displayed with acceptable speed on a PC with less than stellar performance.

2. Methods

The shape and position of the waves were found by forming two isosurfaces for each component of the velocity vector. The surfaces were taken at the values of 0.002 and -0.02. Smaller values were found to produce very complicated structures that were difficult to analyze, as well as producing unacceptably large output. Larger values showed too little to be useful. All six isosurfaces are converted to a final form - 3D polygons – and then optimized by converting the polygons to efficient triangle strips. Finally quadric decimation is applied to remove unneeded faces. The space savings from this approach are dramatic - the largest isosurface files are approximately 6MB. Compare two of these files - 12MB to the initial file size of 108MB. Most of the files are much less than 6MB, making it practical for machines with 1GB of memory.

The visualization displays these isosurfaces varying over time using a media player type interface. A slider allows seeking to a specific timestep while other controls allow the visualization to be advanced and reversed. There is also a facility for automatic playback, but speed is limited to avoid disk thrashing on machines with insufficient memory to load the full dataset.

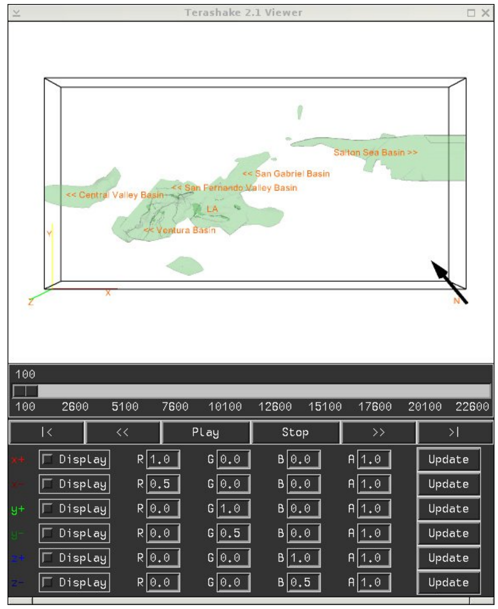

Fig 1. The Interface

The sediment basins are displayed using the same technique used for the waves. The only difference is that the isosurface is taken at 2500 as recommended in the data description. By watching the motion of the waves in relation to the basins the answers to questions 1, 2, and 5 can be found.

3.1 Question 1

The answer to question 1 is yes, waves do seem to follow the sediment trench in the Whittier-Narrows region. Beginning around timestep 10000 it is possible to see waves generated in the San Gabriel Basin focusing down the trench. This focus becomes clearer as time goes on. However, this does not seem to be the only source of significant motion in LA after the primary waves pass - the LA Basin itself is emitting waves because it was shaken quite strongly.

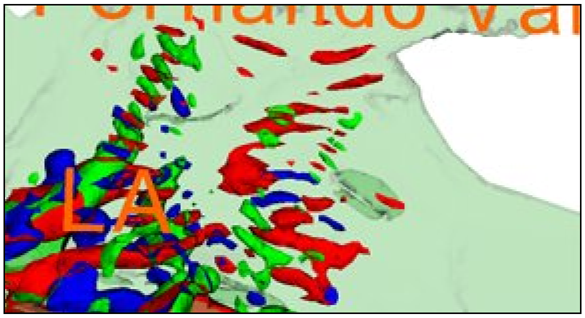

Fig 2. Waves focus down the Whittier-Narrows Region (Question 1)

3.2 Question 2

The answer to question 2 appears to be no. There is no visible focus to the waves - they continue traveling in the same direction. Waves emitted by the strongly shaken basins also travel in the same manner.

3.3 Questions 3 & 4

Answering questions 3 and 4 is somewhat less straightforward. Because there are separate contours for each component of the velocity vectors at each timestep it can be somewhat difficult at first to spot different types of waves. However, after some examination, the user can see that x+ contours moving west with no y or z movement indicates an S wave. The same contours, if moving South, would indicate a P wave. Spotting wave conversion is somewhat more difficult because the coarse granularity of the contours makes it problematic to see the difference between, for instance, a Love wave and a Raleigh wave traveling on top of an S wave.

In Ventura Basin near the end of the simulation (~ timesteps 17000-19000) we can see some interesting wave activity that can help answer these questions. The visualization shows that the waves are frequently changing direction and converting between wave types. Because of the topology of the area (a deep, narrow basin) it would appear that the waves are reflecting off the walls of the basin and converting types as they bounce and intersect. Ventura Basin then, is the answer to both questions. More generally, wave reflections probably occur at any tall interface like the walls of the basin and wave conversions probably occur wherever wave reflections do.

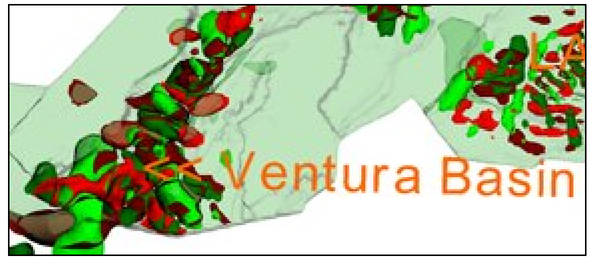

Fig 3. Waves reflecting in the Ventura Basin (Questions 3 & 4)

3.4 Question 5

The answer to question 5 is yes; strongly shaken basins do act as wave sources. This can be clearly seen at the Salton Sea Basin and the Ventura Basin. After the primary, powerful waves pass through the basin it continues to emit waves from the point at which the waves first contacted the basin and they travel down its length.

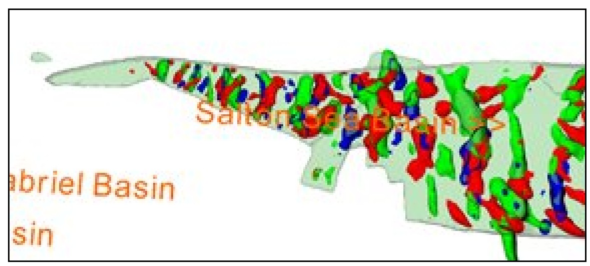

Fig 4. Waves generated in the strongly shaken Salton Sea Basin (Questions 2 & 5)

4. Acknowledgements

The program was developed in Ruby, using Ruby/VTK for the visualization and data processing components and Ruby/TK for the user interface.

Many thanks go to Gettysburg College for funding and to Chris Dickey for assistance with research.

5. References

Schroeder, Will, Martin, Ken, Lorensen, Bill. The Visualization Toolkit. Kitware, Inc. 2002

Shroeder, William. The Visualization Toolkit User's Guide. Kitware, Inc. 2001