[PS]Interpretation, Visualization and Presentation of Digital Well-Log Data in 3D Virtual Reality Space*

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Abstract

Through a collaborative effort between computer scientists and geologists, we have developed an immersive 3D Virtual Reality (3DVR) system within which geological data are imaged. The data imaged in the system include well-logs and surfaces; e.g., surfaces created from well-log correlations, gravity data, magnetic data, Shuttle Radar Topography Mission (SRTM), and LIDAR data. We have created interactive interpretation tools which allow us to interpret, in real time, these various data sets while immersed in the data volume.

Interactive interpretation of well-logs is particularly effective when the strata being investigated are sampled by wells at a horizontal frequency at, or greater than, the Nyquist frequency of the depositional environments within the strata. With Nyquist sampling, the environments are sufficiently represented in the imaged well logs as to allow visual recognition and correlation of the synchronous depositional environments throughout the 3D volume. That is, the immersed interpreter may move about in the subsurface data and follow a log facies much as one might walk along a stream or through a backswamp in the real world.

Drilling programs for coal development or coalbed natural gas (CBNG) production are often spatially dense enough to satisfy the Nyquist criterion. Therefore, 3DVR systems for interpreting well-log and other data sets will be particularly useful in CBNG development programs.

Through a multi-year effort studying the CBNG potential of the Wilcox strata of northern Louisiana, we have created a database containing more than 1000 digital well-logs which may be displayed and interpreted in this system. We show and explain the utility of the system with a subset of these well logs from areas where the well-log density is sufficient to satisfy the Nyquist condition.

Interpretation, Visualization and Presentation of Digital Well-log Data in 3D Virtual Reality Space

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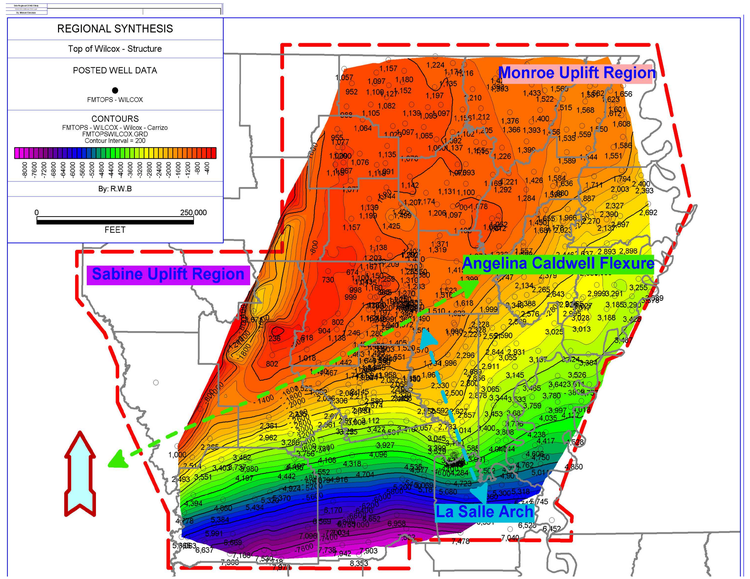
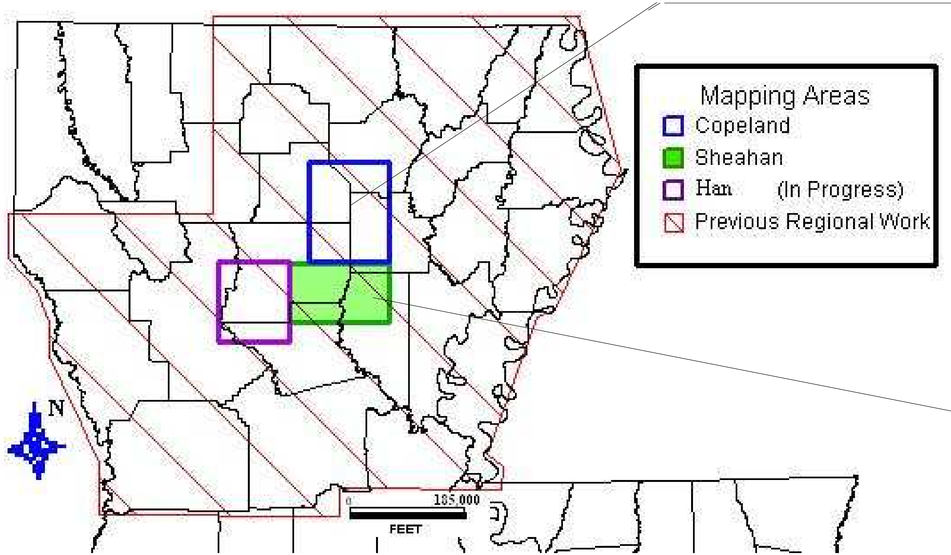
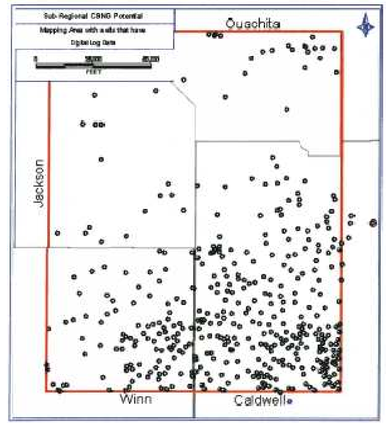


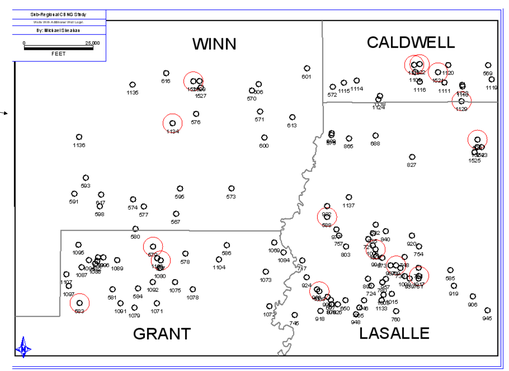
General Study Area, Well Distribution for Reconnaissance Studies, Regional Structure



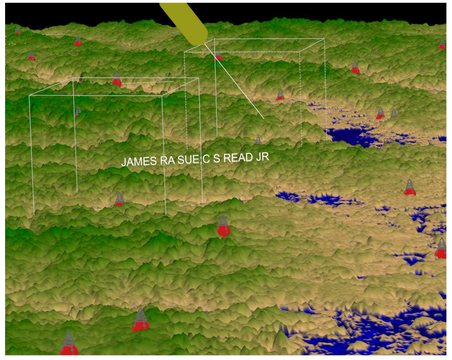
Areas of Detailed Studies…All Wells Which Reach the Lower Wilcox



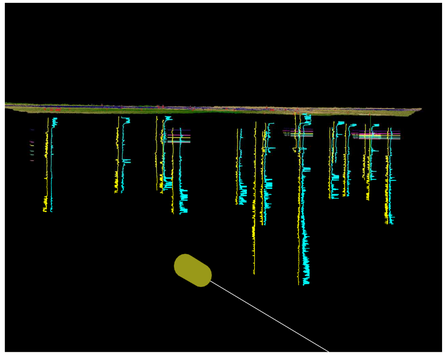
Copeland's Well Distribution



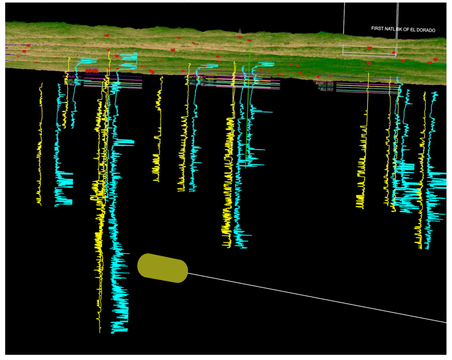
Sheahan's Well Distribution



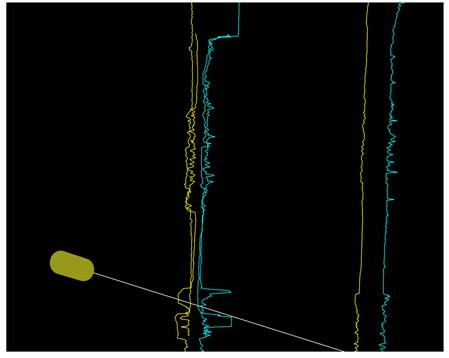
SRTM topography map of a portion of northern Louisiana showing well locations and how our interactive "pointer" is used while in 3D VR to turn on (or off) the logs of selected wells.



A nearly horizontal East to West looking, North at right, one eye's view of some wells. Note the southward dip of the visually correlateable facies…some lower Wilcox horizons are marked.



One eye's view from within the 3D system of the digital logs of selected wells "hanging" beneath the SRTM topographic surface.



One eye's view of two wells whose images have been superposed by moving the viewers perspective within the 3D VR system. Detailed correlation may be achieved quickly and interactively.

OUR ABSTRACT:

Through a collaborative effort between computer scientists and geologists we have developed an immersive 3D Virtual Reality (3DVR) system within which geological data are imaged. The data imaged in the system include well-logs and surfaces; e.g., surfaces created from well-log correlations, gravity data, magnetic data, Shuttle Radar Topography Mission (SRTM), and LIDAR data. We have created interactive interpretation tools which allow us to interpret, in real time, these various data sets while immersed in the data volume.

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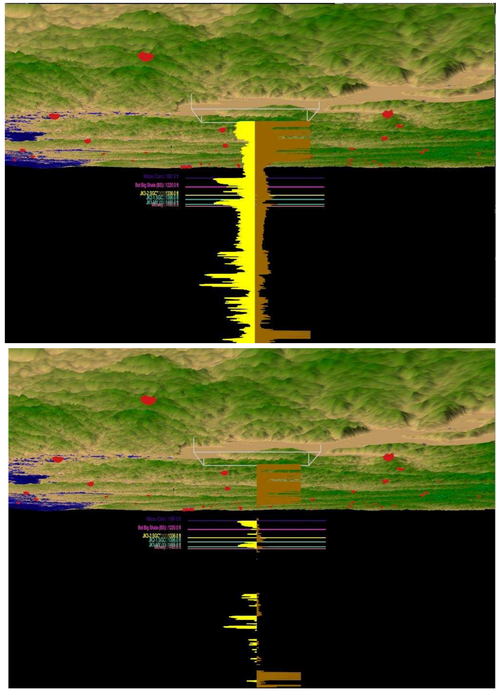
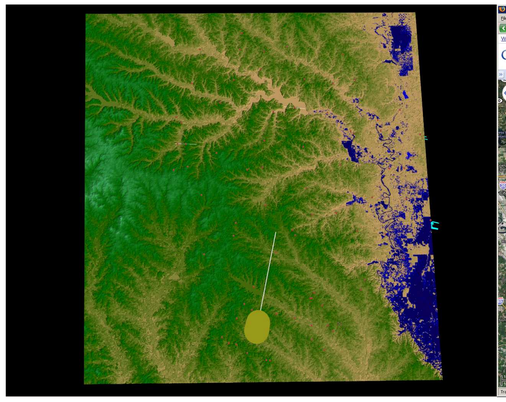


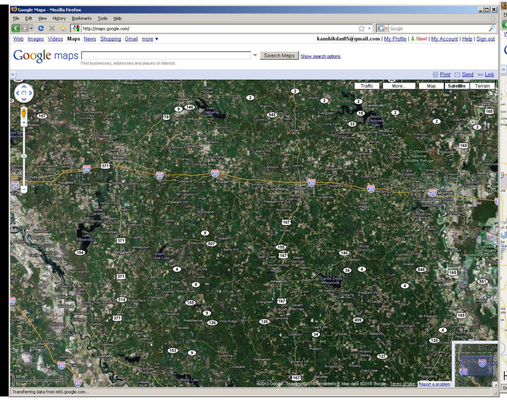
The upper image is of a log with the resistivity & SP curves colored. Cutoffs have been applied to the curves in the lower image…isolating sands (yellow) and coals (brown) within the Wilcox. We have just achieved this capability. We feel that when we apply this technique to closely spaced well-logs the 3D distribution of sands and coals will be readily apparent to the interpreter who is immersed within the data.

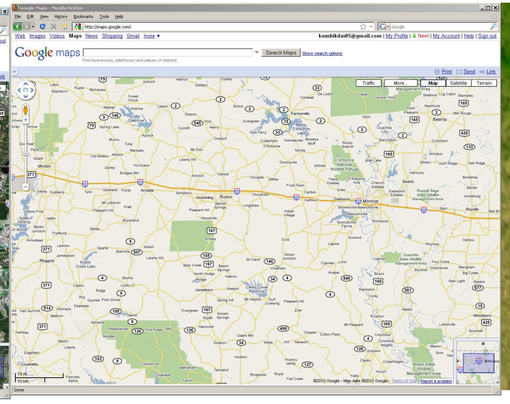
We have over 1000 digital well-logs in our data base, most of which we have digitized ourselves. During our reconnaissance phase the rule was "if two wells satisfy the spatial distribution requirements select the deeper and digitize from top to bottom." Our goal is to be able to walk through the virtual subsurface of northern Louisiana in immersive 3D virtual reality while we interactively correlate well-logs, visualize facies distributions and create maps. Given our experiences with this and other geological data sets (Chicxulub Impact Structure—gravity, magnetics, Shuttle Radar Topography Mission (SRTM) topography and southern Louisiana LIDAR topography) in 3D virtual reality we completely believe that we will be able to understand, interpret and convey the relationships in the subsurface more quickly and better than is possible with 2D or pseudo 3D presentations.

While this capability will be enlightening at all scales we believe it will be especially powerful where the well control is very high as in coalbed natural gas fields or in coal exploration. We are working on techniques to apply while immersed in 3D which will allow us to visually and intuitively correlate from well to well to see the 3D relationships of subsurface facies…to be able to see the "forest" (facies distributions) while looking at the "trees" (the wells).

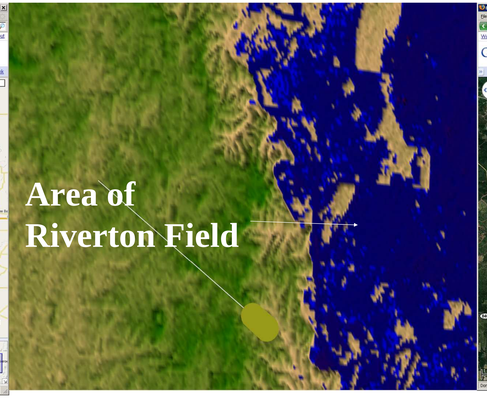


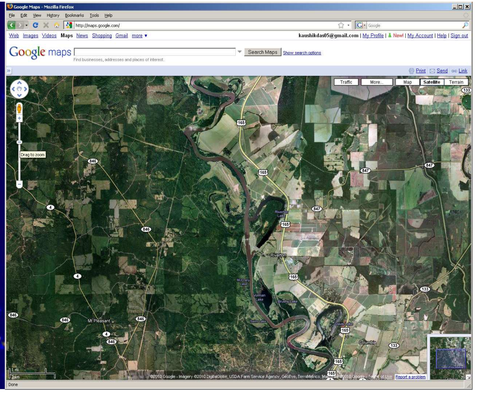
SRTM 3D surface of a portion of our study area. Colors are elevation only. This is the "basemap" from which our well-logs are "hung."





Satellite view and map of the general area of the SRTM image.





A portion of the images to the left centered near to the active coalbed natural gas drilling area near Columbia, LA.