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Geological 3D model visualization in Cave settings, challenges and limitations

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During the last decade new developments in visualization hardware and software with geoscience applications have improved our ability to portray complex data in a user-friendly manner. This technology provides new avenues for innovative research operations and teaching efforts with multi-sourced data sets spanning the 3D arrangement of geological structures and seismicity to the distribution of rainfall, runoff and surface processes.
Since October 2010 a 3-sided virtual reality Cave has been operative at the Institute of Environmental and Earth Sciences at Potsdam University. This facility, which is open to industry and academic partners, is an integrative part of PROGRESS, the Potsdam Research Cluster for Georisk Analysis, Environmental Change and Sustainability. Already during the initial planning and setup phase of the installation, the focus was on the usability for research and teaching. Key for usability are (1) a fast and smooth data/model transfer from standard geological software (e.g. Visit, MOVE, PETREL, ArcGIS) to the 3-dimensional visualization in order to avoid time consuming data transformation to highly specified visualization software, and (2) the capability to modify models directly within the visualization cluster by the user with the familiar standard software. This is achieved with Techviz, a software that allows to run at a level above the mentioned standard applications in a Cave setting. The Cave comprises three 3.84 x 2.4 m screens (two side walls, one floor) with a resolution of 2 mm per pixel. The applied 3D stereo technology is Active Stereo for small groups (up to five persons) and Active Infitec for groups of up to ten persons. Users are tracked with an ART head-, flightstick- and finger-tracking system.
The advantages of Active Stereo are color brilliance and high contrast. Using the Active Stereo mode with several persons in the Cave shielding of the synchronization signal between the emitters and the goggles occur and sporadically results in distorted 3-dimensional impressions. The passive goggle system “Active Infitec” provides less contrast in the display, but provides an undistorted 3-dimensional impression for several viewers standing in the Cave. This system is therefore the preferred stereo mode for teaching purposes.
In the research realm using 3-dimensional visualization in the Cave provides improved and much faster recognition of complex structures and offers the immediate possibility of discussing and manipulating models during discussions with peers. A successful utilization of this system by many researchers requires, however that the familiarization with the technical and management aspects is brief in order to attract frequent users that can implement and visualize own data/models. The user will use familiar software for display and manipulation, while the software organizing the display signal in the Cave works in the background. One shortcoming is that the perspective is only calculated for the tracked head (of the principal user), while other users do not have a similar perspective. This circumstance requires moderate changes of viewing angles from the main user. Nevertheless, this projection technique allows groups to discuss scientific questions through advanced visualization and combination of diverse spatiotemporal data.
Our experience with this system as a teaching tool is excellent. Student feedback emphasized the improved visual recognition of complex structures compared to classical 2D figures. This very important aspect will ultimately lead to an increase of 3-dimensional visualization covering many geologically relevant structures and patterns (e.g. crystal lattice, fossil shapes, seismic cubes, phase diagrams, folds etc.), providing a profound introduction into the 3-dimensionality of Earth Sciences starting already at the BSc level. Without doubt, virtual reality is an excellent tool for visualizing, researching and teaching geological data/models and complex spatial relationships that will ultimately lead to frequent use in education.