LOWERING BARRIERS TO PUBLIC COMMUNICATION WITH 3D GROUNDWATER MAPPING AT ALBERTA GEOLOGICAL SURVEY: EXAMPLES FROM CANADA’S OIL SANDS AREAS.

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The Province of Alberta, Canada, has recently embarked on a watershed-focused, community-empowered approach to management of its surface-water and groundwater resources. The increased involvement of non-scientists in the resource-management process means that scientific agencies and private-sector consultants face significant challenges when communicating with policy makers in advisory bodies.

There are serious challenges facing hydrogeologists communicating with the public:

- Hydrogeologists need to re-attain public recognition and acceptance that specialized scientific knowledge has high value in the resource-management process and not just high cost. We need to recognize and adapt our communication strategies to new decision-making processes that are more inclusive. Inclusive processes can be more legalistic, emotive and value-laden while being proportionally less scientific or technical in nature.

- Hydrogeologists need to accurately and respectfully convey concepts about complex processes operating underground over long periods of time to persons with only general levels of science education.

- Hydrogeologists need to capture and convey the degree of uncertainty in hydrogeological mapping and forecasting without losing credibility with the lay public and decision makers.

At the Alberta Geological Survey (AGS), we are using three-dimensional (3D) mapping techniques to address these challenges. Experience has shown us that new workplace solutions are needed to facilitate this change, particularly in the areas of data management, gridding, and public presentation. First we will highlight how specific data-management and data-capture initiatives have helped us build the foundation for 3D modeling. Second, we will discuss how we give geological interpretation to grids in ways that help transfer geological skills from flat paper to 3D computer images. Lastly, we will show how we add more processing to lower the barriers to public understanding of these images.

DATA MANAGEMENT

Three-dimensional mapping requires a more sophisticated data-management infrastructure than 2D mapping. Two areas of strong growth driven by the need for 3D mapping are the adaptation of relational database technology and the digitization of paper legacy-data.

Adaptation of Relational Databases

The biggest single infrastructural change in AGS’ groundwater studies has been the transition from ASCII flat-files and spreadsheets to relational databases. This change has facilitated 3D mapping in several ways. First, relational databases allow us to rapidly query and blend very different data types based on a range of spatial or temporal relationships. The downside to this adaptation has been the increased stress on geologists and information professionals to maintain productivity while the platform, software, and processes continually change.

Digitizing Paper Legacy-Data

Like many geological surveys, AGS and its partner agencies in the provincial government have a huge legacy of paper files. Although these files are useful, they cannot be used directly to facilitate 3D mapping since data are not accessible in digital form. As an organization, AGS has therefore put substantial resources into sorting and organizing its paper data legacy, creating a searchable metadata catalogue of worthy legacy items. This system helps locate paper records, after which it is left to projects to digitize records as needs arise. In parallel to this process, the AGS groundwater program has supported digital capture of several key parts of the Alberta government groundwater-data legacy. This includes digitization and geospatial assignment of spring records, lake-bottom bathymetries and water-well petrophysical logs. The latter have been voluntarily placed on file with government agencies over the past several decades but are underused due to their present format. When digitization is
completed, these data sets can be blended with digital elevation models, water-well lithology logs and hydrographs to dramatically enhance 3D groundwater mapping in the province.

**GRIDDING**

True 3D modeling involving generation and characterization of bounded geological bodies is not done routinely at AGS. This is mainly because our processes and information-management infrastructure cannot yet support it. Though we continue to evolve to that goal, we remain in what is often termed a “2.5D” work world. In this sense, we represent regional geological bounding surfaces by 2D grids in 3D space. Scalar properties like permeability and porosity, or categorical classifications like lithology or genetic units, are represented by grid-block assignments or zonation on the grids. The three-dimensional extent of these properties is implied to exist for the vertical distance between offset 2D grids rather than being explicitly defined by point values or continuous definition in voxels.

Nevertheless, working in a 2.5D geological modeling paradigm actually is effective for two reasons. First, it is relatively easy to access 2D grid processes in common desktop geological or GIS software. Second, many regional stratigraphic concepts work well in a bounding-surface hierarchy in which lack of true 3D rendering or definition is not fatal. Indeed, using grids enables regional stratigraphic modeling in a geotemporal as well as a geospatial framework.

**PUBLIC PRESENTATIONS**

The primary driver towards 3D mapping and modeling at AGS is to facilitate public and stakeholder understanding. Three-dimensional mapping creates an extra burden on geoscientists to learn new tools and processes. The payoff comes in renewed public interest in our work. As a secondary motive, we also gain more insight into hidden geological relationships through the extra processing. At AGS, we have enhanced our use 3D maps and models in three ways to engage our stakeholders and lower barriers to understanding.

**Use of Animation**

We use animation in two main ways. Like many others before us, we have discovered that 3D models on computer or projection screens are not easily understood in a casual glance by lay people. The use of animation and lighting effects to spin, fly-through, shadow and otherwise render the static 3D models in more dynamic ways is not just embellishment, but are critical for the lay person to recognize the surface or model they are looking at onscreen. This is especially true in a public presentation setting where they are engaged for mere minutes or seconds. Second, we also use animation in 2D and 3D to show the effect of time.

**Use of Familiar Visual Idioms**

Though not strictly a 3D technique, we are finding success with applying familiar visual idioms to our models to lower the barriers to the public to access our information. A prime example is the use of faux or real hand-coloring of 3D block diagrams instead of complex graphical fills (e.g., sand stipple or limestone blocks) for public presentation. Although the same geological information is contained in these diagrams, use of a very familiar, even childlike, visual graphical idiom removes the need for the casual or lay viewer to interpret unfamiliar graphical patterns and colors before receiving our geological message. An example is shown in Figure 1 below.

**Use of tactile models**

Before 3D rendering and visualization tools became available with desktop computers, geologists often made plaster or clay models of geological models to explain 3D geological relationships to non-scientists otherwise unable to decipher complex geological maps and cross-sections. At AGS we have come full-circle; using 3D printing technology to render 3D digital geological maps as colorful, 3D, scale models for the non-scientist. We find that having a model in hand is extremely helpful in lowering the barrier of entry into understanding our technical presentations. Interestingly, we have found that geologists’ reaction can be quite muted to the tactile models – in contrast to the typically enthusiastic reaction of the lay persons we are striving to reach.

**SUMMARY**

At Alberta Geological Survey, we have invested extensively in creating digital data sets and growing our capabilities to do geoscience in a digital world and to create 3D renderings of subsurface geology for our stakeholders. The biggest payoff and greatest motivation to doing this work is the real gain in public understanding
and support for our ongoing activities. We must learn to appreciate that the human brain is foremost a powerful visual processing instrument. With the right three-dimensional, colorful, dynamic images, the public will see and understand geological relationships rapidly with little prior training. But if the imagery is not done correctly, it will not succeed. Therefore, much effort needs to be spent to lower all possible barriers to understanding the 3D imagery so that the extra work involved in its creation pays off.

Figure 1. An example of the use of familiar visual idioms to communicate geology to lay audiences.