Pattern recognition skills to identify geologic features are critical for geoscientists performing volume imaging procedures and interpretation. Such skills are developed over many years of experience. However, if geoscientists study micro-depositional systems using natural depositional models that are easily accessible, they can accelerate both their pattern recognition and interpretation skills.

Micro-depositional systems are simply small scale features on the ground that cover an area of less than 1 m². They can illustrate classic sedimentological, depositional and stratigraphic details and relationships between individual elements within the overall framework. By studying high resolution photographs of these natural “backyard” sedimentary systems, explorationists can improve their ability to perceive details, incorporate...
various elements into a depositional system and project interpretation where seismic data quality is poor. Since the processes of volume imaging and interpretation require pattern recognition skills throughout, it is critical to develop such skills. An example of evaluating a micro-depositional system is discussed below with a focus on important geologic processes.

New workflow for today’s workloads
Recent advancements in 3D seismic acquisition, interpretation and computer technologies have resulted in the exponential phenomenon of ‘more data faster.’ Interpreters who utilise traditional workflows from the 1980s quickly find themselves overwhelmed with data and behind in their work. Workflows based on a volume approach, i.e. analysing data in bulk, are needed to keep up with today’s evaluation workloads. Therefore, working with a single seismic slice has by necessity morphed into working with multiple slices simultaneously. Volume methods are actually more suitable for geologic analysis because of the 3D nature of geology.

Volume imaging is a 3D imaging process based on applying opacity or transparency filters and other visualisation tools such as colour enhancements to isolate and visualise geologic features within a volume in 3D space. Initial visualisations are usually coarse, and pattern recognition skills are used to guide the imaging process. An example of volume imaging results is shown in Figure 1a, which reveals a low stand fan system, and its Figure 1b interpretation. During the volume imaging process, visualisation parameters are adjusted to refine the image according to what the geoscientist recognises as a geological feature. The volume imaging process, therefore, includes the interplay between image enhancement, pattern recognition and interpretation. Pattern recognition is the key skill that guides the imaging process and is the root of the interpretation. The ultimate goal of volume imaging is to produce a 3D geomorphologic image and/or a 3D enhanced profile of the subsurface geology that illustrates important characteristics.

Skills and training take time
The 3D volume imaging approach requires two fundamental interpretation skills:

- The application of opacity with other visualisation technologies to bring out the geological features in the 3D image.
- Pattern recognition skills for guiding the imaging process and interpreting the results.

Both of these go hand in hand, and each makes the other one easier to do. The problem is that mastering these skills is both an art and a science, and training...
geoscientists how to do it properly requires considerable investment of time and money. A field course in understanding river deltas, for example, can require two weeks of travel, hotel, meals and offsite classroom expenses. Students are taken to a series of outcrops situated miles apart, where portions of different deltaic facies are exposed, and the student must infer the entire depositional system in 3D space. There is another way to supplement the study of geological features and patterns much faster and at far less expense.

Backyard depositional models

The study of backyard depositional systems can provide microcosmic analogies of the macro world. After each rain the author photographs hundreds of such features, each with its own variations that perfectly honour the laws of nature. This way, numerous depositional systems can be studied in their entirety in a short period of time with respect to accommodation, sediment source, pathways, energy level, etc. - without post depositional deformation. By seeing the entire natural system, the characteristics of each element can be studied with respect to its surroundings, controls and conditions.

Studying backyard depositional phenomena must be supplemented by 3D seismic imaging of shallow subsurface geology to hone explorationists' pattern recognition and interpretation skills. At reservoir depths, imaging geologic detail deteriorates and pattern recognition becomes more important. Image deterioration is due to the various limitations of seismic data, which include:

- Resolution limitations because of lower seismic frequencies.
- Impedances influenced by post depositional effects.
- Objective zone can be commingled with noise and subject to various artefacts.
- Data can be distorted by overlying features such as canyons, velocity anomalies and gas and fluid effects as well as compaction and structural overprinting.

Often we are only able to see parts of the entire system, but with a higher level of pattern recognition skills and with additional knowledge of the multitude of geologic variations studies as a reference, geoscientists can improve their ability to project and predict realistic geologic forms and interpolate over gaps in the data and build a better interpretation.

Micro-depositional systems

Photographs of micro-depositional systems are studied and used as geomorphologic conceptual models for depositional architecture and 3D seismic interpretation. The idea is not to search for the perfect 'lookalike' model, but to grasp the geologic interplay between various sedimentological, depositional and geomorphological elements that fit into the overall framework. Since real world seismic data often images only portions of a geologic system, first hand knowledge of entire depositional systems and their variations provide a valuable mental library from which to draw upon to formulate an interpretation.

To illustrate the geologic richness of studying a micro model, a detailed interpretation is made focusing on several key geologic elements and processes. The example in Figure 2, which was photographed after fairly strong rain, covers an area of several square metres and shows interesting depositional details. The width of the feature is approximately 2 m, and north is toward the top of the image.

The sand system in Figure 2 is situated on a concrete path that is slightly dipping northward. Moisture in the northern area (the dark area) hints at the lowest topographic areas next to the rock wall. Overall, the sand system appears to have undergone two major phases, an initial phase of deposition and a subsequent phase of reworking and modification. Figure 3 shows details of two fan systems.

Figure 3. Enlarged insets in map view showing fan details.

Figure 4. Interpretation of main bar extent and bi-current and sediment pathways.

Figure 5. Early modification and truncation of bar front by strong lateral currents.

Figure 6. Second pulse from south reworking bar and breached bar front by delta systems.
Interpretation of the micro-model
Initially, a north prograding bar was deposited, thickening to the north, as shown in Figure 4. The predominant sediment source is from the south, and the dominant water current direction is from the west, north of the bar. As the bar system prograded northward, the northern limit appears to have been truncated and reworked by strong eastward currents, as shown in Figure 5. The reworked frontal edge appears as oblique ridges in the western front of the bar and braided channels to the east. The transition point coincides where the northern current direction is partially diverted to the southeast, due to an ‘embankment’ that also trends northwest to southeast. The diverted current appears to have eroded southward into the northern portion of the bar in its eastern region.

The second major phase is a significant surge predominately from the south (see Figure 6). This appears to have eroded the southern edge of the bar further north, truncating around the entire western edge of the bar with deltas breaching the bar front in the west central area. This second phase appears to be sediment poor. The two deltaic fan lobes that breached the northern band of ridges appear to have been sourced from reworked sediment updip in the triangular shaped bypass area. The northward protrusion of the fans beyond the bar front are well preserved, suggesting that the predominant influx is from the south and the eastward transverse currents diminished considerably.

The surge from the south obliquely eroded and reworked the sediment in the southeastern area into northward confined splay fans. The energy level appears insufficient to breach the frontal braided facies of the bar. The band of northern oblique braided ridges as a whole may have acted as a depositional barrier. Overall, the delta forming episode appears to define a waning phase of the fan bar system.

Summary
The interpretation of a backyard depositional model contains the same ingredients of many active exploration projects being worked today. Increased knowledge and experience of depositional systems can be accelerated by studying these easily accessible examples. Rapid growth in both pattern recognition and geologic interpretation skills is critical for interpreters today. The three prong approach of 3D volume interpretation comprises imaging the features, applying pattern recognition skills and interpretation. This is a powerful method for working the massive amount of data volumes being produced by today’s advanced technological and computing power.

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