# THE SHAPE OF 3D SEISMIC INTERPRETATION

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Seismic interpreters routinely use the shape of an interpreted surface in developing prospects, with the classic hydrocarbon trap being a ridge-shaped anticline. Carbonate buildups may appear as dome-shaped and karst collapse features as bowl-shaped. Differential compaction often results in valley-shapes over shale-filled channels.

The interpretational value of a given shape is dependent on its depositional, diagenetic, and tectonic deformation context. If the channel fill is sand and the surrounding matrix shale, differential compaction can result in an incised valley appearing as a ridge, thereby providing a lithologic indicator. In flat-lying carbonates, joints will often be diagenetically altered and appear as valleys, while fracture intersections will appear as bowls. As always, the interpreter needs to be aware of the seismic data quality. In areas of limited lateral and vertical resolution, diffuse, or poorly-imaged faults may give rise to a recognizable shape anomaly. Negatively, velocity pull-up may induce deeper ridges and push-down deeper valleys on what might actually be flat structure.

Coupled with coherence, which delineates reflector edges, volumetric shape helps us rapidly recognize structural and stratigraphic style on horizontal and vertical slices. Pop-up blocks may appear as a ridge bounded on both sides by low-coherence faults. Listric faults may be associated with a ridge-shaped roll-over anticline. Gas- and water-charged debris flow that can be drilling hazards may appear as high-coherence, dome shaped blocks.

Quantitative measures of reflector shape computed from uninterpreted seismic volumes are a by-product of volumetric curvature. Volumetric curvature is now well-established in the interpretation community, with workflows developed to correlate healed fracture zones to ridges in shale plays to help guide hydraulic fracture stimulation programs. While the shape of an anomaly is most-easily understood in terms of reflector geometry, we can also compute the ‘shape’ of reflector amplitude and acoustic impedance. For instance, we find that ‘valleys’ of low acoustic impedance are correlated to structural ridges in the Woodford Shale of the Arkoma Basin, suggesting the presence of either fractures or diagenetic alteration.

More recently, we have made progress in the volumetric quantification of pinch-outs and unconformities, providing images of both the magnitude and azimuth of reflector convergence. We have also made progress in volumetric mapping of flexures, delineating areas where the curvature changes most rapidly, often associated with drag or antithetic faulting about major faults.

I will illustrate these concepts through application to data acquired in the Midcontinent and Texas.

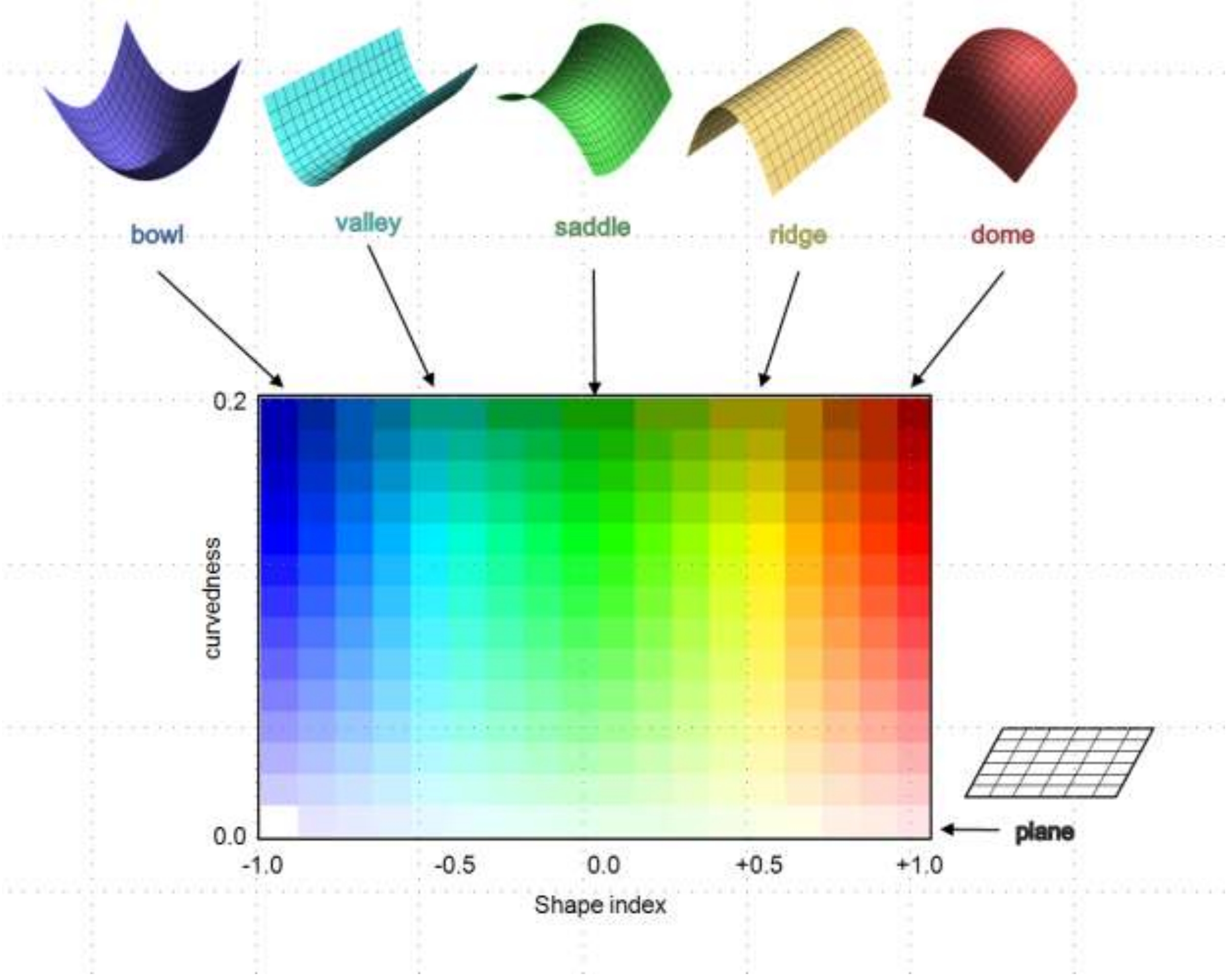

Figure 1. Color coding of reflector shape representing the intensity of bowls (blue), valleys (cyan), saddles (green), ridges (yellow), and domes (red). Zones of no deformation are planes, colored as white.

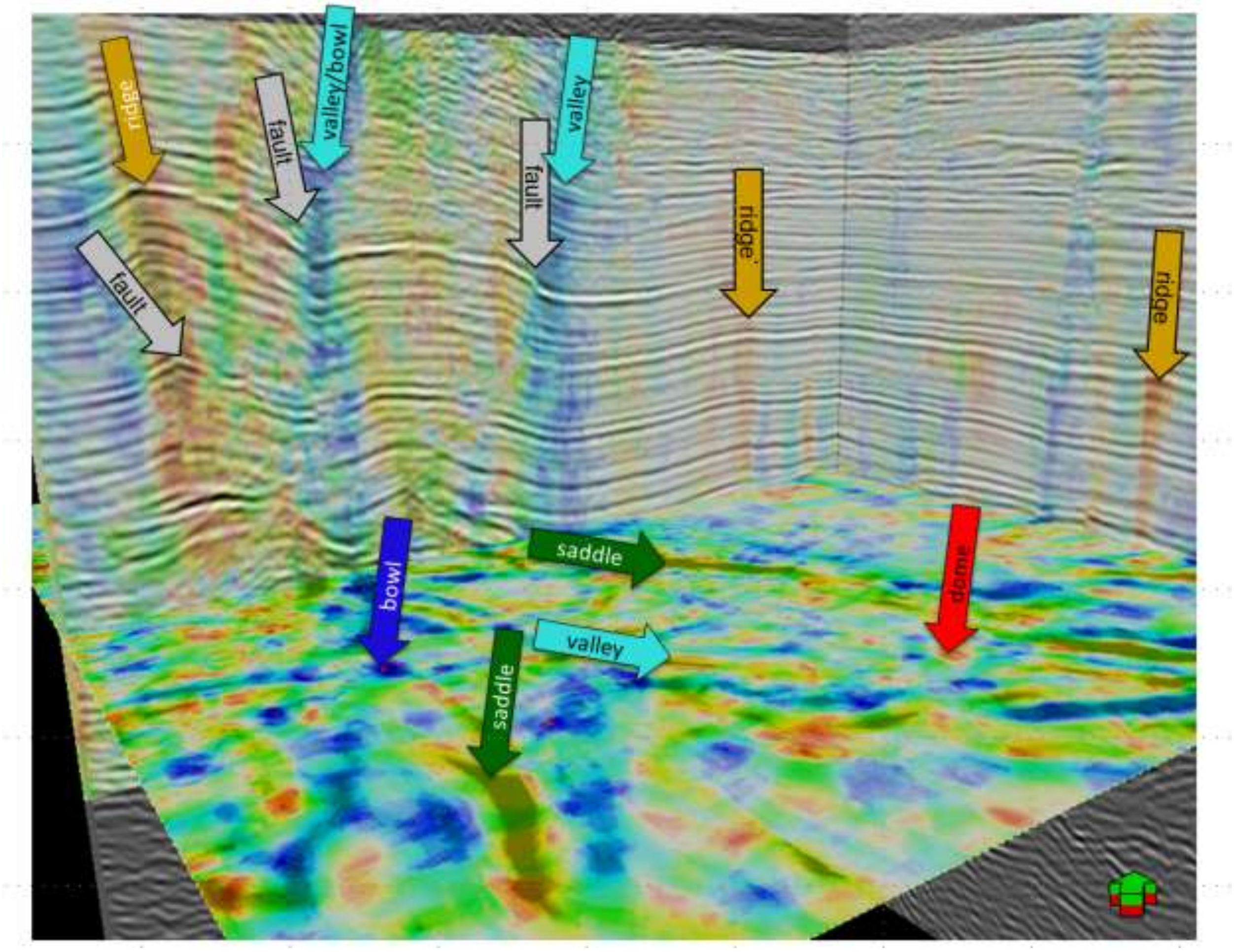

Figure 2. Co-rendering of seismic amplitude and reflector shape of a structurally complex terrain using the 2D color bar shown in Figure 1. (Figure from Mai et al., SEG Expanded Abstracts, 2009).