D Static Geometric Analysis

Analysis of static geometric parameters such as dip and curvature of surfaces can provide valuable insights into the tectonic evolution of a system. Analysis of the curvature of folded surfaces (4) yields information on the strain created by deformation and has been shown to provide data on the probable orientation and density of fracturing (Lisle, 1994).

Simple curvature gives a measure of the rate of change of dip. This is calculated for each vertex in a surface, by taking the normals to each of the 6 triangles surrounding the vertex, and calculating an average normal for the vertex. (The calculation is weighted to account for the area of the triangles, larger triangles have a greater weighting). A value for curvature is then produced from the divergence of the normals of the triangles surrounding a vertex to the average normal .

The definition of the Gaussian curvature at any given point is the product of the two principal curvatures (the maximum and the minimum), which are orthogonal to each other (Lisle, 1994). The Gaussian curvature shown in 4 was calculated by determining the misfit angle generated by flattening a 3D triangular grid. Surfaces which have a Gaussian curvature are non cylindrical. Structures such as domes and saddles have a high Gaussian curvature.

E Dynamic Geometric Analysis

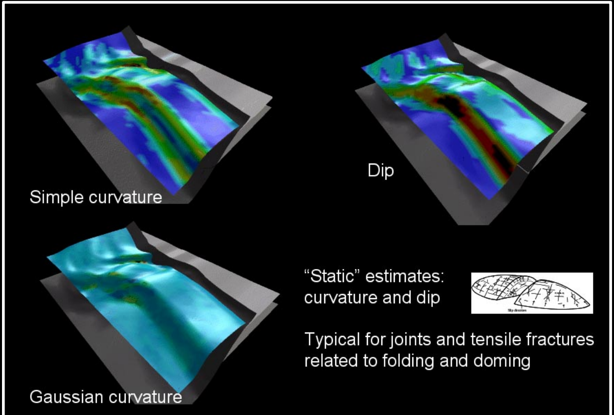
The deformation history of geological system will have a key role in the development of fractures. Once a geological model has been restored to flat (see previous board) forward modelling can be used to track the evolution of the shape of a surface to its present day configuration.

Such shape evolution is a record of the strain on a surface (5). Current and cumulative dilatation provides information on the magnitude of change in area on a surface and are indicators of potential for fracture development and fracture density.

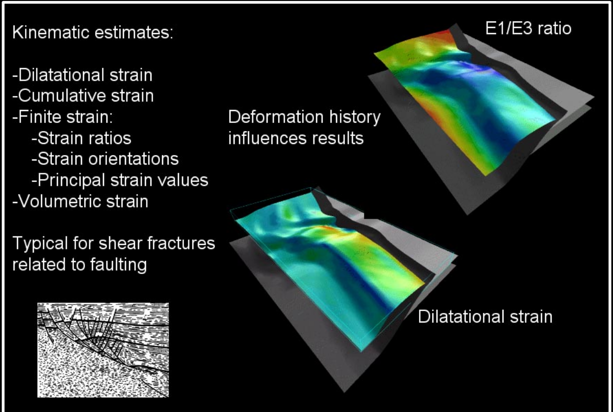
Finite strain can only be applied to volumes (but can be mapped on to surfaces). The change in position of the vertices of strained, relative to unstrained tetrahedra allows the calculation of Volumetric Dilatation, Principal Strain Values, Strain Orientations and Plane Strain Ratios (6).

Strain data can be used to determine the potential for fracture development, fracture density and the dominant orientation of fractures. It is useful to point out the good correlation between static geometric parameters, such as dip, and geometric paramters such as the magnitude of maximum strain, (e1).

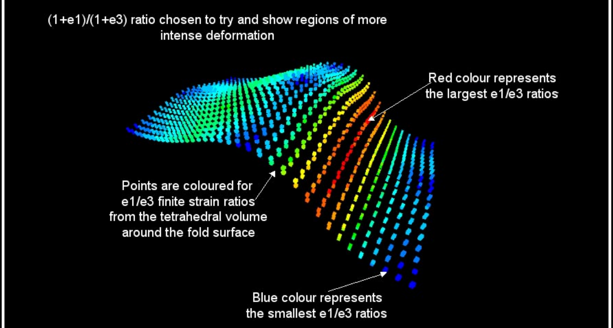
The surface shown in box 7 is mapped for e1, where red is greatest magnitude. The dip of each triangle making up the surface is also shown (as points) where red is the steepest. There is a good correlation between the dip of the surface and the magnitude of e1 finite strain. Thus, simple geometric parameters can provide data that can be used in the prediction of fracture density.



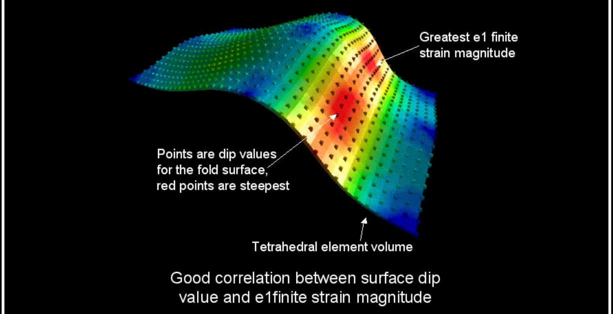
4 Static geometric parameters as proxies for fracturing



5 Dynamic geometric parameters as proxies for fracturing



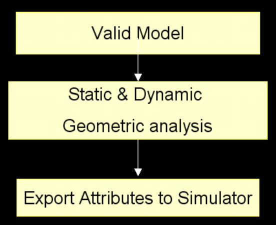
6 e1/e3 strain ratio showing areas of intense deformation



7 Comparison between dip and e1 finite strain magnitude

F Data for Reservoir Simulation

All of the data derived from geometric analysis can provide attribute maps that can be used to provide insights into reservoir properties in areas of poor well control (8). For example maps of Gaussian Curvature and Finite Strain azimuths could provide data for conditioning maps of permeability enhancement (PEF) factors away from wells.



8 Use of results from geomtric analyses

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