

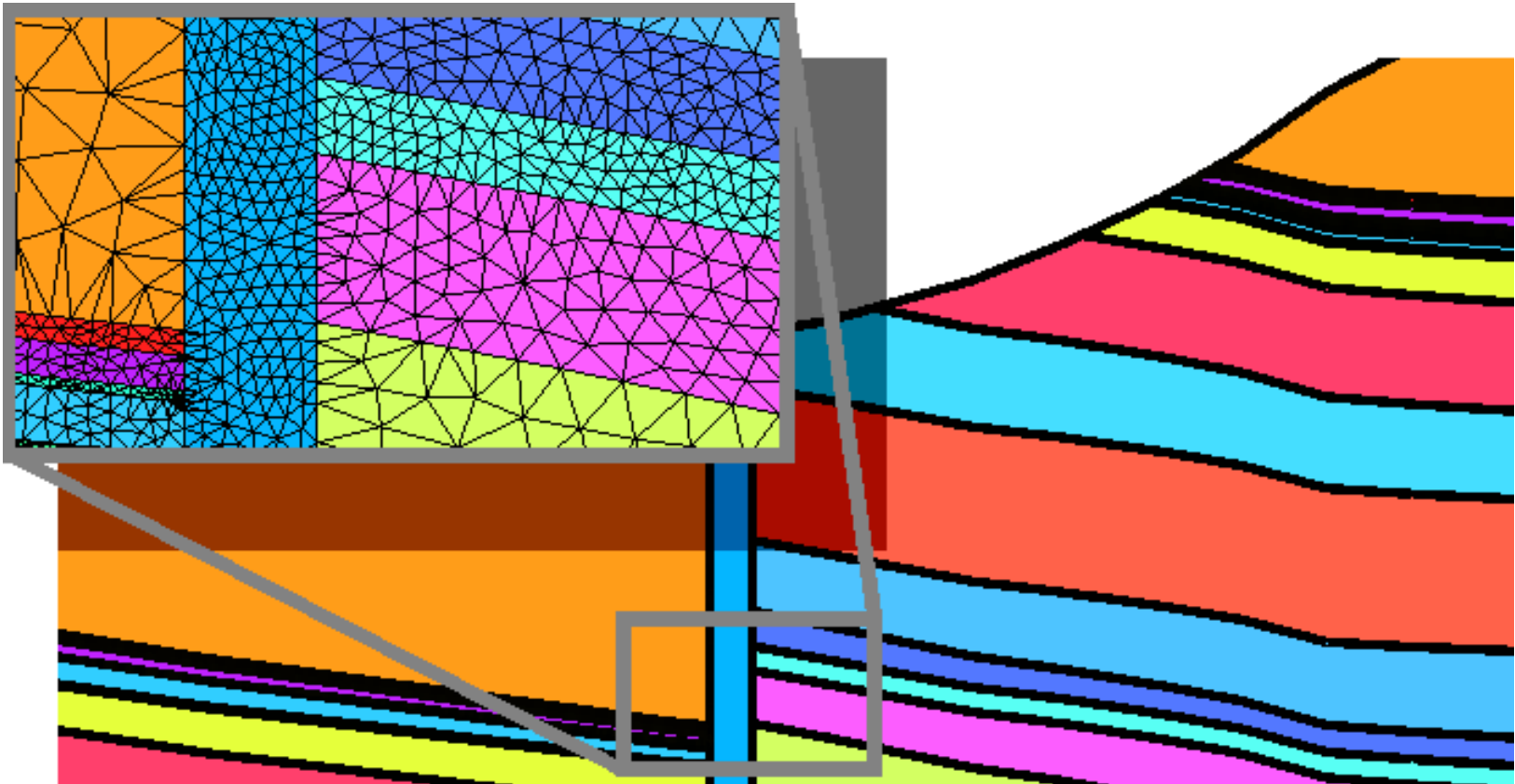
# LaGriT

Los Alamos Grid Toolbox

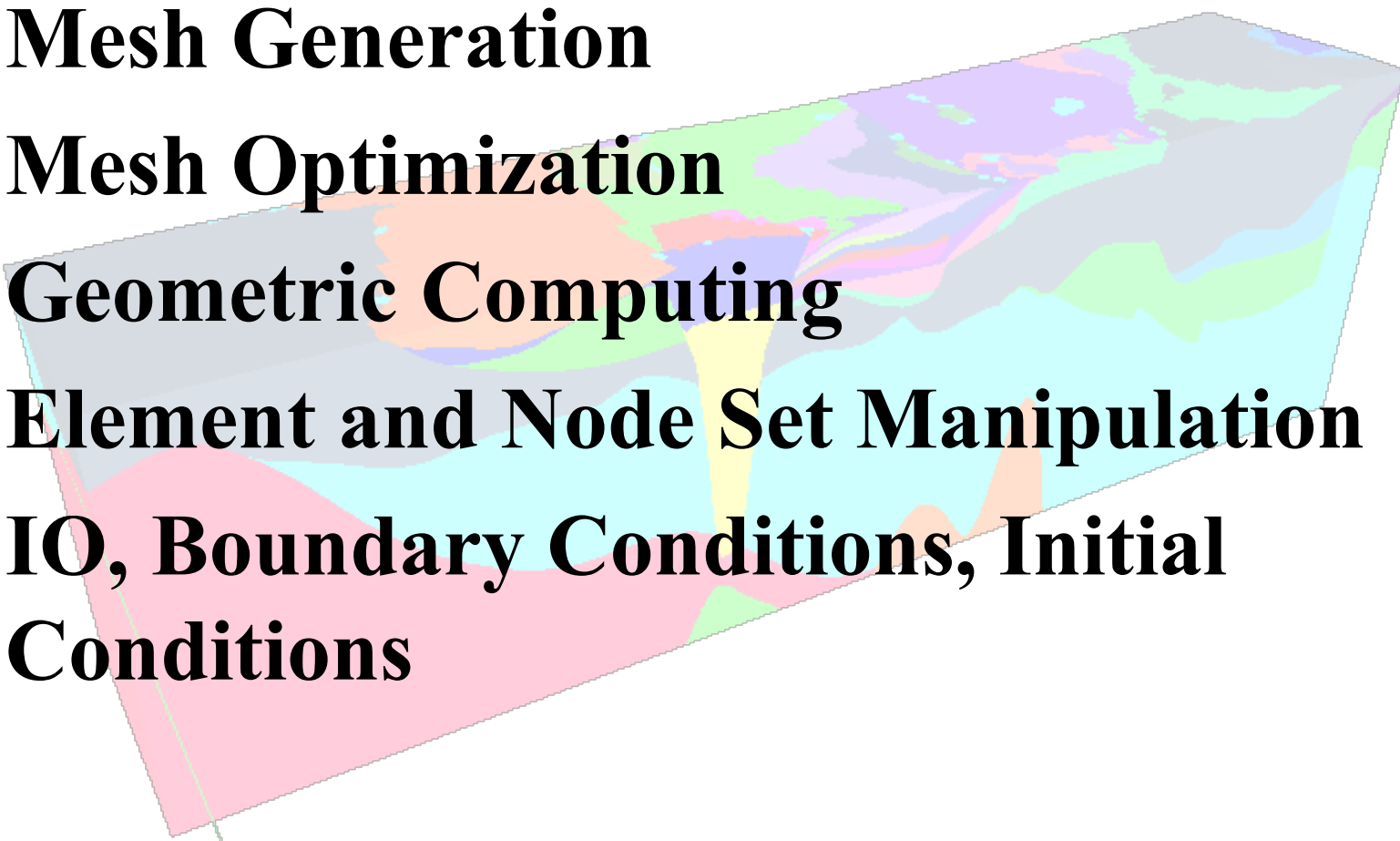
Carl Gable

[meshing.lanl.gov](http://meshing.lanl.gov)

[lagrit.lanl.gov](http://lagrit.lanl.gov)



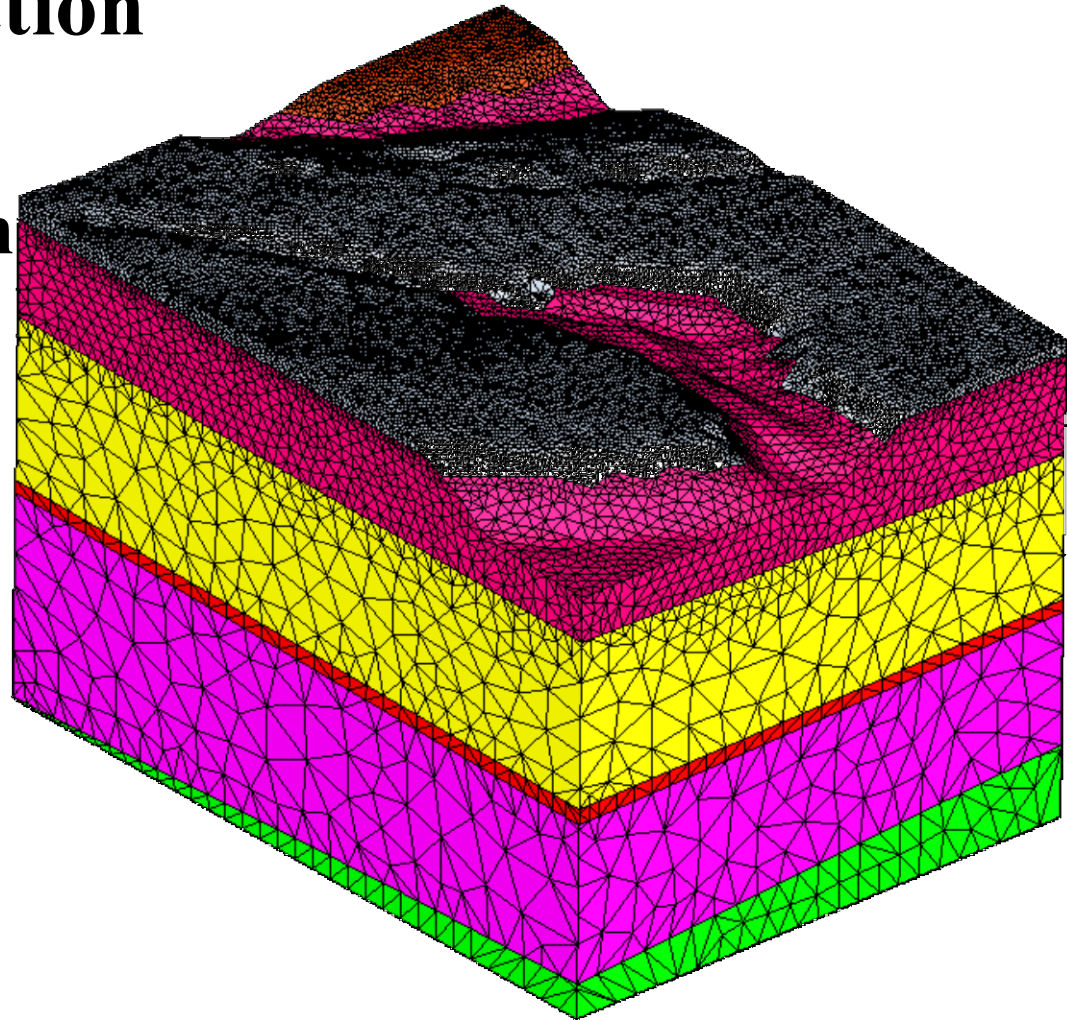
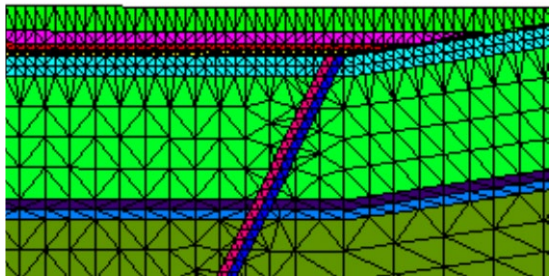
# LaGriT

- **Mesh Generation**
  - **Mesh Optimization**
  - **Geometric Computing**
  - **Element and Node Set Manipulation**
  - **IO, Boundary Conditions, Initial Conditions**
- 

# LaGriT: Mesh Generation

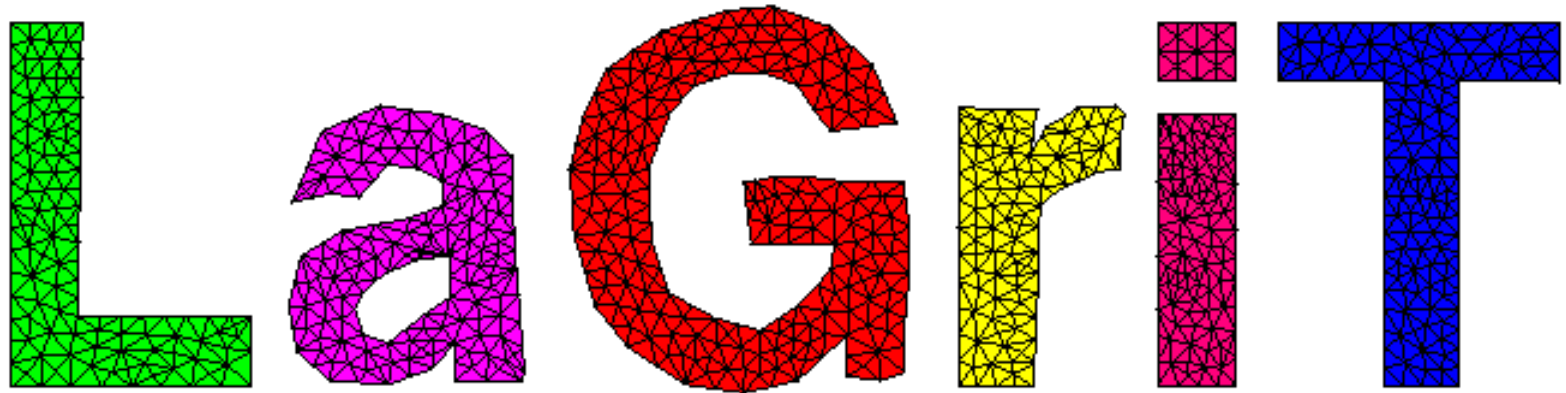
## Delaunay point connection

- 2D triangulation
- 3D tetrahedralization



# LaGriT: Mesh Generation

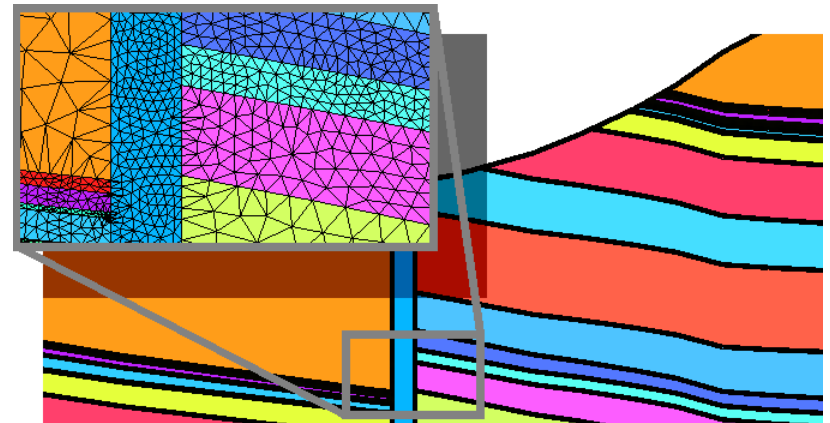
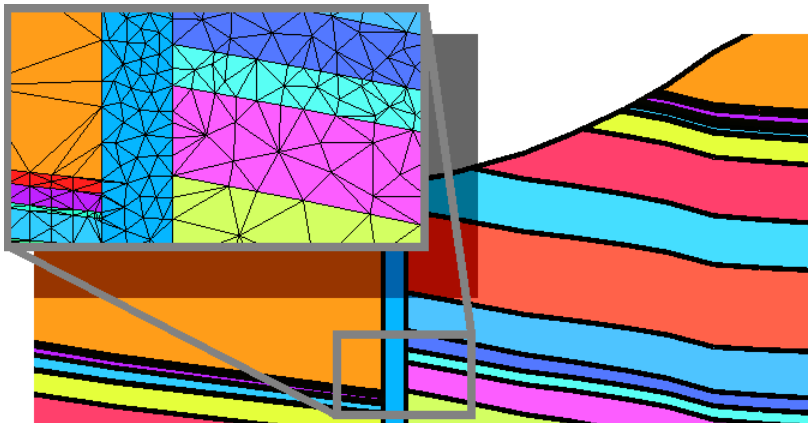
- 2D arbitrary (concave) polygon triangulation





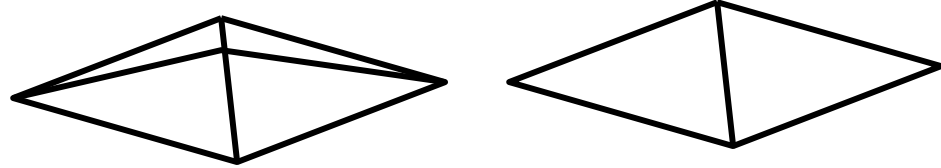
# LaGriT Mesh Optimization

- **Refine**
  - edge, face, element
  - Rivara
- **Refine**
  - field value, field gradient, aspect ratio, volume, arbitrary point

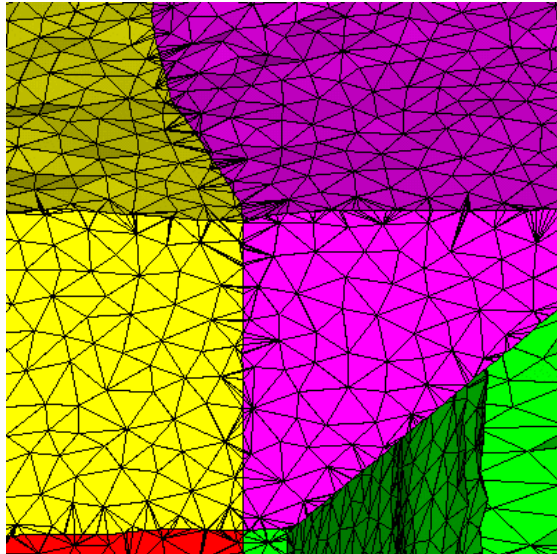


# LaGriT Mesh Optimization

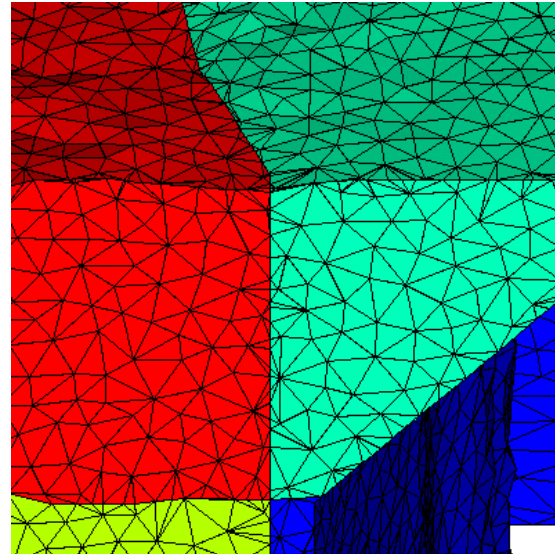
- **Derefine**



– edge length, volume, aspect



**Original Elements**

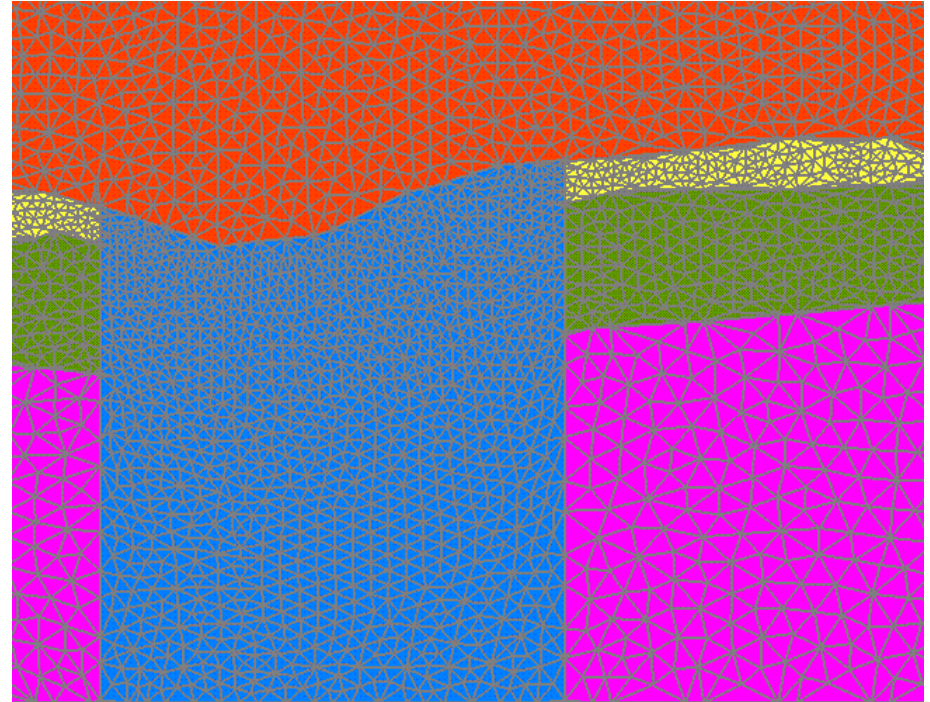
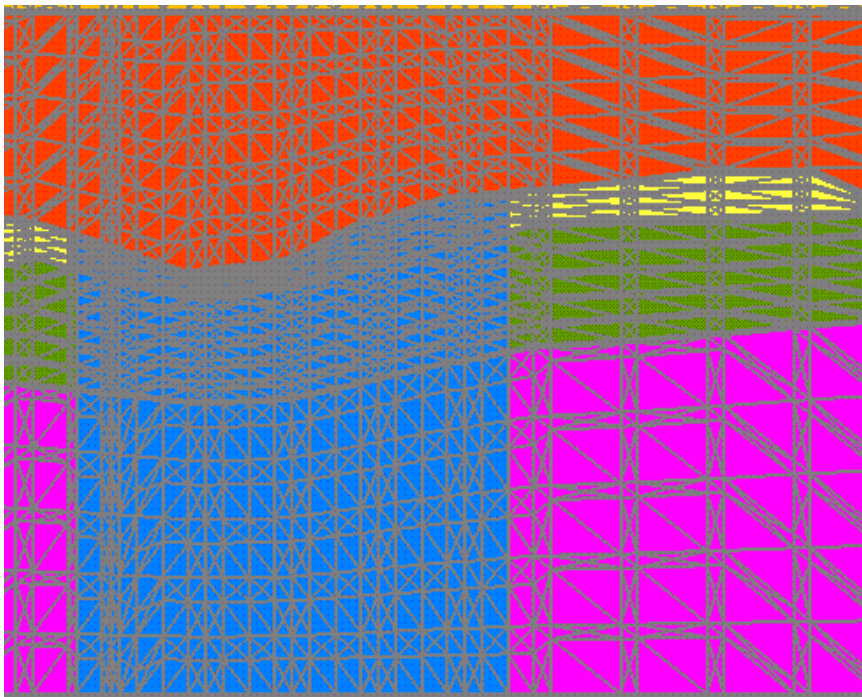


**Filter: Remove small area and high aspect ratio elements while maintaining geometry.**



# LaGriT Mesh Optimization

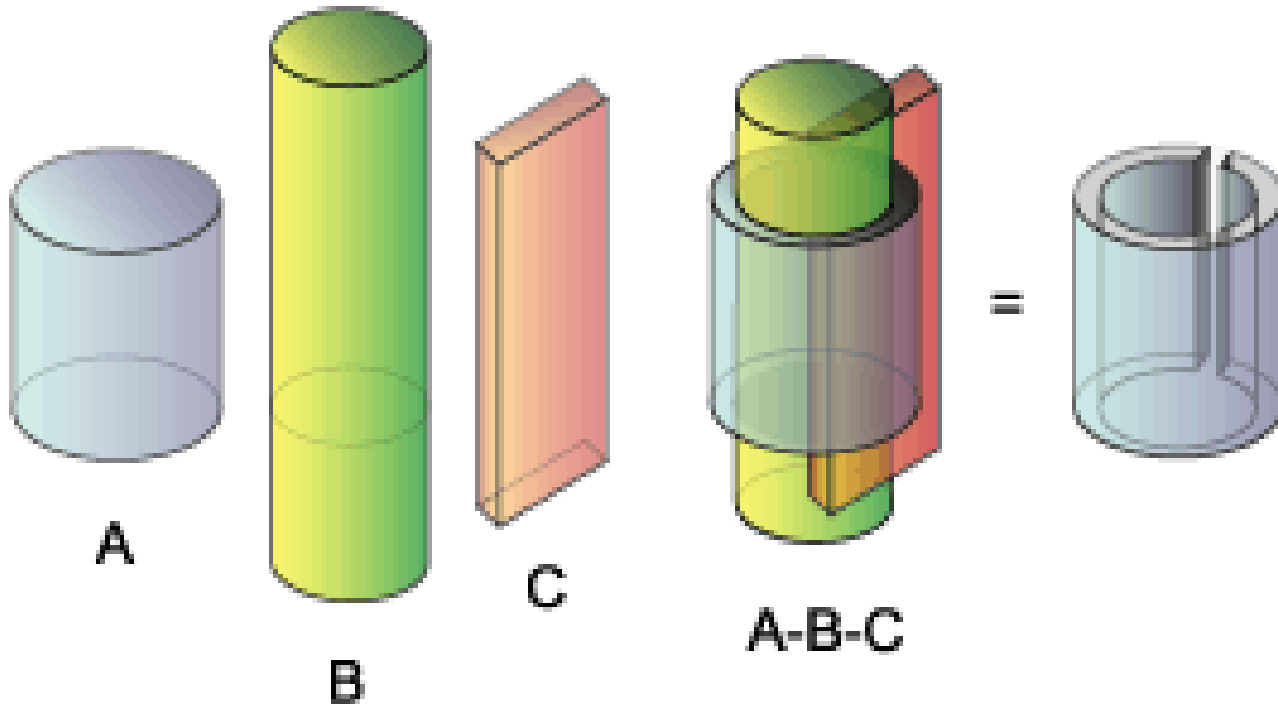
- **Smooth**
  - elliptic, laplace, random
- **Massage - refine-derefine-smooth**





# LaGriT Geometry

- **Constructive Solid Geometry**

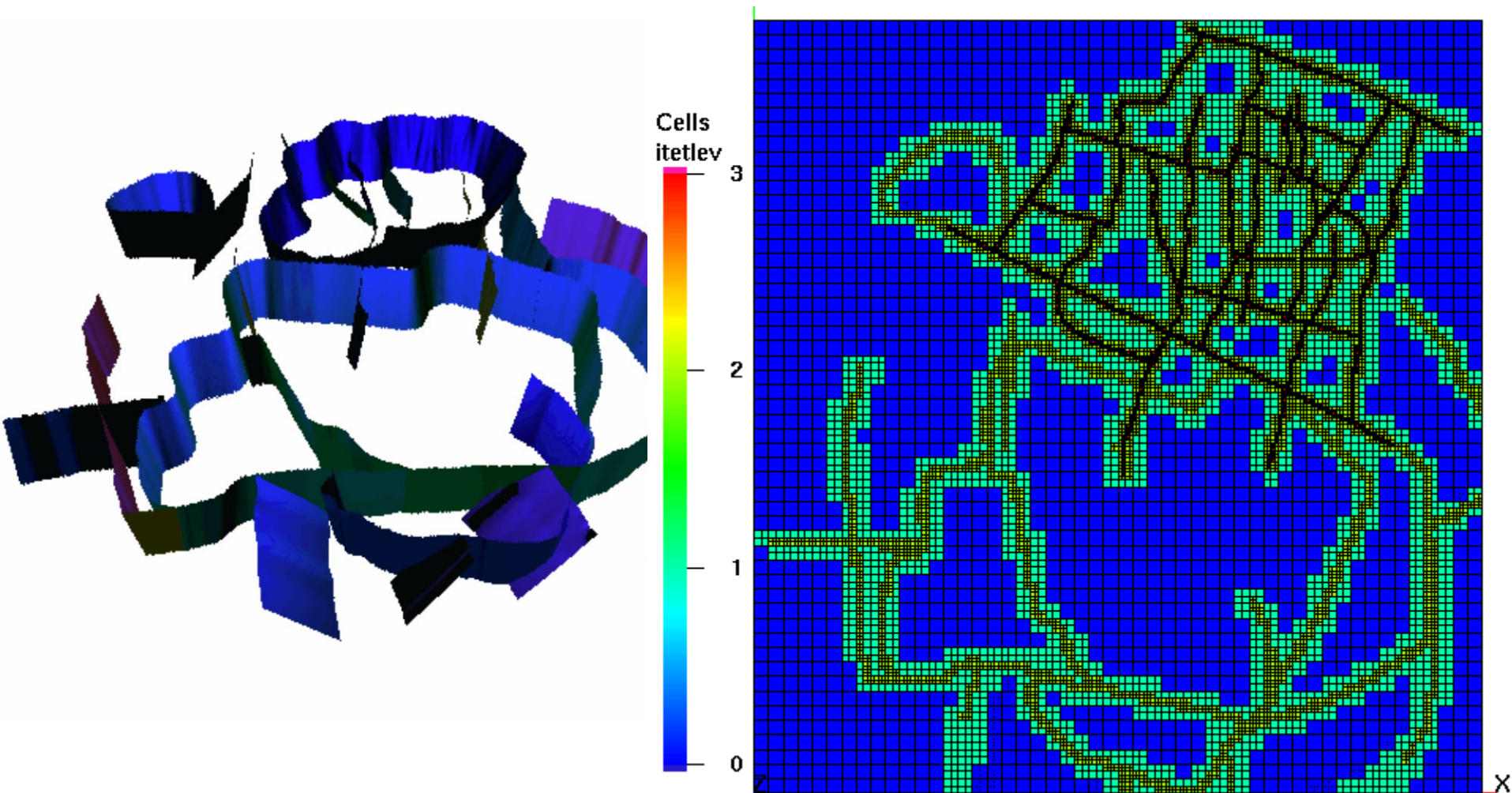


```
surface/s_a/intrface/cylinder/x1,y1,z1/x2,y2,z2/radius  
surface/s_b/intrface/cylinder/x1,y1,z1/x2,y2,z2/radius  
surface/s_c/intrface/box/xmin,ymin,zmin/xmax,ymax,zmax/  
region/r_ring/gt s_c and gt s_b and le s_a
```





# Example: Mesh-2-Mesh Intersect



Intersect fault surfaces with mesh to select elements to be refined with quadtree type **refine**.

# LaGriT Element and Node Set Manipulation

- **Point and Element Sets: PSET, ELTSET**
  - **Attribute: le,lt,ge,gt,eq,ne**
    - *e.g.* nodes/elements with saturation  $> 0.5$
  - **Geometry: xyz, rtz, rtp**
    - *e.g.* nodes/elements inside a box, cylinder, sphere
  - **Region**
    - *e.g.* identify all nodes/elements inside a region
  - **Logical: union, intersect, not**
    - *e.g.* nodes/elements inside a sphere and saturation  $> 0.5$
    - *e.g.* nodes/elements inside a sphere or saturation  $> 0.5$

# LaGriT Element and Node Manipulation Commands

- **Translate**
- **Scale**
- **Rotate: rotatept, rotateIn**
- **Filter**
- **Perturb**
- **Remove**
- **Multi-Key Sort**
- **Reorder**
- **KDTree Search**



# LaGriT Grid Attributes

- **Real and integer node and element attributes**
- **Element area, element volume**
- **aspect ratio, dihedral angle, solid angle, min/max edge length ratio**
- **Identify Sliver, Wedge, Needle, Cap**
- **Unit normal, area normal vector**
- **Synthetic normal to surface nodes**
- **Volume/Area integration of floating point node or cell attributes**
- **Dual mesh connectivity**
- **Voronoi and median volume and face area**

# LaGriT Output Options

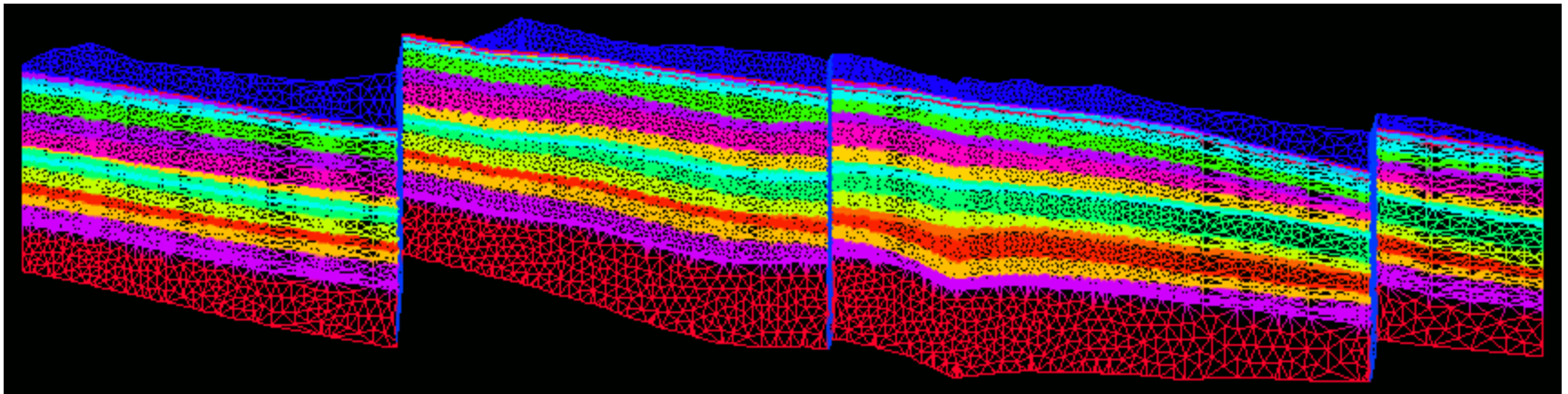
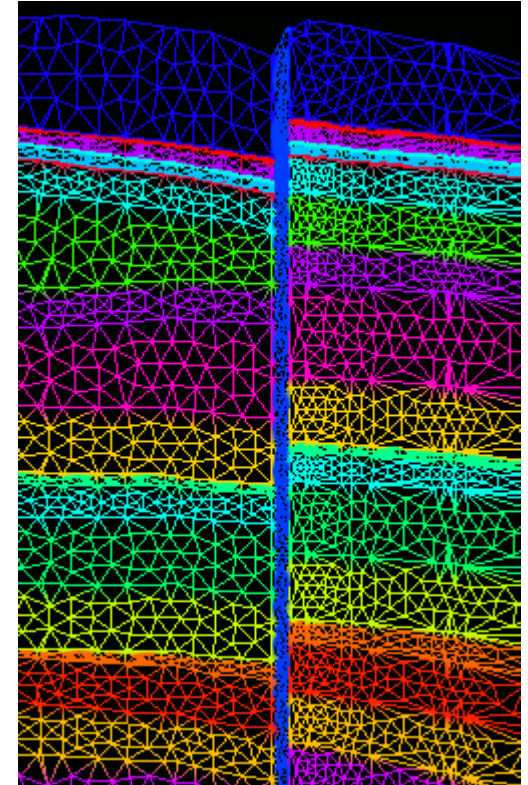
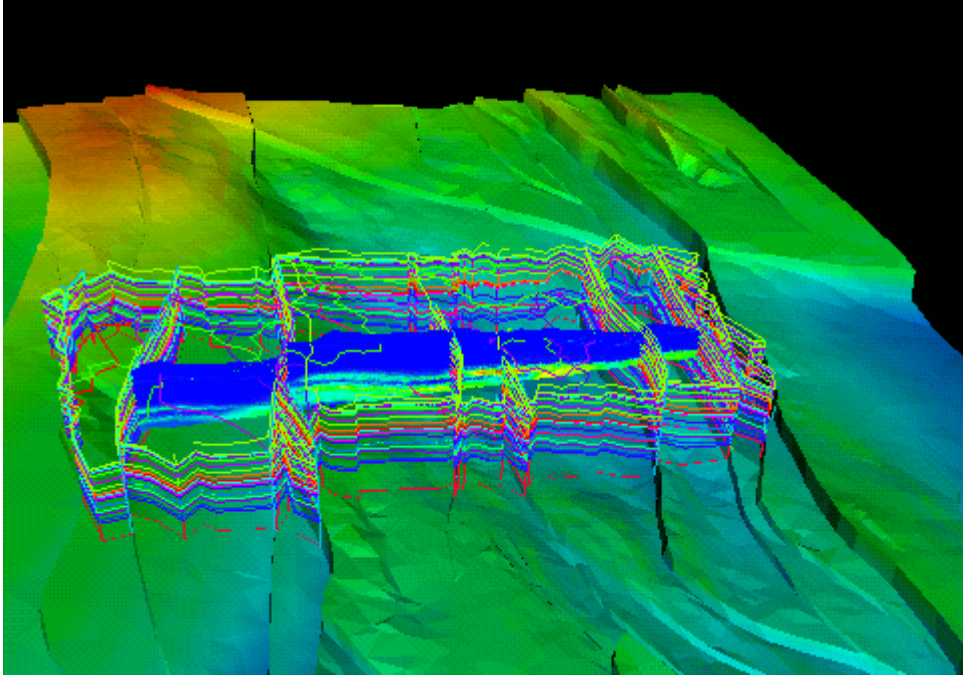
- **PyLith**
- **GeoFEST**
- **FEHM**
- **AVS, GMV, Tecplot**
- **STL, FLAG, X3D**

# Mesh Manipulation

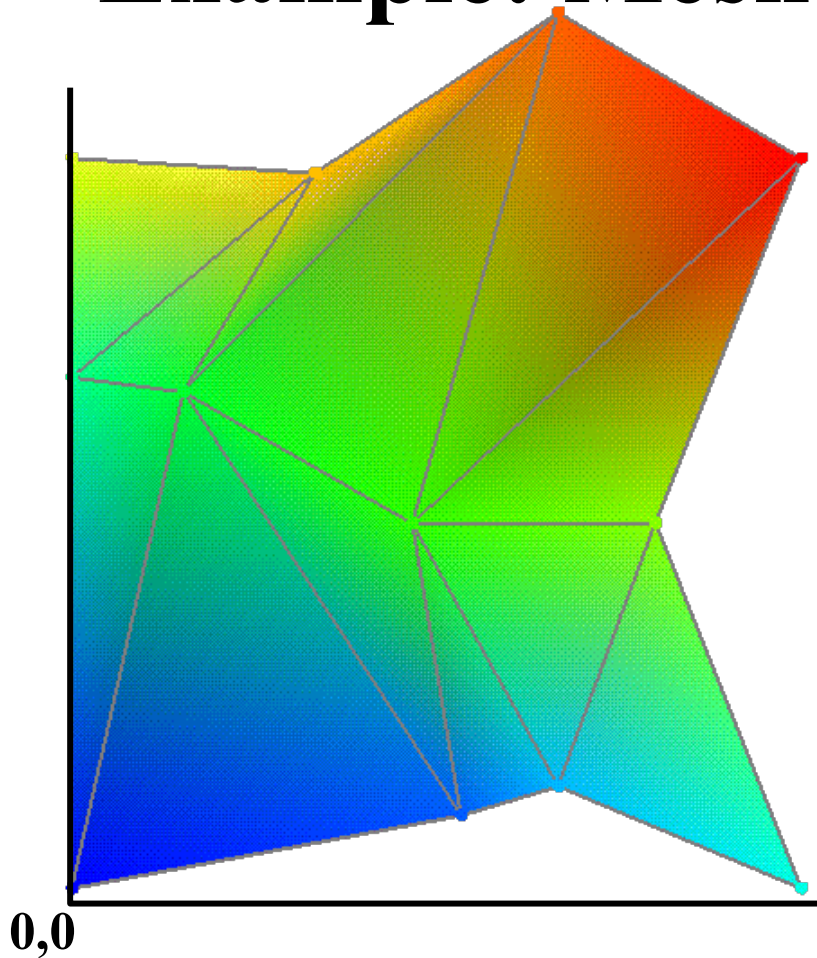
- **Extract Lower D - 3D – 2D – 1D**
  - Volume, Face, Line
- **Extract 2D Surface (plane, isosurface, arbitrary triangulation) from 3D mesh**
- **Extract Line (well bore) from 3D mesh**

# Mesh Manipulation

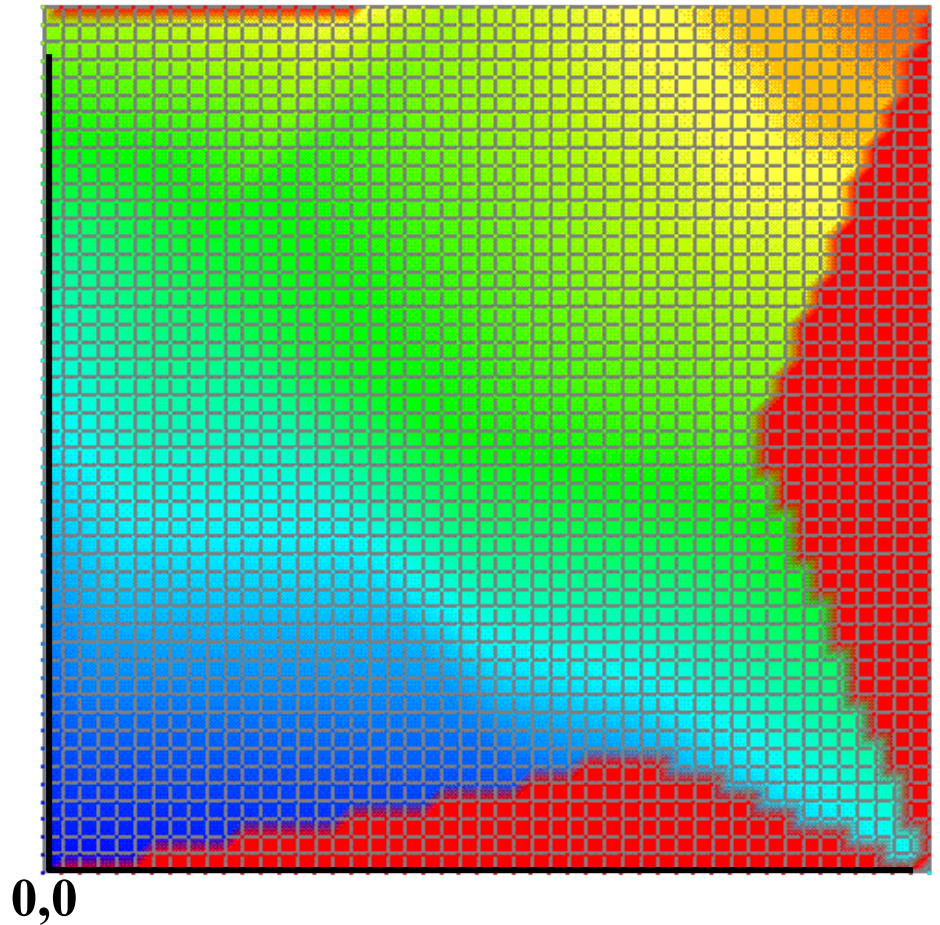
- Extract 2D Surface (plane) from 3D mesh.



# Example: Mesh-2-Mesh Interpolate



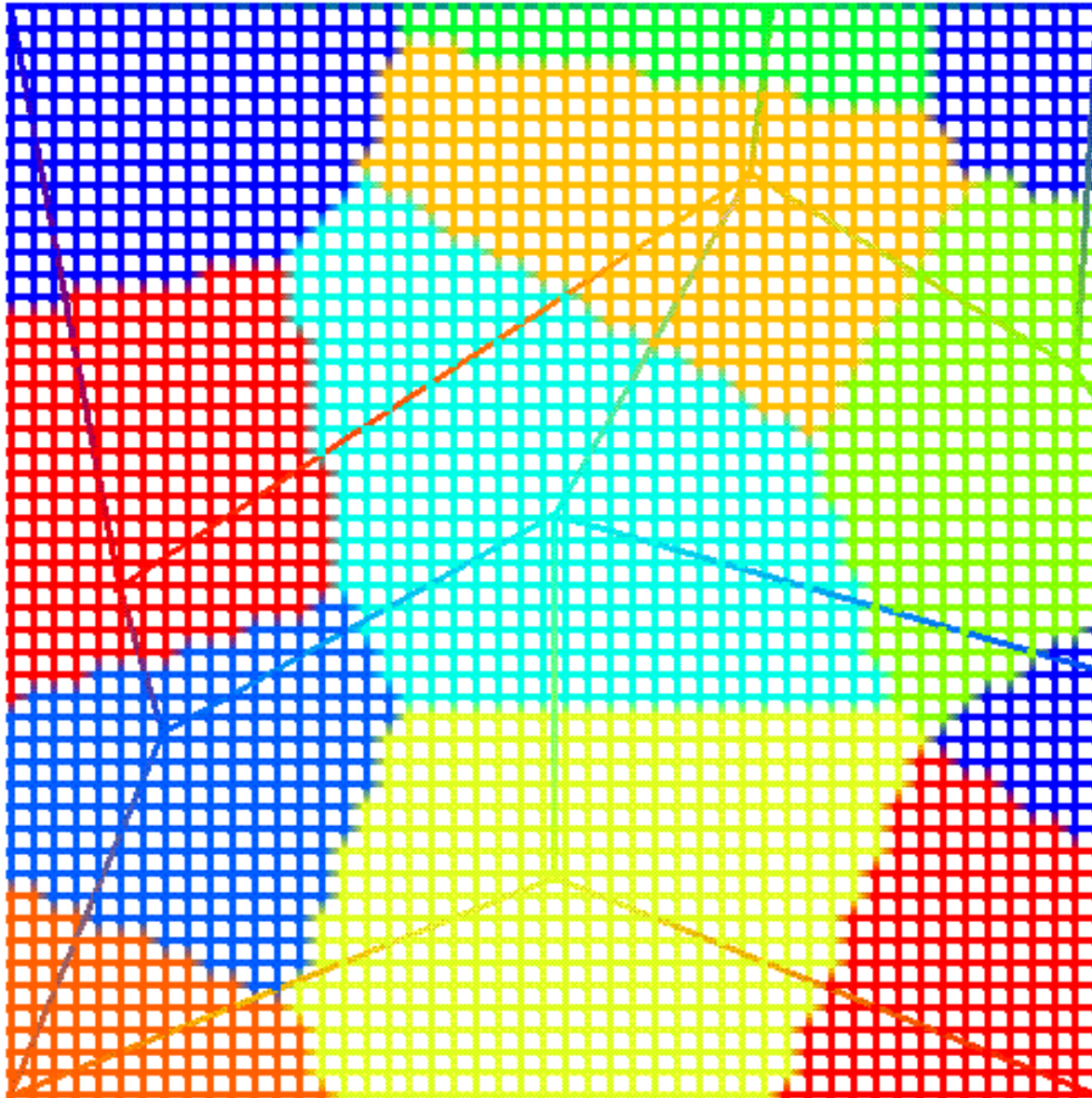
**Source mesh with attribute defined on nodes.**



**Sink mesh with attributes interpolated from source mesh. Nodes in sink mesh outside source mesh are identified.**



# Example Mesh-2-Mesh Interpolation

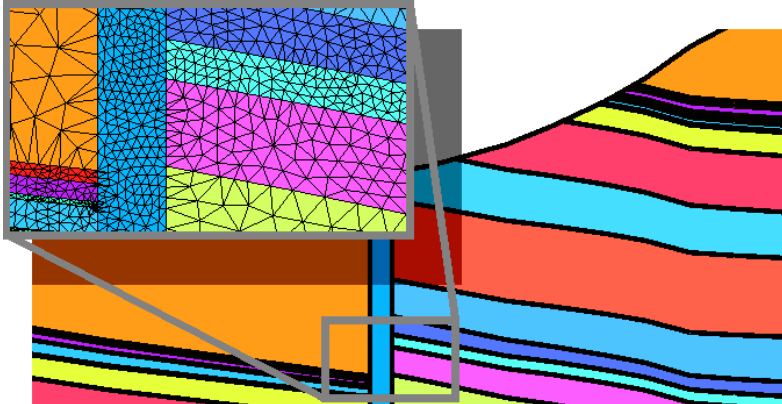
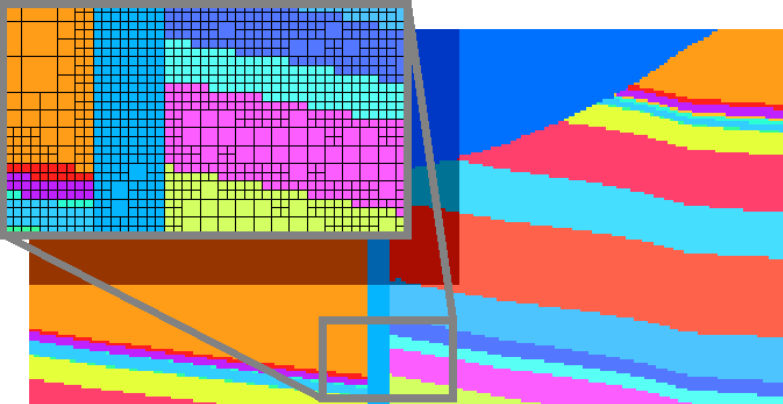
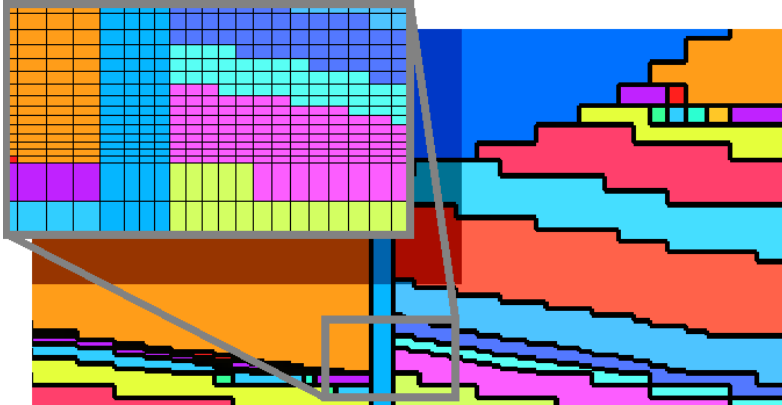
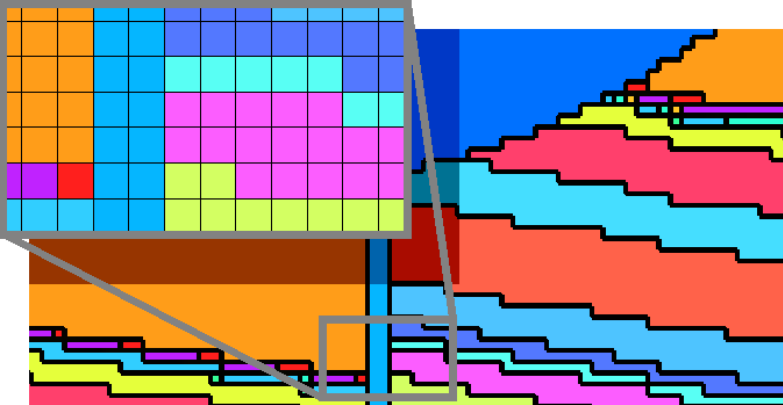
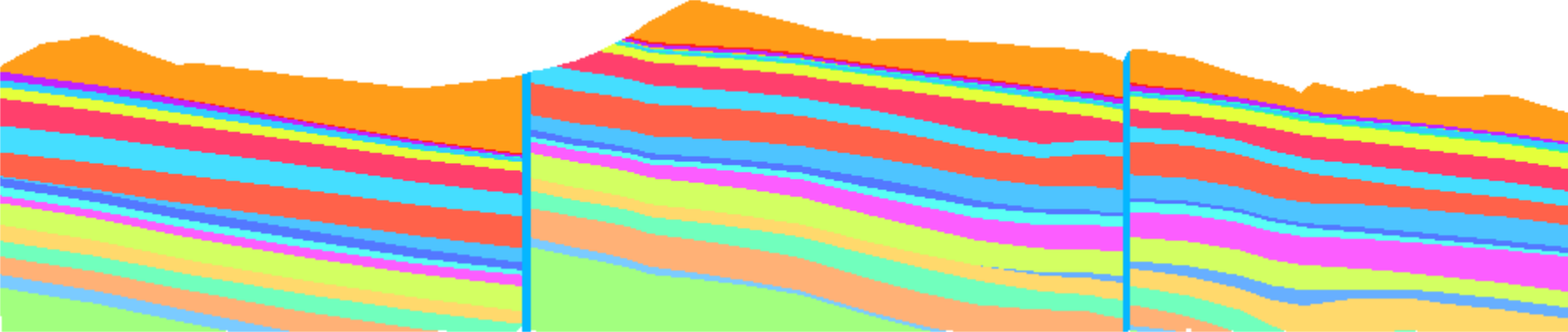


**Voronoi – Nearest  
Point Integer  
Interpolation**

**Colors of fine quad  
mesh indicate  
nearest node of low  
resolution points.**



# Same Geometry, Different Mesh Method



# METIS Interface

- **Supports METIS mesh partition algorithm calls**

Partition:

```
metis /partition/ metis_partmeshnodal / node / 32
```

```
metis /partition/ metis_partmeshdual / dual / 32
```

Reorder:

```
metis / reorder / metis_edgend / dual
```

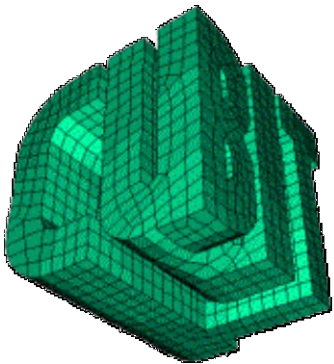
```
metis / reorder / metis_nodend / node
```

# **What is the LaGriT Interface?**

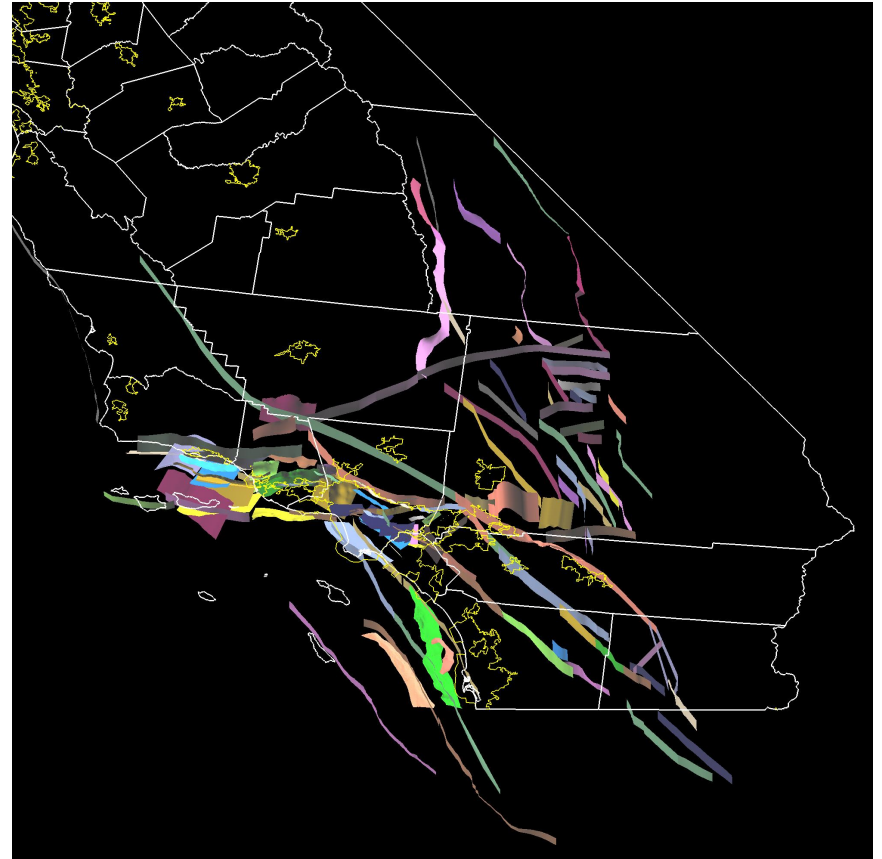
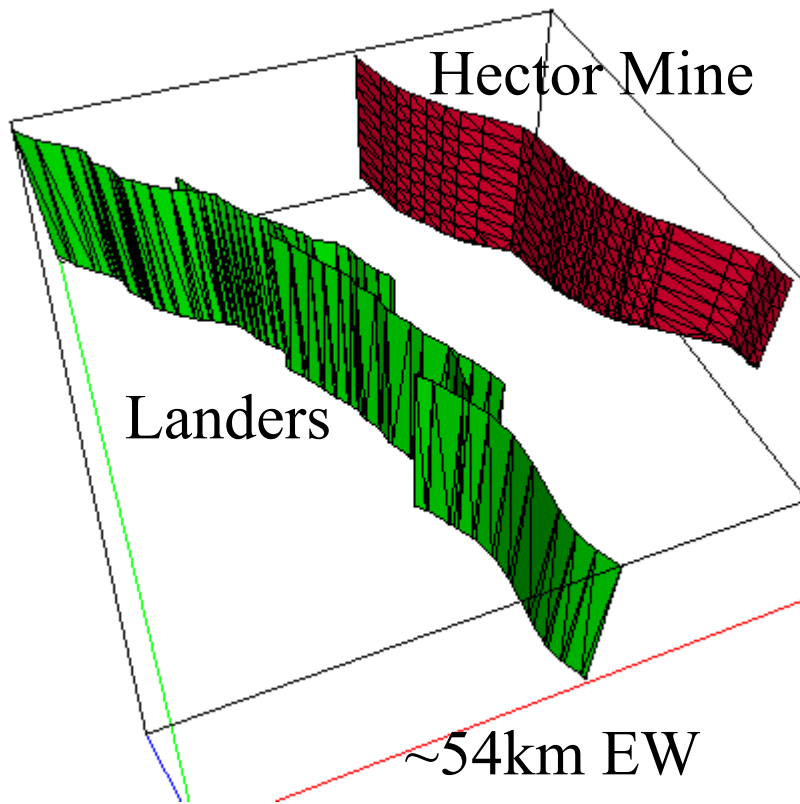
- **Command Line Driven**
- **Control File Driven**
- **Call from Fortran, C, C++**
- **Data structures can be accessed and manipulated by user**
- **Developer interface for extension and user modules**
- **Platforms: Linux, Mac, Sun, SGI**

# What LaGriT Is Not

- **No GUI interface**
- **No advancing front algorithm**
- **No interface for ACIS, Autocad, ... CAD**
- **Not unstructured hex mesh (see Cubit)**



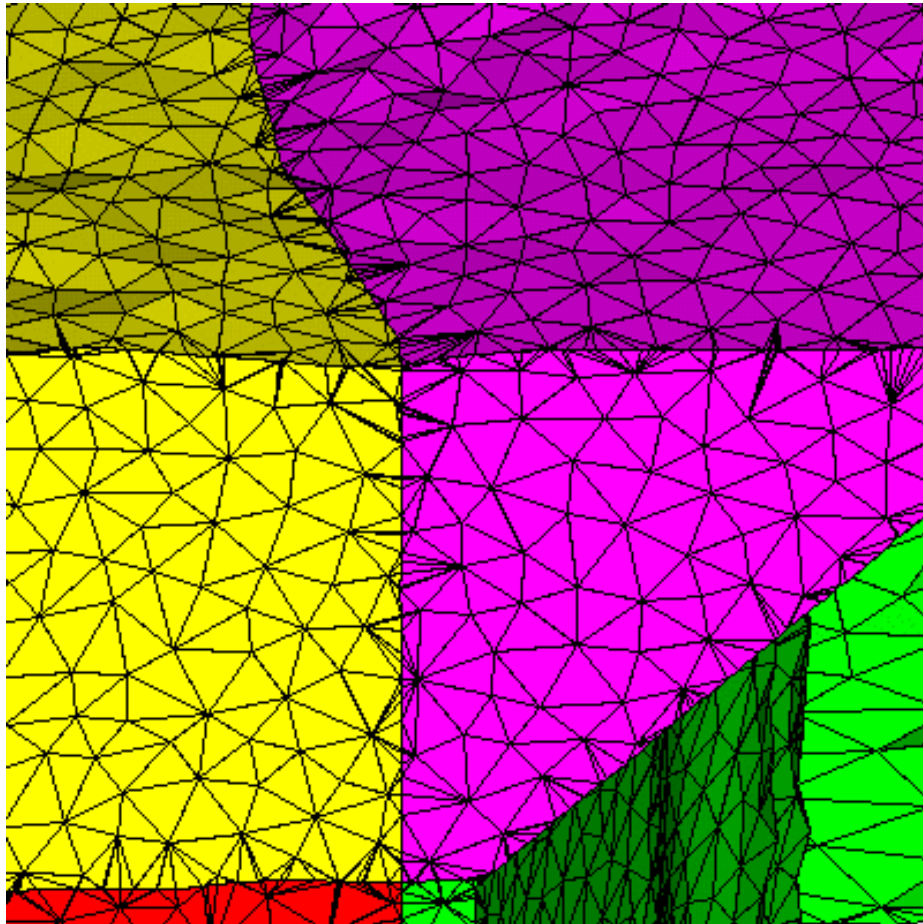
# Southern California Earthquake Center (SCEC) Community Fault Model (CFM)



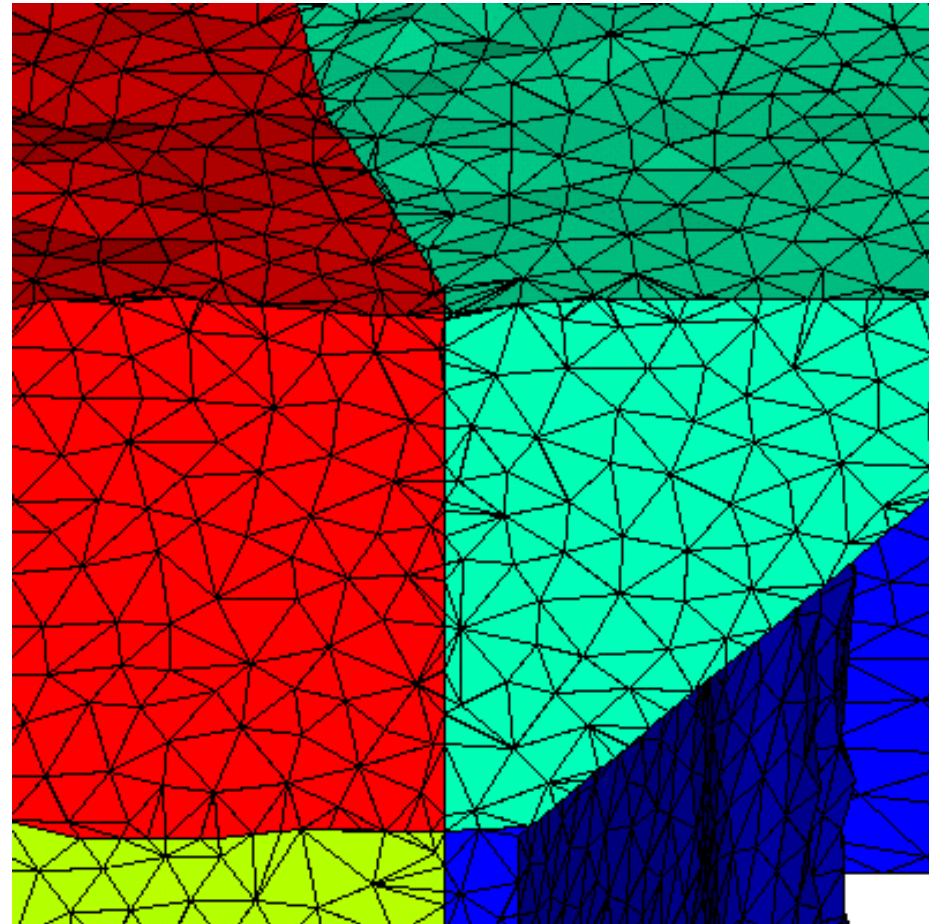




# Mojave Block Model



**Original Block Triangles**



**Filtered Block Triangles:**  
Remove small area and high aspect ratio elements while maintaining geometry.

# LaGriT

[meshing.lanl.gov](http://meshing.lanl.gov)

[lagrit.lanl.gov](http://lagrit.lanl.gov)

