中国地质大学
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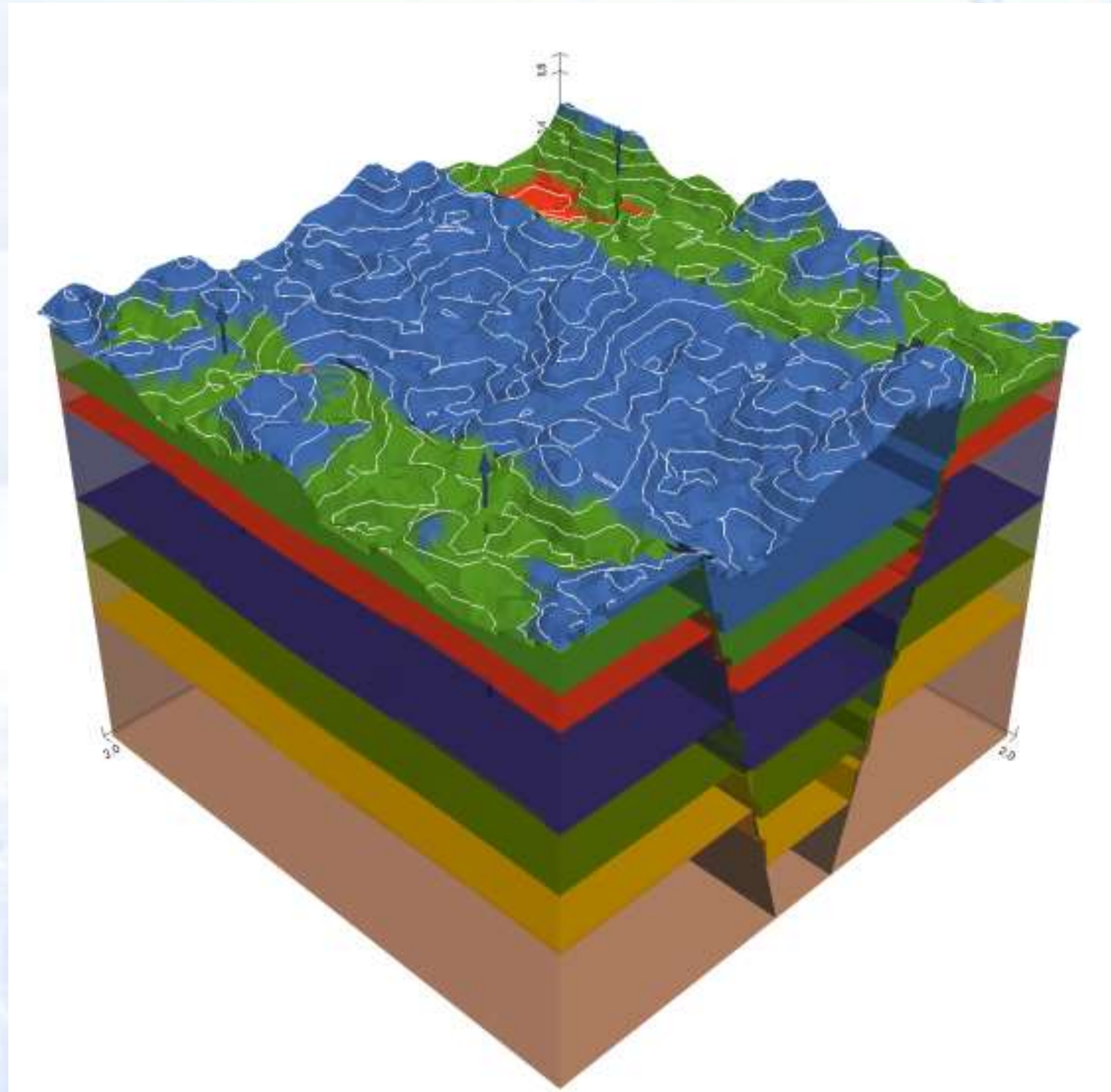
艰苦樸素 求真务實

GemPy （隐式地质建模）

李健

- GemPy的基本原理
- 数字化地质
- GemPy的输入文件



Potential-field method

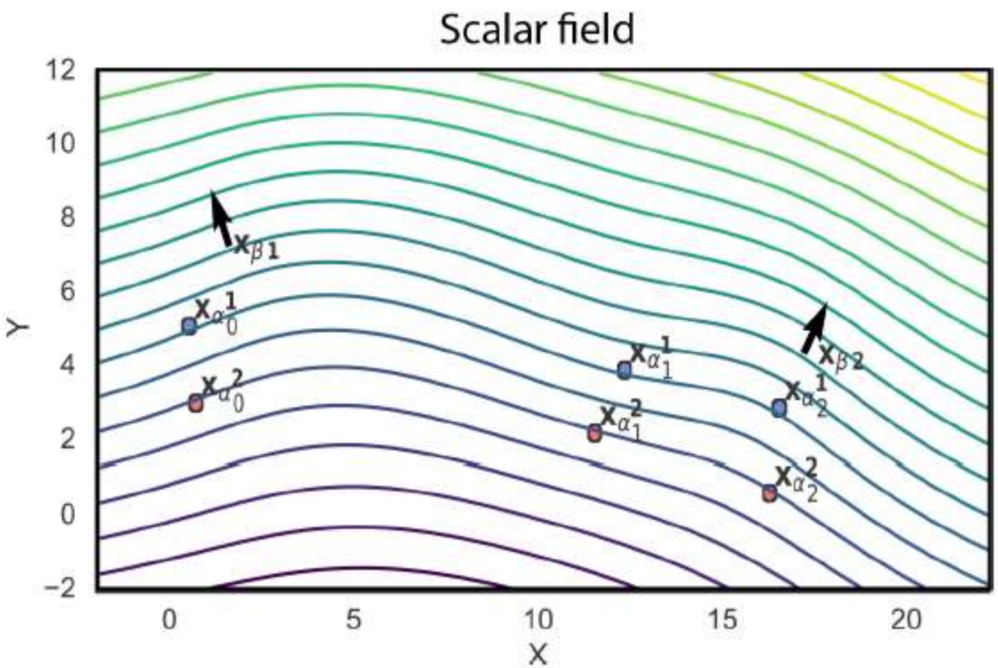


Figure 2. Example of scalar field. The input data are formed by six points distributed in two layers ($x^1_{\alpha\, i}$ and $x^2_{\alpha\, i}$) and two orientations ($x_{\beta\, j}$). An isosurface connects the interface points and the scalar field is perpendicular to the foliation gradient.

Lajaunie et al. (1997)

建立potential-field method是GemPy的生成3D地质模拟的核心方法。

```
import gempy as gp

# Main data management object containing
geo_data = gp.create_data(extent=[0, 20, 0, 10, -10, 0],
                          resolution=[100, 10, 100],
                          path_o="paper_Foliations.csv",
                          path_i="paper_Points.csv")

# Creating object with data prepared for interpolation and compiling
interp_data = gp.InterpolatorData(geo_data)

# Computing result
lith, fault = gp.compute_model(interp_data)

# Plotting result: scalar field
gp.plot_scalar_field(geo_data, lith[1], 5, plot_data=True)

# Plotting result: lithology block
gp.plot_section(geo_data, lith[0], 5, plot_data=True)

# Getting vertices and faces
vertices, simpleces = gp.get_surfaces(interp_data, lith[1], [fault[1]], original_scale=True)
```

Listing 1 生成一个单独的scalar filed模型（图2）和绘制规则网格的一个剖面（图3a），提取界面处的表面点。

从标量场到地质块模型

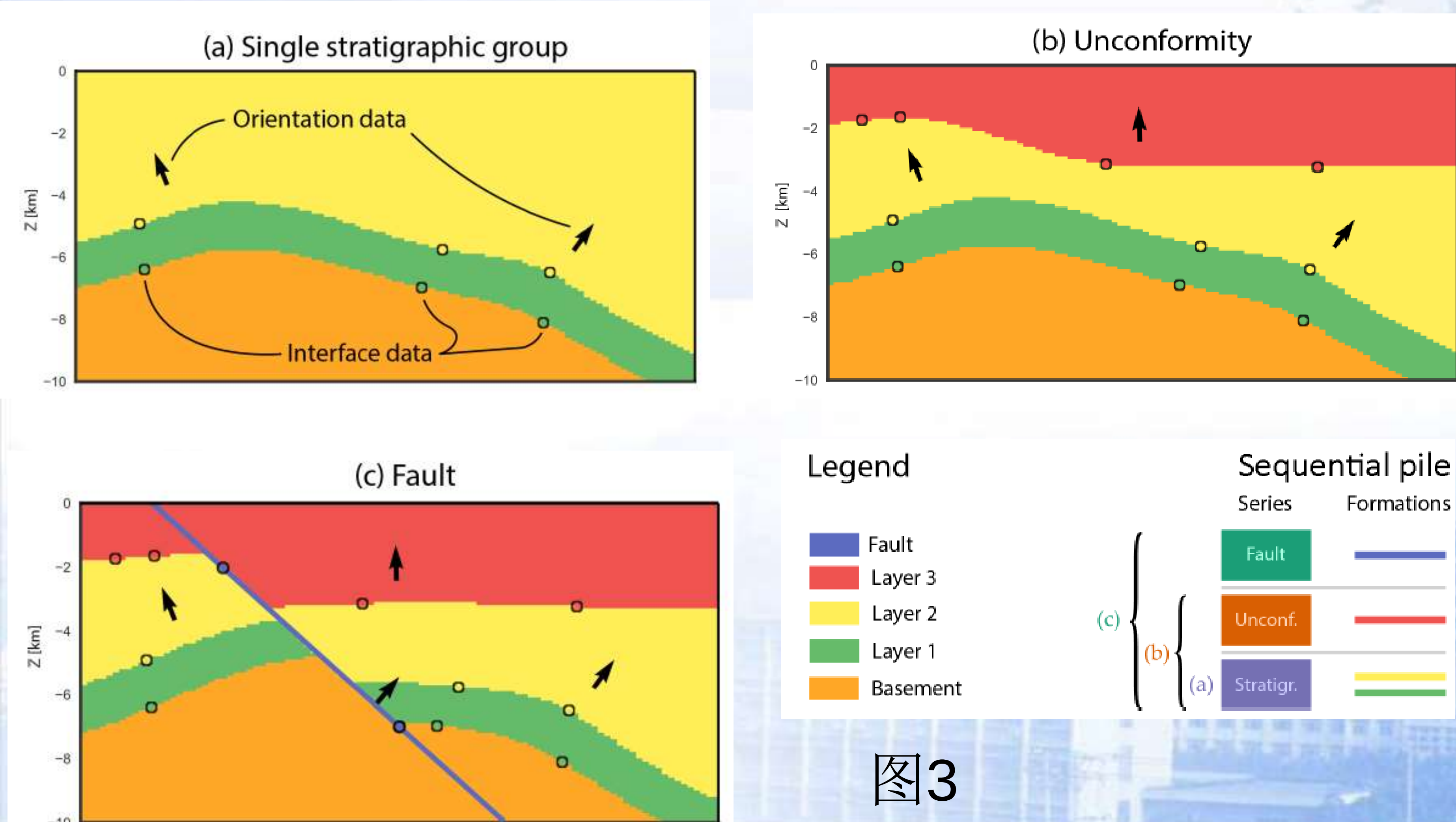
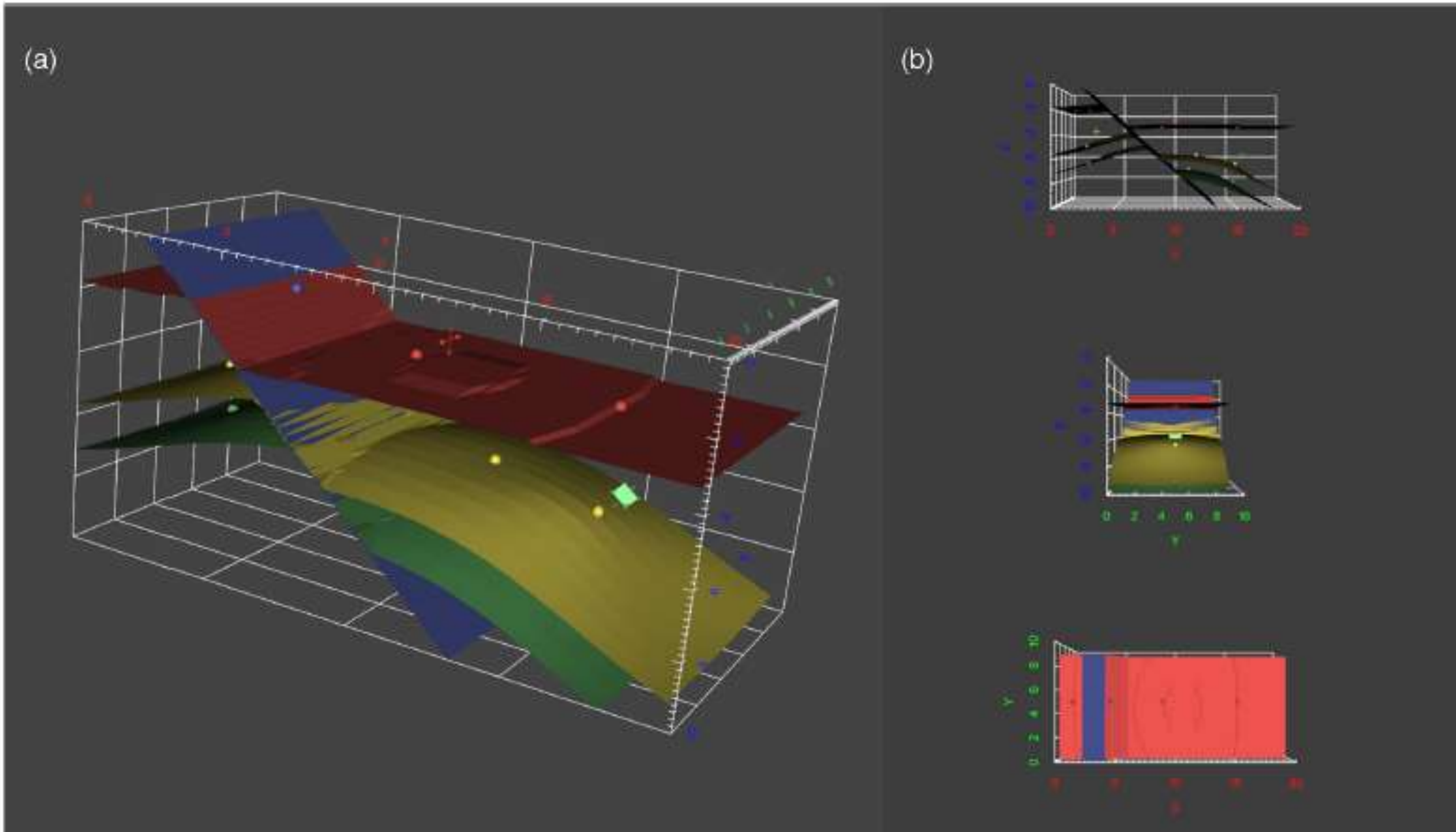


图3



内建的vtk 3D可视化提供交互式地质模型可视化（3个视角）

➢数字化地质 Wikipedia

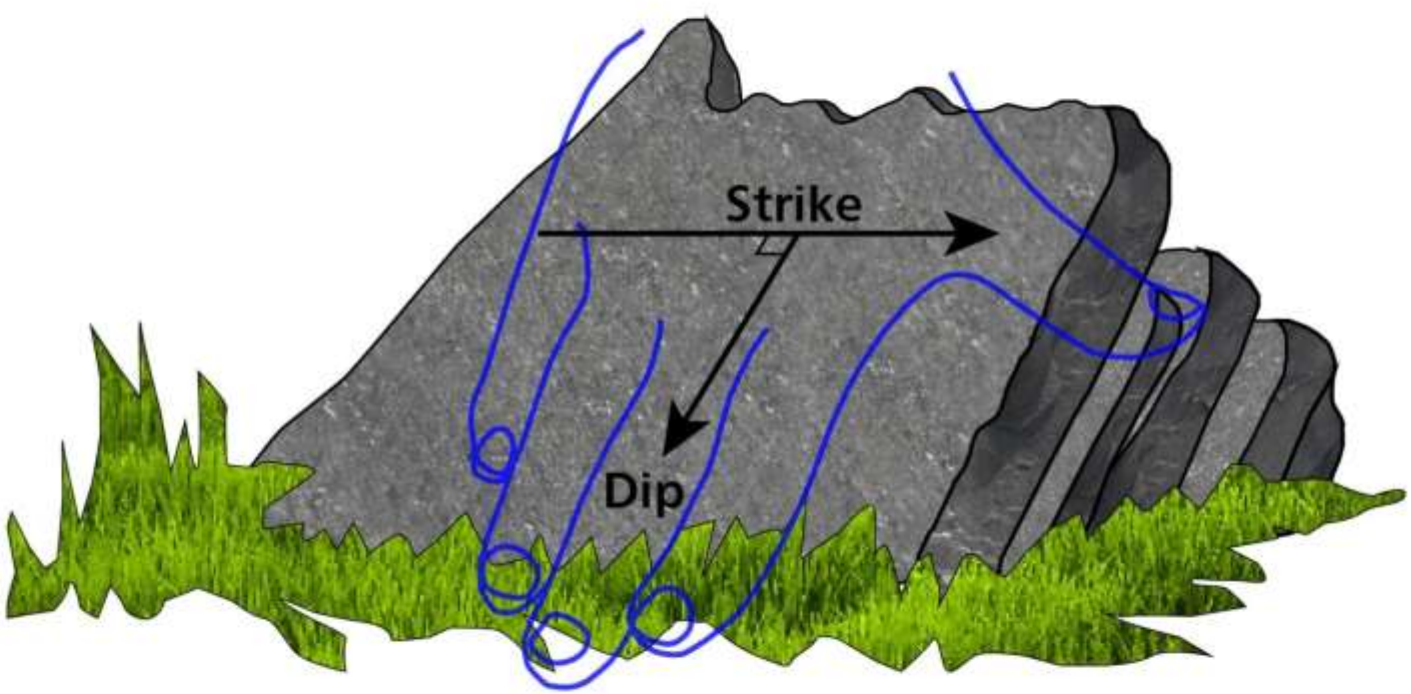
传统的地质图

数字时代的地质图

优点和缺点

李晨阳，王新春，何春珍，吴轩，孔昭煜，李晓蕾. 2019. 全国1：200 000 数字地质图（公开版）空间数据库.中国地质，46(S1):1-10.

右手准则：平面的方向(orientation)朝向观察者的视线，当倾角(dip)朝右


Strike
Dip

露头(Outcrops)的构造分量测量

Planar Structures

Orientation (strike): corresponds to the azimuth of the horizontal line perpendicular to the line of greatest slope of the plane. The orientation is measured in relation to geographic north in a clockwise direction on the horizontal plane. The values are between 0° and 360° where 360° indicates North.

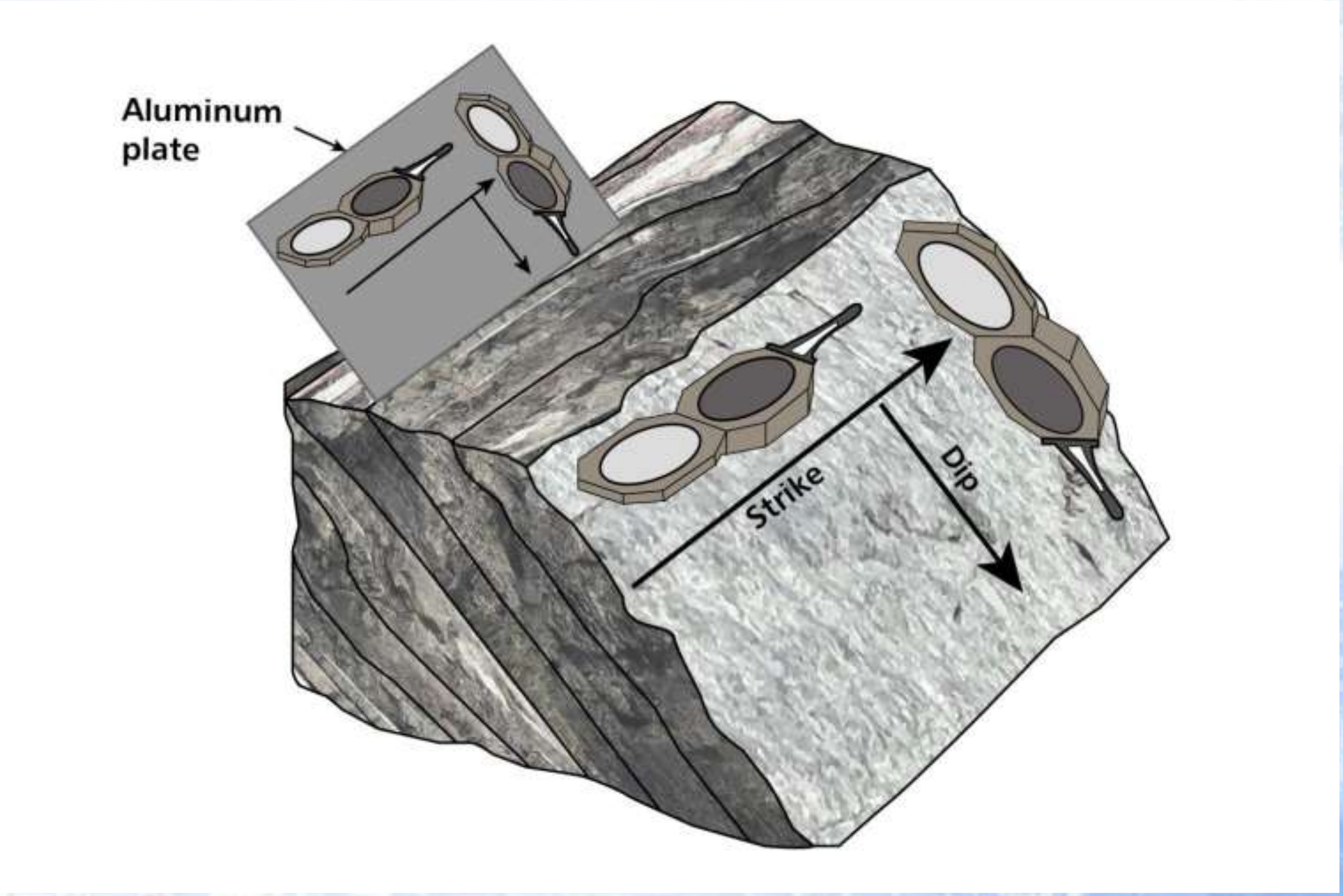
Dip (dip): corresponds to the angle between the line of greatest slope of the plane and the horizontal. The value of the dip is between 0° (horizontal plane) and 90° (vertical plane).

Linear Structures

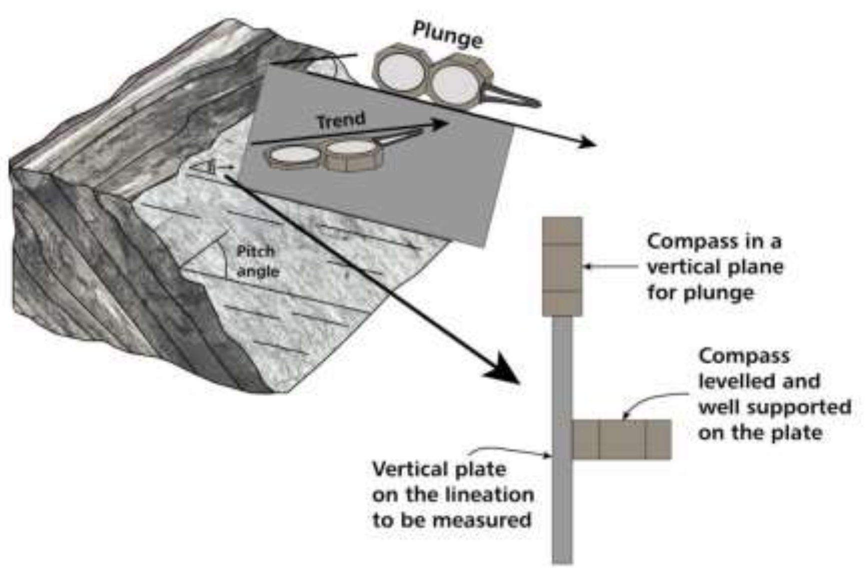
Orientation (trend): corresponds to the azimuth of the vertical plane that contains the line in the direction of its plunge. The orientation is measured in relation to geographic north in a clockwise direction on a horizontal plane. The values are between 0° and 360° where 360° indicates North.

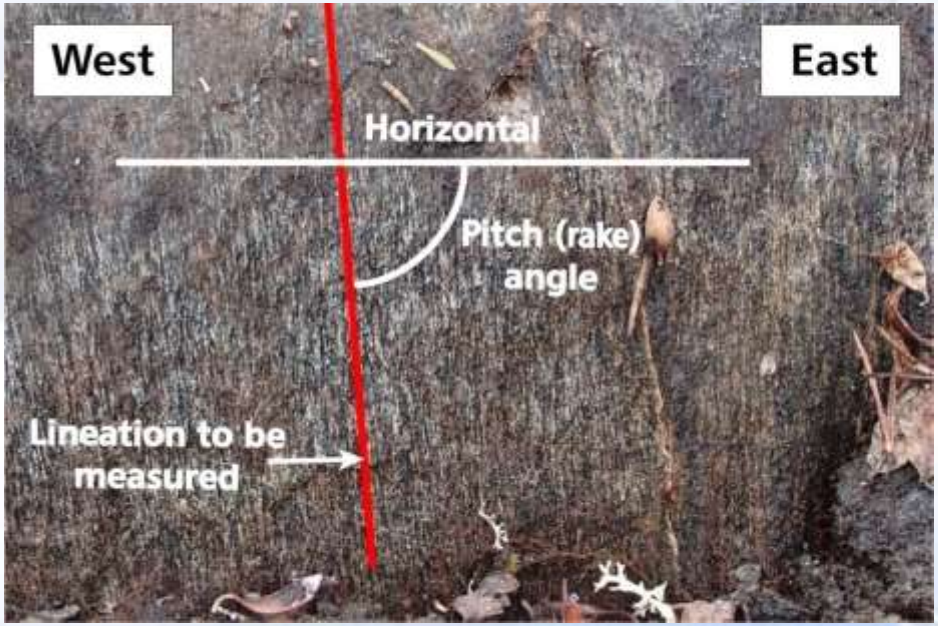
Dip (plunge): corresponds to the angle of the lineation with respect to the horizontal. The value of the plunge is between 0° and 90° and may not exceed the value of the dip of the plane on which it is measured.

平面构造的测量

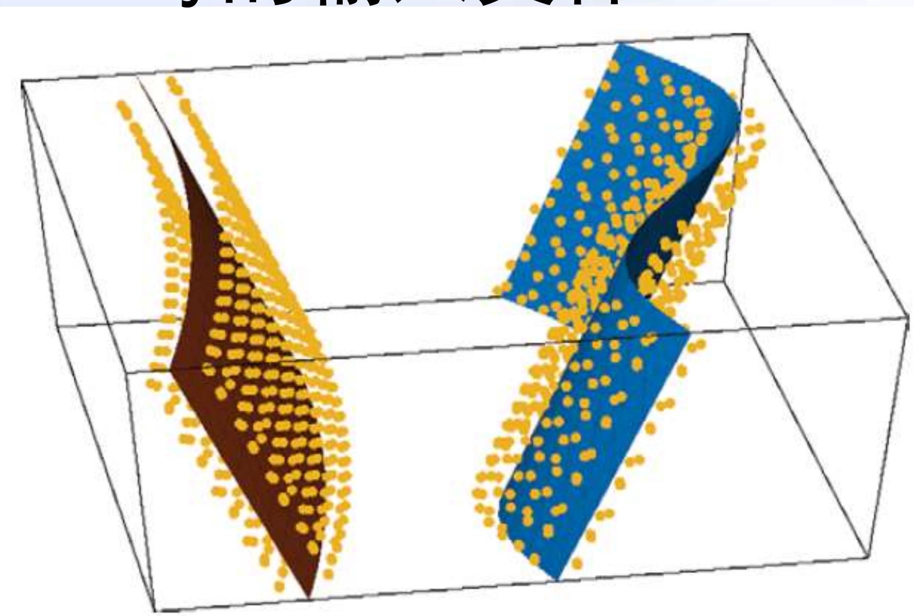


线状构造的测量 （有两种方法）

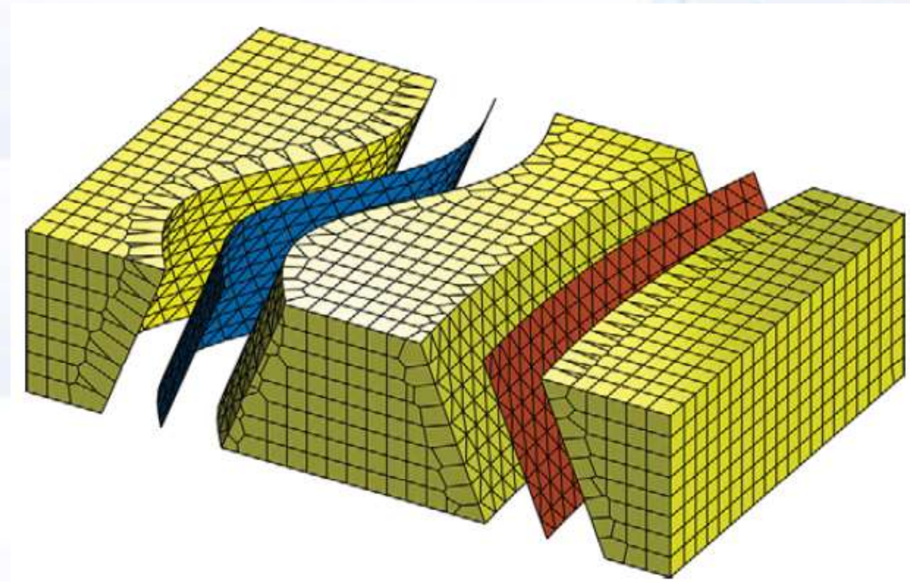




GemPy的输入文件



2个断层的位置示意



考虑断层的PEBI网格

Fault： dip, polarity, azimuth, orientation

Formation （产状）

Foliation

Questions

- 测井、录井、地震剖面建立地质模型？导入MRST？
- 使用MRST生成角点网格，生成ECLIPSE输入文件（ASCII)？
- 断层数据的理解？

fault_depth.csv
fault_line.csv
height.csv
res_depths.csv

```
366613.3427,6248316.475,473
366594.1636,6248292.617,473.12
366562.4445,6248248.259,473.24
366537.8795,6248215.831,473.36
366503.0092,6248167.478,473.48
366471.276,6248131.648,473.6
366442.8716,6248061.786,473.72
366442.306,6248085.981,473.84
```

Gempy的输入文件格式：

Fault.csv

```
X,Y,Z,formation
551308.0638427734,7817436.131347656,-9982.79296875,Claudius_fault
551332.5639648438,7817579.006347656,-9904.140625,Claudius_fault
551369.22265625,7817557.0078125,-9829.345703125,Claudius_fault
551392.1899414062,7817380.302246094,-9829.375,Claudius_fault
```

Moureze_Points.csv

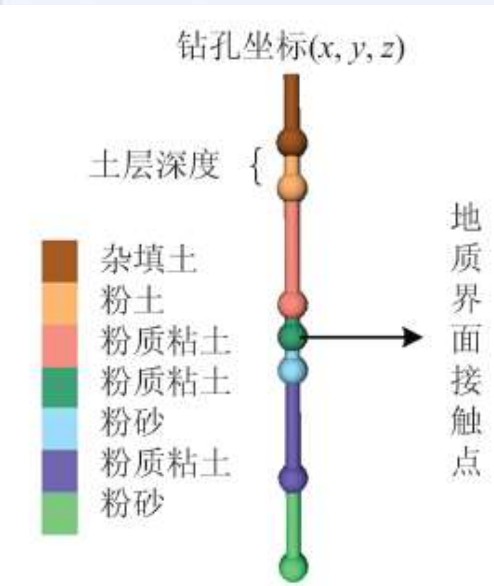
```
X;Y;Z;OrientX;OrientY;OrientZ
272.000000;86.000000;-149.12;-99999.000000;-99999.000000;-99999.000000
256.198395;344.000000;-100;0.671273;0.641262;0.371719
236.000000;17.083025;-90;-99999.000000;-99999.000000;-99999.000000
199.974075;351.877136;-157.355;0.447513;0.563921;0.694065
```

Paper_GU2F_sc_faults_topo_Foliations.csv

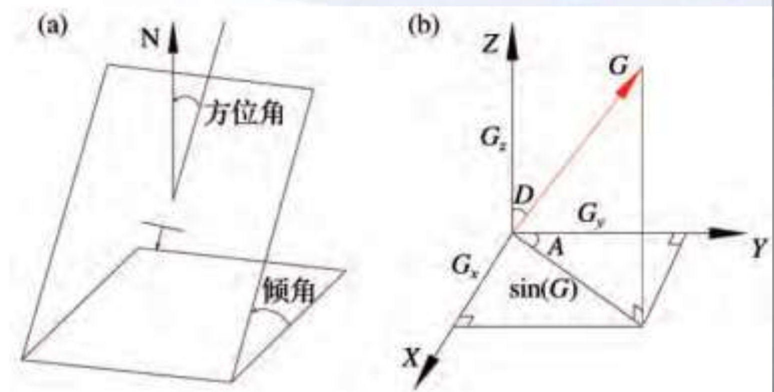
```
X,Y,Z,azimuth,dip,polarity,formation
393936.142320,6693632.776940,957.702303,263.276747,1.193492,1,Permian
396918.892567,6693984.396839,977.204803,83.276747,0.349367,1,Permian
351487.758871,6688628.772226,-7385.646697,83.277000,6.546000,1,Permian
338518.168564,6650708.570891,-4542.306605,256.590252,1.789915,1,Permian
397464.032464,6663077.533819,959.378895,268.100891,1.432093,1,Permian
```

Paper_GU2F_sc_faults_topo_Foliations.csv

```
X,Y,Z,azimuth,dip,polarity,formation
393936.142320,6693632.776940,957.702303,263.276747,1.193492,1,Permian
396918.892567,6693984.396839,977.204803,83.276747,0.349367,1,Permian
351487.758871,6688628.772226,-7385.646697,83.277000,6.546000,1,Permian
338518.168564,6650708.570891,-4542.306605,256.590252,1.789915,1,Permian
397464.032464,6663077.533819,959.378895,268.100891,1.432093,1,Permian
```



(a) 钻孔数据



$$\begin{cases} G_j^x = \sin(D) \times \sin(A) \times Polarite \\ G_j^y = \sin(D) \times \cos(A) \times Polarite \\ G_j^z = \cos(D) \times Polarite \end{cases}$$