(6) Plotting routines

March 1, 2022

0.0.1 (6) Plotting routines

All the plotting routines for the full model, note that GemPy model needs to be recalculated here.

[2]:
```python
# Import dependencies
import gempy as gp
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import copy
import gstools as gs
import pyvista as pv
import pyvistaqt as pvqt
import PVGeo
import matplotlib

import warnings
warnings.filterwarnings("ignore")

pd.set_option('display.precision', 2)
```

```
WARNING (theano.configdefaults): g++ not available, if using conda: `conda
install m2w64-toolchain`
C:\Users\Ariel\anaconda3\lib\site-packages\theano\configdefaults.py:560:
UserWarning: DeprecationWarning: there is no c++ compiler.This is deprecated and
with Theano 0.11 a c++ compiler will be mandatory
  warnings.warn("DeprecationWarning: there is no c++ compiler."
WARNING (theano.configdefaults): g++ not detected ! Theano will be unable to
execute optimized C-implementations (for both CPU and GPU) and will default to
Python implementations. Performance will be severely degraded. To remove this
warning, set Theano flags cxx to an empty string.
WARNING (theano.tensor.blas): Using NumPy C-API based implementation for BLAS
functions.
```

0.0.2 1. Reload and recalcualte Geo-structural model

[ ]:
```python
# Load model from notebook (2)
geo_data = gp.load_model('Geo-structural model NJ shelf')

# Set interpolator
interp_data = gp.set_interpolator(geo_data, compile_theano=True,
                                  theano_optimizer='fast_compile')

# Compute model solution
sol = gp.compute_model(geo_data)
```

```
Active grids: ['regular']
Setting kriging parameters to their default values.
Compiling theano function…
Level of Optimization:  fast_compile
Device:  cpu
Precision:  float64
Number of faults:  0
Compilation Done!
Kriging values:
                                        values
range                                150731.18
$C_o$                              540949761.9
drift equations  [3, 3, 3, 3, 3, 3, 3, 3, 3]
```

0.0.3 2. Loading porosity well data)

[4]:
```python
# Load data
df = pd.read_csv("Data/Wells/Complete_set_corrected.csv")
df.head()
```

[4]:

	X	Y	Z	Porosity	Sequence	Well
0	28200	76200	-372.13	10.7	m54	m28
1	28200	76200	-568.73	13.3	m58	m28
2	28200	76200	-671.83	15.0	m58	m28
3	28200	76200	-693.95	15.6	m58	m28
4	28200	76200	-692.00	16.0	m58	m28

0.0.4 3. Loading realization of porosity model

[32]:
```python
results_df = pd.read_csv("Results/Model_realization_20210728.csv")
results_df.head()
```

[32]:

	X	Y	Z	Porosity	Sequence
0	250.0	250.0	-30.0	43.23	m1
1	250.0	750.0	-30.0	37.98	m1

```
2  250.0  1250.0 -30.0     35.32       m1
3  250.0  1750.0 -30.0     37.96       m1
4  250.0  2250.0 -30.0     38.46       m1
```

0.0.5 4. Plotting full 3D model

[5]:
```
# Plot full model without gempy

#cmap = plt.cm.get_cmap("viridis", 6)
p = pvqt.BackgroundPlotter()

pc = pv.PolyData(np.c_[results_df["X"].values, results_df["Y"].values,␣
↪results_df["Z"].values])

pc["Porosity"]=results_df["Porosity"].values

spacing = lambda arr: np.unique(np.diff(np.unique(arr)))
voxelsize = spacing(pc.points[:,0]), spacing(pc.points[:,1]), spacing(pc.
↪points[:,2])

pc = pc.cast_to_unstructured_grid()

grid = PVGeo.filters.VoxelizePoints(dx=voxelsize[0][0], dy=voxelsize[1][0],␣
↪dz=voxelsize[2][0], estimate=False).apply(pc)

#p.add_mesh(grid, opacity=1, show_edges=False, lighting=False, cmap=cmap)
p.add_mesh(grid, opacity=1, show_edges=False, lighting=False, cmap="viridis")

p.set_scale(zscale=30)
p.camera_position = (320, 200, 3)
p.show_grid(xlabel="X [m]", ylabel="Y [m]", zlabel="Z [m]")

p.show()
```

[6]:
```
# Plot full model with gempy

gpv = gp.plot_3d(geo_data, plotter_type='background', show_data=False,␣
↪show_surfaces=False, show_lith=True)
cmap = plt.cm.get_cmap("viridis", 10)

gpv.p.add_mesh(grid, opacity=2, show_edges=False, lighting=False, cmap=cmap)
#gpv.p.add_mesh(grid, opacity=1, show_edges=False, lighting=False,␣
↪cmap="viridis")

gpv.p.show_grid(xlabel="X [m]", ylabel="Y [m]", zlabel="Z [m]")
gpv.p.hide_axes_all()
```

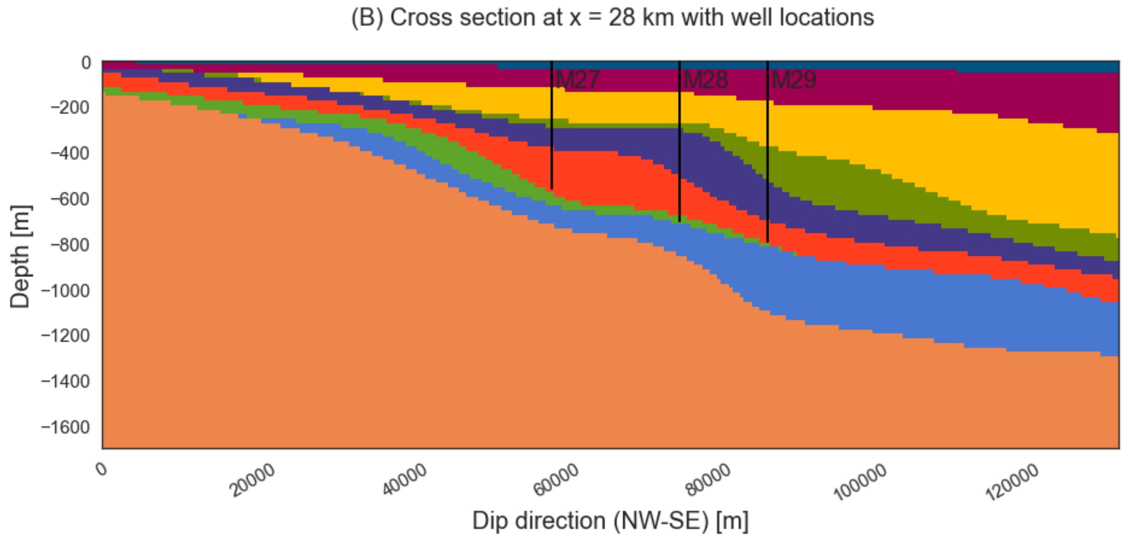
```
gpv.p.set_scale(zscale=30)
gpv.p.camera_position = (320, 200, 3)

gpv.p.show()
```

0.0.6 5. Plotting structural sections

[7]:
```
# Dip section at cell n=56, roughly well location
n = 56

fig=plt.figure()

fig.p = gp.plot_2d(geo_data, cell_number=n, direction="x", show_data=False,␣
↪show_lith=True, show_boundaries=False,
                    ve=30, figsize=(14,5))

fig.p.axes[0].set_xlim(geo_data.grid.regular_grid.extent[2], geo_data.grid.
↪regular_grid.extent[3])
fig.p.axes[0].set_ylim(geo_data.grid.regular_grid.extent[4], geo_data.grid.
↪regular_grid.extent[5])
fig.p.axes[0].set_ylabel("Depth [m]", fontsize=20)
fig.p.axes[0].set_xlabel("Dip direction (NW-SE) [m]", fontsize=20)
fig.p.axes[0].set_title(" (B) Cross section at x = 28 km with well locations",␣
↪fontsize=20, pad=30)

# Make wells full lines
fig.p.axes[0].plot([df[df["Well"]=="m27"]["Y"].values[0],␣
↪df[df["Well"]=="m27"]["Y"].values[0]],
                    [0, df[df["Well"]=="m27"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M27", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m28"]["Y"].values[0],␣
↪df[df["Well"]=="m28"]["Y"].values[0]],
                    [0, df[df["Well"]=="m28"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M28", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m29"]["Y"].values[0],␣
↪df[df["Well"]=="m29"]["Y"].values[0]],
                    [0, df[df["Well"]=="m29"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M29", linewidth=2)

# Well labels
plt.text(df[df["Well"]=="m27"]["Y"].values[0]+400, -115, 'M27', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m28"]["Y"].values[0]+400, -115, 'M28', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m29"]["Y"].values[0]+400, -115, 'M29', zorder =100, ␣
↪fontsize=20)
```

```
fig.p.axes[0].tick_params(axis='both', which='major', labelsize=15)

plt.savefig("Figures/Cross_section_structural_dip", bbox_inches="tight")

fig.show()
```

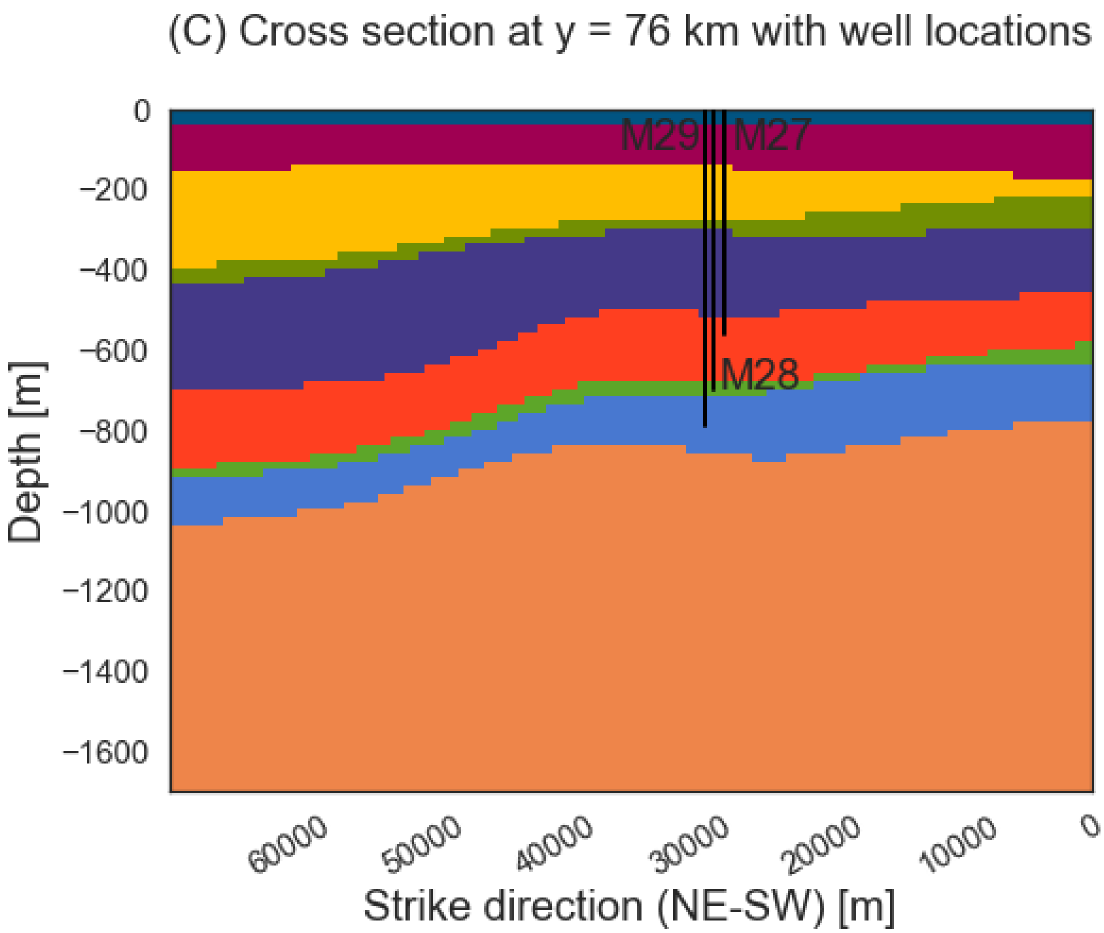
```
<Figure size 748.8x514.8 with 0 Axes>
```



[8]:
```
# Strike section at cell n=152, roughly well location
n = 152

fig=plt.figure()

fig.p = gp.plot_2d(geo_data, cell_number=n, direction="y", show_data=False,␣
↪show_lith=True, show_boundaries=False,
                    ve=30, figsize=(14,5))

fig.p.axes[0].set_xlim(geo_data.grid.regular_grid.extent[0], geo_data.grid.
↪regular_grid.extent[1])
fig.p.axes[0].set_ylim(geo_data.grid.regular_grid.extent[4], geo_data.grid.
↪regular_grid.extent[5])
fig.p.axes[0].set_ylabel("Depth [m]", fontsize=20)
fig.p.axes[0].set_xlabel("Strike direction (NE-SW) [m]", fontsize=20)
fig.p.axes[0].set_title("(C) Cross section at y = 76 km with well locations",␣
↪fontsize=20, pad=30)
fig.p.axes[0].invert_xaxis()

# Make wells full lines
```

```python
fig.p.axes[0].plot([df[df["Well"]=="m27"]["X"].values[0], df[df["Well"]=="m27"]["X"].values[0]],
                    [0, df[df["Well"]=="m27"]["Z"].values.min()], c="black", zorder=100, label="M27", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m28"]["X"].values[0], df[df["Well"]=="m28"]["X"].values[0]],
                    [0, df[df["Well"]=="m28"]["Z"].values.min()], c="black", zorder=100, label="M28", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m29"]["X"].values[0], df[df["Well"]=="m29"]["X"].values[0]],
                    [0, df[df["Well"]=="m29"]["Z"].values.min()], c="black", zorder=100, label="M29", linewidth=2)

# Well labels
plt.text(df[df["Well"]=="m27"]["X"].values[0]-400, -100, 'M27', zorder =100, fontsize=20)
plt.text(df[df["Well"]=="m28"]["X"].values[0]-300, -700, 'M28', zorder =100, fontsize=20)
plt.text(df[df["Well"]=="m29"]["X"].values[0]+6500, -100, 'M29', zorder =100, fontsize=20)

fig.p.axes[0].set_aspect(30)
fig.p.axes[0].tick_params(axis='both', which='major', labelsize=15)

plt.savefig("Figures/Cross_section_structural_strike", bbox_inches="tight")

fig.show()
```

```
<Figure size 748.8x514.8 with 0 Axes>
```



[9]:
```
# 3D model with section lines

# view model 3D
gpv = gp.plot_3d(geo_data, ve=30, plotter_type='background', show_data=False)
gpv.p.camera_position = (320, 200,3)

# Make two points to construct the line between
a1 = [28000, 0, 20]
b1 = [28000, 134000, 20]

a2 = [0, 76000, 20]
b2 = [69000, 76000, 20]

# Preview how this line intersects this mesh
line1 = pv.Line(a1, b1)
line2 = pv.Line(a2, b2)

gpv.p.add_mesh(line1, color="grey", line_width=5)
```

```
gpv.p.add_mesh(line2, color="grey", line_width=5)

gpv.p.add_point_labels([a1, b1], ["A", "A'"], font_size=20,␣
 ↪point_color="black", text_color="black")
gpv.p.add_point_labels([a2, b2], ["B", "B'"], font_size=20,␣
 ↪point_color="black", text_color="black")

gpv.p.camera_position = (320, 200,5)
gpv.p.hide_axes_all()
gpv.p.show_grid(xlabel="X [m]", ylabel="Y [m]", zlabel="Z [m]")
```

[9]: (vtkmodules.vtkRenderingAnnotation.vtkCubeAxesActor)000001FFDCE82F40

0.0.7 6. Plotting porosity sections

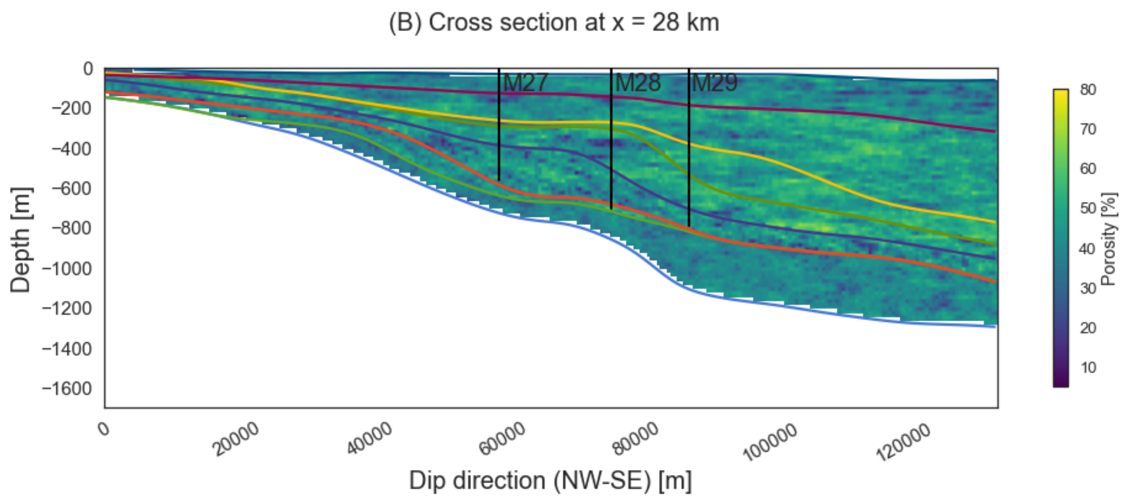
[10]:
```
# Routine for putting result back into model
rounded_lithblock = sol.lith_block.round(0)
rounded_lithblock = rounded_lithblock.astype(int)

por_block = rounded_lithblock.copy()

for i in np.arange(2,9):
    # mask by array of input surfaces (by id, can be from different series)
    mask = np.isin(rounded_lithblock, i)

    seq = str(np.unique(results_df["Sequence"])[i-2])

    test = results_df[results_df["Sequence"]==seq]

    por_block[mask]=test["Porosity"].values

# reshape and zero out basement and seafloor
por_block = por_block.reshape(geo_data.grid.regular_grid.resolution);
por_block[por_block==9]=0
por_block[por_block==1]=0
```

[11]:
```
# Dip section at cell n=56, roughly well location

n = 56

fig=plt.figure(figsize=(30,30))
fig.suptitle("Cross section")

fig.p = gp.plot_2d(geo_data, cell_number=n, direction="x", show_data=False,␣
 ↪show_lith=False, ve=30, figsize=(14,5))
```

```python
section = por_block[n,:,:].T

# Mask data == 0
section = np.ma.masked_where(section <=0, section)

# cmap = plt.cm.get_cmap("viridis", 10)
cmap = plt.cm.get_cmap("viridis")
cmap.set_bad(color='white', alpha = 1)

c=fig.p.axes[0].imshow(section, extent=geo_data.grid.regular_grid.extent[2:],␣
↪cmap=cmap, origin='lower', clim=[5,80])
fig.p.axes[0].set_xlim(geo_data.grid.regular_grid.extent[2], geo_data.grid.
↪regular_grid.extent[3])
fig.p.axes[0].set_ylim(geo_data.grid.regular_grid.extent[4], geo_data.grid.
↪regular_grid.extent[5])
fig.p.axes[0].set_ylabel("Depth [m]", fontsize=20)
fig.p.axes[0].set_xlabel("Dip direction (NW-SE) [m]", fontsize=20)
fig.p.axes[0].set_title(" (B) Cross section at x = 28 km", fontsize=20, pad=30)

# Make wells full lines
fig.p.axes[0].plot([df[df["Well"]=="m27"]["Y"].values[0],␣
↪df[df["Well"]=="m27"]["Y"].values[0]],
                   [0, df[df["Well"]=="m27"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M27", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m28"]["Y"].values[0],␣
↪df[df["Well"]=="m28"]["Y"].values[0]],
                   [0, df[df["Well"]=="m28"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M28", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m29"]["Y"].values[0],␣
↪df[df["Well"]=="m29"]["Y"].values[0]],
                   [0, df[df["Well"]=="m29"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M29", linewidth=2)

# Well labels
plt.text(df[df["Well"]=="m27"]["Y"].values[0]+400, -115, 'M27', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m28"]["Y"].values[0]+400, -115, 'M28', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m29"]["Y"].values[0]+400, -115, 'M29', zorder =100, ␣
↪fontsize=20)

fig.p.axes[0].set_aspect(30)

plt.colorbar(c, shrink=0.75, label="Porosity [%]")

fig.p.axes[0].tick_params(axis='both', which='major', labelsize=15)
```

```
plt.savefig("Figures/Cross_section_por_dip", bbox_inches="tight")
```

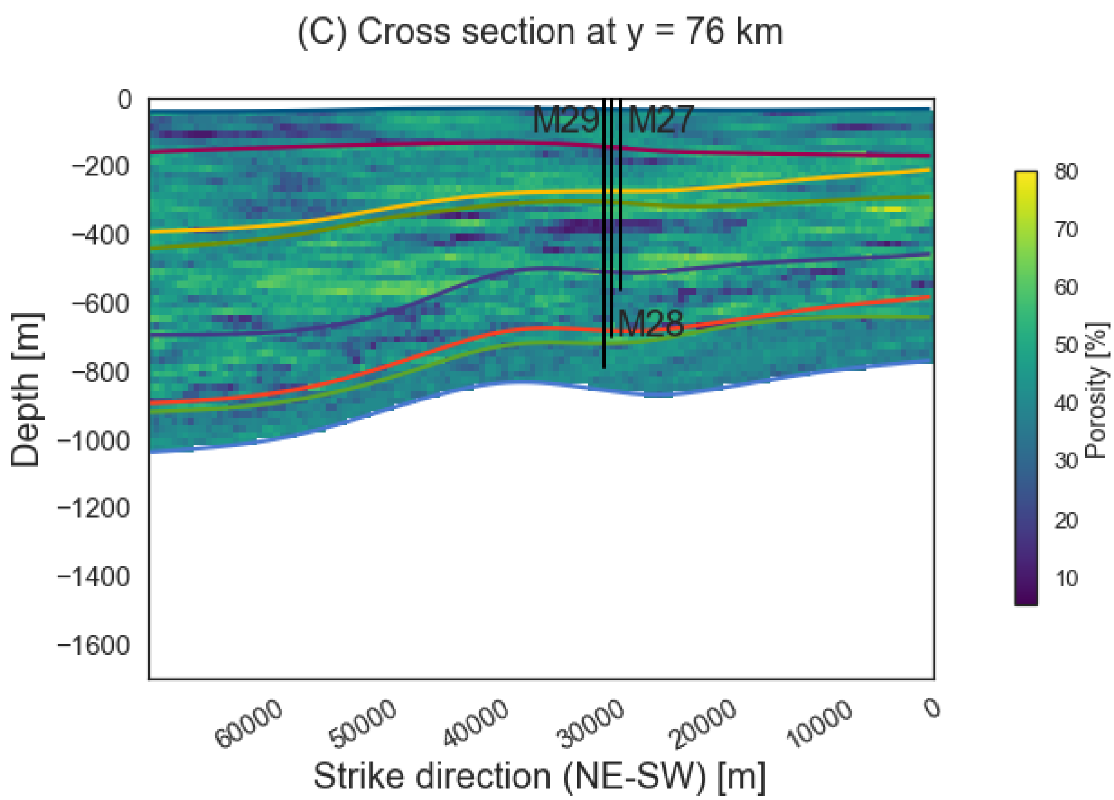
<Figure size 2160x2160 with 0 Axes>



[13]:
```
# Strike section at cell n=152, roughly well location
n = 152

fig=plt.figure()

fig.p = gp.plot_2d(geo_data, cell_number=n, direction="y", show_data=False,␣
↪show_lith=False, show_boundaries=True,
                   ve=30, figsize=(14,5))

section = por_block[:,n,:].T

section = np.ma.masked_where(section <=0, section)

# cmap = plt.cm.get_cmap("viridis", 10)
cmap = plt.cm.get_cmap("viridis")
cmap.set_bad(color='white', alpha = 1)

c=fig.p.axes[0].imshow(section, extent=[0, 69000, -1700, 0], cmap=cmap,␣
↪origin='lower', clim=[5,80])

fig.p.axes[0].set_xlim(geo_data.grid.regular_grid.extent[0], geo_data.grid.
↪regular_grid.extent[1])
fig.p.axes[0].set_ylim(geo_data.grid.regular_grid.extent[4], geo_data.grid.
↪regular_grid.extent[5])
```

```
fig.p.axes[0].set_ylabel("Depth [m]", fontsize=20)
fig.p.axes[0].set_xlabel("Strike direction (NE-SW) [m]", fontsize=20)
fig.p.axes[0].set_title("(C) Cross section at y = 76 km", fontsize=20, pad=30)
fig.p.axes[0].invert_xaxis()


# Make wells full lines
fig.p.axes[0].plot([df[df["Well"]=="m27"]["X"].values[0],␣
↪df[df["Well"]=="m27"]["X"].values[0]],
                    [0, df[df["Well"]=="m27"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M27", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m28"]["X"].values[0],␣
↪df[df["Well"]=="m28"]["X"].values[0]],
                    [0, df[df["Well"]=="m28"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M28", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m29"]["X"].values[0],␣
↪df[df["Well"]=="m29"]["X"].values[0]],
                    [0, df[df["Well"]=="m29"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M29", linewidth=2)

# Well lables
plt.text(df[df["Well"]=="m27"]["X"].values[0]-400, -100, 'M27', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m28"]["X"].values[0]-300, -700, 'M28', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m29"]["X"].values[0]+6500, -100, 'M29', zorder =100, ␣
↪fontsize=20)

fig.p.axes[0].set_aspect(30)
fig.p.axes[0].tick_params(axis='both', which='major', labelsize=15)

plt.colorbar(c, shrink=0.75, label="Porosity [%]")

plt.savefig("Figures/Cross_section_por_strike", bbox_inches="tight")

fig.show()
```

```
<Figure size 748.8x514.8 with 0 Axes>
```



[14]:

```
# Location of sections in 3D model

#cmap = plt.cm.get_cmap("viridis", 6)
p = pvqt.BackgroundPlotter()

pc = pv.PolyData(np.c_[results_df["X"].values, results_df["Y"].values,␣
 ↪results_df["Z"].values])

pc["Porosity"]=results_df["Porosity"].values

spacing = lambda arr: np.unique(np.diff(np.unique(arr)))
voxelsize = spacing(pc.points[:,0]), spacing(pc.points[:,1]), spacing(pc.
 ↪points[:,2])

pc = pc.cast_to_unstructured_grid()

grid = PVGeo.filters.VoxelizePoints(dx=voxelsize[0][0], dy=voxelsize[1][0],␣
 ↪dz=voxelsize[2][0], estimate=False).apply(pc)

#p.add_mesh(grid, opacity=1, show_edges=False, lighting=False, cmap=cmap)
p.add_mesh(grid, opacity=1, show_edges=False, lighting=False, cmap="viridis")
```

```
# Make two points to construct the line between
a1 = [28000, 0, 20]
b1 = [28000, 134000, 20]

a2 = [0, 76000, 20]
b2 = [69000, 76000, 20]

# Preview how this line intersects this mesh
line1 = pv.Line(a1, b1)
line2 = pv.Line(a2, b2)

p.add_mesh(line1, color="grey", line_width=5)
p.add_mesh(line2, color="grey", line_width=5)

p.add_point_labels([a1, b1], ["A", "A'"], font_size=20, point_color="black",␣
↪text_color="black")
p.add_point_labels([a2, b2], ["B", "B'"], font_size=20, point_color="black",␣
↪text_color="black")

p.camera_position = (320, 200,150)
p.set_scale(zscale=30)
p.hide_axes_all()
p.show_grid(xlabel="X [m]", ylabel="Y [m]", zlabel="Z [m]")

p.show()
```

0.0.8 Plotting permeability sections

[4]:
```
### Here load model
results_df_perm = pd.read_csv("Results/Model_realization_por-perm_20210728.
↪csv") # probably better all in one
```

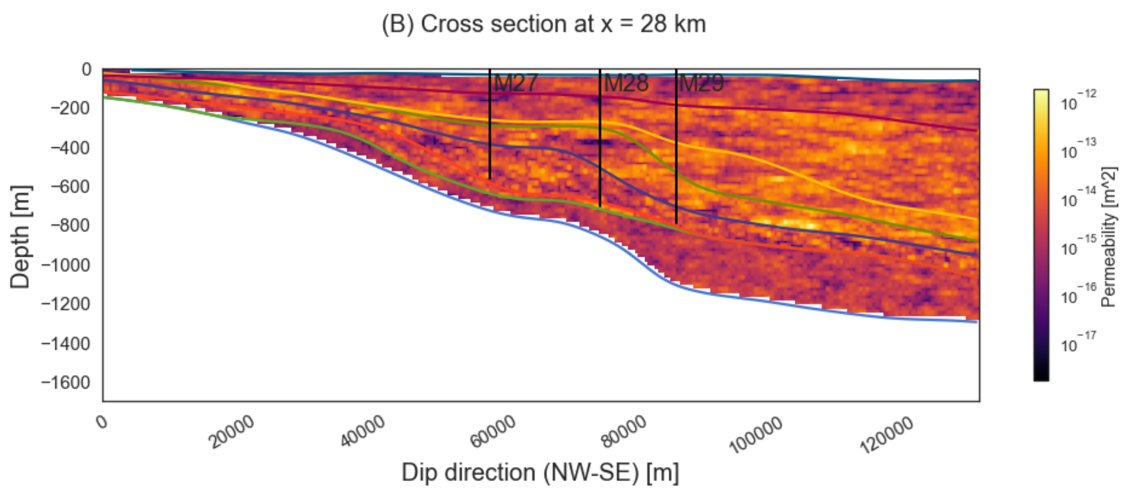
[16]:
```
# Routine for putting result back into model
rounded_lithblock = sol.lith_block.round(0)
rounded_lithblock = rounded_lithblock.astype(int)

perm_block = rounded_lithblock.copy().astype("float64")

for i in np.arange(2,9):
    # mask by array of input surfaces (by id, can be from different series)
    mask = np.isin(rounded_lithblock, i)

    seq = str(np.unique(results_df_perm["Sequence"])[i-2])

    test = results_df_perm[results_df_perm["Sequence"]==seq]
```

```
    perm_block[mask]=test["Permeability"].values

# Reshape and zero out basement and seafloor
perm_block = perm_block.reshape(geo_data.grid.regular_grid.resolution);
perm_block[perm_block==9]=0
perm_block[perm_block==1]=0
```

[19]:
```
# Dip section at cell n=56, roughly well location
n = 56

fig=plt.figure(figsize=(30,30))
fig.suptitle("Cross section")

fig.p = gp.plot_2d(geo_data, cell_number=n, direction="x", show_data=False,␣
↪show_lith=False, ve=30, figsize=(14,5))

section = perm_block[n,:,:].T

# Mask data == 00
section = np.ma.masked_where(section <=0, section)

#cmap = plt.cm.get_cmap("viridis", 10)
cmap = plt.cm.get_cmap("inferno")
cmap.set_bad(color='white', alpha = 1)

c=fig.p.axes[0].imshow(section, extent=geo_data.grid.regular_grid.extent[2:],␣
↪cmap=cmap,
                       norm=matplotlib.colors.LogNorm(), origin='lower')
fig.p.axes[0].set_xlim(geo_data.grid.regular_grid.extent[2], geo_data.grid.
↪regular_grid.extent[3])
fig.p.axes[0].set_ylim(geo_data.grid.regular_grid.extent[4], geo_data.grid.
↪regular_grid.extent[5])
fig.p.axes[0].set_ylabel("Depth [m]", fontsize=20)
fig.p.axes[0].set_xlabel("Dip direction (NW-SE) [m]", fontsize=20)
fig.p.axes[0].set_title(" (B) Cross section at x = 28 km", fontsize=20, pad=30)

# Make wells full lienes instead
fig.p.axes[0].plot([df[df["Well"]=="m27"]["Y"].values[0],␣
↪df[df["Well"]=="m27"]["Y"].values[0]],
                    [0, df[df["Well"]=="m27"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M27", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m28"]["Y"].values[0],␣
↪df[df["Well"]=="m28"]["Y"].values[0]],
                    [0, df[df["Well"]=="m28"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M28", linewidth=2)
```

```
fig.p.axes[0].plot([df[df["Well"]=="m29"]["Y"].values[0],␣
↪df[df["Well"]=="m29"]["Y"].values[0]],
                   [0, df[df["Well"]=="m29"]["Z"].values.min()], c="black",␣
↪zorder=100, label="M29", linewidth=2)

# Well labels
plt.text(df[df["Well"]=="m27"]["Y"].values[0]+400, -115, 'M27', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m28"]["Y"].values[0]+400, -115, 'M28', zorder =100, ␣
↪fontsize=20)
plt.text(df[df["Well"]=="m29"]["Y"].values[0]+400, -115, 'M29', zorder =100, ␣
↪fontsize=20)

fig.p.axes[0].set_aspect(30)

plt.colorbar(c, shrink=0.75, label="Permeability [m^2]")

fig.p.axes[0].tick_params(axis='both', which='major', labelsize=15)

plt.savefig("Figures/Cross_section_perm_dip", bbox_inches="tight")
```

```
<Figure size 2160x2160 with 0 Axes>
```

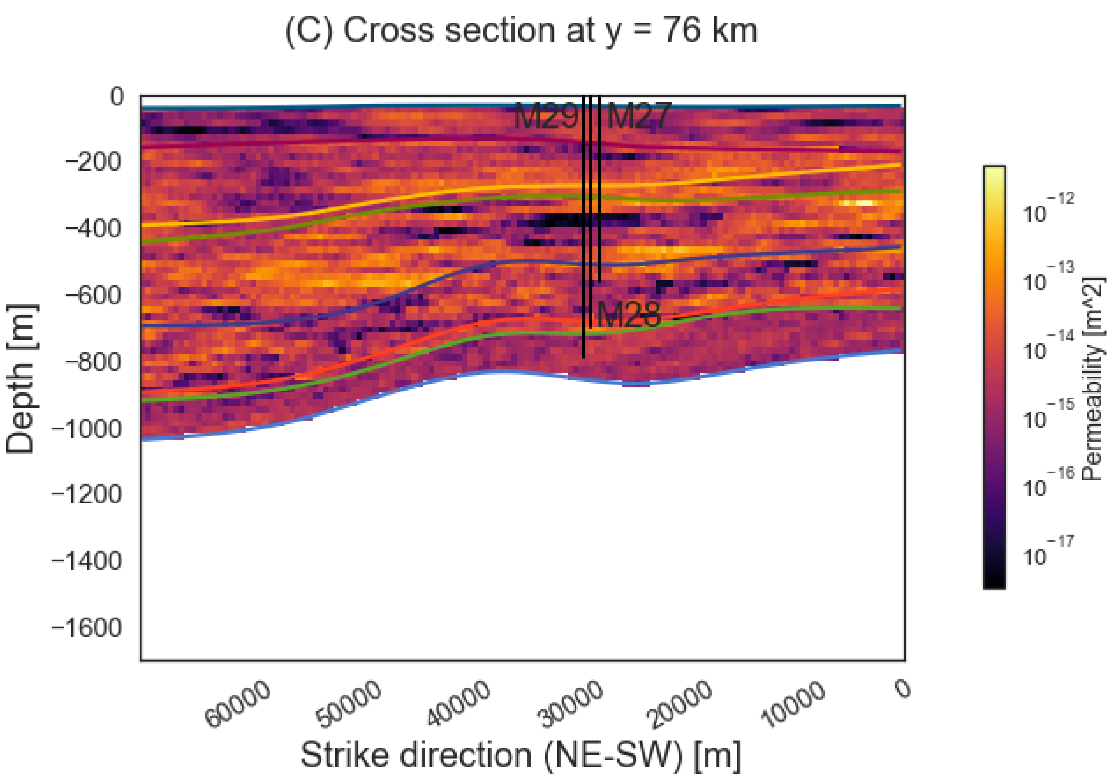


[20]:
```
# Strike section at cell n=152, roughly well location
n = 152

fig=plt.figure()

fig.p = gp.plot_2d(geo_data, cell_number=n, direction="y", show_data=False,␣
↪show_lith=False, show_boundaries=True,
```

```
                    ve=30, figsize=(14,5))

section = perm_block[:,n,:].T

section = np.ma.masked_where(section <=0, section)

#cmap = plt.cm.get_cmap("viridis", 10)
cmap = plt.cm.get_cmap("inferno")
cmap.set_bad(color='white', alpha = 1)

c=fig.p.axes[0].imshow(section, extent=[0, 69000, -1700, 0], cmap=cmap,
                       norm=matplotlib.colors.LogNorm(), origin='lower')

fig.p.axes[0].set_xlim(geo_data.grid.regular_grid.extent[0], geo_data.grid.
 ↪regular_grid.extent[1])
fig.p.axes[0].set_ylim(geo_data.grid.regular_grid.extent[4], geo_data.grid.
 ↪regular_grid.extent[5])

fig.p.axes[0].set_ylabel("Depth [m]", fontsize=20)
fig.p.axes[0].set_xlabel("Strike direction (NE-SW) [m]", fontsize=20)
fig.p.axes[0].set_title("(C) Cross section at y = 76 km", fontsize=20, pad=30)
fig.p.axes[0].invert_xaxis()


# Make wells full lines
fig.p.axes[0].plot([df[df["Well"]=="m27"]["X"].values[0],␣
 ↪df[df["Well"]=="m27"]["X"].values[0]],
                    [0, df[df["Well"]=="m27"]["Z"].values.min()], c="black",␣
 ↪zorder=100, label="M27", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m28"]["X"].values[0],␣
 ↪df[df["Well"]=="m28"]["X"].values[0]],
                    [0, df[df["Well"]=="m28"]["Z"].values.min()], c="black",␣
 ↪zorder=100, label="M28", linewidth=2)
fig.p.axes[0].plot([df[df["Well"]=="m29"]["X"].values[0],␣
 ↪df[df["Well"]=="m29"]["X"].values[0]],
                    [0, df[df["Well"]=="m29"]["Z"].values.min()], c="black",␣
 ↪zorder=100, label="M29", linewidth=2)

# Well labels
plt.text(df[df["Well"]=="m27"]["X"].values[0]-400, -100, 'M27', zorder =100, ␣
 ↪fontsize=20)
plt.text(df[df["Well"]=="m28"]["X"].values[0]-300, -700, 'M28', zorder =100, ␣
 ↪fontsize=20)
plt.text(df[df["Well"]=="m29"]["X"].values[0]+6500, -100, 'M29', zorder =100, ␣
 ↪fontsize=20)
```

```
fig.p.axes[0].set_aspect(30)
fig.p.axes[0].tick_params(axis='both', which='major', labelsize=15)

plt.colorbar(c, shrink=0.75, label="Permeability [m^2]")

plt.savefig("Figures/Cross_section_perm_strike", bbox_inches="tight")

fig.show()
```

<Figure size 748.8x514.8 with 0 Axes>



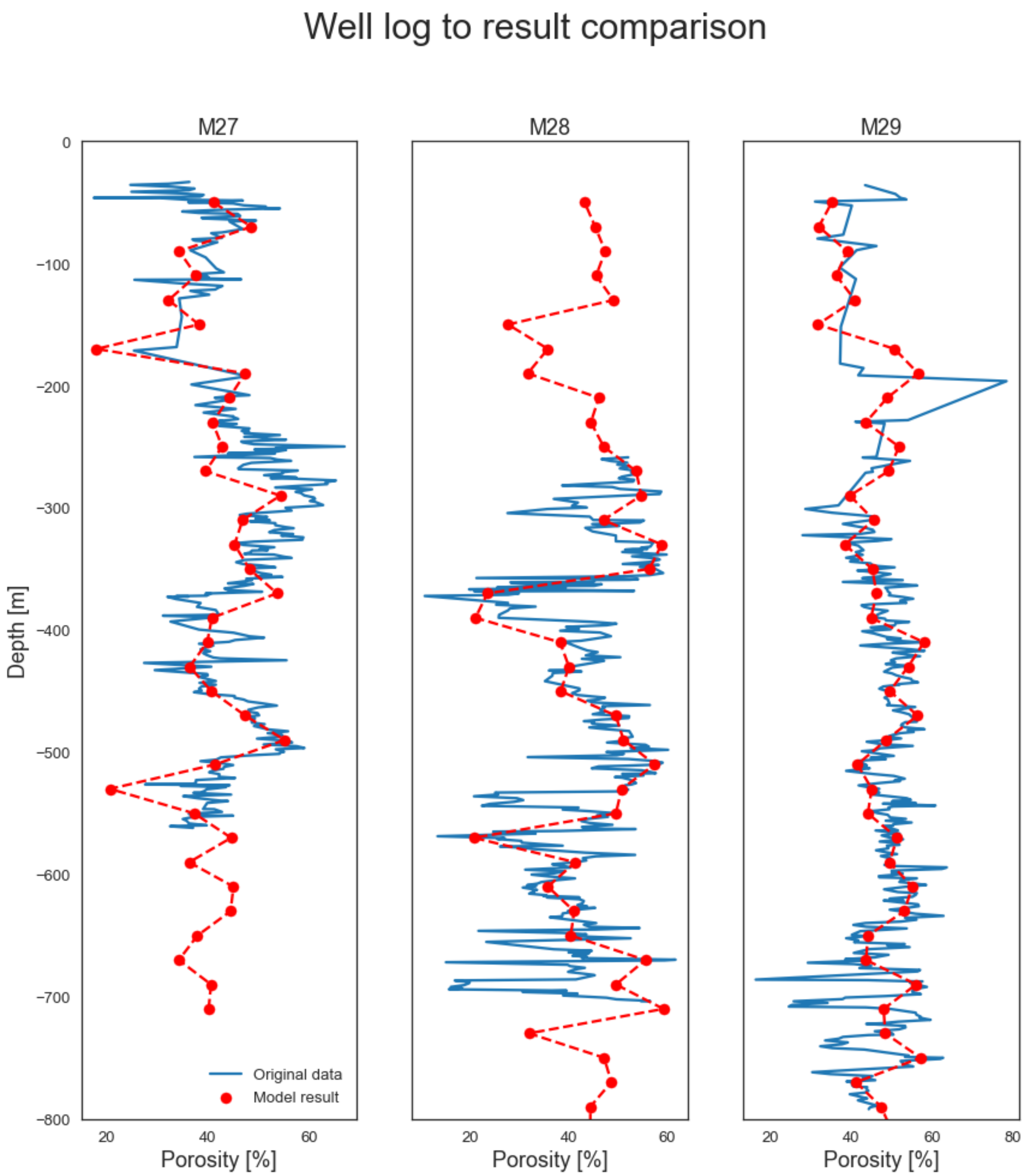
0.0.9 Plotting well comparison

[6]:
```
# Mask by closest grid location
maskM27 = (results_df["X"].values==27250) & (results_df["Y"].values==59250)
maskM28 = (results_df["X"].values==28250) & (results_df["Y"].values==76250)
maskM29 = (results_df["X"].values==28750) & (results_df["Y"].values==87750)

# Mask and sort
resM27 = results_df[maskM27].sort_values("Z")
resM28 = results_df[maskM28].sort_values("Z")
resM29 = results_df[maskM29].sort_values("Z")
```

```
df = df.sort_values("Z")
```

[8]:
```
# Plot well comparison
fig, ax = plt.subplots(nrows=1, ncols=3, figsize=(14,15), sharey=True)
fig.suptitle("Well log to result comparison", fontsize=30)

ax[0].set_title('M27',fontsize='18')
ax[0].plot(df[df["Well"]=="m27"]["Porosity"], df[df["Well"]=="m27"]["Z"],␣
↪label="Original data")
ax[0].plot(resM27["Porosity"], resM27["Z"], color='r', linestyle="dashed")
ax[0].scatter(resM27["Porosity"], resM27["Z"], color='r', label="Model result",␣
↪zorder=100)
ax[0].set_xlabel('Porosity [%]',fontsize='18')
ax[0].set_ylabel('Depth [m]',fontsize='18')
ax[0].legend(loc=4)
ax[0].set_ylim(-800,0)

ax[1].set_title('M28',fontsize='18')
ax[1].plot(df[df["Well"]=="m28"]["Porosity"], df[df["Well"]=="m28"]["Z"],␣
↪label="Original data")
ax[1].plot(resM28["Porosity"], resM28["Z"], color='r', linestyle="dashed")
ax[1].scatter(resM28["Porosity"], resM28["Z"], color='r', label="Model result",␣
↪zorder=100)
ax[1].set_xlabel('Porosity [%]',fontsize='18')
#ax[1].legend(loc=4)

ax[2].set_title('M29',fontsize='18')
ax[2].plot(df[df["Well"]=="m29"]["Porosity"], df[df["Well"]=="m29"]["Z"],␣
↪label="Original data")
ax[2].plot(resM29["Porosity"], resM29["Z"], color='r', linestyle="dashed")
ax[2].scatter(resM29["Porosity"], resM29["Z"], color='r', label="Model result",␣
↪zorder=100)
ax[2].set_xlabel('Porosity [%]',fontsize='18')
#ax[2].legend(loc=4)

#fig.savefig("Figures/Well_log_comparison_M28blind.
↪png",dpi=450,bbox_inches='tight')
```

[8]:
```
Text(0.5, 0, 'Porosity [%]')
```



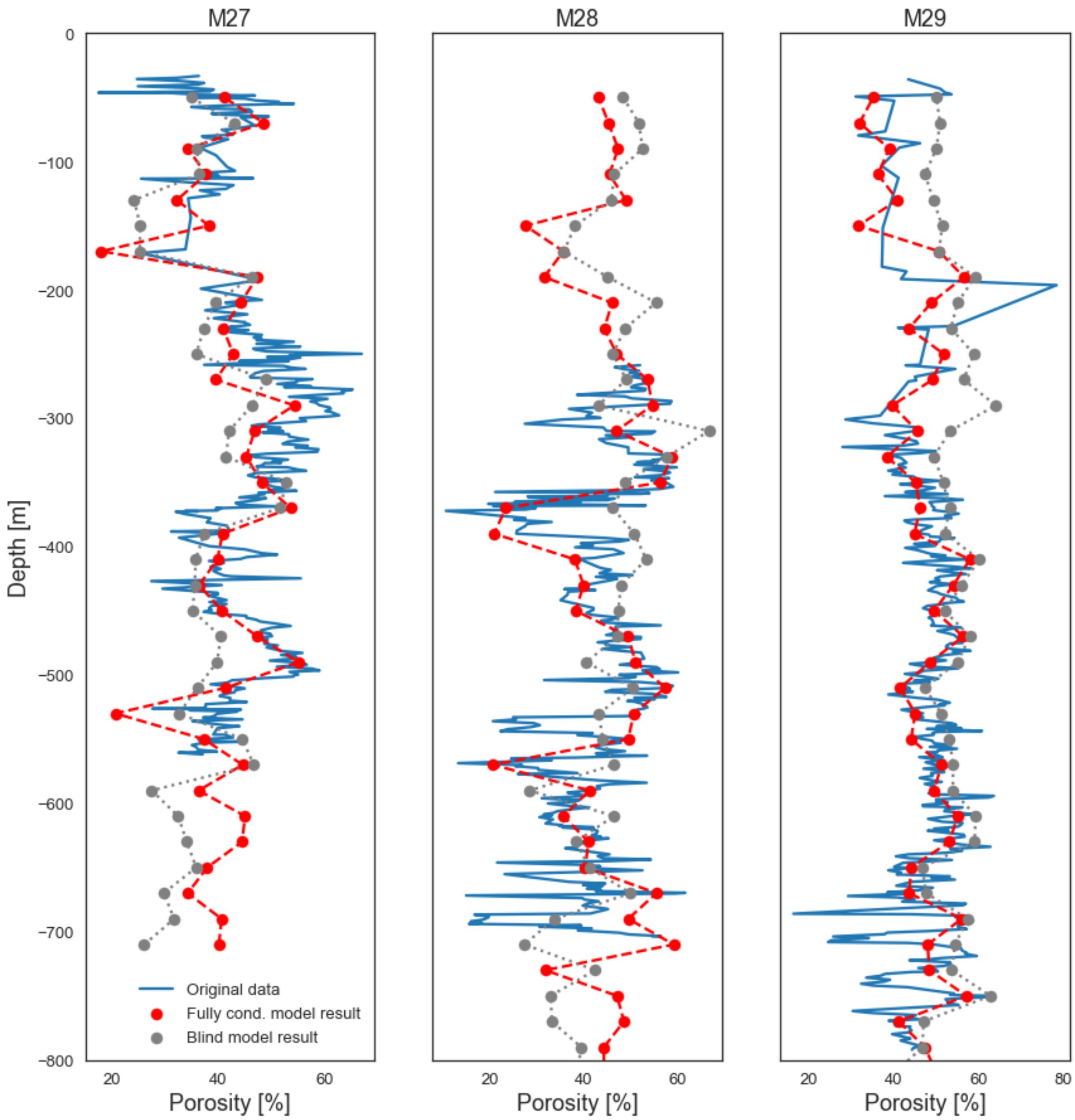
1 A blind test comparison

In this section, we show the results of two realizations. One model result was generated using all 3 available wells. The blind model result was generated with only two wells, M27 and M29.

[35]:
```
results_df = pd.read_csv("Results/Model_realization_20210728.csv")
blindresults_df = pd.read_csv("Results/Model_realization_20220228.csv")
```

```
# Mask by closest grid location
maskM27 = (results_df["X"].values==27250) & (results_df["Y"].values==59250)
maskM28 = (results_df["X"].values==28250) & (results_df["Y"].values==76250)
maskM29 = (results_df["X"].values==28750) & (results_df["Y"].values==87750)
maskM27b = (blindresults_df["X"].values==27250) & (blindresults_df["Y"].
 ↪values==59250)
maskM28b = (blindresults_df["X"].values==28250) & (blindresults_df["Y"].
 ↪values==76250)
maskM29b = (blindresults_df["X"].values==28750) & (blindresults_df["Y"].
 ↪values==87750)
# Mask and sort
resM27 = results_df[maskM27].sort_values("Z")
resM28 = results_df[maskM28].sort_values("Z")
resM29 = results_df[maskM29].sort_values("Z")
resM27b = blindresults_df[maskM27b].sort_values("Z")
resM28b = blindresults_df[maskM28b].sort_values("Z")
resM29b = blindresults_df[maskM29b].sort_values("Z")
df = df.sort_values("Z")

# Plot well comparison of 2 control wells vs 3 control wells
fig2, ax = plt.subplots(nrows=1, ncols=3, figsize=(14,15), sharey=True)
#fig2.suptitle("Well log to result comparison", fontsize=30)

ax[0].set_title('M27',fontsize='18')
ax[0].plot(df[df["Well"]=="m27"]["Porosity"], df[df["Well"]=="m27"]["Z"],␣
 ↪label="Original data")
ax[0].plot(resM27["Porosity"], resM27["Z"], color='r', linestyle="dashed")
ax[0].scatter(resM27["Porosity"], resM27["Z"], color='r', label="Fully cond.␣
 ↪model result", zorder=100)
ax[0].plot(resM27b["Porosity"], resM27b["Z"], color='grey', linestyle=":")
ax[0].scatter(resM27b["Porosity"], resM27b["Z"], color='grey', label="Blind␣
 ↪model result", zorder=100)

ax[0].set_xlabel('Porosity [%]',fontsize='18')
ax[0].set_ylabel('Depth [m]',fontsize='18')
ax[0].legend(loc=4)
ax[0].set_ylim(-800,0)


ax[1].set_title('M28',fontsize='18')
ax[1].plot(df[df["Well"]=="m28"]["Porosity"], df[df["Well"]=="m28"]["Z"],␣
 ↪label="Original data")
ax[1].plot(resM28["Porosity"], resM28["Z"], color='r', linestyle="dashed")
ax[1].scatter(resM28["Porosity"], resM28["Z"], color='r', label="Fully cond.␣
 ↪model result", zorder=100)
ax[1].plot(resM28b["Porosity"], resM28b["Z"], color='grey', linestyle=":")
```

```python
ax[1].scatter(resM28b["Porosity"], resM28b["Z"], color='grey', label="Blind␣
↪model result", zorder=100)

ax[1].set_xlabel('Porosity [%]',fontsize='18')
#ax[1].legend(loc=4)

ax[2].set_title('M29',fontsize='18')
ax[2].plot(df[df["Well"]=="m29"]["Porosity"], df[df["Well"]=="m29"]["Z"],␣
↪label="Original data")
ax[2].plot(resM29["Porosity"], resM29["Z"], color='r', linestyle="dashed")
ax[2].scatter(resM29["Porosity"], resM29["Z"], color='r', label="Fully cond.␣
↪model result", zorder=100)
ax[2].plot(resM29b["Porosity"], resM29b["Z"], color='grey', linestyle=":")
ax[2].scatter(resM29b["Porosity"], resM29b["Z"], color='grey', label="Blind␣
↪model result", zorder=100)

ax[2].set_xlabel('Porosity [%]',fontsize='18')
#ax[2].legend(loc=4)

fig2.savefig("Figures/Well_log_comparison_blindtest.
↪png",dpi=450,bbox_inches='tight')
```


M27
M28
M29
Depth [m]
Porosity [%]
Porosity [%]
Porosity [%]
Original data
Fully cond. model result
Blind model result
0
-100
-200
-300
-400
-500
-600
-700
-800
20
40
60
20
40
60
20
40
60
80

[ ]: