

Tutorial case study C (Unconformities and intrusives)

[Parent topic: User Manual and Tutorials](#)

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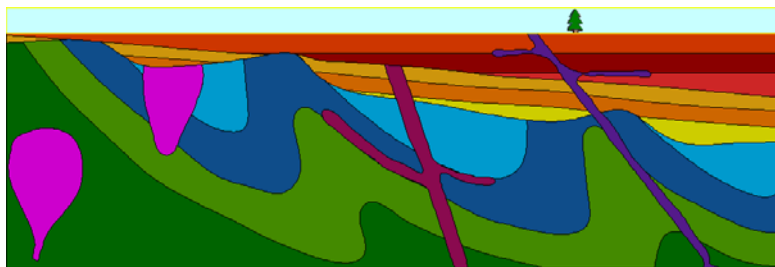
Stratigraphic Relationships—Series, Unconformities and Intrusives

This tutorial uses a simple (2D-only) model to demonstrate 3D GeoModeller's management of typical stratigraphic rock-relationships

Series – a package of formations with a common geological history, and a broad expectation that the various geological time-line horizons within the series will have similar shapes.

Unconformities – an erosional (cross-cutting) geological event. Although non-depositional, these geological events are typically needed to correctly capture the geological history. Series are typically separated by unconformities.

Intrusives – a typically cross-cutting geological event. Because they are cross-cutting, there are topological similarities between intrusions and erosional + subsequent depositional events.



This generalised cross-section illustrates various stratigraphic relationships. Understanding the relationships is fundamental to geological mapping and interpretation and fundamental in using 3D GeoModeller. The section shows three series of geological strata, separated by two unconformities. There are intrusives of three different ages.

In 3D GeoModeller you can specify that 'geological contact points' define the tops or bottoms of geological units. It does not matter which you use, but this choice does have an impact on the way that 3D GeoModeller manages cross-cutting relationships (erosion surfaces, intrusives).

This case study demonstrates both top and bottom, showing how you can achieve the same result with either method. Demonstrates that a slightly revised (and simpler) stratigraphic pile is needed

In this case study:

- [Tutorial C1—Demonstrate a series using tops](#)
- [Tutorial C2—Demonstrate a series using bottoms](#)
- [Tutorial C3—Examine a sequence of geological events](#)

Tutorial C1—Demonstrate a series using tops



Parent topic:
Tutorial case
study C
(Unconformities
and intrusives)

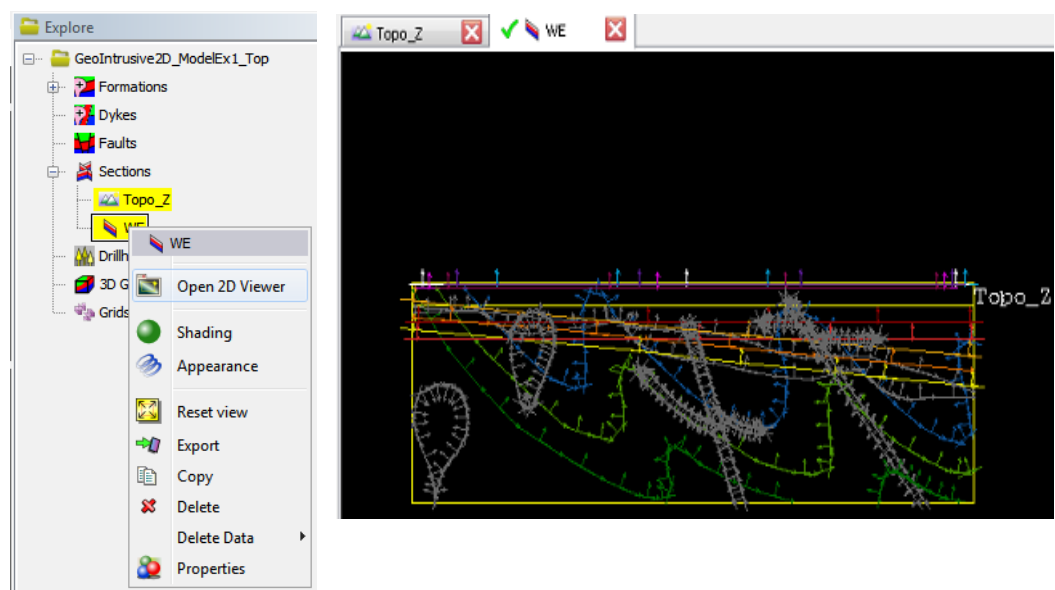
This tutorial is a demonstration. You will not change data in the project. You will only calculate and plot the model. In this tutorial:

- [Tutorial C1—Steps](#)
- [Tutorial C1—Discussion—Series and erosional events](#)
- [Tutorial C1—Discussion—Cross-cutting relationships of intrusives](#)

Tutorial C1—Steps

Parent topic:
Tutorial C1—
Demonstrate a
series using tops

- 1 If required, save and close any project that you are currently working on.
- 2 From the main menu choose **Project > Open** OR
From the **Project** toolbar choose **Open**  OR
Press CTRL+O.
Open:
`GeoModeller\tutorial\CaseStudyC\TutorialC1\Beginning_project\TutorialC1.xml`
- 3 *(If you want to perform your own operations on this project, changing its data)*
Save the project with a new name in the folder you are using for your tutorial data.
From the main menu choose **Project > Save As** OR
From the **Project** toolbar choose **Save As** 
Do not overwrite the completed version of this Tutorial that we have supplied in your 3D GeoModeller installation.
- 4 In the **Project Explorer**, expand **Sections** to show section WE.
- 5 From the section WE shortcut menu in the **Project Explorer**, choose **Open 2D Viewer**. 3D GeoModeller displays the geology observations recorded in this section view.



6 *Compute the model with all components of the project*

7 From the main menu choose **Model > Compute** OR

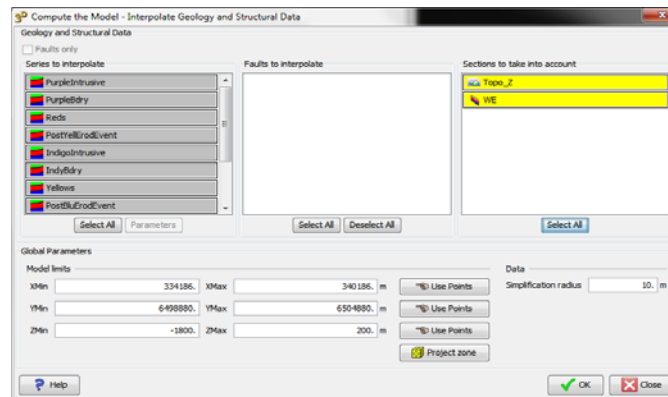
From the **Model** toolbar choose  OR

Press CTRL+M.

In the **Compute the model** dialog box, set parameters as follows:

- **Sections to take into account:** All
- **Series to interpolate:** All

Choose **OK**.



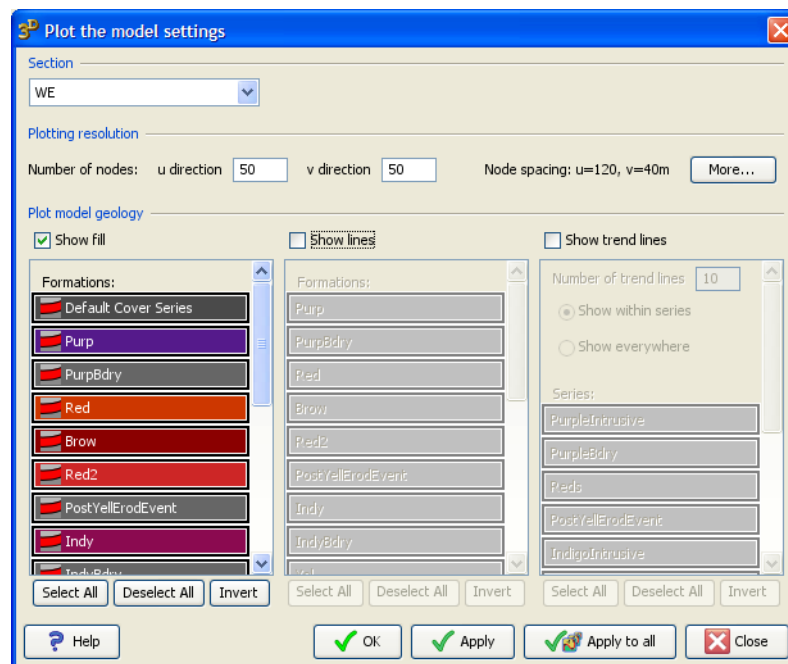
8 *Plot the model using fill on section WE*

Select **WE** tab in the **2D Viewer** (if not already showing).

From the main menu choose, choose **Model > Plot the model settings** OR

From the **Model** toolbar, choose **Plot the model settings**  OR

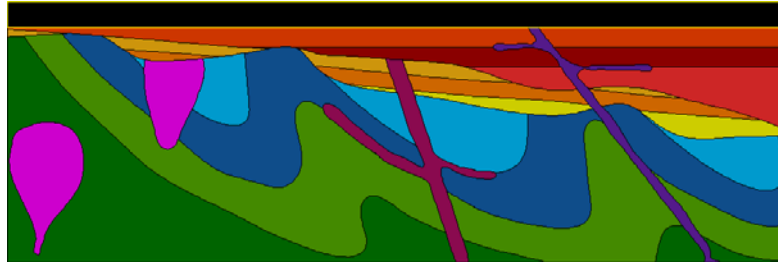
Press CTRL+D.



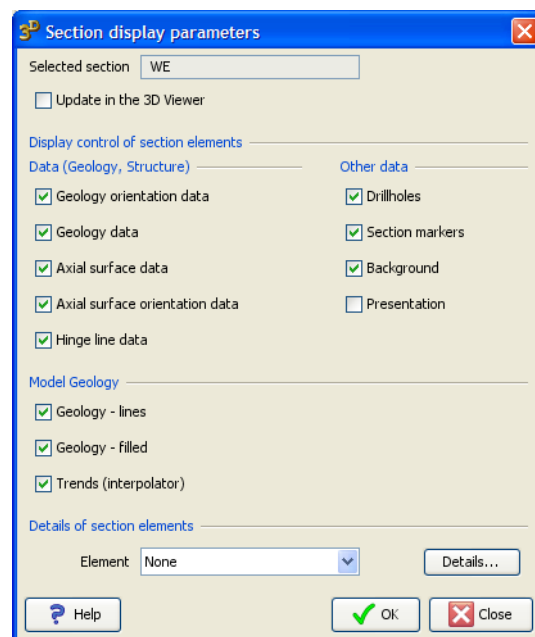
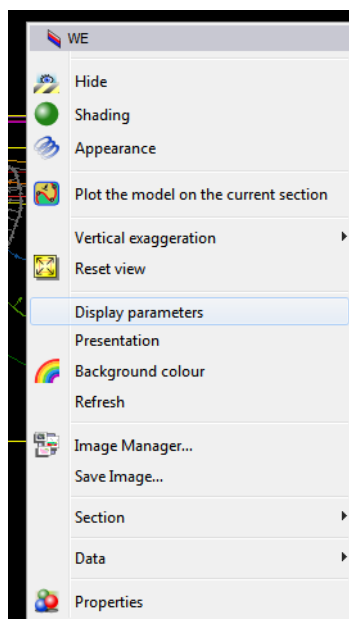
In the **Plot the model settings** dialog box:

- Check **Show lines** and clear **Show fill**.
- Choose **OK**.

3D GeoModeller plots the model in the **2D Viewer**. The illustration here shows the model data only. When you first view the plot, you may see the project data as well. See the following step for display options.

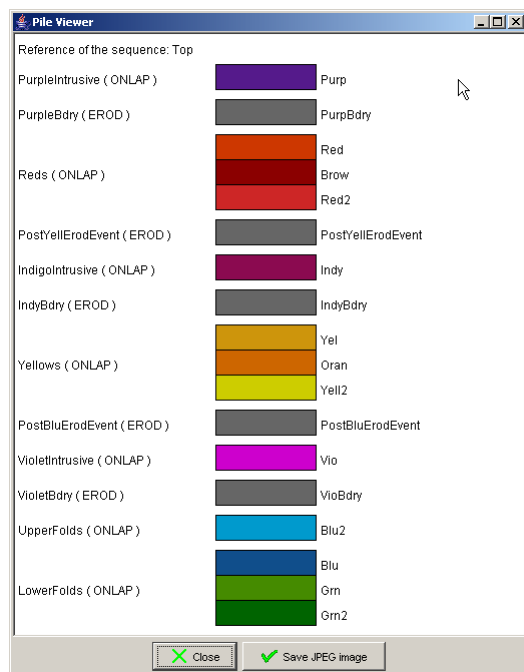


- 9 (Optional) From the shortcut menu, choose **Display parameters** and try various display options (Choose **OK** when selected).



10 Display the stratigraphic pile diagram

From the main menu, choose **Geology > Stratigraphic Pile: Visualise**.

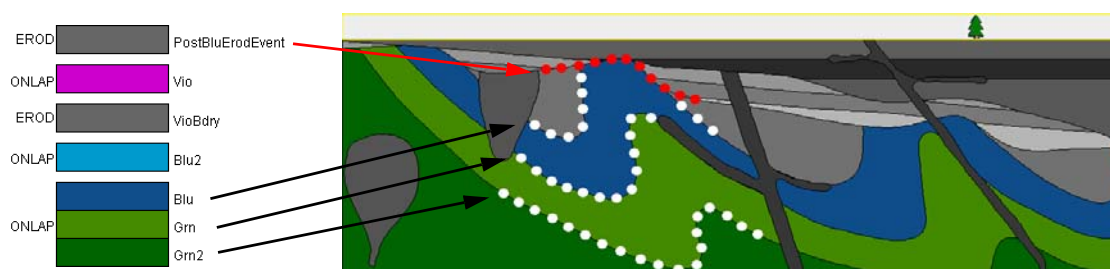


Tutorial C1—Discussion—Series and erosional events

Parent topic:
Tutorial C1—
Demonstrate a
series using tops

Lower series

Series—a set of geological horizons that have a shared geological history and an expectation of similar shape. The conformable contact at the top of Blu is part of this series but the erosional contact (in places also at the top of Blu) is not. It is a separate geological event.

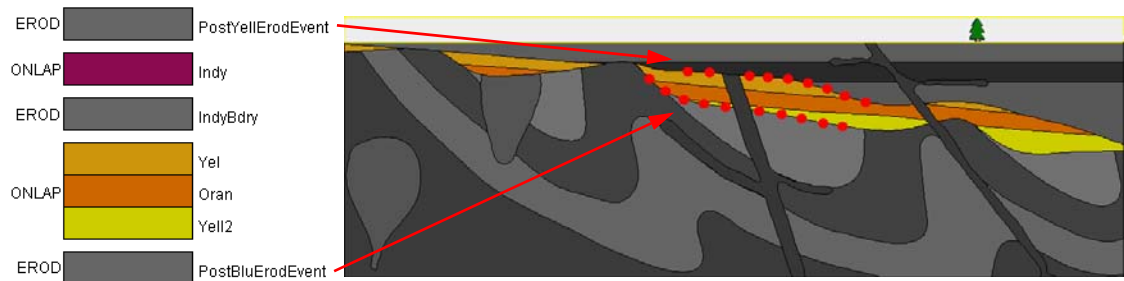


What about the light blue formation (Blu2)? Where is it defined in the model? Why?

Middle series

Again note that only certain parts of the geological contacts are part of the series and the erosional surfaces above and below are separate geological events.

Where is the top of the Yel formation defined in the model? It has been plotted as being 'somewhere above the PostYellErodEvent' and is roughly parallel with the other (lower) parts of this 'Yellows' series Why ?

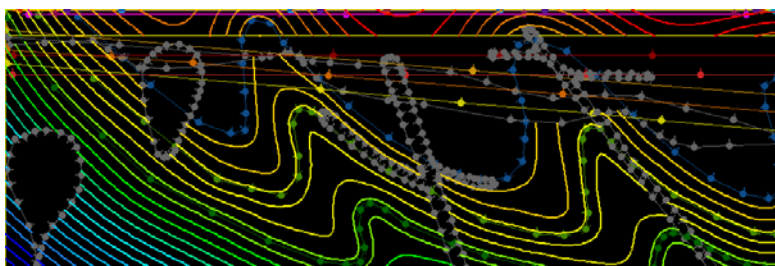


Summary

It is important to make the distinction between different geological events since different events typically have quite independent surface shapes! An erosional surface may have no relationship to a subsequent depositional event. Therefore it is common to define an EROD (cross-cutting) horizon, followed by a separate ONLAP formation. The EROD unit in this example does not define a physical body of rocks but simply defines an horizon. It also effectively defines the bottom of the next stratigraphically-higher packages of strata.

Conversely, where geological horizons do have a shared geological history (and thus an expectation that their surface shapes also have much in common), then it is useful to group these together into one series. The advantage? You can bring more observations of geology together and better define the overall set of shapes for this series of strata.

We can illustrate this set-of-shapes by plotting the potential for a series. Note how the computed potentials for the LowerFolds series honour the observations for all three horizons (Grn2, Grn and Blu).



Geology is a science notorious for its under-sampling! If you can use more observations to achieve an improved global result, this is an advantage.

Tutorial C1—Discussion—Cross-cutting relationships of intrusives

Parent topic:
Tutorial C1—
Demonstrate a
series using tops

The stratigraphic pile

Examine the stratigraphic pile. Notice that for each intrusive there are two formations defined.











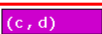







The lower of the two is EROD and defines the cross-cutting rock-relationship between the intrusive, and the country rock that it intrudes.

The second is ONLAP and constitutes the intrusive rock material itself.

Why do we have this complexity?

Each item in this stratigraphic pile defines the top of a formation. For a cross-cutting intrusive, however, we need to also define a (stratigraphic) bottom.

Reference of the sequence: Top

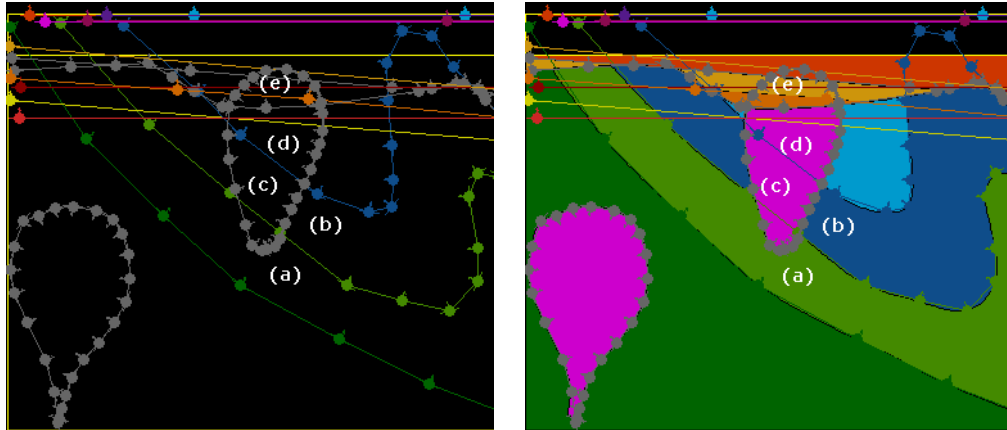
PurpleIntrusive (ONLAP)		Purp
PurpleBdry (EROD)		PurpBdry
Reds (ONLAP)		Red
		Brow
		Red2
PostYellErodEvent (EROD)		PostYellErodEvent
IndigoIntrusive (ONLAP)		Indy
IndyBdry (EROD)		IndyBdry
		Yel
Yellows (ONLAP)		Oran
		Yell2
PostBluErodEvent (EROD)		PostBluErodEvent
VioletIntrusive (ONLAP)		Vio
VioletBdry (EROD)		VioBdry
UpperFolds (ONLAP)		Blu2
		Blu
LowerFolds (ONLAP)		Grn
		Grn2

The intrusive formations

Now examine how these two intrusive items are used in the section view. Note that there is an ‘up-side’ and a ‘down-side’. This is true of every contact in 3D GeoModeller.

(a), (b) are below the intrusive contact.

(c), (d) & (e) are above the intrusive contact.



You can decipher the geological model by working in the same way that 3D GeoModeller does—by interrogating the model!

(a) is above Grn2, below the top of Grn, and below all of the EROD horizons. It therefore must be Grn.

(b) is similar and must be Blu.

(c), like (b), is above Grn and below the top of Blu but it is also above the EROD contact called VioBdry.

Note that it is also below all of the other ‘erod’ events in the stratigraphic column.

This means that it must belong somewhere stratigraphically above VioBdry, and stratigraphically below PostBluErodEvent. It therefore must be the intrusive, Vio.

Where in the model is Vio itself defined to exist? How does this work at the very top of this model?

(d) is similar and must also be Vio.

(e) is similar but above a later EROD event. the later EROD event takes precedence.

Tutorial C2—Demonstrate a series using bottoms

Parent topic:

Tutorial case study C

(Unconformities and intrusives)

In this tutorial:

- [Tutorial C2—Steps](#)
- [Tutorial C2—Discussion—Tops and Bottoms](#)

Tutorial C2—Steps

Parent topic:

Tutorial C2— Demonstrate a series using bottoms

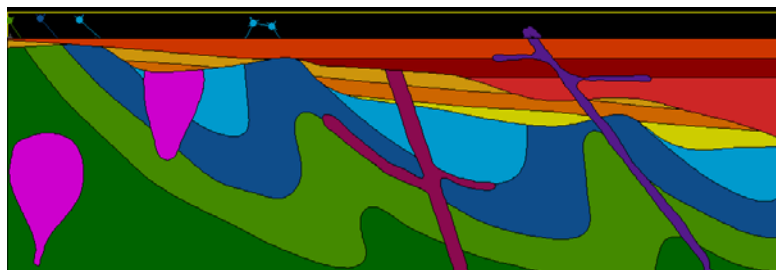
The basic operations in this tutorial are similar to those in the previous tutorial. Refer to [Tutorial C1—Steps](#) for detailed instructions.

- 1 If required, save and close any project that you are currently working on.
- 2 Open the following project:
`GeoModeller\tutorial\CaseStudyC\TutorialC2\Beginning_project\TutorialC2.xml`
- 3 *(If you want to perform your own operations on this project, changing its data)*
Save the project with a new name in the folder you are using for your tutorial data.

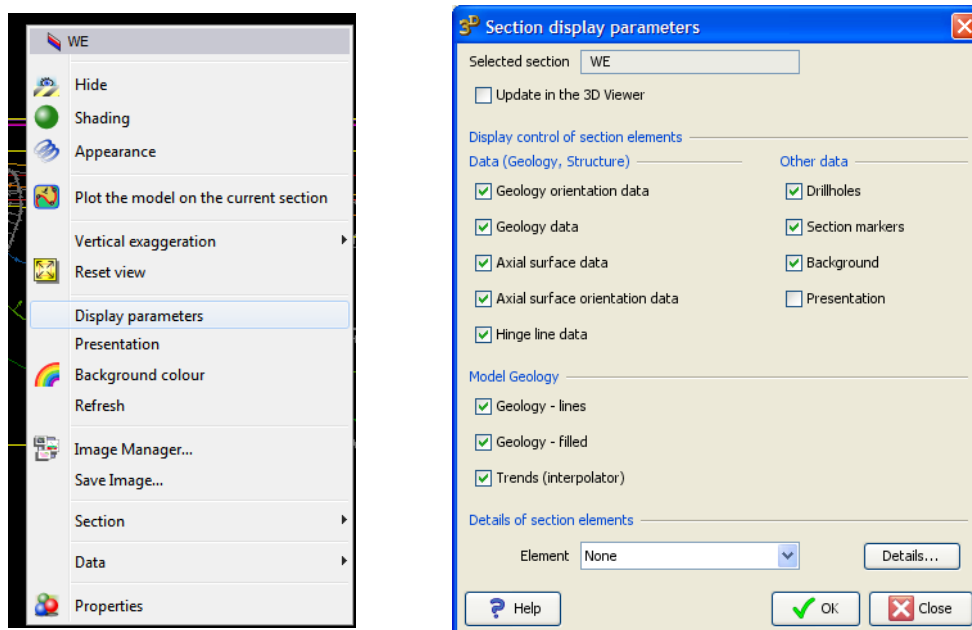
Do not overwrite the completed version of this tutorial that we have supplied in your 3D GeoModeller installation.

- 4 Display the **WE** section in the **2D Viewer**.
- 5 Compute the model with all components of the project.
- 6 Plot the model using fill in section **WE** in the **2D Viewer**.

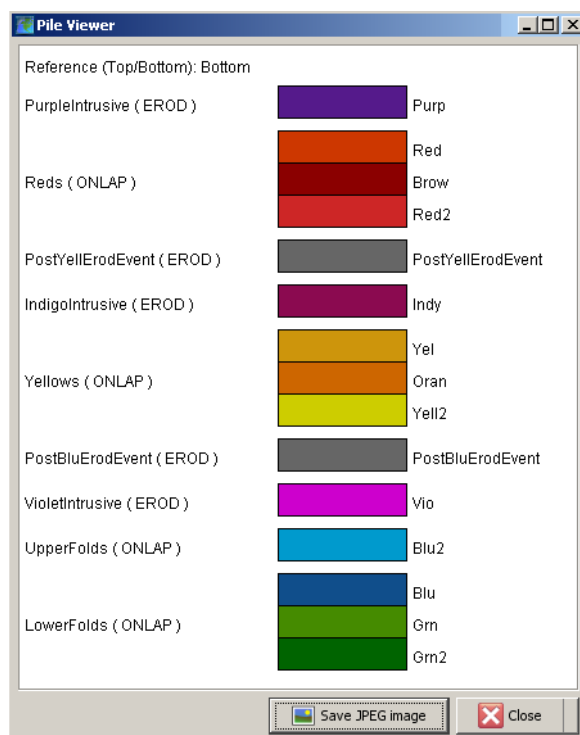
3D GeoModeller plots the model in the **2D Viewer**. The illustration here shows the model data only. When you first view the plot, you may see the project data as well. See the following step for display options.



- 7 (Optional) From the shortcut menu, choose **Display parameters** and try various display options (Choose **OK** when selected).



- 8 Display the stratigraphic pile diagram

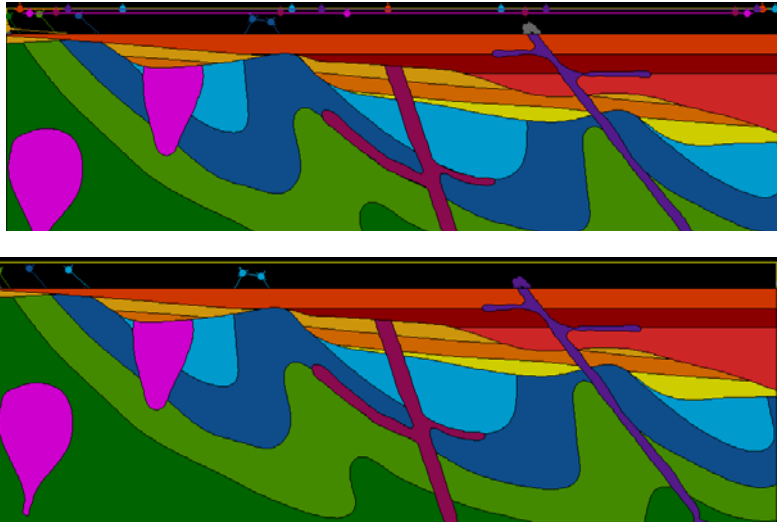


Tutorial C2—Discussion—Tops and Bottoms

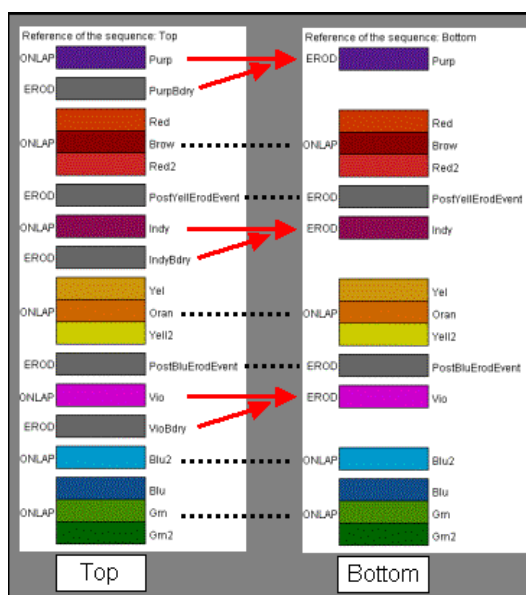
Parent topic:
Tutorial C2—
Demonstrate a
series using
bottoms

Compare the approaches

The two cases – ‘define the tops’ and ‘define the bottoms’ should achieve identical geological model outcomes. There are several data input differences, but the results should be the same.

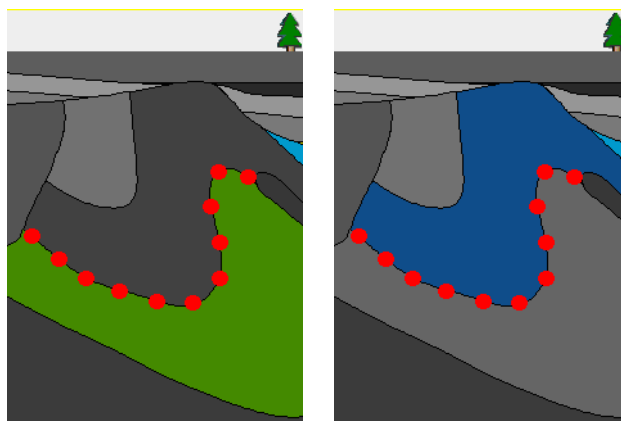


The definition of the stratigraphic pile for the two options is the same, except for the intrusives. For the bottom case, a single erosional contact can define an intrusive.



It's fairly obvious—but important to note—that geological contact data are used differently, depending on whether we are using the 'top' or 'bottom' reference.

For example, for the 'top' case, the geological contacts define top of Grn (left). For the 'bottom' case, these same contact points are assigned to different geology. They now define bottom of Blu (right).



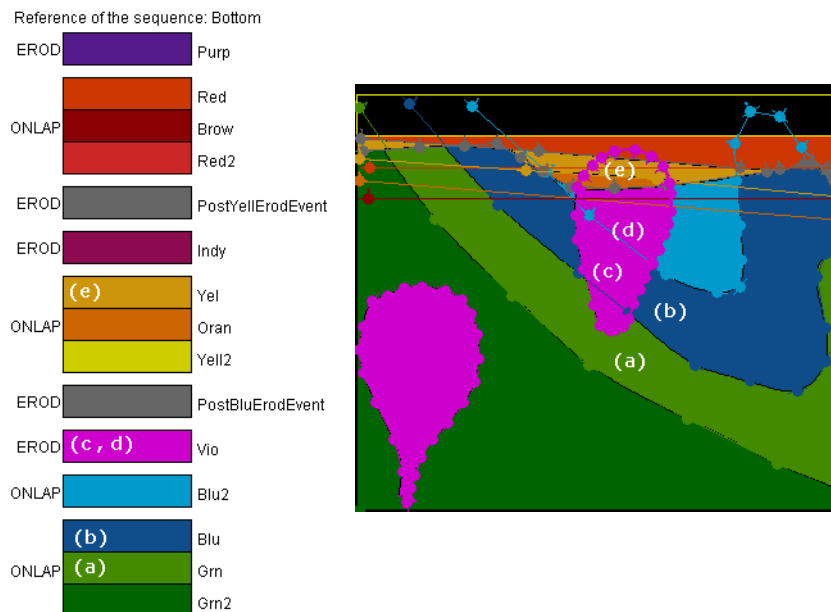
Interrogate the model

As you did in [Tutorial C1—Demonstrate a series using tops](#), interrogate the model and satisfy yourself that 3D GeoModeller is rendering the geology correctly and logically, based on:

- The contact points defined in the model and
- The stratigraphic column.

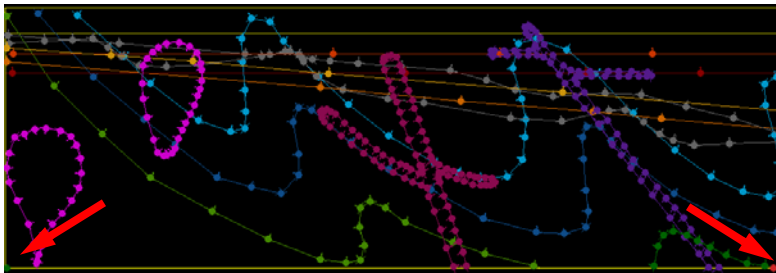
When you define the stratigraphic column, you:

- Define an order of events
- Set the Onlap or Erode (topological) switches. Onlap means ‘A stops on B.’ Erode means ‘A cuts across B’.

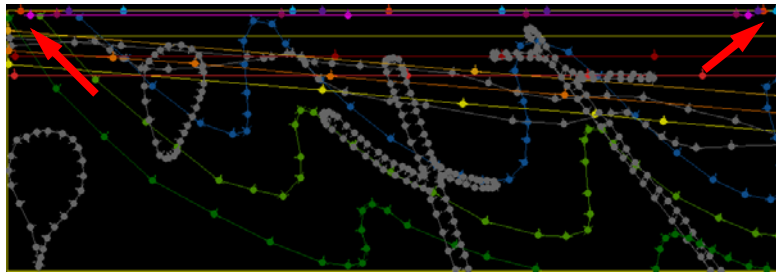


Geological observations at the very bottom or the very top

There are three geological observations defined at the very bottom of the model. What are they? Why are they defined down at the bottom of the model?



By contrast, for the ‘top’ case in [Tutorial C1—Demonstrate a series using tops](#), there are many geological observations defined at the very top of the model up in the air. What are they? Why are they defined up at the top?



Tutorial C3—Examine a sequence of geological events

Parent topic:
Tutorial case study C (Unconformities and intrusives)

In this tutorial we examine a series of 3D GeoModeller projects. The series illustrates the sequence of geological events that created the Case Study C project area. The first project shows the initial series of folded strata. In each project through the series, we progressively add later intrusive and erosional events.

Sections and stages in this tutorial:

- [Tutorial C3—General instructions](#)
- [C3 Stage 1—Folded strata](#)
- [C3 Stage 2—Intrusion events 1](#)
- [C3 Stage 3—Erosional events 1](#)
- [C3 Stage 4—Intrusion events 2](#)
- [C3 Stage 5—Erosion events 2](#)
- [C3 Stage 6—Intrusion events 3](#)

Tutorial C3—General instructions

Parent topic:
Tutorial C3—Examine a sequence of geological events

For each stage of this tutorial, follow these instructions.

The basic operations in this tutorial are similar to those in the first tutorial of this case study. Refer to [Tutorial C1—Steps](#) for detailed instructions.

- 1 Open the project from the corresponding subfolder of **GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project**
- 2 *(If you want to perform your own operations on this project, changing its data)* Save the project with a new name in the folder you are using for your tutorial data.

Do not overwrite the completed version of this tutorial that we have supplied in your 3D GeoModeller installation.

- 3 Display the **WE** section in the **2D Viewer**.
- 4 Compute the model with all components of the project.
- 5 Plot the model using fill in section **WE** in the **2D Viewer**.

C3 Stage 1—Folded strata

Parent topic:
[Tutorial C3—
Examine a
sequence of
geological events](#)

This stage contains the initial series of folded strata.

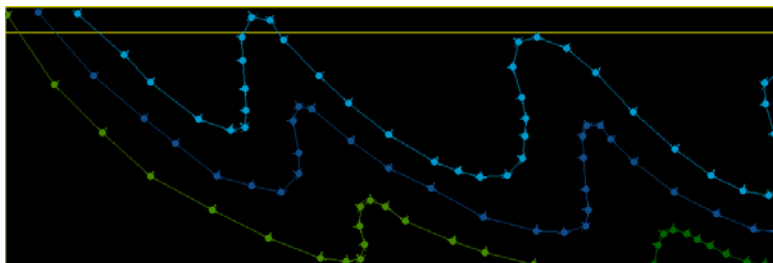
The project is available in:

`GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project\
TutorialC3_1\TutorialC3_1.xml`

For instructions, see [Tutorial C3—General instructions](#). Do not overwrite this completed version of this tutorial that we have supplied in your 3D GeoModeller installation. You can save a copy (**Save As**) somewhere else on your hard drive if required.

In the following illustrations you can see:

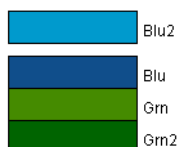
- The original data
- The calculated model displayed in filled mode
- The stratigraphic pile



Reference of the sequence: Bottom

UpperFolds (ONLAP)

LowerFolds (ONLAP)



C3 Stage 2—Intrusion events 1

Parent topic:
[Tutorial C3—
Examine a
sequence of
geological events](#)

This stage contains two intrusions.

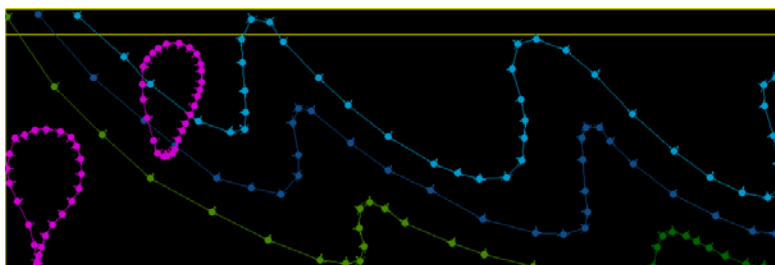
The project is available in:

`GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project\
TutorialC3_2\TutorialC3_2.xml`

For instructions, see [Tutorial C3—General instructions](#). Do not overwrite this completed version of this tutorial that we have supplied in your 3D GeoModeller installation. You can save a copy (**Save As**) somewhere else on your hard drive if required.

In the following illustrations you can see:

- The original data
- The calculated model displayed in filled mode
- The stratigraphic pile



Reference of the sequence: Bottom

VioletIntrusive (EROD)

Vio

UpperFolds (ONLAP)

Blu2

LowerFolds (ONLAP)

Blu

Gm

Gm2

C3 Stage 3—Erosional events 1

Parent topic:
Tutorial C3—
Examine a
sequence of
geological events

This stage includes erosional events.

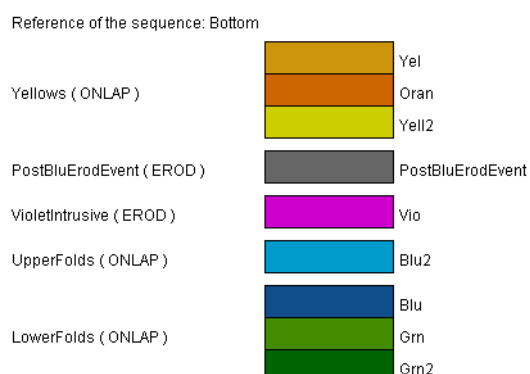
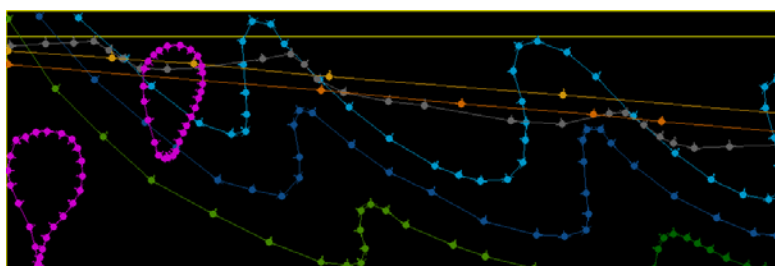
The project is available in:

GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project\
TutorialC3_3\TutorialC3_3.xml

For instructions, see [Tutorial C3—General instructions](#). Do not overwrite this completed version of this tutorial that we have supplied in your 3D GeoModeller installation. You can save a copy (**Save As**) somewhere else on your hard drive if required.

In the following illustrations you can see:

- The original data
- The calculated model displayed in filled mode
- The stratigraphic pile



C3 Stage 4—Intrusion events 2

Parent topic:
Tutorial C3—
Examine a
sequence of
geological events

This stage includes a second set of intrusional events.

The project is available in:

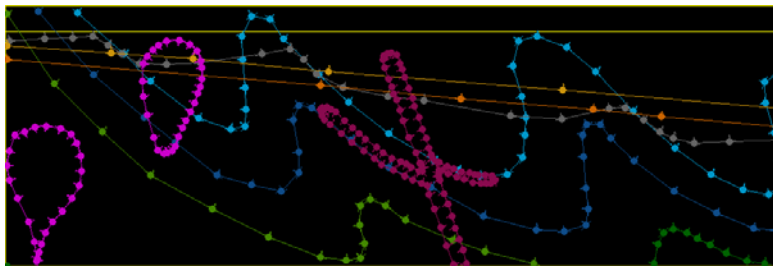
GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project\
TutorialC3_4\TutorialC3_4.xml

TutorialC3_4\TutorialC3_4.xml

For instructions, see [Tutorial C3—General instructions](#). Do not overwrite this completed version of this tutorial that we have supplied in your 3D GeoModeller installation. You can save a copy (**Save As**) somewhere else on your hard drive if required.

In the following illustrations you can see:

- The original data
- The calculated model displayed in filled mode
- The stratigraphic pile



Reference of the sequence: Bottom

IndigoIntrusive (EROD)	Indy
Yellows (ONLAP)	Yel
	Oran
	Yell2
PostBluErodEvent (EROD)	PostBluErodEvent
VioletIntrusive (EROD)	Vio
UpperFolds (ONLAP)	Blu2
	Blu
LowerFolds (ONLAP)	Gm
	Gm2

C3 Stage 5—Erosion events 2

Parent topic:
**Tutorial C3—
Examine a
sequence of
geological events**

This stage includes a second set of erosional events.

The project is available in:

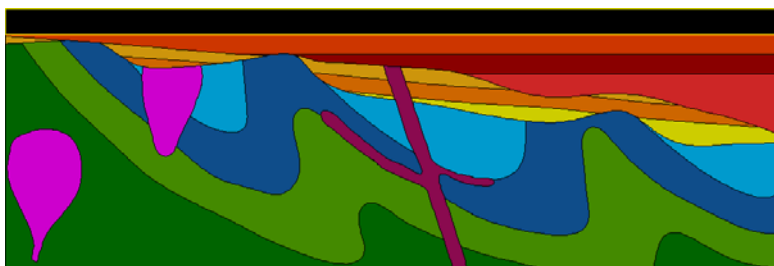
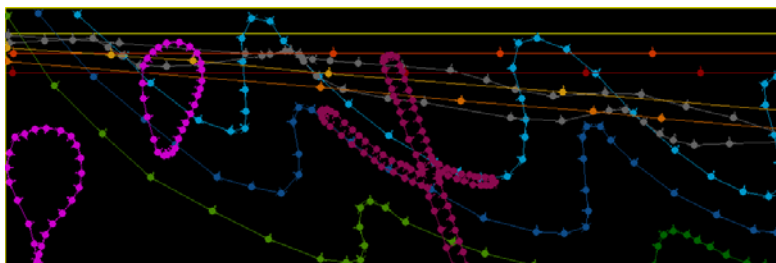
**GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project\
TutorialC3_5\TutorialC3_5.xml**

For instructions, see [Tutorial C3—General instructions](#). Do not overwrite this completed version of this tutorial that we have supplied in your 3D GeoModeller

installation. You can save a copy (**Save As**) somewhere else on your hard drive if required.

In the following illustrations you can see:

- The original data
- The calculated model displayed in filled mode
- The stratigraphic pile



Reference of the sequence: Bottom

		Red
		Brow
		Red2
Reds (ONLAP)		
		PostYellErodEvent
PostYellErodEvent (EROD)		
		Indy
IndigoIntrusive (EROD)		
		Yel
		Oran
Yellows (ONLAP)		
		Yell2
		PostBluErodEvent
PostBluErodEvent (EROD)		
		Vio
VioletIntrusive (EROD)		
		Blu2
UpperFolds (ONLAP)		
		Blu
		Grn
LowerFolds (ONLAP)		
		Grn2

C3 Stage 6—Intrusion events 3

Parent topic:
**Tutorial C3—
Examine a
sequence of
geologicalevents**

This stage includes a third set of intrusional events.

The project is available in:

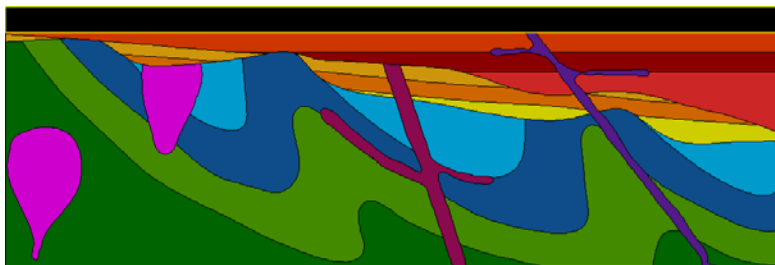
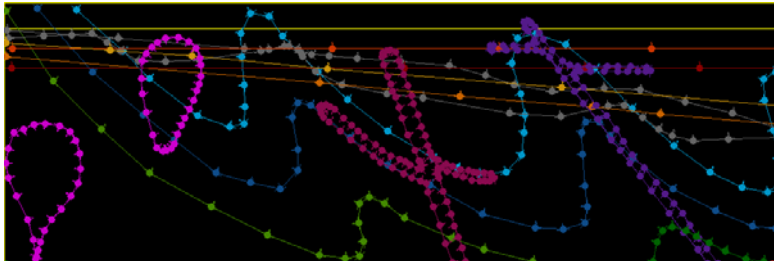
**GeoModeller\tutorial\CaseStudyC\TutorialC3\Beginning_project\
TutorialC3_6\TutorialC3_6.xml**

For instructions, see [Tutorial C3—General instructions](#). Do not overwrite this completed version of this tutorial that we have supplied in your 3D GeoModeller
















installation. You can save a copy (**Save As**) somewhere else on your hard drive if required.

In the following illustrations you can see:

- The original data
- The calculated model displayed in filled mode
- The stratigraphic pile



Reference of the sequence: Bottom

PurpleIntrusive (EROD)		Purp
		Red
Reds (ONLAP)		Brow
		Red2
PostYellErodEvent (EROD)		PostYellErodEvent
IndigoIntrusive (EROD)		Indy
		Yel
Yellows (ONLAP)		Oran
		Yell2
PostBluErodEvent (EROD)		PostBluErodEvent
VioletIntrusive (EROD)		Vio
UpperFolds (ONLAP)		Blu2
		Blu
LowerFolds (ONLAP)		Gm
		Gm2