Tectonic Reconstruct *for ArcGIS 10.0*

Reference Manual

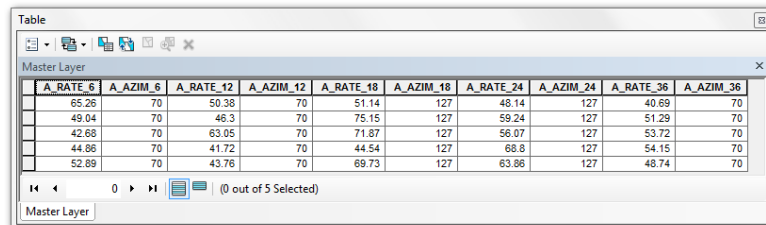|	
Version:	1.1
Date:	September 28, 2011
Install Files:	TectonicReconstruct.esriAddIn
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Description:	*Tectonic Reconstruct* provides a set of tools for the sequential reconstruction of tectonic features. Polygon or polyline type geometries, populated with rates of movement and directions, are continuously displaced from their present location for different points in time (time slices). Once reconstructed, displacement parameters for each feature in each time-slice may be modified through an editing environment designed specifically for the recalculation of displacement values through map interaction.
Requirements:	ArcGIS Desktop 10.0
Manual update:	October 5, 2011

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Toolset capabilities

Input features

Tectonic Reconstruct uses a ***Master layer*** as the **main source** of **rates** and **azimuths** of each feature to be reconstructed, for a predefined set of time *slices*. These values are stored in attribute table fields and are used by the toolset in the computation of displacement vectors in order to derive the new location of features.

	Table									⊠

Master Layer ×

A_RATE_6	A_AZIM_6	A_RATE_12	A_AZIM_12	A_RATE_18	A_AZIM_18	A_RATE_24	A_AZIM_24	A_RATE_36	A_AZIM_36
65.26	70	50.38	70	51.14	127	48.14	127	40.69	70
49.04	70	46.3	70	75.15	127	59.24	127	51.29	70
42.68	70	63.05	70	71.87	127	56.07	127	53.72	70
44.86	70	41.72	70	44.54	127	68.8	127	54.15	70
52.89	70	43.76	70	69.73	127	63.86	127	48.74	70

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Master Layer

Output time slices

Construction

Time slices are generated by first running a **Construction** on the selected *Master layer*. Through this process, the toolset outputs a collection of layers that hold the features displaced in each time-slice. Each of these layers is placed inside a corresponding map *data frame*, allowing for easy manipulation of individual slices during map design and export. Once constructed, features can also be edited to update their rate and azimuth if need be.

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□ Layers
  □ ☑ Master Layer

□ time_slice_6
  □ ☑ time_slice_6

□ time_slice_12
  □ ☑ time_slice_12
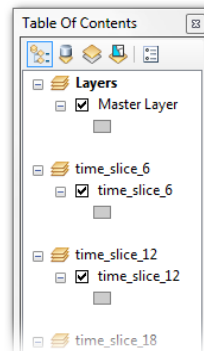
□ time_slice_18

Displacement editing

Displacement magnitudes of tectonic blocks or faults may be modified from one time-slice to the next inside an editing environment designed specifically for the calculation of rate and azimuth values. Features can be moved in a particular direction to change their azimuth, or a certain distance to recalculate a rate. Changes to features are reflected in subsequent slices by running a **Reconstruction**.

Reconstruction

Reconstructions update features along the remaining of the time-slice record, or from time-slice to time-slice, once a particular time-slice has been edited.
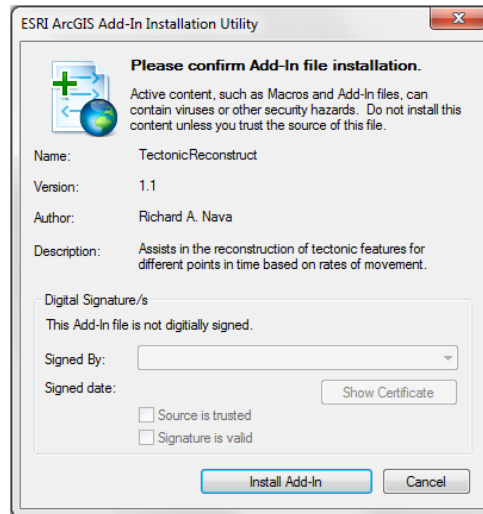
Present

6 Ma

12 Ma

18 Ma

24 Ma

36 Ma

Installation instructions

1. **Close** ArcMap (if open).
2. Double-click the **TectonicReconstruct.esriAddIn** file.
3. Select **Install Add-In** from the ESRI ArcGIS Add-In Installation Utility (Figure 2.1).
4. Click **OK** on the **Installation Succeeded** dialog to finish the installation.


Figure 2.1. Select 'Install Add-In' button on the 'ESRI ArcGIS Add-In Installation Utility'.

Troubleshooting: If the Add-In cannot be installed, make sure to look for administrative options at: Customize > Add-In Manager > Options (panel).

Adding to ArcMap

1. **Open** ArcMap**.**
2. Look for the **Tectonic Reconstruct** toolbar somewhere on the screen.
   a. If the toolbar has not appeared automatically: click on **Customize** > **Toolbars** and make sure **Tectonic Reconstruct** is checked (Figure 3.1).
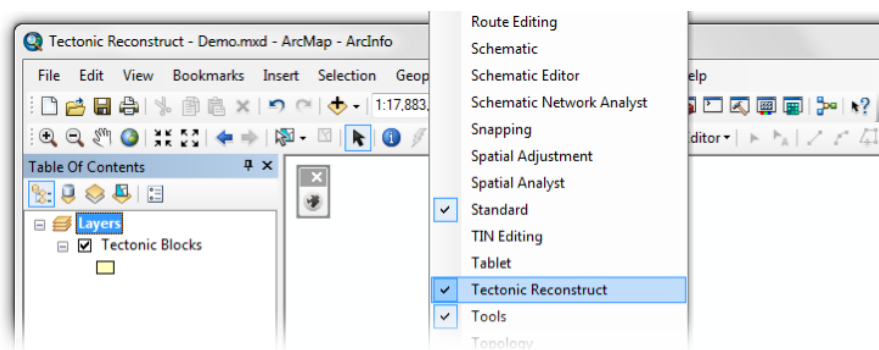
Figure 3.1. If the toolbar doesn't show up the first time you open ArcMap, click on Customize >> Toolbars, and make sure 'Tectonic Reconstruct' is checked.

Toolbar description

The Tectonic Reconstruct toolbar holds a single command button:

	Name	Description
⚙	Tectonic Reconstruct	Show/Hide the Tectonic Reconstruct window.

Table 4.1. Name and description of toolbar components.

Tectonic Reconstruct window

The *Tectonic Reconstruct* window is made up of **two** different panels: the **Slice Construction** panel holds a set of input parameters used to tell the tool where to gather the necessary information from, and how to construct the slices. The **Edit Displacements** panel is used to edit the rates and azimuths of features in a particular time-slice.

Slice Construction panel

Slice Construction panel
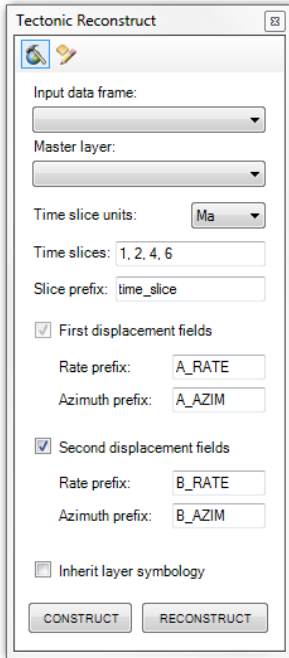
Time slices are the times at which block positions will be calculated in **Time slice units**

Blocks for each time-slice are displaced based on field values (rates and azimuths). **Displacement fields** for each time-slice in the **Master layer** should be prefixed with values entered here. e.g. **A_RATE_2** (for **time_slice_2**)

A **Construction** duplicates and displaces each feature in the Master layer for each time-slice

The **Master layer** contains tectonic features in their present location, with rates (mm/yr.) and azimuths (degrees) for all time slices.

Each slice generated from the list will be prefixed with the **Slice Prefix** value. e.g. time_slice_2 (for 2 Ma)

A **Reconstruction** takes the first time-slice in the **Time slices** list and applies displacements to subsequent ones

Figure 5.1. Brief overview of the Slice Construction panel controls.
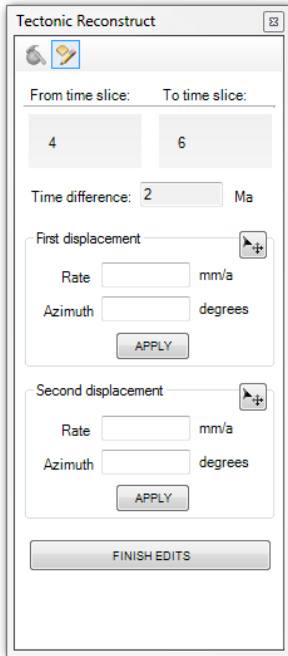
Edit Displacements panel

Edit Displacements panel

The **From time slice** layer holds the position of features before displacement

Each feature can be displaced up to 2 times. Once a feature from the **To** layer is selected from the map, its rate and azimuth values appear in these fields, these can then be modified and reflected on the map using the **APPLY** buttons

The **To time slice** layer contains the displaced features, which are the features to be edited

The **Time Difference** between the two time slices is added to this field to ensure that calculations are using the correct time value

Displacement **tools** are used to interact with features on the map. Field displacement values are automatically updated during feature movement

Changes to feature rates and azimuths are stored in the layer after clicking the **FINISH EDITS** button

Figure 5.2. Brief overview of the Edit Displacements panel controls.

The tectonic reconstruction workflow

Overview

Planning the time-slice scheme.
1. Creating the **Master feature class**.
2. Generating displacement (rate and azimuth) **fields**.
3. Populating feature displacement **Rates** and **Azimuths**.
4. Setting **Construction parameters**.
5. Running the **first Construction**.
6. **Editing** rate and azimuth values of features in a particular time-slice.
7. Reflecting edits on other time slices through **Reconstruction.**

Planning the time-slice scheme

Before you begin using the toolset, it is important to think about the time-slice scheme you will use and the resources that will be needed to construct each time-slice in that scheme.
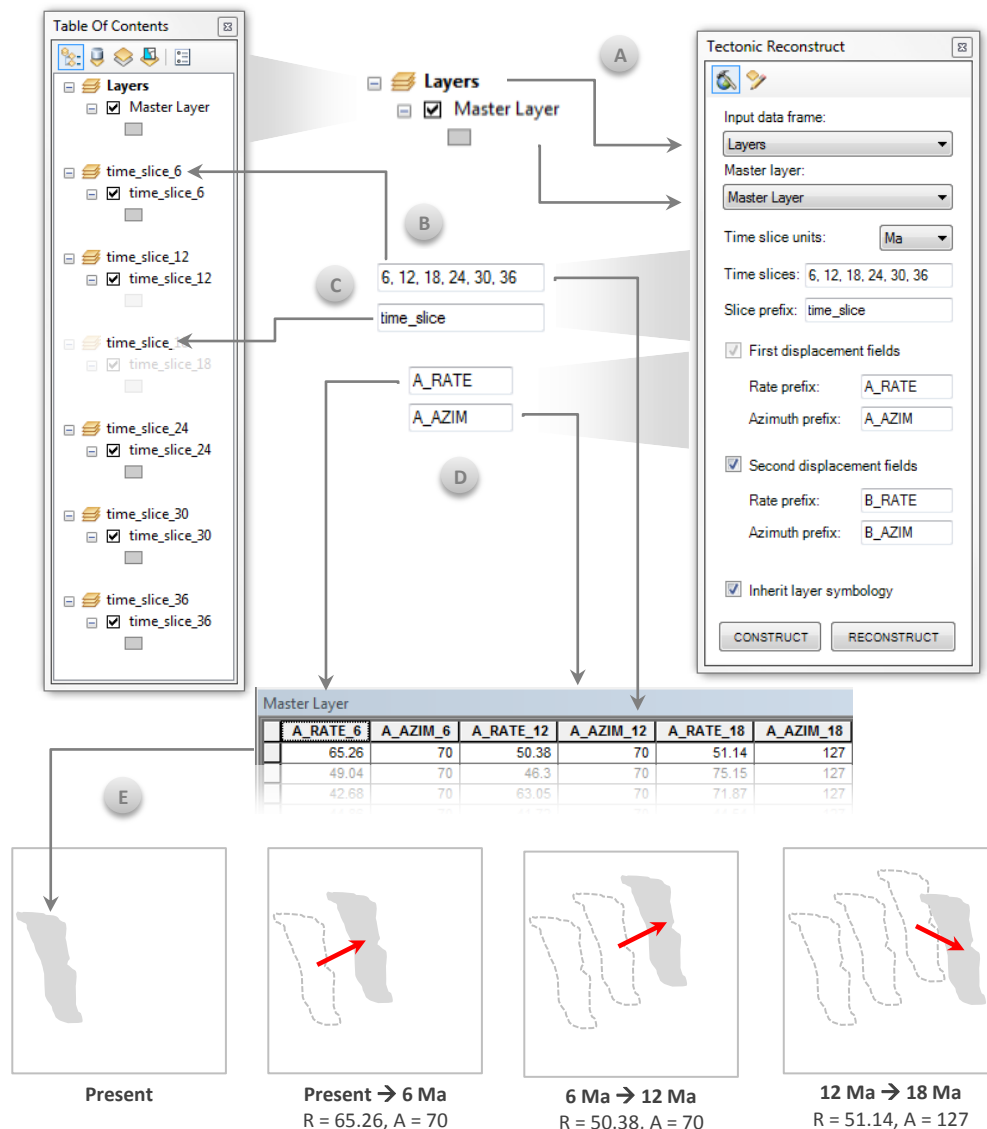
Time slices

Time slices are points in time at which tectonic reconstructions will be generated. The list of time slices to be used by the toolset is entered in the *Tectonic Reconstruct* **Slice Construction** panel. Units for the time-slice list can range from **a** (years) to **Ga** (billions of years) and they are specified in the **Time-slice units** dropdown menu.

Master layer

Tectonic Reconstruct takes an input **Master layer** to perform the first construction of an entire list of time slices. This layer holds the polygon or polyline geometries depicting the present location of tectonic features to be reconstructed. Along with its geometric shape, each feature should store information (attributes) used by the toolset to reposition each feature for each time-slice on the list. The two required values are **rate** and **azimuth**. Features may be displaced up to two different times per time-slice. Displacement fields for each time-slice should be prefixed by the **Rate** and **Azimuth prefix** values entered in the **Slice Construction** panel.

The following is a worked example of how parameters in the *Tectonic Reconstruct's* **Slice Construction** panel relate to the input **Master layer** and its derived time slices:

Figure 6.1. Slice Construction panel parameters and how they relate to the map document and Master layer. **A)** The input data frame and Master layer are selected on the first two fields. **B)** The toolset appends time-slice list values to each time-slice and adds it to the table of contents. Fields on the Master layer should have these values appended to them as well. **C)** The Slice prefix is used as the beginning of the time slice name. **D)** Rate and Azimuth field prefixes should match those on the Master layer attribute table for all time slices. **E)** Displacement example for a single feature across three different time slices. Notice how rate and azimuth values from the Master layer's attribute table are used to generate the displacement vector from one time slice to the next.

1. Creating the Master feature class

a. Navigate to a **folder** in **ArcCatalog**:

b. Right-click > New > **File Geodatabase** > Enter a **name** for the geodatabase.

c. Inside the geodatabase: Right-click > New > **Feature Class**.

d. In the **New Feature Class** dialog:

- Enter a **Name.**

- Select the **Type** of features to be stored (polygons or polylines) > Click **Next**.

- Select (or define) a **coordinate system** for the new feature class > Click **Next**.

Requirement: coordinate system units must be **Meters**.

- Modify the **XY Tolerance** parameters (optional) > Click **Next**.

- Modify the **database storage configuration** (optional) > Click **Next**.

2. Generating displacement (rate and azimuth) fields

… continued:

- Type in the name for each field under **Field Name**, and select **Double** for the **Data Type**.

Option – Import an existing field configuration from another source:

Click on the **Import…** button > Navigate to an existing feature class or table > Select it > Click **Add.**
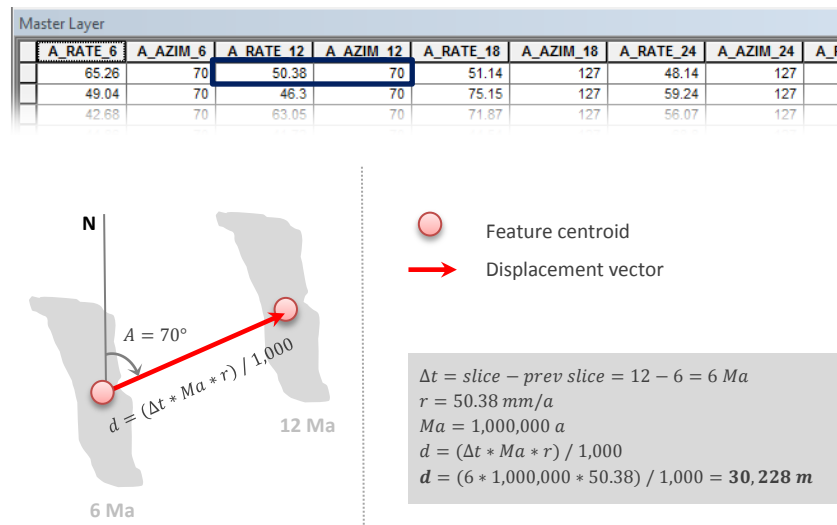
- Click **Finish**.
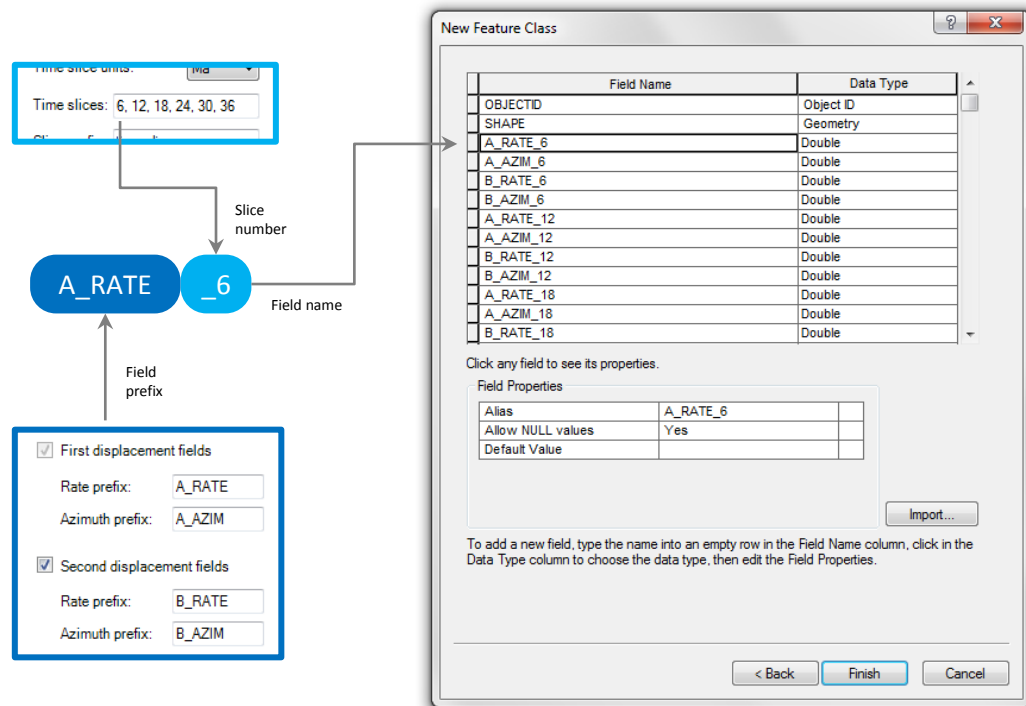
Figure 6.2. Field names are composed of input parameters. The **Rate** and **Azimuth prefixes** for first and second displacements are part of the beginning of the field names, while the **time-slice** number should be appended at the end.

3. Populating feature displacement Rates and Azimuths

As mentioned before, the **Master layer** holds the **present location** of tectonic features and their displacement information for each time-slice. Once features are added to the Master layer's feature class, fields must be populated with displacement data.

Tectonic Reconstruct displaces features from one time-slice to the next by computing a **displacement vector** from **rate** and **azimuth** values:

	A_RATE_6	A_AZIM_6	A_RATE_12	A_AZIM_12	A_RATE_18	A_AZIM_18	A_RATE_24	A_AZIM_24	A_R
	65.26	70	50.38	70	51.14	127	48.14	127	
	49.04	70	46.3	70	75.15	127	59.24	127	
	42.68	70	63.05	70	71.87	127	56.07	127	

Master Layer

N

$A = 70°$

$d = (\Delta t * Ma * r) / 1{,}000$

6 Ma

12 Ma

○ Feature centroid

→ Displacement vector

$\Delta t = slice - prev\ slice = 12 - 6 = 6\ Ma$
$r = 50.38\ mm/a$
$Ma = 1{,}000{,}000\ a$
$d = (\Delta t * Ma * r) / 1{,}000$
$\boldsymbol{d} = (6 * 1{,}000{,}000 * 50.38) / 1{,}000 = \boldsymbol{30{,}228\ m}$

Figure 6.3. Background process of a feature displacement example. The toolset uses the rate and azimuth values from the attribute table to compute a displacement vector.

The following steps assume that geometries representing **tectonic features** (polygon or polylines) have **already been created** inside the **Master layer**:

a. Add the Master feature class to **ArcMap** as a layer:
   - Click on the **Add data** command located on the **Standard** toolbar.
   - Navigate to the feature class we created on **Step 1** above.
   - Select it and click **Add**.

b. On the **table of contents**: Right-click the layer > **Edit Features** > **Start Editing**.

c. On the **table of contents**: Right-click the layer > **Open Attribute Table**.

d. **Select** a feature from the map (or the attribute table).

e. **Type** in the displacement rates (in **mm/yr.**) and azimuths (in **degrees**) in the fields corresponding to each time-slice.
   Repeat this step for all features in the layer. If values **do not exist** for a particular time-slice, you can set them to **zero**, or leave them **empty**. If this is done, the feature **will not be displaced** for that time-slice.

f. When finished, select **Editor** from the **Editor** toolbar > **Stop Editing** > **Save edits** when prompted.

4. Setting Construction parameters

a. **Input data frame**: select the data frame of the **Master layer** containing all tectonic features.

b. **Master layer**: select the **Master layer**.

c.   **Time-slice units**: select the units for the time slices.

d.   **Time slices**: enter a list of times at which tectonic reconstructions will be generated (separated by **commas**).

e.   **Slice prefix**: enter a time-slice prefix to be used in the naming of data frames and layers for each time-slice.

f.   Displacement field **prefixes**: enter the prefix of the fields we created in **step 2**.

g.   **Inherit layer symbology**: if checked, the symbology of the **Master layer** will be applied to each time-slice entered in the **Time slices** field.
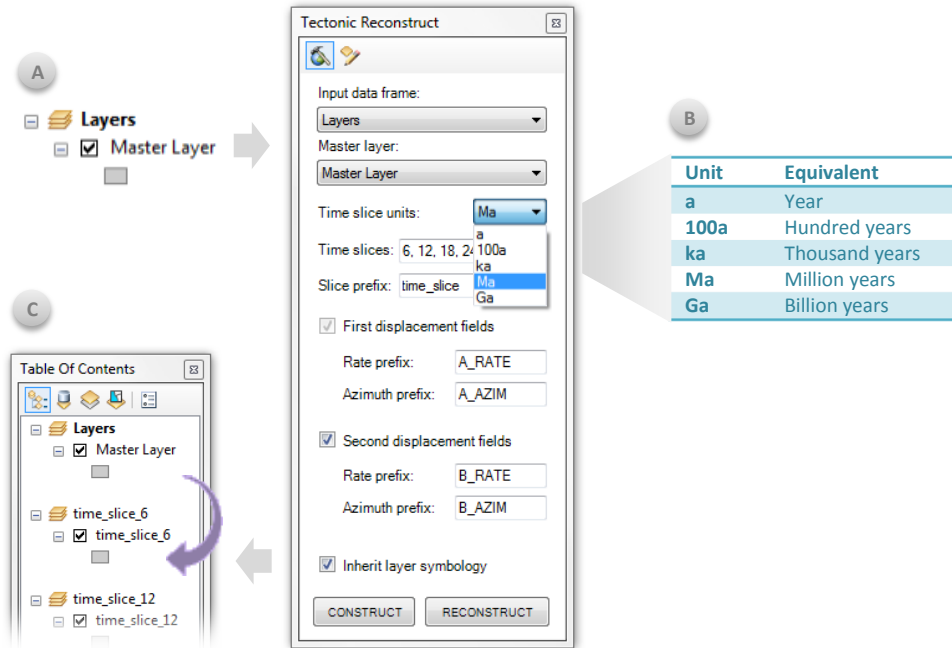
Figure 6.4. A) Input data frame and Master layer example. **B)** Time-slice units available and their description. **C)** The inherit symbology check-box.

5.   Running the first Construction

a.   On the **construction** panel: click **Construct**.

The **first construction** generates a collection of **data frames** with corresponding **layers** for each **time-slice**. The **source** for each newly generated layer resides in the **same workspace** (e.g. geodatabase) as the **Master layer**.

During construction, several fields are added to each time-slice layer. These are used by the toolset to allow for the editing and reconstruction of individual slices.

Field	Description
INPUT_OID	The OID of the Master layer feature
TR_X_COORD	The centroid x-coordinate of the matching feature in previous slice.
TR_Y_COORD	The centroid y-coordinate of the matching feature in previous slice.
(Rates and Azimuths)	Rate and Azimuth fields (with values) copied from Master layer.

Table 6.1. Names and descriptions of fields added to each time slice during construction.

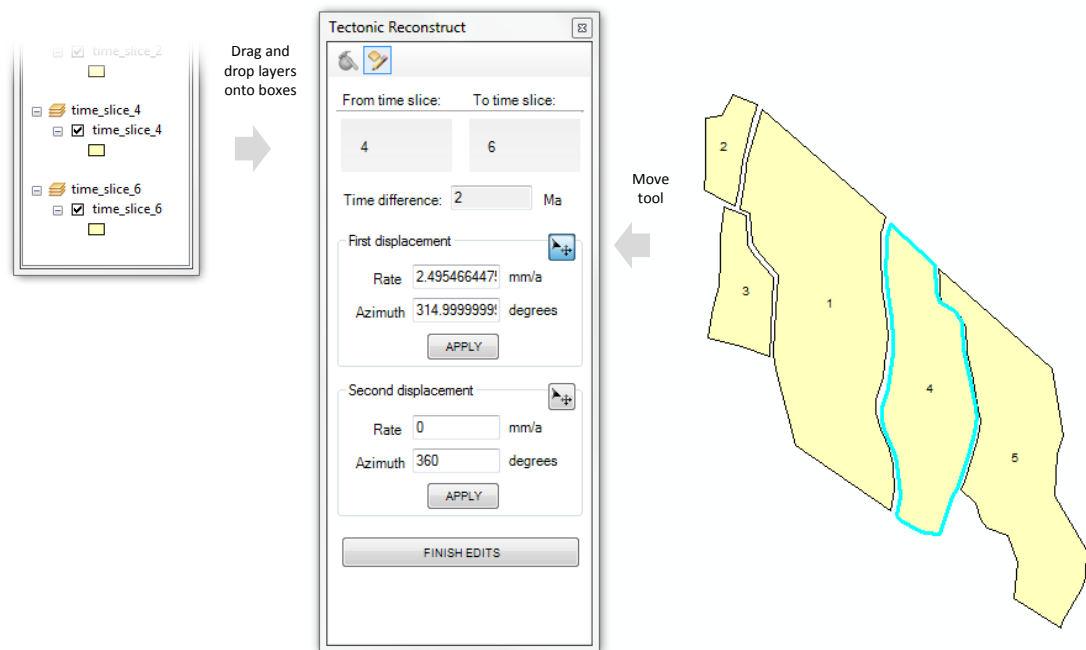## 6. Editing rate and azimuth values of features in a particular time-slice

Editing feature rate and azimuth values from one time-slice to the next takes place in an editing environment designed specifically for this purpose. During a construction, a feature in any time-slice is displaced by a designated rate in a particular direction. These values are first applied as a displacement to the feature when the slices are derived from the **Master layer**. The **Edit Displacements** panel helps with updating the rate and azimuth values of any feature in a particular time-slice through map input.

To edit feature displacement values in a time-slice:

a. Drag the previous time-slice layer onto the **From time slice** box.
b. Drag the time-slice layer to be edited onto the **To time slice** box.

    An edit **session** starts **automatically** and the panel **updates** itself to display rate and azimuth **controls**.
    The time difference between the two time slices is displayed in the **Time difference** field.

  1) Click on the **Move tool,** for either the first or second displacement:
      - Click once on the map to **select** a feature.
      - **Move** the feature by **dragging** the cursor, and **letting go** to finish.


Figure 6.5. Feature displacement magnitudes may be edited using Rate and Azimuth fields located on the Edit Displacements panel, or by interacting with the map directly using Move tools.

  2) Change any displacement values from the panel and click **APPLY**.

c. Click **FINISH EDITS** when done.
d. Run a **Reconstruction**: click on **RECONSTRUCT** on the **Slice Construction** panel (see next step).

7. Reflecting edits on other time slices through Reconstruction

During a **Construction**, time slices are generated from the **Master layer** and are built so that they can be worked on **independent** of the **Master layer**. Because of this, once a layer is edited, a **Reconstruction must be run** right afterwards to "cascade" edits onto features in **subsequent** time slices.

Reconstructions are similar to Constructions in that they displace features from one time-slice to the next. However, a **Reconstruction** only displaces features beginning with the first time-slice entered into the **Time slices** field, whereas a **Construction** begins with the **Master layer**.
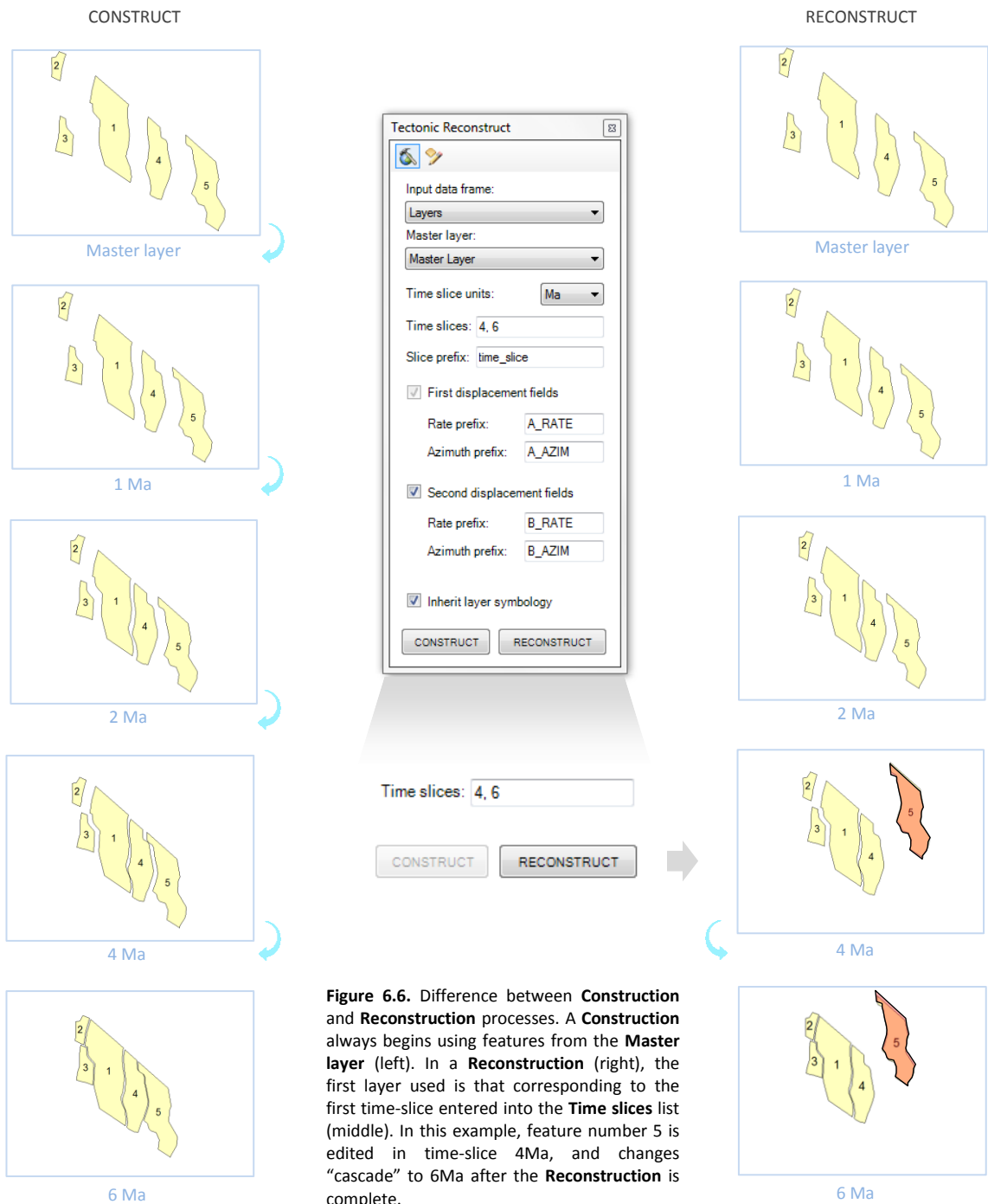

Figure 6.6. Difference between **Construction** and **Reconstruction** processes. A **Construction** always begins using features from the **Master layer** (left). In a **Reconstruction** (right), the first layer used is that corresponding to the first time-slice entered into the **Time slices** list (middle). In this example, feature number 5 is edited in time-slice 4Ma, and changes "cascade" to 6Ma after the **Reconstruction** is complete.

Uninstalling Tectonic Reconstruct

ArcMap

1. From the top menu select: **Customize** > **Add-In Manager** (Figure 7.1).
2. On the **Add-In Manager** window: select the **Tectonic Reconstruct** Add-In and click **Delete this Add-In**.
3. Click **Yes** on the **Delete Add-In** window to confirm.
4. Close the **Add-In Manager** window by clicking **Close**.
5. The Add-In will not be present the **next time** you open ArcMap.
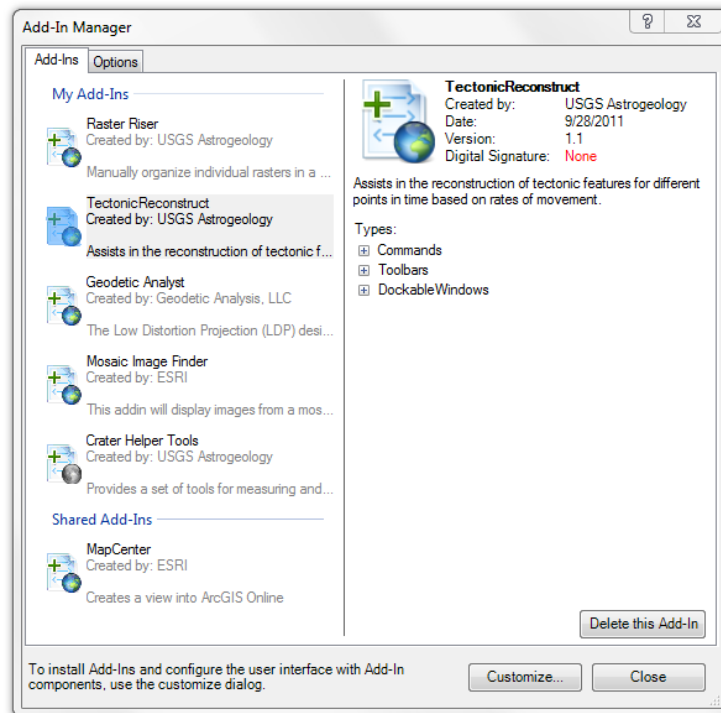
Figure 7.1. The 'Add-In Manager' is used to uninstall Tectonic Reconstruct in ArcGIS 10.0.

Contact Info:

Please email any bugs, comments, and feedback to:

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