Marin Geological Interpretations
Digitizing scale, details and methods

1. Marine geological interpretations at different mapping scales

Depending on the available resources (time, money, personnel etc.), purposes and intended use of end products, marine geological mapping is carried out at widely different scales. Based on the most common mapping projects at NGU we have divided marine mapping into 3 scale categories that require specific interpretation and digitizing approaches :

- **Detailed mapping** *in scales >1:50 000*
  Typically mapping in fjords and small areas along the coast, (Oslofjord, Froan, Grip etc.)
- **Regional mapping** *in scale 1:100 000-1:250 000*
  This is the main mapping scale for Norwegian shelf (MAREANO)
- **Overview mapping:** *in scales <1:500 000)*
  Digitized Old maps and maps based on old and/or discontinuous data (Nasjonalatlas for Norge M 1:3 000 000)

This document is a short summary of methods, requirements and advises for digitizing marine geological interpretations. Understanding the principles and following the rules will help to create uniform maps that are easily readable and will provide meaningful and usable basis for subsequent modeling and new thematic maps.

2. Digitizing and editing at different scales

1. Choice of digitizing scale

The rule of thumb for digitizing is that the map scale on the screen shall not be larger than 2-3 times of the end product, i.e. for mapping in scale 1:100 000, the digitizing scale should not be better than 1:30 000 to 1:50 000. One should also try to use the fixed scale as much as possible, and use Pan tool to move around on the map (alternatively hold C-button or mouse wheel)
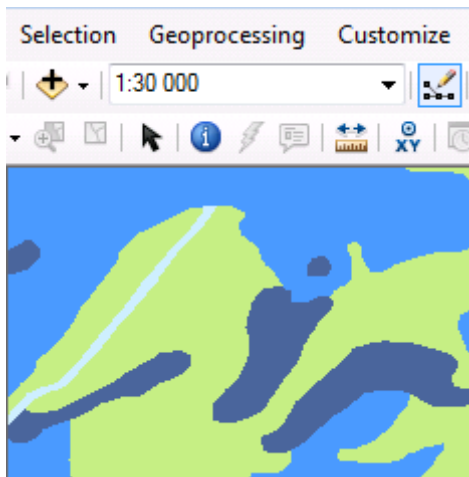

Fig. 1. Remember to zoom-out to chosen digitizing scale after a zoom-in "excursion" on the map for closer look

2. Size of the features and distance between closest objects

It is obvious that different map scales allow different amount of details to be presented on a map. The bigger the map scale, the more details and smaller features can be presented on the map. And the opposite: the smaller the map scale, the bigger the need for generalization. The general rule is that the minimum size for an object that can be seen on the map is 1/2000 of the scale denominator (Table 1.).

Map Scale	MDM
1:10,000	5m
1:50,000	25m
1:100,000	50m
1:250,000	125m
1:500,000	250m
1:1,000,000	500m

Table 1. Examples of the smallest objects on the maps at different scales.
The minimum discernible mark (MDM) is the smallest size the object can be and still be represented at a particular scale.

3. Distance between vertices

3.1. Minimum distance between vertices

Another parameter to consider when digitizing, is the *minimum distance between vertices* on lines and polygon boundaries. When creating paper maps, the commom practice has been one vertex per mm (maximum two vertices per mm). It means that for a map in scale 1:100 000 minimum distance between to vertices shall not exeed 100m.

However, this number is not to be enforced, particularly if the shape of the feature is simple and does not require that many vertices to picture the correct shape of the feature. Nor is it necessary to have constant distances between vertices along the line/polygon.
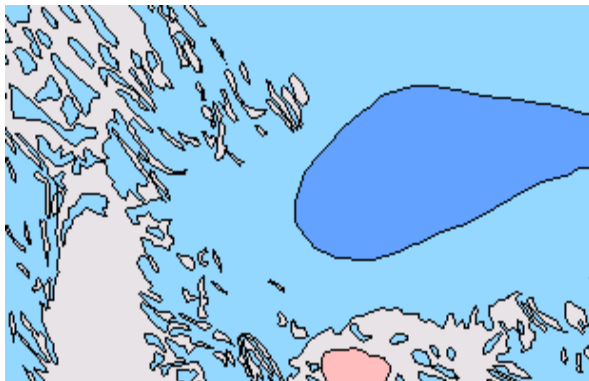

Fig. 2 The blue polygon needs much less vertices to look smooth than the pink polygons with complicated shapes and many details

The number of vertices in a dataset contributes directly to the "heavyness" of the data while used in different applications. Exessive amount of (unnescessary) vertices will also make it much more difficult and time consuming to edit the data if needed. It is thus advised to choose wisely and not create more vertices than it is necessary for rendering a feature in required detail.

3.2. Stream mode digitizing vs. point mode digitizing

When digitizing in the *point mode* you can place the points one by one by the mouse-click. This method is rather slow, but will help to keep the number of vertices low, minimize topology errors and improve the accuracy.

Stream-mode is method of digitizing in ArcGIS in which points are recorded automatically at preset intervals of distance, while moving the cursor with mouse or digitizing pen, and there is no need to click for every vertex. This is the quicker method but can cause the overload of vertices and digitizing errors, like knots and switchbacks that need to be corrected afterwards.
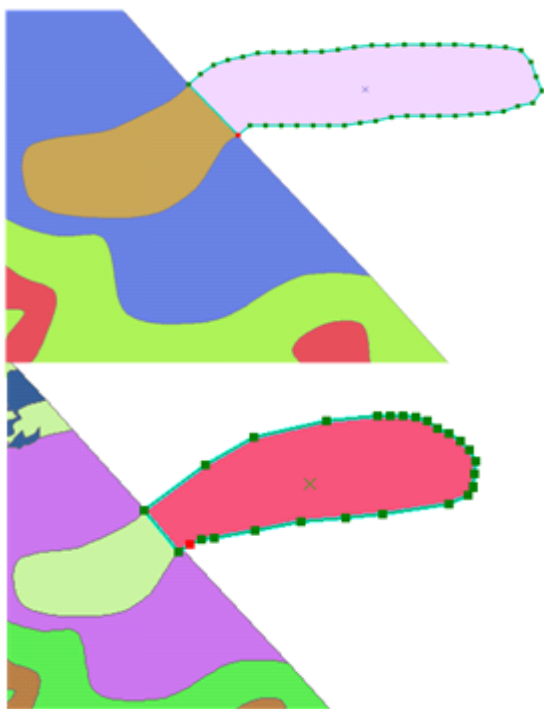

Fig. 3 The example on the top shows a polygon drawn entirely using stream-mode. As can be seen, the stream-mode has created unnecessary many vertices on the straightest parts of the polygon. This should and can be avoided by switching on/off the stream mode depending on the curviness of the feature.

The example on the bottom shows a similar polygon digitized in stream-mode only in the most curved parts.

Stream-mode can easily be switched on and off using F8 key.

Streaming tolerance (distance between vertices) must be set manually, and it can be done by choosing Options in Editor menu, and then General pane. The distance can be either in map units or in meters (allowed when the map is projected). NB! This option will give different results at diferent scales.

3.3. Other functions that can affect distance between vertices

The function SMOOTH in ArcGIS which is ment to smoothen curves will create many new vertices along the line and is therefore not recommended in map production.

Function of GENERALIZE will simplify the shape of lines or polygons within the limits of allowable offset by redusing the number of vertices. If maximum allowable offset is set too large, the shape of the features might became inaccurate. Also, the Generalize tool can create topology errors, and is therefore only reccommended to use with great caution.

3. Some methods, tools and settings for more flawless results

3.1. Snapping

Snapping function should always be used when drawing new lines/polygons in a featureclasse with topology.

 Snapping allows you to create features that connect to each other so your edits are more accurate, with fewer errors. When snapping is turned on, your pointer will jump, or snap to, edges, vertices, and other geometric elements when your pointer is near them and within a certain tolerance. This enables you to position a feature easily in relation to the locations of other features.
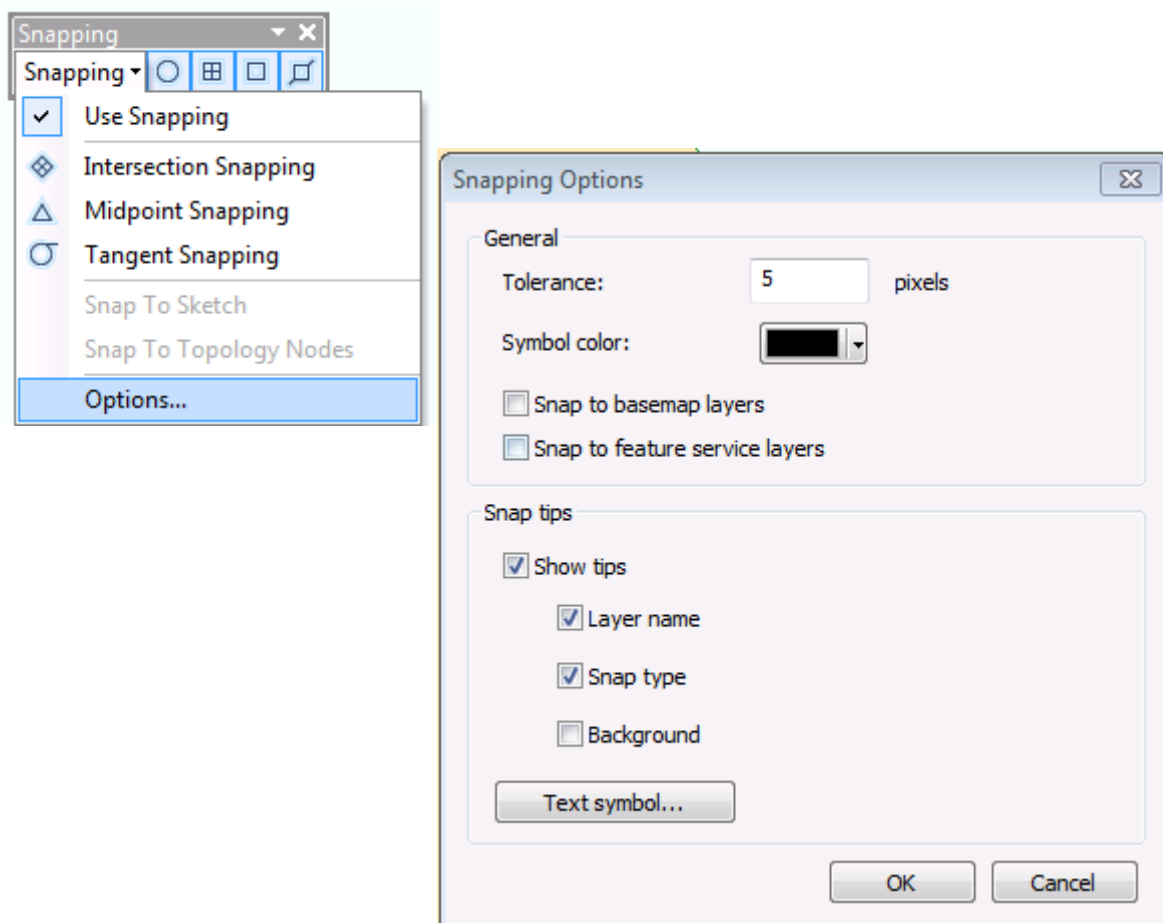
Fig. 4. Snapping toolbar and Snapping options dialog box

3.2. Auto-complete polygon

When drawing new polygons of geological interpretations, you will need to create the polygons next to one another. The polygons should share a border, but you want to avoid digitizing the border twice or having overlaps or spaces between polygons. With Auto-Complete Polygon, you can digitize a new polygon that adjoins an existing polygon, using the existing polygon's geometry.
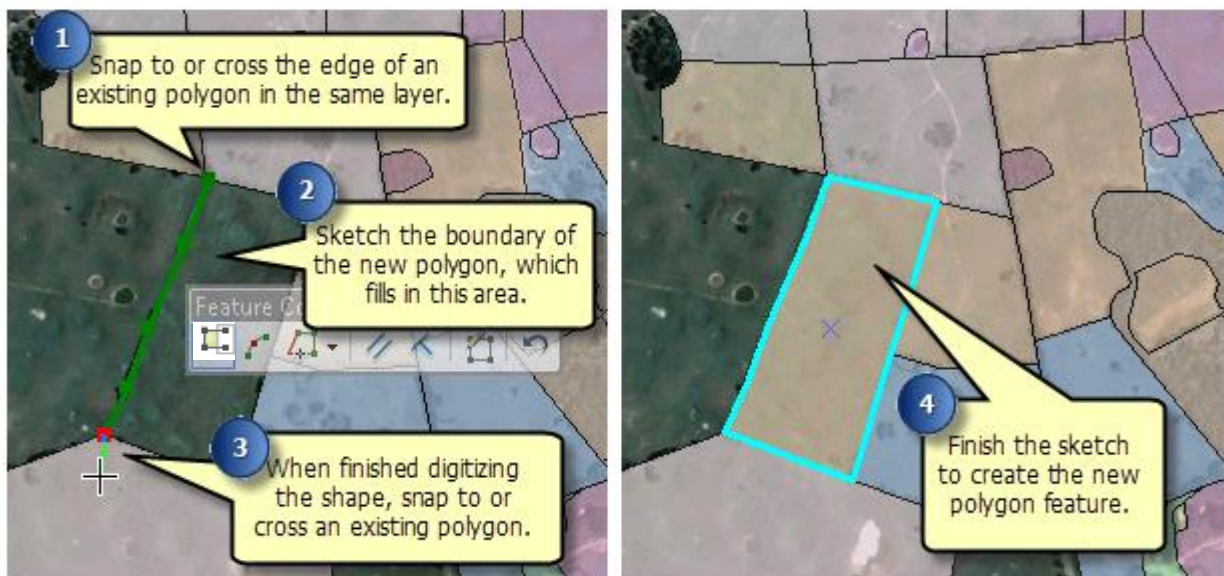

Fig. 6. Using Auto-complete polygon

Warning!

However, Auto-Complete Polygon has a known bug that can have serious consequences for the dataset. When used in closed space between other polygons, the tool will fill out both sides of the space, even as you try to draw a polygon only in one corner. Sometimes it is a usefull function, for example when you try to fill a gap. But when the area is large and the edges of the polygon complicated, especially when there is other polygons inside of the empty area, the autocompleted polygon will not match the borders of the adjacent polygons, often merging with som of them and covering others.

Auto-complete polygon tool must therefore be used with caution, and frequent checks of the results are crucial.

3.3. Tracing

Tracing is a quick and accurate way of creating segments that follow the shapes of other features. In ArcGIS 10, Trace can be used when creating new features, cutting polygons, editing the shapes of existing features, and many other tasks.

Because of this potential danger of spoilng your data when using Auto-Complete polygon, Tracing may be a better option for digitizing small areas within a larger closed space. But as you will have to follow the border of the existing feature with the cursor, tracing will be too painstaking method to trace along long and complicated portions of common borders.
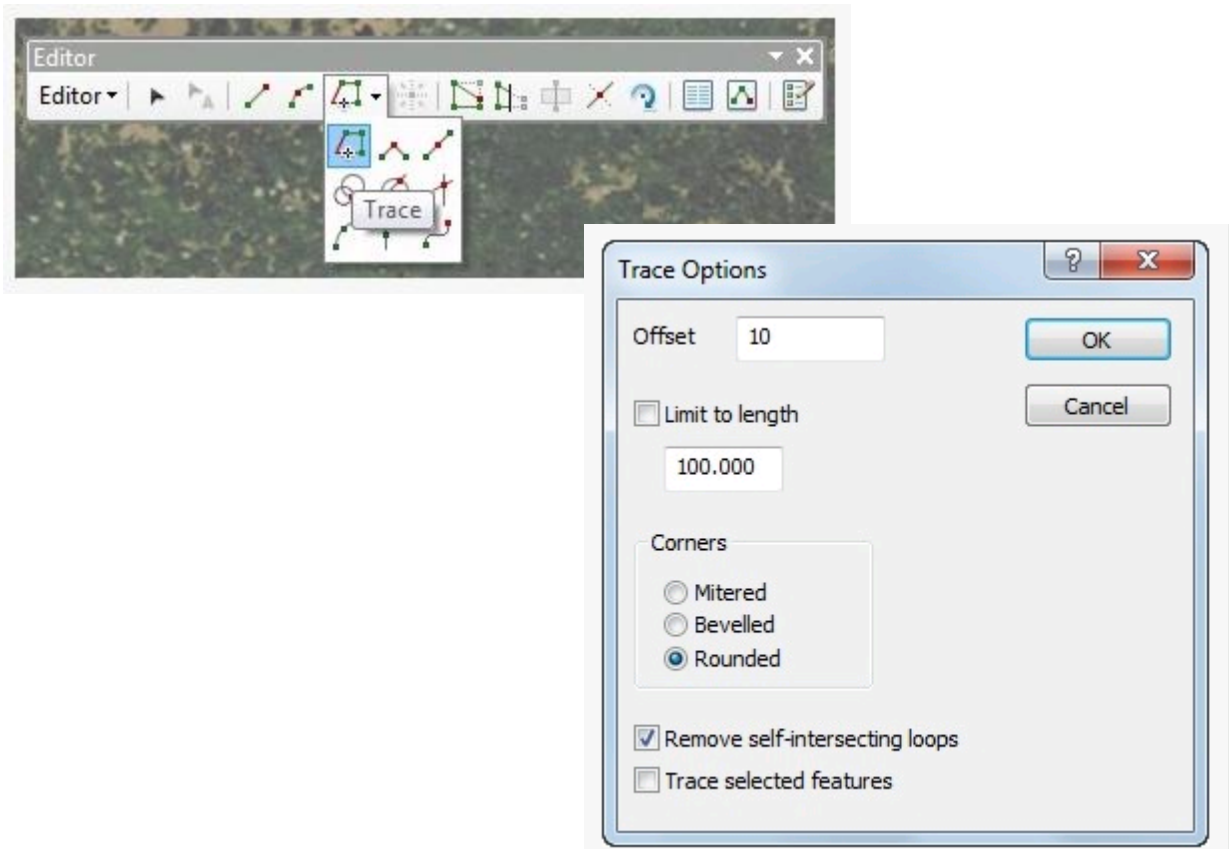
Fig. 7. Trace tool and Trace Options dialog box

3.4. Sticky move

In order to avoid that your lines are moved by only a few pixel without noticing, set the "sticky move tolerance" to a high value (for example 1000) in Editor ->Options ->General
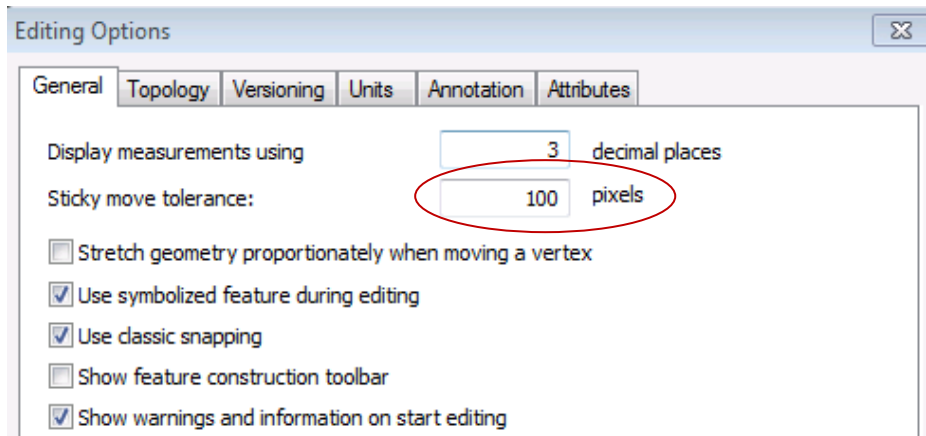

Fig. 8. Stick move tolerance setting in Editin Options dialog box

NB! More detailed instructions for how to use Snapping, Auto-complete polygon and Tracing, and how to set options to these tools, will be added to final user manual. Until then use following links:

For Snapping
http://resources.arcgis.com/en/help/main/10.1/index.html#/Enabling_snapping_classic_snapping/01m60000000z000000/

For Autocomplete plolygon
http://resources.arcgis.com/en/help/main/10.1/index.html#/Creating_adjoining_polygons/01m60000002r000000/

For Tracing
http://blogs.esri.com/esri/arcgis/2010/11/04/getting-the-most-out-of-editing-in-arcgis-10-tracing-features/
https://www.youtube.com/watch?v=fQ2CKy6U8zg

Alternatively search these tools in ArcGIS help or ask *Aave or Kjersti*.

4. Digitizing parameters for MAREANO-maps

The main mapping in MAREANO is defined to be carried out in scale 1:100 000. Although the backscatter and batymetry data in many cases are of high quality and allow recoginizing many interesting details, the ground truthing is too scarce to ensure the accuracy of detailed interpretations. The MAREANO geological maps will be used as basis for several other map products hence it is of crucial importance to keep uniform degree of detail across the Norwegian shelf.

Having high quality multi-beam data, it might be tempting to digitize numerous small features. However, a geologist will have to make knowledge based choices for generalizations and omissions (remember: there is no-one else with your knowledge and experience to make these decisions).

PARAMETER	Value
Final map scale	1:100 000
Digitizing/editing scale	1:30 000 - 1:50 000
Shortest distance to closest object (boundary)	50m
Smallest Area (GCS, db geometry)	0,000002
Smallest area (UTM, m)	Ca 80000m^2
Smallest distance btw. to vertices	100m
Exceptions	Coral reefs/ coral areas

Table 2. General rules for choosing digitizing parameters for MAREANO maps

Notice: even as the minimum area is set to be 80000 m^2 (0,000002 GCS units), in practice it is very difficult to digitize such a tiny object accurately in the scale of 1:30 000. Thus, the minimum size (and smaller if necessary) applies only to coral reefs and other very special seabed features, and in these cases it is rational to zoom in for more detailed digitizing.

5. Topology rules for Marine interpretation data

To ensure that the data forms a continuos fabric, i.e. a polygon data set contains no overlaps and no unintentional gaps, the database is set up with a set of topology rules. All data will be checked for topoplogy error and edited befor being loaded or posted into database. The better the topology is taken care of under digitizing, the less work there will be with "totpology wash".

Feature class	Rule	Description
Polygon	Must Not Have Gaps	A void cannot exist between areas in same layer
Polygon	Must Not Overlap	An area must not overlap another area from the same layer
Polygon	Boundary Must Be Covered By	The boundaries of area features from the one layer must be covered by line features of another layer
Line	Must Be Covered By Boundary Of	Line features from one layer must be coincident with the boundaries of area features of another layer
Line	Must Not Self-Intersect	A line feature from one layer must not intersect itself
Line	Must Not Intersect Or Touch Interior	Line feature from one layer must touch lines from the same layer at its endpoints
Line	Must Not Have Dangles	Line from one layer must touch lines from the same layer at both endpoints

Table 3. Topology rules for marine interpretation data that have both polygon features and accompanying boundary lines.