# ARCVIEW GIS EXERCISE – RESOURCE GEOLOGY

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This exercise is an introduction to the use of ArcView GIS for resource geology. It introduces
several standard Swedish geographic databases. Various maps are composed to answer
spatially related geological question. The first question to answer is where is the
combination of soil and bedrock susceptible to radon gas emissions, and how many
people are potentially affected. The second question is to find suitable localisation for
production of aggregate resources given a set of spatially important factors. The first
part is an introduction to basic ArcView functions. To complete the exercise two maps
have to produced – one showing radon susceptible areas and the number of people
potentially affected, and one showing suitable areas for pits for production of aggregate
resources.

Part 1 - Soils, displaying and zooming

In part I you will learn how to open a project, and how to zoom and move around a map.

Start ArvView (double click the ArcView icon). When
you start ArcView an empty project window labelled
untitled appears. In the menu bar in the Arc View
graphical user interface (GUI) select File and then
Open project in the drop down menu. Navigate to
C:\arbetsstuga2000\Arcview\sgu and open the
project "earthres".
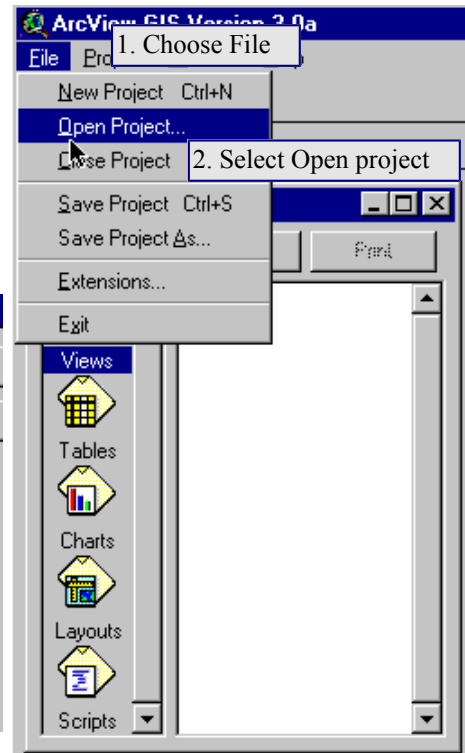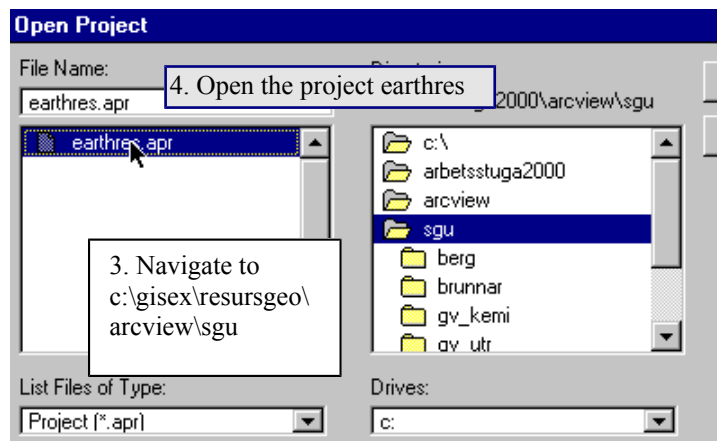
When you open the project ''**earthres**'' you will see the soil map 10 f sv, like the one to the right. The image that you see is just a tif file (not a GIS file). But it has the correct colour scheme for SGU soil maps. Even if it is not a GIS map you can use the tools for zooming and panning around the map. The legend of the map is found beneath the map.
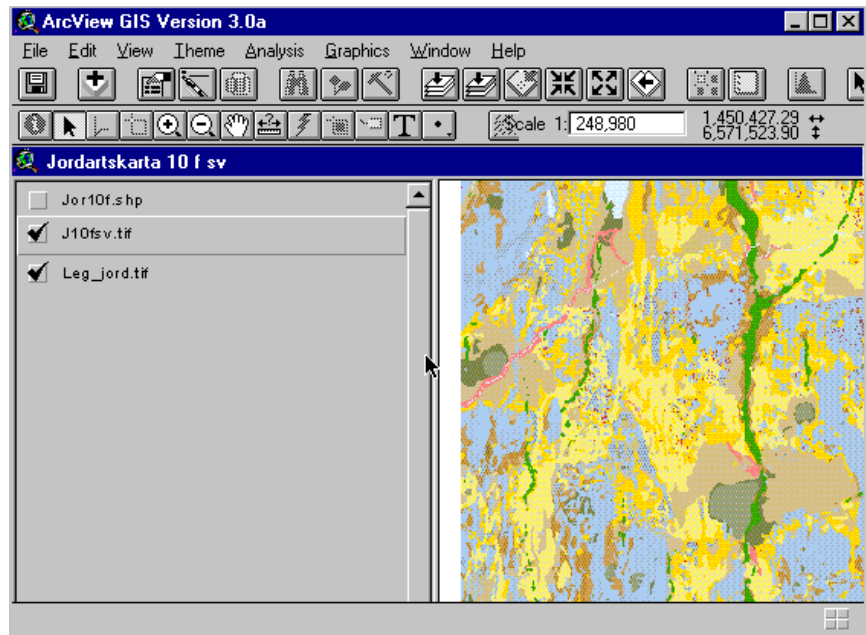

Choose the ''zoom in'' tool by pressing it (it then appears pressed down). The tool can be used in two ways - either just position the cursor in the view and press the left mouse button. The view is zoomed 125 % with the pressed point as a new center. Or click and drag a rectangle with the left mouse button to exactly zoom a new view.

The ''zoom out'' tool works much the other way.

With the "pan" tool you can move around the map.

Use the zoom and pan tools to follow the esker through the map. Is this a landscape from below or above the highest coastline?

The view ''Jordartskarta 10 f sv'' contains 3 themes (or layers), of which 2 where displayed when you started. To the left in the view is the Table Of Content (TOC), where you can determine which layers to display, in what order to display them, as well as colour etc. The theme **j10fsv.tif** is active (it appears lifted). You can activate or deactivate a theme by clicking on its name (not in the box to the left of the name).
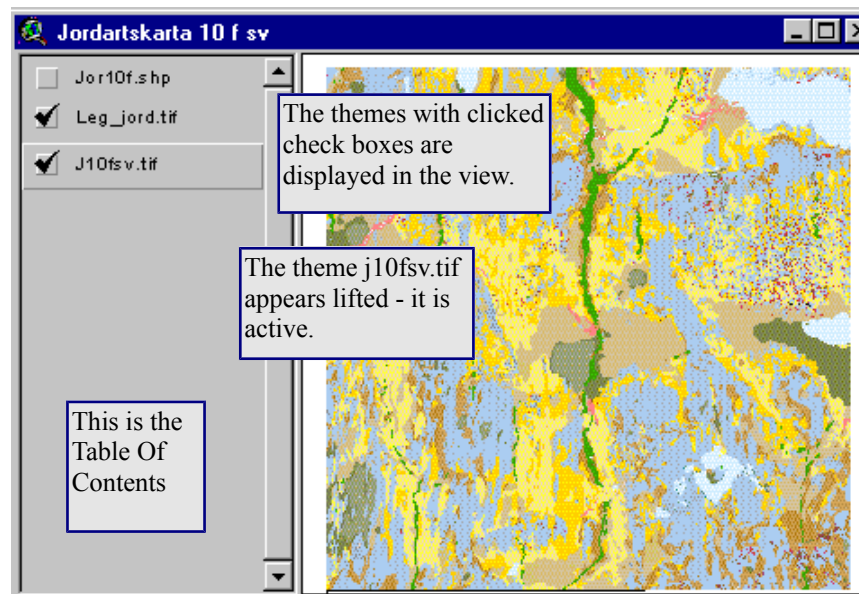
Click the check box to display the theme
jor10f.shp, and also activate this theme. The
TOC should then look like this:
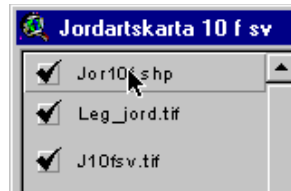
Note that the themes **jor10f.shp** and **j10fsv.tif** do not exactly match. And further **jor10f.shp** is
a transparent layer – it has all the information but what you see is the tif file below it.

By clicking the check-box to the left of the name you can display the theme. If you click the
name of the theme and hold the left mouse bottom pressed you can drag the theme to another
position in the TOC, and thus rearrange the order of display.

You might have noticed that some of the tools and buttons turned from dim to clear when you
activated the theme **jor10f.shp** (If you did not please deactivate the theme **jor10f.shp** theme
and look at the tools and buttons again). The theme **jor10f** is in the format shape - ArcViews
own format. That means that this theme is not just an image - it is a theme with geographic
information (it has geometry and geometric properties relating all its items). One of the tools
that became enabled was the information tool. Select this tool and use the mouse to point
(using the left mouse button) at any position in the map. You will be returned an information
box describing the properties of that point.

Part II - Radon risk - adding and combining map layers

In part II we will add a new map layer, and use the legend editor to put colour to it. Then we
will query the map for certain conditions, and combine queries from two maps to find the
areas with intersecting properties. We will specifically seek out the areas where the bedrock
can be presumed to have a high radon content (younger granites and pegmatite, and organic
shale or "alunskiffer") and where the soil is susceptible to transmit radon to the surface
(coarse material). Finally you shall analyse the number of persons living within areas
potentially affected by radon gas.

We will start by adding the bedrock map from SGU to our view. To add a theme select View
from the menu bar and then Add Theme. You can also add a theme by using the "Add

theme" button.

In the dialogue box for
Add theme navigate to
**C:\arbetsstuga2000\
arcview\sgu\berg**,
select the theme
**berg_10f.shp** and click
OK.
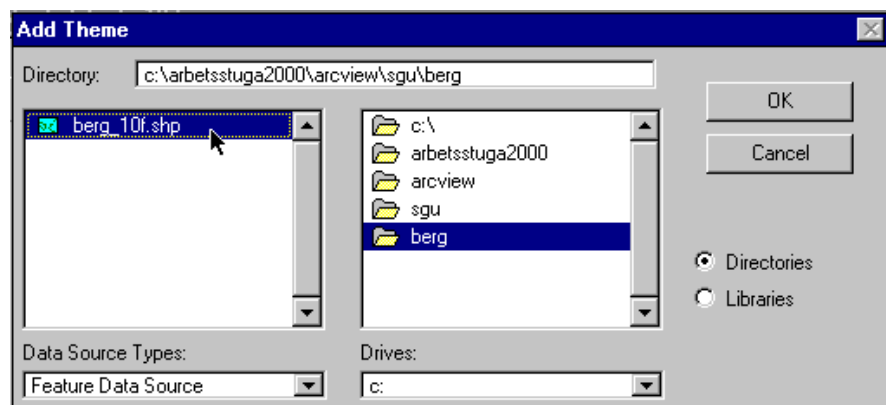
The added theme will end up on top in the TOC. Click the check box to display the theme **berg_10f.shp**. As you will note it has a single colour, and you hence need to classify the map.

Before classifying the map we shall have a look in the theme table of **berg_10f.shp**. Make sure that the theme **berg_10f** is the active theme (that it appears lifted), and use the "open theme table" button. The table contains the attribute data that is related to the theme. Also note how all the tools and buttons changed when you opened the theme table.
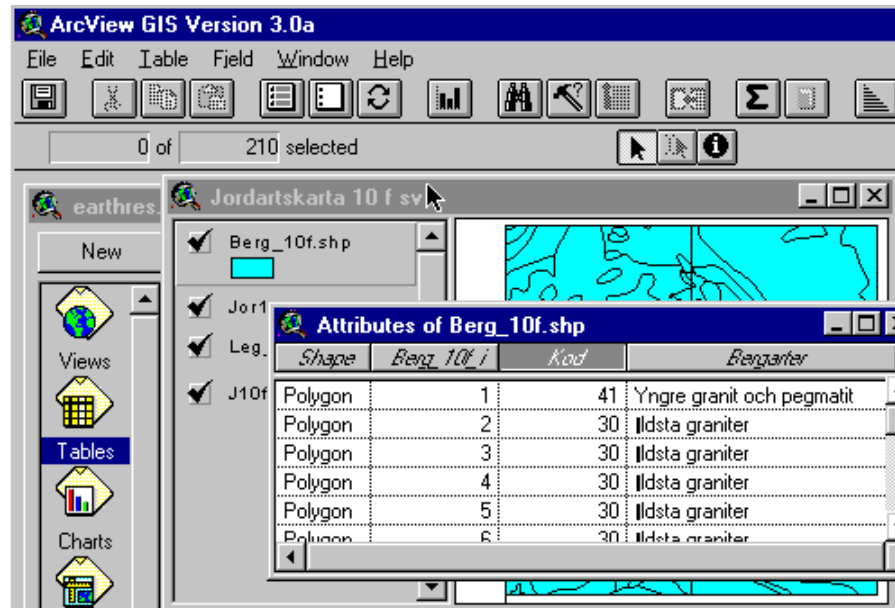
As you can see the theme table contains one row (record) per item, and one column (field) per attribute. We obviously want to use the field "kod" or "bergarter" to classify our map.

To classify the map you need to open the legend editor. Either double click on the theme you want to classify or use the "Edit legend" button. In the legend editor first choose Unique Value as Legend Type.
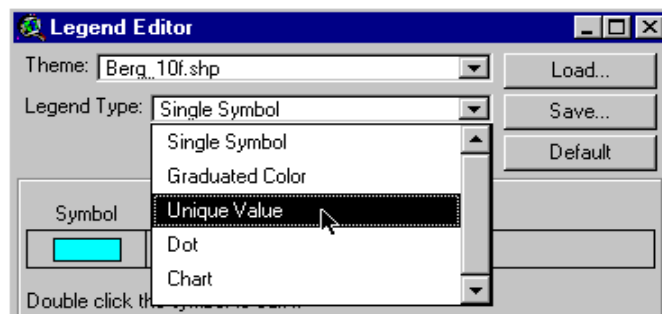
As Values Field you then have to select either "kod" or "bergarter".
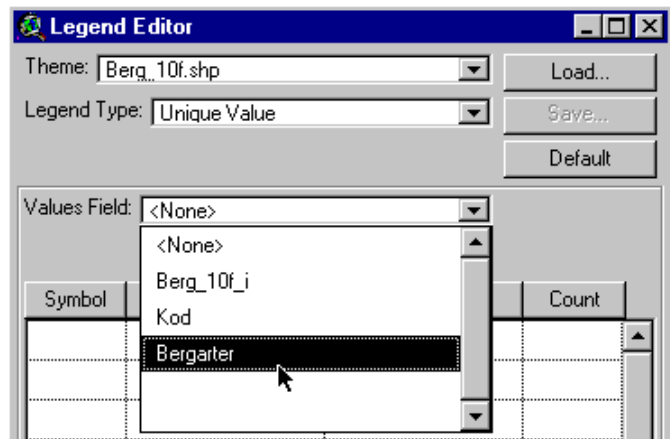
Then the legend editor should look like this. To actually change the map you have press Apply down in the right corner. You can change the style and colour of each individual class by double clicking the coloured rectangle in front of it. By changing colour scheme you have a variety of predefined colour schemes to choose from. At least change the colour of the class "Sjö" (lake) to blue (remember to Apply).
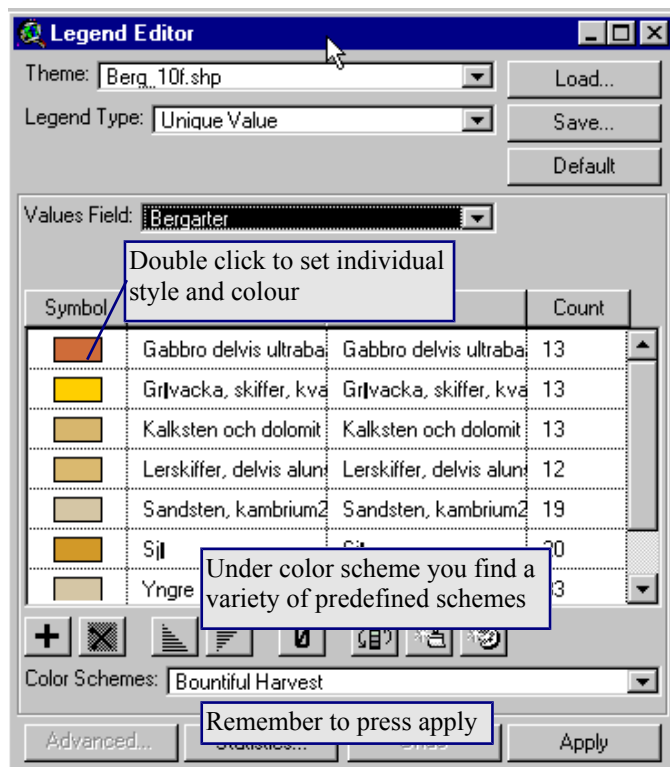
Now we shall identify all bedrock that potentially contains high amounts of radon. In our area we have two types that do contain that - younger granite and pegmatite, and "alunkiffer". Once more open the theme table (make sure that **berg_10f.shp** is the active theme). As you can see there are many records that contain both younger granite and "alunskiffer". You can select any record in the theme table by just pointing at it with the pointer active. The record turns yellow, as does the corresponding feature in the view.
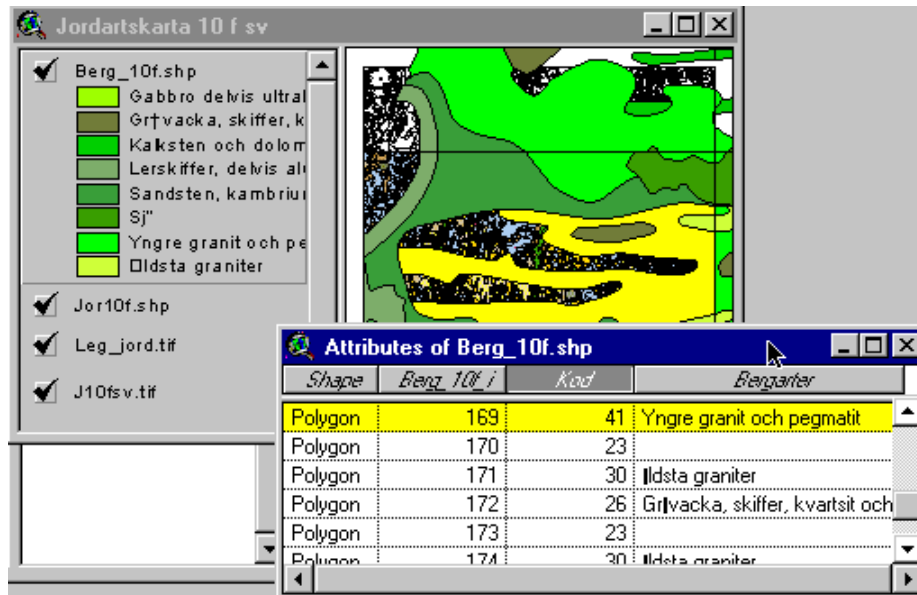
We want to find all areas in the map that are either younger granites or alunskiffer. This is a typical task for a "query builder". Return to the view and make sure that **berg_10f.shp** is the active theme. Either choose Query under Theme in the menu, or press the "query builder" button [icon].

With the query builder you should construct an expression that identifies the two types of bedrock that you think are potential sources of radon. It is preferable to use the field "kod" to seek out those. Since this is a numerical field and the field "bergarter" is a string (thus more susceptible to errors).
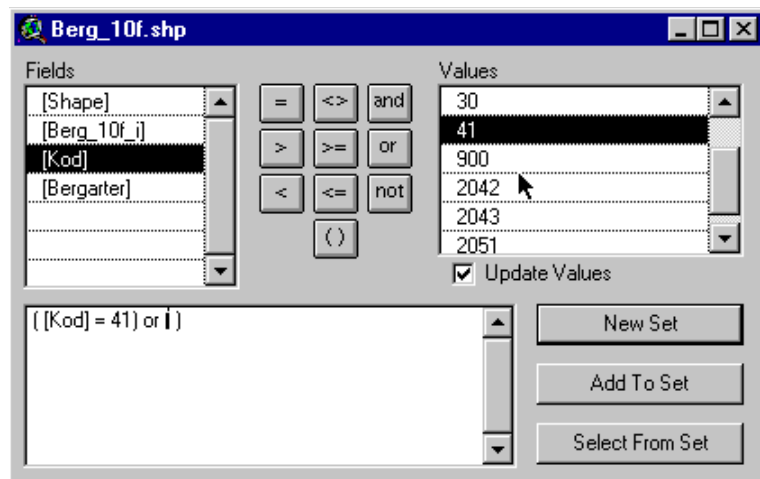
To construct the question:

double click [Kod] to the left
double click "=" in the middle
double click "41" to the right

the corresponding formulation in the box below should then be:

([Kod] = 41)

Press the button New Set. Create a new formula identifying alunskiffer, but this time press the button Add To Set (to create one set which identifies all potential radon emitting formations). You could have done both selections in the same step by putting in an "or" command between the two expressions (try if you want to). Have a look at your map, quite a lot areas should be yellow - that is the potential areas for radon is quite large in the region.

The dosage of radon that people get is more dependent on soil and groundwater conditions, even if the ultimate source is the bedrock. Thus what is important is to find where we have coarse material that intersects with bedrock potentially carrying radon. You must find the classes with coarse material in the soil theme (**jor10f.shp**) and then find out which of the areas that overlay granites or alunskiffrar.

Make sure that the soil map is the active theme. To work you first have to use the function Select By Theme under Theme in the menu. You want to create a New Set (from the soil map) that shows all the parts that intersects with the active features (the ones that are yellow) in the bedrock theme.
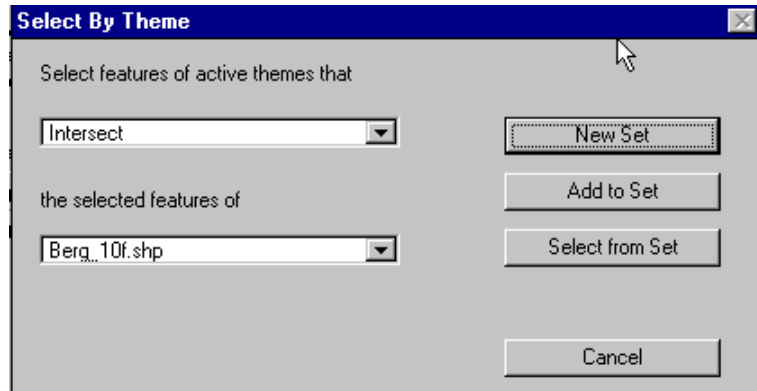
You will not see any change in the soil map - because the soil map is actually just a transparency overlying the tif file we used initially. Thus use the legend editor to fill the soil map with colour (the problem is that filling the soil map with correct colours and symbols is very tedious). Once you have filled the soil map with colour you will notice that approximately half of the soil map intersects with the radon risk areas of the bedrock map (i.e. half the map should be yellow). But from those areas that you have found on your soil map you want to select the subset that contains coarse material. Before creating your query you must open the theme table and identify all coarser material, and what "grid_kod" number they have. The best way is to click on the header of the "grid_kod" field in the table and then use any of the "sorting" buttons

Once again open the "query builder", and complete the following expression:

([Grid_code] >= 50) and ([Grid_code] <= ??)

Use Select From Set (the existing set is that of areas intersecting with radon containing material - *from this set* you want to retrieve those that are also coarse soils). Now you should have identified all the areas with coarse material intersecting potentially radon containing bedrock. To save this result choose Convert To Shapefile under Theme in the menu. Save the created shape file and add it to the view. Select all features in this new theme (necessary for the next step). This is most easily done with a query, or with the "select all" button in the table GUI.

Add the theme that contains census data - you can find it in the **bef07.shp** under **C:\arbetsstuga2000\arcview\scb**. Display (click the check box) and activate the new theme **bef07.shp**. Choose Select By Theme under Theme in the menu, and select those features in **befo07.shp** that intersect with the active feature of the radon theme. Open the theme table of **bef07.shp** - all the people of the yellow records are potentially affected by radon. To look at just the affected records, press the "promote" button . To calculate the total number of people affected select the Field total_pop by clicking on the header of that field, then choose Statistics under Field in the table menu.

Try to create a view that shows the areas with high risk of radon gas emission, combined with the number of people affected. When you have a view that you are satisfied with select Layout under View in the menu. You can create the Layout from the Project window as well, but there is a bug in choosing the layout format if you select that route. You can edit directly in the layout by using the tools in the Layout document GUI. For example choose the pointer tool ![pointer] and click on the text Jordartskarta 10 f sv in the layout, change the text to "Radonrisk" for instance. You can also change the size of the text. Try to grab some other objects in the layout and rearrange them. Also add some more text describing your results (i.e. total number of people affected). Finally add your names to the layout, print it and hand it in to the teacher to pass the first part of the exercise. In the layout below only those areas in the theme **bef07.shp** that contain data and are smaller than a given threshold size are displayed. Further those areas have been converted to Shapefil, and the resulting theme has been classified after total population (Total_pop) using graduated colour as legend type.
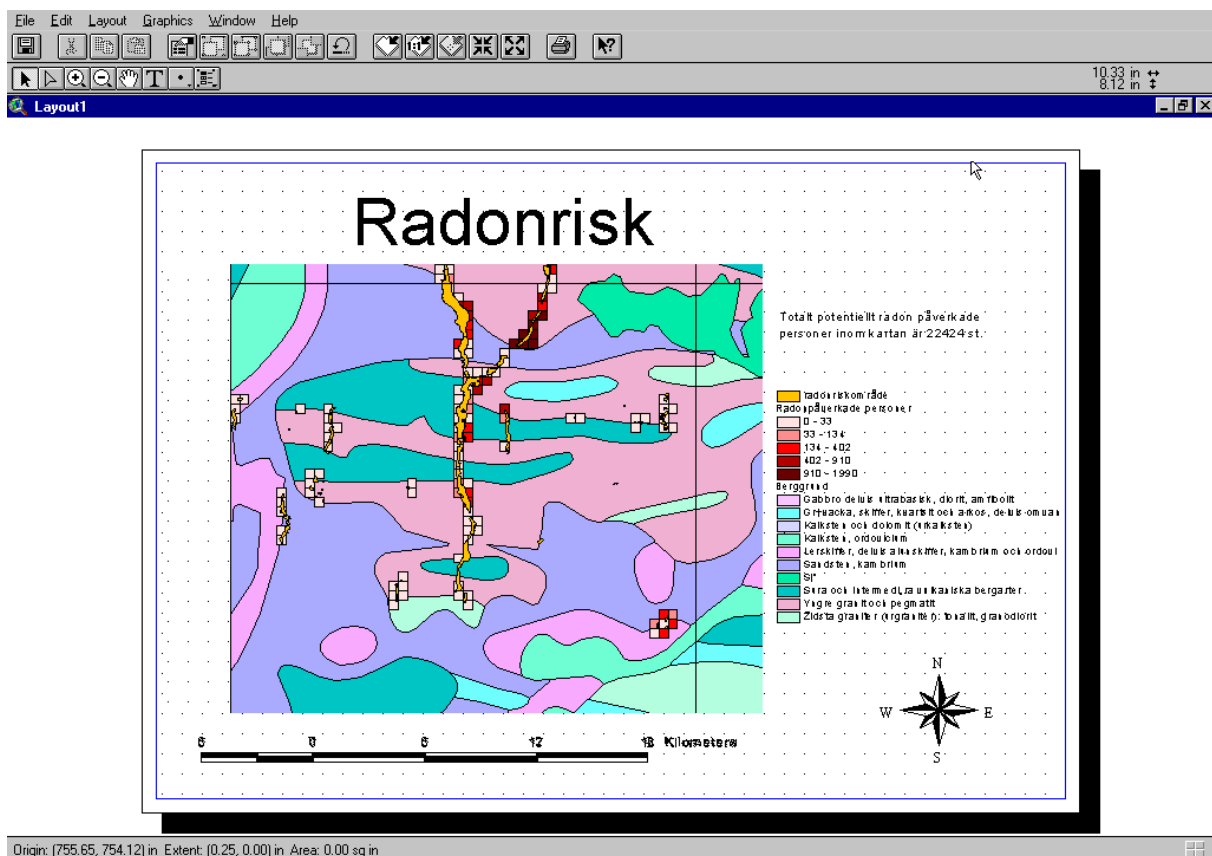
Part III - Identifying suitable sites for mining aggregate resources

In the last part you shall identify suitable areas for producing aggregate resources from the bedrock. To find suitable areas several factors are important. Bedrock and soil type must be suitable. The site of the pit can not be to close to any built up area, but must at the same time be close to the sites of demand, and have good transport connections.

Now it is time to try too figure out where we are in Sweden. To do that you can add some layers from Röda kartan. You find Röda kartan under **C:\arbetsstuga2000\arcview\metria\rodkarta**.

The theme **rt_to90.shp** contains built up areas. Add that layer. Display and activate the theme **rt_to90.shp**. Zoom to full and click on the Label tool 🔲. Click on any built up area and it will be automatically labelled with its name. You can move or delete the label by first selecting the Pointer tool 🔲 and then click the label. Grab the handle to move or press the DELETE key to delete it.

For our task we need a map of the road system – thus add the theme **rt_av94.shp**. You can also add some more layers from Röda kartan if you want to. Here is a list of some interpretations:

av	Allmänna vägar (public roads)
ev	Enskilda vägar (private roads)
tp	Trafikplatser (traffic places)
jv	Järnvägar (railroads)
st	Järnägsstationer (railwaystations)
o	Öar (inslands)
sj	Sjöar (lakes)
vd	Vattendrag (water ways)
to	Tätorter (built up areas)
ma	Skog, öppen mark (landcover)
nr	Naturreservat (nature reserves)

Our last task is to identify suitable areas for supplying aggregate resources to Örebro (you found Örebro did you not?). As sand and gravel are increasingly scarce resources, we are looking for bedrock as an alternative. We thus want to locate areas suitable for a bedrock pit. As transportation costs are crucial for aggregate resources, the pit must be within 15 km from Örebro. Here are the principal steps we are going to follow:

- identify bedrock suitable for production of aggregate resources,
- identify areas that for other purposes are unsuitable for hosting a pit (built up areas, lakes and wetlands, unsuitable soil conditions),
- identify areas around which a buffer must be put where aggregate resources can not be produced (built up areas), and
- identify transportation access (optional).

Use the "query builder" 🔲 to select a set from the bedrock map. The set should show all bedrock types suitable for production of aggregate resources. You can either produce this set in one query (create as "New Set") or subsequent query the map for different bedrock and use "Add To Set". Note that all bedrock types are not suitable for production of aggregate resources. Here is one suggestion for an expression:

[Kod] = 29) or ([Kod] = 30) or ([Kod] = 41) or ([Kod] = ??)

This expression will simultaneously find areas with "Kod" 29, 30, 41 and ??.

Before continuing you have to find all the soil areas that overlay the suitable bedrock types.
Activate the soil map and use Select By Theme under Theme in the menu to select areas of
the soil map that somehow relate to the selected features in the bedrock image.

As can be seen to the right,
you have several option for
how to define the relation
between soil and bedrock..
By using Add to Set you
can use more than one of
the options.
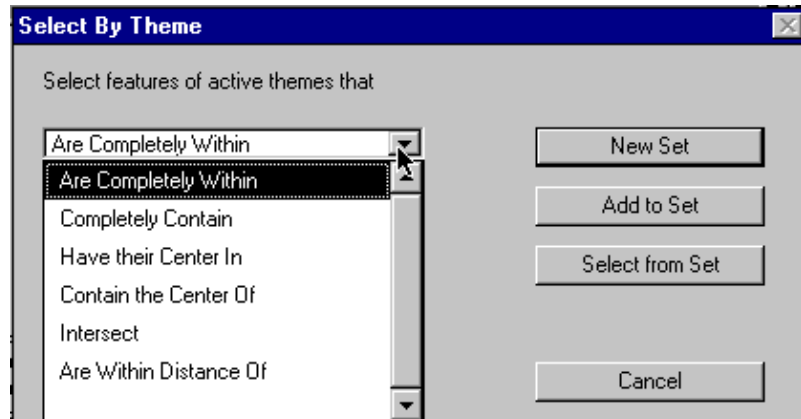
Then we need to find soil types which we can exploit with less conflict. It is suggested that
suitable places for a pit are those without any soil, or those covered with coarse till. In the soil
"Grid_kod" field these types are found as:

coarse till, classes 178-181
surface rock, classes 800-900.

Activate the soil map and use the "query builder" to create a subset from the existing set
showing just those types of soil. You have to put it all in one query (it is not possible to use
subsequent queries this time). Here is a suggestion for the syntax of that query:

([Grid_code] > 177) and ([Grid_code] < 182) or
([Grid_code] > 800) and ([Grid_code] < 900)

There are not too many areas left on you map now if you did everything correct. However,
there are a lot of small areas. Thus use the "query builder" once again to only select those
areas that are at least 2 ha - open the theme table first to identify the field carrying this
information. To do the next steps we must first save our selected set - thus use Convert To
Shapefile under Theme in the menu. Add the new shape theme to the view.

Next we want to exclude those potential sites that are to close to built up areas. To do this first
activate the theme with built up areas (**rt_to90.shp**). And select all records (all built up areas)
- there are several ways to do it. Then activate the new theme with the potential sites.

Choose Select By Theme
under the Theme menu.
Choose the selection to be
"Are Within Distance Of" and
the selected features of
Rt_to90.shp, and Selection
distance "2" km. The selected
set is now those areas that are
closer than 2 km to the city, we
want it to be the other way
around - only areas further
away than 2 km are of interest.
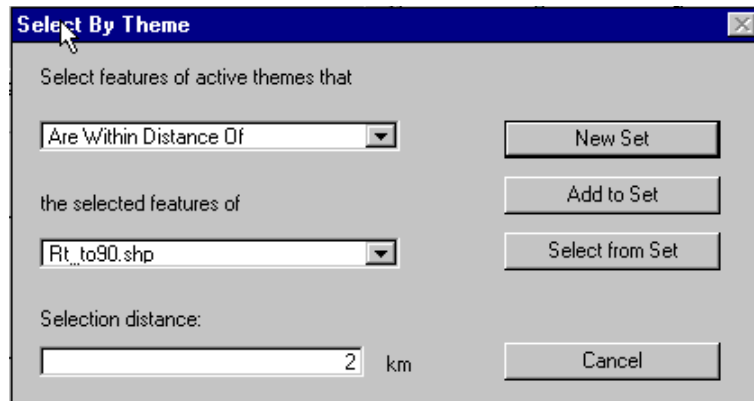
Open the theme table - to switch selected to be non-selected and vice versa press the "switch"
button [icon]. It remains to find out which of the selected sites are within 15 km of Örebro.

Activate the theme **rt_to90.shp**. Use the find button [icon] and fill in "Örebro" in the dialogue
box that appears.

Activate the theme with potential pit areas, where those further away than 2 km from any built
up area should be selected. Next use Select By Theme to find the subset of those areas that
are also within 15 km distance of Örebro. Use Convert To Shapefile in the Theme menu to
save your identified areas.

If you have time you can make a further selection among the identified areas by seeking out
those areas with the shortest distance to the public road system.

Create a layout showing Örebro, other built up areas, the road system and identified suitable
areas for pits for producing aggregate resources. Put you names on the layout and print it.
Hand it in to pass the second part of the exercise.

The end.