

PRODUCTION OF GEOCHEMICAL ATLAS PAGES USING DATADESK AND ARCGIS.

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INTRODUCTION

The presentation of large geochemical and biogeochemical data sets in a concise and informative manner is a major challenge. This has been addressed in the production of a series of geochemical and biogeochemical maps within an atlas of the White Dam Au-Cu prospect in the Curnamona Province of South Australia. This includes atlas pages constructed in the ArcGis 8.3 software package and statistical analysis carried out in the DataDesk software package. A description of the steps involved in the production of a geochemical atlas page and some of the issues encountered is provided here.

THE FINAL PRODUCT

Figure 1 shows an example of a geochemical atlas page produced for samples collected at White Dam.

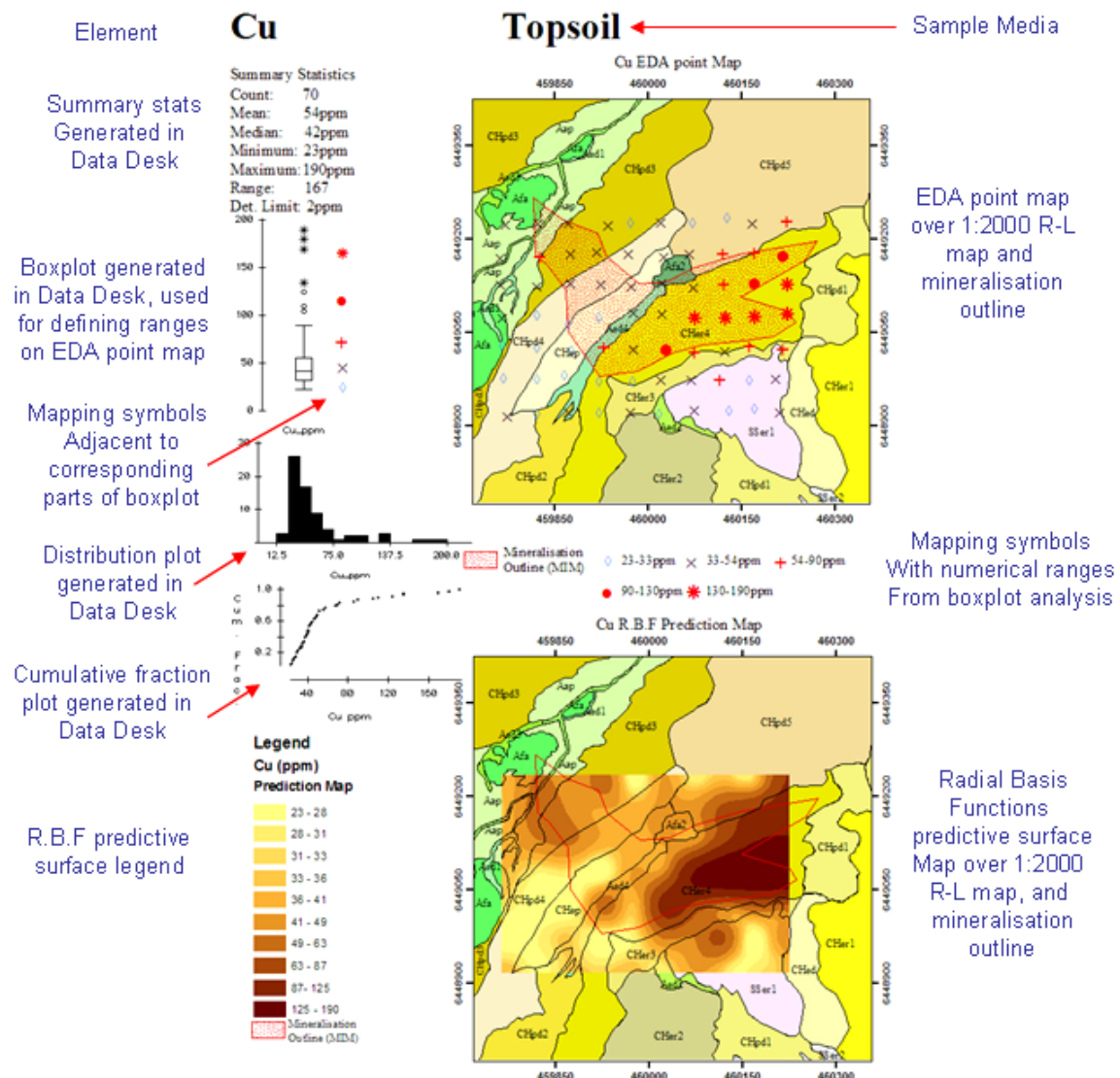


Figure 1: Example Geochemical atlas page with brief descriptions.

The following sections outline in detail the steps to take in DataDesk and ArcGis to produce Geochemical atlas pages similar to Figure 1.

1. LAYOUT AND DATA PREPARATION

The layout of the atlas page is constructed in the ArcMap component of ArcGis. Once a layout has been established information and plots for each element are imported and each element is saved as a new file. This approach means the layout only has to be done once, and that changes to any atlas page can be done simply by reopening the appropriate file.

All statistical analysis was done in DataDesk, with plots copied and pasted into the page layout in ArcMap. The geochemical and biogeochemical data was initially formatted in Microsoft Excel, and then imported into DataDesk using the “send to DataDesk” extension in the tools menu or into ArcGis as an ODBC data source. Formatting the data in Excel prior to exporting to DataDesk and ArcGis involves organising the data into columns with labels in the first row. If labels contain more than one word, an underscore character is placed between each word, not a space character. Where elements have non-numerical values within the assay results due to samples with assay results below detection limits, all non numerical values should be removed and the cell in the worksheet left blank. In some cases below detection values may be assigned a 1/2 detection limit value; the rationale for this is discussed later. The addition of two columns with the easting and nothing coordinates for each sample is also required.

2. DATA ISSUES

When analysing and presenting geochemical data, the question of how to handle below detection values often arises. This issue needed to be addressed before data could be used in DataDesk for boxplot analysis and the production of the various plots used in the atlas pages.

When doing the boxplot analysis, the ranges of values generated for each section of the boxplot are used to define cut-offs for mapping symbols in ArcMap, which allows for the spatial representation of the different components of the data for each element.

The incorporation of below detection limit values for boxplot analysis was problematic, as a non numeric value was ignored, resulting in skewed boxplots which were not representative of the data set. The decision was made that for elements with < 20 results below detection, a 1/2 detection limit would be used to ensure these samples were included in the boxplot analysis. However, when the assay results for each element were plotted as the EDA point map in ArcMap, only samples with detectable results were displayed, to give an accurate spatial representation of where the element was actually detected.

The element assay results for many elements reported 20 or frequently many more sample assays below detection limits. Use of the half detection limit values for these elements was rejected because of the high number of samples below detection, which resulted in artificial ranges for mapping symbols when generated by boxplot analysis.

The generation of summary statistics for each element and the production of the distribution and cumulative fraction plots in DataDesk, and the EDA point maps and Radial Basis Functions predictive surfaces, presented other problems when using 1/2 detection limit values for below detection data. In the case of the cumulative fraction and distribution plots, using the 1/2 detection value often resulted in plots with a large spike in the distribution at the 1/2 detection value for that element. In the production of the EDA point maps, including the 1/2 detection value in the points plotted resulted in the apparent presence of the element at locations that had a significant effect on masking some of the landscape effects in the data.

After careful evaluation of the problems involved in using the 1/2 detection data in the presentation of summary stats, plots and point maps for a number of elements, it was decided to only use the 1/2 detection limits in the generation of boxplots, and not for any other analysis. This decision resulted in the need for two Excel files for each range of elements examined. One file was prepared for boxplot analysis in DataDesk with the inclusion of 1/2 detection limits for samples with < 20 below detection values. A second Excel file with all below detection values deleted, leaving an empty cell in the spreadsheet, was used in for the production of summary stats and plots in DataDesk, and for the production of EDA point maps RBF surfaces in ArcGis.

3. STEP BY STEP GUIDE

Step 1 Page Layout

- Open ArcMap component of ArcGis, and create a new document.
- File menu > page setup, Set page to a4 (or desired size).

- View menu > select layout view.
- Resize the highlighted box labelled “layers” to the desired size for one geochemical map
- With layers box still selected, right mouse click (RMC) on it, and copy, then RMC on another part of the page and paste. This will give 2 identically sized data frames for EDA and RBF maps.
- Position the two data frames (box’s labelled as “layers”) on the page.
- NOTE: Guides can be created by clicking on the rulers on left and top of the layout window
- Insert Menu > select text. This will insert text boxes, insert as many as needed for Element, and media, map title, EDA and RBF map legends, and summary statistics
- In the Table of Contents (TOC) on the left of the ArcMap window there are 2 entries of “Layers”, these refer to the two data frames created previously. RMC one of the “layers” entries and select add data.
- At this point you can add any maps or rectified images to be used as base maps for the geochemical data.
- Save file as template.mxd

Step 2 Importing data to DataDesk

- Format data in Excel as described in layout and data preparation. Produce two files, one with 1/2 detection values where needed, and one with empty cells replacing below det values in spreadsheet.
- In Excel, open file with 1/2 detection values, and select cells required, select tools menu > send to DataDesk (D D). This will open a new DataDesk window, with the imported data. Save Datafile in D D with name to indicate 1/2 detection values for boxplot analysis, e.g., soilsforboxplots.dsk
- In D D select file menu > import, and select the template file to produce numerical values from boxplots,
- Save datafile.
- In Excel, Open file without 1/2 detection values and select required cells, select tools menu > send to D D
- In D D save datafile with name showing media and purpose of file, e.g., soilsplots.dsk

Step 3 Importing data to ArcGis ArcMap

- Create an ODBC connection for the Excel file without 1/2 detection values, using instructions at <http://support.esri.com/index.cfm?fa=knowledgebase.techarticles.articleShow&d=15380>
- RMC on a “layer” in the ArcMap TOC, and select add data, in the “Look in:” dropdown tab select database connections and select the ODBC connection created in the previous step.
- a new icon with a connection path to the data should now appear under the “layer” in the TOC, if not visible, ensure the “Source” tab is selected at the bottom of the TOC.
- In the TOC there will be a Spreadsheet Icon shown with the database connection. RMC on the spreadsheet icon and select “Display XY Data”
- In the box that opens, select Easting from the dropdown menu for the “X Field” and Northing for the “Y Field”.
- click ok
- you will now be able to see your sample locations within one of the dataframes, select the remaining “layers” in the TOC and repeat the steps above so that the sample locations are visible in both dataframes in the layout.
- Save the template.mxd file

The template.mxd file in ArcMap, now has all the required data and links to start producing atlas pages.

Step 4 Completing an atlas page

This section outlines the steps needed to import plots and stats from DD to ArcGis, and involves having 2 DD windows open as well as ArcMap, and PowerPoint. The reason PowerPoint is used is due to a problem cutting and pasting directly from DD to ArcMap, resulting in all plots needing to be pasted into PowerPoint and then copied and pasted into ArcMap. This section will also outline the step needed to produce EDA Point maps and the RBF predictive maps for each element, as it is more efficient to complete all steps for each element at once.

- Open template.mxd in ArcMap.
- Open file with 1/2 detection values added in DD (herein referred to as DD Boxplot).
- Open file without added 1/2 detection values in a separate DD window (Herein referred to as DD stats).

- Open a blank document in PowerPoint.

Boxplots

- In DD Boxplot, Select the first element listed, and drags it to the “corkboard”, a boxplot for the element will be plotted and numerical values obtained for the different cut-off within the boxplot.
- Inspect boxplot for errors.
- Select right lower corner of plot, and Left Mouse Hold (LMH) to resize plot window as needed.
- Whilst plot is still selected, Edit Menu > copy window, to copy boxplot.
- Paste into PowerPoint document.
- RMC on pasted plot in PowerPoint, copy and then paste into layout in Arcmap.
- Resize will text is legible, if plot is to large or small for layout, go back to DD boxplot resize etc till plot pasted in ArcMap is correct size. Whilst this resizing may be tedious for the initial plots an appropriate size is quickly established for all later work.

Summary stats and Histogram

- In DD Stats window, select element.
- Calc menu > summaries > reports will produce a new window in DD with summary stats for element. Type values into text box in ArcMap Layout.
- Plot menu > Histogram, histogram plot will appear, resize if needed and follow cut and paste procedure given above for boxplots.

Cumulative Fraction Plots

- In DD Stats window, select element.
- Calc menu > Frequency Breakdowns, a new window will appear with frequency breakdown for the element.
- In frequency breakdown window RMC on cumulative % and select cumulative % in tab.
- Hold Ctrl button and RMC on Group and select as Y in tab.
- Plot menu > scatterplots, a new window will appear with cumulative fraction plot.
- To relabel plot axes open Derived folder in DD stats, and select results labelled X and Y and rename each, then LMC on arrow in top Left corner of the Cumulative Fraction plot window and select “Turn On Automatic Update” and axes will be updated with new labels.
- Resize plot if needed and follow cut and paste procedure given above for boxplots.

EDA Point Map

- In ArcMap TOC, double click on the “events” listing for the imported assay data.
- In the “Layer Properties” box that opens, select the symbology tab, and select quantities > graduated symbols.
- In “Fields” Select the element needed in the “Value” dropdown menu.
- In Classification, select the Number of classes of data as indicated by the number of division in the Boxplot in Boxplot DD.
- Starting with the lowest values adjust the ranges for each symbol by double clicking on the Range values and entering the upper value as indicated by the numerical values derived in DD boxplot.
- Double click on each symbol and select appropriate mapping symbol and colour.
- Complete for all symbols for that element, click apply, ok.
- The EDA map data frame will now be updated to the symbols and cut-offs specified and the values will also be displayed in the TOC.
- Update the symbols used and numerical values in the menu text boxes u have created under the EDA map.

RBF predictive Surface Map

- In ArcMap, click on the Geostatistical Analyst toolbar and select Geostatistical wizard. (Ensure the data frame you want the RBF to appear on is the shown as the Bold “Layers” in the TOC, if not RMC on the Correct “Layers” and select Activate.)
- Select element wanted in “Attribute” field, and select Radial Basis Functions in “Methods” field.
- Click Next then click Next again.

- Note Root-Mean-Square (RMS) value in Prediction Errors.
- Click Back.
- Make changes to factors such as “Kernel Functions”, “Neighbours to include” and “Include at least” fields and “Shape Type”, clicking next and observing changes to RMS value and regression functions plot till RMS value is minimised and values plot as close to regression line as possible.
- This process is relatively intuitive and becomes much quicker with later pages.
- Once RMS is minimised click Finish and OK, and predictive surface will be shown in data frame in layout.
- Drag RBF entry in TOC Below outline of mapping units entry (if available), to show R-L unit boundaries on RBF surface.
- Insert Menu > Legend and the legend wizard will appear.
- Remove all entries from “Legend Items” Pane except Radial Basis Functions.
- Click Next, Adjust text if needed, click next for all other option windows till legend appears.
- Select legend and move off page layout in layout window.
- RMC on legend, and Convert to graphics, RMC and Ungroup.
- Any unwanted items in legend can now be removed, text edited in text boxes, etc.
- When finished editing legend and repositioning legend items, select all legend items, RMC and Group.
- Move legend into position on page.

Tidying up

- Update Element, and Map titles on page.
- Check all numerical values have been updated.
- Save file under element symbol, e.g., select Save As Cu.mxd.

Now you have completed a geochemical or biogeochemical atlas page for this element, return to step 4 and repeat for all elements required, remembering to Save As, and change filename for each element before saving each new layout.

Atlas pages can be printed directly from ArcMap, or exported in a number of graphics formats, allowing for easy integration with other documents or media.