

Working Draft

V.20200929

# Using QGIS in Mineral Exploration



Version 3.14

Grant Boxer (FAIG, M GSA)

**Consultant Geologist** 

PO Box 368 Maylands WA 6931 Australia

Copyright © G Boxer 2020



### CONTENTS

1:	Summar	у	. 1
2:	Introduct	tion	. 1
3:	About Q	GIS	.2
4:	INSTALL	LING QGIS	.3
4.1	1 P	PC Installation	.3
4.2	2 N	lac Installation	.6
5:	Plug-Ins		. 8
6:	Data Min	ning and Public Datasets	10
6.1	1 A	Australian Data Sets	10
6.2	2 G	Geological Survey of Western Australia	11
6.3	3 L	andgate and Open Data WA	11
6.4	4 G	Geoscience Australia	14
6.5	5 U	Jnited States Geological Survey (USGS)	16
6.6	6 E	European Space Agency (ESA)	19
6.7	7 3	0 m SRTM Tile Downloader	22
6.8	3 C	Coordinate Reference Systems	23
7:	Geologic	cal DATA	25
7.′	1 P	Point Data	25
7.2	2 C	Dutcrop Photographs	30
7.3	3 L	ine Data	39
7.4	4 P	Plotting Drill Hole Traces and 3D Drill Data Display	42
	7.4.1	Geoscience Plugin	42
	7.4.2	Alternative Way to Plot Drill Hole Traces on Plan	46
	7.4.3	Displaying Drill Hole Traces in 3D	48
	7.4.4	Extracting Maximum Values for Drill Holes	50
7.5	5 P	Polygon Data	51
7.6	6 G	Geological Symbols and Geological Patterns	58
7.7	7 G	Geological Line Styles	64
7.8	3 L	abelling Features	66
7.9	9 J	loining Spatial and Non-Spatial Data	70
7.′	10 G	Geological Legends	72
7.′	11 Ir	mporting and Exporting GPS Data	74
7.′	12 U	Jsing the GSWA WAROX and WAMINES data	77
7.′	13 C	Converting Local (Non-Earth) Grids to Real World Coordinates	81
7.′	14 C	Creating a Grid Layout	81
7.′	15 G	GeoPackages	82

8:	DISPL	AYING Geochemical Data	87
9:	Geopl	nysical Data Import and Display	
9	.1	Data Import	
9	.2	Colour Ramps	101
9	.3	Custom Data Stretch	
9	.4	Profiling Gridded Data	
9	.5	Creating Stacked Profiles and Colour Bars	
9	.6	First and Second Vertical Derivatives	
10:	3D	Image Display	
1	0.1	3D Map View	
1	0.2	QGIS2Threejs Plugin	110
11:	Rer	note Sensing	113
1	1.1	Using the Semi Automatic Classification Plugin	113
1	1.2	ASTER Data	118
1	1.3	Landsat Data	
1	1.4	Sentinel 2 Data	
1	1.5	Creating RGB Images	
1	1.6	Principal Components Analysis (PCA)	
12:	Мај	Production	
1	2.1	Print Layout	
1	2.2	Map Templates	
1	2.3	Layout Manager	
1	2.4	Using Variables to Display Information	
13:	Mis	cellaneous tricks and Tips	
1	3.1	Access Databases	
1	3.2	AutoSaver Plug-In	
1	3.3	Spatial Bookmarks	
1	3.4	Colour Ramps	143
1	3.5	Colour Selection	146
1	3.6	Digitising Toolbar (PlugIn)	147
D	escript	ion of the tools	148
	Split r	nulti part to single part	
	Split c	off one part and add it as new feature	
	-	eatures	
	•	e selected features	
	-	nge attributes between selected features	
		ith polygon from another layer	
		ith polygon from another layer	

Fill	ring	149
Fill	gap	149
Fill	gap (all visible layers)	149
Spl	it selected features with selected line from another layer	149
Flip	line	149
13.7	Favourites	
13.8	Point Sampling of Raster Data	
13.9	Profile Tool	151
13.10	Points to Lines and Polygons	151
13.11	QPackage	
13.12	Quick Rectangles, Circles, Ellipse Shapes	151
13.13	Refactor Field	152
13.14	Selecting Drill Holes by Tenement	
13.15	Spatialite Databases	
13.16	Extracting Colour Styling Information from MapInfo Files	154
14: F	References	
APPENI	אוכ	1
Lithol	ogic Patterns for Geological Maps	1
US	GS	2
Ge	oscience Australia	3
Ge	ological Survey of Western Australia	4

#### 1: SUMMARY

QGIS is an open source GIS program for the display and analysis of GIS data. It has developed significantly in the past few years and is now a valuable tool for the mineral exploration industry, and a viable alternative to the commercially available GIS packages. Although not specifically written for geological applications, QGIS can do most of the required GIS tasks required by today's geoscientists. The terminology is different to the usual earth sciences programs but many QGIS algorithms do the same thing but with a different name. There is no dedicated drill hole or cross section module available for QGIS currently, but discussions and plans are progressing to develop this module in the future. The Geoscience plugin is a basic drill hole display option that is available as a free plugin.

This manual examines QGIS and how QGIS can assist geoscientists in undertake mapping and geoscientific tasks in their day-to-day work. The manual has evolved during several years teaching QGIS to geoscientists in Australia and has been produced to offer a go-to document for earth science related GIS activities.

Accessing data from the internet via web map and web feature servers is illustrated to show how using this data can help with compiling available data for an area. Detailed aerial photography and Google Earth can be easily integrated with mapping data to allow the creation of accurate base maps for a variety of geological applications. A wide range of vector and raster (grid and image) data formats can be easily imported into QGIS, including GPS gpx files.

The presentation options for point, line and polygon data are extensive and easily customised. A variety of geological symbols and pattern fills can be applied to points, lines and polygons. Geochemical and geophysical data can also be presented in a variety of display options. Basic 3D display of map data is also available via the QGIS2threejs plug-in.

QGIS has many plug-ins for specialised tasks and the semi-automatic classification plug-in (SCP), is one example where users can select, download and process ASTER, Landsat and Sentinel 2 satellite data. It is recommended that new users peruse the plugins list to see what plugins are available and for those that may be of use in their work.

Map production is easy in QGIS with the "Print Layout" allowing extensive options for the display and printing of maps.

This document is a working draft and in continuous development. There may be errors and omissions, and these will be rectified as time permits. This manual applies to version 3.14. Please feel free to share this document and please contact me if you find any errors.

#### 2: INTRODUCTION

This document is aimed at the exploration geologist, but the techniques outlined are easily transferrable to other areas. The author has been using QGIS since 2015 and the version used in this document is version 3.14.

The reader is encouraged to join the international online QGIS user forum at <u>http://lists.osgeo.org/mailman/listinfo/qgis-user</u>.

This document will not go into the detail that is covered by the official QGIS User Guide and Training Manuals (<u>https://docs.qgis.org/testing/pdf/en/</u>) and other reference books (e.g. Graser 2016) on QGIS on topics like editing etc., but will discuss those tools used particularly in geological mapping, mineral exploration and remote sensing. See this video for an explanation of some of the advanced editing functions - <u>https://youtu.be/jZYKGrlyVCA</u>.

The original default file format for QGIS was the ESRI shape file (\*.shp) and this format has been around for many years and can be read by many software products. It is an old format and has limitations, e.g. field names are limited to 10 characters. QGIS is adopting the new "Geopackage" file format as its default spatial file format. Geopackage files can have different types of vector geometry – points, lines and polygons – and can also include raster images. Geopackage files can be up to 140 TB in size! Layers can be imported into an existing Geopackage by dragging from the Layer panel onto the Geopackage name in the Browser panel. Styling information can be saved into the Geopackage file. When digitising into a Geopackage file, each new feature is auto numbered. Raster images imported into a Geopackage appear to be significantly compressed without any major loss of quality. ESRI and recent MapInfo products can read Geopackage files.

The author has been using QGIS since 2015 after about 20 years using the MapInfo-Discover software. He has been involved in exploration and mining geology for over 40 years, with almost 20 years with CRA Exploration Pty Limited, Argyle Diamonds and Rio Tinto Exploration from 1979 till 1997. The past 20 years (1998 – present) has been engaged in consulting roles to the diamond exploration and mining industry with activities in Australia, Brazil, China, Greenland and India, and exploration for other commodities including base metals, iron ore, and manganese.

#### 3: ABOUT QGIS

QGIS is a user-friendly open source Geographic Information System (GIS) licensed under the GNU General Public License and is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats.

The Open Geospatial Consortium (OGC) is an international consortium of more than 530 businesses, government agencies, research organizations, and universities driven to make geospatial (location) information and services FAIR - Findable, Accessible, Interoperable, and Reusable. OGC's members create free geospatial standards. OGC also actively analyses emerging tech trends, and runs an agile, collaborative Research and Development (R&D) lab that builds and tests innovative solutions to members' use cases. For more information visit "ogc.org".

For those users requiring an introduction to GIS, please see this link <u>https://docs.qgis.org/3.4/en/docs/gentle\_gis\_introduction/</u>.

QGIS is a volunteer driven project. They welcome contributions in the form of code contributions, bug fixes, bug reports, contributed documentation, advocacy and supporting other users on their mailing lists and gis.stackexchange.com. If you are interested in actively supporting the project, you can find more information under the development menu and on the QGIS Wiki. If you find QGIS valuable in your workplace, please donate to the QGIS project – the details are on the website.

QGIS provides a continuously growing number of capabilities provided by core functions and plugins. You can visualize, manage, edit, analyse data, and compose printable maps.

This document will mainly address workflows for geoscientists but there are many other tools available in QGIS and worthy of some exploration of their functions. Currently QGIS does not have a detailed downhole or cross section display option, but there are groups across the world keen to crowd source the development of the drill hole plug-in. The Geoscience plugin does display drill holes in plan and in cross section but is limited in its features. QGIS does not also handle all the various geophysical processing options, and again there is interest from various groups to develop plug-ins for geophysical processing.



A good explanation of QGIS and where it came from can be found here <u>https://www.youtube.com/watch?v=As4hfPecxoU</u>.

If you find QGIS makes a valuable contribution to your business, please consider making a donation to assist with continual code improvements – see this link <u>https://qgis.org/en/site/getinvolved/donations.html</u>.

Installation options are available on QGIS download page (<u>https://qgis.org/en/site/forusers/download.html</u>) with options to download either the development version (via OS4Geo) or the standalone installers (recommended). Both 64 and 32 bit versions are available.

QGIS has been using ESRI shapefiles as the default spatial file format but the new "GeoPackage" format is far superior and will probably become the default file format for QGIS in the near future.

Shape files have a number of limitations such as field/attribute column names are limited to 10 characters, it lacks a time data type, only supports text fields to 255 characters in length and is limited to 2 GB in size.

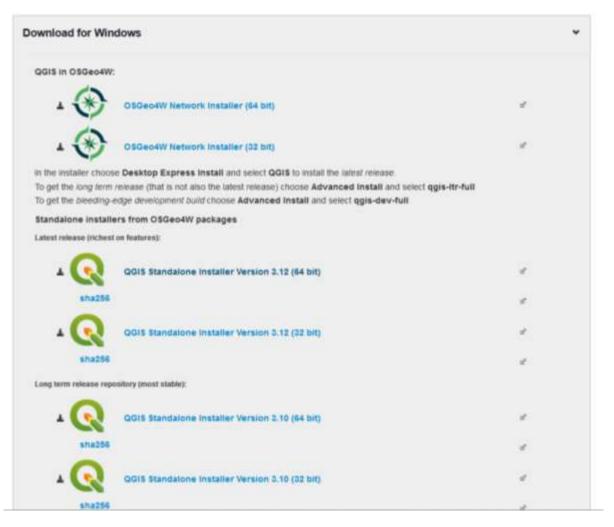
GeoPackage files on the other hand allows point, line vector and raster files to be stored in the one file. Formats/styles can be saved into the Geopackage file and it can be up to 140 TB in size. When adding features during digitising, for example, a Geopackage file will automatically populate the id field with sequential numbers. See this web link for further information <u>https://carto.com/blog/fgdb-gpkg/</u>. Note that Geopackage files are single user only and if you need multiple user access at the same time then PostgreSQL and PostGIS may be required.

#### 4: INSTALLING QGIS

#### 4.1 PC Installation

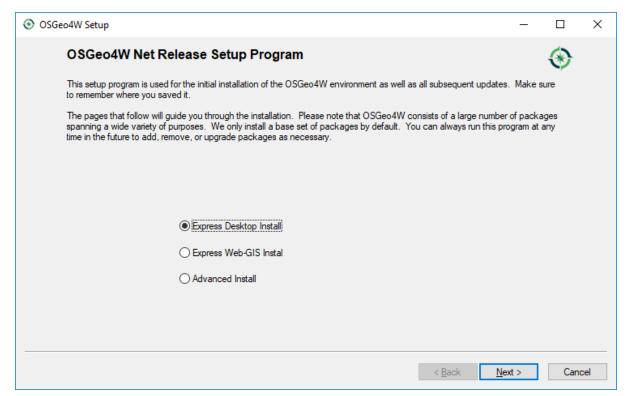
The QGIS program can be downloaded from the QGIS Project website <u>http://www.qgis.org/en/site/</u> and a choice can be made between 32 and 64 bit versions of the recent release and long term release versions. Note that the v2 options are no longer supported and users and encouraged to use v 3.The Standalone Installers will install the program into the Program Files directory.

The OSGeo4W (Open source geospatial for Windows) option can be also be used and places a small executable file on your PC which can be run when desired to update to the latest versions of the LTR and development versions. This version installs the software into the root directory of your PC (e.g. C:\OSGeo4W64). For first-time users, it is recommended to install the "Standalone" version.



The standalone installer will install the program into the program files folder and create a folder on your desktop with shortcuts to the run the program. It is recommended to run the "QGIS Desktop 3.x with GRASS 7.x.x" version which runs the GIS program and associated GRASS GIS functions.

When you run the OSGeo4W option you see the following screen shot. For a first-time installation, choose the "Express Desktop Install" which will install the programs and required utility files.

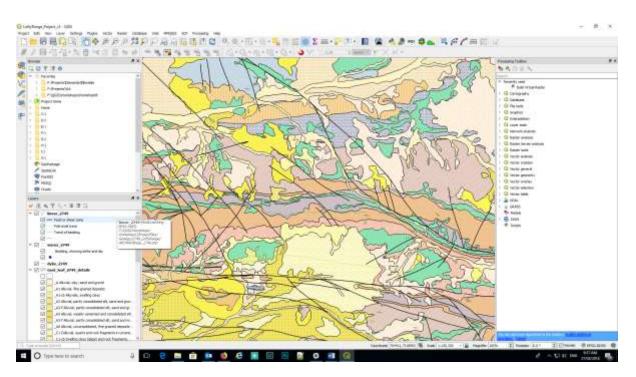


After the initial "Express Desktop Install", you can then check for updates by running the "osgeo4wsetup-x86\_64.exe" file again (usually located in the Downloads folder) where you can select "Advanced Install" and select which products you wish to update. The OSGeo4W option can be used instead of the Standalone Installer option.

Search		Qear				Otherp Other® Gur Other Veril Category
Category	Current	New	В	5.	Size	Fackage
E Al \varTheta Default			1.000			
2 Commandir	ve_Utilities 🕀 Def	lauit				
B Desktop \varTheta	Default					
		Skip	nfa.	10	437k	akia import: norGIS ALKIS Import
		Skip	rah	nja -	423	akis-import-dev: norGI5 ALKI5 Import (fullscheme brench)
	1,4.4-2	Keep	ngs		5864	gpsbabelle: GIPSBabel GUI Frontend
	7.6.1-1	Keep	riju.	nja .	67,117k	grass: GRASS GIS
		Skip	nis.	n/o	25,320k	grass6: GRASS GIS - old stable release
		Skip	nja	nja	324	libzp-bin libzip (executables)
		Skip	nja	njia	160k	osg-bin: OpenSceneGraph (executables)
		Skip	njo	nja	951k	osgearth-bin: OSG Earth (executables)
	3.8.0-1	<ul> <li>Keep</li> </ul>	nja.	ηla	39,30%	qga: QGIS Desktop
	3.9.0-12	03.9.015	13	ηlà	75,504k	ogis-dev: QGIS nightly build of the development branch
		Skip	10	n/a	406,5254	ogie dev pdb: Debugging symbols for QGIS nightly build of the development branch
		Skip	në	nja	34	ogis/full: QGIS Full Desktop (meta package for express install)
		Skip	nja	n/o	Th.	ogis-full-dev: QGIS nightly build of the development branch (netapackage with addition
		Skip	nga	10	R	ogis-full-rel-dev: QGIS nightly build of the latent release branch (metapackage with addi
		Skip	njix	nja	39,638k	ogis-tr: QGIS Desktop (ong term release)
		49 Skip	nga	nja:	69,225k	age &r dev: QGIS nightly build of the long term release branch
		Skip	nja	nja.	359,0834	agis-tr-dev-pdb: Debugging symbols for GGIS nightly build of the long term release bran
		Skip	nix.	nja:	5	ogis-tr-ful: QGIS Full Desktop (meta package; long term release)
		Skip	njis	ηla	69,394k	agis-rel-dev: QGIS nightly build of the release branch
		Skip	nja	nja	391,737k	ogis-rel-dev-pdb: Debugging symbols for QGIS nightly build of the release branch
		Skip	ηο	nja		saga: SAGA System for Automated Geographical Analyses
	2324	<ul> <li>Keep</li> </ul>	nja.		9,647%	saga Itr: SAGA (System for Automated Geographical Analyses; long-term release)
		Skip	1/4	nja	2,129k	tora: database management GUI.
<						)

The select packages window (above) indicates there is an update for v 3.9.0-12 to v 3.9.0-15 in the QGIS development version.

User manual and training documents can be viewed, or pdf versions downloaded from the QGIS web site (<u>https://qqis.org/en/docs/index.html</u>).



The desktop is similar to other GIS applications with menu items along the top and numerous buttons/icons to make it easier to select various options without having to navigate menus. All the menu items and panels are customisable to user preferences. QGIS has operations to import vector and raster data from a variety of formats into QGIS, with excellent editing and analysis tools from the integration of other GIS systems such as GRASS and SAGA. Some of these tools are illustrated in the right-hand panel of the figure above.

If you need to reset the QGIS window and panel locations, go to Settings > Options > System tab, select the Reset button (right hand side of screen) and re-start QGIS.

The appearance of the desktop can also be changed by using the Settings > Options > General tab and in the Application section find the UI Theme where the appearance of the desktop can be modified. A recent addition here is the "Blend of Grey" option.

#### 4.2 Mac Installation

Installation on a Mac is different than for a PC and it is recommended to download and install QGIS from the QGIS download window.

Install the LTR or the Latest Release version.



	eritalitei 🗉 😁 🕁		
grapher's E	🛇 AurQuest Limited - Re. 🚦 SkippySky Astronomy 🕲 Download QSS ( Mac. 🧕 Login ) Malching . 🔮 10 Structural Geologic .	O GRHub-RC-Caroutt	(1) Fee
ET INVOLVE	D DOCUMENTATION		
De	ownload for Windows	•	
Ds	wnload for Mac OS X	-	
	Mac Installer Packages for macOS EI Capitan (10.11) and never		
	installation instructions are in the Read Ne on the dok image. These packages use the		
	python org Python 3 version 3.6, the "maccos/10.9" build - other distributions are not supported, install Python before installing QGS.		
	Additional GGAL formal plugins and PROJ grids are available at syngchase com		
	Latest release (inclusion an Apatoresi):		
	A QQ ODIS macOS Installer Version 3.8.0		
	Long term release (most stable):		
	A QQ OGIS macOS Installer Version 2.4.9		
De	ownload for Linux	۴	
De	wnioad for BSD	٤	
D	winload for Android	¢	

To install the custom (geological) SVG files on a Mac, in QGIS, go to Settings > Options > System tab and location svg files – look for the of the something like /Applications/QGIS3.app/Contents/MacOS/../Resources/svg/. Use the Finder to navigate to the Applications folder, then right click on the QGIS program icon, select "Show Package Contents", open the "Contents" folder and the "Resources" folder. Put the custom (geological) SVG folders into the SVG folder.

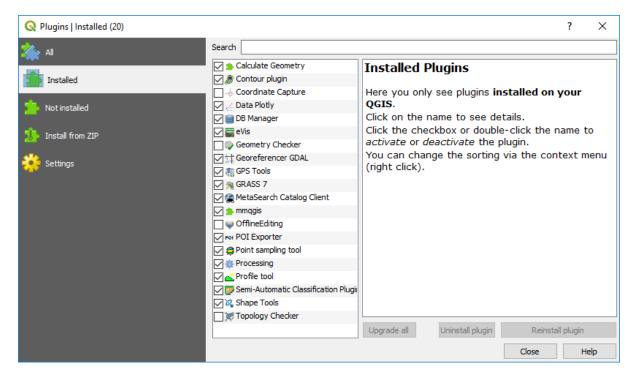
#### 5: PLUG-INS

Plug-ins are small utility programs that greatly expand the capabilities of QGIS. There are currently over 630 plug-ins available for download. These plug-ins are all free and have usually been written to solve a specific problem or task for users. It is recommended that users peruse the plugins list to see what plugins might be applicable to their workflow.

Eleven plug-ins are installed by default in version 3.12 as are listed below.

Coordinate Capture DB Manager Geometry Checker Georeferencer GDAL GPS Tools GRASS7 MetaSearch Catalog Client Offline Editing Processing Topology Checker

To use these pre-installed plug-ins, you may need to enable them in the Plug-Ins > Manage and Install Plug-Ins > Installed window. Enable the plug-ins by selecting the check box next to the plug-in.



Additional plug-ins that are recommended are as follows;

Data Plotly (graphing of data) Geoscience (for plotting drill holes on plans and sections QuickMapServices (add additional services under the extra services option) QGIS2Threejs (3D viewer) Semi-Automatic Classification (satellite data selection and processing) Shape Tools (creation of numerous types of vector objects) Spreadsheet Layers (used to import Excel spreadsheets) SRTM Downloader (for accessing SRTM elevation data)



If the QGIS start-up is being significantly delayed during start-up ("Loading Plugins") then they can be temporarily disabled (Plugins > Installed, tick off those not needed) and only turned on when needed.

In the Plug-Ins > Settings page, check the "Check for updates on start-up" and "Show also experimental plugins". This will then alert the user to updates of existing plug-ins and the release of new plug-ins whenever QGIS is started. Note that when you first open the Plugins manager, you may see a "New" tab to show you what new plugins have been released since you last opened the Plugin Manager. If you are working off-line with no internet, turn-off the "check for updates on start-up" to skip the web search and update function.

🔇 Plugins   Settings				? ×
à All	Check for u	pdates on startup		^
	every time QGIS	starts		•
> Not installed		ble. Otherwise, fetching rep	inform you whenever a new plugin or plug positories will be performed during opening	
1nstall from ZIP	▼ 🗹 Show als	o experimental plugins		
Settings	in early stages concept' tools	of development, and shoul	unsuitable for production use. These plugir d be considered 'incomplete' or 'proof of d installing these plugins unless you intend	
	Note: Deprec unmaintained, installing these available.	and should be considered ' plugins unless you still need	nsuitable for production use. These plugins obsolete' tools. QGIS does not recommen d it and there are no other alternatives	
	Plugin repositor	ies		
	Status	Name	URL	
	Connected	QGIS Official Plugin Repository	https://plugins.qgis.org/plugins/plugins.xml?qgi	s=3.0
			Close	Help

Some managed IT systems block the loading of the Plug-in's repository data. If this happens, try selecting the Settings > Options > Network, and check the use proxy server. Try again to download the repository. If this loads the repositories, then uncheck this box and try again to install the plugins.

Network managers may also restrict the installation of plugins. If you have problems, contact your network manager.



#### 6: DATA MINING AND PUBLIC DATASETS

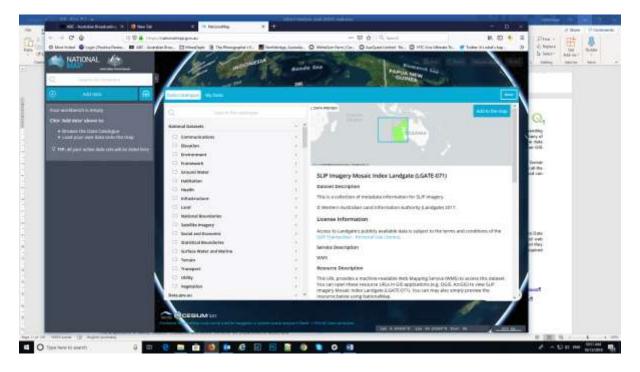
Many government and private corporations have made available datasets for use in GIS programs. There may be usage restrictions and the conditions of use should be checked at the data source. The amount of free data on the web is truly amazing and users are encouraged to explore the web for data.

QGIS has many options to access on-line web datasets. These can be in the form of a WFS (web feature service – vector data), WMS (web map service – raster data) or as a WMTS (web map tile server – tiled raster data, e.g. Google Earth). Australian data can be searched at "data.gov.au" and Western Australian data is available at "data.wa.gov.au".

Satellite data for the ASTER, Landsat, MODIS and Sentinel missions can be downloaded and processed via the Semi-Automatic Classification plug-in in QGIS or via the USGS EarthExplorer portal and this is discussed below. Remote sensing satellite data (including Hyperion multispectral scanner and radar data) can also be downloaded via the USGS EarthExplorer and ESA (European Space Agency) websites.

#### 6.1 Australian Data Sets

The Australian government has the "National Map" portal (https://nationalmap.gov.au) where data can be accessed for Australia-wide data sets or from the individual states and territories. The WA DMIRS (WA mines dept) data can also be accessed via this portal.





#### 6.2 Geological Survey of Western Australia

The Department of Mines, Industry Regulation and Safety (DMIRS, formerly the Department of Mines and Petroleum, http://www.dmp.wa.gov.au/) is home to the Geological Survey of Western Australia (GSWA). This site contains many data sets, most of which can be downloaded from the "Software and Data Centre" (https://dasc.dmp.wa.gov.au/dasc/). Raster and vector data can also be accessed live via their WMS and WFS services (http://geodownloads.dmp.wa.gov.au/downloads/dasc/Static/Resources/Map\_Services/Image\_W eb\_Service\_definition.pdf and http://geodownloads.dmp.wa.gov.au/downloads/dasc/Static/Resources/Map\_Services/Web\_Map \_Service\_definition.pdf). PDF copies and maps and reports are available from their "Bookshop".

Registered raster files of the 100k and 250k geological map sheets have been mosaiced into 1:1 million map sheet areas and are in jp2 (jpeg2000) format registered in GDA94 MGA grid coordinates. The "jp2" format contains the projection and registration data embedded in the file. Raster files of individual map sheets in either GDA94 lat/long or MGA can also be downloaded from the data centre.

Always check that QGIS is using the current coordinate reference system when it loads these files.

The digital vector files for the 250k and 100k geology sheets vary in their data content depending upon the age of the map sheet edition. The GSWA use ArcView for their GIS system and many of their datasets contain "lyr" style and GeoMap "gmp" files. It has been requested that the data supplied by the GSWA also contain the colour and pattern information to allow users of other GIS systems (like QGIS) to style their maps like the GSWA style. This is a work in progress. North Road Consulting (https://north-road.com/slyr/) are developing a plugin to convert "lyr" style files to QGIS style files and this will go a long way in allowing QGIS users to style their maps in a similar fashion to the Arc GSWA maps.

#### 6.3 Landgate and Open Data WA

The WA government has made available a large variety of GIS datasets through their Open Data portal (data.wa.gov.au). Data from other states can be accessed in a similar manner. Searches can be made on this site and both vector data and web service links are supplied. More detailed datasets are available for WA from Landgate, but they may require a subscription. Many datasets are however free, and registration is no longer required for the free datasets.

Links to some of the WA web services are as follows;

#### Web Map Server Links

Public:

https://services.slip.wa.gov.au/public/services/SLIP\_Public\_Services/Property\_and\_Planning/MapServer/WMSServer

Imagery:

https://services.slip.wa.gov.au/public/services/SLIP\_Public\_Services/Locate/MapServer/WMSSe rver

#### Web Feature Server Links

<u>Maps</u>

https://services.slip.wa.gov.au/public/services/SLIP\_Public\_Services/Property\_and\_Planning\_W FS/MapServer/WFSServer

#### Imagery

https://services.slip.wa.gov.au/public/services/SLIP\_Public\_Services/Imagery\_and\_Maps\_WFS/ MapServer/WFSServer

Australian Bureau of Statistics: https://www2.landgate.wa.gov.au/ows/wfsabs\_4283/wfs

To add WFS and WMS layers to QGIS, use the Layer > Add Layer > Add WMS/WMTS Layer.

t		View	Laye	er Settings Plugins Vector Data Source Manager Create Layer	Raster Data Ctrl+L	P	Web MMQGIS SCP Proce	ssing Help
- 0		et ° t		Add Layer	•	Va	Add Vector Layer	Ctrl+Shift+V
Bro	wser	7 1		Embed Layers and Groups Add from Layer Definition File		₽. 9.0	Add Raster Layer Add Delimited Text Layer	Ctrl+Shift+R
*	合 > >	Favorite: F:\Pi F:\Pi	8	Copy Style Paste Style			Add PostGIS Layers Add SpatiaLite Layer	Ctrl+Shift+D Ctrl+Shift+L Ctrl+Shift+M
~ ~ ~	>	F:\Q Project H Home	四ノ母	Open Attribute Table Toggle Editing Save Layer Edits	F6		Add MSSQL Spatial Layer Add DB2 Spatial Layer Add Oracle Spatial Layer Add/Edit Virtual Layer	Ctrl+Shift+2 Ctrl+Shift+0 Ctrl+Shift+0
~ ~ ~		C:\ D:\ E:\	11	Current Edits Save As	*	3 8	Add WMS/WMTS Layer Add ArcGIS MapServer Layer	Ctrl+Shift+W
> >		F:\ G:\		Save As Layer Definition File Remove Layer/Group	Ctrl+D		Add WCS Layer Add WFS Layer	
> >		H:\ I:\	G	Duplicate Layer(s) Set Scale Visibility of Layer(s)		83	Add ArcGIS FeatureServer Layer	
>		X:\		Set CRS of Layer(s)	Ctrl+Shift+C	R	- C & 5	TARA

An example of linking to the Landgate imagery is shown below.

Ci\	Layer Order Tieses	Layers Layer Order Tilesets Server Search				
EAL SACTOR	Landgate Inagery		~			
Pth MAR	Cornect New	Edit Remove Load Save default serv				
Gri Gri Raster	ID Narie	Tide Abstract	8			
HIA Delevited Test			2			
		Crease a New Yorks Connection	r			
N1\ CeoPachage		Connection details				
Spatialite Z Spatialite		Name Landgate Imagery	_			
Post025		URL V. au/public/services/5L3P_Public_Services/Locate/MapGerver/WM	al fam			
Postger/GR		Authentication				
Orade	Image encoding	Configurations Basic Oroose or create on authentication configuration No authentication endinguration Carriligurations store encrypted credentals in the QGIS authentication detailable.				
TR) MILO						
4 * Y 4 * # 🔘 cvade						
☑ √ <sup>°</sup> Anear_2749	Options					
Fault or shear a 200 000	Tão stav					
Pold axiel trace	Request step size	, unique.				
	Feature limit for GetFeatureDife					
CALL WARDY TTAN	GDA94 / MGA zone 50	WHS Options				
E Bedding, show the weat		Referer				
	Use contextual WMS Legend	DPLMode al				
☑ — dyke_2749 ☑ ≔ Gent Surf 2740		Ignore GetMap/GetTile URL reported in capabilities				
nD	Layer name	Ignore democratine on reported in capabilities				
A Aluvial, day	Ready	Ignore axis arientation (WHE 1.3/WHTS)				
Al Abriel fri and L Antilli Feature Server		Drivert axis orientation				
Al Abrids, friend, Antilli Feature Server Al-th Abrida, Briter (1997)	The los	Smooth persep transform				
A2 Aluxial, partly consolidated sit, sand and grav	D L C					
<ul> <li>A2-f Aluvial, partly consolidated sit, sand and gr</li> <li>A3 Aluvial, weakly converted and consolidated sit</li> </ul>	20	OK Cancel	Help			

Some services may require you to register for a username and password.

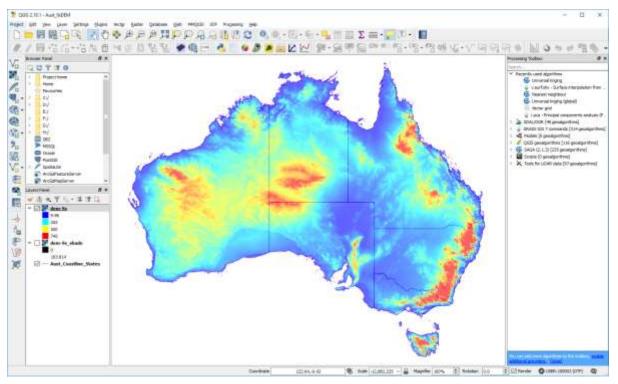
Access to vector data is via the add WFS (web feature server) option. See below for the list of publicly available data (no sign in required) from the Landgate server.

🔇 Data Source Manager   WFS		? ×
📛 Browser	Server connections	
V- Vector	Landgate WFS	•
Raster	Connect New Edit Remove	Load Save
⑦ Delimited Text	Filter	Neur
GeoPackage	SWAN_Bioplan_Regionally_Significant_Natural_Areas_2010 SWAN_Bioplan_Peel_Sector_2010DWER-069_	Name  SLIP_Public_Services_Property_and_Planning SLIP_Public_Services_Property_and_Planning
SpatiaLite	Swan_and_Canning_RiverDevelopment_Control_Area Survey_IndexTextLGATE-085_	SLIP_Public_Services_Property_and_Planning_ SLIP_Public_Services_Property_and_Planning_
PostgreSQL	Survey_Index_LGATE-086_ Structure_Plan_BoundariesDOP-082_ State_Environment_Policy_Cockburn_Protection_Levels_201	
MSSQL	Public_Access_Ways_LGATE-080_ Perth_and_Peel_Urban_Land_Development_Outlook_2016 Perth_and_Peel_Urban_Land_Development_Outlook_2016	
- Oracle	Greater_Bunbury_Regional_Land_Supply_AssessmentDO Geraldton_Regional_Land_Supply_Assessment_2017DOP Geodetic_Survey_Marks_PointLGATE-076	
DB2 DB2	EPP_Goldfields_Residential_Areas_Sulphur_Dioxide_2003 EPB_Local_Assesment_Port_Hedland_Port_2011DWER-06	SLIP_Public_Services_Property_and_Planning_
Virtual Layer	DBCA_Planning_Referrals_ContactsDBCA-033_ DBCALegislated_Lands_and_WatersDBCA-011_ DBCALands_of_InterestDBCA-012_	SLIP_Public_Services_Property_and_Planning_ SLIP_Public_Services_Property_and_Planning_ SLIP_Public_Services_Property_and_Planning_
🚱 wмs	<	
🕀 wcs	Use title for layer name	
WFS	Coordinate reference system	
ArcGIS Map Server	EPSG:4326	Change
ArcGIS Feature Server	<u>B</u> uild query	Close <u>A</u> dd Help

#### 6.4 Geoscience Australia

Geoscience Australia (GA) provides an extensive array of national datasets (see this link for more information "https://data.gov.au/").

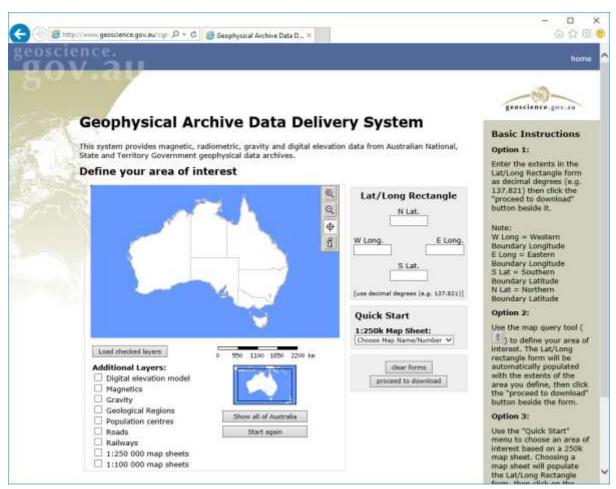
Digital elevation data is also available across Australia from Geoscience Australia (https://elevation.fsdf.org.au/) at a resolution of 1 arc second (approximately 30 m) and is available as a hydrologically conditioned and drainage enforced version (DEM-H). This is a 26 Gb zip file and can be downloaded. The author has cut this into UTM zones which are approximately 7 - 8 Gb in size each zone to improve useability. Depending upon the speed of your PC/laptop, these may need to be further cut into 1:1 million map sheet areas. The 9 second DEM (approximately 250 m) is about 0.8 Gb in size, is also available.



Geoscience Australia, 9 second DEM

Many of these datasets are also available as web services – see this link <u>http://services.ga.gov.au/</u>.

Geophysical data incorporating magnetics, gravity, radiometrics and elevation data can be downloaded as vector (point data) or as grid files. Both national and individual survey data is available for data held by Geoscience Australia via the Geophysical Archive Data Delivery System (GADDS) – Notes GADDS is being upgraded and a new version is due for release by July 2020. The DMIRS will hold data for surveys flown for the GSWA. Data can be filtered by 1:250 000 map sheet area or by geographic coordinates. Check the projection of the dataset before you download, as it may default to geographic coordinates.



Geoscience Australia geophysical data portal.

GA have recently released a new Digital Earth Australia data portal at "https://www.nationalmap.gov.au/".

#### 6.5 United States Geological Survey (USGS)

The USGS hold an enormous amount of free data, most of which is accessible via its EarthExplorer portal (<u>http://earthexplorer.usgs.gov/</u>). To download the data, you are required to register (free) and select a username and password.

ASTER and Landsat data are two of the remote sensing datasets available from the USGS. These datasets are also easily accessed via the Semi-Automatic Classification plug-in in QGIS (see Section 11.1). Digital elevation, radar and Lidar data are also available from the USGS.



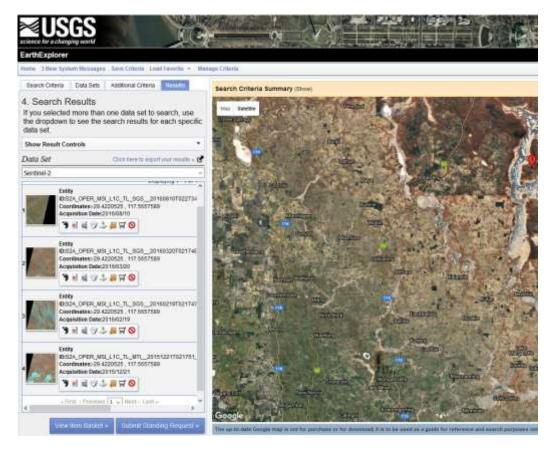
USGS EarthExplorer data portal.

Use the Register button to create a free account or log in if you have an existing EarthExplorer account. Logging in allows you to download datasets.

Enter the search criteria by using a Landsat path/row identifier, or by using the map or by a coordinate. Once you have selected an area, choose the data set you are seeking, add "Additional Criteria" if you want to filter your search, e.g. by date range.



Each of the data categories have a range of datasets available.



If there is data available from your search request, you can then examine the thumbnails of the scenes and select which dataset is the best one for your purposes. The footprint icon will show the area covered by the scene and notepad and pencil icon brings up a better view of the data including its metadata. Click on the download icon to download the data. The format of the data will depend on the data type and this needs to be researched by the user.

#### 6.6 European Space Agency (ESA)

ESA has launched a number of satellites recently in their Sentinel series to observe the land and ocean climate monitoring this areas for and purposes (see site https://sentinel.esa.int/web/sentinel/home). For geological work, the author has found the Sentinel 2 data is most useful. The Sentinel 2 mission monitors variability in land surface conditions, and its wide swath width and high revisit time (5 days) will support monitoring of changes to vegetation within the growing season. The coverage limits are from between latitudes 56° south and 84° north (ESA).

Currently the easiest way to select and download the Sentinel data is via the USGS EarthExplorer portal. Register for a free login and passwords at the portal.

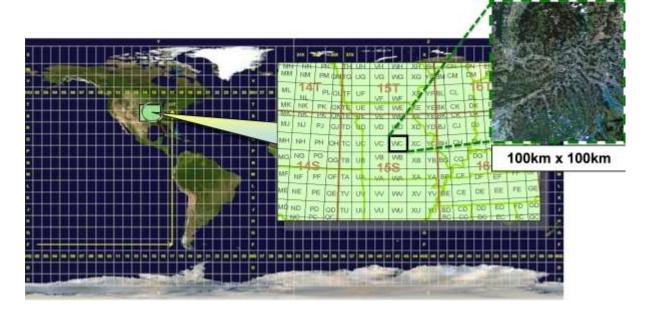
The following description is taken from the ESA Sentinel website.

"Sentinel-2 products available for users are listed in table below.

Name	High-level Description	Production & Distribution	Data Volume
Level-1C	Top-of-atmosphere reflectances in cartographic geometry	Systematic generation and on-line distribution	600 MB (each 100x100 km2)
Level-2A	Bottom-of-atmosphere reflectance in cartographic geometry	Systematic generation and on-line distribution and generation on user side (using Sentinel-2 Toolbox)	800 MB (each 100x100 km2)

Products are a compilation of elementary granules of fixed size, within a single orbit. A granule is the minimum indivisible partition of a product (containing all possible spectral bands).

For Level-1C and Level-2A, the granules, also called tiles, are 100x100km2 ortho-images in UTM/WGS84 projection. The UTM (Universal Transverse Mercator) system divides the Earth's surface into 60 zones. Each UTM zone has a vertical width of 6° of longitude and horizontal width of 8° of latitude. (see Figure 1). Tiles are approximately 600 MB in size. Tiles can be fully or partially covered by image data. Partially covered tiles correspond to those at the edge of the swath.



#### Level-1C product tiling

The continuous acquisition of Sentinel-2 image data in a given MSI mode is called a "datatake". The maximum length of an imaging datatake is 15,000 km (e.g. continuous observation from northern Russia to southern Africa). All products contain granules/tiles from a single datatake. A datatake is presented inside a product as a set of one or more datastrips (corresponding to acquisition segments downlinked to different ground stations)."

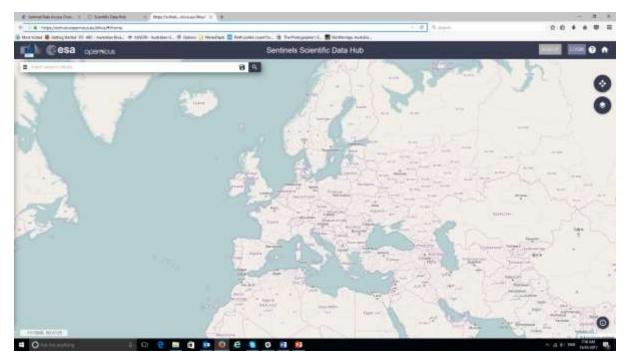
The Sentinel 2 series A and B satellites are of relevance to geology as they have a high spatial resolution and 12 bands of spectral data. The multispectral imager (MSI) covers 13 spectral bands (443 nm–2190 nm) with a swath width of 290 km and spatial resolutions of 10 m (4 visible and near-infrared bands), 20 m (6 red-edge/shortwave-infrared bands) and 60 m (3 atmospheric correction bands). The Sentinel 2 satellites main applications are in monitoring agriculture, forests, land-use change, land-cover change; mapping biophysical variables such as leaf chlorophyll content, leaf water content, leaf area index; monitoring coastal and inland waters; risk mapping and disaster mapping.

Band number	Central wavelength (nm)	<b>Bandwidth</b> (nm)	Spatial resolution (m)
1	443	20	60
2	490	65	10
3	560	35	10
4	665	30	10
5	705	15	20
6	740	15	20
7	783	20	20
8	842	115	10
8a	865	20	20
9	945	20	60
10	1380	30	60
11	1610	90	20
12	2190	180	20

The table below compares Sentinel 2 with other commonly used satellite sensors.

Common Name	Band Range (µm)	Landsat 5	Landsat 7	Landsat 8	Sentinel 2	MODIS
Coastal	0.40 - 0.45			1	1	
Blue	0.45 - 0.5	1	1	2	2	3
Green	0.5 - 0.6	2	2	3	3	4
Red	0.6 - 0.7	3	3	4	4	1
Pan	0.5 - 0.7		8	8		
NIR	0.77 - 1.00	4	4	5	8	2
Cirrus	1.35 - 1.40			9	10	26
SWIR16	1.55 - 1.75	5	5	6	11	6
SWIR22	2.1 - 2.3	7	7	7	12	7
LWIR	10.5 - 12.5	6	6	10, 11		31, 32

The Sentinel data can also be accessed via the Sentinel portal after registration (Sign Up button), see this link <u>https://scihub.copernicus.eu/dhus/#/home</u>.



After logging on to the portal, scroll to your area of interest and highlight a rectangle for your data search. This method of data selection is less intuitive than the USGS EarthExplorer data access

A Sentinel tile index covering the world can be downloaded as a shapefile from the ESA website.

Sentinel 2 data can also be downloaded using the QGIS plug-in "Semi-Automatic Classification" which is discussed below.

Note that radar data is now available from the Sentinel 1 mission.

#### 6.7 30 m SRTM Tile Downloader

The SRTM-Downloader plugin allows the user to download tiles into their map window and these can be saved. Note that you will need a USGS EarthExplorer portal login (free). The dtm tiles are downloaded in one degree tiles in hgt grid format (which QGIS reads with no problem).

You can also use this link to access the 30m SRTM tile data - <u>http://dwtkns.com/srtm30m/</u>. You will need to add your USGS EarthExplorer username and password.

C O Type two to sends



These images are in jp2 (jpeg2000) format which have the image registration information incorporated in the file. QGIS reads and registers these images.

#### 6.8 Coordinate Reference Systems

a 🗴 🔯 🖬 🦉

When using GIS data it is very important to know the coordinate reference system (CRS) of the data. Choosing the wrong projection will misplace the data or prevent it from appearing on your map. QGIS can re-project data on-the-fly (OTF) when bringing data into a map window that has a different CRS to the file being imported. If QGIS cannot recognise the projection of the layer being imported it will flash a yellow warning banner and usually defaults the layer projection to WGS 84. Open the layer properties for the layer and correct its projection.

Note that the CRS in the PROJECT PROPERTIES dialog box affects the way the data is displayed in the map window. The CRS dialog box in the LAYER properties box affects where the points are located on the planet. It is very important to know the CRS of the data being imported into the map window.

The CRS dialog box remembers your recent CRS used and these can be quickly selected from the "Recently Used..." information box. If you have not used a particular projection previously, you can type in the CRS name or EPSG number of the projection into the "Filter" box. For example, the Australian GDA94 geographic CRS has an **EPSG of 4283**. Note that if you type "GDA94" into the filter box it may give you an option of GDA94 as a Projected Coordinate System (EPSG 4938), this is incorrect and will cause problems when trying to display GDA94 lat/long data. Always check you have selected the correct CRS.

GDA94 UTM zones can be easily selected by entering the EPSG starting with "283", then add the zone number, for example GDA94 zone 50 would be EPSG 28350.



WGS84 UTM zones can be selected using "327" then the zone number for the southern hemisphere and "326" plus the UTM zone for the northern hemisphere.

Project Properties   CR	S	>
	Project Coordinate Reference System (CRS)	
General	No projection (or unknown/non-Earth projection)	
•		
Metadata		
CRS	Recently used coordinate reference systems	
- Cito	Coordinate Reference System	Authority ID
Default Styles	GDA94 / MGA zone 50	EPSG:28350
	WGS 84 / UTM zone 51N WGS 84 / UTM zone 51S	EPSG:32651 EPSG:32751
Data Sources	WGS 84 / UTM zone 18S	EPSG:32718
	GDA94 / MGA zone 52	EPSG:28352
Relations	AGD84 / AMG zone 51	EPSG:20351
	GDA94 / MGA zone 51	EPSG:28351
Variables	GDA94	EDSG-//283
Macros	Coordinate reference systems of the world	Hide deprecated CRSs
	Coordinate Reference System	Authority ID
QGIS Server	GDA94 / MGA zone 48	EPSG:28348
	GDA94 / MGA zone 49	EPSG:28349
	GDA94 / MGA zone 50	EPSG:28350
	GDA94 / MGA zone 51	EPSG:28351
	GDA94 / MGA zone 52	EPSG:28352
	GDA04 / MGA zono 52	EDCG-20252
	GDA94 / MGA zone 53	EPSG:28353
		EPSG:28353
	GDA94 / MGA zone 51	EPSG:28353
	GDA94 / MGA zone 51 Extent	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46	EPSG:28353
	GDA94 / MGA zone 51 Extent	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80	EPSG:28353
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0,0 +units=m +no_defs	A CONTRACTOR
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs	
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0,0 +units=m +no_defs	
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proja +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs V Datum Transformations Ask for datum transformation if several are available (defined in global the main of the several are available (defined in global)	setting)
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs ▼ Datum Transformations Ask for datum transformation if several are available (defined in global)	
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs ✓ Datum Transformations Ask for datum transformation if several are available (defined in global	setting)
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proja +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs V Datum Transformations Ask for datum transformation if several are available (defined in global the main of the several are available (defined in global)	setting)
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs ✓ Datum Transformations Ask for datum transformation if several are available (defined in global	setting)
	GDA94 / MGA zone 51 Extent 120.00, -38.07, 126.01, -10.46 Proj4 +proj=utm +zone=51 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0 +units=m +no_defs ✓ Datum Transformations Ask for datum transformation if several are available (defined in global	setting)

The lower map window shows the area of the world where the projection is valid.

If you are using a local grid with no real world projection, you can select the "No Projection" tick box at the top of the window.

#### 7: GEOLOGICAL DATA

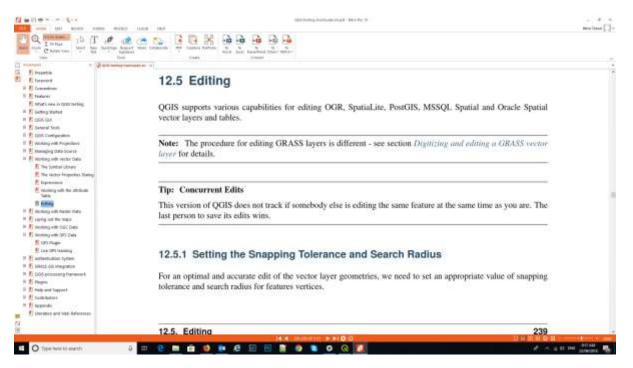
Geological data is varied in nature but is usually either as points, lines or polygons. Geological mapping comprises the collection of points using a GPS, with lines and polygons drawn as an overlay on aerial or satellite images. The following discussion covers a variety of tasks commonly associated with field data collection and interpretation. Detailed editing tasks will not be discussed as there are a numerous resources available on the web, in the QGIS User Manual and various books. A variety of tips and tricks can be found in section 13.

The Android tablet application "QField" is available for tablets and more details on this will be added in the near future. QField can be used in the field for data collection and mapping.

QGIS can sometimes have problems when digitising into layers with differing projections in the map window. It is recommended that digitising be done on layers in one projection at a time. The new file can be reprojected at subsequently into a different projection if required.

Note also turn off the auto-save plugin, if you have this enabled, as it may cause problems during digitising.

Details on the digitising and editing functions can be found in the "QGIS User Guide – Release Testing" (for version 3.12) document which can be found here <u>https://docs.qgis.org/testing/pdf/en/</u>. This guide gets regularly updated.



#### 7.1 Point Data

Field mapping data is collected by various methods. The most basic version and that used by the "old school" is to collect data in a field book and then enter it into a spreadsheet for import into a GIS. Field data collectors vary in their formats and so the user will need to determine what is the best option for their data import. Always include the datum and projection zone (if applicable) when compiling vector data.

GPS points are easily brought in to QGIS by importing a GPS "gpx" file or in some cases direct download from the GPS. Tracks and waypoints downloaded from the GPS in \*.gpx format can be imported via the "GPS Tools" icon located in the left menu bar or via the top menu Vector > GPS > GPS Tools menu. GPX files from Garmin GPS units are usually in WGS84 geographic coordinates (Longitude and Latitude, decimal degree format) by default. GPS points can be uploaded to a GPS using the POI plugin.

Comma separated variable or "CSV" files are a good simple way to import point data and can be an alternative way to import spreadsheet data when there are problems importing Excel files. If you do have a problem with importing an excel file, save the file in CSV format and import into QGIS. Note there can be problems importing large Excel or csv files, e.g. with QGIS scrambling column data, if this is the case, then use the tab delimited text export option from Excel.

Complex CSV files containing a variety of field types can be imported using CSV format files (\*.csvt). QGIS can read field data types from an OGR CSV driver compatible "csvt" file. This is a txt file alongside the data file, but with a "t" appended to the file name extension. The file should just contain one line which lists the type of each field. Valid types are "integer", "real", "string", "date", "time", and "datetime". The date, time, and datetime types are treated as strings in QGIS. Each type may be followed by a width and precision, for example "real(10.4)". The list of types must separated by commas, regardless of the delimiter used in the data file. An example of a valid format file would be: "integer", "string", "st

Another option for importing csv data is to load into Excel and check the field types for each field before importing. Excel files are imported using the "Spreadsheet Layers" plugin. This is found under the Layer > Add Layer > "Add spreadsheet layer" menu. It is especially important to check the data is being correctly imported.

Point geological mapping data such as bedding, joints and outcrop observations can be entered via a spreadsheet where columns can be created to cater for items such as coordinates, observations, and photo references. Remember to always include the datum and map projection data in the file. Symbol file names (full path required) can also be entered into the spreadsheet that will allow QGIS to select the correct symbol and then orientate it using a rotation angle for the correct strike or plunge. An example is shown below of the WAROX (GSWA mapping data, csv format) data from the GSWA Bow 1:100k geological map. Additional columns would be required with symbol file names to allow QGIS to select the appropriate symbol, or alternatively you can choose a "Categorise" symbol style option and edit the symbols for each category manually.

## Q

#### QGIS In Mineral Exploration

E	1 ···-									WARDE	Bavelenv - B	and i					Signi	in 18			
R		ome	Inset	Page	Layout	Formula	Dene	Tesape	Yes	Nitro Pro 1	E Q.Te	imenhat	pine senert fi	i do							R me
Part +	- Ba-	Calibri B J	u -	- [1] 11 = [	• A 0 • A	x = = = =		-	ge fil Center	- 5 -		1.410.000	nditional (				e format		The Field		
Dis	hard is		Pro	41		51	18	ignment		6	Number			bjérs		Crit	K I	64	ting		-
A1			2	2	5 X																
1		1.1	1	e l	D		1.14	G	. W	1.	1.9	ĸ	1.11	M	N. N			£. 11	Q I		34
1	¢	ly .	ARE			E GEOPNT	GEOPINT	FEATURE		STRIKE	DIP DIR	DIP	PLUNG		RANK		ENCI SYME	INCL. INC	300		
2	128.01	1 -16.5	69	0		D	1	1 Bedding,	inclined	45	315	5	8	¢.	0	0		16 456	4;Beddir	ng, showi	ing st
3	128.026	2 -16.50	64	0		0	2	2 Small-scr	iminor ant		0 0		0	0 3	18	0				scale folk	
4	128.352	2 -16.51	71	0		D .	3	3 Sedding,	rinclined	353		1	1	0	0	0		16 456	4;fieddir	ng, showi	ing id
5	128.372	8 16.51	47	0		D	4	4 Bedding,	strike and	43	312		0	0	0	0		28.456	4;Beddir	ig, showi	ing st
1	128.394	5 -16.57	45	0		D	5	5 Sedding,	strike and	357	7 87		0	0	0	0		30 456	4;Redda	ng, showi	ing st
1	128.404	6 -16.51	22	0		D	6	6 Bedding,	strike and	65	155		0	0	0	0		2B 456	4;Beddir	ig, showi	ing st
1	128.419	5 -16.50	82	0		0	7	7 Bedding,	istrike and	333	243		0	0	0	0		28 450	4;8eddir	ig, showi	ing st
	128.436	8 -16.55	18	0		D	1	8 fledding,	sstrike and	287	7 197		0	0	0	0		28 456	4;fields	ng, showi	ing st
0	128,457	2 16.54	58	. 0		D	9	9 Bedding,	strike and	87	177		0	0	0	0		28 456	4;Bøddir	ig, showi	ing st
1	128.395	1 -16.53	65	0		0 1	0 1	0 Bedding,	istrike and	22	112		φ.	0	0	0		30 456	4;Redda	ig, showi	ing st
2	128.383	1 -16.53	93	0		0 1	1 1	1 Bedding,	strike and	C 19	274		0	¢.	0	0		30 456	4;Beddir	ng, showi	ing st
8	128.379.	1 -16.53	06	0		0 1	2 1	2 Bedding,	istrike and	25	3 138		0	0	0	0		28 456	4;8eddir	ig, showi	ingst
4	128.291	1 -16.54	68	0		0 1	3 1	3 Bedding,	strike and	1	1 50		0	0	0	0		28 456	4;8edde	ng, showi	ingst
5	128.035	2 -16.55	43	0		0 1	4 1	4 Bedding,		55			¢.	0	0	0				ig, showi	ing st
		WA	ROX Bo	w	(1)								1.141		20						
Read	DV .	-		-												0.000	i an i		- 1		100%

Below is an example of the "categorised" features of the WAROX data for the GSWA Lissadell 250k map sheet with features manually changed by clicking on each symbol. Once this has been done, remember to **save** the symbols by using the "Style" button and "Save style" to a QGIS qml style file (e.g. GSWA\_WAROX.qml). This style file can then be used to recall these styles. You can choose the "save as default", which creates a qml file with the same file name as the shape file and when you open the shape file, the qml file will be used to determine the way the features are displayed for this layer. Styles can also be saved to a Geopackage file.

🕺 Layer Properties - waro	x_points_e520	2gt   Style	?	×
🤀 General	ategori	zed		•
😻 Style	Column	abc FEATURE V		
abc Labels	Symbol	Change		
	Color ramp	Random colors    Edit		invert
Fields	Symbol	Value	Legen	d
🞸 Rendering		Bedding, showing strike and dip Cleavage, showing strike and dip		ng, sho age, sh
🧭 Display		Crenulation deavage, showing strike and dip Foliation, showing strike and dip		lation ( on, sho
Sctions		Gneissic banding, showing strike and dip Lineation showing trend and plunge direction		sic band
• Joins		Lineation, showing trend and plunge direction Small-scale fold axial surface, showing strike and dip		ion, sh scale fi
🕅 Diagrams		Small-scale fold axis, showing trend and plunge Structural symbols are labelled according to the sequence of deformation events, where known	Small-	scale fi ural sv
🥡 Metadata		Way-up indicator		up indic
8 Variables	<			>
Legend	Classify	世 Delete all	Advano	ed 🔻

To create a new empty points layer, use the menu item Layer > Create Layer > New Shapefile Layer and select a point layer type (**especially important to check the geometry type! And CRS**). Add the required data columns and data types (text, integer, decimal number, date) to attach to each point. Remember shapefile column names are limited to 10 characters and any names longer than this will be truncated. When creating a new vector layer to digitise data, ensure the layer is the correct type, i.e. point, line or polygon, that it has the correct map projection and



add the necessary columns to be able to enter the relevant field data for each feature. Save the file with an appropriate file name. Note that additional fields can be added later if needed. When digitising into a Geopackage file the feature id will be automatically incremented.

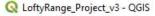
Q LoftyRange_Project_v3 - QG		
Project Edit View Layer	Settings Plugins Vector Raster Datab ata Source Manager Ctrl+L	pase Web MMQGIS SCP Processing Help
Browser Browser Cr Ad Err Ad Cr Ad Err Ad Cr Cr Ad Cr Cr Ad Cr Cr Ad Cr Cr Ad Cr Cr Ad Cr Cr Ad Cr Cr Cr Cr Cr Cr Cr Cr Cr Cr Cr Cr Cr	Preate Layer     Image: Comparison of Comparis	<ul> <li>New GeoPackage Layer</li> <li>New Shapefile Layer</li> <li>New SpatiaLite Layer</li> <li>New Temporary Scratch Layer</li> <li>Create new GPX layer</li> </ul>
File name File encod Geometry	Sing System System Point Point Point Point Point Point Point Point Point Point Point Point Point Point	
New file Name Type Length	else Text data	
Fields I Name d		recision

Note the Type "Real", Length and Precision options where you can restrict the size of the data entered (e.g. UTM eastings length 9 - 6 figures, decimal point and two decimal places). Note that a negative sign, as per the dip, does not use a length, so the dip field in this example could have a length of 5 (00.00 to -90.00).

OK Cancel

Points can be moved in the map window by using the "Move Features" icon in the point edit menu. The layer requires to be set as editable. Note that the coordinates in the underlying table will not change and these coordinates need to be updated using the "Update Coordinates" option in the "Attribute Table".





Project Edit View	Layer Settings	Plugins Vec	tor Raster	Database	Web MM
🗋 🗁 🖶 层		🖑 🍄 🗩		JI F	
//. // 📑 😚	•°° • 1%	â 🛰 B	B 6	1	bc 🍕 🔤
Browser	•°o Move Fea	ture(s) Move Feature(s		₽×	
8 13	ojects\Diamonds\E	lendale		^	$\backslash$

Move tool highlighted in editing toolbar.

If you do move points, remember to update the Easting and Northing values in the table using the geometry operator "\$x" for Easting and "\$y" for Northing. Remember to select the correct column to update! If you fail to do this the coordinates shown in the table will be incorrect. Remember also that the updated coordinates will be in the project projection coordinates. Also remember to save your edits.

● 日 二 日	0 - 0 0		YEAPI							
3 Easting ·	- E							~ Up	date AL Limitate To	in to
te: Point A te: Datum te: Zorie	Deturi GDA94	Zone 90	Easting 397480.0000000	Northing 6741475.000000	RL. 318.0000000000	ObsType	STRK_PLUNG	Dip	Comments Pisolitic laterite o	N
L3 Northing L3 RL als ObsType	GDA94	50	397560.0000000.	6741440.000000.	313.0000000000.	Decking	45.00000000000	35.0000000000	Outcrop of large	н
	GDA94	90	397583.0000000	6741378.000000	309.000000000	Joint	335.0000000000	75.0000000000	Breccia, ven qtz	¥
-A STRK_LUNG -A Dip	GDA94	50	297583.0000000	6741378.000000	305.000000000					۲
Comments Y	GDA94	50	397643.0000000.	6741345.000000	305.000000000	PoidAxis	25.0000000000	45.0000000000	Breccia, smaller c.	۲
GBOS	GD494	50	397643.0000000	6741345.000000	305.000000000					۲
GEOG	GDA94	90	397470.0000000	6741470-000000.	318.0000000000	Bedding	50.0000000000	35,00000000000	Top of pisolite hill.	N
										>

There is a new algorithm that will create X-Y columns from point data and is accessed via the Processing Toolbox > Vector Table > "Add X/Y Fields to Layer".

Q Add X/Y Fields to Layer	×
Parameters       Log         Input layer <ul> <li>Locations [EPSG:28351]</li> <li></li></ul>	Add X/Y fields to layer Adds X and Y (or latitude/longitude) fields to a point layer. The X/Y fields can be calculated in a different CRS to the layer (e.g. creating latitude/ longitude fields for a layer in a project CRS).
0%	Cancel
Run as Batch Process	Run Close Help

#### 7.2 Outcrop Photographs

Photographs of outcrops and report pdf files can be attached to an observation point and allow a point and click to access the photo or report.

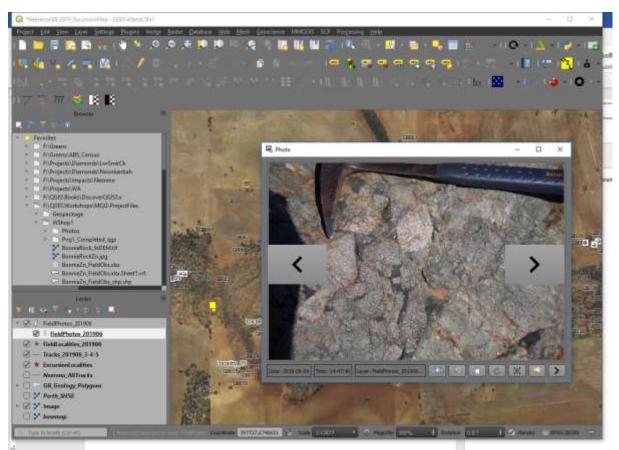
There are three ways to display photos at points. There are two options using the Import Photos plugin, and the third option is going via the Layer Properties > Actions (thanks to Mike Erceg for explaining this process) The last two options require the full path to the photo file to be identified.

#### Import Photos Plugin

If your photos are geo-tagged, i.e. they have their coordinate locations imbedded in the file, then the easiest option is to use the "Import Photos" plugin. Most smartphones take geo-tagged photos unless the location data option has been turned off for photos. I use a Pentax K-1 DSLR and that camera has an in-built GPS, so all photos are automatically geo-tagged. Most smart phones will have embedded GPS coordinates in the photos unless this location feature has been turned off.

To use the Import Photos plug-in, run the "Import Photos" option and select the directory where the photos are located and where you want to store the resulting shape file (this will have all the photo information extracted from the photo file). Choose a suitable filename and press OK. The layer will them be created and using the Plug-Ins > Import Photos > Click on Photos (use a double click), the photos in those locations will be displayed.

<b>Q</b> ImportPhotos		×
Input folder location	F:/Projects/Impacts/Neereno/FieldTrip/201906/Photos	Browse
Output file location	F:/Projects/Impacts/Neereno/FieldTrip/201906/Photos/FieldPhotos_201906.shp	Browse
Load style (optional)	e.g.C:/Users/Grant/AppData/Roaming/QGIS/QGIS3\profiles\default/python/plugins\ImportPhotos\photos.qml	Browse
		OK Close



Viewing Photos Using the Import Photos Plugin and File Widget

You can also display photos using a widget in Layer Properties > Attributes Form. If you have used the Import Photos plugin then use this file to display the photos. Select the field with the photo name field ("Name"), then change the widget type to "Attachment". Enter the default path to the image folder, tick "Relative paths" and "Relative to default path" option. Note the central dialog scroll down box can be difficult to locate but note the scroll bars on the right-hand side.

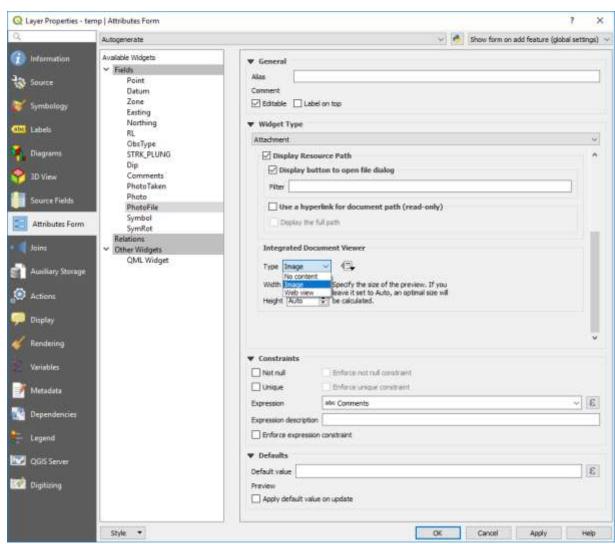




Q Layer Properties - ter	np   Attributes Form ? ×
Q	Autogenerate 🗸 🏓 Show form on add feature (global settings) 🗸
information	Available Widgets V Fields General
X Source	Point Alias Datum Comment
ኛ Symbology	Zone Editable Label on top
(abc Labels	Northing Vidget Type RL the brack
🐂 Diagrams	ObsType STRK_PLUNG Dip Dip
幹 3D View	Comments Default path F:/QGIS/Workshops/Workshop/ProjectFiles/FieldObservations/Images
Source Fields	Photo     Relative paths       PhotoFile     O Relative to project path
🔡 Attributes Form	SymRot
• Joins	Relations     Storage Mode       V Other Widgets     QML Widget       QML Widget     Image File paths
Auxiliary Storage	O Directory paths
😥 Actions	<ul> <li>✓ Display Resource Path</li> <li>✓ Display button to open file dialog</li> </ul>
🧭 Display	Filter
≼ Rendering	· · · · · · · · · · · · · · · · · · ·
8 Variables	Constraints  Not null  Enforce not null constraint
📝 Metadata	Unique     Enforce unique constraint
E Deneration int	Expression abc Comments V E
Tependencies	Expression description
E Legend	Enforce expression constraint
QGIS Server	▼ Defaults Default value
📝 Digitizing	Preview Apply default value on update
	Style   OK Cancel Apply Help

Scroll down the window the central part of the dialog box, past the "Storage Mode" to the "Integrated Document Viewer" section and select "Image". Leave the sizes to Auto.

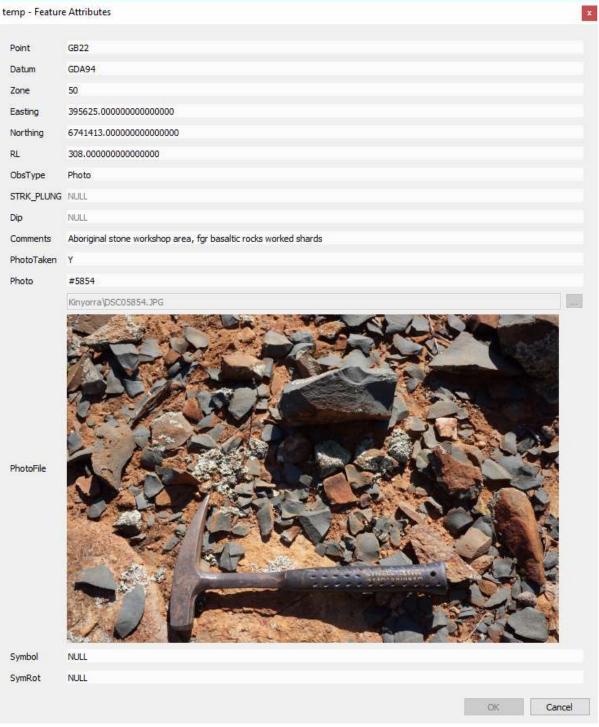




Apply the changes. In the map window, use the "Identify Features" icon to click on a point with a photo (this should open an Identify Features dialog box), then in the identify features dialog box, highlight the point (if you have multiple points in the Identify Features dialog box), open the "form view" (top left icon in the Identify Features dialog box). This will open a new dialog box which may require re-sizing to see the image. If the point with the image is not at the top of the list, select the point and then open the form.







This method of displaying photos allow you to display the comments for example that accompany an image. Note this link is saved with the project and not in the layer properties.



# Viewing Photos by the Action Tab

The second method to display photos is to use the Action option, open the Layer Properties of the layer and select the Action tab. Double click on the Open URL – Open File option.

1								
👸 intérnation 🕺	Туре	Description	Short Title	Action	Capture	Action Scopes	On Notification	Only when editable
Seurce .	Generic	Echo attribute's value	Attribute Value	echo "[% "MV	Ø	Field		
a martine a second	Generic	Run an application	Run application	ogs2ogr -1 "GPK	23	Canvas, Feature		
y symbology	Python	Get feature id	Feature (D	from qgis.PyQt		Canvas, Feature		
🖬 Labels	Python	Selected field's value (identify features t.,	Field Value	from qgis.PyQt		Field		
Diagrams	Python	Clicked coordinates (Run feature actions	Clicked Coordi	from ggis.PyQt		Carivits		
	Open URL	Open file	Open file	[%PhotoPath%]		Canvas, Feature		
3D View	Open URL	Search on web based on attribute's value	Search Web	http://www.go		Field		
Source Fields	Python	List feature ids	List feature ids	from agis-PyCit		Layer		
Attributes Firm	Python	Duplicate selected features	Duplicate select	project = QgsPr.,		Layer		Ø
loine								
Aurilary Starage								
Actions	100 1991		i i					Owate Default Actors
Duplay	F Show in At	tribute Table						

This will open the dialog box shown below.

🔇 Edit Acti	on	×
Туре	Open	✓ ☐ Capture output
Description	Open file	
Short Name	Open file	
Icon		
Action Sco	es	
🗹 Featu	re Scope	
Layer	Scope	
Canva	s	
Field :	соре	
Action Tex		
The conter For the typ	text defines what happens if the action is triggered. t depends on the type. e <i>Python</i> the content should be python code ypes it should be a file or application with optional parameters	
1	<mark>[</mark> %PhotoPath%]	
<		>
abc Photo	Path	∼ E Insert
Execute if	notification matches	
Enable	only when editable	
		OK Cancel Help



In the dropdown box near the bottom of the box, select the field with the photo location and click "Insert" to put the path into the Action Text window. Use the Windows file explorer to navigate to the directory that holds the photos, copy the path and paste it in front of the square brackets that holds the photo file name (as shown in the image below).

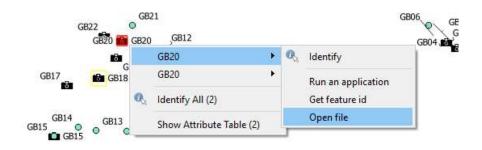
Q Edit Action X
Type Open Capture output
Description Show Photo
Short Name Open file
Icon
Action Scopes
Feature Scope
Canvas
Layer Scope
Field Scope
Action Text
The action text defines what happens if the action is triggered. The content depends on the type. For the type <i>Python</i> the content should be python code For other types it should be a file or application with optional parameters
1       F:\QGIS\Workshop\ProjectFiles\FieldObservations\Images\[%PhotoFile%]         Images\[%PhotoFile%]
The second secon
Execute if notification matches
Enable only when editable
OK Cancel Help

With the "Identify Features" activated for the cursor, right click on a point with a photo and the following will be displayed over the point.

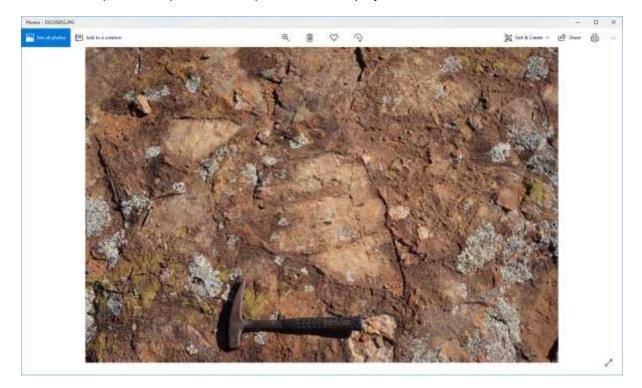




Note there are two photos at this location.



Select the "Open File" option and the photo will be displayed.





temp - Feature Attributes GB22 Point Datum GDA94 50 Zone 395625.0000000000000000 Easting Northing 6741413.0000000000000000 RL 308.0000000000000000 ObsType Photo STRK\_PLUNG NULL Dip NULL Comments Aboriginal stone workshop area, fgr basaltic rocks worked shards PhotoTaken Y Photo #5854 Kinyorra\DSC05854.JPG PhotoFile Symbol NULL SymRot NULL OK. Cancel



### 7.3 Line Data

Line data includes such items as contacts, faults and trend lines and are usually plotted on aerial or satellite imagery overlays. Surface mapping data can be digitised by scanning in the hard copy photo overlay into QGIS (via raster registration) and tracing the linear features, or by direct digitising on screen using the field mapping data as a guide.

When creating a new vector layer to digitise the data, ensure the layer is the correct type, line type for example, has the correct map projection and add the necessary columns to be able to enter the relevant field data for each feature. Save the file with an appropriate file name.

🔇 New S	hapefile Layer						?	×
File name		F:\QGI	S\QGIS3\LinesTe	mp.shp				
File encodi	ng	System	I					•
Geometry	type	°√ <sup>∞</sup> Line	e					-
		Po						
		V Lin	e lygon					
New fie	ld							_
Name								
Туре	abc Text data							•
								- 1
Length	80	Precision						
			Add to fie	lds list				
Fields li	st							
Name	Туре	Len	ath	Precision				
id	Integer		-					
Туре	String	80						
						i 🗟 R	lemove fie	ld
					ОК	Cancel	Help	)

QGIS can automatically assign a unique id numbers for each line after the creation of a group of lines. Open the Layer Properties > Fields, select the id field and click on the field calculator icon and choose "Update existing field", select the id field, select the "row number" operator in the Variables list. Now when you save the file it will allocate a unique id to each feature. Thanks to Chris Franklin for noting this feature. If you are digitising into a Geopackage line file, the id field will be autonumbered.



Only update 0 selected features   Create a new field   Create virtual field   Output field name   Output field name   Output field length   10   Precision   0   Expression   Function Editor     Stores the number   orow_number   ^ * ^ II ( ) 'n'   Search   Current value   Output field length   10   Precision   • Aggregates   > Color   > Conditionals   > Conversions   > Custom   > Date and Time   > Fields and Values   > Fields and Values   > Fields and Values   > Fields and Values   > Math	? ×
Output field type       Whole number (integer)         Output field length       10       Precision         Expression       Function Editor         =       +       /       *       II       ()       In*         Stores the nurrow_number       *       Stores the nurrow.       row_number       *         @row_number       >       Aggregates       *       Current value         >       Color       >       Conditionals       *       Current value         >       Date and Time       >       Fields and Values       *       Fields and Values         >       Furzy Matching       *       General       *       Geometry       *	
= + - / * ^ II () Y'       Search       Stores the nurrow.         @row_number       > Aggregates       > Color         > Conditionals       > Conversions       > Custom         > Date and Time       > Fields and Values       > Fuzzy Matching         > General       > Geometry       > Geometry	•
@row_number       row_number       row.         @ row_number       > Aggregates       Current value         > Color       > Conditionals       Current value         > Conditionals       > Conversions       Custom         > Date and Time       > Fields and Values       Fuzzy Matching         > General       > Geometry       > Geometry	umber of the current
<ul> <li>&gt; Operators</li> <li>&gt; Record</li> <li>&gt; String</li> <li>&gt; Variables</li> <li>row_number</li> <li>layer_id</li> <li>layer_name</li> </ul>	E <b>1</b>

Specific line styles can be added via the top menu Settings > Style Manager option. Geological line styles have been created as \*.xml files and are imported using the "import" option, selectable from just above the Close button in the Style Manager dialog box. Import each style to a category, e.g. Contacts, so they are easier to locate.

<b>X</b>	Style Manager					?	×
	All Symbols	Type here to filter sy					
ľ	Groups topographic GeolContacts	🝸 Marker 🥖	📕 Line 🛛 🏹 Fill	😚 Color ramp			_
	GeolFolds GeolJoints GeolFaults	******		?		^	<b>+</b>
	Ungrouped Smart Groups	contac 1129	contact111	contact1110	contact1111	- 1	
		?		?			
		contact1112	contact1113	contact1114	contact1115		
		?		<b>?</b>	1011030 1000031 1000000		
		contact1116	contact1117	contact1118	contact1119		
		?					7
	₽ <b>₽₹,</b> ▼				1 11100	Clo	se se



Contact the author if you would like to download these style files for contacts, folds, joints, or faults which are based on the USGS symbol sets.

Note that the line direction can be reversed to get the symbols plotting on the correct side of a line, e.g. fault ticks, using the "Reverse Line Direction" in the Advanced Digitising Toolbar (v3.4 or higher).

Line styles can also be created directly via the Style tab of the layer menu. Add an extra layer (using the green plus button) to combine lines and markers. There are numerous styles and options to choose from. Remember to save the style using a qml or "Save as Default" option when finished editing the line style.

You can combine many line styles into the one vector line file, providing you have a column by which the lines can be classified, e.g. feature type "contact".

🕺 Layer Properties - Test_	vector line   Style		? ×	<
🔀 General	E Single symbol			•
	✓			î
(abc Labels	<ul> <li>✓ ● Marker</li> </ul>	•••••••		
Fields	Simple marker			
🞸 Rendering				
🧭 Display	Symbol layer type	Marker line	-	
Actions	Marker placement (     ① with interval 3.000000	Imilimeter •	•	
• ┥ Joins	O on every vertex			
Diagrams	<ul> <li>on last vertex only</li> <li>on first vertex only</li> </ul>			
🥡 Metadata	O on central point			
E Variables	O on every curve point Offset along line 0.000000	Ailimeter	•	

Lines can be edited by first highlighting the layer in the Layers panel and clicking the enable editing icon (pencil). A pencil symbol will then appear next to the layer being edited in the Layers panel. Remember to save your edits when exiting the edit mode. When the line is editable, there will be red crosses on the vertices. Click on the "node" tool (seventh button along from left, next to rubbish bin) then click near a vertex to highlight the vertices, select the vertex you want to move and simply click where you want to move it to. Note QGIS v3 uses "click-click", not "click and drag" methodology. To add more vertices, hover over the line and click on the small red cross that appears. This will create a new point which can then be moved.

See the QGIS User Manual here <u>https://docs.qgis.org/testing/pdf/en/QGIS-testing-UserGuide-en.pdf</u> for up-to-date information on editing. The Testing Version applies to v 3.12.

QW	orkshop_Proje	ct - QGIS									
Projec	t Edit Viev	w Layer	Settings	Plugins	Vector	Raster	Datab	ase	Web M	MQGIS	SCP
		86	1	m 🔹	<b>A</b>	e e		Pg	PR	A	
1		Va Va	• 🎘 ī	Î ~	8	36	$\Leftrightarrow$	abc	۹. ۵	ab ab	abc
	Browser						₽×				
14		10									
	✓ ☆ Favor	ites					^				
$V_{\circ}$	> 📙 F	:\Projects\D	iamonds\Elle	endale							
	> 🚺 F	:\Projects\V	/Α								
Po	👻 📙 F	\QGIS\Wor	kshops\Wor	kshop06							
		D									

# 7.4 Plotting Drill Hole Traces and 3D Drill Data Display

There are two options to displaying drill hole traces on maps. One is to create the horizontal trace and use the "Shape Tools" plugin to plot the lines, or you can use the new "Geoscience" plugin. Both methods are described here.

# 7.4.1 Geoscience Plugin

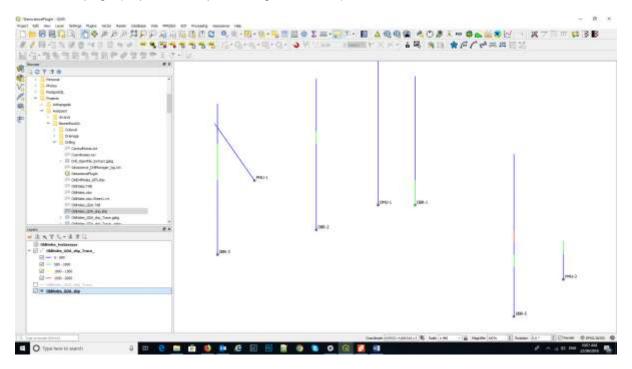
The "Geoscience" plugin (with thanks to Roland Hill) has allowed the plotting of drill hole traces and colour coding of the drill hole traces in QGIS easy. Cross sections can also be created. The drill set up screen allows you to select the collar and survey files. You will need to install the plugins in the Plugin Manager. See the documentation for more details (https://www.spatialintegration.com/geoscience-plugin-for-qgis/).

If your tables have commonly used field names, then the plugin will pick the fields.

🔇 Drilling Setup					?	×
Collar						
		Collar Layer	° OldHoles_GDA_	shp [EPSG:28350]		•
HoleID	abc HoleID 🔹	Hole Depth	1.2 Depth 🔹			
Easting	1.2 East 🔹	Northing	1.2 North 🔹	Elevation	1.2 Zone	-
Azimuth	1.2 Az 🔻	Dip	1.2 Dip 🔹			
Survey	Surve	y Layer (Optional)			•	
HoleID Depth	• •	Azimuth	-	Dip		•
Options						
Down dip i	s negative 🗹		Default section width	50		
Desur	vey length 1m	•	Default section step	50		
				OK	Ca	ncel



A De-survey option calculates the top and bottom points in xyz coordinates, and creates a desurvey layer which shows the trace of the drill hole. The data to be displayed down the drill hole trace needs to be imported as a non-spatial file with hole id, from, to and data fields. Down hole data can be assays, lithologies, or other data. If the downhole data fields are in a csv file format, make sure this is imported vis the Data Source Manager > Delimited Text option so that QGIS interprets the correct field types. The help menu for the plugin describes the workflow and a link to the web page (https://www.spatialintegration.com/).



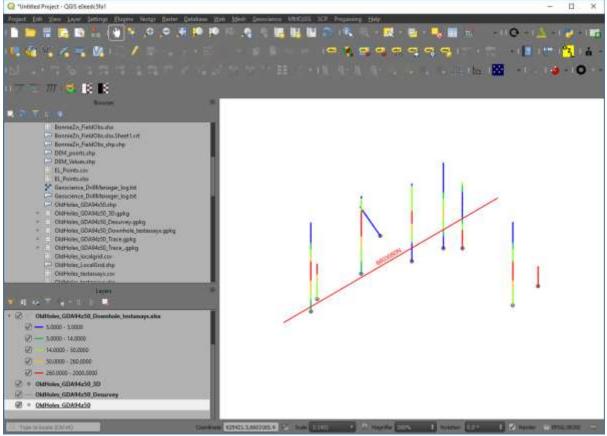
To enable labelling of assay results down hole, create 3D values of the mid-points of the assay intervals. This will then allow the display of multiple assay values by duplicating the assay-mid-point layer and choosing the data to be displayed. To create sample mid-points calculate these using the (x1 + x2)/2 calculation for each of the XYZ from-to fields. To display the lithology as a hole trace colour, make sure you include the lithology layer in the desurvey option, then use the symbology tab to colour by lithology (categorise).

The drill hole traces (the desurveyed layer with the down hole data attached) can be coloured via the "Symbology" tab using any attribute. Note that when you import the downhole data, e.g. assays, make sure the "from", "to" and assay values are recognised as numbers not text.

To create a cross section, use the "Section Manager" and using the "Use Map Canvas" and select the envelope width, draw the required section line.



#### Q \*Untitled Project - QGS exerticities

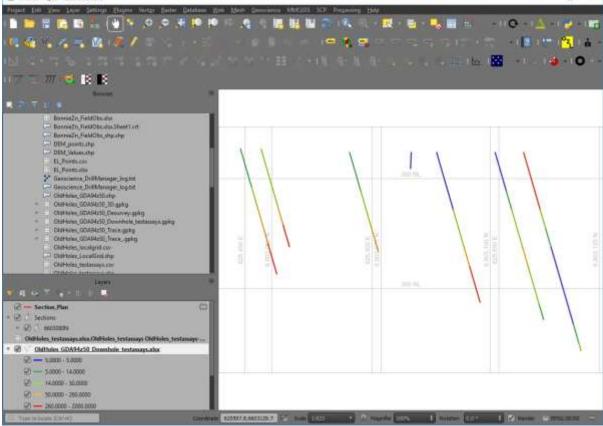


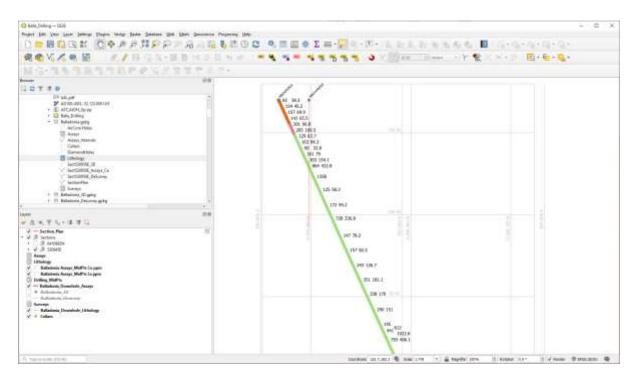
The cross section will be created in a "new" location on the map. To get back to the collar positions, right click on the collars layer and "zoom to layer".



11

#### Q \*Untilled Project - QGS effective!





Cross section plot with the hole trace coloured by lithology and the assay values of two elements displayed using their mid-point locations.



# 7.4.2 Alternative Way to Plot Drill Hole Traces on Plan

Surface drill hole traces can also be plotted on plans using the Shape Tools plugin. To plot drill hole traces, a collar file with collar coordinates, azimuth and horizontal projected distance columns are required. The horizontal distance – trace length – is calculated using the following formula;

Trace length = hole length \* cos(radians(dip))

<b>Q</b> Expression Dialog		? ×
Expression Function Editor		
= + - / * ^    ( ) \n' "Depth" * cos(radians("Dip" * -1) ) Output preview: 67.400000000002	<ul> <li>Aggregates</li> <li>Arrays</li> <li>Color</li> <li>Conditionals</li> <li>Conversions</li> <li>Date and Time</li> <li>Fields and Values</li> <li>Fuzzy Matching</li> <li>General</li> <li>Geometry</li> </ul>	Depth* * cos(radians("Dip* * -1))
		OK Cancel Help

Note if down dip is negative, multiply the dip by -1 (as in the above example).

6	Q OldHoles_GDA_shp :: Features Total: 10, Filtered: 10, Selected: 0											
	/ 26 日 2 日 2 日 2 日 2 日 2 日 2 日 2 日 2 日 2											
	1.2 Distance ▼ = ε □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □											
	HoleID	Datum	Zone	East	North	Az	Dip	Depth	LocalEast	LocalNorth	Distance	
1	DMU-1	GDA	50.000	625555.00	6603090.00	360.00	-60.00	134.80	10125.00	9450.00	67.40	
2	DMU-2	GDA	<b>50.000</b>	626030.00	6603049.99	180.00	-60.00	177.15	10600.00	9410.00	88.58	
3	PMU-1	GDA	<b>50.000</b>	625504.99	6603099 <b>.</b> 99	325.00	-60.00	56.000	10075.00	9460.00	28.00	
4	PMU-2	GDA	<b>50.000</b>	625454.99	6603049.99	360.00	-60.00	55.000	10025.00	9410.00	27.50	
5	PMU-3	GDA	50.000	625629.99	6603059.99	360.00	-60.00	31.000	10200.00	9420.00	15.50	
6	DBR-1	GDA	50.000	625570.00	6603090.00	360.00	-60.00	104.00	10140.00	9450.00	52.00	



Using the Shape Tools plugin (from icon task bar) select the Create icon and the Line tab.

ο Nitro Pro 10 Ω	QGISv3_MinExpIn_draft_201805a.docx Search
- 1	aBb( AABBC AaBbCcl AaBbCcl AaBbCcD AaBbC
e Web MMQGIS SC	P       Processing       Help         Image:
<b>Q</b> Create Shapes	? ×
Input points layer	OldHoles_GDA_shp
Shape Type	● ★ 米 ◆ ★ ● ♥
Azimuth/Bearing field	Az 🔻
Distance field	Distance 🔻
Units of distance	Meters 💌
Default azimuth/bearing	0.0000
Default distance	0
	OK Cancel Apply

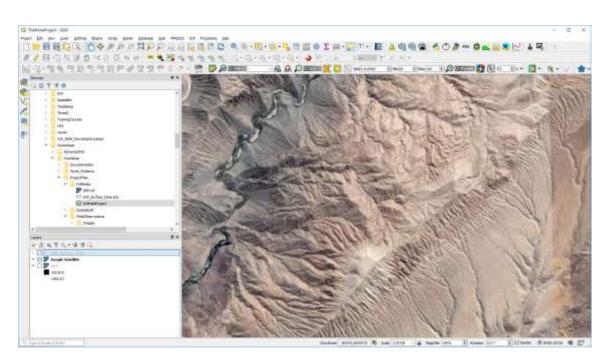
Select the Azimuth column for the hole azimuth and the distance field for the length of the hole trace. Check the units of distance is in metres. The result should look something like below with the hole traces created in a new virtual file – remember to save it with a relevant name.

008. na bit pa juga bang biga nang biga balan bit 196(22) 12 Mujang pit	b
)●根盤協商 西本またが発見分泌治療法の 化生	·图·普·马尔里奇 · 图 Δ· · · · ·
★ 目前的 - 本市市市市市市市市市市市市市市市市市市市市市市市市市市市市市市市市市市市	12-13-13-13 V Came Institut
1日もちおちちおやかちちゃく ちょう ★は ★戸門	進調
Ares an	
LUTIO	
1 Dates	
P D Presso	
* Doby	
D11 dateside also	10
12 Canada Jay Merris at 12 Caluare 2017 00	
IT means lies are py	
1 <sup>10</sup> Television (magnetic field)	
III Shinka juudidi Jaki Jip III Shinka Jiwa Jip din	
14 Datates_bases 146	
10 Tableage.doc 10 Tableage.doc Bast of	
1444 C. K.	
新生産業業長を事業員	
[2] * Stitute Line also [3] Institute, Process play	
	*
Service 12111 Renders 18 10000 Russes & Los 14,007	a manter 100% 2) familier 2.1 * 2 (2) familie di anto-412 (

# 7.4.3 Displaying Drill Hole Traces in 3D

It is also possible to display drill hole data in 3D using the QGIS2threejs plugin. All that is required it to have the 3D coordinates for the sample points to be calculated. This is a fairly basic display option and will hopefully be superseded with the development of the drill hole and cross section module planned for the future. The QGIS2threejs plugin displays the centre points in XYZ coordinate space. The sampling data can be coloured according to any attribute in the file, e.g. assay values of Cu.

To display the downhole data, the 3D coordinates are required for the drill hole traces. In the example below, the XYZ mid-points have been calculated for assay intervals. In the main map window, then DEM, Google Earth satellite image and the file containing the 3D coordinates of surface and drill hole samples have been loaded. The DEM layer and sample layer are not displayed (but loaded).

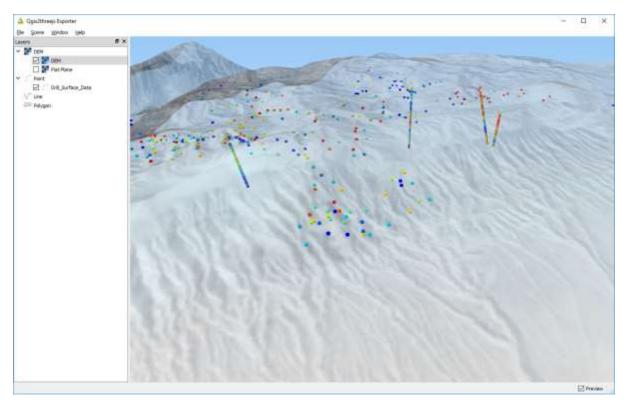


When opening the QGIS2threejs plugin, select the DEM for the elevation and right-click on the samples layer to select the z coordinate.



Object type	Cylinder	•
Z coordina	te	
Altitude	○ Z Value ○ M Value	ion
	1.2 Z 🗸	3
Mode	Absolute	•
<u>S</u> tyle		
Color	Feature style	•
Opacity	Feature style	•
Radius	Expression	•
	10 ~	3
Height	Expression	•
	10 ~	3
Features		
_ O All featu	res	
Easture	s that intersect with map canvas extent	

The 3D image can then be rotated and tilted as desired. The surface satellite image has been set to 30% transparency to be able to see through the surface.



It has been noted by the author that some installations using Win7 may be unstable, and it is recommended to use Win10. Always remember to save your projected regularly.

To select the maximum assay value by drill hole, use the "maximum" function.



Expression	Function Editor			
08		Q. Search	Show Help	expression "Cu_W"+maximum("Cu_W",
	**************************************	Aggregates     Armys     Armys     Color     Conditionals     Conversions     Date and Time     Fields and Values     Fields and Values     Fuezy Matching     General     General     Geometry     Mac 1 arms	*	"DrR_Hole") Recently used expression. Cu_%"=maximum("Cu_%", "Drill_Hol

# 7.4.4 Extracting Maximum Values for Drill Holes

This can be done at least two ways. The first way is to calculate the drill hole statistics and group by drill hole (algorithm "Statistics By Category"). This method requires coordinates for all assay points.

The second method is to use an SQL query on a Geopackage file. Save the collar file and the assay file into a Geopackage, then use the DB Manager to connect to the Geopackage. Open the SQL Window, second icon from left, and then run the SQL query as shown below. Do not forget to add the "geom" column to the query so the resulting layer can be plotted. Each point will have the max value attached.

DB Manager Database Table				- 🗆 ×
and the second se	Export to File			
hoviders	Info Table Pre-	Anna Max Au by Hole	No (Baladonia.gokg) 🗶	
GeoPackage     Belladonia.gpkg     AirCore Holes	Seved g.	ery Max_Au_by_HoleNo =	Name Max_Au_by_HoleNo Seve Delete Load File	s Save As File
Assays Assays Intervals Assays MidPts Collars DiamondHoles Ethology Sect330950E_3D	2 PROM Co 3 Join As 4 ON Coll	llar#	(Anasys,Au_ppm),geom	
V <sup>™</sup> Sect530950E_Assays_Ce V <sup>™</sup> Sect530950E_DeSurvey		vs. 0.006 seconds		Query History
√ <sup>∞</sup> SectionPlan	HoleNo	lax(Assays.Au_ppn g	tom	
Surveys assays-collars	1 158AC001	0.003 b'SP'or	0%s01%s	
III layer_styles	2 188AC002	0.0025 b'GP'or	0%a01\x	
BonnieRockZn_geopackage.g     B NAust_Geol_1M.gpkg	3 188AC003	0.0025 b1GPlos	00x01\x	
III NSW255E.gpkg     III PlantsDeta.gpkg	4 158AC004	0.0025 b'GP\a	10%/01%	
<ul> <li>E terr50_gb.gpkg</li> <li>Oracle Spatial</li> </ul>	V Load as new layer			
PontGIS     SpatiaLite     Writual Leyers	Column with unique		💌 🗹 Geometry column geom	Retrieve columns
	Avoid selecting b	958 J.		Lord
				Canal

### 7.5 Polygon Data

Polygon data is added by creating a new polygon layer (Layer > Create Layer > New Shapefile Layer or New Geopackage Layer), selecting type "polygon", set the projection information and enter the additional fields for the polygon file. Note that if you are creating a Geopackage file, it will auto-number every new feature when digitising.

Workshop_Project - Project Edit View	QGIS Layer Settings Plugins Vector Raster	Database Web MMQGIS SCP Processing Help
	Data Source Manager Ctrl+L Create Layer	New GeoPackage Layer       Ctrl+Shift+N
	Add Layer Embed Layers and Groups Add from Layer Definition File	New Shapefile Layer     New SpatiaLite Layer     New Temporary Scratch Layer
	Copy Style Paste Style	Create new GPX layer

The additional columns might hold data such as geological code, geological descriptions, etc. Remember to select the correct field type (string, number, and precision, etc) and also remember that field names are limited to a length of 10 characters in shapefiles – but not in Geopackage files.

🔇 New Shapefile La	yer				?	×
File name		F:\QGIS\QGIS3\Po	olyTemp.shp			
File encoding		System				•
Geometry type		Polygon				•
		Include Z dimer	nsion	Include M values		
		EPSG:28350 - GDA	A94 / MGA zone 50		-	
New field						
Name						
Type abc Text da	ata					<b>•</b>
		<b>N</b>				
Length 200		Precision				_
		Add 1	to fields list			
Fields list						
Name	Туре	Length	Precision			
id	Integer	10				
Code	String	80				
Lithology	String	200				
				Re	emove fie	ld
			(	OK Cancel	Help	

When creating new objects in a shape file, every new polygon should be assigned a unique "id" number. If you keep these unique, then it is easier to select and alter polygons which can be then selected by their id. Note that digitising into a Geopackage file will automatically number the id field.

To add a new polygon, highlight the polygon layer in the Layers panel, and toggle the editing button (pencil icon). Numerous polygon options are available - see the second row of menu. To add a new polygon, use the Add Polygon Feature icon. Hover over each icon for an explanation of the icon actions. If not all the digitising and advanced digitising options are not show, check the top menu View > Toolbars options.

QGIS can also assign a unique id numbers for each polygon in a shape file after digitising is compete. Open the Layer Properties > Fields, select the id field and click on the field calculator icon and choose "Update existing field", select the id field, select the "row number" operator in the Variables list. Now when you save the file it will allocate a unique id to each feature. Thanks to Chris Franklin for noting this feature.

🛒 Field calculator		? ×
Only update 0 selected features         Create a new field         Create virtual field         Output field name         Output field type         Whole number (integer)         Output field length         10       ♀         Precision       0	☑ Update existing field	<b>-</b>
@row_number	row_number ^ Aggregates Color Conditionals Conversions Custom Date and Time Fields and Values Fuzzy Matching Geometry Math Operators Record String Variables row_number layer_id layer_name V	Stores the number of the current row. Current value: 1
	ОК	Cancel Help

If you want to calculate areas of polygons, add an "Area" column to the polygon table. Note you must set the projection to a metre projection, e.g. UTM, not geographic degree units, and select your units in the Project Properties > General > Measurements dialogue box. You can then populate this field by using the calculation option in the Attribute Table option. Make the layer editable and then use the \$area function to calculate the relevant field area.

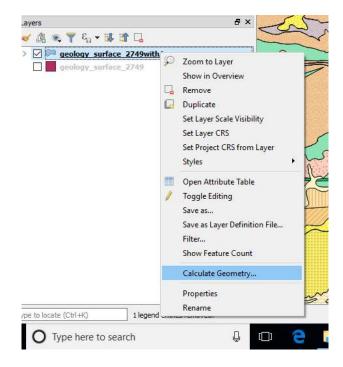
Note that the units of area are set in the Project Properties > General > Measurements dialogue box. These units can be changed on the fly, but you need to refresh the values in the calculated area column to reflect the new units. The area can also be viewed by selecting the Layer



Properties > Display > Field option so that the area can be displayed when you hover the mouse over the polygon when the Info Tool is activated.

Ø	geology_surface_s	:d5112 :: Features to	tal: 906, filtered: 906	, selected: 0	_		×
1	🗾 🗟 🖥	💼   🗞 🚍 💟 I	👆 🝸 🔳 🍫 🔎	8 🛙 📙	1. 🔛 🚍		
1.2	Area 💌 = 8	\$area		~	Update All	Update S	elected
	CODE	JNCODE	Area				^
1	Qc	sd5112;Qc	0.37				
2	P_kl	sd5112;P_kl	0.04				
3	P_kl	sd5112;P_kl	0.08				
4	Qs	sd5112;Qs	0.07				
	D ka	ed5112-0 kc	0.03				×
7	Show All Features						3

Areas can also be calculated via the Calculate Geometry plugin. Right click on the layer name in the Layers Panel and select "Calculate Geometry". The Calculate Geometry plugin allows you to select your area units. Perimeters can also be calculated this way. Make sure you do some check areas to ensure your results are correct.





	roject Edit View Layer Settings Plugins Vector	Raster Database	Web MMQGIS S	SCP Processing Help
Browser & ×	🗅 💳 🖶 🛃 🔂 🖄 🥠 🌮 🔎	P 🗊 🎵 🖗	PARI	6 🖪 🛯 😂 🔍 🍳
	🥖 🖉 🗟 🔁 - 🎘 🛅 🄫 👌 [	7 6 0 4	be 🐐 🔤 aby	abe abe abe be
	Browser	8 ×		
Eavorites				
	😚 🗸 🏫 Favorites	^		

To digitise a polygon, make the layer editable and choose the "Add Feature" polygon icon (4<sup>th</sup> from the left). Click around the polygon using left mouse clicks and finish the polygon with a right mouse click. Nodes can be shifted and added-deleted using the node icon, as per the line editing options.

Creating Drop-Down Lists for Data Entry

A **drop-down list** can be created in QGIS to allow for the attribution of vector items. The use of a drop-down list prevents typographical errors in data entry and can be used to restrict non-standard item names. You can use data from an existing layer or use a csv file for the source of the drop-down box data.

The example below shows a csv file that has been used to apply attributes to the polygon layer.

Lithology_ValueMap.txt - Notepad —	$\times$
<u>F</u> ile <u>E</u> dit F <u>o</u> rmat <u>V</u> iew <u>H</u> elp	
Value,Description	$\sim$
Breccia, Polymict breccia	
Sandstone, Fine grained sandstone	
Shale, Shale	
Granite, Granite	
	$\sim$

In the Layer Properties, select he Attribute Form tab, and change the widget type to "Value Map".



_	Autogenerate	* 🦂 Show form on add feature (global settin
Information Source Symbology	Available Widgets V Fields fd RackType Uthology Relations	✓ General Alas Comment D Editable □ Label on top
Labeis		🐨 Widget Type
Diagrami		Value Map  Combo box with predefined items. Value is stored in the attribute, description is shown in the combo box.
30 View		Load Data from Layer Load Data from CSV File
Source Pields		Value Description 1 Breccia Polymict breccia
Attributes Form		2 Granite Granite
Jone		3 Sandatone Pine grained sandatone
Aution Storage		4 Shale Shale
Display		Add 'NULL' value Remove Selected
Rendering		▼ Constraints
Variables		The four constraint for the four set of the fo
Y ar Niloica		Unique Enforce unique constraint.
Neteclata		bpresion v 8
Dependencies		Expression description
802		Enforce expression constraint
Legend		♥ Defaults
OGIS Server		Default value

The Form Value Relation is used to apply multiple nested dropdown boxes for use in pre-set data entry options. This is useful for entering specific rock types, geological codes or formation names.

The following is from North Road Consulting who ran a crowd funding campaign to get this into the core component of QGIS.

What happens is you have pick lists that can change based on other values. Have a pipe? It can be made out of W, X, Y, and Z. Is it a Water Pipe? It can only be made of X and Z. Wastewater Pipes can only be made of W and Y.

Here is my walk through. I have a point layer and that point layer has a type and a subtype. I stored this all in a Geopackage by the way. The type drives the subtype. You select A and you can only have red or blue. Maybe B is green and white. There are two tables to help with this process tableA is 2 fields: a primary key and a value. TableB has three fields: a primary key, a value, and a foreign key that relates back to Table A. From that you can see Type A can only have a value of Red and Blue. Type D can only be Black and Gray.



		18 ē ≺ »		- 10 S		
	id	type		id	subtype	nk
1	1	Α	1	1	red	1
2	2	В	2	2	blue	1
3	3	с	3	3	yellow	2
4	4	D	4	4	green	2
T Sho	w All Fea	tures, 🛛 🗂	5	5	white	3
			6	6	pink	3
			7	7	black	4
			8	8	gray	4

The point layer has two attributes of concern: type and subtype. Type will be A,B,C, or D. Subtype will be a range of colours that Match the Type picked. If you right click the layer and select attribute forms you can assign a form for data entry. In this case for type the key column is the primary key and the value is the type. Note the Widget type is Value Relation!

⊜	La	yer Properties - wells   Attributes Form		8
Q	Autogenerate	<ul> <li>✓</li> </ul>	Hide form on add feature (global settings)	*
<ul> <li>Information</li> <li>Source</li> <li>Symbology</li> <li>Labels</li> <li>Diagrams</li> <li>Joingrams</li> <li>Source</li> <li>Attributes Fc</li> <li>Joins</li> <li>Auxiliary</li> <li>Storage</li> <li>Actions</li> <li>Display</li> <li>Rendering</li> </ul>	Available Widgets  Fields fid type subtype Relations	<ul> <li>✓ General</li> <li>Alias</li> <li>Comment</li> <li>✓ Editable □ Label on top</li> <li>✓ Widget Type</li> <li>Value Relation</li> <li>Select layer, key column and value of Layer</li> <li>Key column</li> <li>Value column</li> <li>Allow NULL value</li> <li>Order by value</li> <li>Allow multiple selections</li> <li>Number of columns</li> </ul>	column iii tablea • izz id • abc type •	
Variables	@Help Style ▼		✓ Apply X Cancel ✓ OK	;

Lets looks at the subtype field. The key column is the Foreign Key (the part that relates it back to table A). The value column is the subtype. The magic is this – if you look at the filter expression: "fk" = current\_value('type') . See below.

θ	Lay	ver Properties - wells   Attributes Form		8
Q	Autogenerate	- 🛃	Hide form on add feature (global settings)	•
<ul> <li>Information</li> <li>Source</li> <li>Symbology</li> <li>Labels</li> <li>Diagrams</li> </ul>	Available Widgets	✓ General     Alias     Comment     ✓ Editable □ Label on top      ✓ Widget Type		
3D View Source Fields		Value Relation Select layer, key column and value co		
E Attributes Fo		Layer Key column	123 fk	
Joins Auxiliary Storage Actions		Value column           Allow NULL value           Order by value           Allow multiple selections	əbc subtype 👻	
<ul> <li>Display</li> <li>Rendering</li> <li>Variables</li> </ul>		Number of columns           Use completer           Filter expression	1	
<ul> <li>Metadata</li> <li>Dependencie</li> <li>Legend</li> </ul>	Image: Style +	"fk" = current_value('type')	✓ Apply ¥ Cancel ✓ OK	•

The foreign key equals the value of the type widget. When you add a point, you'll see the type drives the subtype.

⊜	wells - Feature Attributes	8
<u>A</u> ctions		
fid	Autogenerate 🚳	
type	A -	
subtype	red 🔹	]
	≭ <u>C</u> ancel ✓ <u>O</u> I	<

In summary, if you select type A, you will only get an option to select colours red and blue.

Value Maps and Form Value Relations are useful tools for adding data. For geological data, you might have a list of rock classes (igneous, sedimentary, etc) and a list of lithologies (basalt, granite, sandstone, etc) for polygon data, or observation type (bedding, joint, vein, etc) for point data.



# 7.6 Geological Symbols and Geological Patterns

Geological symbols can be either specific geological fonts (True Type Fonts) or SVG (scalable vector graphic) symbols. Geological symbols can be downloaded from the internet for free use in QGIS (https://github.com/GISsimbology/symbols). On Windows systems, geological symbol fonts need to be installed by right-clicking on the font file name and selecting Install. Note that some fonts, particularly the ESRI fonts, are proprietary and not free use.

### **Geological Fonts**

Four font sets are available from Geoscience Australia and include ESRI Geology AGSO 1 to 3 (esri\_500.ttf, ESRIGA\_0.ttf and ESRIGA\_4.ttf), GeoscienceMining (GEOSM\_.ttf) and MiningFossilTopo (MINIFT\_.ttf). Other geological and cartographic fonts may also be available depending upon what other software you may have installed (previous MapInfo or ESRI fonts may already be installed on your system and could also be used). Fonts installed on Windows can be accessed via the Windows run box and typing "fonts".

Geological font symbols are accessed via the Layer properties > Style tab and choose the symbol layer type as "font". All the fonts installed on your computer will be accessible and you will need to search through the installed fonts to find the relevant font file and then the relevant font symbol. Adjust the font size to suit.

🔇 Syr	mbol	Sele	ector														?	×
Image: Second																		
÷																		
Symbol	l laye	r typ	e For	nt ma	rker													•
Font	famil	y	Mini	ngFo	ssilTo	ро											~	
Size			7.20	0000	)											Millimeter	•	e.
Fill co	olor																	e,
Strok	colo	or															-	e.
Strok	æ wid	lth	No s	troke	2											Millimeter	•	e.
Join :	style			Beve	1												•	¢.
Rota	tion		0.00														÷	<b></b>
			x 0.		000											<b></b>		_
Offse	et		y 0.	0000	000											Millimeter	•	¢.
			VCe	nter													•	e,
Anch	or po	int	HCe	nter													•	e.
U	U	U	U	U	U	U	U	U			Ш			U	Ш		^	
U	U	U	U	U	U	U	U	L	U	U	L	U	U	L	L			
	•	0	•0	*	~	4	⊗	8	~	⊛	×	*	×	×	8			€.
•	¢	•	⊅	۰	ø	*	•	۶	*	☀	÷	•	*	¥	8			
ĕ	¥	¥	ă	ĕ	۵	*	*	0	•	•	-	*	*	*	Ŷ		¥	
🗹 Enable layer 🛛 🚍 🔲 Draw effects 🔯																		
																	(	ОК

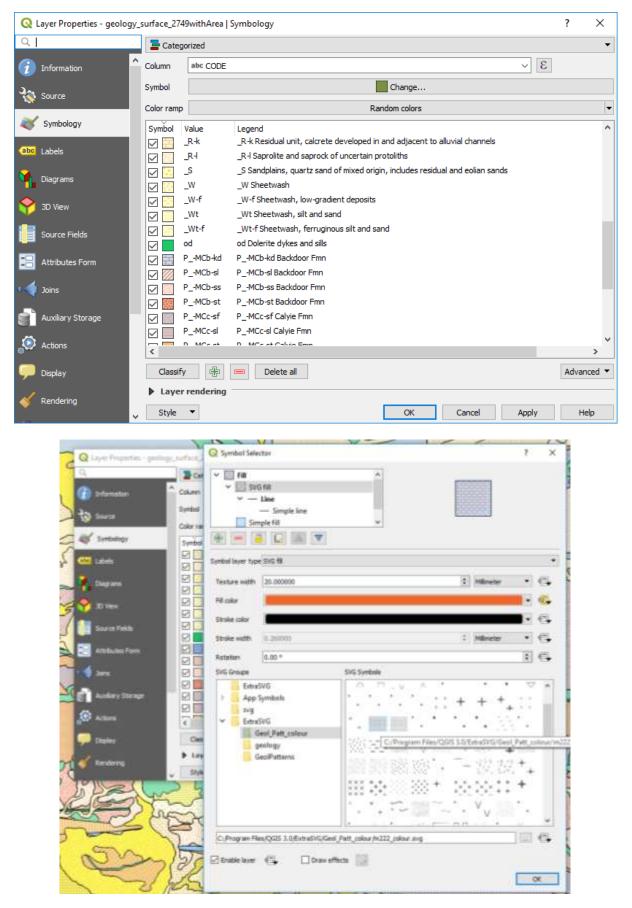
# SVG Symbols and Patterns

A selection of svg geological pattern files shown in the appendix were initially sourced from Stefan Revets' page (<u>https://sourceforge.net/projects/qgisgeologysymbology/files/?source=navbar</u>) and modified to allow the overprint pattern to be coloured. Also see this page <u>https://github.com/afrigeri/geologic-symbols</u>. An alternative location for geological svg patterns is <u>https://github.com/BC-Consulting/FGDC-4-QGIS</u>. The NSW geological survey also supply symbols for their state wide geological maps (<u>https://search.geoscience.nsw.gov.au/product/9232</u>) and are based on the USGS FGDC symbols and the symbols are supplied in folders based on the FDGC documentation.

🛃 🚽 ∓   F:\QGIS\Fe	onts_Patterns\QGIS_Symbols_NSW\QGIS_Symbols\	USGS-StrucPts	– 🗆 ×
File Home Share	View		~ <b>(</b> )
	X Move to → X Delete → I Tor	🗹 🏹 🔜 si	elect all elect none
Pin to Quick Copy Paste access	Copy to V Rename New folder	Properties 😽 📑 Ir	wert selection
Clipboard	Organize New	Open	Select
← → • ↑ 📙 « QG	ilS_Symbols > USGS-StrucPts >	✓ ひ Search USG	S-StrucPts 🔎
A Quick access	Name	Date modified	Type Si:
Desktop	usgs02_faults	1/12/2018 10:04 AM	File folder
	usgs03_geophysical	1/12/2018 10:04 AM	File folder
👆 Downloads 🖈	usgs04_joints	1/12/2018 10:04 AM	File folder
🖆 Documents 🖈	usgs05_folds	1/12/2018 10:04 AM	File folder
📰 Pictures 🛛 🖈	usgs06_bedding	1/12/2018 10:04 AM	File folder
DATABASES	usgs07_cleavage	1/12/2018 10:04 AM	File folder
Images	usgs08_foliation	1/12/2018 10:04 AM	File folder
MinExpIn	usgs09_lineation	1/12/2018 10:04 AM	File folder
Workshop	usgs10_fossils	1/12/2018 10:04 AM	File folder
	usgs11_geophysical	1/12/2018 10:04 AM	File folder
o Creative Cloud Fil	usgs12_fluvial	1/12/2018 10:04 AM	File folder
😻 Dropbox	usgs13_glacial	1/12/2018 10:04 AM	File folder
	usgs14_periglacial	1/12/2018 10:04 AM	File folder
OneDrive	usgs16_eolian	1/12/2018 10:04 AM	File folder
💻 This PC	usgs17_mass_wasting	1/12/2018 10:04 AM	File folder
3D Objects	usgs18_volcanic	1/12/2018 10:04 AM	File folder File folder
Aorus D	usgs19_natural_resource	1/12/2018 10:04 AM 1/12/2018 10:04 AM	File folder
÷ -	usgs20_hazard	1/12/2018 10:04 AM	File folder
Desktop	usgs21_earthquake usgs22_plate_tectonic	1/12/2018 10:04 AM	File folder
Documents	usgs23_uplift_collapse	1/12/2018 10:04 AM	File folder
👆 Downloads	usgs24_impact	1/12/2018 10:04 AM	File folder
Grants iPhone	usgs25_planetary	1/12/2018 10:04 AM	File folder
b Music	usgs26_hydro	1/12/2018 10:04 AM	File folder
Pictures	usgs27_weather	1/12/2018 10:04 AM	File folder
🚽 Storage (NAS (sa	usgs30_topo	1/12/2018 10:04 AM	File folder
Videos			
Local Dick (C)	<		>
26 items			

SVG files can be stored anywhere but the default location for the standalone install option is the Program folder, for example C:\Program Files\QGIS 3.12\apps\qgis\svg. Note that if you install QGIS via the OS4Geo option, the svg files will be located in the "C:\OSGeo4W64\apps\qgis\svg" for the long-term release version, or the "C:\OSGeo4W64\apps\qgis-dev\svg" folder for the development version. It is recommended that this folder is used for the additional geological symbol and patterns so QGIS will find these by default and you will not require to specify and additional svg directory location. If you upgrade your version of QGIS, you may need to copy your extra svg files back into this folder.

To use the geological patterns, for example, you would categorise the layer based on a geological code and then allocate each code a specific pattern fill and background polygon layer. The image below shows the result of "Categorising" the geology and colouring each geological code type.





Note that you have options for size and rotation of the patterns or symbols. The SVG symbols and patterns have discrete file names which can be used to automatically assign symbols and patterns in the "Data Driven Override" of the layer properties file window.

SVG Groupe		SVG Image									
	fuod prokupy GeuPatterns gpicane				·  -		:	K	F.		
C:PROGRA	-1/QGES2~1.58	heen/aps/.hvg//Ges	Patterra/n 29.a	g.			G . (A)	-	TRAC		
• Layer res		1					Casta defined and Description		A.		
aver blending	reole	Normal.					Attraction fails	- 1	15 XX		
antire blende	ing mode	Normal					Pield type: string		id (Jaknown Type)		
Dian effec	0x						Deremer		Datum (string)		
Control fee	iture rendering u	-ter					Variable Edit	•	Zone (storg) Feature (storg)		
Shie *				OK	Cancel	Acety	Patte		Connects (string)		

Coloured backgrounds can be added to the polygon fill by adding another layer in the Symbol Selector dialog box. Add a new symbol layer by using the green plus symbol and move it to the bottom using the down arrow key below the display box.

🕺 Symbol sele	ector			?	×
L.	/G fill - Line Simple line mple fill				
Symbol layer typ	e	Simple fill			•
Fill				•	€.
Outline					e.
Fill style	Solid			-	e.
Outline style	Solid Line			-	€.
Join style	Bevel			-	€
Outline width	0.260000	⊠	▲ Millim	eter 💌	e.
Offset X,Y	0.000000		Millim	eter 🔻	
	0.000000		▲ ▼		
Draw effects	1				tin the second s
				(	ОК

For assistance in selecting colours, go to the "Color Brewer" web site (http://colorbrewer2.org) where there is a vast array of colours and their specifications available. Colour specifications can be specified in QGIS via their hex, RGB or CYMK number.

If you have favourite fill styles, these can be saved as "Favourites" which are then quickly accessible via the Symbol Selector dialog box.

Q Symbol Selector			1 ×
The set of the set	Î		
in a second seco		Lee	•
Lotar - Factor			benikory -
Archese Dr. Bancha Bernah		ter best, tester bask	
pattant pida ampia bica f ampia pa	er angle tel 18		
1		CN Orest	Manual *

The svg fills can also be "embedded" into the file via the "Advanced" options and this allows the files to be used by other users that may not have the relevant svg files installed on their machines.



Smb	nyiki bise		
Control C		4 (mass)	terpolation per tools
Anite State and		l (storer - 4	noter creation
Antice My Country My Country My Country My Country My Country		∧ ≜ ∧ <b>**</b>	intergeneerd Scriegeneertry inter-selection excelosition excelosition excelosition excelosition excelosition excelosition DAL ball BASS BASS BASS BASS BASS BASS BASS BA
		Er.	en Fin. nod Fin. nod Fin.

# 7.7 Geological Line Styles

Linear geological features can be displayed by manually editing the line style in the Layer Properties > Style tab, or by using line styles set up in the top menu Settings > Style Manager window. Full details of how to construct various line styles can be found in a comprehensive document put out by the USGS and can be found here <a href="https://ngmdb.usgs.gov/fgdc\_gds/geolsymstd/fgdc-geolsym-all.pdf">https://ngmdb.usgs.gov/fgdc\_gds/geolsymstd/fgdc-geolsym-all.pdf</a>.

Style (\*.xml) and symbol (svg) files can be found here at Stefan Revett's site <u>https://sourceforge.net/projects/qgisgeologysymbology/files/</u> and in the NSW QGIS Symbols in the "\QGIS\_Symbols\FDGC\_GeologySymbology\svg" folder. Line styles include geological contacts, faults, folds, and joints and are based on the FDGC symbology.

On the main menu, go to Settings > Style Manager and select the Import option in the small box down on the lower left-hand side of the dialog box (looks like two blue lines with dots). Save each group with a name ("tag") so that you can easily identify which line style group you want to display.



Style Manager				?	' ×
Favorites All Symbols	° Marker V <sup>∞</sup> Lin	e 🏳 Fill 😽	Color ramp		
' Tags Colorful Grayscale QGIS 2 Showcase	contac1129	contact111	contact1110	contact1111	,
Topology contact fault	?		?		
fault fold joint topographic Smart Groups	contact1112	contact1113	contact1114	contact1115	
	?				
Add tag Add smart group	contact1116	contact1117	contact1118	contact1119	
Modify group 🔻					
< Import / export 🔹	<b>₽ </b>		Filter syr	nbols	
				Close	Help

Navigate to where your line styles are stored. Import each one (e.g. contact, fold, fault and joint). Remember to add a "tag" so they can be easily selected in the Style Manager.

In the Symbol Selector dialog, select the "Symbols in group" drop-down box, select GeolContacts (or whatever you called this line style group). Select the line style you want and hit OK. This method can be used to modify all the other line styles. To save these line styles remember to save the Style as default in the main Style tab window (under Style > Save as Default).

If you have multiple line styles, make sure you have a column in your table to allow the line types to be "Categorised" so that specific line types can be allocated to different line types.

🕺 Symbol sele	ctor						?	×	
✓ Ma	Marker ∨ SVG mark	cer		~	Ų	~~~~~~	~-		
Unit Milimeter Transparency 0% Color Width 2,80000									
Symbols in group	GeolContacts						∼ Op	en Library	
errer		\$		?		?			
contac1129	contact111	contact111(	contact111	contact1112	contact111:	contact1114	contact1115		
?-		2		<u> </u>					
contact1116	contact111	contact111{	contact1119	contact112	contact112(	contact112	contact1122		
			~~~~?	~~~~	~~~~		******		

Any of these line styles can be edited manually by selecting the layer in the top window. Note that you change the line direction, e.g. fault ticks on other side, by using the "Reverse Line Direction" in the "Advanced Digitising Toolbar".

# 7.8 Labelling Features

Features can be labelled via the Labels tab in the Layer Properties window for each layer. There are many ways to place labels and format them. I will give some examples typically used in geological applications below but there are many other options which you are encouraged to explore (see QGIS User Guide – section 12.3.3 and Graser and Peterson 2016 – Part 2). Note that you can have the labelling panel open and docked by pressing F7, and when you make changes to the labels these are immediately displayed in the map widow. This method removes the requirement to click OK/apply to see changes.

### Labelling points

The Labels tab shows a variety of labelling options such as font type and size, whether you want a halo around the label (buffer) which is useful when the labels are over a coloured background. The Formatting section allows you to specify multi-line labels and word wrap options. The Placement options allow you to test different ways to display your labels.

Q Layer Properties - mineral_drillholes   Labels ? X							
Q	📾 Show labels for this layer	-					
🥡 Information	Label with abc holeid	3 ~					
Source	▼ Text Sample Lorem Ipsum	^					
ኛ Symbology							
(abc) Labels	Lorem Ipsum 🐤 1:6,994 🗸 🔊	✓					
Magrams	abc Text Text	<u>^</u>					
🔶 3D View	+ab c Formatting Font MS Shell Dlg 2	•					
Source Fields	Background Style Regular						
Attributes Form	Placement Size 10.0000	e					
• Joins	Points	e,					
Auxiliary Storage	Color	e.					
Actions	Opacity 100.0 %	<b>₽</b> ,					
C Display	V Style V OK Cancel Apply	Help					

Note that to manually move individual labels, use the "Move Label or Diagram" option in the labelling toolbar.



atabase	Web	Geoscience	MMQGIS SCF	Processing	Help
QE	P	RAI	<u>. II II (</u>	2 0. 0	• 🔣 • 🚍 • 🌄 🛅 📓
3	1	abc 🐴	aba aba	abc abc abc	6-9-9-9-
n de	ÇĐ	₹ (? •	I ML Me M	Move Lab Diagram	el and

There are three placement options and it is suggested to test these options for each application. The "Cartographic" option (points only) will move labels to suit the display. If you need a "halo" around the labels, use the Buffer option. To rotate all the text labels, use the Labels > Placement > Offset from point > Rotation option. This option is useful for labelling drill holes along grid lines.

Q Layer Properties - mineral_drillholes   Labels ? X						
٩	📾 Show labels for this layer 💌 🍖					
🥡 Information 🔷	Label with abc holeid					
Source	▼ Text Sample					
Symbology	Lorem Ipsum					
abc Labels	Lorem Ipsum	↓         1:6,994         ✓				
Diagrams	abc Text Placeme	nt				
幹 3D View	*ab Formatting abc Buffer <ul> <li>Car</li> </ul>	Cartographic      Around point      Offset from point				
Source Fields	Background					
🔡 Attributes Form	•	a 2.0000 🚳 🔁 🚍				
• 📢 Joins	Rendering	Millimeter				
Auxiliary Storage		e offset from From point				
Actions						
🧭 Display		ta defined				
🞸 Rendering		inate X ( Y (				
Variables	Alignm	ent horizontal (= vertical (=)				
📝 Metadata	▼ Pri					
Dependencies		High 🖶				
Egend						
🕎 QGIS Server 🗸	Style 🔻	OK Cancel Apply Help				

Multi-attribute labels can be created using the expression editor. Note the "Output Preview" in the lower left of the dialog box which shows how the labelling will appear.



🕺 Expression dialog	
Expression Function Editor	
= + - / * ^    ( ) '\n'	
"FEATURE"    '\n'    "STRIKE"    '/'    "DIP"	
<	>
	-
Dutput preview: 'Bedding, showing strike and dip 45/58'	

🕺 Layer Properties - WARC	)X_Bow_shp   Labels		?	×
🔀 General	Show labels for this l	ayer	•	<b>\$</b> ::
😽 Style	Label with "FEATURE"   Text/Buffer samp	'\n'    "STRIKE"    '/    "DIP"  e	~	3
(abc Labels	Lorem Ipsum			^
Fields				
🎸 Rendering		•		×
🧭 Display	Lorem Ipsum	Placement		
Sections	+ab < c Formatting	Fidement		^
• Joins	abc Buffer	$\bigcirc$ Cartographic $\textcircled{O}$ Around point $\bigcirc$ Offset from point		
Diagrams	Shadow			
🥡 Metadata	Placement Rendering	Distance 0.0000	•	
Variables		Millimeter	•	
Legend		Quadrant 📳		
				_
		▼ Data defined		
		Coordinate X (= Y (=		
		Alianment horizontal (= vertical (=		~
	Style 🔻	OK Cancel Apply	He	lp



An example is shown below displaying the structure type with strike and dip.

Heb							
3 0, 0, - 🖪 - 8, - 🔩 🔳	E Σ =· . I· I	2					
いる.の.の感気.~~~		0 7 8 8 7 8	9998	800	99.99	医学	e - 🛃
		100 C 💭 O Interna		\$ 200	•		0 3 1
			Bedding, sh \331,0	owing strike an	d dip		
Bodding, showing strike and 351/11	de Rife	d do Bedding, showi 65/0	ng strike and dip				
		Bedding, showing strike and d 357/0	la l				
	Bedding, showing strike and dp 28/0						
	Bedding, showing strike and dip 40	Beating, shaving strike and a 22/0	άρ.				
	1	Beckling, sh	owing strike and d	lo -			
				14.0	stding, showing 17/0	strike and d	¢.

In the Layer Properties > Label there is an option to add "call-outs" where lines can be automatically created to join a point to a label.

Q Layer Properties -	NoonMagTargets   Labels						×
Q	Gingle labels						-
<ul><li>Information</li></ul>	Value abc Name						3 *
Source	Text Sample						
🐳 Symbology	Lorem Ipsum						<b>_</b>
(abc Labels	Lorem Ipsum				<b>1:54190</b>		•
Magrams	abc Text	Callouts					
🔗 3D View	<a>e Formatting</a>	Draw callouts					
Fields	Buffer Background	Style		Simple lines			•
🔡 Attributes Form	Shadow	Line style				. /	
Joins	Callouts	Minimum length	0.000000		\$	Millimeters	• <b>•</b>
Auxiliary	Rendering	Offset from feature	0.000000		\$	Millimeters	• 🗐,
Storage		Offset from label area	0.000000		\$	Millimeters	• 🗐,
Actions		Draw lines to all fea	ature parts				€.
🧭 Display							
🞸 Rendering							
🗧 Variables							
📝 Metadata	• Style •		(	ок	Cancel	Apply	Help



Labelling drill holes with collar names and depths of holes can be achieved using the expression editor in the labelling tab. Note to check the Preview to ensure your syntax is correct.

"Drill\_Hole" || ' - ' || maximum ( ( "Hole\_Depth") ,group\_by:= "Drill\_Hole" ) || ' m'

Expression	Function Editor			
	10 11 12	Q. Search	Show Values	group field
Hale De	•    /    •    •          (    )	'In' Value Aggregates Arrays Color Conditionals Conversions Date and Time Fields and Values NULL	-	Double-click to add field name to expression string. Bibth-Click on field name to open context Values G. Search. All Unique 10 Samples
event BC	17PAW0001 - 174 m	** Drill_Hole		

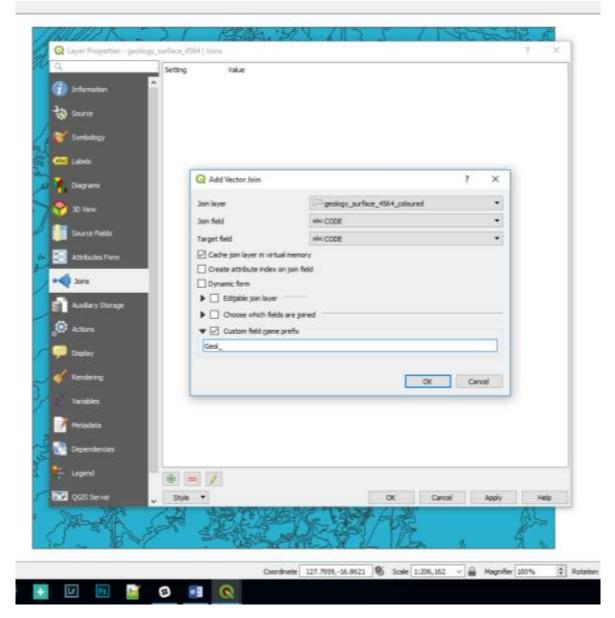
## 7.9 Joining Spatial and Non-Spatial Data

Joins are done via the Layer Properties dialog box. Open both the spatial file (i.e. the layer that is spatially located) and the non-spatial file (without spatial reference). The non-spatial file can be opened by the spreadsheet or text file import and with "No geometry" selected. The non-spatial layer will appear as a spreadsheet icon in the Layer properties panel. Select the spatial layer in the Layers panel you wish to join, open its Layer Properties > Join tab, press the green plus to add a new join, select the join fields (which must have data in common in both layers to allow it to join).

The example below (Bow 100k map sheet) shows the join of the geological polygons with the geological descriptions (from an Excel file) for each of the geological codes for the polygons.

Individual fields can be selected for the join using the "Choose which fields are joined". Select the "Custom field name prefix" and change it to a short abbreviation, remembering that shape files can only have a maximum field name size of 10 characters and this may cause problems later as field names may have been truncated.





After clicking "Apply", examine the join results by opening the layer attribute table and ensuring the join has been successful.

	AREA	PERIMETER	GEDOBS_	GEOOBS_JD	CODE	INCODE	Geol_INCODE	Geol_NARRATIVE	Geol_COMPI
	0.00002	0.02937	2		Cros	4564;Czsa	4564;Cma	Alluvium and colluvium - partly con	
	0.00026	0.08337	1		ium - partly conso PLIPP	idated clay, sit and s 4564PLgPW	and; pebble, cobble a ISS4;PCgPW	tid bouider conglomerate biotite monzogranite	Lamboo Comp
1	0.00001	0.01472	4	106	PLCI	4564,91.0	4564;PLCI	LISSADELL FORMATION: fine- to c	
	0.00058	0.26652	5	100	Czs	4564)Czs	4554;Czs	Abuvium and colluvium - partly con	
	0.00001	0.01444	6	89	OCg	4564,0Cg	4564;DCg	GALLOPING CREEK FORMATION: F	
	0.00024	0.09028	7	94	Can	4564;Czn	4964;Cm	Unconsolidated and partly consolidated sandplain deposits	
	0.00012	0.07798	.0	103	DCg	4564;DCg	4964;DCg	GALLOPING CREEK FORMATION: F.	
	0.00009	0.04495	9	93	Czsa	4564;Czsa	4564;Czsa	Alluvium and colluvium - partly con	
	0.00222	0.64653	10	1035	OCg	4564;0Cg	4564;DCg	GALLOPING CREEK FORMATION: 1	
0	0.00000	0.00855	11	101	Cas	4564)C24	4564;Cas	Alluvium and colluvium - partly con	
1	0.00000	0.00542	12	102	Czsa	4564;C258	4564;Czsa	Alluvium and colluvium - partly con	
2	0.00122	0.24683	13	88	PLCI	4564,RLC	4564;PLCI	LISSADELL FORMATION: fine- to c	
3	0.00123	0.25990	14	82	Ea	4564,Ea	4564;Ea	ANTRIM PLATEAU VOLCANICS: m	

To make this a permanent join, use the "Save As" option by right-clicking on the layer name in the layers panel, and saving the file as a new shapefile layer. If you do not save this joined file, the join will not be permanent, as it is a virtual join only. You may also need to copy the polygon styles from the original shape file to the new spatial file. To do this, right click on the layer name, go to Styles > copy styles > all style categories, then right click on the layer where you want to appy these styles, and paste > paste styles > all style categories. Remember to use the layer properties > Style tab and "save as default" to create a qml file that will automatically apply these styles when the file is re-opened.

## 7.10 Geological Legends

Geological legends in QGIS can be created but the program really needs a plugin to create a geology specific style of legend. Geologists use QGIS very differently to the majority of QGIS users and this would need to be pushed by the geoscience user community. Detailed geological information, e.g. formation names, can be imported into the legend using the Legend tab in the Layer Properties > Legend tab. Note that you may have to join the geological information to the geological polygons, as in the case of GSWA geological data, before you create a more detailed legend.

Q	Layer Properties - Geol_274	9_details_col   Legend	? ×	(
Q		▼ ✓ Text on symbols		
	Information	Symbol Text	^	ן ךי
	Information	_W Sheetwash unit		
2	Source	_W-f Sheetwash unit		
	,	Wt Sheetwash unit		
~	Symbology	_Wt-f Sheetwash unit		
		od Dolerite dykes and sills Mafic intrusive unit		
abc	Labels	PMCb-kd Backdoor Fmn Backdoor Formation		
		PMCb-sl Backdoor Fmn Backdoor Formation		
M.	Diagrams	PMCb-ss Backdoor Fmn Backdoor Formation		
		PMCb-st Backdoor Fmn Backdoor Formation		
Y	3D View	PMCc-sf Calyie Fmn Calyie Formation		
-		PMCc-sl Calyie Fmn Calyie Formation		
	Source Fields	PMCc-st Calyie Fmn Calyie Formation		
8	Attributes Form	Text Format Set Labels from Expression	•	
•◀	Joins	▼ Embedded widgets in legend		
e'i	Auxiliary Storage	Available widgets Used widgets		
٩	Actions	Opacity slider		
-	Display			
Ý	Rendering			
3	Variables			
2	Metadata			
	Dependencies			
÷	Legend			
	QGIS Server	Style	Help	

In the window above, the label text has been selected using the "Set Labels from Expression" which then opens the expression builder window (below).

<b>Q</b> Expression String Builder		? ×
Expression Function Editor		
= + - / * ^    ( ) ''n' "G_UNITNAME" Output preview: 'Backdoor Formation'	Q. Search         G_NUMBER_         G_UNITNAME         G_GSWASTAT         G_RANK         Values         Q. Search         all unique         10 samples         'Alluvial unit'         'Backdoor Formation'         'Colluvial unit'         'Colluvial unit'	group Field Double-click to add field name to expression string. Right-Click on field name to open context menu sample value loading options. Notes Loading field values from WFS layers isn't supported, before the layer is actually inserted, ie. when building queries.
		OK Cancel Help

Q "AIF × Edi. ⑦伊以後及四馬にあったる局部局 単合単類の ●●近点目に注意 時後を) pro peo peo pao pao pao peo peo peo peo peo peo peo peo Layout Dens ä Backdoor Formation P\_-MCb-sl Backdoor Fmn N N E (Legend) 8 E Her.I Backdoor Formation P -MCb-ss Backdoor Fmn Backdoor Formation P\_-MCb-st Backdoor Fmn Catyle Formation P -MCc-sf Calyle Fmn Iters People fee # > Calyle Formation P\_-MCc-sl Calyie Fmn 1 Calyle Formation P\_-MCc-st Calyie Fmn Ugarari Formation P -MCi-sl Calyie Fmn 8 Discovery Formation P -MEd-cl Discovery Fmn Kiangi Creek Formation P -MEk-sl Kiangi Ck Fmn Kiangi Creek Formation P\_-MEk-st Kiangi Ck Fmn D MELCHINARTE Emp s: 279.665 mm - 551.25 mm 201.0% page 1

The legend will be displayed in the print layout window as shown below.

Work is in progress to automatically assign geological patterns and descriptions from the GSWA polygon colouring information and pattern fills with the vector data for their digital maps.

# 7.11 Importing and Exporting GPS Data

To import points and tracks from a gpx file collected using a GPS unit, use the menu item Vector > GPS > GPS Tools, select the gpx file to upload and the data type (tracks or waypoints). After you have imported the point or track file to QGIS, save it as a shape file to enable editing of this data. If this option is not available in your Vector tools, turn it on in the Plugin Manager.

<b>Q</b> GPS Tools					?	×
Load GPX file	Import other file	Download from GPS	Upload to GPS	GPX Conversions		
	Workshops\Workshop(	08_v3\ProjectFiles\GPS\7	Trks_20141113.gpx		⊠	
r cutare types	Routes					
	☑ Tracks					
			OK	Cancel	He	elp



To send data to your GPS device, use the POI ("point of interest") plug-in. The plug-in allows you to select the layer you want to upload, the column containing the point names (or ids) and an optional comments column (up to 254 characters). The plug-in creates a gpx file which can then be easily uploaded to your gps via a direct file transfer or GPSBabel (for older models). The projection of the layer does not need to be in WGS84. Select the folder where you want the file to go, select the layer to export as a gpx, enter the filename in the "Default Category Name" box, then select the column to be used as the "POI" name. The "Optional Description Column" can be used to upload other columns such as a site description into the "Comment" and "Description" fields of the gpx file.

🕺 POI Exporter	?	×
Select Output POI Folder		
F:\Temp\GPSFiles		
Output Format GPX		-
Input Vector Layer		
FieldLocs_2017		-
Select Category Column (Optional)		
[Use Default Category]		•
Default Category Name (This will become the file name)		
ExportPoints		
Select Column to be used as the POI Name		
Point		-
Default POI Name		
POI		
Optional Description Column		
Comments		-
OK	С	ancel

If you have problems with the gpx files, you may have to download the free "GPSBabel" utility (<u>https://www.gpsbabel.org/</u>) or purchase the GPS Utilities program (<u>http://www.gpsu.co.uk/</u>, US\$60). The GPS Utilities program has a vast array for GPS formats that you can read or write. After you imported the GPX file into QGIS, remember to save the GPS layer as a shp file to allow for editing of the data.

Note that when uploading points to a GPS via a gpx file, you may need to save the shape file in a WGS84 (Lat/Long) projection and add two new text fields for "Name" and Desc". Note that to include a long description in the DESC (Description) field, such as an outcrop observation, ensure you make the string length to be 254 characters. Note that some GPS units will only display a certain number of characters, for example the Garmin etrex Vista C only displays 30 of the 254 characters. Copy your point id's from your location reference column into the "Name" field using the attribute table. Do the same to copy any comments into the "Desc" field. Save the shape files as a gpx file with GPX USE EXTENSION "YES" before uploading to the GPS. The point id's will then appear as your waypoint names and the comments will appear in the notes section.



Format	GPS eXchange Pr	output formyT					
						-	
File name	and the second second	icts/Neereno/	ieldTrip/Feld_gpx_stra	el.gpx		Browse	
layer name							
CRS	Default CR5 (EPS	sucrisse - Wu	840			-	3
Encoding			177-0			-	
Save on	ly selected factory	90					
Select	fields to export	and their e	oport options				
🗹 Add sav	ed file to map						
Symbology (	export.		No symbo	ylogy		•	
Scale			1:50000			\$	
♥ Geom	etry						
Georetry	type		Automatic	ć .		*	
(C) Partie	multi-type						
Indud	e 2-dimension						
🐨 🗌 Ext	tent (current: la	yer)					
▼ □ Ext	tent (current: la	yer) North	751890				
West 37			751890	East	4630-40		
121				East	403040		
121	9720	North South	730500				
121	9720	North	730500	East Nap men d			
West 37	9720	North South	730500				
West 37	9720	North South	730500				
₩wwt 32 ♥ Datase GPX_EXTE	9720 ource Options	North South Learn ochest	730300				
Datas     GPX_EXTE	ource Options BISIONS_NS	North South Learn ocherit	730300				
Datas     GPX_EXTE	NY729 OUICE Options BISIONS_NS BISIONS_NS _EXTENSIONS	North South Learn exhibit ogr http://osger	730300				
West 32     Datass     GPX_EXTE     GPX_EXTE     GPX_LISE,     LINEFORM	19729 Durce Options Englong Jos Englong Jo	North South Carent Control Con	730300			•	
West 33     Datass     GPX_EXTE     GPX_EXTE     GPX_USE,     LINEPORP     Layer	19729 Durce Options Englong Jos Englong Jo	North South Carent Control Con	730300				

Open GPSBabel and select the gpx file to be uploaded, check Device "Garmin serial/usb" and device name "usb".

GPSBabel					5 <u>8.05</u>		×
ile Help							
Input	Format GPX XML						•
File Name(s) "F:/	Projects/Impacts/Nee	ereno/FieldTrip/FieldLo	ocs_2017_WGS84.gpx				
Options							
Translation Options	🖁 🗌 Routes 📗	🚦 🗌 Tracks 🔹	Filters			More Op	otions
Output O File  Device Device Name: usb;	Format Garmin se	rial/USB protocol					٠
Options							
gpsbabel -w -i gpx -f F:/P	rojects/Impacts/Nee	reno/FieldTrip/FieldLo	cs_2017_WGS84.gpx ·	o garmin -F usb:			
Options gpsbabel -w -i gpx -f F:/P Translation successful	'rojects/Impacts/Nee	reno/FieldTrip/FieldLo	cs_2017_WGS84.gpx -		) Close	He	Ip



The lower window will confirm if the upload has been successful.

A live link to your GPS can be accessed via the View > Panels > GPS Information panel with various connection, display, and digitising options. This allows the user to have QGIS running and a live map link via the gps.

## 7.12 Using the GSWA WAROX and WAMINES data

The WAROX (2019 edition) database contains the GSWA field locations, sample sites, outcrop photos and petrography reports. The Microsoft Access database supplied by the GSWA contains pre-defined queries to make it easier to access the data. The query "qry\_detailed" allows the user to extract the GSWA observation sites and "qry\_summary" indicates if photographs have been taken of outcrops. The query "qry\_photos" contains the photo information. Note the location of the photos is in the LocationID field and needs to be joined to the "qry\_summary" to assign a location to each photo. To import this data into QGIS, export the query as a csv (qry\_detailed.csv), ensuring you select the first row as field names, and then import this into QGIS via the CSV import option. Change the projection to GDA94 from the default WGS84. The Access queries can also be modified to allow the extraction of observation sites with photos only.

In QGIS, open the layers attribute table, make editable and add another column (called something like "SourceFile") of type string (text) with width of 100 characters. Save this update. This "SourceFile" column will hold the file location and photo number that will allow QGIS to display the photo for this location. The next step will concatenate the directory path and photo file name into the "SourceFile" column.

Click in the column selector to select the "SourceFile" column and then enter the following expression in the expression editor "concat('*directory location*'||"SourceFile") substituting the directory location to point to where you have saved the WAROX photos. Note you need to change the default back slash (\) to a forward slash (/) in the directory path or you will get "?" replacing the back slashes. Save the file.

		the second second		cted: 0				×
		and the second se	Y T & P	a faile at the second second				
a SourceFile	8	concat(F:/Proj	jecta/WA/WAROX/PH	OTOS/WAROX/11 P	hoto (Cl*)	Update All	Todate 5	Semiliar
1.0	CATIONNO	STIED	OLAT	DLONG	SourceFile			1
	455490	RHSMUG001857	-25.9680700000	127.8175499999	F:/Projects/WA/WARDX/PHOTDS/WAROX/E7415948-F660-4E5C-8980-AAF6D5CI	PB8C.jpg		
	533013	RHSMUG002498	-26-1122500000	127,4201400000	F:/Projects/WA/WAROX/PHOTOS/WAROX/485788A4-4F3C-49A3-8C87-03E8CC6	9205E.jpg		
	533013	RHSMUG002498	-26.1122500000	127.4201400000	F:/Projects/WA/WAROX/PHOTOS/WAROX/64E74152-6977-4EDB-8FA0-37A46DC8	84508.jpg		
	505528	RHSMUG002283	-26-1214599999	127.5252100000.	F:/Projects/WA/WAROX/PHOTOS/WAROX/30A6805E-43C8-4FAE-83FA-FA0F4862	363D-jpg		
	416288	PMEMUG000523	-25.6377600000	128.1871399999	Ft/Projects/WA/WAROX/PHOTOS/WAROX/8E885081-1FCA-4486-8010-9F8F3688	5A6D6.jpg		
	416268	PMEMUG000523	-25.6377600000	128.1871399999	F:/Projects/WA/WAROX/PHOTOS/WAROX/91099019-1F0A-498F-8A0A-9008AF4	50764.jpg		
								P

You may want to Categorise the points into those with and without photos using a "Rule based" styling using photo SourceFile is Not Null for points with photos (meaning there is a photo link), and no photo when SourceFile is Null (no photo link). I have used a photo icon to indicate if there is a photo available at a particular location.

After saving the file, you can then use the eVis plug-in (Database > eVis > EVis event id tool) to click on and display photos linked to that site. The Action properties for the layer can also be used



to display photos. An example below shows the WAROX points displayed to indicate whether a photo was available at that location.

🚀 Layer Properties - WAROX_Photos   Style					?	×			
🤀 General	^	and Rule-based							•
		Label 🖉 💿 NoPhoto			ceFile" is Null	Min. scale	Max. scale	Count	Duplica
(abc Labels		🗹 💼 Photo		"Sour	ceFile" is Not Null				
Fields		<						Symbol	> levels
🞸 Rendering	P	Refine selected rules 🔻							
🧭 Display		▼ Layer rendering							
Actions		Layer transparency Layer blending mode	Normal		•				0 🜩
• Joins		Feature blending mode	Normal		•				
Diagrams	Ľ	Draw effects Control feature rendering order	er						() () ()
🥡 Metadata	Ļ	Style 🔻			OK	Cancel	Apply	H	Help

Event Browser	- Displaying records 01 of 01				?	
play Option	s Configure External Applications					
				Previous	Next	
eld	Value					1
Location I	{B9CD7555-FA06-4306-AEE9-70C1EE	E0C9A16}				
Photo (Cli	6429C0EC-00D0-489E-83C6-88DCC7					
Field ID	15					
Descriptio	2					
Keywords	outcrop - general south					
Direction LOCATIONNO						
LOCATONINO						-
400 500			PROPERTY AND INCOME.	and the second second		-

A similar process can be used to display linked petrographic reports and photos in the WAMINES database. See below an example from the WAMINES database. To display pdf files, you will need to add the pdf display program in the "Configure External Applications" tab.

	Displaying records 06 of 34	? >
splay Options	Configure External Applications	
		Previous
eld	Value	1
CONFIDENTI	Public	1
WABMINENUM		
OBSERVATIO ORIGINATOR	20100921000000 Peel T.	
	Underground	
FEATURETYP	Open Stope	
LATITUDE	-27,978899	
Service of		
Zest	E dia	Martin and Anthony
PRED A	and the second se	
State State		ARE CONTRACTOR
		as the main and
		A Plant
	CARE AND AND A LINE ALL WALL	- Landson
- ALL	KILL HE CONTRACTOR OF THE	
	a share the second of the seco	
AND		
A DAY		and the second second
A Start		
RUN		TEACOND TO TO
A HEALT		start and and and
<b>S</b> DA		CARLE REPARTS
BI BI		A CONTRACT OF A
		The Provent
	PRAL AND AND AND AND	2. Carte
		C. State
		Close



PDF files can also be displayed via the Action tab, add the cmd /c command to the action text.

Q Edit Act	on		×
Туре	Windows	•	Capture output
Description	Open Petrology Report		
Short Name	Open Petrology Report		
Icon			
Action Scope	s		
Field			
Canv	as		
Laye			
✓ Feat	ire		
Action Text			
The action	text defines what happens if the action is triggered.		
For the ty	nt depends on the type. De <i>Python</i> the content should be python code types it should be a file or application with optional parameters		
1	cmd·/c·"[%PetroRptFullPath%]"		
			5 Insert
	notification matches		
Enable	only when editable		
		OK Cancel	Help



## 7.13 Converting Local (Non-Earth) Grids to Real World Coordinates

There is no easy way to convert non-earth coordinates but there is a way by using the v.transform algorithm. The algorithm requires an x, y coordinate for the grid origin and an optional rotation amount. This data is should be available from the mine surveyor or can be calculated. The author uses a small python program that uses 2 common sets of points to calculate a grid origin and rotation amount. The workflow below is for point data and within one UTM zone in metre coordinates only. If you would like a copy of this python code, please contact me.

Using a new project workspace, change **project projection** to "no projection" then open the local grid file using the local coordinates (e.g. drill holes in local coordinates). Check that the local coordinates in the map window look correct.

Run the v.transform algorithm with the points in local grid coordinates. To find this algorithm display the Processing Toolbox in the RHS of the map window, type v.tr in the search box and the v.transform algorithm should now be displayed. Double click on it to open the v.transform dialog box. Use the parameters for x, y and rotation.

Allocate the new projection to the points by **firstly**, setting the projection of the transformed layer to your desired UTM projection (**very important to do this first**) via the Layer Properties > Source tab, then change the project projection to your UTM projection. Close the original local coordinates file and zoom to the extent of the new transformed layer to check the transformation was successful.

This will produce a transformed (virtual) layer which will need to be "Exported As" to save the file permanently.

## 7.14 Creating a Grid Layout

A regular grid of points can be created via a table of coordinates or using the "Regular Points" algorithm. Other create grid options are available in the Processing Toolbox, but these two methods are the simplest.

To create a grid, from a table of coordinates, use the "Create points from Table" algorithm located in the Processing Toolbox under the Vector Creation list. Input the table that contains the coordinates, select the X and Y coordinate fields, with optional Z and M fields as well, check the CRS and run. The algorithm will create a series of points with id's only. Use the attribute table to add Easting and Northing fields if desired to attach the point coordinates.

To create a grid of points using the map window, use the "Regular Points" algorithm in the Vector Creation list. The extent of the grid can be entered manually or defined by the map window extent. Set the grid spacing and check the CRS and run. The resulting grid can be rotated (using the Vector Geometry > Rotate algorithm) or the "Rotate Feature" on the map window icons (next to the "Move Points" icon). Both methods allow the user to select the point for rotation and the amount of rotation.

If you want to create non-square or hexagonal grids, for example, use the "Create Grid" option under the Vector Creation options.



## 7.15 GeoPackages

The following is from the Open Geospatial Consortium (OGC) website (<u>https://www.geopackage.org/</u>).

GeoPackage is an open, standards-based, platform-independent, portable, self-describing, compact format for transferring geospatial information.

The GeoPackage Encoding Standard describes a set of conventions for storing the following within an SQLite database:

- vector features
- tile matrix sets of imagery and raster maps at various scales
- attributes (non-spatial data)
- extensions

To be clear, a GeoPackage is the SQLite container and the GeoPackage Encoding Standard governs the rules and requirements of content stored in a GeoPackage container. The GeoPackage standard defines the schema for a GeoPackage, including table definitions, integrity assertions, format limitations, and content constraints. The required and supported content of a GeoPackage is entirely defined in the standard. These capabilities are built on a common base and the extension mechanism provides implementors a way to include additional functionality in their GeoPackages.

What all this means is that you can create a Geopackage with vector data containing point, line and polygon data with their respective stylings, and also include raster data files.

Field names are not restricted to 10 characters, as is the case with shape files.

GeoPackages can be used to transfer complete projects with all the data and display attributes – see the end of this section for details.

When digitising into a Geopackage file, the id field is automatically incremented. The data is spatially indexed so panning and window refreshes are much faster.

Geopackages have a .gpkg file extension.

To create a new blank GeoPackage, use the Layers > Add New Layer and select Geopackage. The following dialog box will appear.



🔇 New GeoPack	age Layer					×
Database						
Table name						
Geometry type	📕 No geometry	/				•
	Include Z dim	iension 🗌 Ir				
	EPSG:28350 - GD	A94 / MGA zor	ne 50			•
New Field						
Name		_	_	_	_	
		_	_	_		
Туре	abc Text dat	a				
Maximum leng	th	_	_			
				l	🚛 Add to Field	s List
Fields List						
Name	Type	Los	igth			
INdiffe	Туре	Lei	igui	_	_	_
	_					
					Remo	ve Field
	Options					
		_	_	_	_	
Layer identifie						
Layer descript						
Feature id colu	umn fid					
Geometry colu	ımn geometry					
Geometry colu		a spatial index				
Geometry colu		a spatial index				ance) (Help)

The database name will be the new Geopackage name and make sure you selected the three dots to the right of the entry field to ensure you know where it will be saved. The table name will be the layer within the Geopackage. Ensure you select the correct geometry for the layer and the correct CRS of the data. Add your required fields for the table/layer and press OK to create a Geopackage.

🔇 New GeoPack	age Layer		×
Database	orkshops\Workshop\Proje	ectFiles\FieldObservations\N	eereno_Geology.gpkg 🛛 🛄
Table name	Outcrop Geology		
Geometry type	🎮 Polygon		•
	Include Z dimension	Include M values	
ĺ	EPSG:28350 - GDA94 / M	IGA zone 50	•
New Field			
News			
Name			
Туре	abc Text data		٠
Maximum lengt	th 🗌		
			III Add to Fields List
Fields List			
Name	Туре	Length	
Code	text		
Lithology	text		
			Remove Field
	Options		
Layer identifie	r Outcrop Geology		
Layer descripti	ion		
Feature id colu	umn fid		
Geometry colu	mn geometry		
	🗹 Create a spatia	lindex	
			OK Cancel Help

Once a Geopackage has been created, shape files in the layers panels can be selected and dragged into the browser panel and added to the Geopackage file by overlying the layer on the Geopackage name (a small plus symbol will be displayed when overlayed in the correct place).

# Q

### QGIS In Mineral Exploration

Q *yemp - QGIS 2139047d78
Project <u>E</u> dit <u>V</u> iew <u>Layer</u> <u>Settings</u> <u>P</u> lugins Vect <u>or</u> <u>R</u> aster <u>D</u> atabase <u>W</u> eb <u>M</u> esh
i 🖹 📛 🗒 🕵 🐒 i 🖑 🏘 🔎 🗩 🕅 💭 🔎 🔎
i 🖳 🍪 Va 🔏 🖏 i 🕅 i 🖉 🧶 🚍 🖓 😿 👘 🔫
1月•元水中西西西西北小水水花水•西
Browser
🔍 🕽 🔻 🗗 🤉
<ul> <li>Fonts_Patterns</li> <li>ProjectFiles</li> <li>DrillHoles</li> <li>Example3D</li> <li>FieldObservations</li> <li>FieldObs.gpkg</li> <li>FieldObservations.csv</li> <li>GeoPackageProject</li> <li>Neereno_Geology.gpkg</li> <li>Outcrop Geology</li> <li>Q yemp</li> <li>yemp.shp</li> <li>Geochemistry</li> <li>Geology</li> <li>Geophysics</li> </ul>
Layers
🍯 🔍 🔍 🏹 🦂 🕂 🛤 🖬 🖳
Outcrop Geology
v 🖉 🙏 yemp
🧭 Bedding
🖉 🖵 Joint
🗹 📾 Photo
Ø

Geopackages can also be used to store complete projects. Currently this requires three steps.

Firstly, use the Processing Toolbox > Database > Package Layers algorithm to package all the vector layers into a Geopackage – this algorithm only saves the vector layers. Ensure you tick the "Save layer styles into GeoPackage" (only available in versions 3.8 and higher).

<b>Q</b> Package Layers		×
Parameters       Log         Input layers	•	Package layers This algorithm collects a number of existing layers and packages them together into a single GeoPackage database.
0%		Cancel
Run as Batch Process		Run Close Help

The next step is to drag the raster layers into the new GeoPackage, then close the original layers.

The last step is to re-open them using the GeoPackaged files. Reorder the layers as required and save the project into the same folder as the GeoPackage.

You will then have a GeoPackage file \*\*\*.gpkg and an associated project file (\*\*\*.qgz) which when moved together will be the complete project data package.

Note that Geopackages can only be edited by single-user at a time.



## 8: DISPLAYING GEOCHEMICAL DATA

Geochemical data is usually in the form of an excel spreadsheet or as a text file. Open the file in QGIS via the "Spreadsheet Layers" or CSV file open options depending upon the format of your data. See section 6 above for opening spreadsheet and csv files, and the potential use of CSV format files (\*.csvt) for large complicated csv files. If you have problems importing large csv files exported from Excel, save the file as a tab-delimited text file and import this into QGIS.

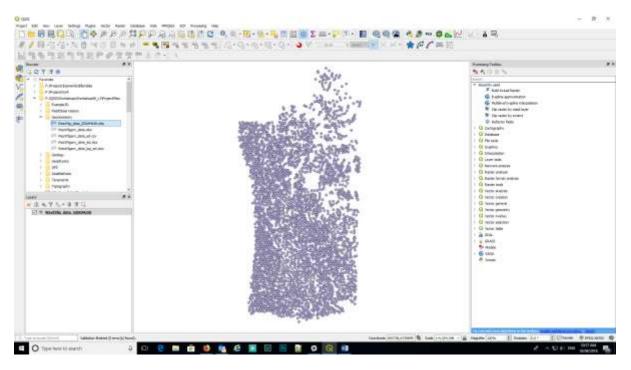
loGAS has created a QGIS plugin for its export files and can be downloaded from the ioGAS website (https://reflexnow.com/download-qgis-plugin-for-imdex-iogas/).

When loading your data, ensure the data has been loaded into QGIS as the correct field type, i.e. as a number, not as a string (text) field. This can be checked using the layer's Layer Properties > Fields tab.

When the data has been imported into QGIS, make sure you check the correct coordinate system has been selected.

Use the View > Statistical Summary option to display the statistics for a particular field. This helps to identify potential problems with the data such as negative values representing below detection limit data.

Geochemical point data can be displayed as points and can be coloured or sized according to value.



To filter out bad data, use the "feature filter" in the Source tab of the Layer Properties to filter out all the negative numbers (below detection or not assayed) - see the following image as an example for the Cr data.

🔇 Laye	r Properties - WestYilg_data_GDA94z50   Source	?	×
Q	▼ Settings		
<b>i</b>	Layer name WestYilg_data_GDA94z50 displayed as WestYilg_data_GDA94z50		
8	Data source encoding UTF-8		
	▼ Coordinate reference system		
*	Set source coordinate reference system	-	
abc	EPSG:28350 - GDA94 / MGA zone 50 Create spatial index Update extents	•	
	Create spauai intex		
	▼ Provider feature filter		
<b>*</b>	"Cr" > 0		
•			
		Query Bu	uilder
sì -			
ي 😳			
<b>~</b>	Style   OK Cancel Apply	He	:lp

Use the query builder, as shown below. Note that this has only been done for Cr values in this example.

<b>Q</b> Query Builder						?	×
Set provider filter on WestYilg_data_GD	A94z50						
Fields			Values				
Be		^					
Bi							
Cd							
Ce							
Cl							
Co				Sample	A	1	
Cr				bumpic		•	
Cs		¥	Use unf	filtered layer			
▼ Operators	> LIKE		%	IN	IOT IN		
<= >=	!= ILIKE		AND	OR	NOT		
Provider specific filter expression	n						
"Cr" > 0							
<							>
		OK	Ī	est <u>C</u> lear	Cancel	He	lp

This is important for geochemical data so the negative values do not influence the statistics of the data.

Univariate statistics can be calculated using the View > Statistical Summary panel. This opens a panel under the browser panel, where you can select the layer and data field for which field you



want to calculate statistics. The mean, standard deviation, first quantile, third quantile and the Inter Quartile Range (IQR) are among some of the calculated results.

To examine the statistics of the data, use the View > Statistics Panel and select the field to be queried.

Statistics ×						
° WestYilg_data_GDA94z50 ▼						
1.2 Cr	3 ~					
Statistic	Value					
Count	3141					
Sum	1.498e+6					
Mean	476.919					
Median	250					
St dev (pop)	1195.39					
St dev (sample)	1195.58					
Minimum	20					
Maximum	22200					
Range	22180					
Minority	109.439					
Majority	160					
Variety	290					
Q1	170					
Q3	390					
IQR	220					
Missing (null) values	0					
Selected features	only	2 -				

In this example note that the first and third quantiles are 170 and 390 ppm Cr with an IQR (inter quartile range) of 220. Geochemist's would say that any values over 720 ppm Cr (Q3 + ( $1.5 \times IQR$ )) are anomalous.

To colourise your data, use the Layer Properties > Style tab to select the way you want the data displayed. The simplest way is to use the "Graduated" option and colour the point values. Note that this works on numeric values only. Select the column you wish to colour the points by and the desired colour ramp and hit the "Classify" button. Under the display window, you can also select

the way the points are coloured. You can use a variety of methods. You can also manually edit the ranges in the display window.

To colour the geochemical data by assay value, select the Style tab in the layer properties panel. Select the Graduated option in the top drop-down box. Select "Cr" as the field to be displayed. Select a suitable "colour ramp", select Mode "Quantile (Equal Count)", change Classes to 8, hit "Classify" (if you forget to hit Classify you will not any colours!). You will note that the boundary between the second and third quantile is 170 ppm (Q1) and the boundary between the sixth and seventh range is 390 ppm (Q3). Other display modes may be more applicable, and this will depend upon your data and how you want to display the data.

🔇 Laye	er Properties - Wo	estYilg_data_(	DA94z50   Symbology		?	×
Q	😑 Graduated					•
<i>i</i> ^	Column	1.2 Cr	3 ~			
	Symbol		O Change			
२ <u>२</u> २२	Legend Format	%1 - %2		Precision	0 😫 🛛	Trim
🔍 📗	Method	Color				•
abc	Color ramp					•
	Classes H	istogram				
	Symbol Value	es 0 - 130.00	.egend 20 - 130			
<ul> <li></li> <li></li> </ul>		00 - 170.00	130 - 170			
		00 - 210.00	170 - 210			
		00 - 250.00	210 - 250			
-8	250.0	00 - 300.48	250 - 300			
	✓ ○ 300.4	48 - 390.00	300 - 390			
•	90.0	00 - 590.00	390 - 590			
• 4 0 0	✓ ● 590.0	00 - 22200.00	590 - 22200			
Ó	Mode Quantile	(Equal Count)	•		Classes	8
	Classify	÷	Delete all		Advan	ced 🔻
<b>—</b>	Link class bo	undaries				
*	Layer rend	lering				
ç •	Style 🔻		OK Cancel	Apply	He	elp

The top two classes are below 170 ppm (25<sup>th</sup> percentile) and the bottom two classes are greater than 390 ppm (75<sup>th</sup> percentile). You can manually edit the second last range so that its upper value is 720 ppm (anomaly threshold) and it will automatically update the eighth data range.



📿 Lay	ver Properties - WestYilg_data_GDA94z50   Symbology		?	×
Q	Graduated			•
<i>i</i>	<sup>^</sup> Column 1.2 Cr · Ε			
રેજ	Symbol O Change			
	Legend Format %1 - %2	Precision 0	÷	Trim
*	Method Color			•
abc	Color ramp			-
	Classes Histogram			
1	Symbol Values Legend			
	20.00 - 130.00 20 - 130			
	✓ ● 130.00 - 170.00 130 - 170			
	✓ 170.00 - 210.00 170 - 210			
	210.00 - 250.00 210 - 250 			
8				
•	✓     390.00 - 720.00     390 - 720       ✓     720.00 - 22200.00     720 - 22200			
ei -	720.00 - 22200.00 720 - 22200			
	Mode Quantile (Equal Count) 🔻	C	lasses 8	3 🖨
٩	Classify 任 🗩 😑 Delete all		Advand	ced 🔻
<b>—</b>	Link class boundaries			
*	Layer rendering			
ç.	Style   OK Cancel	Apply	He	lp

In the figure above I have selected the >720 ppm and enlarged the symbol.

Other options are available for the display of the data – see the "Mode" drop-down box.

Note you can vary the displayed number of decimal places in the legend by using the "Precision" option in the dialog box.

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	8 x	175	
CTTO	a		
Privorites     Filfrojects/Dianon/sty/Elendase     Filfrojects/Dianon/sty/Elendase     Filfrojects/WA     Filfrojects/WA     Filfrojects/WA     Filfrojects/WA     Filfrojects/WA     Geodemosity     Westfilgarn_data_ed.xbx     Westfildarn			7
> Topogradiv Topogradiv sens ✓ A: •, ▼ F <sub>1</sub> = 3: 3* C₂ ✓ West'Nk data GDA94c50	* 		•
20 - 138         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170         21 - 170			

The drawing order can be varied so that all the high values are plotted on top. To do this scroll down the Symbology dialog box to the "Layer Rendering" option, turn on the "Control feature rendering order", then click the sort icon on the right-hand side.



Q Layer Properties — We	stVilg_data_GDA54z	50 — Symbolog	W.						×
Q	들 Graduate	bd							. +
(information	Value	1.1 ()							*   8
to Source	Symbol	1			٠				-
Symbology	Legend forma	r %1-%2						Precision 0	🗘 🖌 Trim
	Method	Color							
abeli Labeli	Color ramp	1							-
DB Masks	Classes	Histogram							
🔗 30 View	Symbol *	Values	Legend						
Diagrams	*:	-10.00 - 130.00 130.00 - 170.00 170.00 - 210.00	-10 - 130 130 - 170 170 - 210						
Fields	V 0 V 0	210.00 - 250.00 250.00 - 300.12							
Attributes Form	V • V • V •	300.12 - 390.00 390.00 - 590.00 590.00 - 22200.0							
Autiliary Storage	Mode IIIE	jual Count (Quant	die) =					Classes	8 \$
Actions	Classify	·	Delete Al						Advanced *
Cisplay	🗸 Link dess	boundaries							
🥳 Rendering	🐨 Layer R	endering							16
C Temporal	Opecity			Layer		Feat		100.	0 %
A CONTRACTOR OF STREET	Blending mod	÷		Normal		+ Nor			
Variables	Draw effe	ects							100
📝 Metadata	🖌 Control fe	sature rendering o	yrder						24
Dependencies	Styla	-				OK	Cancel	Apply	Help

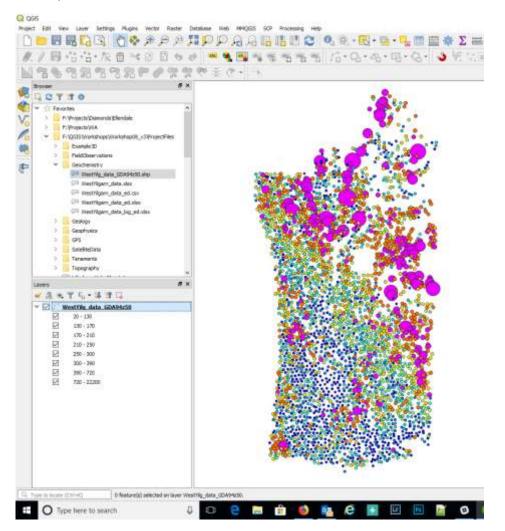
Select field to use for the ordering and whether you ascending or descending order.

🔇 Define Order							×
	Expression			Asc / Des	sc	NULLs hand	ling
1 <sup>1.2</sup> Cr		-	3	Ascending	*	NULLs Last	-
2		•	3	Ascending	*	NULLs Last	•
		Oł	(	Cance	el	Help	

Points can also be classified by size. Click in the Symbol box (where it says "change") to bring up the symbol selector window. Highlight the "Marker" layer in the top left, then click on the far-right hand side of the Size options where there is a little square box with a down arrow. This is the "Data Driven Override" button. Click on this and scroll down to "Size Assistant" where you can select the symbol size by the field "Cr". Select the field to use for the size, then refresh so that QGIS can calculate the data range in that field. Select OK to apply. Close the layer properties window.

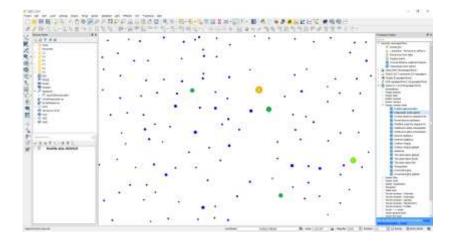


• • Marker © Singl	le marker				0		
						-	
91 111 111	123 196 0						-
Opecity					200.0 %	-	<u>[4]</u>
Culor					-	1.	Precision
Side 3.00000					ŧ	the second se	
Rotatien 0.00 *					3	Data define Description.	
Symbols in All Sym	bola				OpenL	Store Data in	Contraction of the second s
٠	Ť	Θ	0	0	٠		r t, double, string 🔹
airport	worm	capital	circle	city	diamond	Experimiee Variable Edit	<i>.</i>
*	٠	٠	•	0	•	Parte Assistant	
diamond bi	diamond gr	diamond red	dot black	dat white	dot blue	Assolution	
	•	٠	۰	•	•		
dot brown	dat green	dot orange	dat pink	dot purple	dot red		
	-	0	0			+	Cancel Apply
mbol size			_				?
/mbol size					2000		?
it rce 1.2	2 Cr		3 🗸		4000		?
rce 1.: es from 20	2 Cr .000000 200.00000		<b>₽</b> <sub>23</sub>		4000 6000		?
rce 1.7 es from 20 22	.000000 200.00000	0 [	÷		4000 6000 8000		?
t cce 1.7 es from 20 22 Apply tran	.000000 200.00000	0 [	<b>₽</b> <sub>23</sub>		4000 6000 8000 10000		? :
t ce 1.: es from 20 22 ] Apply tran ut	.000000 200.00000	10 [ /e			4000 6000 8000		? :
t cce 1.: es from 20 22 Apply tran put from	.000000 200.00000 Isform curv 1.000000	0 [ /e			4000 6000 8000 10000		?
t ce 1.: es from 20 22 ] Apply tran ut from e method	000000 200.00000 ssform curv 1.000000 10.00000 Flannery	0 [ /e			4000 6000 8000 10000 12000		?
t ce 1.: es from 20 22 Apply tran out from e method onent	.000000 200.00000 Isform curv 1.000000 Flannery 0.57				4000 6000 8000 10000 12000 14000 16000		?
t ce 1.: es from 20 22 Apply tran out from e method onent	000000 200.00000 ssform curv 1.000000 10.00000 Flannery				4000 6000 8000 10000 12000 14000		? :
t ce 1.: es from 20 22 Apply tran out from e method onent	.000000 200.00000 Isform curv 1.000000 Flannery 0.57				4000 6000 8000 10000 12000 14000 16000		?
t es from 20 22 Apply tran out from e method onent	.000000 200.00000 Isform curv 1.000000 Flannery 0.57				4000 6000 8000 10000 12000 14000 16000 18000		?
rce 1.3	.000000 200.00000 Isform curv 1.000000 Flannery 0.57				4000 6000 8000 10000 12000 14000 16000 18000 20000		?



To create a grid of the geochemical data, zoom to an area of data that you want to grid and open the Processing Toolbox (right hand side window) > SAGA > Raster Creation Tools > Multilevel bspline. Select the field to grid and click select and enter a file name (if you want a permanent file output) and location to where you want to write the grid file. It is important to make sure QGIS can write to the folder (not the default Program Files folder), otherwise the operation will fail.

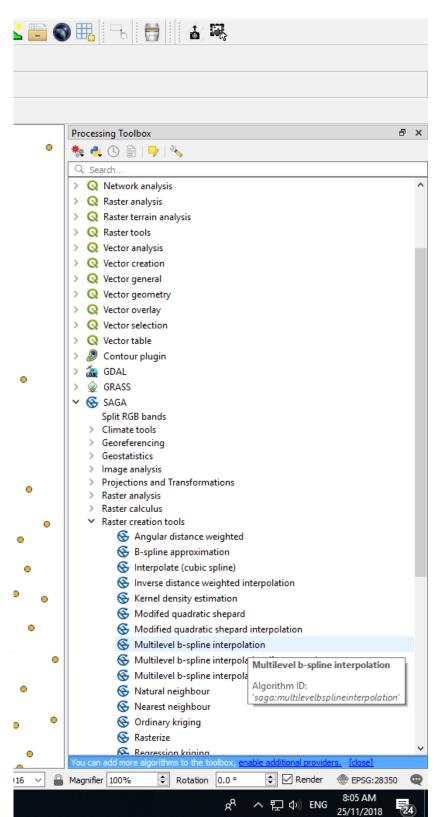
Zoom in to a subset of the data, as shown in the figure below.







– 0 X

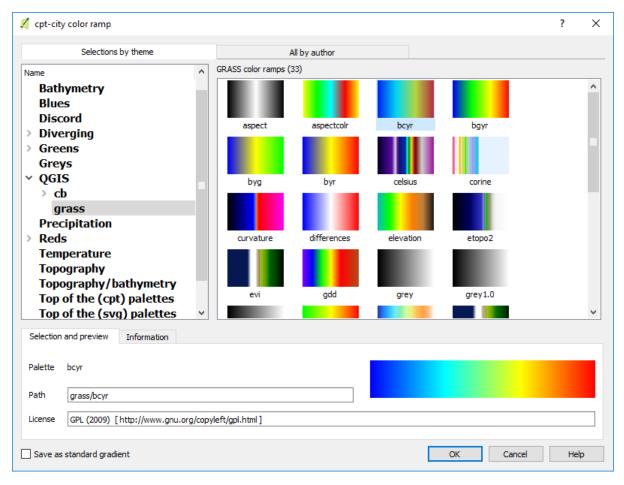


To limit the area over which the grid will be calculated, use the canvas extent for the "Output extent" (click on the ... to see the extent options).



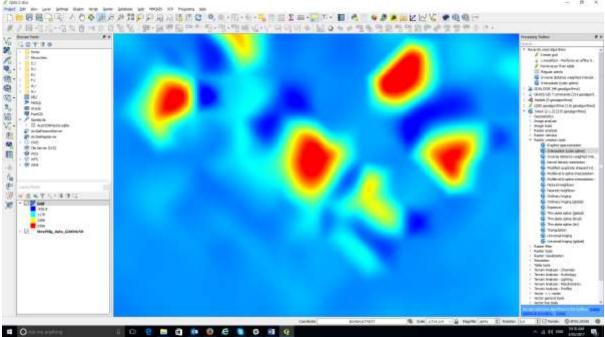
Q Multilevel b-spline interpolation	?	×
Parameters Log		
Points		
° WestYilg_data_GDA94z50 [EPSG:28350] ▼		2
Selected features only	-	
Attribute		
1.2 Cr		•
Method		
[1] with B-spline refinement		-
Threshold Error		
0.000100		-
Output extent (xmin, xmax, ymin, ymax)		
485096.60443558684,790012.5622012096,6385201.397308595,6633195.895791517 [EPSG:28350]		
Cellsize		
100.000000		-
Fit		
[0] nodes		•
Grid		
[Save to temporary file]		
Open output file after running algorithm		
0%	Canc	el
Run as Batch Process Run Close	Help	)

The default grid colouring is greyscale. To add colour to the grid, open the Layer Property > Style tab and select pseudocolour as the render type. If you can't see the desired colour ramp, scroll to the bottom of the colour ramp display box and select "New Colour Ramp", then Colour Ramp Type "cty-city". A large range of colour ramps can then be selected.



A common ramp to use is the QGIS > grass "bcyr" colour ramp. Save this as a standard gradient (lower left-hand tick box) and save "Save Color Ramp" with a suitable name (e.g. Default Colour Ramp).





There are a variety of gridding option in QGIS (see menu item raster > interpolation) but I have found the SAGA gridding tools, which includes b-spline, inverse distance and kriging, to be the best for geochemical data. Note that the spline method will not be exact and will overshoot and undershoot some of the point values. Check a few different methods to find one that suits you best.

# 9: GEOPHYSICAL DATA IMPORT AND DISPLAY

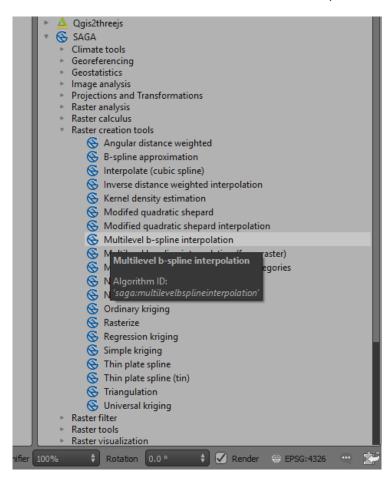
## 9.1 Data Import

Geophysical data usually comes as located data files (text) or grid files. QGIS can read many grid formats with \*.ers, and \*.tif (geotiff) files the most common, and these can be loaded by dragging the file name from the Browser Panel into the map window. Note that Geosoft \*.grd files require conversion to \*.ers files via their free viewer Oasis Montaj program (available from www.geosoft.com).

When opening located data text files, remember that shape files can only have field names up to 10 characters in length. If your text files have longer field names, then it is suggested you use a free text editor like Notepad++ (<u>https://notepad-plus-plus.org/</u>) or ATOM (<u>https://atom.io/</u>, for large files) to modify the field names.

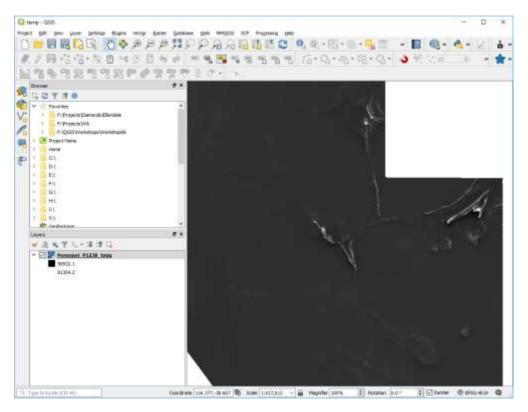
Alternatively, after you have imported the located data, you can save it as a Geopackage file which does not have the 10 character field length restriction.

There are numerous methods to create grids of located data. I typically remove the tie lines by using a filter based on the Line number before I create the grid. One method I have found useful is to use the SAGA > Raster creation tools and use the "Multilevel b-spline interpolation" option.



Grid files are treated as raster files and are usually displayed as greyscale by default. To change the display, open the layer properties dialog and select "Style". A variety of options are available including changing the colour ramps, colour stretch and display value limits. For a coloured image, use the Render Type > "Singleband Pseudocolour" option.

You may also want to create a polygon file as an outline of the area to be gridded. This can then be used to clip the grid to the data.



# 9.2 Colour Ramps

Additional colour ramps are available by clicking on the down arrow to the right of the "Color ramp" dialog box and selecting "Create New Color Ramp...", select "Catalog: cpt-cty" from the drop-down box to display a variety of available colour ramps.

Colour ramps have also been developed by the Centre for Exploration Targeting (CET) in Perth that have better colour perception. These can be reviewed and downloaded from here "<u>https://peterkovesi.com/projects/colourmaps/</u>". Download the QGIS xml file and import via the Options > Style manager dialog box. My preference is to use the CET-R1 to CET-R3 ramps which are rainbow style colour ramps and they have the blue to magenta colour ranges which work well for shading magnetic images for example.



Cpt-city Color Ramp					
Selections by theme			4	I by author	
All Ramps	Palettes for QGIS (68) YIGnBu	TOB	YIDrRd	aspect	
Bathymetry Blues					
Discord Diverging	aspectook	bcyr	bgyr	byg	
Diverging Greens Greys					
QGIS	byr	celsus	corine	curvature	
Precipitation Reds					
Temperature					
Topography	differences	elevation	etopo2	evi	
Topography/bathymetry Top of the (cpt) palettes Top of the (svg) palettes					
Transparency Y	gdd	grey	grey1.0	grey255	
Selection and preview Enformation					
Path					
license					
Seve as standard gradient				Cance	Heb

The "bcry" is a also good option for colouring geophysical data grids. Select the "Save as standard gradient" tick box in the lower left of the dialog box, then the Save Color Ramp.

Transparency	Interpolation Line	ar	
<ul> <li>Histogram</li> <li>Rendering</li> <li>Pyramids</li> <li>Metadata</li> <li>Legend</li> <li>QGIS Server</li> </ul>	Color ramp Label unit suffix Value 50932.1 61055.12 71181.17 81304.2	Invert Color Ramp Blues Default_colour_ramp Greens Greys Magma RdGy Reds Spectral Viridis All color ramps	
	Mode Continu	Create New Color Ramp Edit Color Ramp	Classes 5 \$
	Classify	Save Color Ramp	

Save the color ramp with a name, e.g. default colour ramp, and "Add to favorites" so it shows up on your quick colour ramp select options.



a firmation	Rand res	<ul> <li>Singleband parada</li> </ul>	-					
Solate:	Dest	Berd 1						2
		Ne	90912.1	- 1	Hav.	81304	,	
Style	> 11m / m	as values settings			1999	(Januar)		
Demperature	brine palature							8
	Color range					_	-	
102171	Label unt	Invent Color I	lang					5
	adfa Take		_					5
-	509.12.5	Defait, one	1,1970					
	6.9515.3 71381.3	i Green						
retations	81304.2	Greys Higher						
		1 MGr						
gilli Server		Reds						
Sandretz		1 Sector						
		Vivida						
		All-color ramp						
		Orante New C	Color Ramp.					4
	Plude Cartle		11.00				Causes 1	8
	CemPs	Save Calor R	erų.					
		frange values						- 1
	▼ Calue res							
	Sanding mos	de Normal		*		14	to Keest	
	Support			Cont			0 10	
	Saturatori	100	1		cale (Off			
	He.	Colorer	5.8	rength			005.3	
	w terange	Ang						
	Style +				OK I	Dentel A	toly in	-

Note that you can use the information icon to examine the values of a pixel or grid location. If the value is not displayed in the Identify panel, try minimising the left-hand side column, as sometimes the column width is too wide for the panel to display the cell value on the right-hand side.

Tal Ia	1 💱 🕾 😼 🛙	0
Featur	e	Value
¥ 0		srtm_65_14
Y	srtm_65_14	
	Band 1	2494
	> (Derived)	

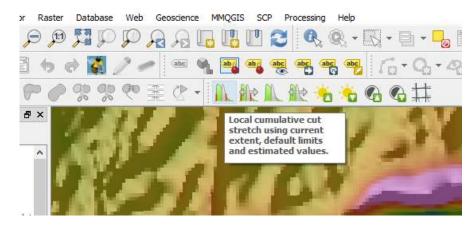
If you open a grid file and have difficulties displaying the data, e.g. with 1VD magnetic images, zoom in to a small area of the grid and then "Stretch to Current Extent" (available as a right click on the layer name in the Layers panel) to stretch the data to something visible.



## 9.3 Custom Data Stretch

The Raster toolbar has a collection of basic display options to change how the image is displayed.

Images can be stretched to the entire image or window extent. See the mouse over for how these icons work.



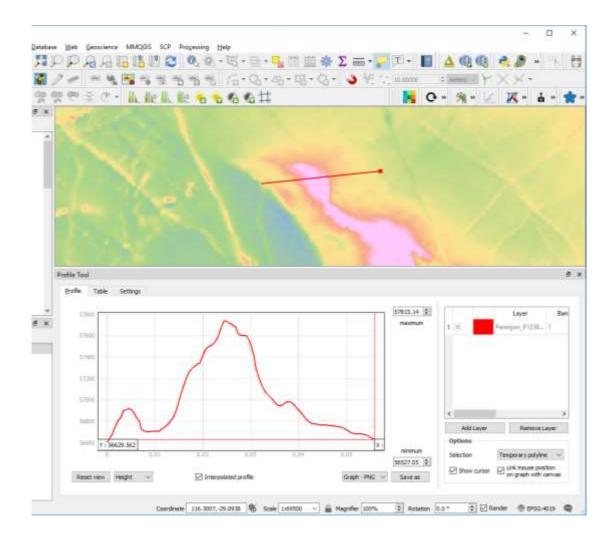
Display settings can also be selected in the Symbology tab of the Layer Properties.

yer Properties - Perenjori_P1	izst_tring   S	ymbology			7	
	Band render	ing				
nfumiation Re	nder type Sk	ngleband pseudocol	or •			
arce Ba	nd B	land 1				•
	м	in .	55999	Мах	57487.9	
Symbology	Hin / max	values settings				
	Use: defn	ed				
	Cumulațive	e 2.0 🔹 - 91	8.0 후 %			
listogram .	) Min / max					
landering	O Mean +/- standard o	degiation × 2.00	*			
Vramids:	Statistics exte	nt		Current canvas	•	1
	Accuracy			Estimate (faster)	•	1
retadata	and a second	1001-1				
	terpolation U	near				•
Approx	lor ramp					٠
	bel unit ffix					
Īv	alue	Color Lak	ei		2	*
	55999	=53				1
	56022.822 56046.644					
	56070.467					
	56092,800					
	56116.623					
	56140.445					
	56164.267					
	56188.090					
	56211.912	7 562	212			
	56235.735	1 563	236			
	56259.557	5 562	60			
	56281.891					
	56305.713					
	56329.535	8 563	30			~
140	ode Continuo	1,18 ·			Classes 64	2
t	Classify	+ = 2				
	] Cip out of ra	arge values				
1.1	Color render					
Tio .	nding mode	Normal		*	to Rese	et
BRC		Sector Se				

# 9.4 Profiling Gridded Data

To obtain a profile across any gridded data, use the "Profile" plugin. Open the Profile plugin (usually on the menu bar) and use the "Add Layer" button to add the layer from where you want the values extracted. Draw a line using one click to start and a double click to complete the line.

The resulting profile values can by copied to the clipboard (under the Table tab) for use in programs like Excel.



# 9.5 Creating Stacked Profiles and Colour Bars

Creating "stacked profiles" of data, especially magnetic data is important for the identification of small discrete features in wide spaced aeromagnetic data. One example is in the search for kimberlite pipes in regional (>300 m) spaced line data.



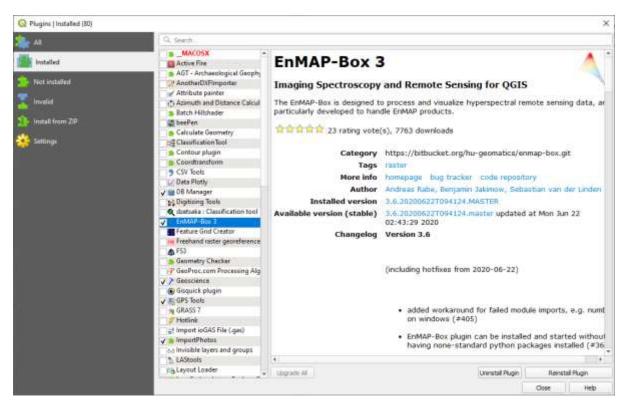
This algorithm has been created by Benoit at GeoProcessing

(http://www.geoproc.com/be/plugins.xml) in South Africa and is part of their "GeoProc" toolset. The stacked profile tool allows the user to import located line data to plot stacked profiles of the data. It is important that the located data is in "point" format not multi-point data format.

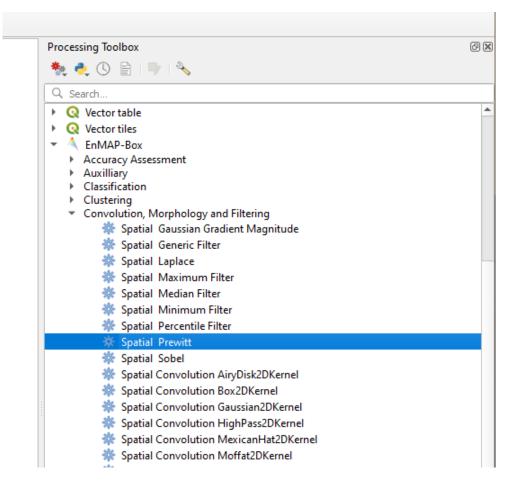
Coloured bar scales can also be created for coloured images using the Composer > Create Colour Scale Bar" tool. There are some dependencies that require installation for these to work so please read the installation instructions. The plugin loads the menu items into the Processing Toolbox.

# 9.6 First and Second Vertical Derivatives

First vertical derivative images can be created using the EnMap Box plugin and can be downloaded from this link (<u>https://www.enmap.org/enmapbox.html</u>). This plugin has been designed to cater for a new satellite due to be launched later in 2020 and has a large variety of tools for remote sensing data including filtering.



When the plugin is installed it puts and additional link in the Processing Toolbox.



The Spatial Prewitt filter creates a first vertical derivative (1vd) image, the Spatial Laplace filter creates a second vertical derivative (2vd) image and the Spatial Gaussian Gradient Magnitude filter creates a type of analytical signal image.

Clipping of the resultant images may be required and set the background with no data to zero or -99999 so it can be set to transparent.

Note also when creating images for use in MapInfo, create ERMapper ers grid files.



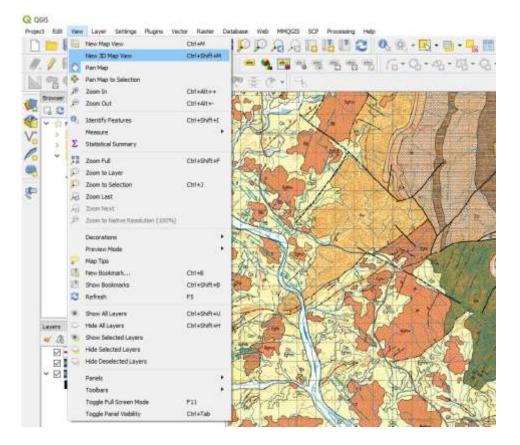
## 10: 3D IMAGE DISPLAY

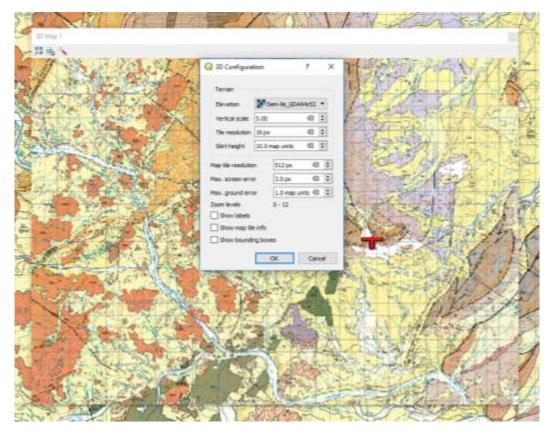
QGIS v3 now has a 3D view capability built in as a standard part of the program (3d Map View) or by using the QGIS2threejs plugin. The options for the 3D Map View are limited at this time but a recent crowd funding effort has enabled planning and extra programming for the 3D options to be greatly improved. The QGIS2threejs is the best option at this time for viewing geological data in 3D. Downhole drill hole traces can be displayed if the 3D coordinates have been calculated.

### 10.1 3D Map View

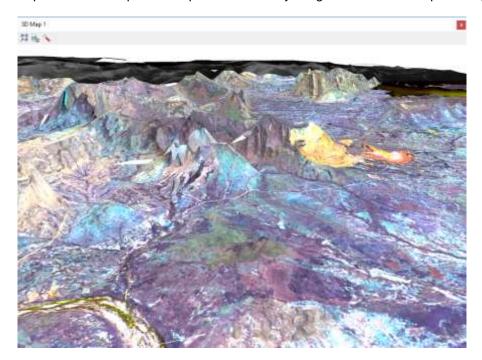
The layers require to be projected, i.e. not a geographic projection, lat/long, and they should all be in the same projection.

To run the 3D view, place the layers into the map window with the DEM layer at the bottom of the layer stack. Go to the View > New 3D Map View menu item and create a 3D map window. Resize the window to suit and select the little spanner symbol to open-up the options dialog.





Select the layer to be used as the "Elevation", set the vertical exaggeration and press OK. Use the hand icon to move the display in the window. To tilt the display to see the 3D effect, hold the shift key and drag the mouse towards down. With the shift key depressed you can also rotate the image. Scroll speed will be dependent upon the size of your grid files and the speed of your PC.



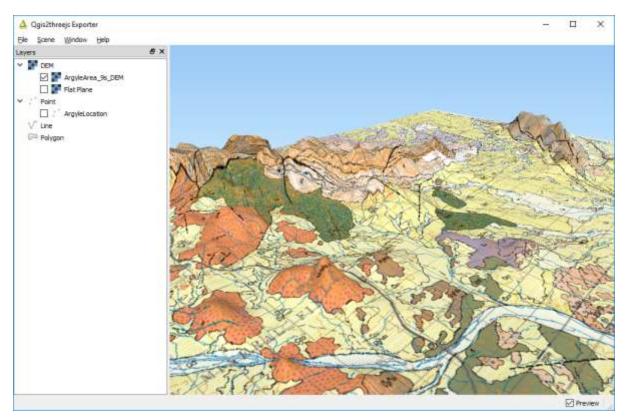
Any image displayed in the map window can be used for 3D display.



## 10.2 QGIS2Threejs Plugin

This plugin is more flexible than the 3D map view at the present stage of its development for geological application. The layers require to be projected, i.e. not a geographic lat/long projection, and they should all be in the same projection. If you have data in 3D, i.e. with x, y and z coordinates, then this plugin can display the data. If you get weird effects, you may have a lat/long layer in the map window which may be causing problems. Close any lat/long layers and re-run the plugin.

To use this plugin, load a DEM or any type of grid file over which you would like to drape data. For example you may wish to drape a satellite image or geological map over a digital terrain model



Make sure the grid is on the bottom, with the layers to be draped on top of the DEM/grid layer. Run the QGIS2Threejs plugin and select the DEM layer.

Vertical exaggeration can be changed using the Scene > World Settings dialog box.



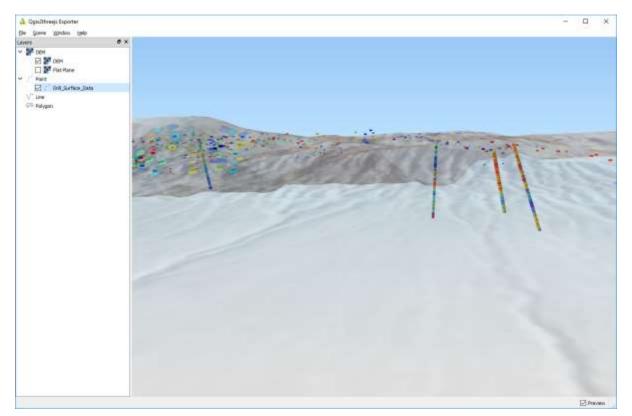
Scale and shift		
Base size	100	
Vertical exaggeration	5	
Vertical shift	0	
Background		
Sky		
Solid color	Oxrrggbb	
Display of coordina	ates	
<ul> <li>Coordinates in the</li> </ul>		
Latitude and longi		

If you have vector data with a z (e.g. RL or elevation data) then right click on the vector layer name in the QGIS2Threejs window and select the z value to use in the "Z Coordinate" options. Downhole drill hole data can be plotted using this method.

Object type	Cylinder	•
Z coordina		
Altitude	O Z Value O M Value O E	xpression
	1.2 Z	3 ~
Mode	Absolute	•
<u>S</u> tyle		
Color	Feature style	•
Opacity	Feature style	•
Radius	Expression	•
	10	~ 8
Height	Expression	•
	10	× 8
<u>F</u> eatures		
🔿 All featu	res	
Eeatures	that intersect with map canvas e	extent



The image below shows a Google Earth image, draped over a SRTM digital terrain model, with a vector file of surface samples and drill hole sampling.



### 11: REMOTE SENSING

The availability of free satellite and other remote sensing data has created unique opportunities for the display of this data to assist geological interpretation and analysis. QGIS can display the normal satellite images but it also has a powerful plugin, the Semi-Automatic Classification (SCP) plug-in, which can be used to source, select, download and process satellite imagery. Video tutorials are available on the web (<u>https://www.youtube.com/watch?v=GFrDgQ6Nzqs</u>) and cover a variety of remote sensing applications including land cover classification.

To download ASTER and Landsat data, you are required to register (free) at the USGS EarthExplorer portal. These registration details will be required to be entered on the SCP download/login window. Sentinel data download requires (free) registration at the ESA Sentinel data access portal. Note that it might take three or four days for your registration at ESA to become active. Recently, the search times on the ESA site via the SCP plugin have been very slow and it has been my experience lately that the USGS EarthExplorer portal is the fastest way to select and download ASTER and Sentinel data.

## 11.1 Using the Semi Automatic Classification Plugin

Selection, downloading and processing of satellite remote sensing data can be achieved using the Semi Automatic Classification Plugin (SCP) written by Luca Congedo (<u>https://fromgistors.blogspot.com/p/semi-automatic-classification-plugin.html</u>). After installing the plugin you can open the plugin via the main menu bar. Note the plugin automatically adds panels and toolbars which I normally close to free up window space.

Band set	Lugin data 🔎 Search	Download options			
Download products	Shorth parameters	1 1 4 4 40	LR (x (un)	V A.ett	🛞 Show 拜
Preprocessing	Producta Sentinel-2 V	and have con-	2016-01-01 v to 2018-11-07 v	10.000	Max doud cover (%) 500 1
Band processing	Results 20 2 Filter	case non L	totector of the [asternov of]		Find Q
Postprocessing					
Band calc	Add CoenstreetMap to the IN	ap (ip OpenstreetMap contributors, 7	The cartography is licensed as CC BY-5	4. The Usage Policy)	
Batch	Product	ProductiD	11		
🕻 Settings					<b>A</b>
About					8
🗄 User manual					
Online help					L.
				Preview	۲
Support the SCP	¢		,		•
	COMPANY IN				

The main SCP window shows tabs for downloading data, as well as a variety of other pre and post processing options, band calculations and tools for land cover classification.

To download data you need to register with the USGS via their EarthExplorer portal (free registration, <u>http://earthexplorer.usgs.gov/</u>) for ASTER and Landsat data and with the European Space Agency (ESA) via their Sentinel data access portal (https://scihub.copernicus.eu/dhus/#/home). Enter these login details into the relevant sections of the SCP Download Products > Login data tab. Make sure you click "Remember" so you don't have



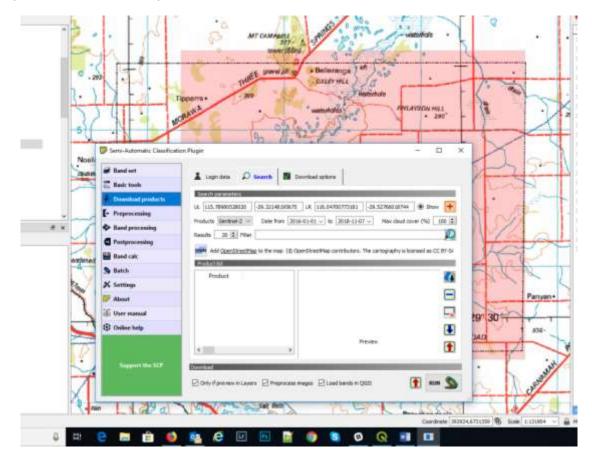
to re-enter your login details each time. Note also that logins with ESA make take a couple of days to initialise.

Semi-Automatic Classificatio	n Plugin	-		×
	Login data 🔎 Search 🚺 Download options			
Basic tools	Login <u>https://ers.cr.usqs.qov</u>			
Preprocessing	User grantboxer Password ••••••	M r	emember	
Band processing	User Password	V r	emember	
Postprocessing	Login Sentinels Service https://scihub.copernicus.eu/apihub			
Band calc	User grantboxer Password ••••••		emember	
🗙 Settings				
P About				
User manual     Online help	Download			
Support the SCP	✓ Only if preview in ✓ Preprocess image ✓ Load bands in QC		RUN 🌋	•

Once all the logins are complete, then you are ready to download data. Have the area that you wish to obtain data displayed in your QGIS map window as we will create a search area directly into this window. Click on the Search tab of the Download Products window.

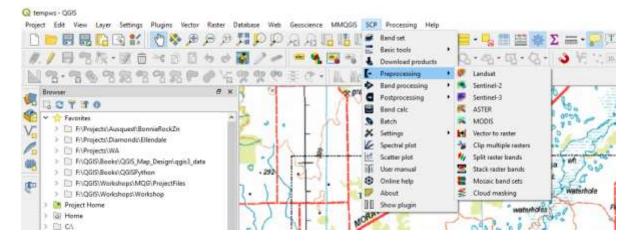
i Band set	Login data 🔎 Search 🚺 Download options		
Basic tools			
👆 Download products	Search parameters	)      show +	
<ul> <li>Preprocessing</li> </ul>			
Band processing	Products Sentinel-2 Date from 2016-01-01 v to 2018-11-07 v	Max cloud cover (%) 100 🖨	
Postprocessing	Results Sentinel-3	<b>X</b>	5
Band calc	Add L4-5 TM ID to the map (© OpenStreetMap contributors. The cart	ography is licensed as CC BY-S/	J
Batch	Product 11-5 MSS		1
Settings	Pro MYV6 MOV6 Y		
About			
🖩 User manual			
Online help			J
	< Preview		
	< >		
Support the SCP	Download		

The required product can be selected via the "Products" dropdown list. To select a search area, click on the orange-red cross in the top RHS of the window, then left click the top left hand side of the map area, then right click on the lower right hand side to set your search area. This will then populate the search area parameters.





You can further refine your data search by entering for example a Sentinel 2 tile number into the "Filter" window to speed up searching and ensuring you only download the required tiles. You can select the maximum allowable cloud cover and any date ranges. Note that for ASTER data only download data prior to 1<sup>st</sup> April 2008 as the SWIR became non-operational after that date.



Once you have selected the search area, open the "Preprocessing' window.

The Preprocessing window allows SCP to do atmospheric and other adjustments to the source satellite data after download, e.g. DOS 1 atmospheric correction on L1C corrected Sentinel 2 data. Note that preprocessing will only occur if the "Preprocess Images" check box is ticked in the Download window. If you download Sentinel 2 L2A data, the atmospheric corrections have already been applied. Note also the other check boxes to limit what gets downloaded and what is displayed in the map window.

Once you have set your search parameters, click the "Find" icon.

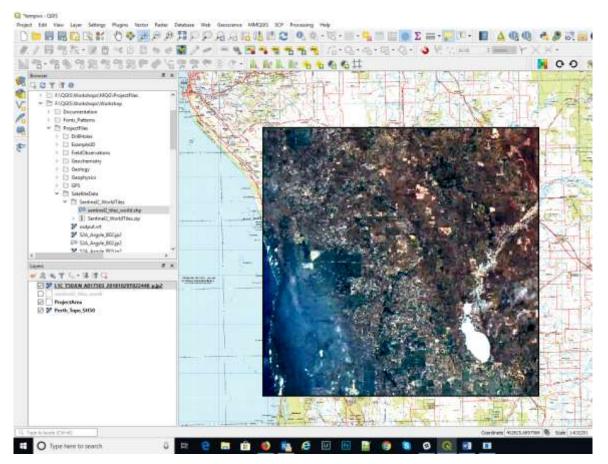
# Restart	Lines Dues	B Derital ates			FIL
T. Seli turb					-
L Constitued products	Englishmen	I Provide the second			N
- Proprocessing	14. [10.000/089679	CB.147964681 SA [18-184225		****	1
· Sand processing	Police Served 2	Set file (2084031-) 16 (2	THE LEW - Mee deal		
C Protorocoming	feach SEA free RAN	2223020000000000000000	190-1-2-2010-2-10-0	Red Red Longe	LAN .
Best cal:	An Delivering of the	ne (ElbechetRe ontdukrs Te unsper	ty is iteration (C.S. SA. The Joan Price)		·
S 844	Pontiet	Pastart0			Stand-
X terms	Poses	reactor .			121
W About				B	1 mil
E thermanad					har
(B Cader July					AND
			Prevani		
				-	Panyan
Annual State	1			1 -2	9 30
	and the local division of the local division		-		40 54-
	the second secon			The second se	and the second

SCP will search the data for tiles fitting the search parameters. The time to retrieve the data will depend upon internet speed. If you get a time-out error or cannot connect type message, check your login details.



Rand set Rank tools	Luger data 🔎 Search 🖬 Deveload options
Download products	Shaft dy pay anothers
- Preprocessing	UL 115.80603089979 -28.34776804000 UR 116.03662134513 -29.52160136305 @ Show 🕇
Band processing	Products (Sentrel-2 V Date from (2016-01-01 V to (2018-11-06 V) Nex doud cover (%) 10 2
Postprocessing	Readly 10 2 Piber 503.N
Band calc	Aid CostStateStap to the map (@ OpentitivedMap contributions. The cartography is isoeneed as CC BY 4A. The Librar. Policy)
S Batch	ProductID
× Settings	1 1 1C TRUEN ANT 1901 JOINT023448
About	ETC_TSOLIN_A005082_20180011T021829     1 ETC_TSOLIN_A005348_201806824T021250     ETC_TSOLIN_A005348_20180710521821     ETC_TSOLIN_A005488_20180710521821
E User manual	4 .L1C_T50/LN_A005344_20160704T021231 4 .L1C_T50/LN_A005314_20160714T021231
🕄 Online help	
Support the SCP	

A list of selected tiles will be shown in the ProductID window and each item can be highlighted and viewed in the RHS window. Note that you can now choose between Sentinel 2 L1C and L2A processing levels. The L2A data has been corrected for atmospheric effects. Check that the scene is suitable, e.g. no cloud over your area of interest, then click the icon "Display preview of highlighted images in map". This will then download a low-resolution full scene image into your map window to ensure it covers the correct area.



To download this data, return to the Download products window and make sure the "Download" "Only if preview in Layers" is checked on. This will ensure only those layers you have in the map window will be downloaded. If all OK, click the run button and save it to the required location. The download and pre-processing may take some time, 10-20 minutes, and it is advised not to use QGIS during this time as it may crash the process. Other programs on your PC may be used.

The download process will entail downloading all the band data, then running the selected corrections, before displaying the final set of image bands into your map window. These bands can then be used to create RGB images and allow band ratios to be calculated.

Note that you can create a multiband tiff file that holds all the band data in one tiff file. This can be created via the Raster > Miscellaneous > Build Virtual Raster option, and by selecting all the bands and then using the "Highest" resolution, so that the pixel sizes of all the bands will be the same ("pansharpened to the smallest pixel size). Processing of this multiband file is now possible in the SCP or Orfeo Tool Box plugins.

The SCP Plugin also allows the user to do a multitude of other task including Principal Components Analysis (PCA). Note that to use PCA all the images must have the same pixel size, and this may require "resampling" of the image (use the Processing Toolbox > SAGA > Raster Tools > Resampling algorithm).

## 11.2 ASTER Data

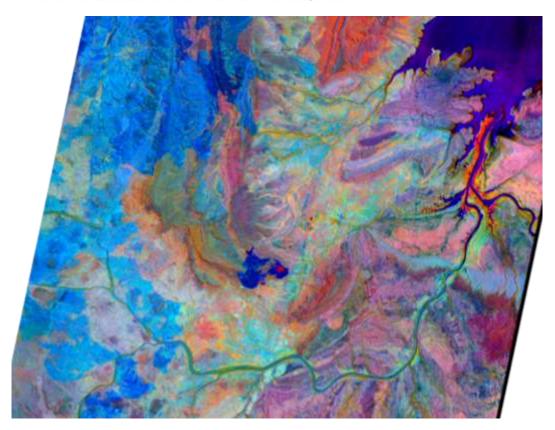
Details of the ASTER (Advance Spaceborne Thermal Emission and Reflection Radiometer) scanner bands are shown in the figure below (from Abrams and Hook 2016).

ASTER

ASTER data is now freely available worldwide but note that the SWIR sensor (bands 4 to 9) became inoperable on 1<sup>st</sup> April 2008, and therefore only data acquired before this time will be suitable for mineral mapping.

Subsystem	Band No.	Spectral Range (µm)	Spatial Resolution, m	Quantization Levels
	1	0.52-0.60		
VNIR	2	0.63-0.69	15	8 bits
	3N	0.78-0.86		
	3B	0.78-0.86		
	4	1.60-1.70		
	5	2.145-2.185		
SWIR	6	2.185-2.225	30	8 bits
	7	2.235-2.285		
	8	2.295-2.365		
	9	2.360-2.430		
	10	8.125-8.475		
	11	8.475-8.825		
TIR	12	8.925-9.275	90	12 bits
	13	10.25-10.95		
	14	10.95-11.65		

Table 1: Characteristics of the 3 ASTER Sensor Systems.



An example of ASTER band combinations using ratio 4/7 (red), 4/3 (green) and 2/1 (blue) around the Argyle mine area.



ASTER bands and band ratios for geological applications are shown in the tables below (from ASTERDataProcessing\_GA7833.pdf available from Geoscience Australia).

Common ratio	&	band	combinations
--------------	---	------	--------------

Features	Red	Green	Blue	Reference
Vegetation and visible bands**	3, 3/2, or NDVI	2	1	
AIOH minerals/advanced argillic alteration***	5/6 (phen)	7/6 (musc)	7/5 (kaol)	Hewson (CSIRO)
Clay, amphibole, laterite	(5x7)/6 <sup>2</sup> (clay)	6/8 (amph)	4/5 (lat)	Bierwith
Gossan, alteration, host rock	4/2 (goss)	4/5 (alt)	5/6 (host)	Volesky
Gossan, alteration, host rock	6 (goss)	2 (alt)	1 (host)	
Decorellation (envi)	13	12	10	Bierwith
Silica, carbonate, basic degree index	(11×11)/10/12 (silica)	13/14 (carb)	12/13 (basic)	Bierwith
Silica, carbonate	(11×11)/(10×12)	13/14	12/13	Nimoyima
Silica	11/10	11/12	13/10	CSIRO
Discrimination for mapping	4/1	3/1	12/14	Abdelsalam
Discrimination in sulphide rich areas	12	5	3	
Discrimination	4/7	4/1	(2/3) x (4/3)	Sultan
Discrimination	4/7	4/3	2/1	Abrams (USGS)
Silica, Fe <sup>2+</sup>	14/12	(1/2) + (5/3)	MNF Band 1	Rowan (USGS)
Enhanced structural features	7	4	2	Rowan (USGS)

\*Comments by Hewson

\*\*Equivalent to Landsat RGB 432

\*\*\*Alunite/pyrophyllite, mica, kaolinite/dickite

Band rations are easily calculated in the SCP plug-in. My personal experience for using the ASTER data in Western Australia and Peru, is that the discrimination ratios using ratio 4/7 (red), 4/3 (green) and 2/1 (blue) works well in most situations. The AIOH minerals/Advanced argillic alteration combination and the Alunite-Kaolinite-Pyrophyllite image also works well for detecting alteration associated with porphyry copper mineralisation.

# **Commonly used ratios**

Feature	Band or Ratio	Comments	Reference
Iron			
Ferric iron, Fe <sup>3+</sup>	2/1		Rowan; CSIRO
Ferrous iron, Fe <sup>2+</sup>	5/3 + 1/2		Rowan
Laterite	4/5		Bierwith
Gossan	4/2		Volesky
Ferrous silicates	5/4	Fe oxide Cu-Au	CSIRO
(biot, chl, amph)		alteration	
Ferric oxides	4/3	Can be ambiguous*	CSIRO
Carbonates / Mafic M	inerals		
Carbonate / chlorite / epidote	(7+9)/8		Rowan
Epidote / chlorite / amphibole	(6+9)/(7+8)	Endoskarn	CSIRO
Amphibole / MgOH	(6+9)/8	Can be either MgOH or carbonate*	Hewson
Amphibole	6/8		Bierwith
Dolomite	(6+8)/7		Rowan, USGS
Carbonate	13/14	Exoskarn (cal/dolom)	Bierwith, Nimoyima, CSIRO
Silicates			
Sericite / muscovite /	(5+7)/6	Phyllic alteration	Rowan (USGS);
illite / smectite			Hewson (CSIRO)
Alunite / kaolinite / pyrophyllite	(4+6)/5		Rowan (USGS)
Phengitic	5/6		Hewson
Muscovite	7/6		Hewson
Kaolinite	7/5	Approximate only*	Hewson
Clay	(5x7)/6 <sup>2</sup>		Bierwith
Alteration	4/5		Volesky
Host rock	5/6		Volesky
Silica			CONTRACTOR D
Quartz rich rocks	14/12		Rowan
Silica	(11×11)/10/12		Bierwith
Basic degree index (gnt, cpx, epi, chl)	12/13	Exoskarn (gnt, px)	Bierwith, CSIRO
SiO2	13/12	Same as 14/12	Palomera
SiOz	12/13		Nimoyima
Siliceous rocks	(11×11)/(10×12)		Nimoyima
Silica	11/10		CSIRO
Silica	11/12		CSIRO
Silica	13/10		CSIRO
Other			
Vegetation	3/2		
NDVI	(3-2)/(3+2)	Normalised difference vegetation index	

Other possibly useful ASTER band calculations and combinations are listed below.

Abrams Ratio - 5/7, 4/5 and 3/1 in RGB

Sabin Ration -5/7, 3/1 and 3/5 in RGB



Mineral Indices of Ninomiya (2004)

OH Minerals Index – (Band 7/ Band 6) \* (Band 4/Band 6)

Kaolinite Index - 4/5 \* 8/6

Alunite Index - 7/5 \* 7/8

Calcite Index - 6/8 \* 9/8

Porphyry Alteration Index – 4, 6 and 8 and RGB (advanced argillic and phyllic alteration in pink to red colours)

Alunite and kaolinite enhanced by 4/5 or 4/6

Sericite - phyllic alteration enhanced by 5/6

Propylitic alteration enhanced by 5/8

Remember the resulting images may have artefacts caused by low sun angles, clouds, etc. so be cautious in using the data. Remote sensing vendors can undertake more advanced processing and interpretation of this data, and the rough processing described herein should be used with caution.

## 11.3 Landsat Data

Landsat 8 data is collected over 11 bands as illustrated below.

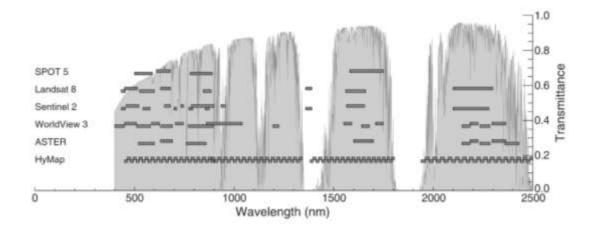
Band Reference Number	Band Description	Band Center (nm)
1	Coastal Aerosol (Operational Land Imager (OLI))	433
2	Blue (OLI)	482
3	Green (OLI)	562
4	Red (OLI)	655
5	Near-Infrared (NIR) (OLI)	865
6	Short Wavelength Infrared (SWIR) 1 (OLI)	1610
7	SWIR 2 (OLI)	2200
8	Panchromatic (OLI)	590
9	Cirrus (OLI)	1375
10	Thermal Infrared Sensor (TIRS) 1	10800
11	TIRS 2	12000

Landsat 8 band combinations are usually bands 4, 3 and 2 in the R, G and B channels for an aerial photo type image, whereas the combination of bands 6, 4 and 2 typically enhances the geology. Band 8 is used to pan-sharpen the 30 m images to 15 m resolution. The SCP plug-in will automatically pan-sharpen the RGB images if this option is selected.



## 11.4 Sentinel 2 Data

The Sentinel 2 satellites are designed for earth observation and the figure below illustrates the comparison with the other satellite data bands (from van der Meer et al 2014). The Sentinel satellite constellation has been launched by the European Space Agency (ESA) and the derived data is available free of charge. See ESA website (<u>https://sentinel.esa.int/web/sentinel/home</u>) for more detail on the available data and data access. You need to register (free) on the Sentinel web site to be able to download the Sentinel data.



When using Sentinel 2 data, it is recommended to use bands 4, 3 and 2 (for RGB) for the natural aerial photo type image and a combination of bands 12 or 11, 4 and 2 (for RGB) which can enhance the geology in a scene. Users should experiment with various band ratios to find which is the most suitable for their application.

The following list of recommended band combinations is from the Sentinel education web page (https:/Sentinel-hub.com/develop/education).

Natural Colour	B4 (red), B3 (green), B2 (blue)
Colour Infrared (vegetation)	B8, B4, B3
False Colour (Urban)	B12, B11, B4
Agriculture	B11, B8, B2
Vegetation Index	(B8 – B4)/(B8 + B4)
Moisture Index	(B8A – B11)/(B8A + B11)
Geology	B12, B4, B2
Bathymetric	B4, B3, B1
Atmospheric Penetration	B12, B11, B8A
SWIR	B12, B8A, B4
NDWI	(B3 – B8)/(B3 + B8)
SWIR-2	B2, B11, B12

The figure below from van der Meer et al 2014 compares ASTER ratio mineral mapping to the equivalent bands in the Sentinel 2 data.



Sentinel-2 band ratios as an analogue of ASTER band ratios, used as proxies for mineralogy. Modified after Kalinowski & Oliver (2004). The table is limited to ratios that fall in the wavelength range of Sentinel-2.

Feature	ASTER	Sentinel-2
Iron		
Ferric Iron, Fe3+	2/1	4/3
Ferrous Iron, Fe2+	5/3 + 1/2	12/8 + 3/4
Laterite	4/5	11/12 <sup>a</sup>
Gossan	4/2	11/4
Ferrous silicates (Biotite, chloride, amphibole)	5/4	12/11 <sup>a</sup>
Ferric oxides	4/3	11/8
Carbonates/Mafic minerals		
Carbonate/Chlorite/Epidote	(7 + 9)/8	÷.
Epidote/Chlorite/Amphibole	(6+9)/(7+8)	-
Amphibole/MgOH	(6 + 9)/8	7
Amphibole	6/8	-
Dolomite	(6 + 8)/7	-
Silicates		
Sericite/Muscovite/Illite/Smectite	(5 + 7)/6	-
Alunite, Kaolinite, Pyrophyllite	(4+6)/5	-
Phengitic	5/6	-
Muscovite	7/6	-
Kaolinite	7/5	-
Clay	$(5 \times 7)/6^2$	-
Alteration	4/5	11/12 <sup>a</sup>
Host rock	5/6	
Other		
Vegetation	3/2	8/4
NDVI	(3-2)/(3+2)	(8-4)/(8+4)

<sup>a</sup> ASTER bands 5-7 fall within band 12 of Sentinel-2.

# 11.5 Creating RGB Images

There are two methods available to create a coloured image ("rgb") of remote sensing or any other 3 band data set. We can use the Raster > Miscellaneous > Build Virtual Raster option or the "Vitual Raster Builder" plugin. Ensure you have the files in the correct order as it assigns the red channel to the lowest image, green to the middle image and blue to the upper image in the Browser panel.

The Raster option is shown below.



Project Edit View Layer Settings Plugins Vector	Raster Database Web MMQGIS SCP Processing Help
	Image: Align Rasters     Align Rasters       Georeferencer     Image: Align Rasters
	Analysis +
Browser	Projections •
	Miscellaneous 🕨 🎽 Build Virtual Raster
Geology	Extraction   Raster information  Conversion  Merge  Build overviews (pyramids)
SatelliteData	Tile Index

The Build Virtual Raster window will be displayed. Select the input layers as the ones to use for the RGB composite.

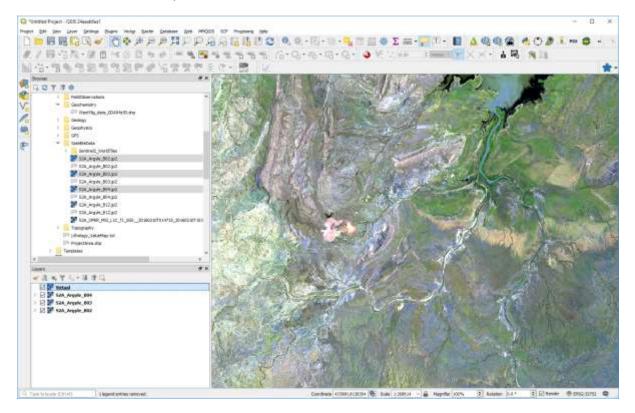
Parameters Log			
nput layers			
0 elements selected			
lesolution	Q Multiple selection	1 ×	
average	2 S2A_Argyle_802 [EPSG:32752]	Select al	
⊡ Layer stack	S2A_Argyle_803 [EP\$G:32752]		
Allow projection differen	S2A_Argyle_B04 [EPSG:32752]	Clear selection	
Virtual	S2A_Argyle_B12 [EPSG:32752]	Toggle selection	
(Save to temporary file)		Add file(s)	1961
🗟 Open output file after nu		OK	
a			
GDAL/OGR console call		Cancel	
gdabudhrt -resolution ave processing_93040a14fe164 processing_93040a14fe164			emp/
			0% Const
un as Batch Process		Run in Background Close	Heb



Q Build Virtual Raster	?	×
Parameters Log		
Input layers		
3 elements selected		
Resolution		
highest		•
☑ Layer stack		
Allow projection difference		
Virtual		
[Save to temporary file]		
Open output file after running algorithm		
GDAL/OGR console call		
gdalbuildvrt -resolution highest -separate -input_file_list C:/Users/Grant/AppData/Local/Temp/ processing_93040a14fe1646739b9eaee7a5666ab3\buildvrtInputFiles.txt C:/Users/Grant/AppData/Local/Temp/ processing_93040a14fe1646739b9eaee7a5666ab3/80b598999c324a118ae6d5fca47ce56b/OUTPUT.vrt		
0%	Ca	ncel
Run as Batch Process Run in Background Close	н	elp

Select the "Highest" resolution to ensure you obtain the highest resolution possible and is similar to "pansharpening" where the larger pixels will be resampled to match the smaller pixels. Press "Run in Background" and the composite colour image will be produced as a virtual image.

To save this file permanently, you need to right-click on the "Virtual" file name and save as a chosen file format, usually GeoTiff.



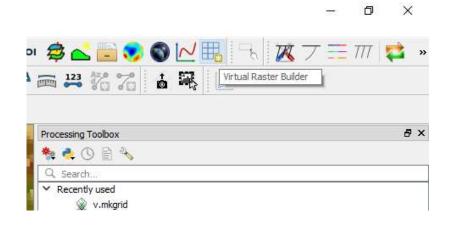


To adjust the colour stretch, zoom into a part of the image where you want to see more detail and then use the Layer panel to right click on the RGB layer and select "Stretch using current extent". This can be done multiple times until you get the desired result (see below for example). Alternatively you can activate the "Raster Toolbar" and use the toolbar to adjust the colour stretch.



The "Virtual" RGB image is currently only a temporary file. To create a permanent image, right click on the image layer in the Layers panel and select "Save As" Select the "Rendered Image" option, click the "Browse" and select the folder and required file name. Change the coordinate system if required. When all is OK, click OK. It may take some time to create the tiff file depending upon the size of the image and the speed of your computer.

The other option for producing the RGB image is by using the "Virtual Raster Builder" plugin.





He Virtual Raster Builder 0.5					-				×
VRT Structure	Source Files	Output	Help						
	Filter			·	译	1	8	M.	×.
Virtual Raster * Band T \$2A, Argyle, B12a * Band 2 \$2A, Argyle, B04a * Band 3 \$2A_Argyle, B02a	File/Band > S2A_Argyl > S2A_Argyl > S2A_Argyl	e_804.jp2	Value/Description						
Files 3 #Bands 3 ▼ Spatial Extent 月月月100 13									
0%									

Add the files via the "Source Files" tab and these can be renamed in the left hand side window for reference purposes, e.g. Band1 can be renamed to Band12. The RGB creation is done via the "Output" tab and this creates a temporary virtual file.

H Virtual Raster Builder 0.5						1.27		×
VRT Structure	Source File	a Output	Help					
14 in 11 11 11 12 10 12 0	Path	F: \QG2S Wor	shops Workshop Project	Files\Satu	fiteData'o	utput.vrt	•	1
Virtual Raster		1n-Memory	open after creation					
V Bend 1	No data							_
SZA_Argyle_B12.j	CRS	as source	fies					
S2A_Argyle_B04j		SP56/32752	WEIS BA / WITH JONE 525					11 112
<ul> <li>Band 3</li> <li>S2A_Argyle_B02.j</li> </ul>	Bounds	🗹 automatic						
		aner jam		1982	NAMES:			
		y mits com		1991	ymme.			
	Resolution	highest *	980					
	NERO BIRNI	ing ican						
#Files 3 #Bands 3	30		2.94)					
▼ Spatial Extent	Resampling	NearestNeigh	bour					
月月月 日								
· · · · · · · · · · · · · · · · · · ·								
9						ave .	Ca	criel
0%					-			nulai
.078								

The resulting RGB image can be saved via the Save Raster layer option.

🔇 Save Raster I	ayer as						?	×
Output mode 🔾	Raw data 🔘	Rendered imag	je					
Format GeoTIFF	:					•	Create	VRT
Save as GIS\Wo	rkshops\Worksho	p08_v3\Projec	:tFiles\Sat	elliteData\Se	ntinel\SA2_Ar	gyle_12-4-2_t	if.tif 🖾	
CRS EPSG:2835	2 - GDA94 / MGA	zone 52					•	
Add saved file	e to map							
Extent (cur	rent: layer)							^
		North 82000	000.0001					
West 399960.	0000			E	ast 509760.	0000		
		South 80902	200.0001					
Current	layer extent	Calcula	te from la	iyer 👻	Map vi	ew extent		
Resolution	(current: laye	r)						
Horizontal	10		Vertical	10		Layer re	esolution	
O Columns	10980		Rows	10980		Laye	er size	
Create	Options							
Profile Defaul	t						~	
		Name				Value		
								~
					OK	Cancel	Help	

Note there are options for saving as a geopackage or GeoTiff file and modifying the output projection Geopackage files are much more compact (smaller) than equivalent GeoTiff files.

To merge adjacent satellite images/bands, use the Processing Toolbox > SAGA > Raster tools > Mosaic raster layers. Option settings that have worked in merging adjacent ASTER scenes are Interpolation – "4 B-Spline", Overlapping areas – "6 feathering", Blending distance – "1000", Match – "regression", Cell size – "15" (or 30 m, 60 m, 90 m - to match the relevant pixel sizes for the images being merged), Fit – "Cells" and save to a file. All other setting as default.

If you have problems merging adjacent satellite images where you get edge effects between adjacent scenes, try downloading and installing SAGA (<u>http://www.saga-gis.org/en/index.html</u>). This a powerful and free GIS analysis program and has a good help file (<u>https://sourceforge.net/projects/saga-gis/files/SAGA%20-</u>

%20Documentation/SAGA%205%20User%20Guide/. The mosaicking option is found in the

Geoprocessing > Grid > Grid System > Mosaicking menu item. Use the Match option "match histograms of overlapping area".

## 11.6 Principal Components Analysis (PCA)

Principal Components Analysis (PCA) can be undertaken using the Semi-Automatic Classification plugin or via the Orfeo Tool Box (https://www.orfeotoolbox.org/CookBook/QGISInterface.html). The input files for the PCA analysis require they have the same pixel size and may require resampling if necessary (see Processing Toolbox > SAGA > Raster Tools > Resampling). The easiest way to ensure the a common pixel size is to create a multiband raster using the Build Virtual Raster and selecting the "Highest" resolution option.

If you need to resample the raster to a different cell/pixel size, ensure you check the cell size and "Fit" to cell, otherwise it will offset the resulting image.

<b>Q</b> Resampling			×
Parameters Log			
Grid			
S2A_Argyle_B12 [EPSG:32752]			×
Preserve Data Type			
Upscaling Method			
[0] Nearest Neighbor			~
Downscaling Method			
[0] Nearest Neighbor			~
Output extent (xmin, xmax, ymin, ymax) [optional]			
[Leave blank to use min covering extent]			
Cellsize			
10.000000			
Fit			
[1] cells			$\sim$
Target system [optional]			
			~
Grid			
[Save to temporary file]			
Open output file after running algorithm			
		0%	Cancel
Run as Batch Process	Run	Close	Help

In the SCP plugin, create a Band Set using the Band Set tab. Press refresh to show what bands are available (in the Layers panel) then select the layers to be used for the band set – highlight the required bands, then click the plus symbol "Add band to band set". This set of bands will be used in the PCA analysis.



Brain	H.X.					_
43770	Servi-Automatic Classificat	too Pluge				
<ul> <li>AST_Angula_TREDUR</li> <li>AST_Angula_TREDUR</li> </ul>	a Band set	Automatic productor				
🂕 AGT_Augule_TRUIAR	and Ball tests	5			1	0
<ul> <li>AST_Argola_T#1508</li> <li>AST_Argola_T#1608</li> <li>AST_Argola_T#1608</li> </ul>	A Download products	Single leaved list				
F AST_Angele_WelkT.of	[- Proproceeding	AST, Argula, SHIM AST, Argula, SHIM				U
ACT_Augule_VINELISE ACT_Augule_VINESISE	· Saud processing	AST_Argin_Stifts				E
2 compartilid 9000005e41906 09323 891933091 3.58	C Postpresessing	AST_Armite_Set81				+
Support Methods/S005644066952096440001268 Support Methods/S005644068952094410001268	E Rend tak	AST_Argin_THEE AST_Argin_SHIES				-
2 extpart10/98036490695230/e193891.4a/	S Seich	Destinet Drimpe				2.1
mappin18d9800005er105691200e11000113.00 august18d900005er106095230e113301.608	X Settings	Band set 1				1
PCA_basd_12#	About	Bandroome	Center-univelength	the second second		
PCA, band, 218	The ser manual	1 AST_Algyle_SWRM	10	Multiplicative Fector	8	1
4000 《吉韦学儿·法律征	S Online help	7 AST, Argyle, SW85 1 AST, Argyle, SW86	1.0 1.0	4	0	I
State		<ul> <li>AST_Arg/re_SWR7</li> <li>AST_Arg/re_SWR9</li> </ul>	4.0 5.0	1	0	1
State Annalis Annalis America		<ul> <li>ATLAsg/s_SW90</li> </ul>	80	Ť	D	LES
South State S						E
🗆 🎾 All Jospin Sullina						E.
N N 1 Performance	Support Bix SOF	1+1				100
		Quit causings artings aTRS (bands 1, 2, 3), 5 2, 6,	7, 4, 4, 18, 18, 18, 19, 19 (c)	(iii 3i) is Tru Rented	- 1	
		Excitor total			-	ĩ

Click on the Band Processing tab and select PCA. Check that the input band set is correct, select 3 components (required for an RGB colour image) and press Run. Select the target directory for the results to be saved. Note in the image above I have used the SWIR ASTER bands for the PCA analysis.

🗲 Band set	1	
	Band combination 🛛 🖉 PCA	🏂 Spectral distance
Basic tools		I
👆 Download products	Input	
<ul> <li>Preprocessing</li> </ul>	Principal Components Analysis of band set	
Band processing	Select input band set 1	
<ul> <li>Postprocessing</li> </ul>	Use NoData value	
🚆 Band calc		
S Batch		
🗙 Settings		
🦻 About	Run	_
🗐 User manual		RUN 🗞
Online help		
Support the SCP	Output	

This process will produce three PCA images, PCA1, PCA2 and PCA3. Use the Virtual Raster Builder plugin to produce the RGB image (as above).

## 12: MAP PRODUCTION

## 12.1 Print Layout

The Print Layout is the tool to produce maps for output. Various standard page sizes can be selected as well as creating custom sizes. Everything to do with the final map design is done in the print layout. Map creation is described in Hands-On Workshop 1. If you lose tab views, click on the "Views" menu option in the layout window and scroll down to Panels to reselect them for display.

To ensure you get true scale plots, it is important to have the main map projection in a metres projection (i.e. UTM) and not in a geographic lat/long projection. Problems may be created with the scale not being correct on the map output when the main map window is in a lat/long projection.

## 12.2 Map Templates

Templates can be constructed for use with a variety of map sheets sizes, e.g. A4, A3, A2, A1 and A0 in either landscape or portrait orientation. Frames and title blocks are simply constructed as rectangles and standard text boxes added into the rectangles. Shapes and text boxes are selected from along the left-hand side margin of the map composer window. The figure below illustrates an example of a template complete with title block. Templates can be dragged into the print layout window from the Browser panel, which will then automatically set the correct page size.

	 S Greeker-CreaterGelige
	 Give Jean-Consider Catage TITLE SubTitle



Each item of the template is listed in the Item panel and can be turned on or off and edited. Note that the position of the features can be set and adjusted using the "Position and Size" options in the item properties dialog box. Each item, e.g. page frame, insert box, logo, etc., has its own item properties and these can be varied independently.

• •	1	হ	>				
34	Layo	ut	Item Properties	Items			
	Items					8	×
	۲		Item				
			T Title				
			T SubTitle				
			T Author				
			T Drawn				
	$\square$		T DwgNo				
			Projection	1			
			T Date				
			T Revised				
			T RptNo				
				Conc	ultant		
		$\checkmark$			ulldil		
		$\checkmark$	Grant Log InfoBlock				
		$\mathbf{\nabla}$	VerticalLir	-			
	$\square$	$\leq$	TitleBlock	_	sert		
		$\overline{\checkmark}$	TitleBlock	-			
		$\overline{\nabla}$	TitleBlock	-			
		$\overline{\checkmark}$	TitleBlock	_ _TopInse	ert		
			TitleBlock	_outline			
			Page_Out	line			
	Guidea	-				æ	×

The image above shows all the items that map up the map frame.



icture					
0.00 °	(				÷
Syr	ic with map				7
North a	lignment	Grid north			*
Offset		0.00 °			\$
	tion and siz	ze			
Page	1				•
x	215.043 mr	143 mm			¢,
Y	152.256 mm			<b>*</b>	€,
Width	8.467 mm				€,
Height	7.408 mm				€,
Referen	nce point				

The example above is the "Logo" item (diamond image on the layout) and its location is referenced to the top left-hand corner of the page as shown in the 3 x 3 box array. It is located 215 mm to the right and 152 mm below the top left hand corner of the page, with a width of 8 mm and a height of 7 mm.

Each text box has a location and is edited as required in the Label > Main Properties window. The image below shows the "Author" field selected and the details can then be added to the existing text, or changed as required. If the text boxes require adjustment, use the position and size options attached to the item.

Grant Boxer	- Consultant Geologist	Ime     Ime     Ime     Surface     Active     Drawn     Draw
	SubTitle	Calant 🗢 Plais proportina
Author	91	• This preparities . Action
Author:	Date:	• Nuix properties
Drawn:	Date: Revised:	This preparities     Action     Action     The second
	Date:	This properties     Autor     Autor     Autor     Autor     The second sec

Note that these templates may require adjustments for different printers and plotters depending on their "print area".

The position and size of the inserted map window can be adjusted under the "Map" item properties and using the "Position and Size" options. The reference point in the figure below shows the measurements from the top LHS of the page.

			_					
		T Grant E	Boxer - Cons	sultant				
		📉 Grant L	.ogo					
		🔲 TitleBlo	ock_ForthIn	sert				
L			al. Thindle					4
	Item Propertie	es					ð	×
	Map 1							
	Overvie	ws						^
	Position	and Size						
	Page	1		-				
	x	25.000	•		٦			
	Y	35.000	<b></b>	e,	_	mm	~	
	Width	790.000	•		٦	mm		
	Height	475.000	•	e,	J	mm	~	
	Reference	● ○ point ○ ○ ○ ○	Õ					Ī
	Rotatio	n						
	🕨 🗌 Fran	ne						۷
5.677 mm	page: 1		26.3%	~				

To insert a map of fixed/pre-determined size, in the Print Layout, select the View > Manage Guides and set the horizontal and vertical guide lines. The inserted map windows can then be adjusted to fit these guide lines. Grids can also be used to align map items.

Guides		x
Page 1  Horizontal Guid	es	•
10	mm	
200	mm	
<ul><li>♥ ■</li><li>♥ Vertical Guides</li></ul>		
16	mm	
285	mm	
<b>+</b>		
	Apply to All Pages	
	Clear All Guides	

## 12.3 Layout Manager

The layout manager shows what layouts are attached to the project. You can have many layouts of different sizes and configurations all saved with the project. If you have a set layout where you need different themes on maps, you can use the duplicate button to make a copy of the layout. Note that you need to "lock" layers in a layout to prevent a refresh from re-drawing the layout display.



🖄 Layout Manager	—		$\times$
A1L Neereno Excursion Localities			
Show Duplicate Remove		Rename	
▼ New from Template		Kename	
Empty layout		Crea	te)
Open template directory User Default			
		Close	Help

## 12.4 Using Variables to Display Information

Variables can be used to populate information in text boxes, e.g. the map author's name, QGIS version, or the file path to the Project file. There are various types of variable and they can be applied globally, for a specific project or layout.

Global variables apply to QGIS overall and they can be found in the manin menu item Settings > Options and the Variable tab.

<b>Q</b> Options   Variables			×
<u>ि</u> ।	Expression Variables		
🔀 General	Variable	Value	
System		Value	
System	qgis_locale	'en'	
🌐 CRS	ggis_os_name	'windows'	
Ĩ.	ggis_platform	'desktop'	
Data Sources	ggis_release_name	'Master'	
🞸 Rendering	qgis_short_version	'3.9'	
Kendening	qgis_version	'3.9.0-Master'	
🖾 Canvas & Legend	qgis_version_no	30900	
	user_account_name	'Grant'	
Map Tools	user_full_name	'Grant'	
Colors	author_name	'Grant Boxer'	
Colors			
📝 Digitizing	****		
Layouts			
🥙 GDAL			
8 Variables			
Authentication			
르륵 Network			
Q Locator			
1 Advanced			F F
Acceleration			
🔆 Processing			OK Cancel Help

A number of default global variables are added by QGIS. Note that I have added a new variable name "author\_name" with its value being Grant Boxer. I can then use this variable to add my name anywhere on a layout by using the [%@author\_name%] statement.

950	Item Properties Layout Items		
	Item Properties		×
L	abel	_	_
	▼ Main Properties		
	Author: [%@author_name%]		
	Render as HTML		
	Insert an Expression		
	▼ Appearance		
	Font		•
	Font color		
	Horizontal margin 1.00 mm	≪	•
_	Vertical margin 1.00 mm	$\otimes$	÷
	Horizontal alignment		



There are similar windows for the Project Properties and Layer Properties.

	Variables	
Information	Variable	Value
	▼ Global	
Source	qgis_locale	'en'
🖌 Symbology	qgis_os_name	'windows'
Junioology	qgis_platform	'desktop'
Labels	qgis_release_name	'Master'
	qgis_short_version	'3.9'
Diagrams	qgis_version	'3.9.0-Master'
	qgis_version_no	30900
💋 3D View	user_account_name	'Grant'
	user_full_name	'Grant'
Source Fields	author_name	'Grant Boxer'
Attributes Form		
	project_abstract	и 1
🚺 Joins	project_area_units	'square meters'
_	project_author	u de la construcción de la const
Auxiliary Storage	project_basename	'LwrSmkCk_201906.ggs'
	project_creation_date	<datetime; 00:00:00="" 2000-01-01=""></datetime;>
Actions	project_crs	'EPSG:28352'
	project_crs_definition	'+proj=utm +zone=52 +south +ellps=GRS80 +towgs84=0,0,0,0,0,0,0,'
Display	project_distance_units	'meters'
/	project_ellipsoid	'NONE'
Rendering	project_filename	'LwrSmkCk_201906.qgs.qgz'
Variables	project_folder	'F:\Projects\Diamonds\LwrSmkCk'
yanables	project_home	'F:\Projects\Diamonds\LwrSmkCk'
📝 Metadata	project_identifier	
	project_keywords	0
Dependencies	project_path	1/ 'F:\Projects\Diamonds\LwrSmkCk\LwrSmkCk_201906.ggs.ggz'
	project_title	r: (Projects (Diamonas (EwismikCk (EwismikCk_201900.qgs.qg2
Legend	▼ Layer	
-		eman lawan
🛃 QGIS Server	layer layer id	<map layer=""></map>
🖉 Digitizing	layer_id	'CurrentTenements_d17f6969_4b97_4e9d_9bd8_f6237c540c82' 'CurrentTenements'
🖄 Digitizing	layer_name	Currencienements
		수 · · · · · · · · · · · · · · · · · · ·
	Style 🖕	OK Cancel Apply



# 13: MISCELLANEOUS TRICKS AND TIPS

# 13.1 Access Databases

Connecting to an Access database requires some additional steps than required for the open source database programs.

Open the 64-bit ODBC admin window (via the Windows search box) and add another "Access 64-bit line", select the database name and location in the User DSN tab – e.g. "LateriteChem".

No.	S ODBC I	Data Source A	dministra	ator (64-bi	t)					:	×
	User DSN	System DSN	File DSN	N Drivers	Tracing	Connection	Pooling	About			
	<u>U</u> ser Data	Sources:									
	Name		Platform	Driver					A <u>d</u> d.		
	Access Excel Fil		64-bit 64-bit	Microsoft B	Excel Drive	ver (*.mdb, *.a r (*.xls, *.xlsx	, *.xlsm, *.	xlsb)	<u>R</u> emo	ve	
	Laterite( MS Acc	Chem ess Database	64-bit 64-bit			ver (*.mdb, *.; ver (*.mdb, *.;	· · · ·		<u>C</u> onfigu	ire	
	<							>			
						about how t n only be use			indicated data p er.	rovider. A	
						OK	Cano	el	<u>A</u> pply	Help	



ODBC Microsoft Access Setup	? ×
Data Source <u>N</u> ame: LateriteChem	OK
Description:	Cancel
Database	
Database: F:\\FullData\YilgamAtlasGeochem.mdb	<u>H</u> elp
<u>S</u> elect <u>C</u> reate <u>R</u> epair Co <u>m</u> pact	Advanced
System Database	
● Non <u>e</u>	
◯ Da <u>t</u> abase:	
S <u>v</u> stem Database	Options>>

In the Open Data Source Manager, select the Add Vector option, and type of Database. Connect to the database and Add.

🔇 Data Source Manag	er   Vector			? X	(
Erowser	Source type				
Vector	○ File ○ Directory	: HTTP(S), doud, etc.			
Raster	Encoding	System		•	
Delimited Text	Database				
🤗 GeoPackage	Type ODBC Connections			•	
🌽 SpatiaLite	LateriteChem			•	
PostgreSQL	New	Edit	Delete		
MSSQL					
Oracle					
DB2 DB2					
Virtual Layer					
wms/wmts					
🛟 wcs					
💬 wfs 🗸			Close <u>A</u> dd	Help	



🔇 Create a New O	GR Database Connection	×							
Connection Inform	nation								
<u>T</u> ype	ODBC -								
Name	Name LateriteChem								
Host	Host								
<u>D</u> atabase	LateriteChem								
Port	Port								
Authentication									
Configurations	Basic								
	te an authentication configuration								
No authentica	tion 🔹 🥢 📼 🕀								
Configurations authentication	store encrypted credentials in the QGIS database.								
	Test Connection								
	OK Cancel Help								

The next window will display the tables available for import.

ayer ID	Layer name	Number of features	Geometry type	
0	AtlasAnalyses	0	Unknown	
1	AtlasAnalysesPGE	0	Unknown	
2	AtlasAnalysisLog	0	Unknown	
3	AtlasLaboratory	0	Unknown	
4	AtlasMethods	0	Unknown	
5	AtlasSampleCharacteristics	0	Unknown	
6	AtlasSampleDetails	0	Unknown	
8	Extract flat table	0	Unknown	
7	Standards: AnalysesStandards	0	Unknown	

If the table has spatial data, e.g. coordinates, then after import, use the Processing Toolbox > Algorithms > Vector Creation > Create Points Layer from Table, and select the field for the coordinates and the applicable Coordinate Reference System.



# 13.2 AutoSaver Plug-In

The Auto-Saver plug-in will save your project at regular intervals. I have had problems with this turned on during digitising and I recommend it is turned off when creating new files.

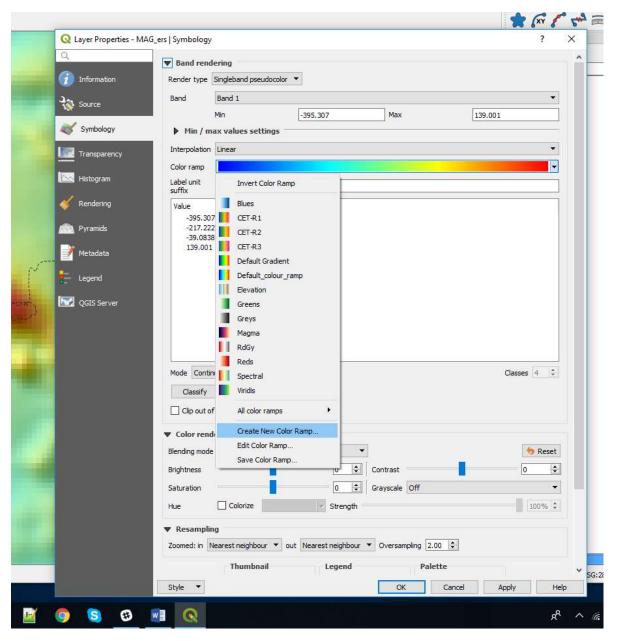
# 13.3 Spatial Bookmarks

Bookmarks are used to remember the extents of a map window and they are saved with the project data. When a bookmark is saved, the bookmark list panel is displayed. Bookmarks are created via View > New Bookmark or via the Browser panel.

# 13.4 Colour Ramps

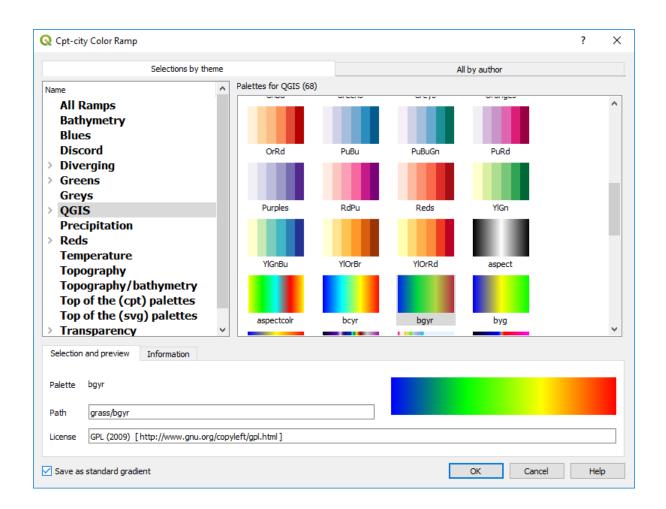
To add additional colour ramps to the default option use the "Create New Colour Ramp" from the drop down box to the right of the Color Ramp selection box,. The preset colour ramps are shown in the "Color Ramp" dialog box and I recommend the Catalog: cpt-city option which will display the next dialog box.

There are many different groups to select from, but I prefer the QGIS tab, and the continuous colour bands, e.g. "bgyr".



436 54	-217 -39.1 139			
	Q Color ram	?	×	
	Please select color rai	mp type	:	
	Gradient		-	
	Gradient			
	Color presets Random			
l	Catalog: cpt-city			
	Catalog: ColorBrewe	r		_
ous 🔻				
#	- 2 🖻 🗟			
ange values	1			

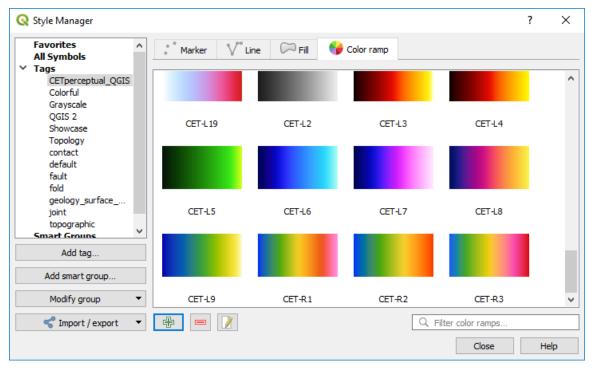




New colour ramps can also be imported via the Style Manager dialog box.

The Centre for Exploration Targeting (CET) in Perth have developed colour ramps that are better for visual perception (see this link <u>https://peterkovesi.com/projects/colourmaps/</u>). They are available in a QGIS xml format that can be imported via the Style Manager. These styles can then be access as favourites. My preference for data grids such as magnetics is to use the CET-R1 colour ramp.





#### 13.5 Colour Selection

To assist in selecting colours for maps, you can visit the ColorBrewer website (<u>http://colorbrewer2.org</u>) where rgb, hex and cymk values of a huge variety of colour options can be viewed and selected as required.

#### **Data Searching**

When searching large datasets, a number of options can be used. Spatial searches can be done in your map window but text searches are best done via the Expression form.

Highlight the layer in the Layers panel, bring up its attribute table and click on the "Select Features Using an Expression" button.

1	DH_LenRiv_Noon :: H	Features total: 1753	5, filtered: 17535, se	lected: 0					- 0	×
1	282 55	1 5 <b>8 5 9</b>	TIOP	8 B IS IS	副語					
	A_Number	Hale_ID	Lwtitude	Longitude	Easting	Northing	MGA_Zone	Max_depth	Hole_type	2
1	59481.00000000	DVDH800	-17.4713395183	124.6855963214	678987.0000000	8067511.000000	51.00000000000		AC	21
2	59481.00000000	DVDH803	-17.4726948067.	124.6856087811	678987.0000000.	8067361.000000	S1.00000000000		AC	21
3	59481.00000000	8LDH3055	-17.4798308999	124.6858815523	679009.0000000	8066571.000000	51.00000000000		AC	21

This will bring up the expression editor window. Click on the central panel to select the field to search in, then press "all unique" in the lower right hand side of the dialog box to show all the entries in this field. You can filter by entering values into the "Values" window. Double click the field name to enter it into the left hand panel. Use the function button to add a function, e.g. "=" and then double click on the value to search for in the right hand panel. Hit select to run the query.

💋 Select by expression - DH_LenRiv_Noon		? ×
Expression Function Editor		
= + - / * ^    ( ) ''n'	Search	group Field
"Hole_ID" = '04BAE17-01'	<ul> <li>Aggregates</li> <li>Color</li> <li>Conditionals</li> <li>Conversions</li> <li>Date and Time</li> <li>Fields and Values</li> <li>A_Number</li> <li>NULL</li> <li>Project_Na</li> <li>Hole_ID</li> <li>Tenement_O</li> <li>Latitude</li> </ul>	Double click to add field name to expression string. Right-Click on field name to open context menu sample value loading ontione Values Search VdBAE17-01' '04BAE17-02' '04BAE17-03' '04BAE17-04' '04BAE17-04' '04BAE17-05' '04BAE17-05'
Cutput preview: 0	Longitude v	Load values all unique 10 samples
		ତି Select ▼ Close

Go to the attribute table and select the "Move selection to top" of the table. This may take a little while in large datasets but it will display the selected record(s) at the top of the table and highlight them.

-	A tamber	Hole_ID	T T P	Localtate	Easting	Northing	MGA_Zone	Max_depth	Hole_t	and the second
	70092 00000000	a statement of the second s	Nove select	ton to top	709205-0000000	80701901000000	51.00000000000		10	1
	59481.00000000	OVDH800	-17.4713395183	124.6855963214	678987.0000000	8067511.000000	51.0000000000		AC.	2
	59481.00000000	DVDH803	-17.4726948067	124.6856087811	678987.0000000	8067361.000000	51.00000000000		AC	2
ł	59481-00000000.	BLDH3055	-17.4798308999	124.6858815523	679009-0000000	8066571.000000	51.00000000000		AC	2
5	59481.00000000	8L0H3056	+17.4800567811	124,6858836303	679009-0000000	8066545.000000	51.00000000000000		AC	2

To show these on the map, select the "Pan map to selected rows" icon and the map will pan to the area of the selected features.

-	X 10 12 13 13 13	1 20 - 1 4	TEAP	10 ID ID	11 M					_
	A_Number	Hole_ID	Letitude part m	up to the selected ro	wirs (Ctri+P)	Northing	MGA_Zone	Max_depth	Hole_type	_
	75092.00000000	0404E17-01	-17.4445249038	124.9697496225	709200.0000000	8070190.000000	51.0090900000		LD.	ц
	59481.00000000	CVDH800	-17.4713395183	124,6855963214	678987.0000000	8067511,000000	\$1.00000000000		AC	21
	59481.00000000	DVDH803	-17.4726948067	124.6856087811	678987.0000000	8067361.000000	51.00000000000		AC	21
	59481.00000000	BLDH3055	-17.4798308999	124.6858815523.	679009.0000000.	8056571.000000	51.0000000000		AC	21
	59481.000000000	SLDH3056	+17.4800567811	124.6858836303	675005.0000000	8066546.000000	51.00000000000		AC	21

# 13.6 Digitising Toolbar (PlugIn)

Every tool is activated as soon as the active layer is of an appropriate type and in edit mode. Keep in mind that some tools need that the current layer's CRS matches the project CRS.

As a general rule of thumb your **editing layer's CRS and the project's CRS should match**. It makes life easier. If you need results in a different CRS, transform the layer after you have finished your digitizing session.

All edits can be undone/redone using QGIS' standard undo/redo capabilities.

## Description of the tools

Split multi part to single part

**applies to**: MultiPoint, MultiLine and MultiPolygon layer

- 1. batch mode: The selected multi-part features in the active layer are split into single part and added to the layer as new features, keeping the attributes of the original (multi-part) feature.
- 2. interactive mode: click on any multi-part feature. The feature will be split into single parts which are added to the layer as new features, keeping the attributes of the original (multi-part) feature.

Split off one part and add it as new feature

#### applies to: MultiPoint, MultiLine and MultiPolygon layer

Click on any part of a multi-part feature. The part will be deleted from the original feature and added as a new (single-part) feature to the layer keeping the attributes of its parent (multi-part) feature.

#### Split features

applies to: Line, multiLine, polygon and multiPolygon layers

Works exactly like *Split Features* tool in QGIS' *Advanced Digitizing Toolbar* when applied to non-multi features. When applied to multi features the user is asked via a dialog (see below) which of the newly created geometries (fraction of a part) should become the new feature. The other fraction stays as part within the original multi feature. Thus it replaces QGIS' *Split Parts*, too, which is of limited use, because its application results in an invalid geometry if the split-off part is not edited any further. The dialog shown when splitting multi-part features has four buttons:

- 1. Cancel aborts the current splitting operation and leaves all features untouched.
- 2. No to All aborts the splitting of the **current** feature and leaves it untouched.
- 3. No leaves the currently highlighted fraction in the multi-part feature.
- 4. Yes accepts the currently highlighted fraction for becoming the new feature.

Merge selected features

applies to: any layer with a primary key field, i.e. a database layer

This works as the *Merge selected features* button in QGIS Core, except that Core's *Merge selected features* deletes all selected features and then inserts a new feature. DigitizingTools' method offers the user to choose which feature to keep by choosing its primary key value. This feature's geometry is updated with the combined geometry of all selected features, while all other selected features are deleted. This feature will be removed once <u>#13490</u> is closed and implemented.

Exchange attributes between selected features

#### applies to: any vector layer

Exchanges the attributes between two selected features of the active layer. Reasoning: when splitting features in a layer coming from a database provider the user can thus control which feature is going to keep the primary key value (important for related tables).

Cut with polygon from another layer

applies to: line and polygon layer (multi or single part)

# R

#### QGIS In Mineral Exploration

Choose another layer whose selected features are used like a cookie cutter on the active layer. Everything that falls under the cutter feature(s) is erased. If a selection exists in the active layer only selected features are cut. In case a feature would completely disappear, a message is issued to the user, asking if this feature should be deleted.

Clip with polygon from another layer

**applies to**: line and polygon layer (multi or single part)

Choose another layer whose selected feature is used like a cookie cutter on the active layer. Everything that falls under this feature will survive, everything outside will be erased. If a selection exists in the active layer only selected features will be clipped.

Fill ring

applies to: polygon layer (multi or single part)

Fill rings (islands) in polygons with new features. This tool has two modes:

- 1. batch mode: all rings in the selected features are filled with new features. The attribute set for all features is identical and can be entered once if form popup after feature creation is not suppressed.
- 2. interactive mode: click into any the ring. A new feature is snuggled into the ring.

Fill gap

applies to: polygon layer (multi or single part)

Fill gaps between the selected polygons of the active layer with new features. The algorithm has to union all selected features first, thus the selection is necessary to speed up the process, especially if the layer contains **many** features. This tool has two modes:

- 1. batch mode: all gaps between the selected features are filled with new features. The attribute set for all features is identical and can be entered once if form popup after feature creation is not suppressed.
- 2. interactive mode: click into the gap to be filled. A new feature is snuggled into the gap.

Fill gap (all visible layers)

applies to: polygon layer (multi or single part)

Fill gaps between the polygons of all visible layers with a new feature: click into the gap to be filled. A new feature is snuggled into the gap.

Split selected features with selected line from another layer

applies to: line and polygon layer (multi or single part)

Splits all selected features of the active layer with the selected line feature of another layer. The splitting creates new features (not multi features). Each new feature resulting from being split retains its original attributes.

Flip line

applies to: line layer (multi or single part; does not make too much sense with multi part, though)

Flip the direction of a line, i.e. reverse the node order within the line. This tool has two modes:

- 1. batch mode: all selected lines are flipped.
- 2. interactive mode: click any line feature to have it flipped (successful clicking depends on layer's snap settings).

#### 13.7 Favourites

To add a directory as a Favourite for quick access, right click on the "Favourites" item in the Browser panel, then add directory. The favourite directory will then make it much quicker to access commonly used files.

#### 13.8 Point Sampling of Raster Data

To find point values in a raster grid, use the Processing Toolbox > Raster Analysis > Sample Raster Values algorithm. This creates a new layer which can then be used to overwrite the original layer with the new values.

🔇 Sample Raster Values	×
Parameters Log	 Sample raster values
Input Point Layer          • * FieldLocalities_shp [EPSG:28350]       • …          Selected features only         Raster Layer to sample	This algorithm creates a new vector layer with the same attributes of the input layer and the raster values corresponding on the point location. If the raster layer has more than one band, all the band values are sampled.
✓ Merged_1s_SRTM [EPSG:28350] ✓ ✓ Advanced parameters	
Output column prefix	
Elevation	
Sampled Points	
[Create temporary layer]  ✓ Open output file after running algorithm	
0%	Cancel
Run as Batch Process	Run Close Help

The Point Sampling plug-in tool can also be used to sample points in a grid, e.g. drill hole collar elevations using a digital elevation grid. The output creates a separate file with the resulting values. The point and grid layers need to be in the same projection. The tool is found under the Plugin > Analysis > Point Sampling Tool.

Q Point Sampling Tool ?	×
General Fields About	
Layer containing sampling points:	
Drillholes_GeoPackage	•
Layers with fields/bands to get values from:	
Drillholes_GeoPackage : MAXDEPTH (source point)	^
Drillholes_GeoPackage : HOLEID (source point)	
Drillholes_GeoPackage : TARGET_COM (source point)	
Drillholes_GeoPackage : OPERATOR (source point)	
Drillholes_GeoPackage : PROJECT (source point)	
Drillholes_GeoPackage : ANUMBER (source point)	
Drillholes_GeoPackage : PERIOD_FRO (source point)	
Drillholes_GeoPackage : PERIOD_TO (source point)	
Drillholes_GeoPackage : EXTRACT_DA (source point)	
dem-9s : Band 1 (raster)	~
Output point vector layer:	
Points Browse	
Add created layer to the map	
Status:	
OK Close	2
Complete the input fields and press OK	.:

Select the layer containing the points to be used for the data extraction (drill holes), then select the fields to be exported with the points (Hole number), and then select the layer with the elevation data (e.g. dem-9s:Band 1). This will then create a file with hole number and elevation. This will then need to be joined to the drill collar file for example. I find it quicker to use the v.what.rast algorithm above, as this automatically undated the data field.

### 13.9 Profile Tool

This plug-in allows the user to put a line across a grid and obtain a profile along the line.

### 13.10 Points to Lines and Polygons

To create a line or polygon from a list of coordinates, for example an excel spreadsheet with tenement corners, use the Processing Toolbox > SAGA > Vector Line Tools > Convert Points to Lines and/or Convert Lines to Polygons.

### 13.11 QPackage

The QPackage plug-in allows the user to create a project file with an associated folder holding all the relevant layers for that project. Note that this will only copy vector files.

### 13.12 Quick Rectangles, Circles, Ellipse Shapes

The Shape Digitising tool bar allow the creation of vector shapes, e.g. rectangle and circles.

## 13.13 Refactor Field

The Refractor Field algorithm allow the modification of a tables' attributes. Be careful using this!

	Point	Detum	Zone	Easting	Northing	RL	ObsType	STRK_PLUNG	Dp	Contrient
1	G802	GDA94	50	397480.0000000.	6741475.000000	318.000000000				Pholitic laterit
ą	G803	GDA94	50	397560.0000000	6741440.000000	313.000000000	Bedding	45.00000000000	35.0000000000	Outcrop of las
3	GB04	GDA94	50	397583.0000000	6741378.000000	309,0000000000	Joint	335.000000000	75.0000000000	Breccia, vein
ŧ	GB04	GDA94	50	397583.0000000	6741378.000000	309.0000000000.				
1	GB05	G0494	50	397643.0000000	6741345.000000	305.000000000.	FoldAxis	25.0000000000.	45.0000000000.	Breccia, small
	G805	GDA94	50	397643.0000000	6741345.000000	305.0000000000				
7.	G805	GDA94	50	397470.0000000	6741470.000000	318-0000000000	Bedding	50.0000000000	35,0000000000	Top of pisolite
	G807	GDA94	50	398085.0000000	6741780.000000	307.000000000	Bedding	65.0000000000	35.0000000000	Breccia with g
ł	GBBB	GDA94	50	398037.0000000	6741806.000000	307.000000000	Bedding	75.00000000000.	35.0000000000	Granitic claste
0	G808	GDA94	50	398037.0000000.	6741806.000000	307.000000000				
1	GB09	GDA54	50	398040.0000000	6741845.000000	307.0000000000	Bedding	90.0000000000	35.00000000000	Megabreccia
2	G809	GDA94	50	398040.0000000	6741845.000000	307.0000000000.				
3	G809	GDA94	50	398040.0000000.	6741845.000000	307.000000000				

Note the fields with way too many decimals. These can be fixed using the Processing Toolbox > Vector General > Refactor Fields.

	ameters Log								- '	Refactor fields
	t lover PieldLocs: 2016 who (EPSG:28350)							•	161	This algorithm allows editing the structure of the attributes table of a vector layer. Fields can be
	elected features only								(Real	modified in their type and name, using a fields mapping.
ek	s mapping						Sector Sector			The original layer is not modified. A new layer is generated, which contains a modified attribute
	Source expression	1	Field name	Type	-	Length	Precision	^	1101	table, according to the provided fields wapping.
	whet Zone ~	3	Zone	String	*	254	0	100	100	
	1.3 Easting ~	3	Easting	Double		23	2		4	
	1.3 Northing ~	ε	Northing	Double	•	23	2			
	a.a RL v	£	RL	Double		23	2		10	
ć	alic ObsType 🗸	ε	ObsType	String		-254	. 0			
	1.2 STRK_PLUNG ~	ε	STRK_PLUNG	Double	*	23	31			
	1.3 Dip ~	Ë	Dip	Double	*	23	S1			
100	fields from layer Pield.ocs_2016_sho							to Fiel	ds mapp	ing
	ctored								non iden LOS_MA	
	alle terrene ar y beyer]							1.712	103,1994	CHARLE .
14	open output file after running algorithm									
										0% Canal

Field names, types and other info can be changed in this window.

### 13.14 Selecting Drill Holes by Tenement

To select drill holes in a tenement, simply highlight the drill hole layer in the Layers panel, then in the top menu bar choose, select Features by polygon, then right click on the polygon you want to use to select the drill holes, the select layer (e.g. tenements layer) will be listed, just select that



layer and the holes will selected for that tenement. Note this may not worked with layers in different projections.

The other method that can be used is the Processing Toolbox > Vector Selection > Select by Location algorithm.

<b>Q</b> Select by Location	? ×
Parameters       Log         Select features from <sup>°</sup> Drillholes_GeoPackage [EPSG:4283]	Select by location This algorithm creates a selection in a vector layer. The criteria for selecting features is based on the spatial relationship between each feature and the features in an additional layer.
Run as Batch Process	0% Cancel Run Close Help

If you hold the "Alt" key while making a selection QGIS, it switches from an "intersects" type selection to a "contains" selection mode. (This also works while holding the shift modifier to add to a selection, or ctrl to subtract from a selection!).

### 13.15 Spatialite Databases

A Spatialite database is a simple, single file database structure that can hold very large files but with the advantage that the data is spatially referenced. The spatial referencing allows the data to be quickly displayed when panning across a map. This is very useful for data such as the 250k vector data (from GA) for Australia or the large GSWA open file drill hole database.

The use of Spatialite database files can rapidly increase the speed of accessing large data sets. As an example, the entire 1:250 000 Geoscience Australia Australia-wide topographic vector data in zipped shapefile format is 1.01 Gb in size (GA file 64058.zip) and comprises many layers including road, rivers, etc. This file can be loaded into a Spatialite database file of about 3 Gb, but although a large file, the data is spatially indexed, and re-drawing of the data is very fast when panning from area to area.



Another spatialite option is to use the new GeoPackage file format which can store large datasets comprising vector, raster and non-spatial data.

## 13.16 Extracting Colour Styling Information from MapInfo Files

Colour polygon information can be extracted from MapInfo files using an RGB extraction routine in the MapInfo-Discover module.

## 14: REFERENCES

Abrams M and Hook S. 2016 (downloaded) ASTER User Handbook, Version 2. Jet Propulsion Lab, Pasadena.

Bureau of Mineral Resources. 1989. Symbols Used on Geological Maps. Geoscience Australia, publication GA21883.

Cutts A and Graser A. 2018. Learn QGIS – Fourth Edition. Packt Publishing, Birmingham.

Graser A. 2016. Learning QGIS – Third Edition. PACKT Publishing, Birmingham.

Graser A and Peterson G N. 2016. QGIS Map Design. Locate Press.

Janousek V, Farrow C M and Erban V. 2006. Interpretation of Whole-Rock Geochemical Data in Igneous Geochemistry: Introducing Geochemical Data Toolkit (GCDkit). Journal of Petrology, vol. 47, no. 6, p 1255-1259.

Kalinowski A and Oliver S. 2004. ASTER Mineral Index Processing Manual. Geoscience Australia, publication no. GA7833.pdf.

McQueen K G. 2017. Identifying Geochemical Anomalies. Downloaded from <u>http://crcleme.org.au/Pubs/guides/gawler/a7 id anomalies.pdf</u>, 2<sup>nd</sup> April 2017.

QGIS Project. 2017. QGIS User Guide – Release 2.14. Downloaded from <u>http://docs.qgis.org/2.14/pdf/</u>. Dated Jan 18<sup>th</sup> 2017.

San B and Sumer E O. 2004. Comparison of band ratioing and spectral indices methods for detecting alunite and kaolinite minerals using ASTER data in Biga region, Turkey. ResearchGate tba.

Strumberger V. 2016. Use of QGIS in Mineral Exploration, Vol.1. Download from author at <u>Velizar.strumberger@gmail.com</u>.

USGS. 2006. FGDC Digital Cartographic Standard for Geologic Map Symbolization (PostScript Implementation). US Geological Survey.

Van der Meer F D, van der Werff H M A and van Ruitenbeek F J A. 2014. Potential of ESA's Sentinel-2 for geological applications. Remote Sensing of Environment, vol. 148, pp. 124-133.

Yamaguchi Y and Naito C. 2003. Spectral indices for lithologic discrimination and mapping using the ASTER SWIR bands. International Journal of Remote Sensing, vol. 24, no. 22, p 4311-4323.

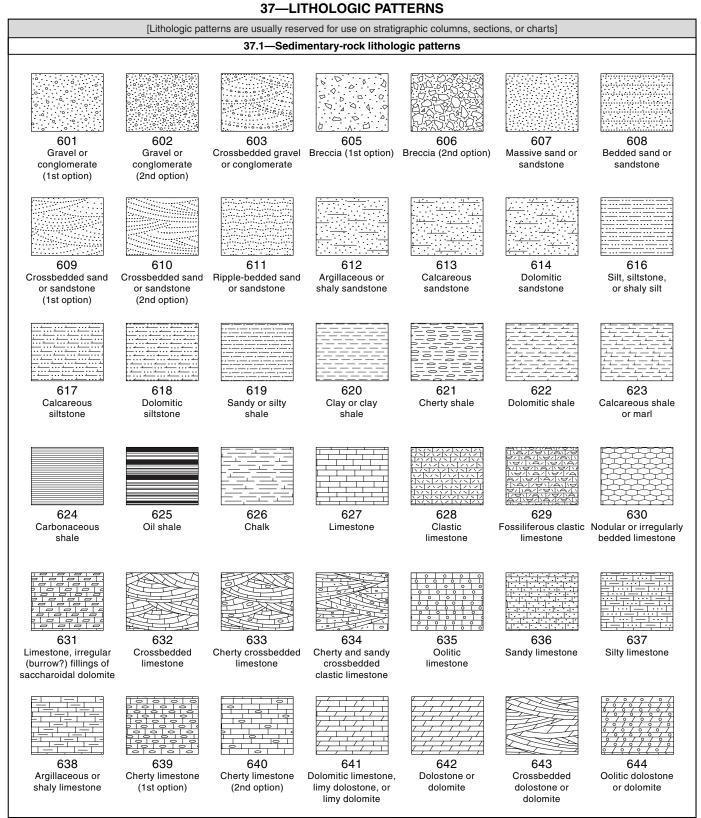


# APPENDIX

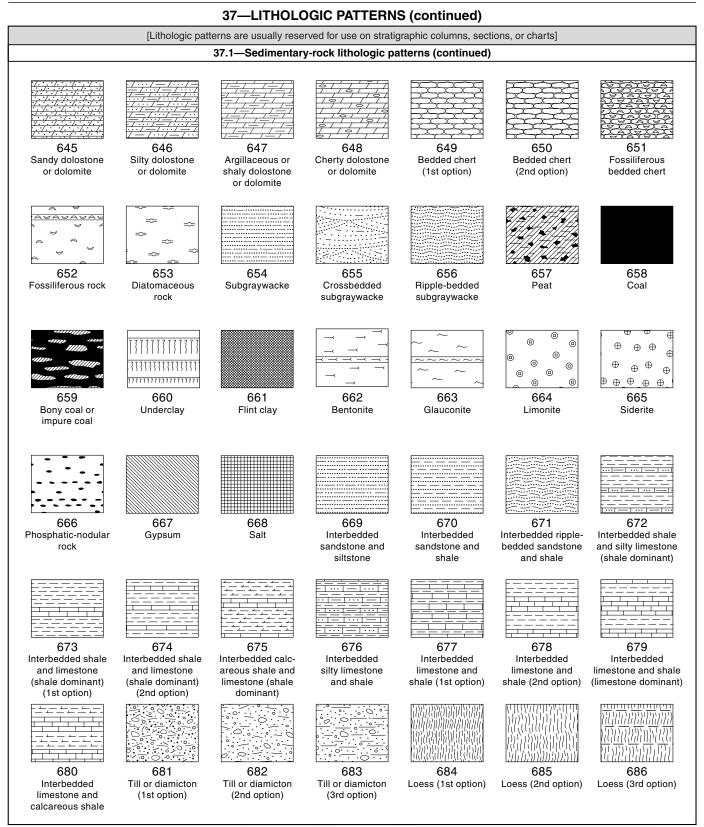
Lithologic Patterns for Geological Maps



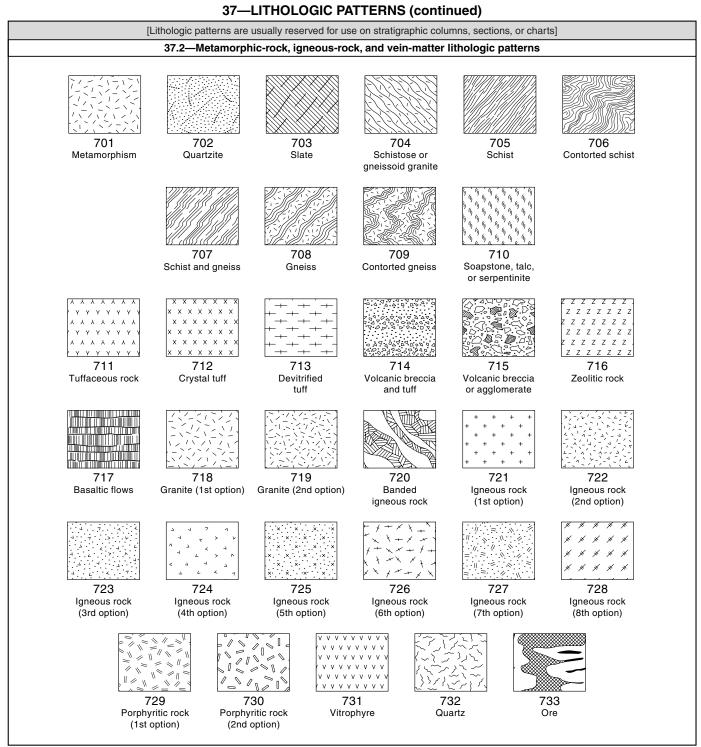
USGS (FGDC STD-013-2006)



\*For more information, see general guidelines on pages A-i to A-v.

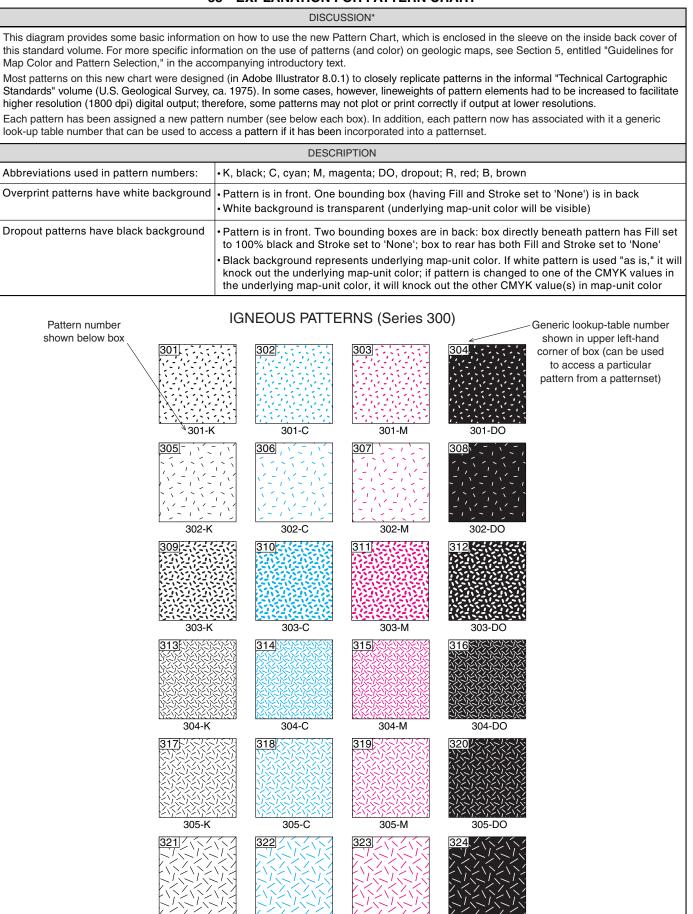


\*For more information, see general guidelines on pages A-i to A-v.



#### \*For more information, see general guidelines on pages A-i to A-v.

#### **38—EXPLANATION FOR PATTERN CHART**



306-C

306-k

306-M

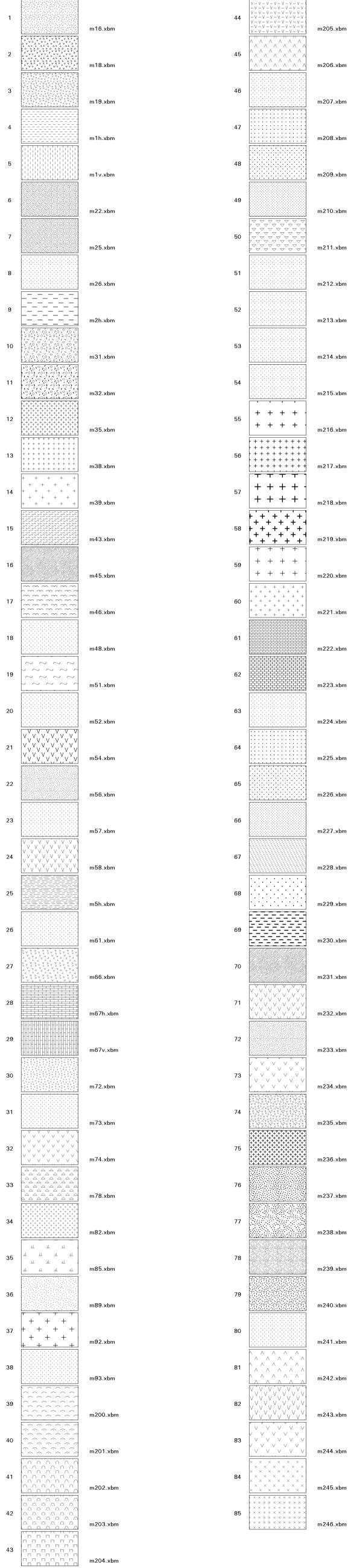
306-DO



Geoscience Australia

# Proposed shadeset : pattern94.shd 19 Jul 95

# (some patterns still to be created)

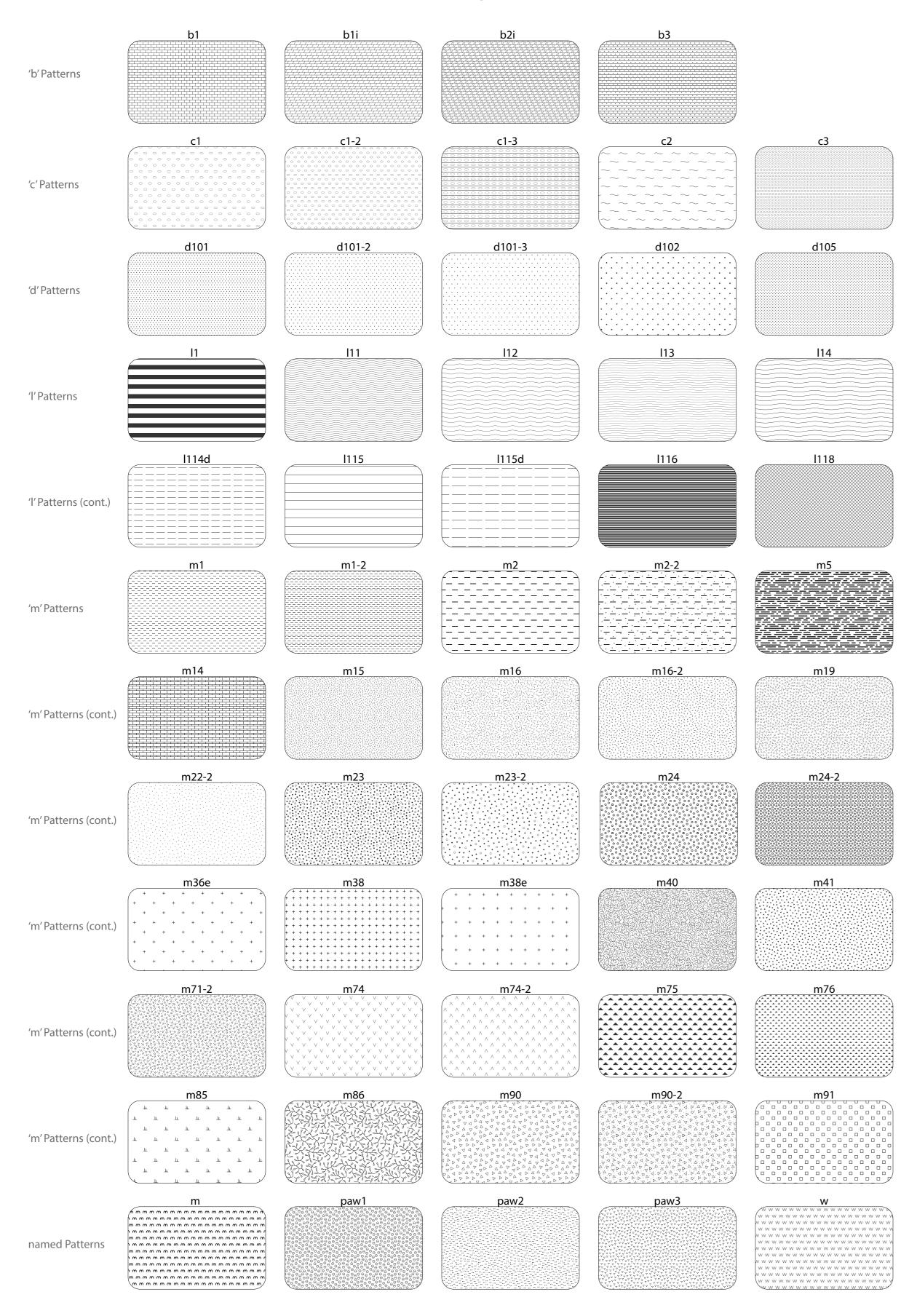




Geological Survey of Western Australia

# GSWA - Series Mapping Patterns — June 2017

Constructed with Adobe Illustrator CS6 — Map Production Manual Section - 17



0000000	c3-2	c3-3	<u>c3-4</u>	<u>c3-5</u>	c3-6	<u></u>
	d105-2	d105-3	<u>d110</u>	d110-2	d111	
	l102	l102-2	l103	l104	l107	
	m5-2	m6	m6-2	m10	m10-2	
	m19-2	m19-3	m20	m20-2	m22	
	m25	m26	m26-2	m29	m30	
	m59	m59e	m59-2			
	m76-2	m76-3	m76-4	m77		
	m91-2	ʻp' Patterns	p1	p2	<u>p3</u>	
	waves					

