

Mineral Exploration Targeting

PART 1 – Data Preparation



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What is mineral exploration targeting?

Mineral exploration targeting is the identification of potential areas or zones favorable for the development of economic production of a certain mineral. It is based on existing data, new interpretation of existing data and integration of the information gathered.

The main goal is to expedite the exploration process and, consequently, reduce the cost of doing it.

Targeting, under other names, was always used by geologists to narrow down the prospect area and to achieve the best results possible. Modern geologists with today's technological advancements (such as better computing power, access to geospatial and geophysical data, and Geological Surveys making available their databanks) allowed us, using some new software and programming scripts, to delineate zones (targets) in a process called mineral exploration targeting. This will be the subject of this material and detailed description of this process will be covered using real data in a real case study. Reinforcing that the goal here is to demonstrate how to execute mineral targeting, and not necessarily achieving a positive outcome.

We will cover here:

Part 1

- Gathering the data
- Data Loading
- AOI and CRS
- Raw Data
- Reprojection and Mosaic

Part 2

- Data Validation Visually and Statistically
- Organizing and extracting information for the targeting process

Part 3

- Target identification
- Sources of Ranking data

Part 4

- Ranking
- Result Evaluation



Gathering the data

A large area of approximately 150 by 200 km, located in the Borborema Geological Province in Brazil Northeast region, was selected for this tutorial. The area was chosen based on the availability of good airborne geophysical data at a reasonable spacing, presence of several (and distinct) mineralized areas, and a very interesting geological framework. The targeting will be executed over a smaller portion of the data obtained but, a larger base will be created here for further processing.

The goal here is to illustrate how to get freely available data from several sources.

<u>Image data</u>

Sentinel2 images and DEM can be downloaded from the ESA Copernicus data hub. Just create an account and download the necessary scenes.

https://dataspace.copernicus.eu/

After the login, the following dashboard hub will appear.



Please pan to the location of interest:





Now, using the following tool, make a square covering our zone of interest.

Lat: -7.613, Lng: -38.265



Place the first vertex at:



The final vertex will be: Lat: -5.944, Lng: -35.898





Now click on the SEARCH button:



Select Sentinel 2, L2A 10% max cloud cover:



Also select the CCM DEM data provider:





In the Time Range select the date From as:

TIME	RANGE:				
From:	2010-11-30	>	bb 00	∧ : mm 00	•
Until:				•	•
<	2024-08-06	>	hh 23	\$: mm 59	٥
Filt	er by months				
		Sea	arch		

And click the Search button.

A list of available Sentinel2 scenes and DEM from the period selected will appear.



They are not loaded at once and you must click on this button (Load More) to load more scenes. They are listed from the most recent to the oldest.





The following Sentinel2 scenes were used in this tutorial:

- S2B_MSIL2A_20231126T125259_N0509_R052_T24MXS_20231126T150155.SAFE
- S2B_MSIL2A_20231126T125259_N0509_R052_T24MXT_20231126T150155.SAFE
- S2B_MSIL2A_20231126T125259_N0509_R052_T24MXU_20231126T150155.SAFE
- S2B_MSIL2A_20231126T125259_N0509_R052_T24MYS_20231126T150155.SAFE
- S2B_MSIL2A_20231126T125259_N0509_R052_T24MYT_20231126T150155.SAFE
- S2B_MSIL2A_20231126T125259_N0509_R052_T24MYU_20231126T150155.SAFE

Navigate to until they are listed in the list on the left a click on the scene to be downloaded, the following dialog will appear:

Results		>	
Showing 1 result			
S2A_MSIL2A_20240 Mission: SENTINEL Sensing time: 2024	0628T125311_N0510_R052_T24MXS_2 -2 Instrument: MSI 0-06-28T12:53:11.024Z	0240628T173252.SAFE Size: 1114MB	
Visualize SENTINEL-2 (MSI	S2M5I2A	8 🕀 🖪 🛓	
			Download product

Just click on the button "download product". You can download up to 4 concurrent scenes.

The same process for the DEM files. The ones used in this tutorial are:

DEM1_SAR_DTE_30_20101220T080714_20130426T080910_ADS_000000_GnWw_9afe815d.DEM

- DEM1_SAR_DTE_30_20101220T080714_20130426T080910_ADS_000000_hKdH_9afe815d.DEM
- DEM1_SAR_DTE_30_20101231T080715_20121112T080940_ADS_000000_YGnO_9afe815d.DEM
- E DEM1_SAR_DTE_30_20110213T080712_20121101T080857_ADS_000000_XI0N_9afe815d.DEM

Save all the downloaded zip file into a folder. You can close the Copernicus hub now and move to the next step.



Geophysical data

The geophysical data used in this tutorial was downloaded from:

https://geosgb.sgb.gov.br/geosgb/downloads.html

Browse to this folder:



And download these two projects (geotif and raw XYZ data) that will be used in this tutorial:



Save the downloaded zip file into the same folder we loaded the Sentinel2 and DEM image data.

Gravity data

The semi-quantitative gravity geophysical data can be downloaded from:

https://icgem.gfz-potsdam.de/calcgrid

This data may be useful when doing targeting over large areas since the grid is at low resolution (~1km grid spacing).



Three products will be downloaded here. Select the longtime model, The functional selection and the grid as following:

Longtime Model
EIGEN-6C3stat
EIGEN-6C4
EIGEN-6S
EIGEN-6S2
EIGEN-6S4 (v2)
EIGEN-CG01C
EIGEN-CHAMP03S
EIGEN-CHAMP03Sp
EIGEN-CHAMP05S
EIGEN-GL04C
EIGEN-GL04S1
Eurotional coloction

Functional selection	
gravity_anomaly_sa	
gravity_anomaly_bg	
gravity_earth	
gravity_ell	
potential_ell	
gravitation_ell	
second_r_derivative	
water_column	-



Click on "start computation" button.





A new page will open, and the processing is executed. When finished the following should appear:

← → ♂ St icgem.gfz-potsdam	xde/calc_stat#e19094df47229103cl5562320ce006704331c2a3f48d840098ed2fb33b76aab2	🖈 🖸 🛛 🧔
	EIGEN-6C4 gravity_anomaly_bg 40401 gridpoints [-38.036.0 ; -8.06.0]	results share link

Click on results and this page should appear:

			C1 Todos os marcadore
		Grid Calcul	ation results for gravity_anomaly_bg of EIGEN-6C4
ICGEM Home Gravity Field Models Satic Models Satic Models Satic Models Satic Models Calculation Service Reguiry rais User-defined points Calculation Results Calculation Results Calculation Results Calculation Results Satic Models Satic Models	Functional: Model: Ond: Reference System: Height over Ellipsoid: Maximum degree used: Zarco Degree Herm: Tade System: Calculation Time: Mar / Mar: Mar / Stofer: Download Grid - Gooff (ar 53. AbB) - Suther 7 Grad (b157 / Kb)	gravity_anomaty_bg EIGEN-8C4 Longitude: 3.00°, -3.60° Latitude: 4.0°, -6.0° Cards Step Ort 4441 gridpoints WVS84 0.0 meters 2.1160 d7.1160 Yes unmodified 50s -3.6866 m / -0.778 m -27.591 m / 12.759 m	
Temporal Models			40 -32 -24 -16 -8 0 8 16 24 32 40
Trend & Amplitude			
Spherical Harmonics			x
Evaluation			Subscribe to the
Spectral domain			ICGEM-users mailinglist.

Download the grid in ascii and geoTiff formats:

Download Grid

- ICGEM Format, XYZ Ascii (2.1 MiB)
- GeoTiff (316.3 KiB)

Repeat for

Functional selection					
gravity_anomaly_sa	-				
gravity_anomaly_bg					
gravity_earth					
gravity_ell	-1				
potential_ell					
gravitation_ell					
second_r_derivative					
water_column	Ŧ				

And:

Functional selection

height_anomaly	*
height_anomaly_ell	
geoid	
gravity_disturbance	
gravity_disturbance_sa	
gravity_anomaly	
gravity_anomaly_cl	
gravity_anomaly_sa	-

Save the downloaded files into the same folder we loaded the Sentinel2, DEM image data, and other geophysical data. Now we are going to organize and prepare the data for preprocessing.



Data Loading

Once all the data is downloaded, and we conclude the uncompressing of these files we will load the data using QGIS to preview and organize the several sources of data starting with the Sentinel2 scenes.

We downloaded six scenes and now it is time to open these scenes grouped by bands. Nine bands will be used in this tutorial. They are:

Bands 2, 3 and 4 corresponding to the visible spectra.

Bands 5, 6 and 7 corresponding to the VNIR spectra.

Band 8A corresponding to the NIR spectra.

Bands 11 and 12 corresponding to the SWIR spectra.

After opening all files, the structure grouped by bands should look similar to:

Ŧ	✓	றி	SEN	NTINEL2
	÷.		ற்	SENTINEL2-B02
	÷.		றி	SENTINEL2-B03
	÷		றி	SENTINEL2-B04
	÷		றி	SENTINEL2-B05
	÷		ற்	SENTINEL2-B06
	÷		ற்	SENTINEL2-B07
	÷		றி	SENTINEL2-B8A
	÷		ற்	SENTINEL2-B11
	Ŧ	✓	ற்	SENTINEL2-B12
		÷.	✓	T24MXT_20231126T125259_B12_20m
			✓	T24MXU_20231126T125259_B12_20m
			✓	T24MYT_20231126T125259_B12_20m
			✓	T24MYU_20231126T125259_B12_20m
			✓	T24MXS_20231126T125259_B12_20m
		÷.	✓	T24MYS_20231126T125259_B12_20m

And the images will be displayed as:



Note - use the same interval of values to get a homogeneous image of the 6 scenes. Example: 0 to 8000.



Using a similar procedure, open the 4 DEM scenes structured as illustrated below:

- 🗸 례 DSM
- V Sources Control C
- V Copernicus_DSM_10_S08_00_W038_00_DEM
- Copernicus_DSM_10_S07_00_W037_00_DEM
- 🗸 📝 Copernicus_DSM_10_S07_00_W038_00_DEM

And the images will be displayed as:



Note - use the same interval of values to get a homogeneous image of the 4 DEM scenes. Example:50 to 1200.

Now we will load the geophysics data initially using the final product images (3 bands RGB file). This is not the appropriate format to work with targeting and we will see further down how to retrieve the geophysical data in the right format for targeting using the XYZ raw data and interpolation.



Airborne Gammaspectrometry

Ternary









Th





Total Count



Airborne Magnetometry

Total Field





Analytical Signal



First Derivative





Modeled Gravity Data

The gravity tif files must be adjusted to float 32 type to plot properly. You can do this using the QGIS converter tool.

Bouguer Anomaly



Grav Disturbance





Second derivative of Grav disturbance



At this stage the GEOPHYSICS folder on QGIS should look like:

Ŧ	✓	ற்	GE	DPHYSICS
	Ŧ		ற்	TERNARY_RGB
		۰.	\checkmark	1092_TERNARIO_RGB
		۰.	\checkmark	1091_TERNARIO_RGB
	-		ற்	K_RGB
		۰.	\checkmark	1091_KPERC
		۰.	\checkmark	1092_KPERC
	-		ற்	U_RGB
		۰.	\checkmark	F 1091_EU
		÷.	\checkmark	F 1092_EU
	-		ற்	Th_RGB
		۰.	\checkmark	F 1091_ETH
		۰.	\checkmark	F 1092_ETH
	Ŧ		ற்	TC_RGB
		÷.	\checkmark	1091_CT
		÷.	\checkmark	1092_CT
	-		đ	MAG_RGB
		۰.	\checkmark	1092_MAG
		۰.	\checkmark	1091_MAG
	-		đ	ASA_RGB
		۰.	\checkmark	1092_SINAL
		•	\checkmark	1091_SINAL
	-		đ	DV1_RGB
		۰.	\checkmark	1092_1DV
		•	\checkmark	F 1091_1DV
	Ŧ	✓	đ	GRAVITY
		۰.		second_r_DV_corrected
		۰.	V	gravty_disturb_corrected
				ba anomaly corrected



AOI and CRS

The dataset covers most of the Borborema Province. It is a huge area, and the targeting exercise here will cover only a portion of it.

For this tutorial we will define our Area of Interest (AOI) as:

Coordinate Reference System:	EPSG:32724 – WGS 84 UTM ZONE 24S
Resolution:	20x20 metres
Easting:	699,960 to 809,760
Northing:	9,190,240 to 9,300,040

Geophysics Raw Data

Geophysical surveys presented as RGB Images quite often are subject to squeezing and stretching that always do not represent the real value (quantity) of the data. A new approach is necessary using the XYZ raw data to extract/interpolate the right quantity that will be needed in the targeting ranking process that will be executed later.

The following R script will extract the relevant to us fields from the **gammaspectrometry** survey and convert it to a vector point with the relevant attributes. We will extract the points into single point shapefiles files with the real values of Total Count, K, U and Th for the Gammaespectrometry. The Total magnetic field will be extracted too with the second script. This procedure, due to the large area, will take a considerable time to process (10 minutes and 85 minutes respectively). You can download the final shapefiles <u>here</u> if you are in a hurry.

```
xmi<-699960
xma<-809760
ymi<-9190240
yma<-9300040
lin<-c('a')</pre>
0<-1
wd<-'C:/Users/User/Desktop/R algo/PBRN/1091/XYZ'#adjust according to your system
set.wd(wd)
flcon<-file('1091 GamaLine.XYZ',open='r')#adjust according to your system</pre>
tmp <- readLines(flcon, n=5)</pre>
coluna <-c(strsplit(substring(readLines(flcon, n=1),11),"\\s+")[[1]])</pre>
tmp <- readLines(flcon, n=4)</pre>
wd<-'C:/Users/User/Desktop/R algo/PBRN/1092/XYZ'#adjust according to your system
setwd(wd)
flcon2<-file('1092_GamaLine.XYZ',open='r')#adjust path according to your system</pre>
tmp <- readLines(flcon2, n=10)</pre>
while (length(line <- readLines(flcon, n = 1, warn = FALSE)) > 0) {
   if(substring(line,1,4) == ' & substring(line,21,21)!='*'){
      v<-as.numeric(strsplit(line, "\\s+")[[1]][2])
      w<-as.numeric(strsplit(line, "\\s+")[[1]][3])</pre>
      if(v>xmi & v<xma & w>ymi & w<yma){
        lin[o]<-line
        0<-0+1
      }
    }
}
```

```
close(flcon)
while (length(line <- readLines(flcon2, n = 1, warn = FALSE)) > 0) {
   if (substring (line, 1, 4) == ' & substring (line, 21, 21) != '*') {
      v<-as.numeric(strsplit(line, "\\s+")[[1]][2])</pre>
      w<-as.numeric(strsplit(line, "\\s+")[[1]][3])</pre>
      if(v>xmi & v<xma & w>ymi & w<yma){
        lin[o]<-line
        0<-0+1
      }
    }
}
close(flcon2)
wd<-'C:/Users/User/Desktop/R algo/PBRN/1091/XYZ'#adjust according to your system
setwd(wd)
r <- strsplit(sub("^\\s+","",lin), "\\s+")</pre>
s <-as.data.frame(do.call(rbind, r))</pre>
names(s) <- coluna</pre>
cols = c(1:(ncol(s)-3))
s[,cols] = apply(s[,cols], 2, function(x) as.numeric(as.character(x)))
snew<-s[c('X','Y','CTexp','Kperc','eU','eTh')]</pre>
library(terra)
sgeo<-vect(snew, geom=c("X", "Y"), crs="epsg:32724")</pre>
e<-ext(699960,809760,9190240,9300040)
extrc<-crop(sgeo,e)</pre>
writeVector(extrc, 'gamma.shp', overwrite=TRUE)
```

The same procedure will extract the relevant to us fields from the magnetometry survey.

```
xmi<-699960
xma<-809760
ymi<-9190240
yma<-9300040
lin<-c('a')</pre>
0<-1
wd<-'C:/Users/User/Desktop/R algo/PBRN/1091/XYZ' #adjust according to your system
setwd(wd)
flcon<-file('1091 MagLine1.XYZ',open='r') #adjust according to your system</pre>
tmp <- readLines(flcon, n=5)</pre>
coluna <-c(strsplit(substring(readLines(flcon, n=1),11),"\\s+")[[1]])</pre>
tmp <- readLines(flcon, n=4)</pre>
flcon2<-file('1091_MagLine2.XYZ',open='r') #adjust according to your system</pre>
tmp <- readLines(flcon2, n=10)</pre>
wd<-'C:/Users/User/Desktop/R algo/PBRN/1092/XYZ' #adjust according to your system
setwd(wd)
flcon3<-file('1092 MagLine1.XYZ',open='r') #adjust according to your system</pre>
tmp <- readLines(flcon3, n=10)</pre>
flcon4<-file('1092 MagLine2.XYZ',open='r') #adjust according to your system</pre>
tmp <- readLines(flcon4, n=10)</pre>
while (length(line <- readLines(flcon, n = 1, warn = FALSE)) > 0) {
   if(substring(line,1,4) == ' & substring(line,21,21)!= '*'){
      v<-as.numeric(strsplit(line, "\\s+")[[1]][2])</pre>
      w<-as.numeric(strsplit(line, "\\s+")[[1]][3])</pre>
      if(v>xmi & v<xma & w>ymi & w<yma){
        lin[o]<-line
        0<-0+1
      }
    }
}
close(flcon)
while (length(line <- readLines(flcon2, n = 1, warn = FALSE)) > 0) {
   if(substring(line,1,4) == ' & substring(line,21,21)!= '*'){
      v<-as.numeric(strsplit(line, "\\s+")[[1]][2])</pre>
```



```
w<-as.numeric(strsplit(line, "\\s+")[[1]][3])</pre>
      if(v>xmi & v<xma & w>ymi & w<yma){
        lin[0]<-line</pre>
        0<-0+1
      }
    }
}
close(flcon2)
while (length(line <- readLines(flcon3, n = 1, warn = FALSE)) > 0) {
   if(substring(line,1,4) == ' & substring(line,21,21)!='*'){
      v<-as.numeric(strsplit(line, "\\s+")[[1]][2])
      w<-as.numeric(strsplit(line, "\\s+")[[1]][3])</pre>
      if(v>xmi & v<xma & w>ymi & w<yma){
        lin[o]<-line
        0<-0+1
      }
    }
}
close(flcon3)
while (length(line <- readLines(flcon4, n = 1, warn = FALSE)) > 0) {
   if(substring(line,1,4) == ' & substring(line,21,21) != '*') {
      v<-as.numeric(strsplit(line, "\\s+")[[1]][2])</pre>
      w<-as.numeric(strsplit(line, "\\s+")[[1]][3])</pre>
      if(v>xmi & v<xma & w>ymi & w<yma){
        lin[o]<-line
        0<-0+1
      }
    }
}
close(flcon4)
wd<-'C:/Users/User/Desktop/R algo/PBRN/1091/XYZ' #adjust according to your system
setwd(wd)
r <- strsplit(sub("^\\s+","",lin), "\\s+")</pre>
rm(lin)
s <-as.data.frame(do.call(rbind, r))</pre>
rm(r)
names(s) <- coluna</pre>
cols = c(1:(ncol(s)-3))
s[,cols] = apply(s[,cols], 2, function(x) as.numeric(as.character(x)))
snew<-s[c('X','Y','MAGIGRF')]</pre>
rm(s)
library(terra)
sqeo<-vect(snew, geom=c("X", "Y"), crs="epsg:32724")</pre>
e<-ext(699960,809760,9190240,9300040)
extrc<-crop(sgeo,e)</pre>
writeVector(extrc, 'mag.shp', overwrite=TRUE)
```

Reprojection and Mosaic

It is important now to make sure that all the raster data are at the right resolution (20x20), CRS (EPSG:32724) and extension. The Sentinel scene bands meet these criteria. We will have to interpolate the raw geophysics data points, adjust the Gravity data, the DEM data and the interpolated Geophysics of Total Count, K, U, Th and Mag Total Field.

We can use QGIS to do this effectively.



DEM

In the menu Raster select Merge.



In Input layers select the four DSM files:

Q Merge	×
Parameters Log	Currais Novos
Input layers	-
4 inputs selected	
Grab pseudocolor table from first layer	Input layers
Place each input file into a separate band	Python identifier: 'INPUT'
Parameters Log	
Input layers	
✓ Copernicus_DSM_10_S07_00_W037_00_DEM [EPSG:4326]	Select All
Copernicus_DSM_10_S07_00_W038_00_DEM [EPSG:4326]	Clear Salartian
✓ Copernicus_DSM_10_S08_00_W037_00_DEM [EPSG:4326]	Clear Selection
Copernicus_DSM_10_S08_00_W038_00_DEM [EPSG:4326]	Toggle Selection
1091_TDV [EPSG:4326]	
1091_CT [EP50;4320]	Add File(s)
1091_ETH [EPSG:4326]	Add Directory
1091_C0 [CF30;4326]	Add Directory
1091_KFEKC[EFSG:4320]	ОК
1091 SINAL [EPSG:4326]	
1091 TERNARIO RGB [EPSG:4326]	

Click run and a temporary file **Merged** will be created and open.

Now we will crop this temporary file to the extension of our Sentinel2 Scene using one of its bands. Open the Raster menu and select Extraction \rightarrow Clip Raster by Extent.



	<u>R</u> aster <u>I</u>	Database	<u>W</u> eb	<u>M</u> esh	Processing Help
	🐮 Raste	er Calculat	or		la 🖪 🧠 🖡 🖪 🔿 🔁 🗉
-	Index	Orama		×	
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1	Proje	ctions		•	
	Misc	ellaneous		•	
Ó	Extra	ction		Þ	E Clip Raster by Extent
	Conv	ersion		•	Clip Raster by Mask Layer
	🌞 Align	Rasters			Contour
		6	7 3	Pau	u-dos Ferros

Select Merged as Input layer and Select the clipping extent from any layer T24MYT.... and Run.

124WIY5_202311201125259_802_20m	Tan
T24MYS_20231126T125259_B03_20m	
T24MYS_20231126T125259_B04_20m	Calculate from Layer
T24MYS_20231126T125259_B05_20m	Calculate from Layout Map
T24MYS_20231126T125259_B06_20m	Calculate from Bookmark
T24MYS_20231126T125259_B07_20m	😡 Use Current Map Canvas Extent
T24MYS_20231126T125259_B11_20m	Draw on Map Canvas
T24MYS_20231126T125259_B12_20m	Cacin
T24MYS_20231126T125259_B8A_20m	De
T24MYT_20231126T125259_B02_20m	nta 5
F T24MYT_20231126T125259_B03_20m	
T24MYT_20231126T125259_B04_20m	
T24MYT_20231126T125259_B05_20m	· ·
T24MYT_20231126T125259_B06_20m	Cancel A
T24MYT_20231126T125259_B07_20m	Esperanç
T24MYT_20231126T125259_B11_20m	Ajuda
T24MYT_20231126T125259_B12_20m	Lagoa Sec
T24MYT_20231126T125259_B8A_20m	ampina Gra

Change the layer CRS using Raster \rightarrow Projections \rightarrow Warp(reproject).



Enter the field as below and click Run:



🔰 Warp (Reproject)		
Parameters Log		
Project CRS: EPSG:32724 - WGS 84 / UTM zone 24S	•	ľ
Resampling method to use		
Nearest Neighbour	•	
Nodata value for output bands [optional]		
Not set	4]
Output file resolution in target georeferenced units [optional]		
Not set		
▼ Advanced Parameters		
Additional creation options [optional]		
Profile	-	
母 Validate Help		
문 (프 Validate Help Output data type		
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The final step is exporting the temporary memory Layer **Reprojected** as a tif file and fine tune the extension.

 Reprojected 	<u> </u>	S I A DI
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	Copy Layer	Tenente Ananias
	Re <u>n</u> ame Layer	Uiraúna
116	Zoom to Native Resolution (100%)	
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	E <u>xp</u> ort	→ Save <u>A</u> s
	Styles	Save as Layer Definition File
50	Add Layer Notes	Save as <u>O</u> GIS Layer Style File
gisPB	Properties	



Name the file and dem_clipped.tif and use the GeoTIFF format. Change the CRS to EPSG:32724 set the resolution to 20 and adjust the extent as below:

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Click OK.



The following dem_clipped layer will open:



Delete the temporary memory files.

Þ	- 20	Reprojected	\square
Þ	- 2°	Clipped (extent)	\square
Þ	- 2°	Merged	

Now create a group called **Final Preparation** and move the layer to this group folder. Also move the nine (9) Sentinel2 bands (2, 3, 4, 5, 6, 7, 8a, 11 and 12) of T24MYT_20231126T125259_B??_20m to this folder.

Repeat the following procedure with the three (3) gravity layers and move them to the **Final Preparation** folder too.

Bouguer Anomaly

Open the Raster menu and select Extraction \rightarrow Clip Raster by Extent.

Change the layer CRS using Raster \rightarrow Projections \rightarrow Warp(reproject)

Export the temporary memory Layer **Reprojected** as a tif file and fine tune the extension.

Name the file and bouguer_clipped.tif and use the GeoTIFF format. Change the CRS to EPSG:32724 set the resolution to 20 and adjust the extent as below:

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ayer name												
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Gravity Disturb

Open the Raster menu and select Extraction \rightarrow Clip Raster by Extent.

Change the layer CRS using Raster \rightarrow Projections \rightarrow Warp(reproject)

Export the temporary memory Layer **Reprojected** as a tif file and fine tune the extension.

Name the file and gdisturb_clipped.tif and use the GeoTIFF format. Change the CRS to EPSG:32724 set the resolution to 20 and adjust the extent as below:

mat GeoTIFF C:\Users\User\Desktop\R algo\PBRN\gdisturb_clipped.tif c:\Users\User\Desktop\R algo\PBRN\gdisturb_clipped.tif er name EPSG:32724 - WGS 84 / UTM zone 245 FExtent (current: user defined) West 699960 East 809760 East 809760 Calculate from Layer * Layout Map * Bookmark * Current Layer Extent Map Canvas Extent FResolution (current: user defined) Horizontal 20 Vertical 20 Layer Resolution Columns 5490 Rows 5490 Layer Size Name Value Name Value	put mode 🤇	🖲 Raw data 🔵 Rend	dered image								
name C:\User\User\Desktop\R algo\PBRN\gdisturb_clipped.tif er name EP5G:32724 - WGS 84 / UTM zone 245 FExtent (current: user defined) West 699960 East 809760 South 9190240 Calculate from Layer * Layout Map * Bookmark * Current Layer Extent Map Canvas Extent FResolution (current: user defined) Horizontal 20 Vertical 20 Layer Resolution Columns 5490 Rows 5490 Layer Size Name Value Name Value	nat	GeoTIFF							-	Create	e١
er name EPSG:32724 - WGS 84 / UTM zone 245 EExtent (current: user defined) West 699960 East 809760 South 9190240 Calculate from Layer * Layout Map * Bookmark * Current Layer Extent Map Canvas Extent Resolution (current: user defined) Horizontal 20 Vertical 20 Layer Resolution Columns 5490 Rows 5490 Layer Size Name Value Name Value	name	C:\Users\User\Desktop\	R algo\PBRN\gdi	isturb_clipped.tif							
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Disturbance Second Derivative

Open the Raster menu and select Extraction \rightarrow Clip Raster by Extent.

Change the layer CRS using Raster \rightarrow Projections \rightarrow Warp(reproject)

Export the temporary memory Layer **Reprojected** as a tif file and fine tune the extension.

Name the file and 2DVdisturb_clipped.tif and use the GeoTIFF format. Change the CRS to EPSG:32724 set the resolution to 20 and adjust the extent as below:



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r 🗌 Cre	ate options					
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Interpolating raw geophysics data points

The following script will be used to create the tif images from the interpolated gammaspectrometry data.

```
library(terra)
#Working directory first file
wd<-'C:/Users/User/Desktop/R algo/PBRN/1091/XYZ' #adjust according to your system
setwd(wd)
dado<-vect('gamma.shp')</pre>
e<-ext(699960,809760,9190240,9300040)
r<-rast(ext=e, res=20, crs="epsg:32724")</pre>
ct <- interpIDW(r, dado, 'CTexp', radius=550)</pre>
writeRaster(ct,'CTgamma.tif',overwrite=T)
k <- interpIDW(r, dado,'Kperc',radius=550)</pre>
writeRaster(k, 'Kgamma.tif', overwrite=T)
u <- interpIDW(r, dado,'eU', radius=550)</pre>
writeRaster(u, 'Ugamma.tif', overwrite=T)
th <- interpIDW(r, dado,'eTh', radius=550)</pre>
writeRaster(th, 'THgamma.tif', overwrite=T)
#open mag file
dado<-vect('mag.shp')</pre>
m <- interpIDW(r, dado, 'MAGIGRF', radius=550)</pre>
writeRaster(m, 'TFmag.tif', overwrite=T)
```



Load the gravity, the magnetometry raster and the gammaspectrometry raster created above into the Final Preparation Group in QGIS.

The Final Preparation Group should be like this:



Part 1 Conclusion

Now we create a stacked scene with all the raster layer above using QGIS. This tif file will be used in the nest Part.

First, we will rename the layer as following:

✓	ற்	Fin	al Preparation
÷		2	001_T24MYT_20231126T125259_B02_20m
÷		8	002_T24MYT_20231126T125259_B03_20m
÷		8	003_T24MYT_20231126T125259_B04_20m
×		8	004_T24MYT_20231126T125259_B05_20m
×		8	005_T24MYT_20231126T125259_B06_20m
×		8	006_T24MYT_20231126T125259_B07_20m
×		8	007_T24MYT_20231126T125259_B8A_20m
÷.		8	008_T24MYT_20231126T125259_B11_20m
÷		8	009_T24MYT_20231126T125259_B12_20m
÷	✓	8	010_dem_clipped
÷.		8	011_Kgamma
÷.		8	012_Ugamma
÷		8	013_THgamma
÷.		8	014_CTgamma
÷.		8	015_TFmag
•		8	016_bouguer_clipped
×		8	017_gdisturb_clipped
÷		8	018_2DVdisturb_clipped



Select Raster \rightarrow Miscellaneous \rightarrow Build Virtual Raster.



Select the 18 layers as input layer is the order showed below:

Input layers	
✓ 001_T24MYT_20231126T125259_B02_20m [EPSG:32724]	Select All
✓ 002_T24MYT_20231126T125259_B03_20m [EPSG:32724]	Clear Selection
✓ 005_124WFT_20231126T125259_B04_20m [EPSG:32724]	cical ocication
▼ 004_124M11_202311261125259_805_20m [EPSG:32724]	Toggle Selection
✓ 006 T24MYT 20231126T125259 B07 20m [EPSG:32724]	Add Ele(-)
▼ 007_T24MYT_20231126T125259_B8A_20m [EPSG:32724]	Add File(s)
✓ 008_T24MYT_20231126T125259_B11_20m [EPSG:32724]	Add Directory
009_T24MYT_20231126T125259_B12_20m [EPSG:32724]	
✓ 010_dem_clipped [EPSG:32724]	OK
✓ 011_Kgamma [EPSG:32724]	
✓ 012_Ugamma [EPSG:32724]	
✓ 013_THgamma [EPSG:32724]	
 014_CTgamma [EPSG:32724] 	
015_TFmag [EPSG:32724]	
 016_bouguer_clipped [EPSG:32724] 	
 017_gdisturb_clipped [EPSG:32724] 	
 018_2DVdisturb_clipped [EPSG:32724] 	
OpenStreetMap [EPSG:3857]	



Mark "Place each input file into a separate band" and Select Resolution as Highest.

Parameters Log	
nput layers	
8 inputs selected	
esolution	
Highest	•
Place each input file into a separate band	
Allow projection difference	
Advanced Darameters	
Add alpha mask band to VRT when source raster	has none
Add alpha mask band to VRT when source raster Override projection for the output file [optional] Resampling algorithm	has none 💌 🌚
Add alpha mask band to VRT when source raster Override projection for the output file [optional] Resampling algorithm Nearest Neighbour	has none
Add alpha mask band to VRT when source raster Override projection for the output file [optional] Resampling algorithm Nearest Neighbour Nodata value(s) for input bands (space separated) [optional [option]]	has none
Add alpha mask band to VRT when source raster Override projection for the output file [optional] Resampling algorithm Nearest Neighbour Nodata value(s) for input bands (space separated) [o Additional command-line parameters [optional]	has none
Add alpha mask band to VRT when source raster Override projection for the output file [optional] Resampling algorithm Nearest Neighbour Nodata value(s) for input bands (space separated) [o Additional command-line parameters [optional]	has none
Add alpha mask band to VRT when source raster Override projection for the output file [optional] Resampling algorithm Nearest Neighbour Nodata value(s) for input bands (space separated) [o Additional command-line parameters [optional]	has none

Now save the Virtual layer as prep_mosaic.tif using:

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•	-	01	Properties	Service Comes & Party



🔇 Save Raste	er Layer as										×		
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What we did until this point was to organize and level the different data into a common raster dataset with real quantities and same resolution that will be used in the next Part of this targeting exercise.



Before we move into the next Part, let's preview each individual layer (or group of layers).

On QGIS double-click **prep_mosaic** and select the following bands 3 as red 2 as green and 1 as blue and a True color (TCC) composite will be displayed.





Select bands 9 as red 8 as green and 7 as blue and a "geology" false color composite (FCC) corresponding to SWIR+SWIR+NIR will be displayed.

Q Layer Properties - prep_	mosaic — Sym	bology					×			
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Select bands 11 as red 12 as green and 13 as blue and a Ternary K-U-Th false color composite (FCC) gammaspectrometric response will be displayed.

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Checking single bands starting with the DEM. Select band 10.





Select band 14 for gamma total count.

🗞 Source

🗠 Histogram

🕔 Temporal

Pyramids

Elevation

🧪 Metadata

Display

Rendering





Select band 15 for Mag Total Field residual.





Select band 16 for Modelled Grav Bouguer.





Select band 17 for Grav Disturbance.





Select band 18 for Grav Disturbance 2nd Derivative.

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The dataset preparation is an important step and from this resulting file with stacked raster based on satellite images, digital elevation model, airborne geophysical survey and gravity models we will generate in the next Part new layers that will be applied in the final mineral exploration targeting.