# Aynak Information Package
# Part XI Creation of a Vulcan 3D model

Compiled by the Afghanistan Geological Survey and the British Geological Survey

# Contents

# 1 Introduction

This document outlines what has been achieved during the construction of a Vulcan 3D model of the Aynak copper prospect, Afghanistan. The modelling work was completed between March and August 2005, and was based largely on borehole information and digitised geological sections provided by Stan Coats and Pete Dunkley from Kabul (BGS-Kabul).

# 2 Data available

The following data were provided by BGS-Kabul (all grid references in local grid).

*Topography*: Contours at 10 m intervals, extending from (25000, 89800) to (30000, 93600). Spot heights: 66 points in the same area as the contours. Format: jpeg image digitised from tracing. Some roads and tracks plus buildings were also traced and scanned into a separate jpeg image.

*Surface geology:* Geological map of crop at rockhead, extending from (25200, 90200) to 29600, 93200) with a small extension to y = 93400 from x = 28600 to 27000. This map shows the main stratigraphic units, faults, numbered section lines, some borehole collars, trenches and open pits, and outlines of main orebodies and prospective areas. Format: tif image scanned from paper copy.

*Boreholes*: An Access database containing borehole information including collars; survey data; downhole assays for Cu, Cuox, and oxidation; and downhole lithology and age.

*Geological sections:* 38 sections across parts of the area showing geological linework, orebody/high grade areas and boreholes. Format: tif image scanned from paper copy.

*Geological plans*: 2 level plans at 1980 m and 2160 m showing geological linework, orebody/high grade areas, open pit bottoms, section lines and some boreholes for Central Area only.

# 3 Modelling process

Some of the data are applicable to the wider geographic area around Aynak (as defined by the limits of the topography above). These include topography, rockhead geology and boreholes. Some data, however, are more useful or limited in certain parts of the area. Two main prospects have been modelled using Vulcan: the Central Area and the Western Area. In the Central Area, there are over 130 boreholes and level plans at 1980 m and 2160 m. Vertical sections also exist in this area. In the Western Area, the main source data are derived from vertical sections; boreholes are scarce (only 13 logged and available in the database) and there are no level plans. Hence the modelling strategies for the Central and Western Areas were different. In this section, the modelling for all areas is described first and then the modelling for each of the Central and Western Areas is described in turn.

## 3.1 ALL AREAS

### 3.1.1 Digitising surface geology and surface features

The main stratigraphic units from a geological base map were digitised within Vulcan by importing the map image file, and geo-registering it in x-y space at an arbitrary z (2500m). The digitised units are 1,2,3,4,5,6 and 7 (units grouped by age with 1 being oldest, 7 being youngest) plus subdivisions of an older gabbro amphibolite, igneous intrusions and faults.

Units digitised from the map are in layers for each unit with names of the format “MAP_B_1” where this is base unit 1 on the map.

There appear to be several υR(?) units intercalated with R(?)vl so these are numbered U1,U2,U3 from oldest to youngest (the oldest being in core of anticline), and the top and base of each of these units were digitised. These are called MAP_B_U1, MAP_T_U1 (T=top; B=base) etc. A unit of the same rock is in a small faulted block in the west of the area (x,y = 25200,91000), and has been named MAP_T_UU (U undifferentiated).

A map grid was drawn by using world co-ordinates within the model and checked to the map grid as imported on the image file. There is a mismatch of up to 5m relating to image integrity (eg, folds and tears in scanned paper map).

Section lines were digitised from the image and object names were assigned according to section number. This enables section names to be displayed in Vulcan.

Roads, tracks and buildings were digitised by importing and registering the jpeg image provided on a triangulation at 2500m.

### 3.1.2 Borehole database

1. A Vulcan borehole database was created in using Microsoft Access data from “Aynak_boreholes.mdb”.
2. A former BGS VULCAN ISIS database design was modified so that lithological and assay data could be loaded (datasheet name = DHD).
3. Errors were noted and reported to BGS-Kabul. Several iterations were made to correct errors and add further boreholes until the database was as complete as possible.
4. There may still be some errors in the logging or survey of holes, and some were identified during modelling of surfaces. For example, the base of a unit in one borehole being inconsistent with other neighbouring boreholes. This may be real due to localised tectonic effects, or it may be incorrect logging of holes.
5. Boreholes can be displayed by age or by assay of Cu (total), Cu (oxide) or oxidation.
6. The most recent borehole database is named “aynk050518.dhd”.

### 3.1.3 Section digitising

a) TIF files of sections were converted to GIFs and then to pexels (Vulcan image file).

b) A triangulation was created along each section line digitised from the surface geology map, and extending from a depth of 0 to 2700m.

c) The pexel file for each section was loaded and registered onto the corresponding triangulation in its true world position using at least three pexel control points. Visual inspection of the section relative to grid lines and boreholes confirmed correct positioning of the section. If there was a significant mismatch (> 10m), the registration procedure was repeated using a different set of control points.

d) The same units as for the surface geology map were digitised. Additionally, surface topography and rockhead lines were also digitised. These are in layers prefixed by "SEC_***" eg "SEC_B_1" for the base of unit 1.

e) The procedure was repeated for each section.

f) On sections, only stratigraphic boundaries were digitised. There is more information on the sections and map relating to the ore grade. This is quite difficult to interpret but it may be possible to digitise and model ore horizons in the future.

g) Sections only cross part of the area under investigation and are limited to places with particular mineral potential. Typically sections are ca. 1 km long, although many are much shorter (200-300 m).

h) Bases of geological units usually match with bases of units at rockhead. There are some discrepancies and some minor editing of either rockhead geology or section geology was required to provide consistent intersections.

i) If geological units were absent from sections, then approximate locations of intersections were digitised to make a more complete set of linework. Linework was estimated from thickness of beds on the same or neighbouring sections and from the geological linework at rockhead.

### 3.1.4 Surface Modelling

Once sections and boreholes were complete and digitised in Vulcan, triangulated surfaces were created.

Topography: A surface triangulation was created using the contours and spot heights. This was checked against topography from section lines. In places, there is some discrepancy. The topography from contours and spot heights was used in preference to the section data, since there may be slight errors in the registration of the sections.

Surface features: Digitised roads, tracks and buildings were registered onto the topographic surface. Solid triangulations of individual buildings were then "built" with a nominal height of 3m.

Rockhead: Rockhead surfaces (as triangulations) were created from base of Neogene-Quaternary from section lines and borehole intersections were present. This surface is rather coarse but is based on the only data available on the level of rockhead in the area.

In the Western area, as borehole information was very limited, the rockhead surface was generated using the base of the Neogene-Quaternary from section lines, together with limiting polygons derived from the 'solid' geology areas marked on the 1:5000 scale geological map. Where necessary, interpretation lines and points (layer = RH_INT_W) were added in Vulcan, by working in cross-section mode, in order to obtain a 'reasonably realistic' surface.

As modelling neared completion, the rockhead surfaces for the Central and Western areas were merged into a single triangulated surface (triangulation = RHD_combined_E_W.00t).

## 3.2 CENTRAL AREA

The main thrust of the modelling in the Central Area is to create consistent surfaces for stratigraphic units 1 to 7. Preliminary block models were also produced, but these are only for illustrative purposes.

### 3.2.1 Stratigraphic surfaces

Initial inspection of the sections from the Central Area revealed that the units did not correspond to the same units in boreholes or on the Western Area sections. On discussion with BGS-Kabul, it appears that the sections from the Central and Western areas were drawn at different times, and different interpretations were made of the geology. A table was provided to relate the two interpretations, and the sections were digitised so that the units were the same as the Western Area and the borehole logs.

For each stratigraphic surface in the Central Area, there are several sources of data: rockhead geology, borehole intersections, bases of units on section lines and bases of units on level plans.

Initially, it was felt that the best model would be created using bases of units on section lines. These were used to create a first pass of the base of unit 4. Two main problems became apparent from this test surface. First, some of the section lines have great complexity (wavelength of folds of the order of a few metres). On the scale of the deposit (ca. 2 km), it is not sensible to try to model this wavelength of fold on surfaces. Second, the structure did not always match up with the borehole intersections or bases of units from plans or at rockhead. In particular, minor faults, sub-parallel to bedding, were often present on section lines, but were not apparent on rockhead geology or on plans. These small faults cannot be tracked between sections, and generally have small (few metres) offsets. Their main effect is to thicken (or thin) units. These minor faults have been ignored.

On discussion with BGS-Kabul, it was decided that in the Central Area, boreholes should be taken as the primary source of information together with intersection of units at rockhead and on level plans. The surfaces were then created from these datasets as follows (the base unit 4 used as an example, but the same applies for each unit).

a) Create layer called B4_BH_E from points on boreholes indicating base of unit 4. Delete any boreholes in the Western Area, and inspect for anomalous intersections in the Central Area. These are often due to the base of the unit being at the end of a hole, and thus not being the true position of the end of the unit base.

b) Load lines from PL_B4_E (base of unit 4 on level plans).

c) Copy lines from MAP_B4_E_R (rockhead geological linework for unit 4 registered onto the rockhead triangulation) into layer called B4_POLY_E such that they indicate the limits of the unit in the Central Area. The limits of the area are taken as the area where there are boreholes or linework on plans. If the boreholes or plans extend outside the area covered by the rockhead triangulation, then additional linework may need to be copied from MAP_B_4 (geological linework for unit 4 at 2500m). The linework from this latter layer will not be in its true position, so some extrapolation is required to estimate where rockhead would be. This is done by looking at the trend of the rockhead surface in the vicinity of the extrapolation and assuming that the general dip remains consistent beyond the triangulation.

d) Append points to the ends of lines in B4_POLY_E that coincide with borehole intersections or ends of linework from PL_B4_E. Ensure lines are consistent. Join the lines to make a single boundary polygon.

e) Create surface triangulation using B4_POLY_E as boundary polygon (include in triangulation), and using layers B4_BH_E and PL_B4_E as data points.

f) Inspect surface for anomalies such as inconsistent boreholes, cross-overs, sudden changes of dip.

g) If a borehole is anomalous, display the borehole stick coloured by lithology. Occasionally, the bottom of hole is in the middle of a unit and therefore the automatic intersect is too high. Delete the point or move it to a location more consistent with neighbouring boreholes.

h) If there is a cross-over, check what is causing the cross-over. Do the same procedure as in (g) if a borehole appears to be in error. If the linework from the plans is in error, attempt to adjust linework to make it more consistent with surrounding information.

i) To create a smoother surface, it may be necessary to draft construction lines to include in the triangulation process. For example, in the noses of folds, the triangulation algorithm may have made a flat surface, where a concave/convex surface would be more realistic. In this case, estimate where the base of the unit would go and draft a line of set of lines to force the triangulation to make a more realistic surface. These lines are in B4_CONSTR layer.

j) For the bases of units towards the bottom of the sequence (1-3), the information from boreholes and plans becomes sparse. It may be necessary to estimate where intersections on boreholes lie or where linework on plans may be so that cross-overs are avoided. Any interpolated or extrapolated lines and points are also put in B4_CONSTR layer.

### 3.2.2 Faults

Inspection of rockhead geology and plans showed that there are only three faults present. Two early faults run parallel to each other and approximately ENE-WSW. These two faults are cut by a later fault running approximately NNE-SSW. Only the latter fault is traced along its length down to the 1980 m level. The NNE-trending fault has a horizontal throw of up to ca. 100 m, although in places it is no more than 10 m. The horizontal throw is variable along it length and with depth. The two ENE-trending faults have horizontal throws of up to 25 m, but these are more commonly less than 10 m.

Simple triangulated surfaces for these three faults have been created using intersections with rockhead and the two level plans.

### 3.2.3 Open pit

The open pit was modelled using linework labelled “bottom open pit” from plans at 2160 and 1980 m, plus the outline of open pit on the geology map. A simple surface triangulation of the open pit was created, and a new topography was made by cutting a “hole” in the surface triangulation where the pit would be.

### 3.2.4 Block modelling

From grade information on boreholes three simple block models have been derived. All three models were oriented along strike, and have the following parameters.

Block model origin: X=27200, Y=91700, Z=1200 (local grid, m)

Bearing of X axis = 115°

Offset (size of model) X=1800, Y=2200, Z=1500 (all in m)

Variables: Cu, Oxid, CuOx, lith, age

Grade estimations were made of Cu, CuOx and Oxid and populated to the model. The estimations were from a mapfile from aynk050518.dhd using straight compositing i.e., exact data from boreholes with no interpolations.

The first model used a parent block size = 50m (in xyz); sub-block = 10m (in xyz); maximum block = 50, 10 (parent, sub-block). Two subsequent models used parent block sizes of 25 m and 10 m respectively, with subblock sizes of 5m.

In general, the block models show that the Cu mineralization is more or less stratiform, and lies predominantly in units 4 to 6, although there are some high grade areas outside this envelope. The smallest block sizes tended to create bulls eyes around boreholes in the grade estimation.

These block models should be used only for illustrative purposes, since a full geostatistical analysis of the data has not been done, and the grades in the boreholes cannot be confirmed since the core is no longer in existence.

### 3.2.5 Interpretation of the structure in the Central Area

The unfaulted triangulated stratigraphic surfaces have been viewed with the faults and the block models. This section outlines the main structures present in the Central Area.

The overall structure in the Central Area is of a broad syncline to the north, with a fold axis striking to the NE and plunging at ca. 20-30°. The dips of the limbs are slightly asymmetric with the steeper limb on the SE (up to 60°) and the shallower limb to the NW dipping to no more than 45°, although there is considerable variation in dip between stratigraphic units and geographically, with dips becoming more gentle further to the NE as the fold becomes broader. To the south of this syncline is a tight anticline with a fold axis striking at 050°, and which also appears to be folded along an axis perpendicular to the main axis. This folding of the fold axis may be a result of interference with other, later structural events. To the south of this anticline is a further syncline, which has steeply dipping limbs. This syncline is less well defined from the data available, but appears to have limbs which dip at up to 75° and may even be overturned on the southern limb, although borehole constraints are poor.

The three modelled faults appear to cut across the strike of the axes of the main anticline-synline structures. The strike of the axis of the northernmost syncline is ca. 025-040°. The axis of the central anticline strikes at ca. 050° and the axis of the southern syncline strikes at 055°, whereas the main fault strikes at 008° in the south veering to 036° in the central part and then to 061° in the north. The two minor faults have reasonably consistent strikes between 066° and 076°, and they run across the central anticline.

Given the small throws on the two minor faults, it seems reasonable that these two faults do not make any significant offset on the stratigraphic units and thus the units are not cut by the faults in the model. The major fault is more problematic since the horizontal displacement is highly variable and it cuts across the main folding. It is possible that the variation in the dip of the folding might contribute to the apparent changes in throw across the structure.

The structure of the stratigraphic units can be largely explained by the folding outlined above, and there is no need for major offsets of the units by the faults. Thus, no offset has been modelled apart from the base of unit 7 which had an obvious offset in the subcrop at rockhead and therefore was relatively easy to model.

The majority of economic mineralization lies in the broad northern syncline to the north of and away from the faults. This conclusion should be treated with caution, however, since there are fewer boreholes with assay data in the southern syncline to the south of the faults.

### 3.3 WESTERN AREA

As borehole data was generally unavailable in the Western area, the Vulcan model in this area was created using the cross-section data only. The Russian published cross-sections were imported into Vulcan, registered into the correct x, y, and z orientations, and the following horizons were digitised from them into Vulcan layers.

- Base of Units 1 to 7
- Top and Base of the Breccia horizons
- Fault plane intersections

(See appendix 1 for a full list of layer names)

Some minor editing of the resulting digitised horizon lines was necessary in places, mainly to ensure an exact tie between intersecting cross-section lines. For this reason, the resulting linework in the Vulcan model may not always agree totally with the original Russian interpretation (which was not carried out with the benefit of 3-D visualisation), but generally the original interpretation was found to yield a very satisfactory result when viewed in 3-D

Creation of the Western area model was then achieved by the following summarised methodology:

1. Edit cross-section linework of individual horizons as described above

2. Generate initial 'raw' temporary (i.e. not retained in the final model) triangulations for the base of each Unit 1 – 7, and the top/base of the breccia.

3. Generate triangulations of individual fault surfaces by

    a. Identifying individual fault trace intersections by viewing in 3-D.

    b. Extracting individual fault traces to separate layers, as far as possible.

    c. Create triangulations of individual fault surfaces using

        i. cross-section fault traces,

        ii. additional interpreted lines and points added in Vulcan, and

        iii. fault intersections with rockhead/topographic surface, digitised from the 1:5000 geological map and registered on rockhead/topographic surface as appropriate.

4. Modify the 'raw' triangulations for the Units 1-7 and Breccia horizons, (created in step 2 above), by adding interpretive control lines and points as appropriate (generally by working in cross-section mode in Vulcan) and finally re-triangulating each horizon using

    i. digitised cross-section linework

    ii. additional interpreted lines and points added in Vulcan

    iii. outcrop/subcrop lines on with topographic/rockhead surface, digitised from the 1:5000 geological map and registered on topographic/rockhead surface as appropriate.

    iv. interpreted intersections with fault plane surfaces derived from Step 3 above.

5. The resulting triangulations from Step 4 were then further subdivided into two main types:

    a. 'normal', where reasonably good Russian cross-section control was available.

    b. 'conjectural', where it was desired to give some indication of the likely structure, but no control of Russian cross-section lines was available.

Using this methodology, generally complete triangulations were constructed for the base of Units 1, 3, 5 & 6, and the top and base of the Breccia. Units 2, 4 and 7, have been partially completed in the time available.

Note that there seem to be at least two horizons of Breccia present in different areas: (i) between Units 3 and 4 (coloured yellow on the 1:5000 geological map) and (ii) above Unit 7. Generally the Breccias exhibit a more deformed structure than the stratigraphic Units 1 – 7.

A full list of triangulations with descriptions is given in appendix 2.

# 4 Movies and screen capture images

To illustrate the general structure portrayed in the completed Vulcan model, a series of movies and still images was created using the screen capture/animation facility within Vulcan. These show various oblique perspective cross-section views (dynamic moving sections in the case of the animations). The still images were further enhanced by annotations, added using Adobe Photoshop.

# 5 Data archiving

Data and models are all archived to:

\\Kwsan\WorkSpace\IBD\AfghanistanMinerals\Data\

This includes all CDs returned to Keyworth from Afghanistan, Vulcan models, all source data for the models, images and videos exported from the models, and correspondence. The data from the CDs are in folders according the CD number.

A copy of the data model is also present on the AGS server in Kabul, along with a copy of the Vulcan Envisage viewer. This enables the Aynak model to be displayed, rotated, zoomed and sliced, but it does not allow the creation of new layers or 3D objects.

# 6 Conclusions

1. Data collated by BGS-Kabul has been imported into Vulcan software.
2. A regional model (5km x 4 km) has been created of surface topography, a geological map and boreholes.
3. Two sub-areas (ca. 2km x 2 km – the Central Area and the Western Area) were identified as important economic Cu prospects and have been modelled separately.
4. For each area, the bases of unit 1 to 7 have been modelled to provide an indication of the structure of the Cu deposit.
5. In the Central Area, the structure comprises a broad, shallow dipping syncline plunging to the NE. This structure has the majority of the proven economic Cu mineralisation.
6. A tight anticline-syncline pair are located to the south of the main syncline and there is potential for further mineralisation in this area.
7. Overburden thicknesses are variable and range from 0m to over 300m.

# Appendix 1 Vulcan Layers

| | |
|---|---|
| 10K_TOP_TR | Base trig construct to register pexel |
| AREAS | Rough outlines of exploration areas |
| AX_ANT_RHD | Axial trace of anticlines at RHD |
| AX_SYN_RHD | Axial trace of synclines at RHD |
| B1_BH_E | Base unit 1 in boreholes, eastern area |
| B1_CONSTR | Construction points, base unit 1, eastern area |
| B1_POLY_E | Base unit 1 limiting polygon, eastern area |
| B2_BH_E | Base unit 2 in boreholes, eastern area |
| B2_CONSTR | Construction points, base unit 2, eastern area |
| B2_POLY_E | Base unit 2 limiting polygon, eastern area |
| B3_BH_E | Base unit 3 in boreholes, eastern area |
| B3_CONSTR | Construction points, base unit 3, eastern area |
| B3_POLY_E | Base unit 3 limiting polygon, eastern area |
| B4_BH_E | Base unit 4 in boreholes, eastern area |
| B4_CONSTR | Construction points, base unit 4, eastern area |
| B4_POLY_E | Base unit 4 limiting polygon, eastern area |
| B4_TIES | Tie lines for construction of base unit 4, eastern area |
| B5_BH_E | Base unit 5 in boreholes, eastern area |
| B5_CONSTR | Construction points, base unit 5, eastern area |
| B5_POLY_E | Base unit 5, bounding polygon, eastern area |
| B6_BH_E | Base unit 6 in boreholes, eastern area |
| B6_CONSTR | Construction points, base unit 6, eastern area |
| B6_POLY_E | Base unit 6 bounding polygon, eastern area |
| B7_BH_E | Base unit 7 in boreholes, eastern area |
| B7_CONSTR | Construction points, base unit 7, eastern area |
| B7_POLYS_E | Base unit 7 bounding polygons, eastern area |
| BH_B1 | Base unit 1 in boreholes |
| BH_B2 | Base unit 2 in boreholes |
| BH_B3 | Base unit 3 in boreholes |
| BH_B4 | Base unit 4 in boreholes |
| BH_B5 | Base unit 5 in boreholes |
| BH_B6 | Base unit 6 in boreholes |
| BH_B7 | Base unit 7 in boreholes |

| | |
|---|---|
| BH_COLLARS | Borehole collars, 4 Mar 05 |
| BH_NAME | Borehole ID  04-Mar-2005 |
| BH_RH | Rockhead in boreholes |
| BH_SEC_B4 | Pseudosections created by joining bhs |
| BLOCK_EXT | Block Model Display extent |
| BUILDINGS | Buildings from 10k and 2k maps |
| DEP_TO_RH | Contours of depth to rockhead |
| EXT_1_W | Extrapolated points/lines on base Unit 1, western area |
| EXT_2_W | Extrapolated pts/lines on base Unit 2, western area |
| EXT_3_W | extrapolated pts/lines on base Unit 3, western area |
| EXT_4_W | Extrapolated pts/lines on base Unit 4, western area |
| EXT_5_W | Extrapolated pts/lines on base Unit 5, western area |
| EXT_6_W | Extrapolated pts/lines on base Unit 6, western area |
| EXT_BRE_B | Extrapolated pts/lines on base Breccia, western area EXT_BRE_T Extrapolated pts/lines on top Breccia, western area EXT_F10A_W Extrapolated pts/lines on F10a (W) |
| EXT_F10_W | Extrapolated pts/lines on F10 (W) |
| EXT_F11_W | Extrapolated pts/lines on F11 (W) |
| EXT_F12_W | Extrapolated pts/lines on F12 (W) |
| EXT_F13_W | Extrapolated pts/lines on F13 (W) |
| EXT_F14_E | Extrapolated pts/lines on F14_E |
| EXT_F14_W | Extrapolated pts/lines on F14 (W) |
| EXT_F15_W | Extrapolated pts/lines in F15 (W) |
| EXT_F16_W | Extrapolated pts/lines on Fault F16 (W) |
| EXT_F17_W | Extrapolated pts/lines on Fault F17 (W) |
| EXT_F18_W | Extrapolated pts/lines on F18 (W) |
| EXT_F1_W | Extrapolated points/lines for F1 (W) |
| EXT_F2_W | Extrapolated points/lines for F2 (W) |
| EXT_F3_W | Extrapolated pts/lines on Fault F3 (W) |
| EXT_F4_W | Extrapolated pts/lines on F4 (W) |
| EXT_F5A_W | Extrapolated pts/lines in Fault F5a (W) |
| EXT_F5_E | Extrapolated pts/lines on F5 (East) |
| EXT_F5_W | Extrapolated pts/lines on F5 (W) |
| EXT_F6_W | Extrapolated pts/line on fault F6 (W) |
| EXT_F7_W | Extrapolated pts/lines on F7 (W) |
| EXT_F8_W | Extrapolated pts/lines on F8 (W) |
| EXT_F9_W | Extrapolated pts/lines on F9 (W) |
| MAP_B1_E_R | Base Unit 1 east registered on rockhead |

| | |
|---|---|
| MAP_B1_NR | Base Unit 1 on map NOT registered on RHD |
| MAP_B1_REG | Base Unit 1 on map registered on RHD |
| MAP_B2_E_R | Base unit 2 east registered on rockhead |
| MAP_B2_NR | Base Unit 2 on map NOT registered on RHD |
| MAP_B2_REG | Base Unit 2 on map registered on RHD |
| MAP_B3_E_R | Base unit 3 east registered on rockhead |
| MAP_B3_NR | Base Unit 3 on map NOT registered on RHD |
| MAP_B3_REG | Base Unit 3 on map registered on RHD |
| MAP_B4_E_R | Base unit 4 east registered on rockhead |
| MAP_B4_NR | Base Unit 4 on map NOT registered on RHD |
| MAP_B4_REG | Base Unit 4 on map registered on RHD |
| MAP_B5_E_R | Base unit 5 east registered on rockhead |
| MAP_B5_NR | Base Unit 5 on map NOT registered on RHD |
| MAP_B5_REG | Base Unit 5 on map registered on RHD |
| MAP_B6_E_R | Base unit 6 east registered on rockhead |
| MAP_B6_NR | Base Unit 6 on map NOT registered on RHD |
| MAP_B6_REG | Base Unit 6 on map registered on RHD |
| MAP_B7_E_R | Base Unit 7 east registered on rockhead |
| MAP_B7_NR | Base Unit 7 on map NOT registered on RHD |
| MAP_B7_REG | Base Unit 7 on map registered on RHD |
| MAP_BASE | Polygon for creating trig for regist map |
| MAP_BR_B_W | Mapped base ?fault breccia (in west) |
| MAP_BR_T_W | Mapped top ?fault breccia (in west) |
| MAP_B_U2 | base middle uR unit, central area |
| MAP_B_U3 | base youngest uR unit, central area |
| MAP_F1 | Mapped line of Fault F1 (W) |
| MAP_F10A | Mapped line of Fault F10 (W) |
| MAP_F11 | Mapped line of Fault F11 (W) |
| MAP_F12 | Mapped line of Fault F12 (W) |
| MAP_F13 | Mapped line of Fault F13 |
| MAP_F14 | Mapped line of Fault 14 (W) |
| MAP_F14_E | Mapped line of F14 extended into eastern area |
| MAP_F15 | Mapped line of F15 (W) |
| MAP_F16 | Mapped line of fault F16 (W) |
| MAP_F17 | Mapped line of Fault F17 (W) |
| MAP_F18 | Mapped line of Fault F18 (W) |
| MAP_F2 | Mapped line of Fault F2 (W) |

| | |
|---|---|
| MAP_F3 | Mapped line of Fault F3 (W) |
| MAP_F4 | Mapped line of Fault F4 (W) |
| MAP_F5 | Mapped line of F5 (W) |
| MAP_F5A | Mapped line of fault F5a (W) |
| MAP_F6 | Mapped line of fault F6 (W) |
| MAP_F7 | Mapped fault line F7 (W) |
| MAP_F8 | Mapped line of Fault F8 (W) |
| MAP_F9 | Mapped line of Fault F9 (W) |
| MAP_FLTALL | Mapped lines of all modelled faults |
| MAP_FLT_E | Faults on base map (East) NOT reg on RHD |
| MAP_FLT_W | Faults on base map (West) reg on RHD |
| MAP_FRAME | Frame around geology base map |
| MAP_FT_E_R | Faults on map east registered on rockhead |
| MAP_GRID | Grid for geology map |
| MAP_IG | various igneous rocks |
| MAP_SECLIN | Section lines from basemap |
| MAP_T_U1 | top oldest uR unit, central area |
| MAP_T_U2 | top middle uR unit, central area |
| MAP_T_U3 | top youngest uR central area |
| MAP_T_UU | uR unit in extreme W and south of area |
| OPENPIT | Open pit from plans |
| PATHS | Footpaths from 1:10k map |
| PLAN2160 | Const lines for trig to reg 2160 plan |
| PLAN2180 | Const lines for trig to reg 2180 plan |
| PL_B1_E | Base unit 1 plans east |
| PL_B2_E | Base unit 2 plans east |
| PL_B3_E | Base unit 3 plans east |
| PL_B4_E | Base unit 4 plans east |
| PL_B5_E | Base unit 5 plans east |
| PL_B6_E | Base unit 6 plans east |
| PL_B7_E | Base unit 7 plans east |
| PL_FAULTS | Faults in plans east |
| PL_RH | Rockhead on plans |
| QTNEO_LIM | Limit of Quat-Neogene from Geol Map |
| QTNEO_RLT | Relimit polygons for Quat-Neogene |
| RH_INT_W | Interpreted RHD in west - conjectural ! |
| RH_POLY | Limit of RHD info on sections |

| | |
|---|---|
| RH_POLY_W | Limit of RHD info on sections in west |
| ROADS | Driveable tracks from 1:10k map |
| SECXXXVIII | Construction lines section XXXVIII |
| SEC_B1_E | Base unit 1 sects east (=1 newsecs) |
| SEC_B1_W | Base unit 1 in sections (West) |
| SEC_B2_E | Base unit 2 sects east (=5 newsecs) |
| SEC_B2_W | Base unit 2 in sections (west) |
| SEC_B3_E | Base unit 3 sects east (=6 newsecs) |
| SEC_B3_W | Base unit 3 in sections (west) |
| SEC_B4_E | Base unit 4 sects east (=7.1 newsecs) |
| SEC_B4_W | Base unit 4 in sections (west) |
| SEC_B5_E | Base unit 5 sects east (=7.2 newsecs) |
| SEC_B5_W | Base unit 5 in sections (west) |
| SEC_B6_E | Base unit 6 sects east (=8.1 newsecs) |
| SEC_B6_W | Base unit 6 in sections (West) |
| SEC_B7_E | Base unit 7 sects east (=8.2 newsecs) |
| SEC_B7_W | Base unit 7 in sections (West) |
| SEC_BR_B_W | Base of Breccia in sections (west) |
| SEC_BR_T_W | Top of Breccia in sections (west) |
| SEC_F10_W | Fault F10 in cross-sections (W) |
| SEC_F11_W | Fault F11 in cross-section (W) |
| SEC_F12_W | Fault F12 in cross-sections (W) |
| SEC_F13_W | Fault F13 in cross-sections (W) |
| SEC_F14_W | Fault F14 in section lines (W) |
| SEC_F15_W | Fault F15 in cross-section lines (W) |
| SEC_F1_W | Fault 1 in sections (west) |
| SEC_F3_W | Fault F3 in section lines (west) |
| SEC_F4_W | Fault F4 in cross-sections (W) |
| SEC_F5A_W | Fault F5a in section lines (W) |
| SEC_F5_W | Fault F5 in section line (W) |
| SEC_F6_W | Fault F6 in section lines (W) |
| SEC_F8_W | Fault F8 in cross-sections (W) |
| SEC_FLTS_E | Faults in sections in East |
| SEC_FLTS_W | Faults in sections in west |
| SEC_IG | Igneous rocks from sections |
| SEC_II | Construction lines section II |
| SEC_III | Construction lines section III |

| | |
|---|---|
| SEC_IV | Construction lines section IV |
| SEC_IX | Construction lines section IX |
| SEC_L1 | Construction lines section 1 |
| SEC_L2 | Construction lines section 2 |
| SEC_L3 | Construction lines section 3 |
| SEC_L4 | Construction lines section 4 |
| SEC_L5 | Construction lines section 5 |
| SEC_L6 | Construction lines section 6 |
| SEC_L7 | Construction lines section 7 |
| SEC_RHD | Base Quat-Neogene (=RHD) from sections |
| SEC_TOPO | Topography digitised from sections |
| SEC_V | Construction lines section V |
| SEC_VI | Construction lines section VI |
| SEC_VII | Construction lines section VII |
| SEC_VIII | Construction lines section VIII |
| SEC_X | Construction lines section X |
| SEC_XI | Construction lines section XI |
| SEC_XII | Construction lines section XII |
| SEC_XIII | Construction lines section XIII |
| SEC_XIV | Construction lines section XIV |
| SEC_XL | Construction lines section XL |
| SEC_XV | Construction lines section XV |
| SEC_XVI | Construction lines section XVI |
| SEC_XXII | Construction lines section XXII |
| SEC_XXIII | Construction lines section XXIII |
| SEC_XXIV | Construction lines section XXIV |
| SEC_XXIX | Construction lines section XXIX |
| SEC_XXV | Construction lines section XXV |
| SEC_XXVI | Construction lines section XXVI |
| SEC_XXVII | Construction lines section XXVII |
| SEC_XXVIII | Construction lines section XXVIII |
| SEC_XXX | Construction lines section XXX |
| SEC_XXXI | Construction lines section XXXI |
| SEC_XXXII | Construction lines section XXXII |
| SEC_XXXIII | Construction lines section XXXIII |
| SEC_XXXV | Construction lines section XXXV |
| SEC_XXXVI | Construction lines section XXXVI |

| | |
|---|---|
| TOPO_CONTS | Topography contours - all |
| TOPO_POLY | Bounding polygon for topography |
| TOPO_SPOTS | Topography spot heights |

# Appendix 2 Vulcan Triangulations

NB – a description is not given where the file name is sufficient to do this.

| | |
|---|---|
| 050525_cu_0_73.00t | Copper grade shell from block model |
| 050525_cu_1_95.00t | Copper grade shell from block model |
| 050525_cu_3_40.00t | Copper grade shell from block model |
| 050727_cu_1_95.00t | Copper grade shell from block model |
| 050727_cu_3_40.00t | Copper grade shell from block model |
| B1_conject_W.00t | Base Unit B1 in west *conjectural* |
| B1_E.00t | Base Unit B1 in east |
| B1_W.00t | Base Unit B1 in west |
| B2_conject_W.00t | Base Unit B2 in west *conjectural* |
| B2_E.00t | Base Unit B2 in east |
| B2_W.00t | Base Unit B2 in west |
| B3_conject_W.00t | Base Unit B3 in west *conjectural* |
| B3_E.00t | Base Unit B3 in east |
| B3_W.00t | Base Unit B3 in west |
| B4_conject_W.00t | Base Unit B4 in west *conjectural* |
| B4_E.00t | Base Unit B4 in east |
| B4_W.00t | Base Unit B4 in west |
| B5_conject_E.00t | Base Unit B5 in east *conjectural* |
| B5_conject_W.00t | Base Unit B5 in west *conjectural* |
| B5_E.00t | Base Unit B5 in east |
| B5_W.00t | Base Unit B5 in west |
| B6_conject_E.00t | Base Unit B6 in east *conjectural* |
| B6_conject_W.00t | Base Unit B6 in west *conjectural* |
| B6_E.00t | Base Unit B6 in east |
| B6_W.00t | Base Unit B6 in west |
| B7_E.00t | Base Unit B7 in east |
| B7_W.00t | Base Unit B7 in west |
| block_ext.00t | Extent of block model |
| Breccia_base_conject_W.00t | Base Breccia in west *conjectural* |
| Breccia_base_W.00t | Base Breccia in west |
| Breccia_top_conject_W.00t | Top Breccia in west *conjectural* |
| Breccia_top_W.00t | Top Breccia in west |

building1.00t

building10.00t

building11.00t

building12.00t

building13.00t

building14.00t

building15.00t

building16.00t

building17.00t

building18.00t

building19.00t

building2.00t

building20.00t

building21.00t

building22.00t

building23.00t

building24.00t

building25.00t

building26.00t

building27.00t

building28.00t

building29.00t

building3.00t

building30.00t

building4.00t

building5.00t

building6.00t

building7.00t

building8.00t

building9.00t

***Notes on Fault triangulations names:***

1. *In the Western area, Fault triangulations are named Fault F1, Fault F2 …. Fault 18.*
2. *In the Eastern (Central area) Fault East 1, East 2, ….East 5, are* ***not*** *the same as Western area Faults F1 – F5.*
3. *Fault F14 is common to both Eastern and Western areas*

| | |
|---|---|
| Fault_1_E.00t | Fault East 1 |
| Fault_1_W.00t | Fault F1 (in west) |
| Fault_10_W.00t | Fault F10 (in west) |
| Fault_10a_W.00t | |
| Fault_11_W.00t | |
| Fault_12_W.00t | |
| Fault_13_W.00t | |
| Fault_14_E.00t | Fault F14 in east |
| Fault_14_W.00t | Fault F14 in west |
| Fault_15_W.00t | |
| Fault_16_W.00t | |
| Fault_17_W.00t | |
| Fault_18_W.00t | |
| Fault_2_E.00t | Fault East 2 |
| Fault_2_W.00t | Fault F2 in west |
| Fault_3_E.00t | Fault East 3 |
| Fault_3_W.00t | Fault F3 in west |
| Fault_4_E.00t | Fault East 4 |
| Fault_4_W.00t | Fault F4 in west |
| Fault_5_E.00t | Fault East 5 |
| Fault_5_W.00t | Fault F5 in west |
| Fault_5a_W.00t | |
| Fault_6_W.00t | |
| Fault_7_W.00t | |
| Fault_8_W.00t | |
| Fault_9_W.00t | |
| Fault_all_modelled.00t | All modelled fault triangulations appended together for convenience |
| MAP_BASE.00t | Triangulation for registering 1:5000 base map |
| OPENPIT.00t | |
| PLAN1980.00t | |
| PLAN2160.00t | |
| RHD_combined_E_W.00t | Rockhead surface combined for both east and west areas |
| RHD_east_bh_sect.00t | Rockhead surface generated from boreholes and sections in east |
| RHD_interpreted_W.00t | Rockhead surface in west generated from section lines and interpreted points/lines |

| | |
|---|---|
| sec_ii.00t | Surface for displaying cross-section line (ii) as pexel overlay |
| sec_iii.00t | As above, for cross-section line (iii) |
| sec_iv.00t | etc. |
| sec_ix.00t | |
| sec_l1.00t | As above, for cross-section line (1) |
| sec_l2.00t | As above, for cross-section line (2) |
| sec_l3.00t | As above, for cross-section line (3) |
| sec_l4.00t | As above, for cross-section line (4) |
| sec_l5.00t | As above, for cross-section line (5) |
| sec_l6.00t | As above, for cross-section line (6) |
| sec_l7.00t | As above, for cross-section line (7) |
| sec_v.00t | As above, for cross-section line (v) |
| sec_vi.00t | As above, for cross-section line (vi) |
| sec_vii.00t | |
| sec_viii.00t | |
| sec_x.00t | |
| sec_xi.00t | |
| sec_xii.00t | |
| sec_xiii.00t | |
| sec_xiv.00t | |
| sec_xl.00t | |
| sec_xv.00t | |
| sec_xvi.00t | |
| sec_xxii.00t | |
| sec_xxiii.00t | |
| sec_xxiv.00t | |
| sec_xxix.00t | |
| sec_xxv.00t | |
| sec_xxvi.00t | |
| sec_xxvii.00t | |
| sec_xxviii.00t | |
| sec_xxx.00t | |
| sec_xxxi.00t | |
| sec_xxxii.00t | |
| sec_xxxiii.00t | |
| sec_xxxv.00t | |

| | |
|---|---|
| sec_xxxvi.00t | |
| secxxxviii.00t | |
| TOPO_10k_conts_spots.00t | Topographic surface generated from contours and spot heights on 1:10k topographic map |
| Topo_with_openpit.00t | Topographic surface including a conjectural open pit model |