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To: Fallon FORGE team
From: Jeff Witter, Principal Geoscientist, Innovate Geothermal Ltd.
Re: Explainer for Fallon FORGE 3D gravity model files
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The purpose of this memo is to provide an explanation of the 3D geophysical modelling files generated as part of the 3D gravity modelling exercise in Phase 2B at the Fallon FORGE site. These data files have been provided to the Geothermal Data Repository (gdr.openei.org). This memo explains both the input files used in the 3D geophysical inversion modelling as well as the 3D density model output files.

The 3D geophysical modelling was performed using the open source SimPEG code (www.simpeg.xyz). The input and output geophysical model files are provided in UBC format (more information on UBC format files can be found at: gif.eos.ubc.ca). The output density model file has also been supplied in .txt file format.

The 3D gravity modelling exercise at Fallon FORGE was guided by: a) a 3D geologic model developed by the FORGE team and b) rock density measurements made in Phase 2B. This information is provided elsewhere in the GDR. The core of the 3D model volume used in the gravity modeling exercise has the following dimensions: 8 km (N-S) x 8 km (E-W) x 4 km (thick). This core model volume is centered on the Fallon FORGE site. The majority of the core model volume has 100 m x 100 m x 100 m cubic cells. Near the land surface, model cells are as thin as 1 m to adequately capture variations in topography.

All horizontal coordinates in the input and output files are in UTMNAD83 zone 11. All elevations are in meters above sea level.

Input files used for 3D inversion modelling

1. *FORGE_All_DEM_100m_Pts_and_GravStaTopo.topo* – UBC-format TOPO file that consists of 30,218 topographic points describing the land surface in the Fallon FORGE geophysical model area. The three columns in the file represent: X and Y coordinates and elevation.
2. *FORGE_GravInv18_MESH_100m_1m_nr_topo.mesh* – UBC-format MESH file that describes the 3D volumetric mesh used in the 3D geophysical inversion modelling. The core of the 3D mesh consists of 80 (N-S) x 80 (E-W) x 126 (Z) cells. The core model volume is made up of cubic cells 100 m in size except near the topographic surface where model cells are as thin as 1 m. This core model volume is surrounded by padding cells that increase in size away from the core mesh. There are 11 padding cells on the N, S, E, and W sides as well as 12 padding cells on the bottom of the core mesh.
3. *FORGE_GravInv18_OBS_Pts_CBA2p55gcm3_RegRem_NEW1.obs* – UBC-format gravity data observation file. This file consists of 1318 gravity data points. The five columns in the file represent: X and Y coordinates, elevation, complete bouguer gravity anomaly in mGal (with 2.55 g/cm^3 reference density and regional removed), and estimated error in the gravity data.

4. *GravInv18_REF_units.mod* – UBC-format model file that represents the different rock units of the 3D geologic reference model developed in Phase 2B. The rock units are numbered 1-5 and are explained in Table 1.
5. *GravInv18_STARTING_DEN_2p55gcm3.den* – UBC-format density model file that represents the starting density contrast values used in the 3D geophysical modelling (using reference density = 2.55 g/cm^3). The starting density values are shown in Table 1.

Geologic Unit	Reference Unit#	Density contrast (g/cm^3)	Density (g/cm^3)
Air	1	-2.55	0
Qs – Quaternary sediments	2	-0.45	2.1
Ns – Neogene sediments	3	-0.35	2.2
Tvs – Tertiary volcanics	4	-0.15	2.4
Mzu – Mesozoic basement	5	+0.15	2.7

Table 1. Density data for 3D geologic reference model using a reference value of 2.55 g/cm^3.

Output files in UBC-format

1. *GravInv18_FWD_2p55gcm3_PRE#2.obs* – UBC-format gravity data file which contains the predicted gravity data derived from forward modelling the 3D geologic reference model and starting densities described in Table 1. The first four columns in the file represent: X and Y coordinates, elevation, and predicted gravity data in mGal.
2. GravInv18_FWD_2p55_RegRem_MISFIT#2.obs – UBC-format gravity data file which contains the misfit between the observed and predicted gravity data derived from forward modelling the 3D geologic reference model and starting densities described in Table 1. The first four columns in the file represent: X and Y coordinates, elevation, and misfit in mGal.
3. *GravInv18_HomHet_2p55_RegRem_0p1err_Lp_Total_Inv#2.mesh*
   GravInv18_HomHet_2p55_RegRem_0p1err_Lp_Total_Inv#2_ROCK_DEN.den
   These two files are UBC-format MESH and model files which represent the 3D density distribution in the core model volume derived from the 3D inversion modelling exercise guided by the 3D geologic reference model and starting density values.
4. *GravInv18_HomHet_2p55_RegRem_0p1err_Lp_PRE#2.pre* – UBC-format gravity data file which contains the predicted gravity data derived from the 3D inversion modelling exercise. The first four columns in the file represent: X and Y coordinates, elevation, and predicted gravity data in mGal.
5. *GravInv18_HomHet_2p55_RegRem_0p1err_Lp_MISFIT#2.obs* – UBC-format gravity data file which contains the misfit between the observed and predicted gravity data derived from the 3D inversion modelling exercise. The first four columns in the file represent: X and Y coordinates, elevation, and misfit in mGal.

Density model output file in Text file format

1. *GravInv18_HomHet_2p55_RegRem_0p1err_Lp_Total_Inv#2_ROCK_DEN.txt* – This file represents the 3D density distribution derived from the 3D inversion modelling exercise The four columns in the file are: X and Y coordinates, elevation, & rock density (g/cm^3).