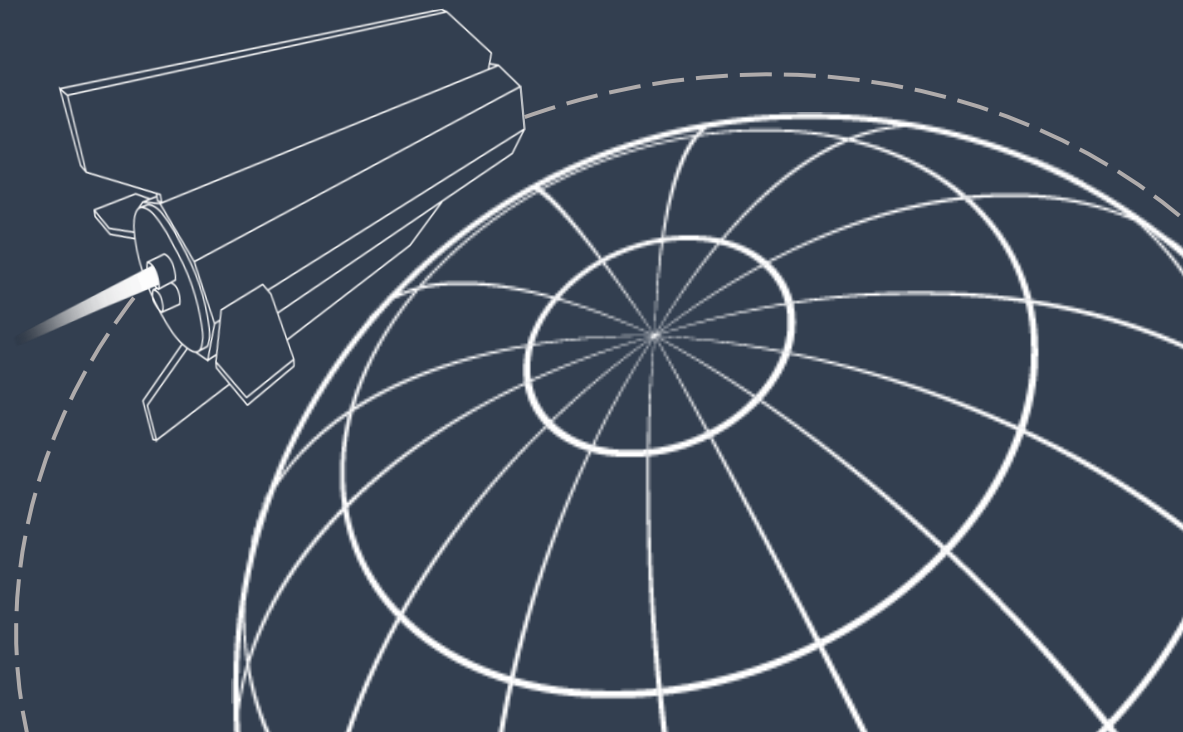
EGU General Assembly 2022

ธรณีวิทยา
จุฬาลงกรณ์มหาวิทยาลัย

DEPARTMENT OF GEOLOGY
CHULALONGKORN UNIVERSITY

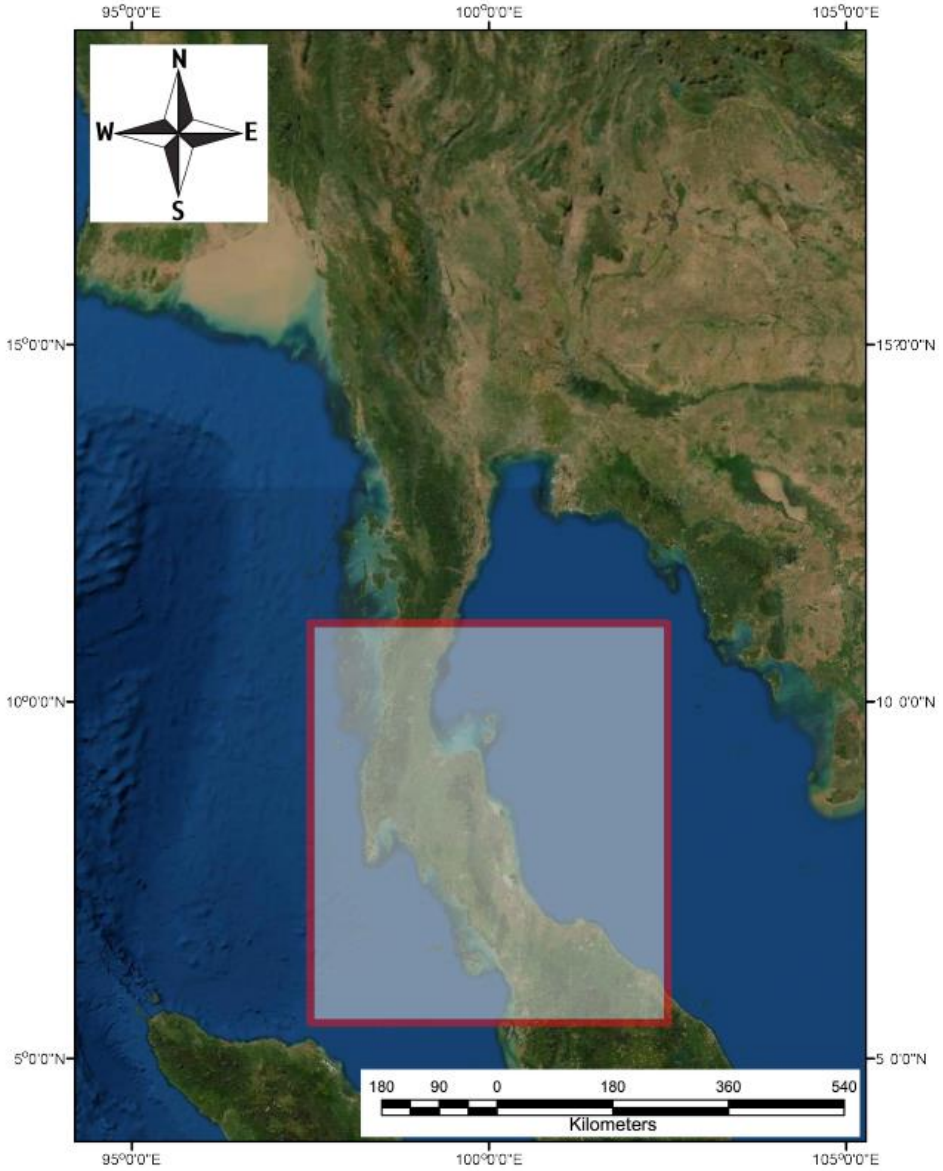
Mapping subsurface structural lineament and geothermal potential areas in Southern Thailand using GOCE gravity data

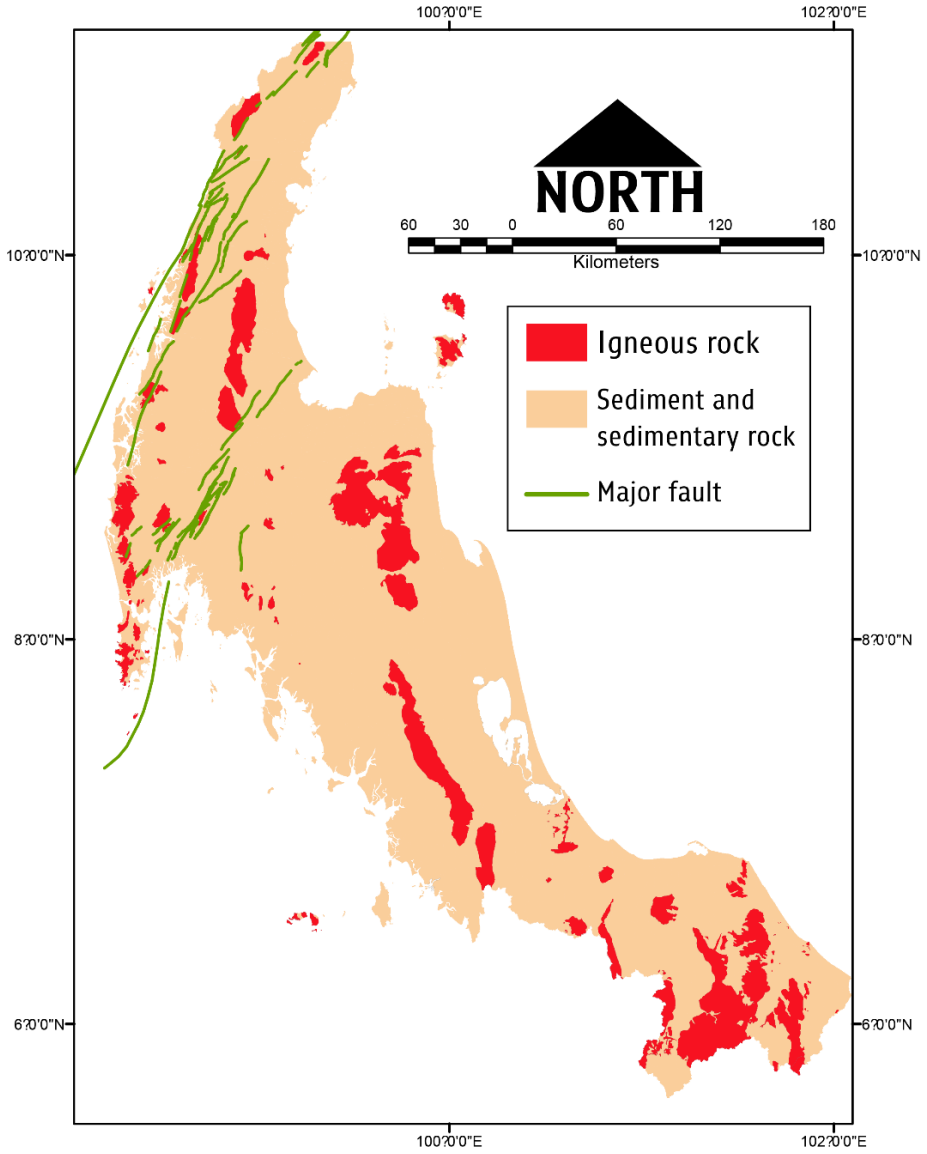
Theethach Phiranram and Piyaphong Chenrai



Abstract
EGU 22-3384

OVERVIEW





Location: 5.5°N to 11.1°N, and 97.5°W to 102.5°W (WGS 1984)

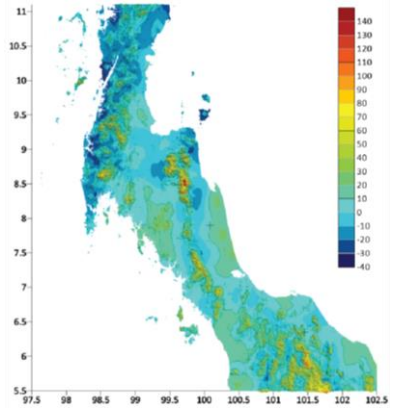
The Southern Thailand was characterized by **major fault** and **igneous bodies**, which made this area **suitable for geothermal exploration**

Objective: Qualitative interpretation of Bouguer anomalies and their derivatives.

METHODOLOGY

Gravity model (GGMplus 2013 (Hirt et al., 2013))

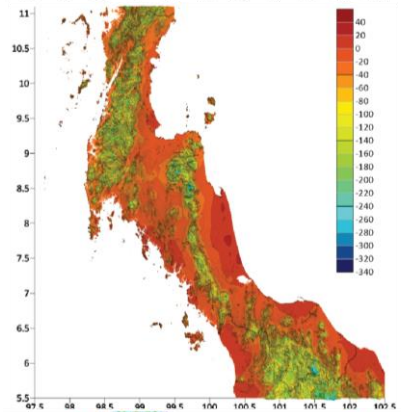
Combination of satellite gravity data, EGM2008, and topographic data.



Gravity anomaly

$$\Delta g = \delta g + \gamma(H) - \gamma(h)$$

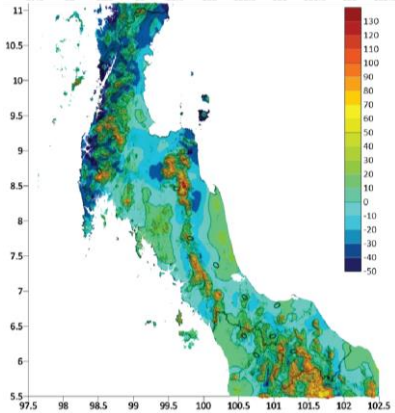
-333.01 to 30.16 mGal
Average = -10.73 mGal



Free Air anomaly

$$g_h = -0.3086h$$
$$g_{FA} = \Delta g - g_h$$

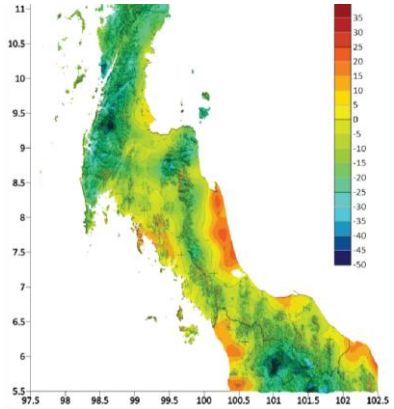
-49.33 to 124.98 mGal
Average = -7.98 mGal



Complete Bouguer anomaly

$$\delta g_{BP} = 2\pi G \rho_B h$$
$$g_{CBA} = FAA - \delta g_{BP} + g_T$$

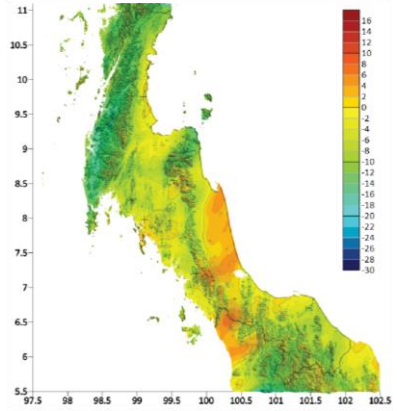
-47.81 to 30.46 mGal
Average = -2.75 mGal



Regional anomaly

$$L(k) = e^{-hk}$$

-28.02 to 14.18 mGal
Average = -2.33 mGal



RESIDUAL ANOMALIES

$$g_{res} = g - g_{reg}$$

-30.96 to 24.50 mGal
Average = -10.73 mGal

- **Low anomalies(L1, L2 and L3)** refer to the **thickening of earth's crust.**
- **Moderate anomalies(M1)** corresponded with **igneous bodies,** and **M2 and M3** correlated with **basin**.
- **High anomalies (H1/1, H1/2, and H1/3)** were interpreted as **limestone**.

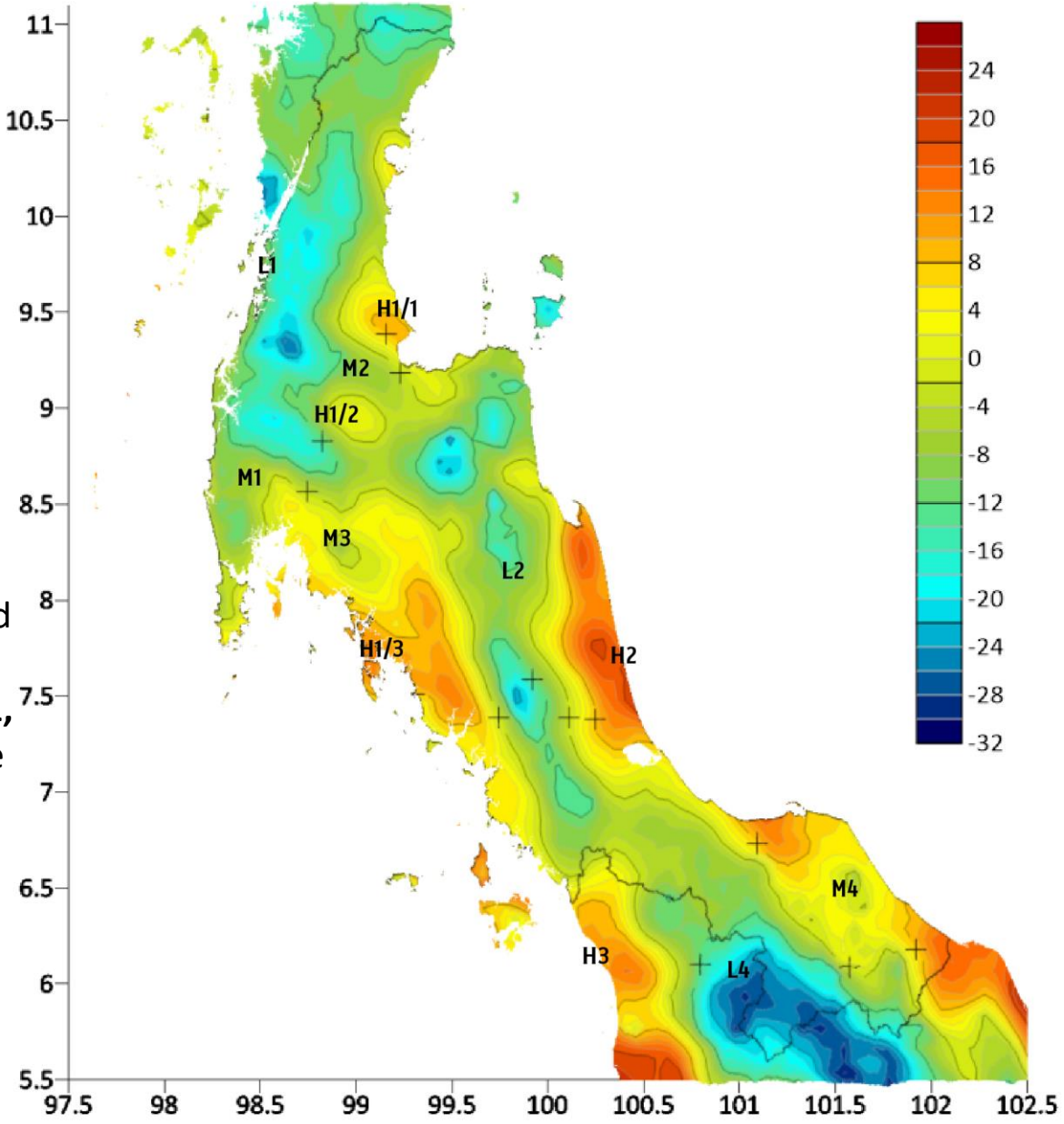


Table 2.1 *Densities of rocks and minerals.* P.V. Sharma, 1997, pg17.

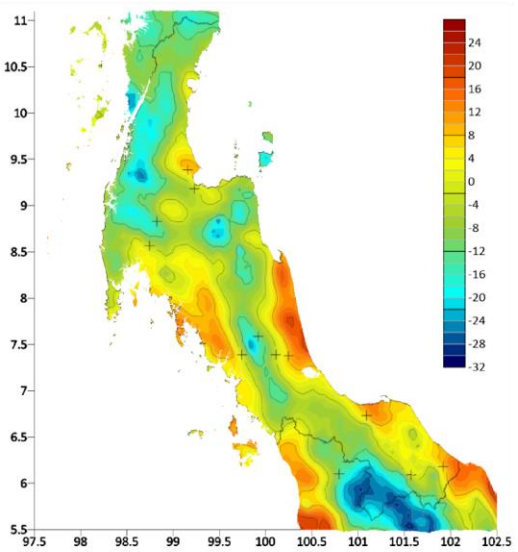
Rock type or mineral	Density (wet) ($\times 10^3$ kg/m^3)
Sand	1.6–2
Moraine	1.5–2
Sandstones (Mesozoic)	2.15–2.4
Sandstones (Paleozoic and older)	2.35–2.65
Quartzite	2.60–2.70
Limestone (compact)	2.5–2.75
Shales (younger)	2.1–2.6 (2.4)[a]
Shales (older)	2.65–2.75 (2.7)
Gneiss	2.6–2.9 (2.7)
Basalt	2.7–3.3 (2.98)
Diabase	2.8–3.1 (2.96)
Serpentinite	2.5–2.7 (2.6)
Gypsum	2.3
Anhydrite	2.9
Rocksalt	2.1–2.4 (2.2)
Zincblende	4.0
Chromite	4.5–4.8
Pyrite	4.9–5.2
Hematite	5.1
Magnetite	4.9–5.2 (5.1)
Galena	7.4–7.6
Granite	2.52–2.81 (2.67)
Granodiorite	2.67–2.79 (2.72)
Syenite	2.63–2.90 (2.76)
Quartzdiorite	2.68–2.96 (2.81)
Gabbro	2.85–3.12 (2.98)
Peridotite	3.15–3.28 (3.23)
Dunite	3.20–3.31 (3.28)
Eclogite	3.34–3.45 (3.39)

Note:
[a] Figures in parentheses are taken to be average values.

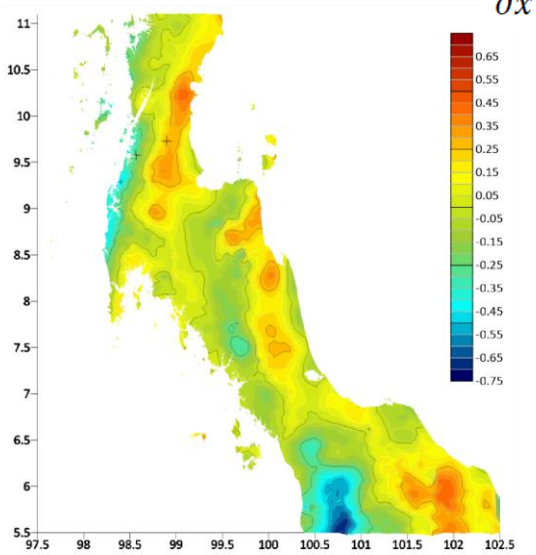
(PV Sharma, 1997)

GRAVITY GRADIENTS

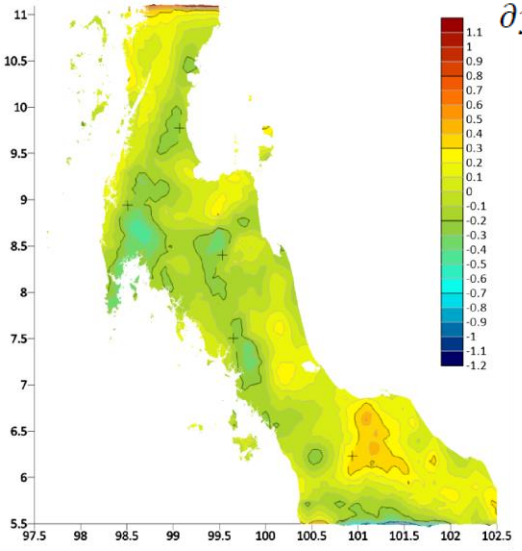
Residual gravity anomaly



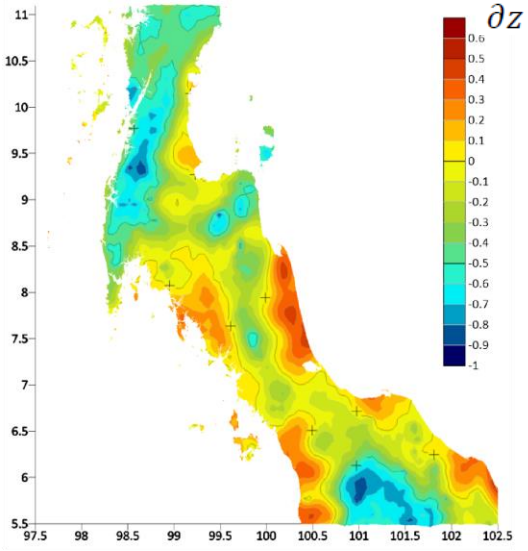
Gravity gradient in x direction. $\frac{\partial g}{\partial x}$



Gravity gradient in y direction. $\frac{\partial g}{\partial y}$



Gravity gradient in z direction. $\frac{\partial g}{\partial z}$



$$\Gamma_{ij} = \mathcal{F}^{-1}\{[K(k)]G(k)\}$$

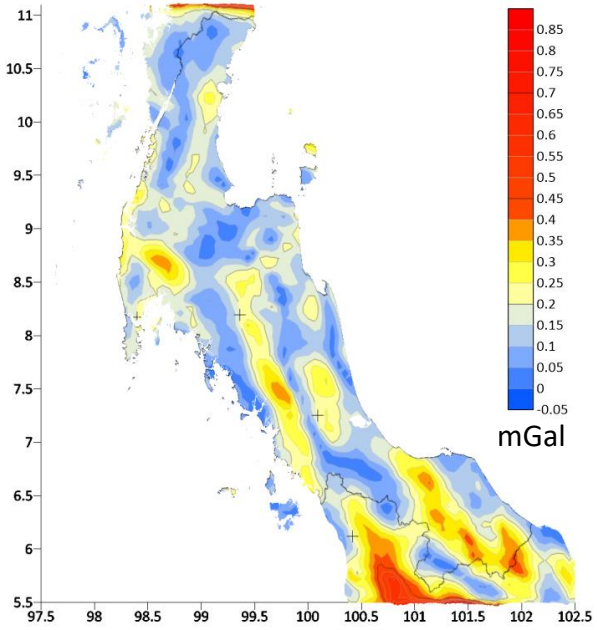
$$g_{z,x} = \frac{\partial g}{\partial x} = \mathcal{F}^{-1}\{-ik_x * G(k)\}$$

$$g_{z,y} = \frac{\partial g}{\partial y} = \mathcal{F}^{-1}\{-ik_y * G(k)\}$$

$$g_{z,z} = \frac{\partial g}{\partial z} = \mathcal{F}^{-1}\{|\boldsymbol{k}| * G(k)\}$$

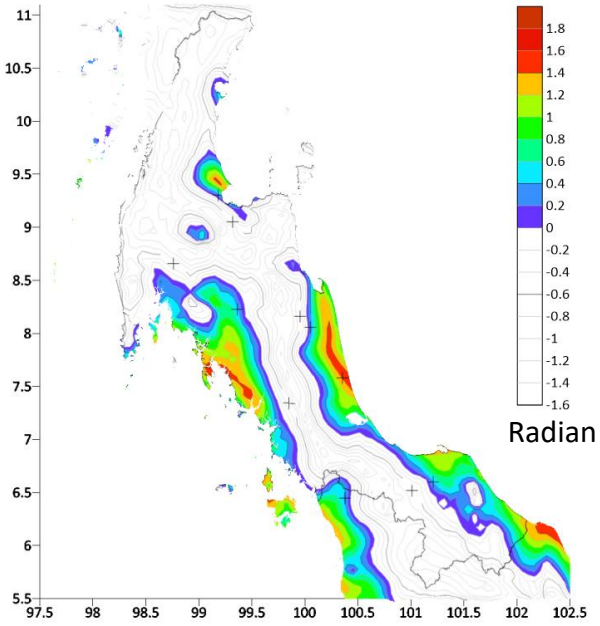
LINEAMENT STRUCTURES

Total Horizontal Derivative (THD)



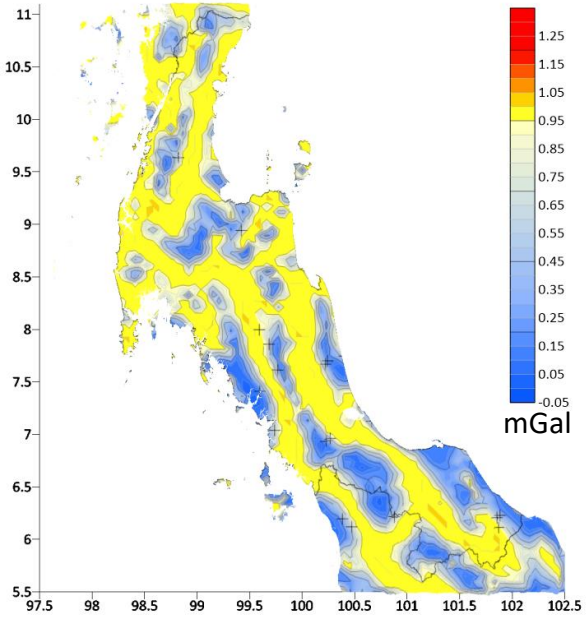
$$THD = \left[\frac{\partial g}{\partial x} + \frac{\partial g}{\partial y}\right]^{-\frac{1}{2}}$$

Tilt derivative (TDR)



$$\mathrm{T}DR = \tan^{-1}\left(\frac{\frac{\partial g}{\partial z}}{THD}\right)$$

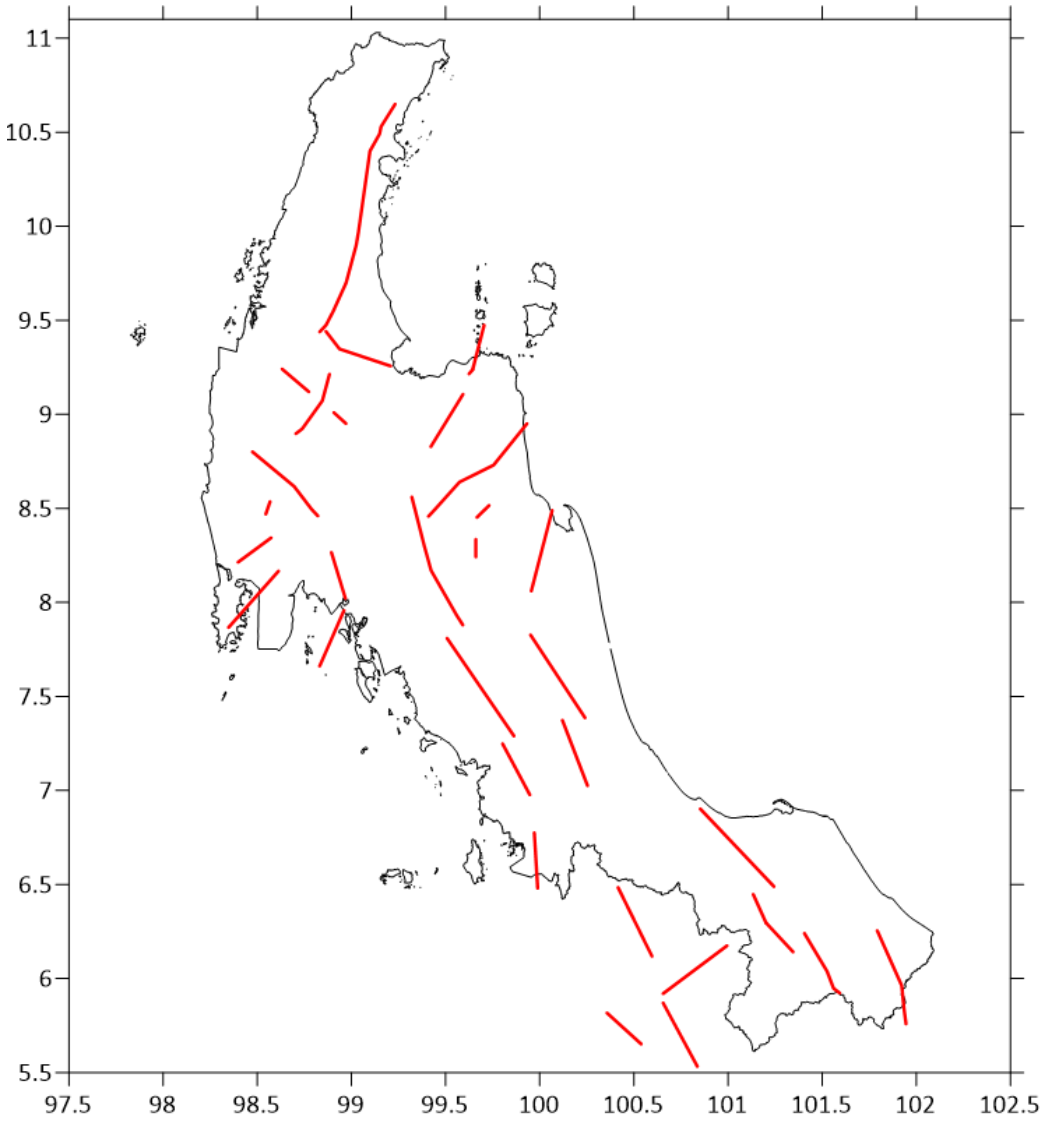
Improved Logistic (IL)



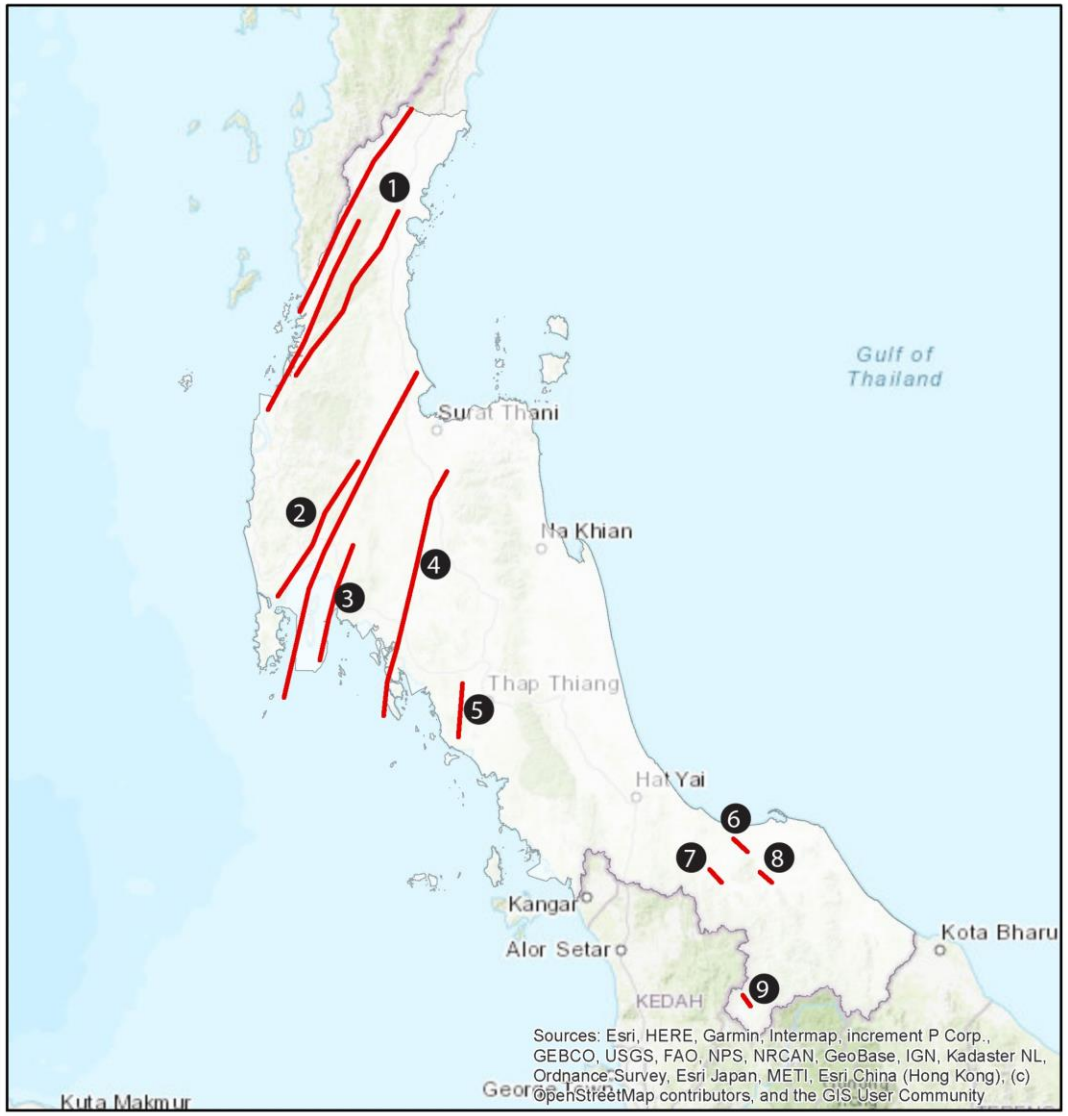
$$\mathrm{IL} = \frac{1}{1 + \exp[-p(R_{HG} - 1) + 1]}$$

$$R_{HG} = \frac{\frac{\partial THD}{\partial z}}{\sqrt{(\frac{\partial THD}{\partial x})^2 + (\frac{\partial THD}{\partial y})^2}}$$

LINEAMENT STRUCTURES



Lineament structures interpreted from THD



Modified from Hinthong, 1997

SUMMARY

Bouguer anomalies are well-correlated with the lithologies and geological structure. Moreover, lineament structures were well delineated by the THD filter.

Further studies must be conducted to prove several ambiguities, e.g., magnetic survey, resistivity survey, and seismic survey.