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L A M P I R A N

Lampiran I: Penurunan Rumus Model Mogi

$$\begin{pmatrix} w_x \\ w_y \end{pmatrix} = \begin{pmatrix} \frac{\partial w}{\partial x} \\ \frac{\partial w}{\partial y} \end{pmatrix}$$

$$R = \sqrt{x^2 + y^2 + d^2}$$

Komponen X (w_x):

$$w_x = \frac{\partial w}{\partial x}$$

$$w_x = \frac{\partial (a^3 \, \Delta P \, \frac{(1-v)}{G} (d \, (x^2 + \, y^2 + \, d^2)^{-\frac{3}{2}})}{\partial x}$$

$$w_x = a^3 \, \Delta P \, \tfrac{(1-v)}{G} \, (d \, \tfrac{-3}{2} (x^2 + \, y^2 + \, d^2)^{-\frac{5}{2}} \, 2x)$$

$$w_x = a^3 \, \Delta P \, \frac{(1-v)}{G} \left(\frac{-3 \, d \, x}{(x^2 + \, y^2 + \, d^2)^{\frac{5}{2}}} \right)$$

$$w_x = a^3 \, \Delta P \, \frac{(1-v)}{G} \left(\frac{-3 \, d \, x}{R^5} \right)$$

Komponen Y (w_y):

$$w_y = \frac{\partial w}{\partial y}$$

$$w_y = \frac{\partial (a^3 \, \Delta P \, \frac{(1-v)}{G} (d \, (x^2 + \, y^2 + \, d^2)^{-\frac{3}{2}})}{\partial y}$$

$$w_y = a^3 \, \Delta P \, \tfrac{(1-v)}{G} \, (d \, \tfrac{-3}{2} (x^2 + \, y^2 + \, d^2)^{-\frac{5}{2}} \, 2y)$$

$$w_y = a^3 \, \Delta P \, \frac{(1-v)}{G} \left(\frac{-3\, d\, y}{(x^2 + y^2 + d^2)^{\frac{5}{2}}} \right)$$

$$w_y = a^3 \, \Delta P \, \frac{(1-v)}{G} \left(\frac{-3\, d\, y}{R^5} \right)$$

Persamaan Model Mogi:

$$\begin{pmatrix} w_x \\ w_y \end{pmatrix} = \alpha^3 \Delta P \frac{(1-v)}{G} \begin{pmatrix} \dfrac{-3\, d\, x}{R^5} \\ \dfrac{-3\, d\, y}{R^5} \end{pmatrix}$$

Dimensi: (Tilt tidak berdimensi dan biasanya diberikan dalam satuan μradian (ppm))

$$\begin{pmatrix} w_x \\ w_y \end{pmatrix} = \alpha^3 \Delta P \frac{(1-v)}{G} \begin{pmatrix} \dfrac{-3\, d\, x}{R^5} \\ \dfrac{-3\, d\, y}{R^5} \end{pmatrix}$$

$$\begin{pmatrix} w_x \\ w_y \end{pmatrix} = \frac{[L]^3 [M][L]^{-1}[T]^{-2}}{[M][L]^{-1}[T]^{-2}} \begin{pmatrix} \frac{[L][L]}{[L]^5} \\ \frac{[L][L]}{[L]^5} \end{pmatrix}$$

Lampiran II: Script Matlab Model Mogi

```
clear
clc

disp('----------------PERIODE n----------------')

%stasiun
%SELOKOPO
    xs_SEL = 439544;
    ys_SEL = 9167528;
%GRAWAH
    xs_GRW = 439486;
    ys_GRW = 9168550;
%LABUHAN
    xs_LBH = 438783;
    ys_LBH = 9164633;

%didefinisikan
v = 0.25;
G = 30000000000;
Zpuncak = 2900;

%looping parameter
alpha = [100:100:1000];
deltap = [1000000 10000000 100000000 1000000000 10000000000
100000000000];
d = [-2600:100:10000];
xc = [439000:50:440000];
yc = [9166900:50:9167900];

for i = 1:10;
    for j = 1:6;
        for k = 1:127;
            for l = 1:21;
                for m = 1:21;

%jarak horizontal komponen x (dx) dan y (dy)
dx_SEL(l) = xs_SEL - xc(l);
dy_SEL(m) = ys_SEL - yc(m);

dx_GRW(l) = xs_GRW - xc(l);
dy_GRW(m) = ys_GRW - yc(m);

dx_LBH(l) = xs_LBH - xc(l);
dy_LBH(m) = ys_LBH - yc(m);

%Jarak stasiun terhadap sumber
R_SEL(l,m,k) = sqrt(dx_SEL(l)^2+dy_SEL(m)^2+(d(k)+Zpuncak)^2);
R_GRW(l,m,k) = sqrt(dx_GRW(l)^2+dy_GRW(m)^2+(d(k)+Zpuncak)^2);
R_LBH(l,m,k) = sqrt(dx_LBH(l)^2+dy_LBH(m)^2+(d(k)+Zpuncak)^2);

%persamaan nilai ungkitan setiap komponen di setiap stasiun
```

```
Wx_SEL(i,j,k,l,m) = alpha(i)^3 * deltap(j) * ((1-v)/G) * ((-
3*abs(dx_SEL(l)))/R_SEL(l,m,k)^5);
Wy_SEL(i,j,k,l,m) = alpha(i)^3 * deltap(j) * ((1-v)/G) * ((-
3*abs(dy_SEL(m)))/R_SEL(l,m,k)^5);
Wx_GRW(i,j,k,l,m) = alpha(i)^3 * deltap(j) * ((1-v)/G) * ((-
3*abs(dx_GRW(l)))/R_GRW(l,m,k)^5);
Wy_GRW(i,j,k,l,m) = alpha(i)^3 * deltap(j) * ((1-v)/G) * ((-
3*abs(dy_GRW(m)))/R_GRW(l,m,k)^5);
Wx_LBH(i,j,k,l,m) = alpha(i)^3 * deltap(j) * ((1-v)/G) * ((-
3*abs(dx_LBH(l)))/R_LBH(l,m,k)^5);
Wy_LBH(i,j,k,l,m) = alpha(i)^3 * deltap(j) * ((1-v)/G) * ((-
3*abs(dy_LBH(m)))/R_LBH(l,m,k)^5);

%data_observasi
Wx_obs_SEL = ;
Wy_obs_SEL = ;
Wx_obs_GRW = ;
Wy_obs_GRW = ;
Wx_obs_LBH = ;
Wy_obs_LBH = ;

%nilai residual observasi dan teoritis
Res_min_SEL(i,j,k,l,m) = sqrt ((abs(Wx_obs_SEL) -
abs(Wx_SEL(i,j,k,l,m)))^2 + (abs(Wy_obs_SEL) -
abs(Wy_SEL(i,j,k,l,m)))^2);
Res_min_GRW(i,j,k,l,m) = sqrt ((abs(Wx_obs_GRW) -
abs(Wx_GRW(i,j,k,l,m)))^2 + (abs(Wy_obs_GRW) -
abs(Wy_GRW(i,j,k,l,m)))^2);
Res_min_LBH(i,j,k,l,m) = sqrt ((abs(Wx_obs_LBH) -
abs(Wx_LBH(i,j,k,l,m)))^2 + (abs(Wy_obs_LBH) -
abs(Wy_LBH(i,j,k,l,m)))^2);

%nilai residual total
Res_total(i,j,k,l,m) = sqrt (Res_min_SEL(i,j,k,l,m) +
Res_min_GRW(i,j,k,l,m) + Res_min_LBH(i,j,k,l,m));

                end
            end
        end
    end
end

%pencarian nilai residual terkecil
Rmin = min(min(min(min(min(Res_total)))))
[i,j,k,l,m] = ind2sub(size(Res_total),find(Res_total==Rmin))
```

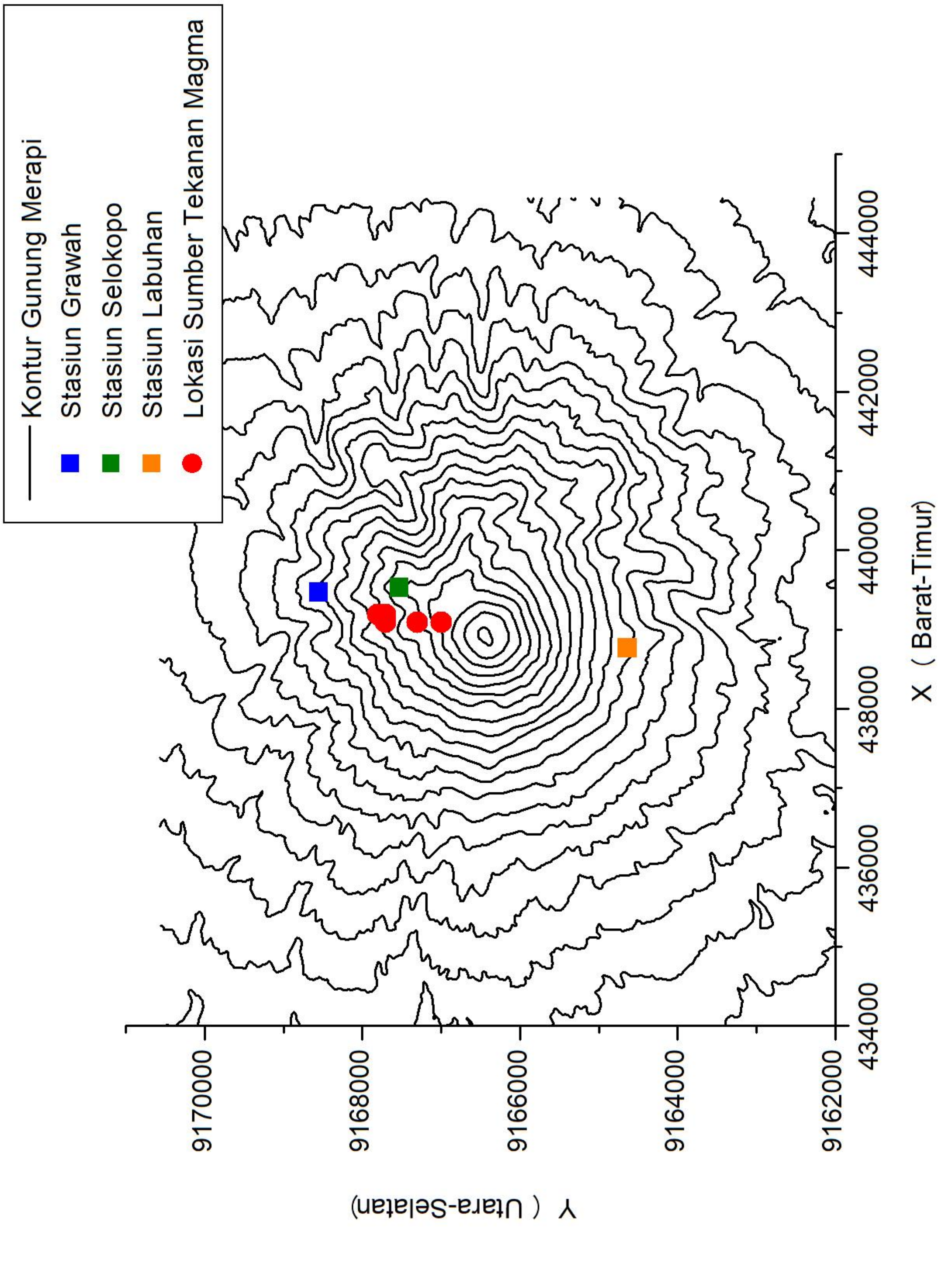
Lampiran III: Script Matlab Volume Suplai Magma

```
clear
clc

%rigiditas
G = 400000000000;

%poisson ratio
v = 0.25;

%shear modulus of the host rock
u = 400000000;

%effective bulk modulus of magma stored in recervoir
k = 1320000000;

%radius sumber tekanan
alpha_1 = ;
alpha_2 = ;
alpha_3 = ;
alpha_4 = ;
alpha_5 = ;
alpha_6 = ;

%perubahan tekanan
delta_P1 = ;
delta_P2 = ;
delta_P3 = ;
delta_P4 = ;
delta_P5 = ;
delta_P6 = ;

%cavity volume cange (ΔV cavity)
Vcavity_1 = (delta_P1 / G) * pi * alpha_1^3;
Vcavity_2 = (delta_P2 / G) * pi * alpha_2^3;
Vcavity_3 = (delta_P3 / G) * pi * alpha_3^3;
Vcavity_4 = (delta_P4 / G) * pi * alpha_4^3;
Vcavity_5 = (delta_P5 / G) * pi * alpha_5^3;
Vcavity_6 = (delta_P6 / G) * pi * alpha_6^3;

%magma volume change (ΔV magma)
Vmagma_1 = Vcavity_1 / (2 * (1-v)) * (1 + ((4*u)/(3*k)))
Vmagma_2 = Vcavity_2 / (2 * (1-v)) * (1 + ((4*u)/(3*k)))
Vmagma_3 = Vcavity_3 / (2 * (1-v)) * (1 + ((4*u)/(3*k)))
Vmagma_4 = Vcavity_4 / (2 * (1-v)) * (1 + ((4*u)/(3*k)))
Vmagma_5 = Vcavity_5 / (2 * (1-v)) * (1 + ((4*u)/(3*k)))
Vmagma_6 = Vcavity_6 / (2 * (1-v)) * (1 + ((4*u)/(3*k)))
```

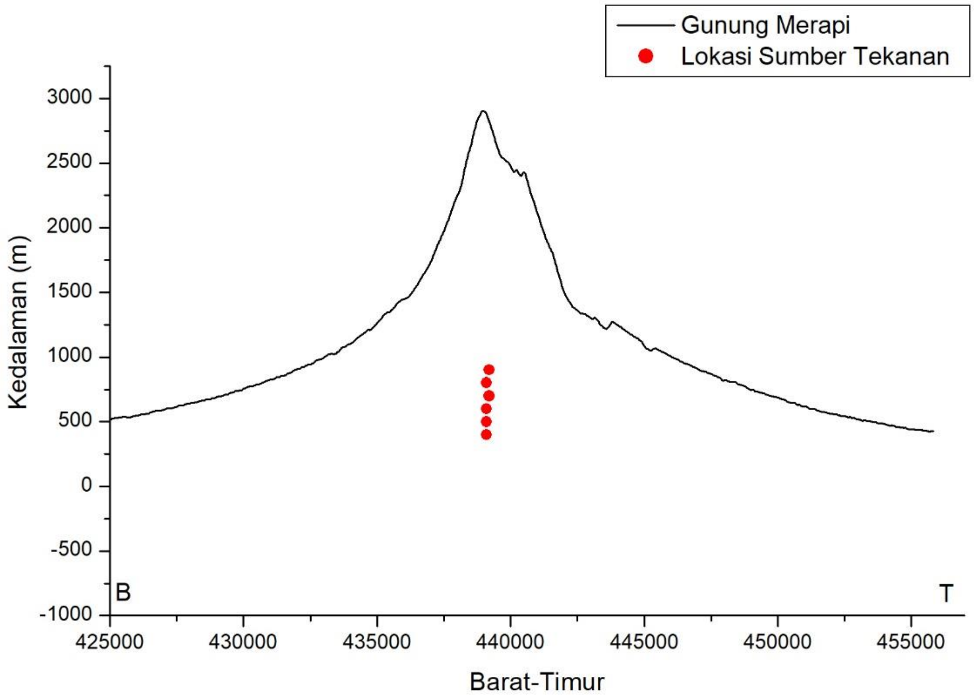
Lampiran IV: Perbandingan Data Observasi dengan Data Teoritikal

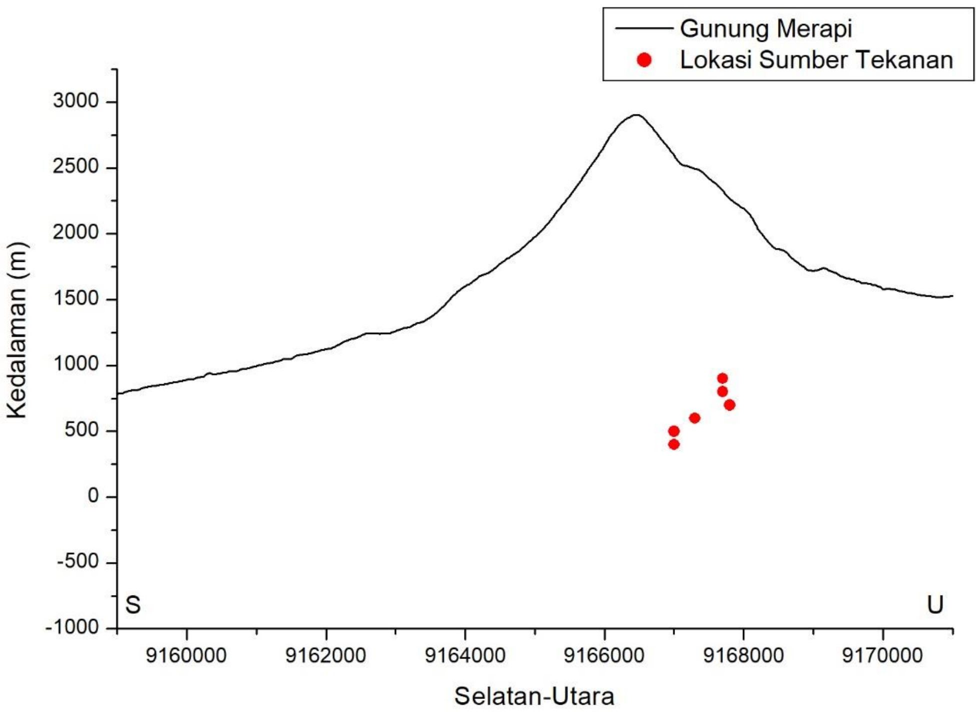
Periode	Stasiun	Observasi		Teoritikal		Rmin	Rmin Total
		ωx	ωy	ωx	ωy		
1	Grawah	8.5	8	-0.6545	-2.6283	0.95082377	2.01934866
	Selokopo	-35	-14	-22.0282	-26.1957	1.78045666	
	Labuhan	0.11	0.004	-0.0817	-0.6097	0.06064014	
2	Grawah	-4	23	-1.1432	-3.7022	1.9508E-05	2.06267817
	Selokopo	-30	8	-28.0467	-14.4023	6.6937E-06	
	Labuhan	0.05	-0.008	-0.0367	-0.3091	3.0136E-07	
3	Grawah	4	-11	-3.8177	-10.0115	1.0051E-06	0.62148041
	Selokopo	20	-8	-16.3623	-12.9376	6.1329E-06	
	Labuhan	0	-0.15	-0.0204	-0.1549	2.0979E-08	
4	Grawah	1	-14	-0.5165	-2.0741	1.1936E-05	1.95923063
	Selokopo	-10	36	-22.3045	-26.5242	1.553E-05	
	Labuhan	0	0.01	-0.0617	-0.4607	4.5486E-07	
5	Grawah	4	-10	-1.7492	-5.1986	5.3028E-06	0.62668759
	Selokopo	5	2	-7.7564	-3.8782	3.3355E-06	
	Labuhan	0	-0.011	-0.0243	-0.1785	1.6922E-07	
6	Grawah	-2	4	-1.2126	-2.6702	1.5454E-06	0.1668995
	Selokopo	-5	-2	-5.6019	-2.1701	6.2548E-07	
	Labuhan	0	0.005	-0.0085	-0.0825	7.7981E-08	

Lampiran V: Pemodelan Lokasi Sumber Tekanan Magma dalam 1 Dimensi



Lampiran VI: Pemodelan Lokasi Sumber Tekanan Magma dalam 2 Dimensi





Lampiran VII: Pemodelan Lokasi Sumber Tekanan Magma dalam 3 Dimensi