

# Brief Description of the Program

## 1. Data Collection and Conversion into Energy Fields

The program loads all seismic events for a selected time period and converts each magnitude into seismic energy using the classical Gutenberg–Richter relation:

$$E = 10^{1.5M+4.8}.$$

Depth is included through an exponential attenuation term that reflects the decrease in stress transmitted to the surface:

$$E_{\text{eff}} = E e^{-d/L_{\text{depth}}},$$

where  $d$  is the depth and  $L_{\text{depth}}$  is the characteristic attenuation length.

## 2. Direct Stress Field (Direct Map)

For each grid node, the program computes the cumulative stress field created by all events using a Gaussian-type distance kernel:

$$K(r) = e^{-r/L},$$

and

$$S_{\text{direct}}(x) = \sum_k E_{\text{eff},k} K(r(x, x_k)).$$

This produces a direct map of accumulated stress, highlighting zones where energy is concentrated.

## 3. Inversion Map (Hidden Stress Field)

To obtain the “hidden”, unreleased stress distribution, a regularized inverse problem is solved:

$$(A^{\top}A + \lambda I) s = A^{\top}y,$$

where

$$A_{k,i} = e^{-r_{k,i}/L}$$

is the influence matrix between events and grid nodes,  $y$  is the vector of effective energies, and  $s$  is the hidden stress field.

Tikhonov regularization suppresses noise and ensures stability. The resulting field is converted back into predicted magnitude:

$$M_{\text{pred}} = \frac{\log_{10}(S) - 4.8}{1.5}.$$

## 4. Time Model (Days Ahead)

Each event decays exponentially in time:

$$E(t) = E_0 e^{-t/\tau},$$

where  $\tau$  is the temporal decay constant (typically 7 days).

For each time step  $t$  (0–30 days), the program recomputes:

- the direct map,
- the inversion map,
- new candidate stress concentration points.

The growth of predicted magnitude allows estimation of the time when a threshold event is reached:

$$t_{\text{hit}} = \frac{M_{\text{thr}} - M(t)}{dM/dt}.$$

## 5. Deep Mantle Method (Hypothetical Depth-Aware Model)

This is not a classical geophysical model but a hypothetical extension of the presented energy–stress framework.

We assume that shallow seismicity may carry partial information about impulse transmission from the lower mantle if a broader influence kernel is applied:

$$K_{\text{deep}}(r, d) = e^{-r/L} e^{-d/H},$$

where  $H \sim 3000$  km is the vertical deformation–transfer scale.

Using this kernel, a “deep stress map” can be defined as

$$S_{\text{deep}}(x) = A_{\text{deep}}^{\dagger} y,$$

where the operator  $A_{\text{deep}}$  accounts for both horizontal distances and vertical stress propagation.

The underlying hypothesis is that:

- small foreshocks,
- weak acoustic or microseismic mantle events,
- anomalous reduction of the  $b$ -value,

may represent the surface projection of a much deeper process developing months to years before a mega-earthquake.

This framework potentially allows identification of “mega-segments” preparing for rupture (magnitude 8.5–9.5), although the exact failure time remains fundamentally uncertain.