Understanding the potency of Giant Thrust Earthquake along Sumatra Subduction zone: **The Effect of Sudden Stress/Strain Loading**

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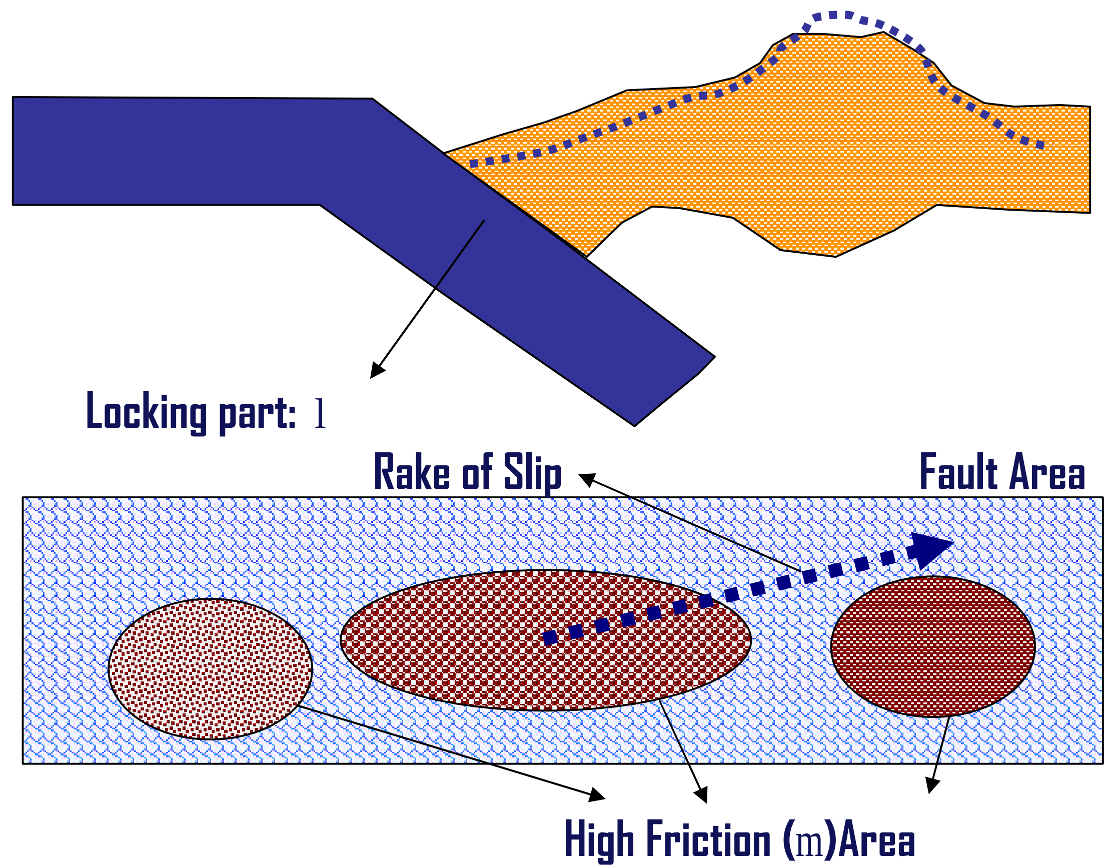
Summary

Several days after Nias Giant Thrust earthquake, I try to study the effect on static strain changing caused by the Off West Coast Sumatra earthquake on Nias and its surrounding. To get more detail analysis, I refer the historical subduction large earthquake based on NewComb & McCann, 1987. First of all, I try to go back about 100 years from the year of 1907. Furthermore, by using the seismic tomography (Widiyantoro, 2004), I try to extract gradient elastic parameters based on the dominant force of tectonic around Sumatra Island. They are λ and μ. Comparing the place of gradient λ, seems likely I could find the good agreement of possibility where the asperity may take a place. To find the more realistic slip-rate during the period of strain build-up, then I try to scale that uniform slip along the fault plane by the normalize gradient λ. By using the above non-uniform slip-rate, then I calculate predicted up-lift and dilatation during pre-seismic period. Referring the 1907 event, then I calculate the predicted up-lift and dilatation. The result seems like confirm with the possibility where the 2004 event may take a place. Furthermore, I try to calculate 200 years up-lift and dilatation of 2004 fault segment and Nias segment during pre-seismic period. The result shows that I could probably estimate the effect of 2004 giant event on Nias segment. On the basis of the above algorithm, finally I try to estimate the effect of Nias Earthquake on Mentawai segment. The result shows that we really need to consider the possibility of future Giant thrust earthquake around Mentawai Island. It seems likely that effect of static stress or strain changing could trigger the above event for the very near future.

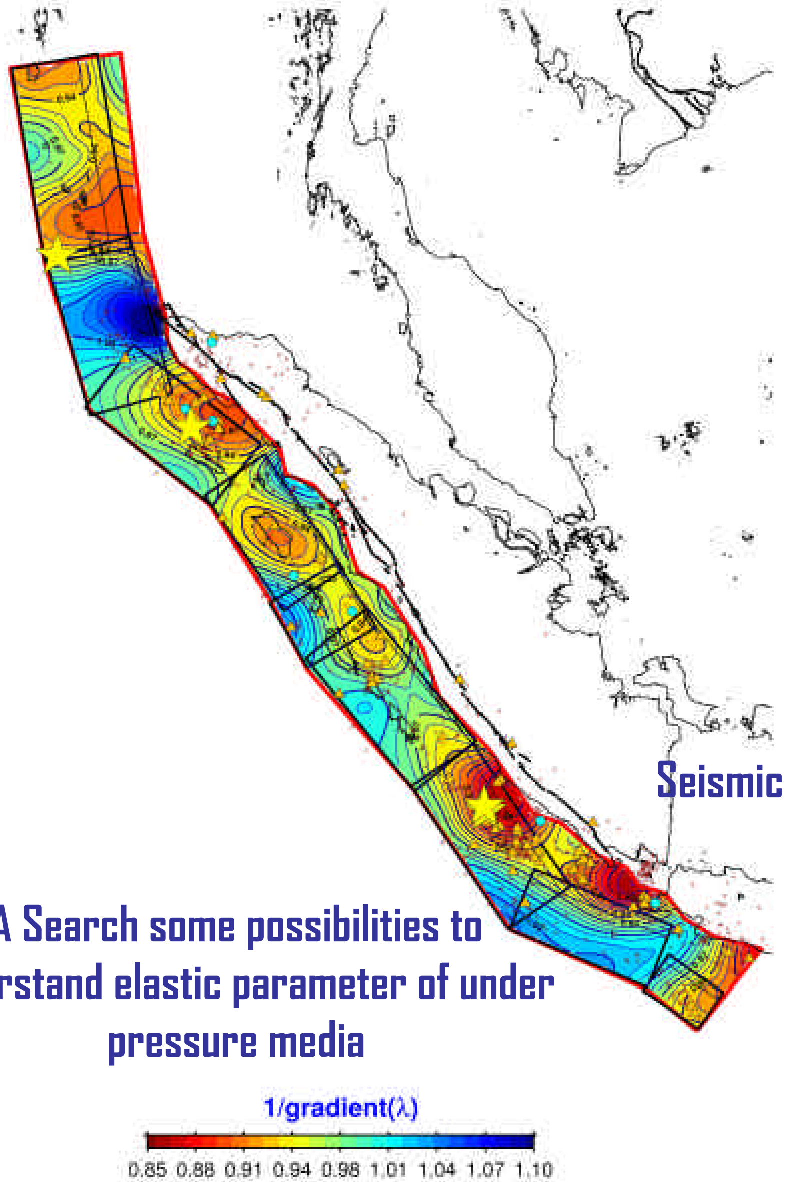
Subduction Earthquake from the view point of Simple Elastic Half Space Model



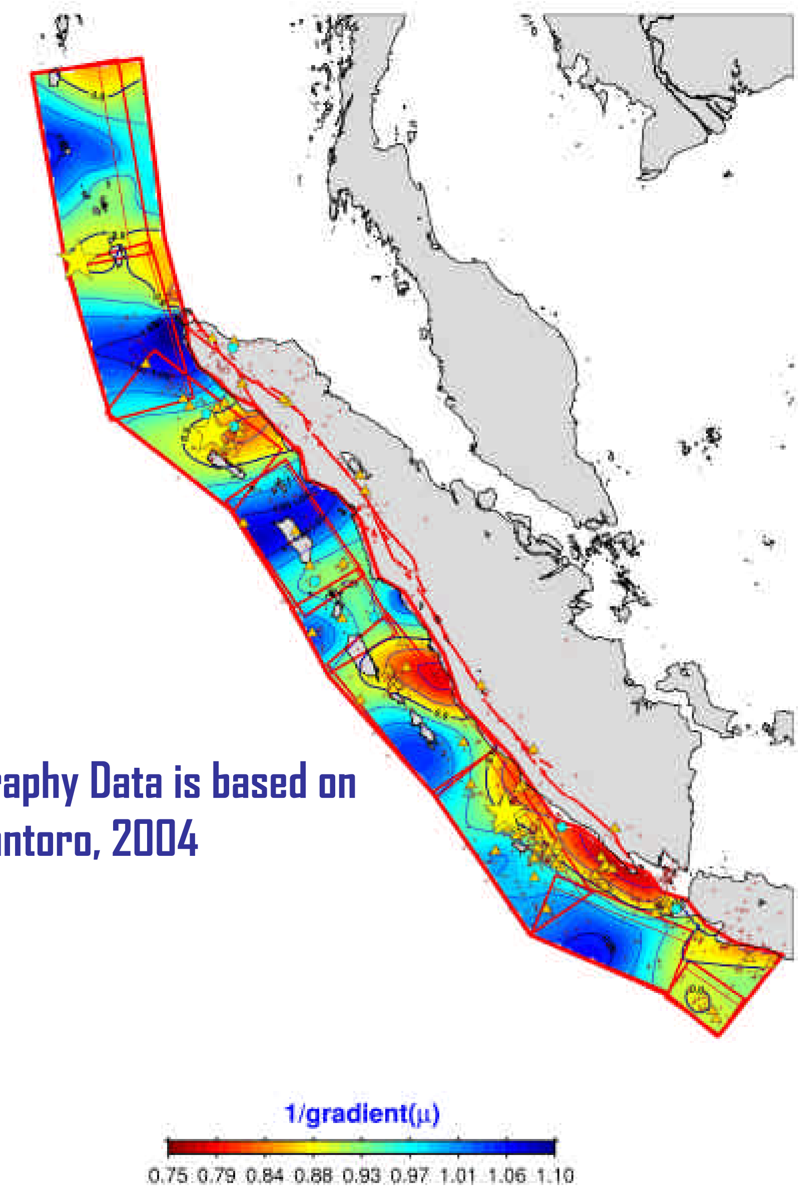
All of Shallow Crustal Earthquake is characterized by Shear Slip, thus l & m might become important parameters.

Fig.1: Simple model to explain how important the elastic parameters in understanding the subduction zone earthquake (W. Triyoso, Jan. 2005)

Elastic Parameters Extraction based on Seismic Tomography



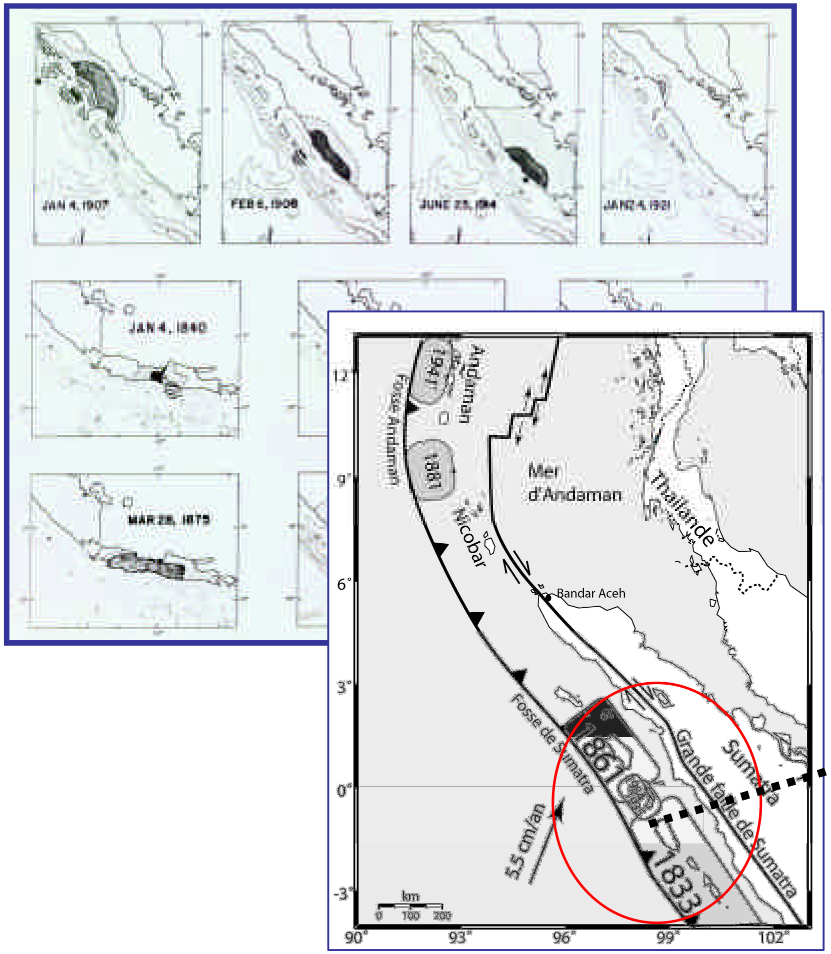
A Search some possibilities to understand elastic parameter of under pressure media



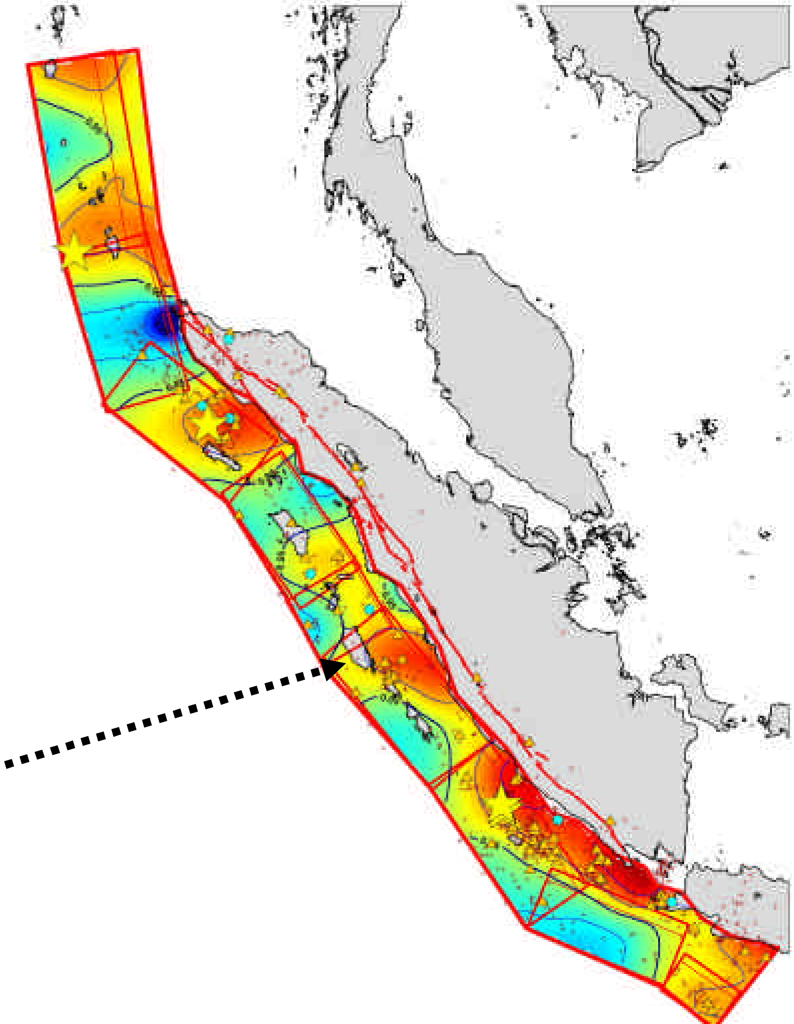
Seismic Tomography Data is based on Widiyantoro, 2004

Fig.2: The results on extracting directional gradient around Sumatra Subduction Zone (W. Triyoso, Jan. 2005). It shows that the possibility of present day large earthquake may confirm with the existence of high gradient of elastic parameters

Historical Large Earthquake and Subduction Boundary (After Newcomb & McCann, 1987)



Product Map (Shallow Large Earthquake Potency) for Sumatran Case



Estimated the place of Large Earthquake Potency seems likely agrees well with Historical Large Earthquake around subduction zone boundary

Fig.3: The results on extracting directional gradient around Sumatra Subduction Zone (W. Triyoso, Jan. 2005). It shows that the possibility of present day large earthquake may confirm with the existence of high gradient of elastic parameters

Modeling Slip-rate subduction segment based on GPS Data (Data Caltech, 2004)

Analytic form by Okada (1985, 1992). Accordingly, the displacement field ui (xl, x2, x3) due to a dislocation du_j (xl, x2, x3) across a surface S in an isotropic medium is

$$u_i = \frac{1}{F}\iint_{\Sigma} \Delta u_j \left[\lambda \delta_{jk} \frac{\partial u_i^n}{\partial \xi_n} + \mu \left(\frac{\partial u_i^j}{\partial \xi_k} + \frac{\partial u_i^k}{\partial \xi_j} \right) \right] \nu_k \, d\Sigma \qquad (1)$$

where d_{jk} is the Kronecker delta, λ and μ are Lamé's coefficients, nk is the direction cosine of the normal to the surface element dS, and the summation convention applies. The term u_{ij} is the ith component of the displacement at (xl, x2, x3) due to the jth direction point force of magnitude F at (xl, x2, x3).

GPS Data (black) & GPS Estimated by Dislocation Model (red)

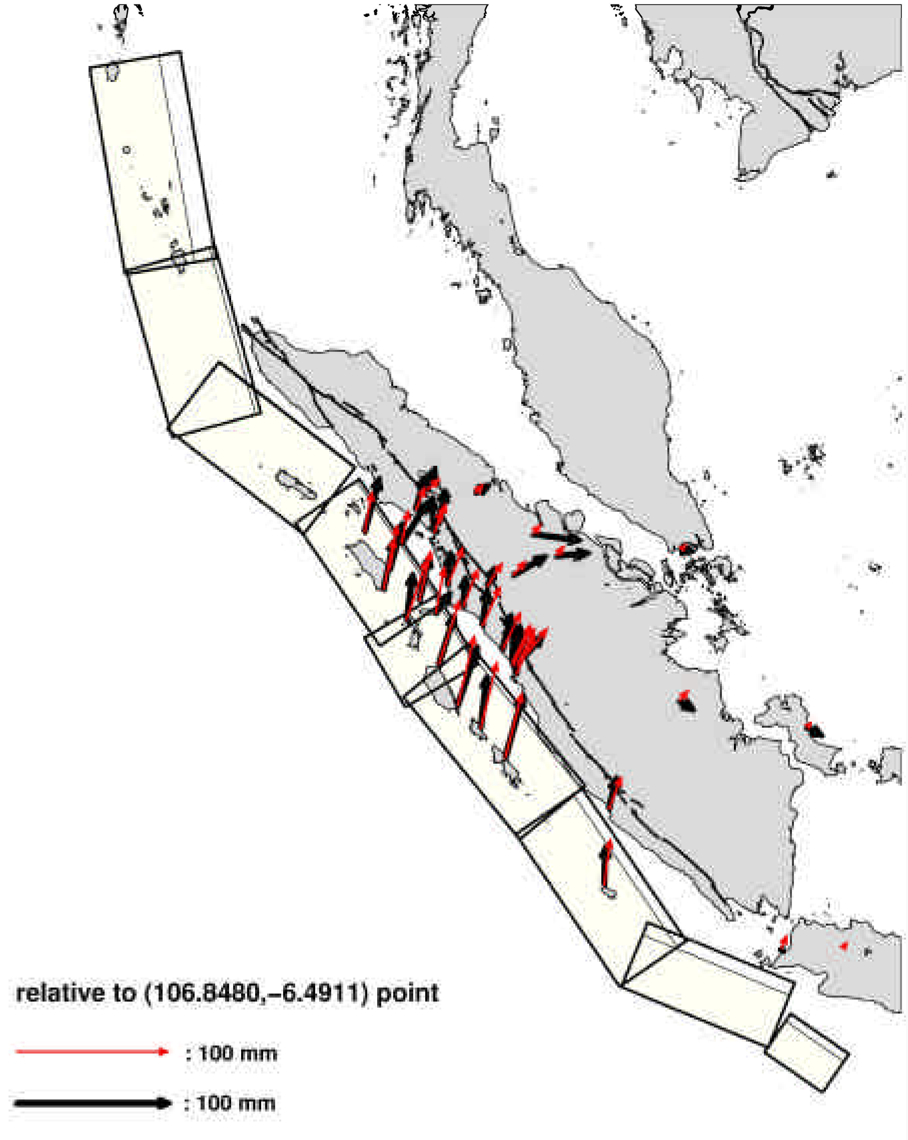
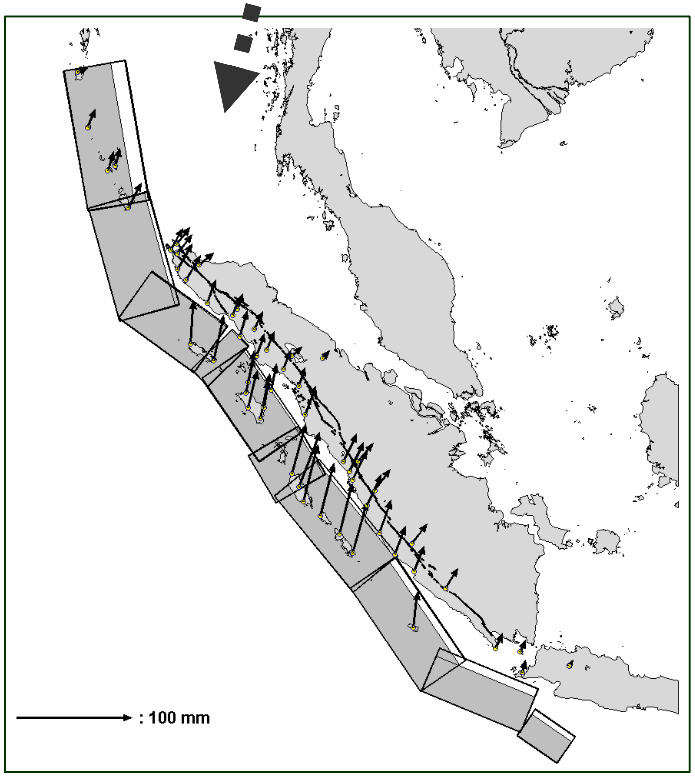


Fig. 4: Preliminary model segmented fault to search the best slip-rate.

Monte-Carlo method (W. Triyoso, 2005)

Triggering by a good agreement of my previous study and the absence or a few on GPS data in Northern part of Sumatra, I try to put some synthetic station then I used Elastic Half Space Model to produce a synthetic GPS data. Furthermore, I use LSC method to estimate Displacement, Strain and etc to understand the Seismic Potency around Subduction Zone.



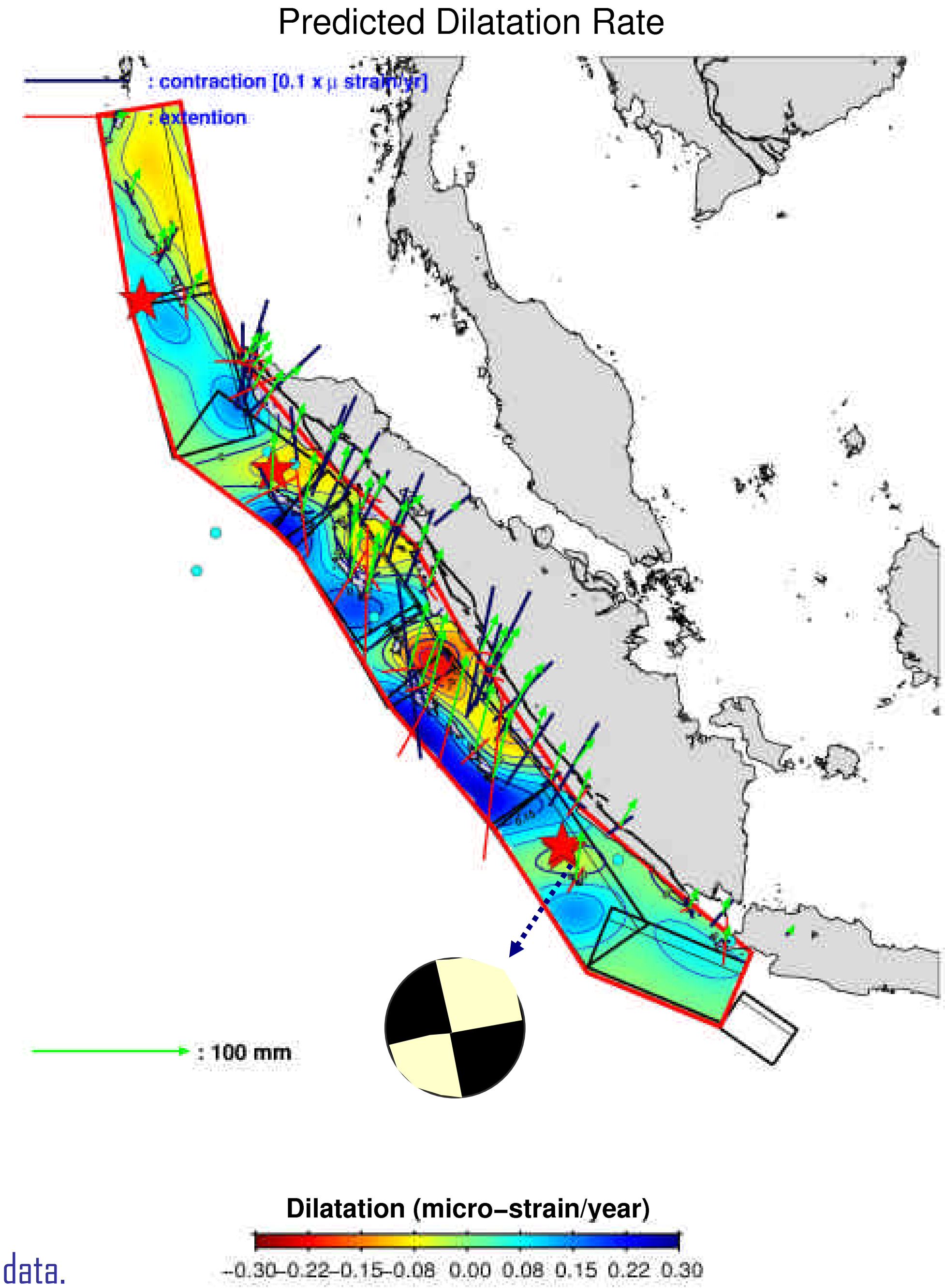


Fig. 5: Predicted dilatation-rate using LSC method based on GPS data.

Detail Subduction Zone Segmentation (After W. Triyoso, 2005)

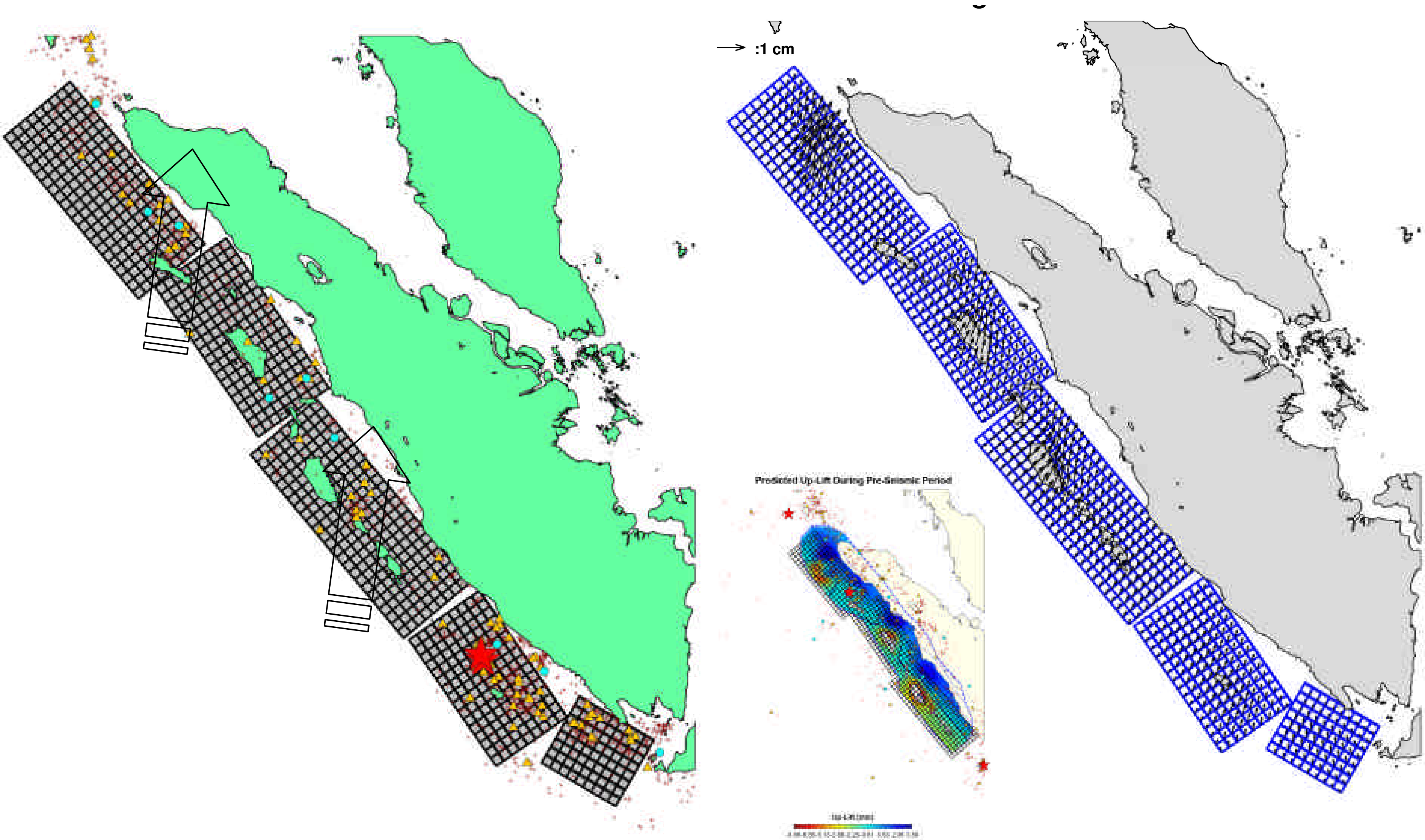


Fig. 6: Detail segmented fault model and non-uniform slip-rate after adjusted by normalize directional gradient λ & the predicted the rate of up-lift during pre-seismic period.

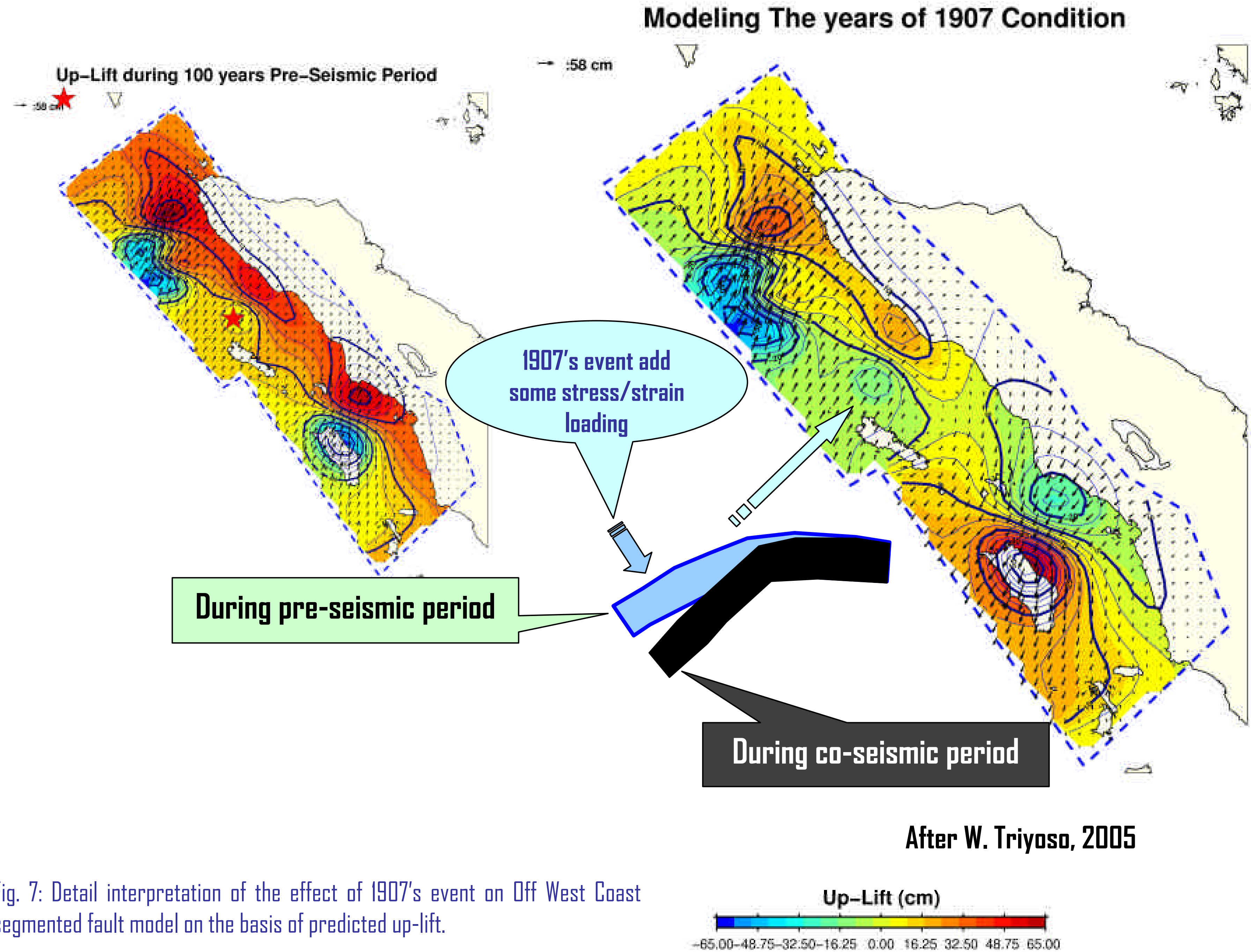


Fig. 7: Detail interpretation of the effect of 1907's event on Off West Coast segmented fault model on the basis of predicted up-lift.

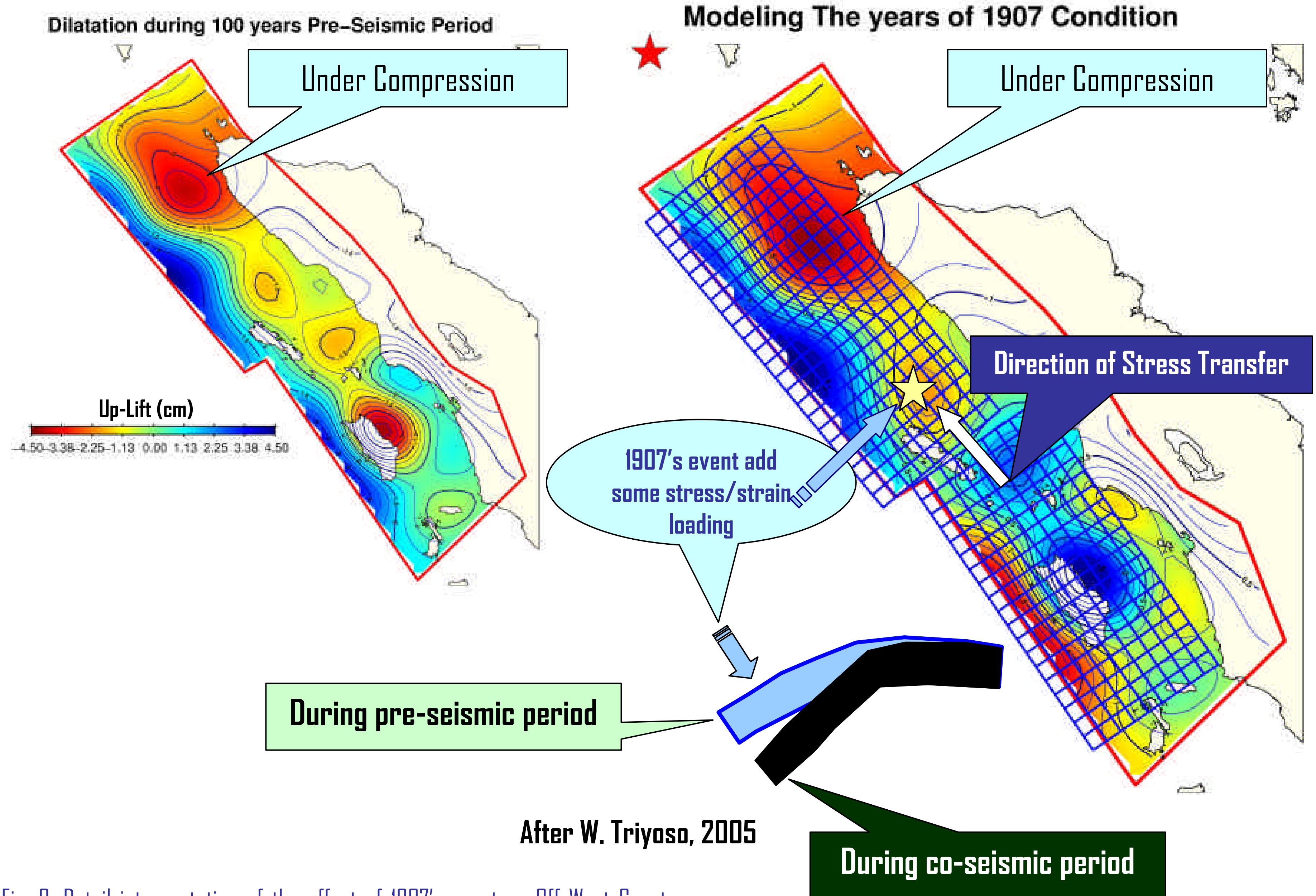


Fig. 8: Detail interpretation of the effect of 1907's event on Off West Coast segmented fault model on the basis of predicted dilatation.

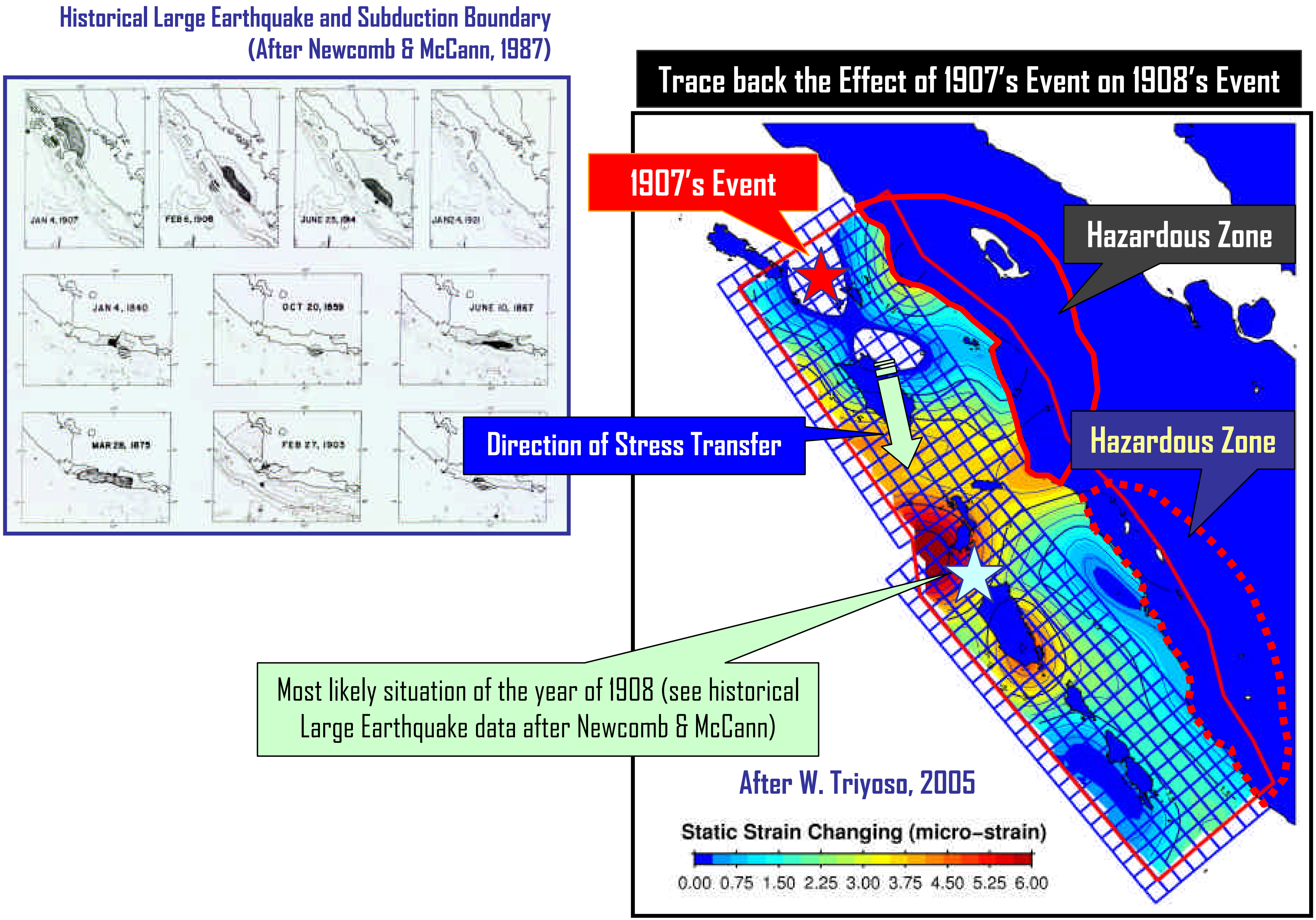


Fig. 9: Predicted the effect of 1907's Event on Mentawai segmented fault model on the basis of predicted static strain changing. Strain changing is simply approached by subtraction of predicted maximum shear strain with predicted dilatation.

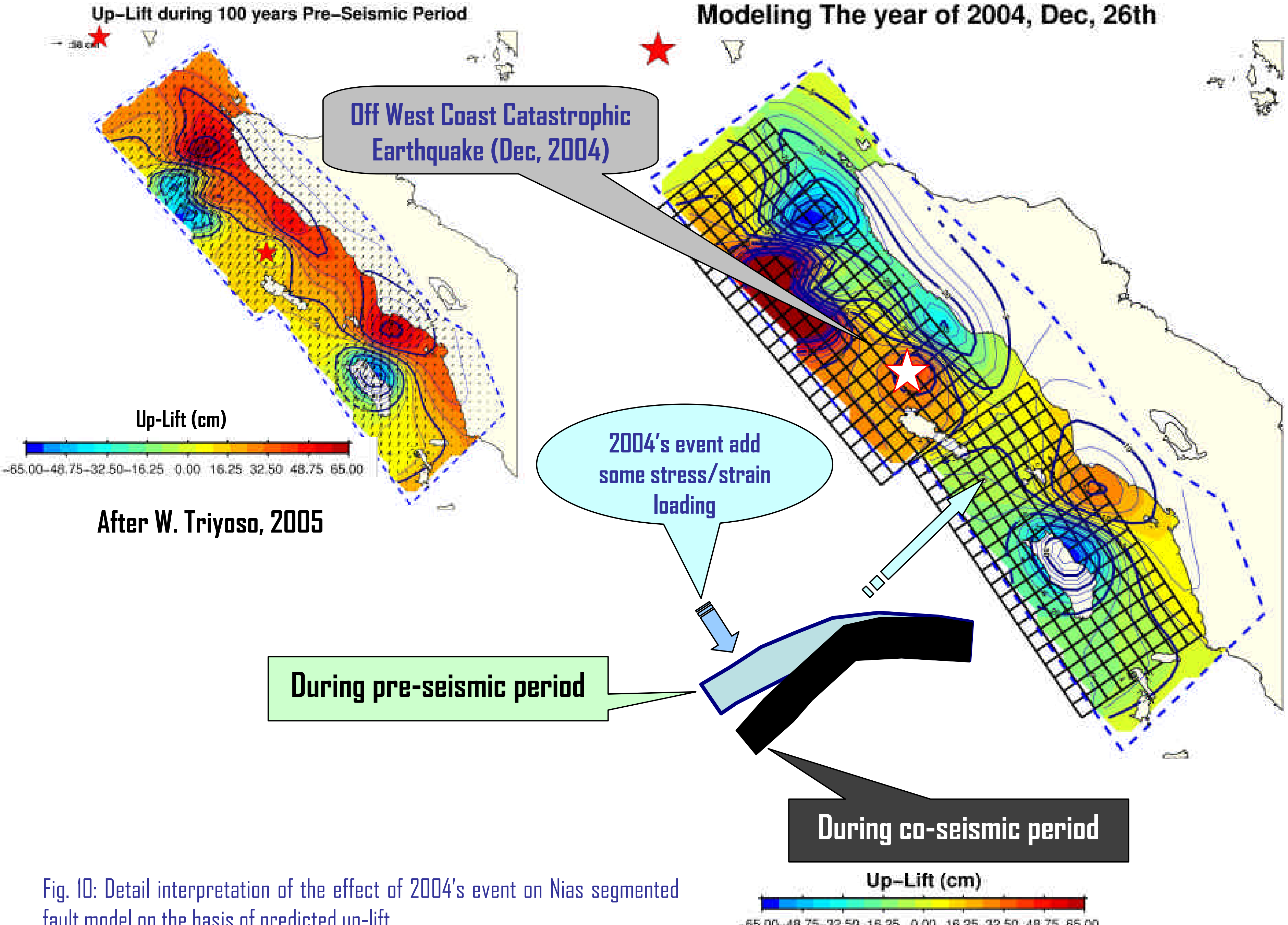


Fig. 10: Detail interpretation of the effect of 2004's event on Nias segmented fault model on the basis of predicted up-lift.

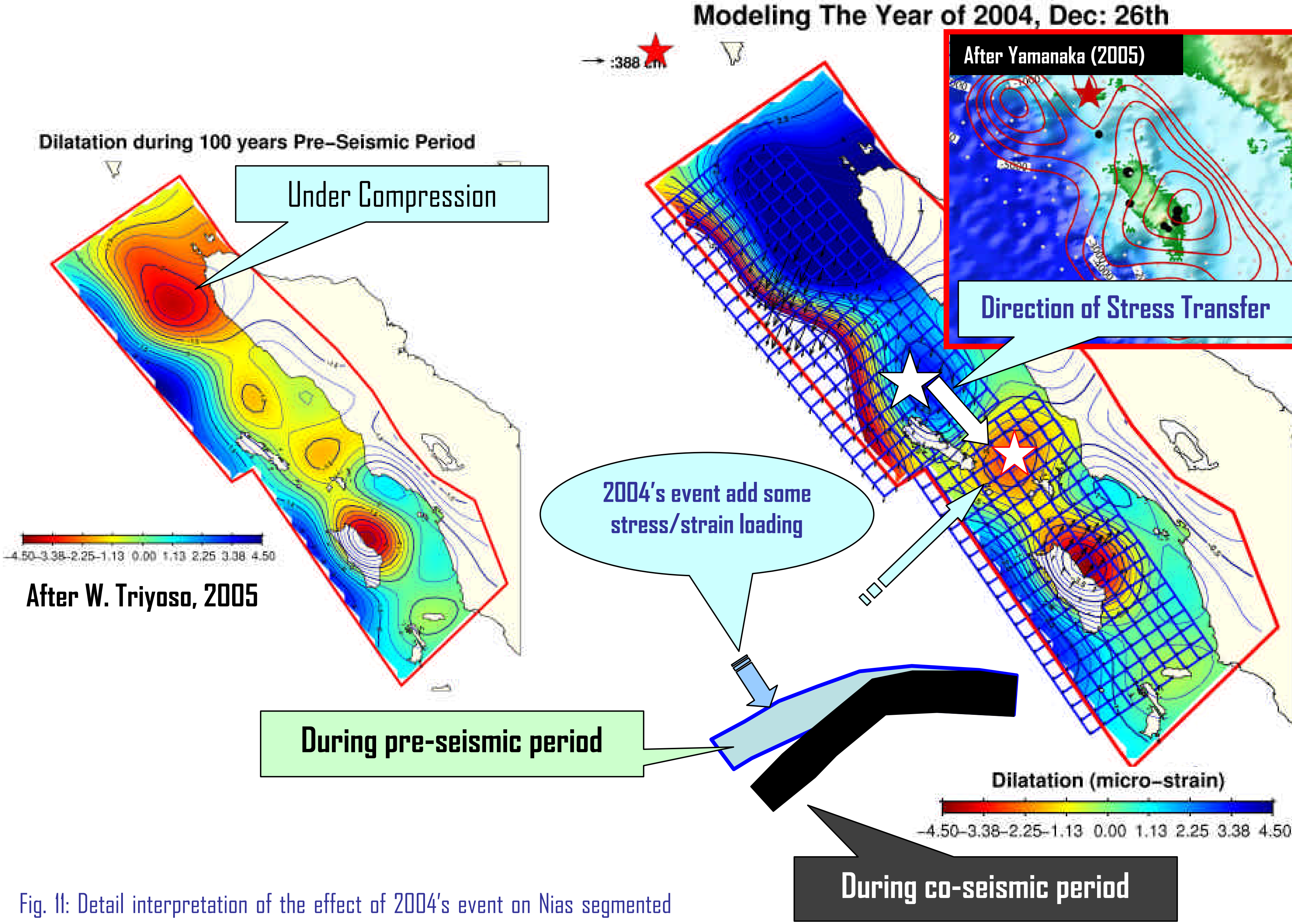


Fig. 11: Detail interpretation of the effect of 2004's event on Nias segmented fault model on the basis of predicted dilatation.

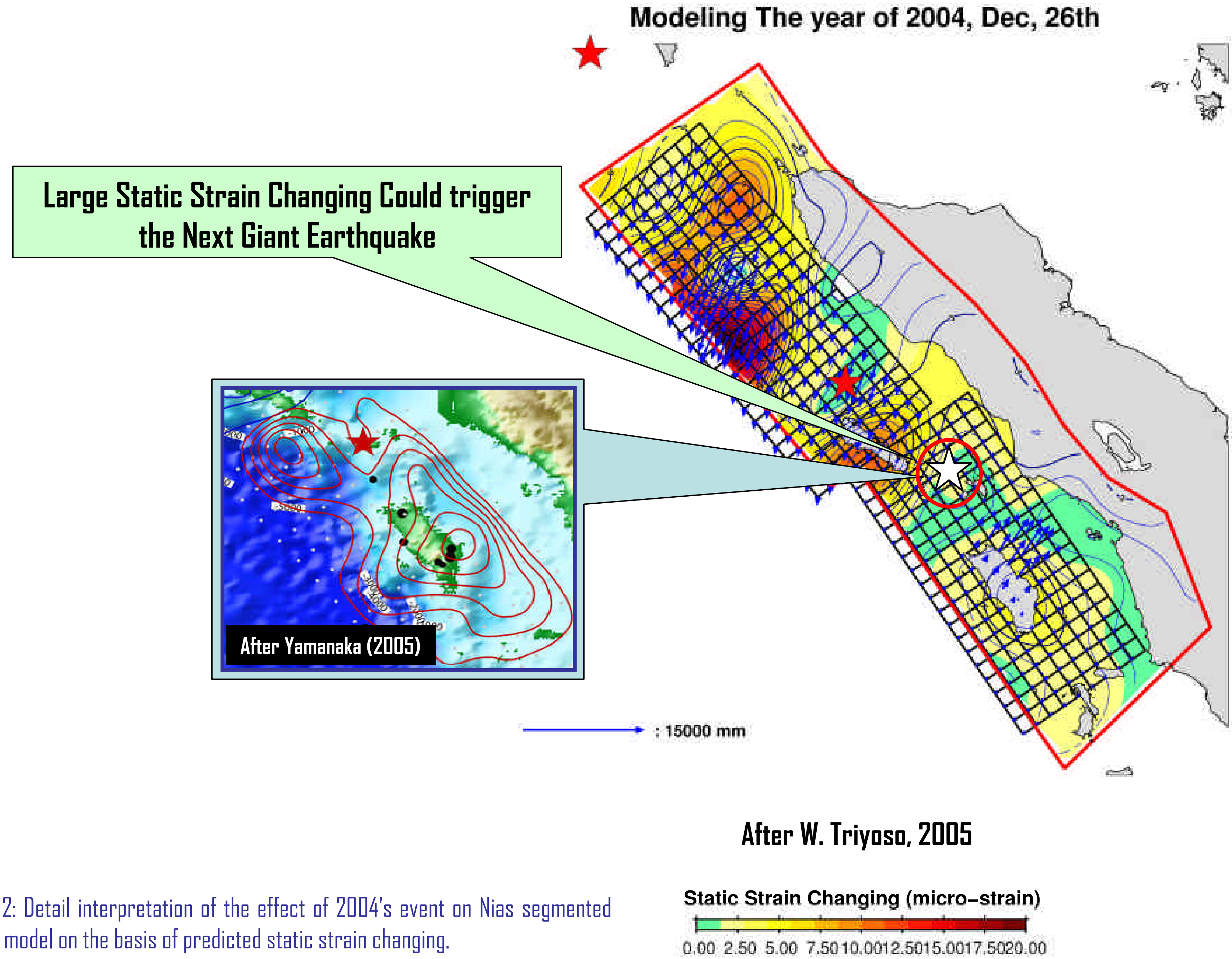


Fig. 12: Detail interpretation of the effect of 2004's event on Nias segmented fault model on the basis of predicted static strain changing.

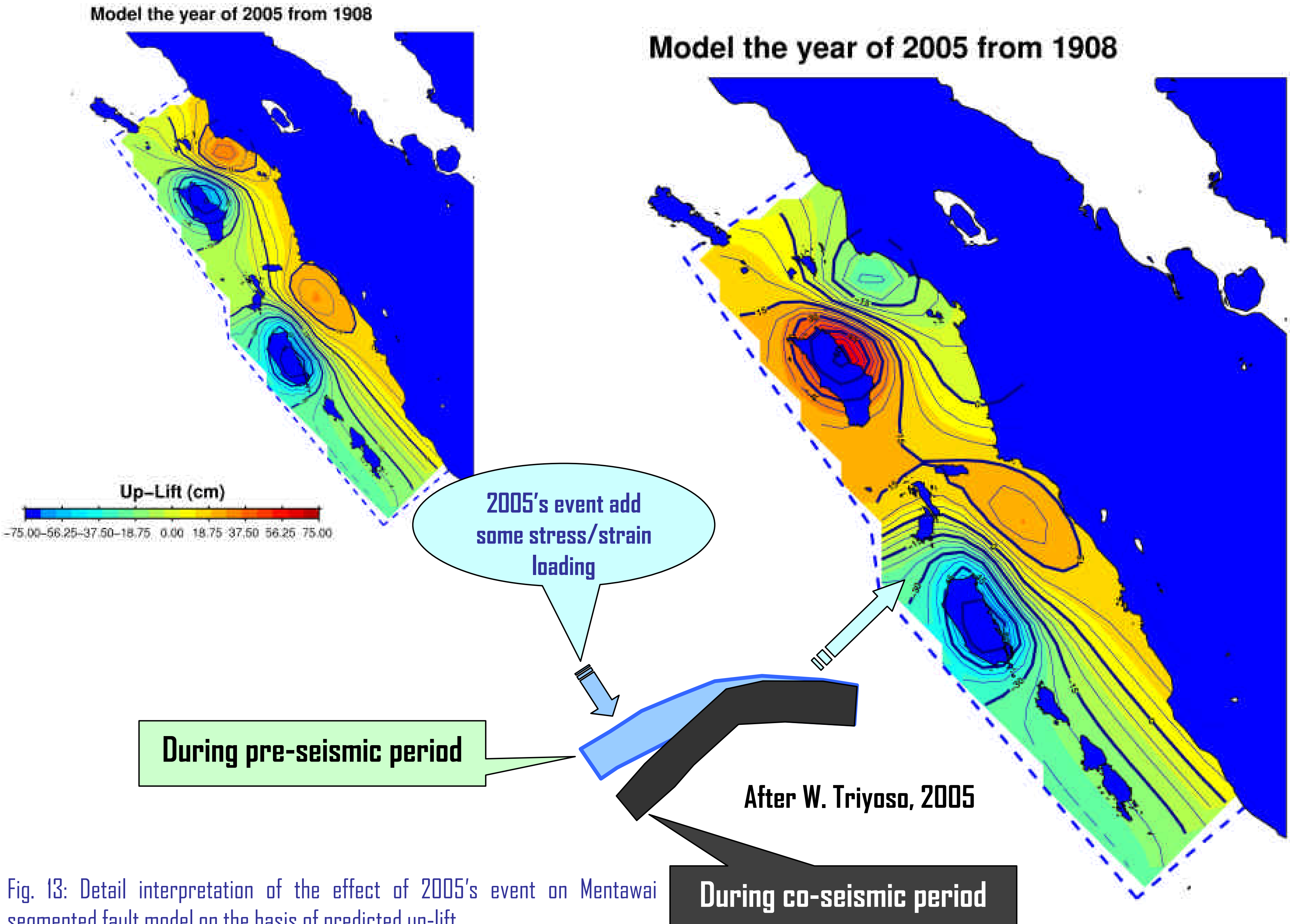


Fig. 13: Detail interpretation of the effect of 2005's event on Mentawai segmented fault model on the basis of predicted up-lift.

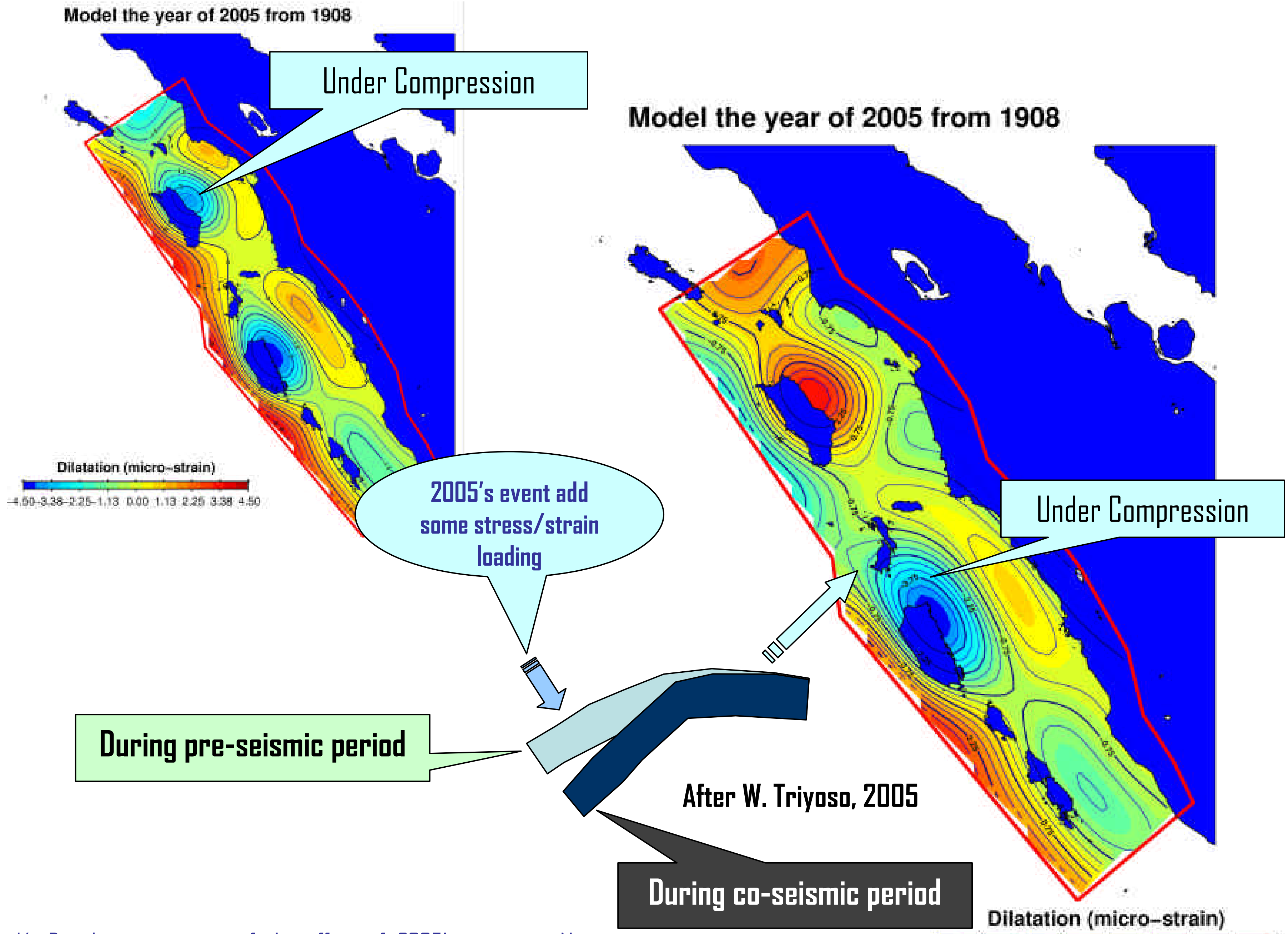
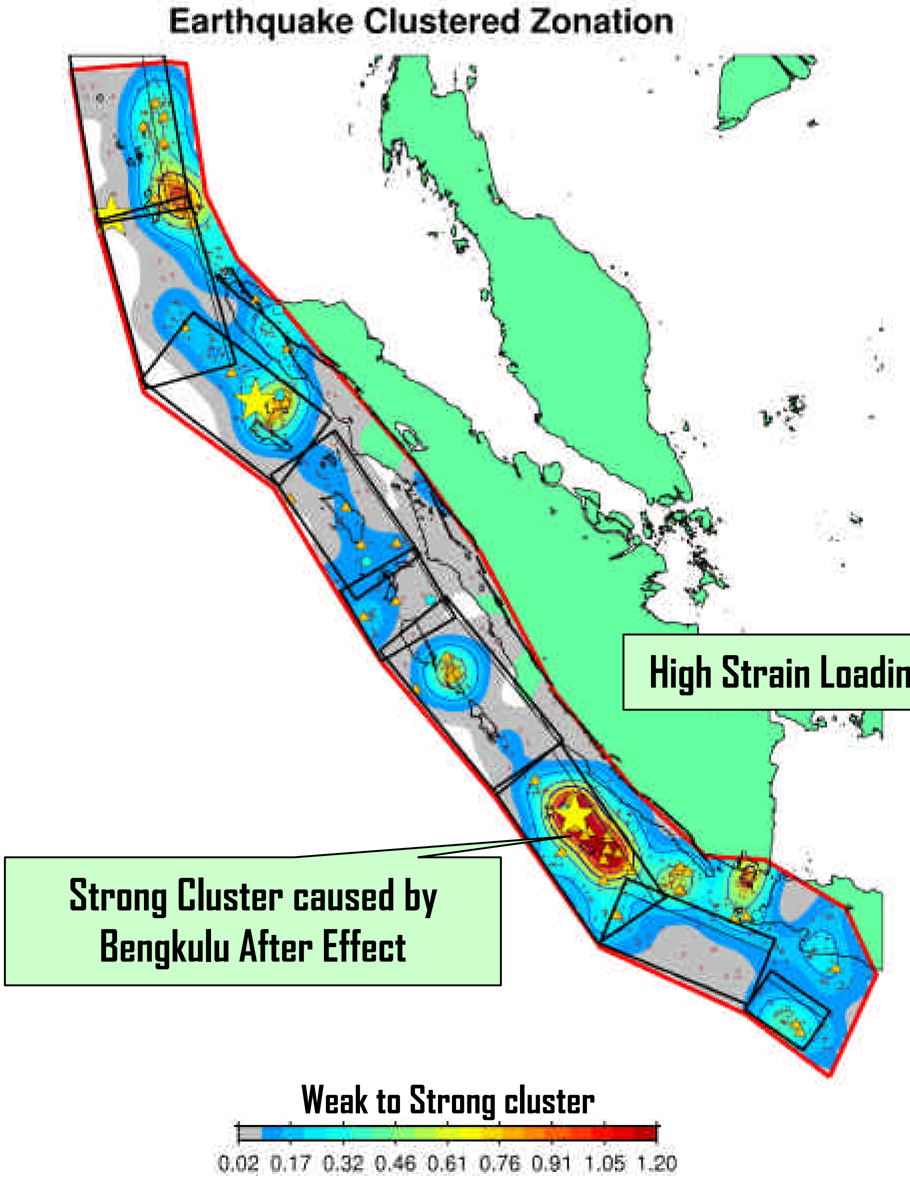


Fig. 14: Detail interpretation of the effect of 2005's event on Mentawai segmented fault model on the basis of predicted dilatation.

Exploring the Available Data



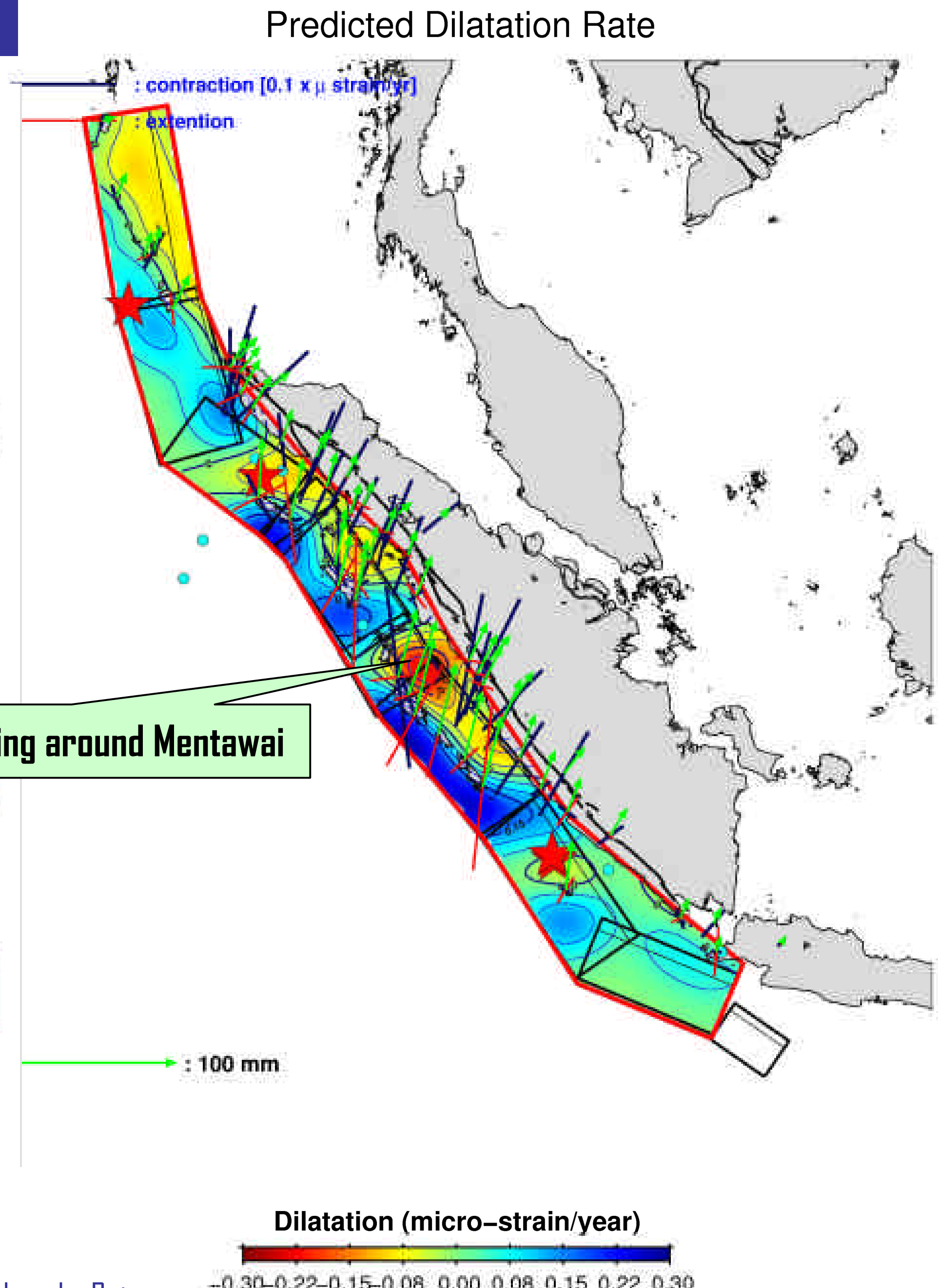


Fig. 15: Exploring the available data to understand the future Giant Thrust Earthquake Potency.

Our situation at present seems likely to be almost equivalence with 1907 to 1908

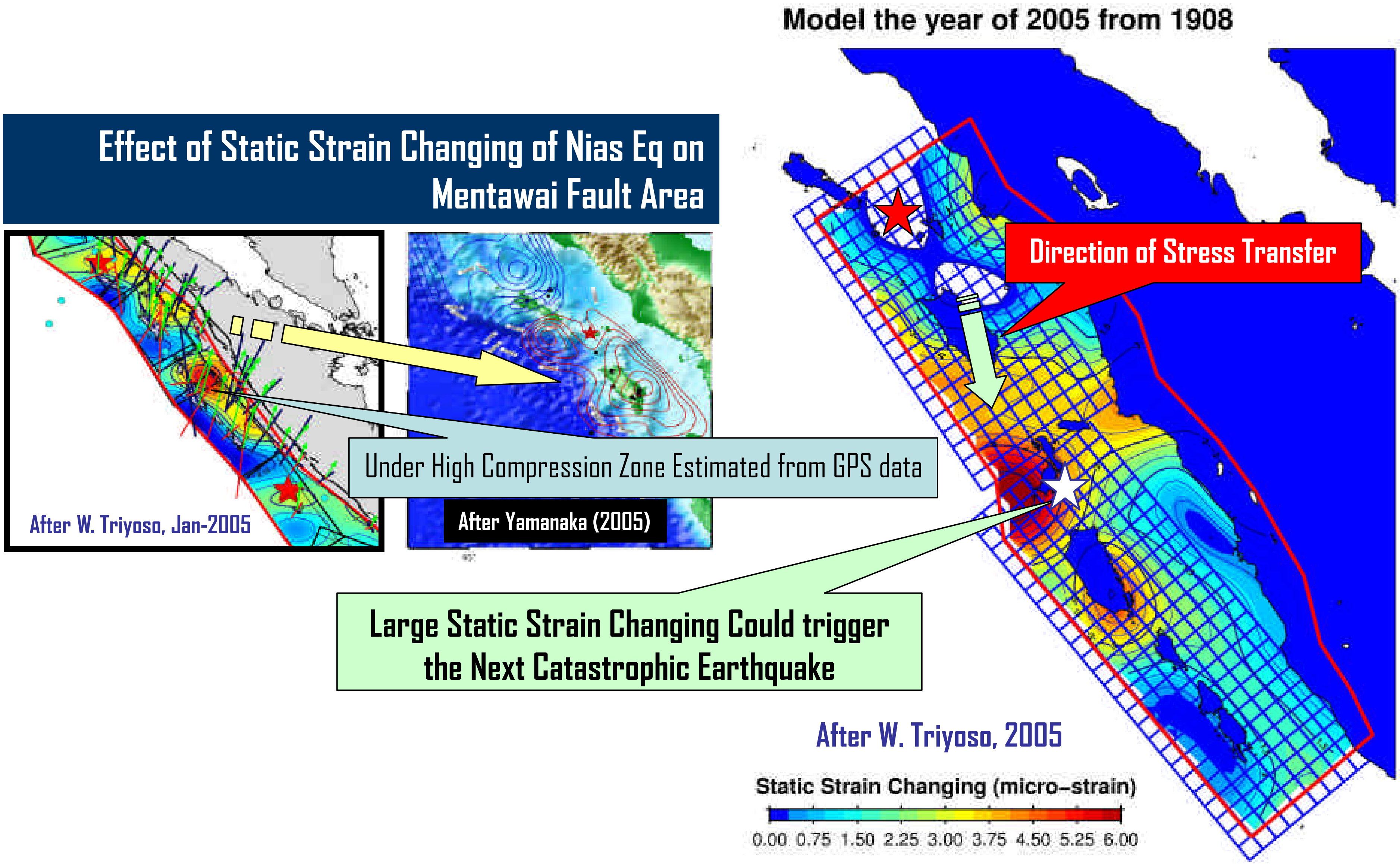


Fig. 16: Predicted the near future Giant Thrust Earthquake on Mentawai segmented fault model on the basis of predicted static strain changing. Strain changing is simply approached by subtraction of predicted maximum shear strain with predicted dilatation.

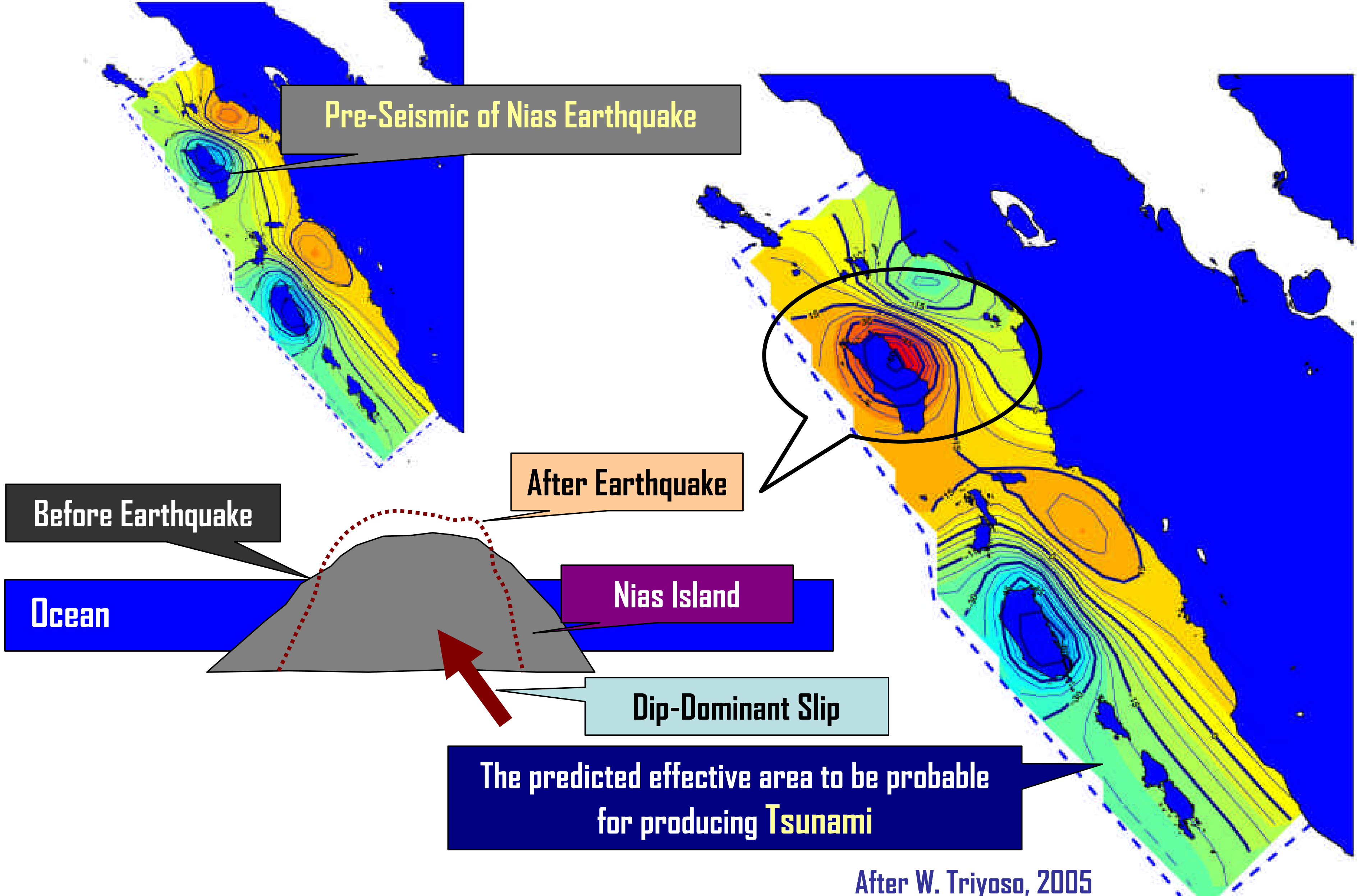


Fig. 17: A Simple model to explain why we don't have any large tsunami during Nias earthquake and Estimating the possibility of having Tsunami when the near future Giant Thrust Earthquake on Mentawai segmented fault ruptured.