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Stress-strain relationship: Postulated concept to understand genetic mechanism associated with a seismic event.

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Abstract

Strain rate measurements, over an area by GSRM[1][8] and GPS data sytems[2][8,10] help in establishing the nature and pattern of the medium and strain velocity. Expansion and contraction rate details, at times, impede detection of exact magnitude, direction of vectors and axis rotation. Minute measurement of direction and magnitude of strain rate, using the proposed concept, helps in better understanding of seismicity. Correlation of data on strain rate for past events of Tibet, Anatolia, 1994, Sikkim, 2011 and Turkey, 2011 supports the concept. Strain develops over considerable time in the overlying stratum at right angle to the applied shearing (max) stress[3] [5,9] ,obeying the internal friction of the stratum,[4][4.9] available seismic energy and law of stress-strain relationship. Using estimated energy (seismic), stress accumulation, the addition or subtraction in the strain rate due to stress developed can be analyzed for a seismic event. This concept may lead to better understanding of stress generation; build up, transfer and final drop.

Key words: Strain rate, Field velocity, Axis rotation, Stress- Strain relationship, Seismicity

Introduction: stress generation effect and its mechanism causing seismic forces[1] [2,13]related with endogenous and exogenesis sources both. Astrophysical like (celestial objects viz; Sun, Moon, mars. and Jupiter) influence on gravitational pull on the Earth which ultimately is responsible for the stress building forces at the interface of Lr-up mantle[2] affecting seismicity at an area. The strain rate measurement by GSRM[4][5,13] , and GPS data system[5][1,3]](almindger1990,1995)Zhao,(1994) and E.Holt,(2004) have cited theirs work on the strain rate measurement on the Asian region of Tibet and Anatolian plateau .Pattern of strain rate expansion and contraction and calculation of axis rotation and field velocity put interesting observations to be investigated in their works. Contraction alludes for overlooking the impending seismicity and expansion for positive occurrence. Through the equation below

$\epsilon_{xyz} = \dfrac{\mathbf{1}}{\varepsilon(\sigma 1 - \sigma 3)} \propto \mathbf{c}\Delta T[\mathbf{1}]$ is utilized for measuring the 3D strain development due to applied stress on the reservoir rock underlying the stratum. On real time analysis with the available data on strain rate and field velocity measurement: Zhao, Almindger et al (1990) Haeins.A, Holt .E etal (2004)could not establish the concrete relationship between stress and

strain behavior to follow up for an impending event. In the present paper mission is to encounter the shortcomings. The latest model version of May 2004 (*i.e.*, GSRM version 1.2) includes 5,170 velocities for 4,214 sites worldwide (Holt *et al.* 2005). The model consists of 25 rigid spherical plates and ~25,000 0.6° by 0.5° deformable grid areas within the diffuse plate boundary zones (*e.g.*, western North America, central Asia, Observations on the available data set for tensor moment of earthquake events since 1976 to recent period on Asian region Viz Anatolia ,and Tibetan plateau [6]shows haplessness to foretell the forthcoming events arrival due

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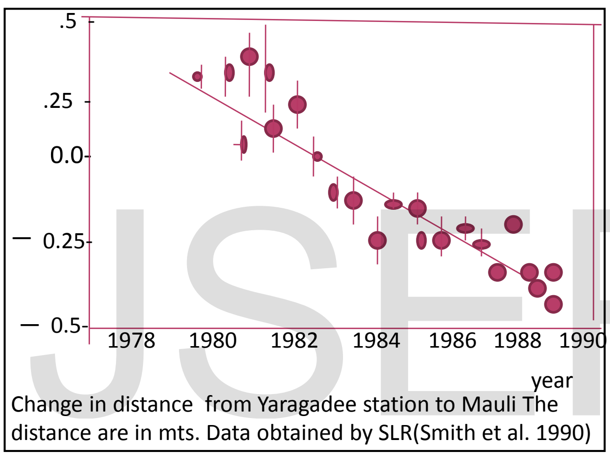
to lack of concrete rules to be follow up. Angular rate of strain velocity vectors , and axial rate both rigorously after investigation over an area put a little bit confusion to understand the actual nature of stress being impended and significant demonstration of strain behavior thereof developed.

On the basis of principles of rock mechanics: Smith .D et al 1990, supported by SLR(Satellite Laser ranging) equipment strain develops not only in one direction but accords the equation as below

$$\text{Cos}\,\beta = \frac{Cos\Delta Py - Cos\Delta PM.\cos\Delta yM}{Sin\Delta PM.Sin\Delta YM}$$ ---------- [2(1-50)][7][3a,3b]

Mission in the paper lies to highlight the novel concepts developed through investigation to explain the appropriate mechanism and cause of seismicity at an area on the basis of strain velocity vectors (in expansion and contraction term) The findings of facts are in support by the ISAR Infermetry;Price and Sandwell(1998) for event of Landers ,California Earthquake (7.3Mw) on June 28, 1992.9[9] [Rock mechanics : JC, Jaeger London Press 1976}



Change in distance from Yaragadee station to Mauli The distance are in mts. Data obtained by SLR(Smith et al. 1990)

Figure:1

Principle and Mechanism: Principal Stress on the rock volume considered cause the strain following law and rules of rock mechanics[10] [3,3a,5.] First, the Collaboratory for the Study of Earthquake Predictability (CSEP; Jordan *et al.* 2007) is accepting global agreement in the seismology.

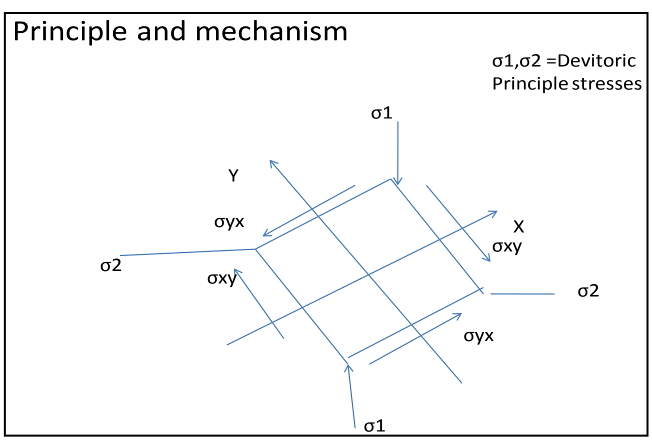


Figure:2

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Fig2 is an attempt to explain the nature of strain produced to impending principal (devitoric) stresses in the horizontal plane over the stratum rock unit: Courtesy: Fundamentals of rock Mechanics by J.C. Jaeger and N.G. .W. Cook (Chapman and Hall, London 1976).

Expression from the rock mechanics[6] [9] Jaeger N. C. et al.(1976) we have,

$\epsilon_1 = \left(\frac{1+\upsilon}{\varepsilon}\right)_{\{}\{\sigma 1(1-\Upsilon)-\upsilon\sigma\mathbf{2}\}$--------------------------3.45{D.E. Smith et al.(1990)[11][4,5]

,Є= strain, υ= poison ratio,$\sigma_1\sigma_2$= principal horizontal (deviatoric)stress ε= elasticity coefficient of the materials. Again strain in the y axis direction

$\epsilon 2 = \left(\frac{1+\upsilon}{\varepsilon}\right)\{\sigma 2(1-\Upsilon)-\upsilon\sigma 1\}$------------------------- (3.46)[12][1,2,3]

With the thermal stress effect on the stratum rock thermally unconstrained we get change in temp.ΔT that can lead to large change in pressure or stress as in the eqn

$\epsilon_1 = \left(\frac{1}{\varepsilon}\right)_{\{}\{\sigma 1-\upsilon\sigma 2+_{\alpha x T}\}$--------------------------(4.188)[13][1,2,3]

From the theory of linear elasticity, Muskhelishvili,N.I.(1963)[14][5] Further linear elasticity is modified as$\varepsilon_1=\varepsilon_2=\varepsilon_3=-\frac{1}{3}\alpha_v\Delta T$ -------------------------4(181)

And,$\epsilon_1 = \frac{1}{\varepsilon 1}(\sigma 1-\upsilon\sigma 2-\upsilon\sigma 3)-\alpha l\Delta T$ ------------4(183)[15][5]

$\epsilon_2 = \frac{1}{\varepsilon}(-\upsilon\sigma 1+\sigma 2-\upsilon\sigma 3)-\alpha l\Delta T$ --------------4(184)[16][5]

$\epsilon_3 = \frac{1}{\varepsilon}(-\upsilon\sigma 1-\upsilon\sigma 2+\sigma 3)-\alpha l\Delta T$ ------------------4(185)[17][5} will give the associated effect of temperature and thermal expansion over the rock stratum. Vertical direction for half spaceσ_3

Is 0 and$\sigma_1=\sigma_2$ $\frac{\varepsilon\alpha l\Delta T}{1-\upsilon}$ ------4(193)[18][5,6] from the Text of rock mechanics. Putting these values into 4(89) we have $T= T_{0+}\Delta T\exp\left(\frac{y\sqrt{\omega}}{2k}\right)\cos(\omega t-y\sqrt{\frac{\omega}{2k}})$-------------------------4(89)[19][5,6,2]

Where y = surface length, k= thermal diffusibility in m^2/s $K=\frac{k}{\rho c}$, c= specific heat of the rock of stratum, α=linear coefficient of expansion.

$\sigma max=\frac{\varepsilon\alpha\Delta T}{1-\upsilon}$.

With thermal and elastic stress effect on rock stratum $\sigma_1=\sigma_2\left(\frac{h}{1-\upsilon}\right)(\rho g\upsilon+\varepsilon\alpha l\beta)$---------4(97) here β is thermal gradient; Pressure at depth h is

$P=\frac{1}{3}(\sigma 1+\sigma 2+\sigma 3)=\frac{1+\upsilon}{3(1-\upsilon)}\rho g h+\frac{2}{3}\frac{\varepsilon h\alpha l\beta}{3(1-\upsilon)}$ 4(98) [20][2,3,4,5]

Thus from the mathematical equations derived from the rock mechanics text and elasticity theory strain behavior can be understood. it is depending on the thermal stress condition and related parametric sources to be developed in possible direction.

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Acquisition of data

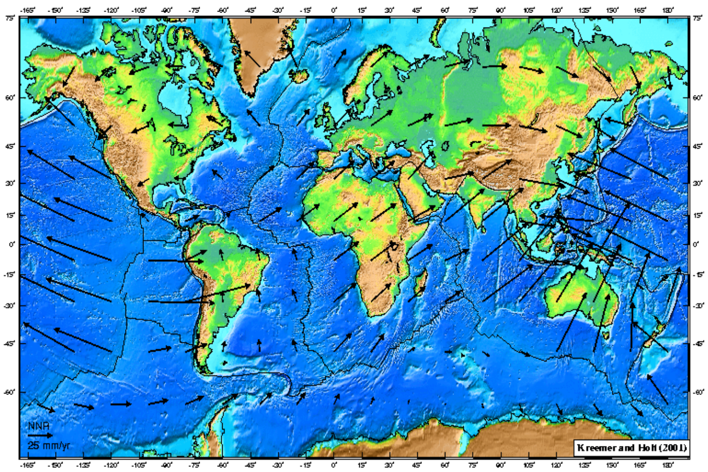

Fig and image coutsey byE.holt (2004) for strain rate measurement on GSRM

Figure:3

Fig3: Strain rates inferred from Kostrov summation of Quaternary fault slip rates (white principal strain rate axes), and corresponding spatial averages of predicted strain rates (black principal strain rate axes) given by bi-cubic Bessel interpolation of fitted velocity values on a curvilinear grid. Fitted strain rate field is a self-consistent estimate determined in a least-squares inversion in which both strain rates and GPS velocities are matched by model strain rates and velocity fields, respectively. Amurian B. -Amurian Block, Ordos B. - Ordos Block, Sunda B. - Sunda Block, WSG - Weihe Shanxi Graben system. From (Holt et al.2000,).In the figure shown velocity vectors are in the opposite direction about the mid Atlantic ridges. Veocity vectors in the right bottom of the map ie SE are due NE and longer comparatively in size. Orientation of vectors at the Asian region are due Nw from oceanic plate of pacific towards the Tibetan Plate .Data gets verified with the observations made by Zhao 1994 and E Holt(2004) Noticeable fact about the pattern of strain can be observed lower and in size and horizontal in direction with the crustal surface (for both oceanic and continental plates)

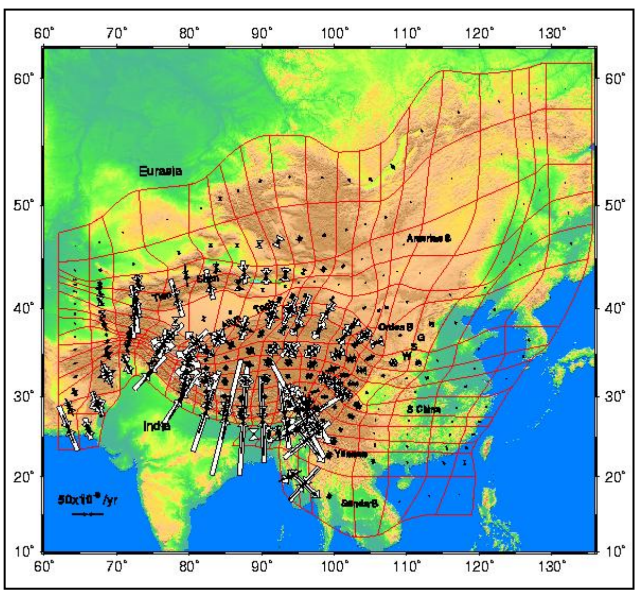

Figure:4

Fig4 displays the 25000grids distribution on the global map. Entire network of strain rate or velocity vectors shows expansion and contraction due to upwelling stress from the(mantle-up-lr)interface. Interesting point is that most of velocity vectors on the Asian continental plates are in contracting mode. Vectors at the oceanic plates are longer and in expanding mode. It is obscure about the stress stored below the crustal reservoir having contracting mode and stress energy already been consumed at the expanding region. It has been significantly observed during the 18thSeptember, 2011 outbreak at Sikkim (6.8Mw) and Turkey7.2Mw on October 24th 2011.

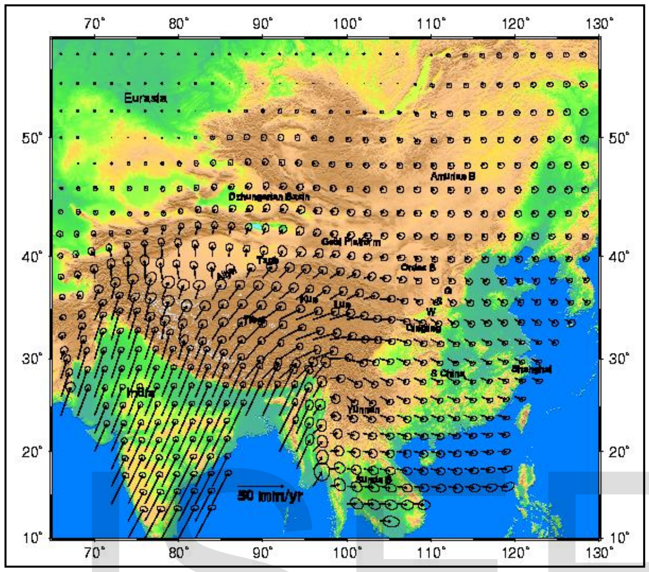

Figure:5

Fig5 depicts the supportive evidence of concept laid in the abstract.: courtesy: Zhao et al Kreemer et al(2000) strain rate measurement for the Tibetan and Asian region prior to Sikkim (2004) 5.7Mw event. In the figure velocity vectors are due north and NE on Indian subcontinent and Tibetan plateau region, respectively. Vectors show the Indian plate moving towards the Tibetan plate .Eurasian plate remains passive w.r.t. Pacific and American Plates. It has been evident even by the Harvard CMT catalogue data set. From Jan1977 to November 2002.

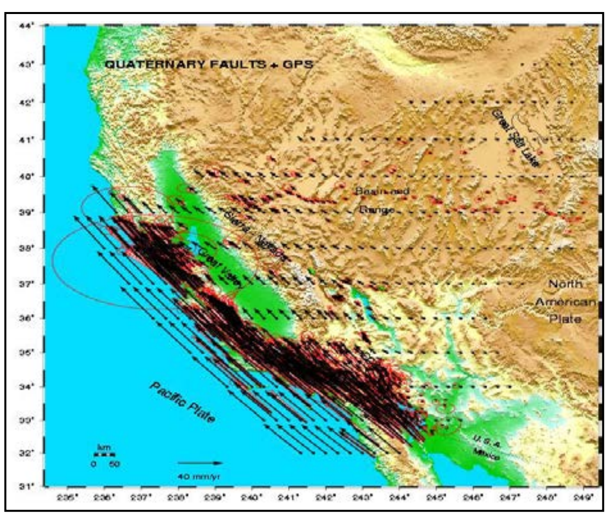

Figure:6

Fig6 velocity vectors of Pacific plate against American fixed plate(relatively) courtesy:Almindger Zhao et al 1998,2004) Figure 6 shows the pattern of strain rate or vectors with greater in amount than the vectors at continental plates of America with respect to Pacific. Eventually has been observed y the events of Chile 7.3mw 0 on 2nd jan 2011 and Mexico 6.5Mw0 on October 2011.vectors are shorter at the continental region than that of Oceanic region of pacific. This has been evident even by the Harvard CMT data catalogue since Jan1977 to Nov.2002.

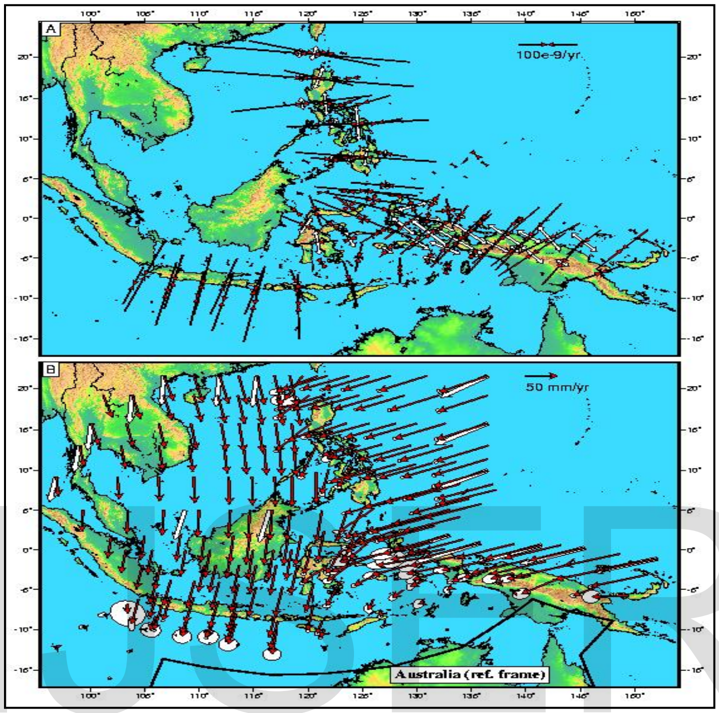

Figure:7

Figure 7 states the direction and amount of vectors in the oceanic region of Indian and pacific plates with relative passiveness of Asian plate.

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Discussion and Conclusion:

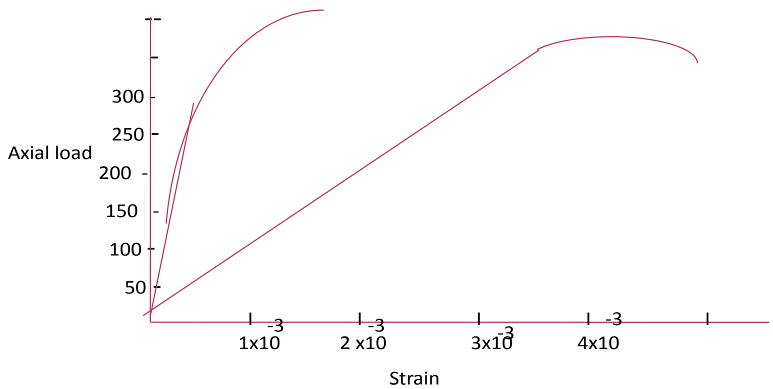

Figure:8

Figure 8 above states the nature of strain against impending stress on the quartzite rocks observed by (Bienweiski, 1967) we infer from the stress –strain relationship whatever the type of stress Litho static-or devitoric shearing (axial) or normal the effect on the rock surface of the stratum depends on the parameters .characters like rigidity G, elasticity ε, density ρ, Poisson ratio υ coefficient of thermal expansion α, thermal diffusibility β.

I Amount and direction of velocity vectors or strain rate is proportional; to the quality and quantity of the stress impending.

II Shorter vectors signify of stored seismic energy at the reservoir of stratum. And hence characterizes of shallow focus expectation.

An III vector of medium size signifies of outbreak stress drop at medium depth.

IV .All the vectors aligned in one direction and with same magnitude it is characteristic of stress line (tangential or radial perpendicular to the vectors observed

V. At right angle to the vectors pattern observed at one region there lies the region of perpendicular stress viz Tangential –to radial and vice versa.

VI Vectors at these two region shows perpendicularity in relation. Velocity vectors of shorter size in general characterizes of foreshocks of seismicity at the region. Whereas larger size signifies greater magnitude of seismicity as in china 1996 with 7.5 Mw.

VII Expectation of epicenter and focus lies better at the terminal point of smaller velocity vectors.

VIII Smaller vectors are characteristics of higher magnitude and Intensity of seismicity at the place of observation..

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