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'Determination of focal depth and estimation of magnitude of seismic energy on the basis of Mohr's stress-strain envelope concept and on outcome of simulation of stress into radial and tangential nature'.

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ABSTRACT

Impending stress within the Mantle (at the UP-Lr interface[1])[28] owing to either astrophysical or terrestrial source[2][28]undergoes interaction with the overlying stratum It is exhibited in terms of structural disturbance , physiochemical changes and related processes[3-4,16,28] and is triggered in magnitude and direction by two components namely radial and tangential[4][24].The progress of these components(mutually perpendicular) is followed by the constraints of internal frictionμ[5][14,17,19](Colombian coefficient)viscosity ή rigidity G, elasticity ε, claperion slope γ(dp/dT)prevailing temperature condition T,Creep rate Є[6] [19,26]conductivity of geomaterials k, density ρ and finally the yield strength[7][17,19]of the stratum rocks. Yield strength when treated with the residual stress [8][19]of the reservoir at the time and space of observation modeling with the Mohr's' envelope and circles of stress[9][-17,19] we find uniformity in parameterized trend. Different models of varying tests for different parameters, there exists a linear relationship between yield strength of the stratum rocks and residual stress in the reservoir of considered conditions (Physiochemical) Yield strength first responds linearly to the residual stress as elastically then after fatigue stage it behaves plastically as the diagnostic for the level of stress drop as characterized in different set of test models. Eventually at particular depth a set of parameterized conditions permits residual stress to exhibit elastic behavior then after fatigue plastic point is observed which the momenfor seismicity is. Radii of circles in the models formed in different tests ascertain the depth of focus of seismic event.

Key words: Mohr's envelope, residual stress, creep rate, stress drop, yield strength.

Introduction:

It has been assumed after a no of arguments that short term prediction of an event is impossible to have any precursory Geller et al1997 [Uveda et al.2009] Despite the classics of rock mechanics and strength of materials in various texts and papers [viz of Byerlee, 1977; Byerlee, and Summers1978].reveals expectations for the short term event forecast and determination of hypo central depth*. **The classical theory of friction [e.g., Bowden and Tabor, 1950]. Friction Theory stipulates that asperity contacts yield plastically and the applied contact normal stress sc is the material yield strength sc = sy, as is consistent with recent contact-scale studies of rock friction [Dietrich and*** **Kilgore**, 1996] work by Shrivastava and Deshpandey (2003) to assemble the scattered links in this context up to the recent panorama of EM radiations' precursory like ULF/UHF,[9] [[15, 16]][Ozunov and Demeter et al2007.]PHP low frequency (1Khz) emission and ionosphere discharge phenomenon viz IR anomaly (FT.Friedmann (2010)[10][16,25]Sprite Elves,[Lee Feng Kuo, Taiwan University2011] and other discharge phenomena have been a great help in forecast of event . Still the profound and reliable technique and theory is always sought. Present paper aims to culminate the findings of lab testing on the rocks for their mechanical properties viz Shearing (peak and yield) strength, coefficient of friction (μ) Poisson ratio(υ)elasticity constants (young's modulus), rigiditymodulusG,andcompressibility1/β[RT Brownetal1967,[11][1,13,15]Kraus,.H.(John ,Wiely,NY(1967)[12],[18,21,22]Muskhelishvil iN,I.[13][22]zvozislovV.V.,,Gringen,1964);[14][17,21]Timoshenko,S.andDH Young,(1962)[15][13]. To find the best possible solution leading to hypocenter depth determination precursory on EM radiation window like ELS[16][12,14,16]Lee Feng(2011),IR anomaly(Ozunov and Deimetre2004,2007 et al) on the platform of GPS and GSRM data under Geodetic method[E.Holt2011)have annexed the steps towards the investigative steps in seismology. Still, the best suitable and reliable technique to determine the focal depth prior an event [post event methods like double difference of allocating hypo central depth by C.Foyle2007 and Cole et al are available] is always sought. Present paper attempts to place a simple graphical model sets based on the culmination of classics of rock mechanics17[13,17,19]JC Jaeger et al.1967,1998)Fung YC(1965) NGW Cook and NI Mushvili(1965) Under lab tests of rocks properties like shearing strength, (residual and peak both [18][13,17,19] RT Brown 1967, Timoshenko,S.andDH Young,: Elements of strength of Materials(Van Nostrand NJ(1962)its variation against residual stress or applied normal stress) σ_n graph(fig1) [19][17,19,]RTBrown1965)

The classical theory of friction [e.g., Bowden and Tabor, 1950]. stipulates that asperity contacts yield plastically and the applied contact normal stress sc is the material yield strength sc = sy, as is consistent with recent contact-scale studies of rock friction [Dieterich and Kilgore, 1996].Under these circumstances, as the macroscopic normal stress increases, the real area of contact increases according to Ac = As/nsc. If the shear resistance of rocks consisting the stratum has greater value than applied normal stress the fracture is not permitted within the framework of parameterized conditions of all the mechanical properties describing the set model. Otherwise the fracture initiation or diagnostically stress drop condition prevails either maintaining internal friction angle (32-45^o) or maximizing the normal stress value and hence minimizing the shear strength. Mechanical Characters(variable and constant both) of stratum rocks viz; compressive strength, tensile strength [20][[17,19]] (RT BROWN 1967) Poisson ratio υ and coefficient of internal friction μ[21] [13,14,17](Mohr1882), J.C. Jaeger(1962) (, MP BILLINGS (1971)et al are significant of particular depth conditions. Thus culmination of these characters bases the theory and mathematical formulation for the hypocenter depth determination in the following principle and mechanism.

Principle and mechanism:

Progress of stress at the particular depth of rock-stratum within the sphere of influence considered in the window of Friction classical theory [22][17,18,19] and rock mechanics analyzed by the FFTformulation [[16]-25,26]depends on the parameters of heterogeneity like μ,ή,υ,ρ,φ,σ, and rigidity G. Where all the symbols have their usual meaning .Differential stress (σ_1-σ_3) plotted against yield strength/shearing strength prepares the circle of sphere of stress defining the condition of parameters mentioned. At prevailing temperature of thermal stress and additional supply of stress it fractionates into tangential and radial components (sayer and Sen1990)Stress propagation from interface of Lr-up mantle to the up stratum rocks can be formulated as $\Delta U=\sigma\times\Delta V$, where U is thermal energy causing stress σ and change in Δv volume of rocks under deviotoric stress. $=(p_r.\sin\theta h_r+ip_r \cos\theta h_r)$[23] [17-20,21]Mishiliereio(1999)Where,pr is the amount of force due to stress acting on the rock stratum on two expected resolved directions by FFT (Fourier formula transform)at the radius (or depth=hr),θ_r=angle of stress component making with the fracture plane .Eventually ipr cosθr represents all the summative form of tangential components direction.ie

$\tau= p_1\cos\theta1\ h_1+p_2\cos\theta_2 h_{2+}$----------$p_n \cos\theta_n h_{n}$-- ---------------------- (A)) where, $h_1 >>> h_n$ and

``$\theta_1 > . > \geq \theta_2 = \theta_{n=} o^o$ to 180^o . Slope of the curve drawn between strength (shearing) and normal stress

Tanθr= ———— =hr sinθr ———-------- (1)

hr cosθ

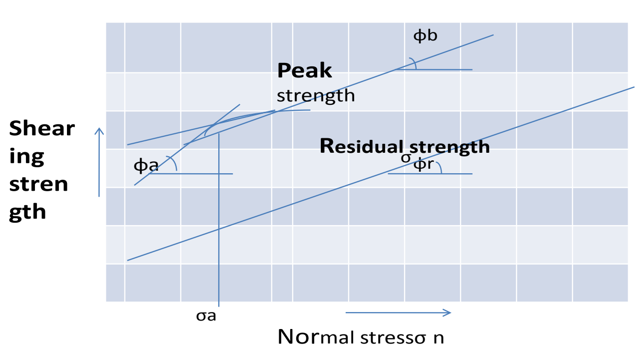
Where,tanθr=μ(coefficient of internal friction) Mohr1882)defines the φ value $32^o$for all the stratum possible for fracture condition[24][17,19,21],

Next, $\sigma n=p_1 h_1 \sin\theta_1+p_2\ h_2\sin\theta_2$+------$p_r h_r \sin\theta_r$------ (B)

Having θ=45±φ/2(Mohr1882)θ makes with the fracture plane ,'σn normal stress applied by the seismic energy[Mohr1882,Beerlyer1997:rock mechanics].

Thus at each step of series (FFT)two individual components are developed perpendicular to each other one tangential and other Radial(normal)eventually the tangential in thermo plastic condition exceeds by 120 Mpa by radial[F. Sen. and Martine Sayer1990]Fig.1 below after FFT. Fractionation is supported by the Maxwell and Boltzmann EM theory, .Fig1

Plot of linearity for shearing strength against the applied normal stress



Courtesy fig: Manual of Rock mechanics byBeryler1997

Mathematical formulation for depth determination

From the rock mechanics σ_3 = 1-υ ———σ1ρgh$_L$---------------- (2) where υ is Poisson ratio G= rigidity G-3υ

Modulus of elasticity acceleration due to gravity=density of the stratum rocks

Change in vertical prescribed stress yields plastically if normal stress sa=yield strength sc [Dietrich &klgore1996] for μ=yield strength

———————— = (slope of the curve) tanθ Residual stress

And,

$$\Delta\sigma_3 = \frac{2(1-\upsilon)\ \rho g h L}{G(3\lambda+2G)} \Delta\sigma_1$$ ----- -------- (3.40-)- where , **ε** **ε**= ————————------------(3.38)[25] [17,19] (λ+G)

From the text of rock mechanics. Furthr ratioΔσ3 — $\Delta\sigma_1$ shearin —= shearing strength

= $\Delta\sigma_1$ ———— ——— is the slope that after Fourier transform simulates into $\Delta\sigma_1$ $\Delta\sigma_1$ normal stress

Sin and Cos components as

$\tau=\sigma_1\sin\theta+\sigma_2\ \sin\theta_{2+}$---------- (3)

Tangential component and radial

$\sigma n = \sigma1\cos\theta_1+\sigma_2\cos\theta_2$-------------(4)

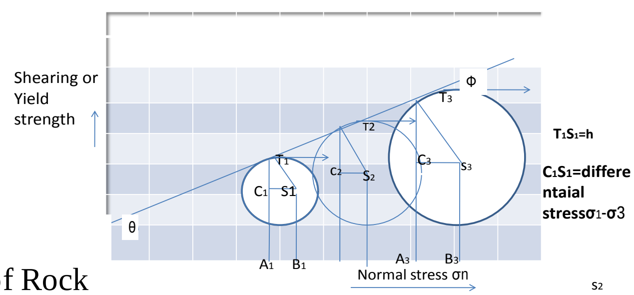
and $\tau=\int\sigma_r \sin\theta_r d\theta$----------(3a) as $\sigma_n=\int p r d v r\cos\theta_r d\theta$--------(4a) where r=1 to n and θ=o to $18o^0$Thus there is at least specific condition for internal friction and $\varphi=32^o$ that gives condition for maximum fracture and thus seismicity [Mohr1882.Bereelier1997,Dietrichklogre(1996) [26][17,19,25]

For all qualifying condition it prevails at all depth hr associating constraints of parameters .which is evident in the fig2 below,

Graphical modeling of stress envelopes for various sets of constraints;

Consolidated fig of all the recorded data of mechanical properties in lab testing displays circles touching linear curve drawn against stress (applied) vs. shearing strength of the rocks of stratum presents domain of characters of constraining parameters at specified depth(radius of the circle).

Graphical modeling of sets of mechanical properties of the stratum rocks characterizing depth conditions of constraints of parameters.



Courtesy: Mannual of Rock Mechanics byBeryleer 1997.

In the figure2.T1S1=h depth of stratum at which constraints of parameters are considered,T_1,T_2-aretangents drawn on the stress circles making angle of internal frictionφC_1S_1etc describes differences of stress(σ_1-σ_3) greater the value more the chance of drop out and seismicity.

Obviously greater value of AnTn greater is the shearing strength of rocks in the stratum indicating higher depth.

Acquisition of data and analysis thereof : We recorded all the information of mechanical properties of rocks like sedimentary ,metamorphic , and igneous all characterizing various depth and tabulated them for tracing the trend of graph between the applied stress (normal)RT Brown 1967]Rock mechanics testing lab.Variation of applied stress against the shearing (peak and residual) strength shows linearity. The slope gave internal friction which is specific for specific depth conspicuous by circle of stress- strength graph by the tangents drawn therein. Angles at various depths formed between the tangents and linear curve gave the critical friction permitting fracture at the depth in the associated rocks,

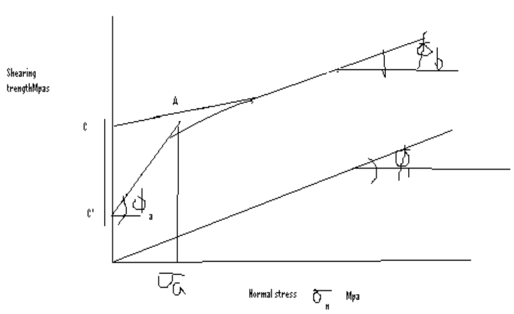
0Table1

Mechanical properties of the rocks type obtained from different localities. Showing linearity,

Rock types	**den sity**	Applied stress	**Poisson ratio**	**Modulus of elasticity**	**remarks**		**Location**	**References**
		Tensile						
Siltstone	2.65		421.52	.30	74.0	1.22	CIMFR Dhanbad .India	Self
Limestone Marmorise	2,67	-	-	.31	83.6	.46	**Ussr**	Belikov,etal1967
Turkemeni aDolomite	2.70	-	-	-	73.9	1.81	do	”
Kerpther Marmorise	2.68	-	-	-	75.6	1.06	--USSR	Do

d								
USSR MoscowDolomite	**2.57**	-	50.5	.32	50.5	1.23.	-USSR	Bellikov 1967
Loamy Sst Yugoslavia	2.56		100.60	.16			yugoslavia	Devorak 1967
USA Ohio .hd	2.56	4.83	113.76		53.72		Ohio USA	Achison et al
SiberiaLowPadigo	2.49			.21	31.7	13.57	USSR	Belikov et .al,1967
UK Portland	2.19		81.3			P=3.6	Ireland	Khaitson and Brother
Brazil Gneiss Gramdam	2.63		115,5	.19	64.3 77.8	P=.7	Brazil	Ruiz 1966
Brazil Eucilidas base Dam	2.75		158.8	..27	70.4	P=.05	do	Ruiz 1966
Brazil Graminha	2.76			.19 .24	15.3 91.7	-na	do	Avila 1966
USA,Edmonston, Diorite	2.86	15.91	154.72	-	-	-na	USA	Kruse et al1967
Brazil Gneissic	2.88	-	-	.13-.19	24.3-95.4	-na	Capivar cachori Dam, Brazil	Aliva 1966

When the data acquired from the lab manual of rock testing unit for mechanical properties in The text and in the lab after testing are plotted on the log paper keeping applied (normal stress) against the shearing strength graph appears as below. We have σn appliedStress (normal) φa angle of internal friction (apparent),φb=angle of internal friction for Which peak strength of rocks are maximum and φi as the asperity of contact that makes with the fracture plane[20][18, 19,25]



With the available data and their analysis a trend virtually linear is obtained in between applied normal stress and shearing strength.(RT Brown et al1967) Bowden and Tabor, 1950 Friction Theory stipulates that asperity contacts yield plastically and the applied contact.[27][13,14]

Discussion and Conclusion: By the recorded data analysis entries made in the table we infer the applied stress is directly proportional to the maximizing shearing (peak and residual strength, Tangents on these linear curve drawn makes asperity contacts. Angle of internal friction is independent of shearing strength of rocks. Under constraints of various mechanical properties of rocks determined reflects uniformity under some rule[James,M.GereBarryJ Gooderio Gere:Mechanics of materials(2010). This is obvious for different sphere enclosing the parameterized constraints of rocks stratum. A friction coefficient approximately independent of normal stress is consistent with experimental data from a wide range of rock types [e.g., summers and Bayer lee, 1977; Byerlee, 1978[28][17,13] These spheres indicate of particular depth heterogeneity. Thus there response to applied stress depending on constraints condition associate with the specific depth of stratum.[James Stewart Calever, Beer Johnson and D.Weklft: engineering mechanics of solids)[29][13,17,21]**Timoshenko,S.andDH Young,: Elements of strength of Materials(Van Nostrand NJ(1962),** Stephen Timoshenko *Mechanics of Materials* , with J. M. Gere, 1st edition, D. Van Nostrand " Company, 1972

Discussion and conclusion

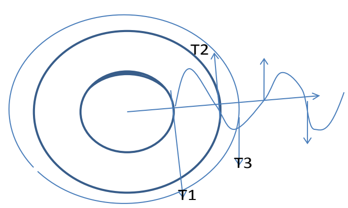


Fig states the location and mathematical Fourier transform of stress into the principal components.

T_1,T_2,T_3 are the tangential components of stress in progress at rt. angle to the radial components at each spherical blow.

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