International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume – 02, Issue – 04, April – 2017, PP – 21-26

Geospatial approach in Slope stability analysis of Barliyar-Coonoor road stretch of the Nilgiris District, Tamilnadu, India

[1]Akilan.v and [1]Askar Ali.E, [2]Naveen raj.T,

[1]*Final year students, Department of Civil Engineering, Velammal College of Engineering and Technology, Madurai*

[2]*Assistant Professor, Department of Civil Engineering, Velammal College of Engineering and Technology, Madurai*

Abstract: The security of inclinations is continually under genuine perils in many parts of Western Ghats, especially in Barliyar-Coonoor slant road expand, making intrusion, loss of human life and economy. To restrict the precariousness of soil grade amidst Barliyar-Coonoor, a fundamental evaluation of roads is required. The stability of the slopes depends on upon the soil shear quality parameters, for instance, Cohesion, Angle of inside rubbing, Unit weight of soil and Slope geometry. The dauntlessness of an inclination is measured by its variable of security using geometric and shear quality parameter in perspective of unbounded grades. In this present study, investigation was done at 10 regions in the above said hill road strectch to estimate the factor of safety of the slope managed by Mohr-Coulomb theory based on shear strength parameter calculated from direct shear test which is a conventional procedure for this study. Back Propagation Artificial Neural Network (BP-ANN) Model is used to expect the factor of safety. The data parameters for the (BP-ANN) are chosen as Cohesion, Angle of inside disintegration, Density and Slope angle and the factor of safety as yield. The results got in BP-ANN system were differentiated and that of conventional procedure and viewed a not too bad comprehension between these two techniques. The results obtained in BP-ANN method were compared with that of conventional method and observed a good agreement between these two methods. The results obtained from these two methods were also compared with the details of actual field Landslide occurred and indicates 71.4% of conventional method locations matching with the physical occurrences and 85.7% of BP-ANN predicted vulnerable locations match with the physically observed landslide locations.

Keywords: Artificial Neural Network (BP-ANN), Back Propagation Soil-Slope, Factor of Safety, Landslide, Slope Stability.

I. INTRODUCTION

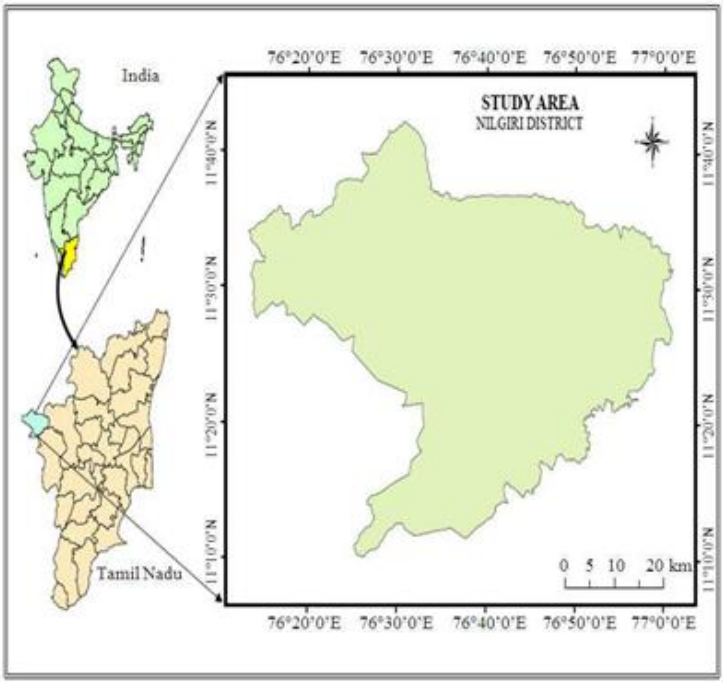
Landslide is a much of the time happening normal phenomenon, particularly in sloping region and it is characterized as the natural or manmade failure of soil mass. It happens chiefly in the slope slants, embankment or cuttings of roadway or railroad and making harms human life and properties. The Barliyar-Coonoor road strech in Nilgiri District of Tamilnadu, India is seriously influenced via landslide in numerous areas in the years 1978, 1979, 1993, 2006, 2009 and 2011 made harms `human life, properties and it is additionally an well known region for continuous landslide during monsoon every year. There is no seepage framework in this extend which prompts dynamic crumbling of the structure of the dirt mass and results in landslide. Aside from the substantial rain fall, taking after variables, for example, Population increment, Infrastructure improvement, Land utilize, Land cover change and road stretching process expands the likelihood of landslide in this slope extend commonly. There are two rainstorm specifically, Southwest (July-September), Northeast (October-December) yield a decent precipitation consistently bringing about landslide in this extend. In 2006 landslides were happened almost in 30 areas of the review zone. The above said road stretch endured soil slips, earth slides, shake falls and land subsidence, because of the way that the road stretch is profoundly defenseless as a result of more extreme slope slant, turn out to be more insecure conditions against landslides. In the a large portion of the areas landslides are conspicuous; the plunge of the bed arrangement is more noteworthy than 60°. The region in which bed plunge towards the slant with plunge point more noteworthy than 45° are hazardous and more inclined to landslide. These actualities warrant a different itemized logical review on the slant soundness of this road strech. Consequently, the investigation of incline steadiness is felt essential particularly in Ghats street areas. Notwithstanding that there are sure places where the incline point is so basic which clears path for landslides. Since such landslides are noticeable in the stormy seasons, this review plans to discover measures to keep up incline solidness which lessens the possibility of landslides.

An observation overview was led in the interstate of Barliyar to Coonoor road stretch around 27 km uncovered that many slant are insecure. Subsequently of this perception, 32 areas were picked and tests were gathered to investigate the slant strength in light of the parameters, for example, Cohesion, Density, Angle of inside rubbing and Slope point. The element of security was controlled by Mohr's Coulomb hypothesis and the acquired outcomes were prepared in Back engendering Artificial Neural Network (BP-ANN) for the expectation of incline strength. It was watched that component of wellbeing anticipated by BP-ANN nearly coordinates with physically happened landslides.

II. STUDY AREA

Nilgiris signifies "mountains in Blue Color," is a standout amongst the most well-known slope locale in India, arranged in Western Ghats and the geological area of the review zone is appeared in Fig. 1. It has pleasant slope stations, for example, Ooty, Coonoor and Kothagiri. The stature of slope range fluctuates in the vicinity of 2280 and 2290 m above Mean Sea Level (MSL).

The territory lies between 11°8'N to 11°15'N scopes and 76°13'E to 77°2'E longitudes, covering a region of 2 593 sq. km. The month to month normal precipitation in the region is 94.20 mm. The times of June, July, September, October and November get a precipitation that is more than the yearly normal precipitation. The region has most astounding normal number of stormy days with 7.3 days for each month, Mean greatest normal temperature of 20.7°C, mean least normal temperature of 9.6°C and mean relative moistness max imum of 76.9% and least of 75.8%. In the past history records, landslide were prevalently happened for the most part in Barliyar to Coonoor street extend.



III. MATERIALS AND METHODS

A. CONVENTIONAL METHOD OF SLOPE STABILITY ANALYSIS

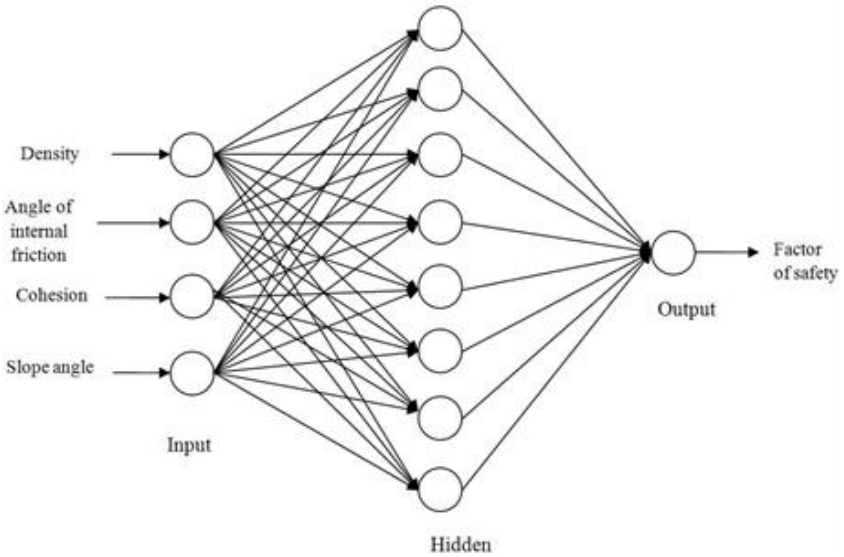
Geotechnical examination was completed in the street length of 27 km in a miniaturized scale level premise and both the undisturbed and bothered soil test were gathered from the 10 areas. Slant of the street in every area was measured with Clinometer, nature of vegetation and area of landslide happened territory were recorded with the assistance of Global Positioning Systems (GPS). The major impacting elements for soil slant disappointment are Density, Cohesive, Angle of inward rubbing and Slope point.

Out of these, the three critical components, for example, thickness, point of interior grinding and attachment were resolved in the research center utilizing undisturbed soil tests gathered from the above areas. Coordinate shear test with 6x6x6 cm shear box has been performed over the examples to decide shear quality parameters under un-depleted condition. The extra charge weight connected over the examples was equivalent to the measure of overburden existing at the site. The variable of security of every area is ascertained utilizing Mohr coulomb hypothesis with the unending recipe as given in Equation (1). The correct scope and longitude of

the testing areas alongside individual soil properties and variable of security are displayed in Table 1. In this, if estimation of variable of security is ≥ 1 speaks to stable state of slant and <1 signifies insecure state of incline:

$$F = \frac{C + \gamma Z \cos^2\beta \tan\theta}{\gamma Z \cos\beta \sin\beta} \qquad (1)$$

Where:
C = Cohesive in g/cm^2
γ = Unit weight of soil in g/cm^3
z = Depth of soil in cm
ϕ = Angle of internal friction in degrees
β = Angle of soil slope to the horizontal in degrees



Latitude (degree N)	Longitude (degree E)	Density of soil g/cc	Angle of internal friction in degree	Slope in degree	Cohesion in g/cm^2	Factor of safety	Slope stability as per soil parameters	Physically observed landslide	Chance of landslide occurrence
11.343	76.873	1.23	25.95	55	29	0.843	Instability	Not Occurred	Possible
11.339	76.861	1.24	17.92	48	35	1.56	Stability	Not Occurred	-
11.335	76.818	1.2	4.57	41	27	0.71	Instability	Not Occurred	Possible
11.334	76.791	1.22	29.68	30	141	3.65	Stability	Not Occurred	-
11.335	76.794	1.12	18.44	35	61	1.64	Stability	Not Occurred	-
11.343	76.873	1.53	10.57	61	53	0.92	Instability	Occurred	-
11.340	76.863	1.21	26.41	35	0	0.71	In stability	Occurred	-
11.335	76.817	1.26	25.01	27	35	1.6	Stability	Occurred	-
11.333	76.792	1.11	7.78	40	70	1.44	Stability	Occurred	-
11.335	76.793	1.17	31.79	43	20	1.86	Stability	Occurred	-

B. ARTIFICIAL NEURAL NETWORK:

Counterfeit Neural Network (ANN) is a broadly utilized delicate processing device in the field of designing examination and it reenacted with the human cerebrum work falsely. It has the capacities of learning, adjustment, self-association, basic leadership, work estimate and vast scale parallel handling. This neural system incorporates Back Propagation calculation, hereditary calculation and insect settlement calculation. The back engendering learning calculation is made out of forward spread and Backward Propagation (BP-ANN). The neural system comprises of information layer, yield layer and at least one concealed layer in which neurons are connected to each other with alterable weight. The forward spread transmits input flag to yield layer through shrouded layer. The retrogressive proliferation ascertains the blunder between test yield and system yield alongside the first association way, during the time spent which the weights and limits of each layers are balanced by the inclination plunge technique.

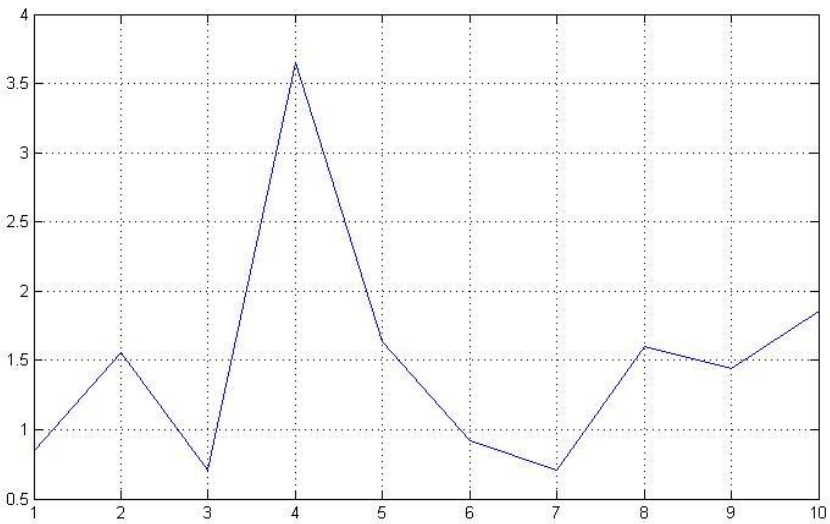
The yield of the system is contrasted and the esteem delivered by the system to decide the mistake which is utilized to assess the execution of the system. The back spread is utilized to distinguish incline strength investigation utilizing Forward engendering and Back ward Propagation (BP-ANN) by .Along these lines in slant security, the dirt parameters, for example, Density, Angle of inside contact, Cohesion and Slope point acquired from the customary strategy were prepared in Neural Network (BP-ANN) utilizing MATLAB rendition 2010a. The preparation was performed with 70% of test and staying 30% utilized as testing information for the expectation of component of security . At first the dataset was standardized with Z score standardization. Density, Angle of interior grating, Cohesion and Slope point were the info layer; component of wellbeing was yield layer and least blunder was accomplished by trial eight neurons in shrouded layer and preparing was performed.

It is found that there are defenseless landslides conceivable in the Barliyar-Coonoor slope street extend. Soil tests from initial 25 areas spoke to Table 1 were utilized to prepare the Neural Network (BP-ANN) and remaining 7 soil tests were utilized to test the prepared system for forecast of element of wellbeing. In the present BP-ANN preparing, four info layers Density, Cohesion, Angle of inward grinding and incline edge, Factor of Safety as one yield layer and eight quantities of Hidden layers were set for constant testing as appeared in Fig. 3. Most extreme preparing times-max ages got in the preparation and testing was 50000 and the normal least blunder was 0.0001.The enactment work utilized as a part of the principal layer was "tansig" the second layer was "purelin". The Back Propagation Artificial Neural Network (BP-ANN) preparing capacity is Levenberg Marquardt and the execution capacity was keep running with measurable files, for example, mean square mistake.

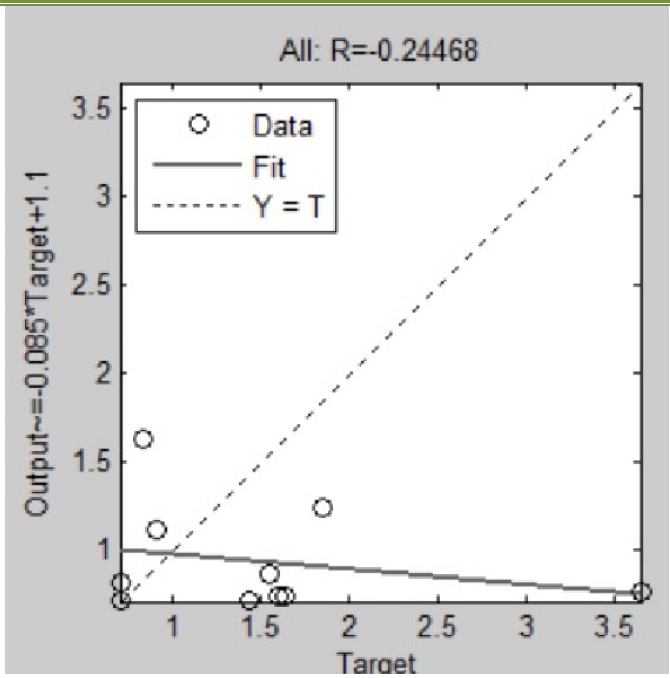
IV. RESULT

The consequences of regular investigation as element of security for the chose 10 areas were exhibited and in this examination, 10 areas guarantees steadiness in understanding to geometrical properties of incline and the geotechnical properties of the slant material. In the steady inclines, slant edges (β) were seen to be not as much as the edge of shearing resistance. Slants in the rest of the 18 areas were recorded temperamental and out of which, inclines in 14 areas were at that point influenced via landslides. In the rest of the 4 areas, the slants are going to fall flat what's more, which requires slant security works at higher need. Most extreme and least element of wellbeing processed in the chose street extend were 2.98 and 0.18 separately. The purpose behind the insecurity being higher slant point, riotous change in land cover, overwhelming rainstorm precipitation, day-today increment in the movement volume and un- established geographical nature of soil.

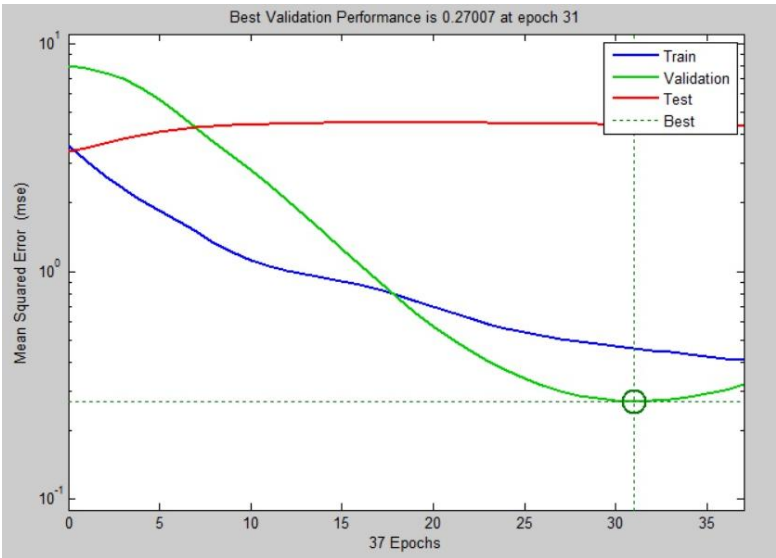
In the Back Propagation Neural Network Analysis (BP- ANN) utilizing Levenberg Marquardt preparing algorithm and mean square error execution calculation, consequences of initial 25 test areas were utilized for preparing set and results of remaining 7 sample areas were utilized for approval of BP-ANN investigation. The BP- ANN preparing execution diagram, Fig. 4 (MSE Vs Epochs) uncovered that the Mean Square Error (MSE) balanced out at 0.0688 at 31 ages. Figure 5 demonstrates the relapse plot between Target values and predicted values with R = 0.99986, demonstrates the level of exactness of forecast.



factor of safety graph



Regression plot between target values Vs predicted values



V. DISCUSSION

The comparative results of conventional slope dependability analysis and the BP-ANN analysiswere outfitted. In the customary strategy, comes about were gotten for specific area alone, though in BP-ANN strategy 10 area parameters were prepared also, in light of the training output is shown for the remaining 7 areas. Comparison of these results demonstrates that the conventional method shows 71.4% precision, while in BP-ANN predicts the incline soundness with 85.7% precision. The BP-ANN anticipated components of security were nearly matches with the factor of safety processed through the customary strategy. Out of the 10 BP-ANN predictions,6 forecasts coordinate with the past history of landslide occurrences. Hence, the BP-ANN procedure has been demonstrated its relevance in slant steadiness expectations.

VI. CONCLUSION

The Barliyar-Coonoor slope street extend is discovered profoundly powerless against landslide and slant assurance measures are especially required in 10 areas. The purpose behind the landslide is being higher incline point and substantial precipitation in storm. Since the range being in woodland and slope incline, delicate

incline assurance techniques, for example, bioengineering might be of especially supportive for adjustment. It was moreover learnt from the present review that the slope incline of study territory for the most part constituted by the union less soil, which gives more favorable condition to landslideevent particularly amid substantial precipitation. BP-ANNprocedure predicts the component of wellbeing against incline security at a satisfactory level of precision of 85.7% and the same has been reflected in its execution criteria. Hence, it can be reasoned that BP-ANN is a dependable system to anticipate the component of security with site particular parametric limitations. Both conventional method and BP-ANN technique demonstrates great in soundness expectation andValidated with past landslide history. Presence of vegetation cover plays a significant role in slope assurance yet stays unincorporated in BP-ANN apparatus. Therefore vegetative cover should be improved to give maintainable answer for incline soundness.

REFERENCES

[1]. Abdalla, J.A., M. Atom and R. Hawileh, 2012.Artificial neural network prediction of factor of safety of slope stability of soils.Proceedings of the 14th International Conference on Computing in Cicvil and Building Engineering, Jun. 27-29, Moscow, Russia.

[2]. Ajaynaithani, K., V. Joshi and C. Prasad, 2002. Investigation on the impact of cloud burst in tehri district, Uttaranchal. J. Geol. Soc. India, 60: 573577.

[3]. Arora, D.S., 1988. A Text Book of Geology. 1st Edn., Mahindra Capital Publishers, Chandigarh. Cho, S.E., 2009. Probabilistic stability analyses of slopes using the ANN based response surface. Comput.Geotechnics, 36: 787-797. DOI: 10.1016/j.compgeo.2009.01.003

[4]. Cruden, D.M., 1991. A simple definition of a landslide. IAEG Bull., 43: 27-29. DOI: 10.1007/BF02590167

[5]. Ganapathy, G.P., K. Mahendran and S.K. Seker, 2010. Need and urgency of landslide Rick planning for Nilgiri, Tamil Nadu, India. Int. J. GeomaticsGeosci. Gopalaranjan, A.S.R.andRao, 1993. Basic and Applied Soil Mechanics. 1st Edn., Wiley, New Delhi. GSI, 2000. District Resource Map Series: Nilgiri District Tamil Nadu, Geological Survey of IndiaXplanatory Note.

[6]. Jha, C.S., C.B.S. Dutt and K.S. Bawa, 2000. Deforestation and land use changes in Western Ghats, India. Curr. Sci., 79: 231-238.

[7]. Jiang, D., S. Xie, G. Li and Z. Jiang, 2007.Comparative analysis between Gray correlation degree and BP Neural Network on identifying slope stability.WestChina Exp. Eng., 12: 8-11.

[8]. Kumar, S.V. and D.V.S. Bhagavanulu, 2008.Effect of deforestation on landslide in Nilgiris district. J. Indian Soc. Remote Sens., 36: 105-108. DOI: 10.1007/s12524-008-0011-5

[9]. Liang, H. and H. Zhang, 2012. Identification of slope stability based on the contrast of BP Neural Network and SVM. Proceedings of the 3rd IEEE International Conference on Computer Science and Information Technology, Jul. 9-11, IEEE Xplore Press, Chengdu, pp: 347-350. DOI: 10.1109/ICCSIT.2010.5564502

[10]. Lin, H.M., S.K.Chang, J.H. Wu and C.H.P. Juang, 2009. Neural network-based model for assessing failure potential of highway slopes in the Alishan, Taiwan Area: Pre-and post-earthquake investigation. Eng. Geol., 104: 280-289. DOI: 10.1016/j.enggeo.2008.11.007

[11]. Manimaran, G., A.A. Ravindaran, S. Selvam, D. Manimaran and M. Sugan, 2012.Characterization and disaster management of Landslides in the Nilgiris mountainous terrain of Tamil Nadu, India. Int. J. Geomat. Geosci., 3: 1-12.

[12]. Naithani, A.K., 2007. Macro landslide hazard zonation mapping using univariate statistical analysis in a part of Garhwal Himalaya. J. Geol. Soc. India, 70: 282-296.

[13]. Neaupane, K.M. and S.H. Achet, 2004. Use of back propagation neural network for landslide monitoring: A case study in the higher Himalaya. Eng. Geol., 74: 213-326. DOI: 10.1016/j.enggeo.2004.03.010

[14]. Ramasamy, S.M., R. Neelakantan and S. Francis, 2006. Predictive and Preventive modeling for landslide in the Nilgiris, South India using remote sensing and GIS. A Perception and Initiatives of DST, Landslides, pp: 177-203.

[15]. Shahin, M.A., M.B. Jaksa and H.R. Maier, 2008.State of art of artificial neural networks in geotechnical engineering.Electr. J. Geotechnical Eng. Terzaghi, K. and R.B. Peck, 1967. Soil mechanics in Engineering Practice. 2nd Edn., Wiley, New York, ISBN-10: 0471852732, pp: 729.

[16]. Valdiya, K.S., 1998. Catastrophic landslides in uttaranchal, central Himalaya. J. Geol. Soc. India, 52: 483-486.