

GERENCIA DE PROTECCION RADIOLOGICA
Y SEGURIDAD

REPO-28

CNEA-NT 24/87

GEOSTATISTICAL INVESTIGATIONS OF
ROCK MASSES. THE SIERRA

C.N.E.A. Biblioteca MEDIO CASE (ARGENTINA)

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REPUBLICA ARGENTINA
COMISION NACIONAL DE ENERGIA ATOMICA
Dependiente de la Presidencia de la Nación
GERENCIA DE PROTECCION RADIOLOGICA Y SEGURIDAD

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INIS CLASSIFICATION AND KEYWORDS

E52.00

FRACTURES

REPOSITORIES (*)

ROCKS

UNDERGROUND DISPOSAL

(*) Not shown in INIS Thesaurus 1985.

GEOSTATISTICAL INVESTIGATIONS OF
ROCK MASSES. THE SIERRA DEL MEDIO
CASE (ARGENTINA)

Matar*, J.A.; Sarquis, M.A.; Girardi, J.P. and Tabbia, G.H.

ABSTRACT

The geostatistical techniques applied for the selection of a minimum-fracturation volume in Sierra del Medio allow to quantify and qualify the variability of mechanic characteristics and density of fractures and also the level of reliability in estimations.

The role of geostatistics is discussed in this work so as to select minimum fracturation blocks as a very important site selection step.

The only variable used is the "jointing density" so as to detect the principal fracture systems affecting the rocky massif. It was used on the semivariograms corresponding to the previously mentioned regionalized variables.

The different results of fracturation are compared with the deep and shallow geological surveys to obtain two and three dimensional models. The range of the geostatistical techniques to detect local geological phenomena such as faults is discussed.

The variability model obtained from the borehole data computations is investigated taking as basis the vertical Columnar Model of Discontinuity (fractures) hypothesis derived from geological studies about spatial behaviour of the joint systems and from geostatistical interpretation.

RESUME

Les techniques géostatistiques utilisées pour sélectionner un volume de minime fracturation dans Sierra del Medio ont permis caractériser quantitativement et qualitativement la variabilité des propriétés mécaniques, de la densité des fractures et aussi du nivel d'exactitude de l'estimation.

La géostatistique employée pour déterminer des blocs de minime fissure c'est une très importante étape dans la sélection d'une place.

On a utilisé seulement une variable pour connaître les systèmes de fissure principaux affectant la masse rocheuse. Cette variable dénommée "densité de diaclase" fut usée dans les semivariogrames concernant les variables régionalisées qu'on a mentionné avant.

Après on a comparé les résultats de fissure avec les études géologiques de surface et de sous-sol pour obtenir des modèles en deux et en trois dimensions et aussi on a analysé la transcendance des techniques géostatistiques pour connaître les phénomènes géologiques locaux par exemple failles.

Le modèle de variabilité obtenu pour le traitement en ordinateur, des données des sondages fut investigué avec l'appui du modèle de colonne vertical de l'hypothèse de discontinuité (fractures), celle-ci a été prise d'une part des études géologiques sur la conduite spatiale des systèmes de diaclases et d'autre part de l'interprétation géostatistique.

1. INTRODUCTION

It is known that foundation road engineering is also supported by geology. All geological data used to inventory, analyze and synthesize natural phenomena are backgrounds on which an engineer can design, plan and build in a secure and harmonious way in accordance with the natural environment.

One of the most significant parameters provided by foundation engineering is rock structural features, especially geological discontinuities, such as: faults, fractures, bedding planes, cleavage, joints, dikes and so on. Discontinuities have a great influence on rock mechanical behaviour because they usually increase the rocky mass strain and decrease its resistivity. These two events are responsible for most of the faults occurred under static or dynamic charge conditions.

In order to obtain trend, dip, spacing, length, fill, wrinkle and density data, a complete discontinuity geological mapping of the rocky massif based on a planned study is required. Then it is possible to assess the number of joint families present, their distribution, significance, intact rock natural blocks etc., in quantitative and qualitative terms.

Geostatistics is another approach use for accomplish these objectives.

2. METHODOLOGY USED

The general methodology employed in the determination of the least fractured area of a rocky mass was as follows: Collection of data to define the final grid and its sampling.

Twenty eight approximately isodistanced stations supplied values of "Number of joints" (N) and their "Spacing" along 10 m lines normal to the strike of the two main systems of joints that affect the rock mass. Then "samples" of the definitive grid (188 stations) were obtained together with the geology and survey of the area.

Rock quality was evaluated from the mechanical point of view, through the N/L and RQDS parameters, the latter being defined as the summation of spacing lengths (more than 10 cm long) per linear meter. N/L and RQDS values were estimated taking these primary data as basis.

DETERMINATION OF THE DEFINITIVE GRID

Different forms and mesh densifications were proposed once the required accuracy in the knowledge of the variable had been established. This analysis was carried out only with the N/L parameter.

HISTOGRAPHY OF N/L AND RQDS

The distribution pattern to which the sampling of N/L and RQDS obey, was used in selecting the type of semivariography to be estimated from them.

The chi-square criterion allowed to define the adjustment of the N/L histogram to the corresponding distribution.

The correlation between the N/L and RQDS parameters is shown at this point (Figure N°1).

SEMI-VARIOGRAPHY OF N/L AND RQDS

To carry out the geostatistical representation of the variables employed, the model of variability from the corresponding experimental semivariographies were obtained. These were estimated considering N-S, NE-SW, E-W and NW-SE strikes (Figure N°2).

To check the reliability of the N/L semivariography to be used in the krigage operator, the Re-Use method was applied.

DETERMINATION OF THE MINIMUM FRACTURATION AREA

It was based on the kriging estimation of the mean values of the variables corresponding to each area in which the sampled surface was assumed to be divided in.

At the same time, the geologic data were analysed in detail which allowed to establish the reliability of the geostatistical model of the investigated area (Figure N°3).

3. DATA ON DEPTH

Once the minimum fracturation area had been selected and in order to begin with the study in depth, the location of 4 deep core drillings (450 to 750 m) was proposed. Such core drilling could be of the inclined or vertical type. Several 4 core drilling - configuration were proposed in the area taking into account the surface fracturation semivariography model. The mesh that became to be related with the least typical deviation of kriging was that once elongated east-west with a side ratio of 5/3.

It should be mentioned that at this stage of the planning, three core drillings between 200 m and 300 m deep had already been performed; thus some fracturation characteristic data were available.

Four deep core drillings were made - PP1; PP2; PP3 and PP4 - and from them the one called PP1 has a 60° south dip on purpose, to detect the influence of some geological structures.

All this work yielded data on the number of fractures per linear meter N/L from 3.05 m deep cores.

The N value comprises all fractures and it is independent of their characteristics. The L value is referred to the core run.

The N/L mean values, corresponding to the bearing resulting from intersecting the drillings with the horizontal bench model derived from the highest point in Sierra del Medio - i.e. Chivas Hill, some 1.350 m

a.s.l., to be used in the three-dimensional model calculations, were computed. The benches were assumed to be 25 m high, this value resulting from studying the semivariography of N/L values for core lengths of 3.05 m.

Since the ranges determined for the vertical drillings are consistent with the bench height, inclusion of short range variabilities is avoided in this first stage of the work.. Figure N°4 shows, schematically, the bench model proposed.

4. CONCLUSIONS

This study has allowed to determine the location of a minimum fracturation area of about 600 x 1000 meters in Sierra del Medio. Geostatistical techniques were applied to the parameters "Number of joints per linear meter (N/L)" and "Index of surface rock quality (RQDS)".

To accomplish the previously mentioned determination, N/L was employed because it is the most representative parameter of the surface structural characteristics of the rock mass.

The minimum fracturation area has maximum values of 5 joints per meter and 25 % typical deviation (this error affecting the former in 1 discontinuity at the most).

The reliability of this area location was corroborated not only by the good correlation existing with data resulting from the Geology in detail, but also by the 200 m deep boreholes in the sampling zone.

It is noteworthy that the application of Geostatistics to this type of problems is associated with a time shorter than that required for the application of traditional exploration techniques.

A three dimensional model using the N/L surface mean values and the depth ones is being carried out at presente.

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Fig. 2 NLM Experimental semivariograms

Fig. 3 Geostitical model of the investigated aerea.

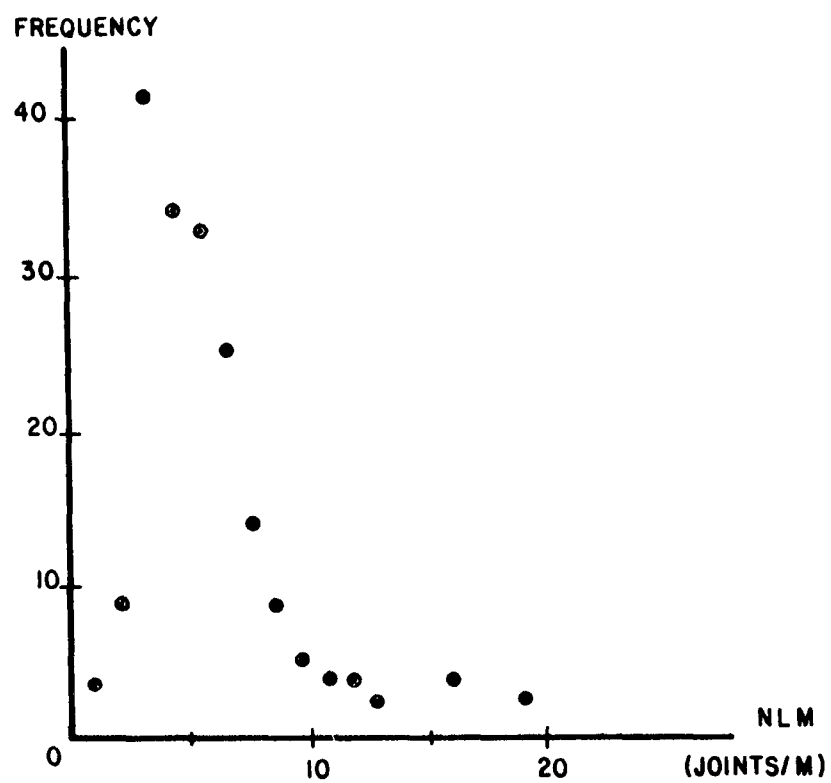


FIGURE 1 - NLM Histogram -

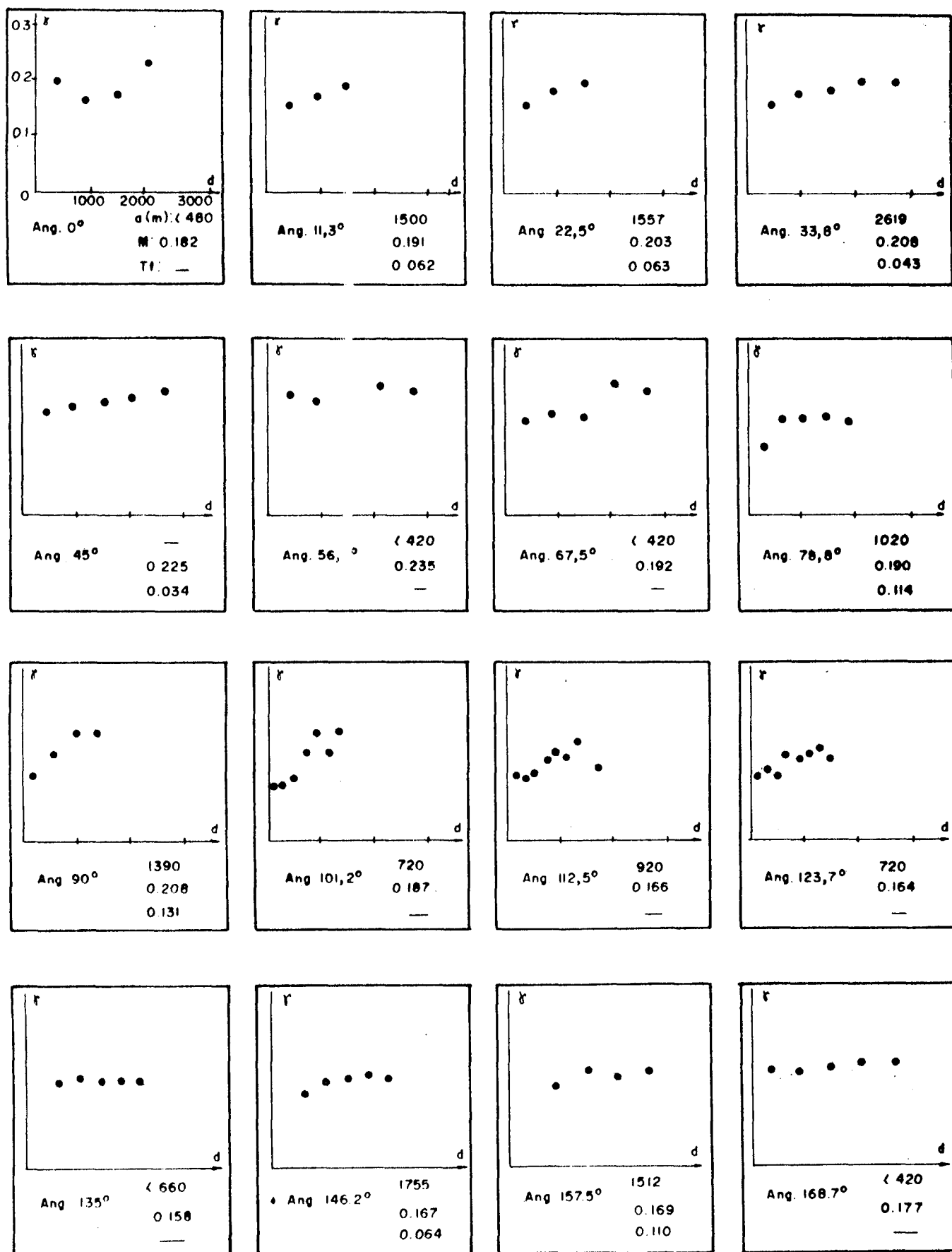


FIGURE 2 - NLM Experimental semivariograms.-

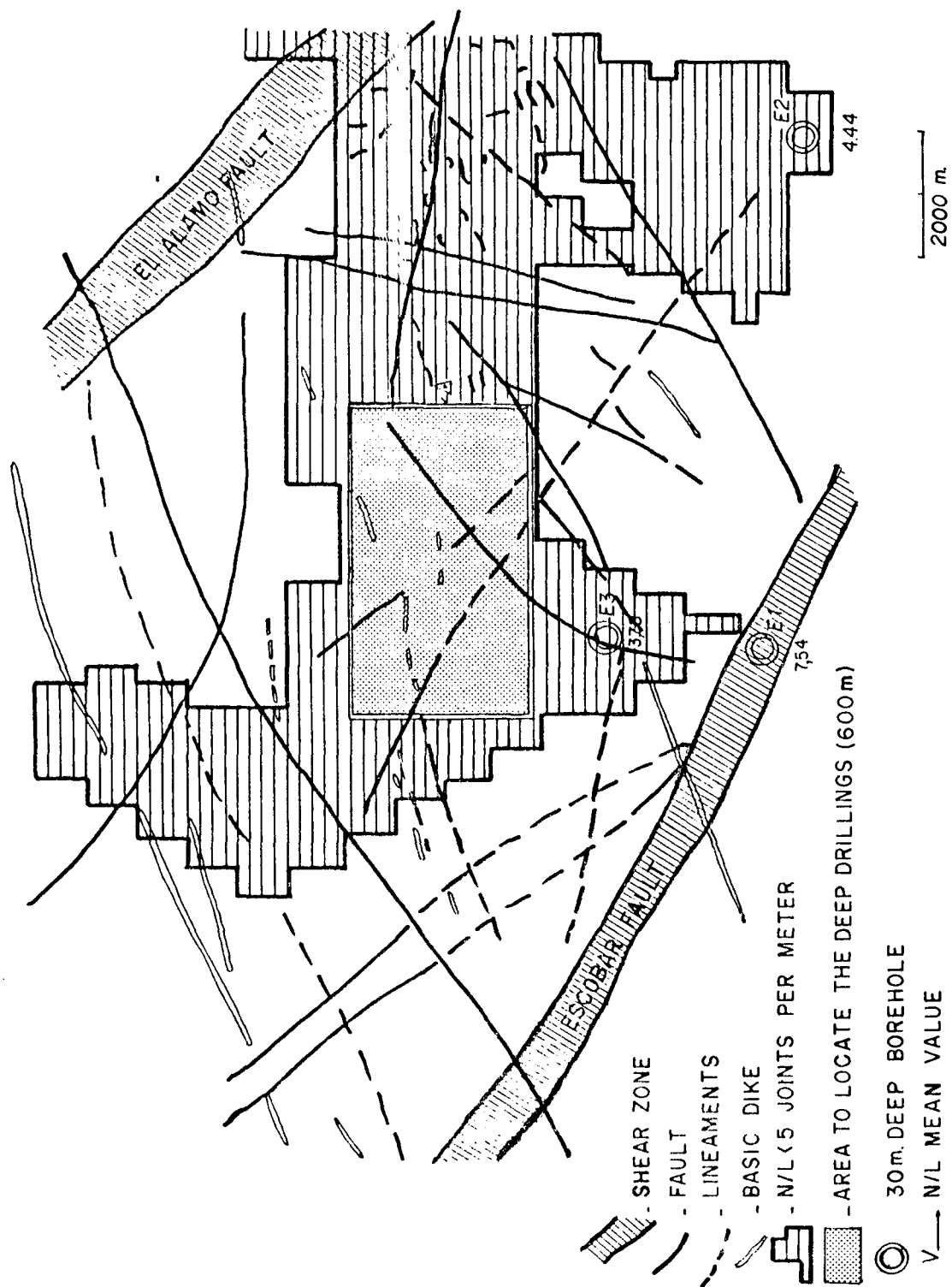


FIGURE 3 - Geostitcal model of the investigated area -

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