Identify Driving Force to Cause Rockmass Destruction from Fracture Distributions

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Abstract

Quantitative correlation method has been applied effectively in analyzing the distribution of fracture groups to identify structural boundary. The application results of the method published from past decades.

In this paper, we present some results of analyzing quantitative correlation of 1494 fracture measurements from 08 different survey sites in Ocdovic-Silua sedimentary rocks on Coto island, belong to Quangninh province of Vietnam by using correlation equation. The obtained results showed that the correlation values among sites are quite good, almost greater than 70%. These results can confirm that the survey sites belong to a structural unit and be affected by the same geodynamic circumstances.

The results obtained from the experiment in this paper have important significantly in identifying the direction of forces which cause rockmass destruction.

Keywords: Fracture distribution, Stereonet window, Quantitative correlation, Fracture correlation coefficient, Direction of driving force.

1. Introduction

A structural domain shows a volume of rock mass and is characterized by a distinct fracture pattern distribution of the intensity, orientation, spacing, size and shape. However, in this study, the determining structural domain only use the number of fractures (intensity) and their orientation distribution.

The identification of structural domain considered from many past decades by Miller (1983), Kulatilake et al. (1990), Martin et al. (2004) because of its close relationship to potential failure of rock blocks on the slope. Recently, Nguyen et al. (2012) also used correlation coefficient method to analyze fracture frequency along a tunnel and determine structural domain boundaries.

The above studies provided helpful tools for determining fracture patterns inside the rockmass and identifying structural domain boundaries.

In this study, using 1494 fracture measurements from 08 different sites in Ocdovic-Silua sedimentary rocks on Coto island, belong to Quangninh province of Vietnam, we continue extending the correlation coefficient method for identifying the relationship among fractures as a basis to determine the forces caused rockmass destruction in this area.

2. Methodology

The methodology used in this study is to calculate correlation coefficient of fracture frequency between two stereonet windows of two different sites. The calculation is carried out based on the number of fracture poles in each cell of stereonet plotted on the lower hemisphere projection (Fig. 1).

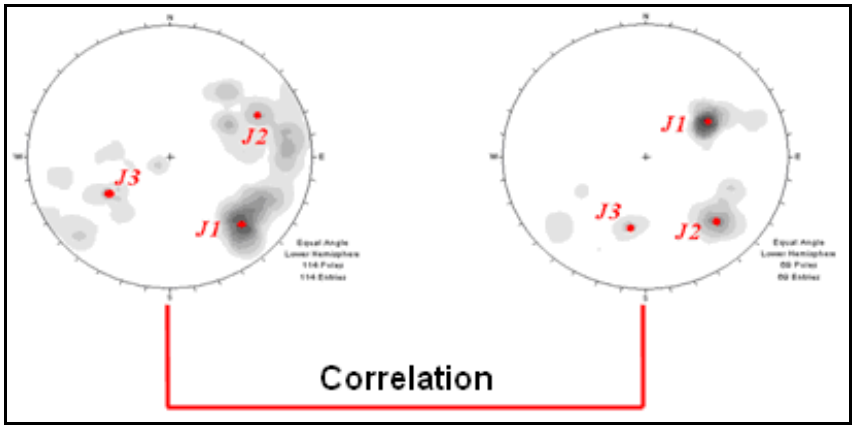


Figure 1. Stereonet pole plot of two sites

Figure 1 shows the fracture frequencies on each stereonet window. After plotting fracture orientations of each site on the stereonet window in Figure 1, the calculation of fracture correlation coefficient between two stereonet windows is carried out by using Equation 1.

$$Correl(x,y) = \frac{\sum (x-\overline{X})(y-\overline{Y})}{\sqrt{\sum (x-\overline{X})^2}\sqrt{\sum (y-\overline{Y})^2}} \qquad (1)$$

Where: x and y are number of fractures in each cell of two stereonet windows; $\overline{X}$ and $\overline{Y}$ are the average values of fracture number of two stereonet windows.

The correlation coefficient expresses the strength of the association between the two variables from two stereonet windows. These values always lie within (-1, 1) and they are independent of the magnitude of the variables. If the correlation coefficient is -1, it means perfect negative correlation; if the correlation coefficient is 0, it means no correlation and if the correlation coefficient is 1, it means perfect positive correlation.

3. Applycation

Application of this study is carried out at Coto island, belong to Quangninh province of Vietnam. Coto island is located in the northeastern area of Vietnam, within 107.70^0-20.94^0 and 107.80^0- 21.03^0. The rocks on Coto island are mainly sediment of Coto formation with the age of Odovic-Silua (O_3-Sct_1 và O_3-Sct_2) (Fig. 2). Since the influence of regional tectonic activity, the rocks of this formation are folded and heavily broken. During the process of movement, the rocks are broken and formed fractures that distributed following certain rules and also leaved the evidences of striae on the rock surface. The existence of the distribution of fracture sets and striae on the rock surface at each site is important information for determining deformation phases and stress field.

The geological survey in this study was conducted at 08 different sites on Coto island as in Figure 2.

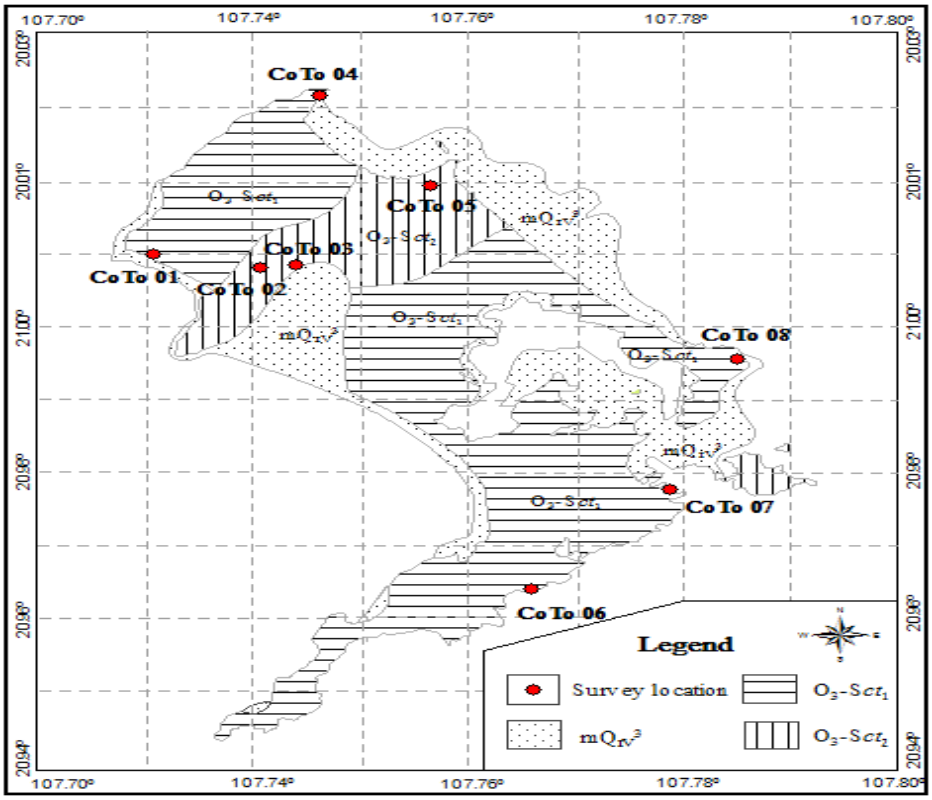


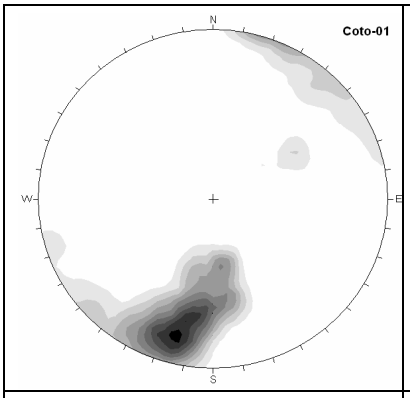
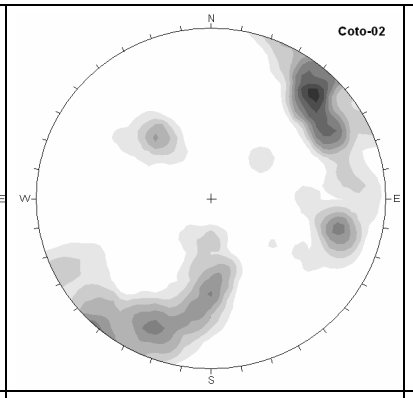
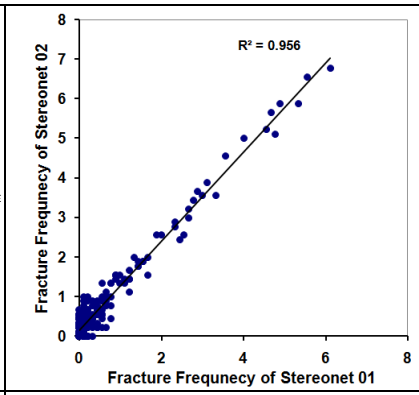
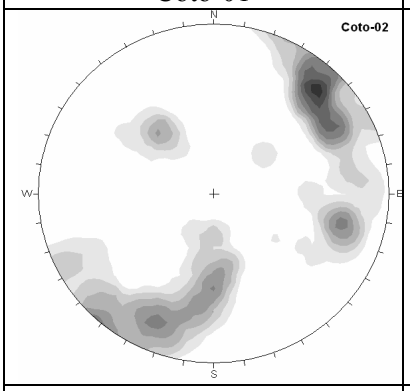
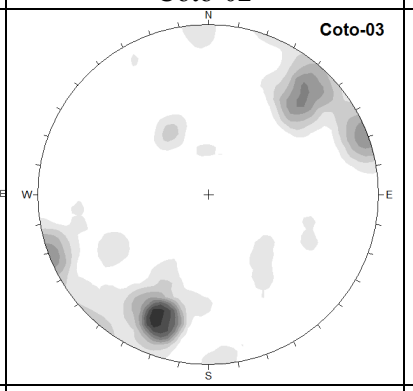
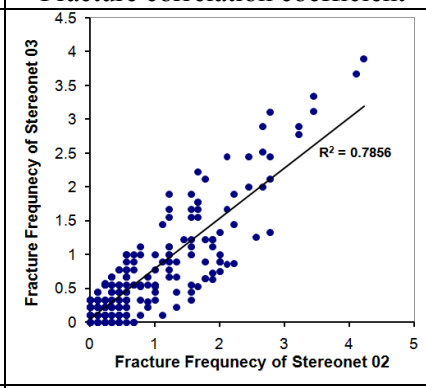
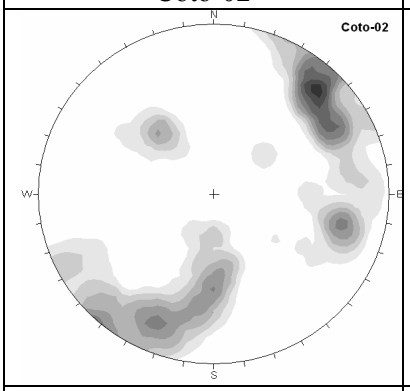
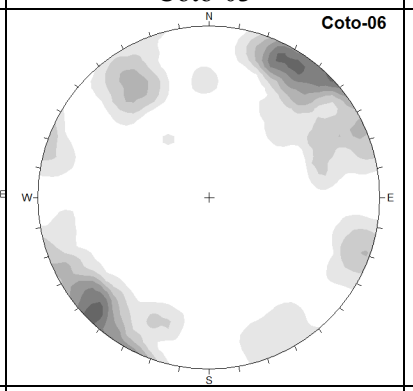
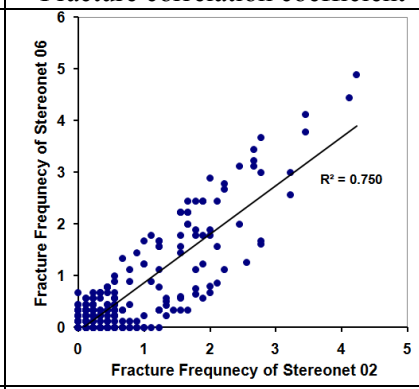
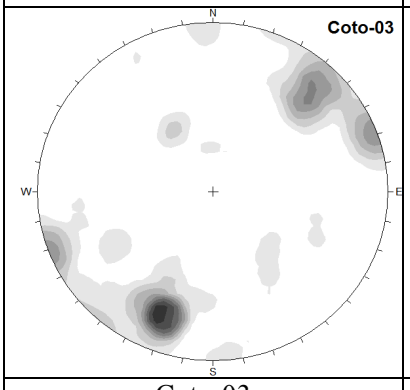
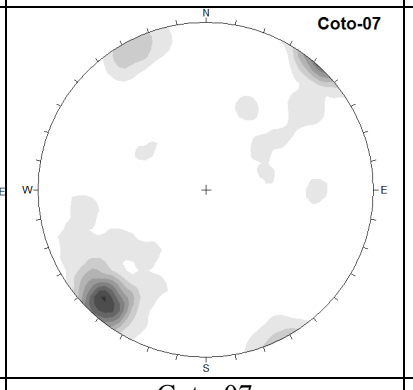
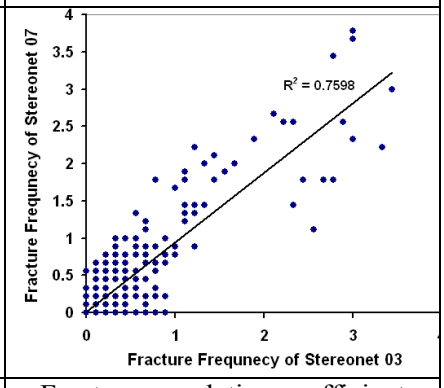
Figure 2. Map of study area and survey locations

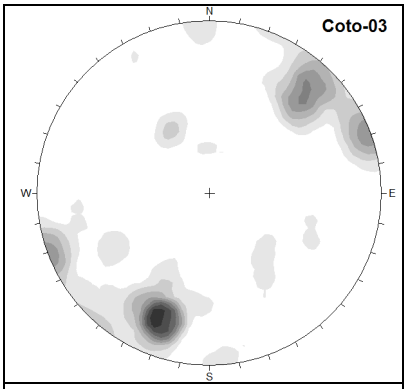
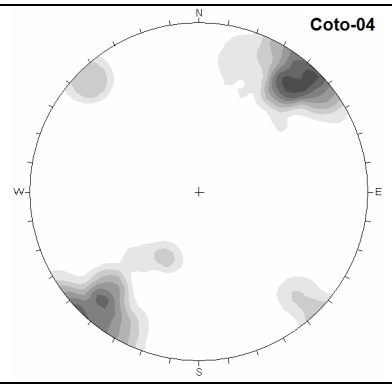
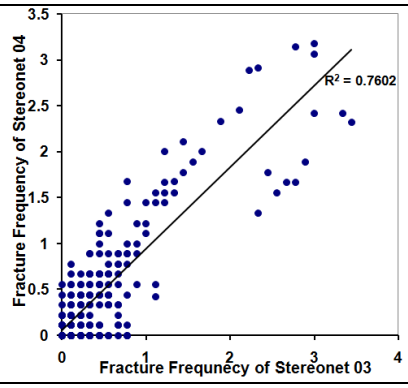
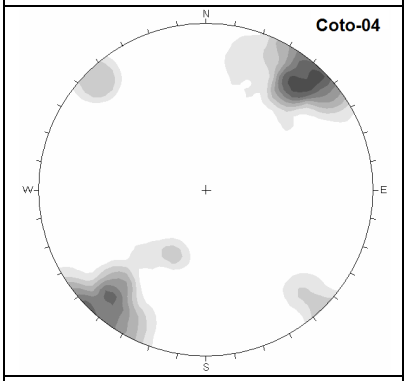
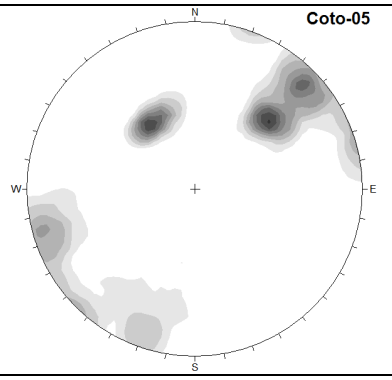
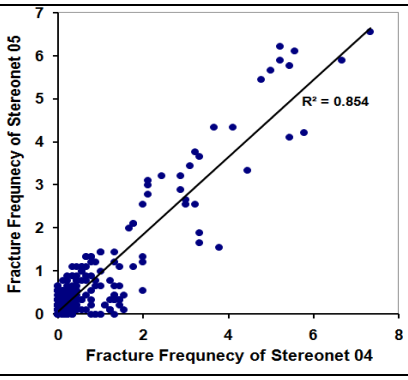
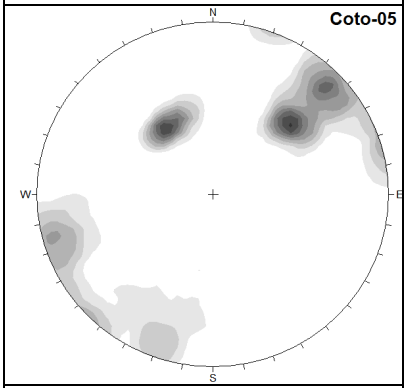
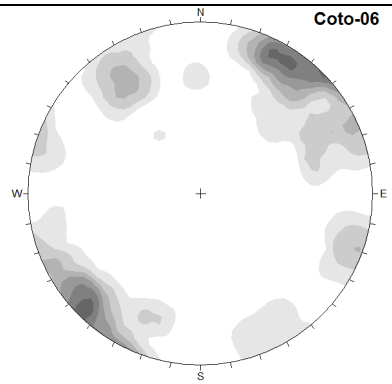
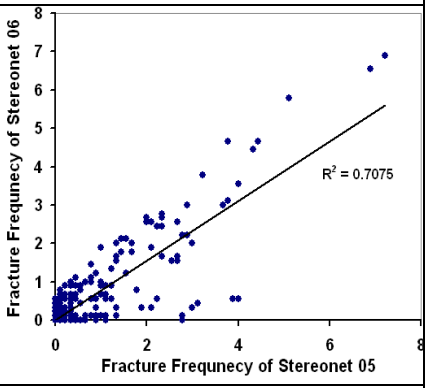
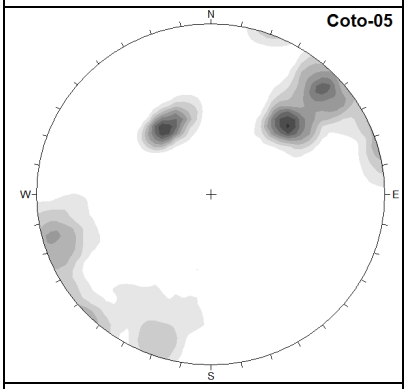
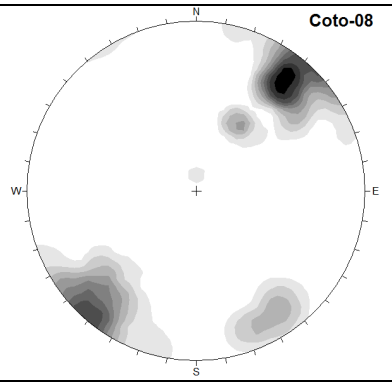
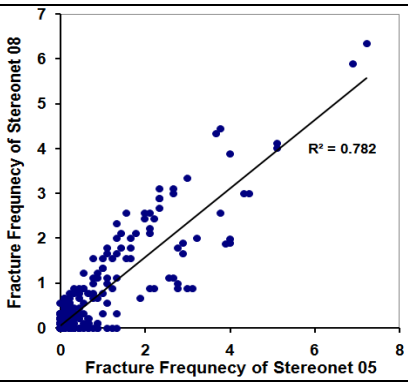
The fracture measurements and striaes on the rock surface together with their coordinate at each site are collected and recorded as in Table 1. However, in this study, it is only fracture orientations are to be used to calculate correlation coefficient among sites.

Table 1. Survey locations and fracture number obtained at each site on Coto island

N0	Location Name	Longitude	Latitude	Fracture number on each survey location
1	Coto-01	107.731481	21.004945	169
2	Coto-02	107.741087	21.003169	203
3	Coto-03	107.744289	21.003451	171
4	Coto-04	107.746846	21.024351	206
5	Coto-05	107.756479	21.013081	219
6	Coto-06	107.764699	20.962920	164
7	Coto-07	107.777416	20.975138	174
8	Coto-08	107.783679	20.991160	188
Total of fracture measurements				**1494**

The fracture measurements obtained at each site in Table 1 are plotted on the lower hemisphere graphic projection and calculated according to each pair of two stereonet windows as in Figure 3.

		
Coto-01	Coto-02	Fracture correlation coefficient
		
Coto-02	Coto-03	Fracture correlation coefficient
		
Coto-02	Coto-06	Fracture correlation coefficient
		
Coto-03	Coto-07	Fracture correlation coefficient

		
Coto-03	Coto-04	Fracture correlation coefficient
		
Coto-04	Coto-05	Fracture correlation coefficient
		
Coto-05	Coto-06	Fracture correlation coefficient
		
Coto-05	Coto-08	Fracture correlation coefficient

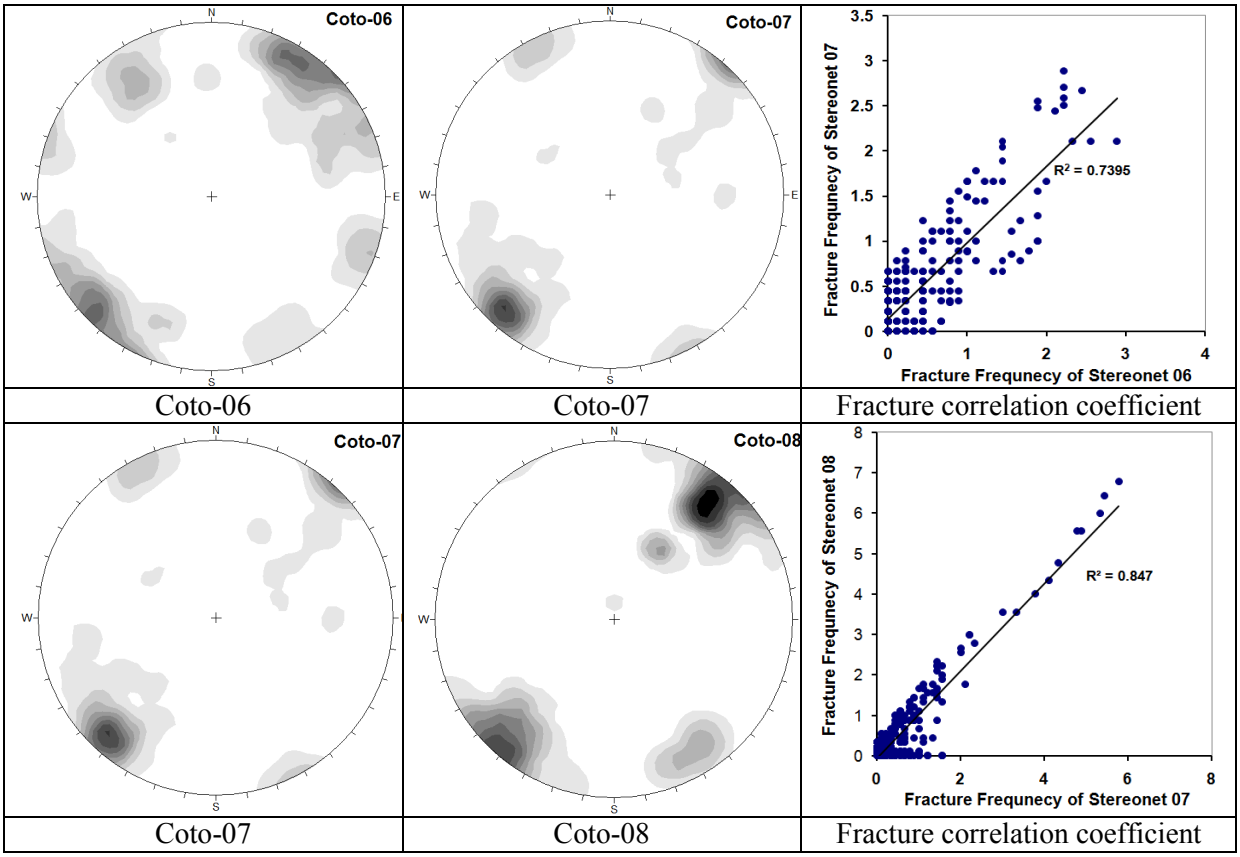


Figure 3. Lower hemisphere graphic projection of fracture orientation and their correlation coefficient according to each pair of two stereonet windows

The results of calculating fracture correlation coefficient among different sites in Figure 3 are summarized in Table 2.

Table 2. Fracture correlation coefficient among different sites on Coto island

No	First steonet window	Second steonet window	Fracture correlation coefficient
1	Coto-01	Coto-02	0.956
2	Coto-02	Coto-03	0.786
3	Coto-02	Coto-06	0.750
4	Coto-03	Coto-07	0.776
5	Coto-03	Coto-04	0.760
6	Coto-04	Coto-05	0.854
7	Coto-05	Coto-06	0.773
8	Coto-05	Coto-08	0.782
9	Coto-06	Coto-07	0.740
10	Coto-07	Coto-08	0.847

The lower hemisphere graphic projection of fracture orientations in Figure 3 showed that the major distribution of fractures developing in NW-SE direction with above 70%. The similarity of the fracture sets among different sites on Coto island created a high correlation coefficient among them. Most fracture correlation coefficient according to each pair of two stereonet windows is obove 70%, some cases are over 90% (Tab.2). High correlation value of fracture orientations among sites on Coto

island reflected well the relationship between them and implied that they exist in the same geodynamic circumstance. According to the experimental model of rock mechanics, the fractures obtained at sites on Coto island are assumed as formed by the compression of NW-SE direction (Fig. 4b).

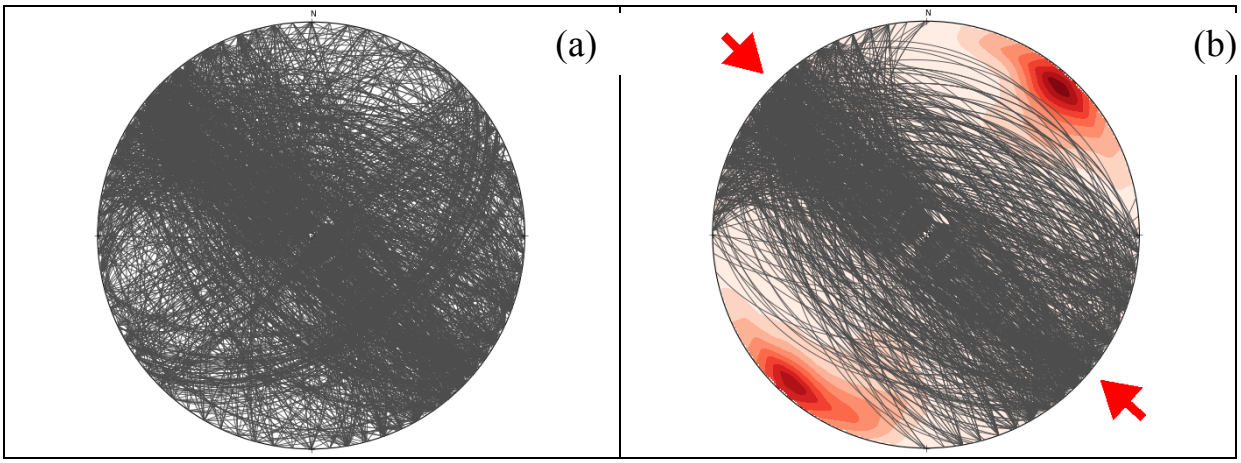


Figure 4. Greate circle of fracture orientation on lower hemisphere graphic projection: a) Whole fractures; b) Strike of fractures in NW-SE direction

4. Conclusions

The analytical results of fracture correlation coefficient among different sites of 08 survey locations in Ocdovic-Silua sedimentary rocks (O_3-Sct_1 và O_3-Sct_2) on Coto island belong to Quangninh province of Vietnam showed that most fracture correlation coefficient according to each pair of two stereonet windows is obove 70%, some cases are over 90%. This result has reflected well the relationship between fractures of different sites and implied that they exist in the same geodynamic circumstance. Base on fracture distributions plotted on lower hemisphere graphic projection and the experimental model of rock mechanics, the fractures obtained at sites on Coto island are assumed as formed by the compression of NW-SE direction.

Acknowledgements: We would like to thank the support of the Project of Vietnam Academy of Science and Technology (VAST05.02/15-16) to complete this paper.

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