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The Fadnoun area, Tassili-n-Azdjer, Algeria: Fracture network geometry analysis

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Abstract

In the Fadnoun area, located in the Tassili-n-Azdjer region, a fracture network geometry analysis was carried out using the 2D geometry analysis technique. The area, situated on a Devonian plateau, is particularly suitable to study and model fractured media. The Fadnoun area and the faults associated with it are an excellent illustration of the Hercynian strain event. The use of linear reconnaissance, based on aerial photographs, and the analysis of fracture centers by the weight distribution method, has allowed setting up scale and general rules to characterize the fracture density. The scale and distribution rules that characterize the spatial distribution of fractures centers showed to be respectively consistent with a fractal character and obey a power law function. However, the curve of cumulative length frequency of fracture traces and the cumulative fracture spacing frequency for all fracture sets show a linear behavior and can be adjusted by a power law. The spacing law between the fractures for each fracture set direction shows a negative exponential distribution consistent with the clustered fractures model. The syn-fault joints tend to increase in frequency near the faults and we interpret the intensively fractured areas as a fault damage zone.

Keywords: Fadnoun; Fracture network; Fractal character; Power law; Scanline

1. Introduction

This paper is an approach to model fractured media through the analysis of 2D fracture network geometry analyses. The quantitative analysis is based on the search of a mathematic rule that controls the geometry of fractured networks. We intend to demonstrate how the use of a linear reconnaissance, based on aerial photographs, and the analysis of fracture centers, by the weight repartition method (Sornette et al., 1993; Bour and Davy, 1999; Bonnet et al., 2001), allow to setup some scale rules characterizing the fracture spatial distributions.

For this purpose, the Fadnoun area, within the Tassili-n-Azdjer region (Fig. 1a and b), seems more interesting for two main reasons. First, the availability of good geological mapping and aerial photography survey and second, a good field reconnaissance. Moreover, the Fadnoun area and the faults associated with it are an excellent illustration of the Hercynian deformation style (strike-slip faults, *en echelon* folds and shearing zones) compatible with a shortening direction (λ_3) to N040° dated Visean (Boudjema, 1987) or about the Carboniferous/Permian transition (Badalini et al., 2002) or more probably during the Early Permian (Haddoum et al., 2001) on which a later Cenozoic deformation (?) is superimposed (Boudjema, 1987). Several studies have analyzed both the spatial and length distributions of fracture networks (Davy et al., 1990; Davy, 1993; Sornette et al., 1993; Bour and Davy, 1998, 1999). Many geologic phenomena, including topography, earthquakes and oil fields sizes are fractal. Fractal concepts applied to fracture networks predict a generic relationship between fractures at all scales (Allègre et al., 1982; Turcotte, 1986). According to Bonnet et al. (2001), the fractal dimension does not completely define the geometry of the fracture system, and a complete characterization should include various geometrical attributes such as fracture

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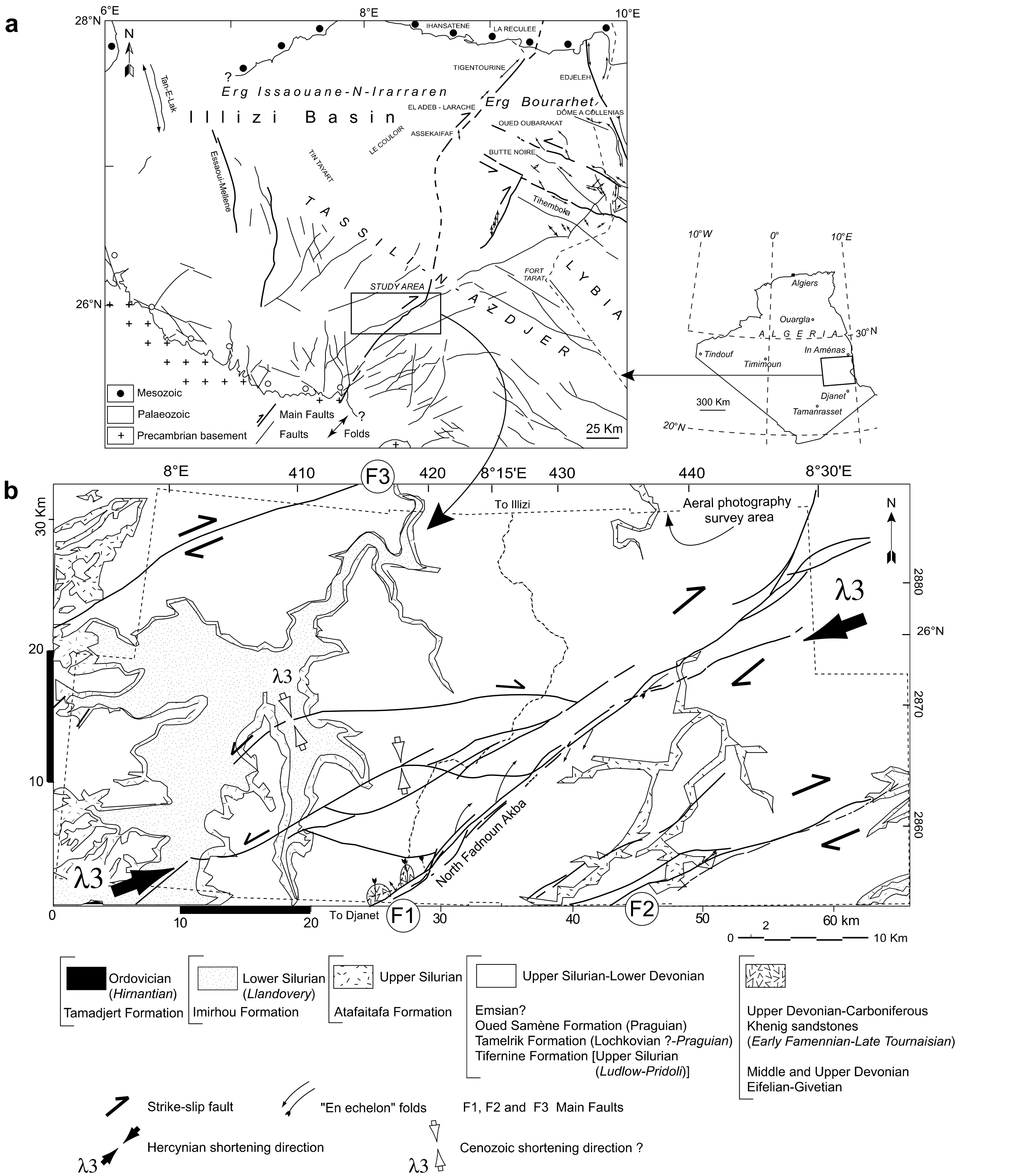

Fig. 1. (a) Location of the study area within the Tassili-n-Azdjer plateau. The map shows the main structural elements and the position of Fadnoun area. Based on Bonnet et al. (1965) and Bennacef et al. (1974), modified. (b) Geological and structural setting of Fadnoun area (Geological map after Bennacef et al., 1974). Note that the structure is tabular and the faults are sub-vertical.

density, length distribution, orientation, roughness of the fracture surface, width, aperture and shear displacement.

The aim of this paper is: (1) to provide an overview of the fracture terminology and mechanisms and age of fracture networks of the Fadnoun area; (2) establish a realistic image of fracture network consistent with a mathematical model without, however, accounting for formation mechanisms (consistency alone with the strain field: $\lambda_1 \geqslant \lambda_2 \geqslant \lambda_3$: finite strain ellipsoid axes is recalled); (3) analyze the fracture length distribution and the fracture spacing; (4) establish the fracture density analysis and (5) apply a fractal concept to fracture networks and to test the power law scaling model.