Geodesy and Geodynamics 14 (2023) 121–129

Contents lists available at ScienceDirect

Geodesy and Geodynamics

journal homepage: http://www.keaipublishing.com/geog

Lineament analysis as a seismic precursor: The El Mayor Cucapah earthquake of April 4, 2010 (M_W7.2), Baja California, Mexico

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ARTICLE INFO

Article history:
Received 17 January 2022
Received in revised form
5 July 2022
Accepted 15 August 2022
Available online 14 September 2022

Keywords:
Lineament analysis
Earthquake
Landsat images
Seismic precursor

ABSTRACT

An earthquake called the M_W7.2 "El Mayor Cucapah" earthquake on April 4, 2010 has been analyzed for seismic precursor. The changes in the lineament system concerning its pattern and time intervals were analyzed during the earthquake preparation period and occurrence using the automated lineament detection method. The Landsat 5 TM images were processed using LESSA and ADALGEO software obtaining similar results. The statistical analysis revealed the stress accumulation due to plate interaction during earthquake formation. The study shows that the number of extracted lineaments changes rapidly about 23 months before the earthquake, and the systems return to the initial stage after 23 months. Most lineaments coincide with the extension of the San Andreas Fault as NW direction is the dominant trend. Thus, it can be concluded that the featural changes within the Rose diagram corresponding to the different strokes direction along with oriented elongation lines as disclosed in the present study using satellite images could be identified as a mid-term and/or short-term precursors of the earthquake. However, even though the dynamism of the El Mayor Cucapah earthquake is found in the extracted lineaments, it is possible to isolate more significant earthquakes even if new ones appear near the zone. Moreover, using two algorithms for lineament detection allows for the tectonics to corroborate the obtained lineaments and dynamism.

1. Introduction

Devastating earthquakes constantly occur worldwide with little or no warning. Several researchers have attempted to understand the physical and geological processes associated with an earthquake with different approaches. Studies such as Total Electron Content before large earthquakes [1,2], crustal deformation by GNSS [3], and InSAR have been studied and proven as distinct precursory detectors [4]. Also, remote sensing techniques during the last years have shown great possibilities for mapping the variations in geological features over a broader scale [5], including earthquakes. The El Mayor Cucapah earthquake of M_W7.2 occurred on April 4, 2010, across the southern region of the United States and Mexico Border. It resulted in quite intense harm in and around Mexicali city and the whole of Mexicali valley. The epicentre of the earthquake is located at 31.13°N, 115.30°W (USGS Earthquake Catalogue), which lies between the Pacific Plate and the North American Plate, near their boundary region, which highlights an arrangement of NW trending transform faults that are parallel to the San Andreas fault framework strands within the Salton Trough. The rupture of the earthquake is caused by normal faulting and rigid lateral strike-slip faulting [6]. During the earthquake preparation, there is an increase in the number of cross-cutting and transverse lineaments. After the earthquake occurrence, the number tends to decrease, thereby considering it for the geodynamic precursor of the earthquake [7]. A lineament can be defined as "significant lines of landscape that reveal the hidden architecture of the rock basement" [8]. The lineaments are known to form an

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Peer review under responsibility of Institute of Seismology, China Earthquake Administration.

Production and Hosting by Elsevier on behalf of KeAi

https://doi.org/10.1016/j.geog.2022.08.001