Space Observed Two Abnormal Linear Clouds before Wenchuan Earthquake

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Abstract: Disastrous Wenchuan Ms8.0 earthquake happened in Sichuan, China, on May 12, 2008. No precursor was reported and no forecasting was made in advance. To search for possible seismic precursor missed, 2,880 pages of cloud photographs observed from stationary satellite FY-2C, Apr 1, 2008 to Jun 1, 2008, were investigated, and the geological structures were spatially overlaid on cloud photographs for spatial relations analysis. Here we show the discoveries that there were two abnormal linear clouds, shaped as arrow and strip respectively, occurred five and three hours before shocking above the geological structures respectively, and that the epicenter was exactly located at the far-intersection point of the two linear clouds. Regional Earth dynamics interpretation and abnormal cloud mechanism ratiocination suggested that the occurrence of the two far-intersected linear clouds was a missed impending precursor of Wenchuan strong earthquake; at least it had foretold the epicenter. The results demonstrate that the geostationary satellite observed cloud photographs are very useful for searching possible impending precursor of strong tectonic earthquakes, and will also be useful for searching for potential underground oil-gas and gas hydrate resource.
Keywords: remote sensing, earthquake, abnormal cloud, geological structure, spatial relations

1 Introduction

The prediction and forecasting of earthquake are most of difficulties and long-term tasks of human beings. A number of signs warning of earthquakes have been proposed, such as foreshock activities, peculiar animal behavior[1], increased low frequency EM-noise[2], concentrations of Radon in water and air[3], ionosphere and magnetosphere perturbation[4], RF Emissions[5], terrestrial gas emanations[6], satellite thermal anomalies (STA)[7] and earthquake clouds. The earthquake clouds of extraordinary shape had been recorded as possible signs of imminent earthquakes in China 345 years ago, and had been ignited during the past decades. It was reported as precursor of M7.8 Kantow earthquake on Mar 7 1978, Japan, of M7.2 Hyogo-ken Nanbu earthquake on Jan 17 1995, Japan[8], of M6.4 Kerman earthquake on Feb 22 2005 and of M6.0 Ahmadi earthquake on Feb 28 2006, Iran[9]. Although the reported earthquake clouds, either ground watched by naked eyes or remote sensing observed by satellite sensors (NOAA, FY-2C, MODIS etc.), have diversiform shapes such as upward tornado, strolling snake, spokewise rods, long strip and splitting corridor, but no intersected linear clouds has been reported, even as possible impending precursor of strong earthquake yet.

The terrible M8.0 Wenchuan earthquake happened in Sichuan (30.94°N, 103.47°E), China at 14:28pm (Beijing time) May 12, 2008, was an extremely heavier natural disaster. Wenchuan town is located 120 Km NW to Chengdu, the capital of Sichuan province, and the epicenter is 60Km SW to Wenchuan and 92Km NW to Chengdu (Fig.1). The seimogenic zone is located in the transition zone of Tibetan plateau to Sichuan basin, and the tectonic movement of the east forepart of Tibetan plateau is blocked by Loess plateau and Yungui plateau to its NE and SE respectively. In the seimogenic zone there are L-faults including F3-1, F3-2 and F3-3 run through SW-NE (Fig.1). The L-faults are a group of compressive right-turn thrust active faults,

where the east forepart of Tibetan plateau thrusts over to Sichuan basin.

This disastrous strong earthquake had resulted in Wenchuan town completely destroyed, 69,016 people dead, 368,545 injured, 18,830 people disappeared and more than 45 million people suffered till 12:00am, June 1, 2008. Unfortunately, no precursor was formally reported and no forecasting was made in advance.

2 Two Abnormal Clouds

To search for possible precursor of the disastrous earthquake missed in advance, totally 2,880 pages of cloud photographs observed from geostationary satellite FY-2C, every half an hour in two months, 40 days before shocking and 20 days after shocking, were download from the web-page of National Satellite Meteorological Center of China Meteorological Adm (http://nsmc.cma.gov.cn/yuntu/showlan.asp). With the geological structures being spatially overlaid on cloud photographs after projection transformation and spatial registration in GIS software, the spatio-temporal variation features of the clouds and the relations between clouds and geological structures are studied.

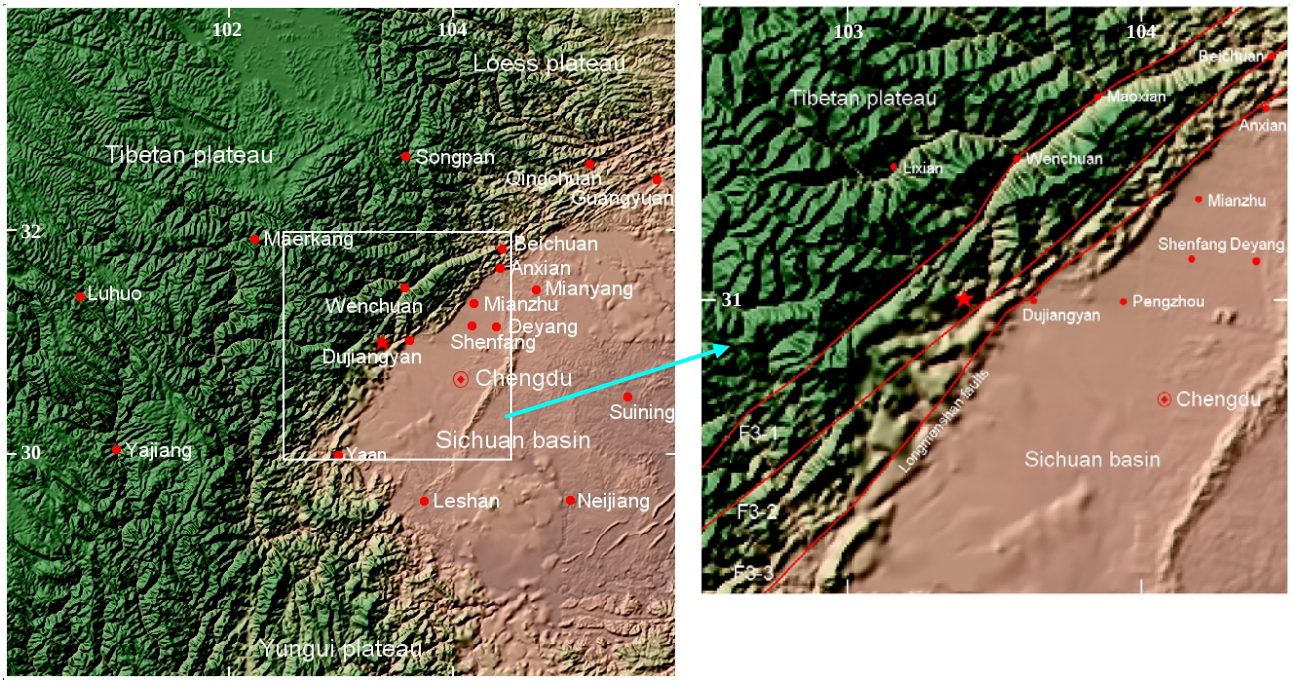

Fig.1 Regional topography around Wenchuan and the geological structures passing by the epicenter

It was discovered that the general movement of clouds above Tibetan plateau, Loess plateau and South China was normal during April-May 2008, but there were two abnormal linear clouds occurred five hours and three hours respectively before the shocking on May 12, 2008 (Fig.2). Its spatio-temporal evolution process is briefed as the followings:

1) An arrow-shaped linear cloud occurred five hours before shocking: There was an intermittent NW-SE linear cloud, with length 600Km about, begun occurring at Chaidamu basin. Its front border located at the upper stream of Yellow river, and got mature and continuous gradually. It looked like an arrow pointing NE to Chengdu, so called as arrow-shaped cloud. The arrow-shaped abnormal cloud developed SE toward the coming epicenter rapidly and reached maximum 800Km at 10:30am. Later, it got more and more haleness from 10:30am to 12:30pm, and kept stable both in spatial position and geometric shape before shocking for four hours about.

2) A strip-shaped linear cloud occurred three hours before shocking: The clouds to the east of Longitude-100^{o} got more at 9:30am-10:30am. Later, the clouds to the east of Longtitude-100^{o} got diffusing rapidly in one hour, but another linear cloud, shaped as an irregular strip, appeared along the west border of Sichuan basin (Fig.3) at 11:30am. The strip-shaped cloud kept stable both in spatial position and geometric shape before shocking for three hours about.

3) Two linear clouds disappeared immediately after shocking: The two linear abnormal clouds begun expanding a little before 14:30pm, and its boundary got fuzzy gradually. At this moment, the disastrous M8.0 Wenchuan earthquake happened at 14:28pm. Immediately after shocking, the positions and shapes of the two linear clouds all got changed for rapid diffusion.

Amazingly, it was furthermore discovered that the epicenter is exactly located at the intersection point of the two linear clouds if the arrow-shaped cloud is axially extended toward the strip-shaped cloud (Fig.2).

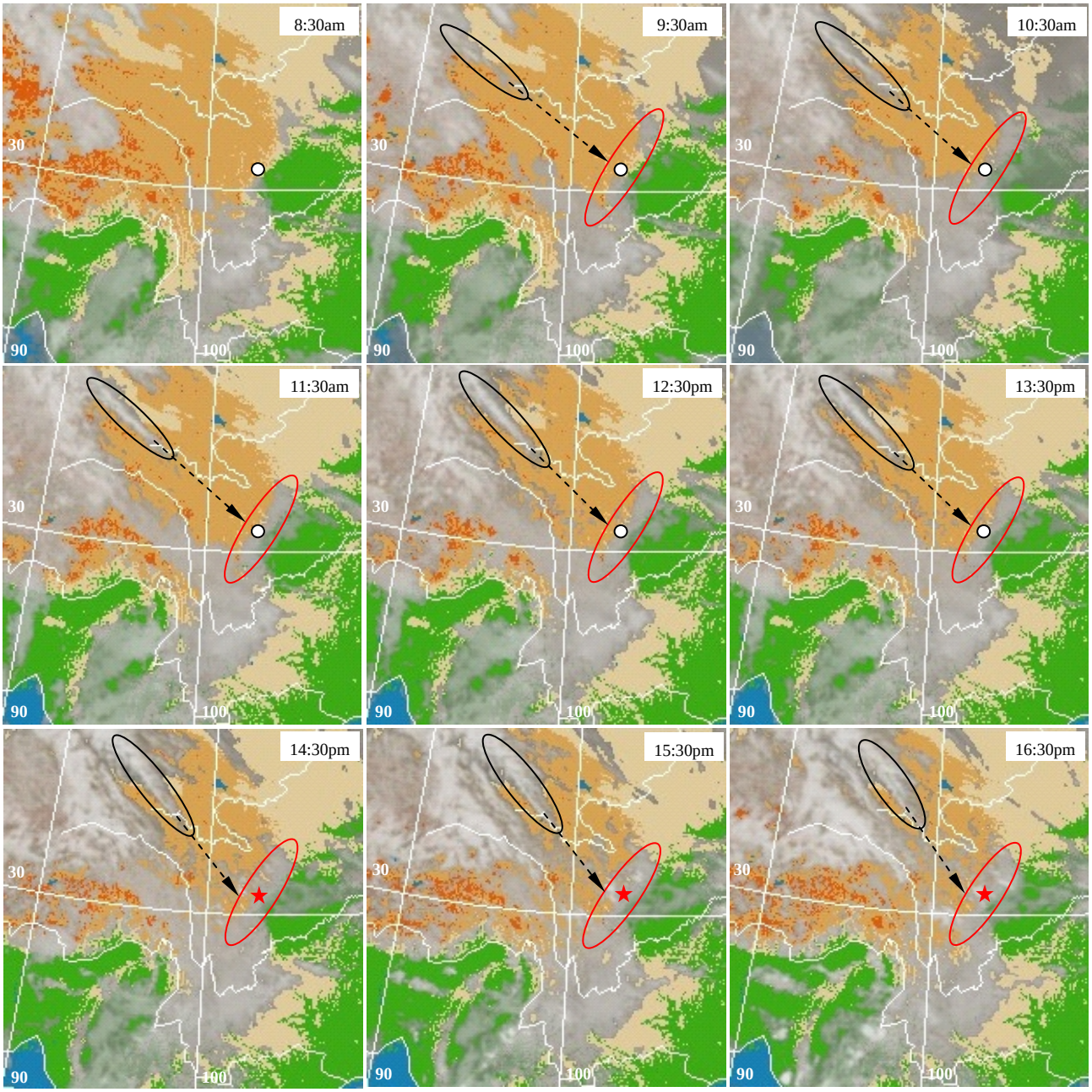

Fig.2 Evolution of two abnormal linear clouds and its spatial relations with the epicenter

3 Spatio-temporal analysis

Is it a happenchance or a necessity?

For geo-spatial relations analysis, a white arrow was drawn inside Kunlun block (dotted black line polygon), with the arrow-shaped cloud totally being included, from the west end of the arrow-shaped cloud and passing through Geermu to the epicenter, Fig.3. It could be seen in Fig.3 that the white arrow zone is a typical seismic active zone in that the arrow starts from Altyn Tagn faults, and the Cenozoic Ezha basin as well as many Quaternary folds inside the Cenozoic Chaidamu basin is enclosed. Except for Kunlun faults, there are two other faults, belonging to Quaternary active fault and new inconspicuous fault respectively, run through the centre area of the white arrow along the south border of Chaidamu basin. Especially, the Kunlunshankou-Dari faults, with several Quaternary active faults and new inconspicuous faults being its branches, run exactly inside and

along the central line of the white arrow and toward the coming epicenter. To the east, the strip-shaped cloud developed along the L-faults, and its west and north border were strictly spatially controlled by the Dongmenggou fault and the Wudu-Mianxian fault respectively.

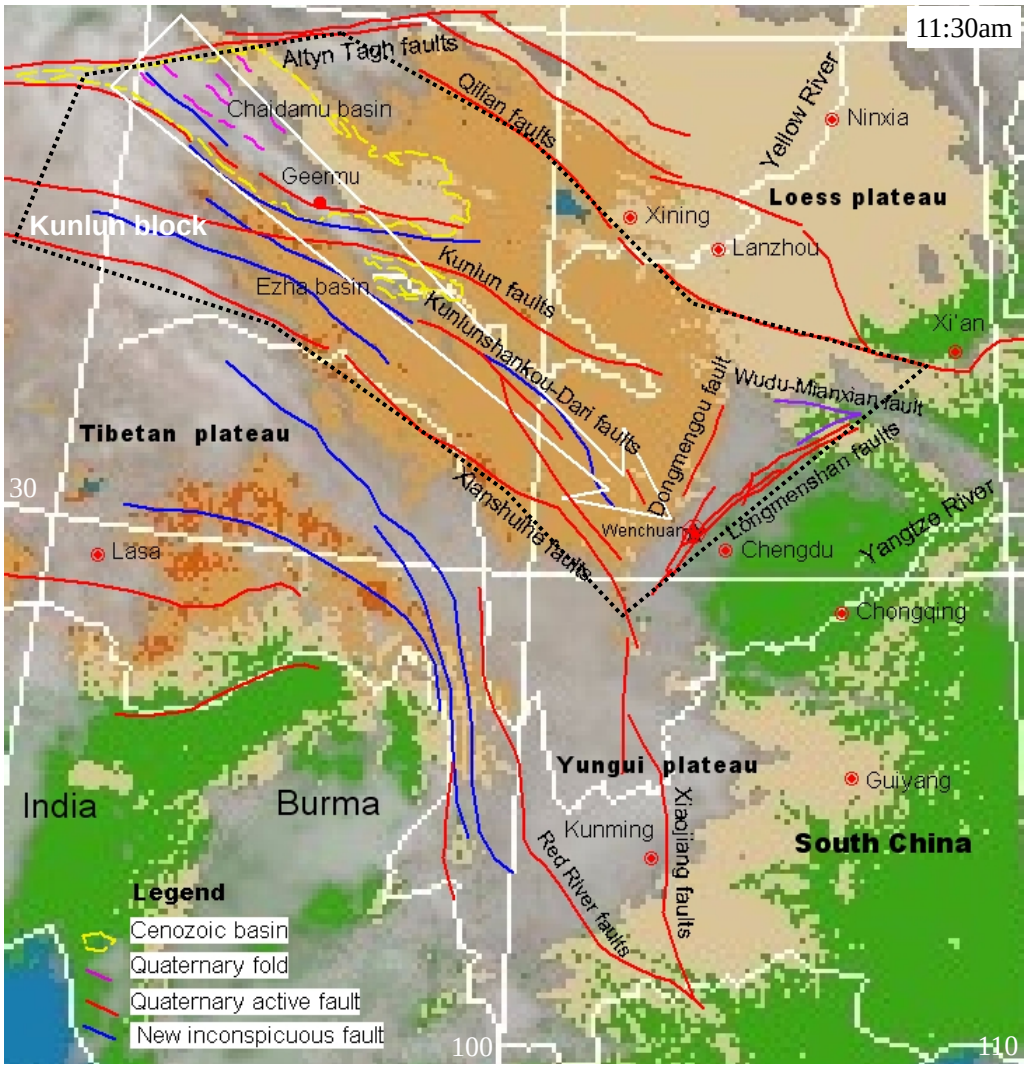

Fig.3 Spatial overlay of regional geological structures on cloud photograph

Besides, all the cloud photographs after shocking till Jun 1, 2008 were checked carefully both in shape and geo-spatial relations. It was concluded that:

1) Locations of linear clouds are exactly in accordance with geological structures: Far away NW to the epicenter, there are the famous Chaidamu basin with abundant oil-gas resource, Ezha basin (Eling lake and Zhaling lake) in tundra of potential natural gas hydrate resource, and seismic active Kunlun faults; while passing through the epicenter, there are the famous Longmenshan faults (in brief be L-faults). After forming in Chaidamu basin initially, the abnormal arrow-shaped linear cloud developed toward Ezha basin passing through Kunlun faults; while the abnormal strip-shaped linear cloud stayed stable after forming along L-faults (Fig.3). It shows that there exist very good spatial relations between the two abnormal linear clouds and the regional geological structures.

2) No similar cloud abnormal occurred after the shock: although there were 192 aftershocks, Ms4.0~6.4, happened along L-faults till Jun 1, 2008, no abnormal clouds occurred again. It shows that the occurrence of the linear clouds is not random but time related with the imminent M8.0 Wenchuan earthquake.

4 Geophysical Interpretation

Somebody believes that earthquake could be used as precursor of imminent earthquake, but others are skeptical. However, recently an experimental study of cloud formation was

successfully conducted[10], a P-hole theory for earthquake cloud mechanism was suggested[11], Earth atmosphere-lithosphere coupling (ALC) effect[12] and Earth lithosphere-atmosphere-ionosphere coupling (LAIC) effect[13] have been proposed. Furthermore, a model of earthquake cloud formation has been constructed that terrestrial gas emanations (TGE, also called as subsurface degassing) could lead to abnormal electric fields, infrared emissions and cloud patterns[13].

In this case, since the northward movement of Tibetan plateau, driven by India plate, was head-on blocked by Loess plateau, it turned to the east along Kunlun faults and Qilian faults. However, one of the primary sub-volume of Tibetan plateau, Kunlun block with Kokoxili, Kunlun faults, L-faults and Xianshuihe faults being its west, north, east and south border respectively (Fig.3), was strongly blocked by Sichuan basin and South China plate. It resulted in the great increment of tectonic stress and the accumulation of elastic energy along L-faults, which made the L-faults being inherently unstable. Therefore, the built-up great stress might had made the crust rocks, along the north and the east foreparts of Tibetan plateau, being ultimately compressed, and resulted in old fissures opening and new fractures producing along Chaidamu-Ezha basin and the L-faults a few hours before shocking. TGE took place in succession along the Cenozoic basins and active faults. Hence earthquake clouds were formed above these basins and faults in linear shape respectively. Generally in rock mechanics and Geo-mechanics, the intersection point is the chief stress concentration zones[14] and the potential rock breaking position along the fault.

5 Conclusions and Discussions

Based on the spatio-temporal analysis on satellite observed abnormal clouds before Wenchuan earthquake referring to regional geological structures, the spatial relations between linear clouds and geological structures were uncovered. It was reached in this paper that:

1) The occurrence of the two far-intersected linear clouds was a missed impending precursor of M8.0 Wenchuan earthquake; at least it had foretold the epicenter of the imminent strong earthquake;

2) The space observed cloud photographs from geostationary satellite are very useful for searching possible impending precursor of strong tectonic earthquakes in a large area, especially of intraplate tectonic earthquakes to happen along geological structures;

3) The rapid spatial analysis with geological structures being overlaid on cloud photographs in GIS software should be a new routine for earthquake monitoring and precursor identifying, and be applied for searching for potential underground oil-gas and gas hydrate resource.

We are sure that earthquake prediction is not a dream in near future. With the essential participation of scientists from multiple disciplines and the cooperation of wider interdisciplinary groups, by paying more attentions to more extensively experimental studies on earthquake precursor[15], by using of the ascendant integrated GEOSS (Global Earth Observation System of System based on spaceborne, airborne and in-situ observations) for monitoring under, on, and over Earth surface[16], and by conducting data fusion on multi-source observations[14]. Observation from space is of extreme importance for geophysics study, global dynamics measurement, tectonic activity analysis and earthquake precaution.

It is believed that the unknown natural laws of Earth interior dynamic and the unclear mechanism of Earth ALC and LAIC process could be revealed gradually. The argument on *earthquake can be predicted or not*[17] is to reach a positive point during the first half of the 21st century.

Finally, we want to end the paper with a famous poem of Su Shi, China Song Dynasty, 900 years ago: *That not knowing the true landscape of Lushan Mountains lies in that you are staying inside the mountains*.

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