

LARGE\_SCALE ROCK-MASS MOVEMENT AT LONGSHOU  
MOUNTAIN, GANSU PROVINCE, CHINA

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ABSTRACT:

Some new geological phenomena can be found with the application of macroscopic features of Landsat images, that we could not see in the past. This paper describes the finding of the large-scale Rock-Mass Movement at Longshou Mountain ( Volume:15kmx18kmx1km sliding distance 23km ) in Gansu Province, Northwest China. Further studying the origin of Rock-Mass Movement has an important practical significance in studying and preventing large geological hazards.

KEY WORDS: Rock-mass, Landsat-images, block, Neotectonic, seismicity, diluvium-fans.

1. INTRODUCTION

Space technology makes possible to distinguish the recognition and analysis of large-scale geological phenomena with remote-sensing images acquired by satellite. Such imagery provides a regional context for investigations of diverse geodynamic processes, including earthquakes, crustal movements, landslides, eruptions, etc. This paper describes an example of a large rock-mass movement that occurred at Longshou Mountain(Longshou Shan), located in Gansu province, Northwest China (Fig1).

Before the study of Landsat images, this structure, located in a sparsely populated region, remained unknown because it was too large to be recognized by conventional geologic mapping. The purpose of this paper is to draw the attention of geologists to the rock-mass movement at Longshou Shan form, because there could be similar phenomena on a comparable scale elsewhere in the world.

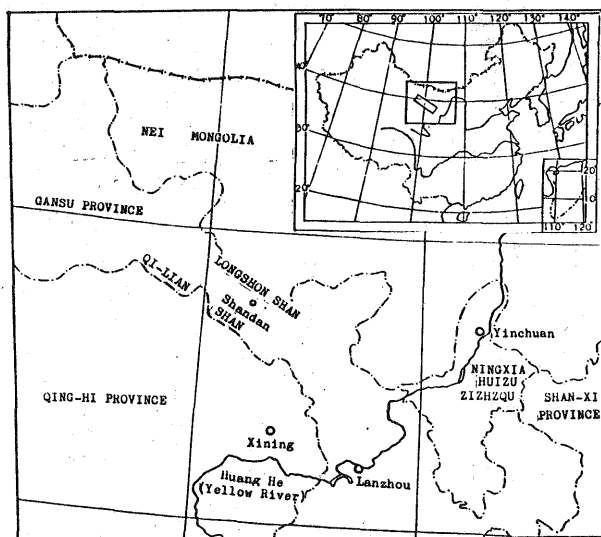


Fig1. Index map showing Longshou Mountain( Longshou Shan) region, Northwest China

## 2. ROCK-MASS MOVEMENT AT LONGSHOU MOUNTAIN

It can be seen from the Landsat images ( Fig2.), Longshou Mountain, is a range that trends approximately  $300^{\circ}$  and has a width of about 10km; it ranges between 2,500-3,000m in elevation(a.s.l.), With and a local relief of 200- 1,600m. The Landsat images clearly shows a rhombus-shaped gap about 15km long and 18km wide in the middle of this mountain range. Correspondingly, about 23km north of this gap, is an isolated rhombus-shaped hill named "Tao-Hua-La-Shan", Which has a local relief essentially the same as that for Longshou Mountain (200-1,600m). Thus, in terms of shape and size, this hill closely matches the rhombus-shaped gap of Longshou Mountain. Moreover, in addition to the match in morphology, the stratigraphy and structures, including faults, also indicate a close correspondence between Tao-Hua-La-Shan and Longshou Mountain(Fig.2). A reasonable interpretation of these observations is that the hill Tao-Hua-La-Shan represents a detached block(15km $\times$ 18km  $\times$ 1km) that slid more 23km to the north; this large "Rock-Mass Movement" in turn created the conspicuous gap in Longshou Mountain.



Fig 2. Landsat image, clearly showing the rhombus-shaped gap in Longshou Mountain, the location and sliding direction of the detached rhombus-shaped rock-mass (Tao-Hua-La-Shan).

Landsat image: NASA.U.S.ERTS, 07OCT75, E-2258-03151-701, 1975

## 3. REGIONAL GEOLOGY, TECTONICS, AND SEISMICITY

Before we can determine the cause of the rock-mass movement described above, we need to consider the stratigraphy, structure, neotectonics, and seismicity of the Longshou Shan region(Gansu Province Geological Bureau, 1971. Shandan sheet Geological map scale 1:200,000 and data p. 71-75).

### 3.1 STRATIGRAPHY AND STRUCTURE

Longshou Mountain is a tightly compressed synclinal structure, with a steeply dipping north flank and shallow-dipping south flank, underlain mainly by Paleozoic and Mesozoic rocks and locally, by Proterozoic strata(Sinian strata Z=Pt1 ).The rocks of the Sinian system(Z) and overlying Paleozoic and Mesozoic strata share a structural axis trending about  $300^{\circ}$ . In addition to the sedimentary rocks, Caledonian granitic rocks, highly cataclastic, also occur in the region. Two major fault zones, one trending about  $300^{\circ}$  and another roughly  $350^{\circ}$  cut Longshou Mountain, and a number of smaller strike-slip faults are developed within these zones(Fig.3).Relatively wide zones of cataclastic, respectively as much as 10-m across, extend beyond each of the fault zones. Fault movements along the two intersecting fault zones have the cut the rocks in region into rhombus-shaped blocks. The orientation and shape of the detached block of Tao-Hua-La-Shan and the Corresponding gap at Longshou Mountain were Controlled By the two dominant regional fault sets.

### 3.2 NEOTECTONIC MOVEMENTS

Neotectonic movements in the region are well documented in the area south of Longshou Mountain (Gansu Geological Bureau data 1971). The gradual tectonic uplift that produced the Longshou range formed large-scale diluvium-fans flanking the mountain; the slop of some of these fans exceeds  $10^{\circ}$ . Significant strike-slip movement is evidenced by the 10-km westward migration of the course of the Shandan river(Fig.4). In addition, there are pronounced offsets of the very thick Quaternary detrital deposits filling the basin flanking the

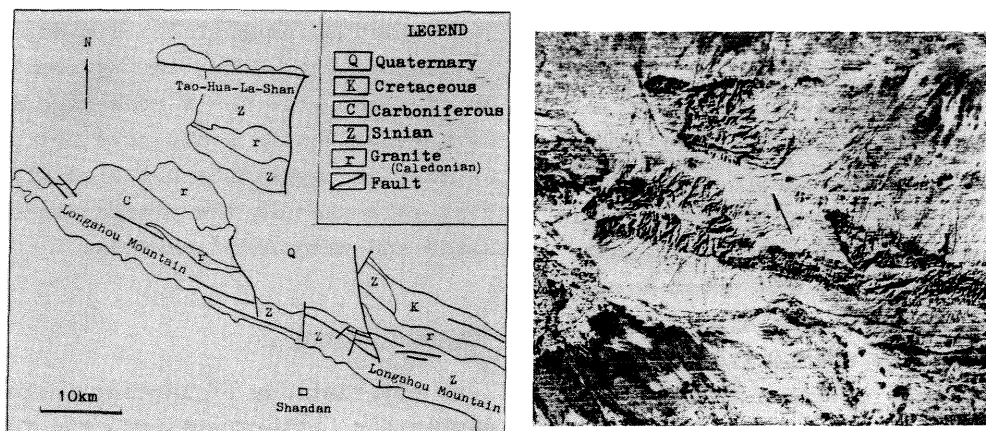


Fig 3. Geologic map of the Longshou Mountain area, showing the principal rock units and faults

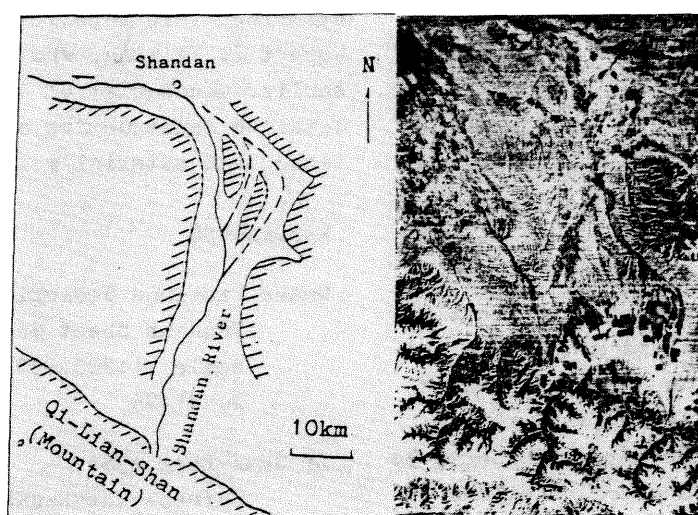


Fig 4. Sketch map showing the westward migration of the Shandan river's by strike-slip fault displacement of about 10-km

range. In summary, abundant geologic evidence indicates strong Neotectonic Movements in the region.

### 3.3 SEISMICITY

Shandan, the county seat of Gansu Province located about 2-km south of Longshou Mountain, has been struck by several historical earthquakes (State Seismological Bureau of PRC, 1987 and Li, 1981). In February 11, 1954. A magnitude-VI earthquake, followed by hundreds of aftershocks, shook an extensive area (50-km×40-km) and caused heavy damage to buildings and civil works (most of the city walls, towers, chimneys

and temples were ruined and 20-30 % of the resident houses collapsed, 47 people died and 330 people were injured, and more than 300 livestock lost lives. Li, 1981). Two fissures, each about 200-m long and as much as 0.2-m wide, appeared south-east of the city as a result of the earthquakes. In addition, an 0.1m-wide, 285°-330° trending fissures formed along the trough (Gansu Province Geological Bureau, 1971.) on both flanks of Longshou Mountain. The north walls of these fissures were down-dropped, and the south walls up-thrown, with total vertical displacements of 0.2-0.5-m. Furthermore, many radial cracks developed on the moun-

tain itself; along the margins of the rhombus-shaped block, several water fountains, aligned about 300°, appeared after the earthquakes. The 1954 and other historical earthquake activity in the Longshou Shan area, together with the geologic record of neotectonic processes, suggest that seismicity probably also must have prevailed in the recent geologic past. If so, then it would be reasonable to assume the large rock-mass movement to form the Tao-Hua-La-Shan hill and associated gap at Longshou Mountain may well have been associated with, and perhaps triggered by earthquake activity.

#### 4. ORIGIN AND SIGNIFICANCE OF THE ROCK-MASS MOVEMENT

Taken collectively, geologic, structural, and seismic data clearly indicate that the Longshou Shan region was, and continues to be, a highly active tectonic zone. The crustal instability intrinsic to this region may reflect some deeper level, but as yet unstudied, tectonic and geophysical processes (Longshou Shan region was an active earthquakes zone in China. Xua and Zhou 1982). Flanking the detached rock-mass (Tao-Hua-La-Shan Hill) are accumulations of loose stone blocks, many 2-5m in diameter, which clearly preserve the outline of the rock-mass after movement. The available evidence thus suggests that the rock-mass movement occurred in the recent geologic past. Unfortunately, present data are insufficient to determine when the movement actually occurred. Nonetheless, it seems not unreasonable to infer that, this movement, involving the displacement of a block with a minimum volume of 185-km volume, probably was a catastrophic rather than gradual process, possibly triggered by one or more major earthquakes.

The Rock-Mass Movement at Longshou Mountain provides a dramatic example that geodynamic processes can occur on a very large scale, which can only be readily studied by satellite-based methods. If a rock-mass movement the size of that at Longshou were to happen now in some densely populated region, it would pose a natu-

ral hazard of potentially disastrous consequences. Therefore, the systematic study of such large-scale rock-mass movement on a global basis would have not only scientific importance but also direct social relevance in the mitigation of landslide and associated hazards.

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#### REFERENCES

- Gansu Province Geological Bureau 1971, Shandan Sheet Geological Map scale 1:200,000 and data P. 71-75
- Li Shan-Bang 1981 Chinese Earthquake, P. 221-224
- NASA, U.S. ERTS Images, 07 oct. 75, 07 OCT. 75, E-2258-03151-701 1975
- State Seismological Bureau Of PRC. 1987 Seismicity Map Scale 1: 6,000,000
- Xu Guo-Ming and Zhou Hui-Lan, 1982 Principle of Seismicity P. 10-13