Atti Accademia Nazionale dei Lincei

Classe Scienze Fisiche Matematiche Naturali

Rendiconti

Roberto Bartole

Structural lineaments of the Central Asian Orogenic Syntaxis from Landsat imageries. Nota II

Atti della Accademia Nazionale dei Lincei. Classe di Scienze Fisiche, Matematiche e Naturali. Rendiconti, Serie 8, Vol. **64** (1978), n.6, p. 614–619.

Accademia Nazionale dei Lincei

<http://www.bdim.eu/item?id=RLINA_1978_8_64_6_614_0>

Geologia. — *Structural lineaments of the Central Asian Orogenic Syntaxis from Landsat imageries.* Nota II di ROBERTO BARTOLE (*), presentata (**) dal Socio A. MARUSSI.

RIASSUNTO. — In prosecuzione della Nota I (pp. 485–489), si analizzano alcune zone tipiche dell'area della *Sintassi*, mettendo anche a confronto i risultati ottenuti con le carte geologiche esistenti.

6. The analysis of LANDSAT imageries has shown that some of the largest recognized lineaments correspond to already well-known structural discontinuities of great extension such as the Talasski-Ferghana fault, the Herat fault, the Quetta-Chaman fault, the Altyn Tagh fault, the Indus suture zone. Other lineaments are strictly parallel to tectonic or stratigraphic discontinuities reported on the existing maps and others coincide with them but have a greater or shorter length; still others are located over known structures or discontinuities but show a diverse orientation, while many do not coincide with any known datum. In zones where the correspondence is good the analysis of satellite data only confirms what is already known from ground observations. Where the correspondence is less evident or missing, however, satellite data furnish the most precious and useful information concerning the existence of peculiarities the geological significance of which is still unknown.

One of the most interesting results evidenced by this analysis is the existence of areas not mentioned in the existing literature in which many short lineaments consistently oriented in preferential directions prevail.

Thus in the western part of the Kun Lun belt many close minor and intermediate lineaments may be grouped into three classes of orientation, each corresponding to the directions N-S, WNW-ESE and NE-SW. This interesting distribution occurs over a vast elongated area, nearly 500 km long and 100 km wide in its central part extending from 76° E to 80° E south of Yarkand (Soche). A similar peculiarity is also found in the south-eastern part of the Himalayan range in a large area extending southeast of the town of Simla, from 77° E to 81° E. Intermediate but especially minor lineaments may be grouped there into the following 6 classes of orientation, each showing a very high degree of parallelism: NNE-SSW, NE-SW, ENE-WSW, WNW-ESE, NW-SE, NNW-SSE (Fig. 1). Comparison with the existing

(*) Istituto di Geodesia e Geofisica – Università di Trieste; attualmente presso Istituto di Geologia – Università di Urbino.

(**) Nella seduta del 13 maggio 1978.

literature has confirmed that some of these lineaments correspond to fractures, faults and folds trending normal and oblique to the Himalayan tectonic trend (Valdiya K. S., 1976).

Other smaller areas characterized by a similar pattern of lineaments have been recognized. In decreasing order of extension these are the area along the course of the Indus river south of the town of Gilgit, which shows the classes NNE-SSW, NE-SW, NNW-SSE; the area southeast of the city of Srinagar with the classes N-S, ENE-WSW, NW-SE; and finally the area north of the town of Samarqand, about 40° N and 67° E, which shows the classes NE-SW, ENE-WSW, NNW-SSE.

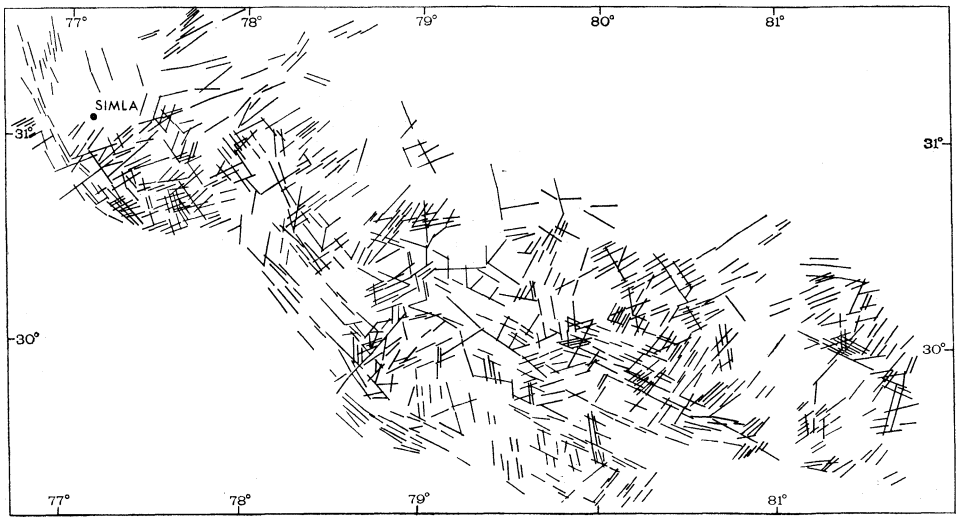

Fig. 1. – Close parallel lineaments detected in the Himalayan area south-east of Simla. They may be grouped in to the following 6 classes of orientation: NNE-SSW, NE-SW, ENE-WSW, WNW-ESE, NW-SE, NNW-SSE.

The analysis of LANDSAT imageries also proved valuable in zones where slight differences occur between the location of the lineaments and the structures or discontinuities reported on the existing geological maps. The most significant example has been found in the area of the Hazara syntaxis north of the city of Islamabad. This area is characterized by a multitude of intermediate and minor lineaments with a predominantly NW-SE and NE-SW direction (Fig. 2). Their disposition displays a pattern which, at first glance, seems to be in agreement with the simplified geologic map of the syntaxis (Fig. 3). A careful comparison between the two reveals however that interesting discrepancies appear along the line following the course of the Jhelum river: the geologic scheme in Fig. 3 shows that the syntaxis is marked by a bend of two very long parallel fault lines which assume the shape of a bell. On the other hand, the examination of the LANDSAT

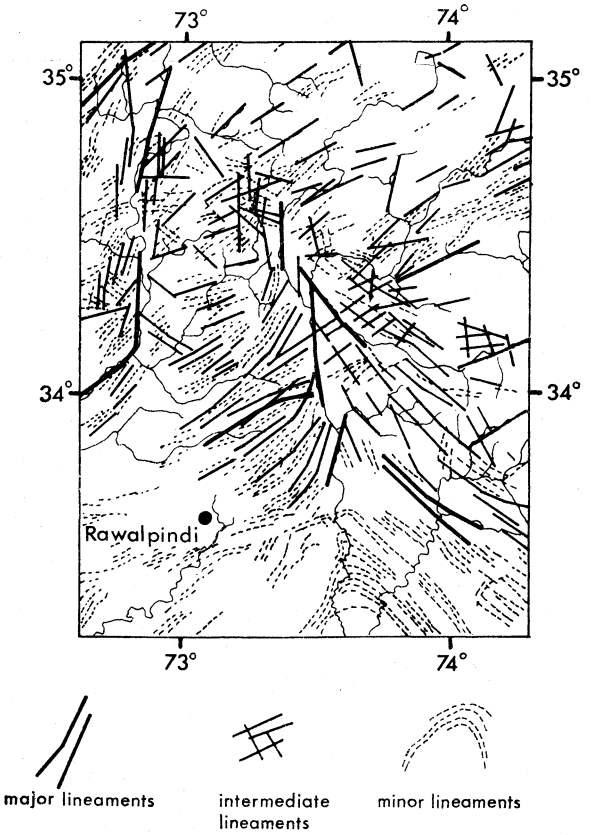

Fig. 2. – Lineaments detected in the Hazara Syntaxis.

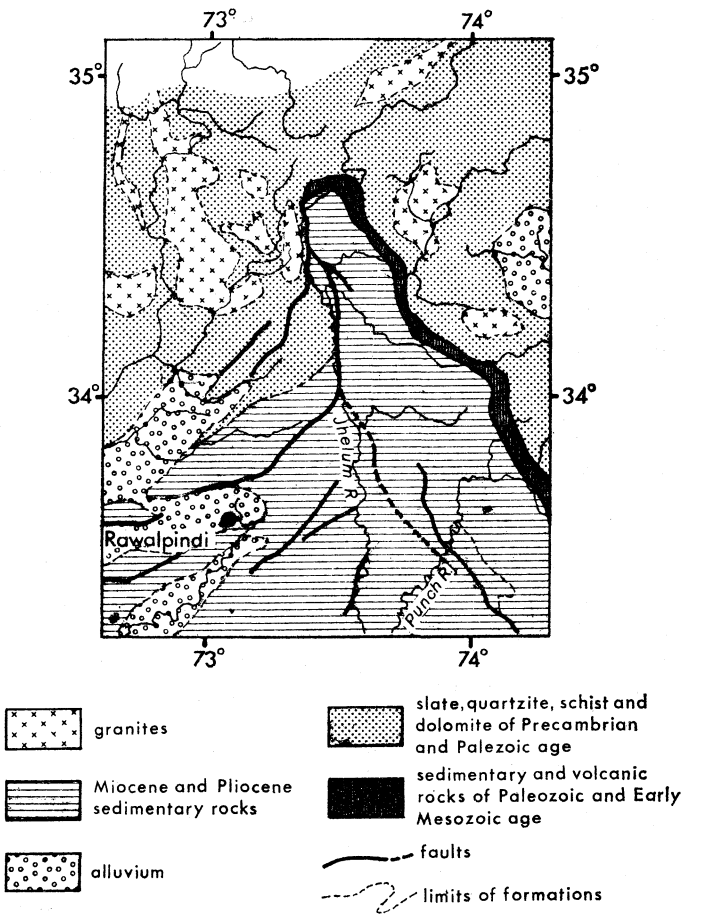

Fig. 3. – Simplified geologic map of Hazara Syntaxis (after Bakr and Jackson, 1964).

imageries does not reveal any bend of the lineaments in correspondence with the syntaxis but rather a sharp junction at a narrow angle. It is worthy of note that the first bendings of the lineaments do not appear until 80--100 km south of the syntaxis, east of Rawalpindi.

Satellite imageries have supplied additional information even in areas where the comparison with the available geological data is in good agreement.

In the Tien Shan the lineaments are in perfect agreement with the most recent geologic and tectonic maps. In fact, both major, intermediate and minor lineaments display there a predominantly E-W orientation and only their eastward extension deviates slightly to the north, such as the main tectonic trends. In the southern part of the belt, at approximately 40° N and 78° E, two major lineaments striking NNW-SSE and NNE-SSW determine the lateral sides of a wedge-shaped block pointing toward the south. Moreover, they cut perpendicularly across a multitude of close, parallel minor lineaments which extend in an ENE-WSW direction. The sharp bending and the evident shifting toward the north suffered by these lineaments in the above-mentioned block lead one to infer that 1) the two major lineaments may correspond to the traces of two transcurrent faults and 2) the wedge-shaped block might have slid toward the north moving along them. In the latest geologic map of this region two faults are reported and in the latest tectonic map only one. Both faults which appear on the former map are shorter than those observed on the LANDSAT imageries and for neither of them is the sense of displacement indicated.

The examination of the imageries used in this study also permitted detection of the horizontal components of the displacement which may have occurred along several lineaments. Two of them coincide with the already well-known Talasski-Ferghana and Quetta-Chaman transcurrent faults, while many additional ones do not coincide with any known discontinuity. Such an example is the N-S major lineament recognized in the eastern part of the Sulaiman range at approximately 30° N and 70° E. Here the evident bending of the ridges in proximity of the lineament reflects an apparent left-hand slip. Another movement has been recognized on the Hissar range north of the city of Dushanbe, about 39° N and 69° E; here an apparent right-hand slip clearly appears from the shifting suffered by the water streams along a major lineament striking E-W. Finally even hydrographic evidence indicates the left-hand movement detected in the upper course of the Indus river at approximately 34° N and 77° E.

7. As for the morphological features, the representation of the areas subject to aging or to rejuvenation must be considered as purely tentative.

A large and very elongated zone of rejuvenation has been recognized along the Kun Lun belt, another along the Himalayan belt and a more limited one along the eastern edge of the Sulaiman range. Areas of rejuvenation have also been recognized in the wide mountain area in Afghanistan

south of the city of Mazar-i-Sharif, in the northern part of the Tien Shan belt, in the Hissar range and finally in the inner part of the Himalayan range whose hydrographic network shows a marked entrenchment.

Conspicuous alluvial fillings characterize the Tibetan highlands between the eastern part of the Kun Lun and the Himalayan belt and the Pamirs between the Karakul and Zorkul lakes. Sedimentary fillings also characterize the southern part of the Tien Shan belt, the vast area extending from the town of Kandahar to Kabul and continuing eastward to Peshawar. Smaller areas of aging characterize the inner part of the Sulaiman range, the surroundings of Quetta and the Srinagar valley.

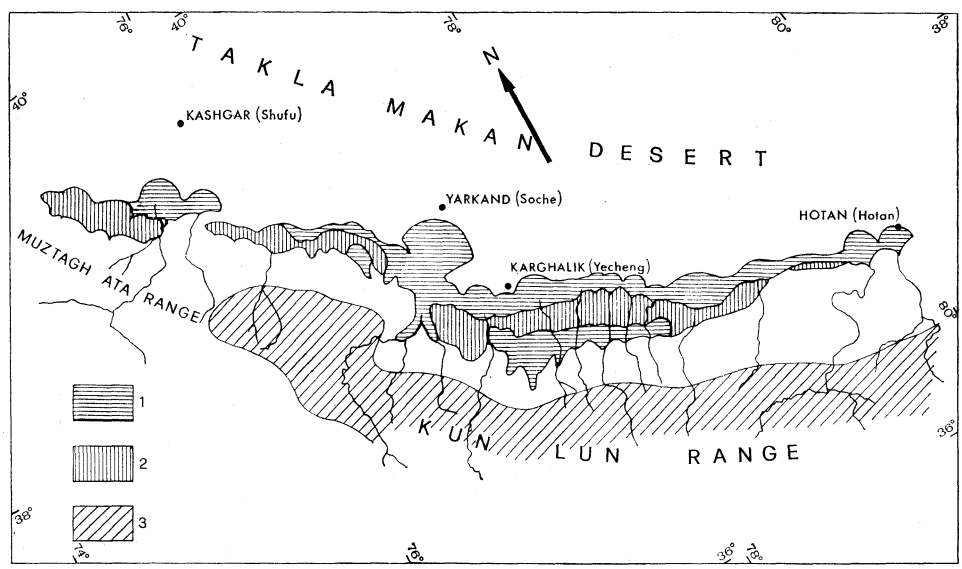

Fig. 4. - Progressive transition from rejuvenation to aging in the area comprised between the Kun Lun range and the Takla Makan desert: 1) prevailing present fluvial deposits; 2) prevailing present erosion in fluvial deposits; 3) rejuvenated mountain area.

A most interesting aspect related to the morphological evidence is to be found in the elongated belt at the foothills of the Muztagh Ata and the Kun Lun ranges, facing the Takla Makan desert (Fig. 4). As a general rule, in this belt, which roughly extends from the town of Kashgar (Shufu) to Khotan (Ho-tan), it is possible to distinguish a progressive transition from rejuvenation which characterizes the mountain area to the aging which characterizes the flat desert area. This is evident on the imageries observing the superficial aspects of the fluvial deposits. The deposits of the inner part of the belt (the ones nearest to the mountains) show rough notched surfaces caused by the prevailing action of erosion of water flows, whereas those situated on the outer part, mainly constituted of alluvial fans, show smooth and gentle surfaces, the action of deposition being presently under way.

The band of fluvial deposits extending to the edges of the Muztag Ata range gives the first significant example in this regard (left side of Fig. 4). Two parallel strips of deposits are displayed: the one adjacent to the mountains is characterized by rough surfaces as opposed to the other which displays smooth ones. The second significant example is given by a larger band of fluvial deposits at the foot of the Kun Lun belt which extends for nearly 200 km southeast of the town of Karghalik (Yeh-cheng) (right side of Fig. 4). The aspect of these deposits has permitted the subdivision of this band into three strips: moving from the mountains toward the desert it is possible to notice an inner strip in which deposition prevails, a central strip characterized by a marked action of erosion, and an outer strip made up of many alluvial fans in which the action of deposition predominates. That is to say, the central strip is subject to rejuvenation while the two adjacent strips are subject to aging.

Acknowledgments

The present research has been sponsored by the Consiglio Nazionale delle Ricerche, Rome.

I wish to thank Prof. Marussi for his constant interest, encouragement and his constructive criticism of the manuscript. I also thank Dr. Ebblin for his advice and Mr. Cavicchi for drawing the maps.

REFERENCES

BAKR A.M. and JACKSON O. R. (1964) - *Geologic Map of Pakistan* 1 : 2,000,000, Government of Pakistan, Ministry of Industries and Natural Resources.

EBBLIN C. (1976) - *Tectonic lineaments in Karakorum, Pamir and Hindu Hush from* ERTS *imageries*, « Rend. Acc. Naz. Lincei », ser. VIII, 60 (3), Roma, 245-253.

ERTS *Reference Manual - General Electric*. Philadelphia, Penn. USA.

Tectonic Map of the U.S.S.R. and neighboring regions (1 : 5,000,000) (1956) - Ministry of Geology and Soil Conservation; Academy of Sciences of U.S.S.R.; Ministry of Higher Education—principal compiler N. S. Shatskii - Moscow.

Tectonic Map of Eurasia (1 : 5,000,000) (1966) - Geological Inst. of the Academy of Sciences of the U.S.S.R. - principal compiler A. L. Iahnsin, Moscow.

Tectonic Map of China and Mongolia (1 : 5,000,000) (1973) - U.S. Geological Survey—principal compiler M. J. Terman, Reston, Va., USA.

Tectonic Map of Afghanistan (1 : 250,000) (1975) - Various authors, Kabul.

Tectonic Map of the People's Republic of China (1 : 5,000,000) (1975) - Chinese Academy of Geological Sciences, Peking.

VALDIYA K. S. (1976) - *Himalayan Transverse Faults and Folds and their Parallelism with Subsurface Structures of North Indian Plains*, « Tectonophysics », *32*, 353-386.