J. Appl. Environ. Biol. Sci., 1(9)291-295, 2011

ISSN: 2090-4215
Journal of Applied Environmental and Biological Sciences
www.textroad.com

Active Tectonics of Qezel Ozan River Basin, NW Iran

Mehran Arian*, Ph.D.; Vahid Hosseini Toudeshki, Ph.D.; Hamideh Noroozpour

[1] Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, Iran
[2]Department of Civil Engineering، Islamic Azad University, Zanjan Branch،Tehran، Iran
[3]Young Researchers Club, Science and Research Branch,Islamic Azad University, Tehran, Iran

ABSTRACT

Active tectonics has an essential role in controlling fluvial systems. The Qezel Ozan River, the longest river system in the North West of Iran, has responded to tectonic deformation thoroughly. In the structural–sedimentary Zoning, the study area is located in Sanandaj – Sirjan, Central Iran and Western Alborz zones. In the course of the Qezel Ozan River, various units of Qom, Upper Red, Lower Red and karaj formations were exposed.

In this study, the first geomorphic anomalies have been identified on the satellite images and approved through DEM and field observations. Then these anomalies have been correlated with structures and magnetic lineaments extracted from geology and aeromagnetic maps. In this way the fluvial anomalies caused by magnetic lineaments are specified and so the active sub-surface folds and faults are recognized. Most of the magnetic lineaments in the Qezel Ozan River basin have caused the geomorphic anomalies in the length of the river and are considered as active sub-surface structures.

KEY WORDS: Alborz, Active, Tectonics, Qezel Ozan, River, Geomorphology

INTRODUCTION

Rivers reply to neo tectonics according to the nature and amount of vertical movement in river basin and the trend of the structures with respect to river flow. Detection and characterization of geomorphic anomalies in the Qezel Ozan River basin provide an additional tool for recognizing the subtle tectonic movements in the region. Current techniques such as seismic data analysis and fault plane solutions of earthquake data can not completely to relate active tectonic movements to any specific fault (Jain and Sinha, 2005). The remote sensing data and digital elevation models coupled with field observations provide data on the nature of vertical movements of sub-surface faults and folds.

This paper presents the results of investigations from the Qezel Ozan River basin, northwest of Iran. The Iran plateau is one of the most tectonically active regions of the world. Numerous studies in the Iran plateau have shown continual convergence and active tectonic in this area (Jakson et al., 2002; Allen et al., 2003; Allen et al., 2004).
Several models and field investigations show that in tectonically active regions the structures and related deformation have a direct control in shaping the landscape and drainage evolution (Gupta, 1997; Delcaillau et al., 1998; Hitchcock and Kelson, 1999; Friend et al., 1999; Burbank and Anderson, 2001; Van der Woerd et al., 2001; Champel et al., 2002). Due to thick alluvial covers in the area, current methods have failed to understand the style of surface deformation caused by the known seismogenic active structures. In this paper, we have tried to understand the surface deformation pattern along the sub-surface faults and folds with the help of geomorphic anomalies.

Geological setting

The study area is located in Sanandaj – Sirjan , Central Iran and Western Alborz zones (Aghanabati, 2004) (Figure 1). In the regional tectonic, Sanandaj – Sirjan and Central Iran zones are located in Turkish-Iranian plateau (Allen et al., 2004). It extends from eastern Anatolia to eastern Iran, and typically has elevations of 1.5–2 km. There are important strike-slip faults, especially in eastern Anatolia and northwest Iran (Talebian and Jackson, 2002).

Alborz Mountains forms a composite orogenic belt and endured shortening and uplift during Tertiary (Alavi, 1996). Arabia–Eurasia convergence and westward motion of the South Caspian relative to Iran is caused deformation in the Alborz. The Alborz range, deforms by oblique shortening onto range-parallel left-lateral strike-slip and thrust faults. The strike-slip faults produce prominent surface ruptures, but main thrusts are often blind. The total oblique convergence is partitioned into strike-slip and compressional components (Allen et al., 2003).

Around the Qezel Ozan River, marl, sandstone, siltstone, limestone, tuff, agglomerate and volcanic rocks are extremely exposed. These rocks belong to Qom, Upper Red, Lower Red and Karaj formations.

*Correspondence Author: Mehran Arian, Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, Iran.
Email: mehranarian@yahoo.com Tel: 091-21-44865757

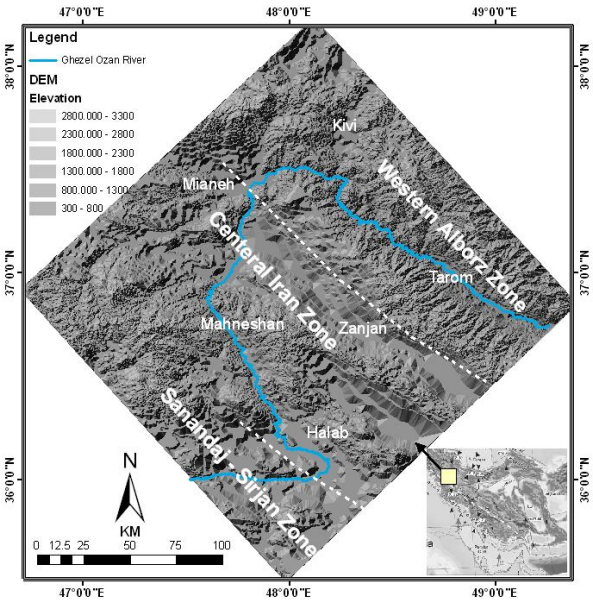

Figure1. DEM of the study area (USGS/SRTM data) illustrating structural and sedimentary zones marked by dashed lines and some urban points in NW Iran. Inset shows DEM of Iran with location of the study area.

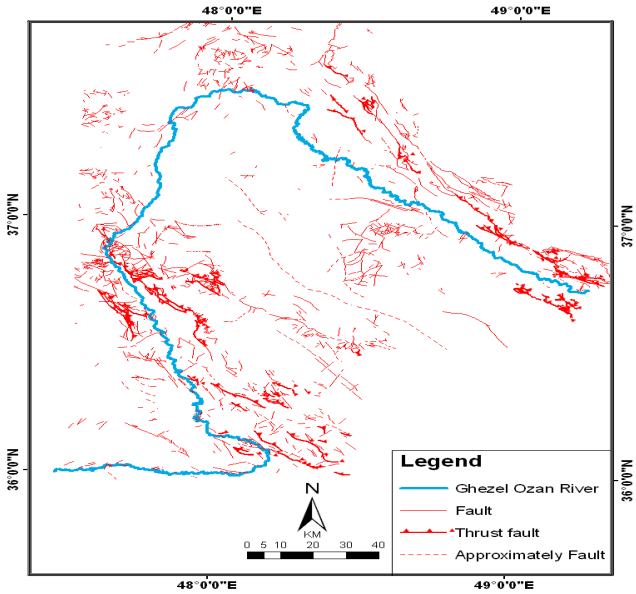

Figure 2. This map shows all faults in the Qezel Ozan River basin.

MATERIALS AND METHODS

In order to identify the active sub-surface structures in the Qezel Ozan River basin the following works are accomplished:

- The geomorphic anomalies in the length of Qezel Ozan River are recognized by use of Landsat ETM images with resolution of 28.5 m and by subsequent field verification.
- The DEM are derived from the contour lines of the 1: 25,000 topographic maps provided by Iranian Survey Organization (ISO) with 10-m contour intervals. The DEM is employed for the preparation of longitudinal profiles of the Qezel Ozan River. The longitudinal channel profiles provide data on river profile irregularities (knick points) that may be due to active tectonics.
- The whole surface structures (faults and folds) are extracted from geology maps at scale 1:100,000 provided by Geological Survey of Iran (Figure 2 and Figure 3).

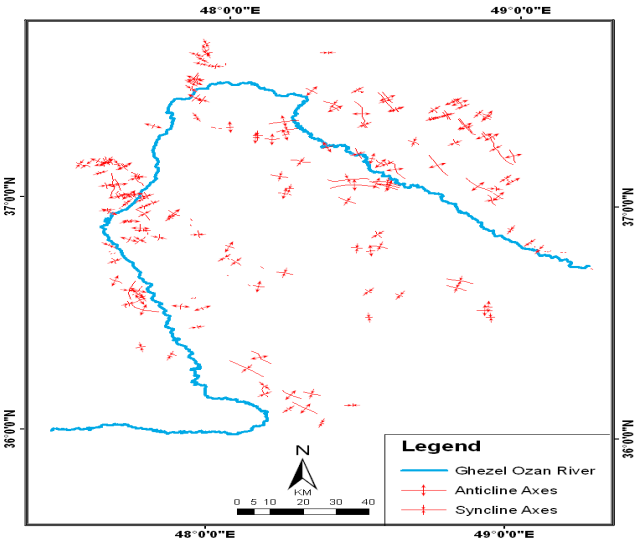

Figure 3. This map shows all folds in the Qezel Ozan River basin.

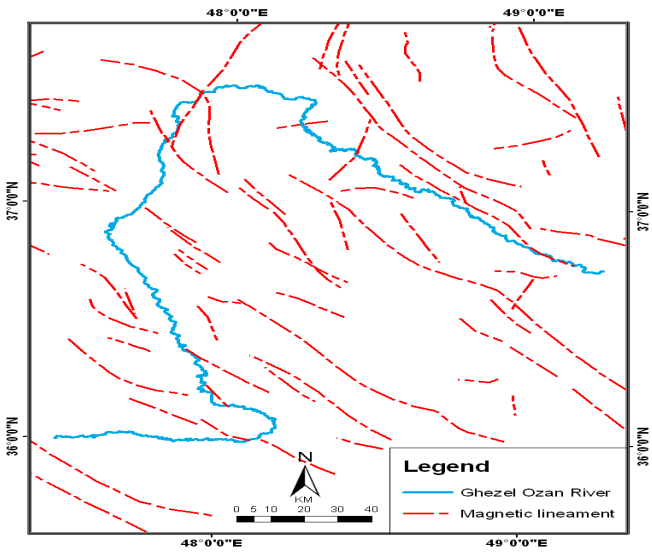

Figure 4. This map shows all magnetic lineaments in the Qezel Ozan River basin.

-The whole magnetic lineaments are extracted from aeromagnetic maps at scale 1:250,000 provided by Geological Survey of Iran (Figure 4).
- The fluvial anomalies created by surface structures are omitted and only the geomorphic anomalies related to magnetic lineaments are considered.

RESULTS

The geomorphic anomalies related to magnetic lineaments in the Qezel Ozan River basin (Figure 5) are as follow:

- Channel pattern variations

Channel pattern variations may be taken place by increase or decrease in slope imposed by an impeding zone of uplift or subsidence (Holbrook and Schumm, 1999). Transform channel pattern of braided to meandering (Figure 6) showing zone of uplift in course of the Qezel Ozan River is caused by a magnetic lineament with trend of NW-SE. Magnetic basement of this lineament is located beneath a sedimentary cover of marl, sandstone, shale and conglomerate rocks. Thus, this magnetic lineament is an active sub-surface structure in the area.

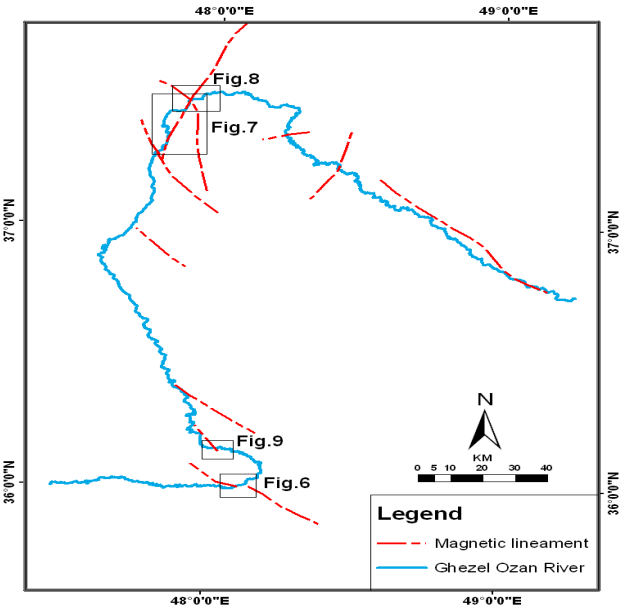

Figure 5. This map shows the situation of the Qezel Ozan River and place of figures 6, 7, 8 and 9 in the study area.

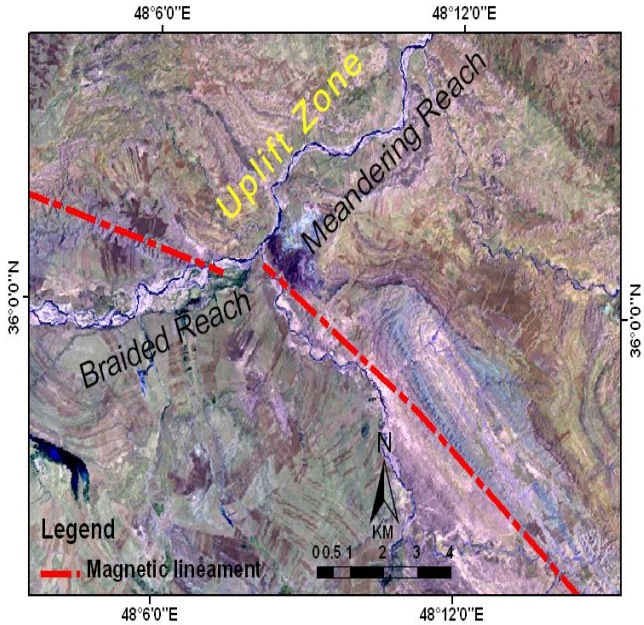

Figure 6. Annotated Landsat image depicting the situation of magnetic lineament and resulting channel pattern variation in the Qezel Ozan River.

- Straightening of river course

In two regions the natural and meandering case of the Qezel Ozan River is destroyed and the course of the river is completely straightened (Figure 7). Both of the straightening are created by a magnetic lineament with trend of NE-SW. Magnetic basement of this lineament is composed of acidic tuffs and igneous rocks with Eocene age. This lineament has had the most influence in straightening of the river course and is accounted to an active sub-surface structure in the area.

- Sudden change in the flow of the river (deflection)

Rivers in coincident with deformed zone will be deflected from uplift zone and into subsidence zone (Holbrook and Schumm, 1999). Deflection of the Qezel Ozan River course (Figure 8) is created by a magnetic lineament with trend of NW-SE. Magnetic basement of this lineament is located beneath a thin sedimentary cover of marl, sandstone and conglomerate rocks. This deflection which is nearly 90 degrees shows the activity of sub-surface structure.

- Knick points in the longitudinal profile of river

Knick points are segments of a river long-profile that are steeper than adjacent segments. A knick point in the longitudinal profile of the Qezel Ozan River is observed which this anomaly is located in place of intersection of the river with a magnetic lineament with trend of NW-SE (Figure 9). Magnetic basement of this lineament is located beneath a sedimentary cover of marl, siltstone and conglomerate rocks. Regarding the invariability of lithology in ground it is inferred that knick point is created by magnetic lineament and, therefore; it is considered as a active sub-surface structure.

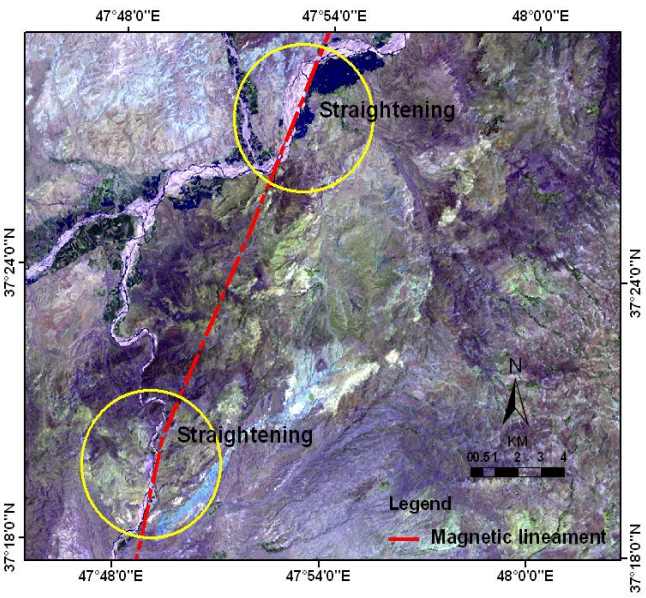

Figure 7. Annotated Landsat image depicting the situation of magnetic lineament and resulting straightenings of the river course in the area.

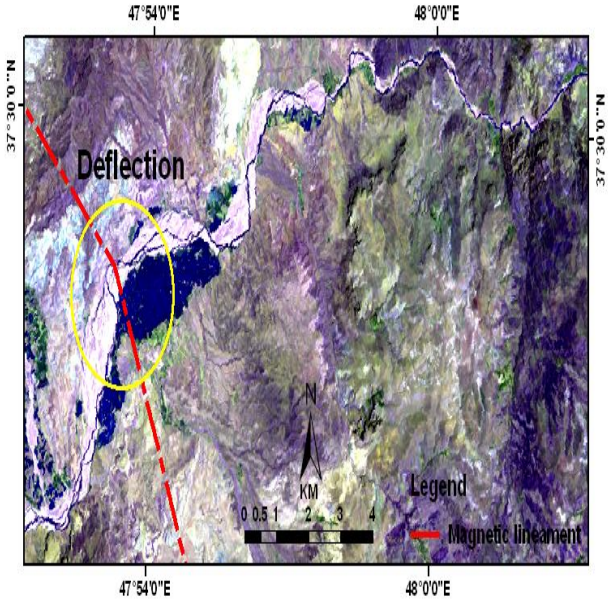

Figure 8. Annotated Landsat image depicting the situation of magnetic lineament and resulting deflection of the Qezel Ozan River.

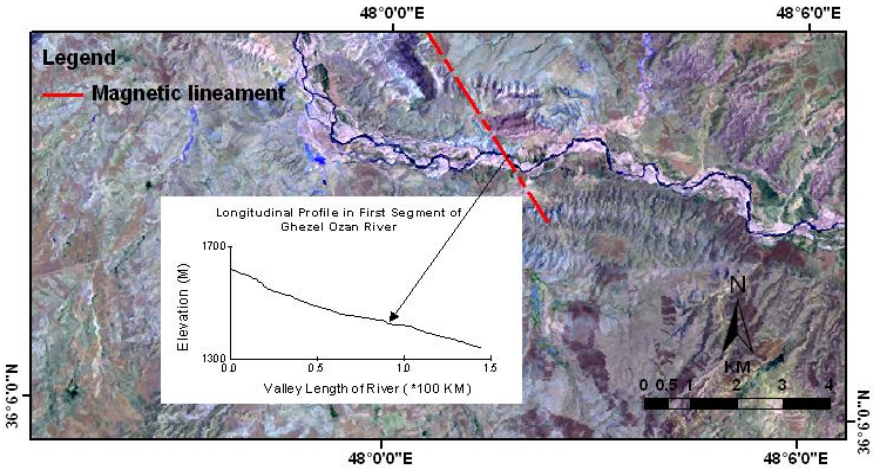

Figure 9. Landsat image depicting the situation of magnetic lineament and resulting knick point in longitudinal profile of the Qezel Ozan River.

DISCUSSION

One of the most important tectonic problems in each region is the recognition of its surficial deformation pattern which is mostly produced by the action of active faults and folds. In many cases, these structures are located beneath a thick sedimentary cover and their direct survey is not possible. Therefore; by the use of fluvial anomalies we can recognize regional surface deformation pattern along sub-surface faults and folds. In the Qezel Ozan River basin, most of the magnetic lineaments are cutting across the river channel and have affected the fluvial processes.

The differential movements along the lineaments have produced longitudinal tilting in the area. In general, channel pattern variations, straightening of the river course, deflection of the river course and knick point in longitudinal profile of the river are some of the geomorphic expressions of active sub-surface structures in the Qezel Ozan River basin. Regarding the trend of these lineaments in the area it is specified that the active sub-surface structures have trends of NW-SE and NE-SW which are concordant with the trend of basement fractures in basement of Iran.

Conclusions

- Most of the sub-surface structures in the Qezel Ozan River basin are presently active, and have produced distinctive response manifested as fluvial anomalies.
- The active sub-surface structures in the Qezel Ozan River basin have trends of NW-SE and NE-SW.
- The sub-surface structures with trend of NW-SE have caused channel pattern variations, deflection of the river course and knick point in longitudinal profile of the river while, the sub-surface structures with trend of NE-SW have only caused straightening of the river course.

Acknowledgements

This work is funded by the Department of geology, Islamic Azad University, Science and Research branch, Tehran, Iran. Also, Special thanks to vice-president for research in Science and Research branch, Tehran.

REFERENCES

Aghanabati, A. 2004. Geology of Iran، Geological Survey of Iran، 619p.

Alavi, M. 1996. Tectonostratigraphic synthesis and structural style of the Alborz mountain system in northern Iran. Journal of Geodynamics. 21: 1–33.

Allen, M.B., Ghasemi M.R., Shahrabi M., Qorashi, M. 2003. Accommodation of late Cenozoic oblique shortening in the Alborz range, northern Iran. Journal of Structural Geology. 25: 655-672.

Allen, M.B, Jackson, J.A, Walker, R. 2004. Late Cenozoic reorganization of the Arabia-Eurasia collision and the comparison of short-term and long term deformation rates. Tectonics, 23,

Burbank, D.W., Anderson, R.S. 2001. Tectonic Geomorphology. Blackwell Science, Massachusetts.

Champel, B., Van der B.P., Mugnier, J.L., Leturmy, P. 2002. Growth and lateral propagation of fault-related folds in the Siwaliks of western Nepal: Rates, mechanisms, and geomorphic signature. Journal of Geophysical Research. 107 .

Delcaillau, B., Deffontaines. B., Floissac, L., Angelier, J., Deramond, J., Souquet, P., Chu, H.T., Lee, J.F .1998. Morphotectonic evidence from lateral propagation of active frontal fold; Pakuashan anticline, foothills of Taiwan. Geomorphology. 24: 263–290.

Friend, P.F., Jones, N.E., Vincent, S.J .1999. Drainage evolution in active mountain belts: extrapolation backwards from present-day Himalayan river patterns. Special Publication International Association of Sedimentologist. 28: 305–313.

Gupta, S .1997. Himalayan drainage patterns and the origin of fluvial megafans in the Ganges foreland basin. Geology. 25: 11–14.

Hitchcock, C.S., Kelson, K.I .1999. Growth of late Quaternary folds in southwest Santa Clara Valley, San Francisco Bay area, California: Implication of triggered slip for seismic hazard and earthquake recurrence. Geology. 27: 391–394.

Holbrook, J., Schumm, S.A .1999. Geomorphic and sedimentary response of rivers to tectonic deformation: a brief review and critique of a tool for recognizing subtle epeirogenic deformation in modern and ancient settings. Tectonophysics. 305: 287– 306.

Jaint, V., Sinha, R .2005. Response of active tectonics on the alluvial Baghmati River, Himalayan foreland basin, eastern India. Geomorphology. 70: 339–356.

Talebian, M., Jackson, J.A .2002. Offset on the Main Recent Fault of NW Iran and implications for the late Cenozoic tectonics of the Arabia-Eurasia collision zone, Geophys. J. Int. 150: 422 – 439.

Van der Woerd, J., Xu, D., Li, H., Tapponnier, P., Meyer, B., Ryerson, F.J., Meriaux, A.S., Xu, Z . 2001. Rapid active thrusting along the northwestern range front of the Tanghe Nan Shan (western Ganshu China). Journal of Geophysical Research. 106: 30475–30504.