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Evaluation of relative tectonic activity in the Tehran basin, central Alborz, northern Iran

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ABSTRACT

Recent deformations in the area studied control structural expansions influenced by tectonic activities, causing transformations of geologic features and morphological landforms. The Tehran basin is located at the southern edge of the central Alborz and is the result of the Arabian–Eurasian convergence and clockwise rotation of the south Caspian basin with respect to Eurasia. Hence, assessment of the drainage pattern permutations and mountain fronts appears necessary. We used six significant morphometric indices for this evaluation: stream length gradient (*SL*), drainage basin asymmetry (*Af*), hypsometric integral (*Hi*), ratio of valley floor width to valley height (*Vf*), drainage basin shape (*Bs*), and mountain front sinuosity (*Smf*). The combined analyzed indices represented the relative active tectonics (*Iat*). The study area was divided into four regions according to the values of *Iat*. These classes include class 1 (very high activity), class 2 (high), class 3 (moderate), and class 4 (low). The regions with high relative tectonic activity mostly correspond with the active structures in the basin. The tectonic activity classes 1 and 2 coincide with the fault mountain fronts in the southern edge of the central Alborz especially the North Tehran fault. The parts of the central Mosha fault and the regions in the east, the southeast, and the west of the basin indicate the moderate class of tectonic activity (class 3). The low elevation plain in the south and southwest of the area shows the lowest relative tectonic activity (class 4).

1. Introduction

The Alborz Mountains in the north of central Iran consist of landforms such as disharmonic folds and fault scarps along the mountain fronts. Recent tectonic activity in the southern edge of central Alborz causes expansion and deformation of the landforms. Seismic records indicate a high frequency of earthquakes of relatively small magnitude (<4) and infrequent large earthquakes (>5.1) in the Alborz (Berberian and Yeats, 2001). In this research, we assess several morphometric indices (Keller and Pinter, 1996). These indices are known to be useful in active tectonic studies (Bull and McFadden, 1977; Keller and Pinter, 2002). These studies are also important in evaluating earthquake hazards, in particular those areas with relatively high activity such as in the Holocene and late Pleistocene (Keller and Pinter, 2002). The previous studies on relative tectonic activity often tend to focus on mountain fronts and analysis of tectonic activities based on mountain front sinuosity (*Smf*) and the ratio of valley floor width to valley height (*Vf*) indices (Bull and McFadden, 1977; Rockwell et al., 1985). Later, other geomorphic indices relevant to drainage systems are utilized for study on active tectonics (Silva et al., 2003). Recent activities of local faults influence drainage systems in most active tectonic areas (Maroukian et al., 2008).

A comparison of several morphometric indices of geomorphological features (Keller and Pinter, 1996), especially with tools such as geographic information systems (GIS), can provide a valuable quantitative method. This procedure presents relative rates of tectonic activity (El Hamdouni et al., 2008). Previously this procedure has been used by researchers in tectonically active areas, such as the SW USA (Rockwell et al., 1985), the Pacific coast of Costa Rica (Wells et al., 1988), the Mediterranean coast of Spain (Silva, 1994), the southwestern Sierra Nevada of Spain (El Hamdouni et al., 2008), and the Sarvestan area of central Zagros (Dehbozorgi et al., 2010). In this study, we assessed six significant morphometric indices: stream length gradient (*SL*), drainage basin asymmetry (*Af*), hypsometric integral (*Hi*), ratio of valley floor width to valley height (*Vf*), drainage basin shape (*Bs*), and mountain front sinuosity (*Smf*). We classified the relative tectonic activity of the Tehran area based on El Hamdouni et al. (2008) and analytical hierarchy process methods. These results were confirmed by field studies.

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2. Geological setting

The structural–sedimentary zone in the north-central Iran plate consists of a folded–faulted belt expanded in an E–W direction from the east of Azerbaijan to the west of Khorasan (Fig. 1). This belt was extended by the S–N convergence of the central Iranian plate (late Triassic) (Berberian, 1983a) and the movement of the south Caspian basin to the NW (Pleistocene) (Jackson et al., 2002; Ritz et al., 2006).

The study basin (12,821.54 km^2) is located at the southern edge of the central Alborz. Generally, the dominant tectonic facet of the study area involves folds and thrust faults (Fig. 1). The S–N contraction formed thrust faults prior to the Pliocene. After the Plio-Pleistocene sinistral strike slip faults, the folding of the sedimentary covering and the development of thrust faults with a N–NE dip were constructed by the diversion of convergence to the SW–NE in Phanerozoic sediments (Allen et al., 2003).

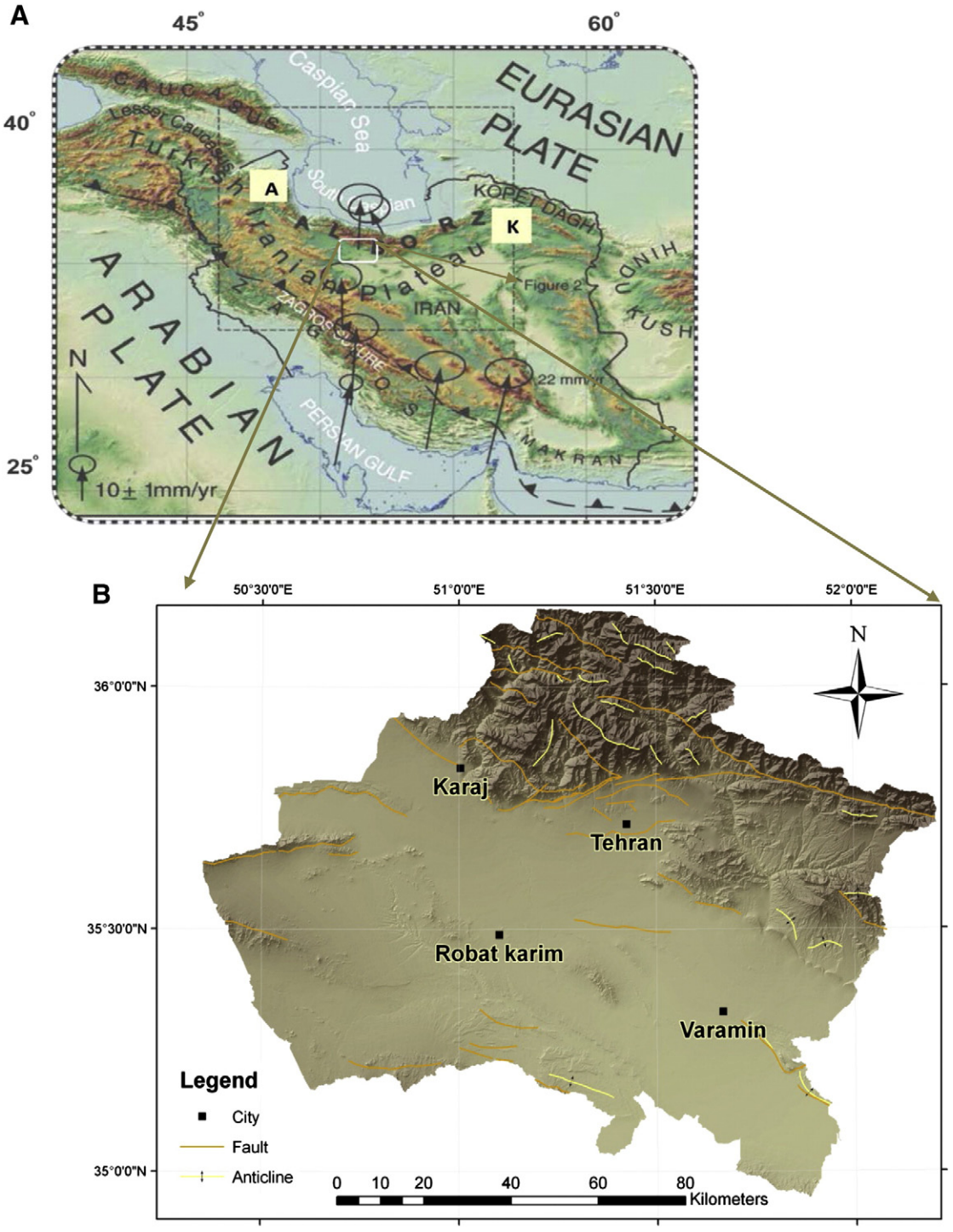

Fig. 1. Location of the study area in (A) a Middle East map (A: Azerbaijan, K: Khorasan) and (B) the study basin. Panel A is modified after Guest et al. (2007a).