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Variations in the kinematics of deformation along the Zagros inclined transpression zone, Iran: Implications for defining a curved inclined transpression zone

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ABSTRACT

The combination of inclined collision and plate boundary shape can control the nature of deformation and the sense of shear along a transpression zone. The present study investigated the effects of a boundary zone with curvilinear shape along a transpression zone on the kinematics of deformation. The kinematics of the Zagros transpression zone varies with the orientation of the zone boundary. Detailed structural and microstructural studies showed sinistral sense of shear on the southeastern part of the Zagros inclined transpression zone (Fars Arc), but dextral sense of shear on the northwestern part of the zone. It is inferred that the both senses of shear were developed coevally under a bulk general shear, regional-scale deformation along a curved inclined transpression miming the shape of the Fras Arc of the Zagros and the reentrant of the Bandar Abbas Syntaxis. The Zagros transpression zone formed by inclined continental collision between the Afro-Arabian continent and Iranian microcontinent.

1. Introduction

Current understanding of transpressional shear zones in some orogenic belts in the world indicates that the presence of curvature along the shear zone boundary corresponds to kinematic variations along these zones. (e.g. Lin and Jiang, 2001; White et al., 2002; Kuiper et al., 2011). The present study uses new data and information about the structural complexities in the southeastern curved part (i.e. Fars Arc, Fig. 1) of the Zagros orogeny. The Sanandaj–Sirjan metamorphic belt is one of the major tectonic units of the Zagros orogen (Fig. 1) and contains zones of ductile transpressional deformation (Mohajjel and Fergusson, 2000; Sarkarinejad, 2007; Sarkarinejad and Azizi, 2008; Sarkarinejad et al., 2008, 2012), which represent a crustal-scale general shear zone accommodating deformation and displacement of metamorphic rocks during inclined collision between the Afro-Arabian continent and the Iranian microcontinents (the Zagros transpression zone; Mohajjel and Fergusson, 2000; McQuarrie, 2004). Based on kinematic shear sense indicators along the NW and central segments of this belt (Dorud-Azna, Dehbid and Ghouri regions) (Figs. 1 and 2), it is clear that the Sanandaj–Sirjan HT-LP metamorphic belt was affected by transpressional shear zones (Mohajjel and Fergusson, 2000; Sarkarinejad and Azizi, 2008; Sarkarinejad et al., 2008, 2012).

The aim of this paper is to constrain the effect of the boundary shape of the transpression zone on the along strike variation in the kinematics of transpression zone based on structural and microstructural analyses. We focused on the southeastern part of the Sanandaj–Sirjan metamorphic belt (Fig. 2), where kinematic criteria for sinistral sense of shear have been recognized, in contrast to dextral sense of shear in the northwestern and central parts of the belt (Mohajjel and Fergusson, 2000; Sarkarinejad and Azizi, 2008; Sarkarinejad et al., 2008, 2012).

2. Geological and tectonic settings

The Sanandaj–Sirjan metamorphic belt is one of the major tectonic units of the Zagros orogeny that extends from the Bitlis area in Turkey to the western end of Makran (Sengör et al., 1988; McCall and Kidd, 1981), across the present-day transition zone from collision (Zagros) to subduction (Makran) (Agard et al., 2005). This belt is a zone of thrust faults that have transported numerous slices of variously metamorphosed Phanerozoic stratigraphic units (Sarkarinejad et al., 2008). During the early-Cimmerian orogeny

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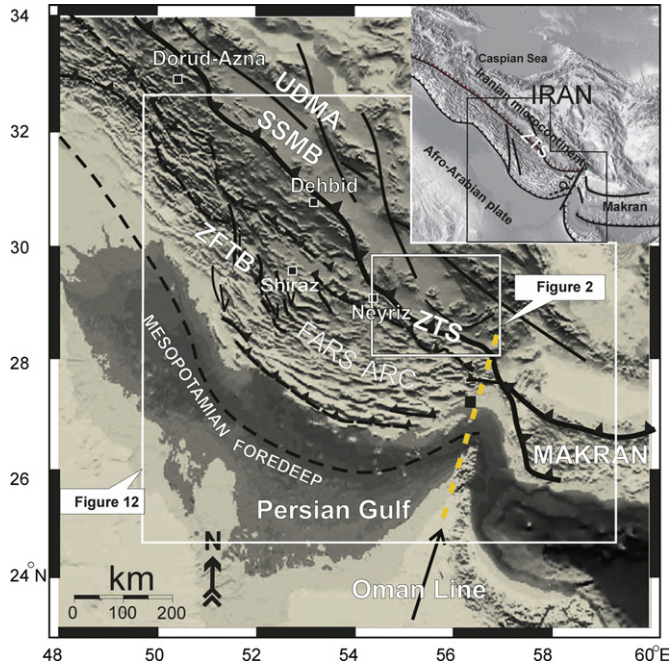

Fig. 1. Index map showing different structural domains of the Zagros Orogen southwestern Iran. (UDMA, Urumieh–Dokhtar Magmatic Arc; SSMB, Sanandaj–Sirjan Metamorphic Belt; ZTS, Zagros Thrust System; ZFTB, Zagros Fold-and-Thrust Belt) inset is shaded topographic relief map showing the Zagros Orogen and Makran (OL, Oman Line). Modified after Alavi (1994).

(Middle to Late Triassic) the Tethyan oceanic lithosphere in the southern margin of Sanandaj–Sirjan zone, created along the accretion axis located to the SW, started to be consumed by oblique subduction under the central Iranian microcontinent (Sheikholeslami et al., 2008). Following the subduction, two main regional metamorphic events and three main phases of deformation have been recognized in the area (e.g. Kargar, 2003; Hoseini, 2004; Orang and Mohajjel, 2009). The prograde metamorphic event during the early-Cimmerian discordance recorded the onset of the compression related to peak of metamorphism (Sheikholeslami et al., 2008). According to Fazlnia et al. (2007), and using U–Pb method, the thermo-barometric peak occurred at 187 ± 2.6 Ma. The peak pressure and temperature were estimated at 9.5 ± 1.2 kbar and 705 ± 40 °C, respectively (Fazlnia et al., 2007).

The Zagros–Makran syntaxis, also named the Bandar Abbas syntaxis (Molinaro et al., 2004; Smith et al., 2005), marks the transition between the 2000 km long NW–SE Zagros belt and the 800 km long E–W Makran belt. The Zendan fault marks the boundary between the eastern termination of the Zagros orogenic belt and the western beginning of the Makran. Beneath Makran, subduction of Arabian oceanic crust is still active. One of the most remarkable features of the transition from collision to subduction is the V-shape of the Zagros–Makran syntaxis, which forms a re-entrant facing the Oman peninsula promontory. Several studies suggest that the Oman peninsula may have interfered with the Zagros collision and be partly responsible for the curved shape of the Zagros–Makran transition (Ricou et al., 1977; Kadinsky-Cade and Barazangi, 1982; Aubourg et al., 2008). West of the syntaxis, the eastern part of the Zagros transpression zone is bent into an arc that is convex toward the south, the Fars Arc, which is the eastern

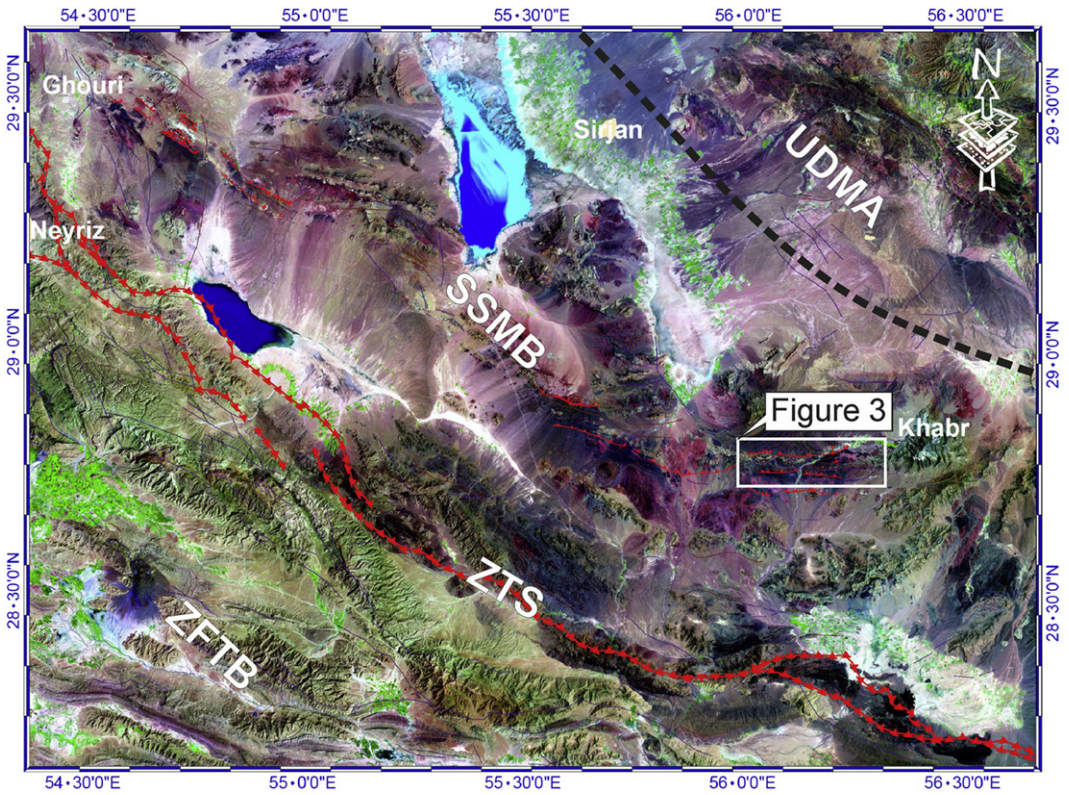

Fig. 2. Satellite image (from MrSID; Multi-resolution Seamless Image Database which is a patented, wavelet-based file format designed to enable portability of massive bit-mapped (raster) images) showing structural setting of the study area (inset box) in the southeastern part of the Zagros Orogen. (UDMA, Urumieh–Dokhtar Magmatic Arc; SSMB, Sanandaj–Sirjan Metamorphic Belt; ZTS, Zagros Thrust System; ZFTB, Zagros Fold and Thrust Belt).