Structural and microstructural analyses of the Saadi fault, south of Shiraz

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Abstract

The zagros orogenic belt is in central part of the Alpine – Himalayan orogenic belt which have been considered as boundaries of collid both between Afro Arabian and Iranian micro – continent. The saadi fault which is part of the zagros orogenic belt. This fault located in the Shiraz urban area. The trend of this fault is NW – SE, parallel with the anticline and syncline of the zagros simply folded belt. For study of the Saadi fault, the natural microgauges such as calcite e – twin and c –axis from oriented samples along the fault planes were used to unravel the deformation history of the fault. Twinning strain (e_1, e_2 and e_3) was calculated using the strain gauge technique. Maximum mean internal strain of Saadi fault region is 3.7 ± 0.12. Twin analysis yield the orientation of the maximum principal stress (σ_1) is NE – SW. That confirm with convergence movement of Iran and Afro – Arabian plates.

Introduction

The mechanical twinning of calcite is one of the principal deformation mechanisms in coarse grained limestone deformed at low temperatures and pressure. [1].

In calcite twinning always occurs in preference to slip, provided that crystals suitably oriented.

Calcite is the most sensitive mineral for twinning and the most likely to provide useful tectonic information, especially in foreland settings where the outcropping formations are mainly sedimentary rocks. Twinning of minerals depends on the magnitude of the shear stress which has been applied to them. It has been proposed to make use of this property for evaluation the stresses which have been supported by a rock during its history. [8].

Turner (1953) and Weiss (1954) introduced the use of calcite twins as a stress gauge. From consideration of the crystallography of calcite, Turner concluded that it must be possible to deduce geologically significant C (compression) and T (tension) direction by measuring the orientation of twin lamellae in deformed calcite rocks. Individual C and T axes are constructed from U – stage measurments of e – lamella and c – axes and then contoured on a stereographic net.

Groshong (1972, 1974) developed the Calcite strain gauge technique, a method that allow the determination of the complete strain tensor which has been used by numerous authors to document strain due to intra – crystalline deformation by twinning in slightly to moderately deformed limestones. [5].

Mean calcite twin width correlates directly with temperature of deformation such that by twins dominate below 170 ˚C and thick twins dominate above 200˚C. Above 250 ˚C dynamic recrystallization is an important deformation mechanism in calcite. [4].

Methods of strain/stress analysis based on calcite twins share the fundamental assumption that the measured twins formed in a homogeneous stress field and were not passively rotated after formation. [8].

All the analysis methods are based on the crystallographic twinning low, but only thin straight twins (types I and II) are suitable for stress – strain analyses. [5].

Geological setting

Iran is located within the active convergence zone between the Arabian and Eurasian plates.

The zagros mountain belt are a seismically active fold and thrust belt resulting from the collision of the Arabian plate with the continental crust of central Iran that began in the miocen and has continued to the present.

One of the oblique slip fault of zagros simply folded belt is Saadi fault. The trend of this fault is NW – SE, parallel with kaftarak anticline. Kaftarak anticline with trend north west – south east and altitude of 2170 meter is located in suburb of the Shiraz city. Most of this anticline consist of Jahrom – Asmari formation.

Resistant limestone anticlines control the characteristic morphology of the region. [9].

One of the most important geological feature that observation in arial photos and field is overturning of northen flank of Kaftarak anticline.

Structural analysis of Saadi fault

In structural analysis, type of joints, the conjugate fractures and displacement were occurred and structures created by Saadi fault are considered.

For joint analysis, selection method only for the main joint and fractures is measured.

Therefor joints were selected at different stations.

Measured data and draw rose diagram show the trend of fractures in this area approximately NE to SW.

Micro structural analysis of Saadi fault

For study of the Saadi fault, the natural microgauges such as Calcite e- twin and C – axis from oriented samples along the fault planes were used to unravel the deformation history of the fault.

In this paper c- axis and e- twin of the oriented samples of calcitic veins, micro veins and slickensides along the saadi fault was measured. The universal stage was used to measure e – twin and c – axis, and calcite strain gauge program was used to determine twinning strain and maximum principal stress (σ_1).

The calcite strain gauge technique has been used successfully to determine strains in slightly to moderately deformed limestones. The technique involves the use of a universal stage to collect calcite twin orientation, thickness and frequency data.

The program calculates principal strain magnitudes ,orientations and computes the Turner compressive (C) and tensile (T) stress axes for each twin set. [2].

Conclusion

Iran one of the most seismically active regions of the globe. Seismicity here is the direct evidence of the continental convergence between the Arabian and the Eurasian.

Twinning strain (e_1, e_2 and e_3) was calculated using the strain gauge technique. The mean maximum values is $e_1 = 3.7\% \pm 0.12$, $e_2 \sim 2\%$ and $e_3 \sim -5.5\%$.

(Lacomb & Mouthereau, 2006) suggesting that internal strain by twinning did not exceed 3 – 4%. This result with the result of this study conforms.

Result of the calcite e – twin analysis (Fig. ٧) represent the calculated positions of σ_1 and σ_3 for the analysed data set.

Maximum principal stress (σ_1) is N 30˚ E to N 40˚ E. This orientation conforms the direction of Arabia – Eurasia convergence and a little difference is probably on deformation conditions.

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Figures:

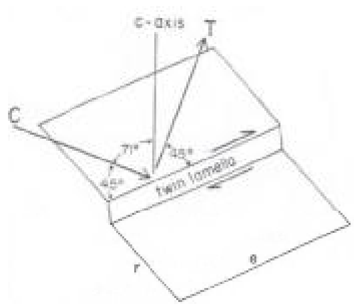

Fig. 1 . Crystal section to show the angular relationships between twin lamellae, c- axes and compression (C) and tension (T) directions, in calcite . [12].

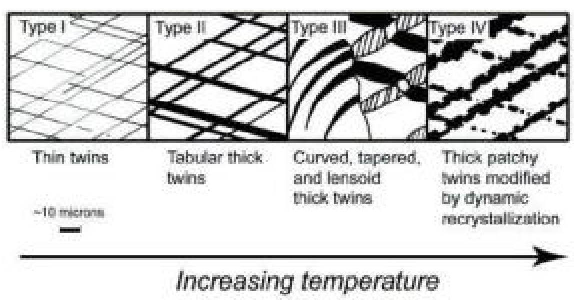

Fig. 2 . Schematic illustration of the influence of temperature on deformed by calcite twinning. [4].

Fig. 3 . Landsat image of Saadi area

Fig. 4 . Overturned layer along Saadi fault

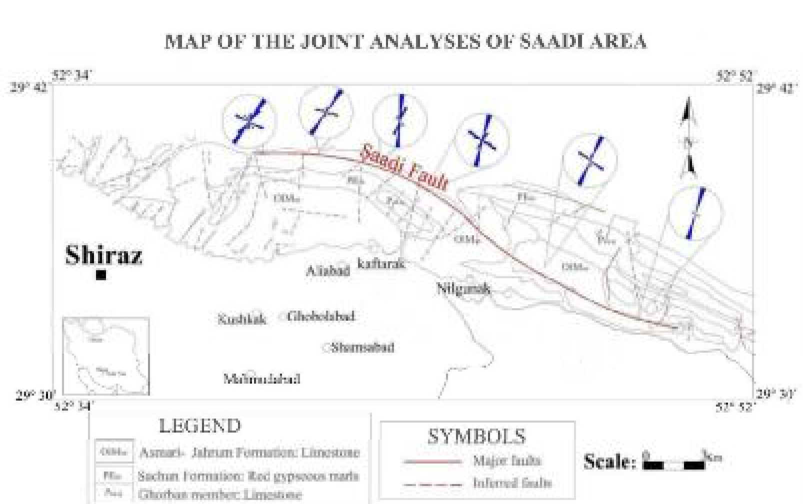

Fig. 5 . Detailed map of the joint analyses data of Saadi area

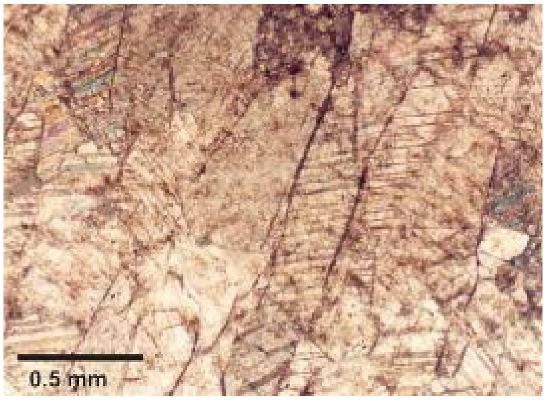

Fig. 6 . Calcite twins in a thin section of study area

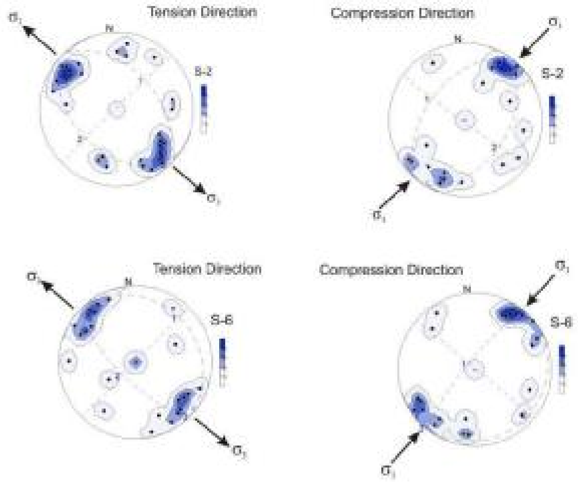

Fig. 7 . Comparison of compression and tension axis distributions.