Study of deformation history in southeast of Iran, based on structural analysis (Nosratabad area)

Mehrvash Nabiei and Sasan Bagheri

M.Sc. graduated of Geology, University of Sistan and Balochestan, Zahedan, Iran

ABSTRACT

Nosratabad area is in southeast of Iran and it is located between lut block and east mountain of Iran. The study of deformational structures in satellite images and field study indicated that this area has a complex tectonic history. The first tectonic event (D1) has occurred from cretaceous until lower Eocene. These folds have located in ophiolitic mélangé unite and Turbidities unite. The evidence in ophiolitic mélangé, that’s its’ age is upper cretaceous, are some micro folds, and in Turbidite unit that it’s age is lower Eocene, are some macro floads. The second event (D2) is synchoronic with sistan sutarezone creation. This even is the most important of deformation event in this area and it has occurred from upper Eocene until Oligocene thrusting and invers folds with NW trend and SW vergence, appearance of slatting in ophioliticMelang and Turbidities units are evidence of this event.The third (D3) has occurred in upper Miocene. The evidence of the third one are folding of Mollas unit in the west of Nosratabad with Oligocene age, and also creation of pull apart basins in tension of Nosratabad strik-slip fault are another evidence of this event. Continuance of Iranian plate compress along with Arabian plate and centralization of most strain in east basin of Iran has caused starting of Kahurak fault activing and reactivation of Nosratabad fault. Folding and faulting of Neogene sediment during of fourth event has occurred in Plio-Quaternary. Tectonic evolution of 60 million years ago of Nosratabad changing area has indicated a variation in tectonic basin of this area. These chang represent a subduction zone of Neotethys until closing of that. Also this evidence represents that cutting and displacement of this suture zone has occurred synchronic with clockwise rotation of Lut block.

Key words: Iran, southeast, structural analysis, Nosratabad area,

Introduction

The study area is located between lut block and East mountain of Iran (figure 1), its longitude is E 58°50′ and its latitudes is N30°40′-N30°55′. Studying structures in deformational area is one of suitable elements for more understanding of deformational mechanism and separation of deformational event [17]. Structures have been studied in this paper are: folds axis, faults, slatting of metamorphic rocks. In this paper has been tried to study primacy and recency of deformational event in Nosratabad area. Also this study is the first one for distinguishing of tectonic history of this area and east evolution of Iran. This suture zone has some terrrene. These are including: ultramaphic and Cretaceous fhylishes [4].

Eocene fhylishes in ophiolitic Melang forms, Oligocene conglomerate and alluvial of margin of lut mostly show- N-S until NNWSSE trend [18], but in to North direction the trend of geological structures and topography of them rotate in to E-W [8]. Also according to berberian and king theory collision of lut block with Afghan block has been caused that east ophiolit Melang of Iran tabernacle in middle Eocene in tension of Sistan suture zone, that it's subduction dip is into East side [3].

Davoudzadeh in its model has imagined that central Iran and Alborz during of Paleozoiec has been located in the North part of Gondvana and in the Lower Treisouse they has been joined to sli ce of south margin of Lurantia, floated as micro plate in the Tethys Ocean. Study on paleomagenthic data, on the Paleozoic sediment represent that east-central Iran microplate has rotated about 135° respect to Lurantia because of closing of paleotethys. These events have been synchronic with Cimerian or upper Hercenian cycle.

In the lower Mesozoicas kaft Phenomena one part of central Iran that has jointed to slice of south margin of Lurantia, floated as micro plate in the Tethys Ocean. Study on paleomagenthic data, on the Paleozoic sediment represent that east-central Iran microplate has rotated about 135° respect to Lurantia cycle from upper triacipous until now[5]. Conrad according to paleomagenthic data of south of lut has
shown that this terrane has rotated about 90°uncloak wise, from Paleocene until Miocene[3].

Fig. 1: location of study area in Iran

According to these data Lut block had a different situation in the north margin of Neotethys ocean in the past time. McCull be lives that the slice of Tethys has been existed between Iranian plate and Arabian plate until upper Miocene with opening of Read Sea. Two margins of these plate has collected to each other in the Pliocene. This collision caused zagros folding in the continental margin of Arabian plate and next thrusting of zagros part has hidden or has destroyed the evidence of oceanic sediment [13].

New study with Bagheri and et al that has done on tectonic of east Lut in Neh bundan area recommend some tectonitratigraphicterrene, that Dehsalm metamorphic complex introduced as an accretianry prism. This complex age is upper terriacous-jorasic or older than it. It also involves some various tectonitratigraphic terrane. Creation of this complex is because of existence of an old subduction zone on north margin of Noetethys Ocean. This margin has jointed to south margin of Lut block (East margin of Lut block as present).

In during of tectonic evolution of Lut block margin from Eocene until now a new accretionary prism as Nehcomplex has jointed to the other old terrene. All of this evolution is because of 90° unclockwise rotation of Lut block from PalEocene until upper Eocene[3].

Allen and et al believe that N-NE movement of some parts of central Iran respect to Afghanistan has been caused sinstral shear in east of Iran [2]. Some convergent has occurred between central Iran and Afghanistan in Sistan and some the other has occurred in west margin of Lut [3]. More structures in east of Iran has formed as strick slip fault activity [8 and 20]. Different kind correlation of these faults with structures can caused various type of deformation in Sistan suture zone.

Material and Methods

Study site description

Study of Nosratabad area according to terrene division:

For understanding the type and this kind of affection of deformational structures, this area has been divided to some terrines. In this area because of contraction of two faults structures, Nosratabad and Kahurak there are a rather perfect out crop of lithosratigraphic unit from upper cretaceous until Plio-Quaterancry. So this area is a suitable place for studying about deformational events. In this area ophioliteMelang outcrop in the east of Nosratabad fault. This unit has been made from basic rock, ultrabasic, pillow lave, planner dykes, pelagic sediment and Radiollarit, that they has been influenced of tectonic and so has been created some shear zone in this area.

Neogen sediment outcrops between Nosratabad fault and Kahurak fault. This unit also involves a Mollas unit that has located at the west of Nosratabad fault as a inclines, and its age is Oligocene. Turbidite unit has located at the east and southeast of Kahurak fault, and also lithology of them and the studies that has been done, this area has been divided to 3 terrene.

As lithological study a complex of Ignious, sedimentary and low metamorphic rocks outcrop in this area, that it is involved: ophiolitic Melang, Intrusive vein like dykes, sandston shale unit and
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Table 1: Tecton stratigraphic terrane, sub tecton stratigraphic, age and lithology

<table>
<thead>
<tr>
<th>Age</th>
<th>Tecton stratigraphic terrane</th>
<th>Sub*</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plio-Quaternary</td>
<td></td>
<td>S.T3</td>
<td>Alluvial sediment, sandstone, silts ton and fine grain Cong lomerato</td>
</tr>
<tr>
<td>Neogene</td>
<td>Stratigraphic terrane</td>
<td>S.T2</td>
<td>Marn sub terrane with sand ton and tiegrain cong lomerate</td>
</tr>
<tr>
<td>Oligo-Miocene</td>
<td>(S.T)</td>
<td>S.T1</td>
<td>Conglomerate sub terrane</td>
</tr>
<tr>
<td>Eocene</td>
<td>Disrupted terrane (D.T)</td>
<td>D.T3</td>
<td>Volcanic sub terrane</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pillow lave</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Toffee</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Andisite layer</td>
</tr>
<tr>
<td>Upper cretaceous</td>
<td>Compositic terrane (C.T)</td>
<td>C.T3</td>
<td>Ophiolitic dyke sub terrane: Diabas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C.T2</td>
<td>Tectonic sub terrane, phylit, metamorphic shale about shist and phylit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C.T1</td>
<td>Ophiolitic melang: serpentine, Gabro, pillow lave, pelagic sediment</td>
</tr>
</tbody>
</table>

According to these divisions for tecton stratigraphic terrane, the deformational event has been divided to four event that will illustrate next.

Method:

Most important of deformational event in Nosratabad area.

The first deformational event (D1) probably is the oldest event in this area. This event mostly is observable in disrupted terrane especially in D. T.1 sub terrane. In this sub terrane (D.T1) fold axes has shown E-W terrane (Figure 2). These trends have been shown in diagrams (Figure3).

**Fig. 2:** fold with E-W trend
Offspring of this event is unknown, at present. Folds with E-W trend probably are the evidence that represent this event has caused synchronic with subduction of Neotethys Ocean and its thrusting. These structures are in Sistan shear zone that the trend of this zone is NNW-SSE, and it is disharmonic with stress ring.

This structure has been influenced with newer deformational event that occurred in other phases. This structures also have been superposed with new structures with NW trend that has created in next event.
The evidence of this event only observed in terrane with upper cretaceous-pliocene age so probably it has occurred in lower Eocene.

Results:

Second deformational event (D2):

One of the evidence of this event is dynamic metamorphism shows slatting and also proceeds phillitic rock, also metamorphism about sub green shist facies has been formed in T.C.1 subterrane. In this area there are some thrust that they are the boundary between, folds with SWvengeance (figure 6) these folds have the some offspring with the thrust, figure 7 has shown its diagram.

Fig. 6: image of Inverse fold in T.c.1, cutting this folds with faults that have been occurred in the third event.

Fig. 7: diagram of Inverse folds with SW vagrancies, according to filed studies.

Second deformational event (D2) in disrupted terrane:

One the most important evidence for this event is existence an angular unconformity between disrupted terrane and stratigraphic terrane. The layers of T.S1 lie on the D.T2 with this angular unconformity. The Dykes in this disrupted terrane with N20Wtrend (figure 8), during of this event, has introduced to this terrane and cut it. This non ophiolitic dykes in this terrane created because of syncollision until post collision magmatism.
Fig. 8: The Dykes in the disrupted terrane with N20W trend

- The third deformational event in tectonic stratigraphic terrane in Nosratabad area
  This event has occurred in Oligocene and Miocene. One of the most important evidence for this event is west Nosratabad folldding. The other evidence of it is Nosratabad fault activity that it has occurred after Sistan suture zone formation. This event also has influenced on old terranes and it has caused that new structures have superposed on old structures of these terranes.
- The third deformational event in composited terrane.
  This event acted on old tectonistratigraphic terrane such as composited terrane, and has influenced on its structures. In this terrane there are some structures such as fold axis with NW-SE trend. This kind of folding is like west Nosratabad folding in ST1 subterrane and the both trend of them is similar.

The west Nosratabad folding is a inclines, that has been formed in third formational event (D3) and the axis trend of this fold is NW-SE. these folds that have formed in this event have been superposed on those structures that have formed during of events.

The trend of them have been depicted on diagrams (Figure 9)

Fig. 9: The folds diagram in composited terrane, according to field studies, NW trend.

- The third deformational event (D3) in disrupted terrane:
  This event is probably because of Nosratabad fault activity. Because of this fault activity the units of disrupted Terrance cut and displacement. Appearance of this fault in the upper Eocene units, represents that, the age of old units that have been added to each other, should be older than the age of Nosratabad fault formation, because this fault has cut all units of this terrane.
  So the age of starting of Nosratabad fault activity in this area is probably oligomiocene and its age is after that Sistan suture zone formation this event has influenced on disrupted terrane and it has caused that some floding structures have superposed on old structures, so the trends of these old structure have been changed and show the same trends like
invers folds that has been formed in this event. (Figure10). Figure 11 has shown diagram of Inver
fold diagram in disrupted terrane.

Fig. 10: Inver fold diagram in disrupted terrane

Fig. 11: Diagram of Inver fold diagram in disrupted terrane

- The third deformational event in stratigraphic terrane.
  
  In this event the west Nosratabad fold has been formed, that this structure is a cincline with NW-SE trend. It is in T.S.1 subterrane.

- The fourth deformational event in stratigraphic terrane:
  
  This event has occurred during of Pliocene. During of this event the most important part of present shape of this area has been formed. D4 has occurred during of a compressional event in Pliocene, it has been caused that T.S2 subterrane has been folded. Evidence of this event includes displacement of stream (figure 12) and old fold axes (figure 13), kahurak fault activity in this area and bending at structural trend of Nosratabad in this event. This event has caused that new structures have been superposed on the old trend and shows a cross lamination in fold (figure 14) this fold show two trends that are crossed.

  At least four major deformational events have occurred in Nosratabad area. The firs one (D1) has occurred at the lower Eocene or prior to. The evidence of this event is folds with E-W trend. This deformational event is synchronic with the first stage of tectonic event. It has occurred at the same time with subduction of ocean.

  The second deformational event (D2) has occurred during of upper Eocene until Oligocene this event is synchronic with closing of east Iranian basin. The evidence of this event are:1 angular unconformity between stratigraphic terrane with oligomicoene age and disruptedterrane, with Eocene age 2-thrusting with SW dip direction 3- Dynamic metamorphism about philit at the margin of Nosratabad fault 4- inversed and cut folds with SW vengeance. This event is synchronic with second tectonic event and also it is synchronic with collision of two blocks.
Fig. 12: Satellite images of displacement of stream

Fig. 13: Satellite images of displacement of old fold axes

Fig. 14: Cross lamination in fold, new trend N15W/60NE has been superposed on old trend
Conclusion:

During of this stage addition of units to lut block has been occurred:

- The thired deformational event (D3) has occurred form lower Oligocene until middle Miocene. During of this even the west Nosratabad fold has been created.

  Also Mollas sediment represents in this area at this time and it is because of collision that has occurred in the second stage activity of Nosratabad fault has related to this event this event is synchronic with the thired tectonic event.

  That it has occurred during of compeltting of collision event. The added units to the lut block during of the second tectonic event, compere morethan past.

- The fourth deformational event has occurred form pliocene until Quaternary, the evidence of this event are: starting of Kahurak fault activity in the study area, displacement of streams and old fold axes, bending of the Nosratabad faulttrend in the north of the area, folding of Pliocene units and cutting of Quaternary alluvial sediment.

  This event is synchronic with the last tectonic event and it related to the post collision event.

  During of the last tectonic event the extensional component of faults are dominant so the Mollas sediment has deposited from Pliocene until Quaternary in this area.

References


