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Geometric analysis of folds and structures related to folding in two thrust zones of Kahorkan and Lashar

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Abstract. In Makran Accretionary Wedge, there are four main structural and stratigraphic states separated from each other by large thrusts: the northern Makran, inner, outer and the coastal. In the folds of Kahorkan Thrust, east-to-south to west-north-west (ESE-WNW) the trend is consistent with folding and directional layering. Plunge-oriented direction of the folds exists in both the upper and lower Miocene slopes from low to high slopes. In Thrust Kahorkan zone, the high slope of right-lateral strike-slip fault (over 80) with NW-SE process, left-lateral movements with NE-SW trend show the Northern General Shortening. Generally, thrust faults have an approximate east-west orientation and the age of these faults reduces from north to south and the structural process of the region indicates that the region is tectonically active.

Key words. Makran, fold, thrust, Kahorkan, Bashagard.

1. Introduction

Prior to the beginning of field harvesting, geological map of 1:100 000 Fannuj and 1:250 000 Nikshahr, Landsat satellite images of ETM + were studied. The profile of the pivot points of the folds, which was obtained from the field debris, was used to calculate the general trend of folding of the area. Moreover, the extension of the axial surfaces of the folds and the direction of their slope can be a good guide for calculating the main stresses of the area and the extent of their folding bonding. In doing so, Schmidt network was used, and the axial surfaces of the folds and the circuit diagram of the polar axis were plotted. In this study, the folds and faults between Lashar and Kahorkan thrusts are examined and compared. The study area is located in the inner Makran between the Bashgard thrust in the north and Kahorkan thrust in the south. It includes Eocene sequences (Tangeh Sarheh units) in the north, Miocene (Pashamsg unit) in the center, and Oligocene (Pirdan unit) in the south with different sedimentary faces [1]. Lashar thrust plate is in the northern part

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of the study area mainly composed of Eocene, and oligocene turbidative sequences [2]. Kahorkan thrust is the lowest structural unit in the western part of Makran, including the oligocene and miocene sediments.

2. Methodology

This plate is the tectonic unit's upper thrust in inner Makran. Bashagard thrust and the fissile zone of the northern boundary of thrust plate and in the south of the lower boundaries are thrust faults, which have identical names, such as thrust plates. Basically, folds and faults are structures within this thrust plate. Elisterstrom covers a large portion of the thrust plate.

Generally, the folds are tight, and in some places discontinuous and close to the isoclinal and the pyloric axis (distances greater than 1 mm), which refer to moderate to severe cleavage (see Fig. 1). The measurement of the axis of the folds shows a general trend of NW-SE and the low and high slope plunges in a straight line, which is consistent with the dimensions taken from the layers and axial panels of the fences. The axes of the folds can be traced back from a thousand to several kilometers, which imply the cylindricality of some structures[3]. The tortoninelastromes cover the discontinuity of the thrust plates, the poor cleavage of the gap in the Chilean Elliststrom matrix to the same tendency of the same cleavage plate-like plate cluster in the underlying sequences, which implies the fold before the elistrestrum by the E-W folds in the same direction with tight folds in the underlying sequences.

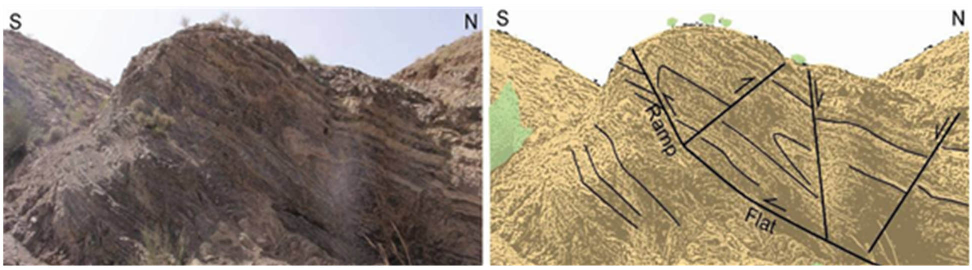

Fig. 1. Photo and painting of Flat and Ramp faults and with folds per unit of pipet at 26 29 30.4 N; 59 58 20.6 E outbreak

Thrust Lashar is in the south of Tang Sarheh where the lower volcanic and deep-sea sediments of the Eocene in the pipeline can be seen thrust on the oligoceneturbodieses and the torsion-eustostromes (see Fig. 2).

The severity of the fault in the oligocene fringe and in the Eocene landrace is higher than that of Elisostromus, showing tectonic activity before and after the elistrestrum during the thrust zone. The best visible outcrop is the thrust zone in the 10-kilometer long south of Tangeh Sarheh. The parallel faults of the layers arranged upwardly uplifting the layers of the flat and ramp systems (Fig. 2), with compatible turbidity sequences, which are susceptible to thin layer tectonics (thin-skin tectonic). Some folds are asymmetric with a tendency toward the south sloping with forward-edged edges by Ramp faults.

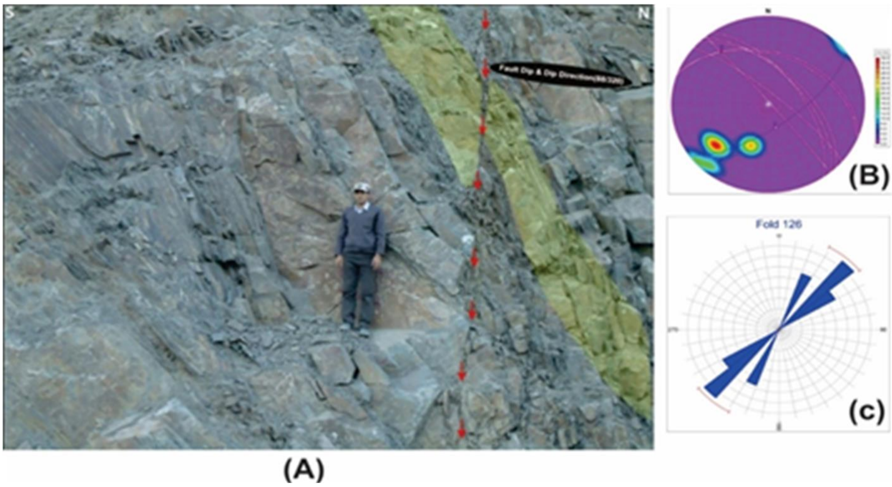

Fig. 2. A view of a fold, vision toward the east, which is tight in the tangential compression-tangential cross-sectional view

3. Results

3.1. Structures of the plate in thrust Kahkuran

Kahkuran thrust plate is the lowest tectonic unit in the western part of inner Makran, which is bounded by the Gasrgand thrust in the north and thrust Kahkuran in the south, including mostly sandstone turbidative of high oligocene (Pirdan unit) and lower miocene (Pashamag) in the north. The discontinuous torsion elastromes are scattered on the northern section of the plate.

Two different styles of folds have been identified from measurements and transverse slices throughout the thrust (Fig. 3).

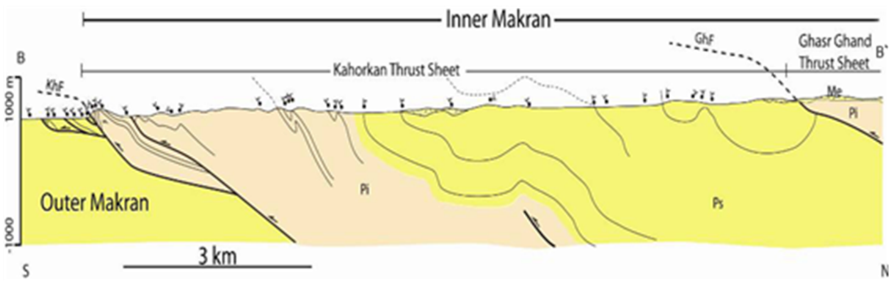

Fig. 3. Cutting of the area of thrust Kahkuran plate, including the upper oligocloss of Pirdan unit (Pi), the lower miocene of Pashamag (Ps) and the eostestromtortonin (Me), which are thrust by thrust Kahkuran on the outer Makran

1. Closed-to-tight folds of different sizes with a tendency towards the south in the upper Oligocene sediments, axial plane foliation in the shale are discrete and strong.

The folds and axial plane foliations are similar, which high oligocene sediments explain in Gasrgand and Pashamagthrusts [4].

2. Folds in the miocene sediments are towards the north, mainly symmetrical, open and round with a long wavelength (greater than 1000 m) and a weak axial plane foliation (Fig. 4). Different structural styles show a stronger deformation in the upper Oligocene sediments of miocene sediments.

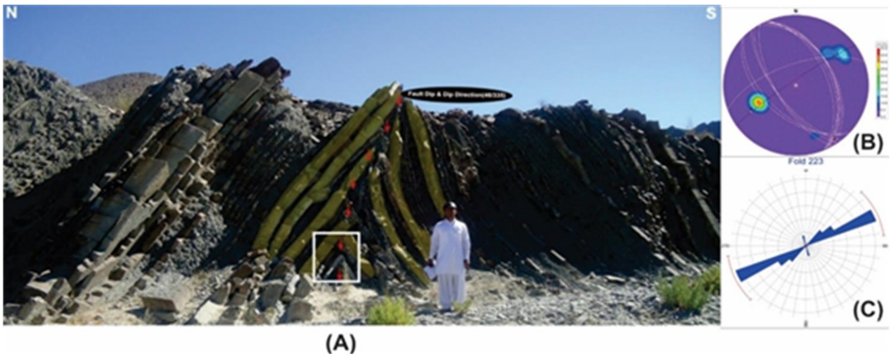

Fig. 4. A–isoclinal fold 20 with south-vergent orientation in the oligocene turbidative; consider the small-scale thrust cutting in the southern cores of the fold, the death to the south within the fold edges, B–graph π with the layering levels in fold edges number 20 is based on the slope and direction of the slope, C–Rose diagram of the lines of the positions taken in fold 20

The eastward to south-east up to west-west (ESE-WNW) trend is consistent with folding and directional layering. The plunge axis of the folds in both the upper oligocene sediments and the lower miocene are from low to high gradients.

The east-west thrust of Kahkuran is located north to the northwest of Nikshahr, and has brought upper oligocene turbidity to the miocene's mid-miocene sediments. Divergence in the hanging wall is poor. The front edges are vertical to collapsed, cut off near the thrust (Fig. 5A), which shows the faults ahead of the fault, and the the hanging wall has reverse faults, and many parallel layers (Fig. 5b). Local ramps show a falt-and-ramp system. It shows the fault data along with Kahkuran thrust of the rotation between Raask and Bent slope towards north to the northeast and the southern slope for the reverse faults. In general, it is a movement towards the south derived from the measurements [5]. Large slopes of right-lateral strike-slip fault (over 80) with NW-SE process, and left-lateral movements with NE-SW show general N-S shortening trend (Fig. 6).

Table 1 summarizes the azimuthal characteristics of axial plane and plunge of folds in the study area.

4. Conclusion

The studies were to examine the geometric and kinematic properties of folds, folding and tectonic construction of the region. The results of these studies show that the studied part is a part of the inner Makran placed between the Bashagard

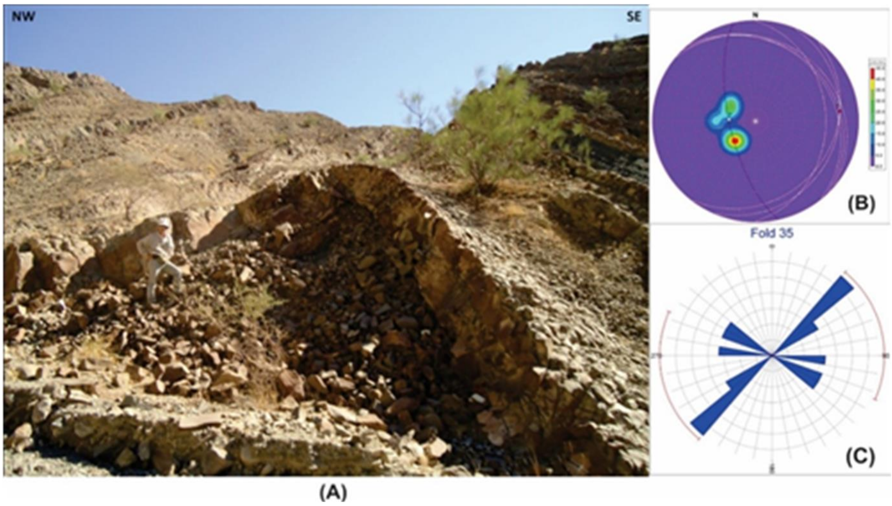

Fig. 5. A–a view of fold 28 in Fluety segmentation (Fluety 1964) based on interlimb angle of this fold of gentle type, B–graph π along with the layering levels in the edges of fold 28 based on slope and direction of slope, C–Rose diagram of the lineline taken in fold 28 (Gps: 26 17 10 N, 60 10 35 E) 26 18 40 N; 060 10 15.6 E

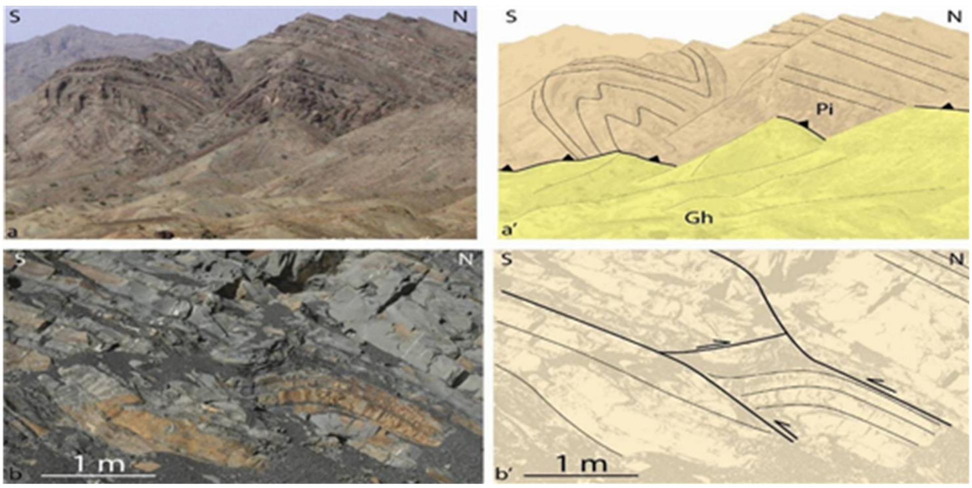

Fig. 6. Top–the photo and painting of fault-propagation on fault in dominant oligocene sandstone of the Pirdan unit (Pi) in the hanging wall of Kahkuran thrust; hanging wall includes the lower miocene marls, with the gypsum of Gasrgand unit (Gh) at 26 16.876 N; 60 10 25.68 E; area of vision about 500 meters, Bottom–photo and painting of thrust and ramp bending drives in dominant sandstones in upper oligocene sediments in 26 17 51.2 N; 60 10 10.2 E outcrops

thrust in the north and Kahkuran thrusts in the in the south, from the lower Eocene sequences to the middle Miocene with different deposited facies. Measurements of fault plates and slican sides in Lashar thrust zone prove NE slope of reverse faults in the south of TangehSarheh and N to NW the slopes of reverse faults along with

S slope of reverse faults in the south of Fannuj. In Kahkuran thrust folds, the east-west to northwest (ESE-WNW), the east-west to northwest trend is consistent with folding and directional layering. The plunge direction of fold axis in both the upper Oligocene sediments and the lower miocene are from low to high slopes. In Thrust Kahorkan zone, the high slope of right-lateral strike-slip fault (over 80) with NW-SE process, left-lateral movements with NE-SW trend show the Northern General Shortening. The slope of the main thrusts is in the north direction. The growth structures in the sedimentation unit show an active tectonic domain. Generally, thrust faults have an approximate east-west orientation and the age of these faults reduces from north.

Table 1. Azimuthal characteristics of axial plane and plunge of folds in the study area

Fold	$\beta = \pi$		Plunge angle	
	Dip	Dip direction	Dip	Dip direction
1	8	79	74	315
2	27	354	68	178
3	32	332	54	182
4	2	108	49	201
5	20	308	70	120
6	8	290	85	125
7	14	300	46	203
8	12	337	57	221
9	8	321	11	230
10	13	135	53	41
11	7	44	45	142
12	15	142	74	323
13	33	9	36	258
14	23	321	68	164
15	53	180	40	11
16	5	341	53	253
17	7	133	72	239
18	13	117	74	305
19	17	140	36	243
20	8	145	29	238
21	33	22	44	258
22	26	6	50	127
23	8	335	49	241
24	12	150	14	243
25	24	11	24	112
26	16	30	34	294
27	5	4	31	271
28	19	83	68	275
29	15	354	40	248

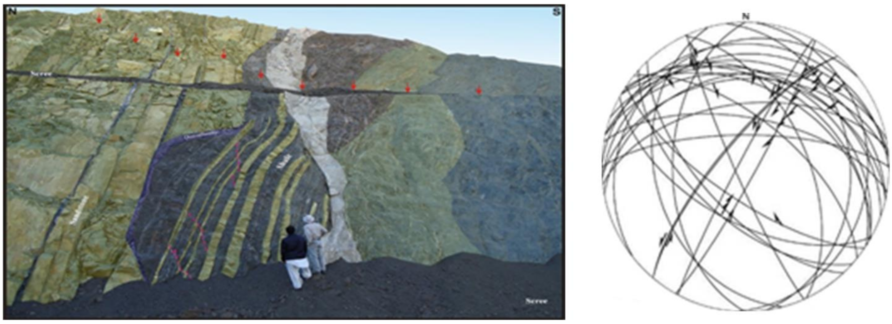

Fig. 7. Measurements of 29 fault plates and slickenside along thrust Kahkuran

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