

Geography and Development  
10<sup>nd</sup> Year - No. 28 - Autumn 2012  
Received : 11/6/2011 Accepted : 18/7/2012  
PP : 31- 39

## **Geomorphology and Genesis of Sahl Abad Playa – East of Iran**

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### **Introduction**

Sahl Abad playa is located at about 120 kilometers south of Birjand at Birjand-Nehbandan road in South Khorasan province. This playa is geographically located between 58° 40' to 60° 10' east longitude and 31° 50' to 32° 15' north latitude , the area of playa is about 1116 km<sup>2</sup> (Figure 1).

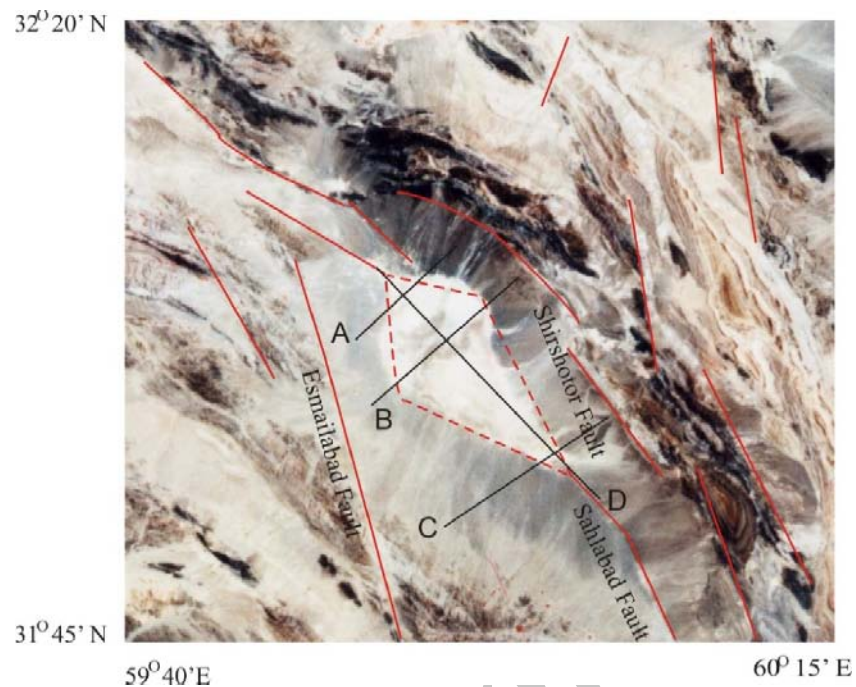
The study area is located in dry and arid climatic conditions. Since there is no meteorology station in Sahl Abad playa, therefore based on the figures of the surrounding areas, it is possible to estimate the annual average of precipitation of all the area about 150 mm (Eshagian, 1990).

Formation of Sahl Abad salt flats has made a new ecology in the north east area of Nehbandan, in this area, extraction of salt storages and different kinds of industrial salts creates a suitable opportunity for sustained job opportunity in the deprived area of Sahl Abad. Therefore recognizing its geomorphology features and natural geography will be a great help for development planning of the area. It is hoped that this study leads to a better recognition of the said flat and be used in the studies for geographical investigations of the area, watershed management, flood control, exploring natural and mineral resources and other similar cases.

Sahl Abad playa is an active sedimentary basin in quaternary. Geomorphology and morpho-tectonic of this playa and the mechanism of its formation are the main goals of the present study.

### **Research Methodology**

Methods include studying aerial in 1/55000 scales, satellite photos in 1/1000000 scales, field works and sampling from sediments and salts up to two meters depth.



**Figure 1: position of Sahl Abad playa on satellite image that shows main faults and position of topographical cross sections of Figure 6. (From Landsat 8).**

### Discussion and Results

First works were done by Krinsley (1970) and Samani (1973). However this is the first work on Sahl Abad playa. Many works have been done on playas around the world. Here some works that related to our work can be referred here such as Castaneda et al. (2005) on facies identification within the playalakes of the Monegros desert in Spain, Gutierrez-Elorza et al., (2005) on Origin and evolution of playas and blowouts in the semiarid zone of Tierra de Pinares, Duero Basin, Spain, Messina et al., (2005) on Macropolygon morphology, development, and classification on North Panamint and Eureka playas, Death Valley National Park CA and Mann et al., 1983 on the effects of structure geology on playas.

Quaternary sediments are important in formation of Sahl Abad playa. These sediments include recent alluviums, alluvial terraces, alluvial fans, sand dunes and salt plain. The study area is a folded, faulted and crushed zone that is formed in a convergent area. Faults are mostly thrust and strike slip. Trends of folds and faults are mostly in north west- south east. The tensional stress with this trend has formed a Pull-apart basin (Figure 1). The most important faults are Shir Shotor, Sahl Abad and Esmail Abad (Figure 1).

Sahl Abad playa extended 1880 kilometers squares. Based on geological and topographical maps, aerial photos, field observation and Krinsely (1970), Samani (1973), Ahmadi (1988) and Torshizian (1994), two types and few faces have been identified.

1- Mud flats types: There are five facies including puffy and soft faces, plough surfaces (Figure 2), clay plain, Nebka and clay-slat polygons (Figure 4).

2- Salt plain type: there are five faces including clay polygons, salt faces with clay –salt blossoms, salt polygons and black salt faces, salt polygons with salt blossoms (Figure 5) and salt faces (Figure 6).

There are three distinct parts from margin to center of playa.

1- Clay flat: this part is formed by clay, silt and a little salt. Margin of this part is frequently dry and show a puffy ground. This part is about 37.5% of the salt plain (Figure 7).

2- Wet zone: in this part moreover Sodium chloride, gypsum and other salts are present. This part has more salt than the previous part. The extension of this area changes during year and depend on precipitation. This part is about 18.6% of the salt plain.

3-Salt crust: this part has perfectly white colour because salt crust is thick here. This part has lowest elevation and therefore ground water surface is high in this part. Due to evaporation and capillary pressure salt coming up to surface and forms salt crust. This area is about 17.45% of the salt plain.



**Figure 2: Plough surfaces in north west margin of Sahl Abad**



**Figure 4: Clay-salt polygons**



Figure 5: Polygons with salt blossoms



Figure 6: Salt faces with a thick layer of salt that is formed in high evaporation of brackish waters

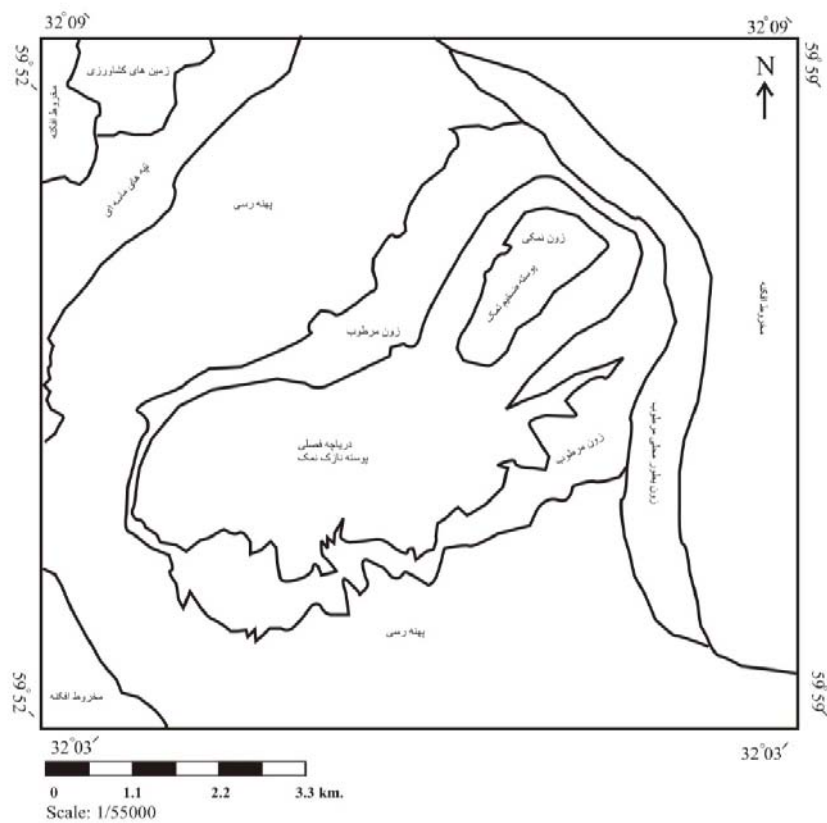


Figure 7: Sahl Abad Geomorphologic zones that is prepared with aerial photos

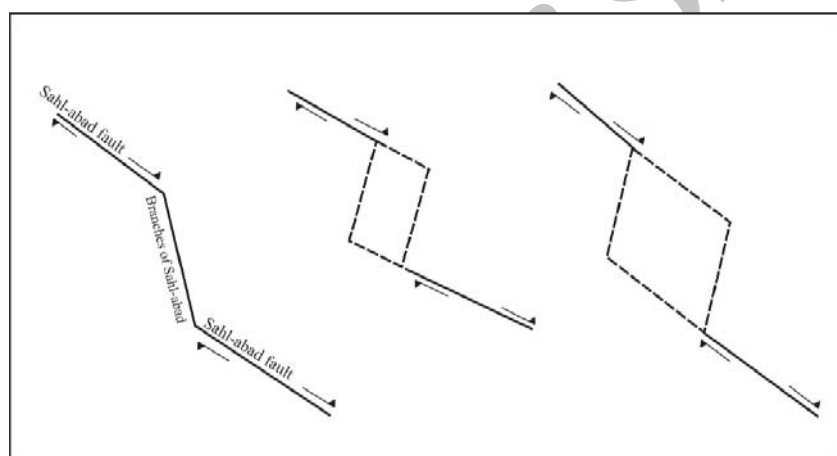
Structural elements in the study area shows Sahl Abad playa is surrounded by strike slip faults and activity of these faults has effected on formation of salt plain. Mann et al., 1983 believes that strike slip faults are seldom straight and will be bent or split. They probably are connected together or far away from each other. Such transform faults will lead to formation of ellipsoid or spherical basins.

Strike slip basins have been discussed (Balance, 1980; Crowell, 1976; Mann & Burke, 1982; Burke et al., 1982).

Pull-apart term was introduced by Burchfiel and Stewart (1960) for the first time and then applied for about 60 quaternary basins that are formed along strike slip faults (Aydin and Nur, 1982).

Enechelan faults normally produced a regional movement. This might lead to formation of extensional and compression zones. Where there is an extension, sedimentary basins are formed and where there is compression, high lands are formed and will be under erosion. These materials will fill the formed basins. Shape of these basins is related to faults patterns. Pull-apart term has been introduced for all strike slip basins.

Based on the above explanations, structural geology of study area, strike slip faults with thick terrigenous sediments in their margins, shape of basin and faulted margin, a Pull-apart basin is suggested for Sahl Abad playa (Figures 1 and 8).



**Figure 8: A development model of Pull-apart basin formation**

In addition to the above factors, river sinuosity increases with slope decrease that sinuosity changes could be related to tectonic activities. Therefore with increase of slope, channel morphology will change to distributed channels shape and this could confirm tectonic rising of the area.

Based on definition, channel sinuosity is channel length to down valley length (Adams *et al.*, 1999.)

$$S = V/C$$

V= length of channel

C= straight length of channels along valley

For investigation of this morphometric index in sahl Abad playa, 33 channels have been selected (Figure 9) and their sinuosity have been calculated (Table 1). The results could be interpreted as tectonic activity of the study area and uprising of the margins of Sahl Abad playa and depression in center.

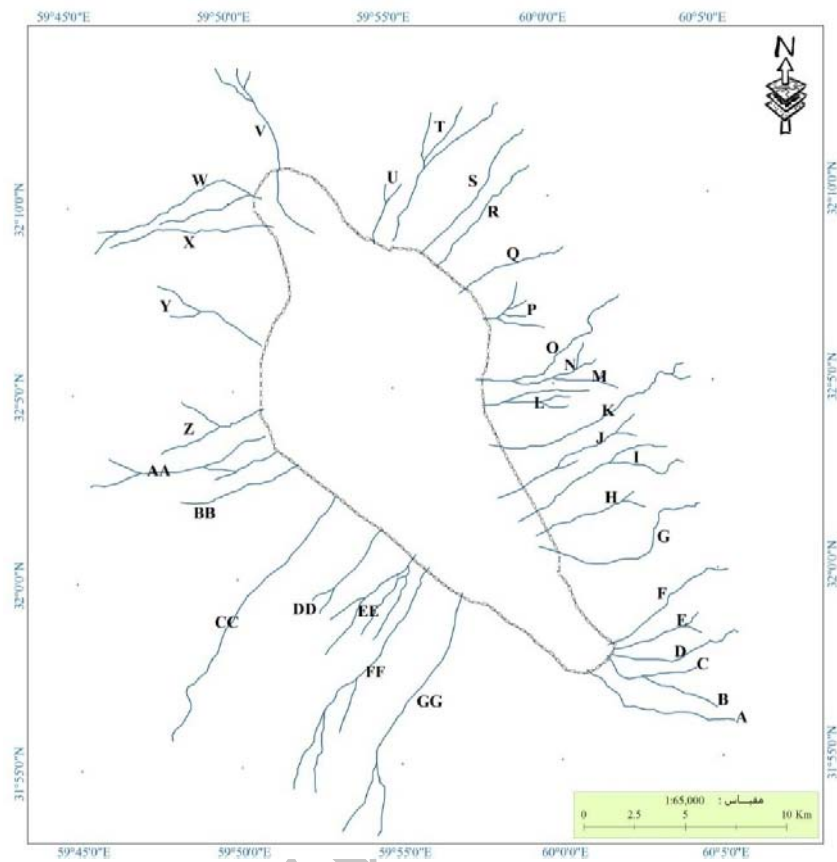


Figure 9: channels position for sinuosity

Table 1: Calculated channel sinuosity in study area

Calculated sinuosity	Channel	Calculated sinuosity	Channel	Calculated sinuosity	Channel
1.14	Y	1.03	X	1.1	A
1.07	Z	1.06	M	1.09	B
1.09	AA	1.11	N	1.05	C
1.08	BB	1.07	O	1.03	D
1.11	CC	1.05	P	1.09	E
1.04	DD	1.03	Q	1.02	F
1.08	EE	1.09	R	1.06	G
1.08	FF	1.06	S	1.05	H
1.12	GG	1.05	T	1.1	I
Position of channels are plotted in figure 13.		1.07	U	1.09	J
		1.09	V	1.06	K
		1.02	W	1.11	L

### Conclusion

Two types of clay and salt plains have been identified in Sahl Abad playa. In Mud flats types, four faces including puffy and soft faces, plough surfaces clay plain, Nebka and clay-slat polygons and in Salt plain type five faces including clay polygons, salt faces with clay –salt blossoms, salt polygons and black salt faces, salt polygons with salt blossoms and salt faces have been recognized.

Based on structural setting, strike slip faults and thick clastic sediments beside the faults, shape of basin and faulted margins can probably suggest that Sahl Abad is a Pull-apart basin. Generation of this basin is interpreted due to strike slip fault actions (operation) that are branched from Nehbandan fault. However, it could be mentioned that this basin is in young stage and there is no volcanic action.

Based on Sahl Abad active fault and morpho-tectonic interpretation it is suggested that the basin is in extension state. Calculation of channel sinuosity also confirmed an active tectonic in the area and it is expected that Sahl Abad plain is going to be bigger.

Further studies on Sahl Abad area are suggested and it is hoped that the result of this study could be used in natural geography, water management, flood control and mineral resources.

**Acknowledgment:** This research has been supported by the University of Birjand (Research affairs). We thank M. Bardeh (previous student of Geology Dept. of Birjand University) and Mr. E. Yazadan panah (PhD student of geology Dept. of Birjand University) for their help in field and lab works.

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